CHAPTER 3

PETROGRAPHY

One hundred fifty-six thin sections of the carbonate rocks collected from the Chiang Dao area were studied using a polarizing microscope. These thin sections were stained with both Alizarin Red S and potassium ferricyanide by the method of Bouma (1969). Alizarin Red S aids in distinguishing calcite from dolomite and potassium ferricyanide distinguishes carbonate minerals containing ferroan minerals from those with little or no ferroan minerals. The combine solution causes a pink to red-brown color in non-ferroan calcite, mauve to blue in ferroan calcite, no stain in non-ferroan dolomite, and very pale blue or green in ferroan dolomite (Adams and Mackenzie, 1998).

Folk's (1962) classification was used to describe the composition and texture of the carbonate rocks. Wilson's (1975) and Flügel's (1982) microfacies and facies zone classifications were used to interpret the depositional and ecological conditions of the limestone samples. Detailed descriptions and figures of each thin section are in the appendix. Eight microfacies were recognized as a result of this study. These are: oosparite, pelsparite, cortoidsparite, oncoidsparite, biomicrite, biosparite, intrasparite, and other microfacies.

3.1 Oosparite microfacies

The oosparite microfacies is an important group of carbonate rocks in this study. There are two groups of ooids. One has a carbonate mud nucleus and the other has a foraminifera nucleus. However, the cortices of both groups have mainly a radial structure.

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Description

This microfacies has 60 percent allochems and 40 percent sparite. Porosity is nil. The allochems are made up of 40 percent ooids, 10 percent peloids, 5 percent

intraclasts, and 5 percent bioclasts. The ooids are in sparry cement and most have a carbonate mud nucleus. However, some ooids have a foraminifera nucleus. No nuclei are terrestrial grains. There are some occurrences of bimodal ooids (see appendix). The ooid size varies from 0.22 to 0.55 millimeter. Peloid size is 0.10 to 0.15 millimeter. Intraclast size is 0.42 to1.70 millimeter. Small foraminifera, echinoderm plates, shell fragments, brachiopod spines, and coral fragments make up the bioclasts. There are micrite envelops on some bioclasts (Figure 3.1).

Interpretation

This microfacies is the standard microfacies 15 of Wilson (1975) and Flügel (1982). The oolites are well-sorted, well-formed ooids with tangential microstructures. They are commonly 0.50 to 1.50 millimeters in diameter. The fabric is usually over-packed; always cross-bedded, and indicates a high-energy environment in oolite shoals, beaches, tidal bars, and tidal inlet environments.

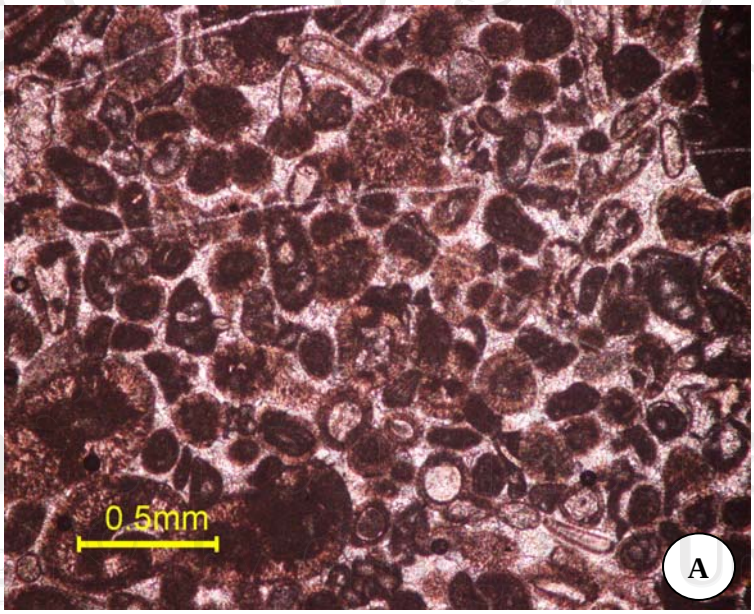

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Figure 3.1 A) Thin section of sample N 4/2 of the Khao Tham Pong section showing an oosparite microfacies. The ooid nuclei are carbonate mud. The cortex is a radial structure. The cement is sparite. The calcite veins have two generations.

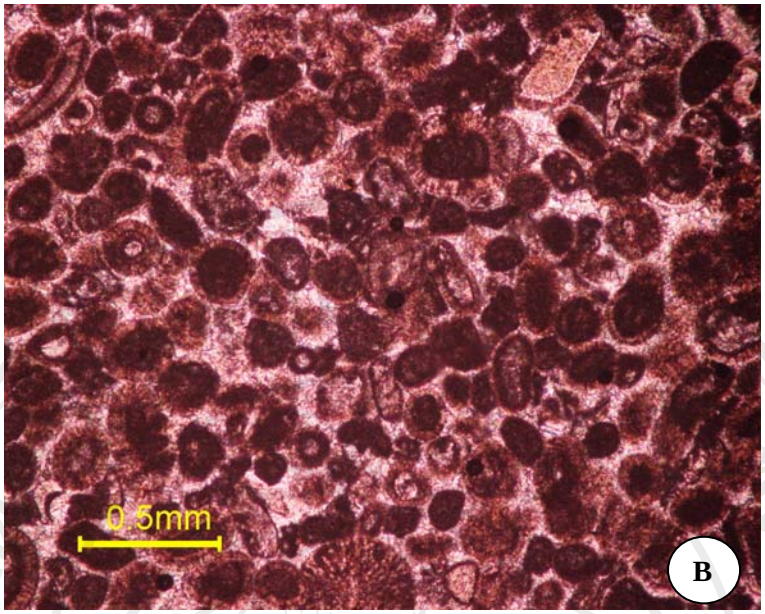

Figure 3.1 B) Stained thin section of sample N 4/1 of the Khao Tham Pong section showing the red color of non-ferroan calcite.

