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PETROGRAPHY, PETROCHEMISTRY OF LAMPROPHYRES AND ECONOMIC ASPECTS IN WINPYAN QUARRY, BILIN TOWNSHIP, MON STATE

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Abstract

The research area is situated about 170 km north-east of Yangon and about 96 km north-west of Mawlamyine. Lamprophyres are melanocratic, porphyritic and hypabyssal rocks. Lamprophyre is mainly composed of hornblende, plagioclase, orthoclase and opaques. Under the microscopic study, this lamprophyre may be classified as spessartite; it has medium-grained porphyritic and panidiomorphic texture, dominantly comprising euhedral to subhedral forms of hornblende phenocrysts, groundmass of plagioclase and minor amount of K-feldspar and quartz. According to the chemical analysis data, MgO-K_2O-Al_2O_3 and Fe_2O_3-Al_2O_3-MgO ternary diagrams show that the samples fall in the lamprophyre field. MgO-Al_2O_3-CaO triangular diagram indicates that the samples fall in the field of alkaline lamprophyre. These lamprophyres have high K_2O and Na_2O concentration and show alkaline characters. Due to the alkaline characters, lamprophyres are porphyritic, volatile-rich igneous rocks, which are emplaced as dykes. Lamprophyre is observed as dyke intruding into the pyroxenite at Winpyan quarry. This dyke is a very late phase of large igneous intrusion. By the field investigation and petrographic analysis, the petrogenesis of lamprophyre may be considered as magmatic origin. Lamprophyre in the research area are generally thought to be derived from low degree partial melting of a lithospheric mantle that has been previously metasomatised by subduction-related fluids. Absolute age of the lamprophyre is still unknown, due to lack of radiometric dating of the rock. In the research area, the age of the biotite granite is 51.9 ± 0.7 Ma (Eocene) in age. Therefore, the age of lamprophyre may be younger than Eocene age. Specular hematite ore minerals found near the lamprophyre dyke. Specular hematite has been used as jewellery; such as necklaces, rings and bracelets. By wearing specular hematite, it makes to treat disorders of the blood, to heal broken bones, to help the effects of electromagnetic fields and to protect toxic energy from computers.

Keywords; lamprophyre, alkaline lamprophyre, magmatic origin, specular hematite

Introduction

Location and size

The research area is situated about 170 km north-east of Yangon and about 96 km north-west of Mawlamyine. It is lying between Latitude 17˚12´45´´N to17˚21´45´´N and Longitude 97˚09´00´´E to 97˚14´45´´E in one-inch topographic map No. 94G/3 and G/4. It extends about 8 km from east to west and 14.4 km from north to south. The total areal coverage is about 116.5 km. The location map of the research area is shown in Figure 1.

Physiography and Drainage

The northern, north-western and south-eastern parts of the study area are mountainous terrain and southern and western parts have rolling hills and central and southern parts have flat-lying topography, Figure 2. In the study area, the longest Bilin River flow from north to south, in the eastern boundary of the study area. Gonnyinnwe Chaung (flowing north to south) is found in the western part of the area. In the eastern part of the area, Yinon Chaung flow from east to west and Paingdawe Chaung is located in the central part and flow from east to west. The drainage pattern of the research area is medium to coarse dendritic, radial and sub-parallel drainage pattern. The drainage pattern of the research area is shown in Figure 3.

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Regional Geologic Setting

The research area is located in Bilin Plain, which lies in the northern continuation of Thaninthayi granite belt, which is actually a part of western tin bearing batholiths known as western tin belt of South East Asia Tin Province (Mitchell, 1977 and Nyan Thin, 1984). Bertrand et al, 1999 considered that this area is a part of the Shan Scarp from Thaton in the South to Mandalay in the North.The belt also lies within a part of Mogok Belt (Searle and Haq, 1964), which extend from Putao in the north through Mogok to Mottama in the south. Prior to the major phase of intrusions, the country rocks appear to have been affected by regional metamorphism and structural deformation possibly related to the Triassic-Jurassic Indonesian orogeny. Therefore, these contact metamorphic effect of granitoid intrusions superimposed on the already regional metamorphosed country rocks (Khin Zaw, 1990). Structurally, the research area is bounded by NNW-SSE trending two major fault systems. They are Three Pagoda and Papun faults. The Pleistocene alluvium covered the south-western and south-eastern parts of the area as lateritic terrain. Regional geological map of the research area is shown in Figure 4.

