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Identification of Groundwater Aquifer Layers in Sajang Using Vertical Electrical Sounding

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Abstract

Groundwater availability is an essential factor in supporting domestic activities, agriculture, and tourism development in Sajang Village, East Lombok, Indonesia. Nevertheless, scientific information regarding subsurface groundwater potential in this volcanic region remains limited. The research contribution is the evaluation of subsurface lithology and groundwater aquifer potential in Sajang using the Vertical Electrical Sounding method to support groundwater exploration planning. This research applied the Vertical Electrical Sounding (VES) technique with the Schlumberger electrode configuration at two observation points. Field measurements were processed through inversion analysis using IP2WIN software to obtain true resistivity values and interpret lithological characteristics beneath the surface. The interpretation results reveal that the subsurface structure is dominated by volcanic rocks consisting of overburden, andesite lava, and andesite breccia with generally high resistivity values. At the first sounding point, resistivity values range from 77.8 Ωm to 11 × 107 Ωm at depths reaching 150 m. Meanwhile, the second sounding point shows resistivity values between 17.2 Ωm and 44 × 105 Ωm at depths of up to 153 m. The absence of low-resistivity zones indicates that productive aquifer layers are not present within the investigated area. Consequently, groundwater drilling activities are not recommended at the measurement locations. This study provides updated hydrogeophysical information for groundwater assessment in volcanic terrains of East Lombok.

Keywords: Aquifer, Geoelectric, Groundwater, Resistivity, Schlumberger Configuration, Vertical Electrical Soundi

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INTRODUCTION

Groundwater resources play an essential role in sustaining domestic consumption, agricultural production, industrial development, and tourism activities, particularly in regions where surface water availability is limited or highly affected by seasonal climatic variability (Hasan et al., 2018). In volcanic environments, groundwater commonly becomes the primary freshwater resource because volcanic deposits may function either as aquifers or impermeable barriers depending on lithological composition, weathering intensity (Takahashi et al., 2014), vesicular structures, and fracture development (Barbulescu, 2020). The hydrogeological complexity of volcanic terrains is mainly associated with heterogeneous subsurface conditions formed by lava flows, pyroclastic deposits, volcanic breccias, and tectonic discontinuities that strongly influence groundwater infiltration, storage, and flow patterns (Bhalla et al., 2025). Consequently, delineating productive groundwater aquifers in volcanic settings remains a major scientific and engineering challenge in hydrogeophysical exploration studies.

The occurrence and distribution of groundwater in volcanic rocks are closely controlled by variations in porosity and permeability. Dense lava formations generally exhibit low primary porosity and limited hydraulic conductivity (Minangkabau et al., 2020), whereas fractured volcanic rocks (Yassar et al., 2020), weathered zones, and pyroclastic deposits may possess higher permeability and act as productive groundwater reservoirs (Archie & others, 1942). In addition, secondary geological processes such as hydrothermal alteration and weathering may significantly modify both the hydraulic and electrical properties of subsurface materials (Hasan et al., 2018), resulting in substantial contrasts between saturated and unsaturated formations (Ewusi, 2006). These resistivity contrasts are highly important in hydrogeophysical investigations because electrical properties are strongly influenced by water saturation, dissolved ion concentration, pore connectivity, and lithological composition (Akpan et al., 2023). As a result, geoelectrical methods can effectively characterize subsurface hydrogeological conditions and identify potential aquifer zones in complex volcanic terrains (Omar et al., 2023).

In many developing regions, insufficient subsurface characterization frequently causes uncertainty during groundwater drilling activities. Drilling operations conducted without adequate hydrogeophysical investigation often result in unsuccessful wells, low groundwater yield, or economically inefficient exploration programs (Akpan et al., 2023). This problem becomes increasingly significant in volcanic areas where aquifer distribution is spatially discontinuous and difficult to predict solely from surface geological observations. Therefore, accurate subsurface investigations are critically required to reduce drilling uncertainty, improve groundwater exploration efficiency, and support sustainable groundwater resource management (Sugiyanto et al., 2018).

In Indonesia, groundwater availability has become increasingly important due to rapid population growth, agricultural intensification, urban development, and tourism expansion in many volcanic regions. One area currently experiencing increasing groundwater demand is Sajang Village, East Lombok Regency, West Nusa Tenggara Province. Communities in this region strongly depend on springs and shallow groundwater resources for domestic and agricultural purposes. However, increasing groundwater extraction, land-use changes, and prolonged dry seasons may threaten groundwater sustainability in the future. Despite the strategic importance of groundwater resources in the area, scientific information concerning subsurface lithology, aquifer distribution, and groundwater-bearing formations in Sajang Village remains very limited. Previous investigations have primarily focused on regional geological conditions without comprehensively evaluating aquifer characteristics and groundwater drilling feasibility using hydrogeophysical approaches (Puspita & Aprilia, 2022).

