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Geological Mapping of Gunungbatu and Surrounding Areas, Bodeh District, Pemalang Regency, Central Java

Fajar Rizki Widiatmoko*[1], Mochammad Aziz[2], Irwan Firmansyah[2]
[1] Faculty of Mineral and Marine Technology, Institute of Technology Adhi Tama Surabaya
[2] Department of Geological Engineering – University of Jenderal Soedirman
*e-mail: widiatmokogeo@gmail.com

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Abstract

Mapping is the activity of collecting data from an area to be mapped, in the context of geology mapping means collecting data that includes descriptions of rocks, rock structures, rock positions, structure measurements (plunge/trend, pitch, microfold), rock thickness measurements, rock sampling and sketches. landscape, covering an area to be mapped. Research in the area of Gunungbatu and its surroundings, Bodeh District, Pemalang Regency, Central Java Province with the aim of knowing and knowing that it is in the research area by reconstructing the history of formation or geomorphological history, merely tectonic history in space and time, reconstructing geological history based on micropaleontological analysis. Based on the analysis carried out, it was found that the geomorphological units of the study area were divided into 5, namely the Gunungbatu Syncline Hills Unit, the Kali Bodas Anticline Valley Unit, the Girimulya Syncline Hills Unit, the Cenggiri Homocline Hills Unit and the Kebubung Homocline Valley Unit. The geology of the study area consists of two unofficial rock units in order from oldest to youngest, namely the claystone-sandstone unit and the sandstone-claystone unit. The geological structures of the pinpoint folds and faults are Mount Ketos Syncline, Kali Bodas Anticline, Gapura Syncline, Pertapan Igir Syncline, Cenggiri River Rising Fault, Kebubung Dextral Fault, and Girimulya Dextral Fault. The geological history of the research area begins with the book Unit of Claystone in the Middle Miocene Environment in Upper Bathyal. Furthermore, after the claystone-sandstone units were deposited, during the Middle Miocene – Late Miocene in the Deep Neritic Environment, the sandstone-claystone units were deposited with a turbidite mechanism. As well as the geological resource potential of the research area in the form of river utilization in the form of chunks of igneous rock, river sand deposits and gold seepage. Meanwhile, the potential for geological disasters in the form of landslides.

1. Introduction

Mapping is an activity of collecting data from an area to be mapped, where in the context of geology mapping means collecting data covering descriptions of rocks, rock structures, rock positions, structural measurements (plunge/trend, pitch, microfold), rock thickness measurements, rock sampling and landscape sketch, covering an area to be mapped. Where the data recording journey will become a geological trajectory map, then the trajectory map will become a data distribution that represents each part of the mapped area, until finally the rock units are drawn and become a Geological Map. Drawing structures, drawing patterns of the earth's surface, and sketches will become data for drawing landscape units which will later become Geomorphological Maps.

Geological map is a map that provides an overview of the distribution and arrangement of rocks in an area by using colors or symbols, while the signs seen in it can provide a three-dimensional reflection of the arrangement of rocks below the surface. Geomorphological map is a map that provides an overview of the current morphology so that it can be used as a means of initial interpretation which includes lineament patterns, river patterns and landslide zones of an area.

The general research objectives are to determine and identify the research area by reconstructing the history of formation or geomorphological history, reconstructing tectonic history in space and time, reconstructing geological history based on micropaleontological analysis.

2. Methodology

In this practical field work activity in geological mapping, survey methods are used 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 the field research stage, a trajectory map is made, observations of rock outcrops, morphology of the research area, structural measurements, and observations of geological resources and disaster sources in the surrounding area are carried out. Meanwhile, in the laboratory research phase, petrographic analysis and fossil analysis were carried out.

The methods of data collection are: (1) surface data collection is carried out directly in the field using tools, (2) data collection with or without using tools, (3) data collection includes primary and secondary data collection.

The object of this research is fieldwork practice on geological mapping, covering several aspects including aspects of lithology, geomorphology, sedimentology, stratigraphy, structural geology, historical geology as well as excavation materials found in the research area.

3. Results

3.1. Geomorphology of the Research Area

3.1.1 Straightness Pattern

The analysis of the lineament pattern of the study area is based on observations from the results of the straight line drawing from the SRTM (Shuttle Radar Topography Mission) image. The straightness found is in the form of hill straightness and valley straightness [1]. Based on the results of image observations, it is found that the dominant straightness is in the NW-SE direction, this reflects the orientation of the folds and faults in the study area.

