PROCEEDINGS
JOINT CONVENTION YOGYAKARTA 2019, HAGI – IAGI – IAFMI- IATMI (JCY 2019)
Tentrem Hotel, Yogyakarta, November 25th – 28th, 2019

Groundwater Investigation using Sclumberger Vertical Electrical Sounding (VES) in Baturraden Geothermal Working Area (GWA), Central Java, Indonesia

Katarina Evelyn Permata Herho[1], Sandy Hardian Susanto Herho[2]
[1]Geological Engineering Study Program, Faculty of Earth Technology and Energy, Trisakti University
[2]Weather and Climate Prediction Laboratory (WCPL), Bandung Institute of Technology (ITB)

Abstract

Groundwater investigation is becoming increasingly important for Indonesia. It is natural resources for sustainable development of a region.
In this study, we have carried out vertical electrical sounding (VES) at twenty five sites at location of geoelectric survey work in Embung Area, Baturaden Geothermal Project, Pandansari Village, Paguyangan Subdistrict, Brebes Regency.
Geological conditions in this area are included in the unraveled Mount Slamet Lava Formation (Qvs) which is composed of lava, tuff and lava deposits. The range of types of resistivity is obtained between 20.97 and 6315.50 ohmmeters. At intervals of 11-100 ohmmeters the lithology of this resistivity is tuffaceous-sandstone. At 100-1000 ohmmeter is mudflow and the interval> 1000 ohmmeters is lava.

Introduction

Geological condition based on the geological map of the Purwokerto sheet (Figure 1). Location of the investigation included in the unraveled Mount Slamet Lava Formation (Qvs) which is composed of volcanic lava deposits, tuffs and lava.

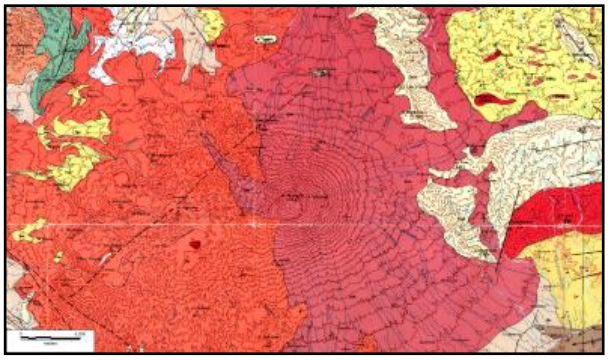


Figure 1. Geological Map of the Purwokerto Sheet (M. Djuri, H. Samodra, T.C. Amin & S. Gafoer, 1996)

Vertical Electrical Sounding (VES) to find locations that have potential groundwater content and the position of depth of groundwater which will be used to determine locations that have deep groundwater potential and can be used economically by using deep drill well, besides that it is also used as a basis for the preparation of a budget plan that is needed for the manufacture of boreholes. The geoelectric survey work is carried out in Embung Area, Baturaden Geothermal Project, Pandansari Village, Paguyangan District, Brebes Regency with twenty five sites spread (Figure 2).

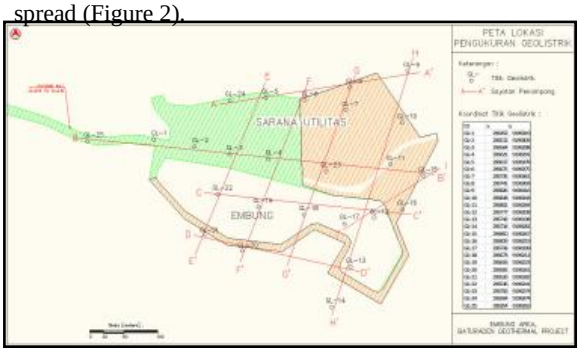


Figure 2. Geoelectric Measurement Location Map

Data and Methods

Electric current (direct current) is flowed through two current electrodes A and B (Figure 3), there will be a potential difference between the two currents. The potential difference is measured through 2 potential electrodes M and N which are then recorded by the receiver (receiver). The measurement results of the electrical values will be converted into rock types, the position of depth and thickness.

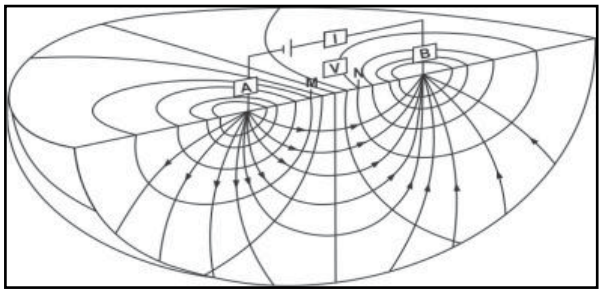


Figure 3. Schlumberger Electrodes Arrangement and Electric Flow Patterns

In the Schlumberger configuration method the arrangement of electrodes is set with certain distance values. This configuration method of potential electrodes M and N is always placed between the current electrodes A and B.
Ohm's law that is used as the basis for calculating the geoelectric probe in obtaining the resistance of the apparent type must be multiplied by the distance factor (K factor).

