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The detailed morphological formation based on geological investigation in Somawangi and surrounding areas, Mandiraja District, Banjarnegara Regency, Central Java

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Abstract

Geological mapping is an activity to be able to know the geological conditions of a field. Somawangi Village and its surroundings have a geological history depicting the history of the past that continues until now. This location is located in Mandiraja District, Banjarnegara Regency with a morphology consisting of rock outcrops that record past history which can be used as learning media for the field of geological science. This study aims to determine the geological conditions and resource potential as well as geological disasters at the research site. From the results of the study, it can be concluded that the Geomorphology of the research area can be divided into 3 geomorphological units, namely the Sloping Structural Hills Unit (S3), Structural Sloping Lowland Unit (S1), and Volcano Denudational Hills Unit (V14) with the composition The stratigraphy of the study area is divided into 5 rock units, from the oldest to the youngest, the Somawangi Volcanic Breccia Unit, the Sandstone Unit, the Andesite Lava Unit, the Tuff Rock Unit, and the Kaliwungu Volcanic Breccia Unit. The geological structure of the research area is the Left Fault which is found along the rivers and hills in the eastern area of the research location with an emphasis on northeast-southwest. And the geological potential of the research area can be divided into 2, namely positive potential such as mining of sand and rocks around the river, the use of red soil as a ceramic and brick material, the use of andesite lava which has the potential to mine minerals, and the presence of mineralization alteration in the research area. While the negative potential is the potential for land movement or landslides

1. Introduction

Currently, the field of geology is starting to have a very important role in the community, especially information about the geological conditions that develop and work in the area. The development and progress of this science will encourage experts to conduct research regionally because a more detailed study is still needed to complement the existing geological data including geomorphological conditions, stratigraphy, geological structures and other applied geological aspects [1].

The geological conditions of the field for a geologist as well as a prospective geologist is a place to be able to obtain data and as a medium to enrich themselves with the geological science being studied. Almost all activities related to the earth, such as physical development with all its consequences, then exploration and exploitation of geological resources as well as geological disaster mitigation of an area will require geological data which will get optimal results if the geological data required is of high quality [2].

Geological mapping is an activity to be able to know the geological conditions of a field. Somawangi village and its surroundings have a geological history depicting the history of the past that continues until now. This location is located in Mandiraja District, Banjarnegara Regency with a morphology consisting of rock outcrops that record past history which can be used as learning media for the field of geological science [3].

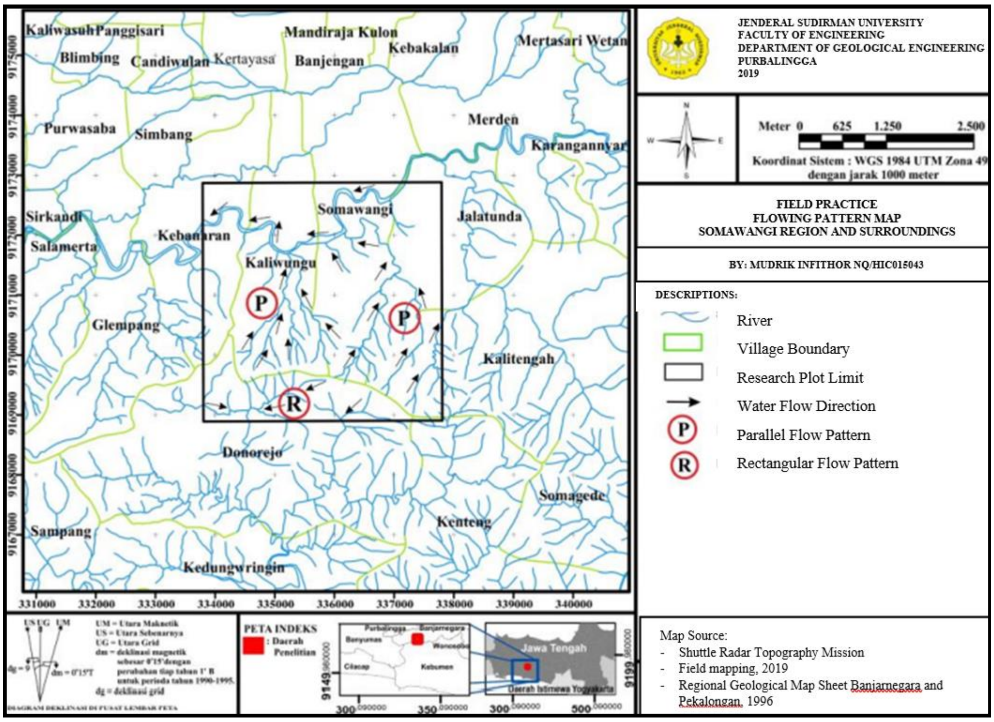


Figure 1. The river pattern map of the study area

2. Methodology

This research begins with a literature review activity. Where at this stage data collection is carried out through library studies and reports of previous research results [1]. Then proceed with geological mapping by collecting surface geological information and producing an output form in the form of a geological map containing information on the distribution and composition of rocks and indications of geological structures that may affect the distribution of rocks in the area [2]. The next activity is taking field data in the form of outcrop identification and geomorphological identification. After collecting field data, then proceed with the data analysis phase including stratigraphic analysis, petrographic analysis, geomorphological analysis, and geological structure analysis [3].

