PETROGRAPHY AND DIAGENESIS OF THE KALAW FORMATION IN THE TIGYIT AREA, SHAN STATE (SOUTH)

Wai Wai Lwin[1]*, Day Wa Aung[2], Kyaw Khaing[3]

Abstract

The aim of this paper are to classify the sandstones of Kalaw Formation and to describe diagenesis of these sandstones of the Tigyit area. The research area lies in Tigyit area, Shan State (South) and its situated in the tectonic province of Shan-Tanintharyi Block of Myanmar. The study area is mainly composed of Mesozoic to Cenozoic clastic sediments and subordinate amount of Paleozoic to Mesozoic age of carbonate rocks. Petrographic studies of the selected sandstone samples collected from the Kalaw Formation were carried out in detail. The sandstones of Kalaw Formation have less than 75 percent of detrital framework and 25 percent matrix. The detrital grains are composed of quartz, feldspar, mica, various kinds of rock fragments and very little heavy minerals. Medium-grained sandstones of Kalaw Formation fall in "Litharenites" and fine-grained sandstones of Kalaw Formation fall in the field of "Arkose". Generally, three processes of diagenesis are observed in the sandstones. These are; compaction, cementation and authigenesis.

Keywords: *diagenesis, detrital grains, litharenite, arkose, authigenesis*

Introduction

The study area lies along the highway from Aungban to Loikaw in the Pinlaung Township, Shan State (South) and its fall in the tectonic province of Shan-Tanintharyi Block or in the Eastern Highlands of Myanmar. The location map of the study area is shown in Figure 1. It is mainly composed of Mesozoic to Cenozoic clastic sediments and subordinate amount of Paleozoic to Mesozoic carbonate rocks. The sedimentary rocks are of Late Permian to Early Triassic of Nwabangyi Dolomite Formation, Middle Triassic of Natteik Formation, Jurassic of Loi-an Group, Cretaceous of Kalaw Formation and Pliocene of Hsi-khip Formation. The regional geologic setting of the study area is shown in Figure 2. The present study area divides the Kalaw Formation into three different members: Lower conglomerate-sandstone member, Middle sandstone-shale member, and Upper conglomerate member.

Lower conglomerate-sandstone member is mainly composed of thick-bedded to massive, polylithic conglomerates, and this member is widely distributed at the Myatheintan taung Figure 3. Middle sandstone- shale member is mainly composed of thin to medium-bedded red sandstone interbedded with thin, soft and friable red siltstone Figure 4. Upper conglomerate member is chiefly made up of very massive, hard, dark purplish conglomerate intercalated with minor red siltstone, and reddish sandstone and these member is well exposed at the Myatheintan range, and Tayoktaung Figure 5.

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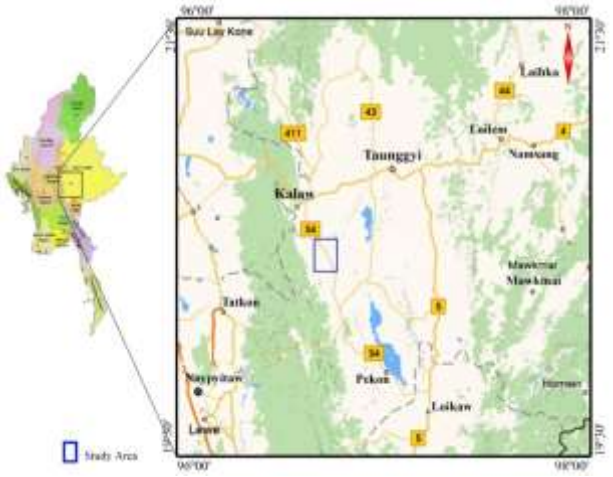


