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Modeling Analysis of Seepage Potential Based on Rock Resistivity Value in Geoelectric Method at Pamukkulu Dam

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Information

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Abstract

Administratively, the research area is the jurisdiction of the Pamukkulu Dam construction project of PT. Wijaya Karya in Kale Komara Village, Polongbangkeng Utara District, Takalar Regency, South Sulawesi Province. The purpose of this study is to determine the condition of the subsurface rock and the pattern and direction of seepage in the construction of the dam. The method used is the geophysical method with geoelectric measurements. The condition of the rocks below the surface in the study area can be interpreted based on the results of observations and resistivity tests where breccia and basalt rock types are on a resistivity scale of >= 100 ohm.m. The value below 100 ohm.m is categorized as a layer of soil or weathered. The result of the interpretation of the seepage modeling is that seepage patterns are found that resemble folds in the form of blue, and also from these patterns the seepage direction is found. From the results of modeling with the voxler application, the direction of seepage in the study area starts from the East and Northeast and leads predominantly to the Northwest and Southwest.

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1. INTRODUCTION

Takalar is one of the districts in the province of South Sulawesi which has a diversity of morphologies it forms. With the shape of the land surface is relatively flat, wavy to the hills. Most of the Takalar Regency area is plains and coastal areas [1]. The unavailability of raw water in several areas is caused by the wavy topography and sub-optimal water control, causing problems that must be handled appropriately. One of the solutions to ensure the availability of raw water as well as equal distribution of irrigation channels is the construction of dams. In order to support the planning of dam construction, engineering geological investigation is required.

Damming a river means changing the natural properties of the river, so that there are both positive and negative technical impacts, as well as influences, problems and constraints both on the dam building and the surrounding environment [2]. Engineering geological investigations need to be carried out to determine the geological conditions and engineering characteristics of the dam construction plan area. The foundation of a dam must rest on rocks that have good carrying capacity so that the dam building will not experience deformation (change in position) due to technical factors, so that the dam will have a long life [3,4].

Administratively the research area is included in Kale Ko'mara Village, North Polombangkeng, Takalar Regency, South Sulawesi Province, based on the astronomical location of the research location at 5°23'54" S and 119°35'34"E. It can be seen in Figure 1 which explains the research area.

2. RESEARCH METHOD

The research method is structured as a reference in conducting research so that the process can run scientifically, systematically, and precisely. In this study, 4 stages were included, namely the preparation stage, data collection stage, data processing stage, data analysis and interpretation, and report preparation stage. In detail, these stages are as follows:

1. The preparation stage consists of administration, literature study, field equipment, determination of geoelectric survey points.
2. The field observation stage includes field surveys [5] and installation of geoelectric devices, as well as retrieval of resistivity data [6,7].
3. The data processing stage consists of field resistivity data which will be processed on Res2NDIV and Voxler software [8].
4. The stage of making a research report

The research methods and stages can be seen in Figure 2 which explains the flow of the research stages.

3. REGIONAL GEOLOGY OF RESEARCH AREA

The regional geology of the research area is in the sheets of regional geology of the Ujung Pandang, Benteng, and Sinjai. This area includes the Districts of Maros, Sungguminasa, Takalar, Jeneponto, Benteng, Bulukumba, Sinjai and Salayar; including the Province of South Sulawesi.

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Figure 1 Map of research location

