Petrographic Description and Petrochemical Character of Granitoid Rocks in Mudu Area, Northern Part of Maungmagan, Dawei District, Myanmar*

Myo Zaw Set[1] and Htay Win[1]

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[1]Department of Geology, University of Yangon, Myanmar (mailto:myozawsetgeol@gmail.com)

Abstract

The present research area is located in Yebyu Township, Dawei District, Tanintharyi Region, bounded by latitude 14.21˚ to 14.26˚″ N and longitude 98.07˚to 98.14˚ E. In the study area, the Mergui Group is intruded by masses of granitic body. The metasedimentary rock of quartzite is exposed only in the northern part of the area. The major igneous rocks found in this area are biotite granite, biotite microgranite and hornblende-biotite granodiorite. Aplite dykes and numerous quartz veins intruded these rock units. Petrographically, suture boundaries of quartz grains show wavy extinction and give slightly parallel alignment in quartzite. The granitic rocks show hypidiomorphic granular texture, and the dominant minerals in decreasing abundance are quartz (33-40%), alkali feldspar (30-34%), plagioclase (20-24%) and biotite (6-10%). In the granodioritic varieties, green hornblende is prominent. Alkali feldspars include mainly orthoclase, string perthite, microcline perthite, and flame perthite. The abundance of perthitic texture indicates feldspar formed at high temperature that has cooled slowly, resulting in unmixing as the solvous curve. The most important accessories are zircon, apatite, muscovite, epidote and sphene. These granitoids contain biotite-hornblende-sphene mineral association, which is a characteristic of I-type. Apatite commonly occurs as inclusions in biotite and hornblende, together with hornblende bearing xenoliths suggesting that these granitoids are I-type.

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University of Yangon
Department of Geology

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Myo Zaw Set

*Htay Win

*Part-Time Professor, Department of Geology

19-11-2015

Outlines

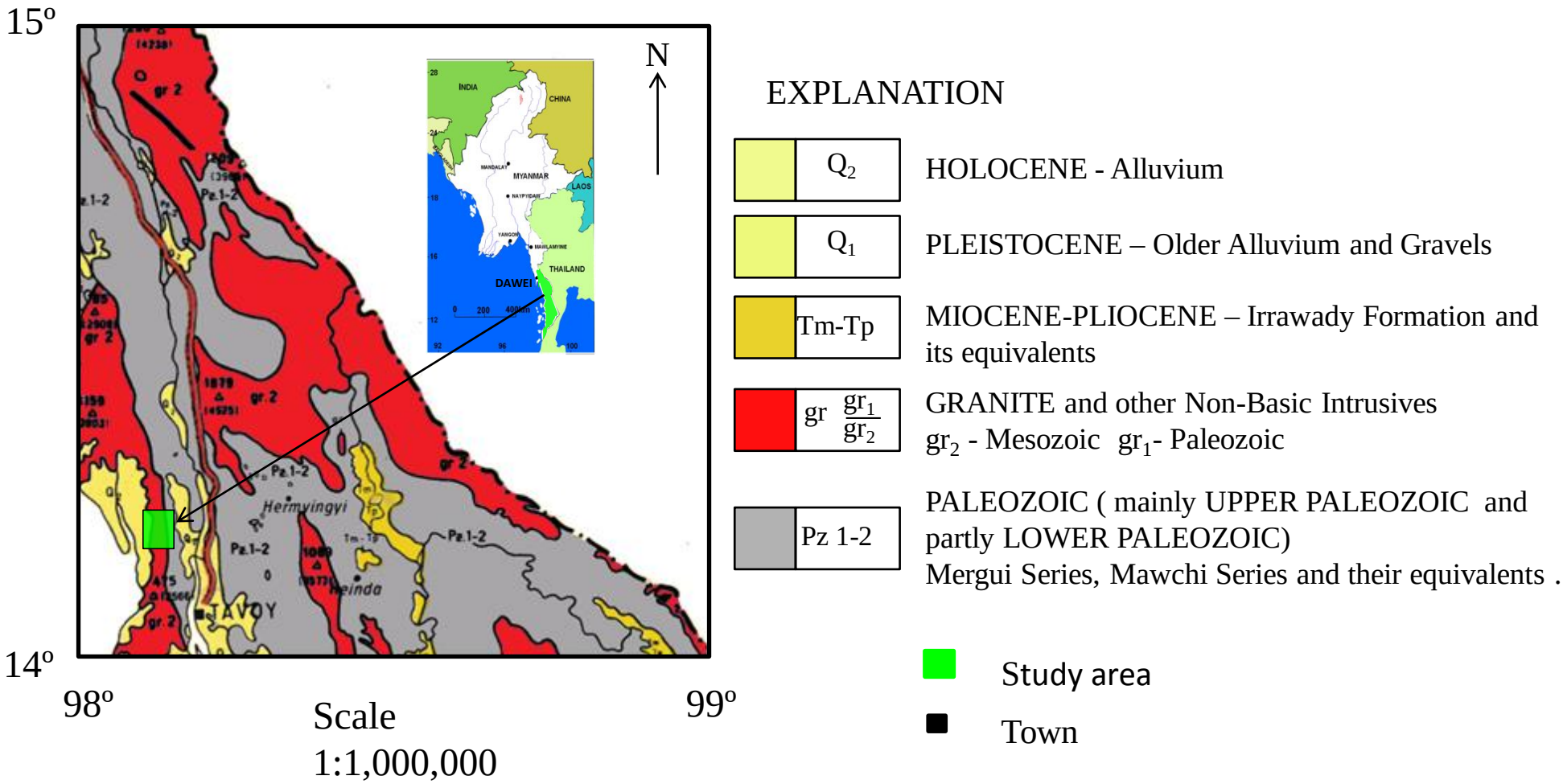
I. Introduction

II. Petrography of Granitoid Rocks

III. Petrochemical Character of Granitoid Rocks

V. Conclusions

Introduction



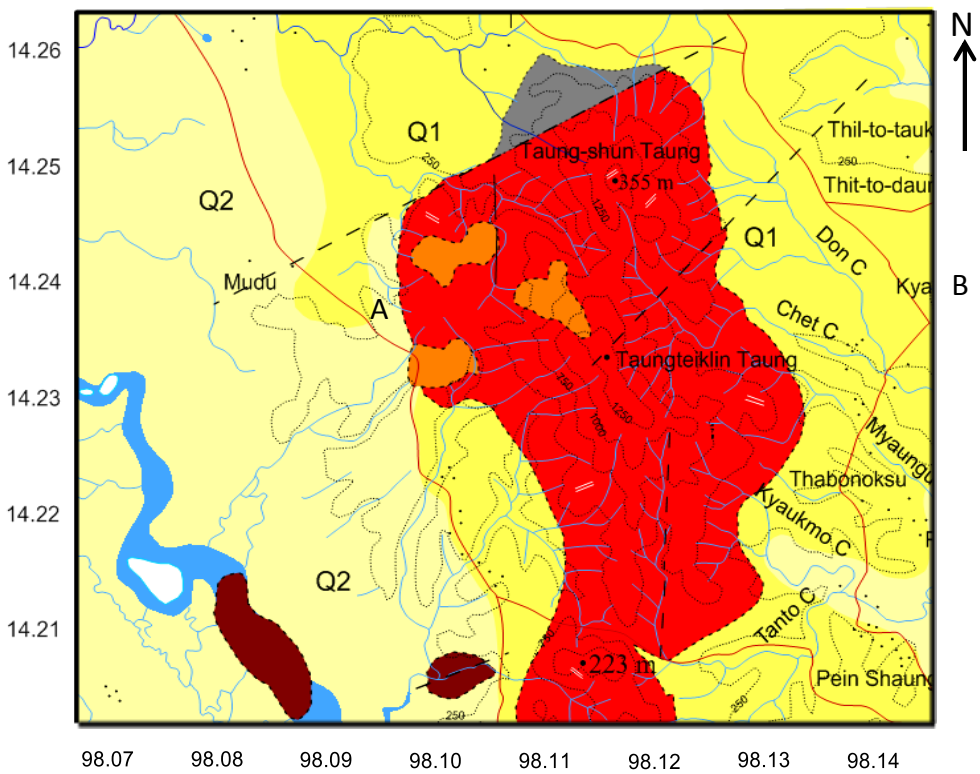
Regional geological map (After one million scale Geological Map of Myanmar,1977)

- bounded by Latitude 14˙21´ N to 14˙26´ N and Longitude 98˙07´ E to 98˙14´ E
- falls in one-inch topographic map sheet No.95 J/3 and J/4

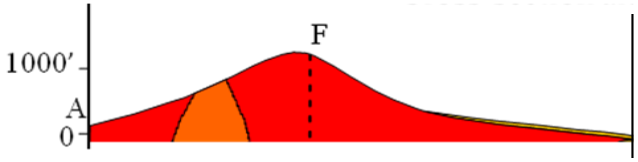
Petrography of Granitoid Rocks

-The research area is mainly composed of granitic rocks. The major rock units are biotite granite, hornblende-biotite granodiorite and biotite microgranite.

