Characteristics of Rock Minerals of the Camba Formation

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ABSTRACT
The Camba Formation (Tmcv) of Tertiary age is spread over the southern part of South Sulawesi, especially in Gowa and Maros Regencies. The Camba Formation, which consists of igneous rocks from the ancient Camba volcano, has different mineral characteristics. Analysis of mineral characteristics using the X-Ray Diffraction (XRD) method. Mineral content found in Camba Pharmaceutical igneous rocks are: Diopside (MgCaSi2O6), Enstatite (MgSiO3), Pegionite ((Ca,Mg,Fe)(Mg,Fe)Si2O6), Albite (NaAlSi3O8), Bytownite ((Ca,Na) [Al(Al,Si)Si2O8]), Anorthite (CaAl2Si2O8), Magnetite (Fe3O4), and Periclase (MgO). The most dominant minerals are Pegionite and Albite, while the least minerals are Magnetite and Periclase. This research will provide additional information for the local government, mining entrepreneurs, and the Gowa district community.

Keywords: *Camba Formation, Igneous Rock, Mineral Characteristics, XRD.*

1. INTRODUCTION

The rocks of the Camba Formation are Tertiary in age, consisting of limestone and intrusive volcanic rocks of the Camba Formation. The two rocks are interspersed in the Parangloe area, Gowa .

Rock is a natural material composed of minerals, both consolidated and unconsolidated, which are the main constituents of the earth's crust and are formed from natural processes. Rocks can contain one or more minerals. Mineral chemistry studies the chemical composition of minerals to identify, classify and classify minerals. The chemical composition of a mineral is fundamental because some of the properties of the mineral/ crystal depend on it. The chemical analysis distinguishes minerals into two types: qualitative and quantitative chemical analysis [1,2].

Magma on the way up begins to lose mobility while still in the lithosphere and forms a magma chamber before reaching the surface. In this situation, the magma will freeze in place, and the ions in it lose their free movement and arrange themselves to form igneous rocks on the earth's surface (intrusive). However, not all types of minerals that form rocks simultaneously under these conditions. Some are formed earlier at high temperatures. According to the Bowen Series, the formation of these rocks has a crystallization pattern [3].

When the magma temperature decreases, the first mineral to be formed is Olivine, followed by Pyroxene, Hornblende, Biotite (discontinuous series). In a continuous series, mineral formation begins with Ca-Plagioclase minerals and ends with the formation of Na-Plagioclase. At the subsequent decrease in temperature, K-Feldspar (Orthoclase) minerals will be formed, followed by Muscovite and the formation of quartz minerals [4].

The study of rock mineral characterization of the Camba Formation was carried out to serve as information for the community and local government in the Energy and Mineral Resources of Gowa and Maros Regencies. This is important to encourage investors to invest their shares in managing mineral mines in the future. The main objective of this research is to determine the mineral content in rocks and map the distribution of minerals in the research location. Generally, mineral content identification is carried out using X-Ray Diffraction (XRD) analysis. The results showed that XRD could identify the mineral components that makeup rocks.

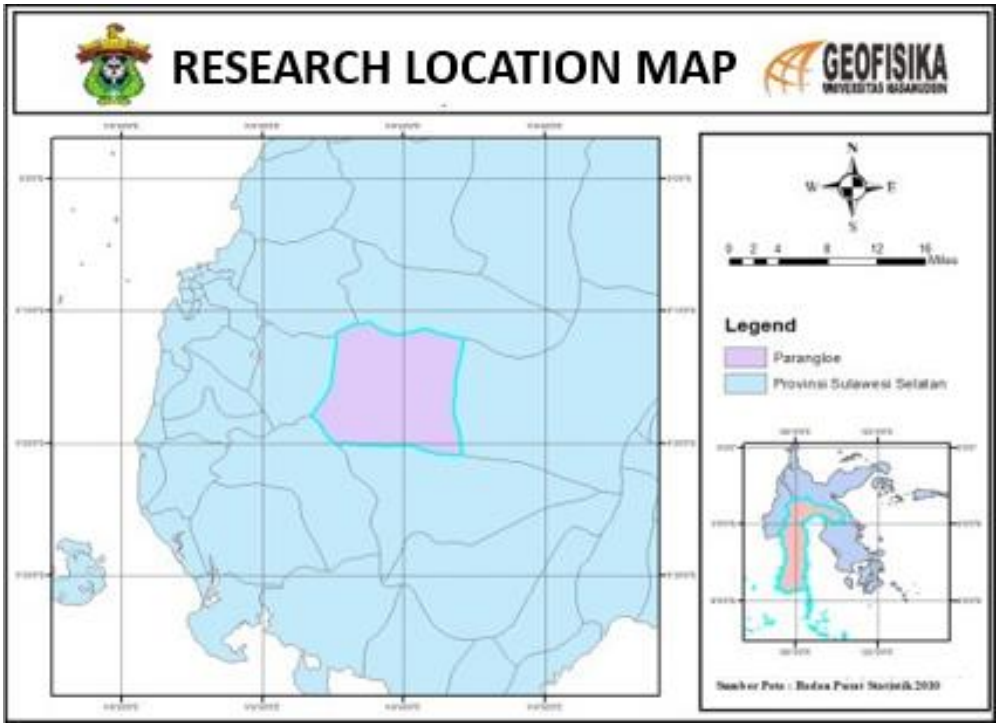

Figure 1. Research Location Map.