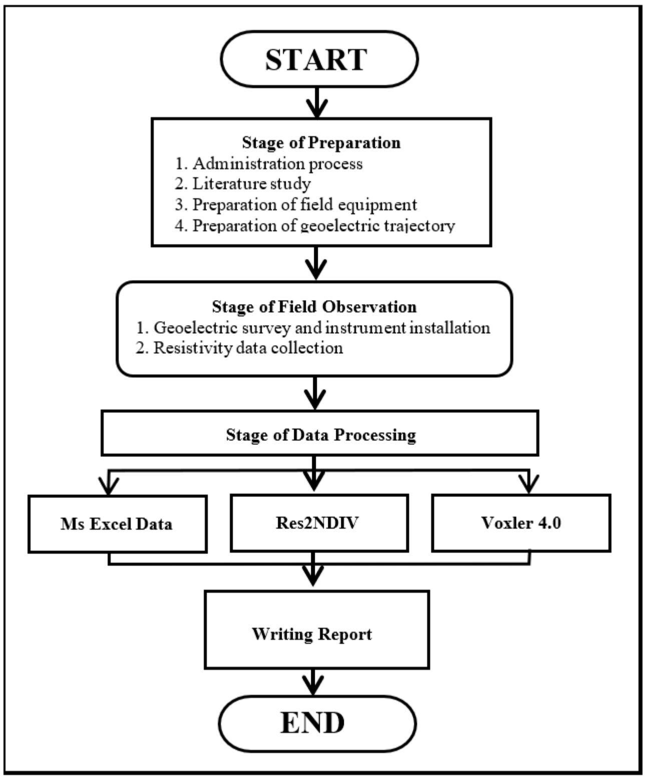

Figure 2 The research flowchart

The map sheet is bordered by the West Pangkajene and Watampone Sheets to the north, the Makassar Strait to the west, the Bone Bay to the east, and the Flores Sea to the south.

The stratigraphy of the study area is composed of Baturape-Cindako Volcano rocks consisting of lava and breccia, with a little tuff and conglomerate intercalation [9]. Basal in structure, mostly porphyry with large pyroxene phenocrysts up to 1 cm and a small portion, dark greenish gray to black in color; the lava is partly fissured and partly stratified, generally breccia with a coarse component, from 15 cm to 60 cm, mainly basalt and a little andesitic, with coarse-grained tuff cement to lapilli, containing lots of pyroxene fragments. [9].

The diorite breakthrough complex in the form of stock and hack at Baturape and Cindako is thought to be a former eruption center (Tpbc); the surrounding rocks are strongly altered, amygdaloidal with the secondary mineral zeolite and calcite: the mineral galena at Baturape is possibly related to this diorite breakthrough; the area around Baturape and Cindako is dominated by Tpbl lava. This unit is not less than 1250 m thick and based on its stratigraphic position is approximately Late Pliocene [9]. It can be seen in Figure 3 which explains the geology of the study area which consists of Tpbv and Tpbl.

4. RESULTS AND DISCUSSION

4.1 Surface Crack and Seepage Zone

Crack zone is an intrusion of igneous rock in the form of shills and dikes that break through previously existing rock. In the maindam and plant areas which are on the right backrest of the project area, there are 11 cracks. There are 3 cracks on the left backrest, namely the tunnel and spillway areas. The cracks that develop in the study area are andesitic basalt which are generally found in the form of Dikes, where these cracks break through not in the same direction as the rock layers. The rock that is broken through is a sedimentary rock in the form of breccia, so that the rock is easily weathered and seepage occurs. However, in several places in the study area, there were also rocks that were broken through by the hack, which did not experience weathering, but there were burning zones or baking effects as shown in Figure 4 and Figure 5.

Cracks and joints that are continuously weathered will experience a weak zone. Weak zone is a weak zone of weathered rock. As a result of this zone surface seepage is found in several places, such as in the area of the dam site where the surface seepage zone is in breach 3. Surface seepage in hack 3 has a large discharge because the condition of the rock has undergone high weathering to become soil.

