Depositional Environments of Ophiolite related Sedimentary Rocks Exposed on the Myitsone Area, Myitkyina Township

Mya Mya Win[1], Wai Min Oo[2] and Thu Zar Htay[3]

Abstract

The research area is situated about 28 miles from north of Myitkyina Township. It a well-known area of the conjunction point of Hmi Hka and Mali Hka Rivers. At the Myitsone area, the red chert, the green chert and the greywacke are situated in sequential order, toward the west. Greywacke is dark grey to greenish grey, well bedded, fine to medium-grained, interbedded with chert bands in some places. Many greywacke were deposited by turbidity currents in basin. Chert is crowded with radiolarian clast which appears as circular or elliptical clear area. Radiolarian rich bedded cherts are interpreted as very-deep water origin, below the carbonate compensation depth (CCD). A variety of rock types comprise the pelagic facies with stratigraphically condensed limestone occurring upon submarine. The research area is recorded three exposures of limestone units. Thin to medium- bedded, bluish-grey to dark-grey, shelly limestone of lower part and thick-bedded to massive, bluish-grey, fossiliferous, calcitic limestone in the upper part are found near Tang hpre village. The second exposure on the eastern side of Hmi Hka river bank contain medium to thick-bedded, bluish-grey to grey, fossiliferous limestone. The third one is at Chinghkran Chaung consist of thin to medium-bedded, bluish-grey to grey, limestone unit interbedded with medium-bedded, chert unit. Petrographically, this limestone unit of five microfacies of Microbioclastic Peloidal Packstone, Calcimudstone with Bioclasts, Intraclastic Pelloidal Packstone, Orbitolina rich Packstone and Fossiliferous pelletal Packstone can be recognized. Each microfacies represents two depositional environments as basinal submarine and slope environments. Stratigraphically and structurally, they are related to ophiolite suites.

Keywords: Greywacke, Chert, Orbitolina limestone

Introduction

The research area is situated about 28 miles from north of Myitkyina Township. It is a well-known area of the conjunction point of Hmi Hka and Mali Hka Rivers. The Myitson area lies in the Eastern Ophiolite Belt of Myanmar (Hutchison, 1975 and Hla Htay, 2006). It is situated along the western rim of Sino-Burma Ranges extending from, Sumprabum in the north, through Myitkyina area and Banmaw, Shwegu and Tagaung in the south. According to Hla Htay (2006), it is a full ophiolite sequence, where Inkhaingbum is the lower part of ophiolite suite and Myitson area is the upper part. Hla Htay (2006) established the rock units in this area are Ingyan-yan Metamorphic (Triassic?), Inkhaingbum Ultramafics and related Rocks (Jurassic?), Myitson Greywacke (Jurassic), Maykha limestone (Cretaceous), Ningdawkha Clastic (Paleocene to Eocene), Tonbun Conglomerate (Miocene to Pliocene), Donbu Melange Zone (Pleistocene) and Alluvium (Quaternary) (Fig. 1).

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Research Methodology

The study carried out for achieving the desired goals and objectives included two stages: field studies and laboratory studies.

I. Field Studies: First an investigation of the geological evidence was done together with a choice of the best exposures in the study area and twenty samples were taken basis on the facies and lithologic changes.

II. Laboratory Studies: Microscopic thin sections were prepared and studied with a polarized microscope for the petrographic analysis. The paleo-depositional environments were interpreted by using Reading, (1981), Reineck & Singh (1980), and named by Raymond (1995). Microfacies studies include the analysis of matrix and grains, textural features, fossil content, petrographic and energy index classification and standard microfacies zone by using Dunham, 1962 and Wilson, 1957. Correlation and interpretation criteria, along with depositional model, were determined from thin sections.

Finding & Results

At the Myitsone area, the red chert, the green chert and the greywacke are situated in sequential order, toward the west. A variety of rock types comprise the pelagic facies with stratigraphically condensed limestone occurring upon submarine. Five microfacies of Microbioclastic Peloidal Packstone, Calcimudstone with Bioclasts, Intraclastic Pelloidal Packstone, Orbitolina rich Packstone and Fossiliferous pelletal Packstone can be recognized. Each microfacies represents two depositional environments as basinal submarine and slope environments. These Jurassic to Pleistocene deposits were deposited on outer-arc basin.

