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The landscape formation history based on the detailed geological investigation in Aribaya and surrounding area, Pangetan district, Banjarnegara regency, Central Java

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Abstract
The research site is in the Aribaya area and surrounding areas with an area of 16 km^2 which is administratively included in Pagentan Subdistrict, Banjarnegara Regency, Central Java Province. The research area consists of 13 villages, namely: Suwidak, Pandansari, Karangtengah, Gumingsir, Karangnangka, Aribaya, Larangan, Talunamba, Clapar, Gununggiana, Pakelen, and Nagasari. Research objects in the form of Geomorphology, Stratigraphy, Geological Structure, Geological History, and Geological Potential. The geomorphology of the research area is divided into the Aribaya Fault Zone Unit, Gununnggiana Lava Flow Ridge Unit, and Aribaya Intrusion Unit. Based on unofficial lithostratigraphic units, the research area is divided into three rock units and the order from old to young, namely: Sandstone - Claystone Distribution Unit, Pyroclastic Brection Unit, and Diorit Intrusion Unit. Precipitated Sandstone - Claystone In the middle-upper neritic bathymetry environment, which belongs to the formation of the early Miocene – Middle-aged vines. Furthermore, tectonic activity occurs that causes the research area to form faults and syncline folds. Then at the time of the Early Pliocene, there was an influence from the activity of Mount Maung which provided sediment supply in the form of andesite fragments and matrix-sized Tuff Crystals so as to form a pyroclastic breccia unit. At the Time of the Pliocene, there was also diorite intrusion. The next process is the exogenous process that causes morphological form as it is today. The geological potential contained in the research area in the form of diorite mining excavations (positive potential) and landslide movement (negative potential) is quite a lot in the research area.

1. Introduction

Geological mapping is a research method carried out by a geologist in order to obtain data such as geomorphology, stratigraphy, geological structures, and other geological aspects so that there are some places whose geological conditions have not been detailed. Aribaya and its surroundings are part of Banjarnegara Regency. This area is composed of vines, Totogan, tread, and diorite intrusive rock formations. Then, from the appearance of the geological map, it was found that there was the activity of geological structures. As an academic, this attracted the author to conduct research in the area. The previous research has revealed a huge scale (1:100,000) of the geological mapping that is not possible to figure out the detailed geological conditions. This research is going to reveal the detailed scale of its geological condition (1:25,000), including the stratigraphic, petrology, dating, paleoenvironment, and concluded by a model of geological history.

2. Methodology

In this study, it begins with a preliminary study in the form of collecting through literature reviews and reports of previous research results, then data collection in the field in the form of data, after that an analysis of the data taken in the field is carried out in the form of geomorphological analysis, stratigraphic analysis, petrographic analysis, geological structure analysis, analysis of micropaleontology.

3. Results

3.1. Geomorphology of the research area

The Aribaya area and its surroundings have different lithological properties, control of geological structures, and weathering which causes this area to have a unique roman form. The shape of the earth's surface that exists today is the result of processes that occurred in the past, both endogenously and exogenously. The Aribaya area and its surroundings are generally valleys to hilly areas with medium to very dense density. The rivers in the research area are rivers with young to mature stadia with V to U valley shapes that flow following the slopes of the existing hills and generally flow relatively from North to South. The research area in the north to the southwest to the west is the Gununggiana Lava Ridge Unit, in the middle to the southeast is the Aribaya Intrusion Hills Unit, and in the south to the north to the northwest is the Aribaya Fault Zone [1].

3.1.1. Research Area River Flow Pattern

The river flow in the research area has two main rivers which are also divided into two watersheds, namely the Mrawu River in DAS 1 in the north and the Sibebek River in DAS 2. The pattern of river flow in the study area is based on its nature, there are intermittent/episodic rivers. quite a lot, located on steep slopes and flowing towards the main river. This episodic river only flows during the rainy season and is dry during the dry season. There are also periodic rivers with large volumes of water during the rainy season but little during the dry season (Figure 1).

Figure 2. The appearance of young (a) and old (b) stadia rivers in the study area Viewed from the flow pattern according to [2], the flow patterns found in the study area are subparallel and rectangular flow patterns. Parallel flow patterns are formed on slope morphology with uniform slope. This pattern indicates a fault crossing the area and a steep slope. The flow pattern is in the intercalated sandstone-claystone unit and the volcanic breccia unit, dominant in young stadia intermittent rivers with a V-shaped valley and is also influenced by the control of the dextral fault structure in the area.

Subsequent river genetic type is characterized by a river that flows in the direction of the rock layers. This type of river is located in the middle of the research area, which is in a tributary of the Mrawu River, Nagasari Village, Pagentan District, Banjarnegara Regency. The lithology found in the area is an alternation of claystone and sandstone, see figure 2 (c).