3.2 Pelsparite microfacies

Description

This microfacies has 55 percent allochems and 45 percent sparite. There is no porosity. The allochems are 40 percent peloids, 5 percent ooids, 5 percent intrclasts, 3 percent cortoids, and 2 percent bioclasts. The peloids are in sparry cement. Their grain size is 0.10 to 0.17 millimeter. Other grains are micrite ooids, intraclasts, and some cortoids. The bioclasts are calcispheres, small foraminiferas, burrow tubes, and ostracods (Figure 3.2).

Interpretation

The pelsparite microfacies is standard microfacies 16. The pellets are likely fecal pellets and, in places, are admixed with concentrated ostracod tests and foraminifera. This microfacies indicates very warm, shallow water and moderate water circulation. Deposition was probably in a lagoonal environment.

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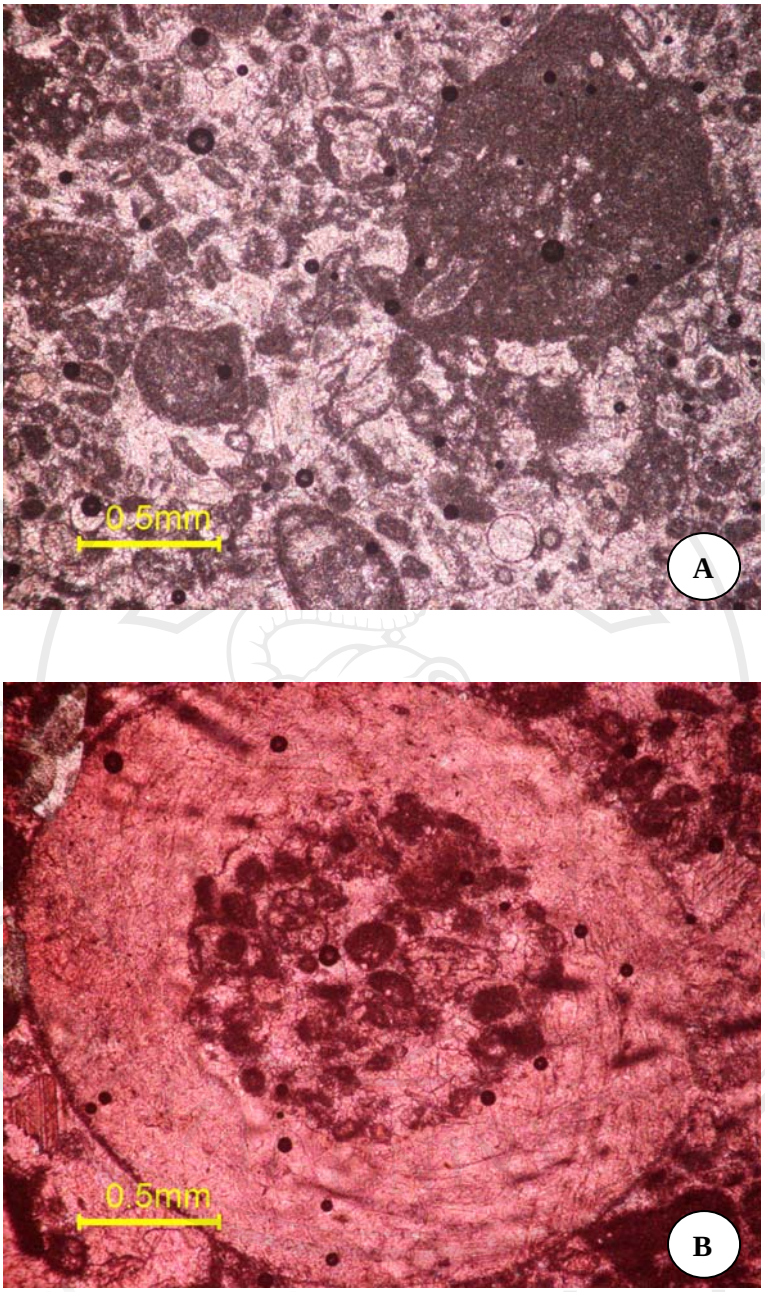

Figure 3.2 A) Thin section of sample E 4/15 of the Khao Tham Pong section showing pelsparite microfacies. Other grains are sub-rounded intraclasts. Ooid grains are rare. Cement is sparite.

B) Stained thin section of sample E 4/15 showing the red color of non-ferroan calcite. The burrow tube in the slide is a significant part of this microfacies; its diameter is 2.22 millimeters.

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3.3 Cortoidsparite microfacies

Cortoids are particles that have relatively thin micrite coatings. These coatings, or envelopes, appear black in transmitted light and white in direct light. They consist of calcite crystals 0.25 to 5.00 microns in size, but are usually about 2 microns (Flügel, 1982).

