

Revealing granitic basement of Garba Hill, Muara Dua Region, South Sumatera based on landsat images, structure, and petrography

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Abstract. The basement that forms the three large basins on the island of Sumatra (North Sumatra basin, Central Sumatra Basin and South Sumatra basin) is very interesting to study. Previous study reported the basement phenomenon of South Sumatra basin is very exceptional because all of the basement boundaries are exposed on the surface. The highland of basement that forms the Garba Hill in Muara Dua, South Sumatra has been identified using Landsat Image band 432 and 753. Hue interpretation from Muara Dua's area landsat image indicates resistance level of rock, water and vegetation. The blue hue on the image portrays river that flows in this area, like Komering River. The pink, gray and light green hues were identified as lack of resistance of bedrock lithology and interpreted as granitic rocks that had been weathered. The dark green to black hue in the form of original hill shape at an altitude of 798 m above sea level illustrates that the vegetations are thick with more resistance of bedrocks lithology, and based on field observation, crystalline rock in the form of granite was found. This interpretation has been supported by structural observation result and petrographic analysis of several samples of the crystalline rock. The basement alignment pattern observed in the SRTM image indicates trends of N320-350°E. This phenomenon is consistent with the NNW-SSE pattern resulted from structural study. This rock has a mineral composition consisting of quartz, orthoclase, plagioclase, feldspar and biotite. This set of minerals characterizes granitic magma. The specialty of basement in South Sumatera basin need to be studied in more detail using the fission track method to know the evolution of the basic thermal history of the bedrock.

Keywords: Basement, Garba granite, South Sumatra basin, landsat, structure, petrography

1. Introduction

Sumatra Island has a unique tectonic structure as indicated by the shape and structure of the island. Previous study consider that this island is the westernmost part of Sundaland [1, 2, 3]. Sundaland is a collection of continental fragments derived from Gondwana and Asia [2]. The period of continental fragments amalgamation occurred since Triassic. During Triassic, subduction occurred to the west on the Pacific Plate in the East Asia. It was the beginning of the Late Cretaceous subduction which associated with the formation of basement of the island of Sumatra. Garba Hill is one of the basements in South Sumatra that is exposed to the surface. Based on previous researchers [1], [3], [4], [5], [6], the structure that developed in the South Sumatra Basin is related to the presence of bedrock uplifts such as those that occur on Garba Hill. Garba is considered as a remnant of the volcanic arc of each other



Jura-Kapur which forms Terrane Woyla above the Keno-Tethys Plate. The presence of alkaline granite feldspar in the basement of Garba became an indication that Garba experienced a collision between Woyla and West Sumatra at the beginning of the Cretaceous which allowed for thickening of the crust causing magmatism. In this study, three approaches will be used to reveal Garba granite based on Landsat 432 and 753 imageries, petrographic analysis and field structure data. The study area is in Muara Dua, Ogan Komering Ulu Selatan District, South Sumatera where crystalline basement rock of Granite Garba Formation exposed (**Figure 1**). This study will integrate the results of field observations, laboratory analysis, and previous studies. All data has been analyzed and interpreted to construct the evolution of pre-Tertiary basement rocks of the study area. The present study relies on field observations that aim to find various variables according to the level of approach.

