

## FAULT ANALYSIS IN POHGAJIH VILLAGE, BLITAR, INDONESIA USING RESISTIVITY METHOD FOR HAZARD RISK REDUCTION

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**ABSTRACT:** A fault estimation has been done in Pohgajih village, Selorejo subdistrict, Blitar district, Indonesia using geoelectric resistivity, dipole-dipole configuration. The study was conducted using Resistivity meter OYO MacOHm. This study aims to analyze the existing fault track at the study site. The analysis of the fault is expected to provide information on the impact of the settlement of villagers in Pohgajih Village. The data acquisition is performed on five measurement tracks with a track length of 150 meters. Visual surveys show that in Pohgajih Village, there are points where people's homes are fractured and severely damaged, and a slanted electric pole as the ground continues to move every year. Based on the interpretation of the resistivity data and the correlation with the visual survey results, the cracked and severely damaged house points were in the low resistivity range. The resistivity varies from 3.4 to 9.8  $\Omega.m$  and interpreted as clay. If traced based on the interpretation of resistivity data and visual surveys then it can be assumed that there is an additional fault, in addition to one track already contained on the geological map. The first fault corresponds to geological information based on the Blitar Sheet Geology Map. However, with the presence of severe damage dwellings at other locations, it is suspected that a second fault is located in the northern part of the first fault. Both faults lead from Northwest to Southeast and are suspected as strike slip fault.

*Keywords: Geoelectric dipole-dipole, Pohgajih Blitar, Fault, Hazard risk reduction*

### 1. INTRODUCTION

The geophysical method is a method that can provide a picture below the surface of the earth without having to do the excavation. One geophysical method can be chosen as a method for fault analysis. This is because Geophysical methods can provide information based on physical parameters such as resistivity values, magnetic anomalies, gravity anomalies and other physical parameters.

Indonesia lies between three large tectonic plates of the Indo-Australian plate, Eurasia, and the Pacific plate. As a result, Indonesia has many volcanoes, frequent earthquakes in various parts of the archipelago as well as tsunamis. Another thing that can happen due to the collision of these plates is the emergence of local faults that can also cause land movement.

Pohgajih village is one of the villages in Selorejo subdistrict of Blitar district. Every year the village experienced land movement, particularly in the beginning of the rainy season. The existence of the land movement is through the cracks in almost all the houses. In fact, one house collapsed as a result of this incident. This causes some residents to move around, often to build houses to avoid cracks every year. However, some choose to stay at home and fix it every year. Based

on the geological interpretation seen on the geological map of the Blitar sheet, the village of Pohgajih is a zone passed by a strike slip fault. This suggests that the possibility of land movement occurring annually in the village of Pohgajih is caused by the movement of the fault.

As one of the mitigation efforts, it is necessary to analyze the existing faults in Pohgajih village, Selorejo subdistrict, Blitar Regency. Fault analysis is done through visual information and supported by the geophysical method. The geophysical method used in this research is geoelectric resistivity of the dipole-dipole configuration. This method is used extensively in searching for groundwater sources and also for monitoring groundwater pollution. This method is also used in engineering surveys to search for subsurface cavities, fractures, and mapping the area of the remains of ancient building foundations buried in archaeological studies, to find out mineral deposits in mining studies and many other applications [1]-[7]

Utilization of geoelectric resistivity method in fault identification has been done. This method can provide an indication of the track fault or the existence of a fault in a location. Such research has been done by [5] in Aceh, [8] in Italy, [9] in Yogyakarta, [10], [11] in Japan.

Therefore, it is important to conduct research

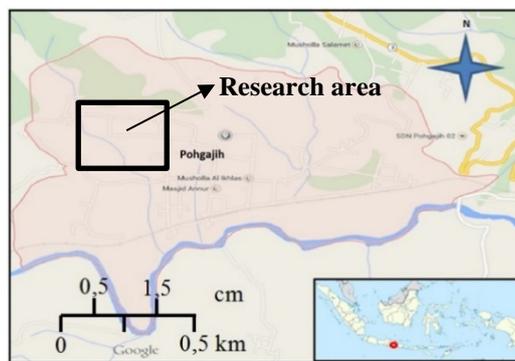
on the analysis of fault in Pohgajih village, Selorejo subdistrict, Blitar district, using geoelectric resistivity method and supported by visual information as the effort of tracing of fault at research location.