2. METHODS

The rock samples used were rock samples taken around the parangloe area (**F**igure 1) which were then carried out by **XRD** analysis to determine the constituent minerals.

The data used in this study is primary data. Sampling locations were carried out directly at several points in the Parangloe area based on field surveys and previous location determinations using Google Earth and the Global Positioning System (GPS). This is done to determine the location of the distribution of samples that have been taken. Determination of sampling location based on distance, the distance between the sample points is not the same because it refers to the geological map. This is done so that the rock samples taken to be tested for their content represent the conditions in the field. The samples taken were fresh, unblemished, and weathered rocks.

Laboratory analysis was carried out to determine rocks' physical and chemical properties that could not be done directly in the field. The data generated by the XRD tool is then analyzed to determine the mineral presentation and metal oxide concentration in rock samples and then tested to determine the pattern of mineral distribution in the study area.

3. RESULTS AND DISCUSSION

3.1. Rock Mineral Content in Parangloe

Table 1. Minerals of each sample.

Sample	Mineral	Compound	Total (%)
I	Diopside	$MgCaSi_2O_6$	41.9
	Enstatite	$MgSiO_3$	22.6
	Pigeonite	$(Ca,Mg,Fe)(Mg,Fe)Si_2O_6$	18.2
	Albite	$NaAlSi_3O_8$	17.3
II	Bytownite	$(Ca,Na)[Al(Al,Si)Si_2O_8]$	48.6
	Diopside	$MgCaSi_2O_6$	26.3
	Albite	$NaAlSi_3O_8$	25.1
III	Pigeonite	$(Ca,Mg,Fe)(Mg,Fe)Si_2O_6$	50.7
	Albite	$NaAlSi_3O_8$	27.3
	Diopside	$MgCaS_{i2}O_6$	22.0
IV	Anorthite	$CaAl_2Si_2O_8$	90.1
	Pigeonite	$(Ca,Mg,Fe)(Mg,Fe)Si_2O_6$	9.9
V	Anorthite	$CaAl_2Si_2O_8$	44.3
	Albite	$NaAlSi_3O_8$	25.7
	Pigeonite	$(Ca,Mg,Fe)(Mg,Fe)Si_2O_6$	25.5
	Magnetite	Fe_3O4	4.4
VI	Albite	$CaAl_2Si_2O_8$	44.3
	Pigeonite	$NaAlSi_3O_8$	25.7

	Diopside	$(Ca,Mg,Fe)(Mg,Fe)Si_2O_6$	25.5
	Periclase	Fe_3O4	4.4

minerals. The results of geochemical analysis using X-Ray Diffraction show several kinds of mineral content contained in some samples. In general, the rock found at

