IDENTIFICATION OF VOLCANIC ROCKS IN IMOGIRI YOGYAKARTA BASED ON SUBSURFACE GEOLOGIC DATA

By Winarti -

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IDENTIFICATION OF VOLCANIC ROCKS IN IMOGIRI YOGYAKARTA BASED ON SUBSURFACE GEOLOGIC DATA

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Abstract

Physiographically, the research area is located in the margin of Yogyakarta and the western part of South Mountain Yogyakarta. Morphology and lithologically, through along of Imogiri could be identified that there are ancient volcanoes. Those could be proved by discovered of the volcanic rocks such as lava, breccias, and tuff. The aim of this research is identifying the presence of volcanic rocks in the length of Imogiri based on subsurface geologic data. To find out the sub surface condition, the geoelectric method of mapping used in this research by dipole configuration at four location (lines) namely in the Karang Asem – Dengkeng, Plencing, Siluk – Selopamioro, and Sindet area. The geoelectric measurement by mapping will be resulted of resistivity profile. Based on the price range of resistivity from those profile, it could be interpreted that the lithology through the length of each line. Each location (line) was measured along 500 metres.The result of measuring on line 1, there are volcanic rocks such as basaltic lava (ρ>600 Ωm), distributed in the northwest to southest in depth of > 30 metres. On line 2, the volcanic rocks can be found such as pyroclastic breccia (ρ>1000 Ωm) in depth of > 20 metres. On line 3, it may be intepreted as the volcanic rocks such lava (ρ = 1000 Ωm), which can be found on the centre part in depth of > 20 metres. On line 4, it it may be intepreted as the volcanic rocks such as lava (ρ = 1100 Ωm), which can be found on the centre part in depth of > 20 metres

Keywords : the volcanic rocks, mapping, resistivity, Imogiri

INTRODUCTION

Generally the tectonic in the south of Java Island is effected by subduction zone of Hindia – Australia ocean plate underneath Eropa – Asia plate which occured since in the middle Tertiary. As the result of those subduction, it produced magmatism – volcanism phenomenon. It's proved by the presence of Tertiary volcanic rocks (ancient volcanoes) which reinforced by the presence of lava and volcanic breccias in some spots in Imogiri. Those locations are still in the western part of Southern Mountain.

The presence of the ancient volcano in those location actually can't be seen easily in the surface caused by the morphology has been obsolencent and the further erotion. So as the visual of the morphology and the volcanism proccess such as the present time volcanoes couldn't be seen. Therefore to find out the location of erruption source in those ancient volcanoes need to be done by subsurface geologic data survey, in this case is geoelectric by the mapping methode. Hartono, G., and Bronto, S.(1999)[1] has studied about the surface data to indicate the presence of ancient volcanoes in Imogiri. But the research which link between the surface data and subsurface data has never be done.

The aim of this research is identifying the presence of volcanic rocks in the western part of Southern Mountain especially in Imogiri by based on price range in resistivity from any rocks, so as it can be sign the presence of ancient volcanoes.

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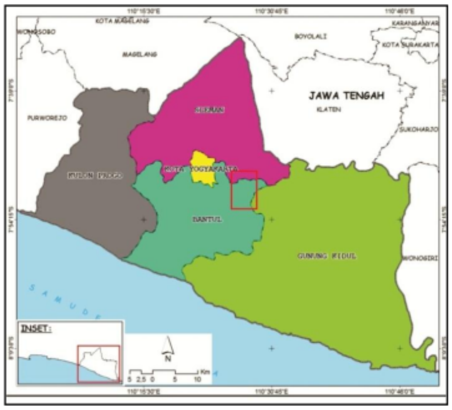
The measurement locations are located in four location (lines) namely (Picture 1) Karang Asem–Dengkeng, Plencing, Siluk-Selopamioro and Sindet area. Four locations are located in Imogiri region, Yogyakarta.