## 2. FIELD SITE STUDY

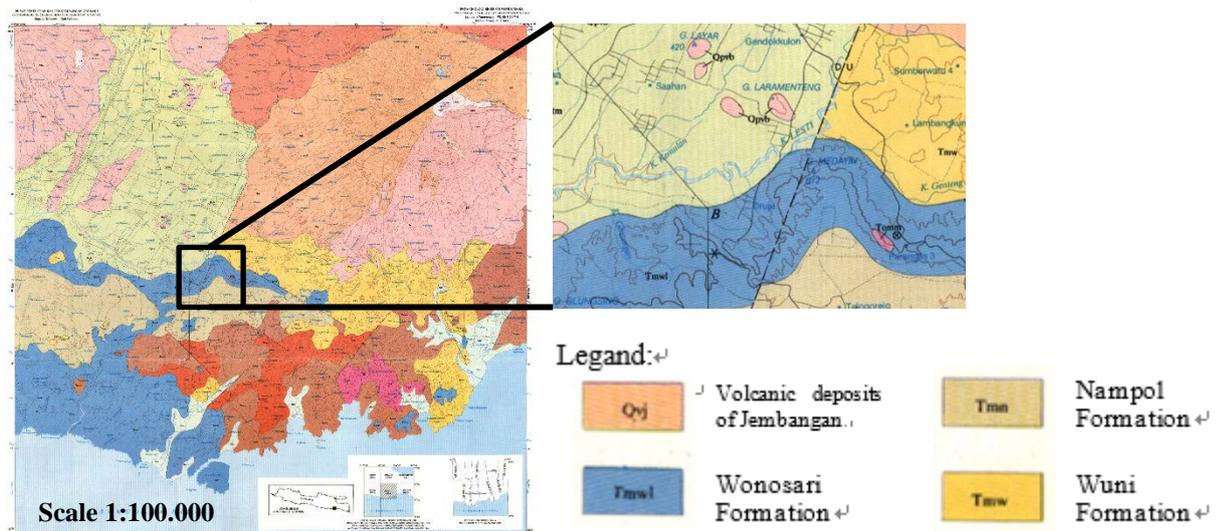
Geographically Pohgajih Village is located at the position of  $8.15115^{\circ}$  SL -  $8.151207^{\circ}$  SL and  $112.414559^{\circ}$  EL -  $112.406488^{\circ}$  EL. The topography of this village is a plateau with an altitude of about 243-262 meters above sea level. The location of Pohgajih Village is between 4 other villages which are still included in Selorejo Subdistrict and Kesamben Subdistrict of Blitar Regency. The village boundaries are Sukoanyar Village at Kesamben Subdistrict, Blitar district in West, Lahor river at Sumberpucung Subdistrict, Malang District in East, Brantas river at Kalipare Subdistrict, Malang District in South, and Selorejo

Village, at Selorejo Subdistrict, Blitar District in North.

Pohgajih Village (Figure 1a) is an area consisting of local settlement, moorland, smallholding plantation, paddy field with 3,501 Ha of the village area. Where an area of 11,626 Ha is settlement and the rest is dry land and rice field area. Based on the geological map of the Blitar sheet, the village of Pohgajih is in the unit of Wuni formation (Tmw) and Tuff Deposits (Qptm). Both are the unit of volcanic rocks. The Wuni formation consists of andesitic-basaltic breccia, laharic breccia, andesitic lava and tuffaceous sandstone intercalation, while the tuff deposits consist of lapilli-tuff, pumice-tuff and lava. Information obtained from the map also shows that the village of Pohgajih is estimated to be passed by a strike slip fault in the southeast-northwest direction. This situation is shown by the dashed lines in Figure 1b [12].



(a)



(b)

Fig 1. (a) Pohgajih Village, (b) Geological Map of Blitar Sheet [12]

### 3. THEORITICAL BACKGROUND

The geoelectric resistivity method uses an artificial current source injected into the ground through the electrode, as seen in Figure. 2.

