Characteristics of Volcanic Rock In The Bualemo Area, North Gorontalo District Based On Petrographic Analysis

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Abstract. The research was conducted in Bualemo Area, Kwandang District, North Gorontalo Regency. The aim of this study was to analyze the petrogenesis of volcanic rocks in the Bualemo Area, North Gorontalo Regency. A mapping technique was utilized in this work to assess the geological conditions of the research site, and petrographic analysis was used to assess the mineral content and rock texture. The findings revealed the stratigraphy of the research region, including an altered andesite unit, an andesite unit, and an alluvial deposit unit, when sorted from old to new. The results of the petrographic analysis show that the rock has a cumoloporphyritic texture, with phenocryst (25%) consisting of plagioclase (60%), k-feldspar (30%), and pyroxene (7%). Pyroxene minerals are all present as phenocrysts, measuring 0.5-0.8 mm, in subhedral-anhedral shape, measuring 0.5-1.5 mm, phenocrysts are starting to turn into secondary minerals, and some are present as relict minerals. The groundmass (75%) consists of predominant plagioclase and minor K-feldspar. The rock is basaltic andesite.

1 Introduction

The geological conditions in the North Sulawesi Arm are very complex, influenced by the tectonic evolution that happened between the Middle Eocene and the present. Tectonic evolution begins with the formation of an underwater volcanic arc along with subduction from the north to the formation of the Celebes Sea [1]. Entering the Late Eocene and Early Miocene, the North Arm underwent rotation. According to [2], the North Arm rotates clockwise 90º with the pole axis at the east end of Manado.

A different opinion was conveyed by [1] and [3]. The magnitude of rotation measured in the western part of the North Arm (120-122° E) is around 20-25° while in the eastern part of the North Arm (122.5º -124º E) there are two patterns of rotation direction, namely clockwise and counterclockwise at 6-85º. The rotation only stopped after the presence of quaternary volcanic activity in the eastern part of the North Arm [2].

Research on tectonic evolution in the North Arm is interesting because it is linked to the concept of tectonostratigraphy. This concept focuses on studying the relationship of lithostratigraphic units which emphasizes the influence of tectonics on the stratigraphic record [4]. Within the framework of the tectonostratigraphic unit, there is an explanation regarding the control of tectonic deformation processes on the rock units produced in the stratigraphic record. A tectonostratigraphic approach to analyzing sediments and sedimentary-volcanic rock complexes. In this regard, the term formation (rock association) is understood as a natural complex whose components consist of layers, members and formations that are para genetically related to each other, both vertically and laterally.

Gorontalo is an area with interesting geological characteristics to study for geological studies and the exploration of mineral resources. The formation of magmatism and sedimentation products in this area took place relatively continuously from the Eocene to the Quaternary, with formation environments ranging from the deep sea to land [5,6,7,8].

Because the Kwandang region and its surrounds are made up of intricate Tertiary to Quaternary age rock formations, they provide an intriguing geological environment for research. This rock formation was formed at the start of the collision between the Sula oceanic plate and the oceanic plate of the northern arm of Sulawesi, it was then carried on by impact in the mid-Pliocene towards the eastern arm of Sulawesi and the creation of a subduction strip along the northern arm of Sulawesi till the present [9].

Previous research has been carried out in the form of geological mapping with a scale of 1:25,000 so detailed research is needed. The age equality carried out refers to previous studies, namely Middle Miocene to Late Miocene. This age determination refers to the similarity of lithology in the Bilungala Volcano Rock Formation (Tmbv). The Bilungala Volcano Formation (Tmbv) of the Middle Miocene age was formed above, consisting of volcanic breccia, tuff and lava. The constituent lithology is gray to dark gray. This unit is thought to have a thickness of more than 1,000 m [10,11]. For this reason, this research focuses on analyzing in detail the andesite volcanic rocks in the Bualemo Area, North Gorontalo Regency.

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2 Research Material and Methods

2.1 Research Material

The research material is a volcanic rock in the Bualemo Area, Kwandang sub-district, North Gorontalo Regency. Geographically, the research location is at coordinates N 0˚47'10" - 0˚48'40" and E 122˚55'0" - 122˚57'5". This location has an area of about 10 km2. This research is specifically in Bualemo Area, North Gorontalo Regency (Figure 1).