Geological Map of Mudu area and its environs, Yebyu Township, Dawei District



Cross-section along A-B



Vertical Scale 1"=1000'

EXPLANATIONS

Quaternary

- Q2 — Younger alluvium
- Q1 — Older alluvium – mainly laterite and lateritic soil and granitic soil

Carboniferous to Early Permian

Metasedimentary Rocks

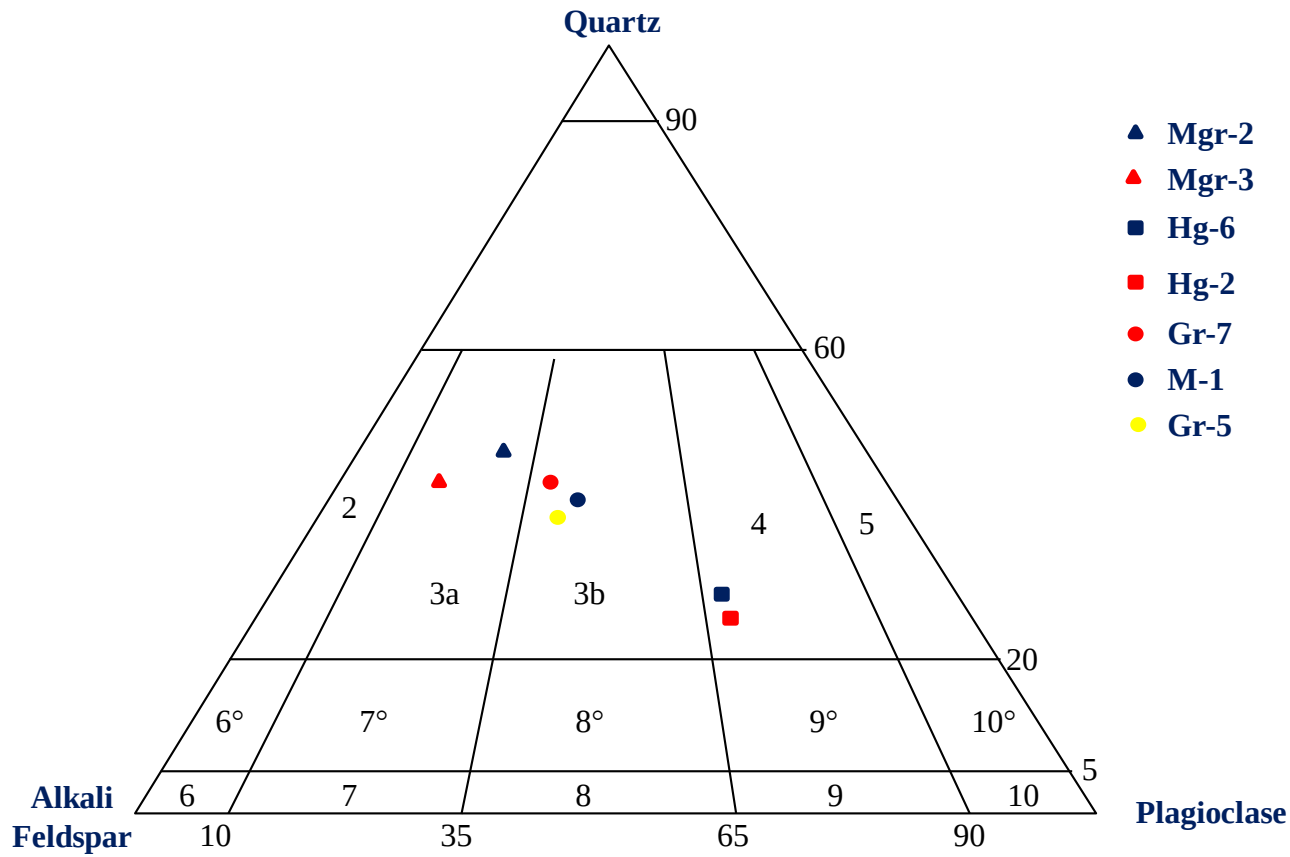
- Quartzite – fine to medium-grained, white coloured, granular texture, suture contact, hard and compact, massive

Igneous Rocks

Mesozoic to Early Tertiary

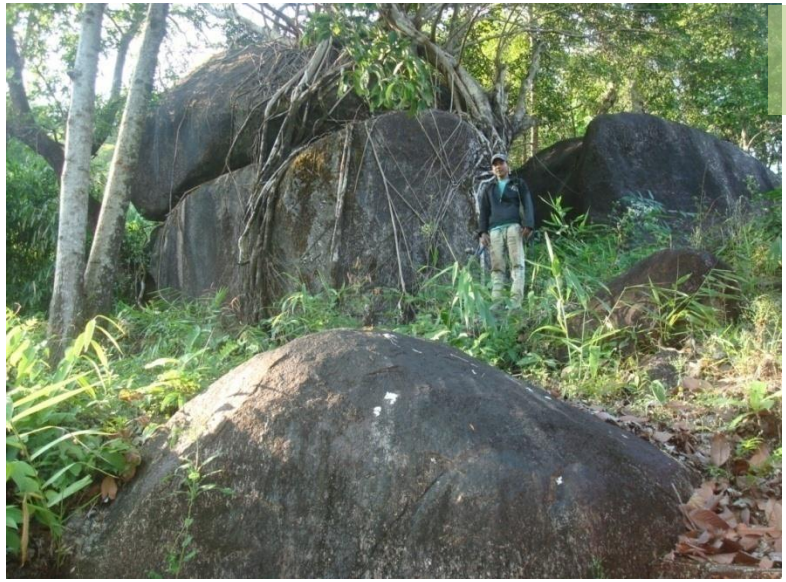
- Aplite dykes – width 5-7.5 cm, fine to medium-grained, slightly equal granular texture
  Quartz veins – width 3-25 cm
- Biotite microgranite – medium-grained, highly jointed, hard and compact, some feldspars are reddish brown due to oxidation
- Biotite granite – coarse-grained, moderately jointed, hard and compact, locally rather large quartz crystals, occur as large massive, boulder and scattered
- Hornblende-biotite granodiorite – coarse-grained, occur as massive, hard and compact, some hornblende crystals with 3 mm in length average

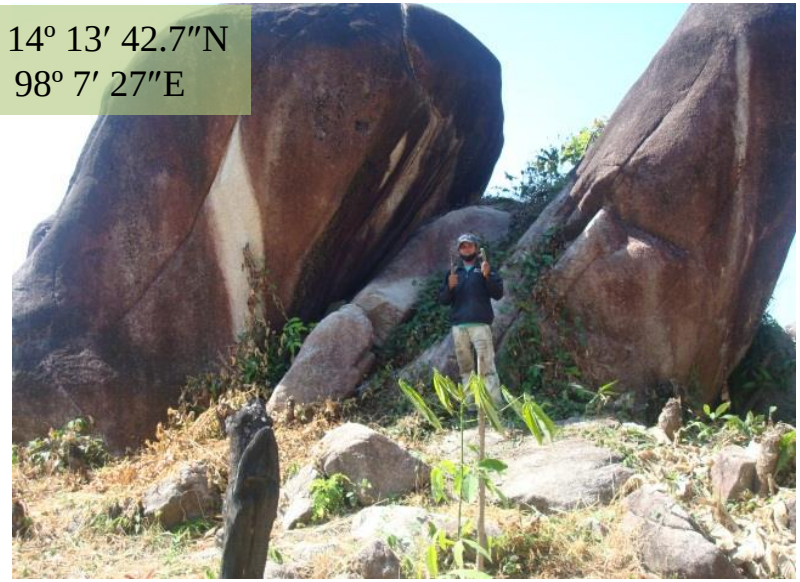
Stream — Lithologic Contact — Pagoda
Road — Lineament — Height point
Contour — Town, village



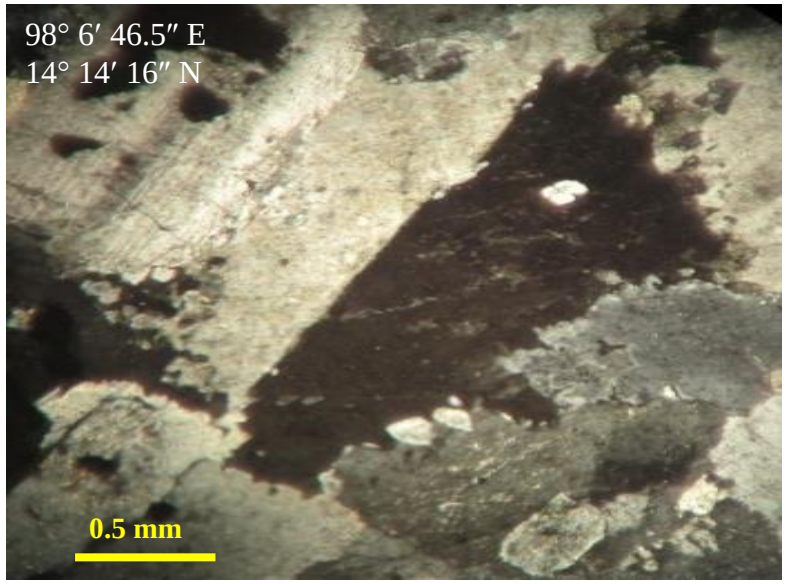
3a- Syenogranite
3b- Monzogranite
4 - Granodiorite

Plotted data of the Igneous Rocks on the IUGS classification diagram (After Le Maitre, 2001)

