

PETROGRAPHIC AND GEOCHEMICAL CHARACTERISTICS OF GRANITIC MYLONITE AND ITS TECTONIC SIGNIFICANCE EXPOSED IN THE KABANI AREA, WUNDWIN TOWNSHIP, MANDALAY REGION

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Abstract

The study area, located in the Kabani region of Wundwin Township, lies within the northern segment of Myanmar's Central Granitoid Belt, bounded by the Sagaing Fault to the west and the Nwalabo Fault Complex to the east. Detailed field and microscopic investigations reveal that the granitic rocks have undergone intense ductile deformation, resulting in well-developed mylonitic textures such as foliation, lineation, and grain size reduction. The geochemical data, including major, trace, and rare earth elements, indicate that the granitic mylonites belong mainly to the calc-alkaline series and are classified as S-type granitoids. Harker variation diagrams demonstrate a fractional crystallization trend, while trace element plots reveal significant enrichment in LILEs and negative anomalies in HFSEs, suggesting crustal influence and subduction-related signatures. Tectonic discrimination diagrams such as the Rb-(Y+Nb), Nb-Y, and R₁-R₂ plots suggest that the protoliths of these granitic mylonites formed in a syn- to post-collisional tectonic setting.

Keywords: Central Granitoid Belt, Harker variation diagrams, mylonitic textures

Introduction

Location and Accessibility

The study area is situated approximately 16 km southeast of Wundwin Township, Mandalay Region, Myanmar. It falls within portions of the topographic map sheets 93C/4 and 93C/8, as well as UTM map sheets 2196-04 and 2196-08. The Meiktila-Mandalay highway and railway line pass to the west of the study area, providing convenient access. The location of the study area is shown in figure 1.

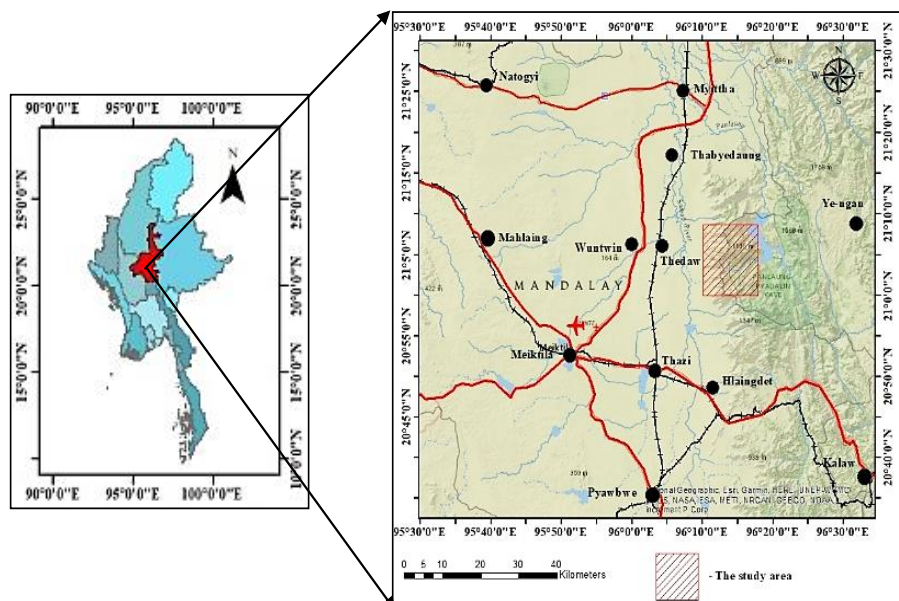


Figure 1 Location map of the study area (source: MIMU)

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Petrogenesis of the granitoid rocks exposed along the Shan boundary fault system, which is the northern adjoining area. Yin Yin Myint, (2009) studied the mineralogy and petrology of northwestern part of Pyetkaywe Batholith, and suggested that all the granites and granodiorite may be continental collision granite and the radiometric dating of diorite unit is late Early Cretaceous (121.8 ± 1.8 Ma), and they may be generated due to the subduction of oceanic Indian Plate beneath the continental Eurasian Plate. Tin Aung Myint *et al* (2017) investigated the Zircon U-Pb Ages and geochemical characteristics of the igneous rocks exposed at Taungkanlant-Nattaung area, Yamethin and Tatkone Townships, Mandalay Region, which is a southern continuation of the study area. They suggest that the granitic rocks of this area are characterized by S type nature and genetically related to the subduction related plate tectonic process. Nay Win Aung, (2024) studied the evolution of microstructure in the mylonite granite of the study area. He proposed that the granitic mylonite of the study area is formed under the deformation mechanism of grain boundary sliding (low strain and crystal plasticity in matrix) to dynamic recrystallization (high strain).

Materials and Methods

Methods of Study

The research for this paper was undertaken over an eight-month period, from November 2024 to June 2025. The petrographic analysis was done through the observation of 5 samples of the granitic mylonite using polarizing microscope combined with digital camera at the laboratories of Mandalay University. A total of 5 representative samples was selected and analyzed. Chemical analyses of rocks prominent in study area were done under the X-ray fluorescence spectrometer at Defense Service Academy Research Center, in Pyin-Oo-Lwin. To interpret the tectonic setting of the study area, tectonic discrimination diagrams were illustrated by using GCD kits software.

