Identification Of Geological Structure In Betung Mountain, Case Study: Itera Observatory Area

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Abstract. The ITERA observatory area is located on Mount Betung, which is adjacent to the Semangko active fault zone. Therefore it is necessary to do mapping and research on the geological structure of Mount Betung. First, the identification of geological structure was carried out through Landsat 8 imagery with 753 composite bands. This composite band was the best in displaying geological structures. Seven geological structures were obtained in the form of faults at Mount Betung. 2 in the south, namely F1 and F2 faults, 2 in the north, F3 and F4 faults, and three faults around the Mount Betung peak, namely F5, F6, and F7. Some of these faults were strengthened by the discovery of 4 waterfalls in several parts of the fault. Talang Teluk waterfall on the fault in F1 fault, Talang Rabun waterfall on F2 fault, Gunung Betung waterfall on F3 fault, and Kubu Jambu waterfall in F4 fault. The four faults have an orientation towards the Northeast-Southwest. Joint data obtained in the field was processed to determine the type of fault. Based on joint data, it is estimated that faults in Mount Betung are normal faults. This fault is a normal fault system due to body force or gravity by its mass load. So that the active fault Semangko was not very influential on Mount Betung.

Keywords: Observatorium ITERA, Betung mountain

1. Introduction

Mount Betung is one of the mountains that is quite close to the city of Lampung. Mount Betung itself is included in a protected forest area which is included in the area of the Great Forest Park Wan Abdul Rahman (TAHURA WAR). The height of this mountain is approximately 1200 meters above sea level.

The observatory area located on Mount Betung is close to the Semangko active fault zone. This can be seen from the frequent occurrence of earthquakes in the western part of Sumatra where the Indian Ocean plate comes under the Eurasian plate. Mapping the geological structure in detail can provide more understanding of the area to be made into an observatory.

Therefore it is deemed necessary to carry out mapping and research on the geological structure of Mount Betung especially in the observatory area. Analysis and mapping were carried out both regionally and finally converged on the study area. Geological mapping, calculation of joint data, analysis of satellite images and topographic analysis will be carried out in this study. Hopefully, the results will be able to provide recommendations on the ITERA observatory land.
This research will begin by gathering various literature on geological structures, topography and Landsat imagery in the research area. There are 3 data that will be used, field data which is primary data, then Landsat image data and topography which is secondary data. Geological mapping as a basis for research will be carried out in the field. This mapping is based on the regional geological map 1: 25,000 pieces of Tanjung Karang by the 1992 Mango. Due to the extent of the previous mapping area, it is not too detailed in the study area. Mapping in the field will include several activities including the joint calculation that will later be processed using the software. Mapping fault fields from evidence found in the field. Also, identification of lithology which is reinforced by thin incisions.

1.1. Study Area

Based on the geological map of the Tanjung Karang sheet by Mangga et al. 1993, the research area is the Young Volcanic Deposition (Qhv b) of the Pleistocene and Holocene age with compositions of andesite-basal, breccia and tuff lava which reached a thickness of several hundred meters scattered near the mountain and also insert in other formations.

Young Volcanic Deposits (Qhv b) are deposited incongruously above the inseparable G. Kasih complex (Pzg) which consists of crumbling sediments and igneous rocks consisting of schist, quartzite, gneiss. Sekis consists of two types, quartz graphite schist, and amphibole schist. It is interpreted as a melting volcano rock. Quartzite, brownish white to medium-reddish coarse reddish granoblastic texture clear, impure metamorphic sediments. For thickness can reach more than 2500 meters.

The geological structure that develops in the study area is quite complex because it is in the Sumatra fault zone. In the eastern part of the study, there is the Lampung Fault - the Long which is a horizontal fissure that stretches from Tarahan to Tanjung Karang. In the south, there is a Menanga Fault which is a reverse fault which cuts Mount Pesawaran. Fault due to the compressional force is also likely to occur in the northern area of Mount Pesawaran, namely Mount Betung, which is a research area.

2. Research Methods
Three data will be used, Field data which is primary data, then Landsat image data and topography in the form of secondary data. Geological mapping as a basis for research will be carried out in the field. This mapping is based on the regional geological map 1: 25,000 Tanjung Karang by the 1992 Mango. Due to the extent of the previous mapping area, it is not too detailed in the research area. Mapping in the field will include several other activities: joint calculations that will later be processed using the software. Fault analysis from evidence found in the field. Also, identify the lithology that is reinforced by the incision.

To support geological mapping, it is also necessary to do the initial stage of research, Citra Landsat analysis. The data used is a band obtained from the main sensor on the Landsat 8 ETM + satellite, which has eight bands or channels. The data can be downloaded for free on the site. Band data processing is done using ERmapper software. By combining several band data, it can be seen the line in the path. This straightness is the initial indication of the existence of a weak field which is most likely a fault. From this Landsat image can also be identified as the lithology in the study area.