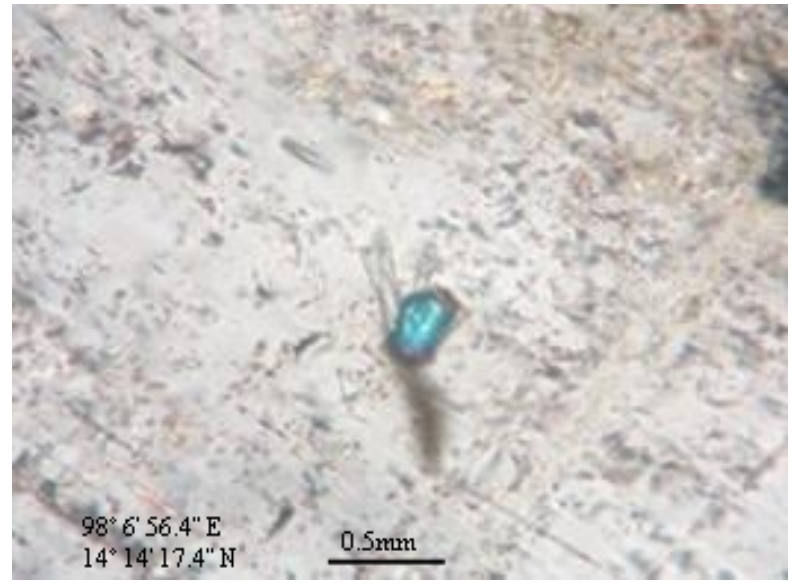




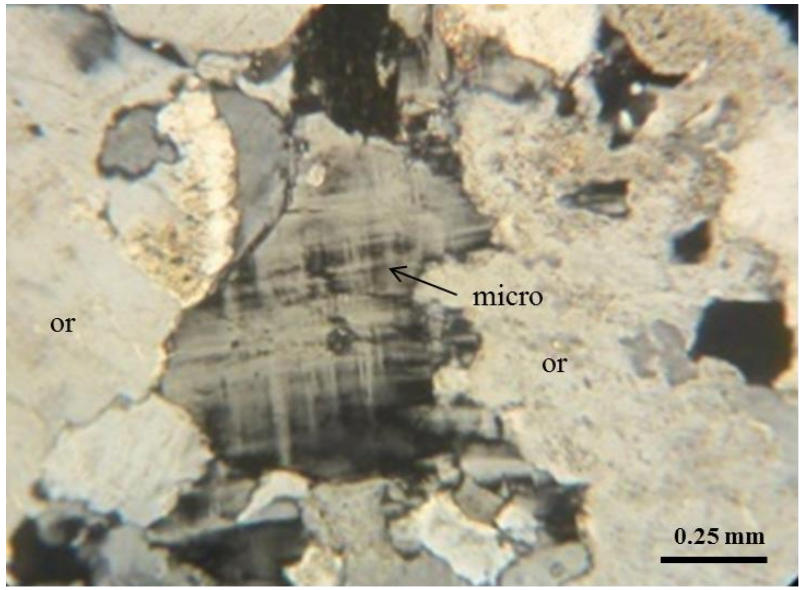
Biotite granite boulder (northwestern part of the study area)



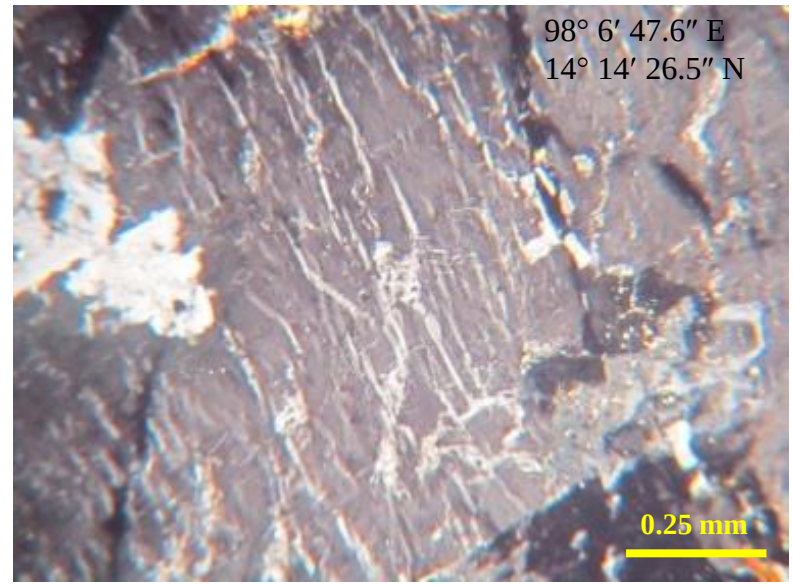
Simple contact twin orthoclase in biotite granite (between.X.N)



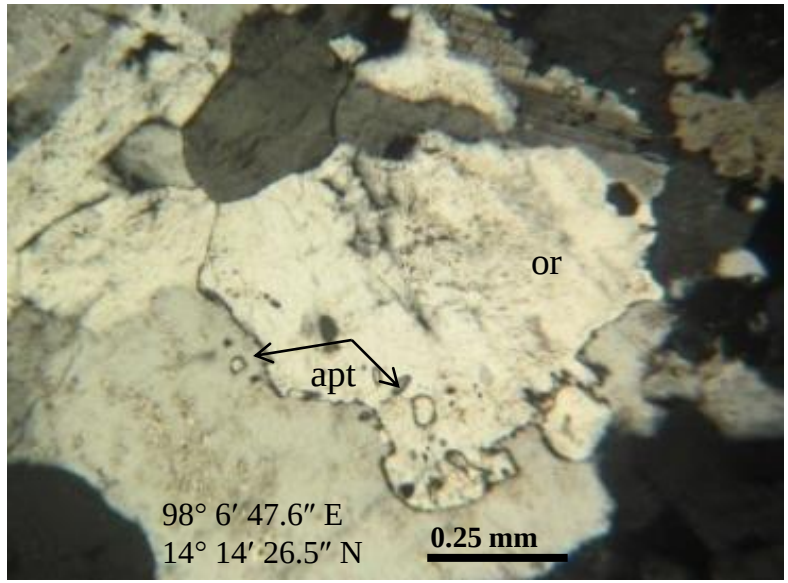
Zircon inclusion in plagioclase, Bet.XN



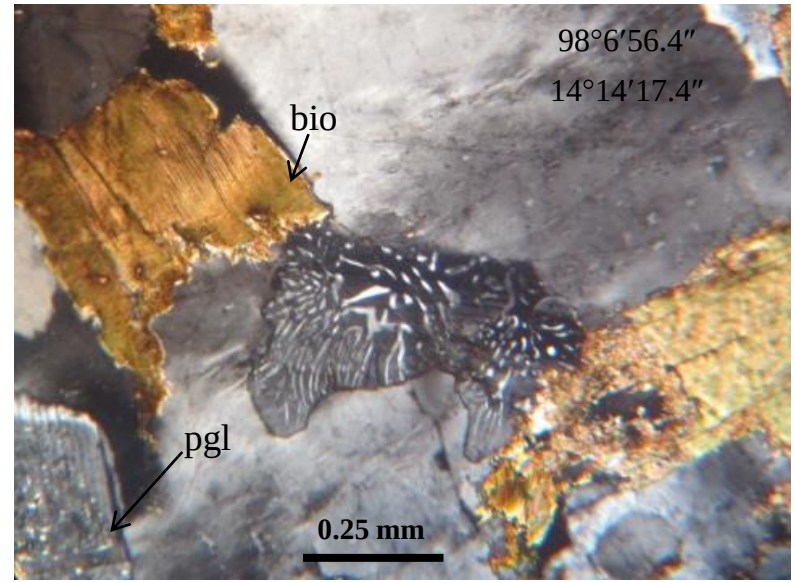
Microcline and sericitization of orthoclase (Bet.XN)



String and flame perthite (betewwn X.N)

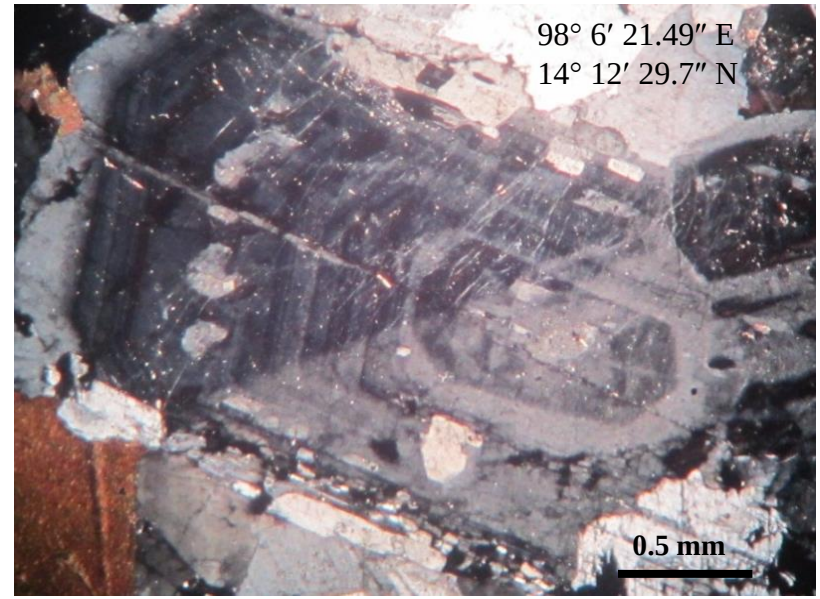


Apatite inclusion in subhedral orthoclase (between.X.N)

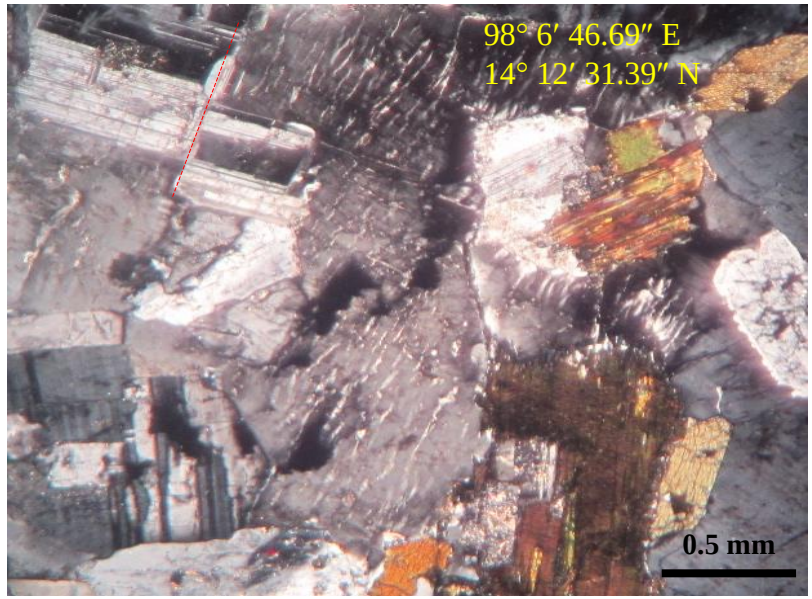


Myrmekitic texture in biotite granite (between X.N)