3. Results and discussions

3.1. Geomorphology of the research area

3.1.1 Flow patterns and river genetics in the study area

In the research area, there are tributaries located in hilly areas and the main river, namely the Sapi River, which has a relative flow direction from east to west (see figure 1). These small rivers are included in intermittent rivers, namely rivers that are not always flowing with water or the discharge is not fixed. Based on the analysis of topographic maps and conditions in the field, it can be seen that there are parallel and rectangular flow patterns in the research area, this refers to the classification of river flow patterns [4]. The parallel is a river flow pattern consisting of several rivers with relatively parallel flow directions to each other. Rectangular is a meandering river flow pattern with right angles. The main river has branches and the meeting between the main river and these branches forms an angle of 90 degrees.

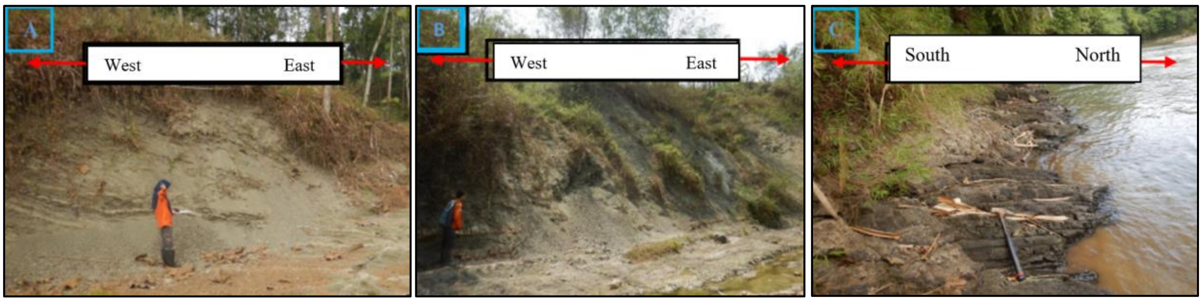


Figure 2. The type of river flow in the study area, obsequent (A), consequent (B), Subsequent (C)

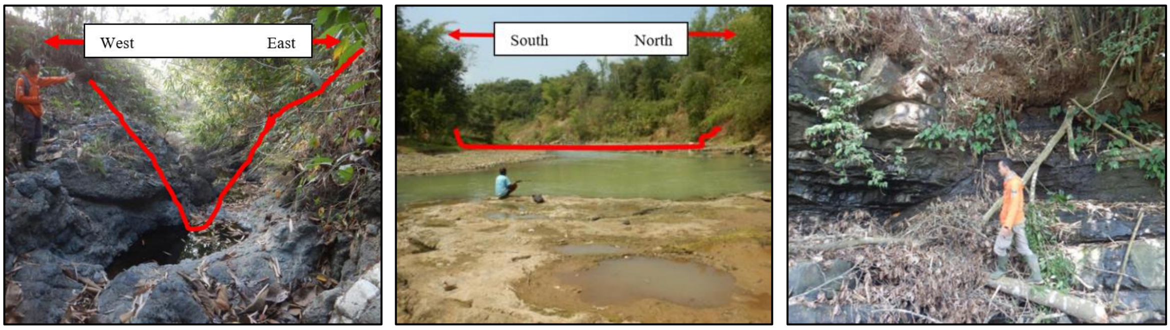


Figure 3. The "V" shaped river valley is in the Somawangi area as a young stadia river (left), the "U" shaped river valley located in the Kaliwungu area named the Kali Sapi River as an adult river (middle), Indication of fault descent in the study area (right).

According to the classification developed by [4]. The genetic types of rivers that develop in the research area are sub-sequence rivers whose flow direction follows the direction of the layer, oblique rivers that flow in the opposite direction to the slope of the layer, and consequent rivers whose flow direction matches with layer slope (see figure 2).

The river stadia in the study area can be observed from the shape of the valley in the river. If the valley is sharp or forms the letter "V" then it characterizes the geomorphic river of a young stage, while the more sloping the valley shape or resembles the letter "U" the more mature the river stadia is. River valley formations found in the study area tend to form "V" and "U" (see figure 3), this stadia river is found in tributaries and also the main river [5].

