Grain Size Analysis of the Irrawaddy Formation in Letpangwin Area, Hinthada District, Ayeyarwady Region

Lin Thu Aung[1], Win Naing[2], Saw Ngwe Khaing[3], Chit Sein[4]

Abstract

The Irrawaddy Formation comprises the unconsolidated sediments of gritty and pebbly sandrocks, thick layers of pebbles and gritty to pebbly loose sand with abundant silicified fossil wood fragments. The present study aims to analyze the grain parameters of the loosely cemented sandrocks from the Irrawaddy Formation exposed in the north-eastern part of Hinthada District, Ayeyarwady Region. The standard deviation (sorting) and skewness of the grain size analysis have been carried out in this work. According to the plot diagrams and cumulative curves, the origin of the rocks of the Irrawaddy Formation from the study area indicates to the river sand.

Key words: Grain parameters, Irrawaddy Formation, unconsolidated sediments, river sand.

Introduction

The Irrawaddy Formation was first assigned as "Fossil Wood Group" by Theobald in 1873. Later, Pascoe (1959) modified it and used the term "Irrawaddy Sandstone". The formal lithostratigraphic name "Irrawaddy Formation" was established in Yenangyaung area by Aung Khin and Kyaw Win (1969). This formation consists of the gritty, pebbly and loosely cemented sandrocks. These are widely distributed in the east of Myanaung-Kyangin area, north-eastern part of the Hinthada District, Ayeyarwady Region.

The geological observation of the Irrawaddy Formation is very few and there is still lacking in grain size analysis on loosely cemented rocks of Irrawaddy Formation exposed in the north-eastern part of the Hinthada District. Therefore, the present study intends to interpret the origin and source of the deposition for Irrawaddy Formation, by grain size analysis.

Study Area

The study area is located in the southwestern part of Myanaung Township, Hinthada District, Ayeyarwady Region (Figure 1). It is situated about 11 km south of Kyangin Township and 8 km from southwest of Myanaung Township. The area is uppermost portion of the triangle-shaped delta region of Myanmar, so called Ayeyarwady Embayment. The Rakhine Yoma is in the west and the classical river of Myanmar, Ayeyarwady, is running from north to south in the east. This area is lying on the foothill of Western Ranges. The area with the elevation of 60 m above the sea level is lying at the edge of eastern foothill of the Rakhine Yoma which is a tightly folded and mountainous tract of southwestern Myanmar.

Materials and Method

The loose sands from the Irrawaddy Formation in the study area were collected for grain-size distribution analysis. The grain-size scale of Wenworth (1922) was applied in sieve analysis. Loose samples were sieved and the skewness, kurtosis, mean, medium, and mode were calculated from these weight percentages.

[1] Demonstrator, Department of Geology, West Yangon University
[2] Pro-Rector, Dr., University of Yangon
[3] Lecturer, Department of Geology, Hinthada University
[4] Lecturer, Dr., Department of Geology, Hinthada University

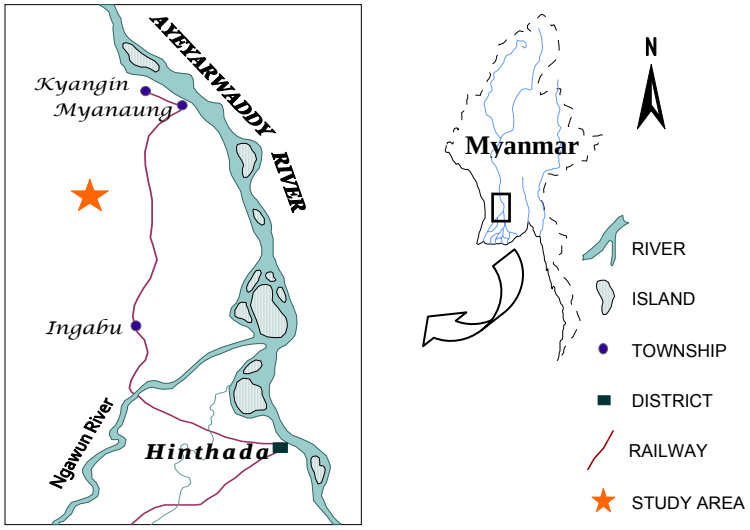

Figure 1 Geographic position of the study area.

