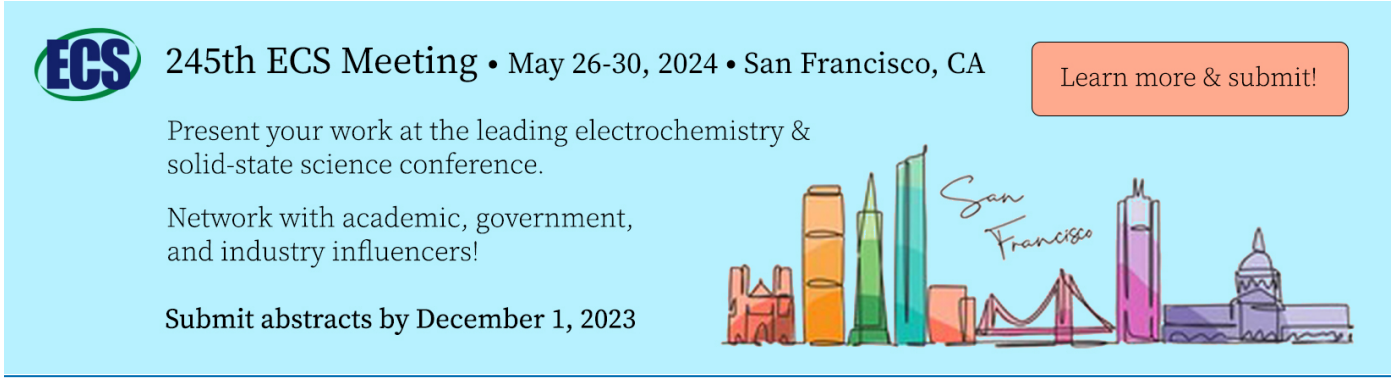
Mataram Fault – New Active Fault Crosses East-West in the Centre of Yogyakarta City



Mataram Fault – New Active Fault Crosses East-West in the Centre of Yogyakarta City

Mudrik R. Daryono[1], Astyka Pamumpuni[2], Dadan D. Wardhana[1], Danny H. Natawidjaja[1]

[1] Research Centre for Geological Disaster, National Research and Innovation Agency (BRIN)

[2] Engineering Geology Department, Bandung Institute Technology (ITB)

mudr001@brin.go.id

Abstract. Yogyakarta has experienced two devastating earthquake disasters: May 26, 2006, Mw6.4, and the penultimate event, June 10, 1867 Mw7.7. The active fault that is thought to be responsible for the two earthquake events is the Opak Fault. However, the Opak Fault has still not been thoroughly well mapped yet. The lack of a high-resolution image, dense vegetation cover, high sediment flux from the Merapi volcano, and human activities eroding the original landscape challenge studying the on-land fault in this area. Our recent study, however, indicates that the Opak Fault is not the only active fault that can cause a major disaster, but another fault strand exists in the area. We mapped the fault using the best available data of DEMNAS assisted by more detailed DEM and Orthophoto, developed from drone survey, and we also conducted Earth Resistivity Tomography (ERT) survey. We found that inferred new active fault is oriented East-West across the center of the high-populated city. The fault runs parallel and close to the famous Mataram channel (Selokan Mataram). The fault is likely continue the previously recognized Dengkeng Fault, east of the Opak fault. The fault strand is indicated by morphological lineaments and a few steam offsets. Our ERT 2D sections have revealed the fault zone in several locations along the inferred fault line. The fault line cut the Young Quaternary rocks; hence, it is an active fault. Further studies are needed to get further details of this newly recognized active fault, such as conducting paleoseismological studies, detailed seismological survey, geodetic GPS measurement, and acquiring a high-resolution image acquisition survey (LiDAR – Light Detection and Ranging Survey).

1. Introduction

Java Island is located on the boundary of subduction of the Hindia-Australia Plate and Eurasia Plate (Figure 1). Yogyakarta city is located in the center of Java and has significant historical earthquakes of Mw6.4 on May 26, 2006, and Mw7.7 on June 10, 1867 [1, 2]. The active fault was studied to find the active fault source of those earthquake events. The challenging environment in this particular site is the tropical condition has intensive rain and erosion; Merapi volcano activity that produces thick – massive – rapid – frequent volcanic deposits; and human activity erases the original landscape. Two previous active faults are the NE-SW fault line of the Opak Fault and the E-W fault line of the Dengkeng Fault.

