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## Petrographic Characteristics and Geochemistry of Volcanic Rocks in the Kyaukmyet Prospect, Monywa District, Central Myanmar

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ABSTRACT

The Kyaukmyet prospect lies approximately 5 km ENE of the high-sulfidation Kyisintaung copper-gold deposit, Monywa district, central Myanmar. Geologically, the research area is remarked by magmatic extrusion that occurred during the Late Oligocene to Middle Miocene of Magyigon Formation which led to the outcrops of volcanic rocks. Study detailed on petrographical and geochemical of the Kyaukmyet volcanic rocks has not been performed before the present work. The principal aim of this paper is to document the petrographical and geochemical characteristics of volcanic suite rocks exposed in the Kyaukmyet prospect. The results of this data have provided insight into the origin of the rocks and petrogenetic processes during evolution. Petrographically, all the studied volcanic rocks in the research area show that trachytic and porphyritic textures with phenocrysts of quartz, plagioclase, and K-feldspar which are embedded in a fine to medium grained groundmass. The accessory minerals of this rock consist of biotite, chlorite and opaque mineral. Geochemically, these volcanic rocks having calc-alkaline nature and classified as volcanic field (rhyolite) as well as volcanic arc setting. Based on the chondrite normalized spider diagram, LREE has enriched to HREE in this area which indicated negative Eu anomaly and subduction tectonic setting.

### 1. Introduction

Myanmar is a tectonically complex region which lies in the eastern margin of the India-Asia collision zone. It is characterized by the continuation of the 1500 km long still active dextral Sagaing Fault that extends from the eastern tip of Himalayan Syntaxis to the north and the Andaman Sea to the south<sup>[1-3]</sup>. Tectonogeographically, Myanmar is divided into two distinct geological provinces including the eastern part (Shan Thai Block) and the western part

(West Burma Block)<sup>[4]</sup>. The eastern part is made up of the Shan Plateau, the Mogok Mandalay Mergui Belt and the Shan Scarps, whereas the western part is composed of the Indo-Myanmar Ranges, the Wuntho-Popa magmatic arc and overlying Cretaceous-Pliocene sedimentary formations<sup>[3,5]</sup> (Figure 1).

The Monywa district is tectonically situated in the active N-S trending the Wuntho-Popa magmatic arc which formed as a result of east dipping subduction in

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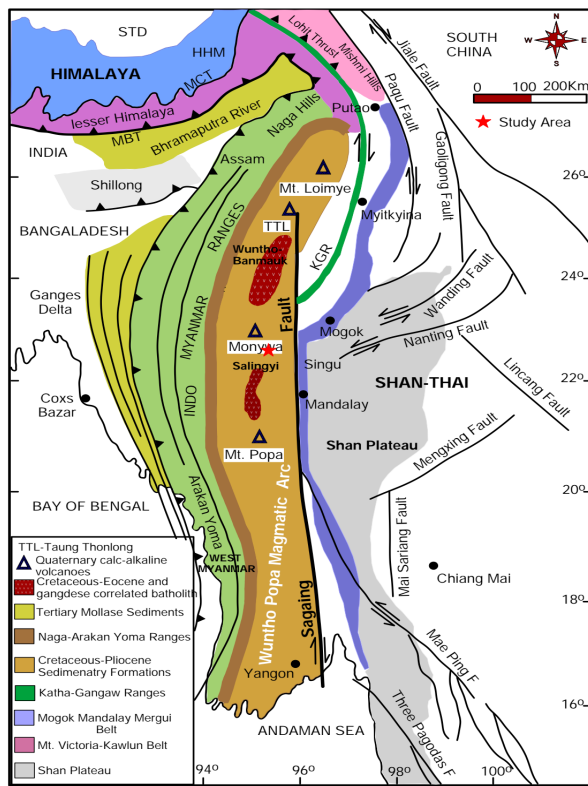
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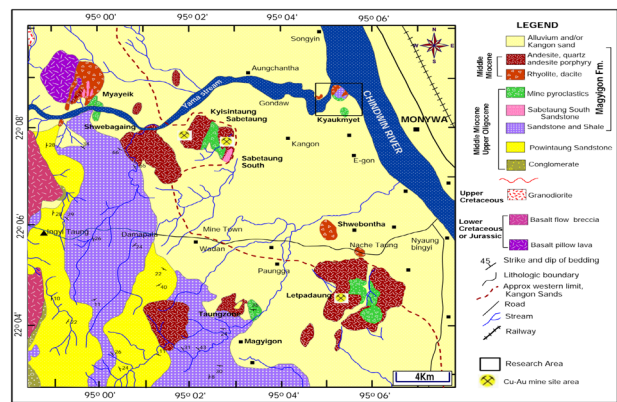
the Andaman-Sunda subduction zone that prolongs from the Gangdese through to the west of Myanmar, and to western Sumatra in the south [6] (Figure 1). In general, the Wuntho-Popa magmatic arc is one of the most important geological conditions as well as mineral belts in Myanmar. It is recognized by the occurrence of Late Cretaceous to Tertiary granodioritic batholiths, and minor Late Cretaceous to Quaternary volcanic rocks [7,8]. It is assumed that northern continuation of the Sunda-Andaman arc, is a N-S trending geanticlinal uplift which exposes Mesozoic intrusions and their host rocks.



