Economic Aspects of Feldspar in the Hlaingdet-Payangazu Area, Thazi Township, Mandalay Division

Myo Min[1], Myo Thiri Sandar Aung[2] and Yu War Chaw[3]

Abstract

The Hlaingdet-Payangazu area is the southern extension of the Pyetkyawe batholith and small amount of metamorphic rocks are formed as the roof pendants. This study focuses on the nature of pegmatite and their geometry, types of feldspar consisting in the pegmatites and reserved estimation of the feldspar based on the quality. The pegmatite dykes and veins are mostly found in the western part of the area. The length of the pegmatite varies from 610 to 6100 cm and 305 to 610 cm in width. The most common type of feldspar is orthoclase-rich alkali feldspar. The trend of pegmatite dyke is NNE-SSW in direction. The open-pit working has to be advanced along the strike of the feldspar deposit. The average ratio of quartz to feldspar is commonly 2:1. According to the ore reserve estimation, the total feldspar reserved for the whole investigated deposits are 150505 metric tons (inferred). Feldspar is used in ceramics for making glass and pottery, both in the body of the ware and in the glaze. It is also used in enamels for household utensils, tile, porcelain sanitary ware and other minor ceramic uses.

Key words: Pyetkyawe batholith, Hlaingdet-Payangazu, pegmatite, alkali feldspar

Introduction

Feldspar is the general name of a group of aluminum silicate minerals containing various amounts of potassium, calcium and sodium. Although feldspar constitutes about 50 percent of igneous rocks, commercial varieties are derived chiefly from pegmatite dikes, mainly granites ones. The Hlaingdet-Payangazu area is the southern extension of the Pyetkyawe batholith and small amount of metamorphic rocks are formed as roof pendants. The nature of exposure is well observed and local people are mining feldspar from pegmatite dykes.

Location

The research area is covered by Myanmar Survey Map Sheet 93D/1, 93D/2, 93D/5 and 93 D/6. It is situated at Latitude 20° 44' N to 20° 51' N and Longitude 96° 10' E to 96° 16' E. It is located between Thazi and Payangazu on Thazi-Taunggyi highway (Figure 1). The location of research area is shown in satellite image (Figure 2).

Methods of Study

1. This study focuses on the use of one inch topographic map and aerial photographs 1:25000 scale for the study of geological mapping.
2. The elevations and positions of levels along pegmatite were determined by GPS and the Burton compass for nature of pegmatite and their geometry.
3. About 50 thin sections were for the microscopic study, for the various types of feldspar analysis, for the study of associated minerals and reserved estimation of the feldspar based on the quality.

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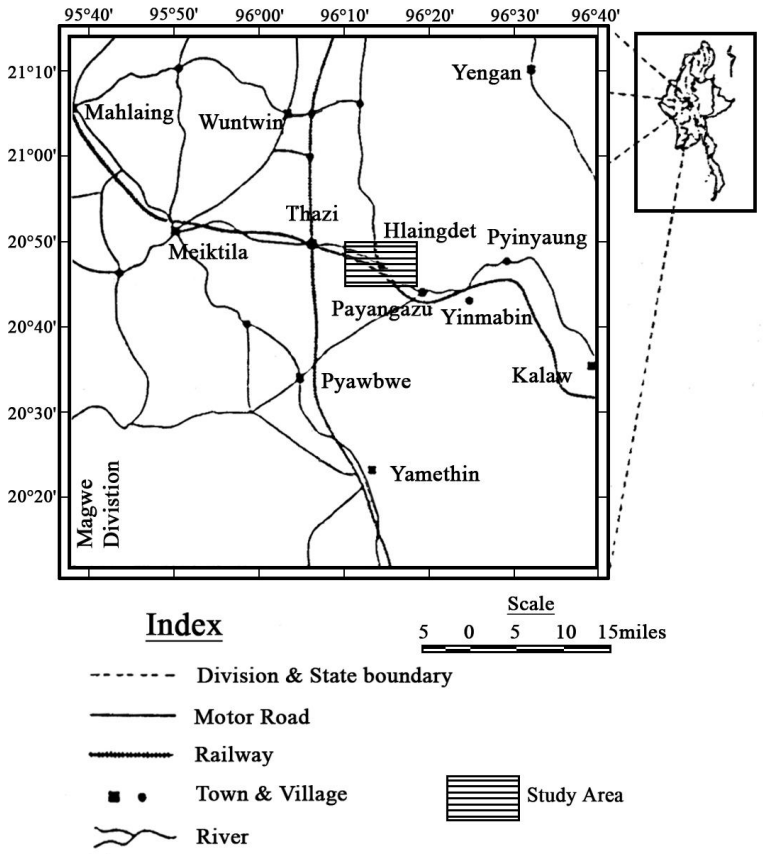