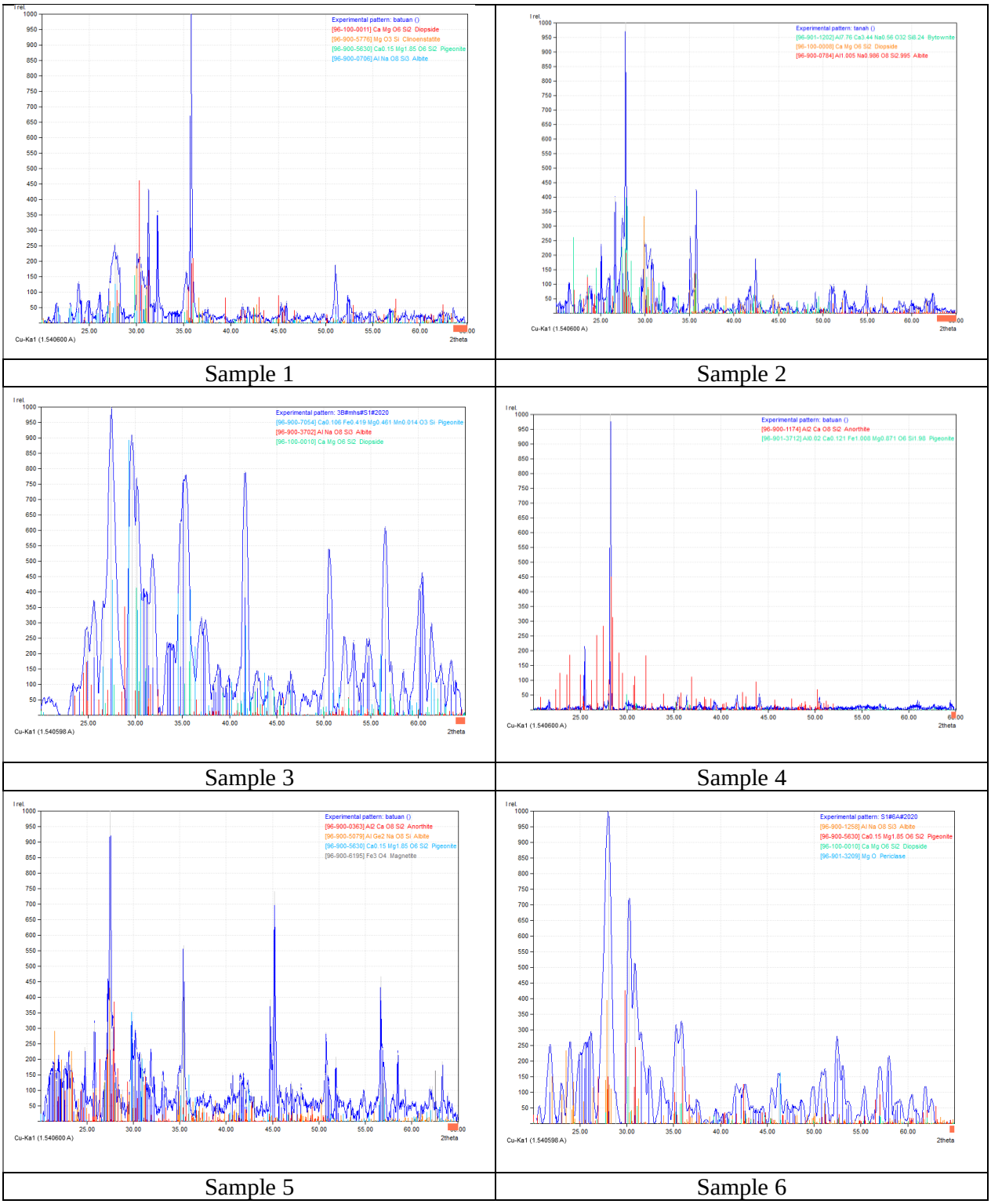

Figure 2. Relationship between intensity and angle 2θ in each sample.

The rock samples used were rock samples taken around the Parangloe area (Figure 1) which were then carried out by XRD analysis to determine the constituent the sampling site is basalt. Based on the results of the analysis of the six samples in the Parangloe area, Gowa

Regency, the resulting rock mineral content with X-Ray Diffraction (XRD) is as Figure 2.

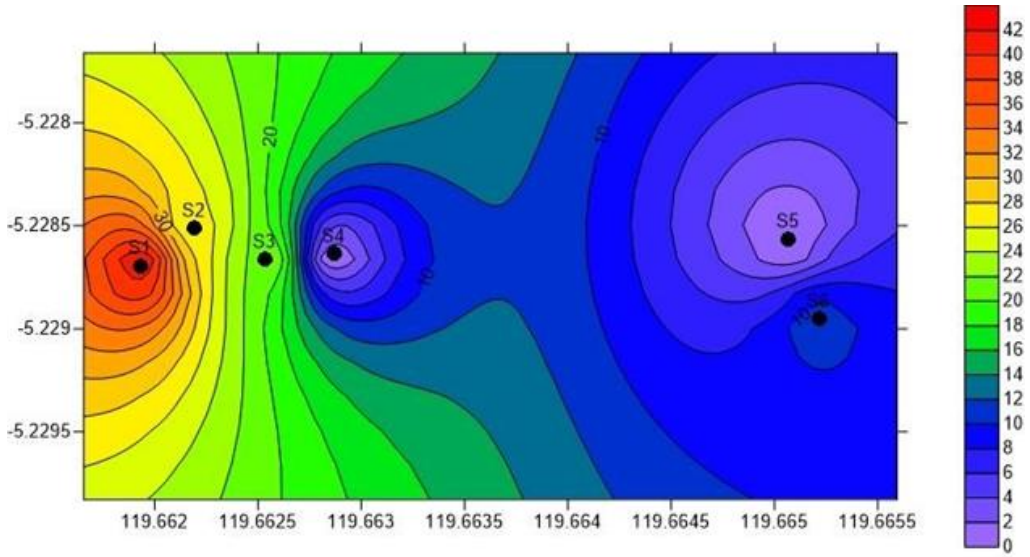

Figure 3. Map of diopside mineral distribution.

