Petrology of the Diorite Rocks Exposed in Salingyi Area, Salingyi Township, Monywa District, Sagaing Region

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Abstract

The study area is situated in the Salingyi township of Monywa District, Sagaing Region. The area is a part of north-south trending central volcanic belt of Myanmar. The study area is composed of igneous, sedimentary and metamorphic rocks. Among them, igneous and sedimentary units are predominants and metamorphics occur in subordinate amount. Most of the igneous bodies are observed as elongated concordant and discordant bodies as dykes, sills, small stocks, and batholiths. Many parts of the area are covered with medium to coarse grained diorites. In the field, the diorite is found to be intruded into the amphibolite schist and gneiss, indicating, diorite is younger than the gneiss and amphibolite schist. Therefore; the geological age of the diorite can be assigned to Early Cretaceous. In ACF diagram the igneous rock of the study area fall within the field of S-type. Field and petrographic evidences of the igneous rock of the study area indicate the study area is interpreted to have been originated from the partial melting of supracrustal source.

Keywords: diorite, early Cretaceous, S-type, Salingyi

Introduction

Location and size

The study area in the Salingyi Township is situated between North Latitudes $21^{\circ}50'$ to $22^{\circ}03'$, and East Longitudes $95^{\circ}00'$ and $95^{\circ}08'$. It covers part of 84 O/I, one inch topographic map. The study area is about 10 miles long in a N-S direction and about 7 miles wide in an E-W direction. It is readily accessible throughout the year by car from Nyaungbingyi, on the western bank of Chindwin River, to Salingyi, nothern boundary of the study area. The location map of the study area and topographic map of the study area is shown in Figures 1.

Regional Geologic Setting

The study area is located in the Inner Burman Tertiary Basin of Bender (1983). It is relatively a low-lying province between the Sino-Burman Ranges to the east and the Indo-Burman Ranges to the west .In accordance with the plate tectonic setting, the Inner-Burman Tertiary Basin can be divided into an Inner-Arc Trough, an Inner Volcanic Arc and the Back Arc Basin. Moreover, the Inner-Arc Trough and the Back-Arc can be subdivided into a number of N-S or NNE-SSW oriented sub-basins which are separated from each other by uplift areas consisting of early Tertiary and older rocks. The Salingyi area lies in the Inner-Volcanic Arc. The NNW-SSE trending Monywa-Salingyi Intrusive and Volcanic Complex separate the Inner-Arc Trough of western part of the Salingyi area from the volcanic and their associated sediments of the Inner-Volcanic Arc of the eastern part. A satellite image of the study area is shown in Fig 2.

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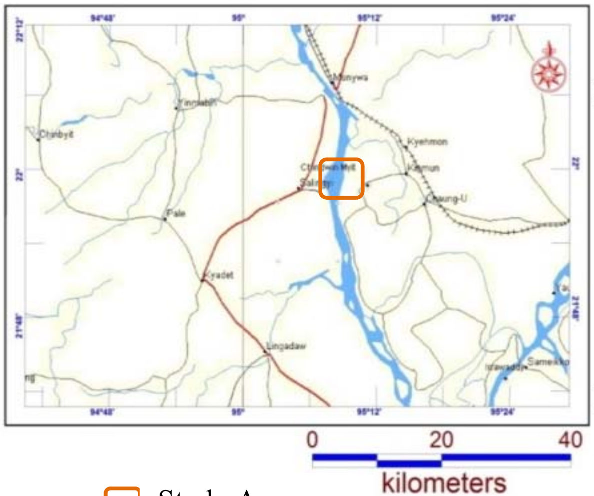


Figure (1). Location map of the study area

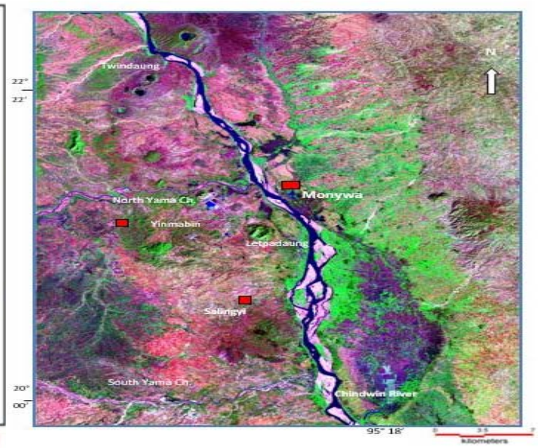


Figure (2). Satellite image of the study area and its environs. (Source: Suntec, 1999)

Stratigraphy

The stratigraphic succession of the Salingyi area is shown in Tables (1) .Geological map of the study area is shown in Fig. (3).

