http://journal.uir.ac.id/index.php/JGEET

E-ISSN : 2541-5794
P-ISSN : 2503-216X

Journal of Geoscience,
Engineering, Environment, and Technology
Vol 9 No 4 2024

RESEARCH ARTICLE

Petrology, Geochemistry, and Magma Evolution Of Basaltic Rocks Of Baturraden Area, Central Java, Indonesia

Yogi Adi Prasetya [1,] *, Akhmad Khahlil Gibran[1], Mochammad Aziz[1], Siswandi[1].

[1] *Department of Geological Engineering, Faculty of Engineering, Universitas Jenderal Soedirman Jln. Mayjen Sungkono Km.5, Purbalingga, Indonesia*

* Corresponding author : yogi.adi@unsoed.ac.id
Tel.:+6281542106639
Received: Jul 1, 2024; Accepted: Nov 21, 2024.
DOI: 10.25299/jgeet.2024.9.04.17882

Abstract

Slamet volcano is the second highest active stratovolcano in Java Island, it has a long volcanic history eruption event, the Baturraden Area is a tourism area in southern part of Slamet Volcano. Baturraden area is the part of Banyumas Regency and it took 30-60 minutes riding motorcycle from Purwokerto city. Our research is focused on studying the petrology, geochemistry, and geological history of basaltic lava on Baturraden Area mainly that formed a waterfall on its location, because there is no a researcher that study basaltic lava on Baturraden, we focus on petrology, and petrography and geochemistry of basaltic lava on Baturraden using XRF methods and focused on magma evolution of basaltic lava rocks on Baturraden Area. Stratigraphically basaltic rocks in Baturraden Area are a part of Slamet Lava 1(SL 1) and Slamet Lava 2 (SL 2). The mineral composition of SL 1 and SL 2 are including the phenocryst of plagioclase, K-feldspar, olivine, clinopyroxene, and opaque minerals, with plagioclase microlites and volcanic glass as groundmass. Plagioclase shows zoning and sieve texture. Seven rock samples are prepared for whole-rock major element compositions of the study, the SiO_2 contents range from 48.13 – 49.17 wt.%. The K_2O contents in all rock samples range from 0.78 – 1.56 wt.%. Geochemical data confirm that SL 1 and SL 2 are from same magma type that magma of SL 1 and SL 1 are influenced by fractional crystallization and magma mixing from new injection of more basaltic magma, as evidenced by the frequent changes in SiO_2 content.

Keywords: Slamet Volcano, Baturraden, Magma Evolution, Magma Mixing.

1. Introduction

Quaternary volcanoes are distributed in Java Island, Indonesia, caused by subduction plate between the Eurasian and Australian Plate (Handley, et, al, 2014) (Fig 1). The volcanoes are situated above sediment deposits since Late Miocene-Pliocene (Sendjaja et., al., 2009). Slamet volcano is the second highest active volcano in Java Island according to the VSI data (Global Volcanism Program, 2013). it has long been eruption history and the first recorded eruption in history was since 1772 AD, its eruption characterized by ash plum, lava flow and ash fall with strombolian eruption type.

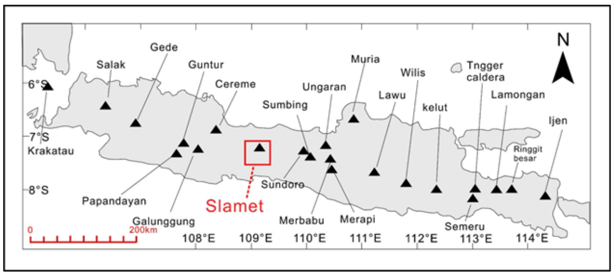

Fig. 1. Distribution of volcano in Java Island

The Baturraden area, situated in the Baturraden district of Banyumas Regency, Central Java, is a notable tourist destination. Accessible by car or motorcycle, it lies approximately 30-60 minutes away from Purwokerto City. Baturraden Area has a several tourism areas that showcases stunning landscapes and is renowned for its natural beauty. It has a waterfall, geomorphology view, Slamet volcano has several hot spring manifestations such as the hot springs of Pancuran-3, Pancuran-7, Guci, Cahaya, Sigedong, and Saketi (Iswahyudi, et, al, 2020) in general, geologically, the waterfall owes its formation to lava flows and lava breccia (Prasetya and Gibran, 2024).

Magma evolution processes have been reported in many volcanoes in Island arc of Java Island such as Muria Volcano (Mulyaningsih, S. et, al, 2022), Sundoro (Wibowo, H. et, atl, 2022), Lasem and Senjong Volcano, (Harijoko, A. et, al, 2022), and Dieng Volcanic Complex (Yudiantoro, D.F. et, al, 2022) . Here our research is focused on studying the petrology, geochemistry, and geological history of basaltic lava on Baturraden Area. We focus on petrology and magma evolution of basaltic lava on Baturraden because there is no a researcher that study basaltic lava on Baturraden. This study seeks to uncover the rock formation type, structure, texture, and mineral composition of basaltic lava on Baturraden, alongside understanding the geochemistry of its basaltic rocks and the processes involved in magma evolution.

2. Regional Geology

Slamet Volcano is a stratovolcano located in Central Java that situated on older sedimentary rocks (Vukadinovic and Sutawidjaja 1995; Djuri, 1996) (Fig. 2). The summit of Slamet Volcano is about 3428-meter elevation above sea level (Masl), it makes Slamet Volcano is the second highest volcano in Java Island after Semeru Volcano. Slamet Volcano is a typical stratovolcano on subduction zone and located about 160 km from subduction zone 310 northward of distance trench (Handley, H.K. et., al. 2014)

Based on geological maps by Djuri, et, al, 1996 Slamet Volcano is divided into three rock units. Qvs is Unidentified volcanic rocks of Slamet Volcano, it contains volcanic breccia, lava and tuff, Qvls is Slamet Volcano Lava is the vesicular andesitic lava, and Qls is the Slamet Volcano Lahar Deposit is the laharic breccia with boulder of basalt and andesitic 10-15cm in diameters (Fig 2).

