Short Communication

Identification of Pumice Deposits from the Samalas Eruption Based on Geoelectrical and Borehole Data in the Tanjung Area, North Lombok Regency

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Abstract: Mount Samalas is part of Rinjani Volcano, which erupted in 1257 AD. This eruption was one of the largest volcanic eruptions ever. This eruption left deposits in the form of pumice that reached tens of kilometers. The results of the eruption can be used as an object of research and important knowledge related to traces of volcanic activity in the past. This study aims to analyze the subsurface lithology suspected to be rock deposits from the eruption of Mount Samalas in the Tanjung area of North Lombok Regency. The method used is the drilling technique, and in each location where the drill data is taken, geoelectric measurements are carried out, There are 6 geoelectric trajectories with a track length of 69 meters. The results showed that the constituent rocks of the Tanjung Region consisted of top soil, silt, pumice, sandstone, clay, and black sand. Then, in the research area, a layer of pumice from the eruption of Mount Samalas was found at a depth of 1–5 meters with a thickness of 1–2 meters.

Keywords: Drill, Eruption, Geoelectric, Mount Samalas, Pumice.

1. Introduction

Mount Rinjani is one of the highest volcanoes in Indonesia with an altitude of 3,726 meters above sea level. Mount Rinjani is located on the island of Lombok, precisely in the northern part of Lombok Island and is the only active volcano on this island [1]. In the 13th century, there was a major eruption that resulted in disasters and droughts in various countries. The large eruption came from the eruption of Mount Samalas [2], [3]. Mount Samalas is part of Rinjani Volcano which erupted in 1257 AD, where it is estimated that the scale of the eruption reached scale 7 VEI (Volcanic Eksplosivity Index). The results of this eruption left a caldera of approximately 6 km^2 which can be seen in Figure 1.

Figure 1. Samalas caldera

In addition to leaving a caldera, the Samalas eruption also produced volcanic deposits in the form of pumice measuring tens of cubic meters. The pumice is scattered in various areas on Lombok Island, especially at the foot of Mount Rinjani. Based on research conducted by Mutaqin et al [4], it was found that there are traces of Samalas in the form of a stratigraphic layer of pumice found in the Gangga area, North Lombok Regency which can be seen in **Figure 2**.

Figure 2. Stratigraphy of pumice layers in Gangga Klu area

One area that is estimated to have pumice deposits in the subsurface is in the Tanjung area of North Lombok Regency, this is evidenced by the results of well observations in the research area that a layer of pumice is found on the surface of the well. Pumice found in the Tanjung area is spread at depths with varying thicknesses below the surface. It is not yet thoroughly known how much thickness, depth, and reissivity value of pumice at that location, therefore further research needs to be done.

Research related to the eruption of Mount Samalas has been done by several previous researchers, including Büntgen et al. [5], and Voigt et al. [6] who revealed that the major eruption that occurred in 1257 AD was an eruption originating from Mount Samalas, it was found that the results of the eruption deposits in the form of pumice. Based on research conducted by Ang et al. [7] found that there were three major eruptions that occurred on Mount Samalas, three types of pumice layers were found in the Gangga area, North Lombok, namely, yellow pumice is thought to be the result of the first period of Samalas eruptions, then the pink pumice layer is thought to be the result of the second period of eruptions, and the white pumice layer is thought to be the result of the third period of Samalas eruptions in the 13th century. Research by Wu et al. [8] obtained based on the results of geoelectric surveys show the distribution of the resistivity value of pumice from the Samalas eruption in the alluvial area, namely the resistivity value ranges from (20 - 958) Ohm.m while in the slope area it ranges from (736 - 2000) Ohm.m.

This research aims to analyze the subsurface lithology and analyze the deposits from the eruption of Mount Samalas in the Tanjung Region using drilling techniques and resistivity geoelectric methods. By combining these two methods, it is expected to interpret more deeply to determine the type of subsurface lithology so that more accurate results are obtained.