Stratigraphy and Structure

Greywacke in this area, also called Myitson greywacke (Hla Htay, 2006) is dark-grey to greenish-grey, medium-grained, medium to thick-bedded are interbedded with chert bands in some places (Fig. 2A). They are nearly NE-SW trending with dip amount 30-35. In the present area, the red chert, the green chert and the greywacke are situated in sequential order, towards the west. They are overlain by Orbitlina rich Createaceous limestone unit. The possible age of this unit is Jurassic. It can be correlated with Ngapyawdaw Chaung Formation with their similar lithology and fossil content.

The chert unit in the research area is well exposed along the east and west banks of the Ayeyarwady River, especially near the confluence of Hmi Hka and Mali Hka Rivers. They are red and green in color. At Myitson, red cherts are thin-bedded and locally show thick-bedded to massive. Red chert and chalcedonic quartz are interbedded at confluence of Hmi Hka and Mali Hka Rivers. Green cherts are easily observed at the eastern side of Ayeyarwady River.Locally, they are show green in weathered surface and red in fresh surface in some places. Both red and green cherts are hard, compact and occur as boulders, high cliff (Fig. 2B & C).

In the Myitson area, the limestone unit of Hmi Hka limestone (Hla Htay, 2006) is exposed at three localities. The first exposure on the eastern side of Hmi Hka River Bank contain medium to thick-bedded, light-grey to grey, fossiliferous limestone. The lower portion of this unit is thicker than the upper part. The upper part is highly jointed and soft. At this Hmi Hka exposure, they are dipping to the east (Fig. 2D & E).

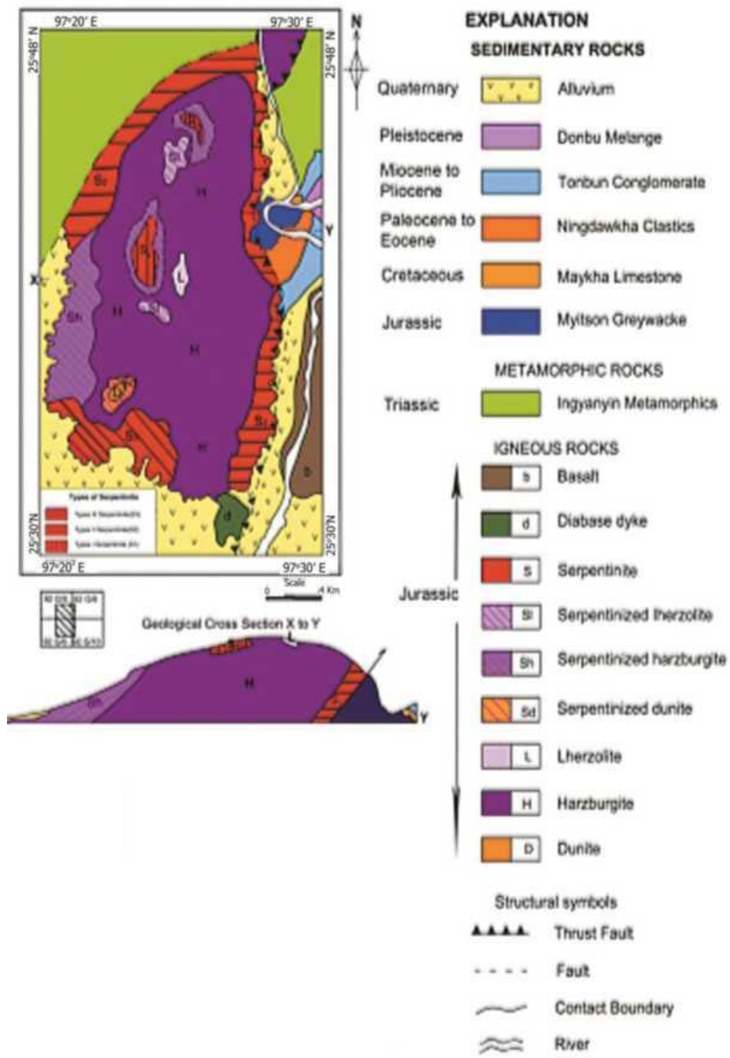

Figure (1). Geological map of the Inkhaingbum-Myitsonearea (after Hla Htay 2006).