Figure 1 Location map of the study area

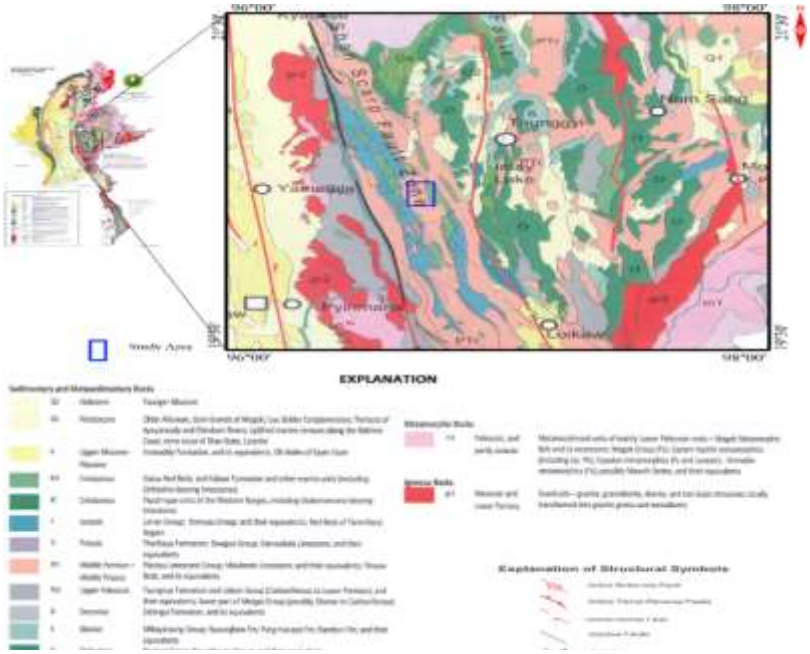


Figure 2 Regional geologic setting of the study area (Source: Myanmar Geosciences Society, 2014)

Figure 3 Interbedded of reddish brown thin- to medium-bedded sandstone and conglomerate occur in the upper member of Kalaw Formation at the Myatheintan taung (N. 20°26´ 18.6" and E. 96°43´ 59.4")

Figure 4 Thin to medium-bedded red sandstone interbedded with thin, soft and friable red siltstone occurring in the middle member of Kalaw Formation (N. 20°28´ 35.9" and E. 96°42´ 42.7")

Figure 5 Massive, hard, dark purplish conglomerate occurring in the upper member of Kalaw Formation (N. 20°26´ 12.1" and E. 96°43´ 35.8")

Petrography and Diagenesis of the Kalaw Formation

Six representative samples were collected from the Kalaw Formation in the Tigyit area. Petrographic studies of the selected sandstone samples collected from the Kalaw Formation were carried out in detail. Modal composition of the various grain types present was estimated by comparing the percentage estimation comparison charts, and the classification scheme of Pettijohn et al. (1987) was used in this petrographic study.

Sandstone

The sandstones of Kalaw Formation have less than 75 percent of detrital framework and 25 percent matrix. The detrital grains are composed of quartz, feldspar, mica, various kinds of rock fragments and very little heavy minerals. The maximum diameter of grains ranges from 0.2 mm to 0.5 mm and minimum diameter of grains, 0.05mm to 0.1 mm. Most grains are angular to subrounded and they generally have moderately to well sorted nature. As the grain contacts are tangential to concavo-convex, the sandstones of the Kalaw Formation have grain-supported frameworks. Detrital grains are set in calcite and hematite cements. Mineral composition and detrital percentages of these sandstones are shown in Table 1, 2 and Figure 6.

Table 1 Mineral composition of the sandstones of Kalaw Formation

Sample No.	KRB-1	KRB-2	KRB-3	KRB-4	KRB-5	KRB-6
	Composition in volume percentage					
Quartz	60	45	53	48	47	35
Feldspar	7	8	8	32	29	38
Rock Fragment	25	32	30	7	8	5
Mica	2	3	3	3	4	13
Heavy Mineral	1	2	1	2	2	-
Matrix	3	7	3	6	6	6
Cement	2	3	2	2	4	3

Table 2 Detrital percentage of the sandstone of Kalaw Formation

Sample No.	KRB-1	KRB-2	KRB-3	KRB-4	KRB-5	KRB-6
	Essential Framework in volume %					
Quartz	65	53	58	55	56	45
Feldspar	8	9	9	37	35	49
Rock Fragment	27	38	33	8	9	6