Description

The cortoid microfacies has 40 percent allochems and 60 percent sparite. Its porosity is nil. The allochems are 30 percent cortoids, 5 percemt peloids, 2 percent intraclasts, 2 percent cortoids, and 1 percent bioclasts. The cortoids range in size from 0.25 to 0.75 millimeter. Most are formed from shell fragments, though some from foraminiferas. Cement is sparite (Figure 3.3).

Interpretation

The cortoidsparite microfacies is standard microfacies 11. This facies develops as winnowed platform edge sand areas that have constant wave action at, or above, wave base of facies zone 6. In this study, it indicates a tidal bar environment.

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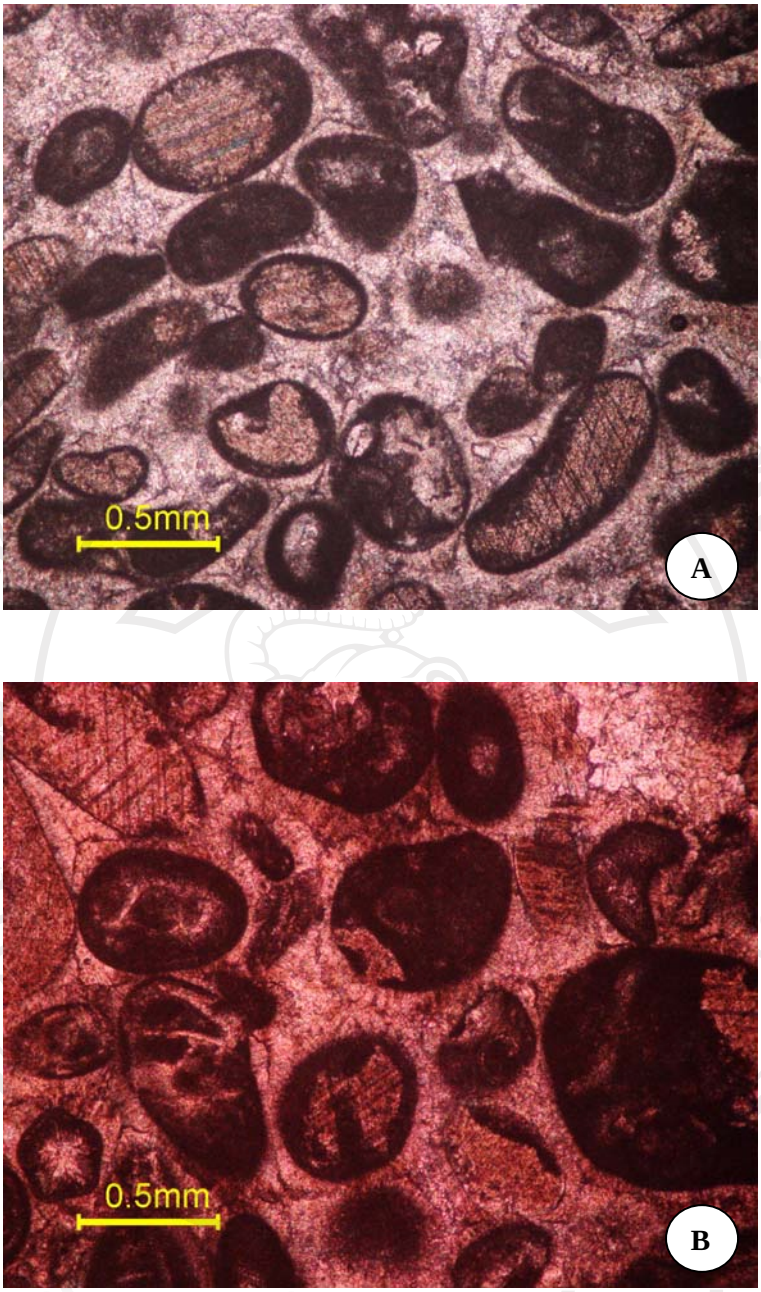

Figure 3.3 A) Thin section of sample E 3/12 of the Khao Tham Pong section showing a cortoidsparite microfacies. The diameters of cortoid grains are 0.10 to 2.00 millimeter. The cement is sparite.

B) Stained thin section of sample E 3/12 showing the red color of non-ferroan calcite.

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3.4 Oncoidsparite microfacies

Oncoids are coated grains that have a calcareous cortex of non-concentric, partially over-lapping laminae. The most common type of oncoid in the geological record is biogenically-coated grains. These may be formed by coatings of a variety of encrusting organisms, such as bryozoans, corals, foraminiferas, serpulids, and algae, especially the crustose coralline, or rhodophytes, and cyanobacteria, or blue-green algae (Tucker et al., 1994).

Description

Oncoidsparite has 50 percent allochems and 50 percent sparite. Porosity is nil. The allochems are 30 percent oncoids, 10 percent ooids, 5 percent cortoids, 3 percent intraclasts, and 2 percent bioclasts. The size of the oncoid grains is 1.25 to 3.37 miillimeter. The bioclasts are small foraminiferas, dasyclads, and bryazoan fragments (Figure 3.4).

Interpretation

The oncoidsparite microfacies is standard microfacies 13. It is an indicator of a moderately high-energy area in facies zone 6; shallow water. This microfacies is an intertidal environment deposit.