Figure 1. Location Map of the Study Area

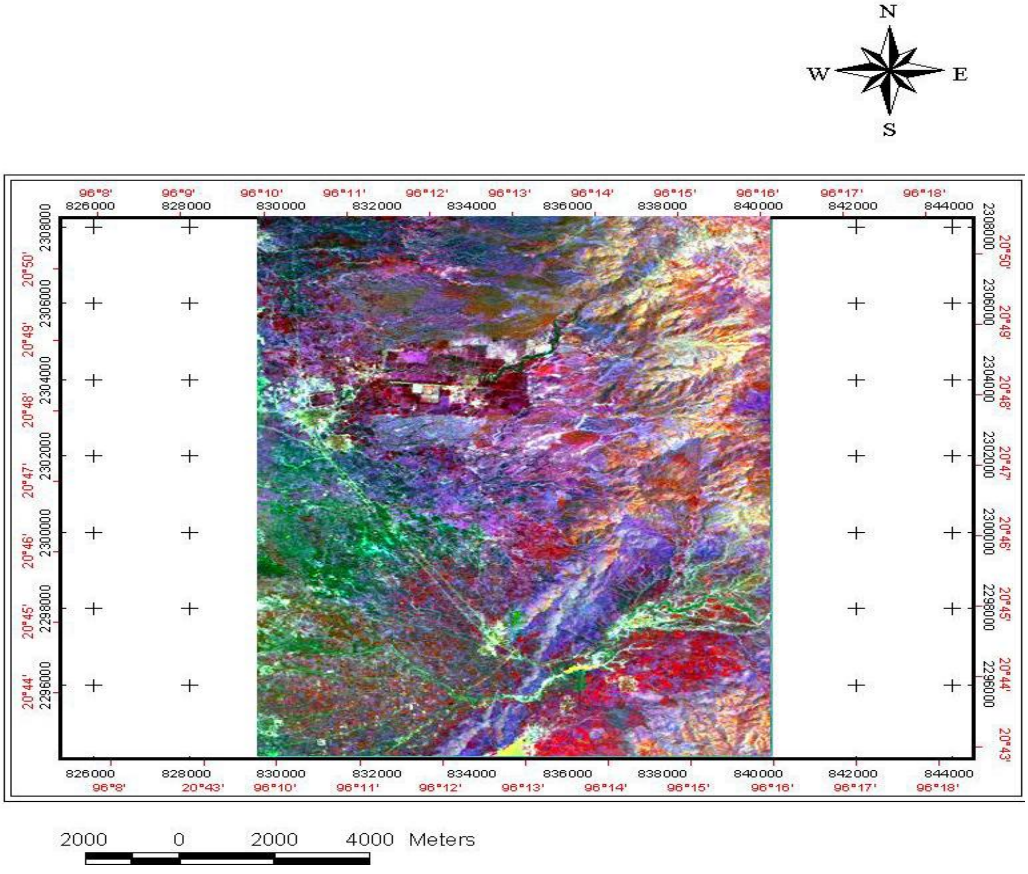


Figure 2. Satellite image of Hlaingdet and Payangazu Area, Thazi Township superimposed on the Band 432 (RGB) of TM image

Previous Works

Clegg (1941) contended that the metamorphic rocks of this area can be traced southward into Mawchi series.

Dutt (1942) regarded all the meta-sedimentary rocks of this area, as the Coal Measure Series (Jurassic), mainly on the basis of similarity in lithology and structural trends, and its relative position to Plateau limestone. Haq (1966) agreed with Clegg in-correlating the Yinmabin Metamorphics (which be designated as the Black Shale Series) with Mawchi Series, which is now considered to range in age from Precambrian to Silurian.

Maung Thein, *et al* (1972), mapped the area on one-inch to one mile scale for the research paper, presented at Myanmar Research Congress.

