Journal of Geology & Exploration
Vol. 3, No. 1, June 2024 : 27 – 40
E-ISSN 2963-2869

Geology and Basalt Petrogenesis in The Amerrung Area Barru Regency South Sulawesi Province

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ABSTRACTS

The research location is in the Amerrung area, Barru Regency, South Sulawesi Province. This area is interesting to learn about the geology and petraceability of the basalt. This study aims to determine the geological conditions and petogenesis of the basalt. This study uses observation, field data collection and petrographic analysis. The geomorphology of the research area is composed of denudasional mountain geomorphological units and denudional steep mountain geomorphological units. The stratigraphy of the research area consists of 3 rock units from m to young rocks, namely porphyry basalt, basalt and volcanic breccia units. The developed geological structure is a combination of the Unsystematic and the Amerrung Inverted Fault. The excavation material consists of basalt and rocks mixed with sand. The geological history of the Amerrung area began during the Middle Miocene and eruptions were effusive. Basalt petrogenesis is formed from the presence of volcanic activity that is effusive in the form of basaltic lava flows that undergo a relatively fast freezing process and form basalt. Basalt is a member of the Tefrite Leussite Formation (Tmca) produced by lava and breccia. This formation has a Middle Miocene-Pliocene Age including the Camba Formation.

ARTICLE INFO
Article History:
Received 23 Feb 2024
Revised 26 Feb 2024
Accepted 11 Jun 2024
Available 30 Jun 2024

Keyword:
Amerrung; Petrogenesis; Basalt; Effusive, Camba Formation

https://doi.org/10.58227/jge.v3i1.167

INTRODUCTION

The current world of the mining industry in Indonesia is increasing and is a special attraction for investors to invest in the mining sector, both foreign and domestic investors (Aswadi, Husain, Gazali, & ..., 2022). The high investment interest in the mining sector has not been realized properly because there is still a limited number of geological data that is more accurate and complete and presented in the form of local geological potential information through detailed geological research on a scale of 1: 25,000 (S. Bakri et al., 2023). There is still limited geological information and the potential of rock excavation materials, which is the background for the author to conduct geological and basalt petrogenesa research in the Amerrung area, Barru Regency, South Sulawesi Province (Widianto et al., 2023). This study aims to determine geological conditions, namely geomorphology, rocks, geological structures, excavated materials, geological history and basalt petrogenesa in the Amerrung area (Nawir, Thamsi, & Agusriandi, 2023).

This research includes a study of geology and basalt petrogenesis in the Amerrung area, Barru Regency, South Sulawesi Province. The main focus of this research is to understand the formation processes of basalt rocks and the geological characteristics of the area. The Amerrung area in Barru Regency is known for its complex and diverse geological formations (Wakila et al., 2023). The basalt rocks in this area are an important part of the regional geological history and provide insights into past volcanic activities. This study will include petrographic, geochemical, and geochronological analyses to identify the formation processes and evolution of basalt rocks (Nawir, Thamsi, & MH, 2023; Thamsi et al., 2023).

This research will provide an overview of the geological conditions in the Amerrung area, including geological structures, rock types, and geological history. The analysis of basalt petrogenesis

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will help identify the magma source, formation conditions, and magmatic evolution that occurred in this area (Faruqi et al., 2023).

Although there have been several previous studies on the geology and basalt petrogenesis in South Sulawesi, there is still a lack of specific data regarding the Amerrung area. This research aims to fill this gap by providing new data and a more in-depth analysis of the basalt rocks in this area (Winahyu et al., 2023). The uniqueness of this research lies in its comprehensive approach to studying basalt rocks in the Amerrung area. By combining various geological and petrogenesis analysis methods, this research is expected to provide new insights into the formation processes of basalt rocks and their contribution to the understanding of regional geology (Firdaus et al., 2024).

The main objectives of this research are to Identify and characterize basalt rocks in the Amerrung area. Analyze the petrogenesis processes that occurred in the formation of basalt rocks. Provide geological data that can be used for further studies and regional development. Contribute new knowledge about the geology and basalt petrogenesis in South Sulawesi.