The second exposure of thin to medium-bedded, bluish-grey to dark-grey, shaly limestone of lower part (Fig. 2F)and thick-bedded to massive, bluish-grey, fossiliferous, calcitic limestone in the upper part are found near Tanghpre village on the west bank of Ayeyarwady River. Bluish-grey unit is fossiliferous and calcitic veins are traversing the limestone unit. The common fossils are ammonite and gastropod (Fig. 3 A,B,C & D). This fossiliferous unit and shaly limestone units are interbedded at their transition zone. In the lowermost portion, the unfossiliferous buff color limestone beds are more shaly, soft and brittle. They are thinner than the upper limestone unit. Their general trend is nearly north-south with dip of about 25^s to 65^s toward east.

The third one is exposed at Chinghkran Chaung, consist of thin to medium-bedded, bluish-grey to grey, limestone unit interbedded with medium-bedded, chert unit. Orbitolina fossils are abundant in bluish-grey limestone unit and its age is designated as Cretaceous.

The young (Pleistocene) melange can be observed on both sides of Hmi Hka River and they are composed of several sizes of rock clasts of all rock units in the area (Fig. 3E).

Figure (2). Photographs showing outcrop exposures of (A) greenish-grey, medium to thick-bedded subfeldspathic- lithic greywacke; (B) red color, thin to massively bedded chert; (C) green color massive and highly deformed chert; (D) light-grey, thick-bedded calcimudstone (Upper part of Maykha Limestone); (E) medium to thick-bedded, light-grey to grey, Microbioclastic Peloidal Packstone (Lower part of Maykha Limestone); (F) thin to medium-bedded, bluish-grey to dark-grey, (Calcimudstone) shaly limestone of lower part.

Figure (3). Photographs showing outcrop exposures of (A,B) gastropods (C) ammonoids (Upper calcitic part of Maykha Limestone); (D) bluish-grey, medium to massively-bedded, Orbitolina rich packstone; (E) melange with their large clasts (serpentinite=sr).

PETROGRAPHY

The study area is composed of both siliciclastic and fossiliferous carbonate sediments.

Sandstones

The sandstone in the present area is subfeldspathic-lithic greywacke variety (Fig.4A). It contains poorly sorted, angular to subangular grains of quartz, feldspar, much lithic detritus, mica and little augite and hornblende. The rock is made up of 65% of framework grains and 35% of matrix.

Quartz grains are angular to subangular and poorly sorted. The size in range from 0.1 mm to 0.3 mm. Quartz consist half of the framework grains. Most quartz grains are clear and show sharp extinction. They may be igneous quartz. The boundaries of some quartz grains are crenulated and dark. They may be metamorphic in origin. Normal igneous quartz is the dominant. Vein quartz is less abundant and recrystallized and stretched metamorphic quartz are rare. Both plagioclase and K-feldspar are present, many are fresh and others are almost completely altered to kaolinite. It sizes are the same as quartz and some show twinning. It contains 5% of the total rock volume.

Rock fragments are made up about 12% of the rock. Most of the rock fragments are argillite and some are igneous or metamorphic rock fragments. The matrix is fine-grained quartz-chlorite-sericite matrix.

Environment: Many greywackes were deposited by turbidity current in basins of various types, usually off continental margins, in back-arc and fore-arc basins and association with volcanics (Tucker, 2001).

Chert

Microscopically, this chert is mainly composed of microcrystalline aggregates of chalcedonic silica (Fig.4B). Radiolarian clasts appear as circular or elliptical clear area. Most of the chert is turbid and reddened by hematite dusts. Preservation of radiolarian is poor and recrystallization obliterated their internal structure. The rock is commonly transverse by small veinlets of chalcedony and microcrystalline quartz.

Environment: Many ancient radiolarian rich bedded cherts are interpreted as very-deep water in origin, having been deposited below the carbonate compensation depth (CCD), at depths of several kilometers (Tucker, 2001).