Tabel 1. Linearity data from SRTM image

No	Hill lineament	Valley lineament	No	Hill lineament	Valley lineament	No	Hill lineament	Valley lineament
1	N 317^0 E	N 130^0 E	13	N 323^0 E	N 289^0 E	25	N 358^0 E	N 350^0 E
2	N 311^0 E	N 133^0 E	14	N 315^0 E	N 311^0 E	26	N 354^0 E	N 343^0 E
3	N 308^0 E	N 131^0 E	15	N 3^0 E	N 302^0 E	27	N 334^0 E	N 13^0 E
4	N 352^0 E	N 171^0 E	16	N 353^0 E	N 311^0 E	28	N 327^0 E	N 312^0 E
5	N 337^0 E	N 171^0 E	17	N 330^0 E	N 323^0 E	29	N 323^0 E	N 328^0 E
6	N 314^0 E	N 109^0 E	18	N 342^0 E	N 332^0 E	30	N 312^0 E	N 14^0 E
7	N 315^0 E	N 188^0 E	19	N 356^0 E	N 305^0 E	31	N 333^0 E	N 315^0 E
8	N 318^0 E	N 190^0 E	20	N 330^0 E	N 225^0 E	32	N 327^0 E	N 311^0 E
9	N 311^0 E	N 161^0 E	21	N 318^0 E	N 347^0 E	33	N 316^0 E	N 291^0 E
10	N 346^0 E	N 162^0 E	22	N 330^0 E	N 340^0 E	34	N 323^0 E	N 292^0 E
11	N 306^0 E	N 229^0 E	23	N 349^0 E	N 304^0 E	35	N 316^0 E	N 298^0 E
12	N 302^0 E	N 224^0 E	24	N 345^0 E	N 316^0 E	36	N	N 282^0 E

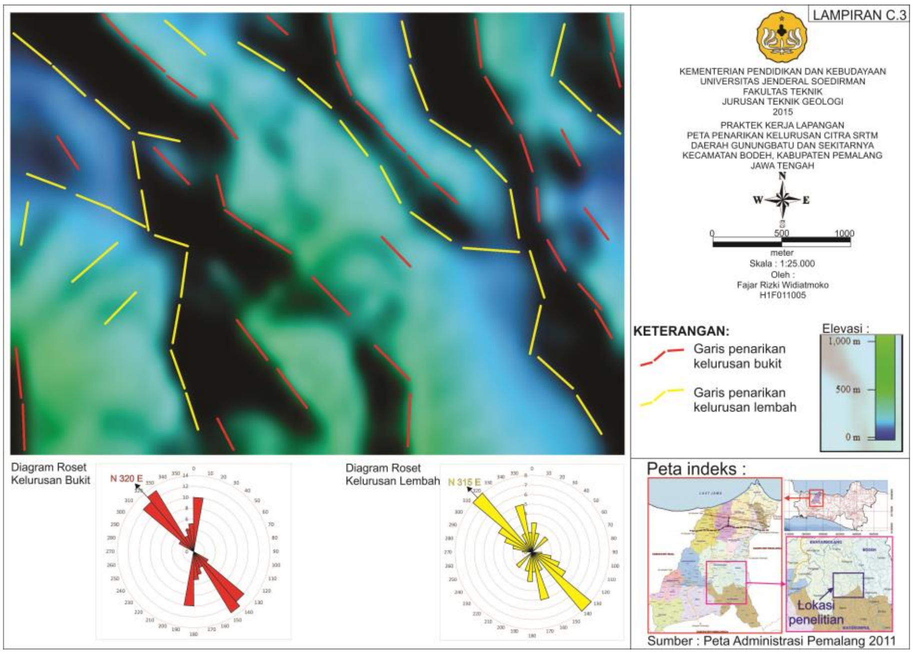


Figure 1. SRTM map with hill and valley lineage draw, dominant direction NW-SE

3.1.2 River flow patterns and river genetic types

The study area has two river flow patterns, including trellis and sub-dendritic [2] [3]. The flow pattern is determined based on the interpretation of the topographic map before heading to the research location, then its characteristics are observed at the location.

The research area in more detail has different genetic types, including Obsequence (O), Sequence (R), and Subsequent (S). it is determined by the results and conditions at the research site based on the position of the rock, slope conditions, and the actual direction of the river [4].

