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Geological Mapping of the Longkeyang and Surrounding Regions, Bodeh District, Pemalang Regency, Central Java

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Abstract

Geological mapping is one of the important things as part of a field study to obtain geological knowledge. This is due to the need for a geologist who is required to be able to understand the geological conditions of an area, one of which is by conducting mapping activities in the field. In conducting this research activity, it is divided into two stages, namely the field stage and the laboratory stage. The purpose of this research is to determine the characteristics and geological conditions, identify resource potentials and potential geological disasters in the research area. Based on the analysis, it was found that the geomorphological units of the study area were divided into 4 (four), namely the Mount Ketos Homocline Hills Unit, the Polaga River Anticline Valley Unit, the Sarangkadu Cycline Hills Unit, and the Mount Lanji Intrusion Hills Unit. The geology of the study area consists of three rock units in order from oldest to youngest, namely the claystone-sandstone unit and the sandstone-claystone unit and the diorite intrusion unit. The geological structure of the pinnacle area is in the form of folds and faults, namely, Polaga River Anticlines, Sarangkadu Synclines, Polaga River Right Shear Fault, Polaga River Left Shear Fault. The geological history of the study area begins with the deposition of claystone-sandstone units during the Middle Miocene in the Upper Bathyal environment. Furthermore, after the claystone-sandstone units were deposited, during the Middle Miocene – Late Miocene in the Deep Neuritic environment, sandstone-claystone units were deposited with a turbidity deposition mechanism. As well as the geological resource potential of the research area in the form of utilization of river deposits in the form of chunks of igneous rock, river sand deposits and indications of the presence of gold. Meanwhile, the potential for geological disasters in the form of landslides.

1. Introduction

Geological mapping is one of the important things as part of a field study to obtain geological knowledge. This is due to the need for a geologist who is required to be able to understand the geological conditions of an area, one of which is by conducting mapping activities in the field. Mapping is done to produce geomorphological maps and geological maps of the area under study. A geological map is a map that provides an overview of the entire distribution and arrangement of rock layers using colors or symbols, while the signs seen in it can provide a three-dimensional reflection of the rock composition below the surface. Geomorphological map is a map that shows the geomorphic units of an area, geomorphological symptoms (lineaments, landslide zones and etc), and river flow patterns. This research was conducted to determine the characteristics, geomorphological conditions, stratigraphic conditions, geological structure conditions, geological history and identify potential resources and potential geological disasters in the research area.

2. Methodology

The research methodology is divided into 2 (two) stages, namely the field stage and the laboratory stage. At the field stage, geological mapping uses a survey method in the form of surface geological mapping which includes several aspects including aspects of lithology, geomorphology, sedimentology, stratigraphy, structural geology, historical geology and excavation materials found in the research area. At this stage, several works were carried out including identification of outcrops, identification of geomorphology and evaluation of geological mapping data.

At the laboratory stage, field data analysis was carried out which included analysis of landsat imagery lineaments, geomorphological analysis (including morphographic analysis, morphometric analysis and morphogenetic analysis) [1], [2], [3], micropaleontological analysis (fossil analysis), stratigraphic analysis referring to on observations of lithology and deposition environment [4], [5], microscopic petrographic analysis of rock incisions, and lastly analysis of geological structures by interpreting topography to see indications of geological structures including interpretation of Landsat imagery, contour line density, river straightness, ridge lineaments, river flow patterns and etc [6]. Then proceed with the stage of making maps based on surface geological observation data along with their analysis which includes geological trajectory maps, geomorphological maps, geological maps, geological resource potential maps and geological disasters.

3. Results

3.1. The Geomorphology of The Research Area

3.1.1 River flow patterns and river genetic types

Based on the results of the analysis, it is known that the pattern of river flow in the study area is the pattern of the trellis river flow which is controlled by a steep slope factor so that the river will be in a straight shape following the direction of the slope with very few river branches. And the subdendritic flow pattern controlled by the structure that occurs in the study area [1], [2]. This flow pattern is found in areas with a rather steep slope, where the tributaries lead to the main river at an acute angle. Meanwhile, the genetic type of the river in the research area consists of subsequence, obsequence, and consequent [7].