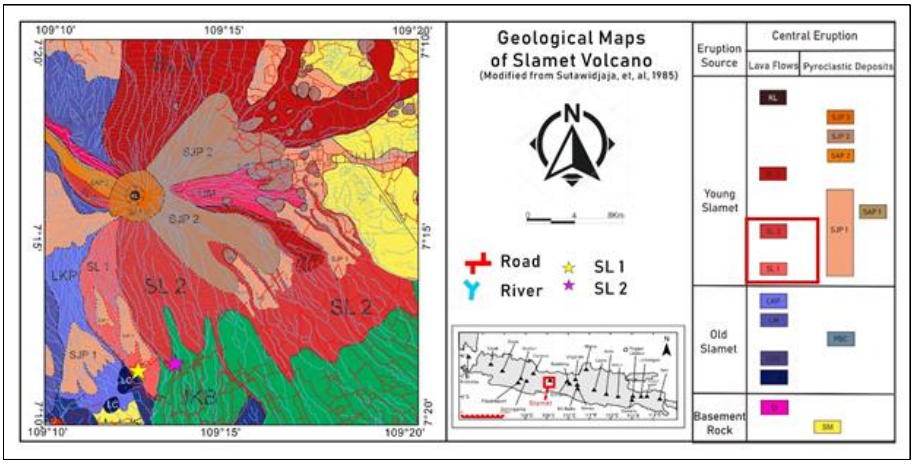

Fig. 2. The geological map of Slamet Volcano modified from Sutawidjaja, et, al, 1985, it shows the sampling location of SL 1 and SL 2, on the right side is the statigraphy of central eruption of Slamet Volcano that shows SL 1 is older than SL 2.

Geologically Slamet Volcano is mainly divided into two parts, Slamet Volcano is divided into two parts, the first Old Slamet (OS) on western part, it is characterized by rough terrain and deep valleys indicating the older rock units (Fig 3) and the rock compositions are Andesitic to Andesite-Basaltic Rocks and there is a pumice deposit reported by Harijoko, et, al (2020). Young Slamet (YS) on eastern part and contain basaltic rocks (Vukadinovic and Sutawidjaja, 1995) and also scoria falls on the the south east part of Slamet Volcano and the part of Young Slamet Volcano deposit (Prasetya and Toramaru, 2022). It is characterized by smooth and sloping morphology indicated as a young rock's formation (Fig 3). The eastern part of Slamet Volcano has 35 Scoria cones which were studied by Sutawidaja and Sukhyar (2009). The magma of Slamet Volcano both Young Slamet and Old Slamet are argued have similar from mantle source based on trace element and rare earth element (REE) data (O. Reubi et. al, 2003; Harijoko, et, al, 2021; Nd Barber, Et, al, 2023)

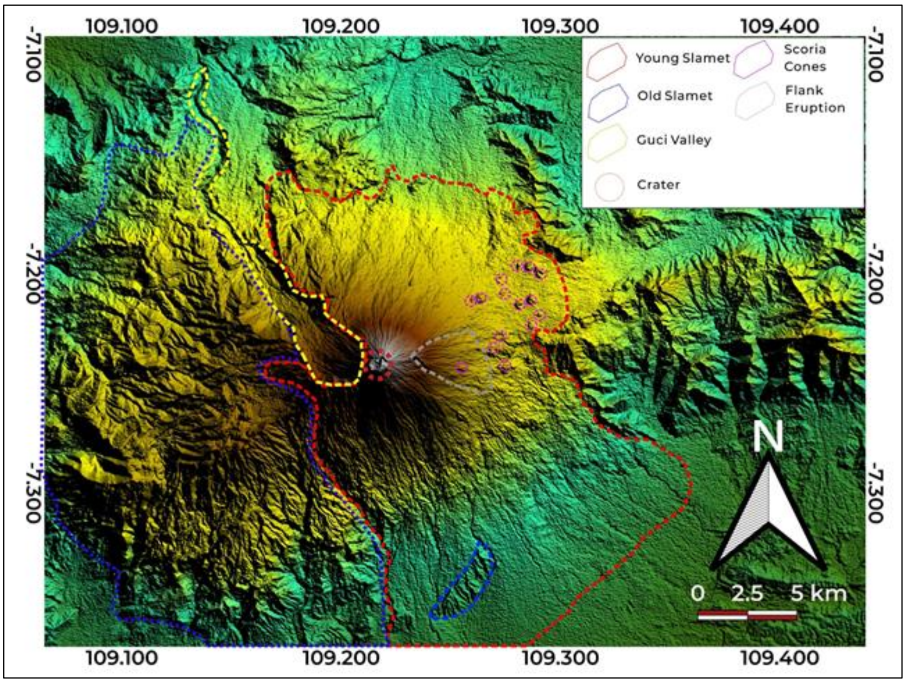

Fig. 3. The Shuttle Radar Topography Mission of Slamet Volcano, it shows that the different of Old Slamet (OS) and Young Slamet (YS) and several morphology on Slamet Volcano such as Guci Valley, flank eruption and scoria cones.

On geological maps of Slamet Volcano by Sutawidjaja et, al. (1985) they also divided the volcanic deposits of Slamet Volcano are divided into 22 volcanic rocks units, there are 4 lava flows of central eruption, 1 pyroclastic deposit and 1 lahar deposit from Old Slamet and the Young Slamet contains 4 lava flow from central eruption and 2 lava flow from flank eruption, 5 pyroclastic deposits from central deposit and 2 pyroclastic deposits from flank eruption, and 3 lahar deposits.

