

CHAPTER 4

SEDIMENTARY FACIES AND FACIES ASSOCIATIONS

4.1 Introduction

Sedimentary facies are distinctive rock or sediment that was formed under certain conditions of sedimentation, reflecting a particular process or environment (Reading, 1978). The facies has five defining parameters: lithology, geometry, sedimentary structure, paleontology and paleocurrent pattern (Selley, 1970). These properties can be established for each facies, and can be used to define facies in rock or sediment sequences. The facies may be subdivided into subfacies or group together into facies associations. Color of sediment is determined based on soil color chart (Munsell, 1905). Sedimentary facies were described in vertical sections and divided into sandy and fine fraction facies and subdivided fine fraction facies again based on characteristics of the sediment. In this study, the results of field observations and the laboratory analysis are used to define sedimentary facies of the exposed sedimentary stratigraphic units in the sand pit of Tambon Lakfah, Chaiyo District, Ang Thong Province.

4.2 Sedimentary facies classification

From the study in field and laboratory, all sediment strata in the sand pit can be described and classified into nine facies. They are Sp, Fsor, Fgrb, Fc, Fyb, Fgror, Frb, Fwf and Fbom facies.

4.2.1 Sp facies: slightly gravelly muddy sand, pale yellowish orange, planar cross bedding, burrow and Fe-oxide.

General description

Sediment in the Sp facies consists of sand, muddy sand, slightly gravelly muddy sand, slightly gravelly sand and gravelly muddy sand (Figure 4.1). The color of sediment in Sp facies is pale yellowish orange to grayish orange, dark reddish brown, light brown to moderate brown and shows dark brown and blackish brown (Figure 3.34). This facies is more than 3 meters thick and overlain by Fwf facies in this study (Figure 3.32). Grain size of sediments is medium to very coarse grain and few of gravel grain. They are poorly sorted, high sphericity and subangular to rounded. The sand consists of quartz, feldspar and muscovite. This sediment facies shows burrows which contained organic clay. The sand bed shows planar cross bedding structure (Figure 3.35). Sediments are grain supported and some clay matrix. Fe-oxide precipitated in sand that affected to sediment particles was aggregated to large form and hardness is increasing which can see as bedding (Figure 3.36). Clay socket is commonly found in lower part of this facies. Moreover, this facies has 5 to 10 centimeters of gray to greenish gray clay layer (Figure 3.37) interbedded with sand bed in the upper part, the middle part and the lower part. Small carbonate concretion and gypsum crystals are found in this facies but uncommon.

Grain size distribution

Grain size of the sand facies is bimodal (Figure 3.38). Sorting of the Sp facies is poor to very poor. Mean grain size is coarse sand. The skewness is positive. It is fine to very fine-skewed or skewed to very skewed towards the coarse side. Kurtosis is platykurtic to extremely leptokurtic or flat frequency distribution to very highly peaked and some sample shows mesokurtic. Sedimentary nomenclatures of the Sp facies are classified based on the Folk diagram, are sand, muddy sand, slightly gravelly muddy sand, slightly gravelly sand and gravelly muddy sand (Figure 4.1). The Sp facies are found in the layer F2, D3 and G5.