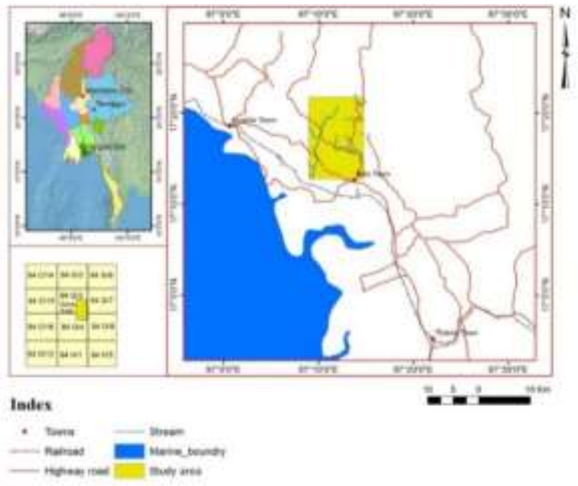

Figure 1. Location map of the research area

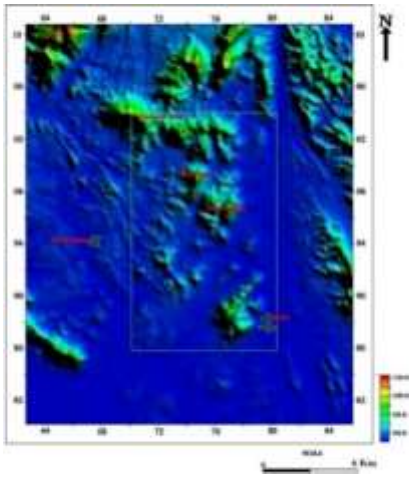

Figure 2. Physiographic map of the research area

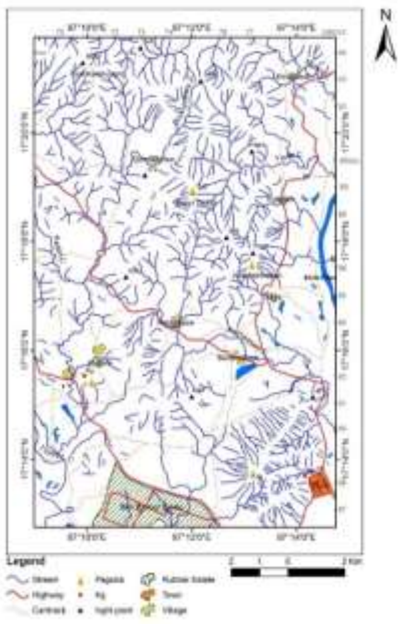

Figure 2. Drainage map of the research area

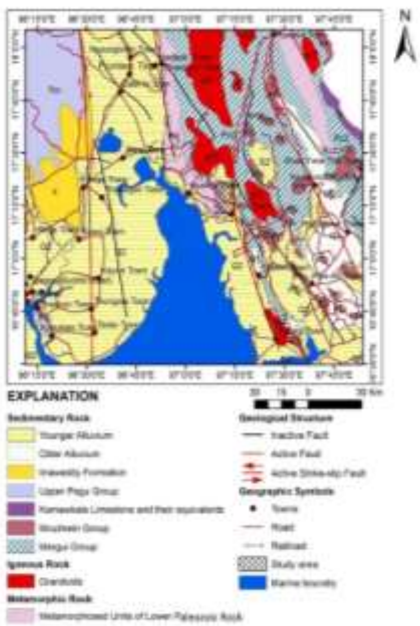

Figure 4. Regional map of the research area (Myanmar Geosciences Society, 2014)

Aim and Objectives

- To carry out the petrography and petrochemistry of the lamprophyre exposed in the research area
- To investigate possible origin and age of lamprophyre
- To know economic aspects in the research area

Research Methodology

A detailed geological field investigation was carried out by using available simple equipments. The geological data in the field were plotted on the enlarged map from one-inch to one-mile topographic map. Detailed microscopic examination, 10 thin sections from lamprophyres were studied under polarizing microscope. As a laboratory method, XRF analyses were done to estimate the percentage of chemical composition in the research area.

Literature Background

Lamprophyres are named after the Spessart region in southern Germany. L*amprophyres* are uncommon; small-volume ultrapotassic igneous rocks primarily occurr as dykes. Lamprophyres are melanocratic, porphyritic, fine to medium-grained igneous rock usually formed at a moderate distance below the surface. Lamprophyres have to be derived from deep, volatile-driven melting in a subduction zone setting, (after Rock, 1991).