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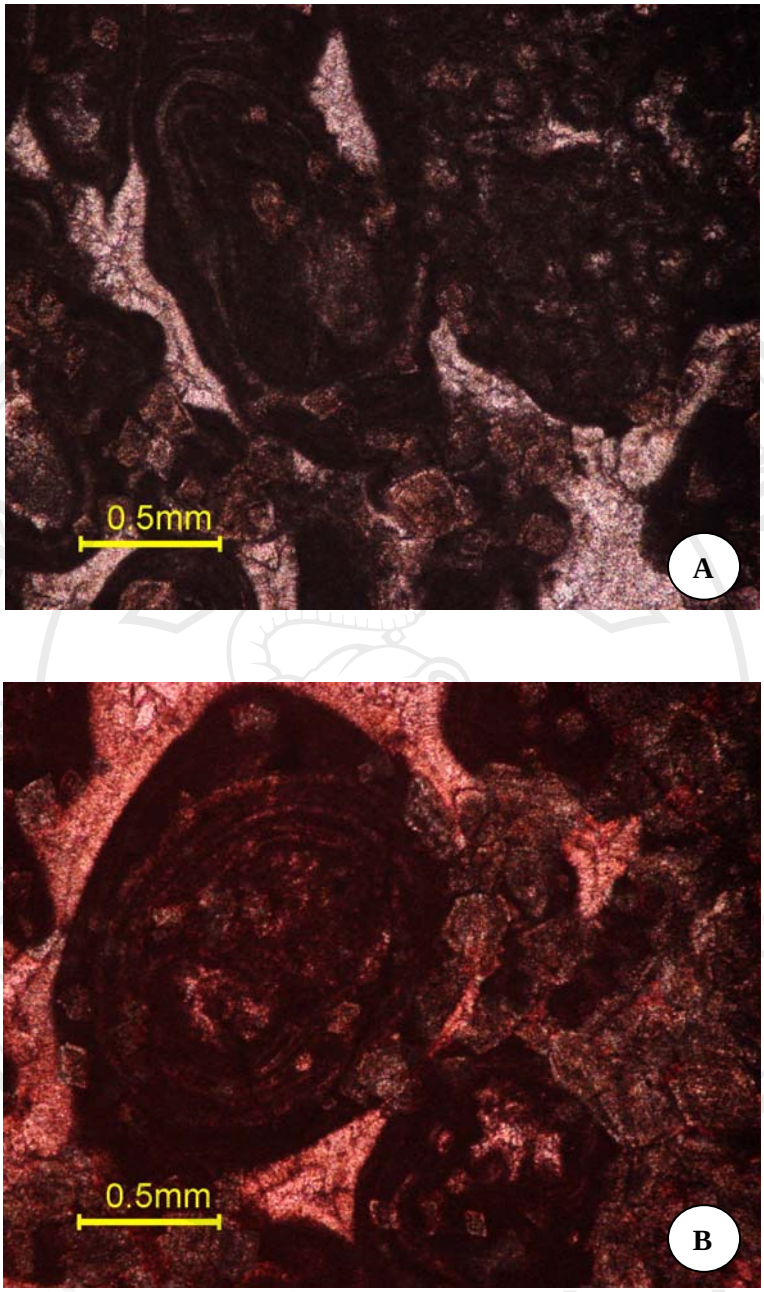

Figure 3.4 A) Thin section of sample CD 93.1/1 of the CD 93.1 section showing oncoidsparite microfacies. The diameters of oncoid grains are 1.25 to 3.37 millimeter. Cement is fibrous-rim sparry cement. Some euhedral to subhedral dolomite crystals are present.

B) Stained thin section of sample CD 93.1/1 showing the red color of non-ferroan calcite. Dolomite crystals are unstained, indicating they are non-ferroan dolomite.

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3.5 Biomicrite microfacies

Description

Biomicrite has 40 percent allochems and 60 percent micrite. Porosity is nil. The allochems are bioclasts and they are in a micrite matrix. These bioclasts are ostracods, phylloid green algae, dasycladaceans, hexaphyllia corals, echinoderm plates, brachiopods spines, small foraminiferas, and crinoid plates (Figure 3.5).

Interpretation

Biomicrite microfacies is standard microfacies 9. Its fragments of diverse organisms have been texturally homogenized through bioturbation. Bioclasts may even be micritized, this indicating shallow water deposition with open circulation at, or just below, wave base in facies zones 2 and 7. Depositional environment is subtidal.

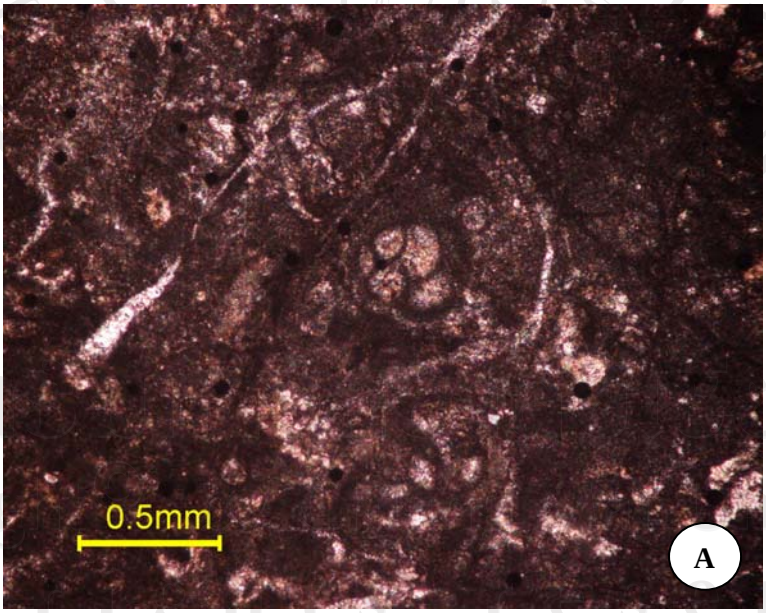

Figure 3.5 A) Biomicrite microfacies thin section of sample CD 4/13 of the CD 4 section. Bioclasts are debris of various organisms and the matrix is micrite.