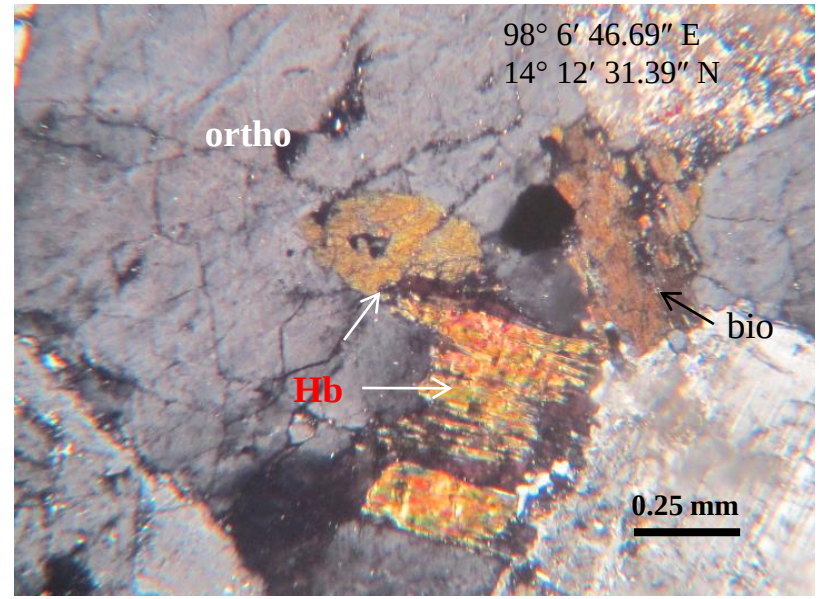
Weathered feature of hornblende-biotite granodiorite exposure in Nabule Chaung



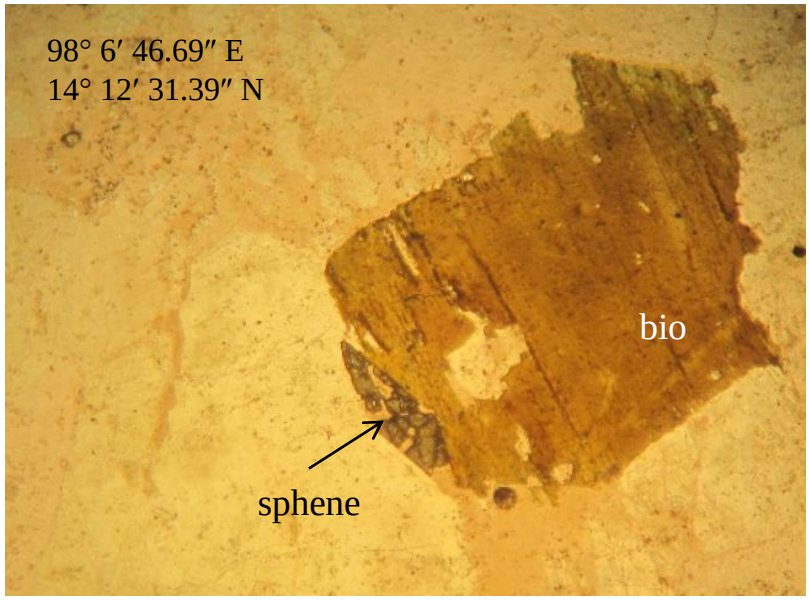
Plagioclase shows Baveno twin and zoning (between.X.N)



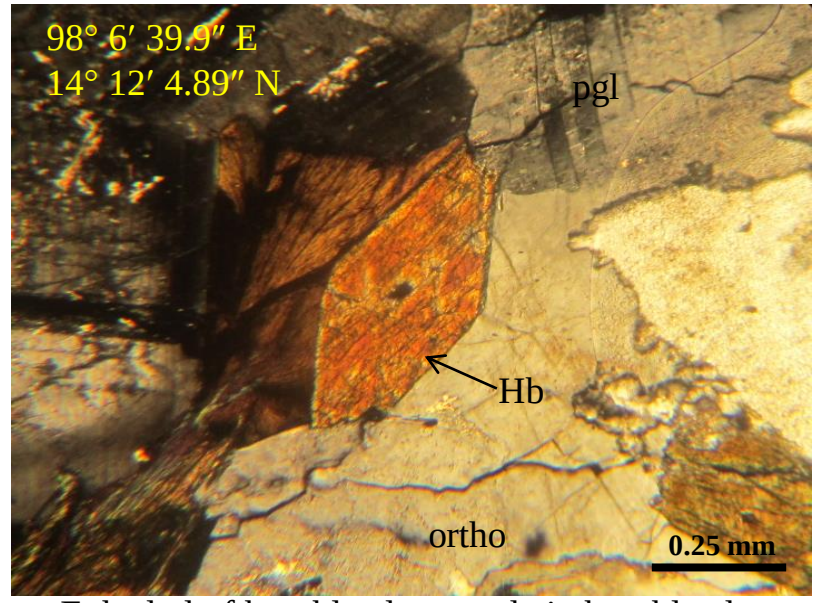
String perthite in hornblende-biotite granodiorite (between.X.N)



Subhedral hornblende crystals in hornblende-biotite granodiorite

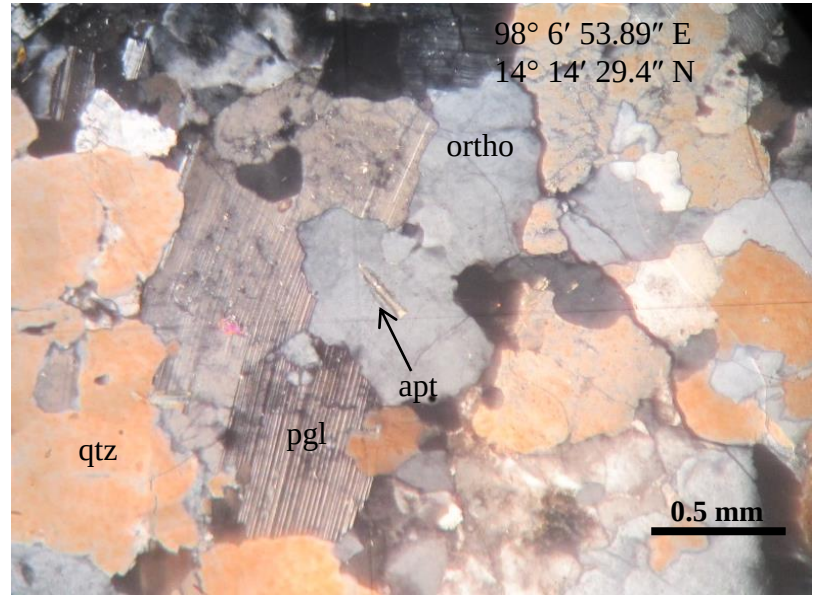


Euhedral sphene in hornblende-biotite granodiorite

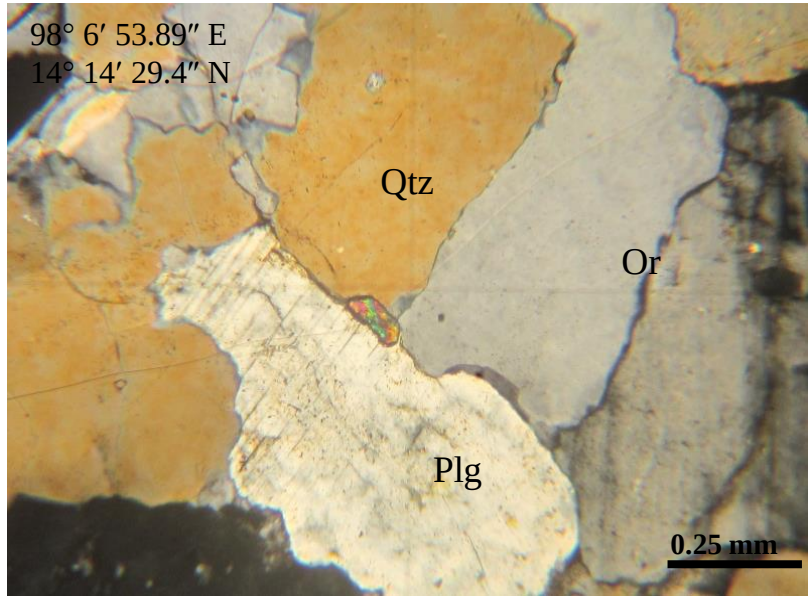


Euhedral of hornblende crystals in hornblende-biotite granodiorite

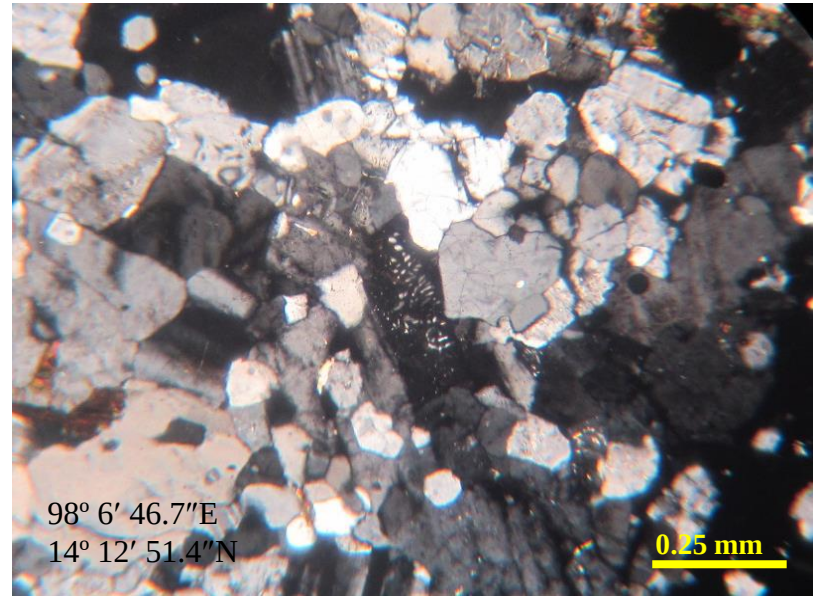
Well jointed nature of biotite microgranite