Results and Finding
Petrography of Lamprophyre

Field description

Lamprophyre (spessartite) has medium-grained texture, it is observed as dyke which is injected into the country rock of pyroxenite at Winpyan quarry, Figure 5. A. Trend is 40˚/220˚. Fresh surface are greenish gray and gray in colour and weathered colour are dark gray and yellowish gray, it is compact and well jointed. Phenocrysts of hornblende crystals are observed on fresh surface of lamprophyre. Good exposures occur in Winpyan old quarry, Figure 5. B. and the thickness of lamprophyre (spessartite) dyke is about 2 m to 4 m.

Microscopic description

Under the microscopic study, this lamprophyre may be classified as spessartite; spessartite is mainly composed of hornblende, plagioclase, orthoclase and opaques. It has medium-grained porphyritic and panidiomorphic texture, dominantly comprising euhedral to subhedral forms of hornblende phenocrysts, groundmass of plagioclase and minor amount of K-feldspar and quartz. Hornblendes occur as principal mafic minerals with simple twin, Figure 5. C. Pale green and yellowish brown colour of fractured and skeletal hornblende is observed, Figure 5. D. Hornblende crystals are highly corroded and penetrated each other, Figure 5. E. Phenocrysts of hornblende are common. Basal section of hornblende crystals is also found in spessartite, Figure 5. F. Plagioclase occurs as fine-grained in the groundmass. Sometimes, it shows as lath-shaped, Figure 5. G. Zoning pattern is well developed in plagioclase feldspar. Alkalifeldspar occurs as minor amount with subdral forms and shows simple twin. Quartz shows corroded and surrounded by fine sericite. Simple contact twin of hornblende is present, Figure 5. H. Accessory minerals are apatite, sphene and opaque minerals.

