International Journal of Multidisciplinary and Current Educational Research (IJMCER)
ISSN: 2581-7027 ||Volume|| 6 ||Issue|| 3 ||Pages 14-21 ||2024||

Analysis of the Geological Structure of Wukirsari and Surrounding Areas, Imogiri District, Bantul Regency, Yogyakarta D.I. Province

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ABSTRACT. One of the regions in Indonesia with favorable geological conditions is the Wukirsari Village, Imogiri District, Bantul Regency, D.I. Yogyakarta Province. This research focuses on the geological structure analysis in the study area located within the Semilir Formation. The research site is situated in the Southern Mountains of Java, intersecting the Meratus and Jawa Patterns. The lithological conditions consist of units of interbedded sandstone tuff and tuff, as well as Andesite Breccia units and Andesite intrusion in the Nglanggran Formation. Regionally, the main structures in Java's Southern Zone are dominated by Northeast-Southwest-oriented faults. This study focuses on identifying fault structures, interpreted through stereonet analysis. Field observations and data analysis results indicate the presence of two fault structures in the study area, namely the Oblique Fault (Thrust-Sinistral Slip) in Wukirsari and Normal Slip Fault in Bawuran. This identification is supported by evidence such as layer offsets, the presence of fault planes, and the existence of fault damage zones. Measurements and stereonet analysis provide further information on the characteristics of fault structures. This research makes a significant contribution to understanding the geological structure in the study area, serving as a basis for evaluating geological disaster risks and planning ntural resource management in this region.

KEYWORDS: Geological Structure, Faults, Wukirsari, Bantul, Yogyakarta

I. INTRODUCTION

Geology stands as a paramount discipline in unraveling the intricate tapestry of Earth's dynamics. Through its lens, we gain profound insights into geological frameworks, the elemental composition of our planet, and the myriad processes sculpting its present state. This pursuit of knowledge finds its crucible in regions where geological formations lay bare, compelling scholarly inquiry to decipher their genesis. Our focus rests within the precincts of the Special Region of Yogyakarta Province, specifically in Bantul Regency's Imogiri District, enshrouding Wukirsari Village. Geographically situated amidst the confluence of the Central Java Depression Zone and the Southern Mountain Zone, an amalgamation of the Meratus and Javanese Patterns unfolds. Notably, within the Southern Mountain Zone, the prevailing geological features manifest as Northeast-Southwest trending faults, their genesis delineated through meticulous gravity analysis (Untung & Sato, 1978). Our scrutiny unveils the intricate fabric of geological structures, notably the Wukirsari oblique fault and the Bawuran normal slip fault, ensconced within the Semilir Formation.

II. REGIONAL GEOLOGY

As per Van Bemmelen's delineation in 1949, Java Island delineates six distinct physiographic zones, including the Northern Java Alluvial Plain, the Northern Serayu Anticlinorium, and the Central Depression Zone characterized by Domes and Ridges, alongside the Central Depression Zone with Quaternary Volcanoes, and finally, the Southern Mountains. Our research area falls within the physiographic confines between the Central Java Depression Zone and the Southern Mountain Zone, the latter being further partitioned into three subzones: Baturagung, Wonosari, and Gunung Sewu (Harsolumekso et al., 1997 as cited in Bronto and Hartono, 2001). Surono's findings in 2009 shed light on the lithostratigraphy of the southern mountains, revealing a predominant composition of clastic and carbonate sediments mingled with Tertiary volcanic remnants. This geological chronicle unfolds with a stratigraphic succession encompassing the Wungkal Limestone Formation, Kebobutak Formation, Mandalika Formation, Semilir Formation, Jaten Formation, Wuni Formation, Nglanggran Formation, Sambipitu Formation, Nampol Formation, Oyo Formation, Wonosari Punung Formation, Kepek Formation, Baturetno Formation, and Alluvium (depicted in Figure 1). Our study focalizes within the Semilir Formation, typified by its alternating layers of sandstone, tuffaceous sandstone, and tuff, and the Nglanggran Formation, characterized by andesitic breccia units interspersed with alluvial deposits and andesite intrusions. In