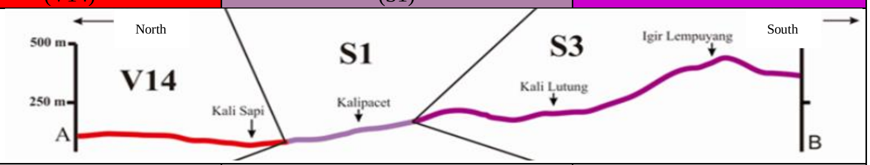
3.1.2 Analysis of the percent slope of the study area

From the results of the calculation, the percentage of the slope of the study area has a very diverse slope. Based on the table of results from the percent slope delineation, it appears that the percent slope of the study area has a slope percent value of 0-140% which has flat - steep.

3.1.3 Geomorphological unit of the research area

The division of geomorphological units is based on variables in the form of morphography, morphometry and morphogenesis [6]. Based on these variables, the Somawangi area and its surroundings can be divided into 3 geomorphological units (see table 1 and figure 4), namely the Sloping Hills-Structural Slope Unit (S3), Structural Sloping-Sloping Lowland Unit (S1), and Volcano Denudational Hills Unit (V14) (see figure 5).

Table 1. A-B Geomorphological Section of the Somawangi and surrounding areas and their geomorphological aspects

Aspect	Volcano Denudational Hills (V14)	Structural Sloping-Sloping Lowland (S1)	Structural Sloping Hills (S3)
Geomorphological section of A-B scale 1: 25,000 H-V			
Highest point	100	150	300
Lowest point	75	100	225
Elevation difference	25	50	75
Flowing pattern	Parallel	Parallel	Rectangular and parallel
Valley shape	U	V, U	V
Lithology	volcanic breccia	Sandstone and volcanic breccia	Breccia, lava, and tuff
Endogenic process	-	Fault and joint	Joint
Exogenic process	Weathering, erosion, transport, and sedimentation	Weathering, erosion, transport, and sedimentation	Weathering, erosion, transport, and sedimentation
Geological structure	-	Major Fault	Fault and joint
Land use	Settlements and plantations	Settlements, fields, and plantations	Settlements and plantations