3. Methods

In this study, we used geological fieldworks, petrographic analysis and geochemical analysis. Geological fieldwork is carried out in Baturraden Tourism Area, during the fieldwork detailed field observation, petrology description, texture and structure of basaltic lava outcrop in Baturraden. We collected seven basaltic rock samples around Baturraden Tourism Area. Because of the sampling permission we only collect sample from three waterfalls, those are Jenggala Waterfall, Pinang Waterfall and Cebong Waterfall The sampling locations are the tourism destination and located in Baturraden Area. We collected five rock samples from Jenggala Waterfall from te waterfall to downstream river, on the Pinang and Cebong Waterfall we only collected one sample on each location because the Jenggalla Waterfall has a wider area than Pinang and Cebong Waterfall that small river. According to geological maps of Slamet Volcano (Sutawidjaja, et, al, 1985) basaltic lava at Jenggala Waterfall is the part of Slamet Lava 1 (SL 1) and basaltic lava at Pinang Waterfall and Cebong Waterfall is the part of Slamet Lava 2 (SL 2) the SL 1 is older than SL 2, on this research we will be divided the basaltic lava on Baturraden Area into SL1 for Jenggala Waterfall and SL 2 for Cebong and Pinang Waterfall (fig. 2). Detailed notes on rock texture and sturcture and mineral composition were made during fieldwork for the purposes of rock description within the research area. We prepared seven basaltic lava samples were subjected to petrographic analysis using a polarizing microscope. This analysis focused on assessing the mineral composition, mineral texture, and rocks textures, along of each sample to ascertain the name of rock samples of the igneous lava rock. Using X-Ray Fluorescence (XRF) we analysed the whole rock chemistry from five rock samples the analysis will reveal the major element composition and trace element. The geochemistry data we plotted on Harker Diagram, Total Alkali Silica (TAS) Diagram (Le Maitre, 2002), all major will be plotted to understand the pattern of geochemistry of rock sample on research location to understanding of magma evolution and petrogenesis of Baturraden Area.

4. Result

4.1 Fieldwork

Baturraden Area is dominated by basaltic lava and laharic breccia. Basaltic lava is the part of the tourism attracted for the visitors, the basaltic lava is commonly dark grey colour, massive outcrop with wide range of distribution, the height of the lava outcrop approximately 6-10 meters height, structure massive, vesicular, columnar join. On the sampling location, Jenggala, Waterfall, basaltic lava is greyish colour with aphanitic texture, small vesicular structure and associated with columnar joint structure. It has height up to 6 meters. We divided the lava outcrop into two units the unit 1 is the upper part and the unit 2 on lower part. The unit 1 has smaller crystal size and more aphanitic and more darker greyish colour, the unit 2 has small-visible crystal size, it has porphyritic texture but small phenocryst of olivine and plagioclase (Fig 4).. The laharic breccia is found on the bottom of the waterfall.

The Pinang and Cebong Waterfall is located in the same river and the Cebong Waterfall located upstream of Pinang Waterfall, the lava is from greyish to dark grey, aphanitic texture and vesicular structure with columnar joint up to 3-4 meters thick (Fig 5).

Laharic breccia is layered with lava flow. This layer of lava and lahar formed several waterfalls that become a tourism destination in Baturraden, lahar is partially weathered, it has a basaltic fragment from boulder to pebbles, fragment shape is dominantly rounded, the matric almost become soil and difficult to be identified (Fig 4).

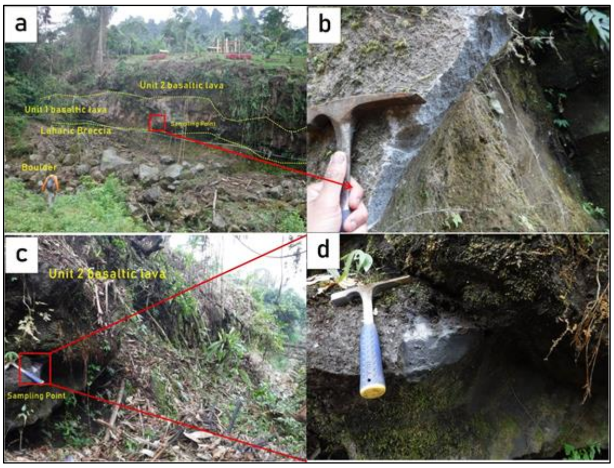

Fig. 4. The photograph of basaltic lava outcrop of SL 1 at Jenggala Waterfall downstream, (a) two units of lava flow in upper part and laharic breccia in under part, (b) sampling point of photo a, the basaltic lava is aphanitic texture, (c) the upper part of unit 1 basaltic lava in picture a, (d) sampling point of picute c.

Fig. 5. The photograph of basaltic lava outcrop of SL 2 at Pinang Waterfall and Cebong Waterfall, (a) basaltic lava flow Pinang Waterfall with the tourist as a scale, (b) sampling point of photo a, , (c) basaltic lava flow at Cebong Waterfall, (d) sampling point of picute c.