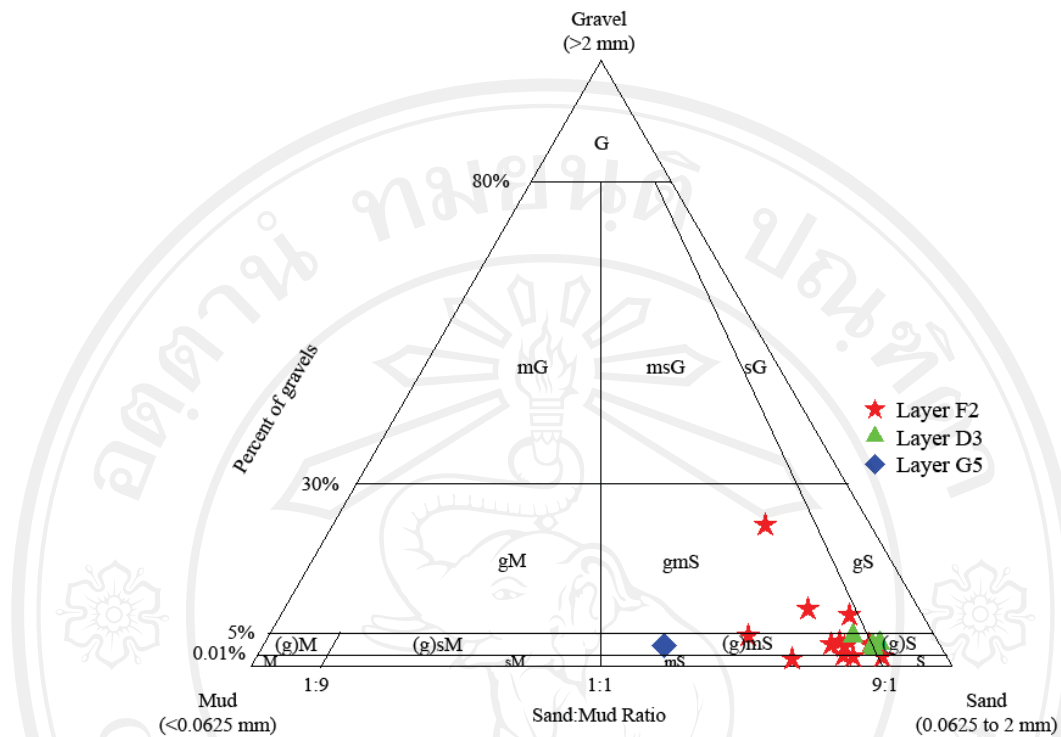


Figure 4.1 Sedimentary nomenclature of the Sp facies (the diagram modified from Folk, 1954).

4.2.2 F_{sr} facies: sandy mud, sand pocket, pale yellowish orange and root fragments.

General description

The F_{sr} facies consist of mud and sand fraction and show pale yellowish orange, light brown, pale reddish brown to dark reddish brown and light gray. Sand fraction in this facies is very fine sand to fine sand. Sand contents in sediment range from 15 % up to 50 %. Organic clay mottle, light brown clay mottle and root fragments can be found in this facies. Small gypsum crystal, Fe-oxide concretion (laterite?) found in layer A1. Shell fragment sample was collected from layer B3. Moreover, in the lower part of this facies show sand sockets. The sand are greenish

gray, clay matrix, fine to medium sand, moderately sorted, high sphericity, subrounded to rounded and compose quartz and feldspar.

Grain size distribution

Sorting of the F_{sr} facies is very poor. Mean grain size is very fine to medium silt. The skewness is negative and positive. Most samples are positively skewness. It is fine to very fine-skewed and coarse-skewed or skewed to very skewed towards the coarse side and skewed towards the fine side. Kurtosis is very platykurtic to platykurtic or flat to very flat peaked. Sedimentary nomenclatures of F_{sr} facies based on the Folk diagram are sandy mud, muddy sand and mud based (Figure 4.2). The F_{sr} facies are found in the layer A1, B2, B3 and A4 (Figure 3.4 and 3.43).

4.2.3 F_{grb} facies: sandy mud and sandy clay, pale reddish brown to dark reddish brown and small gypsum crystal.

General description

The F_{grb} facies consist of sandy mud and sandy clay. The color of this facies are light brown to moderate brown and pale reddish brown to dark reddish brown. The facies thickness range from 0.6 to 0.9 meter. Sediment shows moderate yellow and moderate reddish brown clay mottle and organic clay nodule. The dominant characteristic of this facies is a large amount of small gypsum crystals (Figure 3.65). This facies has sand content about 20 %. It is very fine to fine sand.

Grain size distribution

Sorting of the F_{grb} facies is very poor. Mean grain size is very fine silt. The skewness is negative. It is very coarse-skewed or very skewed towards the fine side. Kurtosis is platykurtic or flat frequency distribution. Sedimentary nomenclatures of the F_{grb} facies based on the Folk diagram are sandy clay and sandy mud (Figure 4.3). The F_{grb} facies are found in the layer E1 and layer D5.

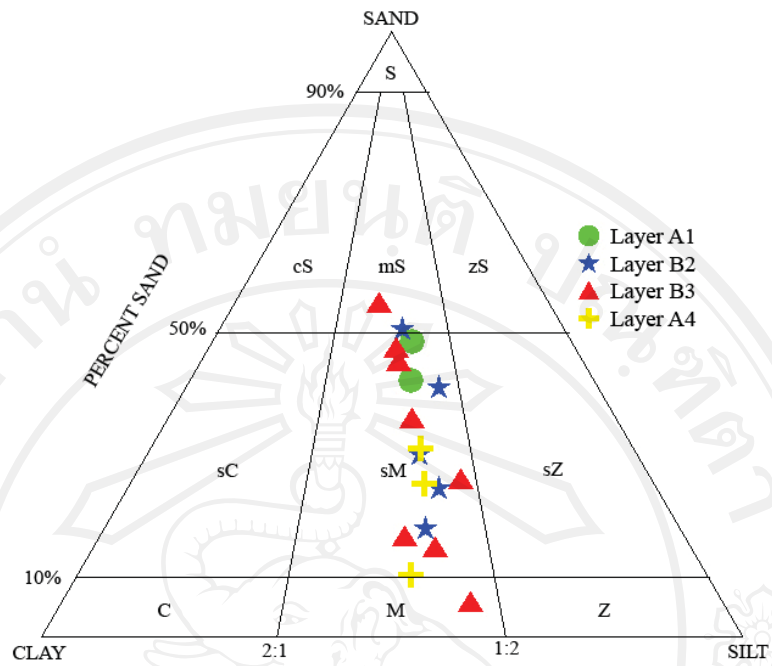


Figure 4.2 Sedimentary nomenclature of the F_{sr} facies (the diagram modified from Folk, 1954).