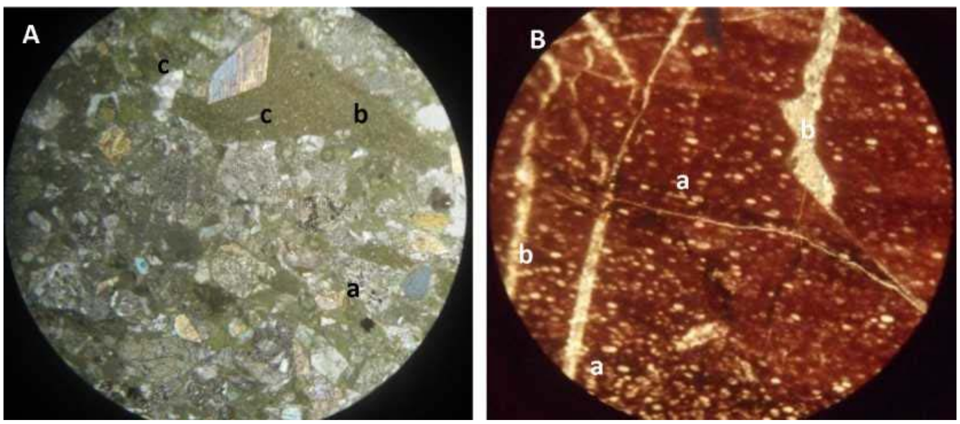

Figure (4). Photomicrographs showing (A) subfeldspathic-lithic greywacke showing olvine (a), quartz (b), rock fragment (c) and aug ite (d); (B)red chert with clear and elliptical shape radiolarian are embedded in the matrix (a) and quartz veins (b).

Melange

This unit is composed of several sizes of rock clasts, from small size about 15cm to large in size about 35cm are within the serpentinite matrix. They are exposed as massive boulders and crinkly texture is also observed. The rock clasts of melange are greywacke, phyllite, mafic-ultramafic rocks, serpentinite and limestone. Their thickness is about 1m to 7m. These are angular to subangular and poor sorted. The morphological features are rough on the surface just like as mega porphyritic texture. The entire rock units in this area are present as clasts in the melange. Therefore, it may be the latest and youngest sedimentary deposition along the Maykha River by neotectonic movement in the study area. They may be defined as tectonic melange (Hla Htay, 2006). The age is assigned as Pliocene to Pleistocene.

Carbonate sediments

Carbonate sediments occur in the upper portion of the rock sequence of the area. Petrographically, this limestone unit is recognized as five microfacies of Microbioclastic Peloidal Packstone, Calcimudstone with Bioclasts, Intraclastic Pelloidal Packstone, Fossiliferous pelletal Packstone and Orbitolina rich Packstone.

Microbioclastic Peloidal Packstone

Megascopically, bluish-grey to light-grey, thin to medium-bedded, fossiliferous Peloidal Packstone with calcite veins and silt patches.

Microscopically, it is mainly composed of bioclasts, micrite, pellets, sparry calcite and silt-size quartz grains. The organic components are bivalves, foraminifera, ostracods, sponge spicules and echinoderms. They are found in both longitudinal and transverse section. Both complete and fragmented bioclasts are embedded in micrite and showing randomly oriented. Mostly, the shell fragments are filled with sparry calcite cement but some are emplaced with blocky calcite. Bivalves are mostly thin-curved pelagic bivalve shells and they are randomly oriented within the micrite. Foraminiferas are mainly Orbitolina sp. and Globigerina sp. (Fig. 5A). They are very-small size and scattered in the matrix. Crinoids show arrowhead-shaped arm-plates.

The matrix is pale brown to brown micrite with scattered recrystallized patches of fairly coarse-grained calcite. Some shell fragments are filled with blocky calcite cement. Irregularshaped pellets and fine-grained quartz (silt-sized) is associated with the groundmass. Fractures in bioclasts and some deformed shell fragments are formed by the process of compaction. Pressure solution features are common within grains, at grain contacts and along stylolite surfaces. The margins of some bioclasts are dissolved and observed as corrosion. The solution zones of seams also termed microstylolite seam are entire with insoluble or grain matter such as pyrite, clay and other minerals occurring the dark appearance. Neospar in some bioclasts and veins are caused by neomorphism.

Environment: The rain of thin-shelled bivalves and planktonic foraminiferas (Orbitolina and Globigerana) in micrite matrix show a deep water, low-energy environment below wave base (Wilson, 1975). It can be correlated with Standard Microfacies SMF 2 and Facies Belt FB 1B of Wilson, 1975.