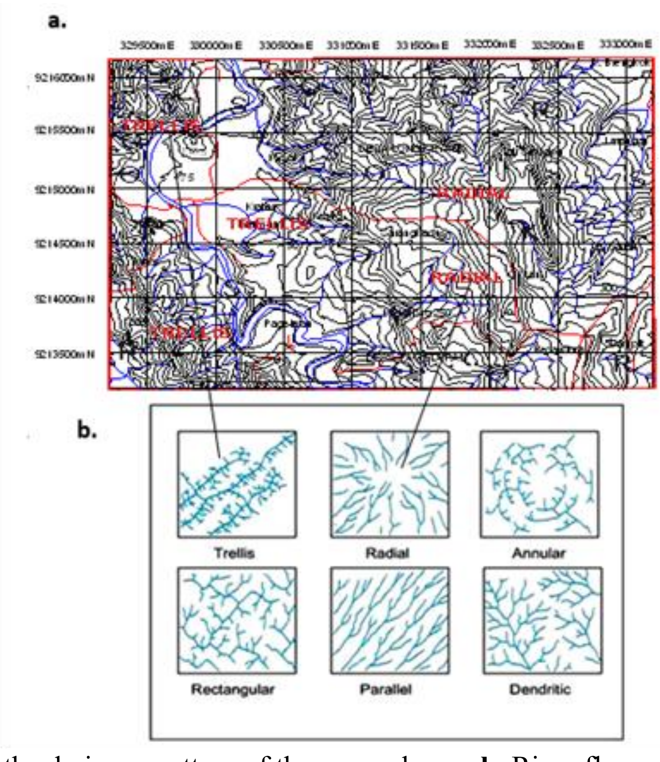
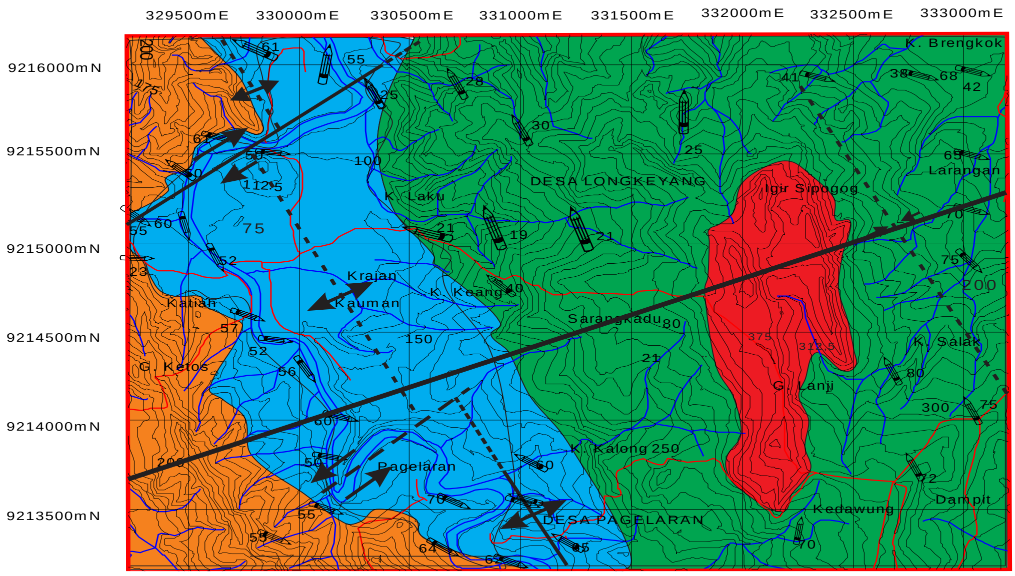


Figure 1. a. Map of the drainage pattern of the research area **b.** River flow patterns according to [1] (adapted from [2])