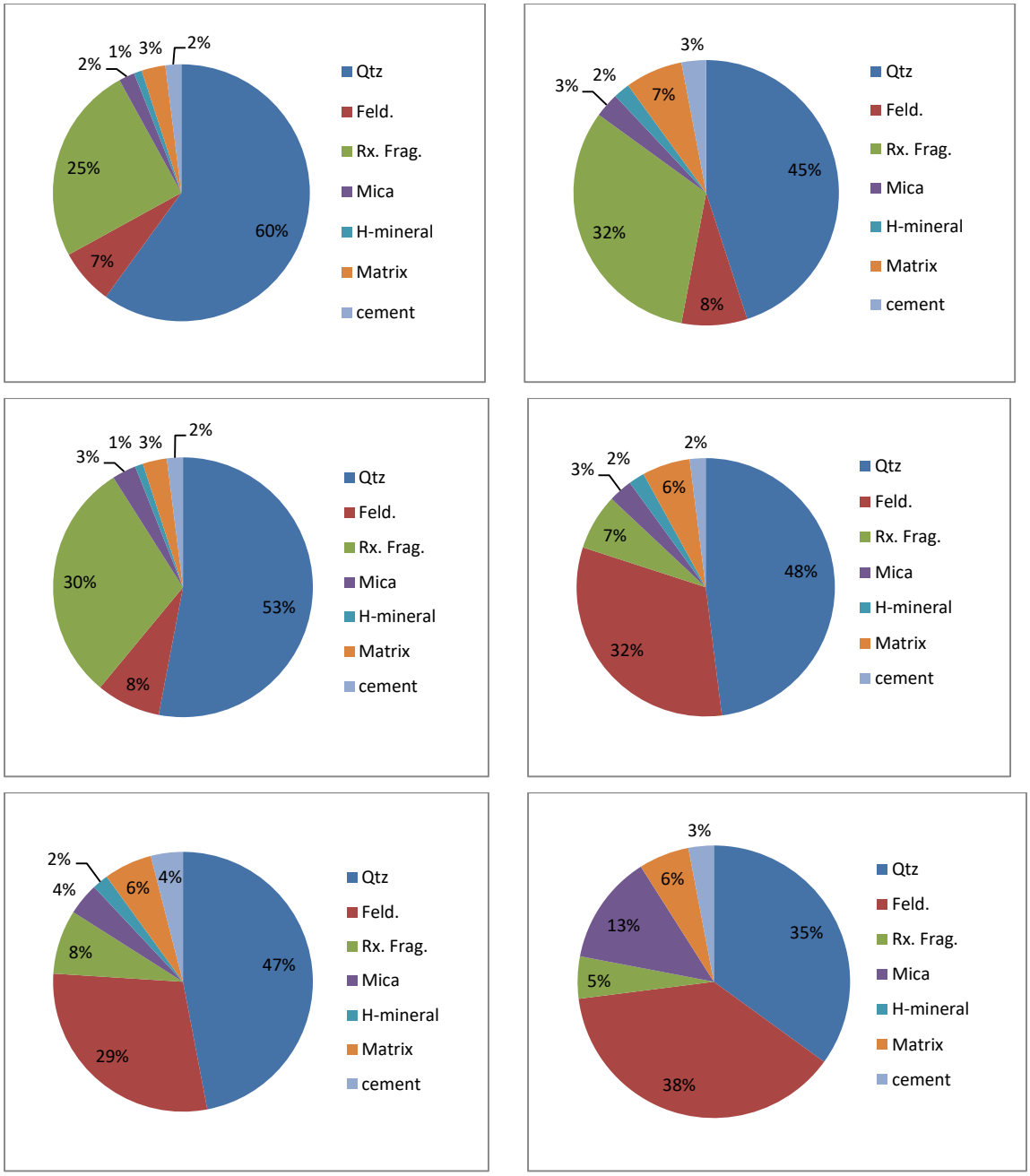


Figure 6 Modal composition of sandstones of Kalaw Formation exposed at the study area

Detrital Fraction

Quartz is the most abundant mineral in these sandstones and it comprises 45 to 65 percent of the total grains. Most of the quartz grains are mono-crystalline. They show undulatory extinction and some have minute inclusions. Some of the quartz grains are corroded by the cement and are often fractured. Nearly two thirds of the total quartz grains are of igneous origin and the rest are derived from metamorphic rocks.

Feldspar comprises less than 10 percent of the total fractions in medium-grained sandstones, but in the finer sandstones of Kalaw Formation it reaches over 45 percent. of the different types of feldspar, potash feldspars, chiefly orthoclase, are more common than the plagioclase. Nearly all of the orthoclase shows a dull or cloudy nature and some grains include the

bright specks formed by sericitization process. Some plagioclase feldspars show polysynthetic twin.