Among various hydrogeophysical techniques, the electrical resistivity method has been widely applied for groundwater exploration because it is sensitive to variations in lithology, porosity, fracture density, water saturation, and dissolved mineral content (Loke et al., 2013). Differences in subsurface resistivity values can therefore be used to distinguish groundwater-bearing formations from compact or impermeable volcanic rocks (Mohamaden & Ehab, 2017). Electrical resistivity surveys have proven effective for delineating aquifer geometry, estimating groundwater potential, and minimizing uncertainty in groundwater drilling programs, especially in volcanic environments characterized by complex geological structures

One of the most commonly used resistivity techniques in groundwater exploration is the Vertical Electrical Sounding (VES) method. The VES method is particularly effective for identifying vertical variations in subsurface resistivity associated with changes in lithology and groundwater saturation at depth (Telford et al., 1990). This method offers several advantages, including relatively simple field implementation, cost efficiency, and the capability to characterize subsurface layering in areas with limited outcrop exposure (Kayode et al., 2016). Previous studies have demonstrated that VES investigations can successfully identify aquifer depth, thickness, and groundwater-bearing formations in both volcanic and sedimentary environments (Bahri et al., 2023). Furthermore, integrating resistivity interpretation with geological information can significantly improve the reliability of groundwater exploration and support long-term groundwater resource management planning (Fadillah et al., 2023).

Although resistivity-based groundwater investigations have been widely conducted in volcanic regions (Aizebeokhai et al., 2017), detailed hydrogeophysical studies specifically related to aquifer characterization and drilling feasibility assessment in Sajang Village are still scarce. Existing studies in the East Lombok volcanic region mainly emphasize regional geology and general hydrogeological conditions (Mangga et al., 1994), while detailed subsurface characterization using the VES method for identifying prospective aquifer zones has not been comprehensively investigated. Consequently, scientific understanding regarding subsurface lithology (Darisma et al., 2020), aquifer distribution, groundwater potential (Muhni et al., 2022), and drilling prospectivity in the study area remains insufficient (Abe et al., 2023). This knowledge gap highlights the importance of conducting integrated hydrogeophysical investigations to support groundwater exploration planning and reduce uncertainty associated with groundwater drilling activities in volcanic terrains.

Therefore, this study aims to identify subsurface lithology and evaluate groundwater aquifer potential in Sajang Village using the Vertical Electrical Sounding method. The research contribution is the integration of VES-based hydrogeophysical interpretation with volcanic geological characteristics to delineate prospective groundwater aquifer zones and assess groundwater drilling feasibility in a complex volcanic environment (Bahri et al., 2023). The results of this study are expected to provide scientific information for sustainable groundwater resource management and contribute to the development of more reliable groundwater exploration strategies in volcanic regions with limited subsurface data availability.

RESEARCH METHODS

This research was conducted in Sajang Village, East Lombok Regency, West Nusa Tenggara Province, Indonesia, which is characterized by volcanic geological formations and complex hydrogeological conditions. The study focused on identifying subsurface lithology and groundwater aquifer potential using the Vertical Electrical Sounding (VES) method with Schlumberger electrode configuration. Field data acquisition and geoelectrical measurements were carried out in 2026 at two observation points selected based on geological conditions, topography, accessibility, and groundwater prospectivity considerations. The location of the study area and measurement line arrangement are presented in Figure 1, while the coordinates of each measurement point are listed in Table 1.

