The Mechanism of Meratus Rotation in South Kalimantan

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Abstract

Meratus mountain lies at South Kalimantan, Indonesia, well known as the ophiolite outcrops as the result of obduction between Petternoster micro continent with Kalimantan, south-eastern part of the Sundaland continental plate.

The “J” shape of Meratus mountain (Sikumbang, 1986), indicated that Meratus mountain had experienced deformation from its original shape. Paleomagnetism data from Miocene Microdiorite located at Gunung Kukusan suggests that Meratus had been rotated 38° counter clockwise (Fuller, 1999).

Several major sinistral strike-slip faults had been encountered in the middle of the “J” shape of Meratus mountain that separated Meratus to be the Southern part and the northern part. The faults were the central of Meratus mountain rotation to form the “J” shape of present day Meratus mountain.

The mechanism of the Meratus rotation was caused by sinistral strike-slip faults that produce the effect of a look-like rotation.

Keywords: Meratus, South Kalimantan, Rotation, Paleomagnetism, Strike-slip faults.

Introduction

Meratus mountain lies at South Kalimantan, Indonesia, well known as the outcrops of ophiolite. The Meratus mountain consist of ophiolite as the result of obduction and collision between Kalimantan Continental microplate and Petternoster Continental microplate. This obduction took place at about 110-115 Ma (Wakita, 2000; Sikumbang, 1986) due to the movement of Indian continent North-East direction before Australian continent movement (Hall, 2012). The North-eastern direction of Indian plate Continent movement was almost perpendicular to the position of Meratus area at that time (Hall, 2000), and formed the Meratus range as a single SW-NE range montain, a mountain that oriented as a stright line.

Geologically The Meratus consists of Ophiolite and Mesozoikum rock which form a high topographic morphology along the Meratus. Tertiary rock sediment deposited surrounding the Meratus which generally form a low relief topography.
accept the sediment were affected by the Kenozoikum thrust fault along the rim of the Meratus (picture 3)

Geographically Meratus lies in the province of South Kalimantan, at coordinate between $0^\circ 36'15"$ to $0^\circ 26'16"$ Sand $114^\circ 033'35" - 116^\circ 45'35"$ E. Form a “J” shape mountain (Sikumbang 1986), constructed from two general orientation, the Southern part and Northern part which make orientation N$69^\circ$E and N$32^\circ$E respectively, each orientation bordered by sinistral strike-slip faults (picture 1).

**Remote sensing Interpretation**

The SRTM data used for interpreting the structures, mainly the faults and the orientation of the structure. Mapinfo7 was the software for interpreting the structures and the orientation of the morphology.

The “J” shape morphology of the Meratus mountain can be easily recognized at any scale on the SRTM data (picture 1). Since the Meratus has a “J” shape orientation, means that Meratus at the present day constructed from 2 orientation of morphology, the Southern part and Northern part which make orientation N$69^\circ$E and N$32^\circ$E respectively. The detail observation around the changes of orientation on the SRTM, can be observed a trace of fault as a lineament in between the two blocks (picture 1), this lineament clearly separated the two blocks as the Southern and Northern block.

The main stream pattern has been drawn from SRTM, almost all the main stream lineament parallel to the direction of the strike slip faults (picture 2), suggest that the strike slip faults affected the stream patterns in the area. The rivers flow follow the fracture pattern created by the major fault. The strike slip fault made a zone of compressional at about 30 km width.

**Field Observation**

The aim of field observation is for the ground checking of the major faults which had been interpreted from the remote sensing using SRTM data. During the field worked, several evidences of the occurrences of the faults has been found. Most of the fault evidences found as the fractures surrounding the investigated faults, or the ruin of the cliff of the fault.

Detail observation has been done on more than 26 locations of outcrop, almost all the outcrop are on the Pre-Tertiary rock (Table I). 15 of them are suggested strike slip faults (picture 2). 6 of them are suggested normal fault and the rest are located at the northern most part are suggested thrust faults.
Picture 1. The location of Meratus mountain (pink-red relief) at South Kalimantan area. The two different orientations of Meratus, bounded by a sinistral strike slip fault (black solid).

Picture 2. The stream pattern with interpreted strike slip fault (yellow line) and the lineament of the river parallel to the fault.
Paleomagnetism

Despite Meratus mountain is an important region in Kalimantan tectonic history but under-sampled paleomagnetically. Sunata and Permanadewi (1998) reported result from a granodiorite, result from the Eocene Tanjung Formation and Ophiolite are given by Sunata and Wahyono (1998). The results from two sites of basaltic flow are given by Lumadyo et al. (1993) (table II).