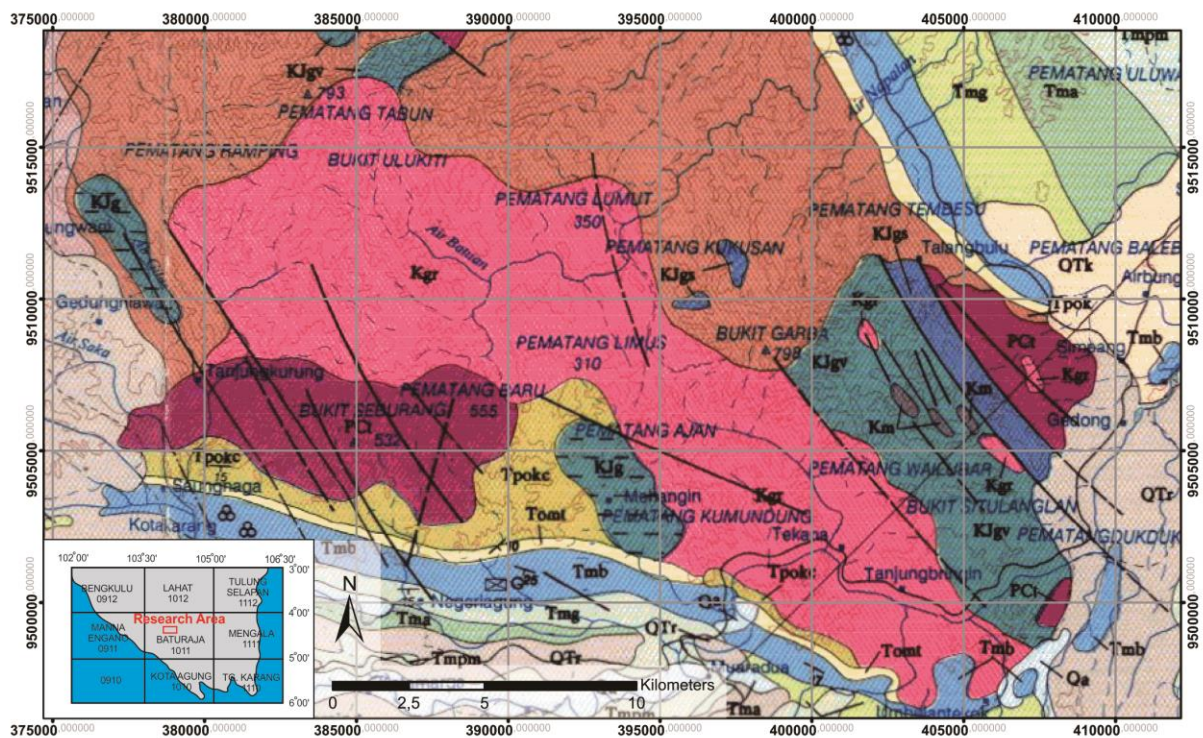


Figure 1. Study Area in Garba Hill basement, Muara Dua, South Sumatra. [6]

2. Method

The present study apply three approaches namely interpretation using DEM and Landsat 432 and 753, petrographic analysis of granitic basement rocks and field data of structures. DEM and Landsat 432 and 753 is in particular a landsat imagery composed of several bands. It is based on the base color (Red, Green, and Blue). Combination of the channels of basic colors will provide certain desired information. Landsat 753 and 432 provide information on vegetation, water, and rock resistance. DEM (Digital Elevation Model) used in assisting the interpretation of geological structures (source: SRTM 57.13 with a resolution of 30 m; USGS, accessed on September 26, 2014). Petrographic analysis is a very important basis for further analysis. In this analysis polarization microscope is used. Petrographic analysis is carried out for rock samples. Based on this analysis we can define the name based on mineral composition, type, texture and structure of rock samples. Structural analysis is carried out using data of structural elements collected from fieldwork during the present study. Structural measurements in the field are based on fracture measurements with linear scanline and rectangular windows sampling. Linear scanline is used in areas that experience shear zones, while rectangular windows sampling is done on the damage or fractured zone.

3. Basement Geology

Pre-Tertiary rocks exposed on the surface in the Garba Hill area is shown in Baturaja Sheet geological map by Gafoer, et al., 1993 (**Figure 1**). Pre-Tertiary rocks consist of Tarap Formation (PCI); Granit Garba (Kgr); Situlanglang Members Garba (KJgs); Member of Insu Formation Garba (KJgv); Garba (KJg); and Melange Complex (Km). Granite Garba is the last intrusion in the Pre-Tertiary period which is 91.3 ± 1.9 million years old [1].

3.1. Tarap Formation

Tarap Formation is the oldest bedrock in the study area of the Late Paleozoic consisting of phyllite, schist, slate, a little marble, quartzite, and hornfels. Megascopically phyllite in Tanjung Kurung, Sungai Gilas, Saung Naga and Negeri Agung villages have gray to black foliation, lepidoblastic, phylitic, clay mineral composition. Mica schist and hornfels, and migmatite at Sungai Gilas adjacent to the phyllite.

3.2. Garba Formation

The presence of Garba Formation is only local in the area of Gedung Wani and Mahagin in the form of basalt, altered andesite, and chert. Serpentine outcrops are found having experienced weathering. These formations are Jurassic in age. There is a few limestone [4] which are found with members of the Insu Garba Formation (KJgv) and the Situlanglang Members of the Garba Formation (KJgs).