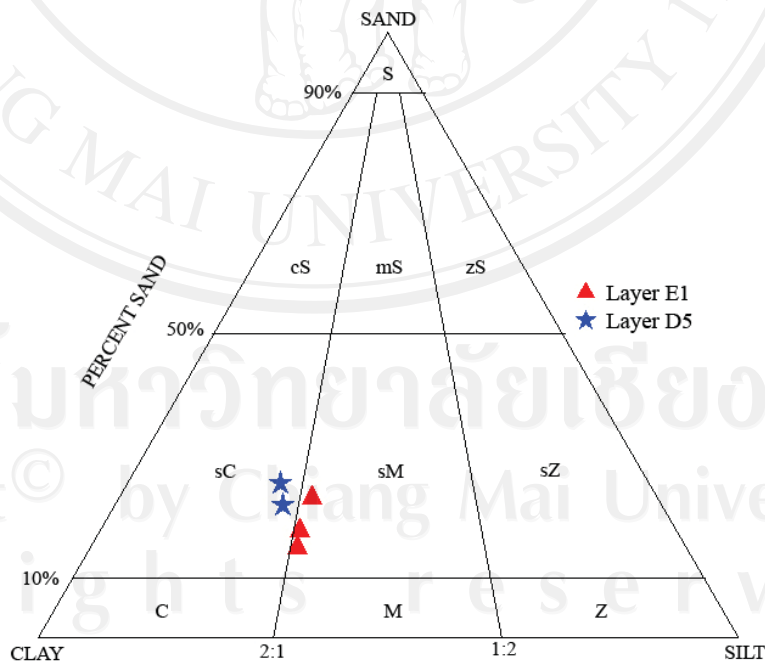


Figure 4.3 Sedimentary nomenclature of the F_{grb} facies (the diagram modified from Folk, 1954).

4.2.4 Fc facies: sandy clay and sandy mud, pale greenish yellow to yellowish gray, carbonate and Fe-concretion and gypsum crystal.

General description

The Fc facies consist of sandy clay and sandy mud. Sediment color of the Fc facies is vary in moderate to dark brown, pale greenish yellow to yellowish gray and light brown to moderate brown. The thickness of this facies range from 1.2 to 2.7 meters. Sediment show organic clay nodule and gray and moderate red clay. Sediment is calcareous. In the lower part of facies shows sand grade incursion into mud. Some sand sockets, can be observed (Figure 3.15). Carbonate concretion are common in this facies, which its grain size range from 2 millimeters up to 4 centimeters (Figure 3.16). The gypsum crystals (Figure 3.18) and Fe-oxide concretions can be found (Figure 3.17), which root or wood fragments is nucleus of the concretion. Moreover, some wood fragments can be found but rarely (Figure 3.19).

Grain size distribution

Sorting of the Fc facies is very poor. Mean grain size is fine silt. The skewness is negative. It is very coarse-skewed or very skewed towards the fine side. Kurtosis is platykurtic to very platykurtic or flat to very flat frequency distribution and ranges from 0.62 to 0.71. Sedimentary nomenclatures of the Fc facies based on the Folk diagram are sandy clay and sandy mud (Figure 4.4). The Fc facies are found in the layer G1 and layer F5 (Figure 3.70).

4.2.5 Fyb facies: clay, mud and sandy mud, yellowish brown, grayish orange, root fragments and shell fragments.

General description

The Fyb facies consist of clay, mud and sandy mud. The sediment color of this facies is grayish orange, light brown to moderate brown, pale reddish brown to dark reddish brown and pale yellowish brown. This facies range from 0.6 to 1.8