General Geology

In the study area, two lithostratigraphic units namely the Pyawbwe Formation (Early Miocene) in the lower part and the Irrawaddy Formation (Late Miocene-Pliocene) in the upper part (Figure 2). The Pyawbwe Formation consists of thick accumulation of fine clastic sediments composed mainly of grey and bluish grey sandy clay, sandstones, intra-formational conglomerate with local present of laminate shale (Figure 3-a) and some microcrystalline limestone lenses with whitish grey to grey color limestone lenses. This formation is well exposed on the Towa Taung (18° 1′ 13″ N & 95° 12′ 10″ E), the southern part of Tondaung Ridge which is parallel to regional strike of NNW-SSE direction. Mud volcanoes also occur at the top of Magyigon taung (18° 1′ 13″ N & 95° 12′ 10″ E) (Figure 3-b), where the Pyawbwe Formation is exposed as inliers structure among the loosely cemented sand rocks of the Irrawaddy Formation.

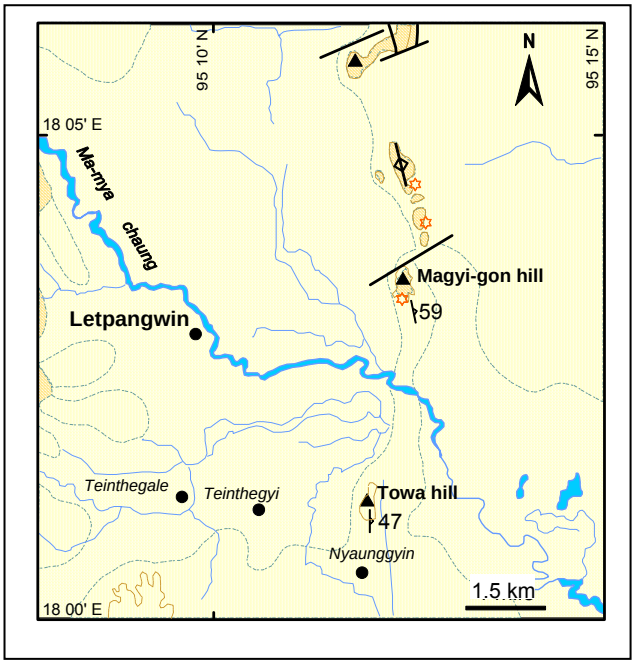

Figure 2 Geological map of the Letpangwin Area, north-eastern part of Hinthada District (After MOGE, 1977 and Lin Thu Aung, 2008).

The Irrawaddy Formation is most widely distributed and covers more than 50% of the total area coverage. Along the eastern part of the area, loose sand and gravel occur as rolling hills. Bedded nature and sequences of the Irrawaddy Formation are recognized at the road cutting and stream section. Very well outcrops are exposed nearby Teinthegyi-Teinthegale village (18° 01′ 45″ N & 95° 10′ 2″ E) and Magyigon Taung (18° 03′ 15″ N & 95° 12′ 42″ E). It is well recognized by poorly lithified cross-lamination (Figure 3-c), wavy bedding with local scouring (Figure 3-d) and nearly horizontal beddings. Graded bedding, planar and trough type cross-bedding also occur. Although the Irrawaddy Formation is usually rich in vertebrate fossils, no occurrences of fauna are observed in the present study area except the small fragments of silicified fossil wood.