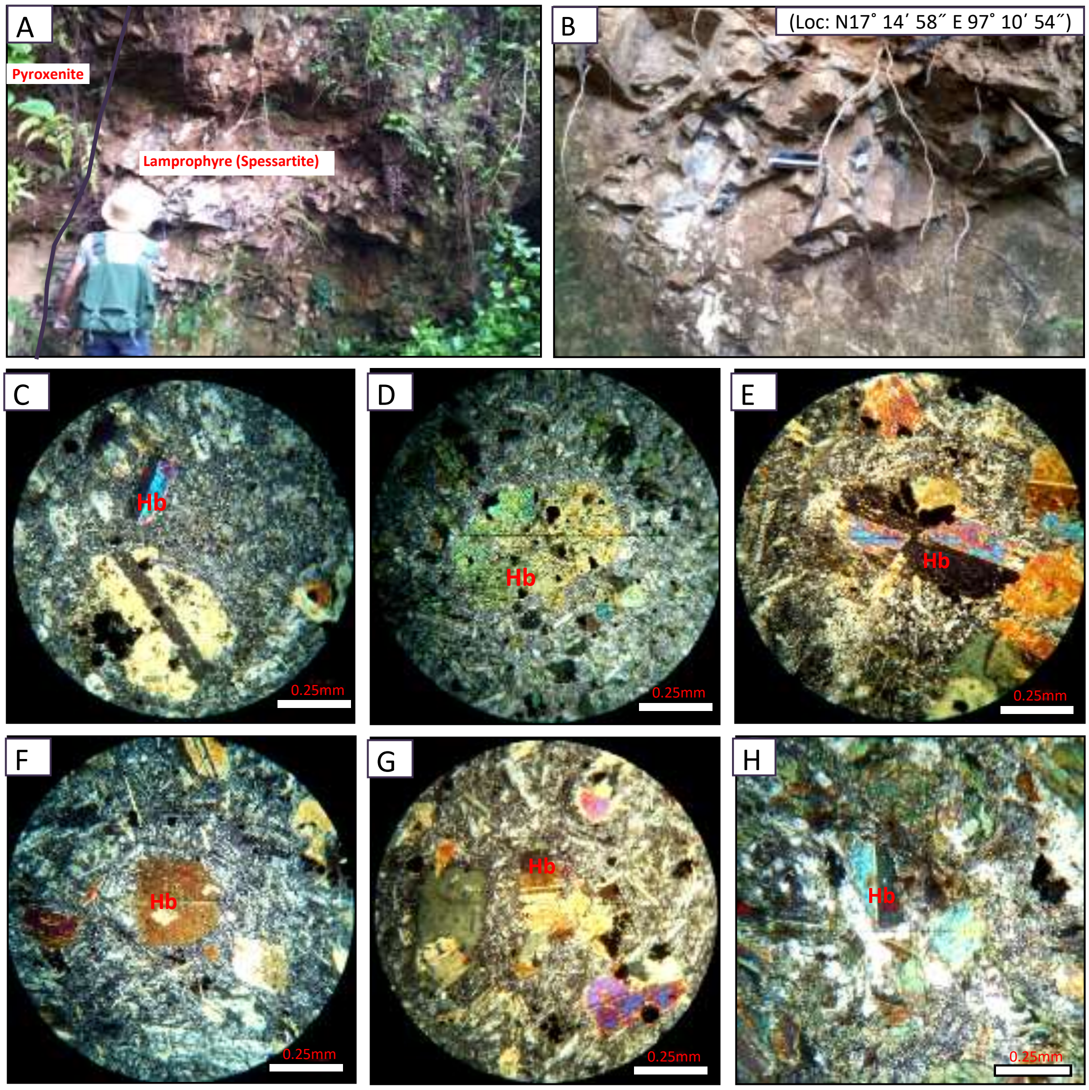

Figure 5. (A) Lamprophyre (spessartite) is intruded into the pyroxenite body at Winpyan quarry, facing 60˚
(B) Exposure of lamprophyre (spessartite) at Winpyan old quarry, facing 90˚
(C) Simple twin of hornblendes (Hb) in spessartite (between X.N, 10X)
(D) Fractured and skeletal hornblende (Hb) in spessartite (between X.N, 10X)
(E) Simple twin nature of hornblende (Hb) in spessartite (between X.N, 10X)
(F) Basal section of hornblende crystal (Hb), magnetite and feldspar laths in spessartite (between X.N, 10X)
(G) Phenocrysts of hornblende (Hb) and groundmass of feldspar laths
(H) Simple contact twin of hornblende (Hb) in spessartite (between X.N, 10X)

Classification of Lamprophyre

According to the (Le Maitre *et al.* 1989), lamprophyre can be classified nine types, Table 1. In the research area, lamprophyre is composed of plagioclase feldspar > K-feldspar and hornblende phenocrysts are the dominant mafic minerals and plagioclase feldspar laths are groundmass. So, it can be defined as spessartite.

Table 1. Classification and nomenclature of lamprophyres based on their mineralogy (after Le Maitre and Rock, 1991)

Light-coloured constituents		Predominant mafic minerals			
Feldspar	Foid	Biotite, diopsidic augite, (±olivine)	Hornblende, diopsidic augite, (±olivine)	Amphibole, (barkevikite, kaersutite), Ti-augite, olivine, biotite	Melilite, biotite, ±Ti-augite, ±olivine, ±calcite
or > pl	—	Minette	Vogesite	—	—
pl > or	—	Kersantite	Spessaritite	—	—
or > pl	Feld > foid	—	—	Sannaite	—
pl > or	Feld > foid	—	—	Camptonite	—
—	Glass or foid	—	—	Monchiquite	Polzenite
—	—	—	—	—	Alnöite

Or, alkali feldspar; pl, plagioclase; feld, feldspar; foid, feldspathoid.