Microphotograph of biotite microgranite

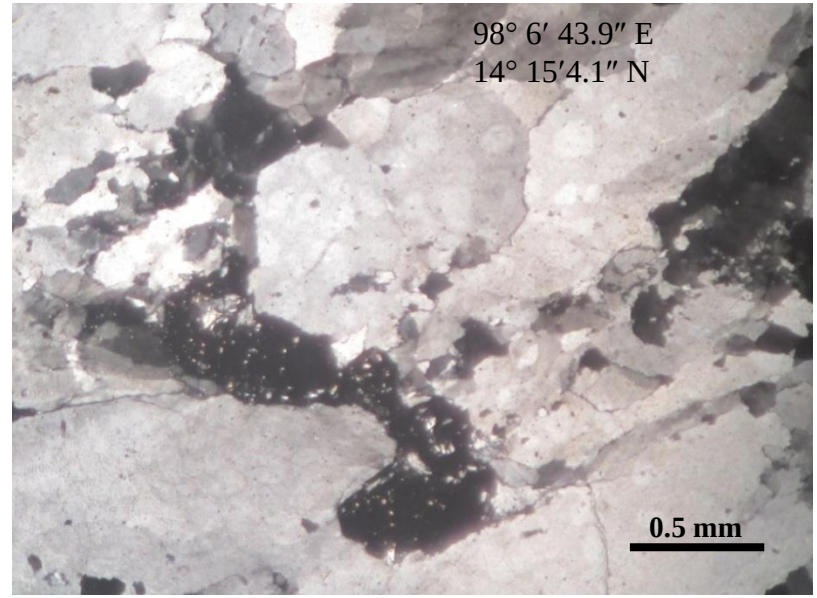


Euhedral zircon inclusion in biotite microgranite



Allotriomorphic granular texture of aplite

Fracture filling quartz crystals in quartzite



Suture contact of quartz show slightly parallel alignment in quartzite (between.X.N)

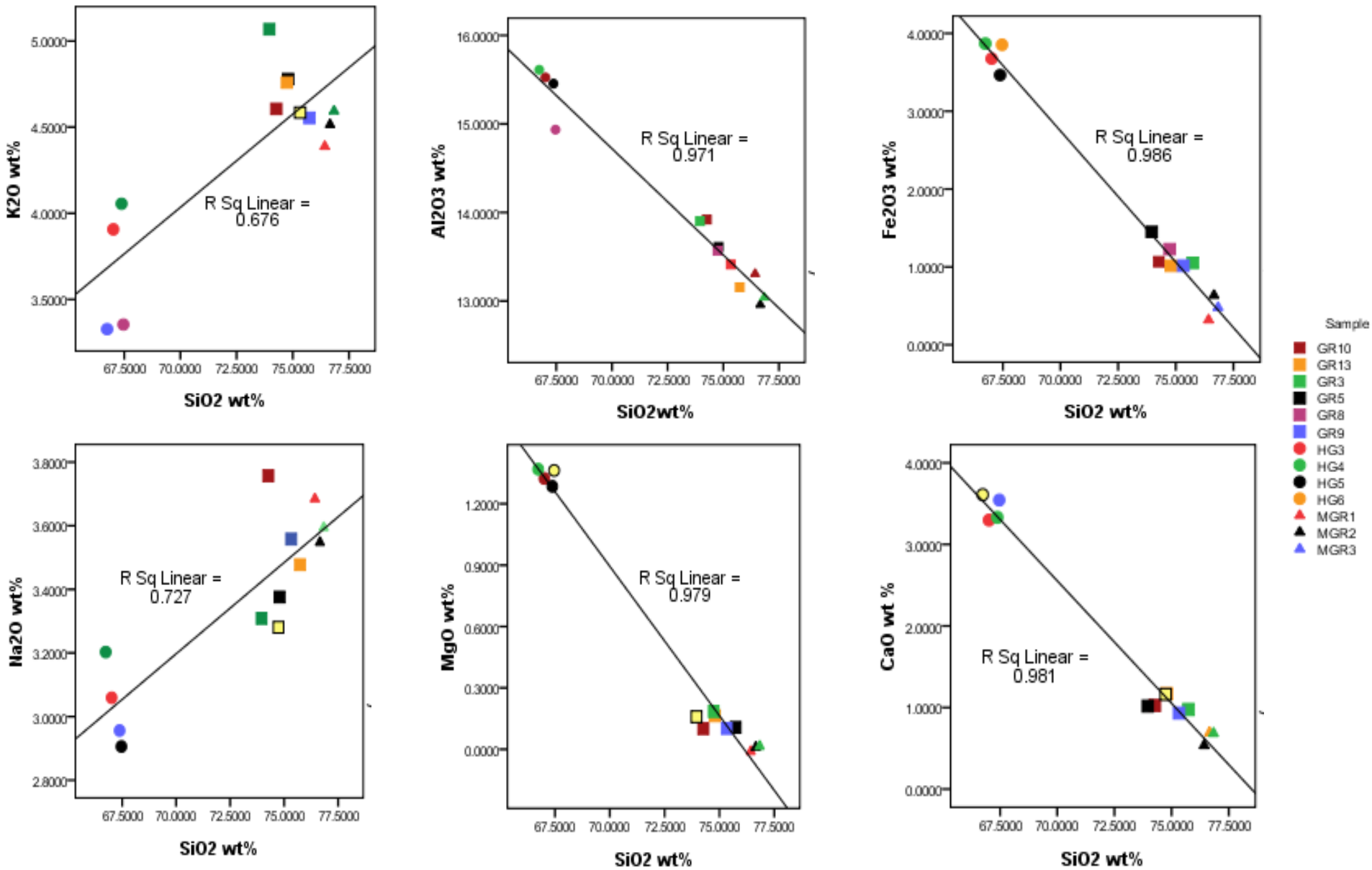
Petrochemical Character of Granitoid Rocks

Analytical Methods

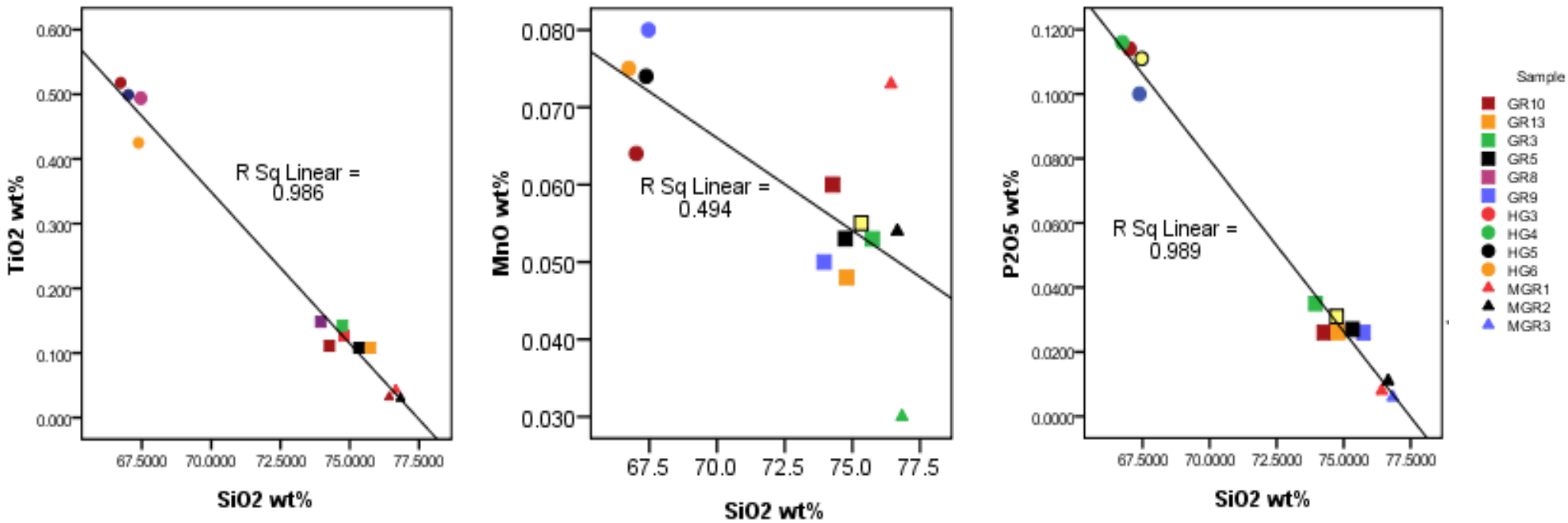
- Totals of 13 representative samples ----------for major oxides, trace elements
- The XRF analyses ---------- at the University of Tasmania, Australia.