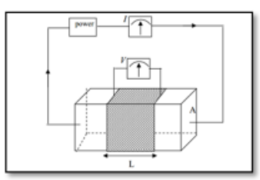
Picture 1. The location of research area

BASIC THEORY

Resistivity Geoelectric

The resistivity methode is one of geophysics methode which bring out the view of the lithology and subsurface structure in any region based on the electrical character of rocks (Dobrin and Savit, 1988)[2]. The basic principle of the resistivity geoelectric is Ohm's Law. Those Law is about the resistance is obtained by the measuring the potential difference and the current which is passed in a conductor. The flowing current (I) through the medium comparable with the potential (V) which is measured and inversely proportional with the medium resistance (R), or can be given by : R = V/I …………..(1)

Basic concept of rock resistivity measurement is modified by measuring the resistance of a sample in laboratory by the scheme given in picture 2 (Telford et al., 1990)[3] : R = ρ. L/A ……..… (2), with R = measured resistance (Ω), ρ = Resistivity of material (Ωm), L= long (metres) dan A= Wide of Area (metres), because R = V/I …… (3), so as $\rho = \frac{V}{I}.\frac{A}{L}$ ………… (4).



Picture 2. The sample of rock which flowed by the current (Telford, et al., 1990)

The amount of price range of resistivity in any kind of rocks and mineral can be showed in table I. Winarti and Chusni Ansori (2009)[4] the study of manganese mineral distribution in breccias in Srati area, Kebumen based on Induction Polarization geoelectric. Manganes mineral is indicated by the value of resistivity is small (<30 (Ωm) while the breccias has the value of resistivity is commonly big.

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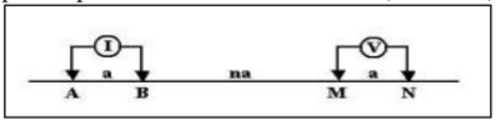
Table I. Price range of resistivity in any kind of rocks and mineral (Telford, et al., 1990)

Kinds of rock / ores	%H^2O	ρ (ohm-meter)
Granit phorpiry		$4,5 \times 10^3$ (wet) – $1,3 \times 10^6$ (dry)
Diorit phorpiry		$1,9 \times 10^3$ (wet) – $2,8 \times 10^4$ (dry)
Granit	0,31 0,19 0	$4,4 \times 10^3$ $1,8 \times 10^6$ 10^{10}
Andesit		$1,7 \times 10^2$ (wet) – $4,5 \times 10^4$ (dry)
Tuff		2×10^3 (wet) – 10^5 (dry)
Basalt		$10\text{-}1.3 \times 10^7$ (dry)
Lava		10^2 -5×10^4
Sandstone	0 1,0	$1 - 6,4 \times 10^8$ $4,2 \times 10^3$

Winarti and Joko Sungkono (2013)[5] studied the existance of groundwater aquifer in volcanic rocks by using the geoelectric methode in Nganjuk area. The result of research is showing the value of resistivity from any volcanic rocks has a big value. But the volcanic rocks which have the groundwater, the value of resistivity is small.

Generally the resistivity methodes can be divided into two (Dobrin, and Savit, 1988), namely mapping and sounding methode. The mapping methode is used for knowing the variation of resistivity heading to lateral direction. The geoelectric mapping by configuration dipole dipole is used in this research (Picture 3).



Picture 3. The electrode formed in Dipole configuration (Dobrin and Savit, 1988)

The physical quantities which measured directly in the field is a potential difference and the current. While the value of the geometry factor (K) is calculate based on the arrangement of the elektrodes used. By the substitue K factor, so the resistivity (the value of resistivity) of rocks can be given in Ohm's Law (Telford, et al., 1990). $\rho = \Delta V/I.K$ .... (5). The amount of geometry factor to configuration dipole is $K = \pi(na^2/a\text{-}na)$ .... (6), so as the amount of the value of resistivity $\rho = \Delta V/I \times \pi (na^2/a - na)$ .... (7).

General Geology

The research area is a border region of morphology between Southern Mountain in the eastern part and Yogyakarta Flatland in the western part of research area. The morphology in this region such as isolated hills among in the Aluvium unconsolidated sediments Merapi Volcano landform. Astuti, B.S, Rahardjo, W., Listyani, R.A., and Husein, S., (2009)[6] called as inlier hills caused by formed in old rocks which surrounded by the young deposit and considered that those isolated hills caused by tectonic activity such as the faulting. Hartono, G., and Bronto (2009) [7] claimed that those isolated hills are monogenesis or direct to the composit, while the fault only has function to open a wayout for magma toward earth surface.