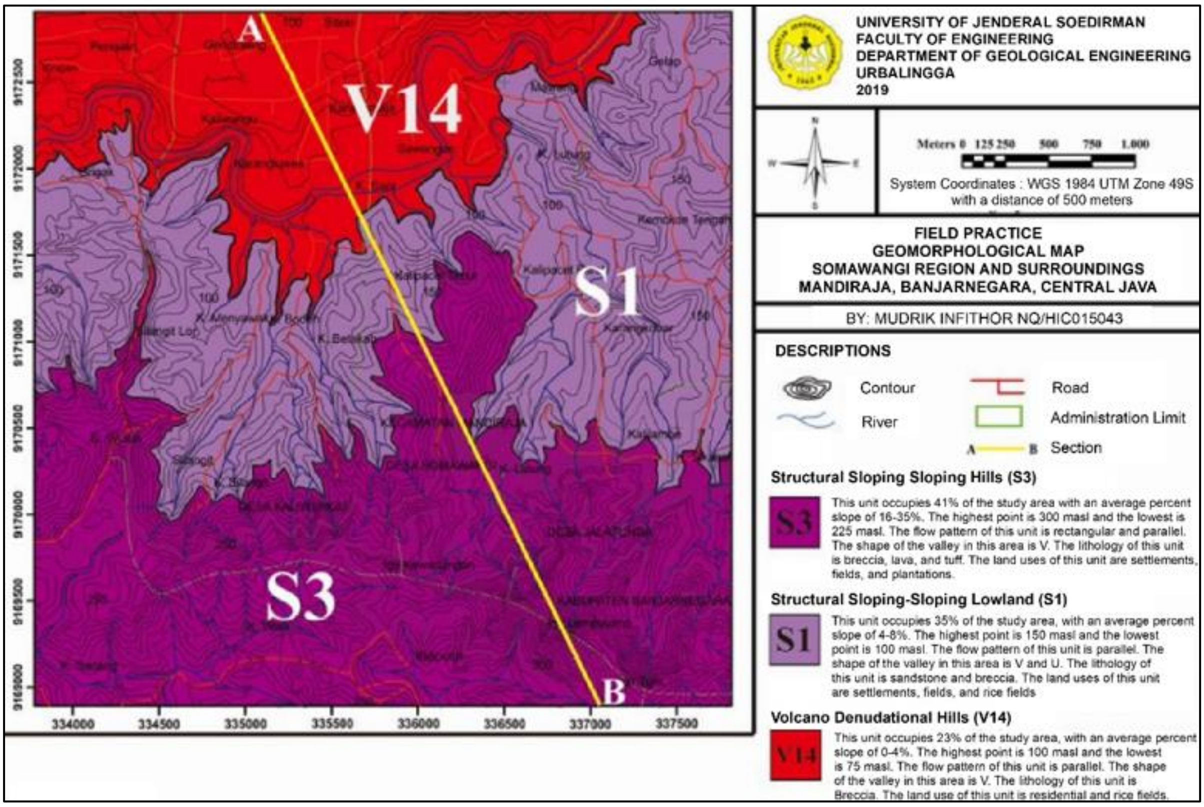


Figure 4. Geomorphological map of the study area

3.2. Geological structure of the study area

The geological structure of the Somawangi area and its surroundings is carried out indirectly and directly. Based on the results of indirect geological structure analysis using SRTM by making straightness patterns of hills and valleys, it can be seen that the lineament pattern of the study area is southeast-northwest [7]–[9]. Then by displaying the results of the analysis of the straightness pattern in the form of a rosette diagram, it can be seen that the direction of the main force acting in the research area is northeast-southwest [10]. Meanwhile, based on direct geological structure analysis carried out by conducting direct observations in the field and analyzing data in the form of offsets on rock lithology, it is known that in the research area there is a lithological offset of sandstone found in outcrop on the trajectory map which indicates there is a downward fault, seen from the movement of the hanging wall that down against the footwall [11].

3.3. Stratigraphy of the research area

Based on the results of the study, stratigraphy at geological mapping locations in the Somawangi and surrounding areas, Mandiraja District, Banjarnegara Regency, Central Java Province is grouped into five-rock units from old to young rock units (see figure 12).

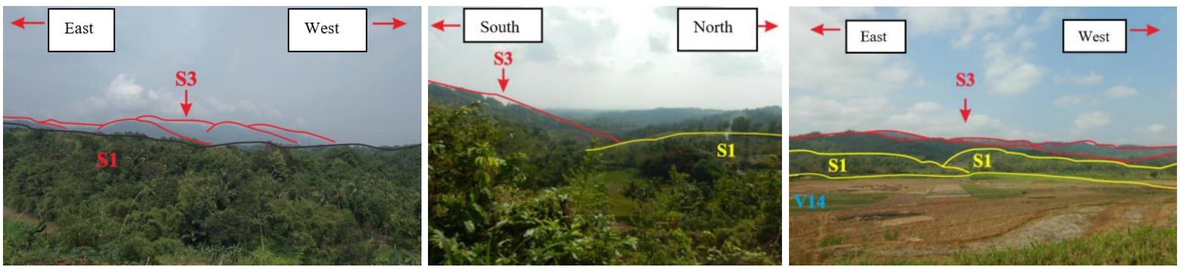


Figure 5. Structural slope Hill unit (S3) (left), Structural sloping lowland unit (S1) (middle), Volcano denudational hills unit (V14) (right)

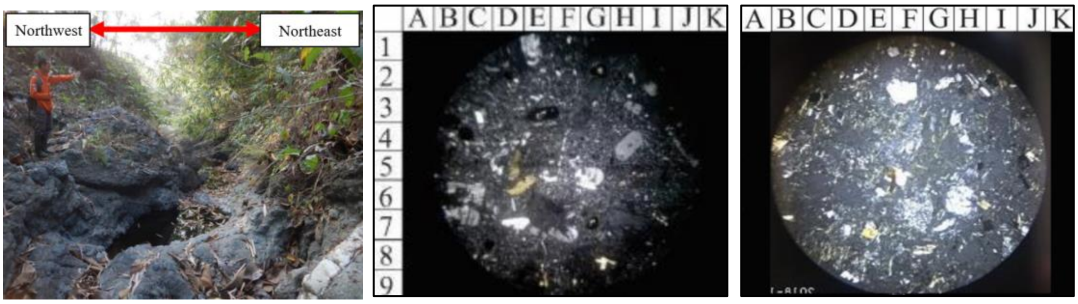


Figure 6. The outcrop of the Somawangi breccia unit (left), the fragment thin section (cross polarization) view of Somawangi breccia unit (middle), the fragment thin section (cross-polarization) view of the Somawangi breccia unit (right).

The volcanic breccia unit (see figure 6) occupies about 45% of the study area. From petrographic observations, the Somawangi Breccia fragment has a brownish white colour on parallel nickel and dark grey colour on cross-linked nickel, the degree of crystallization is hypo crystalline, subhedral-anhedral shape and has a porphyritic texture. The mineral composition consists of plagioclase (45%) andesine, biotite (20%), quartz (5%), glass minerals (20%) and opaque minerals (10%). Based on these petrographic observations, the Somawangi Breccia fragment is called andesite [12]. Microscopic observation of the matrix petrographic sections of the Somawangi breccia revealed that this rock has a mineral composition of quartz (35%), feldspar (25%) and lithic fragments (40%) with a fragment percentage of 60% so that it can be classified as lithic wacke [13]. This rock unit is estimated to be in the Early Miocene to Middle Miocene age [14]. The depositional environment of the Somawangi volcanic breccia unit can be interpreted as being in the Upper Bathial Sea [14]. The stratigraphic relationship of the Somawangi volcanic breccia unit with the unit below it cannot be known, while the unit above which is the sandstone unit is fingering.