Lithic fragments are common in medium-grained sandstones comprising greater than 25 percent of the total detrital fraction, but fine-grained sandstones contain less than 10 percent. The most common lithic fragments are fine-grained sedimentary rocks such as siltstone, limestone, chert, and meta-sedimentary rock, quartzite. Stable fragments of detrital chert and quartzite grains are more abundant than the other unstable rock fragments of the siltstone. The rock fragments are generally oxidized and pigmented by hematite cement. Mostly muscovite comprises 3 to 7 percent of the framework. Bending and contorting of muscovite due to the introduction of hematite and calcite cements are frequently observed. Less than 3 percent of the detrital fraction is composed of heavy mineral grains of hematite, magnetite and hornblende.

Nomenclature

Medium-grained of sandstones contain quartz is less than 75%, feldspar is less than 10%, and rock fragments is greater than 25%. Thus, these sandstones fall in “Litharenites” (according to Pettijonhn, 1987) Figure 7. Fine-grained textures of sandstones consists of less than 75% of quartz, greater than 25% of feldspar, and less than 10% of rock fragments. So, these sandstones are fall into “Arkose” according to Pettijohn (1987), Figure 8.

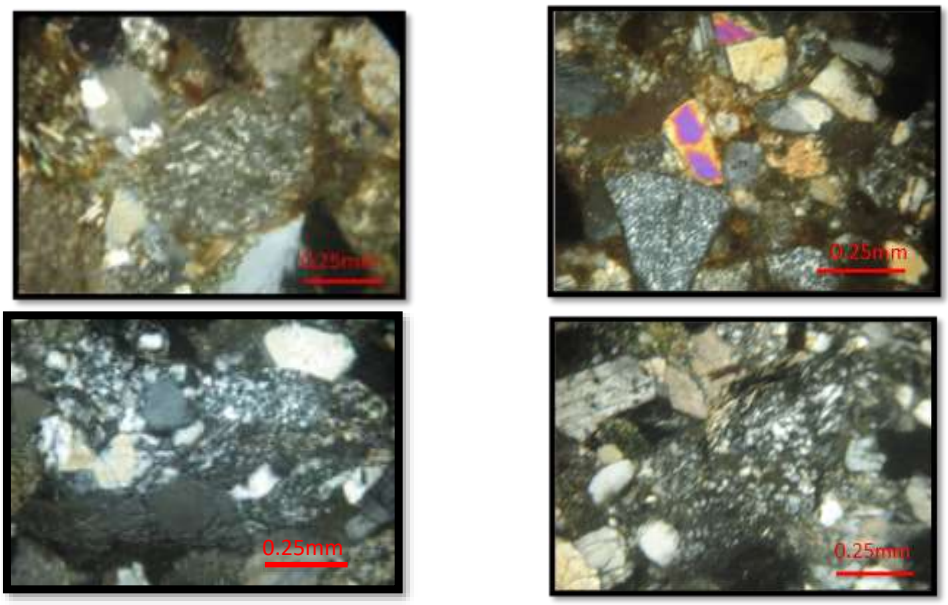
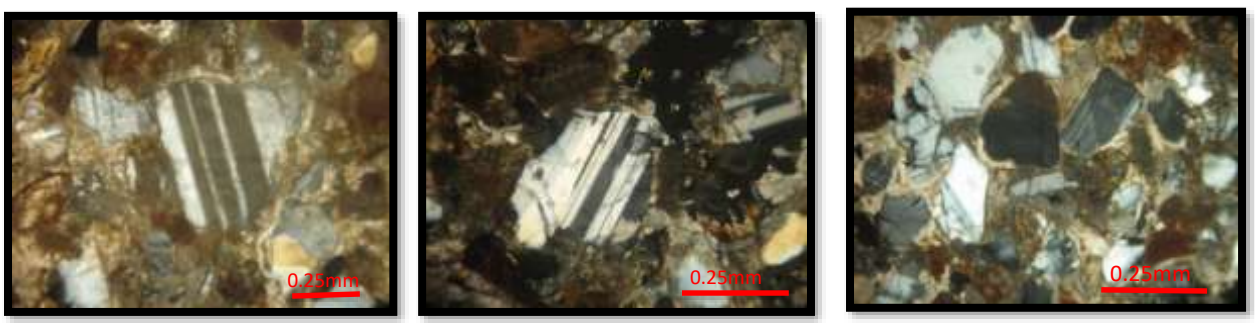


Figure 7 Photomicrographs showing litharenite of Kalaw Formation (Under XN)



