The Analysis of Remote Sensing Imagery for Predicting Structural Geology in Berau Basin East Kalimantan

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Abstract: ***The remote sensing technology were useful and has shown a great promise for large-scale geological mapping to identified of structural features, such as faults and folds. The study presents an investigation for enhancing lineaments with possible relevance to faults in Berau Basin, East Kalimantan, Indonesia using a multi-spectral ASTER satellite image and standard geographic information systems (GIS) techniques. The feature of structural geology in the surface can be recognizing on satellite images. To identification of lineaments possibly related to faults can be ASTER DEM under certain conditions. The result study shown that there are a new 20 faults were identified during the study, offering to updating and modifying of existing geological map of the study area.***

Keywords: Remote sensing, fault, ASTER, Berau basin

1. Introduction

Fault identification is an important point in the field of mineral exploration, oil and gas and urban environment [1, 2, 3]. By the nature of mineral resources and energy resources have always occupied a weak dilatational zone with high secondary permeability. Therefore it is necessary to study the geological structure is very important, to identify the fault system (fracture) that control the density of the point of intersection fracture and fault, which can give the positive impact on the formation of high secondary permeability zones.

Field mapping of fault is time consuming, high cost, and depending accessibility to the fault location. A remote sensing method has the advantage of providing synoptic overviews of structural geological features extending over large areas, short time consuming and a more cost-effective method for fault detection. With integrated an rremote sensing technology and computer-based geographic information system (GIS) is very efficient for identification of faults. However, these methods cannot replace field investigations, but the two can complement each other

The faults are weakness zones in the earth which are represented by some geological features such as drainage stream network, lineaments (linear features), and litho logical contacts between rock units within the rocks of the area [3,4,5]. The drainage stream network in certain area, is mostly depending on heterogeneity of bedrock, slope, and fault systems. Structural lineament is defined as linear geomorphic features due to zones of weakness or structural displacement of the earth's crust. The linear feature also can be seen in the litholigies contact. The study provides a structural geology characterization together with measurement fault, fracture in Berau Basin by integrated study of remote sensing and geographic information system (GIS) and field investigation,. The research location is in the Berau Regency and surrounding areas, East Kalimantan (Fig.1).

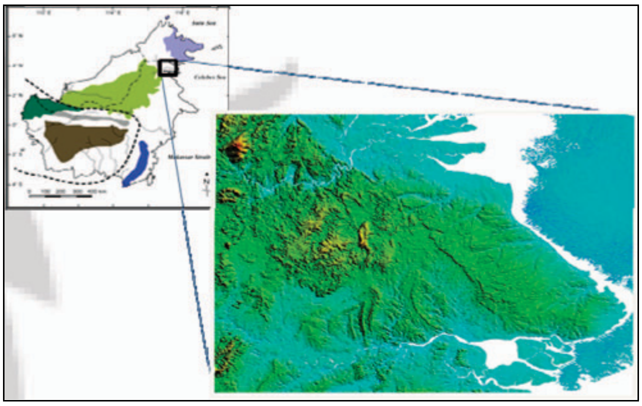

Figure 1: Location of the study area

2. Geological Setting

Berau Basin is located in East Kalimantan Island and which initiated simultaneously with the formation of the Sulawesi Sea by rifting of north and west Sulawesi from east Kalimantan [6] during the early Tertiary and which also led to the formation of the Makassar Strait. Berau Basin encompasses a wide variety of faults, structural elements and trends. Tectonics of the basin was initiated by extension and subsidence during the Middle to Late Eocene formed wrench faults arid resulted in the formation of major NW-SE oriented arches and had stopped by the end of Early Miocene Recent tectonic activity in the Plio - Pleistocene is more dominated by compressional tectonics; which produces a number of horizontal fault. Reactivation occurs in a number of places that transform normal faults into reverse fault, as seen in both the Basin seismic Berau or Tarakan Basin and continues to this day [7, 8], which has made the Berau basin as a stable tectonic regions when compared with Tarakan Basin. Various tectonic activity that occurred in the Berau Basin and surrounding areas form of structural pattern characterized by NW-SE folds direction and NE – NNW fault direction (Figure 2.2). Structural pattern is dominated by faults and folds consistent with fault-sinistral horizontal movement (left strike -slip fault) associated with Maratua - Palu Koro fault system may reactivate the fault pattern formed previously.

The geology of Berau basin area has been investigated by [9]. Surface geological map compiled by [3] was shown anticline and syncline orientate in NW-SE and NNW-SSE trending. While the stratigraphic sequence from the oldest to the young is: Sembakung Formation, Formation Birang, Train Formation, Formation and Formation Labanan Domaring / Sajau; deposited since the Early Eocene s / d Pleistocene (Figure 2).