The sandstone unit (see figure 7) occupies about 12% of the study area. This rock is a medium-coarse sandstone, whitish-grey sandstone, large grains of fine to coarse sand, rounded grain shape, good sorting, closed packing, quartz and plagioclase mineral composition, non-carbonate properties. Based on microscopic observations with 40X magnification in the laboratory on sandstones, the composition of the matrix (35%), cement (10%), quartz minerals (37%), feldspar (18%) percentage of fragments is 55% so that it can be classified in arkosewacke [4] [15]. This rock unit is estimated to be of the Middle Miocene age [14]. The depositional environment of the sandstone units is in the sea (Upper Bathyal) [14]. The stratigraphic relationship between the sandstone unit and the unit below, namely the Somawangi volcanic breccia is fingering because there is a clear contact between the breccia unit and the sandstone unit, while the unit above is the andesite lava unit [16].

The lava unit (see figure 8) occupies about 18% of the study area, has a characteristic white-grey colour, with andesite rock fragment material with non-carbonate properties. Based on 10X magnification microscope observations in the laboratory on andesite lava, obtained a description of brownish-white colour on parallel Nicol and dark brown colour on cross nicol, has a porphyritic texture, degree of hypo crystalline crystallization, subhedral shape.

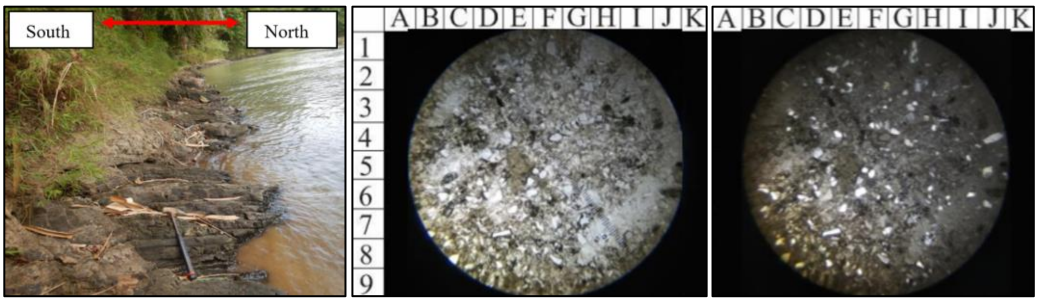


Figure 7. The outcrop of the sandstone unit (left), the thin section (parallel polarization) view of the sandstone unit (middle), the thin section (cross-polarization) view of the sandstone unit (right).

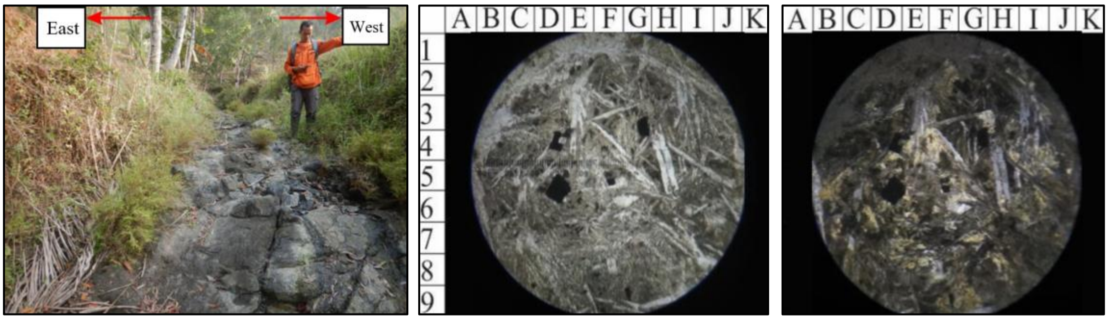


Figure 8. The outcrop of the lava unit (left), the thin section (parallel polarization) view of the lava unit (middle), the thin section (cross-polarization) view of the lava unit (right).

The mineral composition of the lava unit consists of plagioclase (55%) andesine, biotite (20%), quartz (5%), glass minerals (12%) and opaque minerals (8%). Based on these petrographic observations, it is called andesite [12]. This rock unit is estimated to be in the Early Miocene to Middle Miocene age [17]. The depositional environment of the lava units can be interpreted as being in the Upper Batial Sea [17]. The stratigraphic relationship between the lava unit and the unit below, namely sandstone, is fingering, while the unit above is the tuff unit, which has fingering structures.