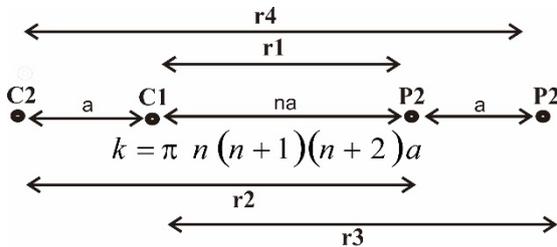


Fig. 2. Dipole-Dipole Configuration [13]

Apparent resistivity equation ( $\rho_a$ ), dipole-dipole configuration for the distance between the electrodes can be formulated as follows:

$$\rho_a = \pi na(n+1)(n+2) \frac{\Delta V}{I} \quad (1)$$

Where:  $\rho_a$  is apparent resistivity (ohm.m)  
 $n$  is integer number  
 $\Delta V$  is potential (Volt)  
 $I$  is current (Ampere). [14]

### 4. METHOD

In this research, the method used is the geoelectric resistivity method correlated with the visual observation result in the research location. The study was conducted in Dusun (Neighborhood) Sopyonyono, Pohgajih Village, Selorejo subdistrict, Blitar district. The tool used is Resistivity meter OYO MacOhm. There are 5 line measurements with a 150-meter track that runs between the southwest and northeast (Figure. 3). The dipole-dipole configuration (Figure 2) uses four electrodes i.e., two current electrodes and two potential electrodes. The current electrode is positioned first and then followed by the potential electrode. The current electrodes (C1 C2) and the potential electrodes (P1 P2) have spaces "a". Initially, the distance between electrode C1 C2 and P1 P2 is "a". As the P1 P2 electrode is moved to the right until the maximum distance is measured, the distance between C1 C2 and P1 P2 becomes "na", where "n" is integer number. Furthermore, the C1 C2 electrode moves to the right as far as "a". And the potential electrode (P1 P2) moves back to the left as far as "a" of C1 C2. Then, P1 P2 moves right to the maximum distance [13]. Spaced electrodes "a" of each line of measurement is at 10 meters, with the information of the topography

(elevation) is measured in every measurement. The configuration used is the dipole-dipole configuration. In addition, the visual information used for the correlation of geoelectric results is done by direct surveys to homes of citizens whose homes are affected by land movement each year. Direct surveys are also conducted for documentation and recording of coordinates of locations affected by land movement.

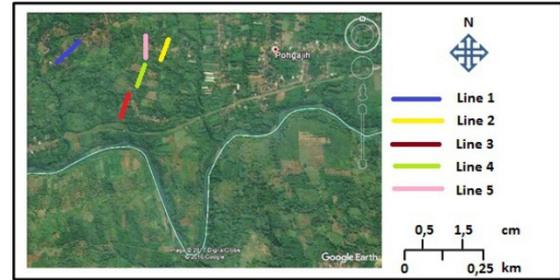


Fig. 3. Line of Geoelectric Resistivity Measurement Method

Res2dinv software is used as an advanced data processing of the data obtained when measuring at the research sites. Data processing is done by 2D inversion method. Preferred inversion method is a method of smoothness-constrained least-squares. The advantages of the least-squares method have been described in several publications. The least square method has the benefit of a linear regression system with calculations for easier error. In that case, this inversion method can provide a relatively accurate picture of the actual conditions by displaying the smallest error [15] [16]. The result of the inversion process is a 2D subsurface structure model with a true resistivity value and true depth variation.

### 5. RESULT AND DISCUSSION

Estimation with Dipole-Dipole configuration resistivity method in Pohgajih Village, Selorejo Subdistrict, Blitar District has been done on five measurement lines. Here are the results of data processing and interpretation.

#### Line 1

The length of line 1 is 150 m with an electrode spacing of 10 m and obtained a description of imaging subsurface soil as in Figure 4. Figure 4 shows that at a measurement length of about 120 meters, the resistivity value is in the range of 5.8-9.8  $\Omega$ m. The visual survey of this place shows that the resident houses are affected by land movement.

The floor and the walls of the house are cracked. Based on the results of a survey to the citizens, incident continues to recur every year despite being repaired. In addition, the length of the line measuring 140 meters with a resistivity value that allows continuous as long as the previous track length 5.8-9.8  $\Omega\text{m}$ , seen the existence of coconut trees and electric poles are sloping toward the southeast.

**Line 2**

The length of line 2 is also the same as the first line of 150 m with an electrode spacing of 10 m and obtained a description of imaging subsurface soil as in Figure 5(a). While the damaged building is shown in Figure 5(b). Figure 5(a) shows that this trajectory is dominated by the low resistivity of 3.4-5.8  $\Omega\text{m}$  suspected as clay. In this track there is no visual supporting data but suspected presence of another local fault trackway to this location as it is visible at a distance of 50 meters to the east of this line. There are residents' houses that are also damaged every year (Figure 5b). However, these residents' houses are different from those of affected residents such as on line 1. There is clay dominance in this location, so it is possible that this area is also vulnerable to the movement of the land due to its very unstable soil conditions.