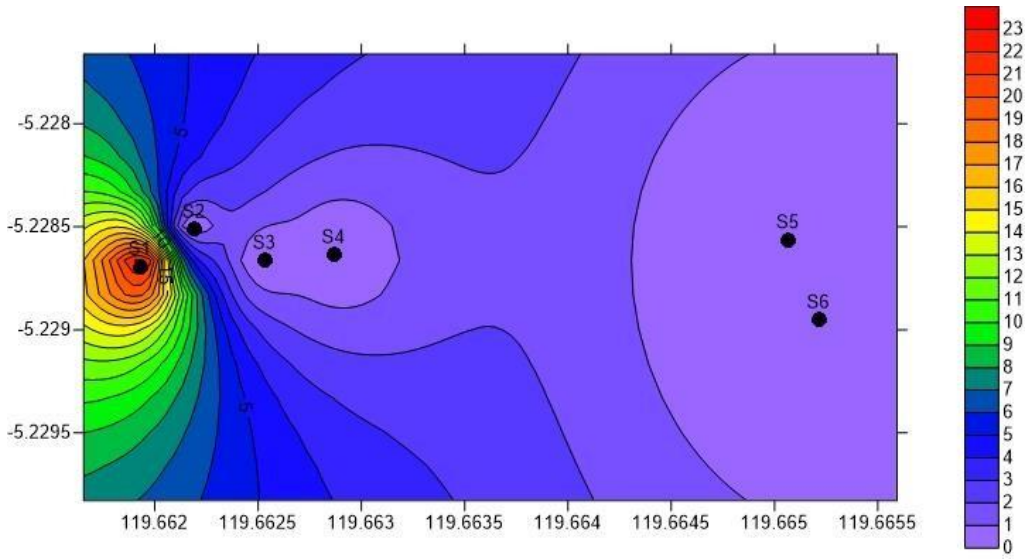

Figure 4 Map of enstatite mineral distribution.

The minerals contained in limestone and volcanic rocks of the Camba Formation in the Parangloe region can be seen in Table 1. The Parangloe area in Gowa Regency, South Sulawesi, is a recreational area for domestic and foreign tourists. In this area, there is a Parangloe waterfall.

3.2. Mineral Compounds Map

The results of geochemical analysis using X-Ray Diffraction showed several kinds of chemical compounds present in some samples. The regional geology of the study area is the volcanic rock of the Camba Formation mapped as a volcanic facies or member of volcanic rock from pyroclastic and epiclastic-marine sedimentary rock sequences. In general, these rocks consist of volcaniclastics, tuff, siltstone, shale, claystone, and marl; inserts limestone, conglomerate, volcanic breccia, and lava (andesite-basalt); local coal inserts [5].

The research area (Parangloe) is a volcanic rock for the Camba Camba Formation (middle-upper Miocene). It occurs below the earth's surface and is lifted to the surface through tectonic processes part of the Camba Formation. Based on the results of the sample analysis, a contour map of the distribution of rock minerals is generated using the surfer 10 software as follows:

3.2.1. $MgCaSi_2O_6$ (Diopside)

The contour map, Figure 3, shows Diopside minerals present in samples I, II, III, and VI. The mineral content in each sample varies greatly. Sample 1 has much mineral content with 41.9%, and sample VI has a minor mineral content of 11.1%. The bottom of the waterfall has very high levels of diopside minerals which are included in igneous rock-forming pyroxene minerals, allowing the location to be indicated as basalt rock.

3.2.2. $MgSiO_3$ (Enstatite)

In the image of the enstatite contour map (Figure 4), the mineral enstatite is only found in sample I, with a mineral content of 22.6%. Enstatite mineral is one of the minerals from the pyroxene phase and is a mafic mineral which is the main mineral forming dark-coloured rocks. Found at the bottom of the waterfall as diopside minerals which indicate basalt rock. This mineral is the same as diopside minerals. This mineral is formed from the discontinuous cooling of magma and is rich in magnesium and silica minerals.

3.2.3. $(Ca,Mg,Fe)(Mg,Fe)Si_2O_6$ (Pegionite)

Pegionite mineral is almost scattered at all sampling points except sample II (Figure 5). This mineral is also forming igneous rocks and includes pyroxene minerals, but in sample II there is no pigeonite mineral. The continuous series is one of the mineral factors that are not present in sample II. In the continuous series, one mineral can turn into another at a specific temperature (temperature drop) due to a reaction to the remaining magma solution. Pegionite mineral has several chemical