Table (1). Rock units of the study area

STRATIGRAPHIC UNITS	GEOLOGICAL AGE
Sedimentary Rocks Units	
Alluvum and gravel	Pleistocene to Recent
Unconformity	
Magyigon Formation	Upper Miocene to Pliocene
Damapala Formation	Oligocene to Middle Miocene
Unconformity	
Igneous Rock Units	
Olivine Basalt	Recent
Veins and Dykes	Upper Cretaceous
Granites	Early Cretaceous
Biotite granite with minor micrograntie	
Diorite	
Dacite	Pre-Cretaceous
Andesite	
Metamorphic Rock Units	
Amphibolite Schist	Pre-Cretaceous
Gneiss	

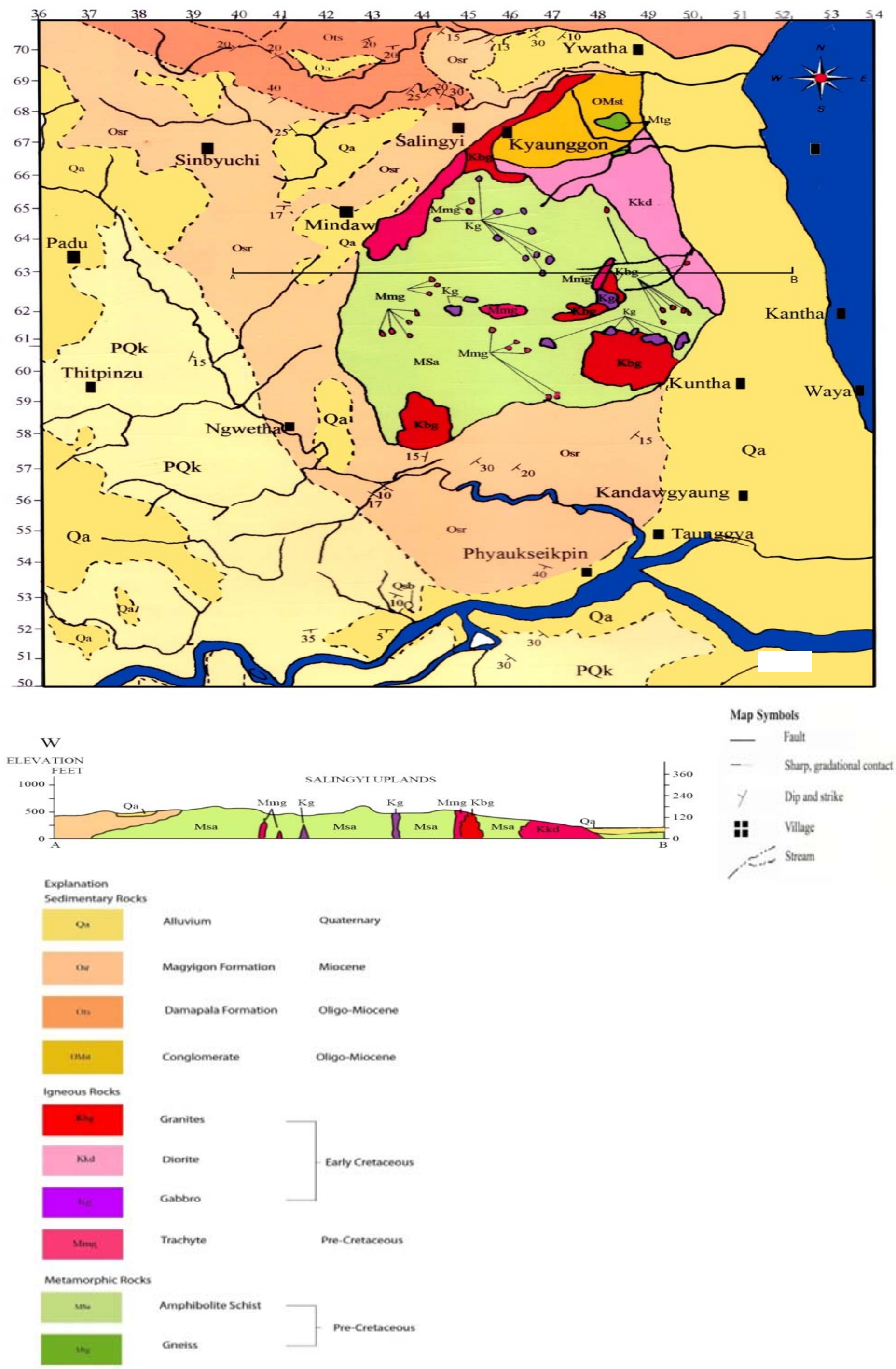


Figure (3). Geological map of the study area and (3b) Geologica cross section of the study area. (Modified: Tin Maung Thein et. al., 1978)

Diorite

Diorites cover many parts of the Salingyi Uplands. Lithologically, they are dark grey, fine to coarse-grained rock. The common minerals found in diorites are feldspar and hornblende with minor amounts of quartz and iron oxides .A good exposure of diorite with schist xenoliths can be seen along the Nyaungbinaing (Fig. 4) The diorites observed in the northeastern (N21°56'55", E 95°5'40") part do not have the stratigraphic relation with conglomerate, because the contacts between those two units are not well exposed (Fig.5). On the basis of textural and mineral criteria, the diorites can be subdivided into four types as microdiorite (Fig.6), diorite, melanodiorite and foliated diorite. Diorite shows exfoliation character and intense kaolinization and chloritization. Major constituents are hornblende and feldspar. Exfoliation is a common character (Fig.7). They cover nearly a quarter of the area. Diorites give rise to form distinct topography with numerous irregular rolling dome-shaped hills.

Figure (4).Diorites observed in the northwest of Nyaungbinaing village (N21°56'55", E 95°5'40")

Figure (5).Well jointed nature of diorite intrusion, found at Mon Su Taw Ya Kyaung, east of Nyaung-binaing (N 21° 56´ 43.6´´, E 095° 05´ 57.2´´)