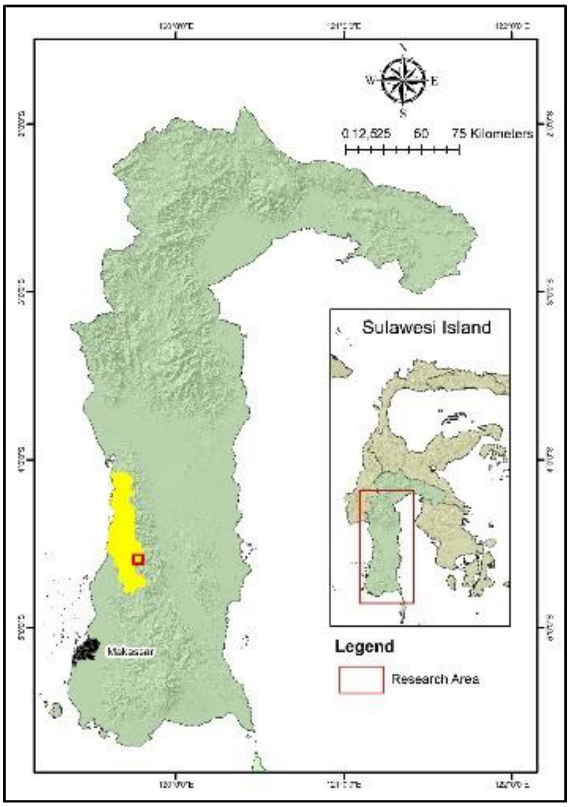

Figure 1. Map of the research location

Regional Geology

The regional geomorphology of the study area is found in two rows of mountains that extend almost parallel, in the north-northwest direction and separated by the Walanae River valley. The mountains in the western part occupy almost half of the area, widening in the south and narrowing in the north with an average altitude of 1500 meters. Its formation is mostly in the form of volcanic rocks and limestone. The mountains in the eastern part are narrower and lower, the average peak height is 700 meters. Its formation is mostly in the form of volcanic rocks. The Walanae Valley that separates the two mountains in the northern part is wider than in the southern part. In the middle of the valley is the Walanae River which flows north. In the southern part in the form of low hills and in the northern part in the form of alluvial plains (Sukamto, 1982).

The stratigraphy of the Amerrung district is included in the TMCA (Leusite Tefrit). Tmca is composed of basalt in the parallel of G. Gatarang which is surrounded by a circular cliff resembling a caldera and also in several other places, characterized by an overflow of leucite content (Sukamto, 1982). The geological structure began at the end of the Early Miocene volcanic activity followed by tectonics that led to the beginning of the Walanae Formation which later became the basin where the Walanae Formation was formed. This event most likely dates back to the beginning of the Middle Miocene and declined slowly during sedimentation until the Pliocene. The decline of the Walanae fault

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is limited by two normal fault systems, namely the Walanae fault which is entirely visible until now in the east and the Soppeng fault which is only exposed discontinuously in the west. During the formation of the Walanae terban, in the east volcanic activity occurred only in the southern part while in the west there was almost even volcanic activity from south to north, taking place from the Middle Miocene to the Pliocene. The main north-northwest fault occurs from the Middle Miocene and grows until after the Pliocene. A large fold that is almost parallel to the main fault is thought to have formed in connection with the presence of horizontal pressure in the direction approximately east-west at the time before the end of the Pliocene.

METHODS

Field Data Collection

Comprehensive field data collection was carried out at each rock outcrop in the study area. This process includes several important steps:

1. Geomorphological Observations: Observing the surface features and geomorphological characteristics of the Amerrung area. This includes analyzing topography, river flow patterns, and other landforms that can provide clues about past geological processes.
2. Lithological Type Observations: Identifying and recording the types of rocks found at each outcrop. This involves visual observation and detailed descriptions of the color, texture, and structure of the rocks.
3. Geological Structures: Observing and recording geological structures such as folds, faults, and joints present in the outcrops. These structures provide important information about geological deformation and the tectonic history of the area.
4. Outcrop Dimensions: Measuring the dimensions of the rock outcrops, including length, width, and height (Nawir, Thamsi, Sanjaya, et al., 2023). This data is crucial for understanding the scale and distribution of basalt rocks in the study area.
5. Presence of Basalt Rocks: Identifying and recording the presence of basalt rocks at each outcrop. This includes observing the physical characteristics of the basalt rocks such as color, texture, and mineralogy.