Topographic data obtained from RBI data that has been in the form of digital data. Data processing will be done using ArcGIS software. Calculation of the density of contour heights can indicate the steepness of a field. The topographic data can be support in the field to identify the geomorphology of the research area. So that topographic data can also help in the interpretation of structures.

From processing the Landsat image data, will get a map of Landsat image alignment, which will be very useful in interpreting structures. From geological mapping, analysis of rock samples will also be carried out under a microscope so that a geological structure map can be produced with the lithology of the research area. From the alignment map of Landsat imagery and geological structure maps, it is expected to be obtained in the form of a map of geological structure dissemination and recommendations for ITERA observation.

3. Result and Discussion

The results of the delineation on Landsat 8 composite 753 are shown in Figure 2. The lines delineated in Figure 4.2 are still associated with the flow pattern. The final results of the delineation of structural alignment consisting of seven faults are shown in Figure 2.

Figure 2 shows that F1 is a fault trending southwest-northeast. It appears there is a line in the area of mount Betung. This fault is associated with the Talang Teluk Waterfall. Parallel to the southern F1 fault, there is also an F2 fault. F2 fault is associated with Talang Rabun waterfall. F1 and F2 faults are one normal fault system caused by the gravitational force of the load of sedimentary material in mount Betung.
In the north of Mount Betung, there is also an F3 fault associated with the Gunung Betung waterfall. This fault is also trending southwest-northeast. In the north of the F3 fault in parallel, there is an F4 fault. F4 fault is associated with Kubu Jambu waterfall. F3 and F4 faults are also a normal fault system caused by gravity.

The presence of lineaments indicates F5, F6, and F7 Fault. Based on the topographic map there are also differences in height on two sides of the fault. F5 and F6 Fault have a southwest direction - northeast. While F7 fault has northwest-southeast direction. F7 fault is located in the northeastern part of Mount Betung.

3.1. Fracture Data

3.1.1. Stop Side 5

Fracture data measured in the field was processed using Dips software. The fracture data is plotted into stereonet. Data in stereonet is drawn into the contour. The contour is the frequency of occurrence of stress plot points. The more data in a zone, the more contours that are obtained.

In figure 3.A, it is the result of a stressed data plot, on the stop site 5. The stereonet shows a tight contour in the direction ± N 330 ° E. The second dominant stress data is ± N 250 ° E. Using the auxiliary plane it is estimated that the main stress namely S1 directed ± N 285 ° E. The main stress is in a sharp angle between the two dominant stress direction data. S2 is in the plane intersection taken 90 ° from 2 dominant stress points while S3 is taken at an angle of 90 ° from the main stress (S1).
In Figure 3.B shows the Rosset diagram from the joint data. The longest lines present the most obtained data. From the figure, it can be seen that the fracture direction data is most directed ± N 45 ° E. And the second dominant data is ± N 325 ° E.

![Figure 3. A. The contour of fracture plot ST 5., B. Diagram of fracture plot ST 5.](image)

### 3.1.2. Stop Side 8

In figure 4.A, it is the result of a stressed data plot, on the stop site 8. In the stereonet there is a tight contour in ± N 210 ° E direction and the second dominant stress data is ± N 110 ° E. Using the auxiliary plane it is estimated that the main stress namely S1 direction ± N 150 ° E. The main stress is in a sharp angle between 2 dominant stress direction data. S2 is in the plane intersection taken 90 ° from 2 dominant stress points. While S3 is taken at an angle of 90 ° from the main stress (S1).

In Figure 4.B shows the Rosset diagram from the joint data. The longest line presents the most obtained data. From the figure, it can be seen that the fracture direction data is the most directed ± 295 ° E. And the second dominant data is ± N 190 ° E.

![Figure 4. A. The contour of fracture plot ST 8., B. Diagram of fracture plot ST 8.](image)

### 3.1.3. Stop Side 9

In Figure 5.A, it is the result of a stressed data plot, on the stop site 9. In the stereonet, the contour is tight in the direction ± N 225 ° E. The second dominant stress data is ± N 125 ° E. Using the auxiliary plane it is estimated that the main stress is S1 directed ± N 170 ° E. The main stress is in a sharp angle between 2 dominant stress direction data. S2 is in the plane intersection taken 90 ° from 2 dominant stress points. While S3 is taken at an angle of 90 ° from the main stress (S1).
In Figure 5.B shows the Rosset diagram of the joint data. The longest line presents the most obtained data. From the picture, see that the fracture direction data has the most direction ± N 315 ° E. And the second dominant data is ± N 215 ° E.