**Figure 1.** Simplified geologic map (modified from [1,3]) illustrating distribution of the main volcanoes and major geological units in Myanmar.

Accordingly, the Mesozoic rocks are further intruded by Cretaceous diorites and biotite granodiorites in the Monywa district. These units are subsequently overlain by Upper Oligocene to Middle Miocene volcanic and volcanoclastic rocks known as the Magyigon Formation including andesite, quartz andesite porphyry, dacite, rhyolite, tuff and lapilli tuff rock units (Figure 2). In addition, the sedimentary succession consists of a basal conglomerate with local limestone overlain by the Powintaung sandstone developing a west-facing scarp. Above are shales, cross-bedded sandstone, and local basalt breccia, with minor consist of interbedded andesitic tuff in the upper part, comprising the Magyigon Formation, which includes

debris flow deposits with rhyolites (Figure 2). The basement rocks are overlain locally by volcanic rocks and both are overlain unconformably by eastward-dipping quartzofeldspathic sandstone of probable Eocene age, with a prominent west-facing scarp slope at Powintaung. Zircon geochronology data reveal that the rocks that area present within the Monywa district consist of Cretaceous-age basement, Oligocene rhyolitic volcanic formed 27-24 Ma, and Miocene andesite porphyry with an emplacement age of 19 Ma [9] respectively. Studies detailed on petrographical and geochemical of the volcanic rocks are still absent till date to constrain the petrogenesis and evolution of the volcanic rocks. In this paper contribution, we present our work on the petrography and geochemical data for the volcanic rocks in order to understand the characteristics of volcanic rocks, magmatic evolution processes during their genesis and implications on their emplacement.

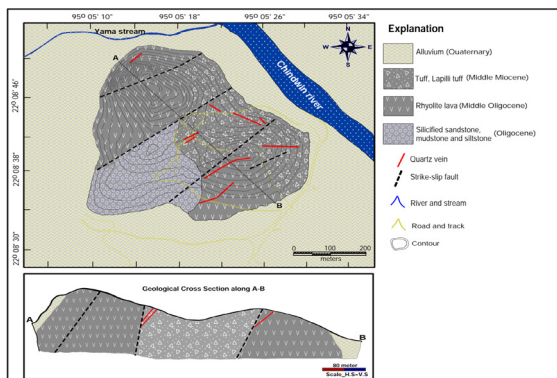


**Figure 2.** Regional geological map of Monywa copper-gold district and the black rectangle is the Kyaukmyet prospect, modified from [10].

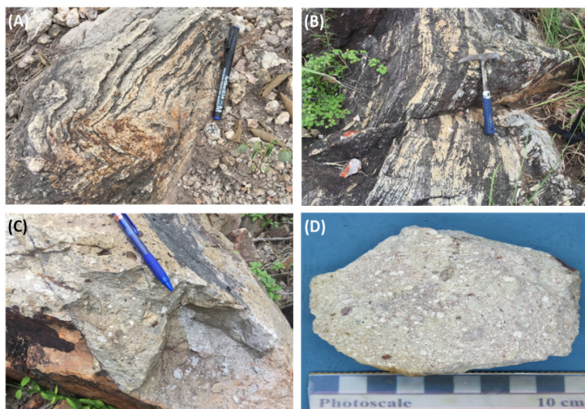
## 2. Geology of the Kyaukmyet Prospect

The Kyaukmyet prospect is located in the western part of Chindwin River (Monywa city), Monywa district, which is a part of the Wuntho Popa magmatic arc (Figure 1,2). The geology of the Kyaukmyet area is characterized by the occurrence of sedimentary, volcanic, and volcanoclastic rocks of the Late Oligocene to Middle Miocene Magyigon Formation. Physiographically, the Kyaukmyet area is situated at the confluence of two large rivers including the Yama Stream and the Chindwin River. In the Kyaukmyet prospect, exposed rock units are dominated by a sedimentary succession consisting of cherty or siliceous mudstone, siltstone, and quartzofeldspathic sandstone and volcanoclastic and volcanic units of tuffaceous rocks, lapilli tuff, and rhyolite (Figure 3). In the research area, a simplified geological map indicates the presence of rhyolite and lapilli tuff as the predominant rock units