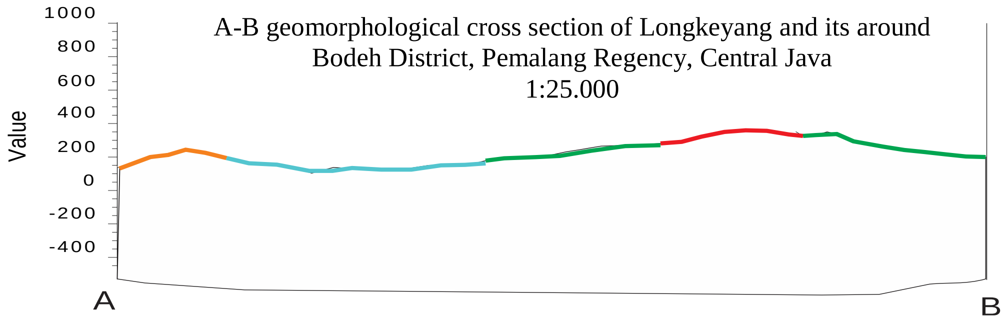
3.1.2 The Geomorphological Unit

The geomorphological unit of the study area is divided into 5 units based on morphometry and morphogenesis [2]. The geomorphological units are: Slightly Steep Volcanic Hills Unit (V6). Structural Hills Unit with Steep Slope (S3), Structural Hills Unit with Slight Slope (S1), Denudational Hills Unit with Steep Slope (D3), and Denudational Hills Unit with Slight Slope (V11).

a.



b.



c.

Description

Ketod mountain homocline hill unit
This unit occupies 10% of the study area, located at an elevation of 175 - 200 masl characterized by the discovery of similar strike/dip as hills. The lithology of this rock is sandstone and rock. This unit area is used for agriculture and settlement

Polaga River anticline valley
This unit occupies 20% of the study area, is at an elevation of 112.5 - 150 masl characterized by sparse contours and opposite dips as valleys. The lithology of this rock is claystone-sandstone, limestone inserts. This unit area is used for agriculture and settlement

Mount Ketos syncline hill unit
This unit occupies 65% of the study area, is located at an elevation of 250 - 300 masl characterized by dense contours and dips meeting each other as hills. The lithology of this rock is sandstone. This unit area is used for forestry, agriculture and settlement

Lanji mountain intrusion hill unit
This unit occupies 5% of the study area, is at an elevation of 250 - 300 mdpl characterized by dense contours as hills. The lithology of this rock is diorite igneous rock. this unit area is used for forestry and excavation

Figure 2. a. Geomorphological Map; **b.** Geomorphological section; **c.** Description of the geomorphological unit of the research area

3.2. The Stratigraphy of Research Area

Based on the results of stratigraphic analysis to determine the age of rocks from old to young and using an informal lithostratigraphic naming system for naming the stratigraphic units of the study area [8], [9], the rock units from the oldest to the youngest are:

1. The Claystone – Sandstone unit
   This unit which occupies 20% of the research area is located in the south-east and north-west areas marked by green on the map covering the Bodas and Kebubung Rivers and has a thickness of 750 m. This unit is an alternation of claystone - sandstone exposed as river valleys, gray to light gray, weathered gray. The results of micropaleontological analysis found planktonic fossils showing the age range of N12-N13 (Blow, 1969) and equivalent to the age of the vines formation with the age of the Middle Miocene. This rock unit is in harmony with the unit above it because of the adjacent age difference. Meanwhile, the relationship between the claystone-sandstone unit and the unit below is not revealed. From the results of the existing fossils, it is known that the deposition occurred in the upper Bathyal environment with a depth of 250-400m [10], [5].