Petrographic Analysis

Petrographic analysis is conducted to determine the mineral composition and texture of the basalt rocks. The steps in petrographic analysis include:

1. Sample Preparation: Collecting basalt rock samples from the field and preparing them for laboratory analysis. The samples are cut into thin sections that can be observed under a petrographic microscope.
2. Microscopic Observation: Using a petrographic microscope to observe the thin sections of the rocks. This observation includes identifying minerals, analyzing textures, and determining the relationships between minerals in the rocks.
3. Mineral Composition: Determining the mineral composition of the basalt rocks. This involves identifying the main and accessory minerals and conducting quantitative analysis to determine the percentage of each mineral.
4. Rock Texture: Analyzing the texture of the rocks, including grain size, grain shape, and the relationships between grains. The texture of the rocks provides information about the formation conditions and thermal history of the basalt rocks.

With these detailed research methods, it is expected to obtain a comprehensive understanding of the geology and basalt petrogenesis in the Amerrung area. The collected data will provide new insights into the formation processes of basalt rocks and their contribution to the understanding of regional geology in South Sulawesi (Aswadi, Husain, Gazali, & Thamsi, 2022; H. Bakri et al., 2023).

RESULTS AND DISCUSSION

Geology of the Amerrung area

The Amerrung area is composed of 2 geomorphological units, namely the denusemial geomorphological mountain unit and the denustrational steep mountain unit. The denudational mountain geomorphological unit occupies about 80% of the entire study area with an area of 24,481 km2. This geomorphological unit stretches from north to south. It has an altitude of 375 meters above sea level.

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Figure 2. The appearance of the denudational mountains (x) in the photo to the east (N 110ºE)

The morphogenous processes that act on this landscape unit are structurally influenced by the denudional process. The dominant geomorphological processes in this unit are destructively dominated by weathering and erosion activities that work on the research area. The erosion found in this geomorphological unit is surface erosion in the form of rill erosion and gully erosion. Rill erosion or groove erosion is an erosion process that occurs on the soil surface (terranean) caused by the work of water in the form of grooves with a size of less than 30 cm while gully erosion or trench erosion is erosion formed in the form of small channels with a depth of 0.3 m and a width of 0.3 m (Thornbury, 1954).
The process of soil movement that can be found is in the form of debris slides. The process of soil movement is mostly found in relatively steep slope areas. This is because in areas with steep slopes, the slope of the slope will be even greater. With the increase in slope slope, weathering, erosion, and soil movement occur.

Figure 3. The appearance of the denudational mountains is debris slide (x) in the photo to the east (N 110ºE)

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The geomorphological unit of the mountains is sharply cut by denudational and has a mountainous topography that has a height difference of 500 - 1000 meters. In this geomorphological attachment it is marked with a dark brown color. Based on the morphographic approach in general, the topographic appearance of this unit is depicted by a very tight contour shape, with the apical shape of the letter "V" shape.

Figure 4. The appearance of the mountains sharply cut by the denudational (x) photographed to the east (N130ºE)

And there are also rivers with point bars in adult rivers which are genetic types of insequent rivers in volcanic breccia rock units with a river flow direction of N 335◦E and a picture direction of N 10°E. The type of river includes the type of periodic river, where during the rainy season the water is abundant while during the dry season the water decreases. The river flow pattern is the merger of several interconnected river individuals to form a pattern in the unity of space (Thornbury, 1969). The development of river flow patterns in the study area is controlled by factors such as slope slope, structural control, geomorphology of a basin river flow pattern, vegetation and climatic conditions. Based on the classification of river flow patterns according to Thornbury (1954) and the results of topographic map interpretation, the river flow patterns that develop in the research area are dendritic flow patterns.