Purposes of Study

The study area lies between two major regional fault systems: the Sagaing Fault to the west and the Nwalabo Fault Complex to the east. The primary purpose of this study is to investigate the petrography and geochemistry of mylonitic granite formed within the fault systems. A key objective is to determine the composition and genetic type of granitic rocks which change to granitic mylonite during this ductile deformation. Ultimately, the study seeks to interpret the tectonic implications of this mylonitization, linking the observed deformation to the regional kinematics of the major fault systems.

Petrography

Field and Megascopic Investigation

Field investigations within the study area reveal extensive mylonitic deformation localized along major fault traces. The affected lithological units exhibit a complete spectrum of deformation textures, ranging from protomylonite to ultra mylonite. These rocks are characterized by intense shearing and prominent foliation, reflecting ductile deformation under differential stress. Mineralogical analysis confirms the presence of a consistent NNE–SSW-trending stretching lineation throughout the sheared zones.

Mylonitization has markedly influenced both metapelitic sequences and associated granitic bodies, resulting in the development of penetrative mylonitic

foliation and lineation. Deformation intensity varies across the units; while some rocks underwent significant mylonitization, others display evidence of brittle deformation, such as fracturing and folding, indicative of varying strain regimes. Notably, granitic rocks have been extensively transformed into mylonite, forming lithological units classified as mylonitic granite (Fig.3).



Figure 3 (a) Highly deformed, highly jointed and brecciated nature of granitic ultra mylonite exposure (b) The close-up view of the granitic proto mylonite

In the context of the study area, **three** primary mechanisms play a pivotal role in this transformation.

Grain boundary sliding constitutes a critical process during the metamorphic evolution from granite to mylonite. As differential stress acts upon the rock, grain boundaries accommodate relative movement between individual mineral grains. This mechanism facilitates the reorientation and rearrangement of mineral grains, contributing to the development of mylonitic textures (Fig.4.a).

Diffusion-driven mass transfer occurs within the crystalline lattice of minerals. At elevated temperatures, atoms and ions migrate through the crystal lattice, leading to recrystallization and the formation of new grain boundaries. This process aids in the gradual transformation of granite into mylonite.

Dynamic recrystallization represents a fundamental response of minerals to deformation. Under the influence of differential stress, minerals undergo continuous recrystallization, resulting in the growth of new grains. The dynamic recrystallization process is particularly pronounced in mylonite, where it contributes to the refinement of grain size and the development of foliated textures (Fig.4.b).

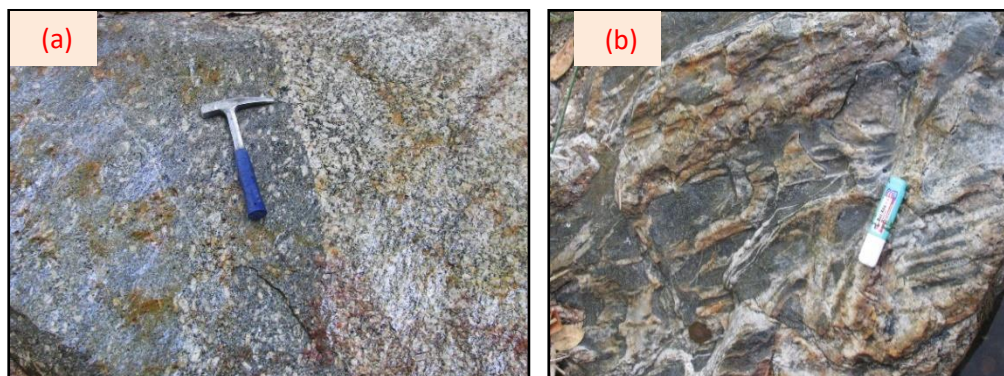


Figure 4 (a) Porphyritic biotite granite showing the reorientation and rearrangement of mineral grains in the mylonite zone (b) The dynamic recrystallization of felsic and mafic minerals in granitic mylonite showing metasomatism

Microscopic Investigation

The matrix of the mylonite predominantly comprises fine-grained quartz, muscovite, alkali feldspar, plagioclase, and biotite. Quartz within the matrix exhibits microstructures indicative of deformation, dynamic recrystallization, and recovery processes. In some areas, quartz occurs as polygonal granoblastic aggregates, whereas within quartz ribbons, it appears coarser-grained with straight grain boundaries and abundant 120° triple junctions, characteristic of equilibrium textures developed during dynamic recrystallization.

Biotite is commonly aligned parallel to the mylonitic foliation, reflecting syn-kinematic growth and recrystallization under directed stress. The breakdown of feldspar during deformation has resulted in the formation of fine-grained mica flakes, which are distinctly aligned along the mylonitic foliation plane (Fig.5.b). Additionally, randomly oriented, anhedral muscovite lamellae are frequently observed in association with K-feldspar, suggesting deformation-induced growth.