Table 1. Petrography data of basaltic rocks of Baturraden Area

NO	Mineral Composition	Rocks Unit						
		Jenggala Waterfall (SL 1)					Cebong Waterfall (SL 2)	Pinang Waterfall
		SL 1B -2	SL 1B-1	SL 1A-2	SL 1A-1	SL 1A-3	SL 2-1	SL 2-2
1	Plagioclase	55	48	54	60	35	57	58
2	Olivine	18	18	16	14	15	12	14
3	Clinopyroxene	10	19	16	10	15	11	9
4	Opaque Mineral	6	5	6	5	5	7	5
5	Groundmass	11	10	8	11	30	13	14
		100	100	100	100	100	100	100
	Rocks Texture and Structure							
1	Vesicular	√	√	√	√	√	√	√
2	Phorpyritic	√	√	√	√	√	√	√

4.2 Petrography

The petrography data shows SL 1 is porphyritic texture and vesicular structure, inequigranular crystal size, anhedral-subhedral crystal shape, mineral compositions are plagioclase, clinopyroxene, olivine and Fe-Ti oxide. Plagioclase occurs as the most phenocryst abundant in rock sample, and it contains glomerocryst, syneusis, zoning, and sieve textures among other mineral textures. Plagioclase phenocryst contains mineral inclusions of olivine, clinopyroxene, and Fe-Ti oxide. The largest plagioclase is 3.31 mm. The crystals of olivine are anhedral-subhedral. Sieve texture present as a mineral texture in olivine. Plagioclase, olivine, and Fe-Ti oxide mineral inclusions are found in olivine. Maximum size up to 2.16 mm. Subhedral clinopyroxene phenocrysts and groundmass have maximum size up to 3.22 mm, pale green in parallel nikol some pyroxenes are weathered. Some of them occurs as aggregate minerals. Inclusion minerals such as olivine and Fe-Ti oxide minerals are found in pyroxene (fig. 6).

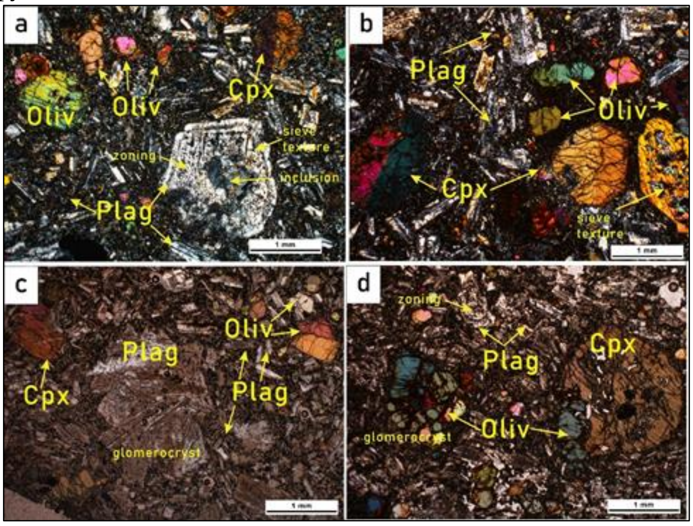

Fig. 6. Photomicrograph of basaltic rocks of Baturraden Area. a) and b) are from SL 1 rock samples, basaltic rock contain phenocryst of plagioclas (plag), olivine (oliv), clinopyroxene (cpx) with mineral texture such as zoning, sieve texture. c) and d) are SL 2 1 rock samples, basaltic rock contain phenocryst of plagioclas (plag), olivine (oliv), clinopyroxene (cpx) with mineral texture such as glomerocryst, zoning and sieve textures.

Slamet Lava 2 (SL 2) is porphyritic texture and vesicular structure a little bit bigger than Slamet Lava 1, inequegranular crystal size, anhedral-subhehdral crystal shape, mineral compositions are plagioclase, clinopyroxene, olivine and Fe-Ti oxide. Plagioclase occurs as the most phenocryst and groundmass abundant in rock sample, mineral textures such as sieve texture, syneusis, zoning and glomerocryst occur in plagioclase. Olivine, clinopyroxene and Fe-Ti oxide mineral inclusions are present in plagioclase phenocryst. Maximum size ranges up to 3.38 mm. Olivine is a common phenocryst and groundmass, occurring a little bit weathered into brown colour on the rim, the crystals are anhedral-subhedral. Some olivine minerals occur as aggregate mineral. Maximum size up to 2.16 mm. Subhedral clinopyroxene phenocrysts and groundmass have maximum size up to 3.60 cm, pale green in parallel nicol some pyroxenes are weathered. Some of them occurs as aggregate minerals. Inclusion minerals such as olivine and Fe-Ti oxide minerals are found in pyroxene (fig. 6).

4.3. Geochemistry Major Element and Trace Element

Seven rock samples are prepared for whole-rock major element compositions of the study, the SiO_2 contents range from 48.13 – 49.17 wt.%. Increasing of SiO_2 is equal to decreasing MgO, CaO, Fe_2O_3 in other hand Na_2O, Al_2O_3, MnO and TiO_2 contents increase (Fig 7). Based on relationship between SiO_2 contents and Na_2O + K_2O these rock samples are classified as basalt (Le Bas et al., 1986; Le Maitre, 2002) (Fig 9). The K_2O contents in all rock samples range from 0.78 – 1.56 wt.% and fall within calc alkaline series for SL 1 and SL 2 of Peccerillo & Taylor (1976) in Sendjaja, Y.A., Kimura, J.I. and Sunardy, E. (2009) (Fig 10). Different trends are observed among the samples of SL 1 and SL 2 where SL 2 seems to be flat that has similar major element and SL 1 has step increasing and decreasing of major element against silica content. The lava flow samples of SL 1 and SL 2 show two linear trends of every major element vs. SiO2, which might indicate magma mixing (Fig 7-10).