The dendritic flow pattern is characterized by flow branches that resemble lines in the leaf cross-section. Basically, the flow pattern is controlled by homogeneous lithology. Where the flow pattern of this river is characterized by a flow structure that is controlled by the type of rock. The genetic type of rivers that develop in the research area is the insequent genetic type. The genetic type of insequent rivers is characterized by the direction of river flow that is not controlled by the position of the rocks around the research area and the lithology that constitutes the research area that the river passes through is igneous rocks.

The determination of river stadia is based on the appearance of the river valley profile, river flow patterns, types of erosion, and sedimentation that work along the river. Each river stadia has its own characteristics and characteristics. The river stadia consists of young stadia, adult stadia and old stadia (Lobeck (1939). Based on the research area, it provides an overview of the shape of the Muda river towards adulthood whose river profile is in the shape of the letter "V". The naming of rock units in the research area is based on informal lithostratigraphy which is juxtaposed with physical characteristics that can be observed in the field, including rock types, combinations of rock types, uniformity of lithological symptoms of rocks and other symptoms of rock bodies in the field, and can be mapped on a scale of 1 : 25,000. Based on unofficial lithostratigraphy, the rock units in the Amerrung area are sorted from the youngest to the oldest, namely volcanic breccia units, basalt units and porphyry basal units.

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This porphyry basal unit was revealed in the southern and western parts of the research area, namely in the southern area in the Tellu Limpoe area and in the western part in the Pujananting part. The determination of the thickness of this unit cannot be determined on the basis of interpretation because this unit is a igneous rock whose lower limit cannot be determined in the field. The appearance of the field of porphyry basalt in a fresh state is black and weathered in a blackish-brown state, the texture of hypoclistalin clastality, porphyroafanitic granularity, with the form of anhedral-subendral minerals, generally composed of olivine minerals, plagioclases, pyroxene and opak minerals and contains a chemical composition that is silica.

Figure 5. Appearance of point bar on the Ampiri river

Figure 6. Appearance of the periodic river type (x) photographed with the flow direction N 335ºE to the north (N 10ºE)

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Figure 7. The appearance of the river flow direction to the basalt showing the genetic type of insequent with a flow direction of N 260ºE in the photo to the north (N 360ºE).

Figure 8. Porphyry basal outcrop in the northwest photo (N 350ºE)

Petrographically, porphyry basal in the study area generally showed brownish-yellow absorption color, blackish-gray interference color, anhedral-subendral mineral form, mineral composition consisting of pyroxene (17%), bitownite (12%), opak minerals (7%), plagioclase microliths (12%), quartz (11%), augite minerals (5%) and base masses (13%) with Mineral size <0.02 mm - < 1.2 mm.