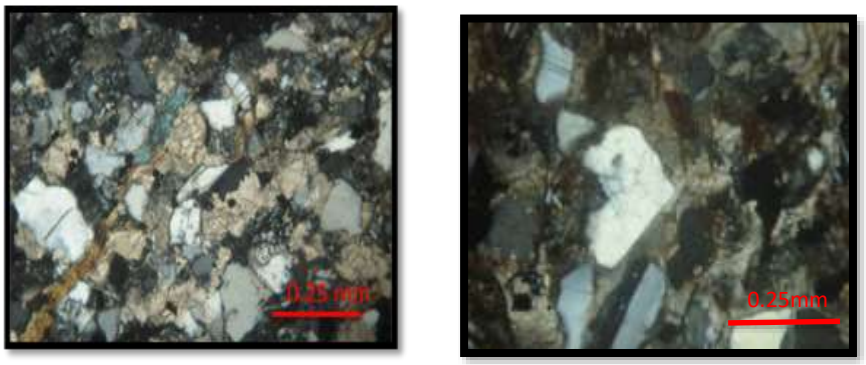


Figure 8 Photomicrographs showing euhedral form of plagioclase feldspar in arkosic sandstone of Kalaw Formation (Between XN)

In a simple quartz-feldspar-rock fragments plot, the sandstones of the Loi-an Group were derived from the craton interior and a recycled orogeny and the sandstones of Kalaw Formation may derived from transitional continental and a recycled orogeny as shown in Figure 9 & 10.

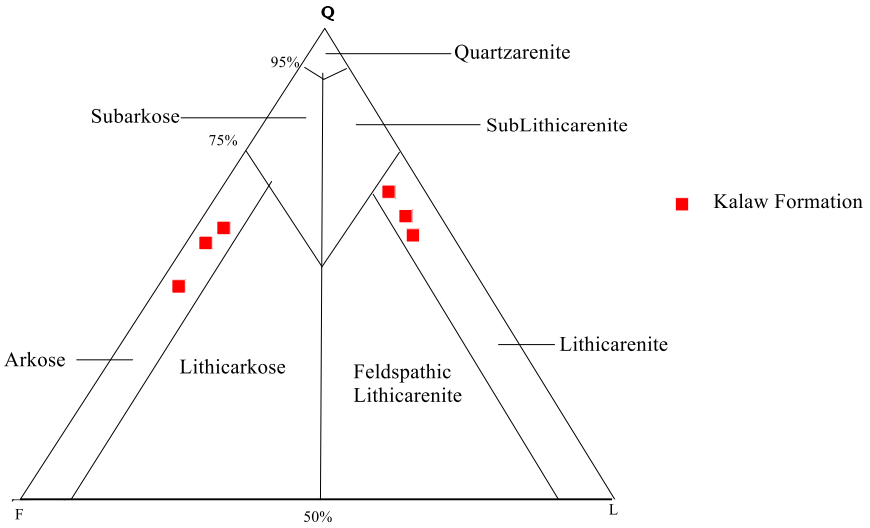


Figure 9 QFL triangular plots of the sandstones of Loi-an and Kalaw Formation (based on Pettijohn, 1987)

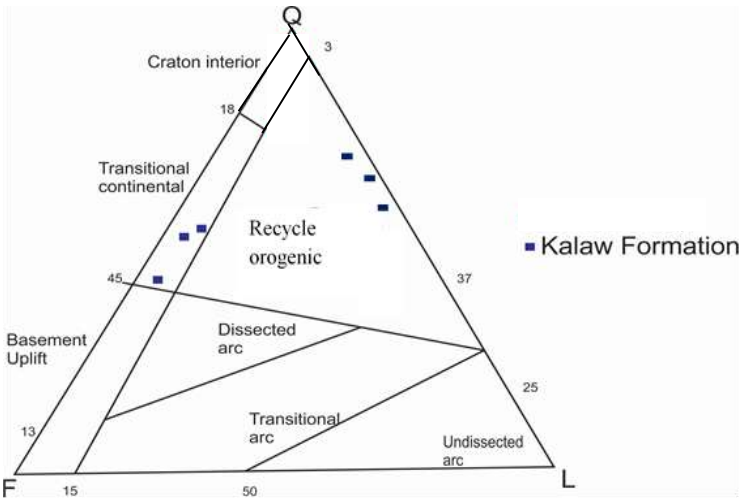


Figure 10 QFL triangular plots showing the provenances of the sandstones of Loi-an Group and Kalaw Formation of the study area (After Dickinson, 1985)

Diagenesis of the Kalaw Formation

Diagenesis has been divided into two stages in the study area (Kalaw Formation) such as early diagenesis, for processes taking place from deposition and into the shallow-burial realms, and late diagenesis for those processes affecting the sediments at deeper levels and on uplift. Generally, three processes of diagenesis are observed in the sandstones. These are (1) Compaction, (2) Cementation, and (3) Authigenesis.