2. Method

This research aims to analyze the subsurface lithology and analyze the deposits from the eruption of Mount Samalas in the Tanjung Region using drilling techniques and resistivity geoelectric methods [9]. By combining these two methods, it is expected to interpret more deeply to determine the type of subsurface lithology so that more accurate results are obtained. Methods This research was conducted in Tanjung Subdistrict, including Tanjung Village, Jenggala Village, Sokong Village, and Sama Guna Village. The equipment used included a cobra drilling machine and a hand drill (manual), while for geoelectric measurements a resistivity meter, battery, GPS, electrodes, cable, hammer, and meter were used. In the data processing process, Microsoft Exel, Res2dinv, and Surfer software were used. In general, the research stages include data acquisition or retrieval, data processing, and data interpretation. Data acquisition was carried out using the drill method and the

Wenner-Schlumberger configuration Geoelectric method carried out on six measurement trajectories as shown in **Figure 3.**
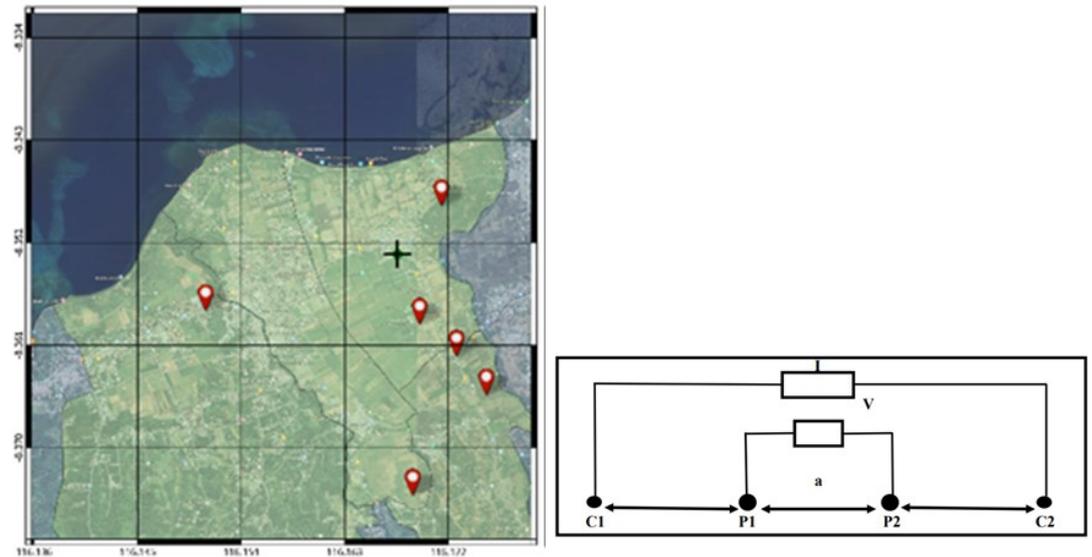

Figure 3. Location Map of measurement points, and (b) Electrode array of Wenner Schlumberger configuration

The geoelectric method is one of the geophysical methods used to investigate subsurface conditions based on the resistivity properties of each rock [10]. Data collection is done by injecting current into the earth through a resistivity meter, then recording the current value and potential difference recorded in the tool. Field measurements use two current electrodes that function to drain the current C1 and C2 and the potential difference is measured using two potential electrodes P1 and P2 [6]. The configuration used is the Wenner-schlumberger configuration, the wenner-schlumberger configuration has a constant spacing rule with a note of the comparison factor of the distance between electrodes C1 P1 and the distance between C1 C2. If the distance between the potential electrodes P1 P2 is a, then the distance between the current electrodes is 2na + a [11], [12]. The electrode arrangement of the wenner-schlumberger configuration can be seen in Figure **4**.

The magnitude of the apparent resistivity value can be expressed as follows [9]

$$\rho_a = K \frac{\Delta V}{I} \qquad (1)$$

where ρ_a is resistivity, ΔV is the potential difference between points P_1 and P_2, I is the injected current, K is the geometry factor which is the amount of correction of the location of the two potential electrodes to the location of the two current electrodes. The geometry factor in the Wenner-Schlumberger configuration is

$$K = n(n+1)\pi a \qquad (2)$$

From the field measurement data, the value of potential difference (ΔV), current (I), and spacing between electrodes are obtained. Next, the value of K will be calculated with Equation (2), then the value of the apparent resistivity (ρ_a) will be calculated using Equation (1). After that, the inversion modeling process will be carried out using Res2dinv software so that a 2D resistivity cross section is obtained. From the inversion results, the results are obtained in the form of a cross section of rock resistivity values with depth. From the cross section, the depth, thickness, and resistivity value of each rock are obtained.

3. Result Data

Based on the data measurements that have been carried out, data in the form of primary data is obtained. Data measurements were carried out using drilling techniques and resistivity geoelectric method with wenner - schlumberger configuration. Measurements were carried out in the Tanjung area, North Lombok Regency. The drill data obtained is interpreted using surfer software to describe the subsurface lithology, while the geoelectric data obtained is processed using Res2dinv software to obtain the resistivity value of rocks

below the surface, which will be used as a reference to see the distribution of rocks contained in the drill data sample. The results of drill data processing are in the form of images of subsurface lithology describing the thickness, depth and type of rock layer found at the research site, while the results of geoelectric data processing are in the form of 2D displays describing the variation of rock resistivity values below the surface which will be used to show the rock resistivity values in the drill data samples.