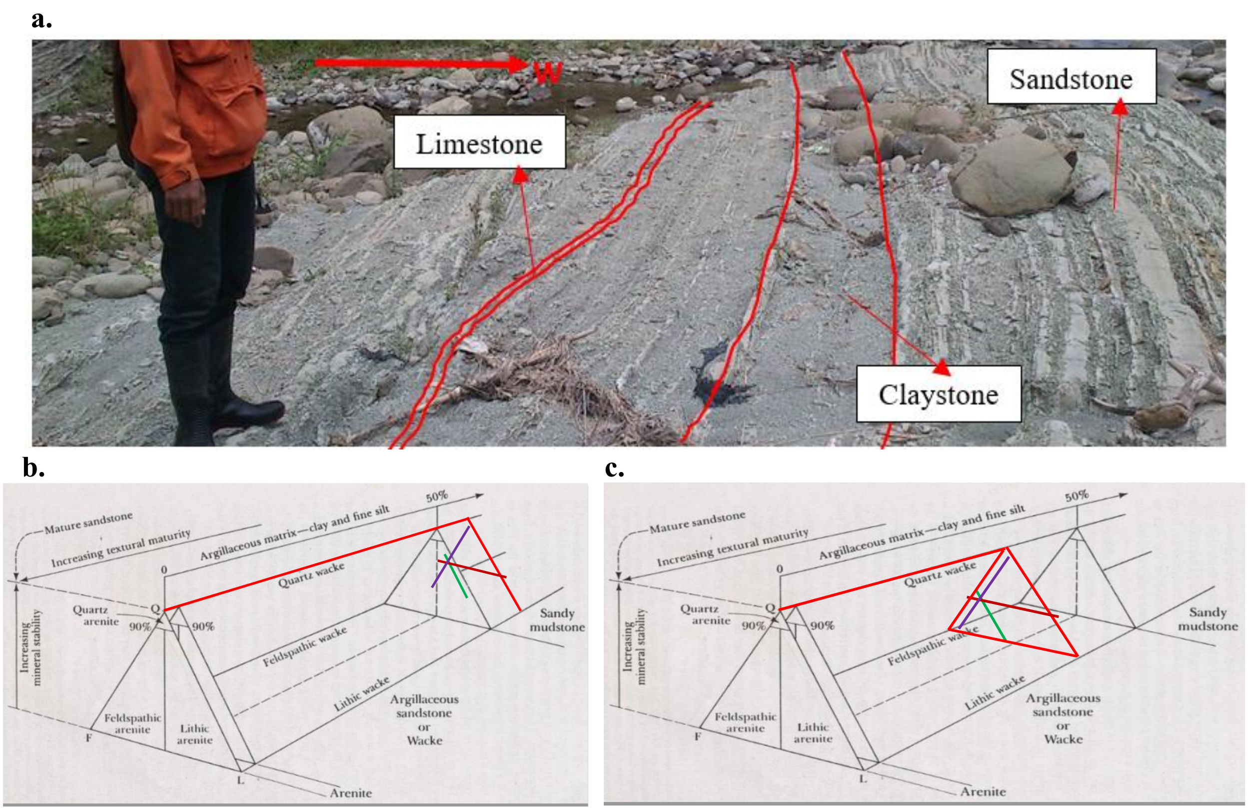


Figure 3. a. The appearance of the CN 19 claystone-sandstone outcrop; **b.** Placement of claystone composition [11]; **c.** Placement of sandstone composition [11]

2. Sandstone – claystone unit
   This unit occupies 70% of the research area and has a thickness of ± 1165 m. This sandstone-claystone unit consists of interspersed sandstone with breccia intercalated claystone. The distribution of these rock units is in the Sarangkadu, Jatingarang and surrounding areas. Exposed as cliffs and river valleys, but dominated as cliffs, dark gray to brownish gray, weathered light gray to brownish gray. The results of micropaleontological analysis found planktonic fossils showing an age range of N13-N16 [4] and equivalent to the age of the vines formation with the age of Middle Miocene - Late Miocene where the unit deposition occurred in a deep neritic zone environment (0-30 m) [5].