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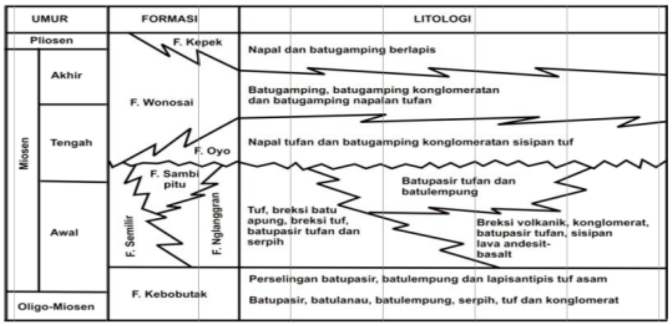
Regionally, largely the Tertiary volcanic rocks in the research area included in Nglanggran Formation. The discussion about regional stratigraphy in the research area emphasized to Southern Mountain stratigraphy of Central Java – eastern part of Daerah Istimewa Yogyakarta namely Baturagung range and Kambegan range. Rahardjo, et al., (1977)[8], Surono, et al., (1992)[9] dan Samodra, et al., (1992)[10], claimed in geology map of Pacitan that intrusion igeneous rock in Southern Mountain is located in the same location or close to the volcanic rocks " turbidite deposits". Baturagung range is formed of Lower Miocene volcanic rocks (Table II).

Table II. The stratigraphy coloumn of Baturagung Range in Southern Mountain (simplified from Rahardjo, et al 1977; Surono, et al., 1992; and Samodra, et al., 1992).



The volcano and Ancient volcano

MacDonald (1972, in Bronto, S.,2013)[11] claimed that the volcano as a place or rupted incandescent rocks or and gases as usual, out to surface and solid material deposit in surrounding those open hole forming the hill or mountain. The place or open hole is a creater or caldera, while the incandescent rocks and gases are magma. The ancient volcanoes or paleovolcanoes according to definition from (Bronto, S.,2013) is a volcano which ever been active in past time, but nowadays the volcano has been inactive and even has been eroded advanced so as the fiture or physical vision of the body has not been an active volcano in the present time, even a little part of body has been covered by the younger rocks. The age of ancient volcano is relatively Tertiary (> 2 millions years ago) or older.

Identification of ancient volcanoes can be done in several ways (Bronto, S.,2013) such by approach in remote sensing and geomorphology, analysis geological map, stratigraphy, and lihofacies of volcano, sedimentology, geological structure, petrology and geochemist, drilling data also approach in geophysics analysis. Mulyaningsing and Sanyoto (2013)[12] in their research in the western part of Southern Mountain Central Java intepreted as a circularly shape (result of SRTM analysis and geomorphology data) showing the existance of ancient volcano activities in Tertiary. Among those the circularly can be grouped into two (2) namely Parangtritis – Dengkeng and Candisari – Nglanggran ancient volcanoes (Picture 4). Bronto, S., (2013) more detaily made a paleovolcanoes in Southern Mountain list especially in Berbah – Imogiri area given in (Table III) based on observation of surface outcrops.

Methods

The methode is used in solving the matter above namely by doing a measurement in resistivity geolectric with mapping resistivity, configuration of dipole. The measurement was done by make four lines which those location in figure picture 5, each line has 500

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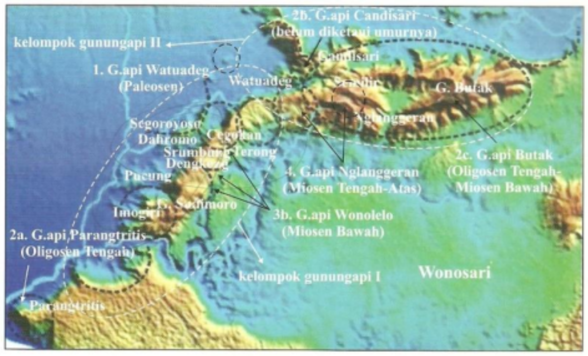
metres in lenght. The resistivity geoelectric measurement is aimed to get the value of current and potential from the rocks / mineral.