Feldspar is generally present in lower modal proportions within the mylonitic matrix. However, microperthitic K-feldspar is the dominant porphyroclastic phase, along with orthoclase and quartz. These K-feldspar porphyroclasts commonly exhibit well-developed strain shadows and are capped by mica-rich zones, indicating intense deformation. Some orthoclase grains show asymmetric extensional structures, revealing the sense of shear during mylonitization (Fig.5.a).

According to the microstructural investigation of granitic mylonite of the study area, this granitic mylonite varies compositional and microstructural feature from place to place depend on strain and dynamic recrystallize condition of localize rocks (Nay Win Aung ,2024).

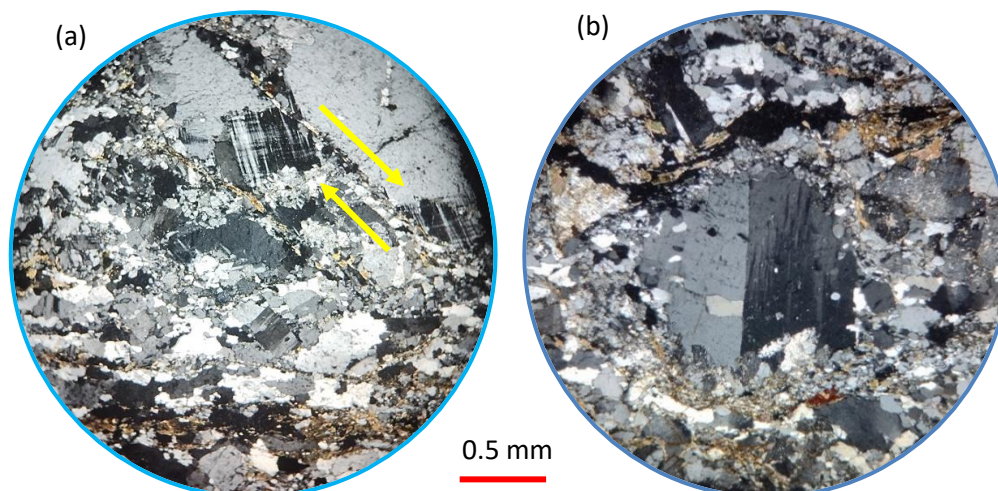


Figure 5 (a) Microcline porphyroclast shows dextral shear sense in mylonitic granite (between XN,50X) (b). Anhedral twin orthoclase with pressure shadows in interstitial quartz and biotite matrix (between XN,50X)

Geochemistry

Whole Rock Analyses

The geochemical composition of the granitic mylonite is shown in (Table 1,2 and 3). Harker variation diagrams are used to demonstrate the behavior of the elements using SiO₂ for crystal fractionation process. Chemically SiO₂ content is ranging from 59.53% to 69.11%. The major oxide of Al₂O₃, TiO₂, MgO, Fe₂O₃, MnO, CaO, Na₂O, K₂O and P₂O₅ of the granitic mylonite rocks collected from study area are versus SiO₂ (Fig.6). In Harker variation diagrams, major oxides of TiO₂, Al₂O₃, Fe₂O₃, CaO, MgO and P₂O₅ are negatively correlated with SiO₂. K₂O and Na₂O are positively correlated with SiO₂. suggesting that this granitic pluton was derived from the evolved magma or derivative magma (Winter, 2010).

Table 1 Chemical composition of the granitoid rock samples of the study area (Major oxide wt%)

Sample No	SiO ₂	TiO ₂	Al ₂ O ₃	FeO	Fe ₂ O ₃	MnO	MgO	CaO	Na ₂ O	K ₂ O	P ₂ O ₅
KBN-8	67.38	0.1703	20.25	0.7145	1.022	0.01623	2.37	0.6501	4.62	2.668	0.0424
KBN-11	59.53	0.2827	20.16	1.464	2.093	0.03797	8.54	2.066	3.44	2.099	0.2013
KBN-18	69.11	0.09504	19.84	0.493	0.7049	0.01065	0.1386	0.4612	6.62	2.404	0.0476
KBN-61	64.74	0.2355	21	1.141	1.631	0.02289	2.67	1.192	3.671	3.387	0.184
KBN-58	63.94	0.1795	21.59	0.7706	1.102	0.0169	3.74	1.027	5.377	2.087	0.0751

Table 2 Standard CIPW Norm for the granitoid rock samples of the study area (wt%)

	Q	C	Or	Ab	An	Hy	Mt	Il	Ap	Sum
KBN-8	25.39794	8.681235	15.76712	39.09315	2.948273	6.120588	1.481953	0.323584	0.10043	88.93944
KBN-11	14.64558	8.95439	12.40449	29.10832	8.934709	21.83715	3.034959	0.537153	0.476805	65.11279
KBN-18	20.26576	5.622728	14.20695	56.01659	1.977125	0.531048	1.022142	0.180584	0.112747	96.11203
KBN-61	24.23272	9.567897	20.0162	31.06298	4.711631	7.052688	2.365035	0.447469	0.435827	84.8798
KBN-58	17.00951	8.797809	12.33357	45.49868	4.604515	9.55641	1.597958	0.341065	0.177884	83.63956

Table 3 Chemical composition of the granitoid rock samples of the study area (Trace element ppm)

