

## **PETROGRAPHY OF MIOCENE SANDSTONES IN THE PYAWBWE AREA, MINBU TOWNSHIP**

Aye Aye Aung<sup>1</sup>, Myitta<sup>2</sup>, Daywa Aung<sup>3</sup>

### **Abstract**

Miocene clastic sedimentary rocks exposed in the Pyawbwe area of Minbu Township occupying the western trough of Central Cenozoic Belt. This mollassic sequence consists of Pyawbwe Formation (Aquitanian) and Kyaukkok Formation (Burdigalian) of Upper Pegu Group (Miocene). The present research mainly focuses on petrography of Miocene sandstones. The sandstones of the study area mainly composed of quartz, feldspar, rock fragments, glauconites, chlorite, mica, bioclasts grains, accessory minerals and cements. Petrographically, the majority of sandstone of the study area are arkose, lithic arkose and feldspathic lithicarenite. The sediments of the study area are derived from dissected arc and transitional arc to undissected arc provenances. The early diagenetic features such as grains compaction, distortion of mica, broken shell fragments, grains compaction of calcitization and glauconization well marked. Late diagenetic features are formation of concretion and nodules, corrosion of grain and iron oxide pigmentation.

**Keywords:** Central Cenozoic Belt, Mollassic, Miocene

### **Introduction**

The study area is situated in the west of Minbu Township, Magway Region. It lies between latitudes 19° 51' 00" N to 20° 04' 00" N and longitudes 94° 37' 30" E to 94° 47' 00" E in topographic map index 84 L/12, 85 I/ 9 and 85/I13 of Myanmar Survey Department (Figure 1). The area is 21.12 km long along the north to south and 16.72 km wide along the east to west. The total areal coverage is 353 square kilometers. The sandstones of the present area are mollassic clastic sediments. The Miocene sandstones constitute about 68 to 83% of detrital grains and 17 to 32% of cements in Pyawbwe sandstones and 78 to 87% of detrital grains and 13 to 22% of cement in Kyaukkok sandstones. These sandstones are composed of quartz, feldspar, mica, heavy minerals and rock fragments. The maximum detrital grains are 1.35 mm in diameter and 0.25 mm in the minimum diameter. The grain to grain boundaries are tangential, long and suture contact. Modal composition of the detrital grains in shown in table(1). The detrital grains of the Lower Miocene sandstones are mostly sub-angular to sub-rounded, medium to coarse-grained arkose, lithic

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1. Lecturer, Dr., Department of Geology, Dagon University,
  2. Part-time Professor Geology Department, University of Yangon,
  3. Professor and Head of Department of Geology, Dr., University of Yangon

arkose and feldspathic litharenite. (After Folk, 1974) see Fig. (2). I would like to aim that the study of the source rock types are suggested by sandstone composition and the provenance terrain from sandstone modal data.

### Methods

Fifty sandstone samples were collected from the stream outcrops of the Pyawbwe and Kyaukkok Formations mainly exposed in western part of Minbu Basin. Standard petrographic thin sections for twenty medium-grained sandstones were cut and examined out of which ten of thin sections were selected and analyzed using a modified Gazzi-Dickinson method of point counting (Gazzi, 1996; Dickinson, 1970, 1985; Ingersoll et al., 1984). A total of 300 – 400 framework grains were identified per thin section for QFL mode and lithic population at spacing of 0.5 mm. The medium-grained sandstones were selected for the provenance study in point counting data because sand grains control on their composition.

Petrographic counting parameters are presented in table 1. Point count raw data are shown in appendix and the data recalculated and resulting modes and lithic percentages appear in Table.2. Four types of triangular plots were constructed from these data. The QFL plots of McBride (1963) and Dickinson (1985) are used for classification and provenance study. Moreover, the triangular plots of Dickinson (1979, 1985); Qm-P-K, Qm-F-Lt, and Lm-Lv-Ls plots are applied as the useful indicators for distinguishing provenances.

