Petrography and Provenance Study of the Moza Formation in Myindwin-Shwebawgyun Area, Mahlaing and Wundwin Townships, Mandalay Region

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Abstract

The research area is situated in Mahlaing and Wundwin Townships of Meiktila District, Mandalay Region. This area lies in the Central Cenozoic Belt of Myanmar. It is low-land area and the rock units are trending in a north-south direction. It is bounded by Sagaing Fault to the east. The Moza Formation (Middle Miocene) is underlying the Khabo Formation (Middle Miocene) and the Khabo Formation also underlying the Irrawaddy Formation (Late Miocene to Pliocene). The Moza Formation is mainly composed of the alternating sequences of sandstone, shale, mudstone and clay. Petrographic studies of sandstone, the composition of detrital grains are microcrystalline quartz, feldspars, bifurcated biotite flakes and various compositions of rock fragments. On the basis of the petrofabric and mineralogical studies of sandstones of the Moza Formation is classified as Subarkose and Sublithicarenite. The overall assemblages of petrographic studies point out that the sandstones of the Moza Formation are considered to be derived from a mixed provenance comprising of sedimentary rocks, low- to high-grade metamorphic rocks and plutonic igneous source. Triangular plot of Moza Formation indicated that those sandstones are falling in the field of recycled orogeny.

Key words: Moza Formation, Miocene, Subarkose, Sublithicarenite, recycled orogeny

Introduction

The research area is located in Mahlaing and Wundwin Townships of Meiktila District, Mandalay Region (Fig.1). Myindwin-Shwebawgyun area lies between latitude N 21º 07′ 46′′ to 21º 12′ 42′′ and longitudes E 95º 42′ 18′′ to 95º 52′ 52′′, in one-inch topographic maps 84 O/12 and 84 O/16. The research area is approximately 8.1 km long in north-south direction and 12.8 km wide in east-west direction, covering area of approximately 102.4 km^2 and is located beside the Yangon-Mandalay Expressway Road. This area is located in the Central Cenozoic Belt. The investigated area lies in the northernmost part of the folded Bago Yoma Uplift within the eastern through (Chit Saing, 2003).

Between the Central Volcanic Line and the Eastern Highlands, the Upper Pegu beds are exposed as anticlines and synclines. Three stratigraphic units are found in the northern part of the Pegu Yoma. These are Taungtalon Sandstone, Moza Formation and Khabo Formation. In the

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research area, Moza Formation (Middle Miocene) and Khabo Formation (Middle Miocene) and Irrawaddy Formation (Late Miocene-Pliocene) are well exposed. The Moza Formation is distributed at the eastern part of the area. Good exposure of Moza Formation can be observed along the road cutting of the Yangon-Mandalay expressway road. The Moza Formation is mainly composed of the alternating sequences of sandstone, shale, mudstone and clay. The geological map of the study area is shown in figure (1). The sandstones are generally light greenish-yellow to light grey, thin- to thick-bedded, fine- to coarse-grained sandstones and micaceous sandstones are observed.

Purposes of Study

This study is selectively analyzed the rocks of Moza Formation in the study area. The investigation is to be worked out the petrology and provenance of the research area.

Materials and Methods

Review of the previous geological works and the aerial photographs relating to the present area were studied before going to the field. The petrography of sedimentary rocks related books were also collected and studied. Field investigation is composed of numerous traverses and detail investigation. The geological maps of one-inch topographic maps 84 O/12 and 84 O/16 refer to previous reports that were used as base maps. Collection of the representative samples of rock units and using GPS for location. The collected samples are made in thin section for study on under polarizing microscope of analyzed samples to describe the detailed mineralogical and to get the petrographic data.