Hornblende Diorite

The hornblende diorite is the oldest plutonic rock which occupies many parts of the area. Firstly, this rock was described as the gabbro and hornblende granulite by Barber (1936). The hornblende diorite exposures have been observed along the stream section and cart road. It is the predominant lithology among diorites and forms a stock like intrusive body in the area. Good exposures of diorite occur along the stream near Shwe-ohn-bin and Nyaungbinaig. Hornblende diorite is mainly composed of plagioclase, hornblende, orthoclase feldspar and quartz. Hornblende is partly altered to epidote in some places. These diorites are notably rich in hornblende and suggest a high degree of magmatic segregation. Dark-coloured covers about 10 sq km and occurs to the north of the northeastern part of the Salingyi uplands adjacent to the Salingyi amphibolite schist to the south. The contact with the amphibolitic schist is not well exposed but relationship with the Baindaung granite body east of Saligyi town implies that the granite intruded the diorite. In hand specimen the rock ranges from medium to coarse-grained and is mostly dark grey but locally pale grey in colour. Microdiorite also occurs in some parts of the area as well.

Figure (6).Microdiorite intrusion found at Shwe Taung Oo Taung (N21°56′33.3′′,E095°04′23.6′′)

Figure (7).Diorite cobble of exfoliation found at Shwe Taung Oo Taung (N21°56′36.3′′,E 095° 04′34.5′′)

Contact relationship and Age

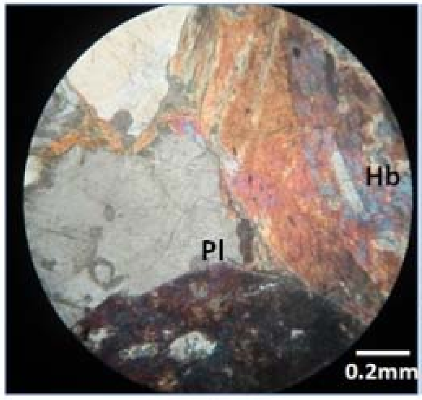
In the field, the diorite is found to be intruded into the amphibolite schist and gneiss, indicating, diorite is younger than the gneiss and amphibolite schist. Moreover, a K-Ar radiometric dating on a hormblende from a sample of the diorite yielded an age of 106± 7Ma (UNDP, 1978c). Therefore; the geological age of the diorite can be assigned to Early Cretaceous.