broader strokes, Java's structural tapestry unravels across four principal orientations: Northeast-Southwest, known as the Meratus Pattern; North-South, designated the Sunda Pattern; East-West, recognized as the Javanese Pattern; and Northwest-Southeast, denoted as the Sumatra Pattern (Pulunggono and Martodjojo, 1994; Satyana, 2007) (see Figure 2). Our research domain, nestled within the Southern Mountain Zone, stands at the crossroads of the Meratus and Javanese Patterns. Here, while regional folding remains indistinct, the landscape is punctuated by Northeast-Southwest trending faults, their presence deciphered through meticulous gravity analysis (Untung & Sato, 1978). These findings contribute significantly to our understanding of the geological dynamics shaping the region. Moreover, the interplay between lithostratigraphy and structural patterns provides invaluable insights into the geological history and evolution of Java Island, underscoring the importance of interdisciplinary approaches in unraveling its geological complexities. Within our study area, the intricate geological composition and structural features provide a rich tapestry for investigating the geological processes that have shaped the landscape over time.

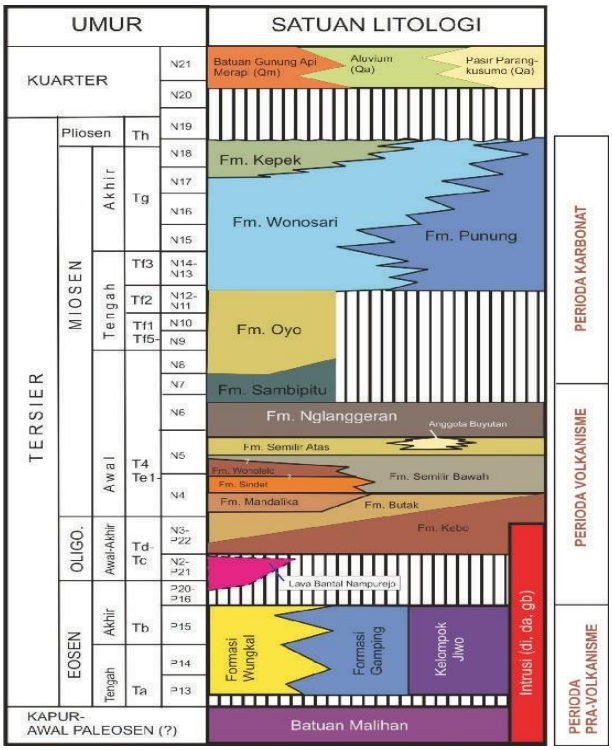

Figure 1. Stratigraphic Coloumn of Yogyakarta (Surono, 2009)

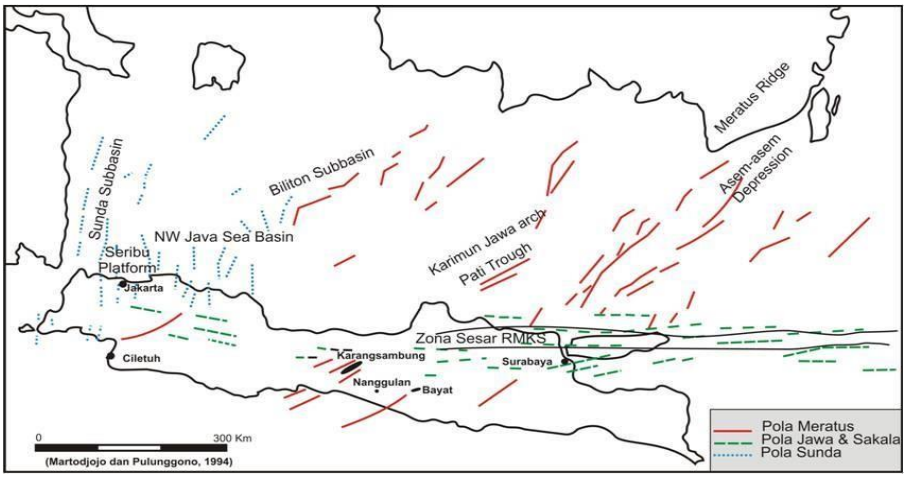

Figure 2. Structural trend in Jawa Islands (Pulunggono & Martodjojo, 1994)