	Ba	Rb	Sr	Zr	Nb	Ni	Co	Zn	Cr	La	Ce	Y	Cs	Ta	Hf	Th
KBN-8	280.7	88.6	71.1	75.6	6	3.8	19.6	20	2.4	30.4	61.3	11	7	0.8	3.1	12.3
KBN-11	232	101.2	85.6	60	5.1	7.9	11	37.8	13.1	26.1	34.6	9.6	19.7	0.8	1.9	8.2
KBN-18	93.6	120.5	23.7	55.2	10.4	3.7	28.6	14.1	1	13.4	36.8	14.4	11.1	1.8	2.5	17.4
KBN-61	407.1	115.6	81.9	152.2	11.6	5.9	41.1	30.8	1.3	44	80.1	17	6.5	0.8	5.4	11.3
KBN-58	275.6	68.8	86	66.7	4.7	4.1	22.2	17.8	3	1.5	17	9.1	5.5	0.8	2.9	8.4

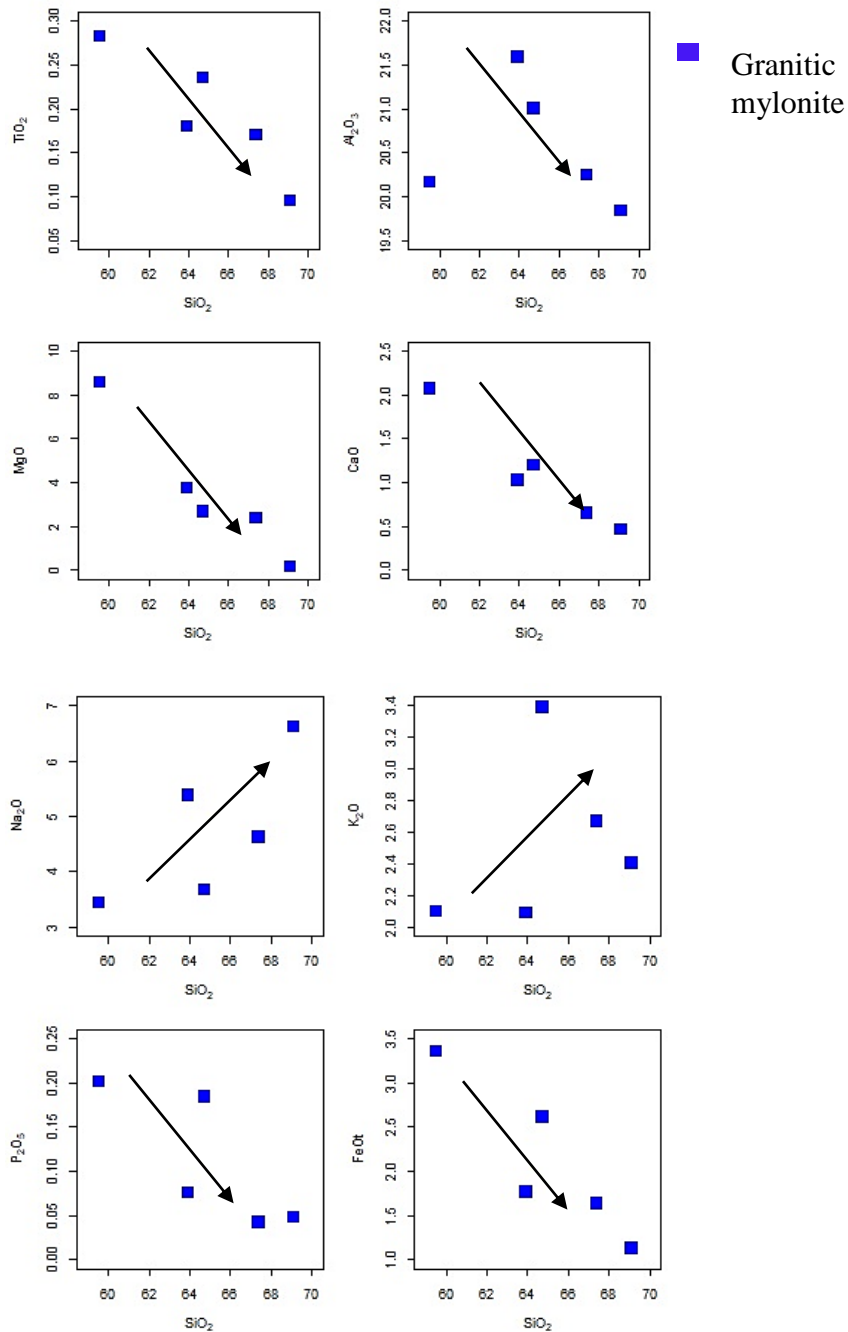


Figure 6 SiO₂ versus major oxide (wt.%) variation plots of the granitic mylonite rocks. Arrows indicate the fractionation trend with silica content.

Chemical Classification

The chemical classification is intended to identify and classify the original igneous rocks according to their major element and trace element compositions.

The chemical classification and nomenclature of plutonic rocks using the total alkalis (Na₂O+K₂O) versus SiO₂ TAS diagram of Middlemost (1994). Most of the samples are plotted within the granite and granodiorite fields. One sample of granitic mylonite is plotted in the diorite field (Fig.7).