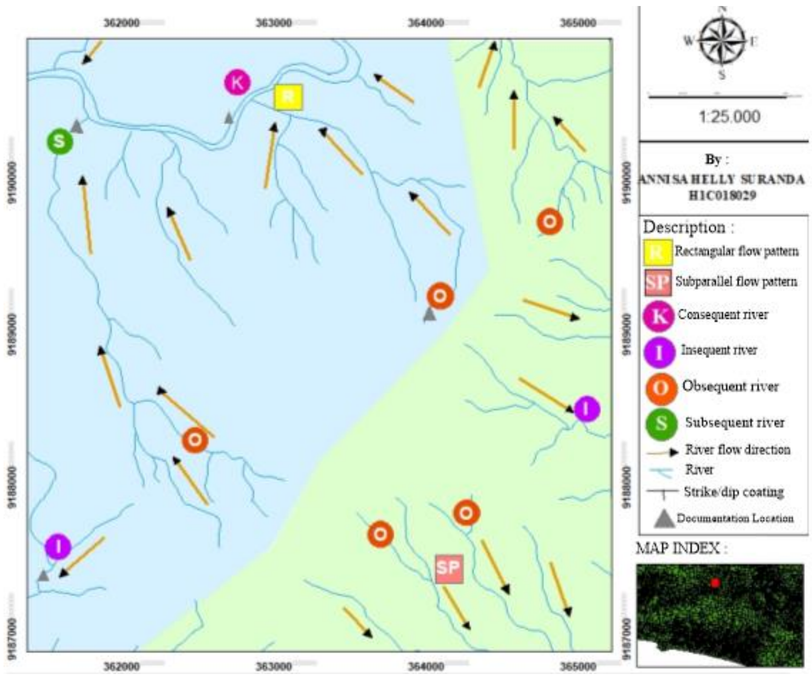

Figure 1. Map of Flow Patterns, Genetic Types and Watershed Division of Aribaya and Surrounding Areas

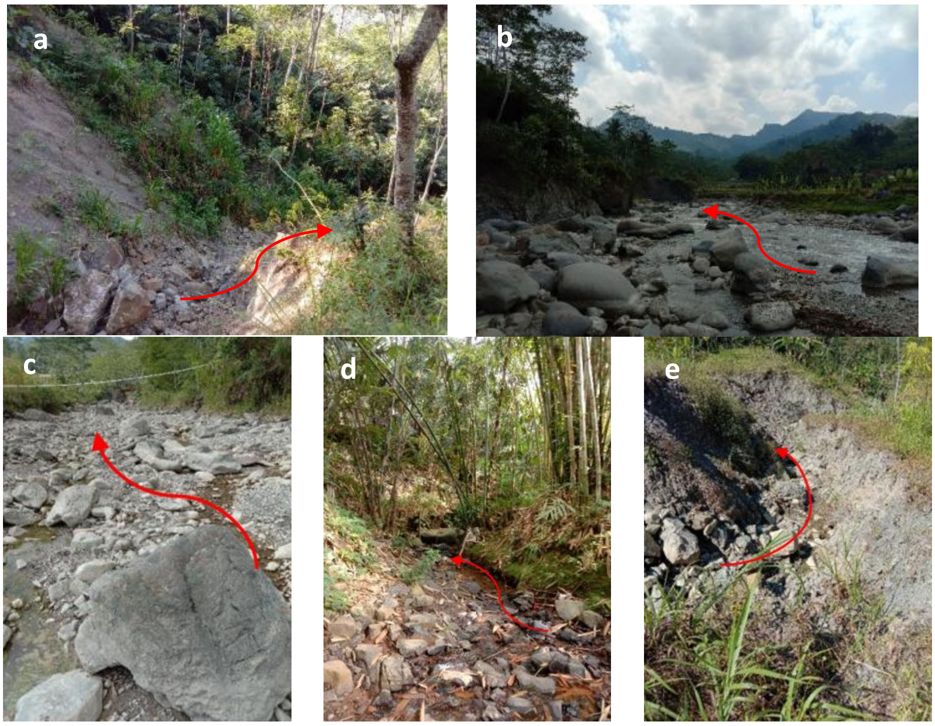

Figure 2. (a) The field look of the young rive, (b) the old river as consequent genetic river, (c) the subsequent river, (d) the obsequent river, (e) the insequent river.

The obsequent River Genetic Type is characterized by rivers flowing in the opposite direction to the direction of the slope of the rock bed. Rivers of this type are found in the Cilemeuh River, Cillopadang Village and Cijati Village, Majenang District, Cilacap Regency. The lithology found in the area is an alternation of sandstone with claystone and volcanic breccias, see figure 2 (d).

The consequent river genetic type is characterized by rivers that flow in the direction of the slope of the rock layers. One of them is found on the Mrawu River in Nagasari, Suwidak, and Pandansari Villages, Wanayasa District, Banjarnegara Regency. The lithology that develops in the area is an interspersed with claystone and sandstone, see figure 2 (b). The insequent river genetic type is a type of river flow that follows a flow where the slope is not controlled by the original slope factor, see figure 2 €.