Petrochemistry of Lamprophyre

The analysis of lamprophyre samples was determined by DSSTRC (Defence Service Science and Technology Research Centre) in Pyin-Oo-Lwin Township. Major element chemistry of lamprophyres is given in Table 2. Compositionally, the samples are basic to ultrabasic; the silicon dioxide percentage varies from 47.28% to 51.93%. Al_2O_3 content is high, varying from 13.1% to 20.26%. The concentration of Fe_2O_3 varies from 9.09% to 13.06% and that of MgO varies from 4.39% to 8.8%. The amount of CaO varies from 7.49 % to 9.34%. The analyses of these rocks are plotted in ternary discrimination diagrams. In the Fe_2O_3-Al_2O_3-MgO triangular diagram (after Cornelissen and Verwoerd, 1975; Kornprobst, 1984), the samples are predominantly in the field of lamprophyre, Figure 6. A. MgO-K_2O-Al_2O_3 ternary diagram (after Bergman, 1987) shows the samples fall in the lamprophyre field, Figure 6. B. MgO-Al_2O_3-CaO triangular diagram (after Rock, 1987) indicates that the samples fall in the field of alkaline lamprophyre (AL), Figure 7. SiO_2 vs Na_2O + K_2O diagram (after Irvine and Baragar, 1971) shows alkaline nature of lamprophyre, Figure 8. The lamprophyres belong to alkaline suite; they are enriched in alkalies. The lamprophyres have high K_2O and Na_2O concentration and show alkaline characters. Sodium and Potassium are known to be relatively more mobile (after Pearce and Cann, 1973; Floyd and Winchester, 1975), this suggests feldspar crystallization to have been relatively late and fractionation dominated by olivine and clinopyroxene crystallization. Alkaline lamprophyres are porphyritic, volatile-rich igneous rocks, which are typically emplaced as small-volume intrusions, dykes. Lamprophyre in the research area are generally thought to be derived from low degree partial melting of a lithospheric mantle that has been previously metasomatised by subduction-related fluids (after Rock, 1991).

Table 2. Major oxide (wt %) and trace elements (ppm) abundances of the lamprophyre from the research area

Sample No	B-04	R-08	B-02	B-03	Sample No	B-04	R-08	B-02	B-03
SiO_2	48.8	51.93	47.84	47.28	Mo	0.06	0.06	0.12	0.11
TiO_2	0.67	0.63	0.56	0.506	Nb	0.05	0.06	0.05	0.08
Al_2O_3	19.4	14.5	13.1	20.26	Pb	6.23	2.15	3.33	3.454
Fe_2O_3	10.5	9.69	13.06	9.097	Ga	-	0.01	1.295	1.341
MnO	0.237	0.15	0.251	0.086	Zn	6.27	11.08	9.657	6.573
MgO	4.39	7.05	8.8	6.263	Cu	5.74	3.88	5.817	8.012
CaO	7.49	7.54	8.694	9.34	Co	10.3	9.58	9.459	7.996
Na_2O	4.29	3.03	3.26	4.01	Si	19.19	19.31	21.77	19.85
K_2O	3.56	2.91	2.48	1.331	Fe	919	897	918.7	898.8
P_2O_5	0.366	0.52	0.421	0.087	Mn	17.55	21.7	20.34	19.12
Total	99.7	97.9	98.47	98.26	Ti	14.14	19.83	14.5	19.69
A/CNK	1.264	1.07	0.907	1.380	Nd	0.73	0.84	0.707	0.656
A/NK	2.471	2.44	2.28	3.29	Pr	0.51	0.534	0.537	0.541
Cl	29.15	25.29	22.744	26.316	Ce	29.8	37.3	28.66	29.33
Ca	38.12	58.51	49.19	38.4	La	0.29	0.311	0.274	0.233
Cd	2.814	1.58	4.299	7.321	Ba	0.39	0.311	0.388	0.623
Ag	3.87	3.29	1.34	4.708	Sb	0.07	0.212	0.051	0.055
Pd	3.89	2.68	0.29	0.966	Zr	36.96	63.69	25.72	63.9
Rh	1.36	-	0.524	2.092	Y	1.72	2.15	0.50	0.69
K	11.46	11.47	10.45	11.87	Sr	306.7	675.4	565.9	405.58
Rb	28.18	27.33	3.5	9.84					