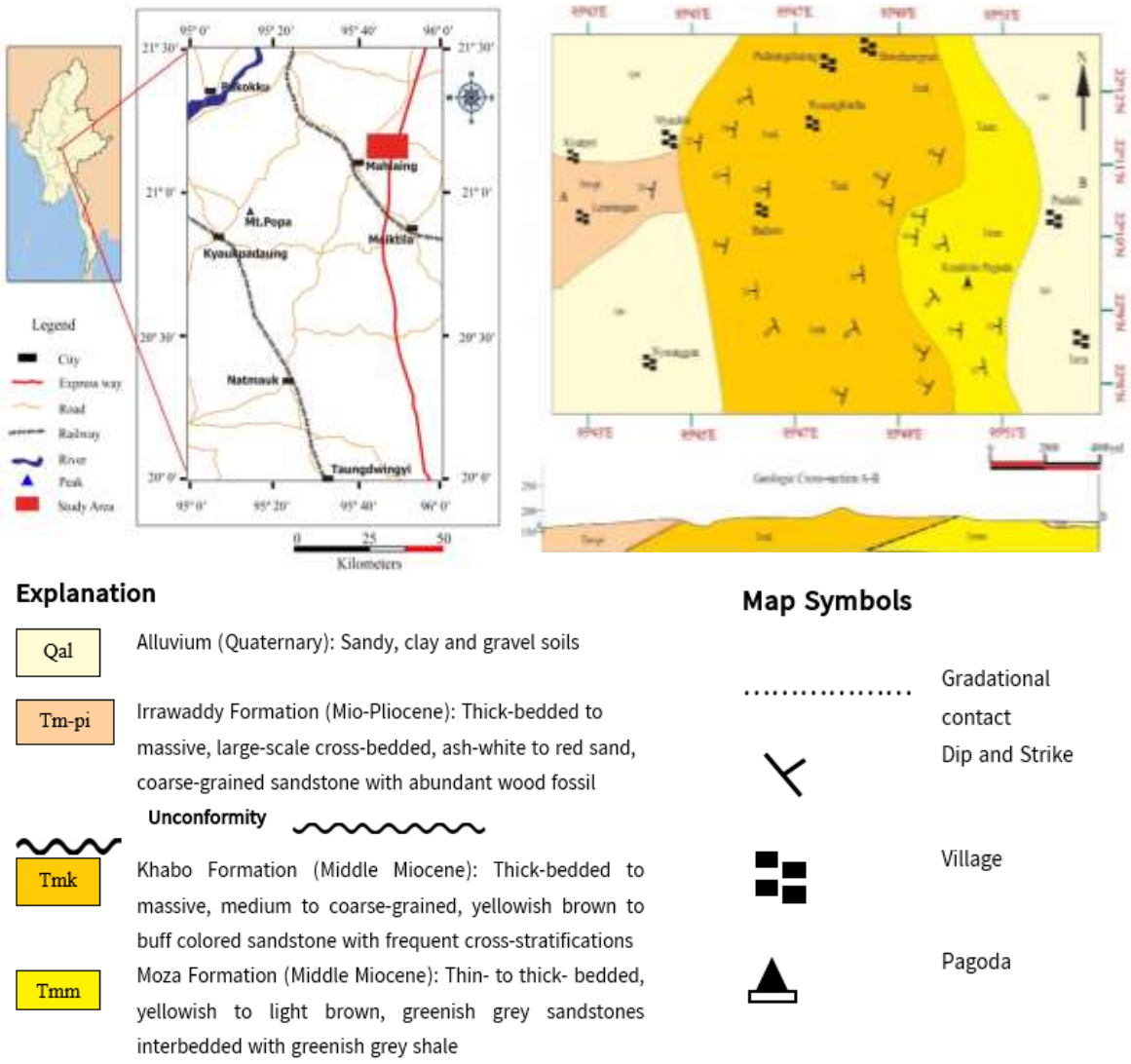

Figure (1) Location map and Geological map of the Myindwin-Shwebawgyun area

Previous Works

Theobald (1873) first introduced the term “Pegu Group” to designate on important group of Oligocene-Miocene deposit in Myanmar Central Belt and subdivided into two parts by an important unconformity which approximated the Oligocene-Miocene boundary. Tertiary sediments are mostly covered the central Myanmar. The hydrocarbon prospects are found in central Myanmar. Aung Khin and Kyaw Win (1968) investigated the geology and hydrocarbon prospects of Myanmar Tertiary geosyncline and expressed the paleogeography of Myanmar during the Cenozoic time. The most remarkable works for the study area and its environs have been done by Myint Thein (1966), Thike Tun Thaw (1977), Maung Maung (1978), Maw Maw(1993), Kyi Khin and Myitta (1999) and more than. They investigated transgression and regression in Miocene sequences of northern Pegu Yoma, central Myanmar, stratigraphy, sedimentology, sedimentary facies and structural geology of central Myanmar for their perspectives.