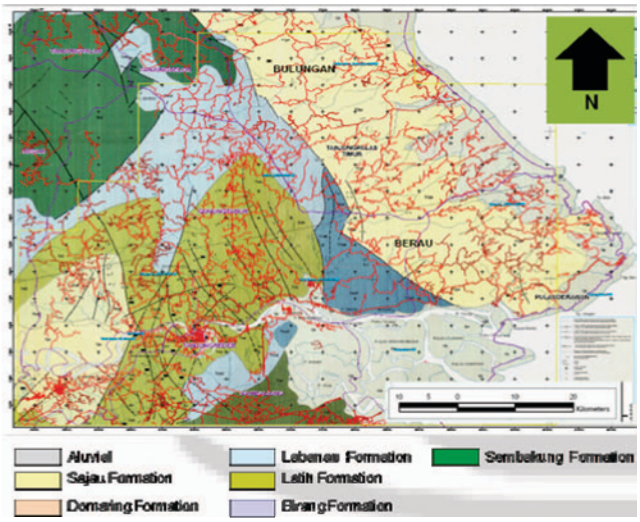

Figure 2: Geological map of Sajau Area showing the location coal samples of Sajau coal Formation in Berau Basin

3. Methods

The study of geological structures in Berau Basin begins with the analysis of Landsat imagery. Lineament structure obtained is used to determine the domains and the location of the key field data collection. The DEM (Digital elevation models) data were used to trace tectonic features and mapping geologically and topographically defined structures. Field observations of the landscape associated with the geological structure are a priority, plus other geological information. Measurements of structural elements that do include bedding plane, fault, fracture. These data were then analyzed using the stereo net for classification of fault, the direction of the main force, and its evolution.

4. Results

4.1. Lineament Structural Macroscopic orientation

Macroscopic structural lineament is generally defined as the area of linear features caused by the alignment of regional morphological features, such as rivers, valleys, and mountains, and tonal features contrast in some places are the surface expressions of fractures or fault zones. Analysis of the structural lineament , and fracture in addition to be able to provide an overview of local tectonic feature , but also can also provide information about the possibility of a regional - scale tectonic evolution in the area that has never been observed.

For estimate and provide predictive patterns macroscopic geological structures through structural alignment pattern can use the data ASTER DEM (Digital Elevation Model Advanced Space borne Thermal Emission and Reflection). To create a framework geological structure, used remote sensing ASTER Digital Surface Model (DSM ASTER) Tanjungredeb sheet RBI 1918-21, RBI and S. Bengawan sheet RBI 1918-23, 1918-24 (Fig.2)

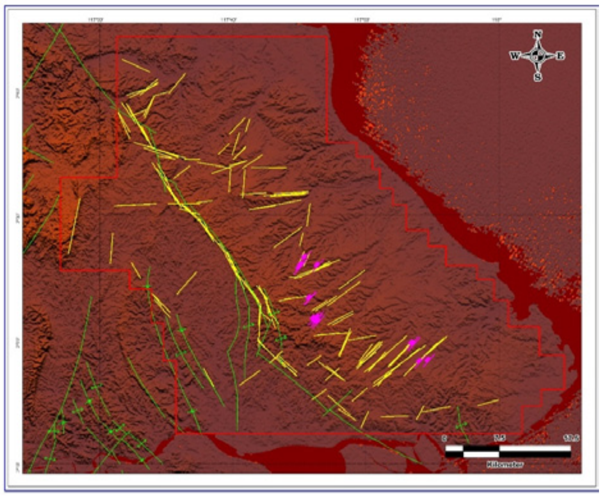

Figure 3: The lineament interpretation using DSM ASTER with a resolution of 30 meters of sheet Tanjungredeb RBI 1918-21, 1918-22 RBI, and RBI Bengawan S. Sheet 1918-23, 1918-24), East Kalimantan, which covers the research area .

Based on the interpretation of morphostructural from ASTER DEM with identifying alignment structural which is assumed to be fault on the DEM Map; then it validation of result was made with the geological truth (field work) in the study area.. Many faults were identified in different field work outcrops. Strike/dip readings of faults have been collected during the field work from different rock outcrops in the area. Based on the field data, these linear features identified on Landsat imagery and DEM are interpreted to be faults (Figure 19). Therefore, the new geological map and more complete with additional geological structural data can be made.