We studied the E-W orientation fault lineament of the continuity of the Dengkeng Fault shown in the white dashed rectangle.

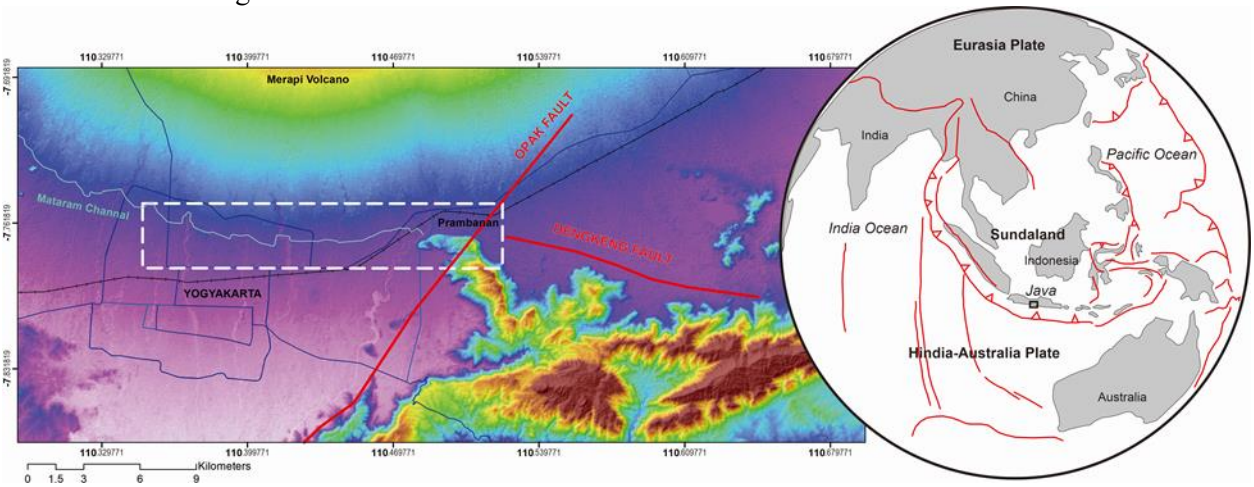


Figure 1. Research location in the world tectonic setting in Java island of Indonesia and detail site in Yogyakarta (white dashed rectangle). Two major faults are known as Opak Fault and Dengkeng Fault.

2. Data and Methods

We interpret geomorphology features to correlate with the active fault movement, such as fault scarp, fault lineament, river offset, hot springs, etc., with the same method to study active fault in Lembang Fault [3], Pasuruan Fault [4] and Sumatran Fault [5]. We use an 8 m resolution DEMNAS Digital Elevation Model (DEM) image on the white dashed rectangle area, the national best available dataset. With the guidance of the fault line interpretation result, we select an exciting location to conduct Earth Resistivity Tomography (ERT) survey using 112 electrodes 5 m cable space of Supersting Multi channels instrument [6].

3. Results and Discussions

The noticeable sinistral/left movement Tambak Bayan river offset existed parallel to the famous Mataram Channel (Selokan Mataram)(Figure 2). River movement reconstruction shows offset is 485±30 m. This fault line is observed with notification as a solid red line with number 1. This solid red line number 1 has continuity to the west with the evidence of river disruption of the Gajah Wong River and Code River (Figure 3). We inferred the fault line is continuing to the west as dashed red line number 2. To the east is the Kuning River. Farther to the east, the fault has a branch as inferred fault line that cuts the Boko Hill, and the northern parallel of slope break of Boko Hill as red dashed line number 4.