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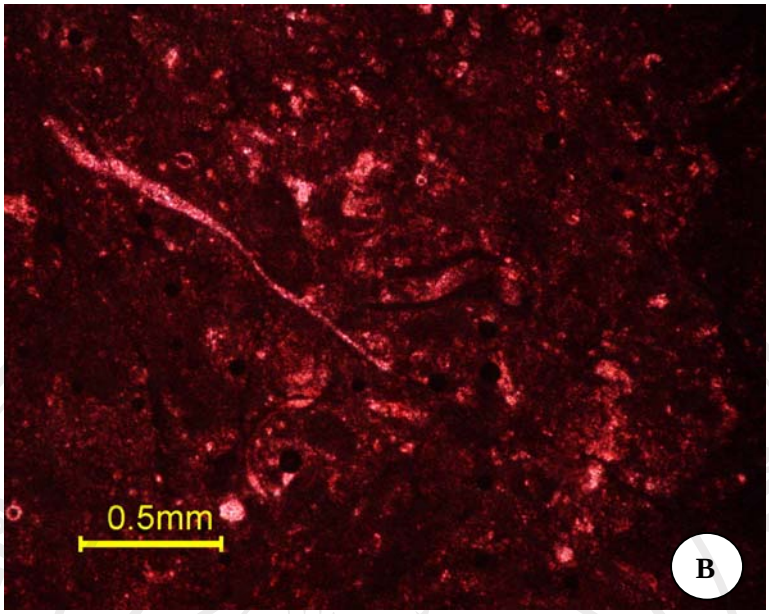

Figure 3.5 B) Stained thin section of sample CD 4/13 showing the red color of non-ferroan calcite.

3.6 Biosparite microfacies

Description

Biosparite microfacies has 40 percent allochems and 60 percent sparite. Porosity is nil. The allochems are 35 percent bioclasts and 5 percent intraclasts. The bioclasts are abundant dasyclad stems ranging in size from 0.32 to 3.00 millimeter. Some bioclasts are phylloid algae, ostracods, echinoderm plates, small foraminiferas, shell fragments, bryazoans, and intraclasts. This microfacies has sparry cement (Figure 3.6).

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Interpretation

This biosparite microfacies is standard microfacies 18. Dasyclads are calcareous green algae that thrive in shallow water of the photic zone. Here, these

skeletal grains are concentrated and indicate deposition in tidal bars and channels of lagoons of facies zones 7 and 8.