at the northern and southeastern part of the Kyaukmyet prospect. These rocks are further intruded by small distributed silicified sandstone, mudstone and siltstone unit. In outcrop, the fresh surface of the rhyolites are usually yellowish to light grey colour and flow banding nature (Figure 4a,4b). The surfaces of the lapilli tuffs are often coated by white to reddish colour ash in fresh surface due to alteration effects (Figure 4c,4d) Stratigraphically, silicified sandstone, mudstone, and siltstone are the oldest rock units. These units crop out in the western and central parts of the research area. Geological structures in the research area prominently trend in an ENE-WSW direction. This structural trend would be controlled by movement along the Chindwin and Monastery Faults. It has been speculated that these northeast-trending structures might be subjected to dextral movement similar to the movement on the well-studied Sagaing Fault [11,12].



**Figure 3.** Simplified geological map of the Kyaukmyet prospect, Monywa district, central Myanmar and cross section along A-B is also shown modified from [13].



**Figure 4.** Representative field photographs of (a,b) flow banding outcrop nature of rhyolite unit, (c) lapilli tuff unit showing white to reddish colour ash in fresh surface due to alteration effects, and (d) hand specimen sample of lapilli tuff.

### 3. Materials and Methods

Based on the field and petromineralogical studies, a total of thirty-four (34) representative samples were collected from the surface outcrop in the Kyaukmyet prospect area. Of these samples, 10 representative samples were prepared for thin-sections with a thickness of approximately 0.03 mm and studied under polarizing microscope NIKON E600POL in order to examine their mineralogical compositions as well as textural characteristics. Subsequently, a total of 24 representative rock samples were selected for whole-rock geochemistry. The concentrations of major and minor elements of 12 volcanic rocks were analyzed by X-ray fluorescence Spectroscopy using a RIGAKU RIX-3100, with relative standard deviations < 5%. For quality control, the reference sample JA-3 was applied as standard sample. The XRF analyses were conducted at the Department of Earth Resource Engineering, Mineral Resource lab, Kyushu University, Fukuoka, Japan and the X-ray machine was carried out at a voltage of 50 kV and a current of 50 mA, scanning speed: automatic and 4°/min for the determination of major and trace elemental compositions. The loss on ignition (LOI) was measured for all of volcanic rock samples by weight difference after ignition at 105°C for 1.5 h first, followed by 500°C for 1 h and 900°C for 2 h. In this study, rare earth elements (REEs) of the 12 samples of volcanic rocks were also analyzed in the same institute by Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) using the open system rock digestion method.

### 4. Results and Discussion

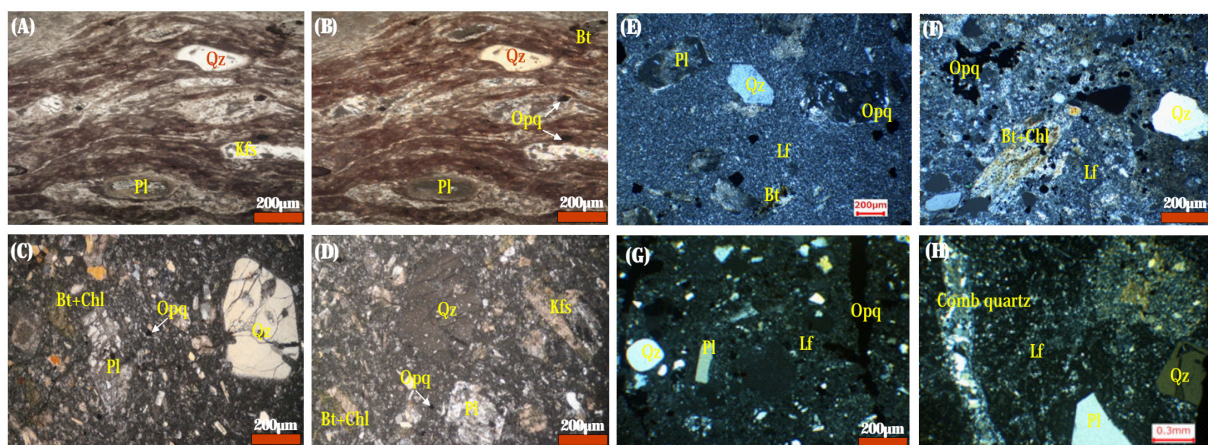
#### 4.1 Petrographic Characteristics

The rhyolite lava shows as a trachytic texture, which represents preferred orientation of the minerals (Figure 5a,5b). It is dominantly composed of quartz, plagioclase, alkali feldspar and trace amount of biotite and opaque minerals which are embedded in a flow banded rhyolite nature (Figure 5a,5b).