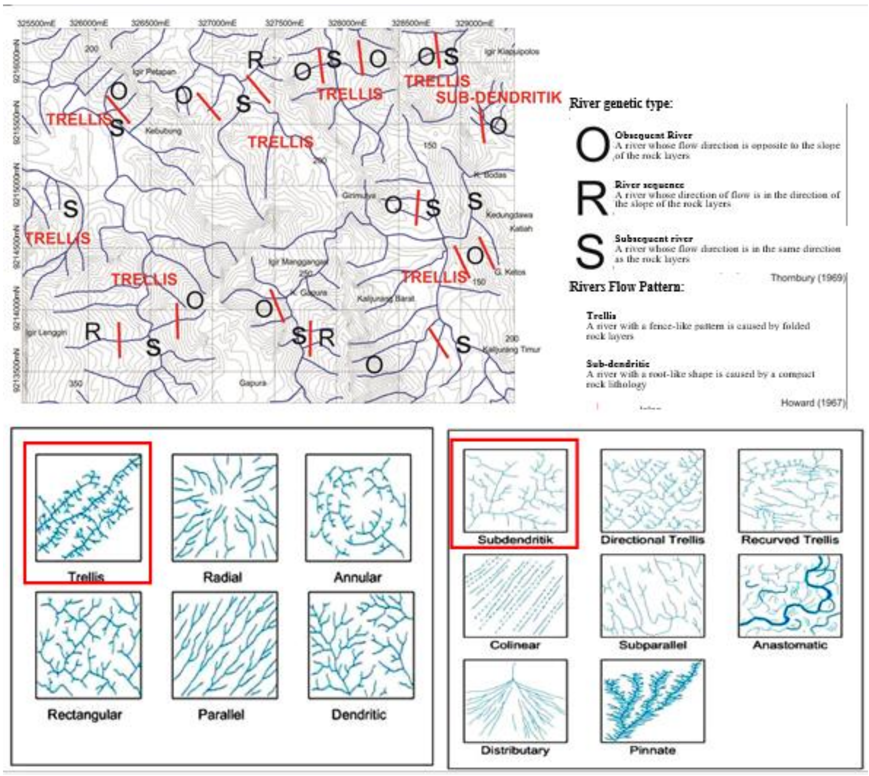
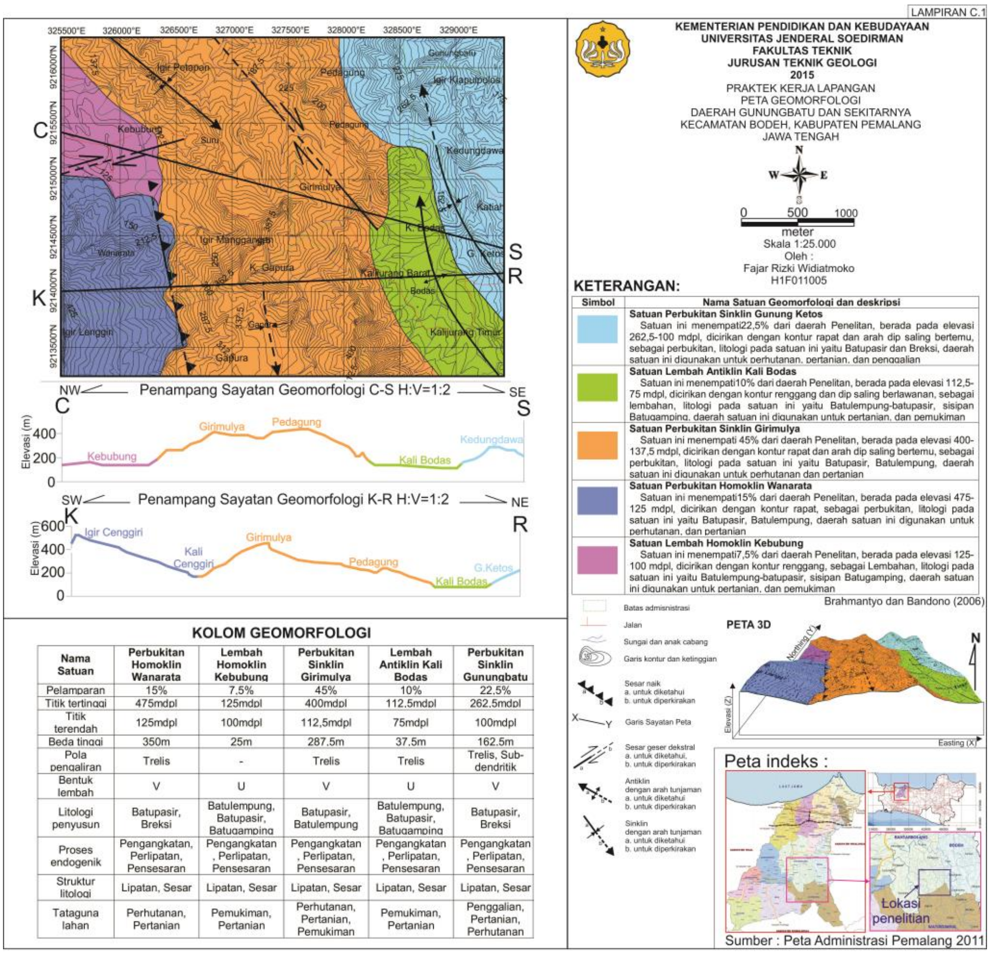


Figure 2. Pembagian pola pengaliran sungai dan pembagian tipe genetik sungai (atas), pembagian pola aliran sungai menurut [2] dan [3] (bawah)

3.1.2 Geomorphological Unit

The research area is divided into 5 geomorphological units, namely the Gunungbatu Syncline Hills Unit, the Kali Bodas Anticline Valley Unit, the Girimulya Syncline Hills Unit, the Wanarata Homocline Ridge Unit, and the Kebubung Homocline Valley Unit.



Nama Satuan	Perbukitan Homoklin Wanarata	Lembah Homoklin Kebubung	Perbukitan Sinklin Girimulya	Lembah Antiklin Kali Bodas	Perbukitan Sinklin Gunungbatu
Pelamparan	15%	7.5%	45%	10%	22.5%
Titik tertinggi	475mdpl	125mdpl	400mdpl	112.5mdpl	262.5mdpl
Titik terendah	125mdpl	100mdpl	112,5mdpl	75mdpl	100mdpl
Beda tinggi	350m	25m	287.5m	37.5m	162.5m
Pola pengaliran	Trelis	-	Trelis	Trelis	Trelis, Sub-dendritik
Bentuk lembah	V	U	V	U	V
Litologi penyusun	Batupasir, Breksi	Batulempung, Batupasir, Batugamping	Batupasir, Batulempung	Batulempung, Batupasir, Batugamping	Batupasir, Breksi
Proses endogenik	Pengangkatan, Perlipatan, Pensesaran	Pengangkatan, Perlipatan, Pensesaran	Pengangkatan, Perlipatan, Pensesaran	Pengangkatan, Perlipatan, Pensesaran	Pengangkatan, Perlipatan, Pensesaran
Struktur litologi	Lipatan, Sesar	Lipatan, Sesar	Lipatan, Sesar	Lipatan, Sesar	Lipatan, Sesar
Tataguna lahan	Perhutanan, Pertanian	Pemukiman, Pertanian	Perhutanan, Pertanian, Pemukiman	Pemukiman, Pertanian	Penggalian, Pertanian, Perhutanan