The tuff unit (see figure 9) occupies about 12% of the research area, has the characteristics of cream white colour, layered structure, material in the form of fine dust, formed outside the earth's surface as a result of volcanic eruptions which is then deposited. Based on 10X magnification microscope observations in the laboratory at Tuff, the following description was obtained: The petrographic observations had a brownish white colour on parallel nicols and black-brown on cross nicols. The mineral composition consists of plagioclase (20%), hornblende (10%), pyroxene (8%), glass minerals (55%), and opaque minerals (7%). Based on these petrographic observations, it is called glass tuff [13], [15]. This rock unit is estimated to be in the Early Miocene to Middle Miocene age [17]. The depositional environment of tuff units can be interpreted as being in the upper bathyal sea [17]. The stratigraphic relationship between the tuff unit and the unit below, namely andesite lava, is fingered, while the unit above it is the Kaliwungu volcanic breccia unit, which is inconsistent because there is no clear contact and far apart in time based on the equivalence of regional geological data between the Waturanda formation (tuff unit) and the tuff unit of Ligung formation (volcanic breccia unit).

The Kaliwungu volcanic breccia unit (see figure 10) occupies about 13% of the study area, has characteristics of a dark grey colour, with weathered conditions and mostly fresh grains of gravel to bomb size, fragments in the form of andesite and basalt and the matrix in the form of non-carbonate sandstone. The petrographic observation of the Kaliwungu breccia fragment has a brownish white colour on parallel nicols and dark grey on cross nicols, has a porphyritic texture, degree of hypo crystalline crystallization, subhedral-euhedral shape. The mineral composition consists of plagioclase (48%) andesine, pyroxene (10%), hornblende (20%), quartz (6%), glass minerals (8%) and opaque minerals (8%). Based on these petrographic observations, the Kaliwungu Breccia fragment is called andesite [12]. This rock unit is estimated to be Pleistocene in age.

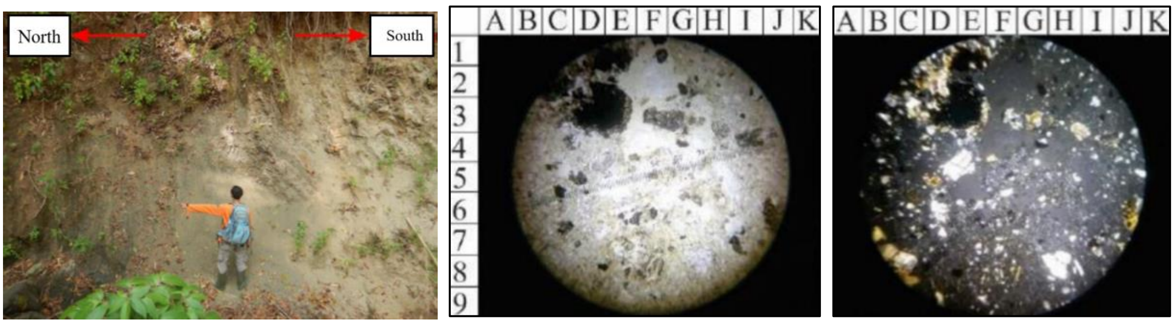


Figure 9. The outcrop of the tuff unit (left), the thin section (parallel polarization) view of the tuff unit (middle), the thin section (cross-polarization) view of the tuff unit (right).

Figure 10. The outcrop of the Kaliwungu breccia unit (left), the fragment thin section (cross polarization) view of Kaliwungu breccia unit (middle), the fragment thin section (cross-polarization) view of the Kaliwungu breccia unit (right).

The depositional environment of the Kaliwungu volcanic breccia unit can be interpreted as being on land. The stratigraphic relationship between the Kaliwungu volcanic breccia unit and the unit below, namely tuff, is not in harmony because there is no clear contact and a large time gap is found based on the equivalence of regional geological data between the Waturanda formation (tuff unit) and the ligung formation (Kaliwungu volcanic breccia unit).

3.3. The geological potential of the research area

In general, the geological potential in a research area is divided into two categories (see figure 11), namely positive and negative geological potential. The first category is geological potential that can cause natural disasters that are a threat to the surrounding environment and humans themselves, which are called negative geological potentials, such as in the research area in the form of landslide natural disasters. While the second category is more positive because it can benefit the general public and local residents, in research areas such as sand and stone mining around rivers, the use of red soil as a ceramic and brick material, and the use of andesite lava which has the potential to mine minerals. there is also an alteration of mineralization in the study area.