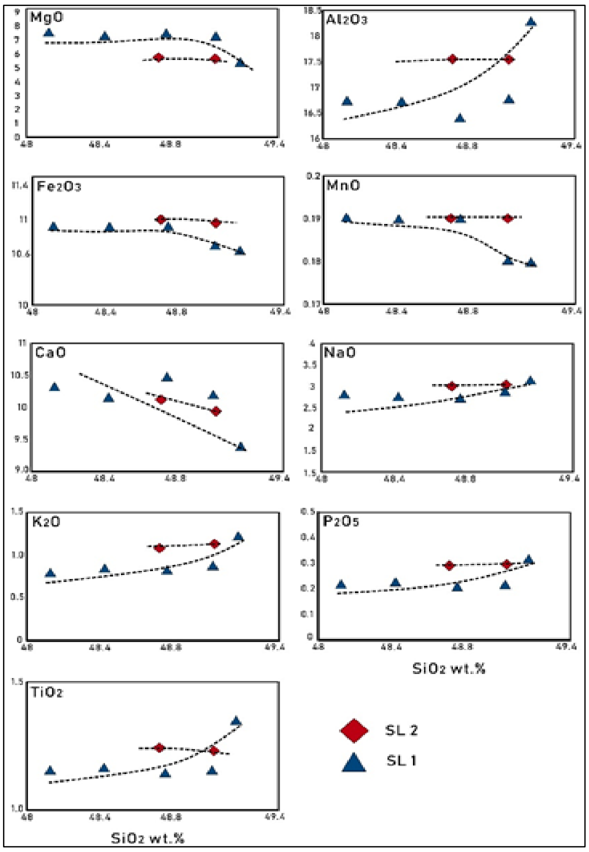

Fig. 7. Bivariate plot of major oxides vs. SiO2 showing the differentiation pattern of SL 1 and SL 2 basaltic lava.

Table 2. Geochemical data of basaltic lava of Baturraden Area

NO	Geochemistry Data	Rocks Unit						
		Jenggala Waterfall (SL 1)					Cebong Waterfall (SL 2)	Pinang Waterfall
	wt.%	SL 1A-2	SL 1B -2	SL 1B-1	SL 1A-1	SL 1A-3	SL 2-1	SL 2-2
1	SiO_2	48.43	48.13	49.03	48.77	49.17	49.04	48.73
2	TiO_2	1.16	1.15	1.15	1.14	1.35	1.23	1.24
3	Al_2O_3	16.73	16.73	16.75	16.41	18.29	17.54	17.53
4	Fe_2O_3	10.92	10.91	10.72	10.91	10.66	10.95	10.99
5	MnO	0.19	0.19	0.18	0.19	0.18	0.19	0.19
6	MgO	7.34	7.48	7.19	7.63	5.32	5.7	5.8
7	CaO	10.16	10.3	10.2	10.48	9.37	9.97	10.12
8	Na_2O	2.77	2.79	2.85	2.7	3.19	3.03	3
9	K_2O	0.82	0.78	0.87	0.81	1.21	1.12	1.07
10	P_2O_5	0.22	0.22	0.21	0.21	0.31	0.29	0.29
	Ppm							
11	F	0.02	-0.01	0	-0.02	-0.04	-0.02	-0.02
12	Ni	69.06	67.83	64.73	70.52	46.34	17.26	17.2
13	Sc	35.86	35.93	37.41	35.5	30.65	33.52	36.66
14	V	288.05	292.45	289.72	290.75	302.49	287.79	288.58
15	Cr	205.26	206.8	194.96	233.44	102.06	42.07	49.49
16	Cu	117.74	117.51	104.04	102.88	141.03	82.86	74.92
17	Zn	81.07	81.76	79.97	81.18	85.67	89.02	89.64
18	Rb	16.24	11.62	16.96	14.38	20.17	23.53	20.9
19	Sr	297.98	307.83	299.13	299.55	352.22	331.01	334.38
20	Y	20.54	20.21	21.05	20.45	23.39	22.73	23.13
21	Zr	97.53	96.88	95.79	94.5	125.89	108.72	107.48
22	Nb	4.98	5.36	5.09	5.67	7.9	6.35	5.73
23	Ba	214.58	208.21	208.04	219.83	288.14	259.29	227.47
24	Ce	19.85	-2.88	12.04	9.05	13.29	27.49	20.2
25	Hf	3.11	2.92	2.32	2.95	3.71	3.3	2.77
26	Ta	4.11	4.13	3.75	3.71	4.82	3.07	2.87
27	Pb	9.23	7.46	8.96	8.57	12.27	9.53	8.36
28	Th	3.59	2.3	4.05	3.29	5.76	4.94	4.38
29	U	1.09	1.17	0.31	0.54	1	0.69	1.18

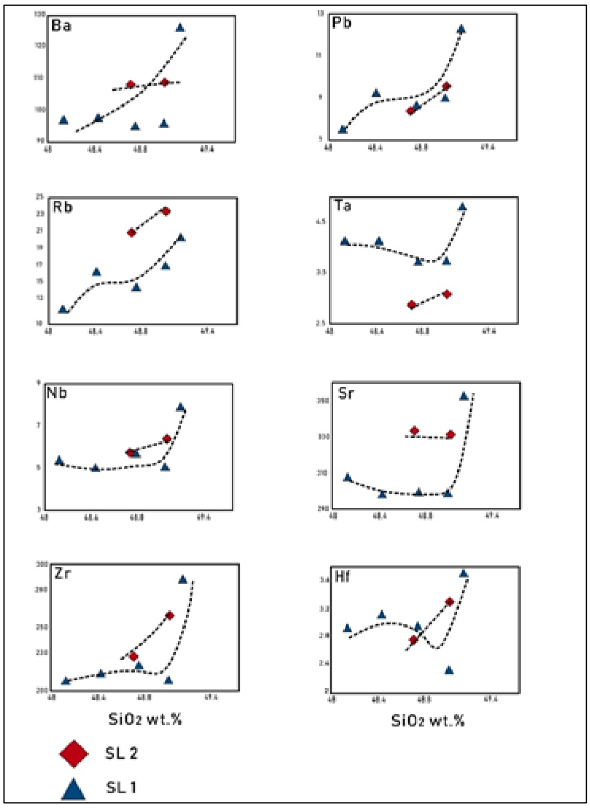

Fig. 8. Bivariate plot of trace elements and REE vs. SiO2 showing the differentiation pattern of SL 1 and SL 2 basaltic lava.