$$\rho a = \pi.\Delta V / I\,(L^2 / l - l/4)$$

ρa = apparent resistivity (ohmmeter)

ΔV = potential difference (volt)

I = current (ampere)

L = half AB current electrode separation (meter)

l = potential MN electrodes spacing (meter)

The apparent resistivity obtained from the calculation according to the above equation is then plotted on a transparent double logarithmic paper to half the distance of half the current electrode (AB / 2) where the distance of the AB stretch to the measurements carried out is 160-250 meters. After plotting it will be obtained forms of apparent resistivity curves to be interpreted quantitatively.
In processing the data carried out the method of interpretation is used 3 (three) layers, ie each apparent resistivity curve is placed above the standard curve for matching, so that the numbers of true resistivity ρ_1, ρ_2, ρ_3 with depths d_1, d_2, d_3. The third layer (d_3) is based on numbers. This apparent will have infinite depth ($d_3 = \infty$)

Result and Discussion

Resistivity Log

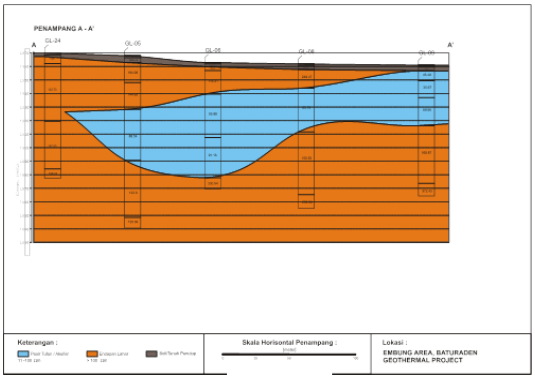
The results of geoelectric measurements at the Embung Area location, Baturaden Geothermal Project, found the range of resistivity values between 20.97 and 6315.50 ohmmeters. The range is divided into certain intervals and can be interpreted as lithological layers.

Table 1. The intervals resistivity and lithology of geoelectric measurements

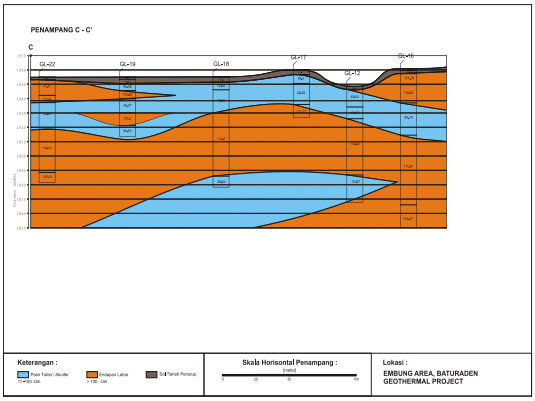
	Resistivity (Ωm)	Lithology
1	11 – 100	Tuffaceous-sandstone
2	100 – 1000	Mudflow deposits
3	>1000	Lava

Geoelectric Section

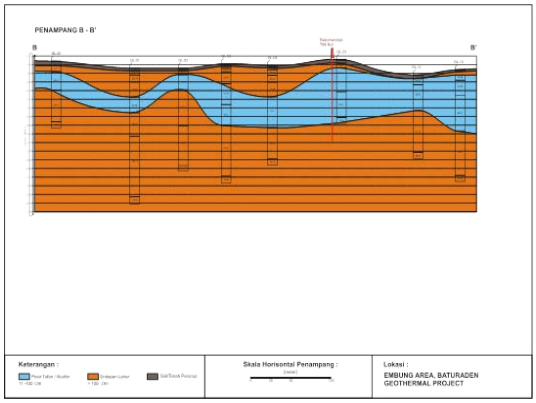
llustrates the thickness and depth of aquifer rock layers, namely in layers that have the ability to store and drain ground water.
The results of the interpretation of the spread of the resistivity value in a vertical type with a geoelectric cross-section at the study site are divided into 9 cross sections.