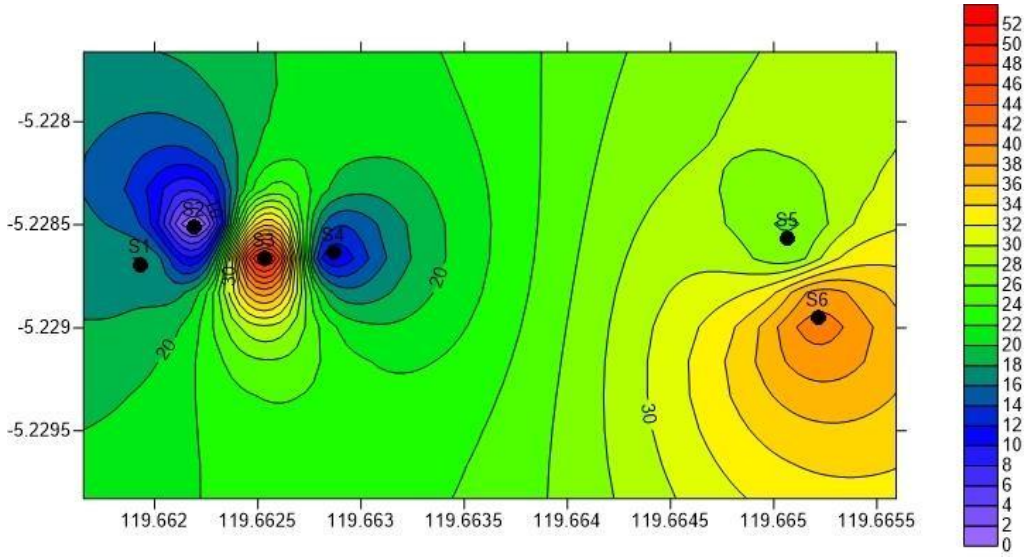

Figure 5. Map of pegionite mineral distribution.

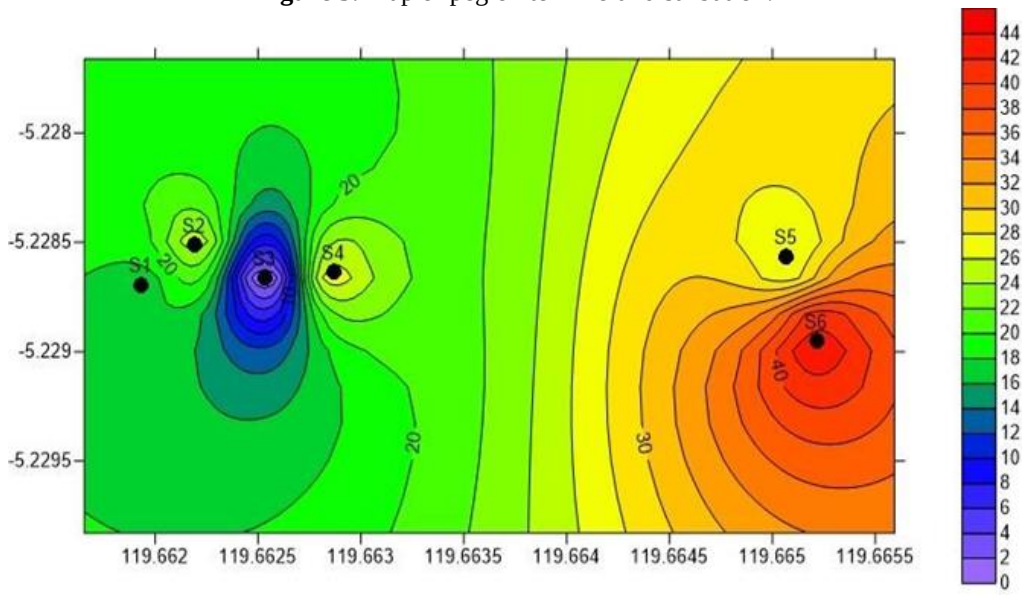

Figure 6. Map of albite mineral distribution.

compounds and mineral elements such as iron (Fe) where these chemical compounds are usually found in volcanic rocks that cool quickly, silicon oxide or quartz (SiO2) is the main component of igneous rock-forming, then calcium (Ca), magnesium (Mg).

3.2.4. $NaAlSi_3O_8$ (Albite)

Albite minerals are almost the same as pigeonite minerals at the study site. The contour image, Figure 6, shows that in sample III, there is no such mineral. Albite mineral is one of the minerals from the plagioclase feldspar phase and includes felsic minerals, which are the main minerals forming light-coloured rocks because they contain a lot of feldspar and lead (feldspathoid minerals). Albite mineral is one of the minerals that form basalt rock.

3.2.5. $(Ca,Na)[Al(Al,Si)Si_2O_8]$ (Bytownite)

Bytownite mineral is only found in sample II shown by the contour map on Figure 7. Mineral content in the sample is quite a lot, with 48.6%. The mineral bytownite belongs to the felsic mineral, which is a light-coloured rock-forming. In the Bowen series, bytownite is between anorthoclase and labradorite, with high temperature and pressure. The top mineral (anorthoclase) with the bottom mineral (albite) has a relationship, is the addition or reduction of the amount of calcium (Na) and sodium (Na) as the temperature drops. The presence of this compound content confirms that sample II includes basalt rock.