Diorite Petrography

Many diorites occur in the study area. Microscopically, plagioclase (35-45%), alkali feldspar (12%), and hornblende (30-35%), with quartz (10-15%) are found (Fig. 8). Magnetite, chlorite and biotite are secondary minerals of the rock constituting nearly (3%). Diorites show holocrystalline and hypidiomorphic granular texture. Under microscope, it shows andesine plagioclase and one or more of the mafic minerals suah as clino and orthopyroxene, hornblende and biotite, magnetite and apatite. Quartz and K-feldspar are present. Olivine is a minor constituent of some diorites.

Abundant mafic inclusions in the plagioclase probably are observed in thin sections. Zoning of plagioclase is common and variable. The majority of feldspars are tabular or prismatic, anhedral to subhedral. Plagioclase shows distinct lamellar twin and sometimes Carlsbad twin. Orthoclase shows simple twin and carldbad twin is rarely observed in the rock. Alkalifeldspar altered to kaolinite is common. Feldspar also occurs as phenocrysts. Hornblende shows the light brown to dark green color, and euhedral to subhedral prismatic form. The most common is green hornblende. Hornblende is replaced by the biotite, epidote and chlorite. It has anhedral to subhedral grains. Inclusions of magnetite, zircon and apatite are also observed in hornblende.

Quartz usually occurs as anhedral, interstitial grains between other minerals. Quartz is present in very small amounts. Wavy extinction can be seen in some quartz crystals. Biotite occurs minor amounts.



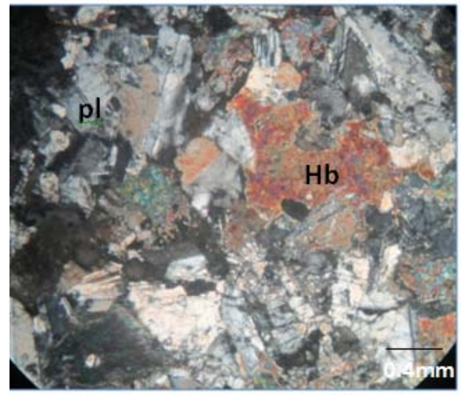


Figure (8). Some plagioclase (Pl) in diorite altered to sericite and the rock also contains hornblende (Hb).

Petrochemistry

Geochemical Analyses of Diorite Rocks

The chemical classification and nomenclature of plutonic rocks are made using (TAS) diagram, adopted from Cox et al. (1979). For this work the $Na_2O + K_2O$ content (total alkalis, TA) and the SiO_2 content (S) are taken directly from the rock analysis as wt% oxides and plotted onto the plutonic classification diagram. The plutonic rocks of the area fall in diorite field (Fig 9).

Major and trace element characteristics

Based on the silica and alkali content, plutonic rocks have been classified into two major series: alkaline and subalkaline. In SiO_2 versus total alkali diagram (Fig. 10) all of the plutonic rocks of the study area fall in the field of subalkaline series. The dividing line follows the work of Irvine and Baragar (1971).

The subalkaline series was further subdivided into tholeiitic and calc-alkaline by using AFM diagram (Fig- 11). AFM diagram showing the nature of the plutonic rocks of the area has affinity to the calc-alkaline series with some exceptions in tholeiitic series. So, it can be considered that calc-alkaline nature of igneous rocks from the study area is genetically related to the subduction related plate tectonic process.

On the K_2O versus SiO_2 diagram (Fig - 12, Le Maitreetal; 1989) most diorite samples fall within low K (tholeiitic series). In Al_2O_3- CaO- ($Na_2O + K_2O$) diagram of Winter (2010) the diorite rocks of the study area are plotted in peraluminous field (Fig- 13).

Condition of the crystallization of the igneous rocks

For the type of igneous rocks various plots have been used to distinguish I-type and S-type (Fig. 14). According to the above petrochemical criteria, the igneous rocks of the study area possess S-type nature. It can be considered that S-type or ilmenite series igneous rocks of the study area are interpreted to have been originated from the partial melting of supracrustal source.

The major and trace elements given by XRF analysis are shown in Tables (2).