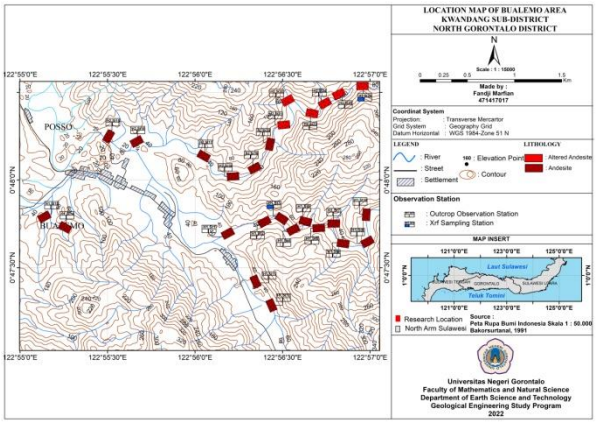

Fig. 1. The research location is in Bualemo Area, North Gorontalo Regency

2.2 Research Method

The method used in this research is the mapping method, and the petrographic method is used to process the data. The mapping method was carried out to determine the geomorphology and stratigraphy of the study area by direct observation in the field using a 1: 15,000 scale map. Retrieval of geomorphological data to determine the existing landform at the research location by observing on maps and direct observations in the field using classification [12]. The age of the rocks was determined using the stratigraphic data collected and the comparability of the formations in the rocks at the study site. The petrographic method is carried out to determine the mineral content, texture, and rock names, from samples taken from the field.

Petrographic analysis of igneous rocks using a computer-connected polarizing microscope. In observing rock sections under a microscope using Nicol cross and Nicol parallel [13,14,15,16,17,18,19,20,21]. This is done to describe the characteristics of the rock-forming minerals and to be more specific in determining the rock name.

Microscopically using a polarizing microscope, namely color, texture including crystallinity, granularity, shape, and relation. Structure (massive and vesicular), mineral composition, and rock naming are based on the classification [22].

3 Result and Discussion

3.1 Geomorphological

Based on the results of direct observation in the research location, there are two formations: the Volcanic Hills Unit and the Alluvial Plains Unit (Figure 2).

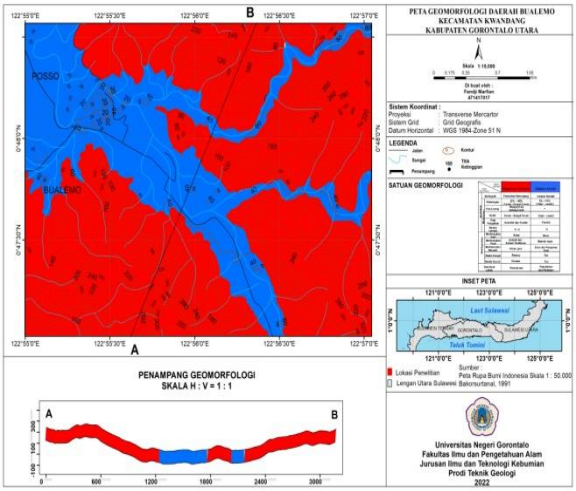

Fig. 2. Geomorphological map of the research area

Volcanic hills covered 70% of the study area and have a dense contour with slopes ranging from steep to very steep (25% - > 45%), with elevations reaching 80-300 m. The pattern of river flow in this unit is dendritic and parallel, and the lithology that forms this unit is andesite rock. The alluvial plain unit is in the center of the study location map occupying 30% of the study area, and it has contour relief ranging from flat to gently sloping, with an elevation of 0-40 m. The flow pattern of the rivers in this unit is parallel. The lithology that makes up this unit is materials from weathering starting from sand blocks.

3.2 Stratigraphy

The stratigraphy of the study area made up of three lithological units, namely the altered andesite unit, the andesite unit, and the alluvial depositional unit (Figure 3).

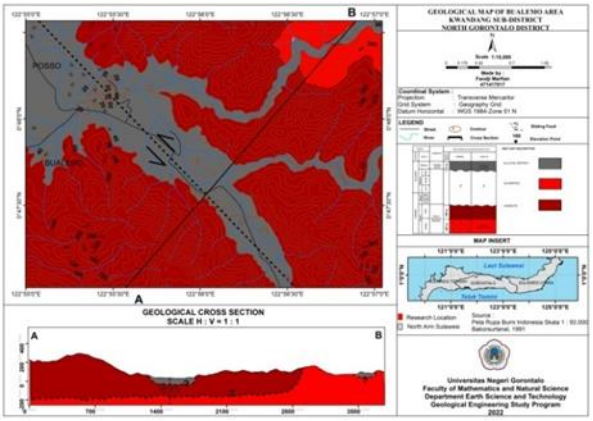

Fig. 3. Geological map of the research area

Altered andesite units covered 5% of the study area with a thickness of 200 meters. The lithology found in this unit is altered andesitic rock with brownish-gray, aphanitic, and holocrystalline rocks with massive properties. The mineral composition are divided into a small quantity of quartz, k feldspars, and plagioclase (Figure 4). This unit is included in the Bilungala Volcano Rock Formation (Tmbv) unit on the geological map of the Tilamuta sheet [11].