Based on the drilling results on track 6, which is located at coordinates 8^0 20′ 48,12" LS dan 116^0 10′ 17,04" BT, a sample of drill data was obtained which was then interpreted so that 5 rock layers were obtained in the drill sample reaching a depth of about 5.5 meters which can be seen in Figure 5.
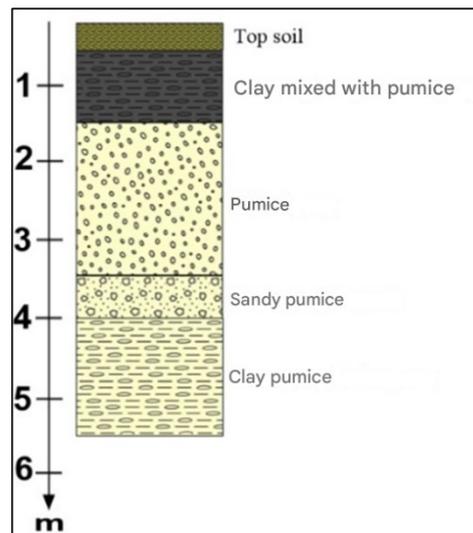

Figure 5. Interpretation result of drill data sample of track 6

At the drilling point on track 6, geoelectric measurements were taken with the direction of the East-West stretch. The results of data processing using Res2Dinv software obtained a 2D resistivity cross section which can be seen in Figure 6. The black line in the figure above is the drilling location point on track 6. Based on the sample drill data generated on track 6, 5 rock layers were obtained which reached a depth of about 5.5 meters. Judging from the results of the 2D cross section (Figure 6), the resistivity value of each rock contained in the drill sample can be determined, it is found that the resistivity value on track 6 ranges from 0.451 ohm.m - 589 ohm.m.
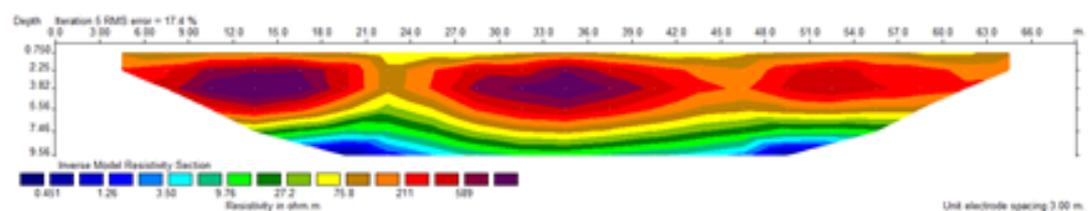

Figure 6. 2D resistivity cross section on track 6

The interpretation results for track 6 can be seen in Table 1.

Table 1. Interpretation of drill data and geoelectric data of track 6

Type of rock	Depth (m)	Thick (m)	Resistivity (ohm.m)
Top Soil	0 − 0.5	0.3	75.8
Clay, pumice	0.5 − 1.5	1.0	75.8 − 211
pumice	1.5 − 3.6	2.1	211 − 589
Sandy pumice	3.6 − 4.0	0.4	211 − 589
Clayey pumice	4.0 − 5.5	1.5	211 − 589

Based on the results of the drill data samples, it is found that the presence of pumice is found in each data collection location, from these samples, pumice is obtained which has white characteristics and looks like fine sand as in **Figure 7** at a depth of (1 - 5) meters with a thickness of (1 - 2) meters.

Figure 7. Pumice found in the study area

Described in research [3] is found three types of pumice with different colors, where the white pumice is the production of Mount Samalas in the eruption of 1257 AD. From these results it is estimated that the pumice found in the research area when viewed from the characteristics contained in the drill data sample is the production of the 1257 AD eruption of Mount Samalas [13].

From the results of the variation in resistivity values found in the research area, it is found that the resistivity value of pumice ranges from (119-771) Ohm.m. Reviewed from the results of research by [4], where one of the data collection locations in the study was in the cape area. The pumice resistivity value obtained in the study for the Tanjung area ranges from (185-755) Ohm.m. From these results it is concluded that the pumice resistivity value obtained in this study is in accordance with the results obtained by the research of Tahwia et al. [14], For the resistivity value of pumice on other trajectories can be seen in Table 2.