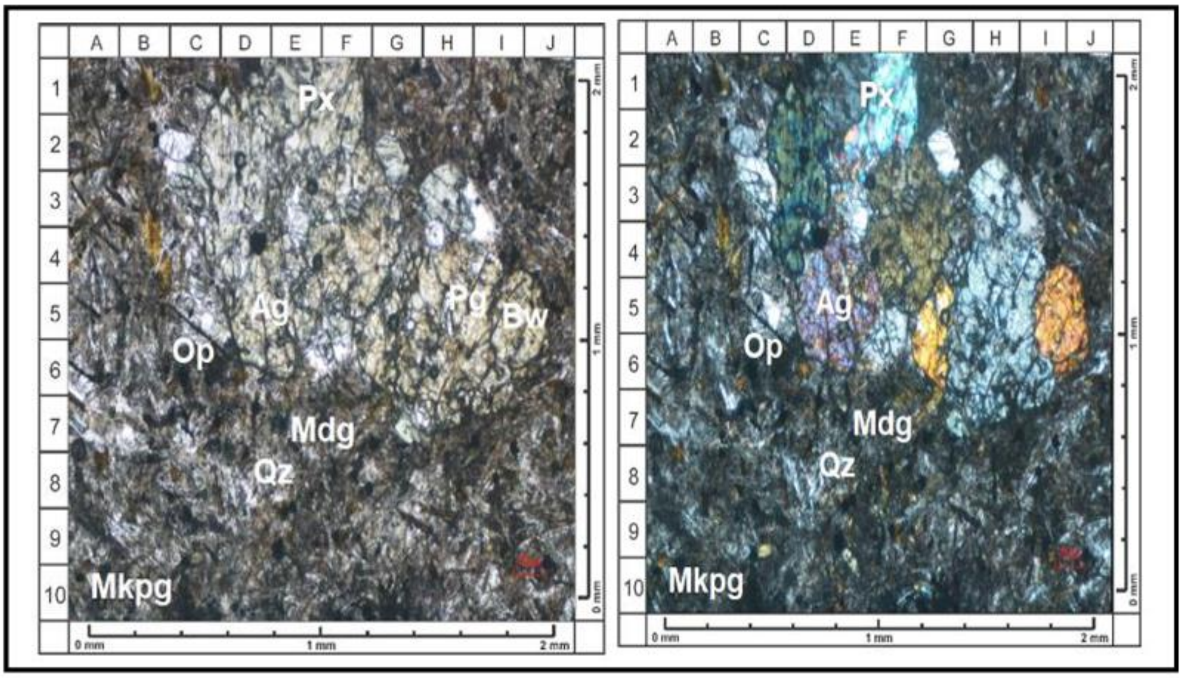

Figure 9 Appearance of porphyry basal petrography with sample code ST 23/VIO/BB on parallel nickel (a) and on cross nickel (b) showing the minerals pyroxene (Px), augite (Ag), plagioclase (Pl), opaq (opq), bitowite (bw), quartz (Ku), plagioclase microlith (Mkpg), and glass base mass (Mdg).

The basal unit occupies about 70% of the total area of the research area. This unit is spread across almost all research areas, namely the Northern to Southern regions, and also the Western part of the research area. Spectacularly, the basalt units found in the study area in fresh conditions showed physical characteristics of blackish-gray and brownish-weathered conditions, hypocriptic crystallinity texture, aphanitic to fanatical granularity, subhedral to prismatic crystal form, composed of plagioclase minerals, opaq minerals, pyroxene and base glass mass. In some places, basalt in this unit is found pillow lava.

Petrographically, the basal unit shows brownish-yellow absorption color, blackish-gray interference color, degree of crystallization of holocrystalline with intercentral special texture, fine moderate faneric granularity, euhedral-subhedral mineral form mineral size ≤1.12 mm, mineral composition of plagioclase (20%), opak minerals (19%), pyroxene (17%), base mass (21%), olivine (14%) and quartz (9%). Volcanic breccia units occupy about 20% of the total area of the study area. This unit is revealed in the northern and western parts where in the northern part it is revealed in the Attimpangnge area and the western part of the Bacu-Bacu area.

The appearance of volcanic breccia in a fresh condition is reddish-brown in a weathered condition of blackish-brown, with porphyritic, massive structure, the size of the grains of shells, the material composition consists of fragments, matrices, tuff and silica cement. The fragment, which consists of andesite fragments and andesite lava, has a medium-coarse sand-sized matrix. There is a cavity that is interpreted as a vesicular structure, a structure of former holes that form irregular circles that occur on top of the outer igneous rock that comes from relatively dilute lava and does not flow quickly. In rocks, hornblende in vision is almost similar to pyroxene minerals, the difference between the two is in its luster, in minerlal hornblende is charcoal gloss while in pyroxene minerals it is glass gloss.

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Figure 10. Basalt outcrop in the north-southwest photo (N20ºE)