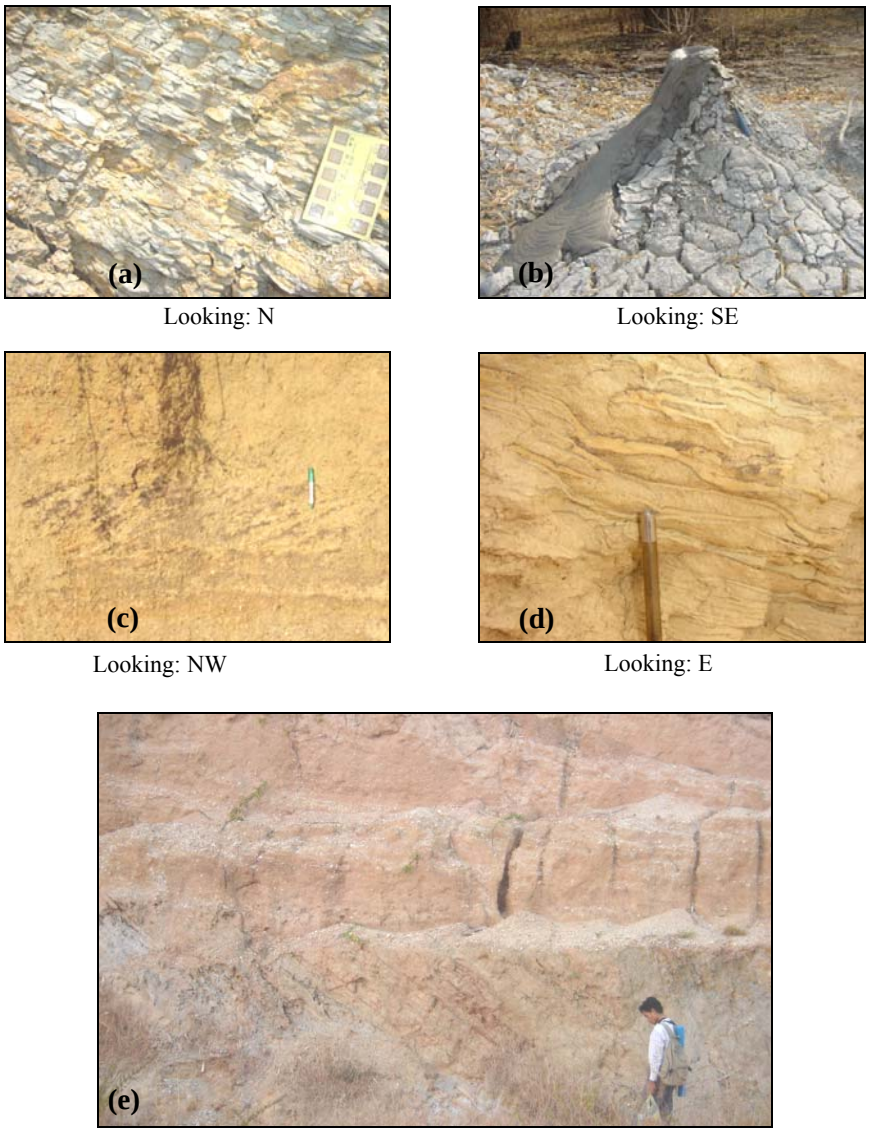

Figure 3 Photographs showing the notable geological features in the west of Letpangwin village

- **Pyawpwe Formation** (a) Laminated shale (b) Mud volcanoes
- **Irrawaddy Formation** (c) Cross-bedding (d) Flaser-bedding

(e) Angular Unconformity between Pyawbwe Formation and overlying Irrawaddy Formation

An angular unconformity between the Pyawbwe Formation and the Irrawaddy Formation can be observed at Towa taung (18° 1′ 13″ N & 95° 12′ 10″ E) (Figure 3-e). The upper part of Irrawaddy Formation is covered by the alluvium and the valley filled deposits.

Results and Discussion

Totally, 16 of loose samples were collected during the field work to analyze grain size distribution (Figure 4).