III. METHOD

The research method employed in this study includes surface mapping, descriptive analysis, and laboratory analysis. Geological structure analysis utilizes the Streonet method with Dip software and fault classification based on Rickard's classification (1962). Multiple cross-sections are generated to determine the continuity of geological structures. Additionally, reconstruction and geological history analysis are conducted to discern differences in the various orders of geological structures formed. The research phases encompass literature review and research planning, field surveys, laboratory research involving structural and petrological analyses, and report compilation. The study area is situated in the Special Region of Yogyakarta Province, specifically in Bantul Regency, Imogiri District, encompassing Wukirsari, Segoroyoso, Wonolelo, Bawuran, and Pleret Villages. Geographically, the mapping area spans from 110° 24' 16.5564" –110° 27'00.1044" E and 7° 51' 37.5948" – 7° 53' 48.5772" S. The research area covers an area of 20 km2, with dimensions of 5 km in length and 4 km in width (see Figure 3). This study employs a comprehensive approach combining field observations, laboratory analyses, and geological reconstructions to unravel the geological structures and history of the study area. The use of advanced software such as Dip for structural analysis enhances the accuracy and reliability of the findings. By employing multiple methods, including surface mapping and cross-section analysis, this research aims to provide a thorough understanding of the geological features and processes shaping the region. Through meticulous analysis and interpretation, this study contributes valuable insights into the geological dynamics of the study area within the broader context of regional geology and tectonic evolution.

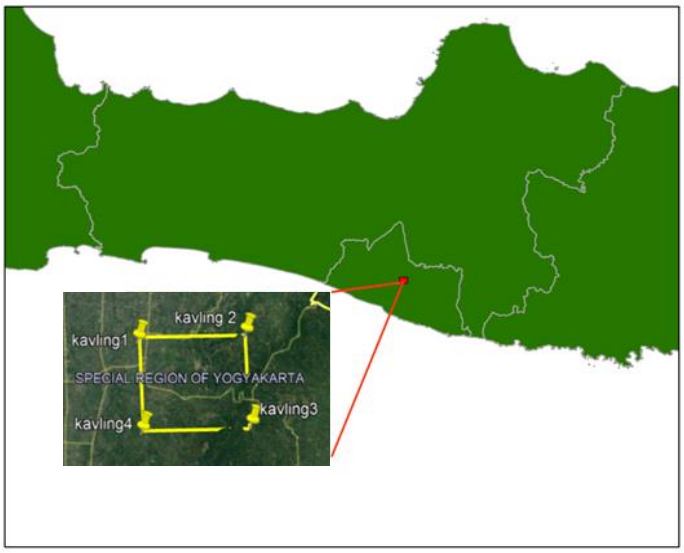

Figure 3. Research Location

IV. RESULT AND DISCUSSION

Field observations indicate that the geological structures present in the research area within the Semilir Formation are indicative of faults. The interpretation of these geological structures is initially based on preliminary observations using a 1:12,500 scale topographic map of the research area. This interpretation is further supported by field data and features found on-site, such as measurements of strike and dip, as well as observations of fractures. Fracture data is then processed using stereonet analysis to determine the dominant principal stress direction acting on the structure. Once the type of geological structure present in the research area is determined, it can be interpreted on the Geological Map of the research area.Faults, or fractures, are displacements of rock layers, both planar and curved, caused by compression or stress and strain. In this research area, several fault structures were identified through contour interpolation and kinematic analysis of available fracture structures. After mapping in the research area, two fault structures were identified:

1. **Oblique Fault (Thrust-Sinistral Slip) in Wukirsari: From field measurements and observations, evidence of this fault was found within the sandstone-tuffaceous sandstone interbedding unit with tuff and tuffaceous mudstone insertions, with layer strikes ranging from N135° E and a dip angle of 30°. The interpretation of this fault is indicated by the following evidence:**

- Identification of fault planes and offsets at LP 6.
- Discovery of a damage zone along the fault line at several LPs.

- Measurement of fault trends around N225° E/81°.
- Observation of unit spread indicating offset on the geological map after orthographic projection to determine unit distribution.
- Presence of fractures such as SF and GF along the fault line.
- Stereographic analysis results using SF data at LP 13, 65, 92, 93, 94, 95, and 97.