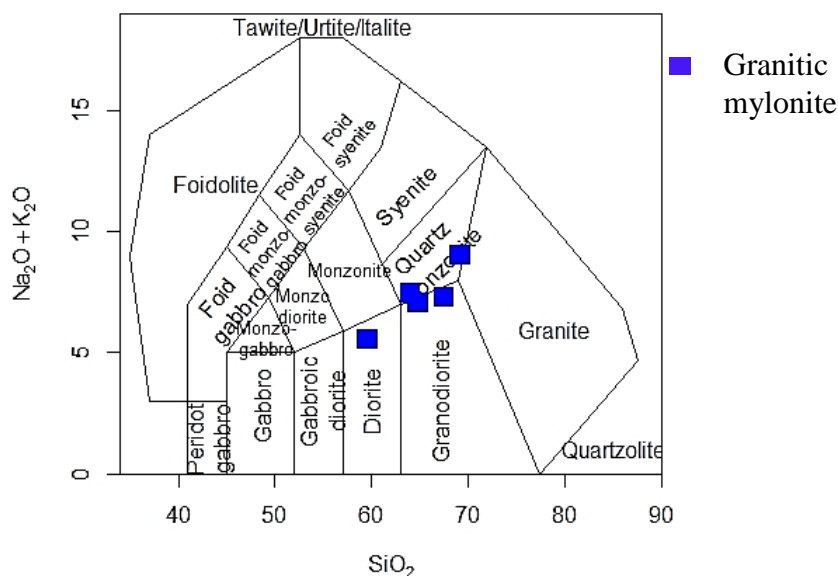


Figure 7 Chemical classification and nomenclature of the plutonic rocks using the total alkalis ($\text{Na}_2\text{O}+\text{K}_2\text{O}$) versus SiO_2 TAS diagram of Middlemost (1994)

The classification based on the trace element data were plotted on the diagrams of Winchester and Floyd (1977). In this diagram, all of the mylonitic granite falls within the granodiorite field (Fig.8).

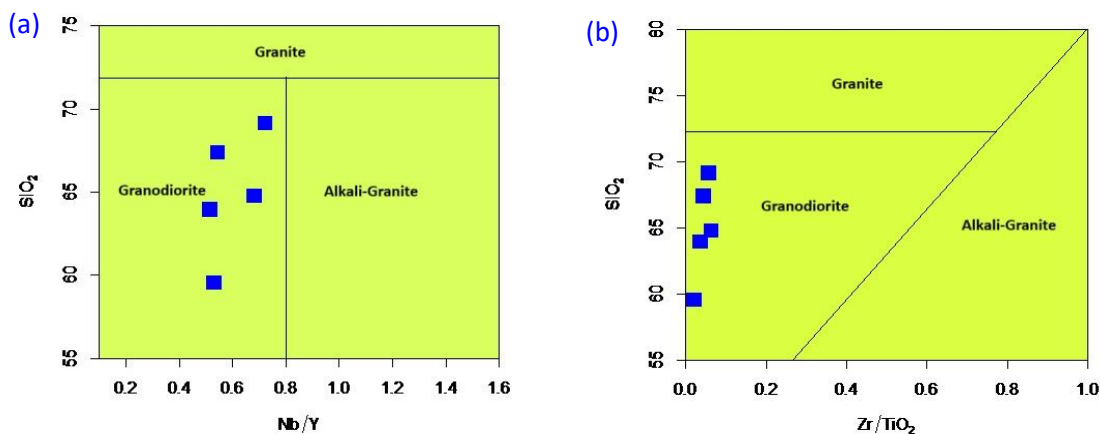


Figure 8 Classification of the granitic mylonite rocks based on the trace elements diagram of (a) SiO_2 versus Nb/Y and (b) SiO_2 versus Zr/TiO_2 binary plot (Winchester and Floyd,1977)

Alkaline/Subalkaline Affinity

In the SiO_2 versus K_2O diagram (Peccerillo & Taylor, 1976), most of the protoliths of granitic mylonite rocks of the study area fall in the calc-alkaline series in (Fig.9). Consequently, the calc-alkaline nature of granitic rocks of the study area is generally restricted to the subduction related plate tectonic process.

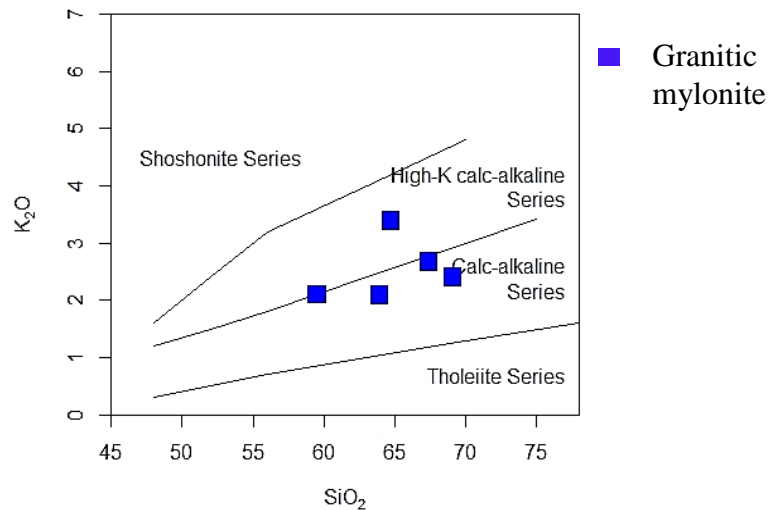


Figure 9 K₂O Vs SiO₂ diagram (after Peccerillo & Taylor, 1976) showing calc-alkaline to high K calc-alkaline series