3.3. Insu Members Garba Formation

Insu Members Garba Formation consists of basalt, andesite, and chert lenses found in Lubar and Rambang areas. Basalt and andesite are rocks that originate from volcanic activity, while the chert is a deep-sea rock, so the possibility of this member of Insu Garba is a product of volcanic activity in the sea.

3.4. Situlanglang Member Garba Formation

Situlanglang Member is indicated by chert outcrops in the study area. In some places the chert found as ivory yellow color, hard, and partly weathered containing radiolaria from the marine environment. The distribution of the chert is along the Situlanglang Hill, Lubar, and the Rambang river that trends NW-SW. The exposures found in Situlanglang hill indicate a major tectonic event in the Jurassic - Cretaceous period.

3.5. Melange complex

This melange complex is found in the middle of the Semitic River in the form of assemblage of limestone, chert, andesitic rocks, siltstone, serpentine, claystone and schist. The melange complex of the Semitic River is embedded in the base of the black clay with the age of the Cretaceous.

3.6. Granit Garba Formation

Granodiorite, diorite and granite from the Granit Garba formation are the youngest intrusions within the Pre-Tertiary rock complex with the K-Ar age 91.3 ± 1.9 million years [1]. Megascopically granite outcrops are reddish gray, holocrystalline, phaneritic, consisting of minerals orthoclase, quartz, and hornblende.

4. Results and Discussion

The highland of basement that forms Garba Hill in Muara Dua, South Sumatra has been identified using Landsat Image Band 432 and 753. From the field data it is found that in Landsat 432 and 753 dark green image areas with high resistance levels are crystalline rock in the form of granitic rocks. While other less resistant rocks, in a brighter colored image of pink to grey dominated by weathering of igneous, metamorphic, sedimentary, and pyroclastic rocks (**Figure 2**).