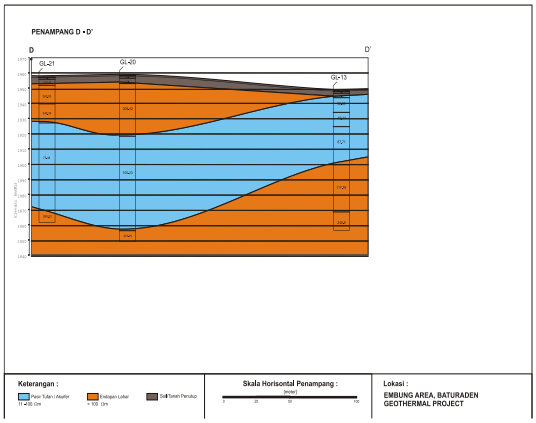
a



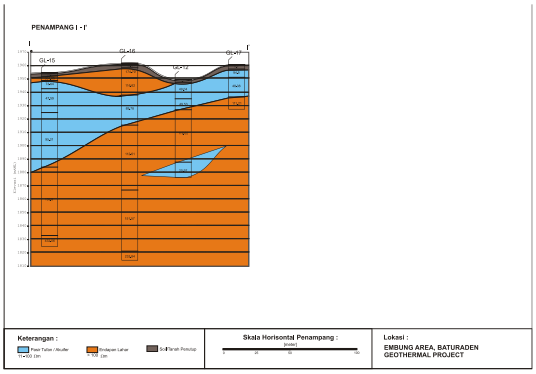
b



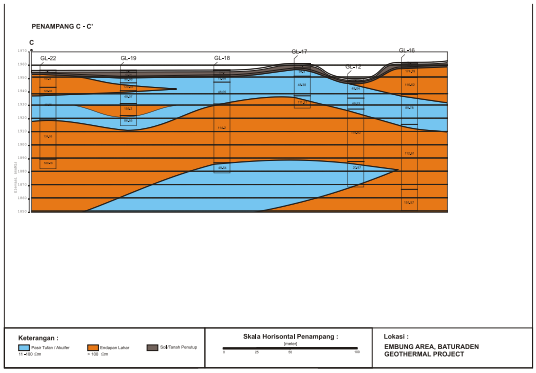
c



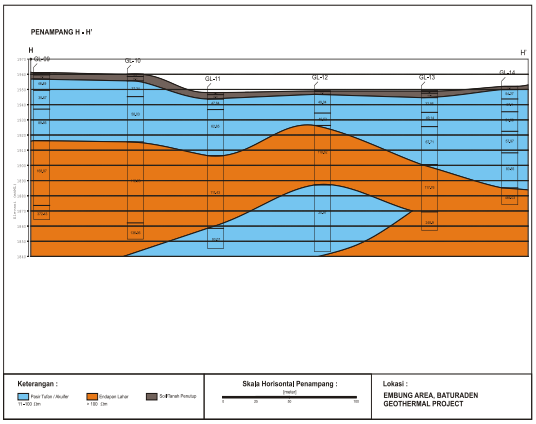
e



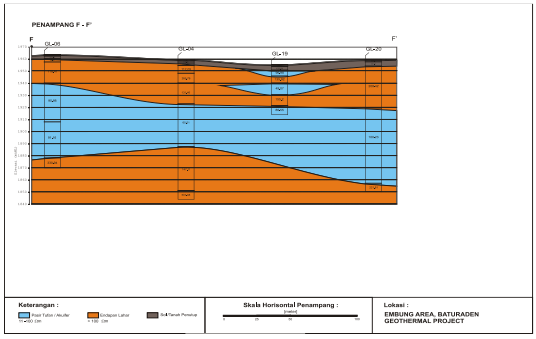
i



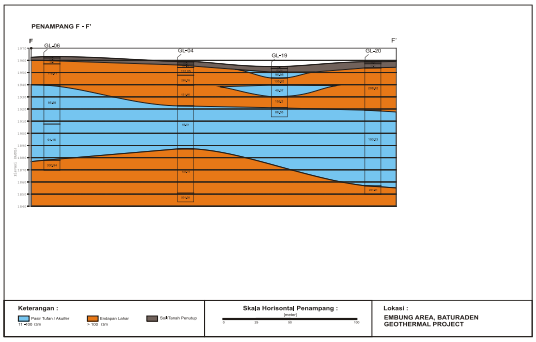
f



j



g



h

Figure 4. Geoelectrical Sections

Isoresistivity Map

The Isoresistivity map provides an overview of the distribution of aquifers in the study location. The Isoresistivity map presented is the value of type resistances at depths of 20, 50, 70 and a depth of 100 meters which illustrates the potential of deep aquifers.
From the isoresistivity map can be seen the distribution of the type of resistivity values that are interpreted as aquifers which are between the value of 11-100 ohm meters which are colored blue. The orange color shows the distribution of lava sediment or lava deposits with a type of resistivity value between 100-1000 ohmmeters.

At 20 meters depth the distribution of aquifers accumulates in the plains around the **retention basin** site at points GL-2, GL-9, GL-10, GL-11, GL-12, GL-13, GL-14, GL-15, GL-17 , GL-18, GL-19, GL-25.