Type of Granitoid Rocks

The characteristics of major elements in granitoid rocks are essential for interpreting the origins of granite types. Various geochemical and petrological plots are utilized to distinguish between I-type and S-type granitoids. Moreover, the ACF diagram further corroborates that the protoliths of the granitic mylonite rocks in the study area belong to the S-type field, as per the classification by Hyndman (1985) (Figure 10).

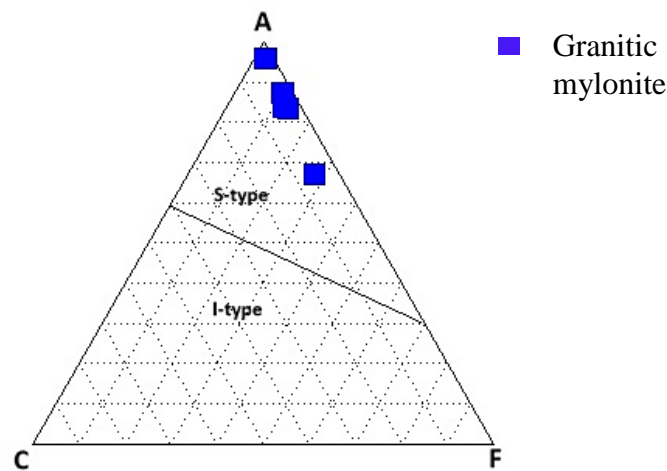


Figure 10 ACF diagram for the granitic mylonite rocks of the study area. Molar ratios: A- Al₂O₃+Na₂O+K₂O, C- CaO, F- Fe₂O₃+MgO (after Hyndman, 1985)

Genetic Type and Tectonic Environment

According to Miniari, (1989), K₂O Vs SiO₂ variation diagram which is divided into the IAG+CAG+CCG+RRG+CEUG and POG, all granitic mylonite rocks of the study area fall within the IAG+CAG+CCG+RRG+CEUG and POG field (Figure .11. a and b). F/AFM Vs M/AFM diagram shows that most of the granitic mylonite rocks fall predominantly in IAG+CAG+CCG environment (Figure 11.d). However, in F/ACF Vs C/ACF diagram shows that one mylonite sample falls in POG field (Figure11.c).

