A HYDROGEOLOGY RESEARCH BY USING SCHLUMBERGER GEO-ELECTRIC METHOD IN DISTRICT *HAMPARAN PERAK, DELI SERDANG, NORTH SUMATERA*

Ir. Syamsul Amien MS.

Head of Electrical Energy Conversion Laboratory
Electrical engineering department, Engineering Faculty
North Sumatera University

ABSTRACT

Due to the population growth, the need for the clean water is likely to increase. Subsrface water sources or groundwater is one of the important sectors of the Government attention, because ground- water is the main alternative source of raw water to supply the water needs for various purposes of human activities. In anticipationof the effect of the development of the region in general, it is necessary to be able businesses for raw water, irrigation and Industr of the groundwater can be as well as how to control over the distribution and causes of infiltration into the soil. This investigation was conducted in District Hamparan Perak, Deli Serdang, North Sumatera. That is by measuring the resistivity and mapping dealer spread a layer of groundwater (aquifers) that an overview of the groundwater can be known. The way to know the state of groundwater aquifers, one of which is the Geoelectric Method is using Resistivity Schlamberger Method.

Keywords : Hydrogeology, Geoelectric, Groundwater.

I. INTRODUCTION

1.1. Background

In order to meet the needs upon clean water in a particular area, variety efforts can be done deal to the condition and the potency of the area. Particularly to the deep well construction, in advance it is needed to conduct a geology research and hydrogeology as the part of exploration activities.The exploration activity with geo-electric resistivity method is a geophysical method to present the lithologies data arrangement of the subsurface rock through the electrical properties of the rock. The geo-electric exploration prediction follows the Schlumberger electrode array system, by flowing electric current into the earth.

The generated field data is pseudo data from the electrical properties of the rock. Through the data processing, it will be found the valid electrical properties of the rocks. The interpretation of the field data will describe the condition of the subsurface rock vertically. Through electrical properties of the rocks, it can be interpreted that variety aspects can meet the requirements. One among others is the prediction of subsurface vertically as well as horizontally along with the prediction of the subsurface rocks arragement and the aquifer prediction. To interpret the data horizontally, it is demanded many measuring points, in this case these measuring points are arranged systematicly (grid system). The scope of the activities cover the geology reserach and hydrology as well as the field data collecting. This

method is conducted as a scientific study based on the scientific principles and method of geophysical exploration work.

1.2. Objective and Purpose

As it has been explained above that this hydrogeology research is conducted by applying the Schlumberelectrode arrangement geo-electric prediction that aims :

a. To predict the existence of the aquifer;
b. To search/find the location, position, thickness, deep and dissemination of the subsurface quifer;
c. The prediction of subsurface lithology through the valid high resistivity arrangement of the rock vertically and the thickness as well as the depth position.

1.3. Used Equipment :

a. The Geo-electric tool consist of:

Current transmitter with the capacity of 1.500 Watt; Reciever with the sensitivity of 0,10 mVolt; The currect cable with the length 1.000 meter; potential cable with the length 200 meter; Total rod electrodes 18 Pcs; Accu 12 Volt ; 50 AH 1 pcs.

b. Field Support Equipment and Studio

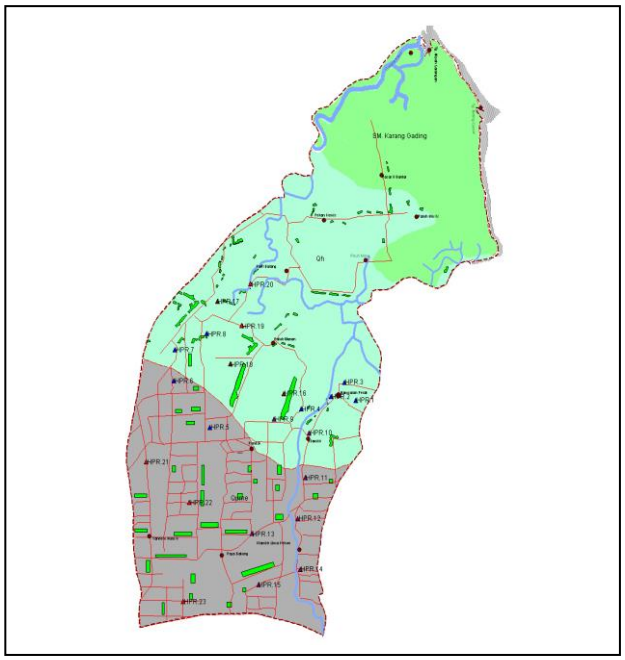
The geological map sheet with the scale 1 : 250.000; RBI Maps with the scale 1 : 50.000 (digital); Geology compass; Palu GeologiGlobal Positioning System (GPS); Handy Talky 4 Pcs; Computer; Printer; Digital Camera.