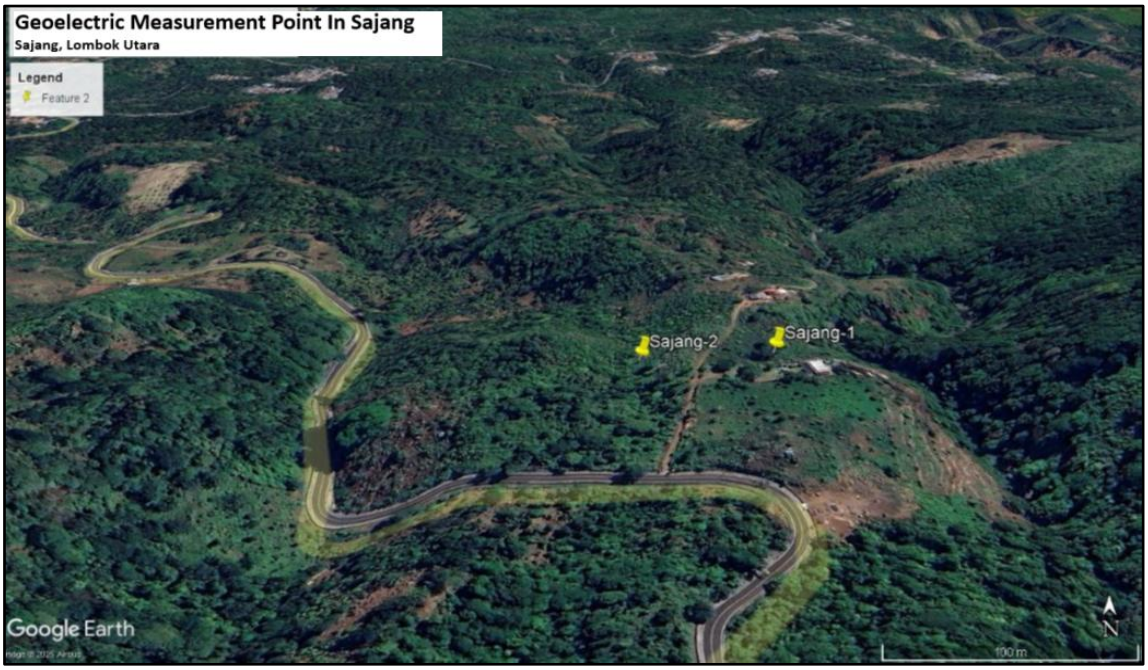


Figure 1. Research Location

Table 1. Coordinates of Geoelectric Measurement Points in Sajang Village, North Lombok Regency

No.	Measurement Point	Coordinates (UTM)	Latitude	Longitude	Elevation
1	Sajang-1	50L; 444094.07; 9081616.45	08.307998	116.492301	724 m
2	Sajang-2	50L; 444025.44; 9081634.60	08.307833	116.491678	678 m

The selection of measurement points considered volcanic geomorphology, surface geological indications, and the distribution of local groundwater sources. These considerations were important to optimize aquifer identification and reduce uncertainty in subsurface interpretation.

Research Instruments and Materials

The instruments and materials used in this study consisted of both field acquisition equipment and data processing software. Geoelectrical measurements were performed using an OJS Resistivity Meter (Figure 2) as the primary instrument for measuring current injection and potential difference. The electrode system consisted of two current electrodes (A and B) and two potential electrodes (M and N) arranged using the Schlumberger configuration. Supporting equipment included cable rolls, connector cables, measuring tape, GPS devices, power supply batteries, and laptops for preliminary processing and data storage. The acquired field data were processed using Microsoft Excel for geometric correction and apparent resistivity calculations. Furthermore, IP2WIN software was employed for inversion modeling and interpretation of one-dimensional subsurface resistivity structures.



Figure 2. Main unit OJS Resistivity Meter

Vertical Electrical Sounding (VES) Method

The geoelectrical resistivity method is an active geophysical technique used to investigate subsurface conditions by analyzing variations in the electrical resistivity of earth materials (Abe et al., 2023). The basic principle of this method involves injecting electric current into the ground through two current electrodes and measuring the resulting potential difference using two potential electrodes. Variations in lithology, porosity, fracture intensity, and groundwater saturation produce different electrical responses that can be interpreted to characterize subsurface layers.

In this study, the Vertical Electrical Sounding (VES) technique with Schlumberger configuration was applied to obtain vertical resistivity variations beneath each measurement point. The Schlumberger array is widely used in groundwater investigations because it provides good depth penetration and is relatively efficient for identifying layered subsurface structures (Aizebeokhai et al., 2017; Sa'diah et al., 2024). In this configuration, the distance between current electrodes (A and B) is progressively increased to investigate deeper layers, while the spacing of potential electrodes (M and N) remains relatively small. The apparent resistivity value was calculated using the following equation (Reynolds, 2011):

$$\rho = K\frac{\Delta V}{I} \quad (1)$$

where:

ρ = apparent resistivity (Ωm),
K = geometric factor,
ΔV = measured potential difference (V),
I = injected electric current (A).

The Schlumberger configuration follows the condition:

$$\frac{AB}{2} \geq 3\,\frac{MN}{2} \quad (2)$$

where AB represents the spacing of current electrodes and MN represents the spacing of potential electrodes. This configuration improves vertical resolution while maintaining measurement efficiency in the field (Darsono & Darmanto, 2019). The VES method is particularly suitable for groundwater exploration in volcanic terrains because resistivity variations can indicate changes in lithology and groundwater saturation (Wahyuni et al., 2024). Saturated layers generally exhibit lower resistivity values compared to compact volcanic rocks or unsaturated formations (Ojo et al., 2024). Consequently, resistivity contrasts can be used to identify potential aquifer zones (Araffa et al., 2019).

Geoelectric Data Processing

The field measurements produced datasets consisting of electrode spacing, injected current, and measured potential differences. Before inversion analysis, geometric corrections and apparent resistivity calculations were performed using Microsoft Excel. The processed data were subsequently imported into IP2WIN software for one-dimensional inversion and subsurface resistivity modeling. The inversion process in IP2WIN applies an iterative least-squares approach to minimize the difference between observed and calculated resistivity responses. During the inversion procedure, subsurface layer parameters such as resistivity and thickness were continuously adjusted until an optimal fitting model was obtained. The final inversion results provided interpreted subsurface resistivity distributions corresponding to lithological variations and groundwater-bearing formations.

