Mechanical Analysis and Statistical Treatment of the Size Analysis of Sandstone in Ywadan-Thanbo Area, Meiktila and Kyaukpadaung Townships, Mandalay Region

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Abstract

The area under present investigation, covering about 60 square miles, occupies part of Kyaukpadaung and Meiktila Townships in Mandalay Region. It is situated between North Latitude 20° 46′ to 20° 52′ and East Longitude 95° 2′ and 95° 37′ covering parts of the one-inch topographic maps, 84 P/5 and P/9.Topographically, the study area is low-lying rolling terrain. The lithology of the study area is characterized by cuesta landform. The study area presents mainly two stratigraphic rock units, Upper Pegu Group and Irrawaddy Formation. Nine samples of loose sands were sieved with Ro-Tap machine for 15 minutes using B.S. sieve of one-phi interval. The data obtained from mechanical analysis were plotted on probability paper and cumulative curves were drawn on this paper so as to obtain the percentile values (φ). These percentile values were calculated on order to obtain the statistical parameters. The size distribution of the Moza, Kabo and Irrawaddy Formations are always unimodals. Mostly the fine admixtures are more abundant than the coarse admixtures.

Keywords: *Ro-Tap machine, cumulative curves, percentile values, statistical parameters*

INTRODUCTION

Location and size

The research area lies in Kyaukpadaung and Meiktila Townships, Mandalay Region. It is bounded by North Latitude 20° 46′ to 20° 52′ and East Longitude 95° 27′ and 95° 37′ in the one-inch topographic maps, 84 P/5 and P/9. This area is North-South 6 miles and east-west 10 miles long. Topographically, the study area is low-lying rolling terrain. The location map of the study area is described in figure (1).

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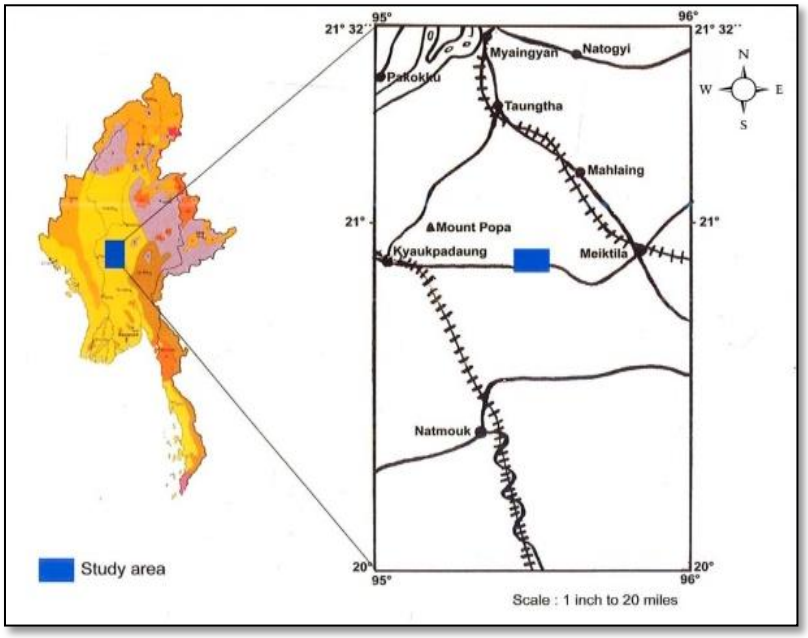


Figure (1). Location map of the study area

Regional Geologic Setting

According to Chhibber (1934), Myanmar is broadly divided into four geotectonic regions. These are the Eastern Highland, the Central Myanmar Belt, the Western Ranges and the Rakhine Coastal Plain from east to west. The research area is located in the western half of the Central Cenozoic Belt between Mt.Popa and Mahaling area. The study area is also the northern continuation of the Bago Yoma. The study area is mainly composed of clastic sedimentary rocks. The study area is underlain by the clastic sediment of Miocene-Pliocene age. The regional geology of the study area and its environs are shown in figure (2).