3.2.6. $CaAl_2Si_2O_8$ (Anorthite)

Based on Figure 8, 15 anorthite minerals are found at the top of the waterfall, precisely in samples IV, and V. Anorthite minerals are included in mafic minerals (formers of dark-coloured rocks because they contain

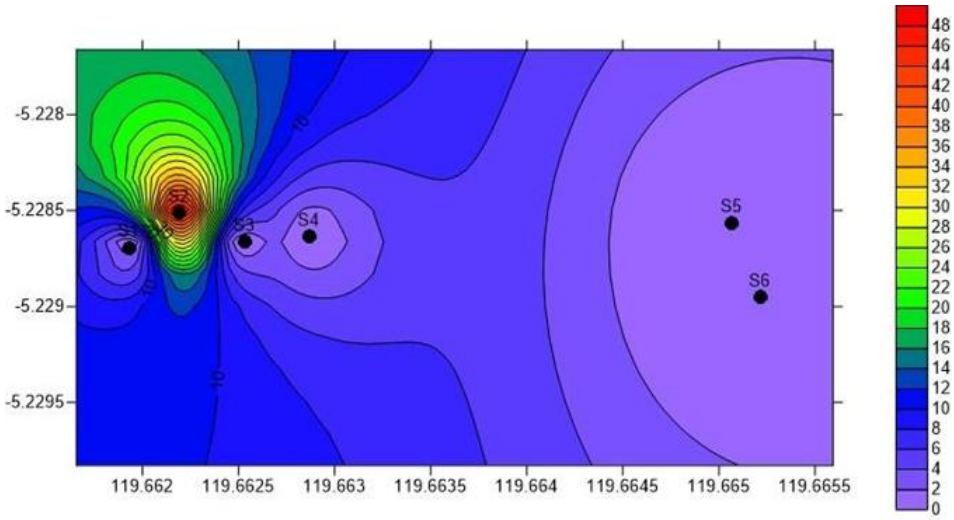

Figure 7 Map of bytownite mineral distribution.

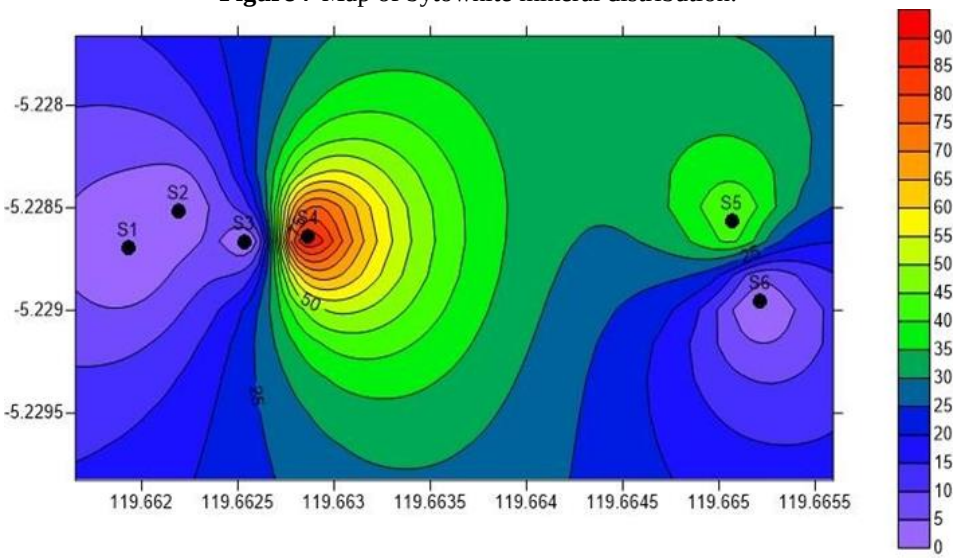

Figure 8. Map of anorthite mineral distribution.

magnesium and Ferrum. This mineral content has many silica mineral compounds, which are the main constituents of igneous rocks. This confirms that samples IV and V are basalt rocks.

3.2.7. Fe_3O_4 (Magnetite)

The magnetite mineral is only found in sample V with a low-grade value of 4.4% (Figure 9) and is formed due to sublimation (change of state from solid to gas without melting first) in conjunction with volcanoes. The magnetite mineral is one of the mineral compounds that make up basalt. This confirms that sample V also includes igneous rock (basalt). Magnetite is a mafic mineral that is the main constituent of dark-coloured rocks and is a type of iron deposit that belongs to the marine deposit type in the form of iron oxide and alteration of pyrite. The chemical compound of hematite has several mineral elements, including iron (Fe) and oxygen (O).