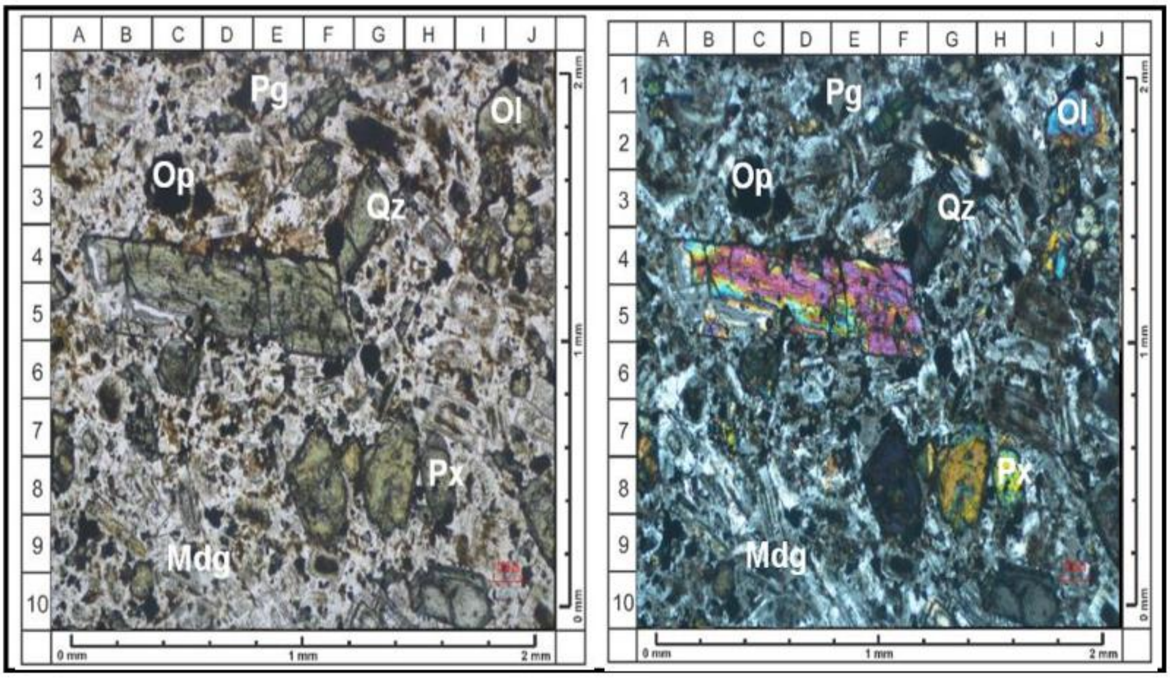

Figure 11. The appearance of basal petrographic in the ST/24/Vio/BB incision on aligned nickel (a) and cross nickel (b) shows mineral content consisting of Plagioclase (Pl), Olivine (Olv), Pyroxene (Px), Opak (Op) and the bottom mass of glass (Mdg).

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Figure 12. Volcanic breccia outcrop photographed westward (N 275ºE)