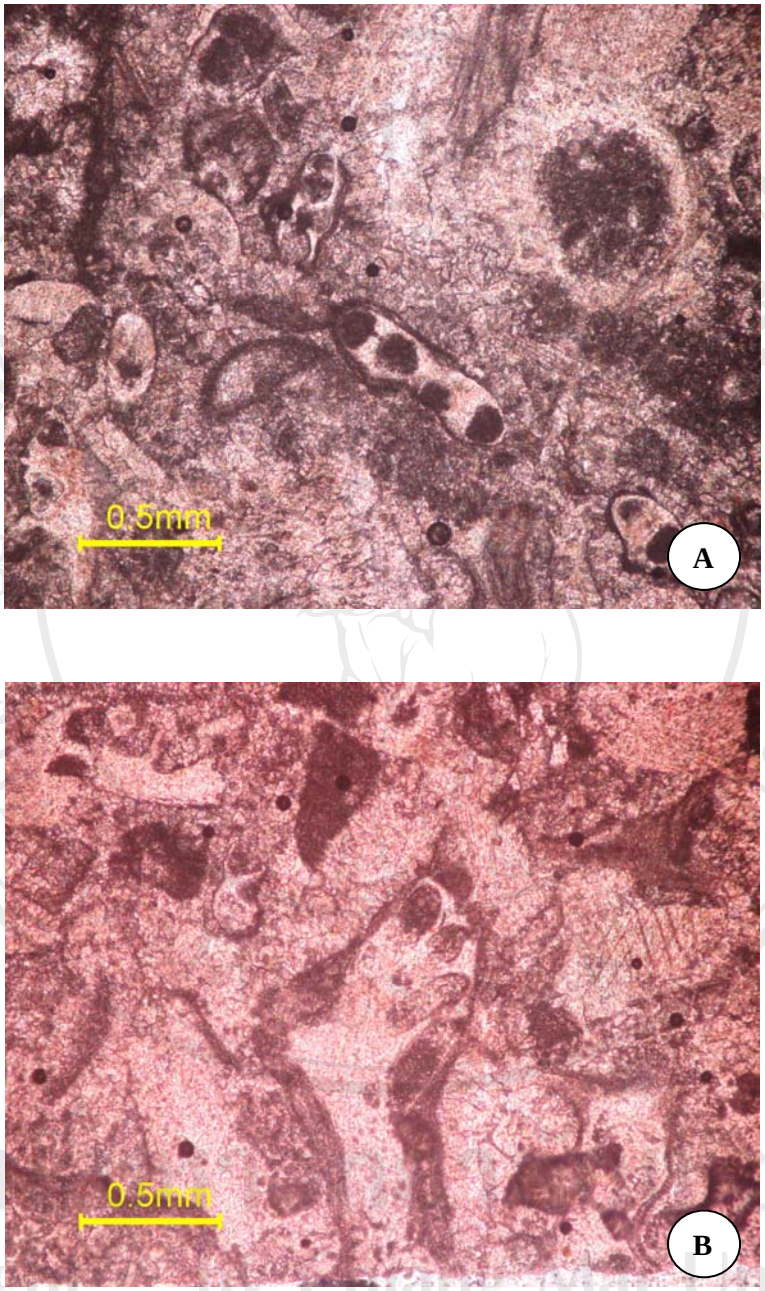

Figure 3.6 A) Thin section of sample CD 92/1 of section CD 92 showing biosparite microfacies.

B) Stained thin section of sample CD 92/1 showing the red color of non-ferroan calcite.

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3.7 Intrasparite microfacies

Intraclasts are reworked products of a substrate which has already been weakly consolidated within a depositional basin (Flügel, 1982). Reworking can take place by waves or currents that disturb the basin floor.

Two types of intraclasts are rather common in shallow water limestone (Flügel, 1982): angular calcarenitic intraclasts produced by the mechanical erosion of lithified beach rocks within the intertidal and supratidal zones and mud intraclasts formed by the dessication of supratidal, partly lithified and sometimes dolomitized, calcareous mudstone.

Description

Intrasparite has 50 percent allochems and 50 percent sparite. The allochems are 40 percent intraclasts, 5 percent peloids, and 5 percent bioclasts. The intraclast grains of this microfacies have a size of 0.32 to 3.50 millimeter. They are a mixture of micrite and bioclast fragments of ostracods, calcispheres, dasyclads, echinoderm plates, small gastropods, and peloids. Sparite is the cement (Figure 3.7).

Interpretation

This intrasparite microfacies is standard microfacies 17. This microfacies commonly is grapestone, or pelsparite that has aggregates of lumps and isolated and agglutinated peloids. There are also some coated particles. The facies indicates a shelf environment with restricted water circulation and tidal flats in facies zones 7 and 8. Depositional environment is a tidal flat.

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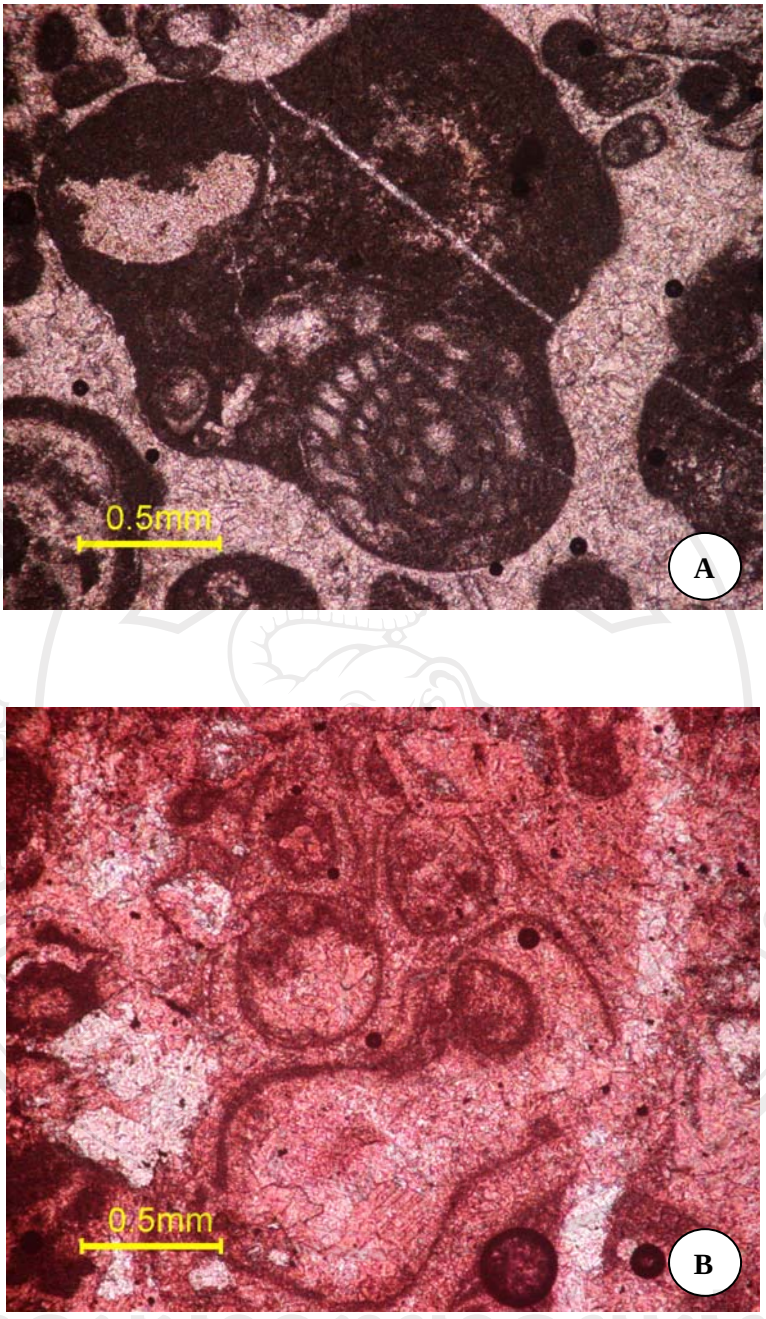

Figure 3.7 A) Thin section of sample N 4/10 of the Khao Tham Pong section showing intrasparite microfacies. The intraclasts are bioclast fragments in micrite. The bioclasts are small gastropods, small forams, and echinoderm plates.