Analytical Results

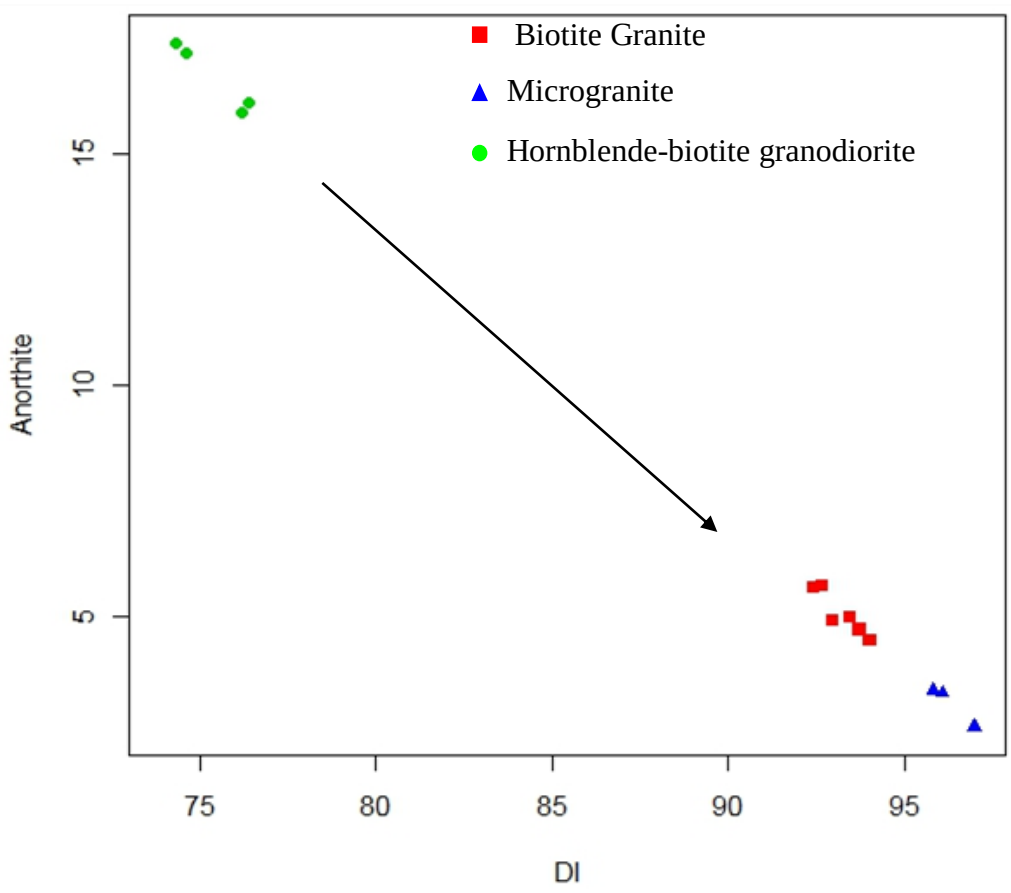
- SiO_2 content of the biotite granite (73.95-75.74 wt%), biotite microgranite (76.43-76.83 wt %), and hornblende-biotite granodiorite (66.74-67.46 wt%)
- Molecular A/CNK ranging from 1.05 to 1.12 and A/NK ranging from 1.19 to 1.28.



Harker variation diagram of the granitoid rocks in the study area

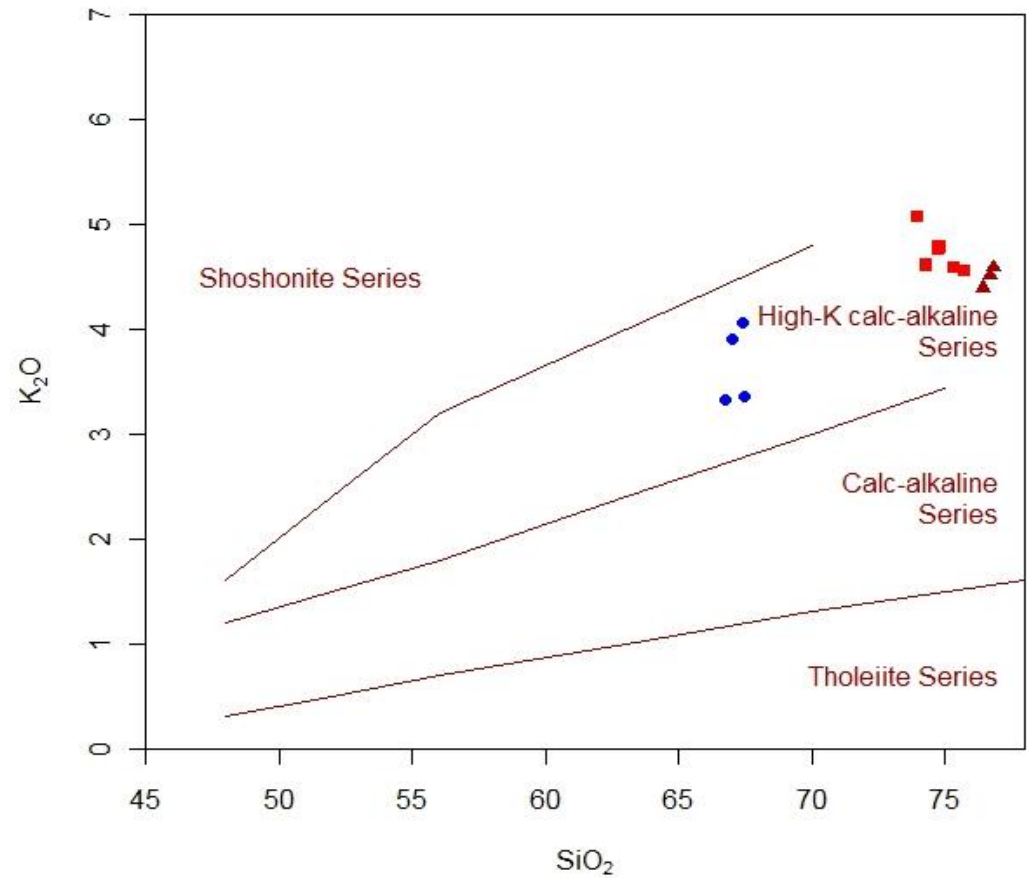


Harker variation diagram of the granitoid rocks in the study area



Degree of differentiation
Hornblende-biotite granodiorite contain more normative anorthite than granites

Anorthite percent (An %) in normative plagioclase plotted against differentiation index (D.I) of Thornton and Tuttle (1960)

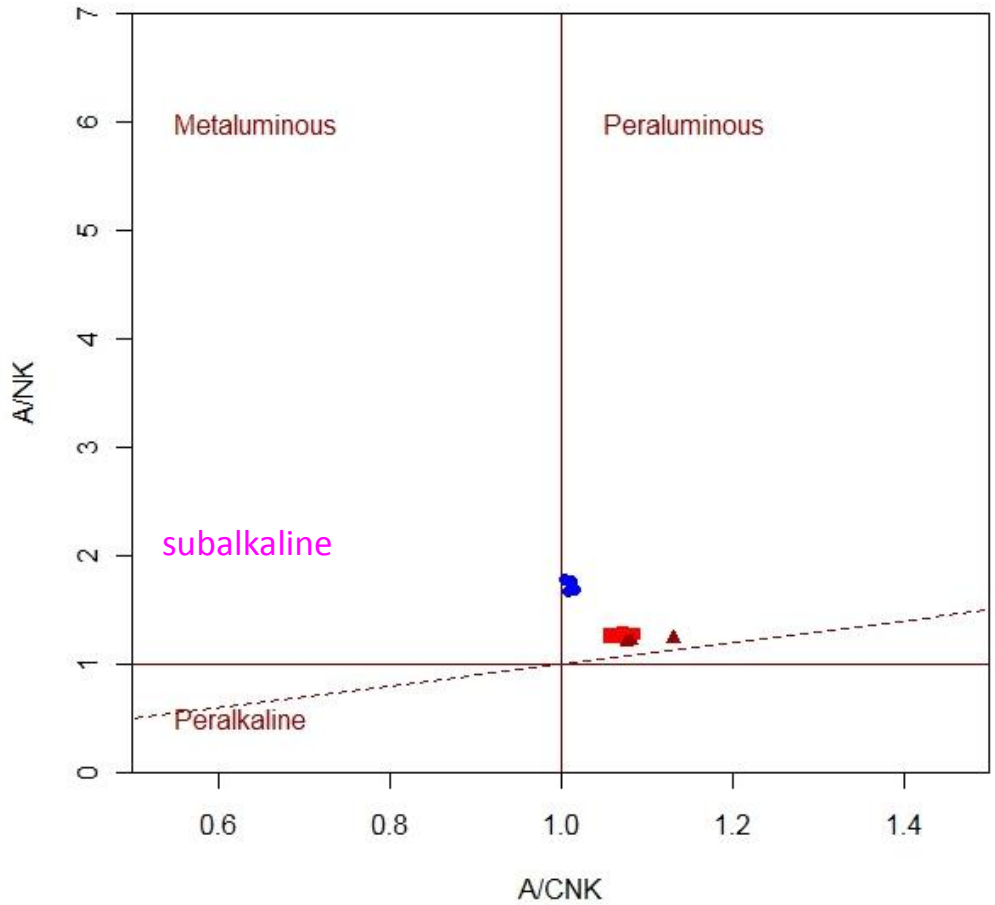


According to SiO_2 Vs K_2O diagram, after Peccerillo and Taylor (1976), the igneous rocks belong to high-K calc-alkaline series.

K_2O vs SiO_2, the dividing line chosen by Peccerillo and Taylor (1976)

Peraluminous Field

- According to Shan (1943), these igneous rocks are predominantly peraluminous with high aluminium saturation indexs of A/CNK and A/NK diagram.