Quartz displays that anhedral to subhedral and plagioclase occurs as phenocrysts, usually euhedral and K-feldspar, also as phenocrysts shows alteration and albitization. The size of the phenocrysts generally ranges from 0.2 mm to 2.5 mm and groundmass minerals <0.1 mm respectively. Phenocrysts of plagioclase and K-feldspar are subhedral to anhedral and developed a wide range of size characterizing trachytic texture (Figure 5a,5b). Flow direction is marked by the presence of parallel oriented plagioclase, biotite and quartz bands defining a preferred orientation.

Rhyolite lava also displays as a porphyritic texture and consists predominantly of quartz, K-feldspar and traces





**Figure 5.** Representative photomicrographs showing common textures in the volcanic rocks (a-b) phenocrysts of euhedral plagioclase, K-feldspar and anhedral to subhedral quartz in trachytic texture of rhyolite, (c-d) euhedral quartz phenocrysts with hexagonal outline in rhyolite, plagioclase, K-feldspar and biotite in an aphanitic matrix, (e) plagioclase, quartz and opaque minerals observed in the lithic fragments, (f) quartz, opaque mineral (pyrite) and biotite altered to chlorite occur in the lithic fragments, (g,h) quartz, plagioclase, comb quartz and opaque minerals occurred in the lithic fragments. Mineral abbreviations: Qz, quartz; Pl, Plagioclase; Bt, biotite; Chl, chlorite; Opq, opaque mineral; Lf, lithic fragment.

amount of biotite and opaque minerals. The phenocrysts of quartz and K-feldspar are distributed throughout a hypocrystalline matrix. In general, phenocrysts of quartz crystals are larger than K-feldspar and it often contains euhedral with corrosion gulfs. The size of the phenocrysts generally ranges from 0.4 mm to 4 mm and groundmass minerals, <0.2 mm. Phenocrysts of amphibole and biotite are much rare, and are partially chloritized. Opaque minerals occur as finely dispersed throughout the rock. The content of quartz is approximately 35% of the total volume of the constituent minerals. Quartz occurs as phenocrysts as well as a groundmass. Some phenocrysts of quartz are characterized by the occurrence of euhedral hexagonal outline (Figure 5c,5d). Between crossed-nicols, it gives first order grey interference color. K-feldspar belonged to subhedral with a grain size that varied from 0.5 to 4.0 mm. Plagioclase crystals have a tabular and elongated shape and commonly occur with corroded and broken edges (Figure 5c,5d). It belonged to subhedral to euhedral, ranges from 0.8 to 3 mm in size, and typically displays sharp contacts. Feldspar is also comprised of phenocrysts as well as a groundmass and some feldspar phenocrysts show perthitic texture and incline extinction with extinction angle  $22^\circ$ . Between cross-nicols, it yields nearly parallel or straight extinction. Biotite contains 6% of total volume of constituent minerals. It is well recognized by its color yellow or yellowish brown and its perfect one set cleavage. Sometimes, it is altered to chlorite (Figure 5c,5d). Other opaque minerals also present in minor amount.

In the research area, lapilli tuff is primarily composed

of fine to medium-grained crystalline quartz with lithic fragment cemented by the fine-grained matrix. This unit is mainly comprised of 40-50% of quartz, 20-30% of clay minerals, 20-25% of plagioclase and 5-10% of opaque minerals respectively. Quartz occurs as phenocrysts and spherulite in the lithic fragments which is associated with opaque mineral (pyrite) (Figure 5e-g). Chlorite appears as the replacement of biotite and illite occurring as the replacement of plagioclase (Figure 5f). The lapilli tuff unit is characterized by porphyritic and fragmental textures. They are strongly altered and the size of fragments ranges from 0.1mm to 1mm in diameter. Originally, this unit has the moderately sorted with grains surrounded by cryptocrystalline volcanic material as a matrix. In addition, quartz veinlet and comb quartz occur in the lithic fragments (Figure 5h).