Figure 3. Geomorphological map of the research area

Figure 4. The Gunungbatu syncline hills unit was photographed from the west Kalijurang hill

Figure 5. The Kali Bodas anticline valley unit was photographed from the West Kalijurang hill

Figure 6. Girimulya syncline hills unit photographed from Mount Ketos

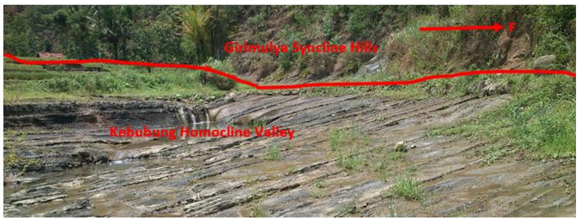


Figure 7. The Kebubung homocline valley unit photographed from the kebubung river

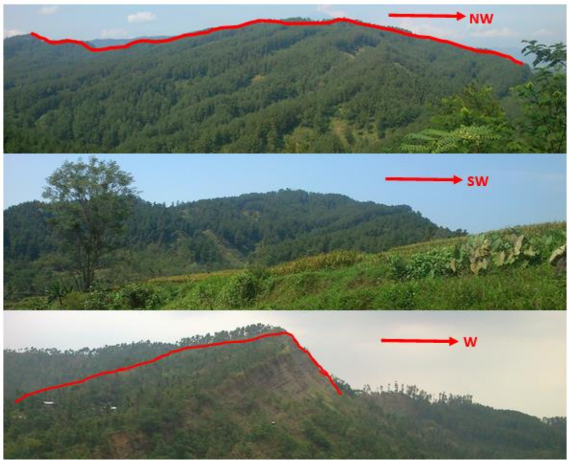


Figure 8. Wanarata Homocline Hills Unit photographed from Gapura hill (top), photo from Cenggiri river (middle), photo from kebubung (bottom).

3.2. Geological Structure of Research Area

Based on the results of field research and data analysis, it is known that the geological structures that developed are shear fractures, tension fractures, brecciation zones, folds and faults. Folds in the form of anticlines are in Kali Bodas and synclines in Mount Ketos, Igir Petapan, and Gapura. Upward fault in the study area, namely the Cenggiri River rising fault and the shear fault in the study area, namely the Girimulya shear fault.