Interpretation

Interpretation of the geoelectrical results was conducted by analyzing resistivity values, layer thicknesses, and vertical resistivity distributions generated from inversion modeling. Lithological interpretation was performed by correlating resistivity values with regional geological information and standard resistivity ranges of volcanic rocks. Aquifer zones were identified based on relatively low to moderate resistivity values associated with weathered volcanic deposits, fractured rocks, sandy layers, or water-saturated formations . Conversely, compact lava flows and massive volcanic rocks generally exhibited higher resistivity values due to lower porosity and groundwater content. The interpretation process also considered the continuity of resistivity layers, depth distribution, and potential groundwater-bearing characteristics to determine the most prospective aquifer zones for groundwater exploration and drilling feasibility assessment.

Table 2. Rock Resistivity Value (Telford et al., 1990)

Mineral	Resistivitas (Ωm)
***Basalt*/ Basal**	$10 – 1{,}3\times10^{7}$
Lava	$100 – 5\times104$
***Tuffs*/ tuf**	$2\times10^{3} – 10^{5}$
***Breccia* / Breksi**	75 – 20.000
***Sandstone*/ Batu Pasir**	$1 – 7{,}4\times10^{8}$
***Limestone*/ Batu Gamping**	$50 – 10^{7}$
***Clays*/ Lempung**	1 – 100
Alluvium and sands	10 – 800

The subsurface lithology and the possibility of an aquifer can be determined from the resistivity values of each layer. Rock resistivity values are shown in Table 2.

Research Flowchart

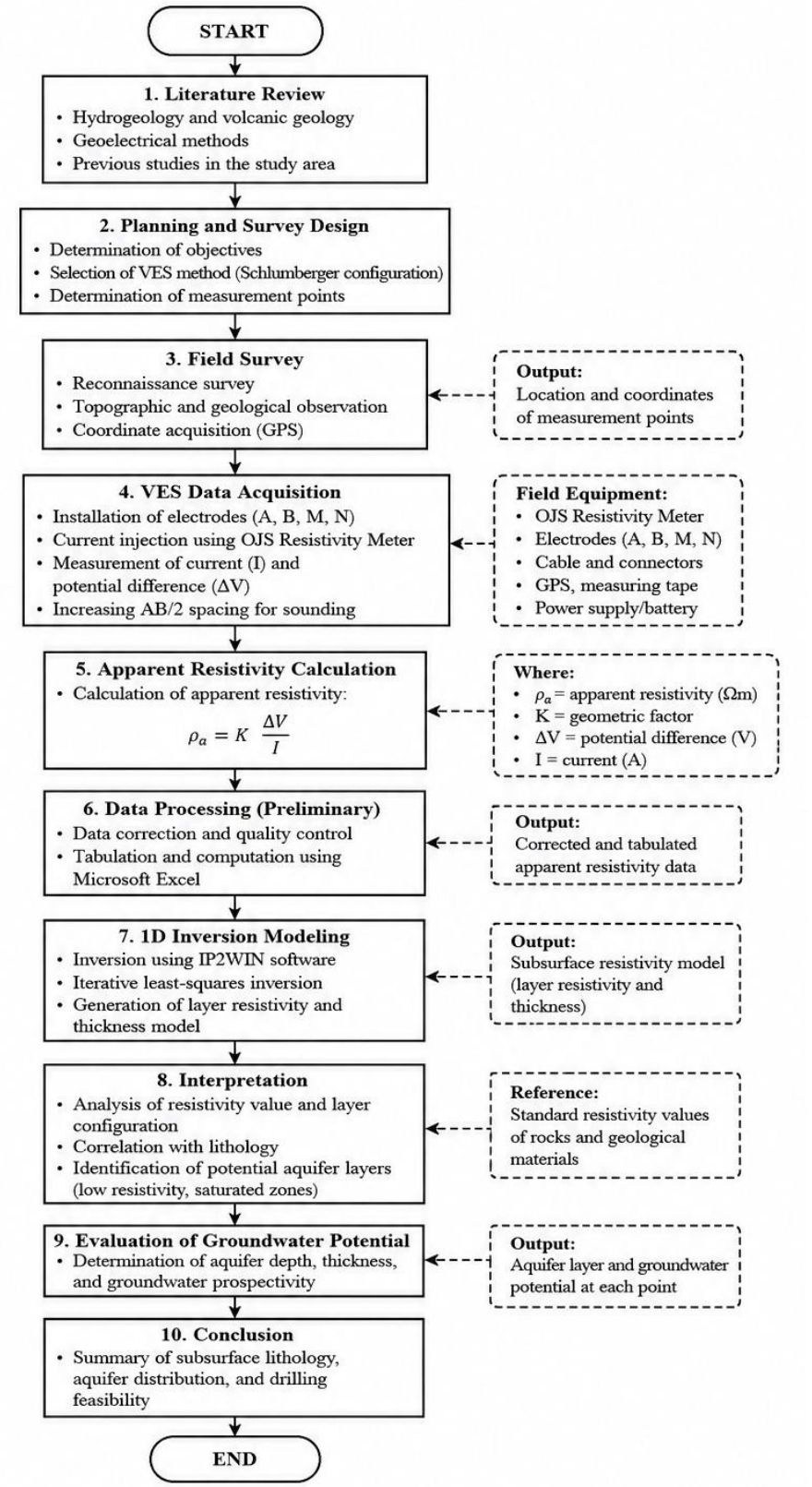


Figure 3. Research flowchart of groundwater aquifer identification using the Vertical Electrical Sounding (VES) method in Sajang Village.