Thein Zaw (1980) studied petrography and geochemistry of Payangazu Area, Thazi Township in his M.Sc. Thesis, Arts and Science University, Rangoon.

Aye Aye Mar (2003) submitted M.Sc. Thesis on the Geology of Payangazu-Kanabaw area in Thazi Township, Mandalay Division.

General Geology

Regional Geological Setting

The area is mainly composed of granitic rocks and metamorphic rocks (Figure 3). The latter mostly occurs as roof pendants. The igneous complex is the southern extension of the Pyetkyawe batholith in the north.

The sedimentary sequences to the east of the area consist of the Lebyin Group (Carboniferous), Plateau Limestone (Carboniferous-Permian), Loi-an Series (Jurassic) and Kalaw Red Bed (Jurassic-Cretaceous). The general structure of the bed is NNW-SSE.

The western part of the area is an alluvial plain and the Irrawaddy Formation is exposed within the Thazi-Yamethin area.

There are two types of fracture system, viz. NE-SW and NW- SE, respectively. The NE-SW trend predominates the other (Figure 4a and 4b).

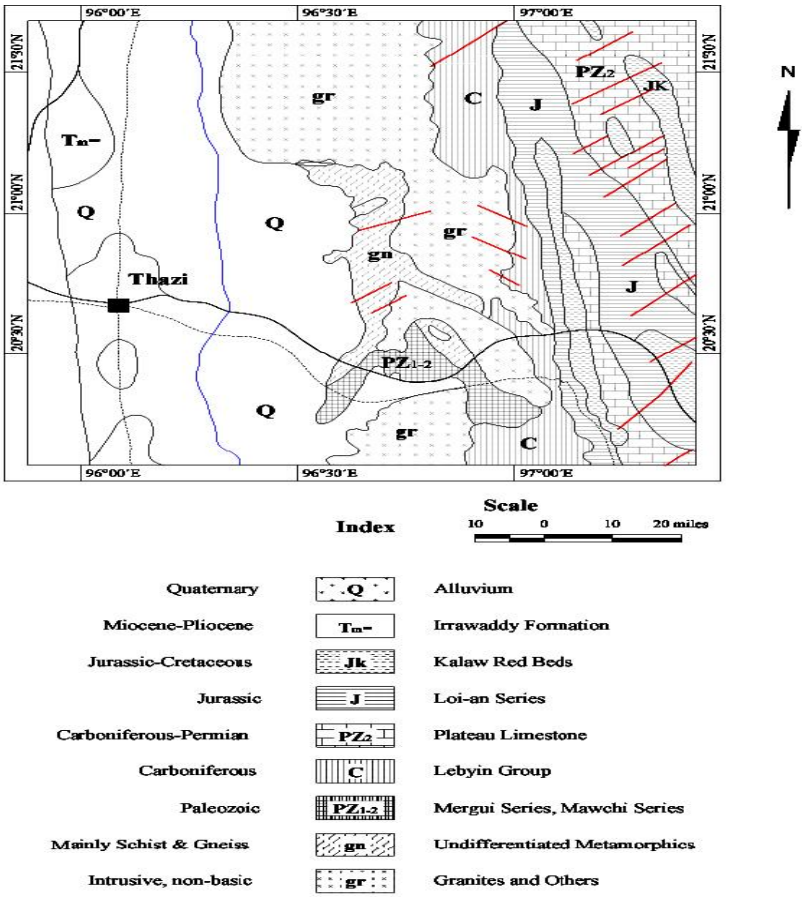


Figure 3. Regional Geological Map of the study area. (After : Geological map of the socialist Republic of the Union of Burma, 1977).