Table (2). Major and minor elements (oxides from wt%) of the dioritic rocks from research area

Sample No.	Granodiorite	Diorite			
	F	I	R	T	U
Na_2O	1.24	2.71	0.706	3.59	0.63
MgO	6.643	0.209	0.961	4.044	2.34
Al_2O_3	17.83	15.56	19.42	15.04	16.16
SiO_2	49.93	68.09	62.01	51.54	58.51
P_2O_5	0.1	0.14	0.073	-	0.301
Cr_2O_3	0.0165	0.0226	0.0178	-	0.0618
K_2O	0.0751	0.19	0.085	0.13	0.0806
CaO	12.06	8.598	11.56	7.74	11.29
TiO_2	0.816	0.394	0.304	0.0883	1.05
MnO	0.151	0.0293	0.07	1.13	6.745
Fe_2O_3	9.496	3.411	4.712	0.161	0.004
SrO	0.0172	0.0242	0.0355	0.0121	0.0286
ZrO_2	0.067	0.0281	0.0221	0.0114	0.0151
Total	98.4418	99.4062	99.9764	83.4868	97.2161
CIPW Norm or Wt% Norm					
Quartz	7.03	34.66	31.29	28.65	25.48
Plagioclase	53.34	52.66	55.54	36.96	46.36
Orthoclase	0.47	1.12	0.53	0.95	0.47
Diopside	13.23	5.81	6.28	-	10.81
Hypersthene	17.68	-	3.13	12.06	11.1
Ilmenite	1.56	0.74	0.57	2.97	1.99
Magnetite	4.13	1.48	2.04	-	-
Apatite	0.23	0.32	0.16	-	0.7
Zircon	0.01	0.06	0.04	0.03	0.3
Chromite	0.03	0.04	0.04	-	0.13
Total	97.71	99.14	99.62	99.91	97.34
DI	**60.8**	**88.4**	**87.4**	**66.6**	**72.3**
Molecular Norm or Cation Norm					
Quartz	8.09	36.27	33.22	31.65	28.58
Plagioclase	59.6	54.14	56.95	41.26	50.25
Orthoclase	0.56	1.22	0.58	1.08	0.55
Diopside	12.21	4.62	5.18	-	9.4
Hypersthene	15.86		2.43	10.99	9.05
Ilmenite	1	0.43	0.34	1.83	1.25
Magnetite	2.43	0.79	1.11	-	-
Apatite	0.22	0.28	0.14	-	0.65
Zircon	0.01	0.04	0.03	0.02	0.19
Chromite	0.02	0.02	0.02	-	0.08
Total	100	99.99	100	99.99	100
DI	**68.3**	**91.6**	**90.8**	**74**	**79.4**

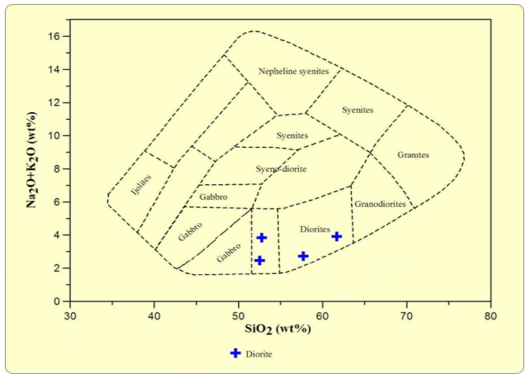


Figure (9). SiO_2 versus $Na_2O + K_2O$ classification of plutonic rocks of the study area (Cox et.al., 1979)

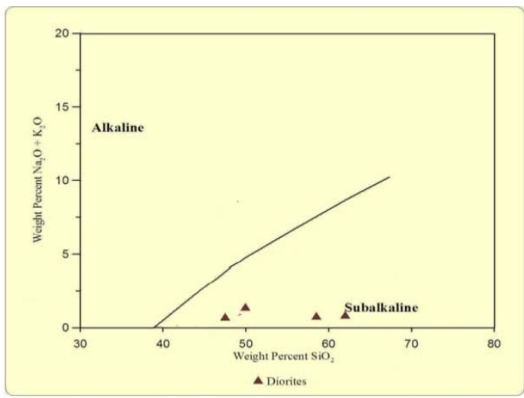


Figure (10). Classification of the plutonic rocks exposed in the study area (Irvine and Baragar, 1971 in Phipotts, 1990)