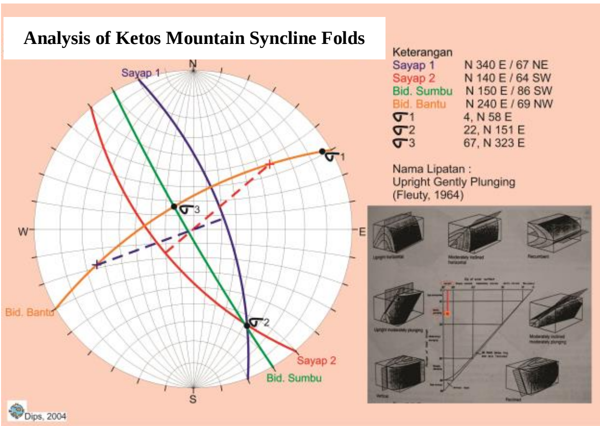


Figure 9. Mount Ketos syncline analysis

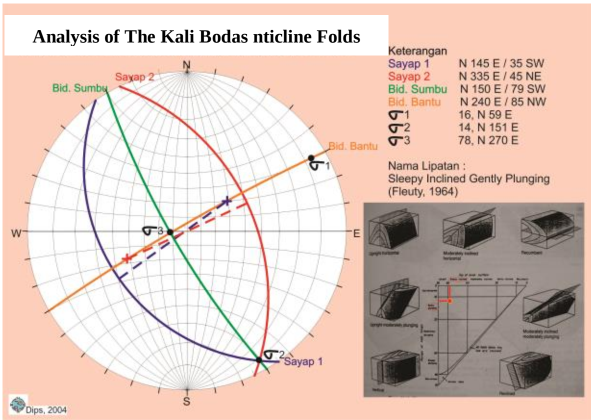


Figure 10. Kali Bodas anticline analysis

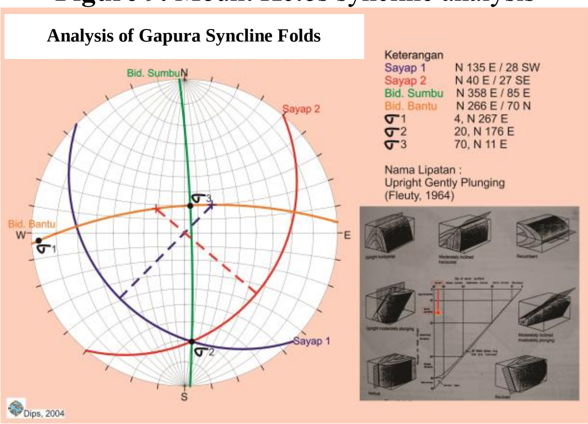


Figure 11. Gapura syncline analysis

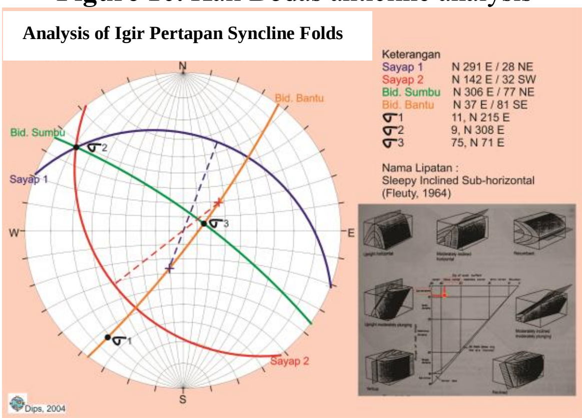


Figure 12. Igir Pertapan syncline analysis

The Girimulya descending dexral fault is found in the Girimulya river which is in the northern part of the study area, based on the direction of the SRTM image, the dominant orientation is NW-SE. The shear fracture data was found in the upstream of the Girimulya river at the JN 27 location which was also proven by the bend of the river.

Table 2. JN 27 shear fracture measurement data

No	SF1(N..^{0}E/..^{0})	SF2(N..^{0}E/..^{0})	No	SF1(N..^{0}E/..^{0})	SF2(N..^{0}E/..^{0})
1	28 / 79	166 / 71	10	30 / 76	152 / 86
2	24 / 87	105 / 50	11	41 / 85	183 / 63
3	40 / 68	94 / 68	12	22 / 74	168 / 70
4	23 / 64	154 / 79	13	21 / 76	139 / 68
5	21 / 86	189 / 85	14	26 / 74	182 / 70
6	25 / 83	200 / 64	15	27 / 78	218 / 63
7	26 / 85	155 / 58	16	35 / 79	167 / 85
8	27 / 75	167 / 69	17	28 / 73	168 / 84
9	29 / 79	172 / 79	18	26 / 76	170 / 72
10	30 / 76	152 / 86	19	40 / 85	157 / 71

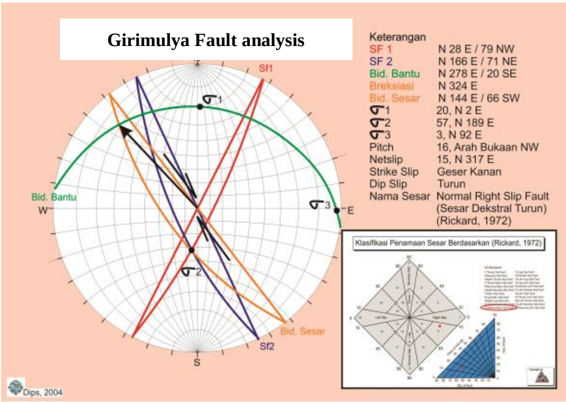


Figure 13. Girimulya fault analysis with result the normal right slip fault

Figure 14. Offset photo of the Girimulya descending dextral fault (above), Photo of the location of the JN 27 shear fracture data collection (bottom)

The Cenggiri River fault is found in the Cenggiri river in the western part of the study area, based on the SRTM image in the area, the dominant orientation direction is N-S. The shear fracture data was found in the Cenggiri River outcrop at the JN 42 location as evidenced by the presence of a waterfall.

Table 3. JN 42 shear fracture measurement data

No	SF1 (N..^{0}E/..^{0})	SF2 (N..^{0}E/..^{0})	No	SF1 (N..^{0}E/..^{0})	SF2 (N..^{0}E/..^{0})
1	125 / 25	67 / 14	11	131 / 30	57 / 6
2	100 / 30	80 / 20	12	129 / 22	72 / 17
3	111 / 28	50 / 8	13	114 / 28	67 / 9
4	124 / 18	66 / 10	14	132 / 19	68 / 10
5	139 / 29	58 / 7	15	118 / 32	66 / 14
6	128 / 27	74 / 9	16	126 / 18	71 / 15
7	115 / 25	59 / 15	17	134 / 29	58 / 13
8	127 / 24	58 / 13	18	124 / 21	61 / 23
9	118 / 18	69 / 16	19	126 / 28	78 / 22
10	130 / 31	70 / 18	20	135 / 22	72 / 10

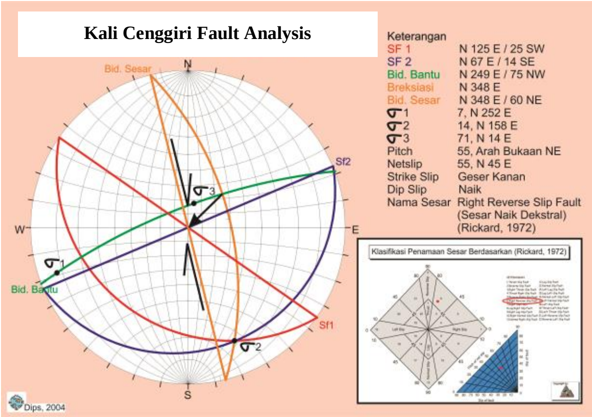


Figure 15. Kali Cenggiri fault analysis with result the right reverse slip fault

Figure 16. Photo of JN 43 Cenggiri waterfall (above), Photo of JN 42 shear fracture data collection location (bottom)

The Kebubung dextral fault is found in the Kebubung river which is in the north east of the study area, a slight lineage is found from the NE-SW oriented SRTM image. The shear fracture data was found in the outcrop of the Kebubung river at the JN 40 location.