B) Stained thin section of sample N 4/8 of the Khao Tham Pong section showing the red color of non-ferroan calcite.

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3.8 Other microfacies

In the study area, especially at the Khao Tham Pong quarry, carbonate rocks have been deformed by many folds and faults. These folds and faults have directly affected the diagenesis of the carbonate rocks. Diagenesis refers to all those processes that occur to sediments after deposition, during burial, and during subsequent uplift. Diagenesis turns sediments into sedimentary rocks. Sedimentary rocks that undergo deep burial or are involved in orogenesis, such that they experience high pressures and/or temperatures, will undergo metamorphism and no longer be classed as sedimentary rocks. There is no hard and fast boundary between diagenesis and metamorphism. As a guide, limestone, as it is buried, will retain a significant part of its primary features so that its depositional texture is still recognizable. However, limestone's metamorphosed equivalents will show little or no sign of the depositional fabric (Adams and Mackenzie, 1998).

3.8.1 Dolomite microfacies

Many carbonate rocks contain the mineral dolomite, $CaMg(CO_3)_2$, and some are totally made of dolomite. Dolomite is largely a secondary replacement mineral, although it can also occur as cement. It can form at many different stages of diagenesis, from soon after deposition to later deep burial. It can also form from water of different compositions: from relatively dilute mixed marine and meteoric water to sea water to hypersaline water to burial brines (Adams and Mackenzie, 1998).

In this study, many thin sections show partial dolomitization. The sizes of dolomite crystals vary, depending on the particular components of the original sediment they replace. But total dolomitization is rare and occurs conformable with folds and faults in this area.

Rocks that are totally dolomitized, where no remnant calcite from the original limestone remains, are dolomite rocks. Some dolomite shows preservation of the

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original fabric of the rock, despite there being no remaining calcite. Such dolomite is sometimes known as mimicking or mimetic dolomite. The fabric of the original rock is usually preserved because the crystal size of the replacement dolomite mirrors that of the original rock or because of different inclusion densities in the dolomite crystals (Figure 3.8.1).

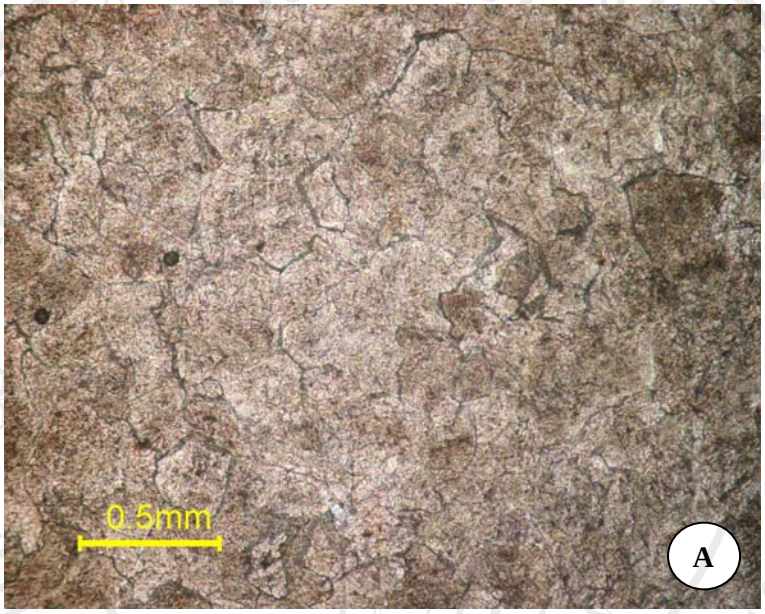

Figure 3.8.1 A) Thin section of sample E 3/7 of the Khao Tham Pong section showing dolomite microfacies. The coarsely crystalline dolomite has a fair proportion of straight boundaries. The fabric is planar subhedral.

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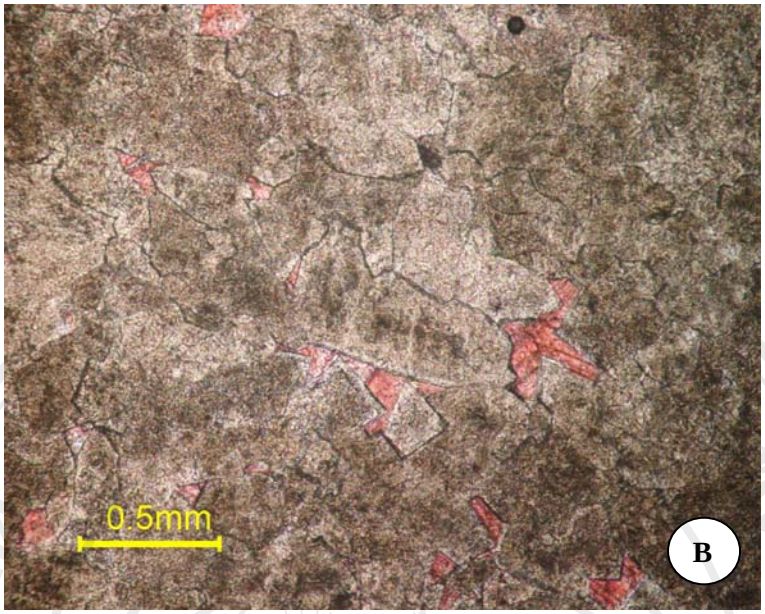