Table 2. Resistivity value of pumice layer on each track

Line	Resistivity (ohm.m)	Depth (m)	Thick (m)
1	119 – 441	1.3 – 2.5	1.2
2	169 – 575	1.7 – 2.3	0.6
3	207 – 550	1.0 – 1.5	0.5
4	258 – 771	0.9 – 1.5	0.6
5	274 – 554	2.7 – 5.2	2.5
6	211 – 589	1.5 – 3.6	2.1

The results of subsurface modeling on other measurement tracks can be seen in the following figure 8.
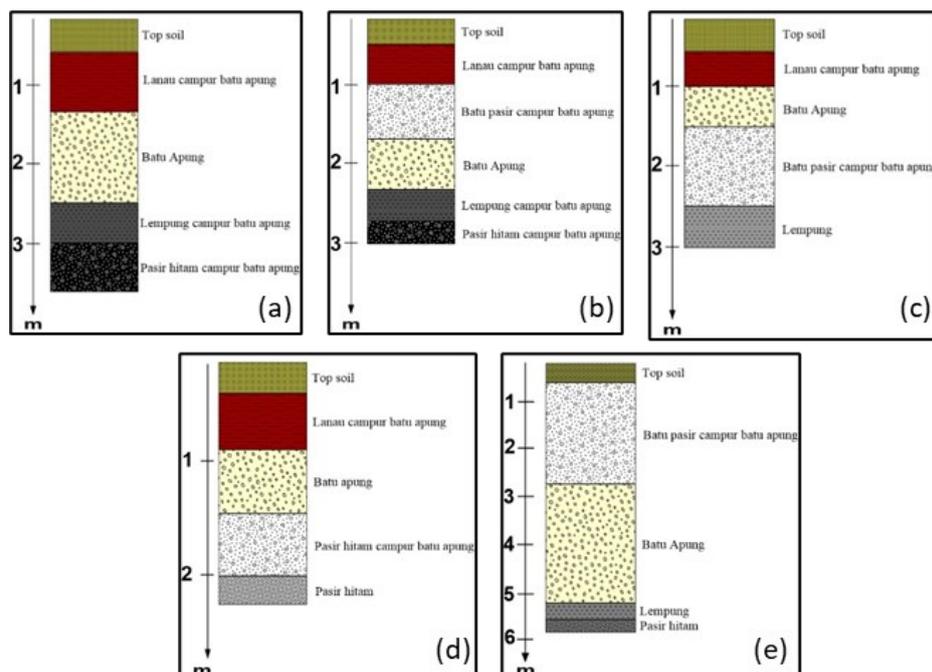

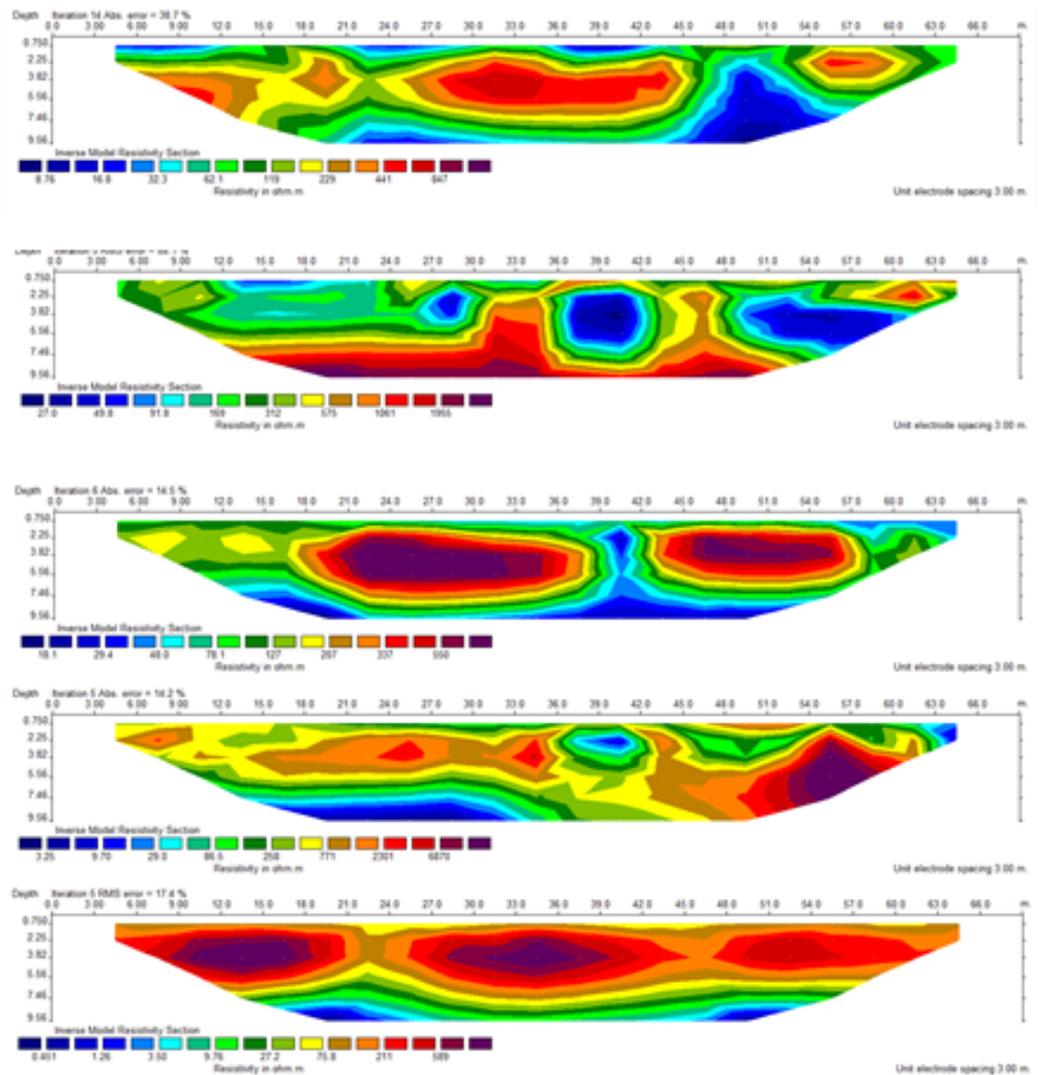**Figure 8. Drill data interpretation results on track 1 – track 5**