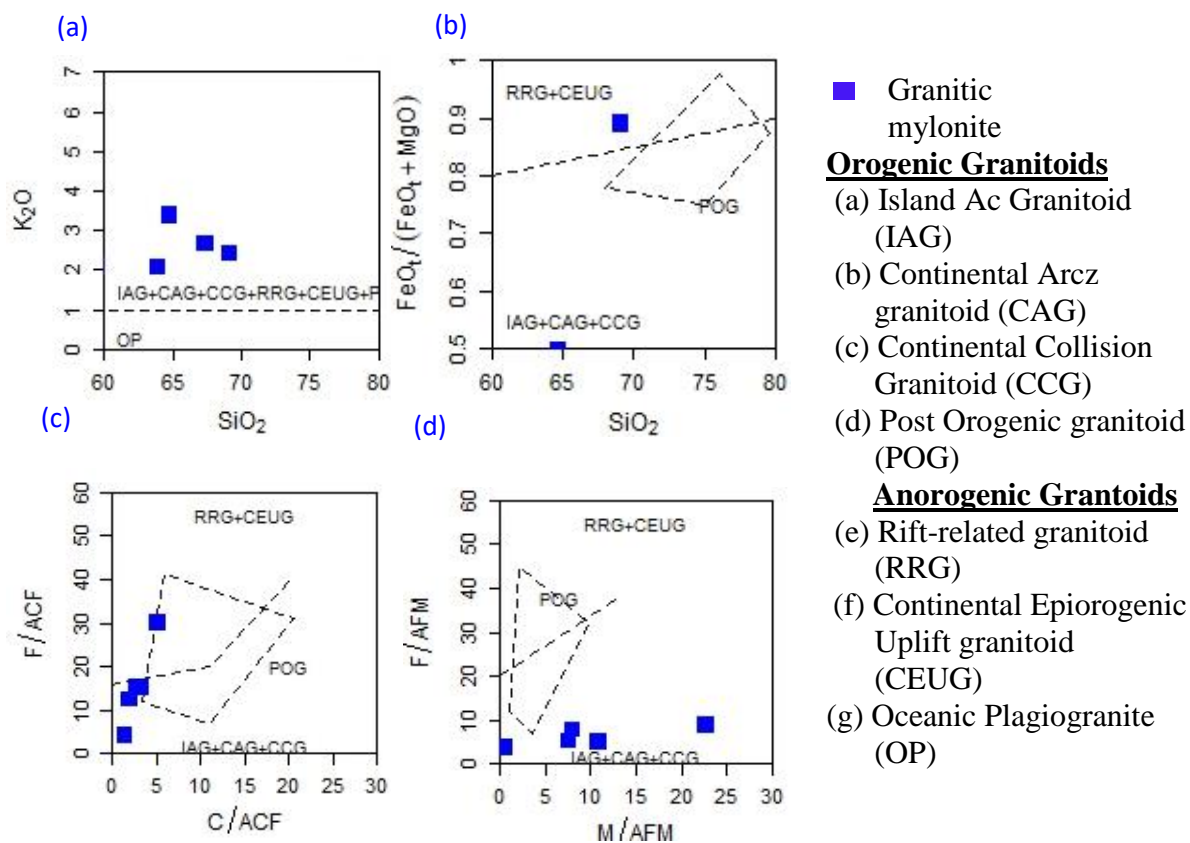


Figure 11(a-d) Tectonic discrimination diagrams based on major oxides for the granitic rocks of the area (after Maniar and Piccoli, 1989)

Based on the Rb vs (Y+ Nb) diagram and Y vs Nb diagram (Fig. 12.a.b), most of the granitic mylonite samples from the study area plot within the Volcanic Arc Granites (VAG) and syn-Collisional Granites (syn-COLG) fields, indicating a dominant subduction-related or syn-collisional tectonic setting (Pearce et al., 1984).

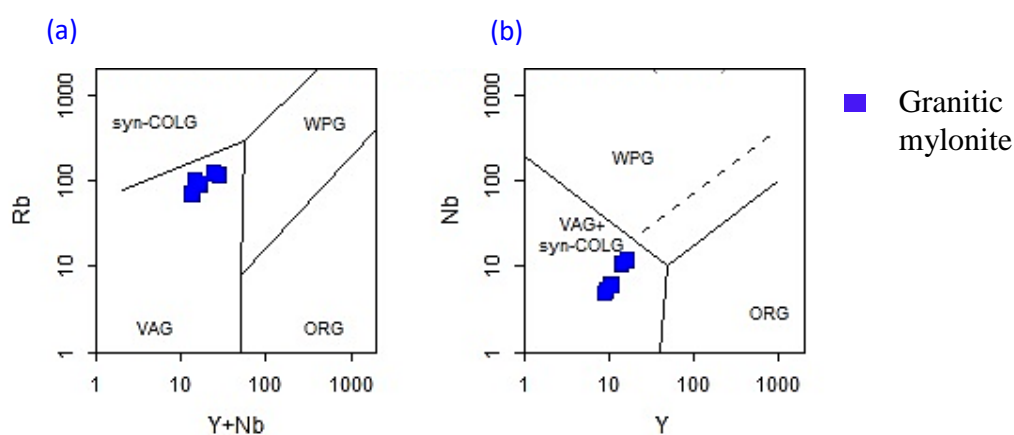


Figure 12 (a) Rb vs (Y+ Nb) diagram and (b) Y vs Nb diagram (after Pearce et al., 1984) showing the tectonic setting of the granitoid rocks from the study area.

Batchelor and Bowden (1985) discriminate the tectonic setting of the granites using R1-R2 binary diagram by geochemical data (Fig.13). Mylonite granites exhibit a scattered distribution, which is attributed to element mobility during their deformation phase. The distribution of samples indicates that the granitic mylonite likely formed in a syn- to post-collisional tectonic regime.

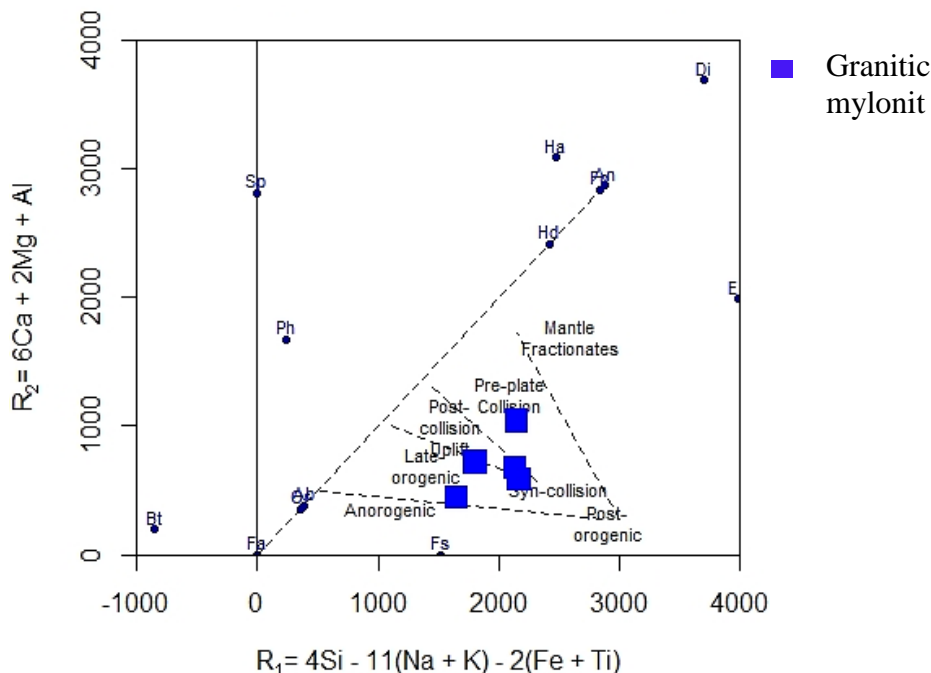


Figure 13 $R_1 = 4Si - 11(Na + K) - 2(Fe + Ti)$ vs $R_2 = 6Ca + 2Mg + Al$ diagram (after Batchelor & Bowden, 1985), illustrating the tectonic setting of the granitic mylonite rocks from the study area.