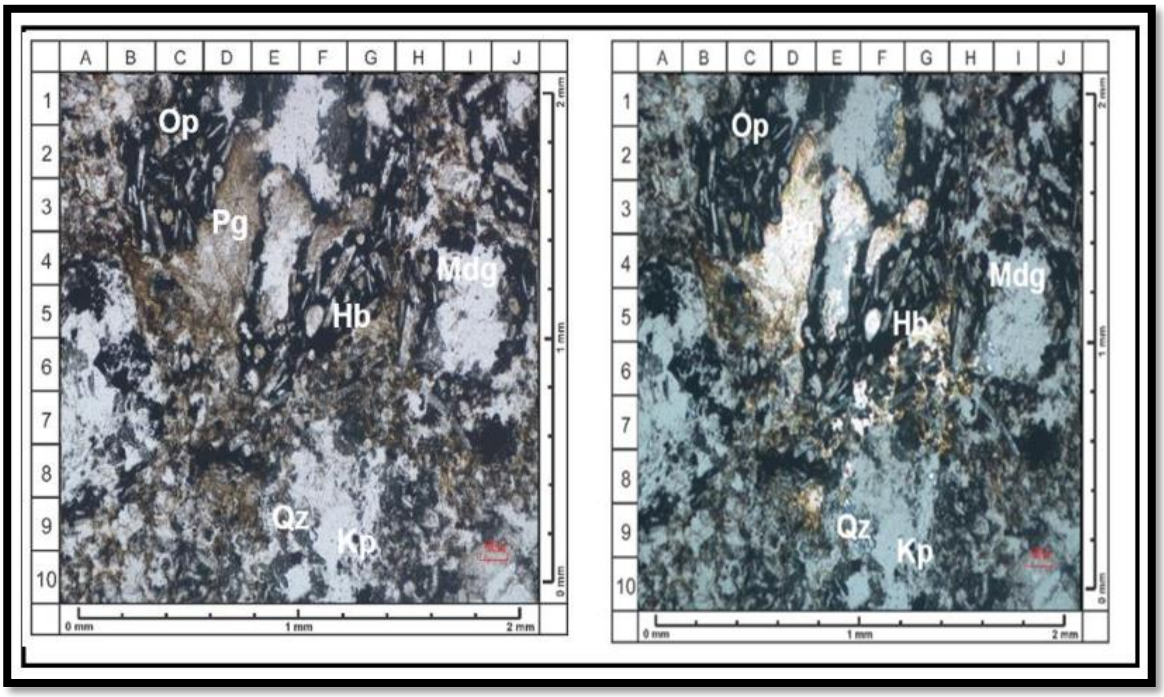

Figure 13. Petrographic appearance of volcanic breccia showing cross nicol (a) and parallel nicol (b)

Petrographically, volcanic breccia shows a brownish-yellow absorption color, a brownish-gray interference color. It has a texture in the form of grain size. The geological structure of the Amerrung area is characterized by rocks cracked by fine cracks known as burly. The type of burly found is unsystematic burly. Unsystematic burly is irregular burly and generally does not cut other burly people. Based on the genetic type, the burly is a shear joint that is formed due to pressure. Non-systematic burly research areas are found in Basalt lithology and volcanic breccia.

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Figure 14. Stout structure with a stout system showing an unsystematic tendency in the Basalt outcrop with photo direction N 140°E

The Reserve Ampiri Fault is a local fault located in the Amerrung area. This fault is relatively extended from northeast to south. The primary and secondary characteristics found in the field in identifying the existence of the structure are fault breccia with the composition of fragments and matrices that undergo displacement, fault reconstruction from the direction of the stress force of the sturdy processing and contour differences in the topographic map.

Based on the main stress pattern of structural data processing, the fault formed is an upward fault.This upward fault is in the western valley area of the research area. The determination of the age of the formation of a sliding fault in the study area is based on the age of the rock unit that the uplift fault passes. The rock unit that is passed by this uplift fault is a volcanic breccia unit of Middle Miocene - Pliocene age, so it can be concluded that the age of the formation of the Ampiri uplift fault is the Middle Miocene.

Petrogenesis Basal

Basalt is a type of volcanic rock formed from the compaction of molten lava. Basalt is igneous rock, meaning that it is formed through the cooling and compaction of magma or lava. Basalt is one of the most common types of rocks on earth. Basalt is known for its dark color, typically ranging from black to dark gray, and its fine-grained texture. Basalt is mostly composed of minerals such as pyroxene, plagioclases, and sometimes olivine.Spectacularly holohyaline crystallinity, aphanitic to fanatical granularity. It has small crystals formed due to the rapid cooling process. The form of subhedral to prismatic minerals with uniformity between grains has a porphyroafanitic inequigranular relationship. The mineral composition observed is pyroxene, plagioclase, opax minerals, and base masses. Pillow lava with a basalt composition was originally a high-temperature molten magma (1,100°C – 1,200°C) according to O. Horikawa (1980) which came out effectively from a volcanic eruption and froze quickly due to exposure to water, both under the sea and in other water bodies such as lakes. Rapid cooling on all sides of the lava due to the presence of water forms the lava body. As it becomes cold and brittle, lava contracts and releases stress that then forms cracks. The fracture produces a polygonal pattern that extends through the lava flow.

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Figure 15. Basalt outcrop photographed to the southwest (N 225°E)

Petrographically, the basal shows the composition of plagioclast, opak minerals, glass base mass, biotites, and ilmenites. Where there are biotite minerals that are formed due to magmatic, metamorphic, and also hydrothermal processes, these bioty minerals come from hornblende and pyroxene which have been further altered to have a form of subhedral minerals most of which have been converted into chlorite. There is an ilmenite mineral where this mineral is formed from high oxidation results which has the form of anhedral minerals, this mineral is associated with the minerals hematite and pyrite.