The microdiorite from Gunung Kukusan has K/Ar age of 19.6 ± 0.76 (Fuller, 1999), sampled paleomagnetically by Sunata and Permanadewi (1998). The result of the paleomagnetic analysis suggest that at the Early Miocene time (20 ma) the area experienced 38° counterclockwise rotation (Fuller, 1999).

Weak rotation is seen in all three samples. Although no strong rotation reported all the samples seem to show a similar pattern to Central and Eastern Kalimantan with the rotated and unrotated direction mixed (Fuller, 1999). Because there are unrotated direction as well as CCW rotated direction, the island of Kalimantan cannot have rotated as a single block (Fuller, 1999).

Discussion

The “J” shape morphology of the Meratus mountain can be easily recognized at any scale on the SRTM data (picture 1). Since the Meratus has a “J” shape, the orientation of the Meratus at the present day constructed from 2 orientation of morphology, the Southern part and Northern part which make orientation N69°E and N32°E respectively. The detail observation around the changes of orientation on the SRTM, can be observed a trace of fault as a lineament in between the two blocks (picture 1), this lineament clearly separated the two blocks as the Southern and Northern block.
The field work suggest that the southern part and northern part of Meratus separated by sinistral strike slip fault which lineament can be traced on SRTM. The ruin of the fault is still standing as a cliff name Batutulis area (picture 4). The analysis report suggest the fault is a normal fault, but the measurement was on the residual of a ruin cliff, no original cliff (sample location N6).

Almost all the main stream lineament parallel to the direction of the strike slip faults (picture 2), suggest that the strike slip faults affected the stream patterns in the area. The rivers flow follow the fracture pattern created by the major fault. The strike slip fault made a zone of compressional at about 30 km width. The compressional zone expressed by the outcrop (N13) at the upstream of Riamkiwa river (picture 5) which show the fractures and concoidal cleavage in the igneous rock.

![Picture 4](image)

Picture 4. The cliff of the main fault at Batutulis area. The bolder at the front ground indicate that the cliff is not the original cliff. Yellow star on map is the position of the pictures.

The most difficult interpretation of the paleomagnetic data from Kalimantan, is that rotated and unrotated sites are intimately mixed in age and in location. The microdiorite from GunungKukusan has K/Ar age of 19.6 ± 0.76 (Fuller, 1999), sampled paleomagnetically by Sunata and Permanadewi (1998). The result of the paleomagnetic analysis suggest that at the early Miocene time (20 ma) the area experienced 38° counterclockwise rotation (Fuller, 1999). The orientation of the Meratus at the present day constructed from 2 orientation of morphology, the Southern part and Northern part which make orientation N69°E and N32°E respectively. Since the northern part has orientation of 26° and added by 38° CCW rotation, means before the rotation the Northern part has the orientation of 70° almost the same orientation as the Southern part.
Since there are unrotated direction as well as CCW rotated direction in the paleomagnetic data, the occurrences of strike slip faults along the rotation pathway, and stream pattern deflected by the strike slip faults, the island of Kalimantan can not have rotated as a single block, rather the island must have been predominantly fixed with the rotated sites recording local rotation in shear zone (Fuller 1999).

The tectonic event at 25 – 20 Ma was the begining of the Australian Continental plate to subduct Asia, marking by Sula spur collision with Sulawesi north arm volcanic arc (Hall, 2012). Proto South-China sea subduction beneath Sabah terminated at 20 Ma and South China spreading was about to end (Hall, 2012).

Two possibilities of stress direction should affected the rotation of Meratus, one from north, the Proto South China sea subduction beneath Sabah, and the other from South, the begining of Australian continental plate subduct Asia.
After reposition the Meratus to the original position, the direction of sinistral strike slip fault is NE-SW. At the same time both stress direction could effected the sinistral strike slip fault developed at the Meratus (picture 6).

Conclusions

The observation in this paper done very simply, but could give a new idea of how Kalimantan Island rotated base on simple ways. Meratus rotated in shear zone, the implication of this fact are the same way will also happened to the rest of Kalimantan island the north of Meratus. Detail observations still need to be done to prove that Kalimantan not rotated as the single block but local rotation in shear zones.

References

Table II

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*Ref* from M. Fuller (1999)