## 4.2 Whole Rock Geochemistry

### 4.2.1 Geochemical Classification

Major (wt%), trace and rare earth element (ppm) concentrations of the volcanic rock samples from the Kyaukmyet prospect are shown in Table 1 and Table 2. The volcanic rocks from the Kyaukmyet prospect mainly comprised of rhyolite and lapilli tuff. These volcanic rocks show 71.84-86.29 wt.%  $\text{SiO}_2$ , 0.099-0.338 wt.%  $\text{TiO}_2$ , 6.707-19.29 wt.%  $\text{Al}_2\text{O}_3$ , 0.483-2.881 wt.%  $\text{FeO}$ , 0.312-0.89 wt.%  $\text{MgO}$ , 0.38-0.432 wt.%  $\text{Na}_2\text{O}$ , 0.083-5.483 wt.%  $\text{K}_2\text{O}$ , 0.071-0.128 wt.%  $\text{CaO}$ , 75-160 ppm Zr, 51-590 ppm Ba, 21-210 ppm Sr, 5-8 ppm Nb, 12-18 ppm Y, 1-196 ppm Rb, 3-49 ppm Cr Table 1.

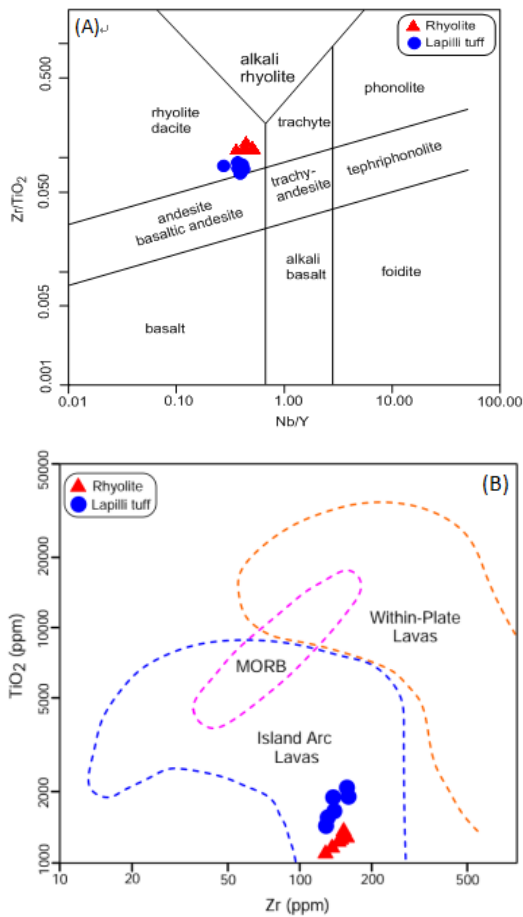
**Table 1.** Whole-rock major- and trace-element concentrations of volcanic rocks from the Kyaukmyet prospect.

Sample ID	KMR17	KMR14a	KMR12	KMR9	KMR2	KMR7	KMLP5	KMLP3	KMLP9	KMLP10	KMLP6	KMLP4
Major elements (in wt%)												
SiO <sub>2</sub>	78.33	73.79	81.68	78.47	71.95	71.84	82.59	83.37	85.69	86.29	84.22	85.27
TiO <sub>2</sub>	0.194	0.207	0.099	0.187	0.219	0.216	0.321	0.27	0.312	0.338	0.257	0.238
Al <sub>2</sub> O <sub>3</sub>	13.58	17.94	9.098	13.48	15.47	19.29	9.041	6.723	7.002	7.167	6.707	7.682
FeO	0.529	0.82	0.833	0.483	0.947	0.84	1.658	2.02	2.881	0.76	2.382	2.033
MnO	n.d	n.d	n.d	n.d	n.d	n.d	n.d	0.002	n.d	n.d	0.004	n.d
MgO	0.783	0.312	0.663	0.763	0.889	0.341	0.593	0.692	0.408	0.727	0.678	0.369
CaO	0.128	0.08	0.117	0.116	0.12	0.085	0.08	0.082	0.097	0.077	0.13	0.071
Na <sub>2</sub> O	0.413	0.378	0.432	0.378	0.409	0.384	0.388	0.385	0.384	0.401	0.387	0.379
K <sub>2</sub> O	1.337	0.083	5.483	1.296	1.616	0.095	1.043	1.413	0.199	1.226	1.186	0.204
P <sub>2</sub> O <sub>5</sub>	0.028	0.079	0.008	0.037	0.19	0.08	0.055	0.065	0.026	0.003	0.043	0.071
H <sub>2</sub> O	4.6	6	1.5	4.71	7.2	6.79	3.89	4.16	2.89	2.83	3.46	3.42
S	0.028	0.016	0.011	0.023	0.809	0.018	0.245	0.712	0.059	0.127	0.464	0.138
<b>Total</b>	<b>99.95</b>	<b>99.71</b>	<b>99.92</b>	<b>99.94</b>	<b>99.82</b>	<b>99.98</b>	<b>99.90</b>	<b>99.89</b>	<b>99.95</b>	<b>99.95</b>	<b>99.92</b>	<b>99.88</b>
Trace elements (in ppm)												
V	13	30	6	13	10	21	19	15	20	22	14	22
Cr	21	10	5	8	11	3	33	25	48	49	25	33
Co	24	23	37	29	32	17	20	38	32	29	22	25
Ni	10	6	10	10	6	7	8	7	10	10	5	7
Cu	12.04	5.03	20.08	0.4	43.07	3.03	11.01	6.07	10.02	13.01	40.01	16.02
Zn	8.4	7.1	11.02	12.7	11.01	22.8	22.1	10.92	16.31	11.8	13.2	21.9
Pb	27.39	12.01	0.8	14.45	11.08	3.09	34.06	4.02	0.09	31.06	3.19	1.19
As	48	23	38	35	106	25	128	162	84	19	127	463
Mo	8	14	5	7	13	14	7	8	4	5	6	7
Rb	64	1	196	62	56	0	47	62	7	67	62	6
Sr	63	113	31	73	210	107	64	78	68	21	40	157
Ba	59	103	299	113	590	96	70	450	107	51	335	387
Y	13	16	18	14	14	16	17	18	15	18	12	16
Zr	135	145	75	130	155	152	160	137	138	157	131	129
Nb	6	6	8	7	7	7	7	5	6	7	5	6