Based on the active fault morphology result, we conduct three selected sites that cross the fault line in Tambak Bayan River - JS03, Kuning River – JS04, and Silembu River – JS06. We run the instrument with 112 electrodes and a maximum space of 5 m. The total length of the survey is 555 m. The results are already corrected based on elevation data for each electrode. JS03 has penetration up to 125 m depth (Figure 4). The resistivity result is interpreted based on the pattern and range of the resistivity values. JS03 has four layers, namely layer100, layer200, layer300, and layer400 (the layer's name is similar, but it is not correlated with other resistivity sections). Close to the center existed the contact of layer300 and layer400 as representing unconformity. This unconformity describes as the fault line of the Mataram Fault. The fault line is cut layer200 and annoying thickness of the layer100 on the top. JS04 has penetration up to 147 m and has five layers, namely layer100 to layer500. Layer500 has contrast bulging on the north side, identified as rock unconformity and interpreted as a Mataram Fault. These fault lines cut all layers through the top - layer100. JS06 is on a flat area and has a penetration of 55 m depth. This JS06 has four layers, namely layer100 to layer400. Close to the North, all layers have uplifted compared

to the southern side. This line is a rocks unconformity and is also interpreted as Mataram Fault. Birds' view of the Tambak Bayan River facing to the east shows the Mataram Fault and the ERT data (Figure 5).

The best available DEM active fault morphology study and ERT result confirmed E-W fault lines parallel to Mataram Channel and crossing the central Yogyakarta City. This fault line continues east, connected to Dengkeng Fault. They were practically addressing fault, namely as Mataram Fault consists of the Dengkeng Section and Tambak Bayan Section (based on this publication). 485±30 m sinistral/left-movement offset same as biggest of sinistral offset Lembang Fault about 460±60 m and age of movement about 200 thousand years ago [3, 7].

4. Conclusions

The best available DEM active fault morphology study and ERT result confirmed E-W fault lines parallel to Mataram Channel and crossing the central Yogyakarta City. This fault line continues east, connected to Dengkeng Fault. 485±30 m sinistral/left-movement offset same as biggest of sinistral offset Lembang Fault about 460±60 m and age of movement about 200 thousand years ago [3, 7]. Further research is necessary and mandatory to study the active fault parameter more accurately. High-resolution DEM data penetrating vegetation cover is a strategic solution dataset to explore and check active fault morphology features (for example, Light Detection and Ranging - LiDAR survey). Geodetic deformation study, Geophysical survey, Paleoseismology trenching, Quaternary Geology age, earthquake historical records in an old manuscript, etc. also give detailed actual earthquake active fault parameters. Excellent and proper parameters are needed to protect the dense and vital city – of Yogyakarta.