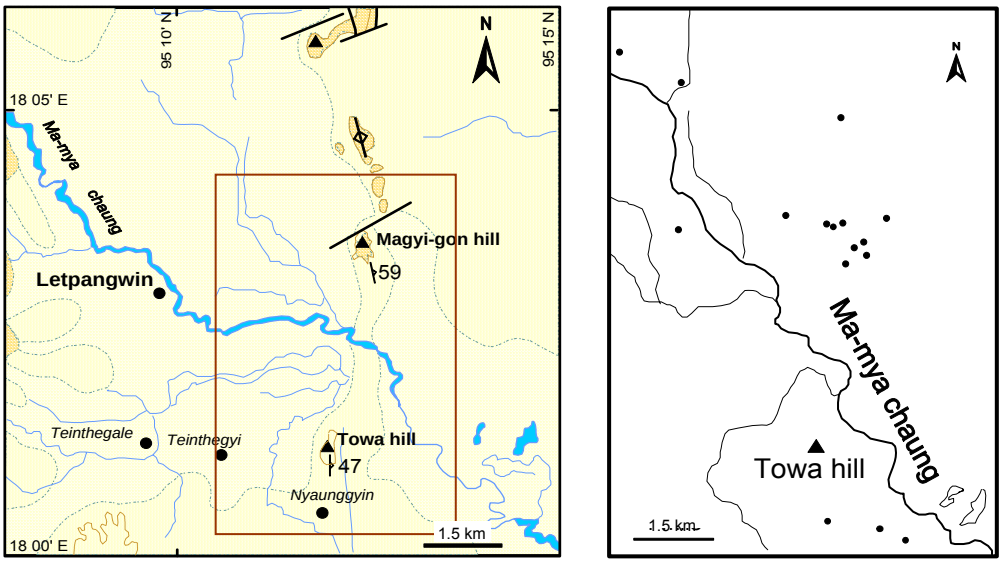

Figure 4 Sample location map (solid circles indicate the locations of collected samples)

The collected samples were dried by heating. Then, they were grinded and sieved to obtain the different size classes of the sediments that are composed in each sample. Sieve opening no. 200, 150, 100, 80, 60, 40, 20, 10 and 4 were used in this work. The resulted size classes were weighed and produced to cumulative percentile value. The histograms and frequency curves were made. Then the data were also plotted on the log probability paper by phi (ϕ) scale. Y-axis represented log probability scale whereas X-axis corresponded to phi (ϕ) scale of the percentile value of each clast size. By using the cumulative curve, the size parameter for each sample was calculated using the following formula.

A. Central Tendency $= \phi 50$

B. Average Size, Median Mz $= \dfrac{\Phi 16 + \Phi 50 + \Phi 84}{3}$

C. Standard Deviation (Sorting) σ_1 $= \dfrac{\Phi 84 \quad \Phi 16}{4} + \dfrac{\Phi 95 \quad \Phi 5}{6.6}$

D. Graphic Skewness Sk_1 $= \dfrac{16 + \Phi 84 \quad 2\Phi 50}{2(\Phi 84 \quad \Phi 16)} + \dfrac{\Phi 5 + \Phi 95 \quad 2\Phi 50}{2(\Phi 95 \quad \Phi 5)}$

E. Kurtosis, K_G $= \dfrac{\Phi 95 \quad \Phi 5}{2.44(\Phi 75 \quad \Phi 25)}$

The resultant values give the size parameter by correlating the verbal scale (Folk and Ward, 1957; Lindholm, 1991). This procedure was done for each sample.

Data analysis

The classes of grain size, its original weight and percentile value for particular collected samples are stated in Table 1.

Table 1 Grain parameters of the samples of Irrawaddy Formation

Sample No.	*Median (Md)*	*Mean (Mz)*	*Sorting (σ)*	*Skewness (Sk1)*	*Kurtosis (KG)*
Sample-1	+1.18	+1.73	+1.85	+0.44	+1.51
Sample-2	+1.05	+0.65	+1.63	-0.44	+6.60
Sample-3	+0.50	+0.93	+1.22	+0.66	+0.57
Sample-4	+1.10	+0.61	+1.53	+0.04	+0.68
Sample-5	+0.05	-0.54	+1.20	+0.66	+0.42
Sample-6	+1.50	+1.63	+4.02	+0.24	+1.43
Sample-7	+0.60	+0.78	+1.36	+0.16	+0.88
Sample-8	+0.30	+0.69	+1.05	+0.75	+0.72
Sample-9	+0.95	+0.42	+1.85	+0.13	+0.004
Sample-10	+1.10	+0.85	+1.98	+0.22	+1.30
Sample-11	+3.20	+3.21	+1.67	+0.004	+0.86
Sample-12	+1.54	+1.60	+0.95	+0.22	+2.52
Sample-13	+0.70	+1.33	+1.63	-0.44	+1.50
Sample-14	+3.15	+3.15	+1.34	+0.06	-0.05
Sample-15	0	+0.44	+0.81	+1.00	+0.46
Sample-16	+1.20	+1.16	+1.11	-0.03	+1.63