**Line 3**

Line 3 also has a length of 150 m with an electrode spacing of 10 m and obtained a description of imaging subsurface soil as in Figure 6. Figure 6, shows that this trajectory is dominated by resistivity between of 5.8 and 9.8  $\Omega\text{m}$  which is suspected as clay and 9.8-28.1  $\Omega\text{m}$  suspected as

sandy clay. On the length of the line, there is a house cracked on both the wall and the floor. At the length of this line, the resistivity looks low in the range from 3.4 to 5.8  $\Omega\text{m}$ .

**Line 4**

Line 4 also has a run the length of 1 to 50 m with an electrode spacing of 10 m and obtained a description of imaging subsurface soil as in Figure 7. Figure 7 shows that at the line length measuring  $\pm 60$  meters, there are houses with cracked at walls and floor. Also, there are empty homes because every year there continues to be land movement, so the house is cracked and has shifted. The range of measuring resistivity in line length (houses with cracked at walls and floor) is 5.8-10.0  $\Omega\text{m}$ .

**Line 5**

Line 5 also has a track length of 150 m with an electrode spacing of 10 m and obtained a description of imaging subsurface soil as in Figure 8. Figure 8 shows that at the line length measuring  $\pm 60$  meters; there are houses with cracked walls and floor. Also, this track is the same as line 2, which is dominated by low resistivity suspected as clay. Similar to line 2, the line is presumed to have a different local fault due to the severely damaged house position and the passage of this track differ from the location of the line 1,3 and 4. The dominance of this clay also causes the area to be a very prone to land movement. Based on the direct survey of people whose homes have cracks in this location, it is said that at this site in 2-3 years ago, also experiencing land subsidence up to 5 meters, but now stops and only cracked home occur each year.

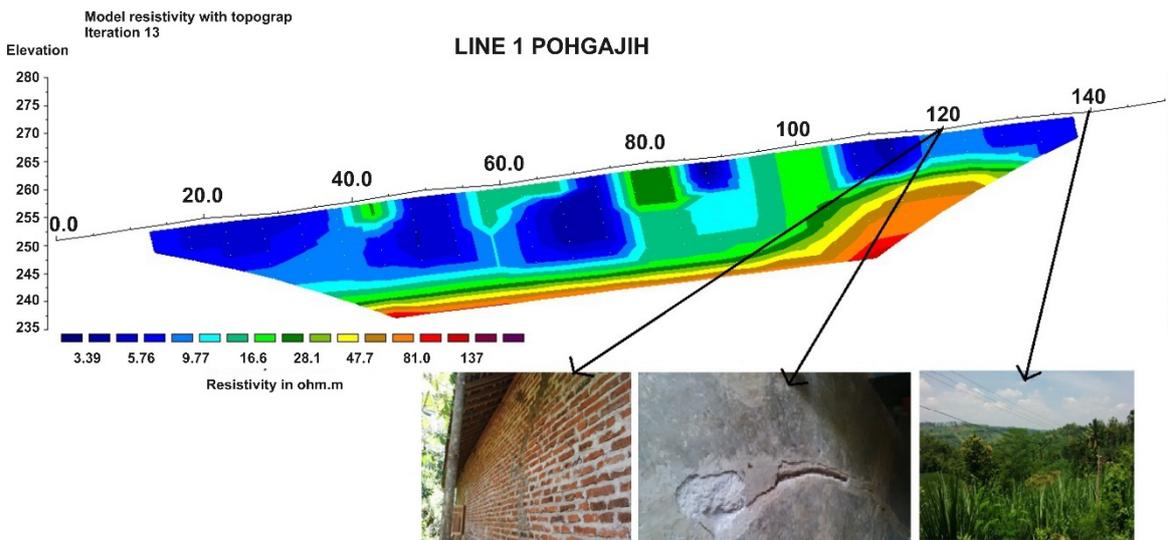


Fig. 4. Correlation of 2D resistivity cross section of line 1 (top), and visual investigation (bottom)