Petrography

Petrographic study of selected sandstone samples are collected from the Moza Formation. Sedimentary petrography is the analysis of both depositional and diagenetic fabric from thin sections under polarizing microscope. Sandstone composition is also influenced by tectonic setting, source rock, and intensity of weathering and erosion of the source rock, depositional environment, diagenetic processes, and topography (Dickinson and Suczek, 1979). Modal compositions of sedimentary rocks are estimated based on comparing the percentage estimation comparison charts, and the classification scheme of Pettijohn, 1975, Tucker, 2001 thin section identification.

Sandstone

According to the microscopic studies, sandstones of the Moza Formation are fine- to medium-grained, and the detrital grains are moderately- to well-sorted and sub angular to sub rounded in shape. It is composed of 70 to 85 percent detrital grains and the cementing material such as calcite and iron cement which constitutes 15 to 25 percent of the total rock volume. The detrital grains comprise of quartz, feldspar, rock fragments, micas, opaque mineral and other accessory components. The maximum diameters of the grains vary from 0.2mm to 0.4mm and the minimum diameter of the gains varies from 0.05mm to 0.1mm. The average grain diameter of the detrital fraction is 0.1mm.

Detrital Constituents

The detrital grains comprise of quartz, feldspar, rock fragments, micas, opaque mineral and other accessory components. Quartz is the most predominating mineral in the studied sandstones and its content ranges from 65 to 75 percent of the total rock volume in the Moza Formation. Quartz occurs preferentially sand-size crystals (monocrystalline quartz), detrital polycrystalline quartz and some of the quartz grains of grain-to grain boundaries are concave-convex contact (Fig.2). The compaction effect in the sandstones is also evidenced by quartz grains that display intensive fractures (Fig.3). Polycrystalline quartz grains that originate as single grains in metamorphic or plutonic igneous rocks, quartz rich sandstones are considered (Pettijohn et al., 1987). They show milky color, grey and white color and slightly undulose and some have nonundulose extinction. Some of the quartz grains are fractured and corroded in nature due to the transportation and diagenetic effects, and then calcite, silica and iron are replaced in these places. As the grains are poorly to moderately sorted and sub-rounded in shapes, which indicates short transportation and immature sediments. Sandstones are composed of a very restricted suite of major detrital minerals and rock fragments, plus a variety of minerals that may be presented in accessory amounts (Table.1).

Feldspar comprises 10 to 20 percent of the total fractions in sandstone of Moza Formation. Feldspars are commonly divided into two main groups; potash feldspars, chiefly, orthoclase, microcline, perthite are more common than plagioclase feldspars. Perthites are the result of slow cooling and so are more typical of plutonic source rocks (Pettijohn et al., 1987). Feldspars are moderately elongate, sub angular to sub rounded in shape will show a cleavage in some orientations, twinning may be seen under cross-polar, and it is often slightly cloudy under plane-polarized light. Microcline shows a very distinctive grid or cross-hatch twinning in thin section under crossed-polar (Fig.4). Perthite is characterized by patchy intergrowths of albite in the form of irregular veinlets. Plagioclase feldspar usually can be identified by its polysynthetic or multiple twinning with twin lamellae that are straight and parallel (Fig.5).

Rock fragments constitute about 5 to 15 percent of the framework grains in average sandstones in the Moza formation. They are derived more from supracrustal rocks undergoing rapid uplift and erosion. The types of lithic grain do relate to plate-tectonic setting of the provenance terrine and adjoining sedimentary basin (Tucker, 2001). The most common rock fragments are sedimentary rocks, such as siltstone clasts and sand clasts (Fig.6). The igneous rock fragments show the myrmekitic texture and metamorphic rock fragments are also rarely observed (Fig.7).

Mica content is 5 percent of the detrital framework in the Moza formation. Biotites plates are subhedral to euhedral in form and show as reddish brown to deep brown in color and bifurcated structure (Fig.8). The grains also appear elongate and may be bent or deformed, mica flakes are quite delicate and can get squeezed between harder grains when sandstone is compacted (Fig.9). Some biotite flakes are partly altered to chlorite and between the grain-grain boundaries replaced by the iron cement. Less than 1 percent of the detrital fraction is composed of heavy mineral grains of magnetite, hematite, and other opaque minerals.

Cementation

The interstitial pore spaces of sandstones are filled with calcite cement and iron cements which constitutes 10 to 13 percent of the rock volume. Calcite cement is more common than the iron cement in this formation. A common feature of this sandstone is corroded of detrital grains and replaced by calcite cement. Silt sized grains of quartz and feldspar matrix also observed in this formation. Moreover, the detrital quartz grains and biotite fragments are coated with iron oxide (iron cement) in some sandstone samples in the Moza formation.