1.4. Implementer Personnel

The implementer personnel on this research are: Team Leader as well as the Geophysics 1 (one); Geology 1 (one) person; Hydrogeology 1 (one) person; Operator 2 (two) people; Freelance field worker 4 (four) people.

1.5. Research Location

The reserach location is located in Tapak Kuda subvillage, Buluh Cina village, Hamparan Perak Subdistict, Deli Serdang district, North Sumatera province with the geo-electrical measuring point as much as 23 points.



Picture 1. Hamparan Perak Map

Hydrogeology research methodology by applying the secondary data from the geology map sheet Medan with the scale 1 : 250.000 that continues by the field observation to the research area by analyzing the geology condition, includes the bedding rock, geology structure, as well as the inundated rocks properties. The prediction of geo-electric is applied with electrod Schlumberger arrangement method. The field data will be presented in the form of vertical resistivity versus the depth. The field data interpretation is applied by using the Lahey Fortran software.

II. HYDROGEOLOGY

2.1. Rock Response Toward Water

Based on the rock outcrop that can be found in the reseacrh area, the dominat rocks are sandy clay with the medium sized of sand, with the gray white colour and good texture of porosity. These rock are acted as the aquifer to dig well. This aquifer depends on the season that during the dry season, it will have the water debit decrease. In order to aplly the drilling, it is predicted that the aquifer includes sandstone and Julurayeu formation.

2.2. Soil Water Condition

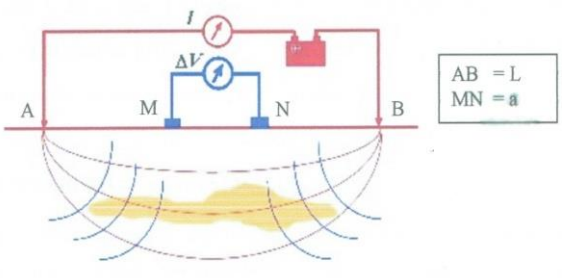
This location is occupied by one household, the water source to daily needs is taken from the dig well with 4 meters depth and 3 meters TKA. This dig well depends on the season that if it is in the dry season then it will have debit deceasing, the water condition is pure and without any smell. The aquifer rocks to the dig well include the sandy clay from alluvial unit, to deep drilling well, the aquifer is predicted as sandstone from Julurayeu formation.

III. GEO-ELCTRIC INTERPRETATION

3.1. Research Method and Geo-physics Analysis

The hydrogeology research with geo-electric method that applied is Schlumberger electrod arrangement model. The length of the current cable (I) and potency (P) is adapted as the requirement (Pict 2.). In this case 600 and 50 meters cable length are use for current is ranging from L/2 = 10 to 300 meters and for potential is ranging from a/2 = 0,5 to 25 meters.

The valid resistivity vertical rock (Table *) can interpret the location and position of the ground water aquifer. On the other hand, the high resistivity can identify the physical properties of the roc as well as the inundated properties of rocks. The morphology and depositionalrocks environment effect the soil water availability.



Pict 2 : Geo-elctric Measurement Circuit-Schlumberger

Resistivity : $\rho \frac{\Delta V}{I}$, whereas K = Geometry Coefitient

$K = 2\pi \left\{\left(\frac{1}{AM} - \frac{1}{MB}\right) - \left(\frac{1}{AN} - \frac{1}{NB}\right)\right\}$

AM = $\frac{L-a}{2}$, AN = $\frac{L+a}{2}$, MB = $\frac{L+a}{2}$ dan NB = $\frac{L-a}{2}$

So :

$$K = 2\pi \left\{\left(\frac{1}{\frac{L-a}{2}} - \frac{1}{\frac{L+a}{2}}\right) - \left(\frac{1}{\frac{L+a}{2}} - \frac{1}{\frac{L-a}{2}}\right)\right\}$$

$$= 2\pi \left\{\left(\frac{2}{L-a} - \frac{2}{L+a}\right) - \left(\frac{2}{L+a} - \frac{2}{L-a}\right)\right\}$$

$$= 2\pi \left\{\frac{2}{L-a} - \frac{2}{L+a} - \frac{2}{L+a} + \frac{2}{L-a}\right\}$$

$$= 2\pi \left\{\frac{4}{L-a} - \frac{4}{L+a}\right\}$$

$$= 8\pi \left\{\frac{1}{L-a} - \frac{1}{L+a}\right\}$$

$$= 8\pi \left\{\frac{(L+a)-(L-a)}{L^2-a^2}\right\} = 8\pi \left\{\frac{2a}{L^2-a^2}\right\}$$

Then it will be found that:

$$\rho = 8\pi \left\{\frac{2a}{L^2-a^2}\right\}, \frac{\Delta V}{I} = \left\{\frac{16\pi a}{L^2-a^2}\right\}, \frac{\Delta V}{I}$$

Whereas :

ρ = resistivity, ΔV = the voltage high in M-N and I = high elctrical current A-B.