Table 4. JN 40 shear fracture measurement data

No	SF1(N..^{0}E/..^{0})			SF2(N..^{0}E/..^{0})			No	SF1(N..^{0}E/..^{0})			SF2(N..^{0}E/..^{0})		
1	229	/	52	295	/	78	6	223	/	64	291	/	82
2	235	/	42	301	/	69	7	230	/	45	299	/	79
3	224	/	63	272	/	83	8	226	/	58	300	/	83
4	215	/	54	284	/	71	9	231	/	51	290	/	79
5	243	/	42	324	/	66	10	235	/	50	295	/	86

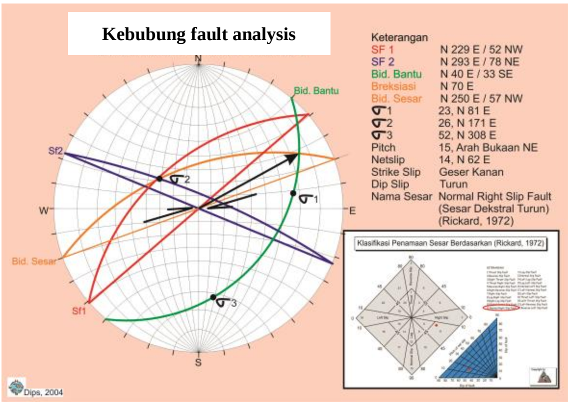


Figure 15. Kebubung fault analysis with result the normal right slip fault

Figure 16. Photo of the location of data collection for the JN 40 shear fracture.

3.3. *Mechanism of Formation of Geological Structure*

Based on the results of data analysis, the results of the geological structure that developed in the study area were as described above. The structure is formed due to the sources of force acting on it.

The source of the N-S-oriented force comes from the tectonic activity of the Eurasian plate colliding with the Australian plate, which is where the Eurasian plate moves to the south, and the Australian plate moves to the north, so that the direction of the resulting force source is the N-S pattern. From this structure, it can be determined that the tectonic activity that occurred in the formation of this geological structure was during the Late Pliocene-Early Pleistocene [5] in [6]. The source of the N-S orientation style has little effect on the research location, the direction of the force at the research location is more oriented to the main force on the NE-SW.

The source of the NE-SW oriented style comes from the style that emerges from the orogenesis of the volcanic activity of Mount Slamet Muda, where in the research area, Mount Slamet Muda is in the SW direction from the research location, this becomes an interpretation of the pattern of forces that appear in the field in the form of folds and the shear fault that surrounds Mount Slamet. This style appears on the young slopes of Mount Slamet. Loose material deposited on the slopes of Mount Slamet becomes a source of gravity mechanism load, so that on the slopes of Mount Slamet it will produce a slip zone in the form of a down fault, from the fault down on the slope it will produce a force on the rock formations at the foot of Mount Slamet, at the foot of the mountain. the Mount Slamet will be the fold zone. While the shear fault is generated from the difference in the speed of each side of the mountain slide, this is due to the difference in the amount of mass and the slope of the slope itself, so that the speed of the Mount Slamet mountain slide will be different [7]. The age of this pattern is estimated at the age of the quarter after the deposition of young Slamet mountain material.

3.4. Stratigraphy of Research Area

Based on petrographic and micropaleontological analysis, the results of the stratigraphy of the Gunungbatu area and its surroundings are sorted from old to young, namely:

1. Unit of Claystone - Sandstone
   This unit occupies 20% of the research area and has a thickness of 344 m. on the geological map and stratigraphic column of the study area, this unit is coloured green. This claystone-sandstone unit consists of interspersed claystone with sandstone and there are also limestone inserts. The distribution of this rock unit in the Kali Bodas and Kebubung areas.