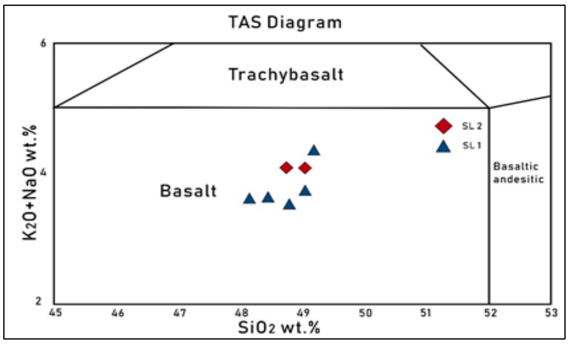

Fig. 9. Total Alkali Silica diagram for SL 1 and SL 2 showing the composition of basalt with silica content 48.13 – 49.17 wt.%.

Trace elements are selected from LILE (Large-Ion Lithophile Elements) and HSFE (High Field Strength Elements). Rb, Ba, Nb, Pb, Ta, Hf, and Zr are dominantly increase against silica content. The Sr content shows the different trend of basaltic lava sample, the SL 2 decrease but the SL 1 increase against silica content (Fig 8). Vukadinovic and Nicholls, (1989) divided lava of Slamet Volcano into 2 types named low and high abundant magma (LAM and HAM) based on incompatible elements, such as Zr/Rb, Hf/Nb, and Zr/Nb against MgO. Both Zr, Nb and Hf are relatively immobile in aqueous system in the mantle wedge and unaffected by fluid input from subducted slab, these elements are very stable in subduction environment (Vukadinovic and Nicholls, 1989).

Based on the classification of Vukadinovic and Nicholls, (1989) the studied rock samples in this study belong to High Abundance Magma (HAM) with Zr/Rb content range from 4.62 to 8.33 ppm, Zr/Nb range from 15.93 to 19.58 ppm and Hf/Nb

0.455 to 0.62 ppm, the source of magma has HAM have been derived by small degrees of partial melting (Vukadinovic and Nicholls, 1989).

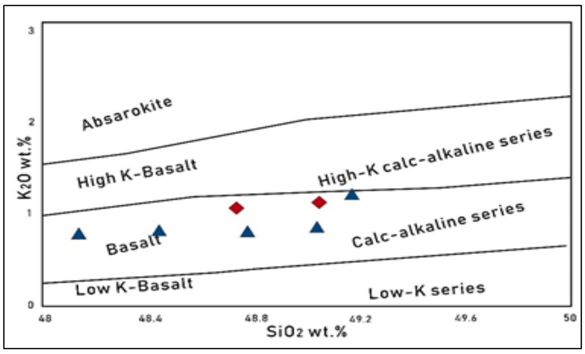

Fig. 10. SL 1 and SL 2 showing the magma series classification on calc-alkaline magma series.

5. Discussion

5.1 Magma Type

Geochemical composition of volcanic rocks can define for the process in the magma chamber, such as a fractionation crystal or magma mixing process. (Winter, 2013). Different trend of geochemical data can provide that the condition of magma chamber beneath the volcano (Wibowo, et, al, 2022). Based on the geochemical data of SL 1 and SL 2 has a different trend with overlapping of silica content, we were able to compare the the Rb/ Nb vs. SiO_2 plot according to Harijoko, et, al, 2022 to define the magma series, based on Rb/ Nb vs. SiO_2 we can identify that SL 1 and SL 2 are from same magma type but the different trend of major element and trance element of geochemical data we can interpret that magma of SL 1 and SL 2 has experienced the fractionation crystal and magma mixing process (Fig 11).

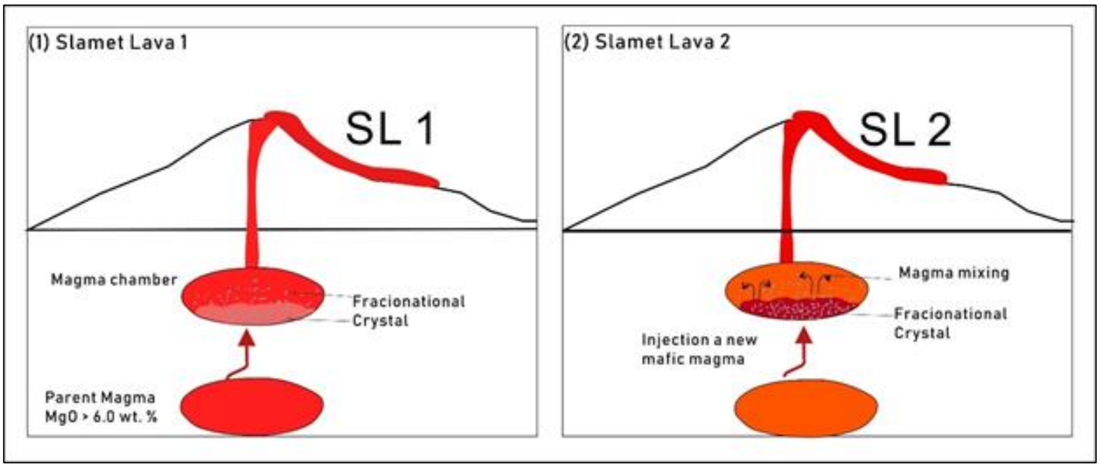

Fig. 11. Chronological model of Slamet Volcano magma chamber for Slamet Lava 1 periode and Slamet Lava 2 periode. (1) the magma of SL 1 that has MgO > 6 wt.% injected into magma chamber from parent magma and the fractionation crystal in magma chamber. (2) The new mafic magma injected from parent magma into magma chamber and the magma mixing happen and erupted as SL 2 basaltic lava.