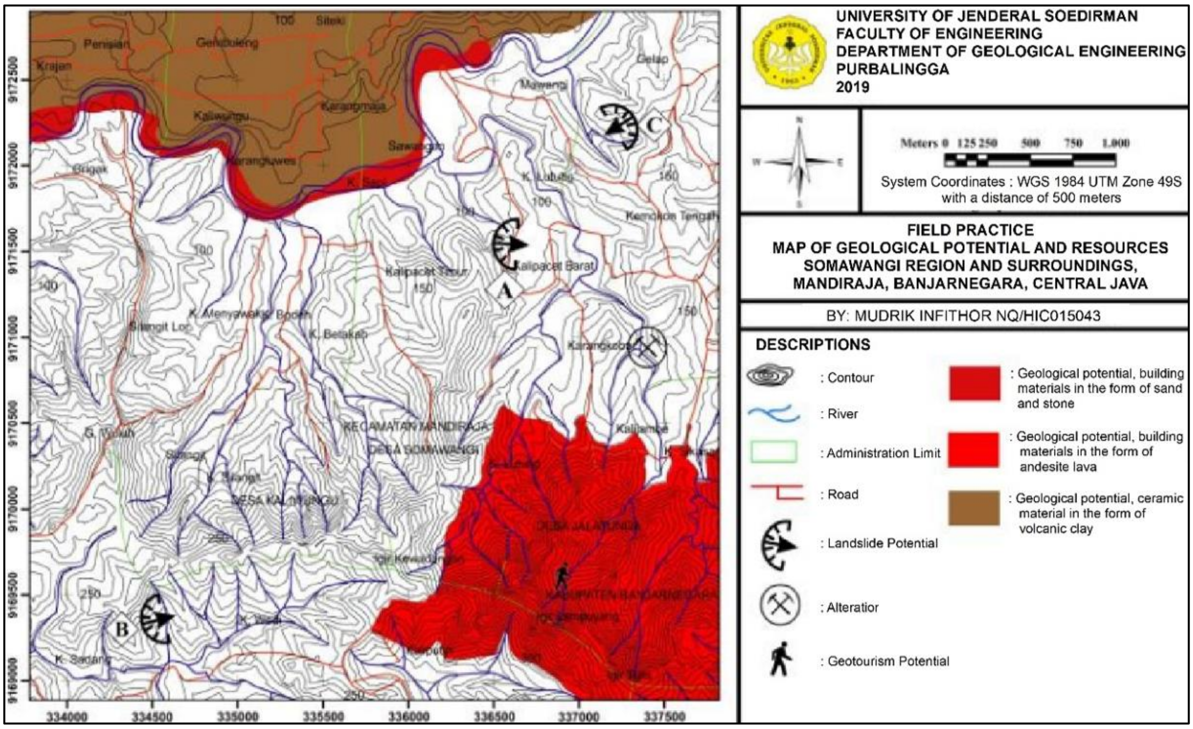


Figure 11. The geologic potential map of the study area

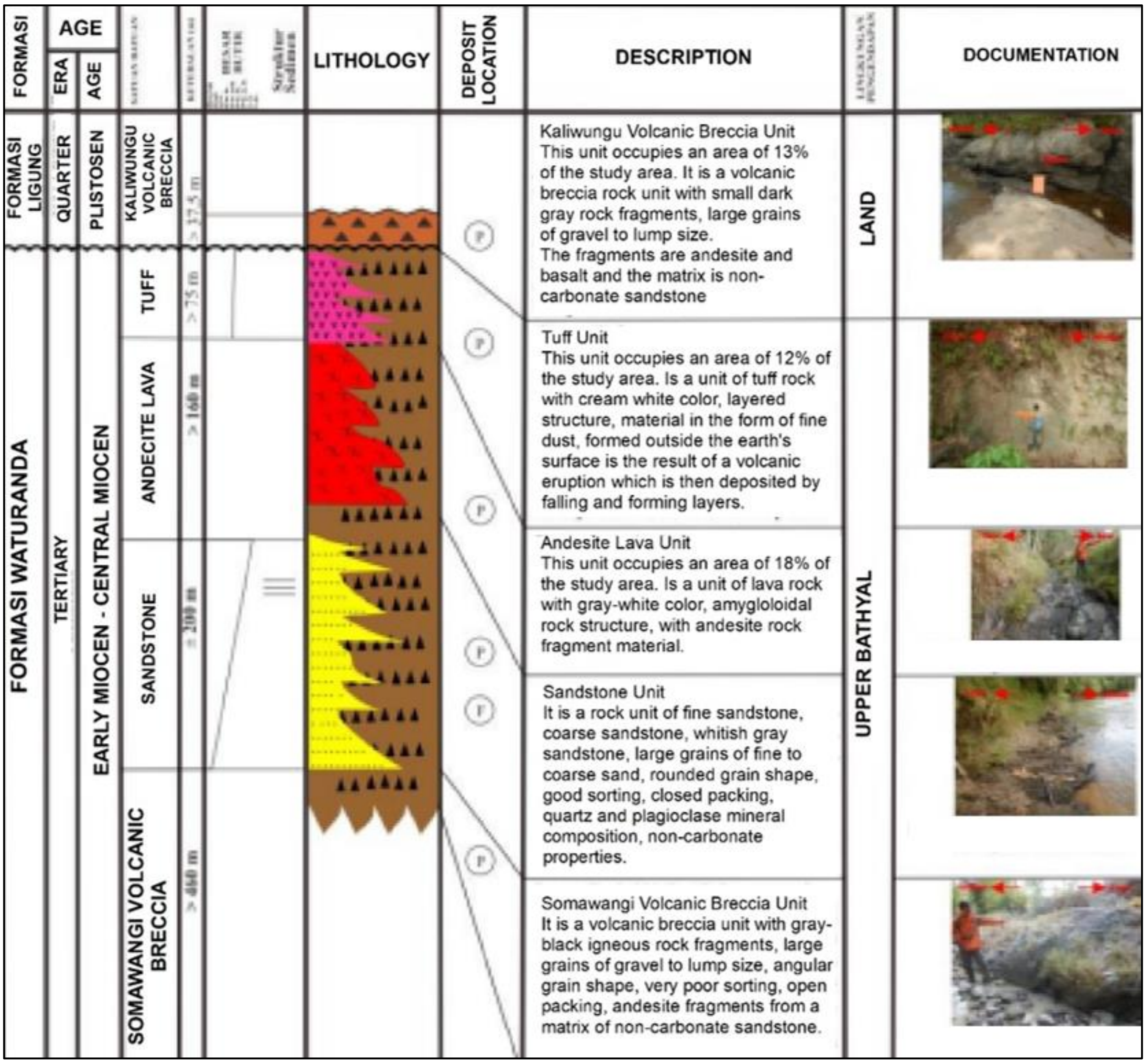


Figure 12. The stratigraphic column of the study area

3.4. The geological history of the study area

In the study area, there are four interlocking units with the Somawangi breccia unit, during the early Miocene there was deposition of the upper bathyal which is interpreted at the beginning of rock formation starting from the Somawangi breccia which was deposited the oldest of all units and at the same time there was deposition of sandstones that eroded breccia units that have been deposited previously, sandstone units have a deposition mechanism dominated by calm laminar currents, so that many parallel laminate structures are found, still during the early Miocene volcanic eruptions occurred in the area and caused the deposition of andesite lava units deposited in the area eroding the unit the breccias that have been deposited in the area after the lava has been deposited following the tuff rock units that were deposited on top of the lava are still at the same time, then a lifting process occurs which causes the area to turn into a terrestrial environment, from the day the lift results cause the rock to experience a change in the direction of subduction of the layers. During the Late Miocene, tectonic trends occurred relatively northeast-southwest which caused the displacement of previously formed rock units. The last unit deposition occurred during the Pleistocene, the occurrence of deposition by the Kaliwungu volcanic breccia unit from the north which was the result of a volcano that closed the deposition of existing units [17].

4. Conclusion