3.2.8. MgO (Periclase)

Figure 10 shows that only sample VI contains these minerals and includes igneous constituents. This mineral is formed naturally from magnesium and oxide, formed by ionic bonds between one atom of magnesium and one atom of oxide, forming a crystal structure. Periclase mineral has a reasonably high magnesium compound and

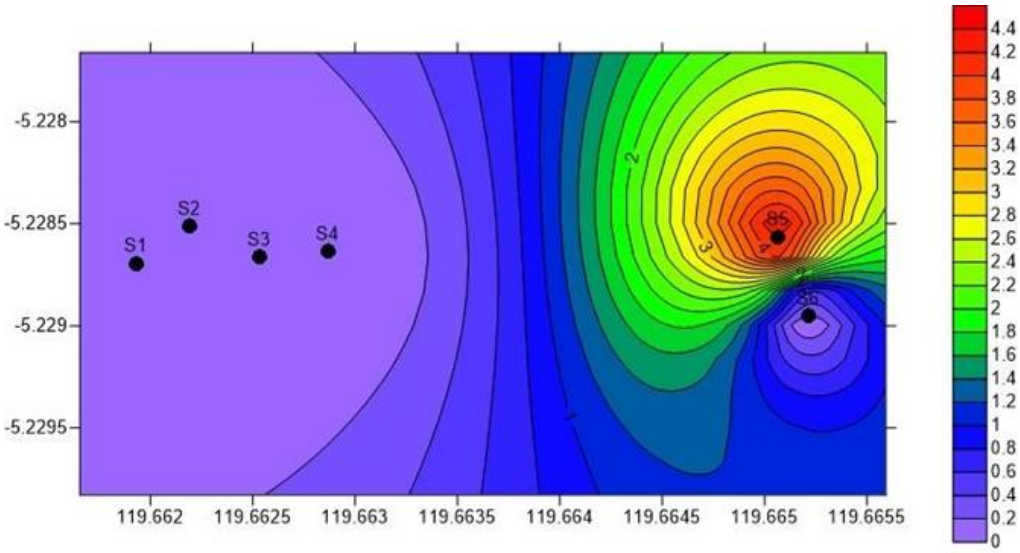

Figure 9. Map of magnetite mineral distribution.

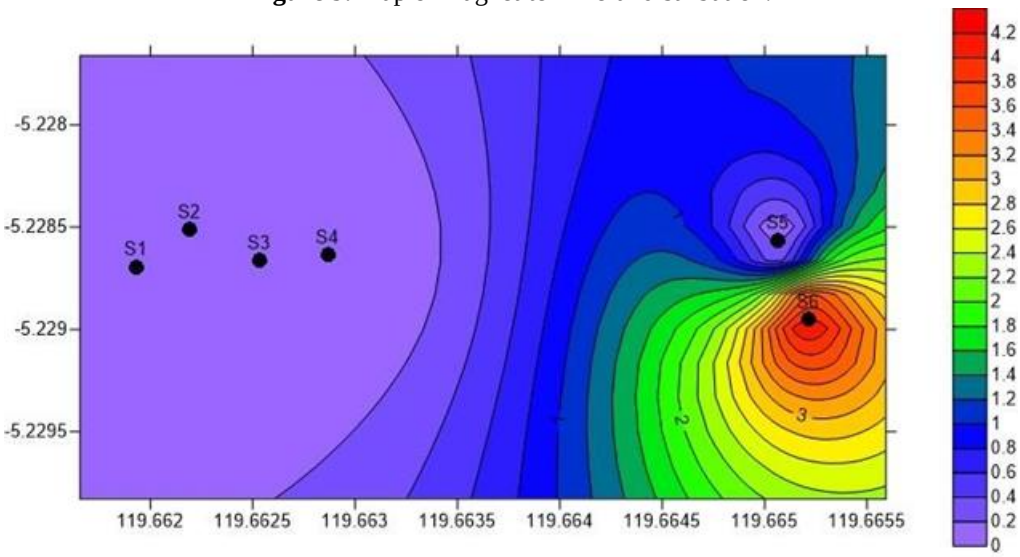

Figure 10 Map of periclase mineral distribution.

is one of the compounds of basalt rock, thus indicating in sample VI, including basalt.

are minerals found in the upper and lower parts of Parangloe Waterfall.