![Diagram of fracture plot ST 9.](image)

**Figure 5.** A. The contour of fracture plot ST 9., B. Diagram of fracture plot ST 9.

From data on contour interpretation and Landsat imagery, there are seven faults located around mount Betung. In general, these faults are trending northeast - Southwest. The faults are also associated with several waterfalls found in the field like Talang Teluk waterfall which is associated with an F1 fault which is south of mount Betung. The Talang Rabun Waterfall is associated with the F2 fault which is also the same system as the F1 fault. Gunung Betung Waterfall which is associated with the F3 fault in the north of mount Betung. Also, the Kubu Jambu waterfall which is associated with the F4 fault which is also the same system as the F3 fault.

From the indication of the field and also the processing of joint data, it can be interpreted that the fault that occurred in mount Betung was a normal fault. At stop site five which is the location of Talang Teluk waterfall which is associated with an F1 fault, it is indicated to be a normal fault. This can be seen from the position of S1 in the stereonet which is relatively in the middle while the S3 point is next to a circle. This also occurs in several other faults. This system occurs due to body force or gravity from its mass load. This occurs in F1 and F2 faults which have fields down in the south while F3 and F4 faults have a downward plane in the north.

### 3.2. Description of Thin Incisions

Rock sample data from 2 stop site made thin incisions. The sample is a sample of Talang Teluk and Kubu jambu.

#### 3.2.1. Talang Teluk Sample

**Description of Megaskopis:**

Fresh gray color, weathered grayish black color, porphyritic texture, hypocrystalline, inequigranular, hypidioromorphic. The mineral composition that can be seen is plagioclase and pyroxene. The basic mass consists of plagioclase microlite.

**Microscopic description:**

Incisions are grayish white, porphyritic texture, the degree of hypocrystalline crystallization, subhedral crystalline form, inequigranular, hypidioromorphic. The mineral composition of these rocks is plagioclase, k-feldspar, and pyroxene as phenocrysts, while plagioclase microlites, and volcanic glass
as the base mass, and other minerals in the form of opaque minerals. Plagioclase 30%, Pyroxene 4%, and K-Feldspar 1%, base mass 50%

![Figure 6. Talang Teluk Thin Incisions](image)

### 3.2.2. Kubu Jambu Sample

**Description of Megaskopis:**

Fresh gray color, weathered grayish black color, porphyritic texture, hypocrystalline, inequigranular, hypidiomorphic. The mineral composition that can be seen is plagioclase and pyroxene. The basic mass consists of plagioclase microlite.

**Microscopic description:**

Incisions are grayish white, porphyritic texture, the degree of hypocrystalline crystallization, subhedral crystalline form, inequigranular, hypidiomorphic. The mineral composition of these rocks is plagioclase, k-feldspar, quartz, and pyroxene as phenocrysts, while plagioclase microlites and volcanic glass as the base mass, and other minerals in the form of opaque minerals. Plagioclase 35%, Pyroxene 10%, K-Feldspar 1%, Quartz 1%, base mass 43%

![Figure 7. Kubu Jambu Thin Incisions](image)
4. Conclusions

Band 753 is used because it is the best composite band to interpret geological structures. Talang Teluk waterfall which is associated with F1 fault which is south of mount Betung. The Talang Rabun Waterfall is associated with the F2 fault which is also the same system as the F1 fault. Gunung Betung Waterfall which is associated with the F3 fault in the north of mount Betung. Also, the Kubu Jambu waterfall which is associated with the F4 fault which is also the same system as the F3 fault.

From the joint data that was processed, it was found that the three faults were normal faults. This fault is formed by the mechanism of body force or gravity by its mass load. The Sumatran major fault in the form of the Semangko fault did not significantly affect the faults at G. Betung. Andesite lava in the northern and southern parts of mount Betung has different characteristics. It is estimated that the two andesites are formed at different times.

5. Acknowledgment

The authors would like to thank Institut Teknologi Sumatera for funding this research so can be carried out well

6. References

[1] Mangga, S. Andi, Amirudin., Suwarti, T., Gafoer, S., Sidarto. 1993. Peta Geologi Lembar Tanjung Karang. Pusat Penelitian dan Pengembangan Geologi.

[2] Van Zuidam, R. A. 1983. Guide to Geomorphologic – Aerial Photographic Interpretation and Mapping. ITC, Endchede The Netherland.

[3] Sukiyah, Emi. 2005. Materi Kuliah: Konsep Dasar Pengolahan Citra Dijital. Universitas Padjadjaran, Bandung.

[4] Anderson, E.M. 1951, The Dynamics of Faulting, Oliver and Boyd, Edinburg.

[5] Ferril, D.A., Morris, A.P., Jones, S.M., Stamatakos, J.A. 1998, Extensional Layer-Parallel Shear and Normal Faulting, J. of Structural Geology, 20, 355 – 362.

[6] Pulunggono, A., Cameron, N.R. 1984, Sumatran Microplates, Their Characteristics and Their Role in the Evolution of the Central and South Sumatra Basins, Proceedings of 13th Annual Convention of IPA, Jakarta, 121 – 144.