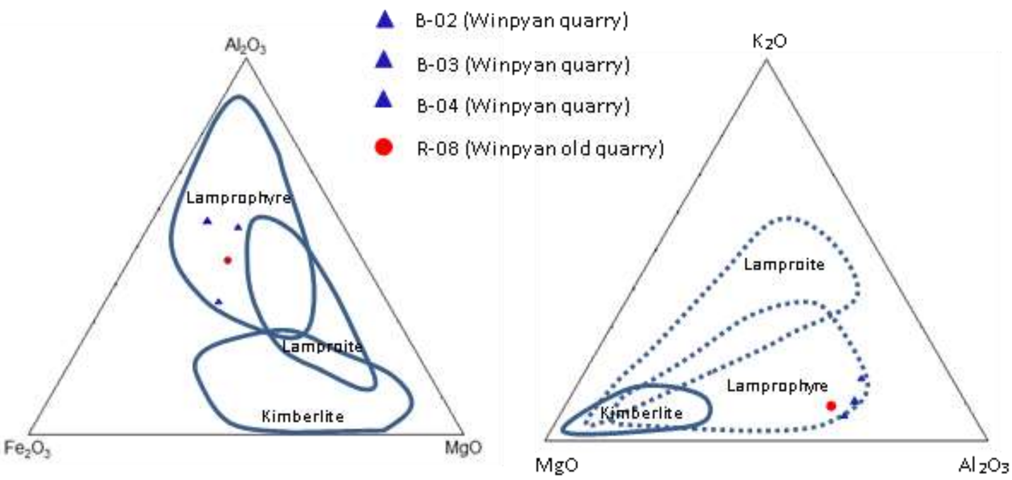

Figure 6. (A) Fe_2O_3-Al_2O_3-MgO diagram shows the samples fall in the Lamprophyre field

(B) MgO-K_2O-Al_2O_3 diagram showing the fields of Classical Kimberlite, Lamproite and Lamprophyre, this diagram shows the samples fall in the field of Lamprophyre (after Bergman, 1987)

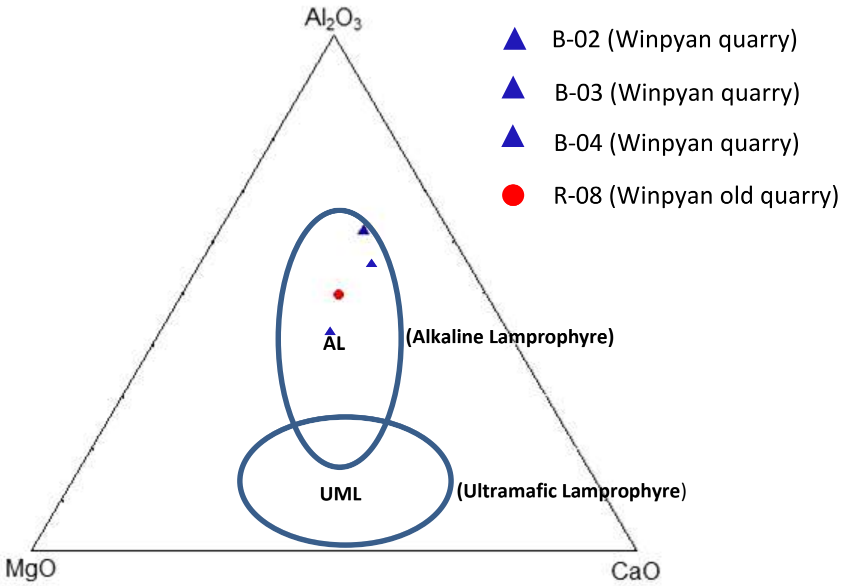

Figure 7. MgO-Al_2O_3-CaO diagram showing the field of AL (Alkaline Lamprophyre) (after Rock,1987)