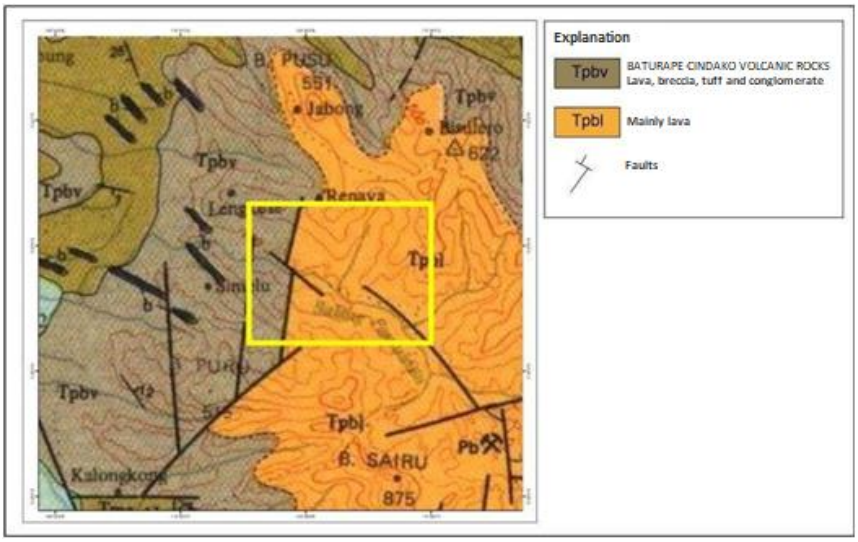

Figure 3 Regional geological map of the research area

Figure 4 Crack in the research area

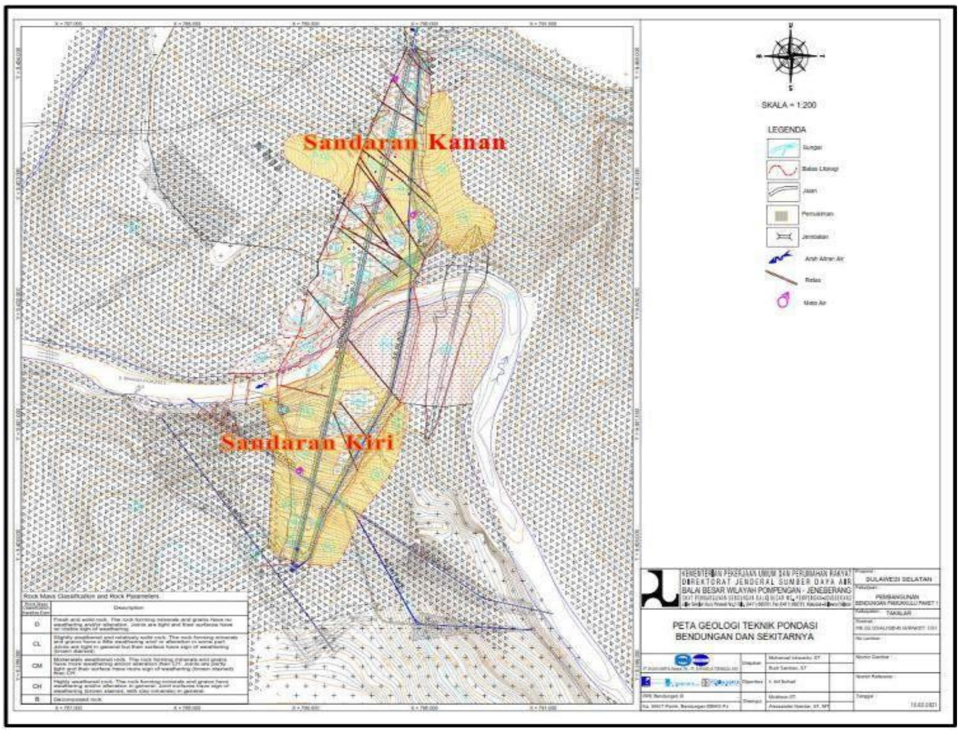

Figure 5 The distribution of cracks in the research area

Seepage zones were also found in cracks 8 and 9 and were also found in the plinth area to be precise at PL 8 and PL 1 which were caused by joints that were continuously weathered as can be seen in Figure 6 and Figure 7.

The seepage zone is a rock zone that contains and is able to pass water, in the research area the seepage zone is in sandy clay sedimentary rocks, why does this happen because sandy clay sedimentary rocks have pores that easily absorb water through them, so when carrying out geoelectrical observations of rocks It has a low resistivity value due to the water content it absorbs. The seepage zone is also found in cracks and joints that have undergone weathering to become a weak zone, so that from this zone the rock will contain water as seepage.

Figure 6 Seepage at As Plinth in PL 1

Figure 7 Seepage on As Maindam in cracked 3

4.2 Interpretation of Correlation between Geoelectric Trajectory and Drill Data

The correlation between the geoelectric trajectories in Figure 8 is also carried out by using drill data to determine subsurface rock as a binder or data validation for geoelectric trajectories, from these data it can be seen the type of rock and cracks as agents of a seepage. From the drill data it is known that sandy claystone and weathered cracks in the spillway, plinth assemblies, and as dam there are indications of seepage seen in Figure 9, Figure 10, and Figure 11. The results of the description can be observed in Table 1.