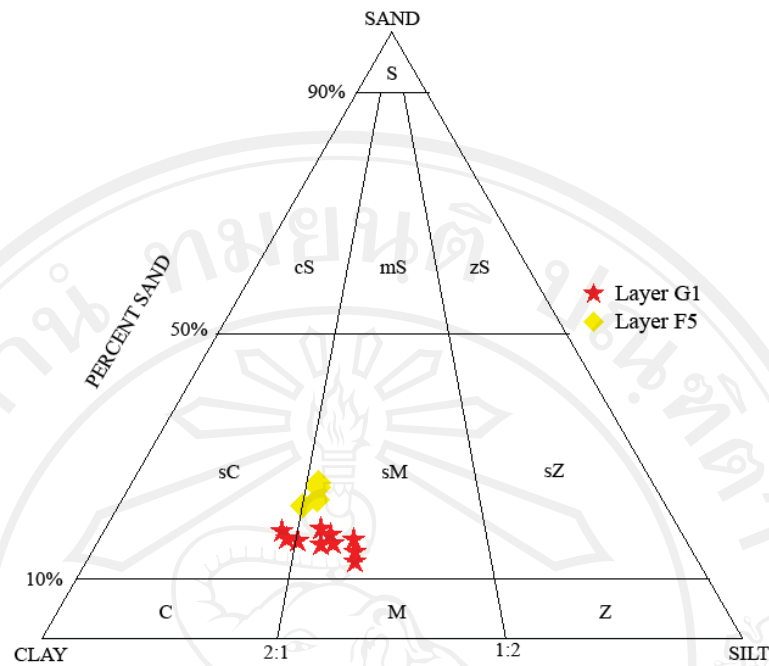


Figure 4.4 Sedimentary nomenclature of the Fc facies (the diagram modified from Folk, 1954).

meters thick. Sediment shows light to medium dark gray clay nodule. Fe-oxide and manganese concretions and shell fragments can be found. Root fragments and organic matter are found in this facies.

Grain size distribution

Sorting of the Fyb facies is poor. Mean grain size is very fine silt to clay. The skewness is negative, ranging from -0.61 to -0.22. It is coarse to very coarse-skewed or skewed to very skewed towards the fine side. Kurtosis is very platykurtic to mesokurtic or very flat frequency distribution to normal peaked. Sedimentary nomenclature of the Fyb facies based on the Folk diagram are sandy mud, mud and clay (Figure 4.5). The Fyb facies are found in the layer A3, A5, B4 and D2.

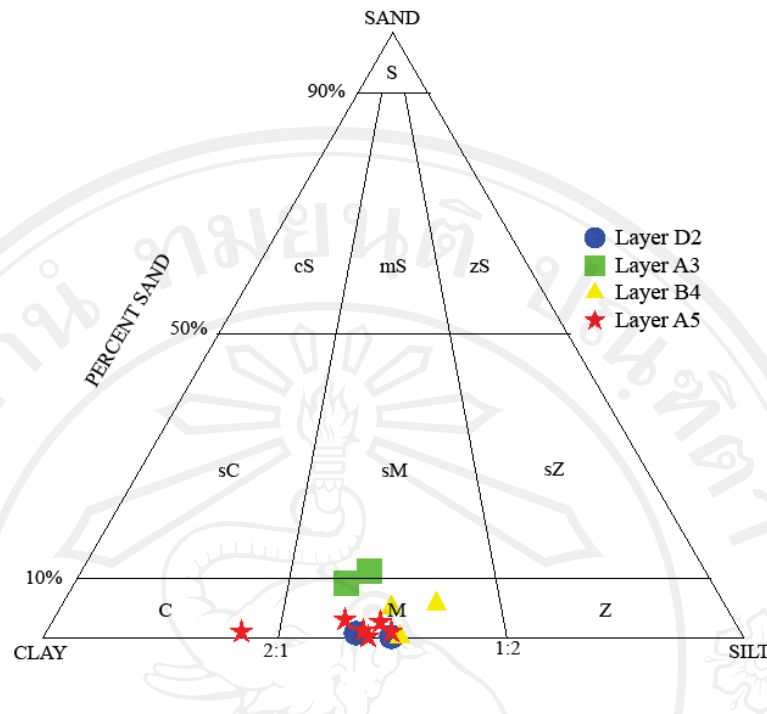


Figure 4.5 Sedimentary nomenclature of the Fyb facies (the diagram modified from Folk, 1954).

4.2.6 Fgror facies: clay and mud, very pale yellow to moderate reddish orange and small gypsum crystal.

General description

The Fgror facies consist of clay and mud. The sediment color is very pale yellow to moderate reddish orange, moderate orange pink to grayish orange pink and yellowish gray to pale greenish yellow. This facies range in thickness from 0.9 to 1.5 meters. Sediment shows moderate reddish brown and grayish black clay mottle and organic clay nodule. The dominant characteristic of this facies is a large amount of small gypsum crystals (Figure 3.57 and 3.65). The Fe-oxide and wood fragments are found but rarely.

Grain size distribution

Sorting of the Fgror facies is poor. Mean grain size is very fine silt to clay, ranging from 7.87 to 8.68 ϕ . The skewness is negative. It is very coarse-skewed or

very skewed towards the fine side. Kurtosis is platykurtic to very leptokurtic or flat to very highly peaked and ranges from 0.79 to 1.53. Sedimentary nomenclatures of the Fgror facies based on the Folk diagram are clay and mud (Figure 4.6). The Fgror facies are found in the layer C4, C5 and D1.