Figure 3.8.1 B) Stained thin section of sample E 3/6 of the Khao Tham Pong section showing the red color of non-ferroan calcite. Dolomite crystals are colorless, which indicates they are non-ferroan dolomite. The intercrystal pore space has been filled with post-dolomitization calcite cement.

3.8.2 Microspar microfacies

Distinguishing the products of aggrading neomorphism or recrystallsation of carbonate mud matrix and fine cements from products of direct cementation or from primary sediments is often difficult. Neomorphic fabrics usually comprise irregular crystal size with remnants of micritic sediment and the presence of carbonate grains floating in a spar matrix. The term microspar is used for neomorphic fabrics of 5- to 15-micrometer average crystal size. Pseudospar is used for neomorphic fabrics of average grain size more than 30 micrometers. The term micrite is used for all fabrics of crystal size less than 5 micrometers (Figure 3.8.2).

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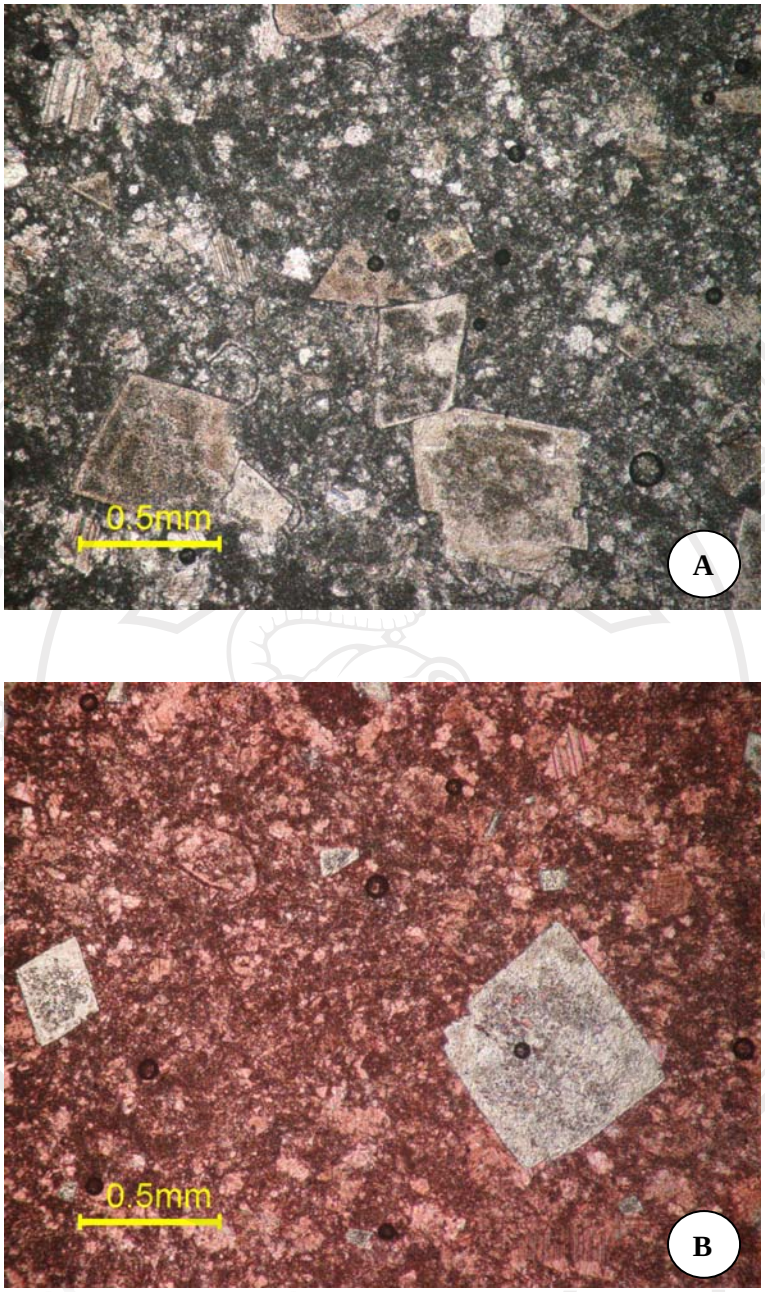

Figure 3.8.2 A) Thin section of sample E 3/8 of the Khao Tham Pong section showing microsparite microfacies. The carbonate grains were destroyed by deformation. The slide shows microspar, pseudospar, secondary micrite, and subhedral to euhedral dolomite crystals, the result of neomorphism.

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B) Stained thin section of sample E 3/8 showing the red color of non-ferroan calcite. Dolomite crystals are colorless, indicating non-ferroan dolomite.

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