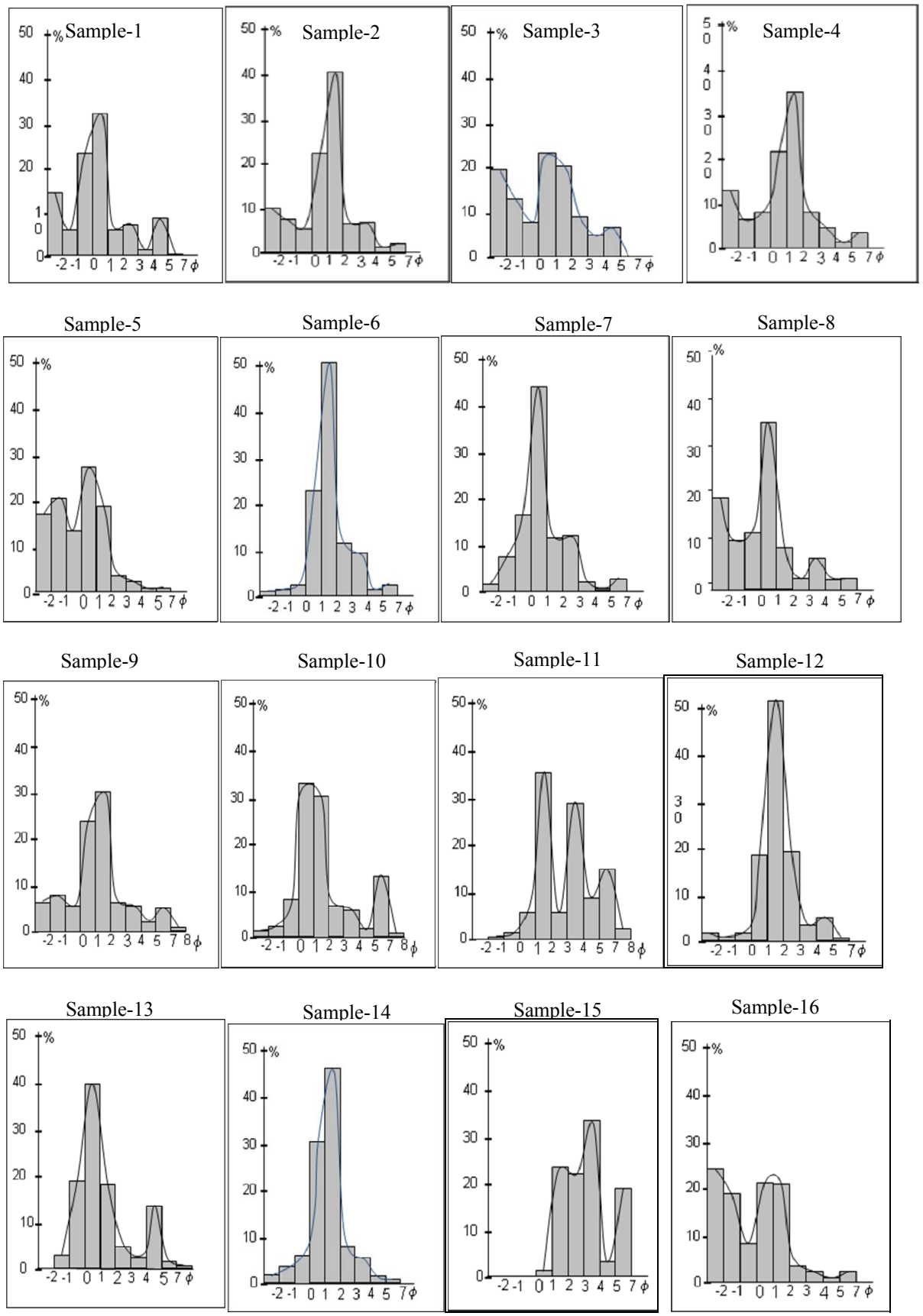

Figure 5 Histograms with the cumulative curves made base up on the grain parameter of the collected samples.