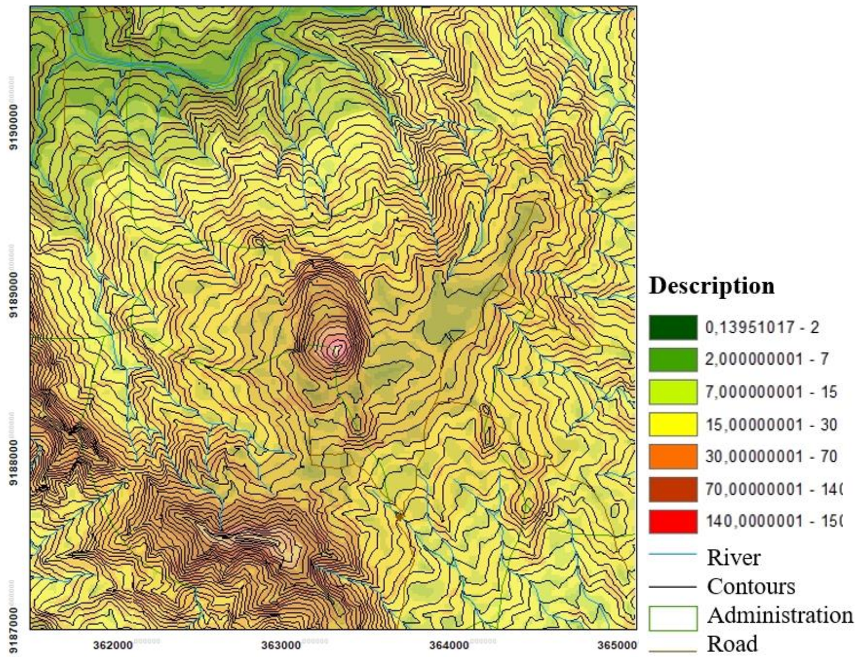

Figure 3. Map of the percentage slope of Aribaya and surrounding areas

3.1.2. Slope percentage

Based on the Percent Slope Map of the Cilopadang area and its surroundings, the area has a flat to the very steep slope, this is based on the slope percent classifications [3]. Areas with percentage values of flat to moderately steep slopes are generally found in the north and northwest of the map. Meanwhile, areas with steep to very steep slope percent values are found in the southwest part of the map to the west see figure 3.

3.1.3. Geomorphologic unit

Based on the principle of the division of geomorphological units, the research area is divided into three geomorphological units, namely the Airbaya Intrusion Hills Unit, which has an altitude of 787 masl to 1150 masl with a dominant slope of steep to very steep. The next is the Aribaya Fault Zone Ridge Unit which has a height of 487 masl to 825 masl, with the dominance of a fairly dense contour density and controlled by the structure in the unit. And the last one is the Gununggiana Lava Ridge Unit with a contour height of 537 masl to 937 masl, dominated by steep slope percent. The division of the geomorphological state of the research area can be described through the Geomorphological Map of the Aribaya and Surrounding Areas, see figure 4.

Aribaya *i*ntrusion *h*ills *u*nit, the morphology seen in this unit is hills with steep to very steep slopes with an average slope percent of around 30 - 140% with relatively tight contours. The topographical height of this unit is 787 masl to 1150 masl with an altitude difference of 363 meters. It is called the Aribaya Intrusion Hills Unit because this unit was formed as a result of an intrusive magmatism process resulting in intrusion hills [2]. In this unit, there is a pattern of sub-dendritic river flow, the genetic type of the river is obsequent and inconsistent, in the form of periodic rivers and intermittent rivers with young to mature stadia which have a V to U shaped river valley. very high, so the area is used as a mining area for C, see figure 5.

Aribaya fault zone ridge unit covers 60% of the research area, located in the middle of the northwest-southeast direction of the study area. It is called the ridge fault zone because this unit is controlled by endogenous processes where the Gumingsir Normal Fault is formed, see figure 5.

Gununggiana Lava Ridge Unit covers 25% of the total area of the study area, located in the southwestern part of the west-south direction of the study area. This unit is marked with brown color on the Geomorphological Map of Aribaya and Surrounding Regions, Pagentan District, Banjarnegara Regency, Central Java Province. It is called a lava flow ridge because this unit is controlled by endogenous processes where volcanism is formed, see figure 5.