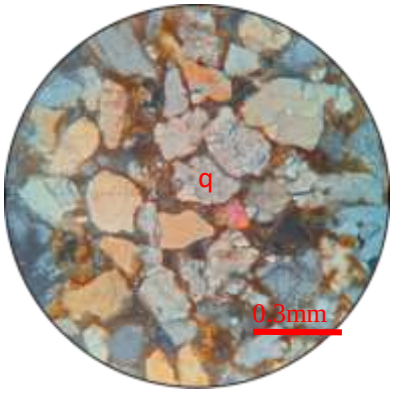

Figure (2) Concavo-Convex contact of monocrystalline quartz(q) grains by compaction effect of the Moza Formation (XN)

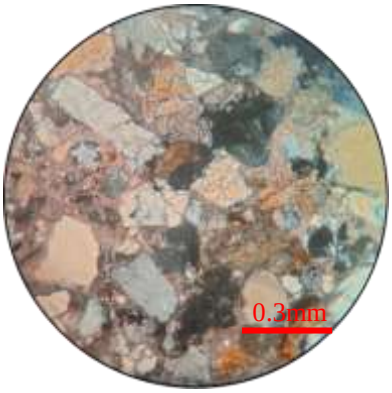

Figure (3) Intensive fracture of quartz grains corroded by calcite cement of the Moza Formation (XN)

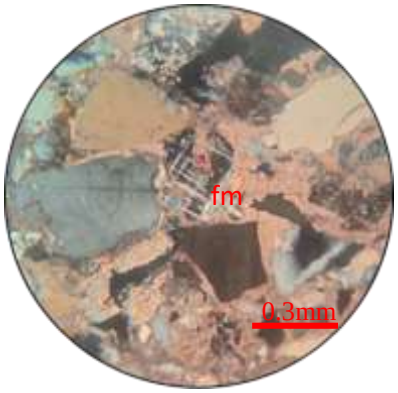

Figure (4) Microcline feldspar(fm) shows cross-hatch twinning, with the two sets of twin lamellae perpendicular to each other of the Moza Formation (XN)

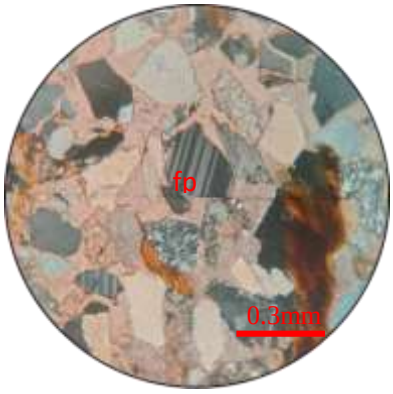

Figure (5) Plagioclase feldspar (fp) gives the polysynthetic twinning of the Moza Formation (XN)

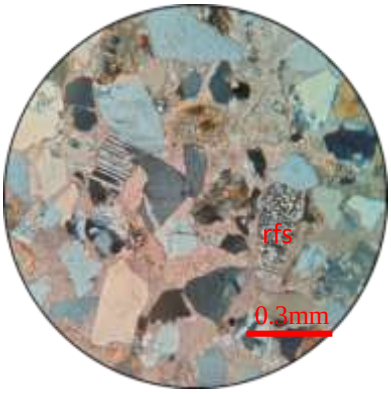

Figure (6) Sedimentary rock fragments(rfs) (sand clasts and siltstone clasts) of the Moza Formation (XN)

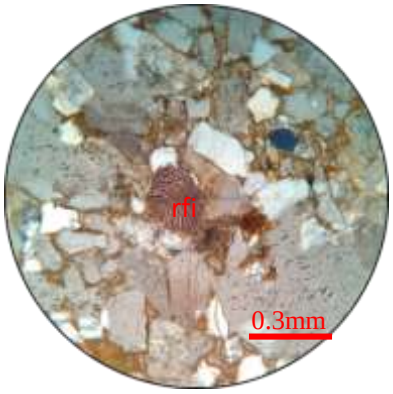

Figure (7) Igneous rock fragment (rfi) show the myrmekitic texture in sandstone of the Moza Formation (XN)