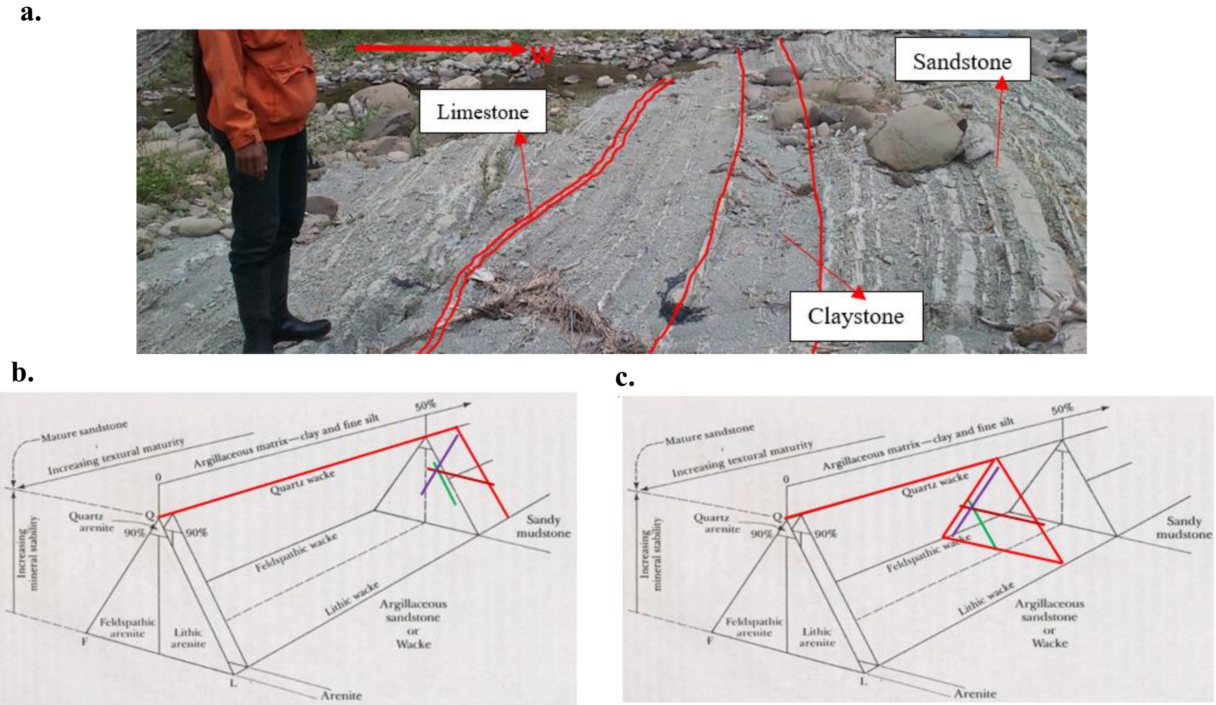
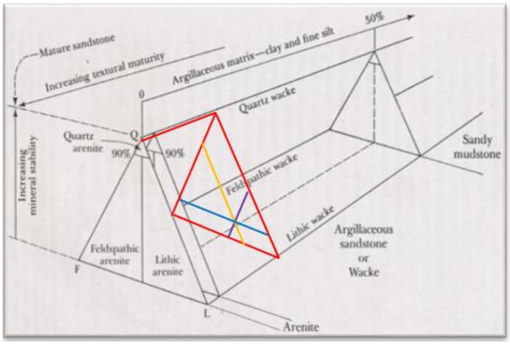


Figure 17. a. The appearance of the CN 19 claystone-sandstone outcrop; **b.** Placement of claystone composition [8]; **c.** Placement of sandstone composition [8]

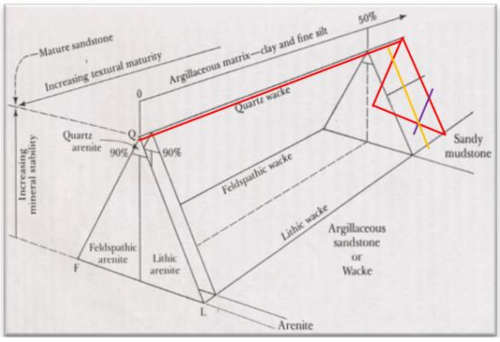
2. Unit of Sandstone - Claystone
   This unit occupies 80% of the research area and has a thickness of ± 1165 m. This sandstone-claystone unit consists of sandstone – claystone, tuff inserts. The distribution of these rock units is in the Cenggiri, Gapura, Ketos, Gunungbatu, Girimulya, and Igir Pertapan areas. The results of micropaleontological analysis found planktonic fossils showing the age range of N13-N16 [9] and equivalent to the age of the vines formation with the age of Middle Miocene - Late Miocene where the unit deposition occurred in the deep neritic zone environment (0-30 m) [10].

a.

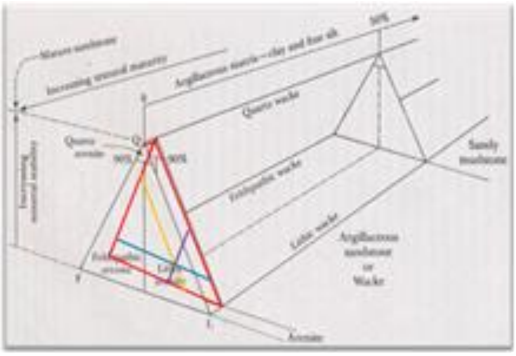
b.



c.



d.



e.

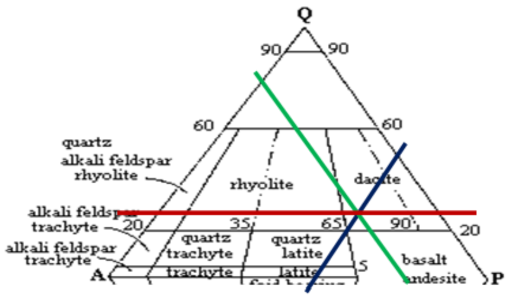


Figure 18. a. The appearance of the outcrop of sandstone-claystone JN 043; **b.** Placement of sandstone composition [8]; **c.** Placement of claystone composition [8]; **d.** Placement of matrix composition [8]; **e.** Placement of breccia fragment composition [11]

3.4. 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 with a depth of about ± 250 - 400 m. Then after the claystone-sandstone units were deposited, during the Middle Miocene – Late Miocene, the sandstone-claystone units in the Outer Neritic environment were aligned with the turbidite current deposition mechanism.

In the Pleo-Pliocene when all the rock units have been deposited, there is a single phase of the compression force which causes a fault and reaches its peak in the late Pliocene-early Pleistocene. The tectonic process also caused the uplift and most of the island of Java has become land, in the study area the recording of the force appears on the Girimulya dextral fault. then during the quarter there were folding and faulting with the source of the NE-SW trending force which was estimated to be from young Mount Slamet.