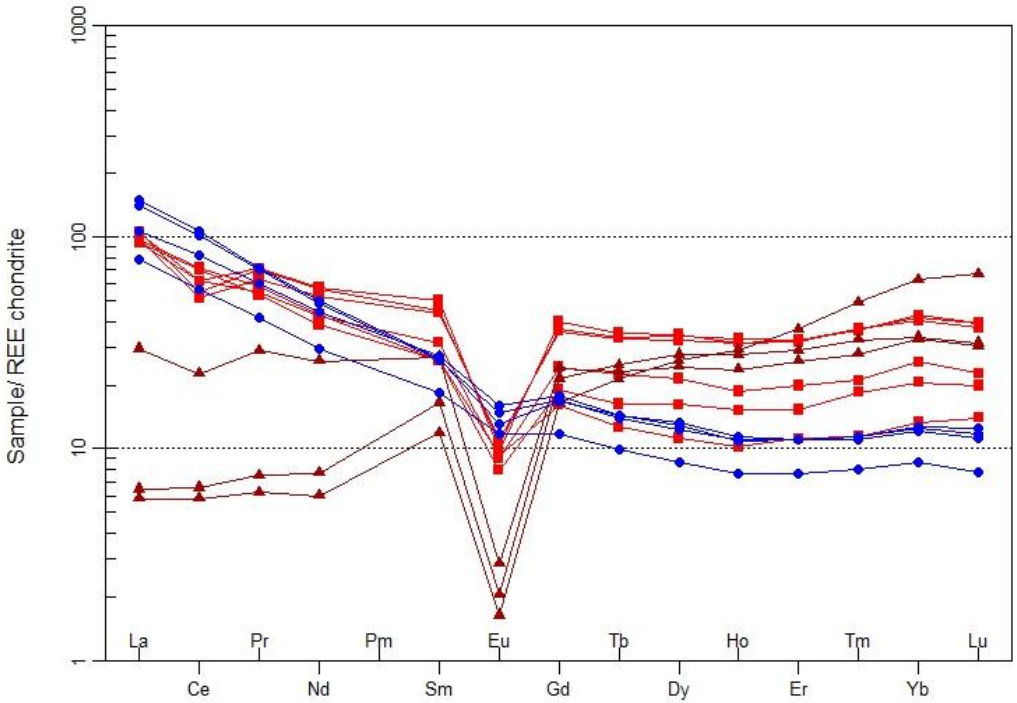
- Biotite Granite
- Microgranite
- Hornblende-biotite granodiorite

❖ Peraluminous and metaaluminous granitoids are chemically defined on the aluminium saturation index (ASI= molar Al_2O_3/ [$CaO+Na_2O+K_2O$]).

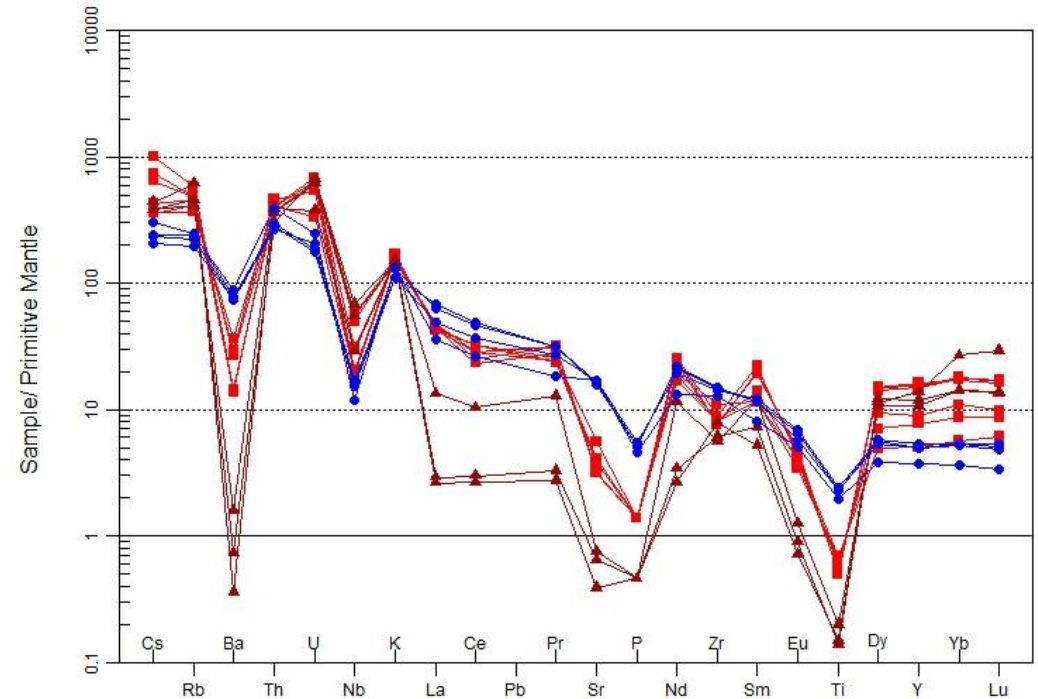
❖ Peraluminous granitoids (ASI>1) and metaluminous granitoid (ASI<1) according to **Zen (1988).**

A/NK (molecular $AL_2O_3/Na_2O+ K_2O$) vs A/CNK (molecular $Al_2O_3/CaO+K_2O+Na_2O$) diagram showing the subalkaline and metaluminous of peraluminous character of igneous rock of the study area (after Shand, 1943)

Chondrite-normalized REE diagram
(after Boynton, 1984)



Primitive-Mantle normalized trace elements multi-variation diagram (after Sun and McDonough, 1989)



- In Chondrite-normalized REE diagram (Boynton, 1984) the hornblende-biotite granodiorites are also characterized by more enrichment of LREE such as La, Ce, Pr and Nd than those in microgranites and flat distributions of HREE such as Tb, Dy, Ho, Er, Tm, Yb and Lu and have prominent negative Eu anomalies indicating the significant role of plagioclase fractionation from the parent magma.

- In Primitive Mantle (Sun and McDonough, 1989) spider diagram, P and Ti anomalies imply that the apatite and rutile may play important roles in their magma source, and strong depletion of Ba, Nb, P and Ti suggests that magma derived from a subduction related setting.

Genetic Type of Granitoid Rocks

• The Igneous Rocks in the study area are-
(by the study of petrography)

1. Mafic minerals (hornblende and biotite) are present.
3. Biotite ± hornblende + sphene association and biotite shows strong pleochroism from yellow to dark brown colour.
4. Accessory minerals include sphene, and apatite are present. Apatite occurs as inclusion in biotite and microcline.

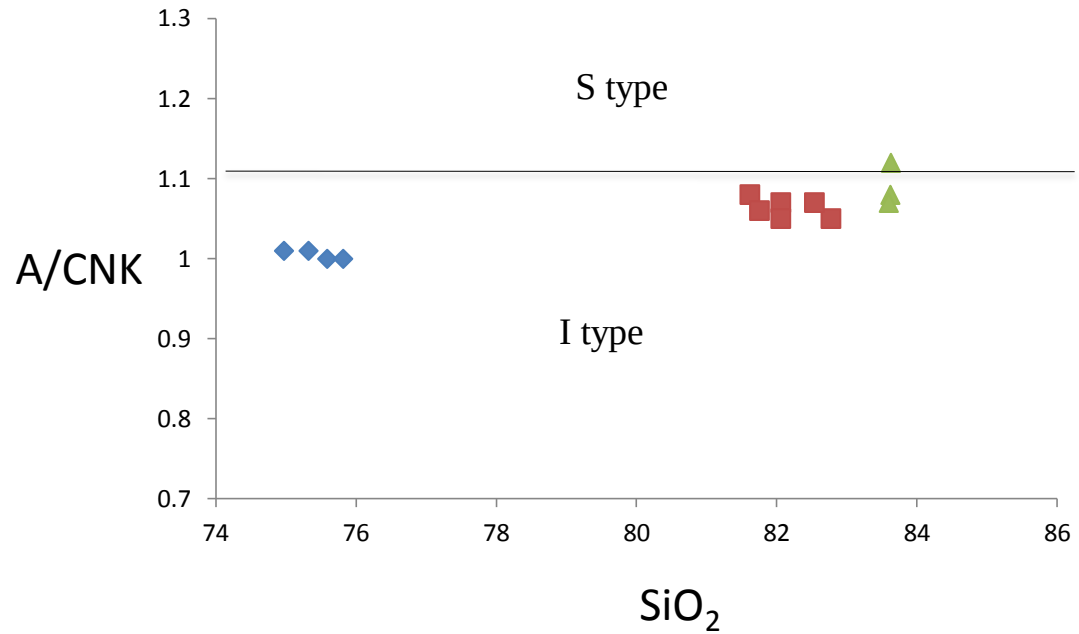
(by the geochemical study)