According to the histograms (Figure 5), most of the samples are indicated to the polymodal, leptokurtic and positive skewed. It is assumed that the samples consist of the high proportion of larger particles (grits and pebbles). The sand is the highest percentile value which has 40% to 50 % of the total components. However, some of the samples (Sample 16, 3) show about 25% and some show about 30% (sample-5) in some places.

Besides, the rocks of the present area comprised particles range from pebble-sized to clay. Pebbles and grits have ϕ 1- ϕ 25 of the total components whereas silt and clayey particles recognize ϕ 99 in the area (Figure 6). The fine-tails indicate the components of finer particles (fine silt and clay). It can be said that the rocks of the study area are pebbly and gritty sandrocks.

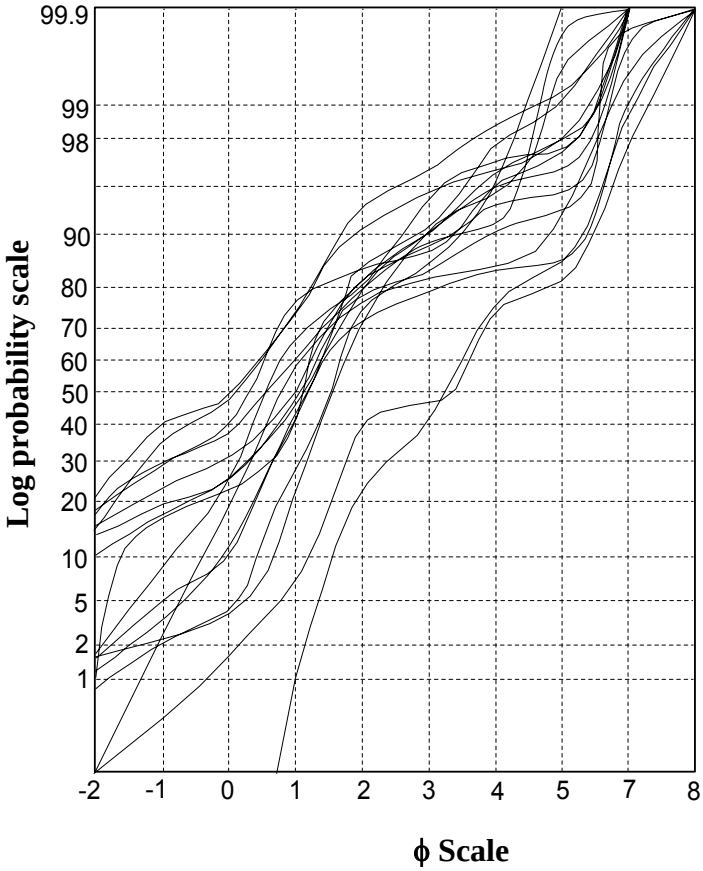

Figure 6 Cumulative curves for loose samples of Irrawaddy Formation in the study area

Sorting Characteristics

The calculated data indicates the positive sorting. Most of the values of sorting range between 1-2 (sample-1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 13, 14 and 16). However, sample 12 and 15 have < 1 and also sample-6 has >4 in sorting value. Friedman (1967) made a genetic classification for sandstones on standard deviation to delineate the environment of deposition which has two subdivisions for medium to fine sand and very fine-grained sands (i.e., mean >1.0 to 2.0) and for coarse-grained sands (i.e., mean <1.00). In the study the second division (for coarse-grained sand) is used because the histograms and cumulative curves of the samples indicate the high amount of sand proportion.

Friedman's classification comprises the four ranks; 0.50 – 0.80 is moderately well sorted, 0.80 – 1.40 is moderately sorted, 1.40 – 2.00 is poorly sorted, 2.00 – 2.60 is very

poorly sorted and >2.60 extremely poorly sorted. It indicates that the beach sand is the lowest in sorting range and glacio-fluvial sand is the highest in sorting.

Genetic Classification

Friedman (1967) made a satirical diagram to show the origin of the sediments. The diagram (Figure 7) was based upon two verbal scales of grain parameters, standard deviation (sorting) and graphic skewness (Table-1). The component of X-axis corresponds to standard deviation and Y-axis is the skewness of the sediments. According to the diagram, the collected samples of the Irrawaddy Formation in the present study area represent to river sand.