Calcimudstone with Bioclasts

Megascopically, it is light-grey, thin-bedded calcimudstone with some bioclasts. Microscopically, it is consisting of a homogeneous to weakly laminated groundmass of interlocking granules of micrite. In this groundmass are scattered very small (clay-size) grains of quartz, pellets and pelagic microfossils bivalves, *Orbitolina* sp.and *Globigerina* sp. are fragmented too small to be identified. Most of the pores are occluded by limemud matrix. Micrite enlargement doesn't occur in this limestone (Fig.5B).

Environment: The occurrence of some pelagic forms and fine detritus in thin-bedded argillaceous limestone may be indicated that deep water below wave base. It can be comparable to Standard Microfacies (SMF 3) and Facies Belt 3 of Wilson, 1975.

Intraclastic Peoloidal Packstone

Megascopically, it is medium to thick-bedded, whitish to light-grey Intraclastic peloidal packstone.

Microscopically, it is mainly composed of grains of peloids, intraclasts and micrite matrix. It is poor to moderate sorted, medium to coarse-grained peloidal packstone. Pellets consist of almost exclusively of dark cryptocrystalline calcite. Many peloids are subrounded, ovid and elongated in peripheral rim are in darker color. The rod-like to elongated shape peloids were made by burrowing organisms such as worms. The regular size of pellets would be fecal origin, or mechanical, in which case the micrite nodules have been broken up and romded to form pellets with a great range in size (Carss and Carozzi, 1965). Fecal pellets are produced by wherever worms and other grazing, burrowing, or swimming invertebrates to burial (Fig. 5C). The dark color of the grains or the peripheral rim is caused by the high content of organic matter (Flugel, 2010).

The intraclasts in this facies are fine to coarse-grained, angular, subrounded to rounded, carbonate clasts. Most of the grains within the clasts are composed with peloids, ooids and bioclasts. Some are mainly composed of mud clasts and various size and shape. Some black lithoclasts also found. The bioclasts are of echinoids, algae and poorly bivalves. The groundmass between the larger elements consists of micrite and scattered recrystallized patches of sparry calcite.

Environment: Coarse-grained, irregular shape and size of peloids may be reworked and current-transported lithic peloids. Lithic peloids reflect where the water energy is extensive enough to reworking (Flugel, 2010). An intraclast is a carbonate fragment of lithified or partly lithified sediment, derived from the erosion of nearby penecontemporaneous sediment from within the basin and redeposited within the same area. Intraclasts can form in many environments, but most typically are produced in setting with intermittently high energy conditions (Scholle & Ulmer Scholle, 2003). These allochthonous material may be emplaced by turbidity flows, by mass movements of debris, or even by volcanic eruption in deep water facies (Wilson, 1975). This facies may correspond to Standard Microfacies SMF 2 and Facies Belt FB 1 of Wilson, 1975.

Fossiliferous Pelletal Packstone

Megascopically, thin to medium-bedded, light-grey, fossiliferous and shelly packstone.

Microscopically, it contains peloids, bioclasts, intraclasts and micrite cement. Peloids are poorly sorted, irregular or elongated in shape, having a maximum size of 0.6mm. In some places, pellets are replaced by sparry calcite (neospar). The skeletal grains are mainly echinoderms with other shell fragments. The echinoderm plates are subangular and some are filled with sparry calcite. Intraclasts are the second most abundance components and mainly composed with micrite and vary in size and shape (Fig.5D).

The interstitial material consists of clear calcite with increasing grain size away from the boundaries of pellets indicating cavity filling. There is also well oriented, clear calcite around the borders of some of the larger pelletoidal elements.

Environment: The accumulation of crinoid plates, intraclasts and peloids indicate transport activity and may be allochthonous. Allochthonous accumulations often are debris flows or turbidites (Flugel, 2010). This facies may be deposited in neritic shelf deposits. It can be correlated with SMF 9 and FB2 of Wilson, 1975.

Orbitolina rich Packstone

Megascopically, it is medium to thick-bedded, bluish-grey, wackestone-packstone. Calcite veins are common. Gastropods and ammonoids are present.

Microscopically, it is mainly composed of bioclasts, lithoclasts, peloids with sparry calcite cement. The bioclasts are mainly benthic foraminifera (*Orbitolina* sp.). They are found as longitudinal, oblique and transverse section. Both complete and fragmented bioclasts are embedded in sparry calcite cement. They showing randomly oriented. Some bioclasts were completely obliterated by neospars. The outer margin of the shell retained as a ghost outline. Most of the echinoderms and crinoids plate are subangular to subrounded in shape. They are filled with single calcite crystal but some are filled with sparry calcite. Most of the fossils fragments, such as algae and echinoderm plates ae encrusted by the boring organisms and forming micrite envelopes along the boundaries (Fig. 5E & F).