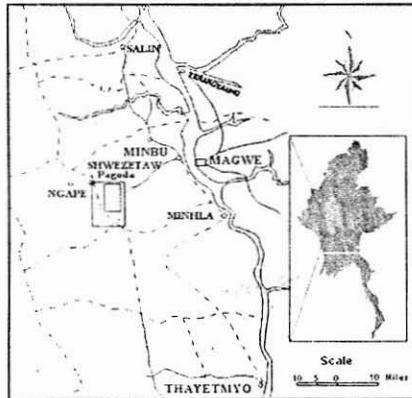


Figure (1) Geographic position of the study area

## **The detrital framework grains**

### **Quartz**

Detrital grains of quartz average about 30 to 39% of detrital fraction. Different types of quartz occur in Kyaukkok sandstones and Pyawbwe sandstones. Generally, monocrystalline quartz grains are more common than polycrystalline quartz grains. Monocrystalline quartz grains consist about 17 to 24 % of Kyaukkok sandstones and less than 10% of Pyawbwe sandstones.

Polycrystalline quartz derived from igneous and metamorphic fragments which are average about 1 to 10% respectively. The grains are mostly elongated or flattered and have a parallel crystallographic orientation. The metamorphic quartz is more elongated than igneous origin. The inclusions in the monocrystalline quartz grains are muscovite, rutile and tourmaline and they show undulatory extinction with extinction angle between 5 ft and 25 ft. The monocrystalline quartz average 0.1 mm to 0.9 mm in size whereas polycrystalline quartz grains range from 0.3 mm upto 0.8 mm in diameter.

### **Feldspar**

The detrital grains of feldspar are averaging about 25 to 50 percent of the detrital framework. Both alkali feldspar and plagioclase occur in Lower Miocene sandstones. Generally orthoclase including microcline is more than plagioclase but microcline is a very few amount of Pyawbwe sandstones. Kyaukkok sandstone is absent of microcline.

Most of the feldspars show sub-angular to sub-rounded, sub-equant to elongated shape and a few plagioclase grains exhibit undulatory extinction. Orthoclase feldspars are absent in twinning. Polysynthetic twin lamellas are distinct in plagioclase.

### **Rock fragments**

The most abundant type of igneous rock fragments is volcanic grains which consist of andesitic fragments with parallel to sub-parallel feldspar laths in the altered fine-grained groundmass.

The second most abundant type of rock fragments is foliated metamorphic grains consisting of chlorite schist, quartz muscovite schist, chlorite phyllite and slate. Most of the sizes are ranging from 0.5 to 1.2 mm in diameter with subrounded and range in 0.15 to 0.58 mm and coated by iron oxide cement.

## Mica

Biotite is more common than muscovite and they comprise about 0.55 to 3.1 % of detrital fraction. They are fresh to slightly weathered and subangular to subrounded in shape. The biotite is considerably altered sericite and mostly altered to chlorite, glauconite and iron oxide. Biotite flakes are bifurcated by introduction of calcite cement due to effect of compaction, mica flakes are bent. Some mica flakes are generally oriented parallel to sub-parallel and frequently occurred distorted crenulated nature.

## Accessory minerals

The dominant accessory minerals are biotite, chlorite, muscovite, hornblende, augite, pyrite, tourmaline, zircon, serpentine and hematite as well as phosphate and glauconite are also present.

Glauconite and pyrite occur in Pyawbwe sandstones.

Chlorite, glauconite and iron oxide are probably altered from biotite and clay minerals (see Galliher, 1936).

The sandstones of Pyawbwe Formation are mostly composed of less than one to two percent and Kyaukkok sandstones consist of one to three percent.

## Cement

In Miocene sandstones, calcite and iron oxide (hematite) cements are more abundant than others. They comprise about 17-32% of Pyawbwe sandstones and 13-21% of Kyaukkok sandstones. The calcite cement composes about 35 to 70 % in all cement types of the sandstones. Occasionally the cement occurs as poikilolitic texture and filled the pore spaces and some voids remain and the calcite crystals have subequant in shape and finely crystalline to medium crystalline (0.02 to 0.9 mm) in size.