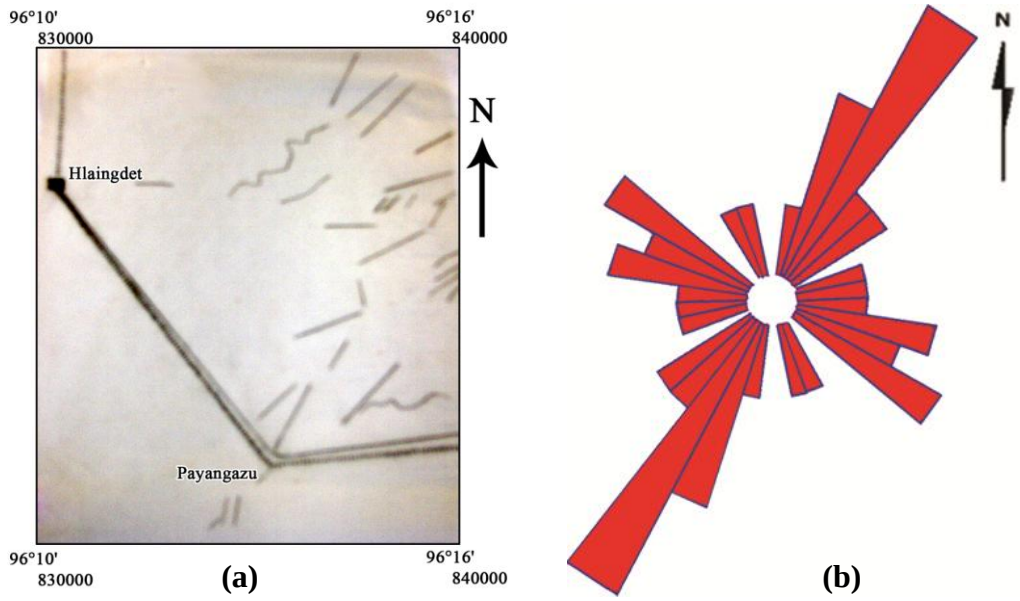


Figure 4 (a) Fractures system map of the study area.
(b) Strike diagram of fracture in the study area

Recognized and mapped rock sequence in the area is shown below. It is made on the basis of field occurrence, such as xenoliths, chilled margins and cross cutting relations.

Rock Sequence (After Myo Thiri Sandar Aung, 2005)

Rock Unit	Age
Alluvium	Recent
Igneous Rocks	
Pegmatite and Quartzo feldspathic vein, Microgranondiorite	Cenozoic
Leucogranite, Hornblendite, Diorite	Early Paleozoic
Metaigneous Rocks	
Granite gneiss, Chlorite schist	Probably Late Mesozoic
Metasedimentary Rocks	
Hornblende-epidote quartzite, Banded biotite gneiss (Yinmabin Metamorphic)	Early Paleozoic

Distribution of Major Rock Units

In the area, diorite is found as xenoliths and poorly exposed. Granite is the most common rock type in the study area. In the western part of the study area, granite gneiss is distinct and porphyritic biotitie granite occurs in the eastern part.

Banded biotite gneiss and migmatite are found in the south of the area. Pegmatite, leucogranite, and microgranite dykes and veins intruded along banded biotite gneiss and migmatite.

Pegmatites

General Character of Pegmatite

In the western part of the study area, the granitic pegmatites are intruding into the host rocks of biotite granite and microgranite. Many pegmatite bodies are sub-parallel to parallel to the foliation cut across the country rocks of granitoid (e.g. porphyritic biotite granite, microgranite). (Figure 5)

Subhedral alkali feldspar is more common in northern part of the study area. Feldspar rich pegmatite is also observed in northern part of the study area. (Figure 6) In the southern part of the area, quartz rich pegmatite is also observed.

The pegmatite veins and dykes show wide variation in size and shape. They are mostly tabular or long and narrow sinous bodies intermittently disappearing under the soil cover, others are branching and irregular. They vary from 610 to 6100 cm in length and 305 to 610 cm in width. The common pegmatites trend are nearly N-S. The main pegmatites dykes striking generally NNE-SSW and dipping about 50° to the east (Figure 7).

Figure 5. Pegmatite dykes intrude into microgranite at Payangazu Area

Figure 6. Feldspar rich pegmatite

There are two types of pegmatite of the mineral composition and texture in the study area.

Simple pegmatite is mostly found in northern part of the study area. It consists of feldspar, quartz and mica. In Taungkanlant area, quartz, orthoclase, plagioclase, muscovite, and biotite are found. Most are subhedral in form and brecciated.

Complex pegmatites are found in Wayonye, Chaukzu Taung and Man Taung. The constituent minerals are quartz, orthoclase, plagioclase, muscovite, tourmaline, apatite, aquamarine and beryl.

The pegmatites boundaries usually have sharp contact with the gneiss, granite and microgranite. The most common of wall rock alteration are epidotization, chloritization and silicification. Petrographic features of many pegmatites in the sudy area show medium to coarse texture.