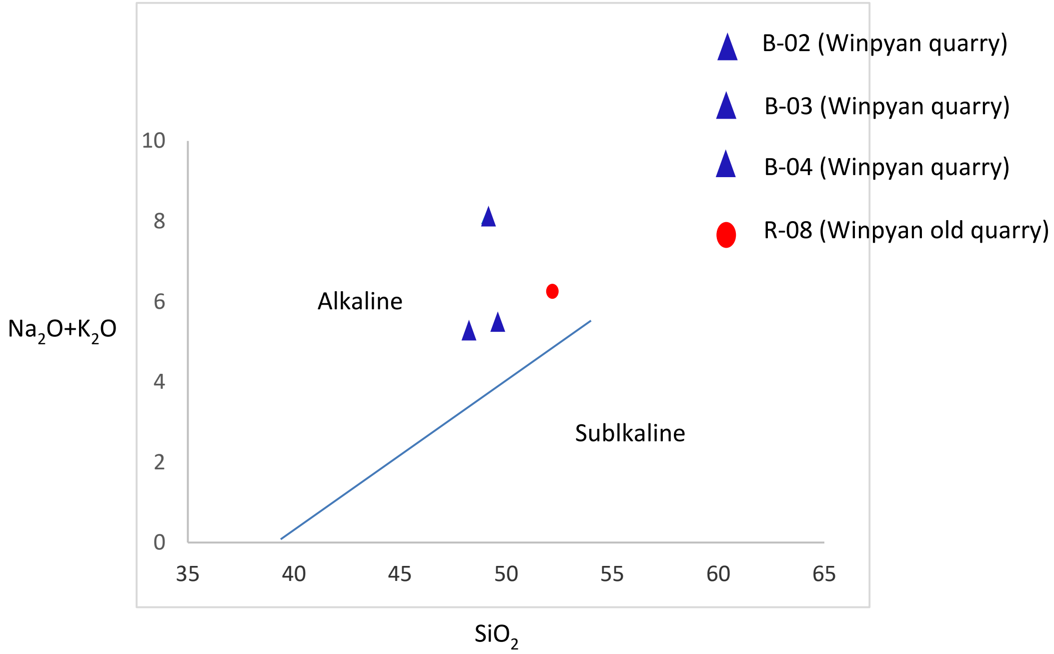

Figure 8. SiO_2 vs Na_2O + K_2O diagram showing alkaline nature of lamprophyre (after Irvine and Baragar, 1971)

Possible origin of Lamprophyre

By the field investigation and petrographic analysis, the petrogenesis of lamprophyre may be considered as magmatic origin. Mineral composition occurs as two generations; phenocrysts and groundmass, i.e., plagioclase feldspar and hornblede in spasserite. It strongly shows zone of plagioclase and hornblende abundantly. Sometimes, it has characterized by granitic composition and aplitic texture; it is possible that basic magma intruded into the granite consolidated to fracture. It displays sharp contact with the country rocks. Moorehouse, 1959 describes that basic materials derived from the mantle and siliceous magma are assimilation involved. Lamprophyric magma formed by remelting crystal of ferromagnesium minerals accumulation at the base of differentiating magma. So, the lamprophyric magma responsible for these dykes is a very late phase of large igneous intrusion.

Possible age of Lamprophyre

Absolute age of the lamprophyre dyke is still unknown, due to lack of radiometric dating of the rock. Pyroxenite xenolith is observed in the biotite granite at the south-eastern part of Alugale village, Figure. 9. It indicates that biotite granite is younger than pyroxenite. The lamprophyre is observed as dyke intruding into the pyroxenite at Winpyan old quarry and which from field relationships is the youngest intrusion at Bilin area. On the result of U-Pb zircon dating methods, the zircon age of the biotite granite from the northern part of Laykhin pagoda in Bilin area is 51.9±0.7 Ma (Eocene), Figure. 10. Therefore, the age of lamprophyre may be younger than Eocene age.

Figure 9. Pyroxenite xenolith found in biotite granite at the south-eastern part of Alugale village, facing 20˚(Loc: N 17˚ 16′ 00″ E 97˚ 11′ 10″)

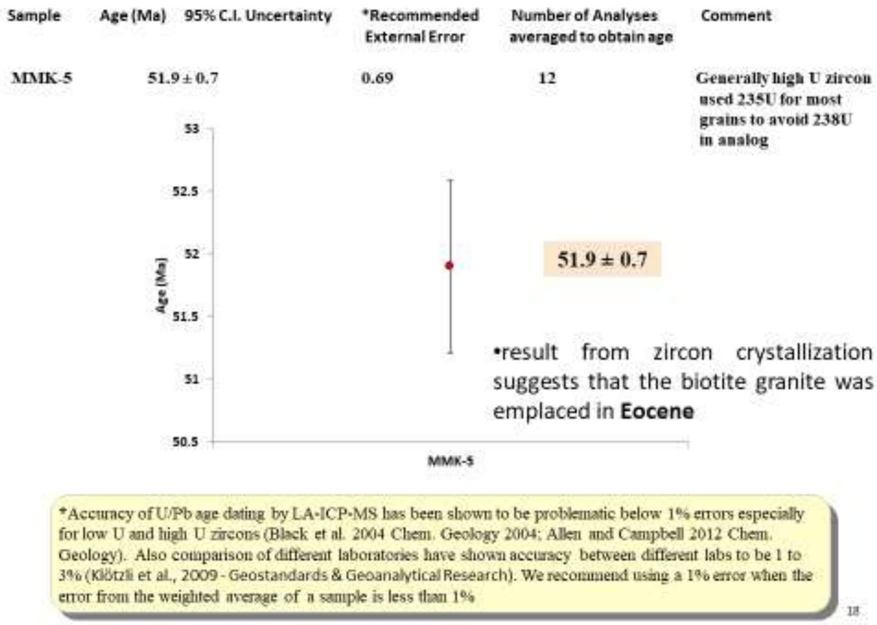

Figure 10. Biotite granite (MMK-5) from the northern part of Laykhin pagoda (Loc: N 17°14′16″, E 97°12′46″) gives the zircons age of 51.9 ± 0.7 Ma (after Mya Moe Khaing, 2017)