Iron oxide cement is also occurred in the fossiliferous lithic arenite of Pyawbwe sandstones and Kyaukkok sandstones as well as inclusion in the calcite cement also present.

Silica cement is formed as quartz overgrowth on detrital grains and they compose about 10 to 15% in all cement types of the Lower Miocene sandstones. Quartz overgrowth formed as the first generation of cement and latter followed by calcite cement which marginally replacement the quartz overgrowths.

**Bioclast**

Most of the molluscan debris are usually leached and their molds are filled with calcite cement. Echinoids fragment is coating with iron oxide which mainly consist about 5% in the biogenic fragments. Foraminifera fragments especially echinoid spines are filled with sparry calcite cement. Larger foraminifera such as *Lepidocyclina* sp. are mainly composed with original calcitic materials and the microfossils of *Globigerinoides* sp. are also present Pyawbwe sandstones and Kyaukkok sandstones.

Table(1) Detrital percentages of the Lower Miocene sandstones exposed in the Pyawbwe area.

Sample No.	Quartz	Feldspar	Rock Fragment	Formation
T-mk <sub>1</sub>	31.86	28.21	39.91	Kyaukkok Formation
T-mk <sub>2</sub>	30.92	52.09	16.45	Kyaukkok Formation
T-mk <sub>3</sub>	32.68	29.38	37.92	Kyaukkok Formation
T-mk <sub>4</sub>	38.20	40.32	21.46	Kyaukkok Formation
Average	36.73	37.50	28.79	Kyaukkok Formation
T-mp <sub>1</sub>	39.67	50.62	9.72	Pyawbwe Formation
T-mp <sub>2</sub>	39.67	50.62	9.72	Pyawbwe Formation
T-mp <sub>3</sub>	37.53	35.33	27.13	Pyawbwe Formation
T-mp <sub>4</sub>	34.44	43.88	21.66	Pyawbwe Formation
Average	36.73	45.10	18.16	Pyawbwe Formation

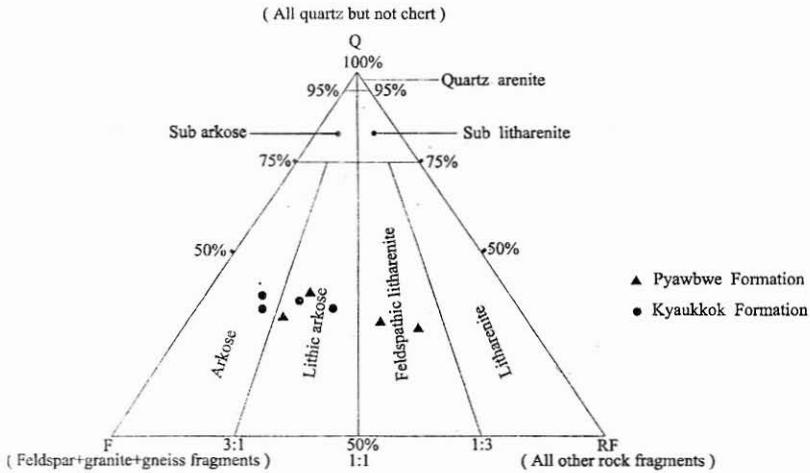


Figure (2) To show the composition of Miocene sandstones exposed in the Pyawbwe area. (After Folk . 1974)

**The indicated provenance of the sandstones**

The detrital composition of sandstones influenced the tectonic setting of its provenance region. Dickinson (1985) distinguished four major provenance terranes: stable craton, basement uplift, magmatic arc and recycled orogen. Provenance and basin are governed by plate tectonics, which controls the distribution of the different types of sandstones (Dickinson & Suczek, 1979). The studies of sandstones within western Minbu basin can be used to unravel the geological history of the provenance terrain. Point count data of the sandstones are recalculated and plotted on QFL, Q<sub>m</sub>PK, Q<sub>m</sub>FL<sub>t</sub> and L<sub>m</sub> L<sub>v</sub> L<sub>s</sub> triangular plots of Dickinson (1979, 1985) clearly demonstrated that the Pyawbwe sandstones and Kyaukkok sandstones fall within the suites of transitional to dissected and undissected magmatic arc provenances (Figure 3 to 6, and Table 2).