4.2.7 Frb facies: mud and sandy mud, moderate reddish orange to pale reddish brown, organic matter and root fragments.

General description

The Frb facies consist of mud and sandy mud. The sediment color of this facies is moderate reddish orange to pale reddish brown and moderate reddish brown (Figure 3.6). This facies has 1.8 meters thick. Sediment shows the moderate reddish brown and light gray clay mottle, organic matter and laterite nodule. Root fragments are found in this facies. Sediments show fine to very fine sand. Moreover, small gypsum crystal and wood fragments are found.

Grain size distribution

Sorting of the Frb facies is poor. Mean grain size is clay to very fine silt. The skewness is both positive and negative. Most samples are negatively skewness. It is very coarse-skewed or very skewed toward the fine side and near symmetrical. Kurtosis is platykurtic to very platykurtic or flat to very flat frequency distribution and ranges from 0.58 to 0.75. Sedimentary nomenclatures of the Frb facies based on Folk diagram are mud and sandy mud (Figure 4.7). The Frb facies are found in the layer B1 and B2.

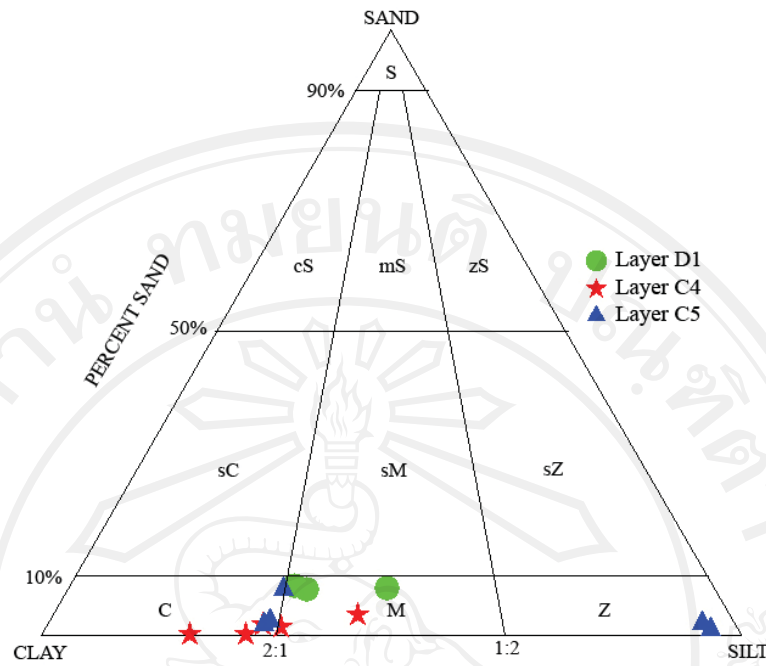


Figure 4.6 Sedimentary nomenclature of the Fgr facies (the diagram modified from Folk, 1954).

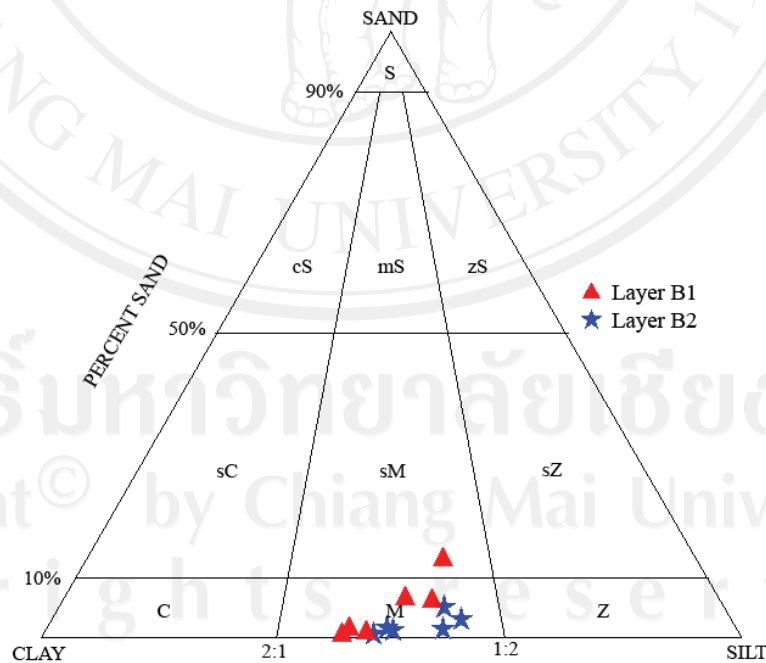


Figure 4.7 Sedimentary nomenclature of the Frb facies (the diagram modified from Folk, 1954).