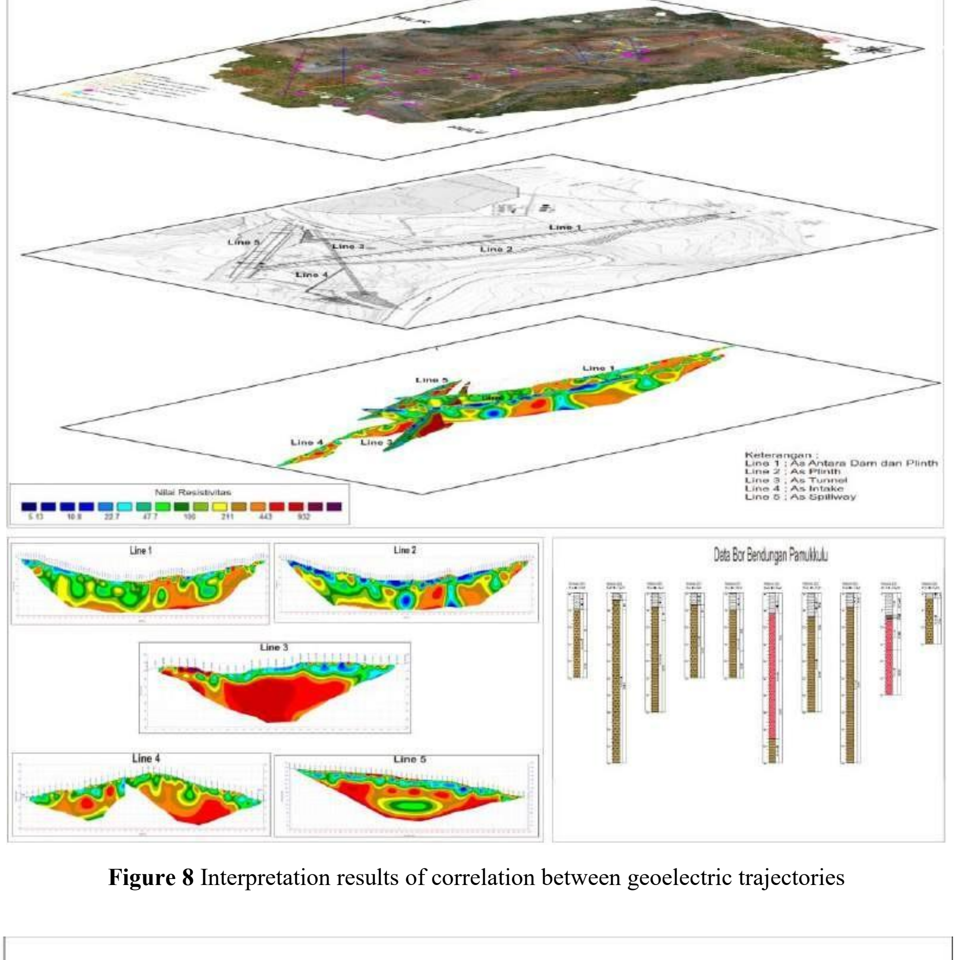

Figure 8 Interpretation results of correlation between geoelectric trajectories

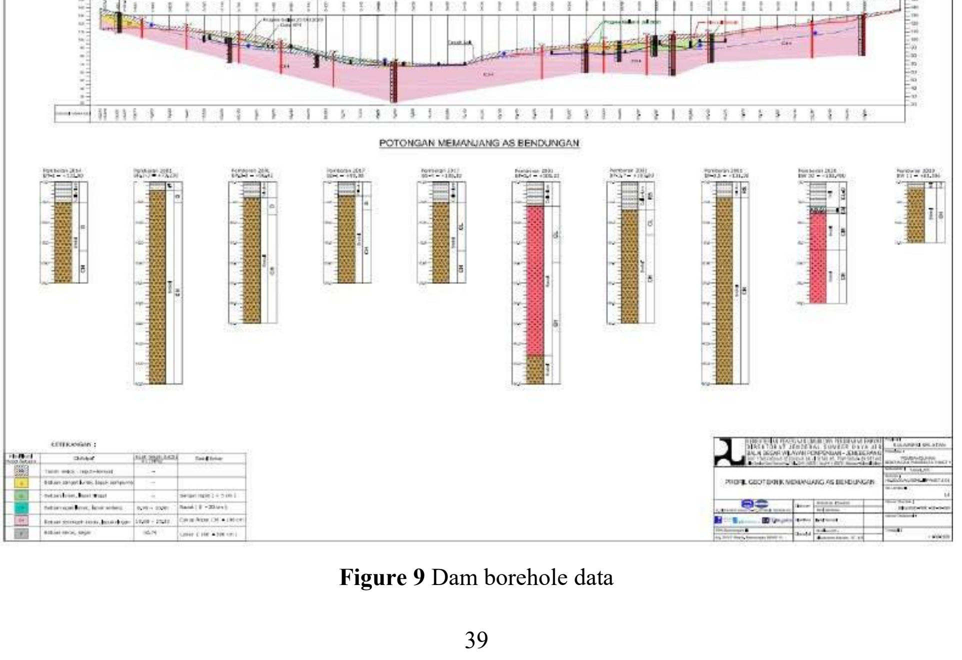

Figure 9 Dam borehole data

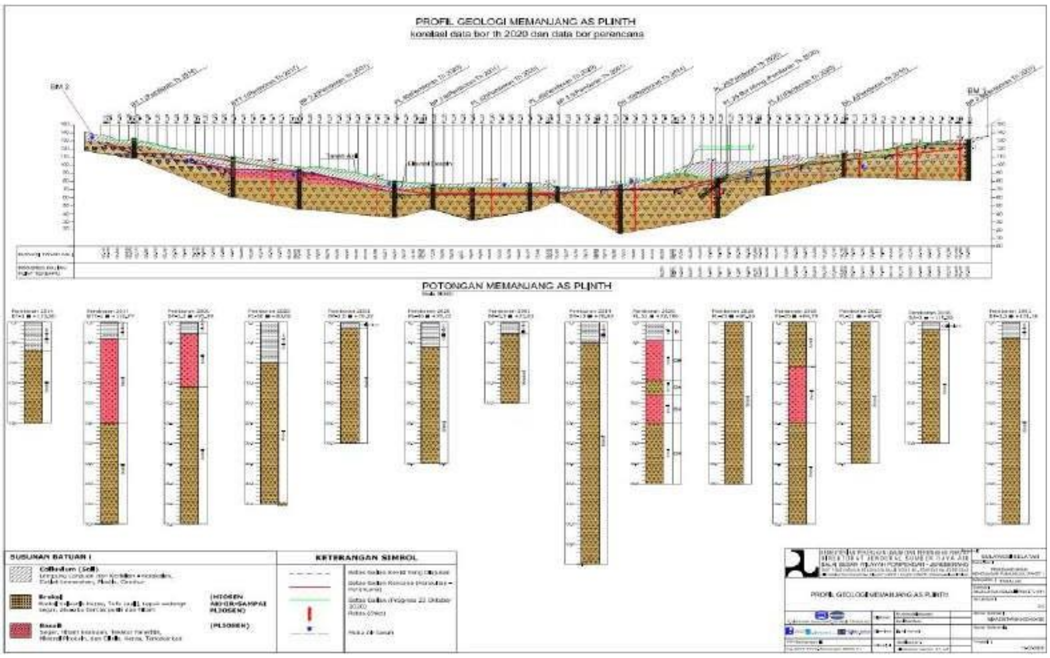

Figure 10 Borehole data as Plinth

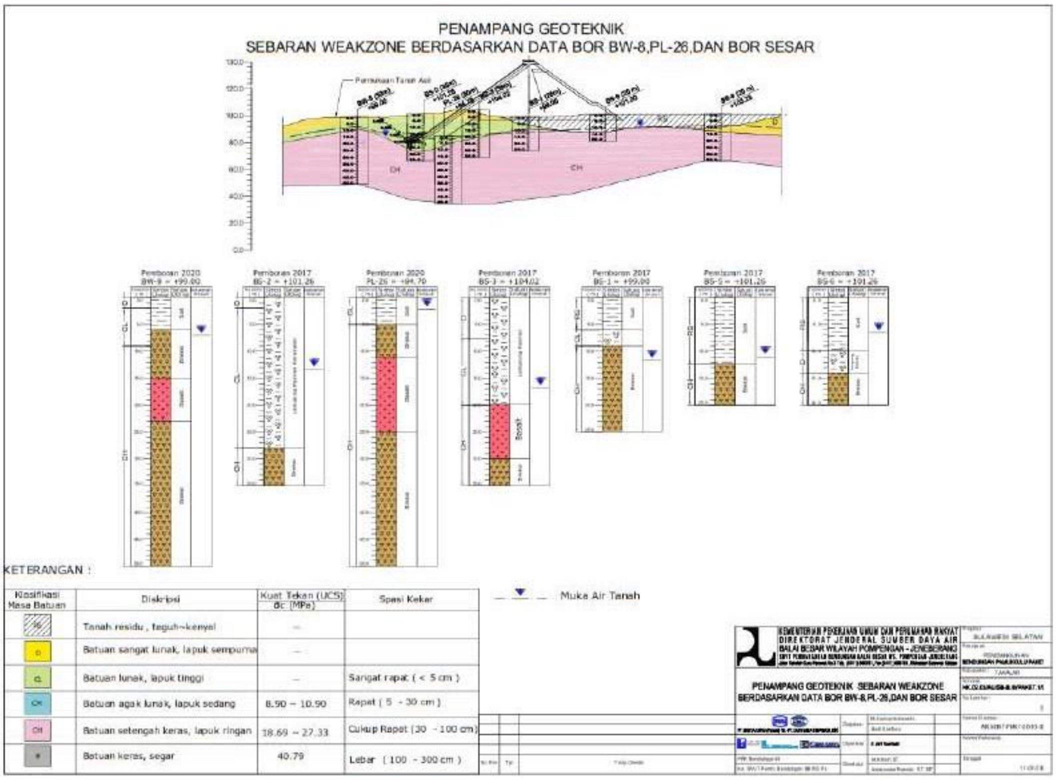

Figure 11 Borehole data at weak zone

Table 1 Hasil deskripsi korelasi lintasan geolistrik dengan data bor

Line	Line Name	Description
1	AS between Plinth and Dam	On this track there are three types of rock resistivity, namely 3.70 - 100 Ohm.m in blue - green, 211 - 443 Ohm.m in yellow - orange, and 444 - 1000 Ohm.m in red, according to Telford, et al. , 1976 and also the drill data can be interpreted as the type of rock on this track is sandy clay, breccia, and basalt as fracture. The dominant basal crack is on the right.
2	AS Plinth	On this track there are three types of rock resistivity, namely 3.70 – 100 Ohm.m in blue-green, 211 – 443 Ohm.m in yellow-orange, and 444 – 1000 Ohm.m in red, according to