After all rock units are deposited, deformation and intensive exogenous processes such as weathering, erosion, transportation and sedimentation occur, resulting in the morphological state of the study area as it is today.

3.5. Geological Potential of Research Area

Based on the results of field observations and data analysis that has been carried out, positive potential results in the research area in the form of stone mining potential in the Kebubung Hamlet along the Rambut River, and the Kali Bodas area. In addition, there is a potential for sand mining that has been excavated by the local community, namely in the area of Mount Ketos and there is oil seepage in Kali Bodas. Meanwhile, the negative potential in the research area is in the form of potential vulnerability to landslides or landslides.

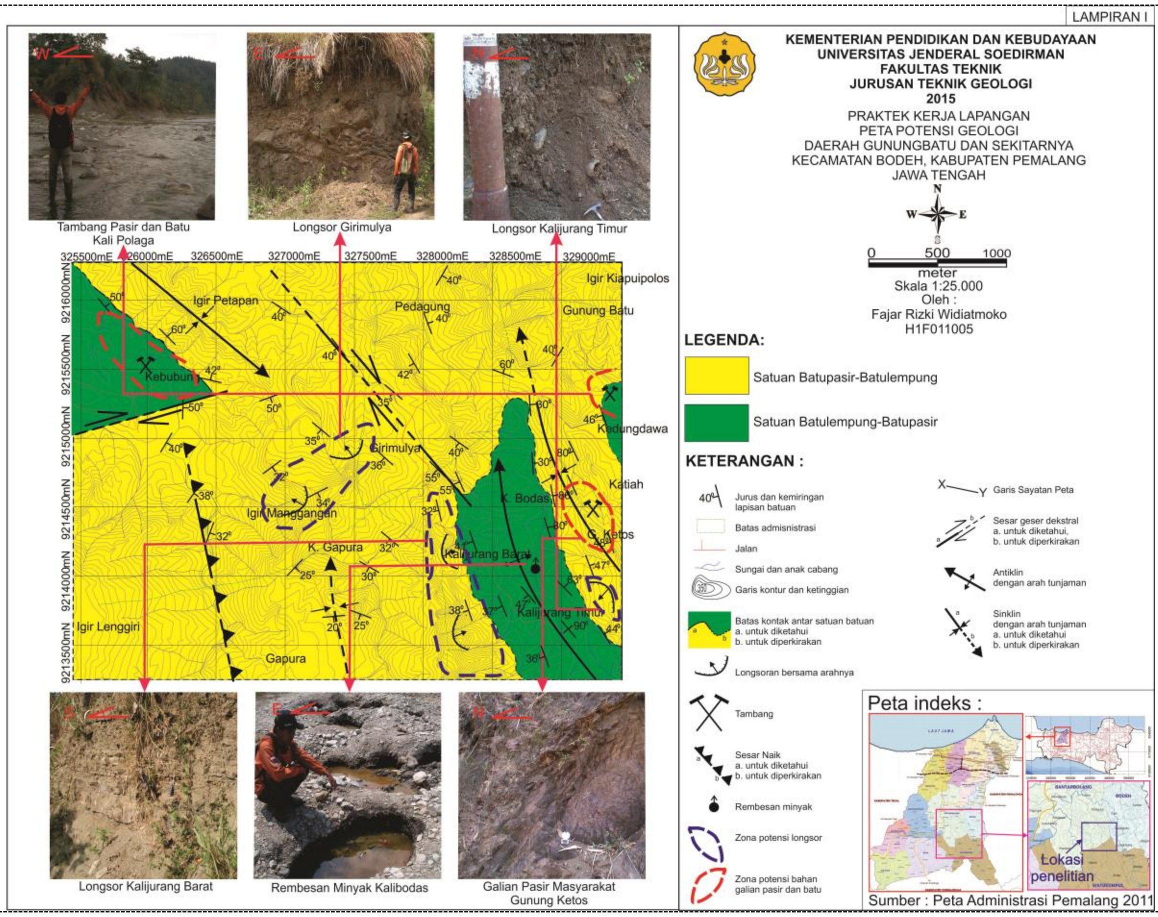


Figure 19. Geological potential map

4. Conclusion

Based on the results of the geological mapping conducted in Gunungbatu Village and its surroundings, several conclusions can be drawn, including:

a. The geomorphological units of the study area are divided into 5, namely the Gunungbatu Syncline Hills Unit, the Kali Bodas Anticline Valley Unit, the Girimulya Syncline Hills Unit, the Cenggiri Homocline Hills Unit and the Kebubung Homocline Valley Unit. Classification using the classification of Earth's Shapes.

b. The geology of the study area consists of two unofficial rock units in order from oldest to youngest, namely the Claystone-Sandstone Unit and the Sandstone-claystone Unit.

c. The geological structure of the pinnacle area is in the form of folds and faults, namely, Mount Ketos Syncline, Kali Bodas Anticline, Gapura Syncline, Pertapan Igir Syncline, Cenggiri River Rising Fault, Kebubung Dextral Fault, and Girimulya Dextral Fault. The structural pattern is relevant with the movement of the dominated structures is relevant with the GPS record as result from subduction of Eurasia – Hindi-Australia.

d. 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. 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 occur so as to produce the morphology as it is today.
e. 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 oil seepage. While the potential for geological disasters in the form of landslides.

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