In doing these research is supported by some supporting tools such as (Picture 6) resistivitymeter is used to measure the current and potential difference, current source (genset), multichannel cable (2 cables) with each cable has 100 metres in lenght, channel mono cable (2 cables) with each cable has 250 metres in lenght, electrodes (20 electrodes), geology compass, hammer, GPS, data table, and written tools



Picture 4. Intepretation of two groups in western part of Southern Mountain based on geomorphology data (Mulyaningsing and Sanyoto, 2013)

Table III. The list of ancient volcanoes in Southern Mountain especially in Imnogiri area (Bronto, S., 2013)

No	The name of ancient volcano	Location	Indication of morphology and lithology
1	Siluk Volcano	In the south of Imogiri Sub-district, east of Siluk _ Panggang main road	A flatland bordered by semicircle escarpment formed in lava flows and andesit breccias.
2	Sudimoro volcano	Sudimoro volcano, Imogiri and Dlingo sub district, Bantul Regency, 7°55'-59' LS, 110°19'-20' BT	Depresion, formed by altered rocks, on the wall and the peak of Sudimoro volcano composed in lava flows layered and andesitic pyroclastic breccias
3	Plencing-Sindet volcano	In the northwest of Imogiri subdistrict, Wukirsari-Trimulyo village	Hills formed by andesitic intrusion Plencing, co-ignimbrite and breccias of pumice Sindet
4	Dengkeng Volcano	Dengkeng, backwood Wukirsari village, Imogiri subdistrict	Isolated hill in the edge of backwood +144 metres, in the east +122 metres formed by dyke, lava, pyroclastic breccias riched in basaltic volcanic bomb

RESULTS AND DISCUSSIONS

The result of processing geoelectric data from four lines produced the profile of lateral and horizontal resistivity. Those four lines figured in picture 7-10, based on those profile it can be intepreted in kind of lithology, the distribution pattern lateraly and vertically. In doing intepretation also surely supported by surface geologic data and published literature.

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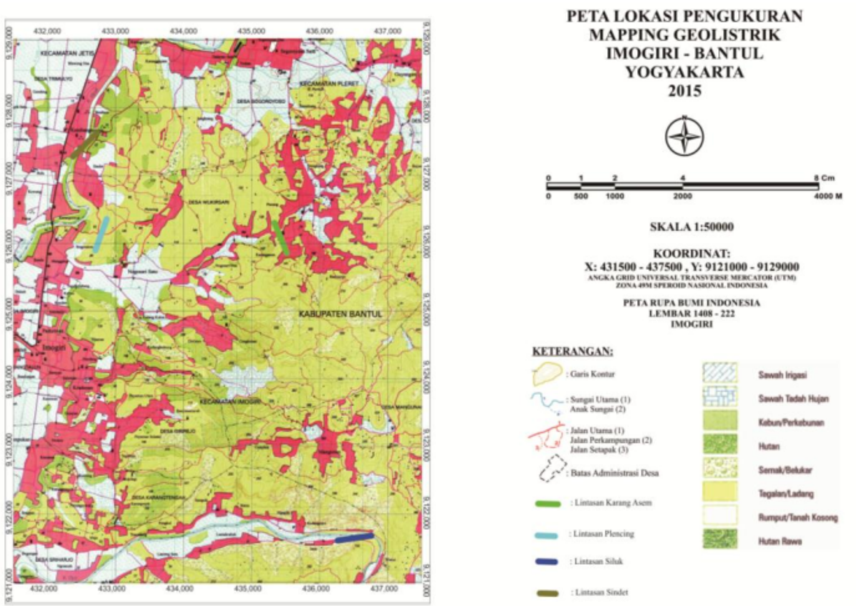
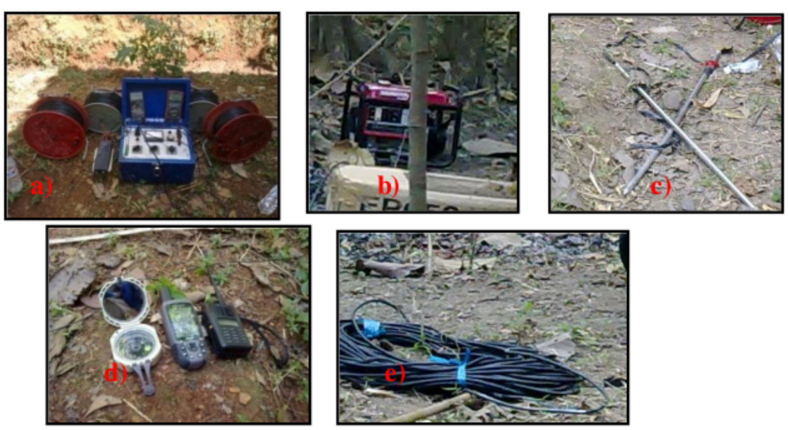
Dengkeng, Wukirsari Village, Imogiri Subdistrict