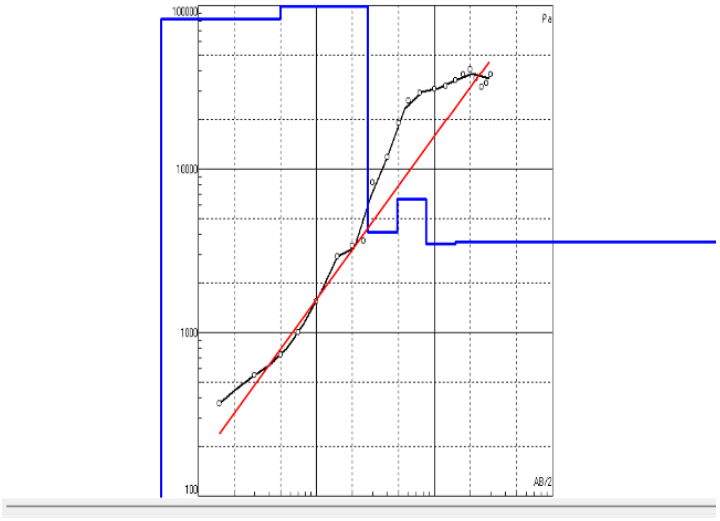
RESULTS AND DISCUSSION

RESULTS

The Vertical Electrical Sounding (VES) survey conducted at the Sajang area produced apparent resistivity data that were subsequently processed using the IP2WIN and Progress software packages to obtain true resistivity values. These true resistivity values represent the electrical characteristics of subsurface lithological layers and were interpreted based on regional resistivity references and geological conditions of volcanic terrains. The interpreted subsurface conditions at each sounding point are presented below. And the interpreted subsurface was has been according to the resistivity values listed in Table 1.

Sajang-1 Geoelectric Measurement Results

The interpretation results of the first sounding point (Sajang-1) are shown in Figure 4. The inversion curve demonstrates significant fluctuations in resistivity values with increasing depth, indicating variations in subsurface material properties. The maximum investigation depth reached approximately 150 m, suggesting that the VES configuration was capable of imaging relatively deep subsurface structures.



1.

N	ρ	h	d	Alt
1	77.8	0.481	0.481	-0.4807
2	82609	2.32	2.81	-2.805
3	82609	2.15	4.95	-4.953
4	3.7E+5	3.79	8.74	-8.744
5	1.1E+8	6.69	15.4	-15.44
6	1.1E+5	11.8	27.3	-27.26
7	4113	20.9	48.1	-48.12
8	6507	36.8	85	-84.96
9	3504	65	150	-150
10	3556			

(b)

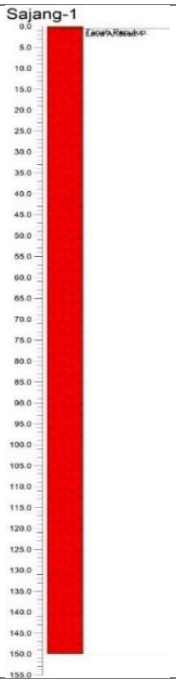
Figure 4. Results of Sajang-1 geoelectric data processing using IP2WIN software. (a) Apparent resistivity curve vs. electrode spacing; (b) Table of true resistivity (ρ), thickness (h), and depth (d) of rock layers in the measurement area.

Based on the interpretation, the subsurface lithology at Sajang-1 consists predominantly of massive andesite lava deposits underlying a thin overburden layer (Tabel 3-4). The overburden occupies the uppermost 0–0.481 m depth interval with a resistivity value of 77.8 Ωm, indicating weathered surface material mixed with soil and organic matter. Below the overburden, the subsurface is dominated by andesite lava extending down to approximately 150 m depth. The resistivity values vary considerably, ranging from extremely low to very high values, reflecting differences in weathering intensity, fracture distribution, and moisture content within the volcanic rock body. However, the generally high resistivity characteristics indicate compact volcanic lava with limited porosity and permeability. No significant low-resistivity saturated zone interpreted as a productive aquifer was identified at Sajang-1. The dominance of compact andesite lava suggests poor groundwater storage capacity. Similar conditions have been reported in volcanic terrains where massive lava flows act as impermeable units due to limited interconnected pore spaces. Previous studies have shown that productive aquifers in volcanic environments are commonly associated with fractured lava, weathered volcanic deposits, or pyroclastic layers rather than intact lava bodies.