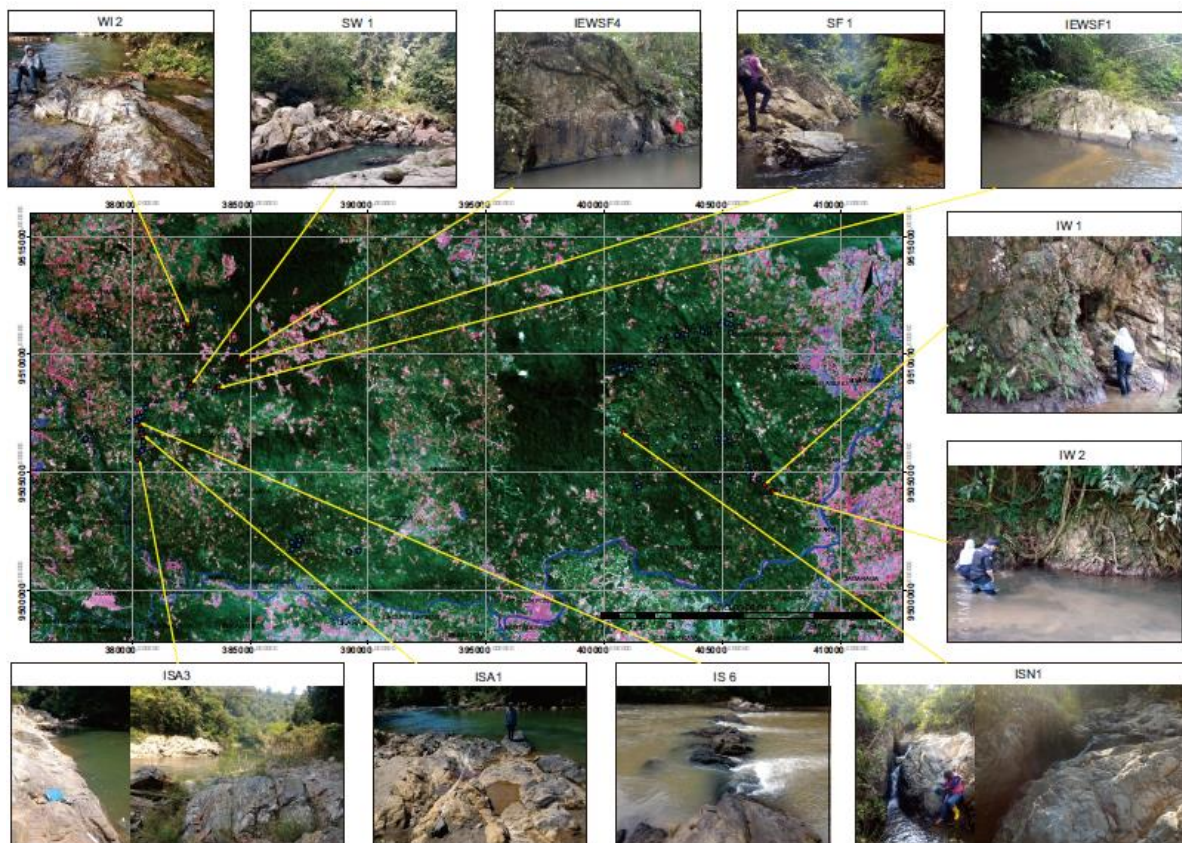


Figure 2. Landsat Image Band 753 and rock sampling locations.

Petrographic analysis of several samples of the crystalline rock's outcrop shows that the granite undergoes alteration. There are chlorite minerals occurring in the samples showing propylitic alteration. This rock has mineral composition containing orthoclase, plagioclase, feldspar and biotite (**Figure 3**). This set of minerals characterize granitic magma.

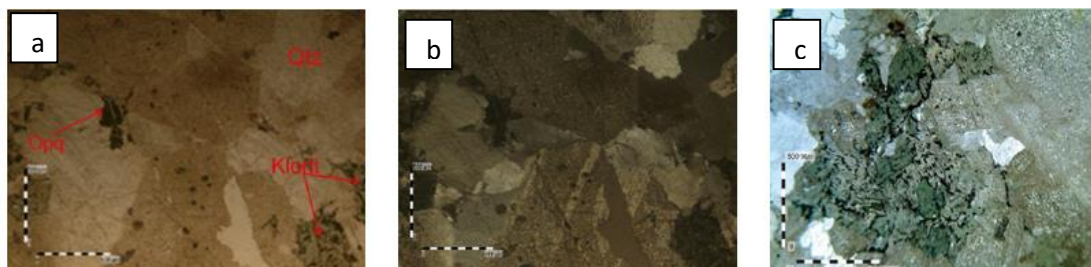


Figure 3. Petrographic of granite from Tekana area a) parallel nicol, b) cross nicol, c) chlorite minerals, propylitic alteration.

Faults found in the study area from fieldwork are dip slip and strike slip faults. Normal faults trending northwest – southeast are the common fault found in the study area. Indications of normal fault include the presence of waterfalls such as those found in Way Lubar, Liki River, Pisang River, and Sungai Gilas. The evidence of Meninting Reverse Fault is found in Meninting River where the area experiences an upward-moving northwest-southeast trajectory with 73° rake and 67° net slip, N 215° E occurring in granitic rocks. Granitic rocks are resistant so the traces of the fault is found as a slickenside. Rambang Strike slip fault penetrates basaltic, andesitic basalt, and Situlanglang granite

and chert indicating that this fault penetrates the older rock to younger intrusion of the Pre-Tertiary rock (**Figure 4**). Some fracture types are also found including pull-apart, en-echelon and pinnate veins, conjugate fractures, trailing-splay in fractures, boudinage, fault breccia, stylolites, and parasitic and pygmatic folds [7] as shown in **Table-1**.