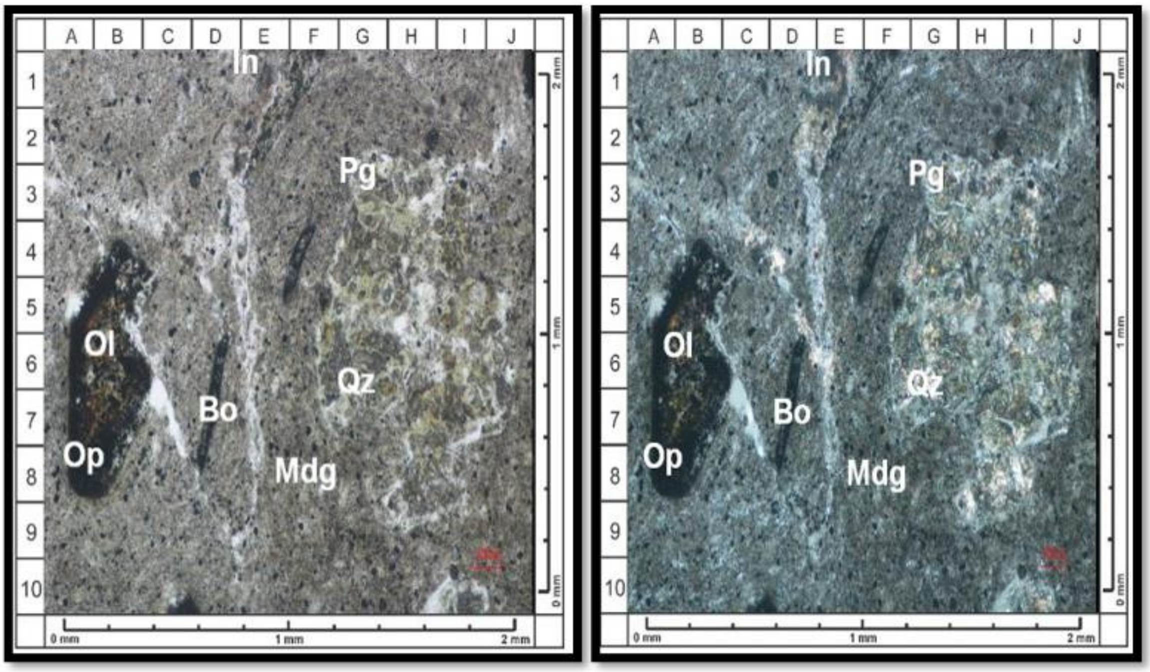

Figure 16. The appearance is petrographically showing the mineral content of Plagioclase (Pg), Biotite (Bo), Olivine (Ol), Opak Mineral (Op). Quartz (Qz) and Glass base (Mdg)

Petrographically through the classification of Clan William, 1954 and Streckeisen, 1976 based on mineral composition, it can be interpreted that the name of the rock in the study area is Basal. Basalt rocks in the study area are the result of effusive volcanic activity where the material released is in the form of basaltic lavaflows that undergo a relatively fast freezing process and form basal units. The basalt unit is a member of the Leusite Tefrite Formation (Tmca) produced by lava and breccia. This formation has a Middle Miocene-Pleistocene age. This formation is a member of the Camba Formation. The results of the observation of petrogafi show the presence of biotite as an indication of being formed due to the process of volcanism.

CONCLUSION

Based on observations, field data collection and petrographic analysis, it can be concluded that the Amerrung area is composed of denudional mountain geomorphological units and denudional mountain geomorphological units and denudional sharply cut mountain geomorphological units. It is composed of 3 (three) units based on unofficial lithostratigraphy compiled by the young chairman, namely the volcanic breccia unit, the basal unit, and the porphyry basal unit. The geological structure of the Amerrung area is unsystematic and the Ampiri reserve fault. d. The potential of excavation materials contained in the research area is basalt excavation materials and sand rock excavation materials. The geological history of the Amerrung area began during the Middle Miocene and eruptions were effusive and exploratory. Basal petrogenesis in the Amerrung area is formed from the presence of volcanic activity that is effusive where the material released is in the form of basaltic lava flows that undergo a relatively fast freezing process and form basal units.

ACKNOWLEDGMENT

The author would like to express his gratitude and highest appreciation to the head of the geological engineering study program, faculty of engineering, university for his permission and support in carrying out and completing research in the Amerrung area, Barru Regency, South Sulawesi Province.

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