Geochemical of Volcanic Rock in Southern Part of Slamet Volcano, Indonesia

Adi Candra*, Januar Aziz Zaenurrohman, Siswandi, Aprian Wahyu Nugroho
Department of Geological Engineering, Universitas Jenderal Soedirman, Purwokerto

*Email: adi.candra@unsoed.ac.id

Abstract. Slamet volcano is the biggest volcano in Central Java, Indonesia which has stratovolcano type. Starting in 1772 until recent, Slamet volcano was erupted with short cycling so that geochemicals on rock are important to know how the history and erupted type. Method of research was conducted by geological survey (surface) and geochemical analysis of sample rocks. Geological condition is consist of lava flow, pyroclastic fall, and laharic deposits that was proven by petrography approached, meanwhile geochemical composition shows calc-alkaline and high K calc-alkaline series, genesis of magma was from continental plate with island arc tholeiitic setting. Depth of magma 155-174 km belom the earth’s surface.

1. Introduction
Slamet volcano is stratovolcano which erupted began (recorded) from 1772 - recent. The characteristics of eruption has ash erupted with lava flowing. Periods of one eruption and another have short cycling [1]. Geochemical has significantly things that should be done due to short cycle of eruption. Rocks as a product of volcano eruption could be given an overview about history of eruption and type of erupted based on geochemical composition.

2. Data and Study Location
2.1. Study Location
The research location has an area of 4 km² which is the southern slope of Slamet volcano, Central Java, Indonesia. Geographic location in UTM is 307550-309550 mT and 9193200 - 9195200 mU. Mount Slamet is included in the Physiography of Quaternary Volcanic Zone [2] and consists of 3 geological sequences, namely old volcanoes, Lebaksiu, and young volcanoes [3].

2.2. Data Collection
Data collecting was conducted by survey of surface geological mapping which observed-indication of geomorphology, lithology, and geological structure. Especially for lithology we collected all of the representative rocks sample to petrography and geochemical analyses based on area of geological mapping.
3. Method
The research uses geochemical methods by X-Ray Fluorescence (XRF) tool and several diagram for interpretation of magma series, magma origin, tectonic setting, and depth of magma.

4. Results and Discussion
Geochemical analyses (x-ray fluorescence) was conducted in three rocks sample (basalt lava, pyroclastic breccia, and laharic breccia) that resulted major element and trace element (table 1).

| No | Elements | Basalt lava | Pyroclastic breccia | Laharic breccia |
|----|----------|-------------|---------------------|-----------------|
| 1  | SiO$_2$  | 50.22       | 50.68               | 51.83           |
| 2  | Al$_2$O$_3$ | 22.15       | 21.07               | 23.66           |
| 3  | Fe$_2$O$_3$ | 12.23       | 13.25               | 10.93           |
| 4  | CaO      | 9.96        | 8.65                | 8.44            |
| 5  | MgO      | 1.98        | 1.85                | 2.14            |
| 6  | TiO$_2$  | 1.67        | 2.29                | 1.54            |
| 7  | K$_2$O   | 1.28        | 1.51                | 0.99            |
| 8  | P$_2$O$_5$ | 0.30        | 0.49                | 0.29            |
| 9  | Na$_2$O  | 0.00        | 0.00                | 0.00            |
| 10 | MnO      | 0.20        | 0.22                | 0.18            |
| 11 | FeO*     | 10.99       | 11.91               | 9.82            |

After we found x-ray fluorescence (xrf) analyses, next step is assigned mineral compositon by normative analyses (CIPW). The result was shown abundance of quartz and corundum high relatively, meanwhile the rock is basalt. It can be explained by Na$_2$O absence in x-ray fluorescence due to limited tools reading (table 2).

The magma series of rocks can be determined based on SiO$_2$-K$_2$O plotting diagram [4]. Basalt lava and pyroclastic breccia belong to high calc-alkaline magma affinity whereas laharic breccia is calc-alkaline magma affinity (Figure 2). From figure 2 shows fluctuated of K$_2$O against SiO$_2$ increasing. It can be interpreted another processes besides crystal fractionation, namely magma mixing or magma assimilation. The result will tend to straight or linear if magma mixing absence.
Table 2. Mineral composition by normative analyses

| No | Elements     | Rocks          |          |          |          |
|----|--------------|----------------|----------|----------|----------|
|    |              | Basalt lava    | Pyroclastic breccia | Laharic breccia |
| 1  | Anortite     | 47.48          | 39.73    | 39.98    |
| 2  | Hypersent    | 21.71          | 22       | 20.22    |
| 3  | Quartz       | 14.24          | 17.12    | 20.83    |
| 4  | Orthoclase   | 7.58           | 8.89     | 5.86     |
| 5  | Corondum     | 3.36           | 4.89     | 7.94     |
| 6  | Ilmenite     | 3.19           | 4.35     | 2.94     |
| 7  | Magnetite    | 1.79           | 1.94     | 1.6      |
| 8  | Apatite      | 0.65           | 1.07     | 0.63     |

Figure 2. SiO₂ vs K₂O comparison diagram.

Characteristic of rock chemical can be obtained magma origin based on interaction rock origin and magma (continent and ocean). Magma origin involves K₂O, TiO₂, and P₂O₅ triangular diagram [5] that shows magma origin interact with continent plate (figure 3).

Figure 3. Ratio K₂O, TiO₂, and P₂O₅
The other triangular diagram for magma origin determination based on TiO$_2$, $10_X$ MnO, and $10_X$ P$_2$O$_5$ [6] shows island arc toleilite by tectonic setting for the magma origin. (Figure 4).

![Diagram](image)

**Figure 4.** Magma origin by tectonic setting

Depth of magma origin that was formed in Benioff zone. It can be calculated by Hutchinson formula [7] which uses SiO$_2$ and K$_2$O percentage. Result of calculated was found depth magma approximately 155-174 km on Benioff zone.

5. **Conclusion**
- Rock geochemical shows calc-alkaline and high K calc-alkaline magma series.
- Magma origin of rocks from plate continent that presence of magma mixing.
- Tectonic setting of rock in research area is island arc toleilite.
- Depth of magma origin is ±155 - ±174 km below earth surface.

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