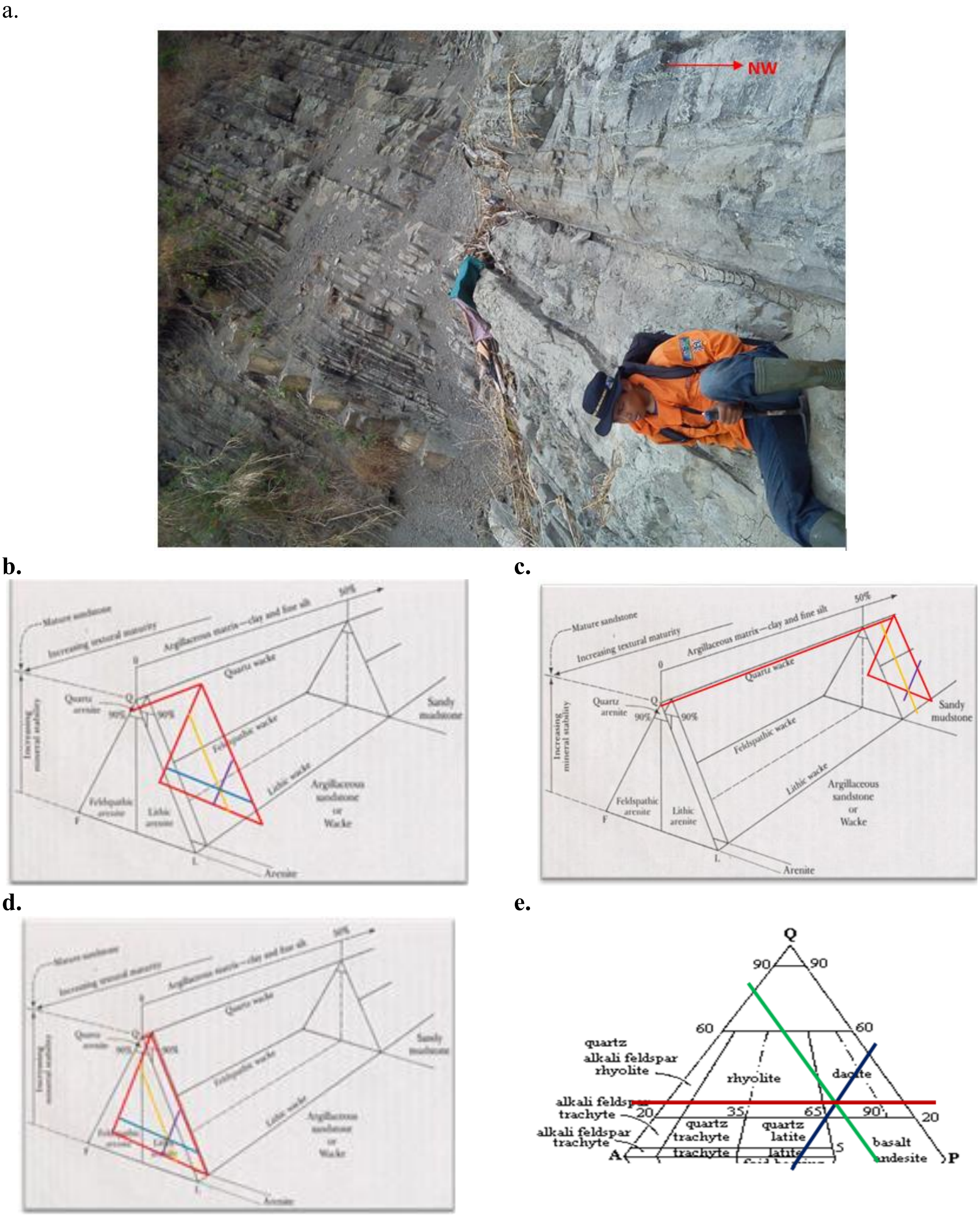


Figure 4. a. The appearance of the CN 53 sandstone-claystone outcrop; **b.** Placement of sandstone composition [11]; **c.** Placement of claystone composition [11]; **d.** Placement of matrix composition [11]; **e.** Placement of breccia fragment composition [12]

3. Diorite Intrusion Unit
   This unit consists of diorite igneous rock which occupies 10% of the study area with an estimated thickness of more than 400 m based on measurements of the geological cross-section of the study area. Diorite intrusion has the characteristics of grey colour, faneric texture, massive structure, mineral composition: pyroxene, plagioclase, quartz, biotite where the distribution is located in the eastern part of the study area with surrounding sandstone units. Based on the analysis of field data in the form of stratigraphic equalization of units and geological structures that developed in this area, the age of this unit is obtained, namely the late Miocene. The stratigraphic relationship of

the Diorite Intrusion Unit with the underlying rock units (Claystone Unit and Sandstone Unit) is inconsistent because this unit is a breakthrough unit.

Figure 5. Diorite outcrop at CN 31 location

3.3. Geological Structure of Research Area

In the research area the geological structure that developed is the Polaga River Right Shear Fault with the fault plane extending from Southeast to Northwest (NE-SW) and the direction of the river N 335° E, Polaga River Left Shear Fault, Polaga River Anticlin, and Sarangkadu Syncline. The main structure is based on the results of kinematic analysis from the results of field data collection which is processed using the kinematic analysis method using a stereonet. Geological structure data that is processed in the form of joint scouring and brecciation which aims to reconstruct the direction of the main forces acting on the rock.

Table 1. Shear Fracture Data of River Polaga

No	Strike	Dip	No	Strike	Dip	No	Strike	Dip
1	230	46	18	344	77	35	154	66
2	140	66	19	244	45	36	90	71
3	87	82	20	190	45	37	356	85
4	144	62	21	92	71	38	192	46
5	240	56	22	154	61	39	87	70
6	154	79	23	265	82	40	328	77
7	260	51	24	2	74	41	330	72
8	170	46	25	345	65	42	64	51
9	72	74	26	270	74	43	150	74
10	160	62	27	155	44	44	255	62
11	290	72	28	257	62	45	142	69
12	175	74	29	75	62	46	4	82
13	65	71	30	84	55	47	200	74
14	335	85	31	345	36	48	320	58
15	245	47	32	64	55	49	246	67
16	352	86	33	155	75	50	315	76
17	256	49	34	87	70			