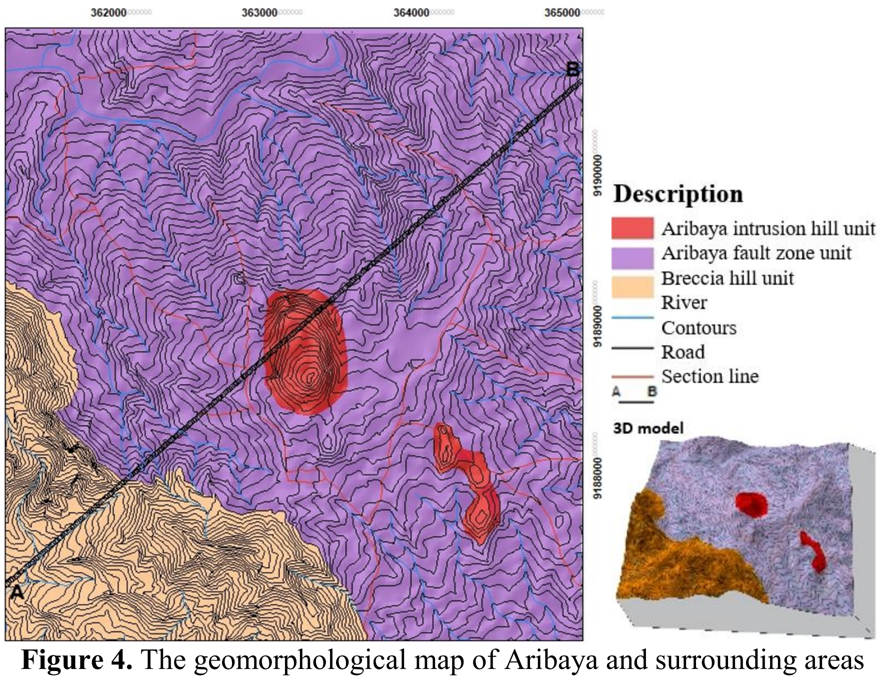

Figure 4. The geomorphological map of Aribaya and surrounding areas

Figure 5. The appearance of Aribaya intrusion hill (left), The Aribaya fault zone ridge (center), the Gununggiana lava ridge (right)

In this unit there is a subparallel river flow pattern, the genetic type of the river is inconsistent consisting of periodic rivers with young river stadia that have a V-shaped river valley. The lithology of this unit is in the form of volcanic breccias with moderate resistance levels so that the area is used as a plantation area. pine.

3.2. Stratigraphy of Research Area

In the study area, it is divided into 3 rock units based on the law of superposition [4] with the youngest in order, namely the diorite intrusion, the alternating unit of claystone - sandstone, and the volcanic breccia unit (figure 6). The grouping of these rock units is based on the lithological characteristics found in the study area. These characteristics can be in the form of lithological types and variations, the presence of sedimentary structures, fossils, the presence of minerals that characterize other rock units, stratigraphic patterns, and arrangements.

3.2.1. The alternating rock unit of claystone-sandstone

This rock unit occupies 60% of the research area. The Alternating Unit of Claystone with Sandstone is a rock unit in the form of claystone lithology alternating with sandstone, and quartz vein material was also found. Judging from the stratigraphic column based on the results of the reconstruction of geological incisions from the Geological Map of the Aribaya and Surrounding Regions, the thickness of the interspersed unit of sandstone and claystone is ± 650 m.