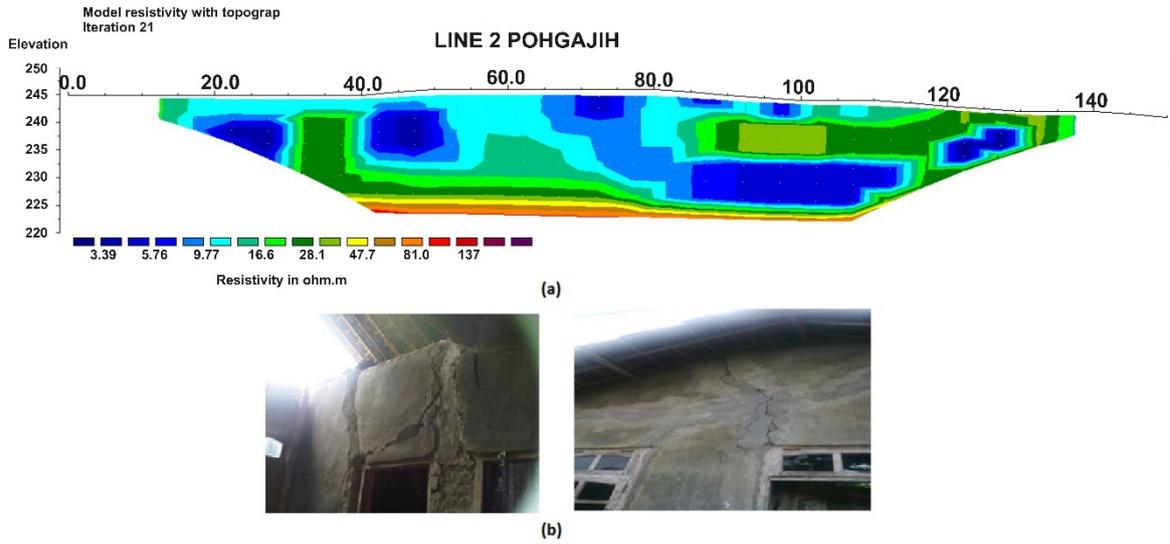


Fig.5. (a) 2D cross section resistivity of line 2, (b) the worst damaged citizen house 50 m from line 2

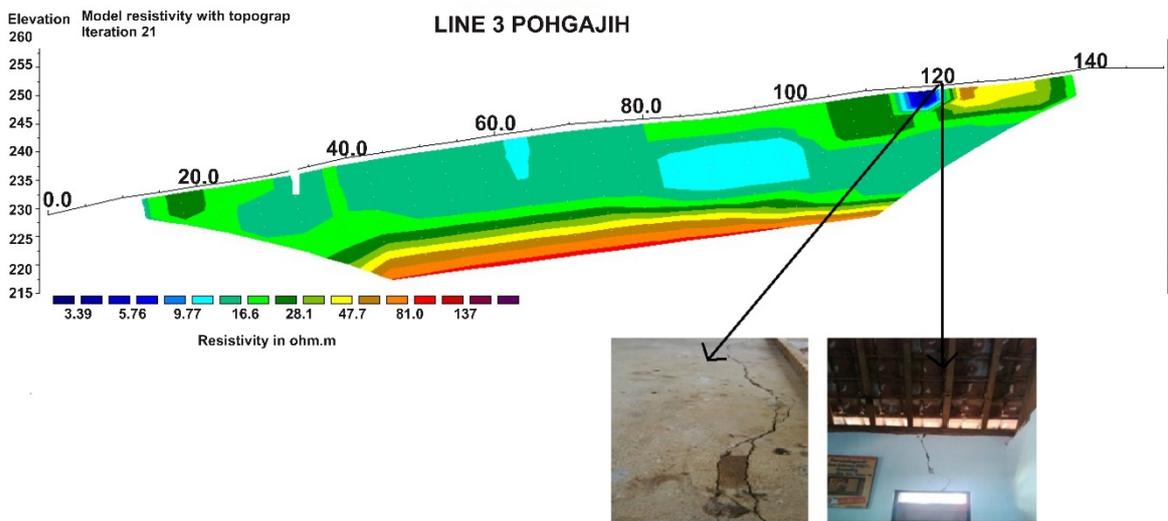


Fig.6. Processing result of 2D resistivity cross-section of line 3 (top), and crack of the wall and roof of a house (bottom).