4.2.8 Fwf facies: clay, mud and sandy clay, grayish black, dusky brown, wood and leaf fragments and mud crack.

General description

The Fwf facies consist of clay, mud and sandy mud. The sediment color of this facies is grayish black to black, dusky brown, pale greenish yellow to yellowish gray, pale yellowish brown, yellowish gray to grayish yellow, dusky yellowish brown to grayish black, moderate brown to dusky yellowish brown and grayish brown to grayish red. The thickness of this facies range from 4.9 to 9 meters (Figure 3.29). It is massive layer and show mud crack structure when it is dried (Figure 3.45). Sediment shows sand grade incursion into mud in the lower part of this facies. The carbonate concretions are found (Figure 3.30) and are in the lower part, near a boundary between mud and coarse sand in this facies. Concretions grain size range from 2 millimeters up to 10 centimeters. Wood and leaf fragment deposit in this facies (Figure 3.31 and 3.46). The contact between Fwf facies and Sp facies are abrupt facies change from coarse to very coarse sand to silt and clay fractions (Figure 3.32 and 3.47).

Grain size distribution

Sorting of the Fwf facies is poor. Mean grain size is very fine silt to clay. The skewness is negative. It is coarse to very coarse-skewed and near-symmetrical or skewed to very skewed towards the fine side. Kurtosis is very platykurtic to mesokurtic or very flat frequency distribution to normal peaked. Sedimentary nomenclatures of the Fwf facies based on the Folk diagram are sandy clay, clay and mud (Figure 4.8). The Fwf facies are found in the layer C3, D4, E2 and E5.

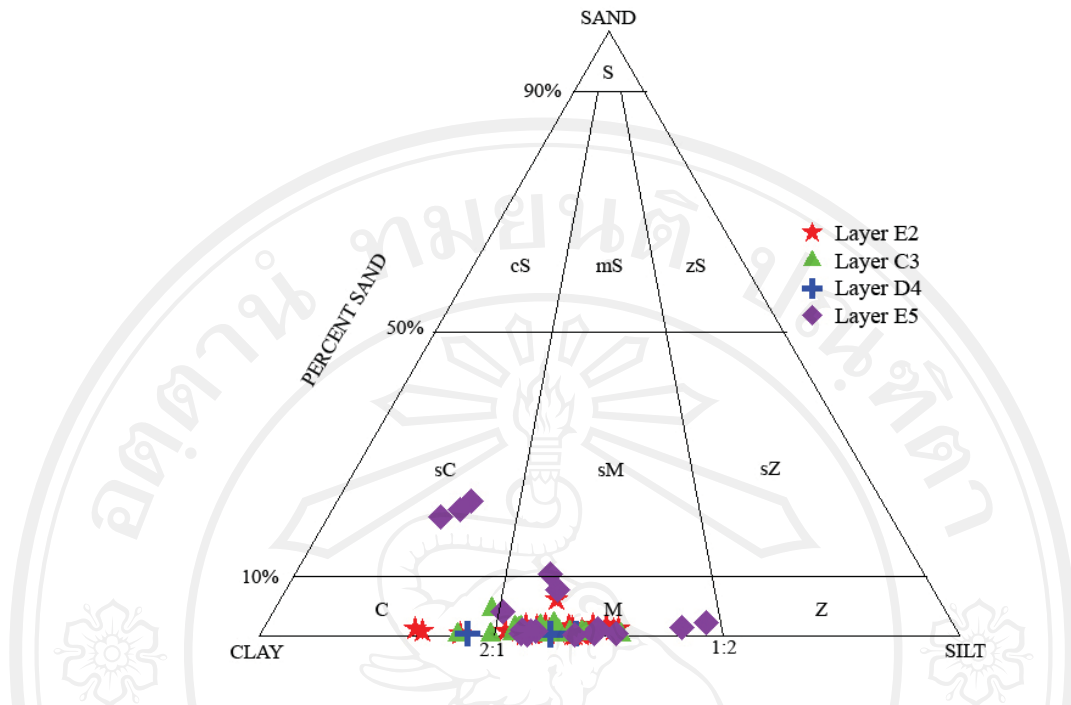


Figure 4.8 Sedimentary nomenclature of the Fwf facies (the diagram modified from Folk, 1954).

4.2.9 Fbom facies: clay, mud, sandy clay and sandy mud, grayish brown to dusky brown and organic matter.

General description

The Fbom facies consist of clay, mud, sandy clay and sandy mud. The sediment color of this facies shows yellow dusky red to dusky brown, grayish yellow green to grayish black, grayish brown to dusky brown. The thickness of this facies range from 0.6 to 2.1 meters. Organic matter, light brown and moderate reddish mottle and root fragment are found commonly. Moreover, the small gypsum crystals and wood fragments are found in this facies but rarely.