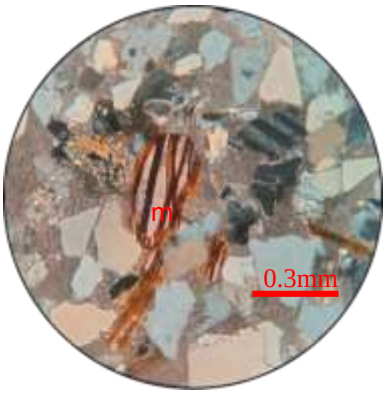

Figure (8) Biotite mica(m) show bifurcaed structure by the replacement of calcite cement in sandstone of the Moza Formation (XN)

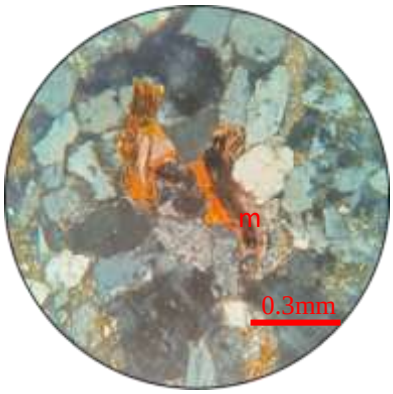

Figure (9) Bending of the biotite mica(m) by compaction effect of the sandstone in the Moza Formation (XN)

Table (1) Modal visual analysis of detrital constituents for the sandstones in the Moza Formation

Detrital Constituents	Volume Percent	Detrital Grains
Major minerals	65% - 75%	Quartz - include monocrystalline and polycrystalline quartz
	10% - 20%	Feldspars - include plagioclase feldspar (albite) and K-feldspars (microcline and perthite)
	5% - 7%	Micas - include predominantly biotite than the muscovite. Occasionally, biotite altered to chlorite.
Rock fragments	5% - 15%	Igneous rock fragments (feldspar laths intergrowth within the fine groundmass), sedimentary rock fragments (siltstone clasts and sand clasts), metamorphic rock fragments (quartzite)
Accessory minerals	1% - 2%	Chlorite, hematite, magnetite and other opaque minerals
Cement	10% - 13%	Matrix – include silt-sized, finer-grained quartz and feldspar grains. Cement - between the detrital grains replacement by the calcite cement and iron cement.

Nomenclature

Quartz content is more than 70 percent and feldspars are more content than the total rock fragments. According to the sandstone classification of Pettijohn et al., 1987, most of the sandstones of the Moza formation fall within the name **Subarkose** and **Sublithicarenite** (Fig.10).

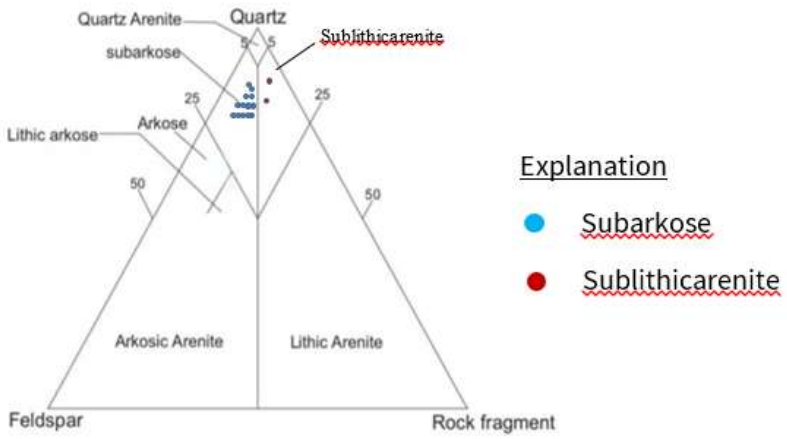

Figure (10) QFL ternary diagram showing classification of sandstones from Moza Formation (After Pettijohn et.al., 1987)

Provenance Study by Detrital Components

The nature and composition of light and heavy minerals have been used to the understanding of the provenance of sediment. The source rock of the Myindwin-Shwebawgyun area may be determined on the petrographical identification of thin sections. The detrital grains comprise of quartz, feldspar, rock fragments, micas, opaque mineral which are cemented with calcite cement and rarely iron cement. Consideration on the evidence of quartz and its relative abundance show that the source area may be mainly granitic terrains.