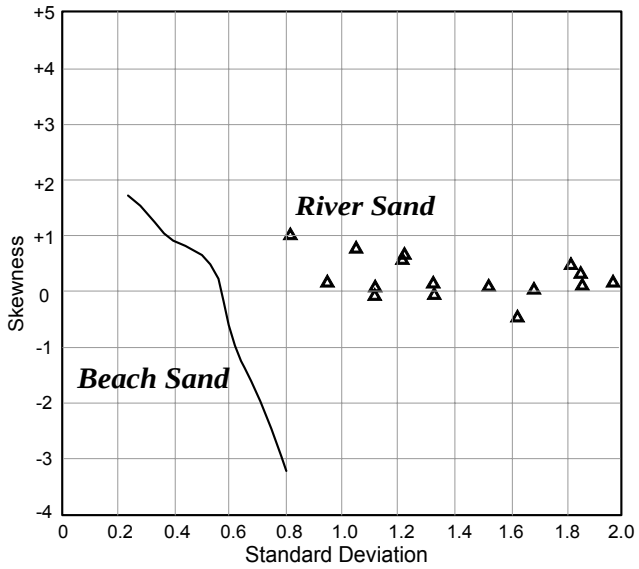

Figure 7 Plot diagram of the samples of Irrawaddy Formation (Friedman, 1967) indicates the environment of deposition.

Conclusion

The study area is located in the southwest of Myanaung Township, Hinthada District, Ayeyarwady Region where the rocks of the Irrawaddy Formation of Miocene-Pliocene is exposed extensively. The Irrawaddy Formation is mainly composed of loosely cemented massive sandrocks with the grain-supported and matrix-supported sandy gravels and gritty sand rocks. Quartz is the most component and other rock pebbles are also found. The histograms reflected to the geometry of these sediments are poly modal, leptokurtic and positive skewed. The calculated data also indicate that these sediments are moderately sorted and poorly sorted in sorting character of Friedman (1967), which represents the possible river sand origin. The plot diagram based upon the standard deviation (sorting) and skewness also indicates that the depositional environment is river sand origin.

Acknowledgements

We would like to express our sincere gratitude to Dr. Tin Tun Myint, Acting Rector, and Dr. San Linn, Pro-Rector, Hinthada University, for their kind permission to submit this paper. We are indebted to Dr. Kyi Kyi Maw, Professor and Head of the Department of Geology, Hinthada Univesity, for her valuable comments. Thanks are also due to Dr. Win Nanig, Associate Professor, Applied Geology Department, for his support of laboratory facilities necessary for sieving analysis.

References

Aung Khin and Kyaw Win (1969). Geology and hydrocarbon prospects of Burmese Tertiary Geosyncline. Union of Burma, *Jour. Sec. & Tech*.. **1** (1): 55-53.

Bender, F. (1983) *Geology of Burma*, Gebruder, Bortrager, Berlin, Stuttgart.

Folk, R.L. and Ward, W. C. Wily (1957) Brazos river bar; a study in the significant of grain size parameter. *Jour. Sed. Petrology*, **27**: 3-26

Friedman, G. M. (1967) Dynamic processes and statistical parameters compared for site frequency distribution of Beach and River sand. *Jour. Sed. Petrology*, **37**: 327-354.

Lindholm, R. C. (1991) *A practical approach to sedimentology*, BS publisher and distributers.

Lin Thu Aung (2008) *Geology and sedimentology of the Yenandaung-Letpangwin area, Hinthada District*, University of Yangon (unpublished project research), p. 110.

Geological Map of Burma (1977) *Myanmar Oil and Gas Enterprise, Ministry of Energy*, One million scale.

Pascoe, E. H. (1959) *A manual of the geology of India and Burma*. 3rd. Edition, Government of India Press, **II**: p. 1343.

Reineck, H. E. and Singh, I. B. (1980) *Depositional Sedimentary Environments*. 2nd Edition (Revised and Updated) New York, Springer-Verlag, p. 549.

Theobald, W. (1873) The geology of Pegu. *Mem. Geol. Surv. India*, **10**: 198-359.

Wenworth, C. K. (1922) A scale of grade and class terms for clastic sediments. *Jour. Geology*, **30**: 377-392.