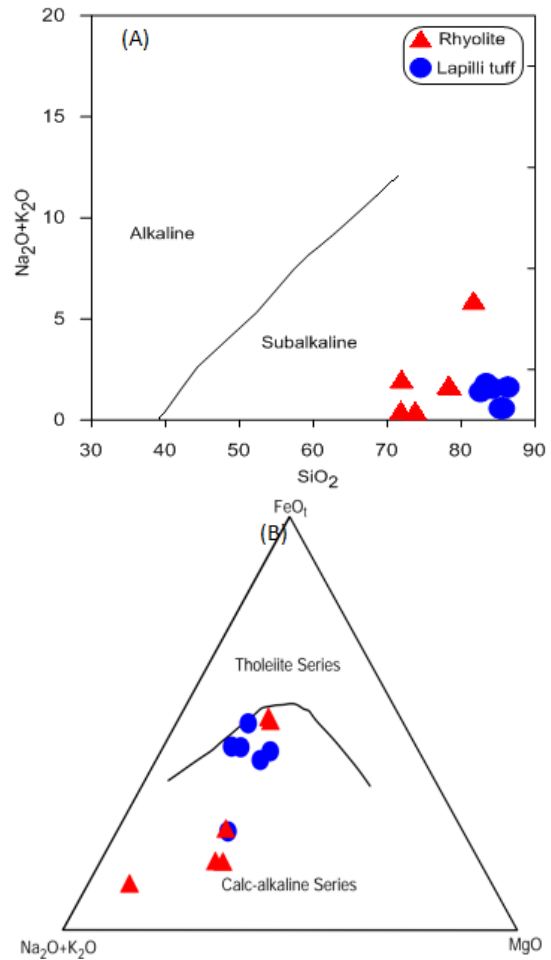
**Table 2.** Rare earth element (ppm) concentrations of volcanic rocks from the Kyaukmyet prospect.

Sample ID	KR17	KR14a	KR12	KR9	KR2	KLP4	KLP7	KLP3	KLP10	KLP9	KLP5	KLP6
Rare earth elements (in ppm)												
La	25.4	10.7	26.9	22.6	23.1	25.7	20.5	13.6	11.9	38.3	18.34	18.2
Ce	44.7	19.9	47.9	41.5	43.2	48.0	36.4	26.6	22.0	64.2	35.05	32.4
Pr	4.10	1.83	4.56	3.83	4.13	4.71	3.5	2.78	2.23	5.76	3.49	3.27
Nd	15.2	6.43	18.9	14.9	16.1	19.0	13.6	11.0	8.88	22.34	15.2	12.9
Sm	1.76	0.91	2.50	1.86	2.21	2.73	2.11	1.44	1.45	2.72	2.298	1.82
Eu	0.54	0.31	0.64	0.45	0.33	0.67	0.56	0.31	0.29	0.56	0.64	0.37
Gd	2.41	1.21	3.26	2.85	2.81	3.48	2.82	1.95	1.69	3.75	2.75	2.4
Tb	0.21	0.14	0.33	0.23	0.32	0.31	0.27	0.18	0.24	0.32	0.25	0.21
Dy	1.58	1.18	1.71	1.57	2.16	1.78	1.75	1.25	1.49	2.19	1.55	1.19
Ho	0.23	0.21	0.25	0.24	0.35	0.32	0.26	0.19	0.30	0.33	0.24	0.17
Er	0.83	0.71	0.88	0.76	1.21	0.98	0.89	0.65	0.93	0.899	0.74	0.67
Tm	0.14	0.12	0.13	0.14	0.23	0.15	0.16	0.09	0.17	0.15	0.12	0.10
Yb	0.94	1.04	1.12	1.01	1.74	1.04	1.05	0.87	1.17	1.18	1.13	0.85
Lu	0.15	0.15	0.15	0.16	0.25	0.16	0.16	0.12	0.198	0.15	0.16	0.13