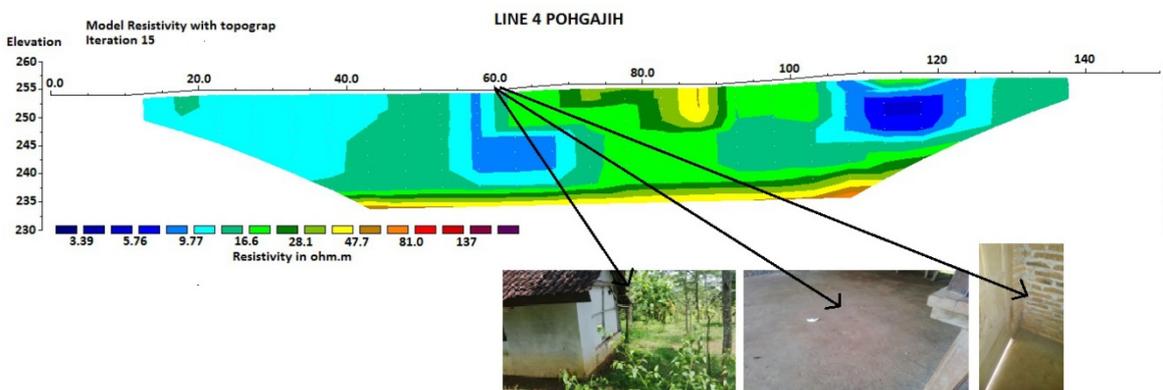


Fig. 7. 2D resistivity result of line 4 (top), and crack of wall in a house (bottom)