Grain size distribution

Sorting of the Fbom facies is poor. Mean grain size is clay to very fine silt. The skewness is negative, ranging. It is very coarse-skewed or very skewed towards the fine side. Kurtosis is platykurtic to leptokurtic or flat to highly peaked.

Sedimentary nomenclatures of the Fbom facies based on the Folk diagram are sandy clay, sandy mud, clay and mud (Figure 4.9). The Fbom facies are found in the layer C1, F1, C2 and B5.

4.3 Facies associations classification

The facies associations classification of this study is based on stratigraphy of sediment layers, sedimentary structures, facies types and grain size variations. From detailed study of the stratigraphic sections and their facies, five facies associations were classified.

4.3.1 Facies association 1

The facies association 1 consists of the Sp facies. This unit can be seen in section 2, section 3 and section 5. Sediments are sand and colors are pale yellowish orange to grayish orange, dark reddish brown, light brown to moderate brown and shows dark brown and blackish brown. Facies association 1 is more than 3 meters thick and is at the bottom of the sections in this study. Grain size of this unit is medium to very coarse sand and few of gravel. They are poorly sorted, high sphericity and subangular to rounded which consist of quartz, feldspar and muscovite. This unit shows burrows which contained organic clay and planar cross bedding structure. Sediments are grain supported and clay matrix. The Fe-oxide is found in sand layer. Clay socket can be found commonly in the lower part of facies. Moreover, this unit has 5 to 10 centimeters of gray to greenish gray clay and interbedded sand layer in the upper part, the middle part and the lower part of facies association 1. The small carbonate concretions and the gypsum are rare. Grain size of the facies association 1 is bimodal. Sorting of this unit is poor to very poor. Mean grain size is coarse sand. The skewness is positive. It is fine to very fine-skewed. Kurtosis is platykurtic to extremely leptokurtic and some sample shows mesokurtic. Sedimentary