The 1.2 kg bulk sample of pegmatites are counted at different working sites. The result shows that at Loc N 20° 30' 10.1" and E 96° 14' 34.8", it shows alkali feldspar 60.83%, quartz 35.5%, garnet 3.2 %, tourmaline 0.24% and muscovite 0.23%. At Loc N 20° 48' 40.5" and E 96° 14' 0.17", it shows feldspar 71.3%,quartz 26%, garnet 1.8%, others (tourmaline or magnetite) 0.9%. At Loc N 20° 45' 58.8" and E 96° 13' 48.6", there are feldspar 63.1 %, quartz 25.4 %, muscovite 7.5 %, garnet 2.8 %, tourmaline 0.9% and beryl 0.3 %, respectively.

Minerals Description of Pegmatite

Feldspar

Pegmatite mainly consists of grey to milky colour alkali feldspars. Grain sizes are up to 30 cm in length and subhedral form. Some are highly weathered and brecciated.

Quartz

Anhedral quartz grains are occurred in pegmatite. It has colourless or milky in colour and maximum size of grains is nearly 5cm in length. In some places association of quartz and muscovite are also observed.

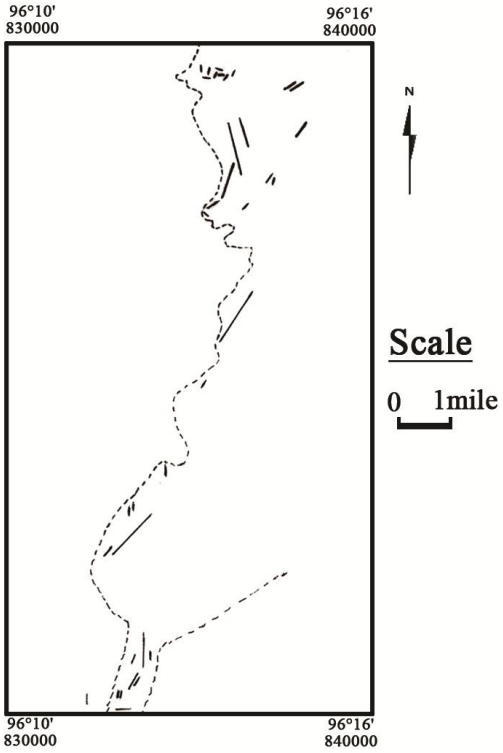


Figure 7. Veins and dykes map of pegmatite in the study area

Muscovite

It is disseminated as small mica book and it is not occurred as commercial lodes in these pegmatites. It is either absent or present in pegmatite.

Garnet

The Almandine garnets are well- observed in margin of pegmatite vein. Red or dark brown in colour and some are weathered. Their grain size is 0.2 mm in length and most of crystals are dodecahedron.

Beryl

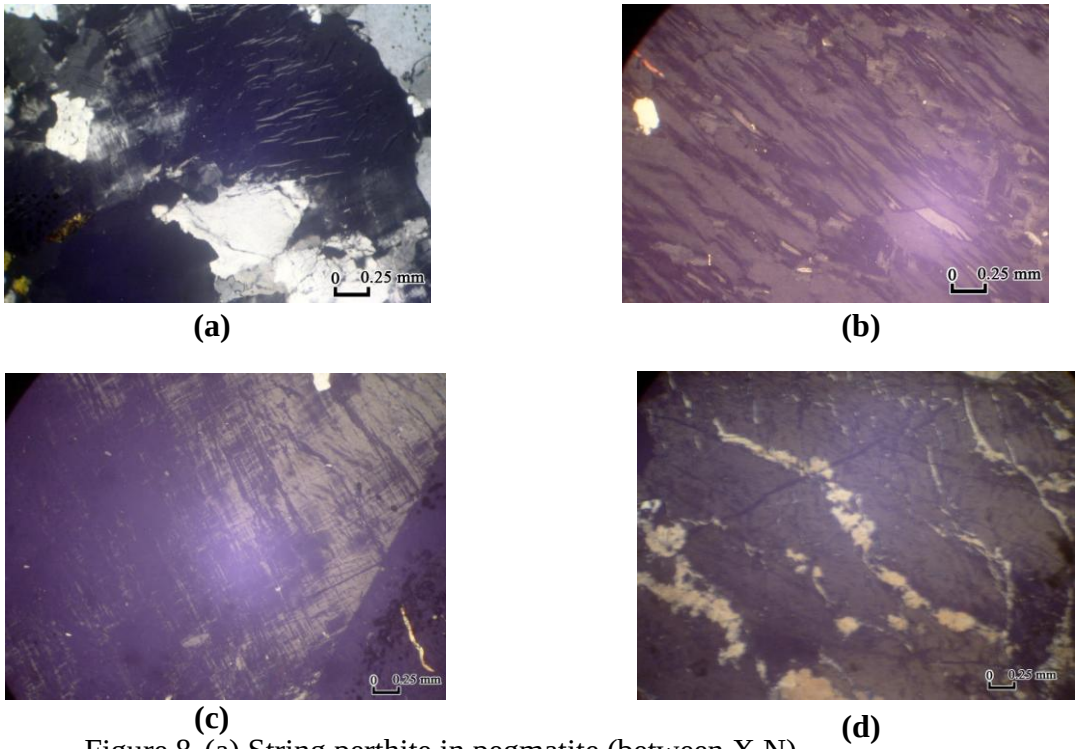
Sky blue and pale green colour of beryl crystals are found in complex pegmatite. Euhedral of six-sided long prismatic in form are observed.