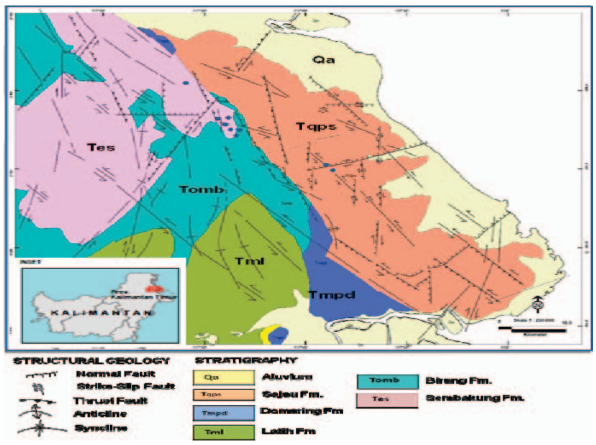

Figure 4: The new geological map of Sajau area with additional interpretation structural geology data from DEM SRTM

In the Berau Basin can be recognized as 120 (one hundred twenty) fault segments, which are small to medium size with range fault length of 1.34 km to 23.81 km. The dominant direction (mode of orientation) and the range of general direction (range); thereby grouping known faults that developed in the study area (Table 1, Fig.4)

Table 1: Direction of Fault Orientations

No.	Orientation (Mode)	Range (Range)	No
A	N 275 E – N 95 E	(270–275) – (90–95)	2
B	N 290 E – N 110 E	(285-290) – (105-110)	1
C	N 310 E – N 130 E	(295-330) – (115-150)	9
D	N 335 E – N 155 E	(330-340) – (150-160)	7
E	N 345 E – N 165 E	(340-350) – (160-170)	7
F	N 5 E – N 185 E	(350–15) – (170–195)	6
G	N 20 E – N 200 E	(15-25) – (195-205)	2
H	N 40 E – N 220 E	(30-45) – (210-225)	8
I	N 55 E – N 235 E	(50-55) – (230-235)	1
J	N 75 E – N 255 E	(70-75) – (255-260)	1

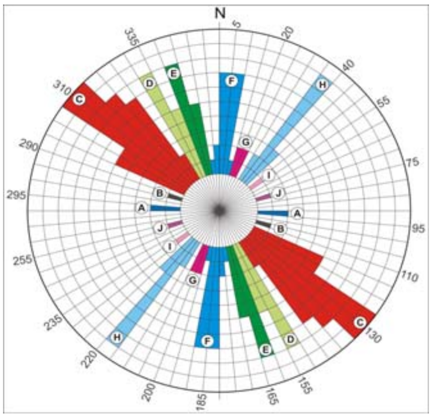

Figure 5: Rosette diagram of faults orientation in, Berau basin

The structural reading (strike/dip) of faults from 23 fieldwork stations have been analyses to compare the result from remote sensing method.. The shear joint completely defined the principal stress direction. Strike and dip of the fractures were plotted in equal-area projection of Schmidt net to obtain and calculate the directions of principal stresses which acted on those faults. Totally 20 strike-dip readings of the shear joints from different rock units of the area were analyzed with the stereographic plot was shown in Figure 5. According to the result of fractures analysis, compressional principal stress (α_1) is measured to be in the NW-SE direction.

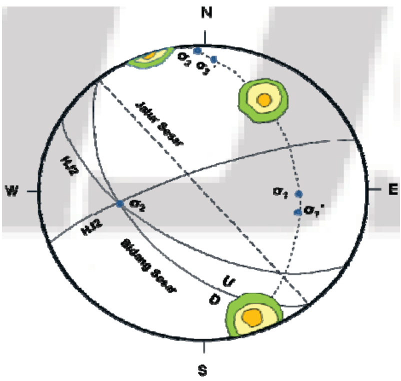

Figure 6: Result of shear joints using stereographic analysis

There are 20 fault segments which may represent new faults in the area being identified. The presence of these faults is not known from the previous study.. These faults could be active due to the Plio-Pleistocene tectonic activity. Most of these faults were active or old faults reactivated. The area was subjected to intensive tectonic activity which resulted in a series of grabens, horsts.

5. Conclusion

The result of study shows that integrated of remote sensing data and GIS technique are powerful tools in identifying geological structures such as fault segments in the remote area such as in Berau Basin. The fault map shows that there is good correlation and distribution between lineament data and faults which identified during field work. The implication of active fault can make a geological hazards; especially for coal mining activity in this area. It is needs to be revised a new geological map with a new data from this research for delineating the hazardous area for mining due to active faults.

6. Acknowledgment

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