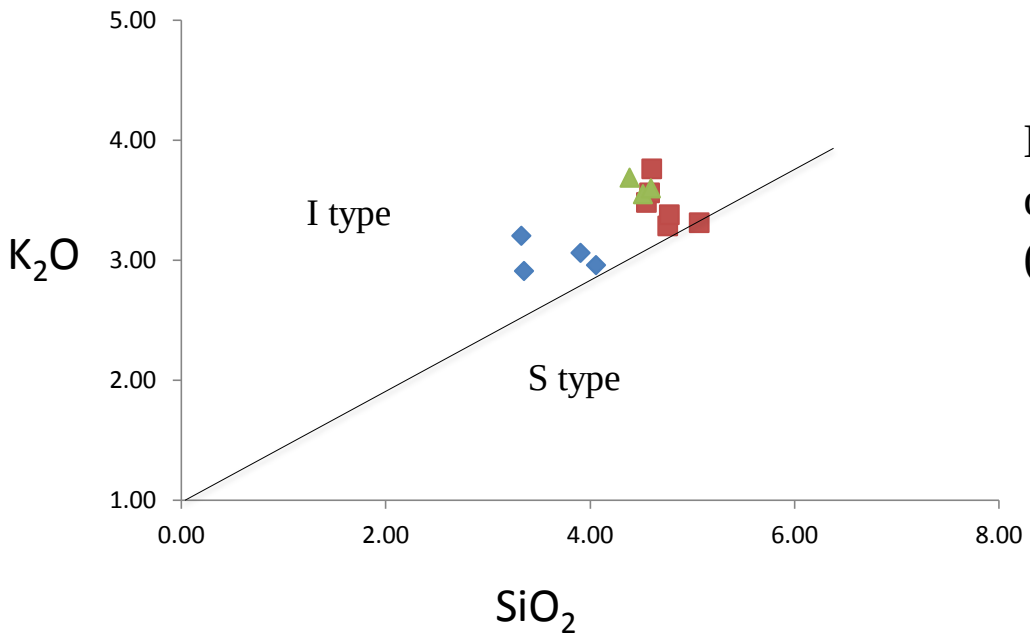
1. decreasing P_2O_5 with increasing SiO_2
2. Normatic Corundum approx. <1%
3. Na_2O is greater than 3.2 % with approximately 5% K_2O
4. In spider diagram plot (primitive mantle) , Ba, Nb P and Ti show negative anomalies
5. Th and U constant indicate the same magma source and I type affinity

- According to Chappell and White (1994), According to SiO_2 vs A/CNK diagram and Na_2O vs K_2O diagram, the granitic rocks of the study area are mostly **I-types** granites.
- According to the petrography and geochemical characteristics, the granitoid rocks of the study area are mostly **I-types** granites.

SiO_2 Vs $Al_2O_3/CaO+Na_2O+K_2O$ (A/CNK) diagram for the granitic rocks of the study area, after Chappell and White (1974)

Mostly I-types





Na2O Vs K2O diagram for the granitic rocks of the study area, after Chappell and White (1983).

Mostly I-types

Economic Possibilities

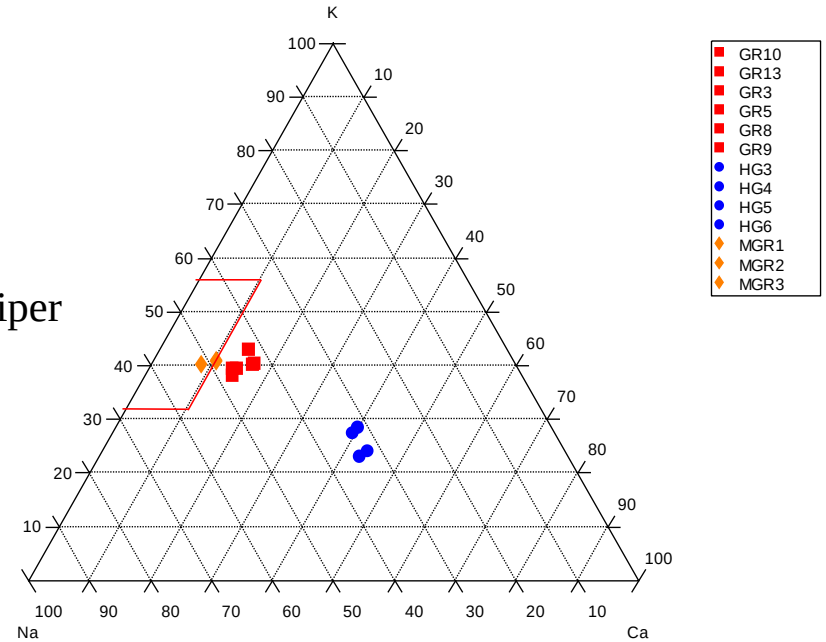
- Granites from the study area can be used as decorative stones. It becomes more attractive as dimentional stones when it is polished. Granites can also be extracted for construction and road materials.

Rare earth elements from the granitic rocks in the study area

Rock	Y	La	Ce	Pr	Nd	Sm	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Gr 3	68.1	30.5	41.6	7.72	31.7	8.58	9.29	1.57	10.45	2.28	6.8	1.2	8.66	1.26
Gr 5	23	30.4	58.1	7.09	25.9	5.12	4.16	0.6	3.61	0.73	2.35	0.37	2.8	0.45
Gr 8	35	29.3	57	6.5	23	5.12	4.95	0.77	5.21	1.09	3.21	0.6	4.3	0.64
Gr 9	69	33	44.2	8.63	34	8.85	9.49	1.58	10.9	2.38	6.84	1.17	8.92	1.27
Gr 10	73.5	32.8	50	8.71	34.6	9.83	10.3	1.67	11.15	2.28	6.7	1.2	8.42	1.2
Gr 13	40.2	29.2	50.2	6.75	25.5	6.19	6.28	1.06	6.91	1.34	4.17	0.68	5.39	0.73
Mgr 1	62.2	1.8	4.7	0.76	3.6	2.31	4.27	1.01	8.4	2.11	7.7	1.59	13.2	2.16
Mgr 2	48.3	9.2	18.3	3.56	15.6	5.3	6.24	1.1	7.86	1.7	5.45	0.91	6.93	0.99
Mgr 3	53.9	2	5.3	0.91	4.6	3.23	5.58	1.18	8.98	1.99	6.15	1.06	7.04	1.02
Hg 3	22.5	43.9	82.7	8.6	29.4	5.15	4.4	0.66	3.96	0.79	2.31	0.36	2.54	0.36
Hg 4	24.1	33.2	66.1	7.41	26.5	5.39	4.64	0.68	4.26	0.82	2.33	0.37	2.64	0.4
Hg 5	16.9	24.5	46.2	5.09	17.9	3.61	3.06	0.47	2.79	0.55	1.61	0.26	1.81	0.25
Hg 6	22.6	46.8	86.8	8.75	29.9	5.18	4.31	0.68	4.13	0.78	2.33	0.37	2.6	0.38

Rare earth elements are critical components in the development of clean energy products and have applications in defense and high-technology manufacturing. The granitic rocks from the study area can be traced for economic important of REEs.

Na-K-Ca triangular plot shows biotitemicrogranite fall in the Sn-bearing Granitoids of New England (after Juniper and Kleeman, 1979)



(i) **Tin (Sn)** Barsukov (1957) suggested that a Sn-bearing granitoid contains 16-30 ppm Sn whereas Sn-barren has 3-5 ppm. the granitoid rocks of the study area contain 1-7 ppm Sn.

(ii) **Barium (Ba)** The average value of 600 ppm Ba was recorded in Sn related. In the study area, there contain a range of 2.5-256 ppm Ba, shows strong negative correlation with silica.

(iii) **Zirconium (Zr)** It is demonstrated that W-Sn bearing granitoid contains less Zr< 10 ppm, whereas barren granitoids have more Zr< 10-50 ppm. A variable amount (85-123 ppm) was recorded in the granitoid rocks of the study area.

(iv) **Yttrium (Y)** Y has an abundance of more than the detection limit of 10 ppm (a range of 23-73.5 ppm) in the granitoid rocks of the study area. Flinter*et al*. (1972) reported that Y content of <10-15 ppm was related to Sn-W-Mo-Cu mineralization.

According to the content of above mentioned trace elements, the granitoid rocks of the study area is considered to be **tin-poor or barren** pluton. Besides, major element distributions indicates that Na-K-Ca plot of the compositions of the granitoids of the study area, except some biotite microgranites, fall outside of the field of Sn-mineralizing granites.

Conclusions

•The study area is composed of major igneous rocks such as biotite granite, hornblende-biotite granodiorite and biotite microgranite.

•Abundance of aplite dykes and quartz veins are probably the result of forceful injection of magma during the final stage of granitic intrusion.

•Myrmekitic texture is observed owing to late magmatic or post consolidation reaction.

•The presence of perthitic textures result exsolution during magmatic crystallization.

•Occurrence of sphene and epidote suggest that high volatile content of magma.

• Plagioclase with combination of Carlsbad twin and polysynthetic twin in hornblende-biotite granodiorite suggests that these are a magmatic origin.

- Petrochemically, it is characterized by the high K, calc-alkaline affinity, Ba, Sr and Nb negative trend and enrichment of LREE (La, Ce, Pr, Nd) which are compatible to those of typical crustal melt (Chappell & White, 1992)
- Strong depletion of Ba, Nb, P and Ti suggests that the magma derived from a subduction related setting and I-type affinity. (Azman.A.Ghani, 2005).
- A prominent negative Eu, Ba and Ti anomaly is normally described the fractional crystallization of plagiolclase, apatite from the parent magma.

Economic Aspects

- Granites from the study area can be used as decorative stones. It becomes more attractive as dimentional stones when it is polished. Granites can also be extracted for construction and road materials.

Rare Earth Elements (REEs)

Rare earth elements are critical components in the development of clean energy products and have applications in defense and high-technology manufacturing.

They are used in items ranging from cell phones and computer hard drives. They are necessary in the production of many green technologies, including electric and hybrid vehicle motors, wind turbines, and energy efficient fluorescent light bulbs.

Rare earth metals and alloys are used in many devices that people use every day such as: computer memory, DVD’s, rechargeable batteries, cell phones, car catalytic converters, magnets and much more.

Rare earths are used as phosphors and polishing compounds. These are used for air pollution control, illuminated screens on electronic devices and optical-quality glass.

Therefore, REEs demand was expected to increase with an increase use in portable equipments. The most abundant rare earth elements are Rubidium, Stronitium, Zirconium, Barium and Cerium.

Therefore, granitic rocks from the study area can be traced for economic important of REEs.