Based on the results of research in Kadidia Village and its surroundings we got several conclusions. The Geomorphology of the research area can be divided into 3 geomorphological units; the Sloping Hills Structural Unit (S3), Sloping Structural Lowland Unit (S1), and Volcano Denudational Hills Unit (V14). The stratigraphic structure of the study area is divided into 5 rock units, from the oldest to the youngest; the Somawangi Volcanic Breccia Unit, Sandstone Unit, Andesite Lava Unit, Tuff Rock Unit, and the Kaliwungu Volcanic Breccia Unit. The geological structure of the research area is the Left Fault which is found along the rivers and hills in the eastern area of the research location with an emphasis on northeast-southwest. The geological history of the study area began in the early Miocene when there was deposition in the bathyal area of the oldest Somawangi breccia and at the same time, there was sandstone deposition. During the early Miocene, volcanic eruptions occurred in the area and led to the deposition of andesite lava units following Tuff rocks that were deposited on top of the lava were still at the same time, then a lifting process occurred which caused the area to turn into a terrestrial environment. During the Late Miocene, tectonic trend occurred relatively northeast-southwest which caused the displacement of previously formed rock units. The last unit deposition occurred during the Pleistocene, the occurrence of deposition by the Kaliwungu volcanic breccia unit from the north as a result of a volcano that closed the deposition of existing units. The geological potential of the research area can be divided into 2, namely positive potential such as mining of sand and stones around the river, the use of red soil as a ceramic and brick material, the use of andesite lava which has the potential to mine minerals, and the presence of mineralization alteration in the research area. While the negative potential is the potential for land movement or landslides.

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