Table (2) Recalculated modal point - count data

Sample No.	Q-F-L%			Qm- F - Lt %			Qm-P- K%			Lithic %			Formation
	Q	F	L	Qm	F	Lt	Qm	P	K	Lm	Lv	Ls	
T-mk <sub>1</sub>	31.86	28.21	39.91	30.32	18.63	51.05	63.93	5.66	32.4	40.93	10.11	48.95	Kyaukkok Fm.
T-mk <sub>2</sub>	30.92	52.09	16.45	27.22	54.9	17.88	33.15	1.94	64.91	19.09	5.31	75.59	Kyaukkok Fm.
T-mk <sub>3</sub>	32.68	29.38	37.92	29.39	30.83	39.77	48.8	5.73	45.46	10.13	21.02	68.84	Kyaukkok Fm.
T-mk <sub>4</sub>	38.20	40.32	21.46	34.42	44.94	20.63	43.37	2.57	54.07	10.65	36.56	54.77	Kyaukkok Fm.
Average	36.73	37.50	28.93	30.34	37.33	32.33	46.81	3.98	49.21	20.20	17.75	62.04	Kyaukkok Fm.
T-mp <sub>1</sub>	39.67	50.62	9.72	31.37	57.58	11.06	35.27	7.09	57.65	33.68	41.71	24.61	Pyawbwe Fm.
T-mp <sub>2</sub>	37.53	35.33	27.13	27.2	41.21	31.59	39.77	14.78	45.46	36.98	44.33	18.69	Pyawbwe Fm.
T-mp <sub>3</sub>	35.26	50.58	14.14	14.78	70.3	14.92	17.32	1.65	80.98	65.10	25.77	9.12	Pyawbwe Fm.
T-mp <sub>4</sub>	34.44	43.88	21.66	34.83	46.91	18.24	42.62	2.35	55.45	53.25	26.01	20.72	Pyawbwe Fm.
Average	36.73	45.10	18.16	27.05	54.00	18.95	33.75	6.47	49.89	47.46	36.46	18.08	Pyawbwe Fm.

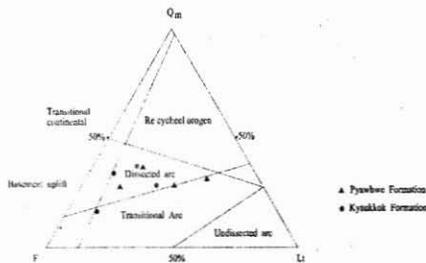


Figure (3) Triangular plots of Qm F Lt showing selected sandstone suites derived from different types of provenances after Dickinson (1985). Pyawbwe sandstones and Kyaukkok sandstones fall within the transitional to dissected magmatic arc provenance.

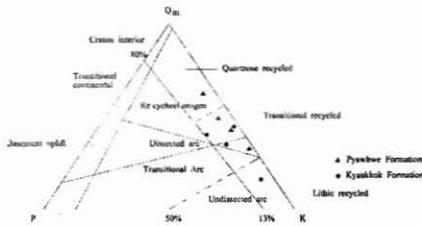


Figure (4) Triangular showing Qm P K diagram of the Miocene sandstones from the Pyawbwe area ( After Dickinson , 1985 )