Compaction

The sandstones of the study area were subjected to intense mechanical and chemical compaction during burial. The grain boundaries appear to be a prominent and diagnostic feature of deeply buried sandstone and are also an indicator of compaction and geothermal gradient (Taylor, 1950 in Arif *et al*., 2009). During compaction framework grains are sliding past each other and packed into a tighter configuration. Some of the monocrystalline quartz grains display intensive fracturing, and large detrital micas are commonly bent around more resistant grains by the forces of compaction Figure 11 (A). Corrosion of detrital grains such as quartz and feldspar are common in the study area Figure 11 (B).

Cementation

The chemically precipitated material, which forms cement, is an important constituent of sandstones (Pettijohn, 1975 in Arif *et al*., 2009). Iron oxide cement are the most common in Figure 12.

Authigenesis

Authigenesis is the process by which new mineral is formed within an enclosing sediments or sedimentary rock during or after deposition by replacement or recrystallization or by secondary enlargement of quartz overgrowth. The most valid source of silica for overgrowth is probably that generated by pressure dissolution of detrital quartz grains during compaction on burial (Turner, 1980 in Arif *et al*., 2009) or by infiltration of silica bearing pore fluids from adjacent areas. Sandstones with high content of volcanic rock fragments and feldspars are subjected too much alteration during diagenesis (Tucker, 2001). The minerals which are usually affected by alteration are feldspars. In the sandstones from the study area, partially coated Iron oxide rim around the detrital grains in the Kalaw Formation Figure 13 A & B, feldspar is altered to sericite and clay minerals Figure 14 A & B.

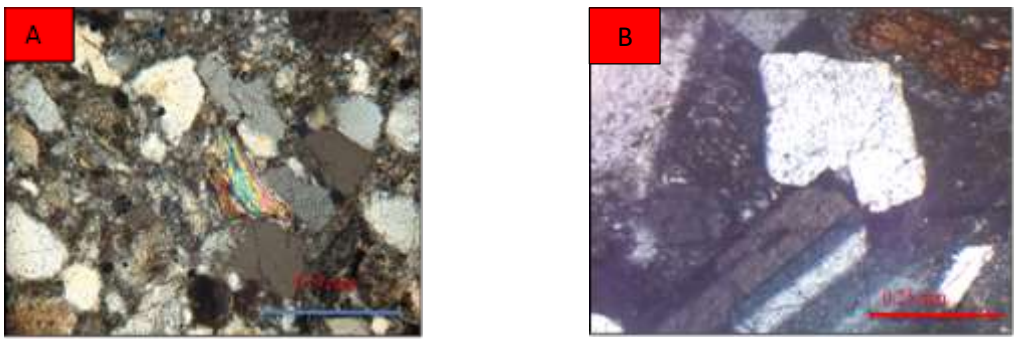


Figure 11 Photomicrographs showing (A) bent and contorted muscovite flake due to effect of compaction in the sandstones of the Kalaw Formation (Between XN), (B) quartz grain corrosion nature in the sandstones of the Kalaw Foramtion (Between XN)

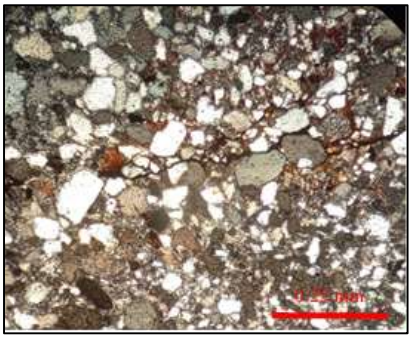


Figure 12 Photomicrograph showing iron oxide cement in the Kalaw Formation (Between XN)