The primordial mantle-normalized spider diagram (Fig.14) for the granitoid samples from the study area reveals distinctive geochemical signatures. The granitoids exhibit significant enrichment in Large Ion Lithophile Elements (LILEs) such as Rb, Cs, K, and Th, which are typically mobile during fluid-related processes and are commonly concentrated in the continental crust.

In contrast, the rocks show pronounced negative anomalies in High Field Strength Elements (HFSEs), particularly Nb, Ti, Hf, and Y. These HFSE depletions, especially the negative Nb anomaly, are widely recognized as indicators of crustal contamination or involvement of subduction-related processes (Winter, 2010).

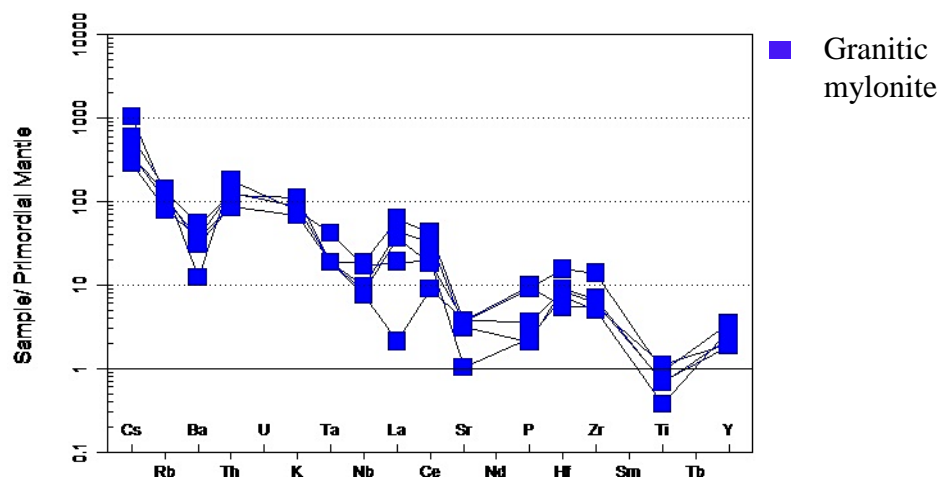


Figure 14 Primordial mantle-normalized spider diagrams of the granitoid rocks from the study area. Normalization values are after Wood et al. (1979).

Conclusion

The granitic mylonite of the study area represents the result of complex tectono-magmatic processes associated with the evolution of the Mogok Metamorphic Belt. Field and microstructural analyses indicate that the protoliths of these rocks underwent intense ductile deformation, forming distinct mylonitic textures indicative of dynamic recrystallization, grain boundary sliding, and high-strain conditions along the fault zones. Geochemical analyses of these rocks indicate crustal-derived S-type granitoids, showing high SiO_2 and Al_2O_3 contents along with moderate to high K_2O levels. Negative correlations between SiO_2 and various major oxides, combined with trace element signatures such as LILE enrichment and HFSE depletion, suggest that these rocks originated from evolved magmas and were influenced by subduction-related processes.

The tectonic discrimination diagrams (e.g., R_1 – R_2 , Rb vs Y+Nb, and Nb vs Y) show that the rock falls into a syn- to post-collisional tectonic setting. This aligns with regional tectonics, where the Central Granitoid Belt and the surrounding metamorphic terranes were affected by the ongoing collision between the Indian and Eurasian plates. The presence of highly deformed granitic mylonite further indicates their emplacement and subsequent reworking during major fault activity, likely associated with the Sagaing and Nwalabo fault systems. In conclusion, the granitic mylonite of the Kabani area serves as a significant indicator of crustal reworking in a collisional tectonic environment, possibly related to the closure of the Tethys and India-Asia collision. Their petrographic and geochemical characteristics reflect a history of magma evolution, deformation, and metamorphism linked to regional tectonic convergence.

Acknowledgements

We would like to thank Rector Dr. Lai Lai Wai, Kyaukse University, for her kind permission to submit this research paper. We also deeply acknowledge Professor Dr. Khaing Khaing Mon, Head of Geology Department in Kyaukse University for her critical reading, valuable advice and discussions throughout this manuscript. We would like to thank Dr. Tin Zaw Oo, Professor in Geology Department, Kyaukse University, for his valuable suggestion, instruction and comments on the present research work. Finally, we want to express special thanks to all our colleagues in the geological field for their helpful advice and encouragement during this preparation.

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