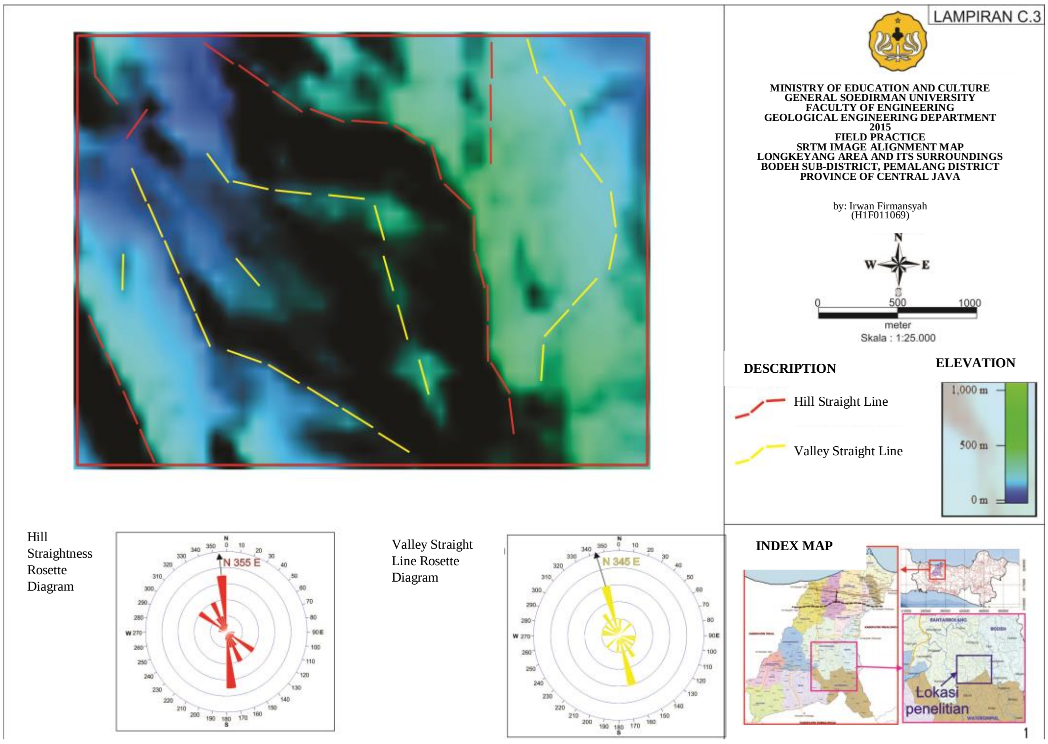


Figure 6. SRTM Image Straightness analysis of the research area

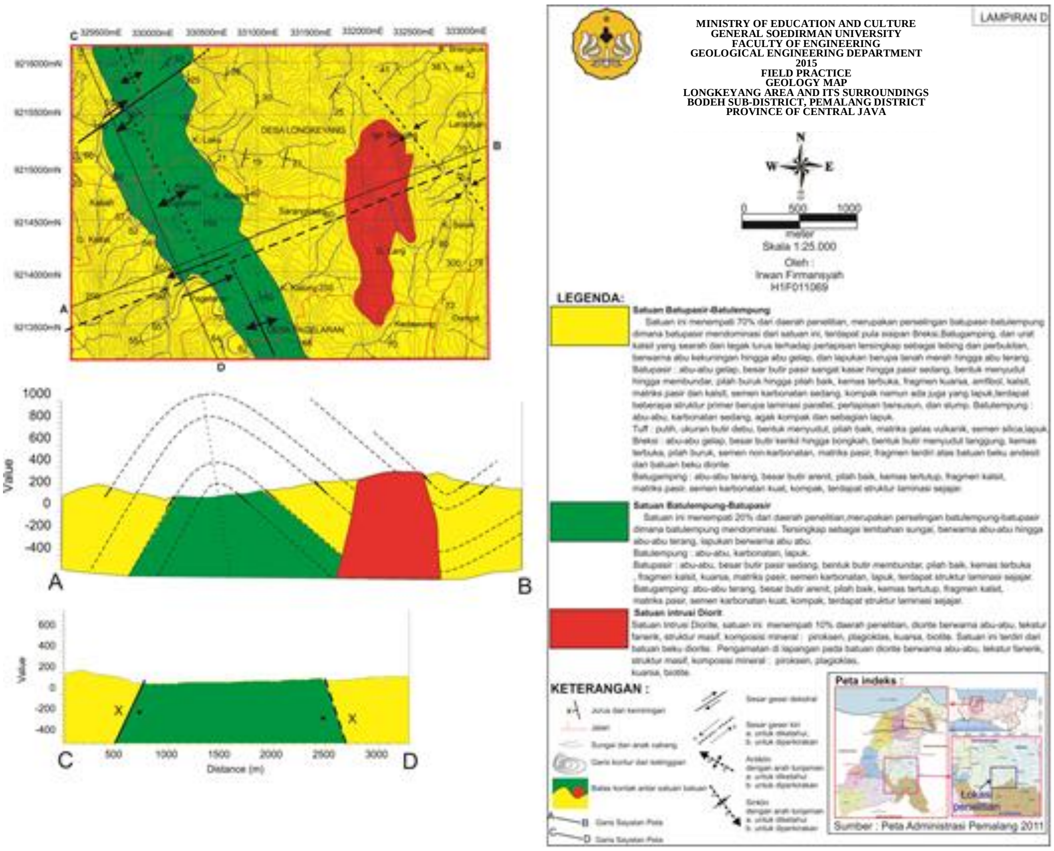


Figure 7. Geological map, structure, and its reconstruction located in the center of the study area