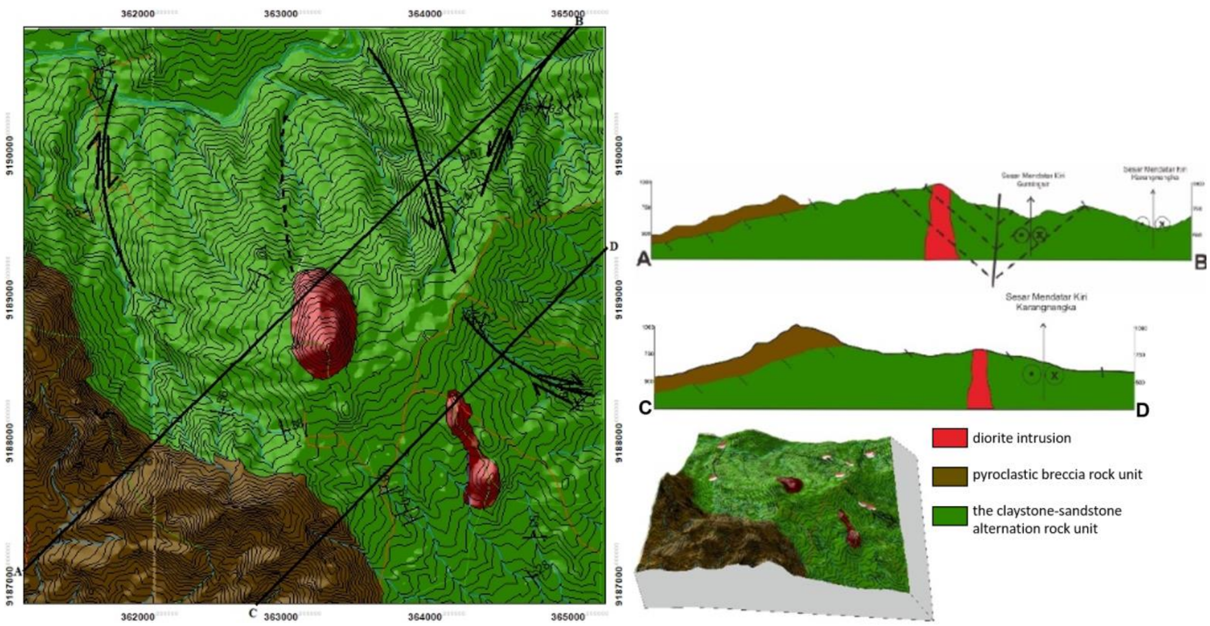

Figure 6. The geological map of Aribaya and the surrounding areas

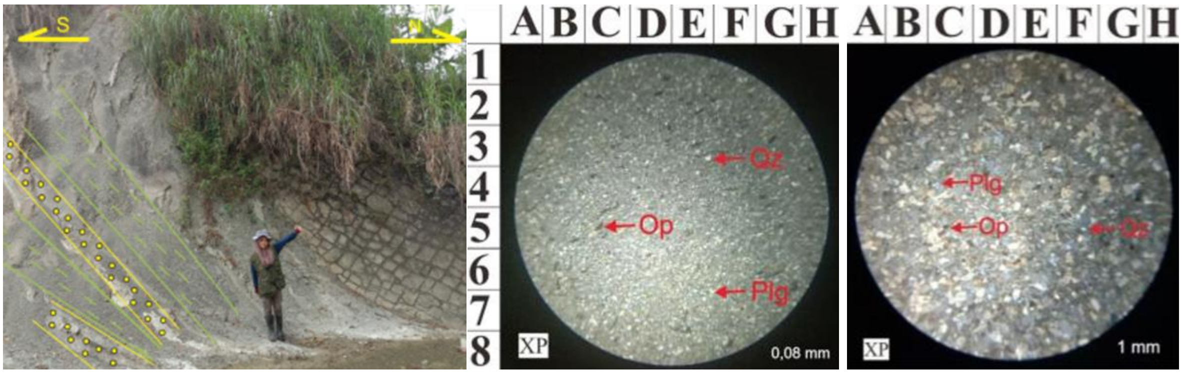

Figure 7. The outcrop photo of the rock unit (left), the thin section image of the claystone sample (middle), and sandstone (right)

The claystone lithology contained in this unit has physical characteristics of a light gray color, clay grain size, moderate to strong carbonate nature with a thickness of about 4 – 240 cm in the field. Claystone lithology has a mineralogy description of 10% Fragment (quartz, plagioclase, opaque minerals), 85% matrix, 5% cement. Based on [5], [6] the name of this stone is "Mudrock".

The sandstone lithology in the form of quartz vein material contained in this unit has the physical characteristics of a carbonated white color with a thickness of about 7-14 cm in the field, grain size of fine sand to medium sand, packed closed, good grain selection, moderate to strong carbonate with sedimentary structures in the form of parallel lamination, flute cast, massive structure, with a thickness of ± 4-240 cm in the field. The sandstone lithology has a mineralogy description of Fragment 45% (quartz, plagioclase, lithic, opaque minerals), Matrix 35%, cement 5%. Based on [5], [6] the name of this stone is "Quartz Wacke".

Based on the micropaleontological analysis in this unit, benthic foraminifera fossils were found, namely Robulus sp, Nodosaria sp, Amphistegina lessonii, Dentalina sp, which characterize the depositional environment [4]. The analysis to determine the relative age used fossils from the foraminifera phylum belonging to the planktonic foraminifera group based on age zoning. The range according to Bolli, et al (1985). In rock samples A.N 7.10, A.N 6.10 Blp, A.N 1.7 Blp, in the lower claystone-sandstone unit the Age is N5-N7, the Middle Section is N8-N12, and the Upper Part is N18-N14. So it can be concluded that the alternating unit of sandstone-claystone has an age between N5-N14, with the discovery of the index fossil Globigerina seminulina. Based on the distribution of lithology and stratigraphic relationships and the Law of Superposition [4], based on regional stratigraphy according to [7] on the Geological Map Sheet Banjarnegara Pekalongan, Alternating Unit of Claystone Sandstone Hereby is part of the Member of the Creeping Formation. The stratigraphic relationship with the overlying rock units that are part of the Kumbang Formation is inconsistent. Based on the results of microfossil analysis and age comparisons from the region, it shows the age of the Early Miocene - Middle Miocene.

3.2.2 Volcanic brecciacia unit

This unit occupies 25% of the map area, is composed of brownish-gray breccia material in the form of fragments and matrix, with the size of gravel to boulder fragments and a matrix of coarse to medium sand, and there is also reddish-brown soil. This rock unit is exposed in a relatively dense contour pattern which is located at an altitude ranging from 537 masl to 937 masl in the southwest part with a west-south trend in the study area. Judging from the stratigraphic column based on the results of the reconstruction of the geological incision from the Geological Map of the Cilopadang and Surrounding Areas, the thickness of this volcanic breccia unit is ± 480 m.

The rock lithology contained in this unit has physical characteristics of dark gray color, has a grain size of gravel to lumps, is packed open, has poor grain selection, is non-carbonate, and is ± 10-300 cm thick in the field. This rock lithology has a composition of rock fragments in the form of 55% phenocrysts (plagioclase, hornblende, pyroxene, quartz, opaque minerals), 45% base mass (plagioclase microlites). Based on [8] the rock name "Basalt Andesite" was obtained.