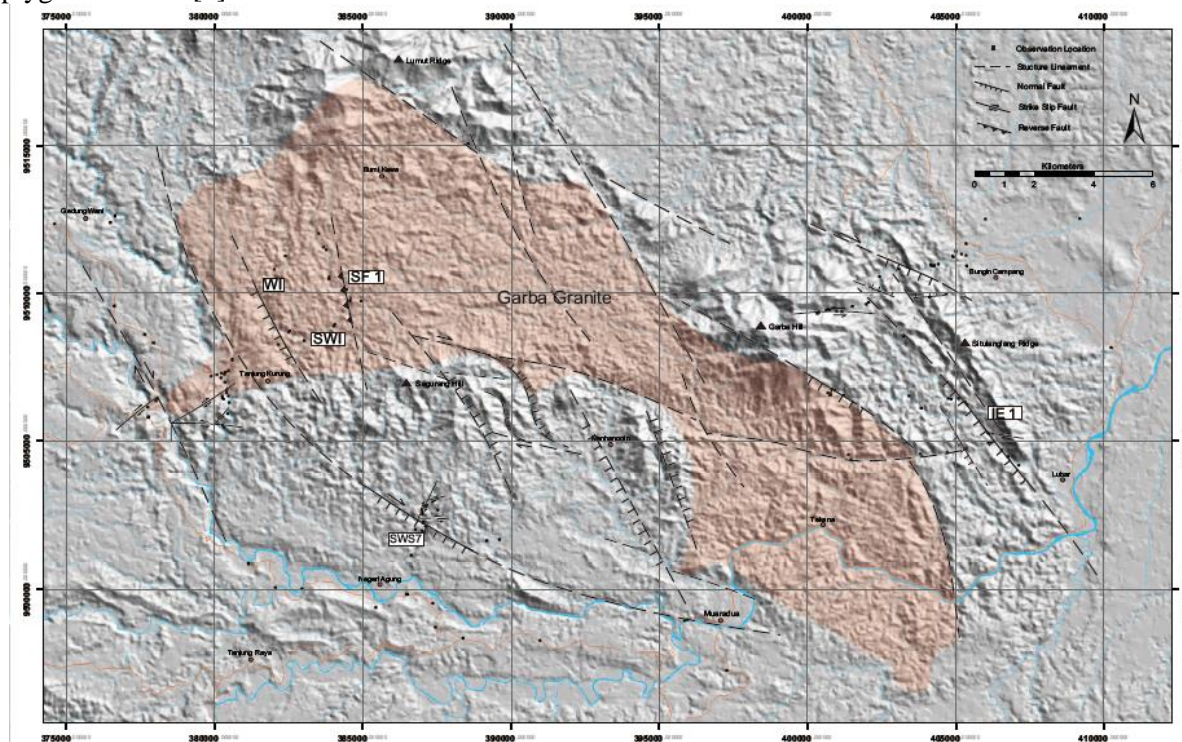


Figure 4. Structural pattern of basement rocks as shown in the SRTM/DEM image. The main trends are N320-350°E, and this structural trend is consistent with the NNW-SSE pattern resulted from structural analysis of field data.

Table 1. Structures of Granite Garba Formation

Location	Position		Lithology	Structure	Fracture types
	Latitude (S)	Longitude (E)			
SW-1	950871.38	382504.389	Granit	Normal fault	Breccia fault, shear fracture
WI-1	9510789.81	381999.798	Granit	Normal fault	
WI-2	9511262.36	382368.230	Granit	Normal fault	Shear fracture
SF-1	9509724.56	384915.214	Granit	Reverse fault	Shear fracture
IEWSF-1	9508595.24	383665.750	Granit	Normal fault	
IEWSF-4	950912.666	384562.801	Granit	Reverse fault	Shear fracture
IS-6	9506624.93	380381.902	Granit	Strike slip fault	
ISA-1	9506304.55	380470.006	Granit	Strike slip fault	Ptygmatic fold
ISA-3	9505543.66	380253.752	Granit	Strike slip fault	Spray, conjugate
ISN-1	9506721.04	400933.982	Granit	Normal fault	Pinnate veins, breccia fault, trailing Boudin
IW-1	9504198.08	407109.217	Granit	Normal fault	
IW-2	9504485.07	406759.052	Granit	Normal fault	

5. Conclusion

Pre-Tertiary (Jurassic-Cretaceous) basement rock found in the study area includes phyllite, schist, slate, a bit of marble, quartzite, hornfels, basalt, andesite, chert, claystone and granitic intrusion. Granite is the youngest intrusion within the Pre-Tertiary rock complex. Granite rocks are more resistant, on the Landsat image it looks green. There are several types of structure that control the structural framework of the basement rocks including normal, reverse and strike-slip faults. Normal fault mainly occurs in all formations even in some places penetrating formations from the oldest to the youngest of Pre-Tertiary to Tertiary rocks, reverse and strike slip faults are only found in some locations and are not well developed. Pre-Tertiary basement rock study in South Sumatera basin need to be studied in more detail and it will be carried out by in the near future by using the fission track method to reveal the evolution of the basic thermal history of the basement rocks in South Sumatera.

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