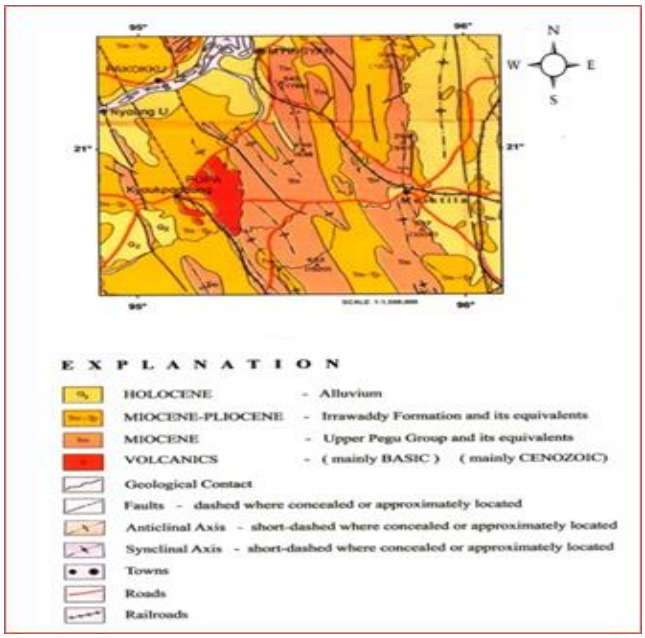


Figure. (2) The regional geologic setting of the study area

Stratigraphy

The study area belongs to a very small segment of the northern portion of the Minbu Basin. It is located at the northern continuation of Bago Yoma. In the present area, the clastic sedimentary rocks are mainly observed. The area constitutes the rocks of Upper Pegu Group and Irrawaddy Formation.

The stratigraphic succession of the study area is as follows:

(3) Irrawaddy Formation (Late Miocene to Pliocene)

(2) Khabo Sandstone (Middle Miocene)

(1) Moza Formation (Middle Miocene)

Purposes of Study

The purpose of the grain-size analysis is to describe an attempt to give the quantitative terminology of the sandstone samples to deduce its environmental condition of the deposition. The other aim also understands the mechanisms operative during transportation and deposition, as well as the distance of sediments transport.

METHODS OF STUDY AND MATERIALS

1. Field Methods

The aerial photographs, on a scale of 1:24,000, were studied to construct the base map of the present area. In the field some photos of notable features such as primary and secondary structures of rock units, outcrop natures, prominent landforms, hills and valleys were taken with camera for photographic illustrations during field works. An attempt was made to obtain samples encompassing the complete range of rock units. Demarcation of the lithologic boundaries, structural trends and possible joints and fault traces were transferred on to a base map of four inches to one mile scale for subsequent ground and detail mapping. GERMAN, G.P.S 12 XL was used for determination of attitude and position of the selected location points. On the basis of these G.P.S data, the different level of lands and hills were identified.

2. Laboratory Methods

To carry out the grain-size classification, the unconsolidated sandstone samples were collected from the measured stratigraphic units. These sandstone samples were dried under sunlight or the oven and then, crushed into loose sands by rubbing with rubber blocks. Mechanical analysis of the obtained loose sand samples was carried out by the conventional sieving method. One-phi interval, about 100 g material was used for each sample.

A dry sample was placed in the upper most sieves in a set of stacked sieve. The stack sieve sieves arranged in order (Sieve nos.18, 35, 60 and 120) so that coarsest sieve was at the top with finer ones below. Then, this order of sieves was placed on a shaking machine. After ten minutes of shaking, the sand that has collected on each sieve and pan was removed and

weighed. The histogram is widely used to present grain-size data. It is simply a bar graph in which the weight percent of sediment in each size class in plotted on the horizontal axis and the frequency (Wt %) on the vertical axis. Another convention is plot the grain size so that the diameter value increases to the left. And the class limits are given in φ units ($\varphi = -\log_2 x$) where x is the grain size in mm.

The size grades were based on geometric scale in which class limits increase from a base of 0.031 mm to 0.0625 mm (very fine sand), 0.0625 mm to 0.125 mm (fine sand), 0.125 mm to 0.25 mm (medium sand), 0.25 mm to 0.50 mm (coarse sand) and 0.50 mm to 1 mm (very coarse sand). Sieving was commonly determining the grain-size distribution of sands.