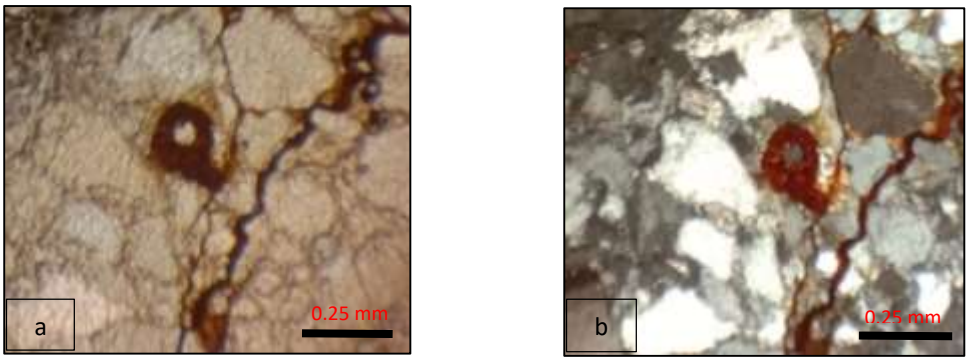


Figure 13 Photomicrograph showing partially coated Iron oxide rim around the detrital grains in the Kalaw Formation (a) PPL, (b) X.N

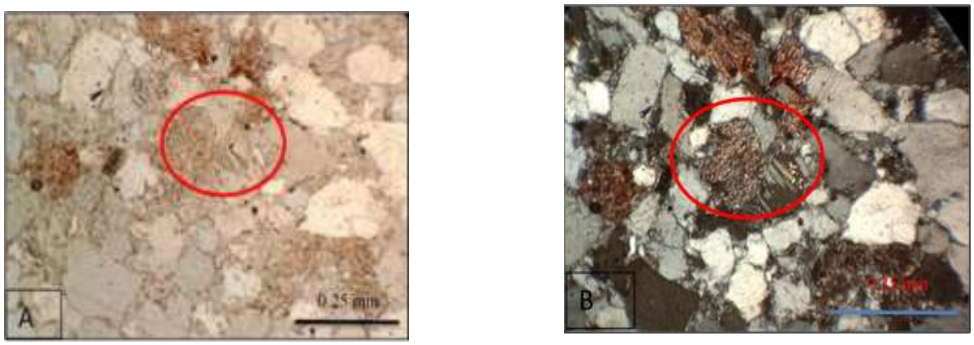


Figure 14 Photomicrograph showing alteration of plagioclase feldspar to clay mineral in the Kalaw Formation (A) PPL, (B) X.N

Paragenetic Diagenesis of Clastic Rocks

In the initial stage, iron oxide cementation occurs around the quartz and feldspar grains, and calcite cementation and silica cementation also appears in the detrital grains. Compaction involved dewatering and closer packing of grains. Some compaction through overburden pressure results in bending of non-resistant grains such as mica. Compaction is the main mechanical event, and began shortly after deposition with a limited amount of grains. Authigenic minerals can be formed at the early stage. Paragenetic diagenesis of clastic rocks of the study area as shown in Figure 15.

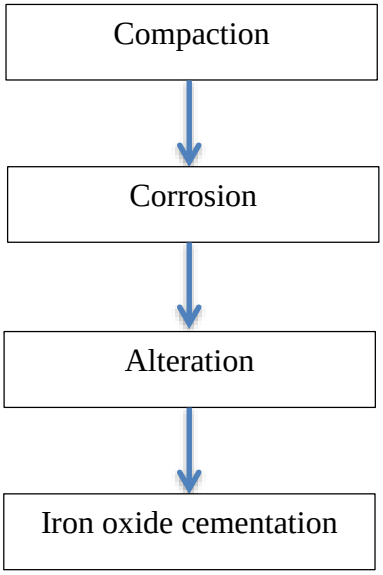


Figure 15 Paragenetic Diagenesis of the Kalaw Formation of the Tigyit area

Conclusion

The study area lies along the highway from Aungban to Loikaw in the Pinlaung Township, Shan State (south) and falls in the tectonic province of Shan-Tanintharyi Block or in the Eastern Highlands of Myanmar. Petrographic studies of the selected sandstone samples collected from the Kalaw Formation were carried out in detail. The sandstones of Kalaw Formation fall in "Litharenites" and "Arkose". Three processes of diagenesis are observed in the sandstones of Kalaw Formation. These are Compaction, Cementation, and Authigenesis.

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