The measuring in this location produced the resistivity cross section in 60 – 70 metres depth from surface (picture 7), with the direction of line is N158°E. From the topography cross section could be viewed a highpoint in the southeast to the centre. Based on the relative value of resistivity may be possibility there the volcanic rock such basaltic lava. This case detected from the value ρ>600 Ωm. The existing of basaltic lava distributed from northwest to southeast in depth of > 30 metres and arise on surface on centre part.



Picture 5. The location of geoelectric resistivity



Picture 6. The field tools are used in research: a). resistivitymeter, b). current source c). elektrode, d). multichannel cable, e). geology compass, GPS and HT

Plencing Mountain, Wukirsari Village, Imogiri Subdistrict

The geoelectric measuring in this location produced resistivity cross section in depth of 30 metres from surface (picture 8), with the direction of line is N200°E. On the

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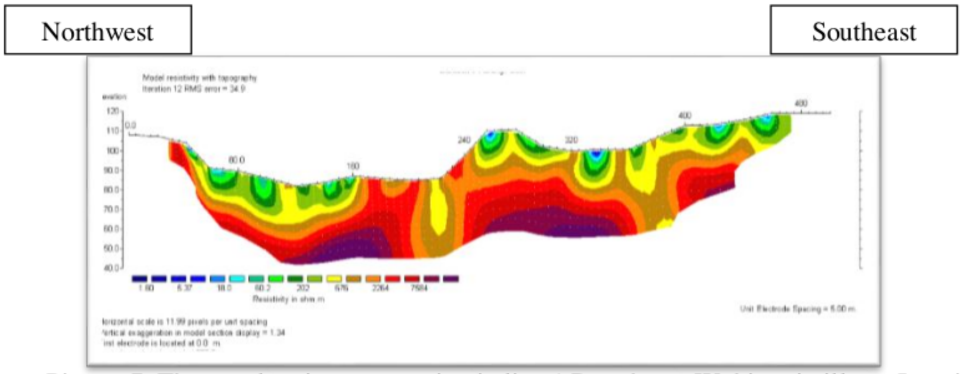
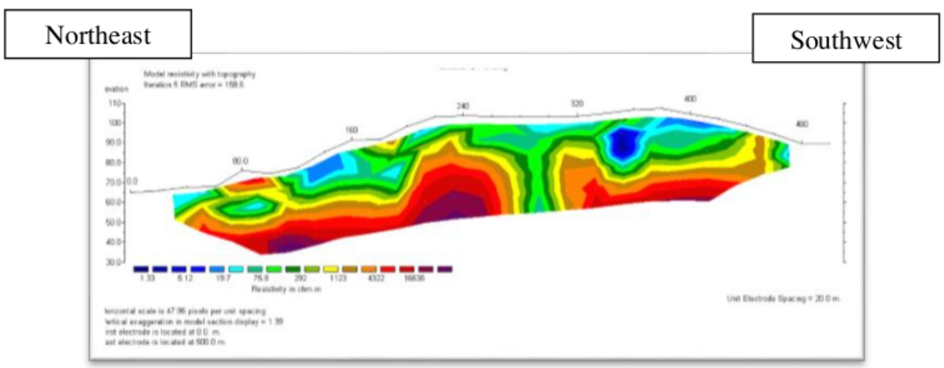
cross section viewed a higher topography in the southwestern part. Based on relative value of resistivity and outcrops data on surface, it may intepreted there are volcanic rocks such pyroclastic breccia (ρ>1000 Ωm). Commonly this rocks distributed from northeast to southwest in depth of 20 metres. While in the northeast part, the pyroclastic breccia there on surface.