By using the mechanical data, the histograms, size frequency curves and cumulative curves were prepared. Histogram is a block diagram which gives the percentage of grain in the grade sizes present in the sediments. Size frequency curve may be obtained from the histogram. It is a smooth curve drawn through the histogram. Cumulative curve is prepared by adding the percentages in succeeding grades and drawing a smooth curve through the points.

From these curves, average grain-size, sorting, skewness, and kurtosis were obtained. By using the formulae of Folk and Ward (1957), mean size, inclusive graphic standard deviation, inclusive graphic skewness and graphic kurtosis were calculated.

1. Greaphic mean

$$Mz = \frac{\varphi 16+\varphi 50+\varphi 84}{3}$$

2. Inclusive graphic standard deviation

$$O_I = \frac{\varphi\ 84-\varphi\ 16}{4} + \frac{\varphi\ 95-\varphi\ 5}{6.6}$$

3. Inclusive graphic skewness

$$Sk_I = \frac{\varphi\ 16+\varphi\ 84-2\varphi\ 50}{2(\varphi\ 84-\varphi\ 16)} + \frac{\varphi\ 5+\varphi\ 95-2\varphi\ 50}{2(\varphi\ 95-\varphi 5)}$$

4. Graphic kurtosis

$$K_G = \frac{(\varphi\ 95-\varphi\ 5)}{2.44(\varphi\ 75-\varphi\ 25)}$$

Mechanical Analysis and Statistical Treatment of the Size Analysis of Sandstone

Nine samples of loose sands were sieved with Ro-Tap machine for 15 minutes using B.S sieves of one-phi interval. The data obtained from mechanical analysis are described in Table (1) and Table (2).

Formation	Moza Fm. (wt %)			Khabo Sandstone (wt %)			Irrawaddy Fm. (wt %)		
Grain Size	Sample No			Sample No			Sample No		
	1	2	3	4	5	6	7	8	9
2 - 1							0.42	0.30	
1-1/2	6.45	0.92	2.80		0.32	2.21	53.10	46.74	1.30
1/2 – 1/4	32.89	22.34	34.44	16.23	24.56	46.52	27.66	35.46	58.98
1/4-1/8	47.31	43.56	45.49	69.27	62.20	29.86	10.12	10.59	29.71
1/8-1/16	7.98	18.08	12.23	9.96	10.93	14.69	2.90	4.59	7.84
1/16-1/32	5.37	15.10	5.04	4.54	2.00	6.72	5.75	2.32	2.70
Total	100.00	100.00	100.00	100.00	99.99	100.00	99.95	100.00	100.03
Sieve lost	-	-	-	-	0.01	-	0.05	-	-
Sieve gain	-	-	-	-	-	-	-	-	0.03

Table. (1) Sieving data resulting from representative mechanical analysis

Formation	Sample No	Percentiles						
		Φ5	Φ16	Φ25	Φ50	Φ75	Φ84	Φ95
Irrawaddy Formation	9	1.23	1.50	1.62	1.90	2.40	2.73	3.50
	8	0.37	0.64	0.76	1.80	1.74	2.13	3.42
	7	0.37	0.62	0.73	0.98	1.74	2.23	4.02
Khabo Sandstone	6	1.18	1.50	1.68	2.03	2.84	3.26	4.40
	5	1.52	1.84	2.00	2.37	2.75	2.93	3.57
	4	1.67	2.00	2.16	2.50	2.82	2.97	3.92
Moza Formation	3	1.18	1.60	1.79	2.27	2.80	3.10	4.10
	2	1.43	1.84	2.40	2.62	3.37	3.95	4.12
	1	0.83	1.39	1.65	2.20	2.69	2.92	4.01

Table. (2) Critical phi values read from probability paper

These data were plotted on probability paper and cumulative curves (Figure.3, 4 and 5) were drawn on this paper so as to obtain the values of 5^{th}, 25^{th}, 50^{th}, 75^{th}, 84^{th}, and 95^{th} percentiles.These percentile values (in φ) were calculated in order to obtain the statistical parameters such as median, mean size, sorting symmetry, skewness and kurtosis, following the formulae suggested by Folk and Ward (1957). These values are shown in Table (3).