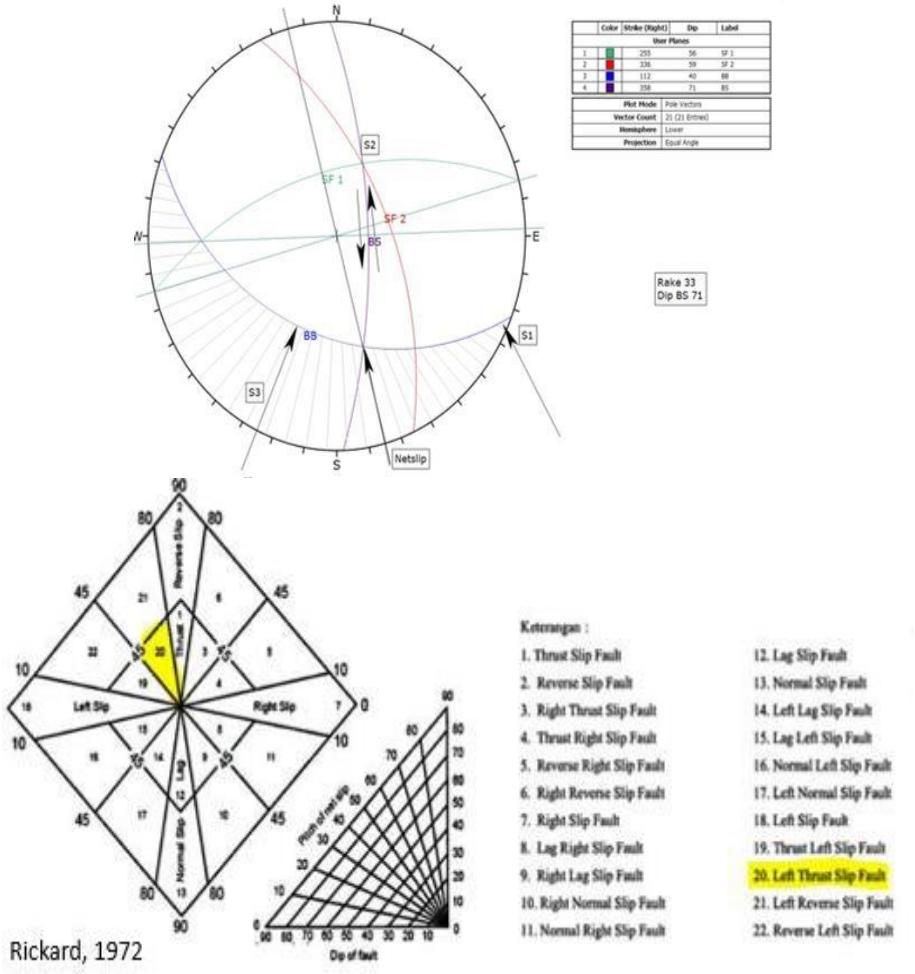

Figure 5. Stereonet Fault Analysis *Oblique* Wukirsari

Table 1. Fracture Data dan Breciation On *Oblique* fault Wukirsari

SF 1		SF 2		Breksiasi	
165	70	144	70	158	90
262	51	220	72	175	90
249	65	222	70	174	90
5	62	274	62	152	90
330	62	100	70	160	90
23	71	340	54	148	90
330	60	348	70	168	90
73	62	253	58	150	90
130	48	256	53		
173	68				
340	74				
8	61				

Photo 1. The appearance of fault planes in outcrops.