On the Nb/Y-Zr/TiO<sub>2</sub> chemical classification diagram<sup>[14]</sup>, all volcanic samples fall within the field of rhyolite/dacite (Figure 6a). The tectonic settings of volcanic rocks are adopted classification scheme of Zr-TiO<sub>2</sub> discrimination diagram<sup>[15]</sup>. In the Zr-TiO<sub>2</sub> plot diagram, most of rock samples are plotted in the field of the volcanic arc setting (Figure 6b). It is also possible that the overlap is due to the involvement of sub-continental lithosphere in magma genesis as pointed out by Watters and Pearce (1987)<sup>[16]</sup>. According to binary plot diagram of SiO<sub>2</sub> versus Na<sub>2</sub>O+K<sub>2</sub>O (Irvine and Baragar, 1971)<sup>[17]</sup>, volcanic rocks of the Kyaukmyet prospect area are shown the nature of subalkaline to alkaline affinity (Figure 7a). AFM diagram is commonly used to distinguish between tholeiitic and calc-alkaline differentiation trends in the sub-alkaline magma series. Volcanic rocks from the Kyaukmyet prospect were plotted on the AFM diagrams<sup>[17]</sup>, Triangular AFM plot suggests that most of volcanic rocks fall within the sub-alkaline field (Figure 7b). Calc-alkaline is typical magma resulted from subduction zone<sup>[18]</sup>.



**Figure 6.** (a) Zr/TiO<sub>2</sub> vs Nb/Y plot diagram showing volcanic rocks classification<sup>[14]</sup>, (b) Zr-TiO<sub>2</sub> tectonic discrimination diagram for volcanic rocks of the Kyaukmyet prospect<sup>[15]</sup>.



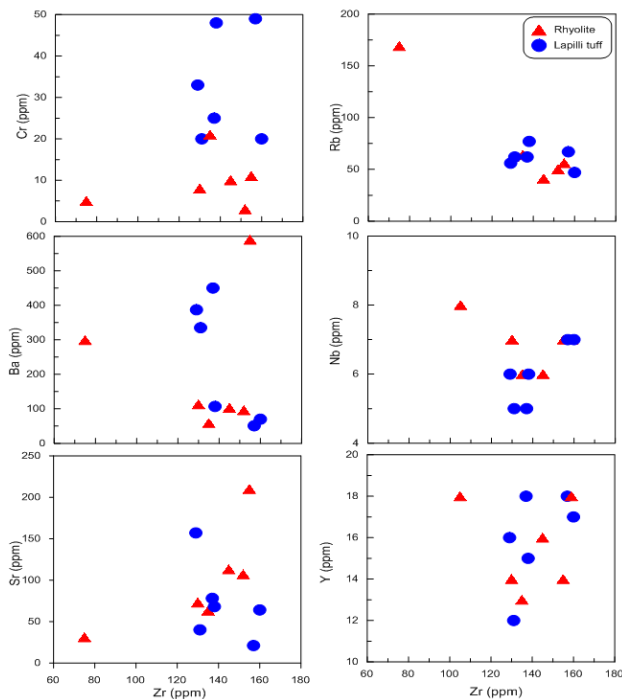
**Figure 7.** (a) Alkali-silica diagram for determining sub-alkaline and alkaline field and (b) AFM diagram showing whole-rock composition in terms of Na<sub>2</sub>O+K<sub>2</sub>O, total iron as FeO and MgO<sup>[17]</sup>.