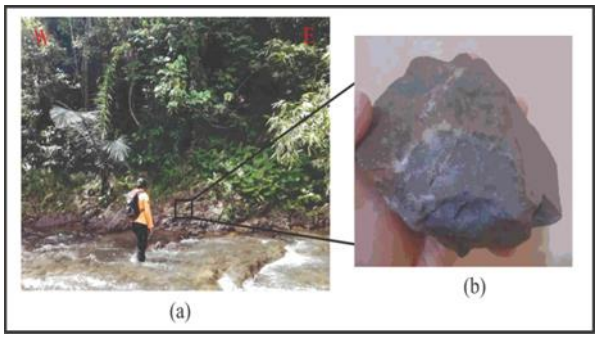

Fig. 4. Outcrop of altered andesite unit at the research area (a) and hand specimen of altered andesite rock sample (b)

The andesite unit covered 70% of the study area, with a thickness that can be seen on the map of 400 meters. The characteristics of the andesite are gray color, holocrystalline, massive with a mineral composition of plagioclase, pyroxene, and k-feldspar. This unit belongs to the Bilungala Volcano Rock Formation (Tmbv) on the geological map of the Tilamuta sheet [11].

The alluvial deposit unit covered 25% of the study area with a thickness of 75 meters. The lithology found in this unit is the result of rock weathering in the form of sand, gravel, cobbles, to lumps, and is not compact. This unit belongs to the Alluvium Formation (Qal) on the geological map of the Tilamuta sheet [11].

3.3 Petrography

This rock, with sample code St 3, is in a river area with an east-west direction with outcrops pointing south of the river. These rocks, when viewed megascopically, are rock conditions with a gray-brown color, with a fanatic texture.

Based on the results of petrographic analysis, this rock has a degree of holocrystalline crystallization, cumuloporphyritic, with phenocryst (25%) consisting of plagioclase (60%), k-feldspar (30%), and pyroxene (7%) (Figure 5). Pyroxene minerals are all present as phenocrysts, measuring 0.5-0.8 mm, in subhedral-anhedral form, measuring 0.5-1.5 mm, phenocrysts are starting to turn into secondary minerals, and some are present as relict minerals. The groundmass (75%) consists of predominant plagioclase and minor K-feldspar. The rock is Basaltic Andesite (Figure 6) [22].

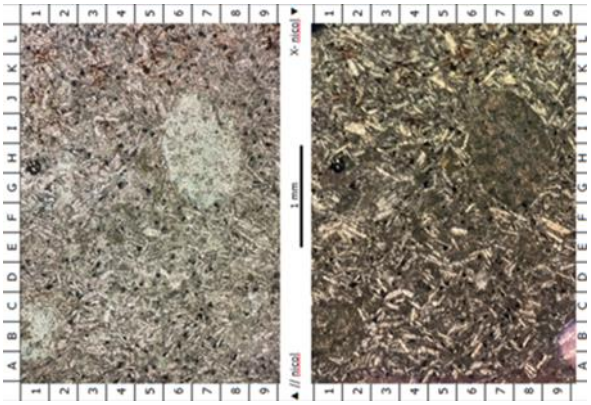

Fig 5. The appearance of petrographic incision based on cross Nikol and parallel Nikol at St 3

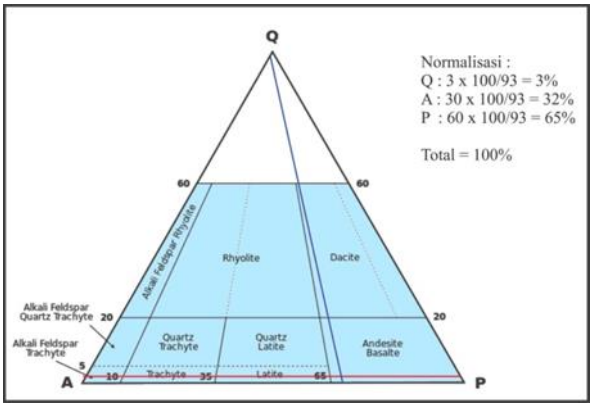

Fig 6. Plotting results at St 3 using the classification of volcanic rock from [18]

4 Conclusion

Based on research conducted by the geomorphology of the study area, there are two units, namely the volcanic hills unit and the alluvial plains unit. The stratigraphy of the study area is divided into 3 units, namely, altered andesitic units, andesite units, and alluvial deposit units. Volcanic rocks found in the study area are andesitic rocks with brownish-gray characteristics, porphyro aphanitic texture having a degree of holocrystalline crystallization, Qumulo porphyritic, with phenocryst (25%) consisting of plagioclase (60%), k-feldspar (30%), pyroxene (7%). Pyroxene minerals are all present as phenocrysts, measuring 0.5-0.8 mm, in subhedral-anhedral shape, measuring 0.5-1.5 mm, phenocrysts are starting to turn into secondary minerals, and some are present as relict minerals. The groundmass (75%) consists of predominant plagioclase and minor K-feldspar. The rock is Basaltic Andesite. The formation of alluvial deposits in the study area.

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