Figure 9. Geoelectric data interpretation results on track 1 – track 5

The results of the interpretation of drill data and geoelectric data on other measurement tracks can be seen in Table 3.

Table 3. Rock resistivity values in the study area

Type of rock	Resistivity (ohm.m)
Top Soil	16.8 - 91
Silt	32.3 - 258
Pumice	119 - 771
Sandstone	169 - 554
clay	75.8 - 575
Black sand	229 - 1061

It is known that there is a layer of pumice at each measurement point with a resistivity value range between (119 - 771) ohm.m which is the sediment from the Samalas eruption. The depth ranges from (1 - 5) meters with a thickness reaching (1 - 2) meters.

4. Discussion

Based on the interpretation of borehole and geoelectrical data from six measurement lines in the Tanjung area, North Lombok Regency, the presence of pumice layers was identified at each measurement location. The pumice was characterized by its white color and fine sand-like texture, found at depths ranging from 1 to 5 meters with a thickness of approximately 1 to 2 meters. The resistivity values associated with the pumice layer ranged from 119 to 771 ohm·m, indicating variations in material composition and moisture content. These resistivity values are consistent with the findings of Octova et al. [15], who also

conducted resistivity measurements in the Tanjung area and reported pumice resistivity values ranging from 185 to 755 ohm·m. This agreement supports the interpretation that the identified pumice layers are deposits resulting from the 1257 CE eruption of Mount Samalas, as previously suggested by Straub et al. [16], who identified white pumice as a product of the cataclysmic eruption that had significant global climatic impacts.

Furthermore, the pumice layers were consistently observed across all measurement lines, both horizontally and vertically, with resistivity values generally higher than those of other lithological units such as topsoil (16.8−91 ohm·m), clay (75.8−575 ohm·m), and silt (32.3−258 ohm·m). These high resistivity values are indicative of the pumice's porous and permeable nature, resulting in lower water saturation and, consequently, higher electrical resistivity. A study by Nurhandoko et al. [17], which also employed resistivity geoelectrical methods in northern Lombok, reported pumice layers with resistivity values between 200 and 600 ohm·m, located at depths of 2 to 4 meters. These findings further corroborate the present results, particularly in terms of depth and resistivity range, reinforcing the interpretation of widespread pumice deposits as remnants of the Mount Samalas eruption.

Additionally, Barbieri et al. [18] emphasized that pumice produced by explosive volcanic eruptions typically exhibits high resistivity due to its high porosity and the presence of air voids formed during rapid magma cooling. This characterization aligns well with the field observations, where pumice appeared as fine, white granules with notably low moisture content.

5. Conclusions

The conclusions that can be drawn from the results of this study are the deposits of the Samalas eruption found at each measurement point. The layer of pumice from the eruption of Mount Samalas is located at a depth between (1 - 5) meters with a thickness between (1 - 2) meters. Based on the results of 2D cross-sections that have been carried out, it is known that the resistivity value of pumice at the research location ranges from (118 - 771) ohm.m.

6. Acknowledgments

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