Economic Aspects

Specular hematite occurs from the south-eastern part of Kyauksein Taung, shown in Figure 11. A, B, C, D. Specular hematite observed near the lamprophyre dyke. The lamprophyre rocks are being used as construction and dimension stones. This specular hematite crystal is a beautiful variety of hematite that has a rich metallic luster on a sparkling silvery polished surface. Specular hematite has been used as jewellery; such as necklaces, rings and bracelets, Figure 12. By wearing specular hematite, it makes to treat disorders of the blood and to heal broken bones. Specular hematite crystal can help regulate the effects of electromagnetic fields and is excellent to have on hand when exposed to toxic energy from computers or other electrical systems.

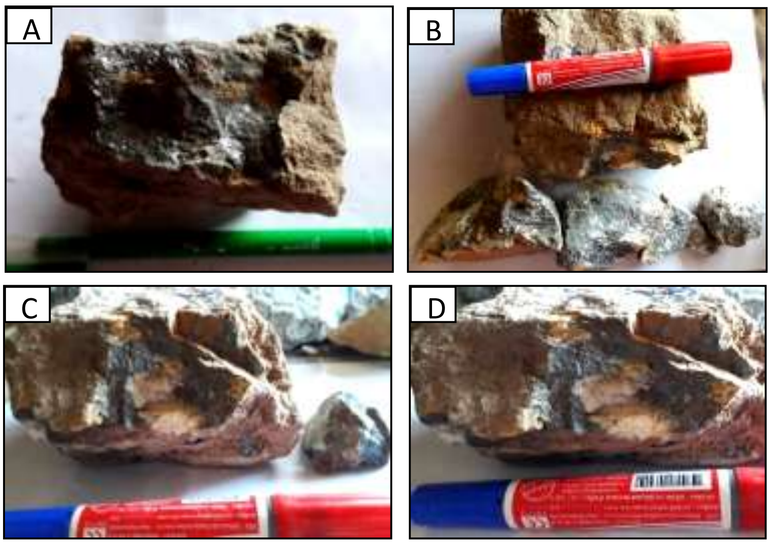

Figure 11. (A, B, C, D) Specular hematite samples occurs at the south-eastern part of Kyauksein Taung (Loc: N 17˚ 15´ 01˝ E 97˚10´ 27˝)

Figure 12. Jewellery samples of specular hematite

Conclusion and Discussion

Lamprophyre is mainly composed of hornblende, plagioclase, orthoclase and opaques. It has medium-grained porphyritic and panidiomorphic texture. Mineral composition occurs as two generations; phenocrysts and groundmass, euhedral to subhedral forms of hornblende phenocrysts, groundmass of plagioclase and minor amount of K-feldspar. It strongly shows zone of plagioclase and hornblende abundantlyBy the field investigation and petrographic analysis, the petrogenesis of lamprophyre may be considered as magmatic origin. Lamprophyres are porphyritic, volatile-rich igneous rocks, which are typically emplaced as small-volume intrusions, dykes. Lamprophyre is observed as dyke intruding into the pyroxenite at Winpyan old quarry. So, dyke is a very late phase of large igneous intrusion. Lamprophyre in the research area are generally thought to be derived from low degree partial melting of a lithospheric mantle that has been previously metasomatised by subduction-related fluids. Absolute age of the lamprophyre dyke is still unknown, due to lack of radiometric dating of the rock. Pyroxenite xenolith is observed in the biotite granite at the south-eastern part of Alugale village. It indicates that biotite granite is younger than pyroxenite. On the result of U-Pb zircon dating method, the zircon age of the biotite granite from the northern part of Laykhin pagoda in Bilin area is 51.9 ± 0.7 Ma (Eocene). Therefore, the age of lamprophyre may be younger than Eocene age. The lamprophyre rocks are being used as construction and dimension stones. Specular hematite found near the lamprophyre dyke. Specular hematite crystal is a beautiful variety of hematite that has a rich metallic luster on a sparkling silvery polished surface. By wearing the specular hematite crystal, it can help regulate the effects of electromagnetic fields and is excellent to have on hand when exposed to toxic energy from computers or other electrical systems.

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