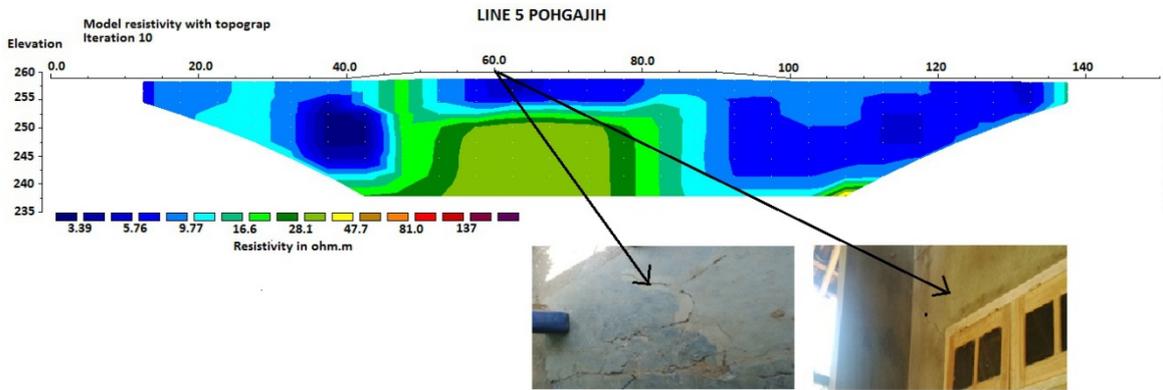


Fig. 8. Correlation of 2D resistivity cross-section of line 5 with visual data

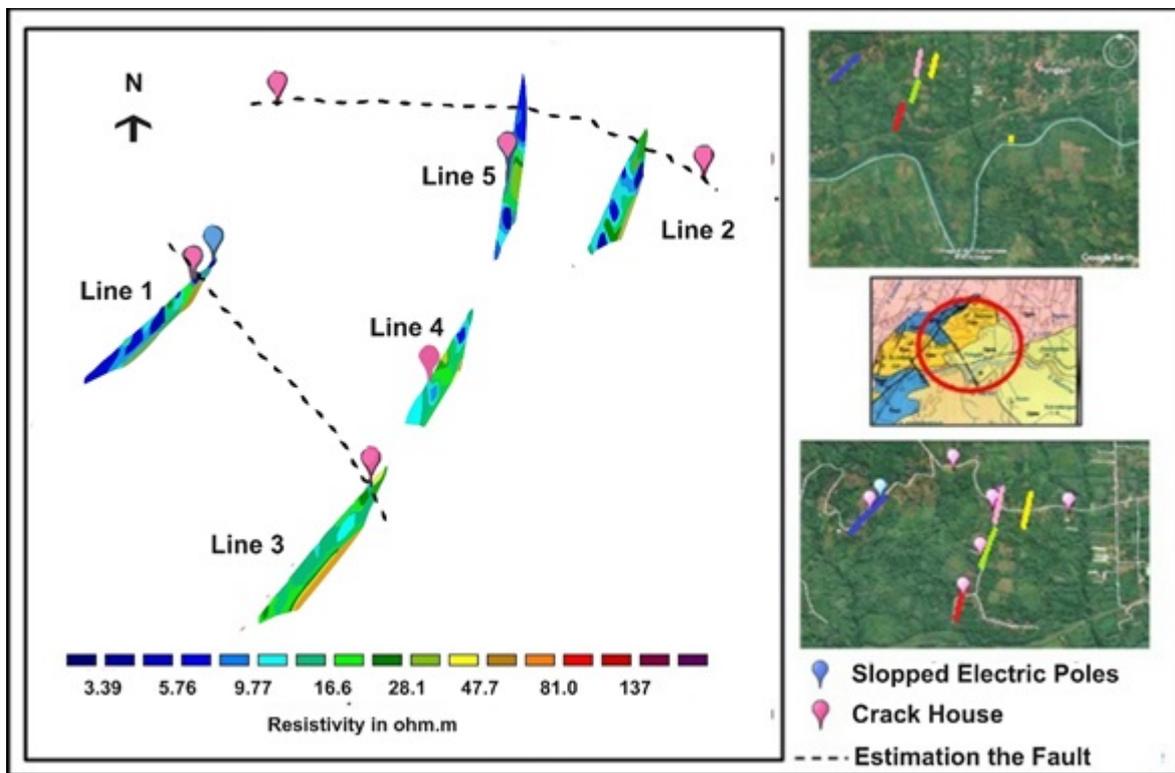


Fig. 9. Correlation of five line measurements and fault estimates

The five lines of measurement can be correlated to predict the direction of the fault in the study site. Based on the results of data processing geoelectric resistivity, it appears that the supporting data visually if mapped on 2D cross sections resistivity lies in the range of 3.4 to 9.8  $\Omega\text{m}$ , low resistivity that is suspected as clay. A 2D resistivity cross section can not show a direct fault due to the absence of a layer intersection owing to the high and low resistivity differences, usually indicating a normal/gravity fault. Therefore, this indicates that the fault in the study area is a strike slip fault. The existence of a strike slip fault is what allows the occurrence of land movement every year at the study site, as shown in Figure 9.

Figure 9 shows that the strike slip fault located at the study site leads from northwest to southeast, based on the correlation between resistivity interpretation data and visual surveys. It may also indicate that the geological map information which allows for the prediction of a fault at the site is exactly in line with the results of the study. However, this study can provide new information; the possibility of another fault leading from northwest to southeast (dashed line) but its position is further to the north of the research location. Another fault is thought to be due to a severely damaged house in the same line with a more severe level of damage than previous fault. Also, there is also information from residents

claiming of a land subsidence around the house that was severely damaged 2-3 years ago. The existence of this fault shows the research location is very vulnerable to the event of land movement, especially, for residents' houses along the alleged fault at this location.

Interpretation of lithology of rocks with geoelectric measurements for the study area is shown in Table 1.

Table 1. Subsurface distribution of the sediment resulting from geoelectric interpretation.

No.	Contour Colors	Resistivity ( $\Omega.m$ )	Rock type
1.	Dark blue	3.4 - 5.8	Clay
2.	Light blue	5.8 - 9.8	Clay
3.	Tosca-Light Green-Dark Green	9.8 – 28.1	Sandy Clay
4.	Yellow-Brown	28.1-81.6	Sandstone
5.	Red-Purple	81.6-137	Sandstone

## 6. CONCLUSION

Based on the correlation result of between geoelectric resistivity method and visual survey result in Pohgajih Village, Selorejo subdistrict, Blitar, shows an occurrence of land movement happening every year in this area due to fault activity. The current faults in this location are suspected to be a strike slip fault. The geoelectric data interpretation can not show the fault route if there is no supporting data in the form of a visual survey. The visual survey correlation demonstrates the presence of severely fractured houses at this location seen on the line of geoelectric measurements with a low resistivity range from 3.4 to 9.8  $\Omega m$  which is clay. There is allegedly two fault in the study area, i.e., one track corresponding to the geological information of the Blitar sheet and one more track north of the previous fault. Both faults lead from Northwest to Southeast. One suggestion to the government that it should be a regulation that it is forbidden to build the houses or other building along the both faults.

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