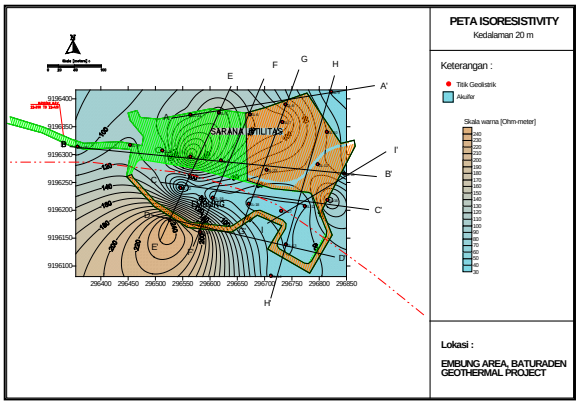


Figure 5. Isoresistivity Map of 20 meters

At 50 meters depth the distribution of aquifers accumulates in the plains around the **retention basin** site at points GL-1, GL-3 GL-4, GL-5, GL-6, GL-7, GL-8, GL-14, GL-15, GL-19, GL-21 dan GL-23.

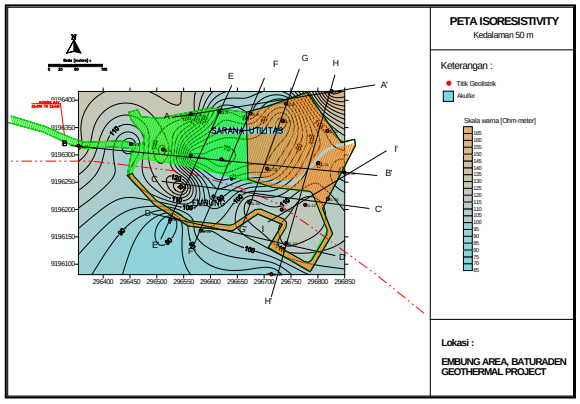


Figure 6. Isoresistivity Map of 50 meters

At 70 meters depth the distribution of aquifers accumulates in the plains around the retention basin site at points GL-3 GL-4, GL-5, GL-6, GL-12, GL-15, GL-18, GL-19, GL-21 dan GL-23.

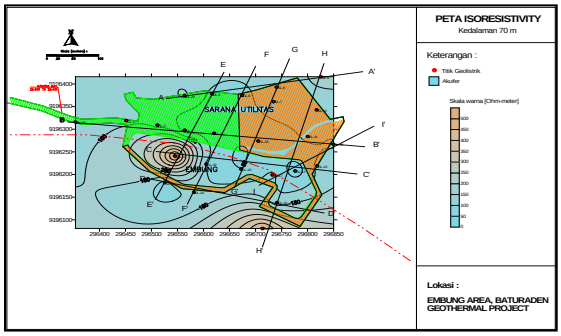


Figure 7. Isoresistivity Map of 70 meters

At 100 meters depth the distribution of aquifers accumulates in the plains around the retention basin site at points GL-11 GL-12, GL-13, GL-18, GL-19 dan GL-23.

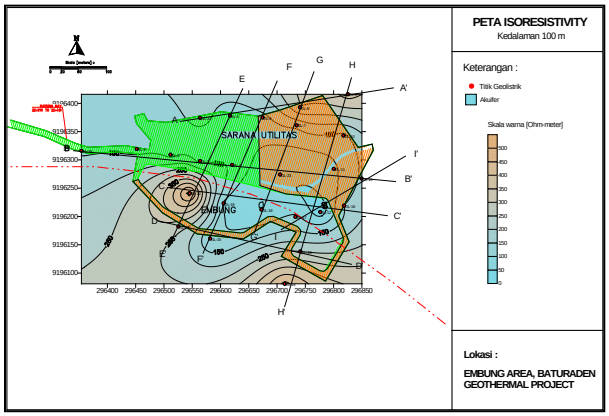


Figure 5. Isoresistivity Map of 100 meters

Conclusions

After doing data processing and interpretation of layer types from geoelectric data are supported by geological, geohydrological and field observations related to soil water aspects, so it can be concluded:
In general, geoelectric measurements in the Embung area, Baturaden Geothermal Project (GL-01 to GL-25) obtained below-ground image are as follows:
1. The distribution of aquifers is evenly distributed around the Embung site.
2. The Embung Area is a groundwater basin area.
3. The lithology condition of the Embung location area consists of soil with a thickness of about 5 meters, laying of mudflow deposits and tuffaceous-sandstone with varying depth and thickness.

References

Afifah, R.S, 2008. Pengolahan Data Geolistrik dengan Metode Schlumberger. Jurnal Teknik, **29**, 120-123

Fetter, C.W. (1994) Applied Hydrogeology. 3rd Edition, Macmillan College Publishing Company, New York

Todd, D.K., 1980. Groundwater Hydrology, John Wiley and Sons, New York

Acknowledgements (Optional)

Authors are grateful to all the colleagues that have had pleasure and honor to work with in groundwater investigation in Baturraden Geothermal Working Area (GWA). Without their participation and feedback, this study would not have been possible.