5.2 Magma Differentiation

Mineralogical compositions of Baturraden Lava phenocryst are plagioclase, olivine, clinopyroxene, and opaque minerals, with plagioclase microlite and volcanic glass as the groundmass. The phenocryst component in the lava both lavas are same they are abundant of phenocryst. The abundant proportion of phenocryst within the lava is related to the lava viscosity. Because the SL 1 and SL 2 lava have similar abundant phenocryst crystal, it indicated that they have similar viscosity.

Bivariate plot of major oxide and SiO_2 shows the decreasing concentration of MgO, CaO, and Fe_2O_3, as SiO_2 increases. On the other hand, in other hand Na_2O, Al_2O_3, MnO and TiO_2 contents increase show a positive correlation with SiO_2. LILE and HSFE, Rb, Ba, Nb, Pb, Ta, Hf, and Zr are dominantly increase against silica content These patterns are typical element behavior that occurs due to fractional crystallization in the magma chamber (Fig 7 & 8). Glomerophyric texture is also observed in plagioclase, clinopyroxene and olivine, the glomerocrysts represent a significant factor in the context of crystal fractionation via crystal settling, as their density is a composite average of the densities of their constituent mineral phases, where individual plagioclase crystals possess a lower density compared to the enclosing magma. Consequently, glomerocrysts are instrumental in influencing the fractionation process (Fig 6).

Stratigraphically SL 1 lava or Jenggala Waterfall basaltic lava is older than SL 2 or Cebong and Pinang Waterfall (Sutawidjaja, et al, 1985). The geochemistry data shows an overlap trend of SL 1 and SL 2, two patterns geochemistry trend are observed on Harker Diagram of major elements and trace elements, therefore the silica content is relative similar for all rock samples. It indicated that SL 1 and SL 2 from one source magma type but both of them are experienced the magma mixing between SL 1 magma and SL 2 magma. The supply of basaltic magma of SL 1 and SL 2 maybe come from the same magma primitive source that SL 2 basaltic magma injected into SL 1 magma this magma differentiation process maybe caused the magma compdoes not significantly change into a more evolved composition (Fig 11).

Magma mixing also observed by mineral phenocryst textures, plagioclase, clinopyroxene, and olivine show similar texture that indicated of magma mixing process. Zoning and Sieve texture in plagioclase and clinopyroxene indicated that evidence of injection of a new-hot magma that cause magma mixing, the plagioclase and clinopyroxene are dissolved because of chemical disequilibrium as a magma mixing process.

5.2 Magma Evolution

As mentioned above that magma of basaltic lava of Baturraden Area experienced the fractionation crystal and magma mixing the silica content of SL 1 and SL 2 is overlapping show that SL 1 silica content is more evolved than SL 2, the silica content fluctuation may be attributed to the fractional crystallization process combined by injection of basaltic primitive magma into the magma chamber that caused the magma mixing of SL 1 and SL 2.

The petrography observation also confirms that magma mixing occurred on SL 1 and SL 2 magma because there are several textures that become evidence such as sieve texture, and zoning texture.

Baturraden volcanic rocks are derived from a basaltic magma that confirm from petrography and geochemical data. The geochemistry data confirm that similar magma type of basaltic magma of Batturaden Area. Based on the SiO_2 vs Rb/Nb show that basaltic magma of Baturraden Area has a similar content this is interpreted that magma is derived from same magma source but likely undergone the magma differentiation process like fractionation crystal and magma mixing.

SL 1 is the older lava unit on Young Slamet Volcano, after Old Slamet Volcanism ended the new magma formed from partial melting of subduction zone and injected into Slamet Volcano magma chamber, the SL 1 has MgO > 6.0 wt.% is suspected the magma SL 1 has influence from primitive mantle magma when it formed in subduction zone. After SL 1 erupted as a lava flow then the SL 2 magma injected into same magma chamber and control the magma mixing in magma chamber.

7. Conclusion

Volcanic rocks on Baturraden Area are a basaltic rocks formation, the basaltic lava flow distributed in a waterfall and river. They are a part of Slamet Volcano Lava that called Slamet Lava 1 (SL1) and Slamet Lava 2 (SL 2). Thin section observation confirms porphyritic, zoning, sieve texture, and glomeroporphyritic textures in the volcanic rock samples. The mineralogical compositions of SL 1 and SL 2 volcanic rocks include the phenocryst of plagioclase, K-feldspar, olivine, clinopyroxene, and opaque minerals, with plagioclase microlites and volcanic glass as groundmass. Plagioclase shows zoning and sieve texture. SL 1 and SL 2 basaltic rocks are confirmed as a basalt from TAS diagram and calc-alkaline from K_2O vs SiO_2 diagram, geochemical data confirm that SL 1 and SL 2 are from same magma type that magma of SL 1 and SL 1 are influenced by fractional crystallization and new injection of more basaltic magma, as evidenced by the frequent changes in SiO2 content and plagioclase textures such as sieve and zoning.

Acknowledgements

This research is funded by BLU Universitas Jenderal Soedirman with research scheme Riset Peningkatan Kopetensi with contract number 26.723/UN23.35.5/PT.01/II/2024.

References

Barber, N. D., Baldwin, S. L., Edmonds, M., Boschetty, F. O., Wibowo, H. E., & Harijoko, A. (2023). Monogenetic volcanoes as windows into transcrustal mush: A case study of Slamet and Loyang volcanoes, Central Java. *Journal of Volcanology and Geothermal Research*.