Microscopic Study of Perthites

Perthites in pegmatites of the study area are vein or rod perthite, mesoperthite, string perthite and microcline perthite (Figure 8a, 8b, 8c and 8d). The perthite lamellae are often very coarse and widely spaced: this indicates large diffusion distances for the alkali ions which again indicates a great mobility of the lattice constituents at moderate temperatures.

Perthites blebs distributed with approximate uniformity in different grains. Perthite blebs are controlled by structure of the host feldspar. Abundance of perthite blebs may decrease toward the edge of the host grain, the blebs are uniformed in size, shape and frequently throughout large grains.

Moorhouse (1959) stated that exsolution perthites result from the crystallization of homogeneous potash-soda feldspar, which on cooling breaks down with the formation of blebs of sodic feldspar distributed through the potash feldspar. After Deer (1992), the temperature of the perthite is below the 500° C and it is orthoclase-rich alkali feldspar. It is considered that it is formed directly from the magma and magmatic pegmatite.



(a) **(b)**

(c) **(d)**

Figure 8 (a) String perthite in pegmatite (between X.N)
(b) Mesoperthite in pegmatite (between X.N)
(c) Microcline perthite in pegmatite (between X.N)
(d) Rodperthite in pegmatite (between X.N)

Microstructures of deformed Pegmatite

Under the microscope, most of the feldspar and quartz show low temperature deformation or cataclastic metamorphism. The significant features are tiny pieces of feldspar grains occur along the margin of large feldspar grain (Marginal granulation), twin bands of feldspar are bent, a few shows broken bands and most of the quartz grains show undulose or wavy extinction. (Figure 9a, 9b, 9c and 9d)

Under the microscope, quartzofeldspathic layer show ductile shear deformation. The following facts are supported the ductile deformation:

(1) Some augen texture of feldspar grains are surrounded by quartz ribbons. Assymmetric pressure shadows are also observed in a plane of simple (dextral) shear. (Figure 10a)

(2) Formation of en-echelon array of feldspar and rotated feldspar grains indicate shear deformation. (Figure 10b)

(3) Formation of en-echelon array of quartzes indicates shear deformation. (Figure 10c)

(4) The fine grained tails of recrystallized muscovite within the crack of feldspar indicate shear deformation. (Figure 10d)