Telford, et al, 1976 . The drill data can be interpreted as the type of rock on this track is sandy clay, breccia, and basalt as fractures. On this track there are many indications of seepage which shows a blue color.
3	AS Tunnel	On this track there are three types of rock resistivity, namely 3.70 - 100 Ohm.m in blue - green, 211 - 443 Ohm.m in yellow - orange, and 444 - 1000 Ohm.m in red, according to Telford, et al. , 1976 and also the drill data can be interpreted as the type of rock on this track is sandy clay, breccia, and basalt as fracture. On this track it is very suitable to be used as a tunnel because the rock is very resistant and indications of seepage are only on the surface.
4	AS Intake	On this track there are three types of rock resistivity, namely 3.70 - 100 Ohm.m in blue - green, 211 - 443 Ohm.m in yellow - orange, and 444 - 1000 Ohm.m in red, according to Telford, et al. , 1976 and also the drill data can be interpreted as the type of rock on this track is sandy clay, breccia, and basalt as fracture. This track is almost similar to a tunnel track for subsurface conditions.
5	AS Spillway	On this track there are three types of rock resistivity, namely 3.70 - 100 Ohm.m in blue - green, 211 - 443 Ohm.m in yellow - orange, and 444 - 1000 Ohm.m in red, according to Telford, et al. , 1976 and also the drill data can be interpreted as the type of rock on this track is sandy clay, breccia, and basalt as fracture. On this track there is a green boulder indication shown.

4.3 Interpretation Results of Voxler Model

The results of the interpretation of 3D modeling on the Voxler 4.0 application provide a color classification into 3 colors from the Res2ndiv application, the colors are blue with a resistivity value of 3.70 – 100 Ohm.m, yellow with a resistivity value of 211 – 443 Ohm.m, and red with a resistivity value 444 – 1000 Ohm.m. In addition, it can be seen the patterns of potential seepage in the study area. These patterns show indentations like folds that reach the surface which can be observed in Figure 12.