Stylolization or non-fabric selective pressure solution that cross cuts all grains types and cements. They beautifully observed as darken or reddish brown by insoluble residue possibly hematite.

Environment: The constituents of this microfacies include benthic foraminifera *(Orbitolina* sp.) and small amount of echinoderm fragments, peloids and intraclasts indicate carbonate slumping from platform distal part and deposition in the deep marine environment (Hallajian, 2012). This coarser bioclastic-lithoclastic packstone of this facies formed at the toe of slope of a carbonate-producing shelf (Wilson, 1975). It belongs to standard microfacied SMF 4 and FB 3 of Wilson, 1975.

Tectonic Setting and Depositional Environments

The study area lies in the western margin of the Eastern Highland and it is also a northern continuatation of the Tagaung-Myitkyina Belt of Upper Ayeyarwady Province of Mitchell et al., (1979). The area is one segment of Ophiolite suite in Myanmar. The marine sediments in this area are associated with this ophiolite suite (Fig.6). This unit contains greywacke, red and green chert, Orbitolina rich limestone and melange.

According to the rock succession of the study area, the mafic and ultramafic also known ancient oceanic crust and upper mantle with metamorphic rock units are overlain by pelagic deep marine sediments and continent derived turbidites.

On the sedimentological evidence the succession apparently young towards the magmatic arc (Reading, 1981). The youngest Cretaceous Orbitolina limestone and melange are observed in the east and northeast of the area. Therefore, the magmatic arc may be found in the east and northeast of the area.

The stratigraphic and petrographic data presented and used to synthesis the paleoenvironmental construction of the area during Upper Jurassic to Pleistocene time. These tectonized marine sediments were developed as outer-arc basin. During Late Jurassic time, Myitsone greywacke and the green and red chert were deposited in the outer-arc basin. At the Cretaceous time, the pelagic Maykha limestone was successively deposited on the lower units. It is interpreted to be open marine facies belt in a rimmed shelf carbonate platform (Fig.7). These facies consisted of shallow and deep marine microfacies associations. Shallow marine facies associations contain Orbitolina rich packstone, bioclastic peloidal packstone and lithoclastic peloidal packstone. Deep marine facies association composed of microbioclastic peloidal packstone and calcimudstone.

This Upper Jurassic to Cretaceous sequence rest unconformably on metamorphic and igneous rocks and previous workers considered it to be thrust westward.

The melange lies unconformably on outer-arc rocks and include blocks of ultramafic and mafic and volcanic rocks. The clasts underwent two or more erosion-deposition cycles before they were eventually incorporated into Upper Tertiary melange with this Upper Jurassic to Cretaceous marine sedimentation in the area came to the end.