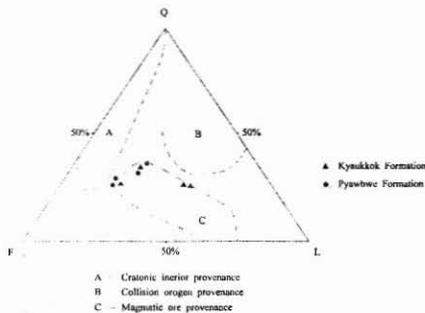


Figure (5) Q.F.L diagram, the plotted points in the centre of the QFL diagram of both Pyawbwe and Kyaukkok Formations. Show characteristic

features of a rather mature (dissected) magmatic arc provenance ( Dickinson & Suczek , 1979)

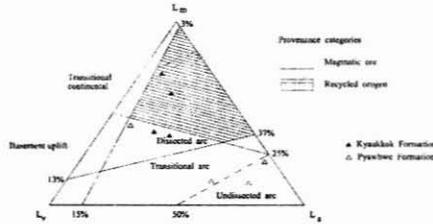


Figure (6) Triangular showing  $L_m$   $L_v$   $L_s$  diagrams of the Lower Miocene Sandstones from the Pyawbwe area ( after Dickinson , 1985 )

Table (3) Showing the probable provenance for the sediments the Miocene of the Pyawbwe area.

Formation	Major Provenance	Subordinate Provenance
Kyaukkok Formation	Recycled Orogen	Quartzose recycled
Pyawbwe Formation	Dissected arc	Transitional recycled
Pyawbwe Formation	Dissected and Transitional arc Undissected arc	Transitional recycled

### Results

According to classification of Folk (1974), the sandstones of the study area fall in the field of arkose, lithic arkose and feldspathic litharenite. Sandstones of the study area mainly compose of quartz, feldspar, mica, rock fragments, glauconite, bioclast grains, accessory minerals and chemical cements. The present research area involves early diagenesis and late stages in the diagenetic features. Formation of quartz overgrowth, clay authigenesis, effects of compaction and pressure dissolution, sidertic cementation, borings, algae coatings and authigenic minerals are the characteristics features of early diagenesis. The microscopic characteristics features such as a variety of

cements, calcite replacements, shrinkages and cracks in glauconite and megascopic features like concretions, cone-in-cone structures, iron nodules and fracture, filling calcite comprises the late diagenesis.

### **Discussion**

Magmatic arc source includes the continental and island arc associated with subduction and metamorphosed sediments. The volcanic grains of Pyawbwe, and Kyaukkok sandstones commonly have andesitic composition and they are usually macro and micro porphyritic. Plagioclase feldspar grains with compositional zoning and volcanic lithic fragments, many of which contain plagioclase phenocrysts are the characteristics constituents of the arc-derived sands. In sandstone suites of transitional between undissected and dissected arc provenances contain minor admixtures of demonstrable plutonic detritus: even through the main sources were still volcanic. Detritus derived from the recycling of the orogenic belts is very varied in composition reflecting the different types of orogen.

Sediment from a recycled orogen may fill adjacent foreland basin or be transported in major river systems to more distinct basins in unrelated tectonic settings.

Lithic grains dominate in many recycled orogen sandstones, and those derived from continental collision mountain belts. Quartz plus sedimentary rock fragments dominate and then the metamorphosed equivalents of the latter as deeper levels of the orogen are uplifted. Most sandstones are derived from uplift and magmatic arc becomes more quartzofeldspathic and less lithic, and potash feldspar increases relative to plagioclase, as volcanics in the arc eroded and then more plutonic rocks are exposed (Diskinson, & Suckez, 1979).

### **Summary**

The present study area lies in Minbu Basin of the Central Cenozoic Belt which consists of the molassic clastic sedimentary rocks of Upper Pegu Group (Lower Miocene) comprising Pyawbwe and Kyaukkok formations. Petrographically, the sandstones of the study area are arkose, lithic arkose and feldspathic litharenite. The source of the sediments are derived the sediments were derived from a crystalline basement uplifted region compromising of

both acid plutonic igneous rocks and low to medium grade metamorphic rocks. Besides, the presence of high temperature quartz represents the sediments to have descended from the volcanic origin.

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