Table 3. Results of Geoelectric Measurement Interpretation of Point Sajang-2

Depth (m)		Thickness (m)	Resistivity (Ohm.m)	Lithology
0	0,481	0,481	77,8	Covering Soil
0,481	2,81	2,329	82.609	Andesite Lava
2,81	4,95	2,14	82.609	Andesite Lava
4,95	8,74	3,79	37 x x 10^{-4}	Andesite Lava
8,74	15,4	6,66	11 x 10^{-7}	Andesite Lava
15,4	27,3	11,9	11 x 10^{-4}	Andesite Lava
27,3	48,1	20,8	4.113	Andesite Lava
48,1	85	36,9	6.507	Andesite Lava
85	150	65	3.504	Andesite Lava

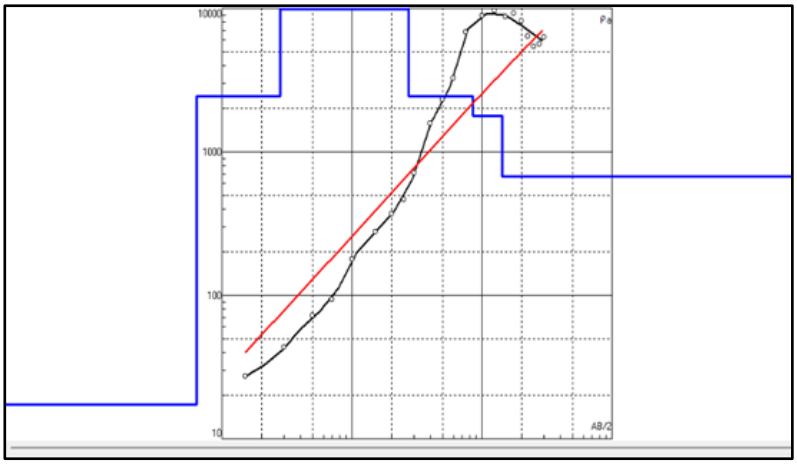
Table 4. Resistivity Log and Interpretation of Rock Layers at Sajang Point-1

Resistivity Log	**Interpretation**
	The subsurface lithology of the SAJANG-1 point consists of the following layers: 1. Overburden: located at a depth of 0–0.481 m with a resistivity value of 77.8 Ohm.m. 2. Andesite Lava: located at a depth of 0.481–150 m with a resistivity value ranging from 3504–11 x 10^{-7} Ohm.m.

Based on the interpretation, the subsurface lithology at Sajang-1 consists predominantly of massive andesite lava deposits underlying a thin overburden layer. The overburden occupies the uppermost 0–0.481 m depth interval with a resistivity value of 77.8 Ωm, indicating weathered surface material mixed with soil and organic matter. Below the overburden, the subsurface is dominated by andesite lava extending down to approximately 150 m depth. The resistivity values vary considerably, ranging from extremely low to very high values, reflecting differences in weathering intensity, fracture distribution, and moisture content within the volcanic rock body. However, the generally high resistivity characteristics indicate compact volcanic lava with limited porosity and permeability. No significant low-resistivity saturated zone interpreted as a productive aquifer was identified at Sajang-1. The dominance of compact andesite lava suggests poor groundwater storage capacity. Similar conditions have been reported in volcanic terrains where massive lava flows act as impermeable units due to limited interconnected pore spaces. Previous studies have shown that productive aquifers in volcanic environments are commonly associated with fractured lava, weathered volcanic deposits, or pyroclastic layers rather than intact lava bodies.

Sajang-2 Geoelectric Measurement Results

The interpretation results of the second sounding point (Sajang-2) are presented in Figure 5. Similar to Sajang-1, the resistivity curve exhibits strong fluctuations with increasing depth. The maximum penetration depth reached approximately 153 m, slightly deeper than the first sounding point.



(a)

N	ρ	h	d	Alt
1	17.2	0.638	0.638	-0.6379
2	2450	0.951	1.59	-1.589
3	2450	1.22	2.81	-2.805
4	10979	2.15	4.95	-4.953
5	10979	3.79	8.74	-8.744
6	4.4E+6	6.69	15.4	-15.44
7	21576	11.8	27.3	-27.26
8	2450	57.7	85	-84.96
9	1784	57.9	143	-142.8
10	669			

(b)

Figure 5. Results of Sajang-2 geoelectric data processing using IP2WIN software. (a) Apparent resistivity curve vs. electrode spacing; (b) Table of true resistivity (ρ), thickness (h), and depth (d) of rock layers in the measurement area.

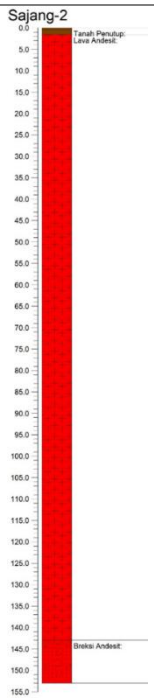
The interpretation results for Sajang-2 are summarized in Table 5.