Where the direction of the arrow in the figure shows seepage in the study area. The results of the interpretation of the dominant seepage potential in tunnel shafts, and also in plinth shafts, dam shafts, and spillway shafts on the surface. Meandering subsurface seepage patterns are marked in blue. The seepage direction starts from the East (T) and Northeast (TL) directions and tends to be dominant to the Northwest (BL) and Southwest (BD) which can be seen in Table 2 based on Figure 12

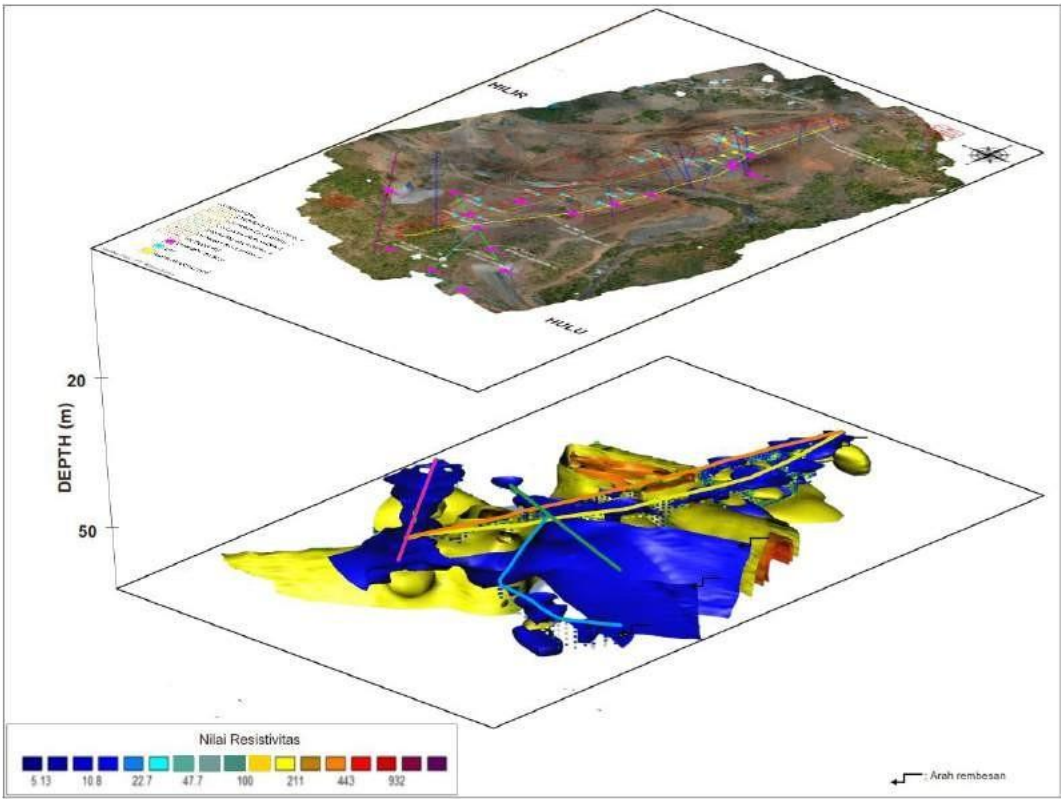

Figure 12 Voxler model

Table 2 Desription results of Voxler Model

Rock types	In voxler modeling the resistivity color is only divided into three color clusters from Res2ndiv. In voxler modeling, the blue color has a resistivity value of 3.70 – 100 Ohm.m for sandy clay rock types, the yellow color has a resistivity value of 211 – 443 Ohm.m for breccia rock types and the red color has a resistivity value of 444 – 1000 Ohm.m with basalt rock type.
Seepage direction	There are two directions of potential seepage, namely: a. The first direction starts from the north-east on the upstream to the north-west on the downstream, passing through the plinth building to the maindam and ending at the spillway building downstream. b. The second direction is from East on the upstream to Southwest on the downstream, passing through the tunnel building then the intake towards the spillway
Seepage potential	The most dominant seepage potential is in tunnel buildings and can be seen in spillway, as dam and plinth buildings which have a blue color.

5. CONCLUSION

Based on the data analysis that has been carried out in the research area, the following conclusions can be drawn:

1. The condition of the rocks below the surface in the study area can be interpreted based on observations and resistivity tests where breccia and basalt rock types are on a resistivity scale of >= 100 ohm.m. The value below 100 ohm.m is categorized as a layer of soil or weathered.
2. The results of the interpretation of seepage modeling show that the as tunnel section has a large seepage potential, there are also sections of the as dam, plinth as well as spillway as on the surface, the seepage potential is shown by the appearance of blue color.
3. From the results of modeling with the voxler application, the direction of seepage in the study area starts from the upstream with the East (T) and Northeast (TL) directions moving downstream towards the dominant direction to the Northwest (BL) and Southwest (BD).

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