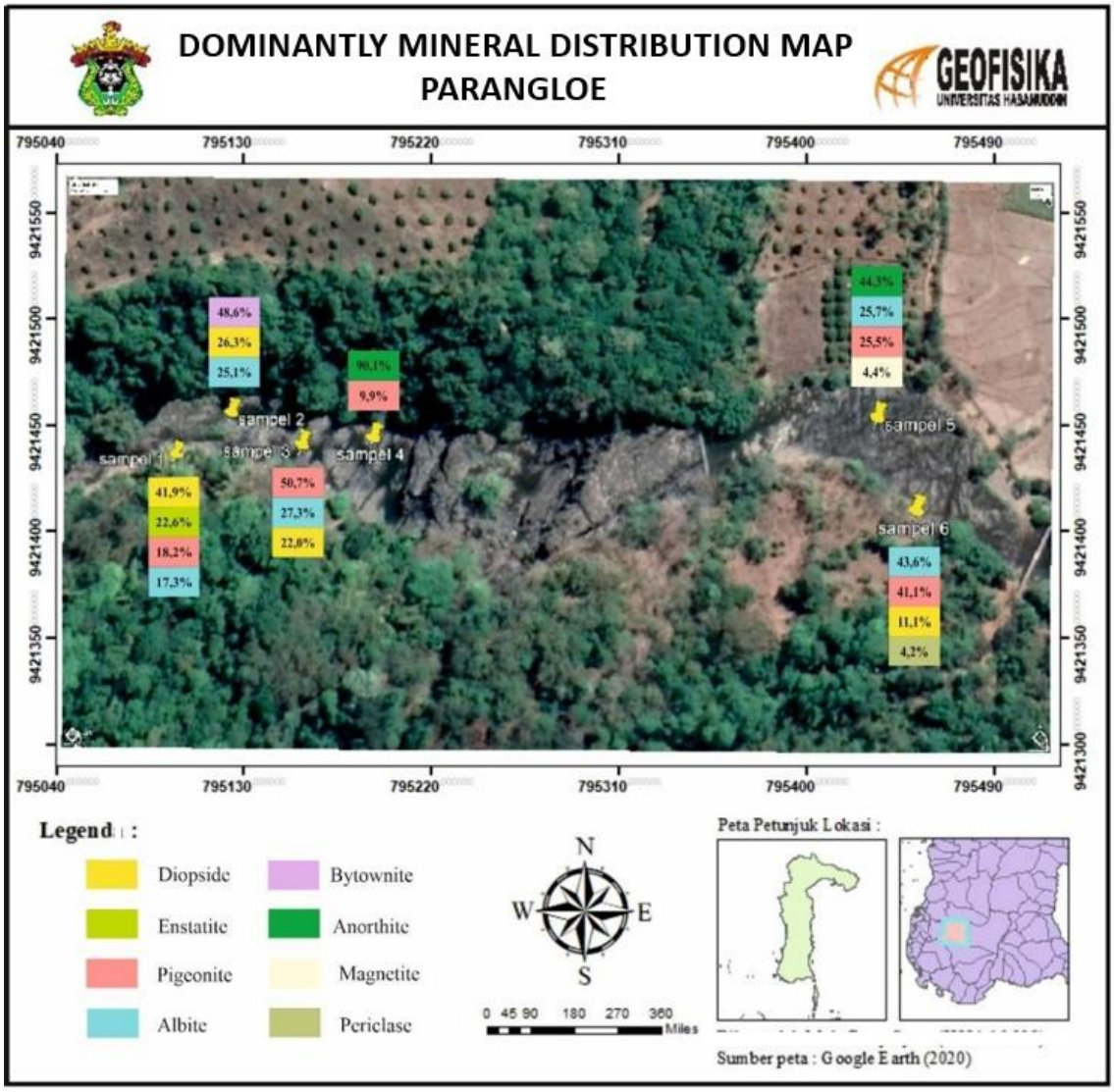

Figure 11. Research Location Map.

3.3. Mineral Distribution Map

The results of geochemical analysis using X-Ray Diffraction show that there are VIII types of minerals, are diopside, enstatite, pigeonite, albite, bytownite, anorthite, magnetite, and periclase, contained in rock samples.

In the mineral distribution map, Figure 11, the most dominant minerals are pigeonite and albite. Almost all of the sampling locations can be found for these minerals. At the top of the waterfall (upstream), there are magnetite and periclase minerals. These minerals are only found in the upstream part of the waterfall and not at the bottom of the waterfall, while at the bottom of the waterfall, there are minerals enstatite and bytownite, which are not found in the upstream part water. Albite and anorthite minerals

4. CONCLUSION

Below are some conclusions that can be drawn from this research:

1. The mineral content contained in the rock samples are diopside, enstatite, pigeonite, albite, bytownite, anorthite, magnetite, and pericles, where the most dominating mineral content is diopside and pigeonite and very little magnetite and periclase.
2. The content of mineral compounds in rock samples are $MgCaSi_2O_6$ (Diopside), $MgSiO_3$ (Enstatite), (Ca, Mg, Fe)(Mg, Fe)Si_2O_6 (Pegionite), $NaAlSi_3O_8$ (Albite), (Ca,Na) [Al(Al,Si)Si_2O_8] (Bytownite), $NaAl_2Si_2O_8$ (Anorthite), Fe_3O_4 (Magnetite), MgO (Periclase).

These minerals are the composition of the magma cooling process, where large groups of pyroxene and plagioclase minerals are found in rock samples.

3. The most dominant minerals are pigeonite and albite. Almost all points of sampling location can be found in these minerals. There are magnetite and periclase minerals at the upstream part of the waterfall, while at the downstream part of the waterfall, there are enstatite and bytownite minerals. Albite and anorthite minerals are minerals found in the upstream and downstream parts of Parangloe Waterfall.

AUTHORS' CONTRIBUTIONS

MAM, MRS, and MFIM have contribution about CONCEPTUALIZATION, METHODOLOGY, FIELD DATA ACQUISITION, SOFTWARE, and WRITING-ORIGINAL draft preparation.

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