Table 5. Results of Geoelectric Measurement Interpretation of Point Sajang-2

Depth (m)		Thickness (m)	Resistivity (Ohm.m)	Lithology
0	0,638	0,638	17,2	Covering Soil
0,638	1,59	0,952	2.450	Covering Soil
1,59	2,81	1,22	2.450	Andesite Lava
2,81	4,95	2,14	10.979	Andesite Lava
4,95	8,74	3,79	10.979	Andesite Lava
8,74	15,4	6,66	44 x x 10^{-5}	Andesite Lava
15,4	27,3	11,9	21.576	Andesite Lava
27,3	85	57,7	2.450	Andesite Lava
85	143	58	1.784	Andesite Lava
143	153	10	669	Andesite Breccia

The subsurface structure at Sajang-2 is also dominated by volcanic deposits, particularly andesite lava. The overburden layer (Tabel 6) occurs at depths of 0–1.59 m with resistivity values ranging from 17.2–2,450 Ωm. This variation likely reflects differences in soil moisture and weathering degree near the surface. The main subsurface unit consists of andesite lava extending from 1.59–143 m depth. The relatively high resistivity values indicate compact volcanic rock with low groundwater potential. Nevertheless, a distinct lithological contrast was identified at depths of 143–153 m, interpreted as volcanic breccia with a resistivity value of approximately 669 Ωm. The breccia unit exhibits lower resistivity compared with the overlying lava sequence, indicating a relatively more porous and fractured material. Volcanic breccia generally contains fragmented rock materials with higher secondary porosity, allowing limited water infiltration. However, the observed resistivity values are still insufficiently low to indicate a saturated and productive aquifer zone.

Table 6. Resistivity Log and Interpretation of Rock Layers at Sajang Point-2

Resistivity Log	**Interpretation**
	The subsurface lithology of the Sajang-2 point consists of the following layers: 1. Overburden: located at a depth of 0 – 1,59 m with a resistivity value of 17,2 – 2450 Ohm.m. 2. Andesite Lava: located at a depth of 1,59 – 143 m with a resistivity value ranging from 1784 – 44 x x 10^{-5} Ohm.m. 3. Breccia: located at a depth of 143 – 153 m with a resistivity value ranging from 669 Ohm.m.

In contrast to the first measurement point, there is a difference in interpretation of the layers. measurement point. There are 3 layers such us overburden with located at a depth of 0 – 1,59 m and resistivity value of 17,2 – 2450 Ohm.m. Andesite lava with located at a depth of 1,59 – 143 m, resistivity value ranging from 1784 – 44 x x 10^{-5} Ohm.m. and in breccia located at a depth of 143 – 153 m with a resistivity value ranging from 669 Ohm.m.

DISCUSSION

The geoelectrical investigation conducted in the Sajang area demonstrates that the subsurface is predominantly composed of volcanic formations, particularly compact andesite lava deposits. The resistivity distribution obtained from both Vertical Electrical Sounding (VES) points indicates significant lithological variation with depth, which is characteristic of volcanic environments with complex geological structures. Nevertheless, the interpreted subsurface profile consistently reveals the dominance of electrically resistive volcanic rocks with limited groundwater-bearing capacity. Similar subsurface characteristics in volcanic terrains have been reported by previous geoelectrical studies, where compact lava deposits commonly exhibit high resistivity values due to low porosity and weak water saturation conditions (Reynolds, 2011; Telford et al., 1990).

The results indicate that no significant aquifer zone was identified at either sounding location. This condition is strongly related to the physical properties of massive andesite lava, which generally possesses low primary porosity because of rapid cooling and crystallization processes during volcanic emplacement. As a consequence, interconnected pore spaces capable of storing and transmitting groundwater are poorly developed. According to hydrogeological studies in volcanic regions, groundwater occurrence is more commonly associated with secondary permeability systems such as fractures, joints, faults, and weathered volcanic layers rather than intact lava bodies (Sepriyenra et al., 2024). The predominance of compact volcanic units in the study area therefore explains the limited groundwater potential identified from the resistivity data.

The interpretation obtained in this research is also consistent with previous studies carried out in several volcanic regions of Indonesia. Research conducted in volcanic terrains commonly reports that

andesitic lava formations are characterized by relatively high resistivity responses and poor aquifer productivity due to their dense lithological nature (Sihotang et al., 2018). In contrast, productive groundwater zones in volcanic environments are generally associated with pyroclastic deposits, highly weathered layers, or fractured volcanic rocks that provide secondary porosity and enhanced permeability (Wahyuni et al., 2024). This hydrogeological behavior explains why groundwater distribution in volcanic settings is often highly localized and structurally controlled.

A distinct lithological variation was observed at the Sajang-2 sounding point, where a volcanic breccia layer was identified at depths between 143 and 153 m. Compared with massive lava, volcanic breccia deposits generally contain fragmented rock materials that may increase permeability and facilitate limited groundwater infiltration. However, the resistivity values observed within this layer still indicate relatively low water saturation. Therefore, although the breccia unit may possess better hydraulic characteristics than the overlying lava sequence, the layer cannot yet be interpreted as a productive aquifer. This finding suggests that the deeper subsurface in the Sajang area remains dominated by relatively dry volcanic formations with restricted groundwater storage capability.