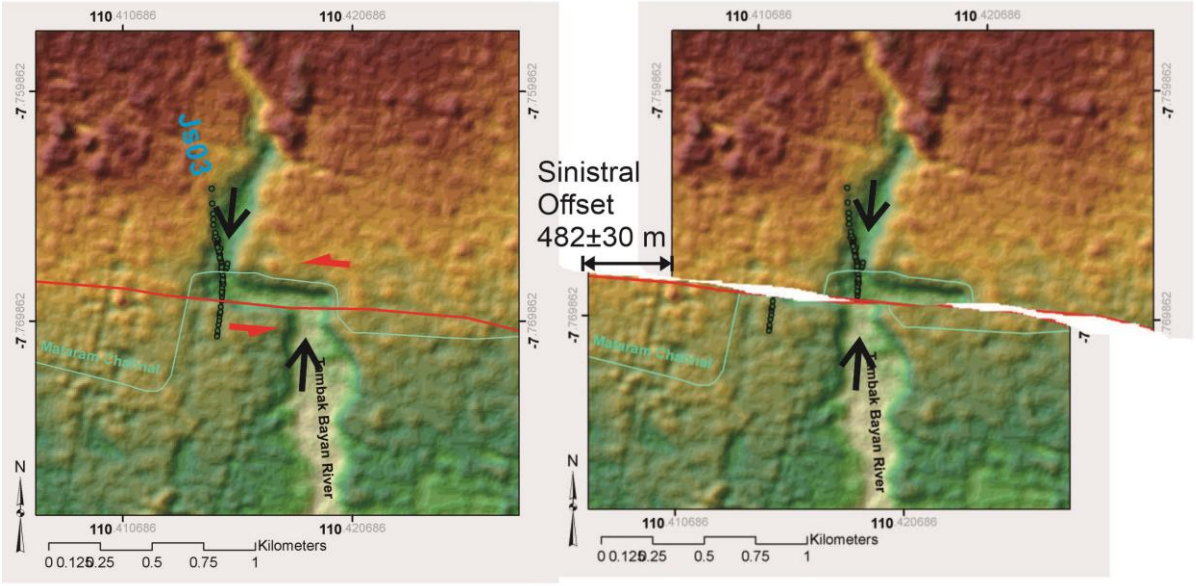


Figure 2. Tambak Bayan Rivers offset. (Left) existed river offset with the electrode points of the JS03 Earth Resistivity Tomography (ERT) line and the famous Mataram Channel. The black arrows are river alignment. (Right) Reconstruction of original river flow shows 485±30 m sinistral/left-movement offset.

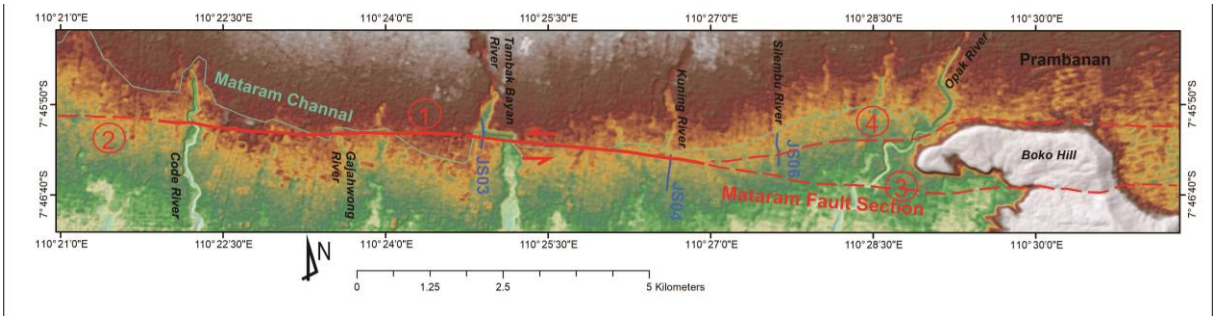


Figure 3. Mataram Fault with E-W orientation. The dashed red line is inferred, Dotted red lines are buried, and solid red lines are observed. The blue lines are Earth Resistivity Tomography (ERT) survey lines. The light blue line is the Mataram channel. Line1 is observed fault alignment. Line2, Line3, and Line4 have inferred fault lines.