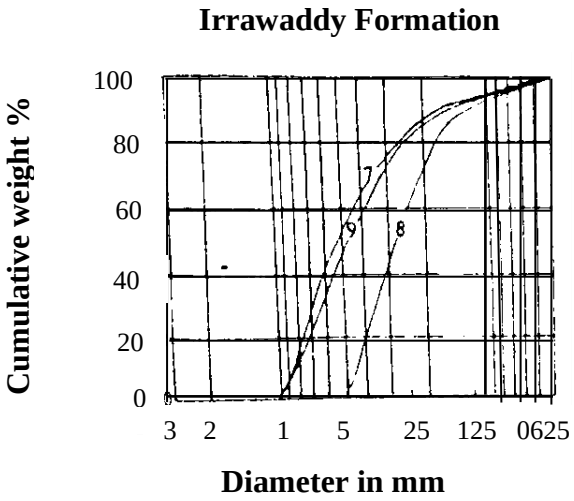


Figure. (3) Showing size distribution of the Irrawaddy Formation by cumulative curve

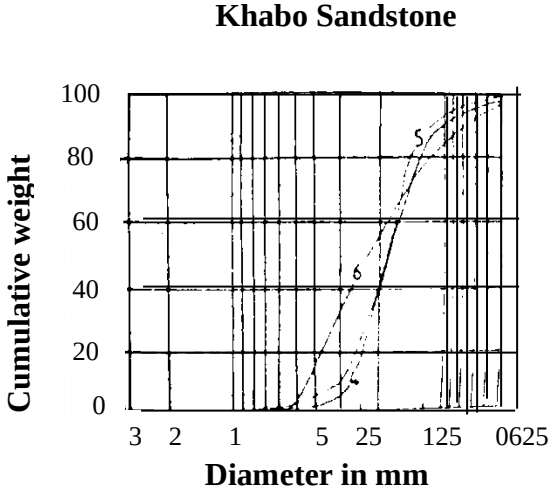


Figure. (4) Showing size distribution of the Khabo Sandstone by cumulative curve

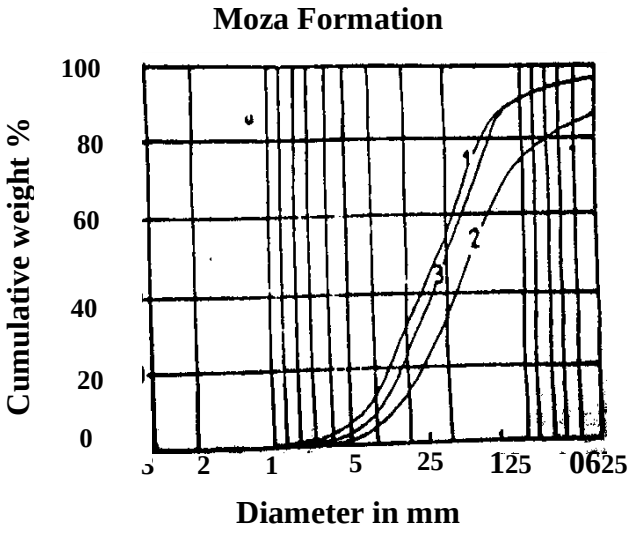
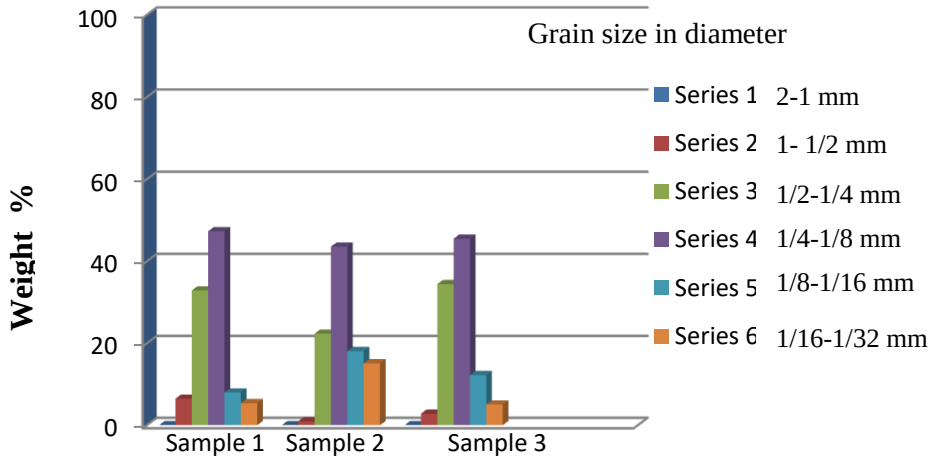