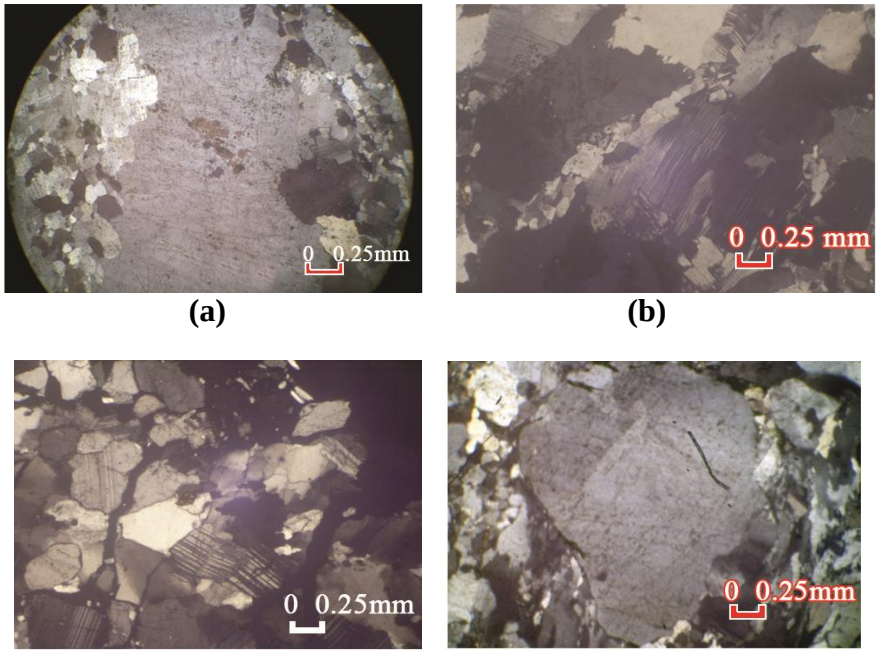


Figure 9(a) Low temperature Cataclastic texture in pegmatite (between X.N)
(b) Twin bands of plagioclase showing bent nature due to deformation (between X.N)
(c) Some plagioclase showing broken bands due to deformation (between X.N)
(d) Wavy extinction of quartz due to deformation (between X.N)

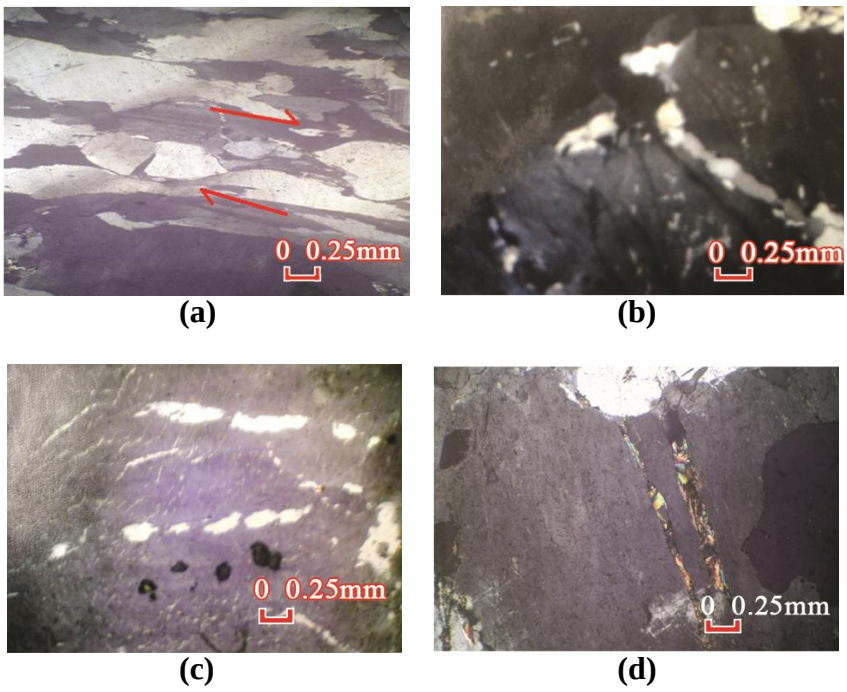


Figure 10 (a) The augen texture of quartzofeldspathic layer showing shear sense by elongation of the quartz grains (between X.N)
(b) The fine grained tails of recrystallized muscovite within the crack of feldspar indicating shear sense (between X.N)
(c) Small grains of quartz indicating micro- mylonitization (between X.N)
(d) En-echelon array of feldspar and rotated feldspar grains indicating deformation (between X.N)

Ore Reserve Estimation

For each vein the following is used;

Volume = Length x Width x Thickness

Ore tons (in situ) = Volume / Tonnage Factor

The Length

The mappable all veins were pinch out, sinous and uneven in nature and have 10 feet or more in length are considered for calculation.

The Depth

It is estimated by measuring directly in the local working and or by the topographic differences.

Tonnage Factor

Tonnage factor is calculated on the basic of the detailed laboratory mineral composition of 24 pegmatite.