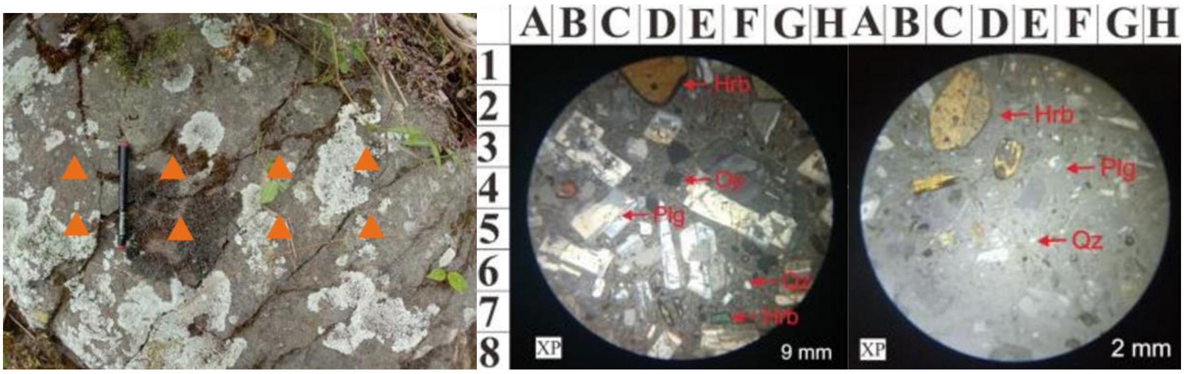

Figure 8. The outcrop photo of the rock unit (left), the thin section image of the fragmented sample (middle), and matrix (right)

Rock lithology has physical characteristics of dark gray color, poor grain selection, tuff, non-carbonate, thickness in the field ± 10-300 cm. The lithology of this rock has a constituent composition of 35% crystals (plagioclase, hornblende, quartz, opaque minerals), 25% lithic fragments, 40% glass.

Based on the results of previous research, Oosthingh (1935) in [9] suggests that some mollusks come from brackish water, some from the tidal zone. The volcanic breccia depositional environment in the study area is in the tidal zone. Referring to the Regional Geological Map Sheet Banjarnegara-Pekalongan [7] the age of the Laharic breccia unit is Early – Middle Pliocene. The stratigraphic relationship with the rock units above which are breakthrough rocks and the alternating units of claystone and sandstone below are not aligned. Field observations found locations showing the Laharic Breccia Unit and the rock unit below it in the form of unconformity contacts, indicated by the presence of a scouring structure. Based on the results of the comparison column, the age indicates the age, namely the Early Pliocene to Middle Pliocene.

3.2.3 Diorite intrusion

This unit occupies 15% of the map area, composed of intrusive rock material on which is overgrown by vegetation. This unit is exposed in a very tight contour pattern located at an altitude ranging from 787 masl to 1150 masl. Judging from the stratigraphic column based on the reconstruction of the geological section of the Geological Map of the Aribaya and Surrounding Regions, the thickness of this intrusion unit is not defined. This intrusion unit is characterized by diorite intrusive rock material. It has a gray color with a weathered to fresh shape. This intrusion unit has a mineral composition of 70% phenocryst (plagioclase, opaque minerals, pyroxene, quartz, hornblende), 30% base mass. Based on [8] the rock name "Quartz Diorite" was obtained. This rock unit has the youngest age among other units in the study area. On the Regional Geological Map Sheet Banjarnegara Pemalang [7], the age of this unit is the Late Pliocene. The relationship between the diorite intrusion unit and the underlying rock unit in the form of a Laharic Breccia unit is inconsistent. This unit is the result of a breakthrough that is influenced by the factors of uplift, folding, and faulting.

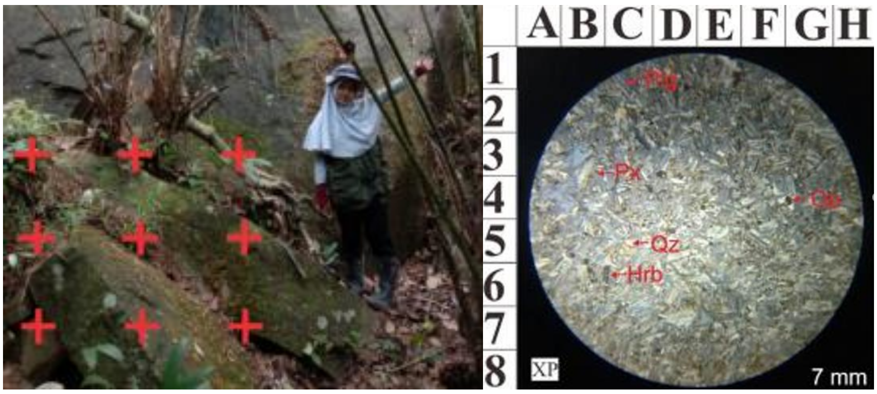

Figure 9. The outcrop photo of the rock unit (left) and the thin section image of the Diorite sample (right)