From a hydrogeological perspective, the resistivity characteristics observed in this study are closely related to lithology, pore connectivity, degree of saturation, and dissolved mineral content within subsurface fluids. Low resistivity values are generally associated with saturated formations, clay-rich materials, and highly weathered rocks, whereas elevated resistivity values commonly indicate dry and compact volcanic rocks with limited permeability (Loke et al., 2013). The predominance of high resistivity zones throughout the study area therefore reflects poor groundwater circulation and weak aquifer development within the investigated volcanic formations.

The hydrogeological implication of these findings is important for groundwater exploration planning in the Sajang region. The absence of significant conductive zones interpreted as aquifers suggests that groundwater drilling within the investigated locations may involve a relatively high probability of failure. Consequently, future groundwater exploration should focus on structurally weak zones such as fractured lava, fault-controlled pathways, weathered volcanic deposits, and topographic depressions that may function as recharge and groundwater accumulation zones (Sepriyenra et al., 2024). Integrating geological mapping with structural analysis and hydrogeophysical investigation would therefore improve the effectiveness of future groundwater exploration programs in volcanic terrains (Alfadli et al., 2021).

This study also contributes new subsurface information for the Sajang volcanic area, where hydrogeological investigations remain limited. The integration of VES measurements with lithological interpretation provides preliminary insight into the distribution of volcanic rock layers and their groundwater potential. In addition, the investigation successfully characterized subsurface conditions down to depths exceeding 150 m, allowing deeper volcanic structures to be identified. Such information is important for regional groundwater resource assessment and may serve as a reference for future hydrogeological studies in similar volcanic environments.

Despite these contributions, several limitations should be acknowledged. The interpretation was derived from only two sounding points, which may not fully represent lateral lithological variations across the study area. Furthermore, subsurface interpretation was based primarily on resistivity characteristics without direct validation from drilling or borehole data. Because resistivity values may overlap between different lithologies under varying saturation conditions, uncertainties in interpretation remain possible. Future investigations are therefore recommended to combine geoelectrical surveys with borehole logging, geological mapping, and hydrogeological measurements in order to improve interpretation reliability and groundwater resource evaluation.

CONCLUSIONS AND RECOMMENDATIONS

The hydrogeophysical investigation conducted using the Vertical Electrical Sounding (VES) method in Sajang Village, East Lombok Regency, provides important information regarding subsurface lithological conditions and groundwater potential within the study area. Interpretation of the resistivity data indicates that the subsurface sequence is predominantly composed of weathered overburden, andesitic lava, and andesite breccia deposits. At the Sajang-1 sounding point, resistivity values vary from approximately 77.8 Ωm to 11 × 10^7 Ωm within an estimated depth of 0–150 m, whereas the Sajang-2 sounding point exhibits resistivity values ranging between 17.2 Ωm and 44 × 10^5 Ωm down to nearly 153 m depth. The generally high resistivity distribution observed at both locations reflects the dominance of compact volcanic formations characterized by low porosity, weak fracture connectivity, and limited groundwater storage capacity.

Based on the interpreted subsurface characteristics, no significant productive aquifer layer was identified within the investigated depth interval. The prevalence of massive volcanic rock units, particularly compact lava formations, suggests unfavorable hydrogeological conditions for substantial groundwater accumulation. Consequently, the investigated area is considered to possess relatively low groundwater potential and is therefore less suitable as a primary target for groundwater drilling activities. These findings emphasize the importance of preliminary hydrogeophysical assessment in minimizing exploration uncertainty and reducing the risk of unsuccessful drilling operations in volcanic terrains.

This study also contributes to the broader understanding of groundwater occurrence in volcanic environments through the application of resistivity-based subsurface characterization. The VES method proved effective for identifying lithological variation and evaluating potential groundwater-bearing zones in areas where direct subsurface information remains limited (Nadhowi et al., 2022). The obtained results may therefore serve as preliminary scientific reference data for future groundwater exploration studies in regions with similar geological settings.

Nevertheless, several limitations should be acknowledged. The present investigation relied on only two sounding points and utilized a single geophysical approach, which may not fully represent the lateral heterogeneity of subsurface conditions across the entire study area. In addition, the absence of borehole verification and pumping-test data limits direct confirmation of the interpreted lithological and hydrogeological conditions. Future investigations are therefore recommended to include additional survey coverage and integrate complementary methods such as Electrical Resistivity Tomography (ERT) (Omar et al., 2023), seismic refraction, and other hydrogeophysical approaches to improve interpretation reliability and spatial resolution. Validation through drilling and groundwater testing would also strengthen future hydrogeological assessments.

Overall, this research highlights the significance of integrated hydrogeophysical investigation for supporting sustainable groundwater exploration in volcanic regions. The study provides important scientific insight into subsurface conditions in Sajang Village and underlines the necessity of comprehensive groundwater evaluation prior to drilling activities in areas dominated by compact volcanic rock formations.

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