The calculation of the average grade at the vein of production workings was made in Table 1 and 2.

Table 1. Calculation of the Average Grade of the Veins in Production Workings

Working sites	Vein number	Vein length	Assay Feldspar %	Width × Feldspar %
Hnahnawin	8	1.5	45	67.5
Kansat	2	6	45	27
Oshipin	2	7	45	315
Taungkanlant	2	12	45	540
Michaung	3	3	45	135
Tonbo	2	30	45	1350
Wayonye	3	7	45	315
Chaukzu Taung	4	16	45	720
		Σ 82.5		Σ 3712.5

The average assay grade of vein = Σ (Width x Feldspar %) / Σ Width

= 3712.5 / 82.5 = 45%

Thus, the average feldspar % in the vein of productions working is 45% feldspar.

The working sites are divided into production working and old workings.

Average Tonnage Factor = 11 cu ft/ton

Average width = 82.5 / 8 = 10.3 ft

Ore tons (in situ) = Volume / Tonnage Factor

Table 2. Reserves-grade Calculation

Working Site	Area (ft^2)	Width (ft)	Volume (ft^3)	Tons	Ton x Grade
Hnahnawin	5650	1.5	8475	154	6930
Kansat	2850	6	17100	1703	76635
Oshipin	30000	7	210000	18223	820035
Taungkanlant	20400	12	224800	7541	339345
Michaung	6960	3	20880	1343	60525
Tonbo	3250	30	97500	200	9000
Wayonye	27040	7	189280	97755	4398975
Chaukzu Taung	21930	16	285090	23586	1061370
		Σ 82.5		Σ 150505	Σ 6772815

Therefore, Ore tons (in situ) = 150505 tons (Reserve)

Average grade of vein = Σ (Tons × Grade) / Σ Tons

= 6772815 / 150505

= 45 % Feldspar

Thus, the average grade of ore in the block is 49.9% feldspar.

Concentrate Factor = $\frac{\text{Concentrate grade}}{\text{Ore recovery - Feed grade}}$

$= \frac{45}{50-5}$

$= \frac{45}{45} = 1$

Thus, 2 tons of mine ore will be needed to produce 1 ton of feldspar concentrate at the concentration plant.

Current Myanmar Price (from Myanmar Ceramic Industries, Hlaingdet, 2005)

Production cost for 1 ton;

Digging price = l000 ks
Labour cost = 1300ks
Truck cost = 800 ks
Train cost = 4660 ks
Total cost = 7760 ks
Assumed sell price = 15,000 ks
Net profit = 7240 ks

Thus, the annual production of 6,000 tons of feldspar concentrate from mine can be valued at Kyats 43,440,000.

Mine Life

Annual production	=	12000 metric tons (mine ore)
Total estimated ore reserve	=	150505 metric tons
Mine life	=	(150505 / 12000) = 12.5 say 12 years.

The Hlaingdet-Payangazu feldspar production has started since 2001. The Hlaingdet-Payangazu project is keeping up with a policy of exploration to find new old bodies to prolong the mine life.

Feldspar Utilization

Feldspar is used in ceramics for making glass and pottery, both in the body of the ware and in the glaze. It is also used in enamels for household utensils, tile, porcelain sanitary ware, and other minor ceramic uses (Jensen & Bateman, 1981). Some feldspar is also an ingredient in scouring soaps, abrasives, roofing materials and false teeth. The potash feldspar and the sodic plagioclase are the commercial varieties, the former being the more important, the plagioclases high in lime are undesirable. The sodic plagioclases high in lime are undesirable. The potash feldspar (orthoclase and microcline) always contain some soda from included albite and the soda feldspar always contains a little lime, iron, manganese and sericite. Feldspar high in potash or soda, upon cooling from fusion, yields a solid glass, but lime rich varieties become partially crystallized.

Conclusion

Pegmatite dykes and veins are common in the western part of the study area. The most common trend of feldspar in pegmatite is NNE-SSW in direction. The length of pegmatite dykes and veins are ranging from 610 to 6100 cm in length and 305 to 610 cm in width. The most important commercial feldspar which is being mined is orthoclase rich alkali feldspar. The calculated ore reserve (inferred) is about 150505 metric tons. The average ratio of quartz and feldspar is commonly 2:1. On calculating the tonnage estimation, expected production year may be 3 to 4 years.

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