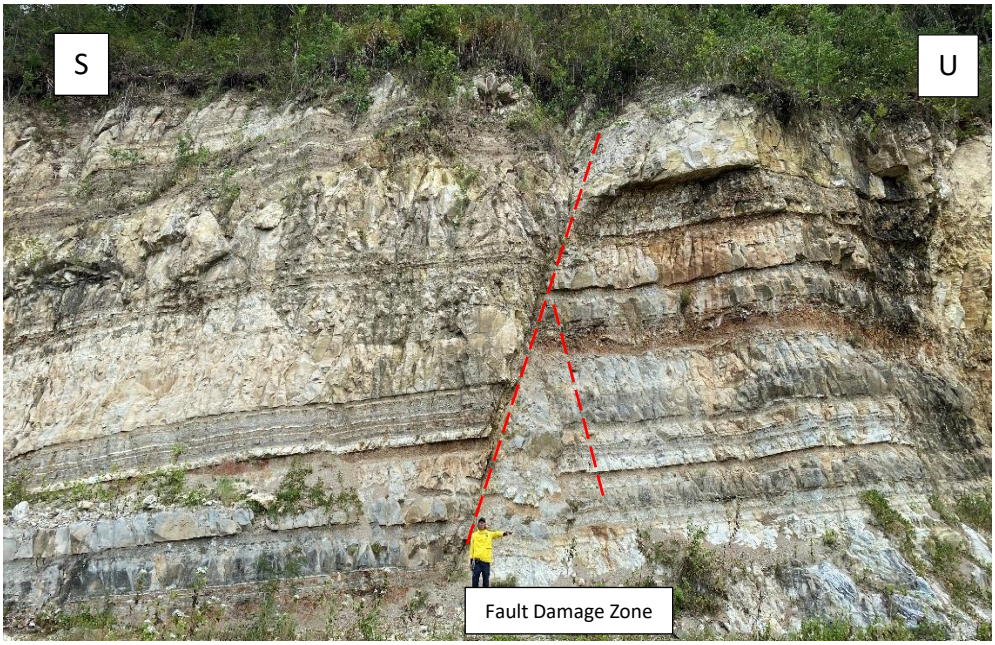

Photo 2. Appearance of *Fault Damage Zone*

2. **Normal Slip Fault in Bawuran: From field observations and measurements, evidence of this fault was found within the sandstone-tuffaceous sandstone interbedding unit with tuff, with layer strikes around N15° E and dip angles ranging approximately 41°. The interpretation of this fault is indicated by the following evidence:**

- Discovery of fractures along the fault zone.
- Identification of fault planes at LP 22.
- Observation of slickensides in outcrops.
- Measurement of fault trends around N272° E/86°, with a Trend Plunge ranging around N275° E/75° and a Rake of 85.
- Stereographic analysis results using SF data at LP 22.

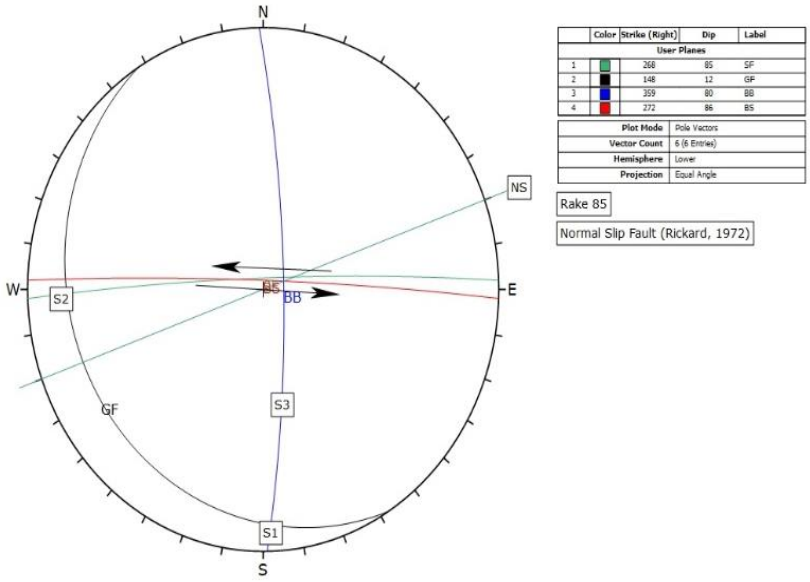

Figure 6. Stereonet Fault Analysis *Normal Slip* Bawuran

Table 2. Fracture Data And Brectiation on *Normal Slipn Fault* Bawuran

SF 1		SF 2		Rake
305	58	184	90	88
65	75	270	83	
316	60	175	90	
50	79	268	83	
280	85	180	81	
30	41	267	84	
280	85	348	70	
34	39	253	58	
25	45	256	53	
270	90			
25	45			
384	90			