Figure. (5) Showing size distribution of the Moza Formation by cumulative curve

Formation	Sample No	Median	Mean	Sorting	Skewness	Kurtosis
Irrawaddy Formation	9	1.90	2.04	0.65	0.39	1.20
	8	1.80	1.52	0.83	-0.25	1.28
	7	0.98	1.28	0.97	0.61	1.48
Khabo Sandstone	6	2.03	2.26	0.93	0.44	1.14
	5	3.37	2.38	0.58	0.11	1.40
	4	2.50	2.49	0.58	0.11	1.40
Moza Formation	3	2.27	2.32	0.81	0.18	1.19
	2	2.62	2.80	0.94	0.19	1.14
	1	2.20	2.17	0.86	0.04	1.25

Table.(3) Size distribution parameter values calculated from phi values on probability paper

By using the data obtained from mechanical analysis of sands were constructed in the form of histograms on graph papers and the representative histograms of each unit were shown in figure.(6) and figure.(7) and figure.(8).



Grain size in diameter

Figure (6). Representative histograms showing size frequency distribution of the Moza Formation

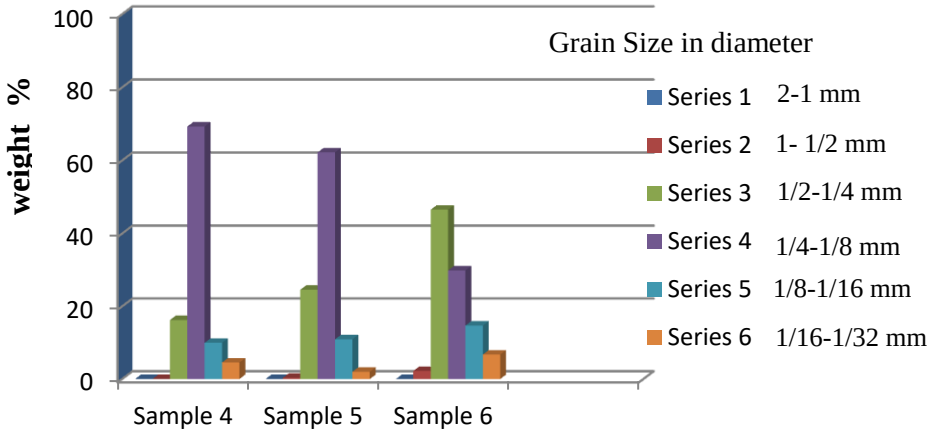


Figure (7). Representative histograms showing size frequency distribution of the Khabo Sandstone