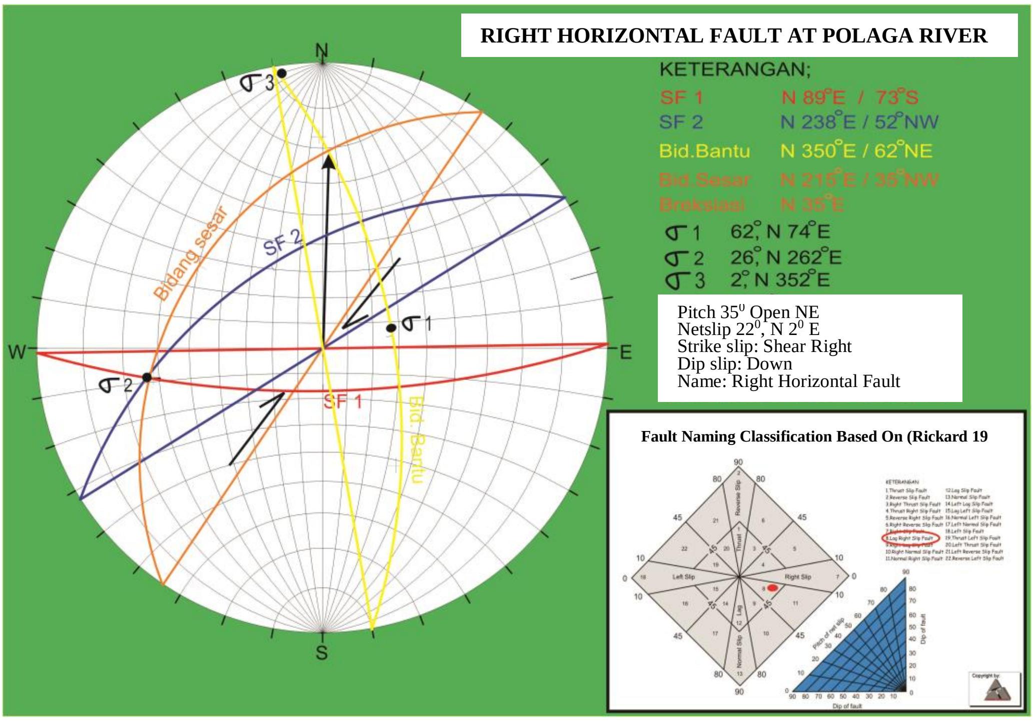


Figure 8. Analysis of the River Polaga fault on a stereonet

3.4. The Geological History of the Research Area

The results of the analysis obtained from mapping data, geomorphological data analysis, petrographic data, micropaleontology, stratigraphy, and structural data, it is known that the history of deposition began in the middle Miocene (N12-N13) in the Upper Bathyal environment. Then after the claystone-sandstone units were deposited, during the Middle Miocene – Late Miocene in the Deep Neritic environment, sandstone-claystone units were deposited with a turbidite deposition mechanism. At the time of the formation of the claystone-sandstone unit then exposed to structures that cause fractures around the Longkeyang area which then from these fractures' magma enters and intrusions are formed. This intrusion unit was formed during the Miocene, the age determination of this unit is based on the regional geology of the Purwokerto-Tegal sheet [13]. This unit breaks through older units, namely claystone-sandstone units at several locations. This unit breaks through the rock layer (dike). then during the late Pliocene-early Pleistocene tectonic processes occurred which caused the uplift of the island of Java. then during the quarter there are folding and faulting with the source of the NE-SW force, so that the pattern of folds and faults formed is NE-SW. Then deformation, weathering, erosion, and sedimentation occurred, resulting in the morphology as it is today.

3.5. The Geological Potential of Research Area

Based on the results of field observations and data analysis that has been carried out, the results of the geological potential in the research area include the potential of geological resources that can be managed and benefit the community where in the research area there is potential in the form of diorite mining, sand and stone mining in the River Polaga river area and indications The presence of gold is located in the area of Mount Lanji, the Kalo Polaga river and in the River Kaeng area. Meanwhile, potential geological disasters are areas that are prone to disasters caused by geological factors and can threaten public safety. The potential for geological disasters found in the research area is in the form of potential vulnerability to landslides or landslides.

a.

b.

c.

d.

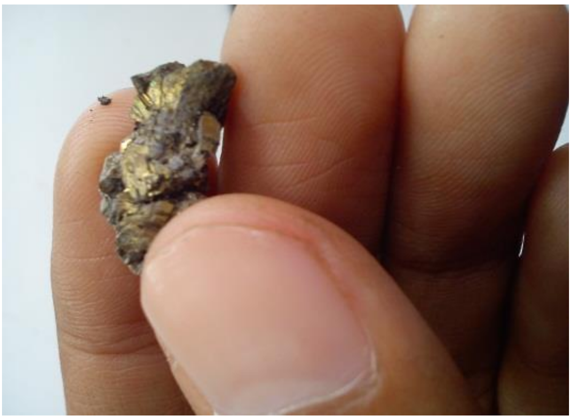


Figure 9. a. Diorite mining in the Mount Lanji area; **b.** Sand and stone mining in the River Polaga area; **c.** Indication of the presence of gold in River Keang; **d.** Indication of the presence of gold in River Keang