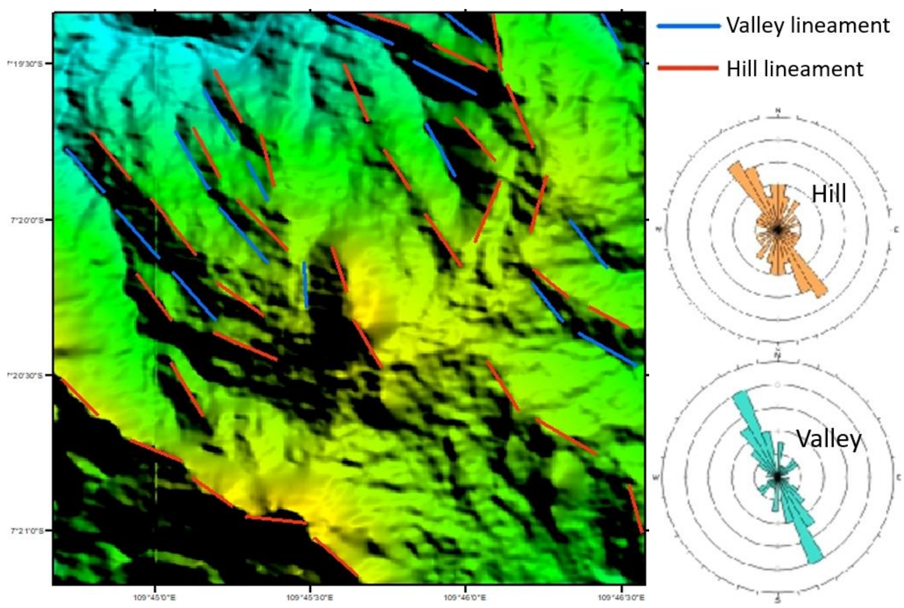

Figure 10. The lineament mapped distribution (left), the rose diagram that shows each lineament directions (right)

3.3. The structural geology of the area

The results of field research and data processing show that there are structural patterns that affect the geological conditions of the research area. The structure is a fault. The fault structures in the study area are Nagasari Left Normal Fault, Gumingsir Right Normal Fault, Karangnangka Left Normal Fault, Karangtengah Right Normal Fault.

Nagasari left horizontal fault, this geological structure is located in the Nagasari area and its surroundings, which is located in the research area and stretches from the northwest to the south. The withdrawal of the Nagasari left normal fault was carried out based on the interpretation of supporting data in the form of hill straightness and valley straightness on the SRTM image, the presence of striking morphological differences in the appearance in the field, and the results of the structural analysis obtained.

Karangnangka Left Horizontal Fault, the analysis of the geological structure of the Aribaya area and its surroundings, Pagentan District, Banjarnegara Regency was carried out in two ways, namely using indirect methods and direct methods. The indirect approach is carried out by analyzing lineament patterns [10]–[12]that exist in the SRTM (Shuttle Radar Topography Mission) and types of river flow patterns to interpret indications of geological structures that occur in the study area. Supporting data is in the form of river straightness, and based on SRTM imagery with hill straightness and valley straightness supports this structure. The value obtained from fracture data in the form of shear fracture also indicates the presence of this fault. Fault analysis was carried out using the joint data and brecciation values on the rosette diagram on a stereonet.

Figure 11. The outcrop of the normal left slip fault (left, middle), The fractures as an indication of fault analysis in the area (right)

Based on the results of the analysis on the stereonet, the fault plane was found to be N 354 0 E/49 0 SW with a pitch value of 52. The direction of the greatest force forming this fault (σ1) is from North (N) to South (S). Strike-Slip movement is normal left and Dip-Slip movement is down. According to [13] this fault is called the Right Normal Slip Fault or Right Normal Fault.

Gumingsir Right Horizontal Fault Its surroundings are located in the north towards the center of the research area. Supporting data in the form of river straightness, Suwidak old stadia river which bends and based on SRTM imagery with hill straightness and valley straightness supports the existence of this structure. The value obtained from fracture data in the form of shear fracture also indicates the presence of this fault. Fault analysis was carried out using the joint data and brecciation values on the rosette diagram on a stereonet. Based on the results of the analysis on the stereonet, the fault plane was found to be N 25 E/67 SW with a pitch value of 7. The direction of the largest force forming this fault (σ1) comes from Northeast (NE) to Southwest (SW). The Strike-Slip movement is horizontal to the left and the Dip-Slip movement is down. According to [13] this fault is called Right Normal Left Slip Fault or Left Horizontal Fault.

Karangtengah’s right horizontal fault is located in the Karangtengah and surrounding areas which are located in the northeastern part of the research area. Supporting data is in the form of river straightness, and based on SRTM imagery hill straightness and valley straightness supports this structure. The value obtained from fracture data in the form of shear fracture also indicates the presence of this fault.

4. Discussion

4.1. Geological history of the research area

After collecting secondary data from regional geology and previous research references and collecting primary data in the form of field data, the authors can explain the geological history that occurred in the research area, namely the Aribaya and surrounding areas, Pagentan District, Banajrnegara Regency. The geological history of the research area begins. from the Early Miocene (N5-N6), evidenced by the presence of fossils of the planktonic foraminifera Globorotalia mayeri [7]. At this time, claystone lithology was deposited with a fairly calm transport current mechanism and dominated by suspension currents [4].