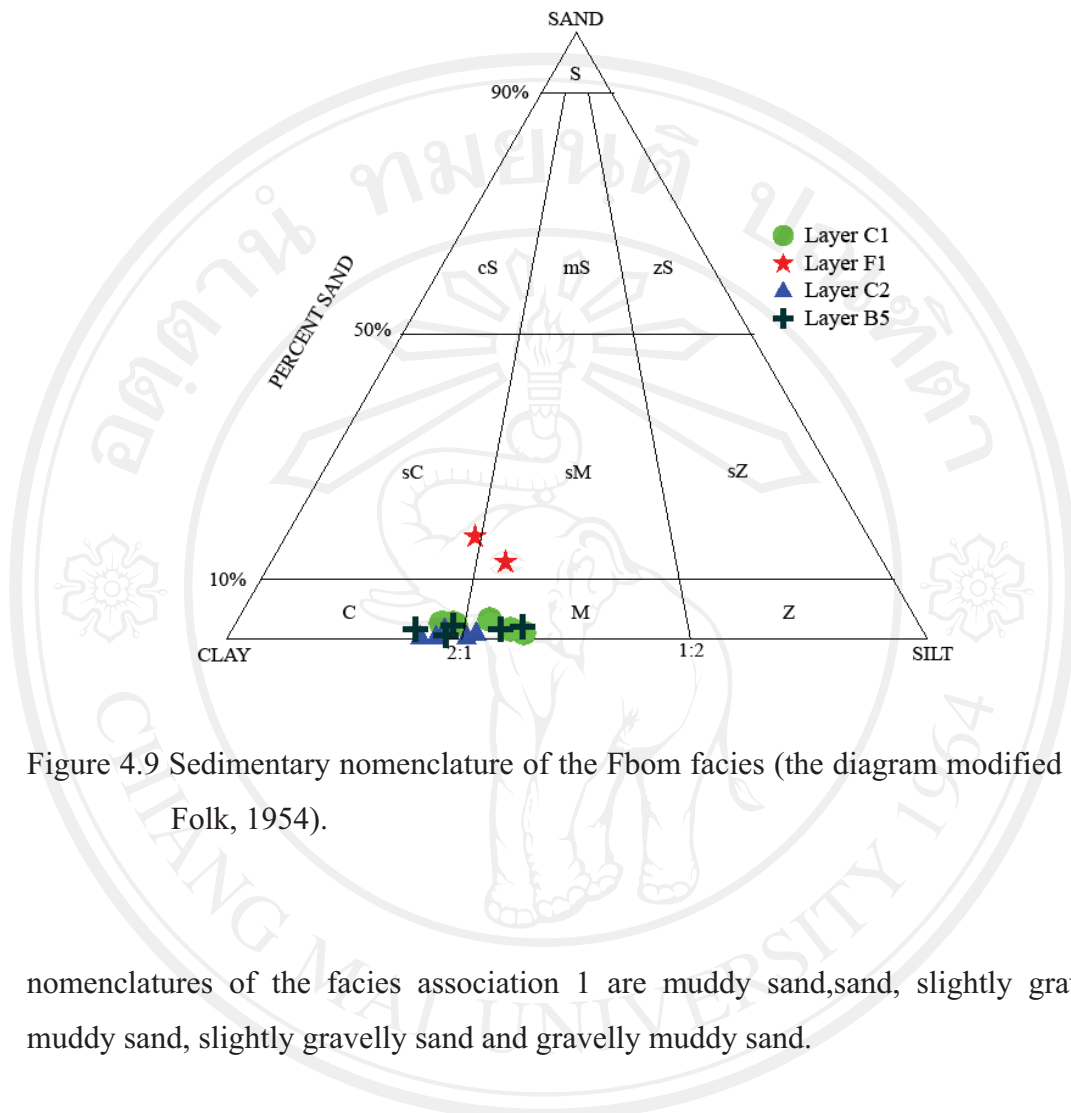


Figure 4.9 Sedimentary nomenclature of the Fbom facies (the diagram modified from Folk, 1954).

nomenclatures of the facies association 1 are muddy sand, sand, slightly gravelly muddy sand, slightly gravelly sand and gravelly muddy sand.

4.3.2 Facies association 2

The Fc facies is member of facies association 2. Sediment color of the unit 2 is pale greenish yellow to yellowish. This facies range from 1.2 to 2.7 meters thick. Sediment show organic clay nodule and gray and moderate red clay. Sediment is calcareous. The lower part of facies association 2, shows sand incursion into mud. The sand socket can be observed. The carbonate concretions are common to observed in this unit, which grain size range from 2 millimeters up to 4 centimeters. The gypsum crystals and Fe-oxide concretions are found which root or wood fragments are nucleus of the concretion. Moreover, wood fragments are rare. Sorting of this

unit is very poor. Mean grain size is fine to very fine silt. The skewness is negative. It is very coarse-skewed. Kurtosis is platykurtic to very platykurtic. Sedimentary nomenclatures of the facies association 2 are sandy clay and sandy mud.

4.3.3 Facies association 3

The Fwf facies is member of the facies association 3. Grayish black to black, dusky brown is the color of sediment. The thickness of this facies range from 4.9 to 9 meters. It is massive layer and show mud crack structure when it is dried. The lower part of unit, sediment shows sand incursion into mud. The carbonate concretions are observed, they are in the lower part that boundary between mud and coarse sand in this facies but rarely, which grain size range from 2 millimeters up to 10 centimeters. Wood and leaf fragment samples deposit in the facies association 3. Sorting is poor to very poor. Mean grain size is very fine silt to clay. The skewness is negative. It is coarse to very coarse-skewed and near-symmetrical. Kurtosis is very platykurtic to mesokurtic. Sedimentary nomenclatures of the facies association 3 are sandy clay, clay and mud.

4.3.4 Facies association 4

The facies association 4 comprises the Fgror facies and the Fgrb facies. The facies association 4 exposes in section 1, section 4 and section 5. The sediment in the facies association 4 is very pale yellow to moderate reddish orange, moderate brown and pale reddish brown to dark reddish brown. The thickness of Fgror facies range from 0.9 to 1.5 meters and Fgrb facies range from 0.6-0.9 meter. Sediment shows moderate reddish brown and grayish black clay mottle and organic clay nodule. The dominant characteristic of this facies is a large amount of the small gypsum crystals. The Fe-oxide and wood fragments are found but rarely. This unit shows sand content about 20 %. It is very fine sand to fine sand. Sorting of the facies association 4 is very poor. Mean grain size is very fine silt to clay. The skewness is negative. It is

very coarse-skewed. Kurtosis is platykurtic to very leptokurtic. Sedimentary nomenclatures of facies association 4 are sandy mud, sandy clay, mud and clay.

4.3.5 Facies association 5

The facies association 5 comprises the F_{sr} facies, the F_{rb} facies, the F_{bom} facies and the F_{yb} facies. The facies association 5 occurred as the top unit of the sections. The thickness ranges from 1.8 to 5.4 meters. This facies association shows mud supported. Sand fraction in this facies association is very fine sand to fine sand. Organic clay mottle, light brown to moderate reddish brown clay mottle, light to medium dark gray clay nodule, and root fragments are found in this facies. The small gypsum crystals and wood fragments are found but rarely. Sorting of the facies association 5 is very poor. Mean grain size is very fine silt to clay. The skewness is negative and positive. Most samples are positively skewness. It is fine to very fine-skewed and coarse-skewed and coarse to very coarse-skewed. Kurtosis is very platykurtic to platykurtic. Sedimentary nomenclatures of the facies association 5 are sandy mud, sandy clay, muddy sand, mud and clay.