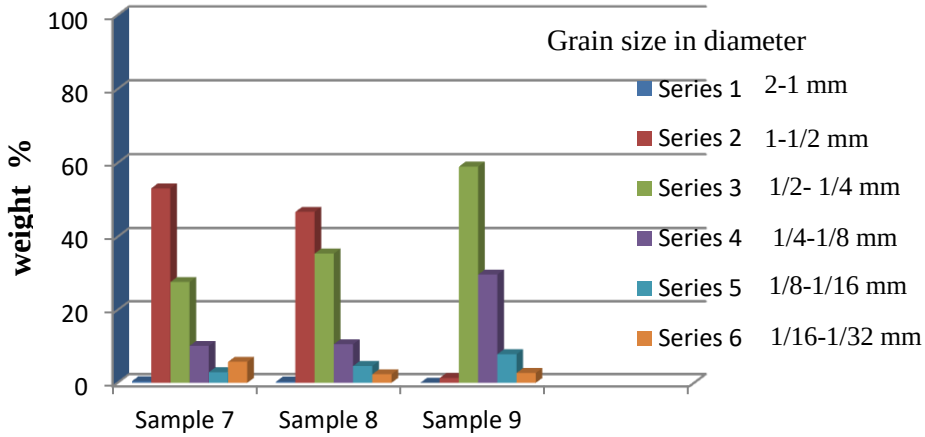


Figure (8). Representative histograms showing size frequency distribution of the Irrawaddy Formation

The size of the Moza and Irrawaddy Formations are always unimodal. Mostly the fine admixtures are more abundant the coarse admixtures. The total amount by weight in coarse admixtures varies 0.03 to 37.24% and that of the fine admixtures from 2.00 to 52.96%. The modal classes in the Moza sandstones are formed by 0.25 to 0.125 mm class, the Khabo Sandstones 0.5 to 0.125 mm whereas the Irrawaddy Formation 1.00 to 0.25 mm. the number of size classes in coarse admixtures ranges from 1 to 3 mm and fine admixtures 1 to 4 mm. the amount in modal class varies from 43.56 to 62%.

Mean and Median Size

The values of mean and median size are shown in table (3). Both mean and median are measurements of the central tendency of the size distribution. Mean is generally more

preferable to the mean diameter as a measure of central tendency because the mean diameter as a measure of central tendency is less influenced by skewness.

In table (3), the values of mean and median size are not usually coincident. There is a slight difference between them. The characteristic feature of mean and median size in table shows that the values of mean increase generally from younger Irrawaddy Formation to the older Pegu Group.

The value of mean size in the Moza Formation ranges from 3.17 to 2.80 mm and in the Khabo Sandstone from 2.32 to 2.49 mm and in the Irrawaddy Formation from 1.28 to 2.04 mm. The value of mean size in the Irrawaddy Formation decreases upward. The median sizes range from 2.2 to 2.27 mm in the Moza Formation, from 2.03 to 3.37 mm in the Khabo Sandstone and from 0.98 to 1.90 mm in the Irrawaddy Formation.

Sorting

The sorting values of these sandstones range from 0.58 to 0.97 mm. The sorting values in the Moza Formation range from 0.81 to0.94 mm, 0.58 to 0.95 mm in the Khabo Sandstone and 0.65 to 0.97 in the Irrawaddy Formation. These sorting values are generally uniform. According to the verbal scale of Folk and Ward (1957), all of the sandstones show moderate sorting.

Skewness

Skewness is the measure of the symmetry of grain size distribution. The values of the study area are shown in table (3). The table show that all of the samples are positively skewed, ranging from 0.04 to 0.61. According to olk and Ward (1957) verbal scale, skewness values 0.03 to 1.0 represent positively very skewed, whereas values - 0.10 to 0.11 nearly symmetrical and 0.03 to 1.0 positively skewed. All of the Irrawaddy sandstones are positively very-skewed. Specimen No.5 shows nearly symmetrical and the rest are positively skewed.

Kurtosis

Kurtosis is a measure of peak in grain distribution. The kurtosis values of all samples are shown in table (3).The values of Kurosis varies from 1.14 to 1.48. According to Folk and Ward's classification (1957), verbal limits of the samples show leptokurtic to very leptokurtic. The majority of these sands are mainly leptokurtic. This fact indicates that the central part of the size distribution is better sorted than the marginal area.

DISCUSSION AND CONCLUSION

The study area is located in the Cenozoic Belt of Myanmar and composed of Miocene to Pliocene clastic sedimentary rock. In the study area, Upper Pegu of Moza Formation (Middle Miocene), Khabo Sandstone (Middle Miocene) and Irrawaddy Formation (Late Miocene to Pliocene) are occurred. The mechanical analysis of sandstones and statistical treatment of the size analysis of the sandstones in the study area show that the sandstones are moderately sorted, positively skewed and leptokurtic to very leptokurtic.

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