Alkali feldspars are more abundant than plagioclase feldspars in this sandstone which is the excellent indicator for igneous source. Alkali and acid igneous source of perthite and microcline feldspars can be recognized in the Moza formation. The occurrence of sand-sized feldspar grains may be indicated as a felsic igneous origin. Because of feldspar of sand-size grade is originally obtained from plutonic rock such as granite origin. Abundant of sedimentary lithic fragments increasing in the study area, suggest a low input from orogenic belts and a high proportion of reworking from older sedimentary deposits. The presence of micas mainly biotite, are frequently observed in the sandstones of the Moza Formation. It might be derived from mica-bearing granite, gneiss; schist and opaque minerals suggest the igneous and metamorphic origin.

Mica flakes are bent and distorted due to early compaction. The compaction effect in the sandstones is also evidenced by straight, long, concavo-convex and breakdown the mineral grains. The overall assemblages of petrographic studies point out that the sandstones of the Moza Formation are considered to be derived from a mixed provenance comprising of sedimentary rocks, low- to high-grade metamorphic rocks and plutonic igneous rocks.

In the QFL triangular of Dickinson (1985), the modal composition data of the Moza Formation falls in the field of recycled orogenic (Fig.11). Dickinson (1985) noted that source components of recycled orogens are predominantly sedimentary strata and subordinate volcanic rocks, partly metamorphosed, exposed to erosion by the orogenic uplift of fold belts and thrust sheets.

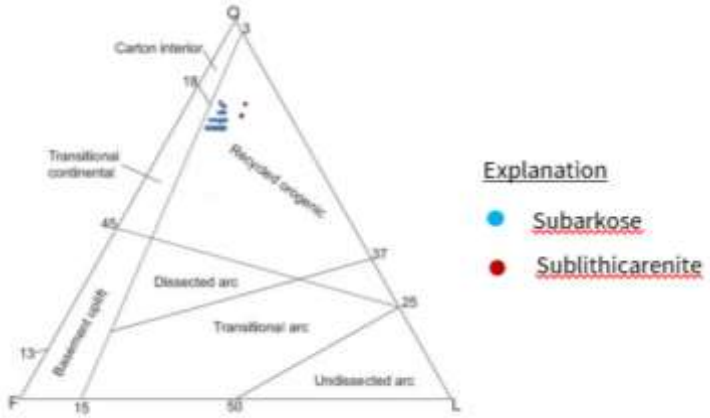

Figure (11) QFL ternary diagram showing selected sandstone samples of Moza Formation derived from different types of provenance after Dickinson (1985) (Q = Quartz, F = Feldspar, L = Rock Fragments)

Result and Discussion

The detrital grains of sandstone of the Moza Formation comprise quartz, feldspar, rock fragments, micas, opaque mineral which are cemented with calcite cement and rarely iron cement. Consideration on the evidence of quartz and its relative abundance shows that the source area may be mainly granitic terrains. Alkali feldspars are more abundant than plagioclase feldspars in this sandstone which is the excellent indicator for igneous source. Alkali and acid igneous source of perthite and microcline feldspars can be recognized. The occurrence of sand-sized feldspar grains may be indicated as a felsic igneous origin. Because of feldspar of sand-size grade is originally obtained from plutonic rock such as granite origin. Rock fragments are generally derived more from supracrusttal rocks undergoing rapid uplift and erosion. The types of lithic grain do relate to plate-tectonic setting of the provenance terrine and adjoining sedimentary basin. The igneous rock fragments are observed that indicated the igneous origin. Abundance of sedimentary lithic fragments increasing in the study area, suggest a low input from orogenic belts and a high proportion of reworking from older sedimentary deposits. It might be derived from granite, gneiss, schist of the igneous and metamorphic origin.

On the basis of petrographic data, those rocks are classified as Subarkose and Sublithicarenite. All the clastic debris indicated the Quartz rich source and possibly derived from recycled Orogeny provenance. It means that the depositional site for Moza Formation is connected with the plate tectonic mechanism possibly convergence plate boundary.

Summary and Conclusion

The research area is falling into the central Low Land and the rocks exposed the whole area are mainly clastic sedimentary rocks of Miocene to Pliocene age. This work emphasize on the petrology of sandstones from Moza Formation. On the basis of petrographic data, those rocks are classified as Subarkose and Sublithicarenite. The depositional site of Moza Formation is connected possibly with the convergence plate boundary. Along this boundary all the sediments are severely affected by shear movement causing folding, faulting and grain-breakage. The crustal deformation of the study area is also related to the nearly N-S trending Sagaing Strike-Slip Fault System. All the clastic debris are derived from Quartz rich source and falled in Recycled Orogen.

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