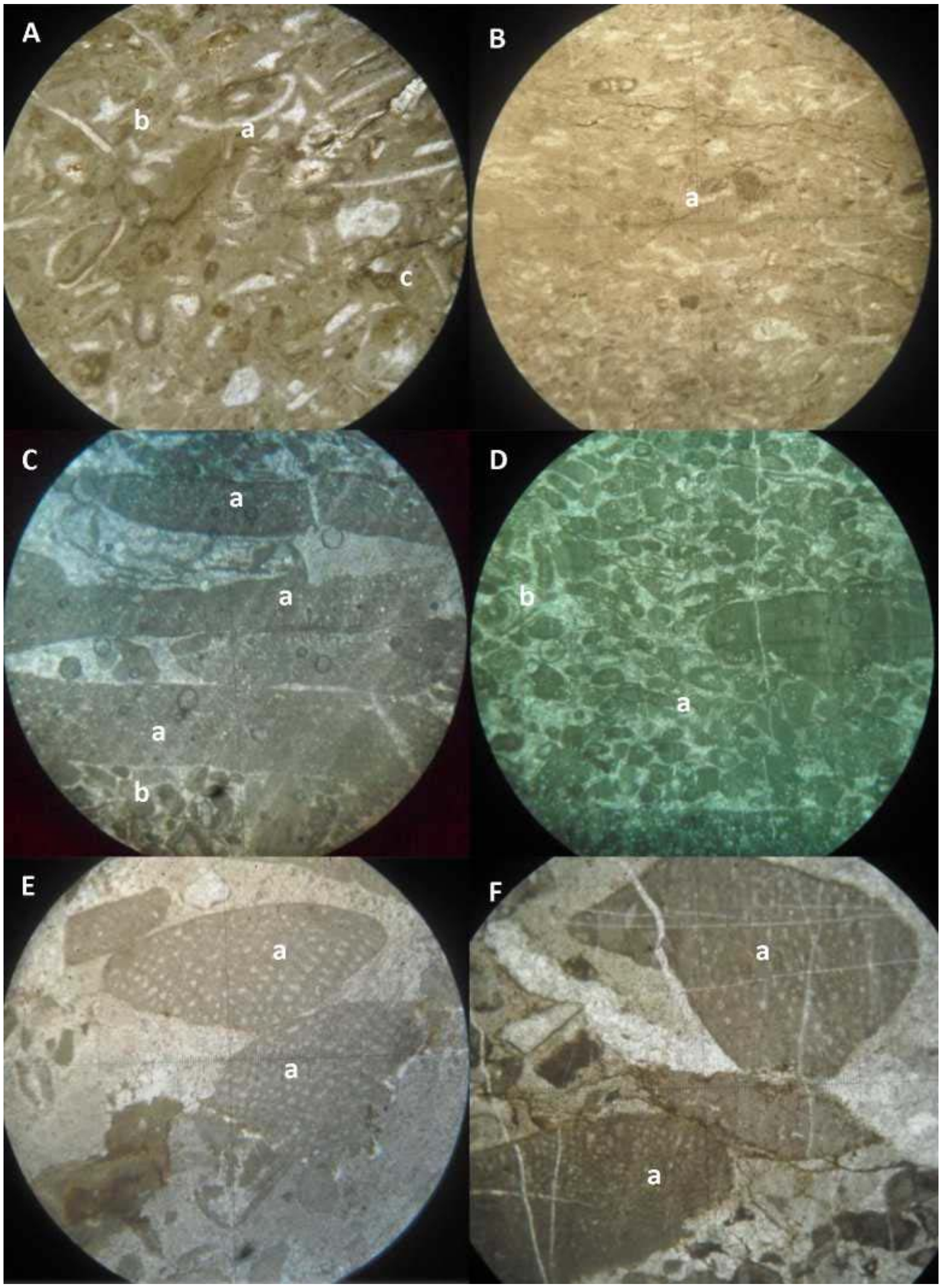

Figure (5). Photomicrographs showing (A) microbioclastic peloidal packstone with bivalves (a) Globigerina sp. (b) and Orbitolina sp. (c); (B) calcimudstone with bioclasts contain (a) Globigerina sp. (a); (C) intraclastic peloidal packstone with intraclasts (a) and pellets (b); (D) Fossiliferous pelletal packstone with pellets (a) and bioclasts (b); (E, F) Orbitolina rich packstone with Orbitolina sp. (a).

Figure (6). Photograph cross section from Himalayas to North - Eastern Burma including the study area (Reading, 1981).

Figure (7). Photograph showing depositional model of the oceanic rock units in the studied

Conclusions

The ophiolite related rock units in the research area are composed of Myitson Greywacke (Jurassic), Maykha limestone (Cretaceous), Donbu Melange Zone (Pleistocene). In the Maykha limestoe, five microfacies were recognized from open marine facies belt in a rimmed shelf carbonate platform. They are as follows: Shallow marine facies associations contain Orbitolina rich packstone, bioclastic peloidal packstone and lithoclastic peloidal packstone. Deep marine facies association composed of microbioclastic peloidal packstone and calcimudstone. The present study indicates that the Jurassic to Pleistocene deposits were deposited on outer-arc basin and apparently young towards the magmatic arc. The younggestmelange lies unconformably on outer-arc rocks.

Acknowledgements

I would to thanks to Dr. Hla Htay, Rector (Retired), Dagon University for his helpful comments and suggestions for improvements of the present research work. I also acknowledge to Ko Aung Phyo Hteik, Maung Lar Zu Tar and Maung Thein Win Htun for their helps, valuable suggestions and opinions in our field works.

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