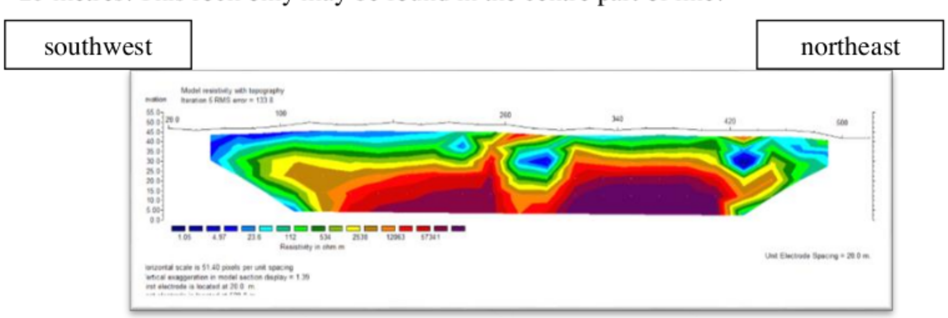
Picture 7. The geoelectric cross section in line 1 Dengkeng, Wukirsari village, Imogiri Subdistrict



Picture 8. The geoelectric cross section in line 2 Plencing Mountain, Wukirsari village, Imogiri Subdistrict

Siluk, Selopamioro Village, Imogiri Subdistrict

The resistivity crosscross section in this location (Picture 9) reached in depth of 40 – 45 metres from surface, with the direction of line N82ºE. On this line, it viewed there are a flat topography. Based on relative value of resistivity and the outcrops data on surface, we may be intepreted there are volcanic rocks such lava (ρ = 1000 Ωm) in depth of more 20 metres. This rock only may be found in the centre part of line.



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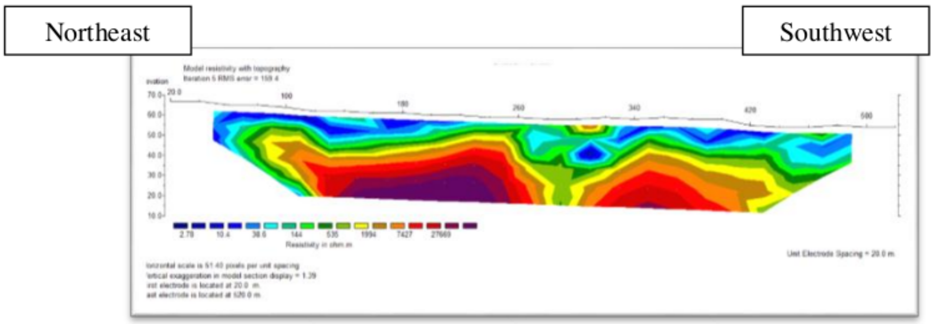
Picture 9. The geoelectric croess section line 3, Siluk, Selopamioro village, Imogiri subdistrict

Oyo River, Sindet Village, Imogiri Subdictrict

the resitivity crosssection in this line (picture 10) reached the depth of 50 metres from surface with direction of line N225^{o}E. On this line viewed a relative flat topography. Based on relative value of resistivity and the outcrops data on surface, it may be intepreted there are volacanic rocks such lava (ρ = 1100 Ωm). Lava is only found in the centre part of line in depth > 20 metres. The surface data of lava, there are many joints, so it can be possibility there a mineralization.



Picture 10. The geoelectric crosssection in line 4, Oyo river, Sindet village, imogiri subdistrict

CONCLUSIONS

Based on the result of study, so it may be concluded that :

1. The study area physiographycally there in the margin of Yogyakarta Platform and Southern Mountain Zone in the western part and regionally included in Nglanngran Formation.
2. The geoelectric measuring done by mapping used configuration of dipole-dipole in four location which indicated as ancient volcanic area.
3. On line 1, there are volcanic rocks such basaltic lava (ρ>600 Ωm), distributed in the northwest to southest in depth of > 30 metres. On line 2, the volcanic rocks can be found such as pyroclastic breccia (ρ>1000 Ωm),distributed in northeast to southwest in depth of > 20 metres. On line 3, it may be intepreted as the volcanic rocks such lava (ρ = 1000 Ωm), which can be found on the centre part in depth of > 20 metres. On line 4, it it may be intepreted as the volcanic rocks such lava (ρ = 1100 Ωm), which can be found on the centre part in depth of > 20 metres.

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