The next phase, which continued during the Middle Miocene (N13 – N 14) [7], as evidenced by the fossil content of planktonic foraminifera, the process of depositing sand-sized sedimentary material with a turbidite current mechanism [14].

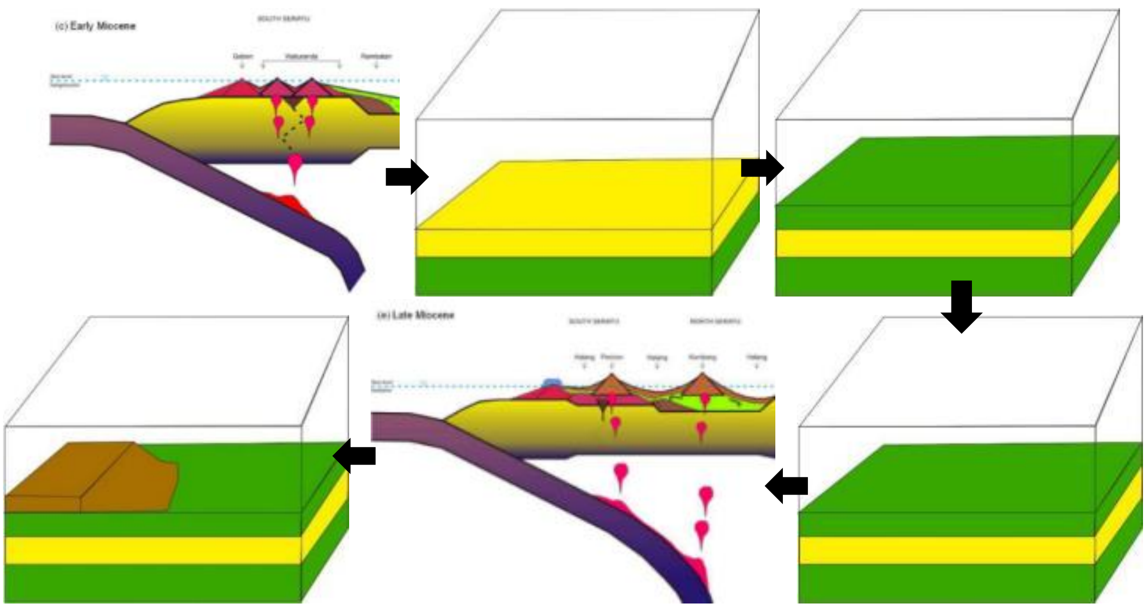

Figure 12. The geological history of the study area

Then in the Miocene to Pliocene, the Rogojembangan volcanic activity occurred in the research area. In the Early - Middle Pliocene, landslides occurred in the central and proximal areas of Maung Volcano, so that the avalanche material was in contact with surface water and carried along the river so that it flowed and was deposited far to the study site. The material is carried away like a lava mechanism. As a result of the formation of the volcano resulted in the appearance of horizontal faults [15] at the research location, namely the Gumingsir, Nagasari, Karangnangka, and Karangtengah Faults.

4.2. Potential Geology

The potential for excavation C is a positive potential found in the research area, namely in the area around Aribaya Village which has been exploited by local residents and mined. Based on the information obtained, the results of the stone mining are used to make house foundations and are marketed to consumers.

The negative potential in the surrounding area is prone to landslides. This can be caused by the morphology of the surrounding area in the form of hills with steep to very steep slopes according to [3]. In addition, the absence of retaining walls to cope with soil movement is a factor that supports landslides. Based on observations, the condition of the slopes with rocks that are quite weathered during the dry season will be very dry so it is very easy to slip, while during the rainy season the condition of the soil is wet the slope conditions will be very slippery so that it can endanger residents living around the research area.[4]

5. Conclusion

From the results of the geological mapping carried out in the Aribaya and surrounding areas, several conclusions can be drawn. The research area is divided into three geomorphological units, based on BMB classification, namely the Aribaya Intrusion Hills Unit, the Aribaya Fault Zone Unit, and the Gununggiana Lava Ridge Ridge Unit. The geological structures that developed in the research area are Aribaya syncline, Nagasari Right Horizontal Fault, Karangnangka Right Horizontal Fault, Gumingsir Left Horizontal Fault, and Karangtengah Left Horizontal Fault. These structures were formed as a result of tectonic forces with a dominant direction of northeast-southwest. The stratigraphic arrangement that composes the research area from old to young is divided into three units, namely the alternating claystone and sandstone units, plutonic breccia units, and diorite intrusions. The geological history of the study area begins in the early to middle Miocene (N5-N14), namely the intercalation of claystone sandstones in the middle-upper neritic bathymetry environment. Furthermore, there is the tectonic activity that forms the geological structure that is currently developing in the research area. During the Pliocene, there was activity from Mount Maung which provided a supply of sediment in the form of andesite fragments and a matrix of coarse sand size to form plutonic breccia units. Then during the Pliocene period, diorite intrusions appeared. The next process is an exogenous process that causes the morphological formation as it is today. The potential of geological resources in the research area is in the form of sources of excavated C mining materials and soil movements that can cause landslides.

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