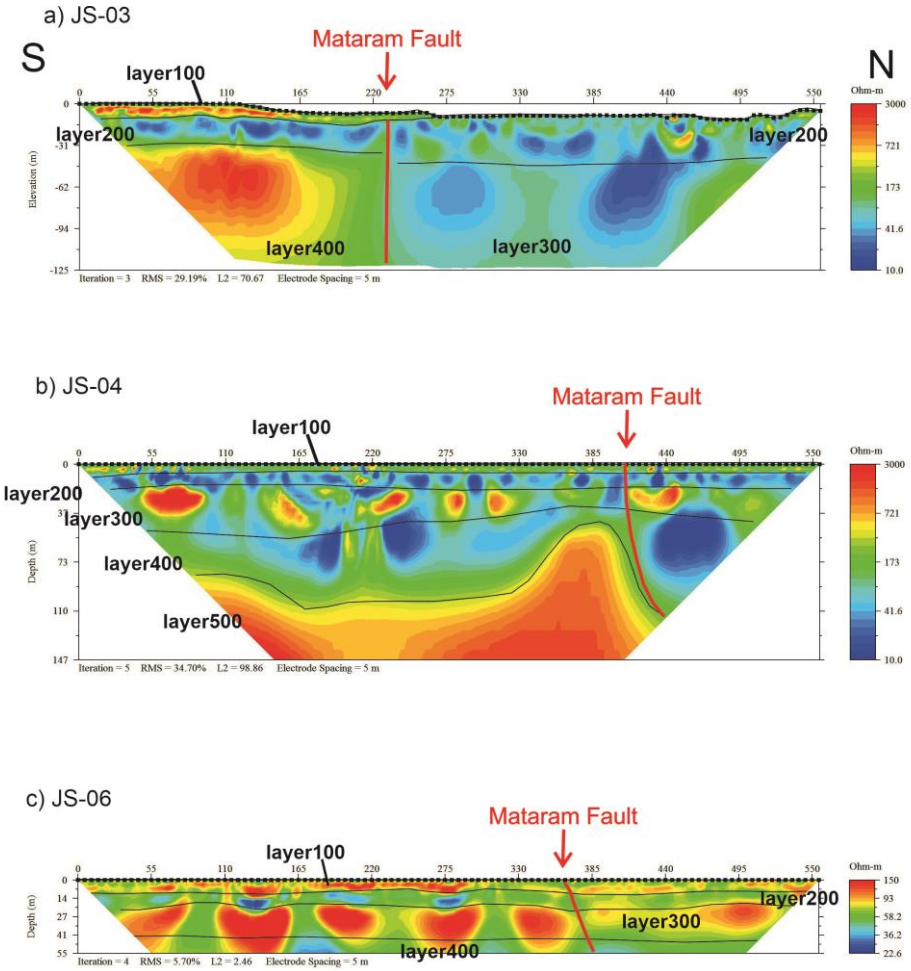


Figure 4. Earth Resistivity Tomography (ERT) of JS-03, JS-04 and JS-06. (a) JS03 has four layers and a fault line on the boundary of unconformity of layer300 and layer400. (b) JS04 has five layers and on the north exists fault, which is uniformity and bulging of layer500. (c) JS06 has four layers, and the fault line of the offset and unconformity contact cuts those layers.

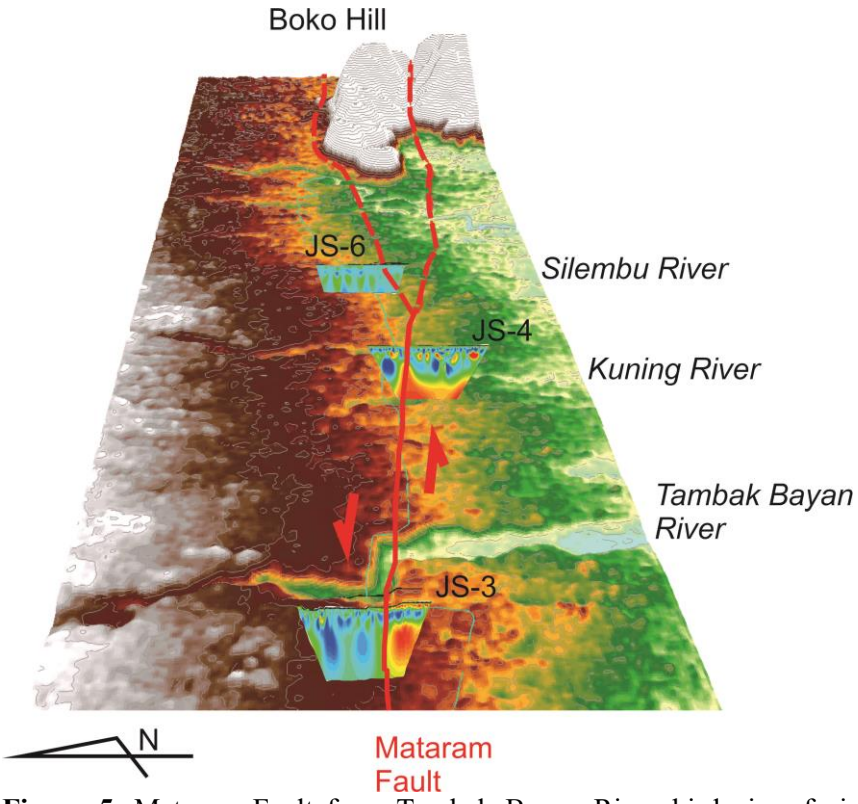


Figure 5. Mataram Fault from Tambak Bayan River bird view facing to the east with the Earth Resistivity Tomography data.

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