Figure 10. The ground movement that occurred in the Polaga River area

4. Conclusion

Based on the results of the research and data analysis, it was concluded that the Geomorphological unit of the research area was divided into 4 (four), namely the Mount Ketos Homocline Hills Unit, the Polaga River Anticline Valley Unit, the Sarangkadu Cylindrical Hills Unit, and the Mount Lanji Intrusion Hills Unit. Classification using the classification of the shape of the Earth's surface.

The geology of the study area consists of three rock units in order from oldest to youngest, namely the claystone-sandstone unit and the sandstone-claystone unit and the diorite intrusion unit.

The geological structure of the pinnacle area is in the form of folds and faults, namely, Polaga River Anticlines, Sarangkadu Synclines, Polaga River Right Shear Fault, Polaga River Left Shear Fault. The movement of the dominated structures is relevant with the GPS record as result from subduction of Eurasia – Hindi-Australia [14]

The geological history of the study area begins with the deposition of claystone-sandstone units during the Middle Miocene in the Upper Bathyal environment. Furthermore, after the claystone-sandstone units were deposited, during the Middle Miocene – Late Miocene in the Deep Neritic environment, sandstone-claystone units were deposited with a turbidite deposition mechanism. At the time of the formation of the claystone-sandstone unit then exposed to structures that cause fractures around the Longkeyang area which then from these fractures' magma enters and intrusions are formed. This unit breaks through older units, namely claystone-sandstone units at several locations. This unit breaks through the rock layer (dike). then during the late Pliocene-early Pleistocene tectonic processes occurred which caused the uplift of the island of Java. then during the quarter there are folding and faulting with the source of the NE-SW force, so that the pattern of folds and faults formed is NE-SW. Then deformation, weathering, erosion, and sedimentation occurred, resulting in the morphology as it is today.

The geological resource potential of the research area is the utilization of river deposits in the form of chunks of igneous rock, river sand deposits and indications of the presence of gold. While the potential for geological disasters in the form of landslides.

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