Photo 3. The Appearance Of Fault Plane On Outcrops

Photo 4. Appearance of *Slickenslide* on outcrops

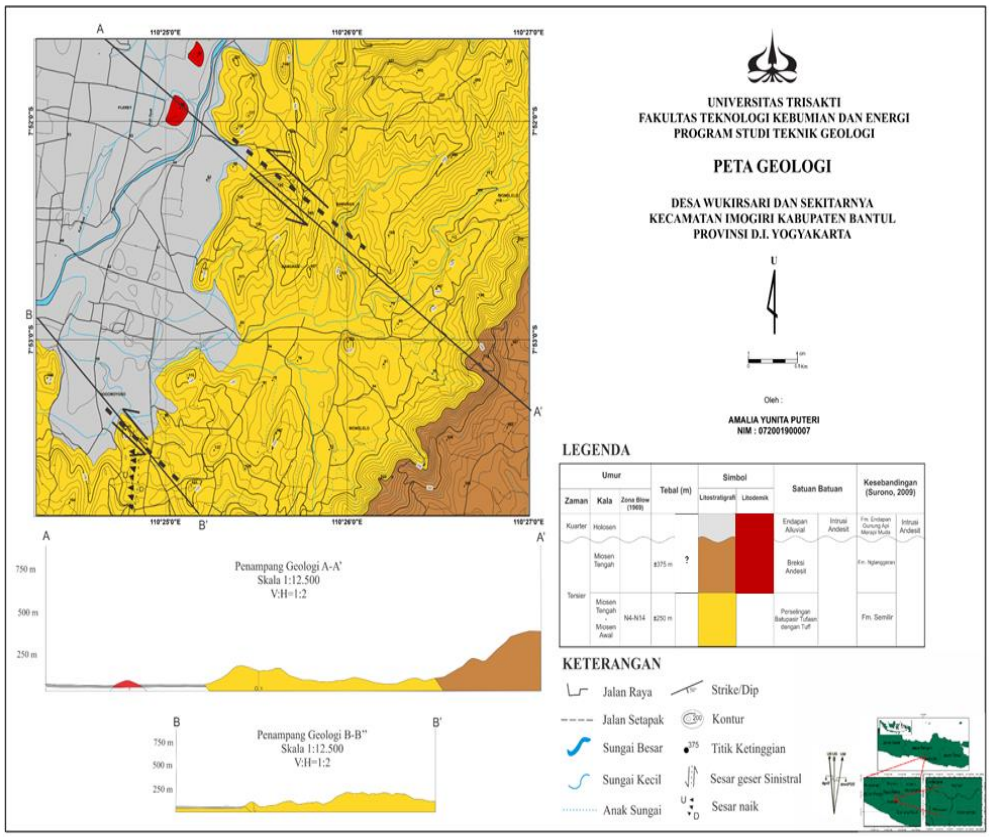

Figure 7. Geological Maps Of Wukirsari

V. CONCLUSION

Based on the processes conducted, the author draws conclusions regarding the geological structure conditions in the Wukirsari and surrounding areas, Imogiri District, Bantul Regency, Special Region of Yogyakarta Province. The conclusions obtained are that in the research area, two fault structures were found, namely the Oblique Fault (Thrust-Sinistral Slip) in Wukirsari and the Normal Slip Fault in Bawuran. This is evidenced by the presence of shear fractures at several research locations, based on stereonet analysis and field evidence. Therefore, the existence of faults, namely the Oblique Wukirsari fault, can be interpreted in the mapping area, precisely in the southwest region. The Oblique Wukirsari fault is clearly visible with evidence of fault damage zones and slickensides. In the northern part of the research area, the Normal Slip Bawuran fault is identified by the presence of fault planes, fracture data, slickensides, and observations of straightness on the map. Both faults are minor faults of the main opaque fault located in the western part of the research area. These findings contribute significantly to the understanding of the geological evolution and tectonic activity in the study area. The identification of fault structures provides valuable insights into the deformational processes and stress regimes that have shaped the local geology over time. Furthermore, the presence of these faults highlights the potential seismic hazards in the region and underscores the importance of continued geological research for hazard mitigation and land-use planning purposes.

ACKNOWLEDGEMENT

The author would like to express gratitude to the Geological Engineering Program and the Faculty of Geological Engineering, Universitas Trisakti (USAKTI), for their financial and moral support. Special thanks for the organization of the Mapping and Research event.

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