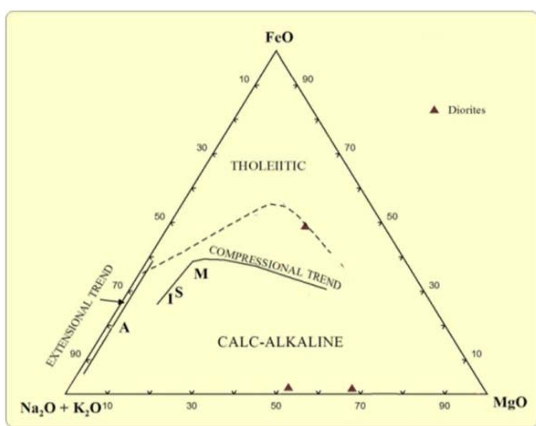


Figure (11). AFM diagram showing the nature of the igneous rocks of the area (Irvine and Baragar (1971) in Winter 2002)

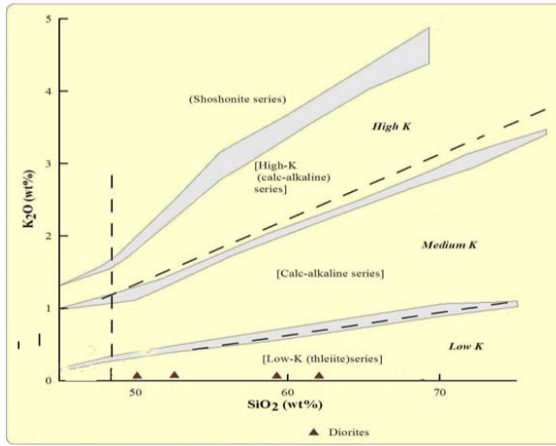


Figure (12). SiO_2 versus K_2O diagram showing high- K Calc-alkaline nature of theplutonic rocks (After Le Maitre et.al, 1989 in Rollinson, 1995)

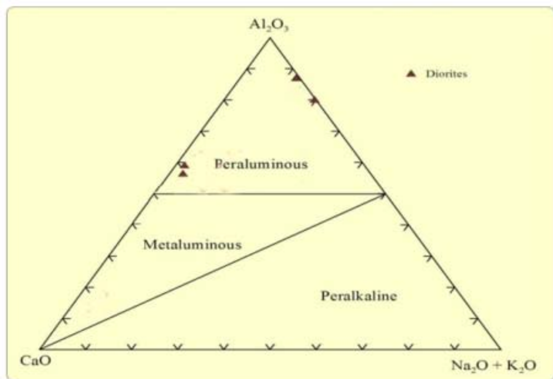


Figure (13). Al_2O_3-CaO- (Na_2O+K_2O) diagram of the plutonic rocks (Winter, 2010)

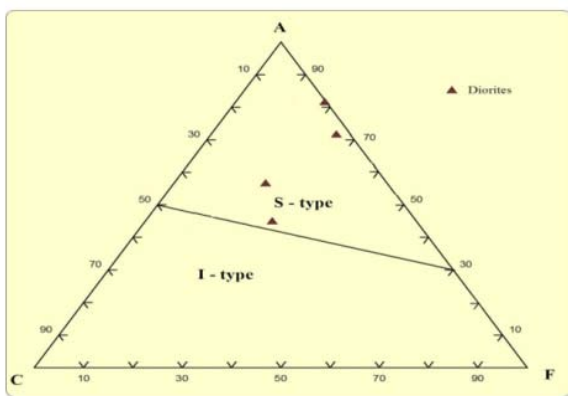


Figure (14). ACF diagram for the plutonic rocks of the study area (after Hyndman, 1985)
Molar ratio: A- Al_2O_3+ Na_2O+ K_2O), C- CaO, F- Fe_2O_3+ MgO

Conclusions

The study area is situated in the Salingyi township of Monywa District Sagaing Region.In the study area, metamorphic rocks of the Pre-Cretaceous age were intruded by the early Cretaceous igneous bodies. AFM diagram showing the nature of the plutonic rocks of the area has affinity to the calc-alkaline series with some exceptions in tholeiitic series. So, it can be considered that calc-alkaline nature of igneous rocks from the study area is genetically related to the subduction related plate tectonic process. Field and petrographic evidences of the igneous rock of the study area indicate the study area are interpreted to have been originated from the partial melting of supracrustal source.

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