Djuri , M., Samodra, H., Amin, T. C., & Gafoer, S. (1996). *Peta Geologi Lembar Purwokerto - Tegal Skala 1:100.000*. Bandung: Pusat Penelitian dan Pengembangan Geologi.

Global Volcanism Program. (2013). (National Museum Of Natural History Smithsonian Institution) Retrieved April 05, 2022, from https://volcano.si.edu/volcano.cfm?vn=263180

Handley,, H. K., Blichert-Toft, J., Gertisser, R., Macpherson, C. G., Turner, S. P., Zaennudin, A., & Abdurrachman,, M. (2014). Insight from Pb and O isotopes into along arc variation in subduction inputs and crustal assimilation for volcanic rocks in Java, Sunda arc, Indonesia. *Geochimica et Cosmochimica Acta*, 205-226.

Harijoko, A., Alifcanta, M. L., Moktikanana, M. L., & Abdillah, M. Y. (2022). Magma Evolution of Lasem and Senjong Volcanic Complex: High-K Magmatism in Sunda Arc, Indonesia. *Indonesian Journal on Geoscience, Vol. 9*(1), 131-145.

Harijoko, A., Milla, A., Wibowo, H. E., & Setiawan, N. I. (2020). Magma evolution of Slamet Volcano, Central Java, Indonesia based on lava characteristic. *The 3rd Environmental Resources Management in Global Region.*

Harijoko, A., Sari, S. A., Wibowo, H. E., Setiawan, N. I., & Moktikanana, M. L. (2021). Stratigraphy, chronology, and magma evolution of Holocene volcanic products from Mt. Slamet deposited in the Guci Valley, Central Java, Indonesia. *Journal of Volcanology and Geothermal Research*.

Iswahyudi, S., Permanajati, I., Setijadi, R., Zaenurrohman, J. A., & Pamungkas, M. A. (2020). Origin of Geothermal Water Around Slamet Volcano,Paguyangan,Cipari, Central Java, Indonesia. *Journal of Geoscience, Engineering, Environment, and Technology*, 181-184.

Le Bas, M., Le Maitre, R., Streckeisen, A., & Zanettin, B. (1986). A Chemical Classification of Volcanic Rocks Based on the Total Alkali Silica Diagram. *Journal of Petrology*, 745-750.

Le Maitre, R. W. (2002). *Igneous Rocks a Classification and Glossary of Terms 2nd Edition Recommendations of the International Union of Geological Science Subcommision on the systematics of igneous rocks.* University Press Cambridge.

Mulyaningsih, S., Bronto, S., Kusniadi, A., Apriyanti, L., Budiyanto, L., & Wiloso, D. A. (2022). The Petrology and Volcano-Stratigraphyof The Muria-Peninsula High-K Volcanic Rocks, Central Java, Indonesia. *Journal of Geoscience, Engineering, Environment, and Technology*, 69-80.

Peccerillo, A., & Taylor, S. (1976). Geochemistry of Eocene calc-alkaline volcanic rocks in Turkey. *Contrib. Mineral. Petrology, 68*, 63-81.

Prasetya, Y. A., & Gibran, A. K. (2024). Geologi Gunung Slamet Tua Dan Gunung Slamet Muda : Kajian Geomorfologi, Petrologi, Geowisata, Dan Bencana Geologi. *Jurnal Geosaintek*, 71-84.

Prasetya, Y. A., & Toramaru, A. (2022). Petrology and Geochemical Comparation of Pumice and Scoria Rocks of Slamet Volcano, Central Java. *Journal of Applied Sciences, Management and Engineering Technology, Vol 3*(1), 19-28.

Reubi,, O., & Nicholls, I. A. (2004). Magmatic evolution at Batur volcanic field, Bali, Indonesia: petrological evidence for polybaric fractional crystallization and implication for caldera forming eruption. *Journal of Volcanology and Geothermal Research*, 345-369.

Sendjaja,, Y. A., Kimura, J. I., & Sunardy, E. (2009). Across-arc geochemical variation of Quatenary lavas in West Java, Indonesia: Mass-balance elucidation using arc basalt simulator model. *Island Arc, 18*, 201-224.

Sutawidjaja, I. S., & Sukhyar, R. (2009). Cinder cones of Mount Slamet, Central Java, Indonesia. *Journal Geologi Indonesia, Vol. 4*(No 1), 57-75.

Sutawidjaja, I. S., Aswin, D., & Sitorus, K. (1985). *Geology Map Of Slamet Volcano, Central Java.* Bandung: Volcanology Survey of Indonesia.

Vukadinovic, D., & Nicholls, I. A. (1989). The Petrogenesis of Island arc basalt from Gunung Slamet Volcano, Indonesia: Trace element and 87Sr/86Sr Constrain. *Geochimica et Chosmochimica, 53*, 2349 - 2362.

Vukadinovic, D., & Sutawidjaja , I. (1995). Geology, Mineralogy and Magma Evolution of Gunung Slamet Volcano. *Journal Southeast Asian Earth Science, 11*(2), 135 - 164.

Wibowo, H. E., Nakagawa, M., Kuritani , T., Furukawa , R., Prambada, O., & Haraijoko, A. (2022). Petrological and geochemical study of Sundoro Volcano, Central Java, Indonesia: temporal variations in differentiation and source processes during the growth of an individual Volcano. *Journal of Petrology*, 1-22.

Winter, J. (2013). *Principle of Igneous and Metamorphic Petrology*. London: Pearson Education Limited.

Yudiantoro, D. F., Haty, I. P., Pambudi, S., Magdalena, E., Putri, A., Takashima, I., & Abdurrachman, M. (2022). Evolution Magmatism of Nagasari Volcano Dieng, Central Java, Indonesia. *Journal of Geoscience, Engineering, Environment, and Technology*, 140-150