#### 4.2.2 Geochemistry of Trace Elements

In the research area, most of the volcanic rock samples have been altered. In order to determine the compositional change which, accompany hydrothermal alteration. Generally, Zr is used as an immobile element during hydrothermal alteration because of very high radius. For the magmatic evolution processes, SiO<sub>2</sub> and some of major oxide elements cannot be used as a result of alteration effect. Therefore, immobile element (Zr) is used in order to instead of SiO<sub>2</sub> in this study. Trace element contents of the Kyaukmyet volcanic rock samples are plotted on the variation diagram to show Zr versus Sr, Y, NB, Rb, Ba and Cr (Figure 8).

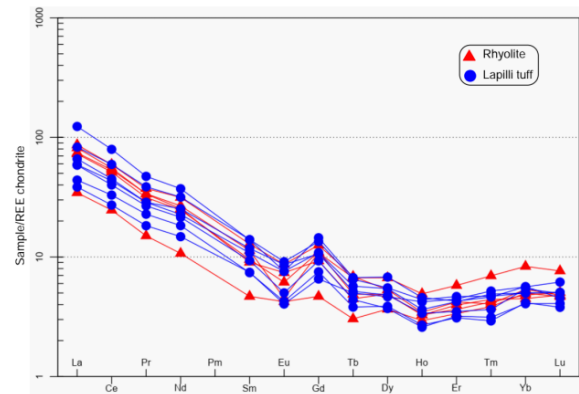
Trace element variation diagram in this study exhibits that Cr versus Zr display negatively correlation (Figure 8) which are recognized to be mobile with altered volcanic rock during hydrothermal alteration. In addition, compati-

ble element Cr decreases with Zr increasing fractionation. Sr, Ba versus Zr negative correlation that is subjected to be most mobile during alteration (Figure 8). Additionally, they show a fairly positive correlation between Zr and Nb and Y (Figure 8). This positive trend is considered to be immobile in the volcanic rocks. Furthermore, Zr versus Rb and Nb are enriched immobile while impacting hydrothermal alteration.



**Figure 8.** Trace elements variation diagram for volcanic rocks of the Kyaukmyet prospect with Zr.

In the chondrite-normalized diagram (Boynton, 1984) (Figure 9), the volcanic rocks (rhyolite and lapilli tuff) are almost enriched than LREE/HREE ratio. The concentrations of light rare earth elements (LREE) of rhyolite and lapilli tuff rock units are generally elevated (La; 10.7-38.3 ppm, Ce; 19.9-64.2 ppm, Pr; 1.83-5.76 ppm, Nd; 6.43-22.34 ppm and Sm; 0.91-2.72 ppm) in contrast to the depleted heavy rare earth elements (HREE). In this figure, the rhyolite and lapilli tuff rock units are relatively enriched than LREE/HREE ratio. Moreover, the chondrite-normalized REE patterns of rhyolite and lapilli tuff rock units are similar to those of the upper continental crust (Figure 9). They show LREE enrichment but HREE depletion in which all samples display negative Eu anomalies indicating its depletion in the upper continental crust. This would probably be resulted from the removal of feldspar (Plagioclase) from the source rock during the crystal fractionation [18].



**Figure 9.** Chondrite-normalized spider diagrams for volcanic rocks from the Kyaukmyet prospect. Using the normalization and ordering scheme of [19].

## 5. Conclusions

Petrographical studies of volcanic rocks (rhyolite and lapilli tuff) from the Kyaukmyet area point out that they were composed mainly of quartz, plagioclase (phenocryst), K-feldspar and opaque minerals. Accessory minerals in these rocks are opaque mineral, biotite and chlorite. In some cases, plagioclases are strongly altered to clay minerals, sericite, and chlorite. On the other hand, volcanic rocks (rhyolite, lapilli tuff) display that trachytic and porphyritic textures with phenocrysts of quartz, plagioclase, and K-feldspar in which various shades of colour i.e. colourless, pink, grey etc. In this study, geochemical and tectonic discrimination diagrams indicated that volcanic rocks are plotted in the rhyolite/dacite field as well as calc-alkaline area. In trace element variation diagram, Zr displays negatively correlated with Cr and Ba which are considered to be mobile with altered volcanic rocks during hydrothermal alteration. On the other hand, Zr shows a fairly positive correlation between Nb and Y. This positive trend is suggested to be that immobile in the volcanic rocks. On the basis of the chondrite normalized spider diagrams, LREE have strongly enriched to HREE in this area which indicated negative Eu anomaly and subduction tectonic setting.

## Author Contributions

T.N.O., K.Z.O and T.Z carried out the fieldworks and developed the concepts, designed on this research. T.N.O. collected the data and samples as well as conducted the laboratory analysis and wrote this manuscript with contribution on discussion from K.Z. All authors were contributed in reading, comments and giving the annotations on this manuscript.



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## Conflicts of Interest

The authors declare no conflict of interest.

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