3.2. Water Bearer

The water bearer is based on :

a). The pseudo-resistivity on this occation is L/2 = 10 meter; L/2 = 50 meter; L/2 = 100 meter and L/2 = 300 meter.

L/2 = 10 meter

On L/2 = 10 meter or L = 20 meter, theoritically it indicates the depth of the flow – through layers about 1/3 X 20 meter = ± 6,5 meter shows thatrock sediment pattern with *the similar pseudo-resistivity rocks*< 20 Ωm head from east – west. On this condition, the water quality is predicted salty to brackish, to the north can be ascertained that the water quality is salty to brackish because it is located in the beach/coastal area. However to the south part cannot be identified precisely how deep or far the salty water/brickish infiltrate the land.

As for the same line of pseudo-resistivity rocks > 20 Ωm it can be seen that the pattern of sediment rocks head from the west to east, the quality of the water is predicted to be good, lithology formation from (Qpme) : Chunks , gravel , sand , silt and clay;

L/2 = 50 meter

On the L/2 = 50 meter with the flow through depth/ layers depth 1/3 X 100 = ± 30 meters can be seen that the sediment rocks pattern with the same line of pseudo-resistivity rocks< 20 Ωm heads from the east to the west, the quality of the water is predicted to be salty – brickish filtrate into the Pondok village.

The same line of pseudo-resistivity rocks> 20 Ωm, can be seen from the rock sediment pattern head from west to east is predicted to be good. The Lithology from Medan formation (Qpme) : Chunks , gravel , sand , silt and clay;

L/2 = 100 meter

On the L/2 = 100 meters with the with the flow through depth/ layers depth 1/3 X 200 = ± 65 meter shows thesediment pattern still head from the east to west with the rock sediment zone is getting smaller towards the same line of pseudo-resistivity rocks< 20 Ωm. On the south part, salty – brickish that filtrate the village/pondok village land. The same line of pseudo-resistivity rocks> 20 Ωm still heads from the west to the east eith the wider dissemination area. The water wuality is predicted to be good. The lithology from Medan formation (Qpme) : Chunks , gravel , sand , silt and clayand Tufa Toba unit (Qvt); Tufa riodasit and some of welded tuff;

L/2 = 300 meter

On the L/2 = 300 meter, with the flow – through layers about 200 meter, shows the sediment rocks to the same line of pseudo-resistivity rocks< 20 Ωm heads from north to

south, on this prone areas the dissemination is getting smaller, the same line of pseudo-resistivity rocks> 20 Ωm is getting wider, the water quality is predicted to be good, on the part of southwest are can be seen that the sediment rock are solid and head to the massive rocks formation. Lithology that is predicted from Julurayeu formation (Qtjr), layering sandstone and mudstone.

b). The valid resistivity of rocks:

From 3 (three) measuring points that are implemented, it can be interpreted that the ground water rocks are homogen from the valid vertical resistivity classification.
Based on the grade of vertical resistivity number, towards the resistivity of te rocks> 1.000 Ωm, the porocity grade of water is low and the permeability is very high, this layer can be interpreted as the layer, not as the aquifer. On the other hand, the grade of resistivity is about 100 - ≤ 1.000 Ωm, the level of porocity is very low, the resistivity is about 50 – ≤ 100, the porocity level is low to medium and the water resistivity is about 10 – ≤ 50, the porocity is medium to high. The valid vertical resistivity of the rock is ≤ 10 Ωm. It is predicted that the water quality is not good. For the coastal area, the water is brickish – salty.
The magnitude of solid vertical resistivity of the rocks and the porocity lever show that the solid/unit level from the aquifer rocks that means the bigger number of the resistivity then the porocity is getting lower and the permeability is gtting higher, The rocks are getting massive and the the ability level of water flow is getting lower, vise versa. The thickness level of the rocks depends on the formation and the available lithology. The thickness/depth of the subsurface rocks and lithology prediction as the the water flow layer, as the following table, taken from one sample measuring point, is:

Tabel * Valid vertical resistivity of the area Hamparan Perak subdistrict

No. points	Thickness (m)	Depth (m)	Resistivity (Ωm)	Formation /Lithology formation*)	Information
HPR.1	0,70	0,00 – 0,70	12	Overburden	
	2,20	0,70 –2,90	5	Form Medan (Qpme)	Shallow aquifer, salty water
	7,70	2,90 –10,60	9		Shallow aquifer, salty water
	28,80	10,60 – 39,40	12	Form Medan (Qpme)	Shallow aquifer, brickish
	118,30	39,40 - 157,70	29		Shallow-deep aquifer,
		157,70 ~	17	Form Medan (Qpme)	discharge area medium – high
				Tufa Toba , Fm Medan	Shallow – deep aquifer, discharge area medium – high
				Form Julurayeu (QTjr)	

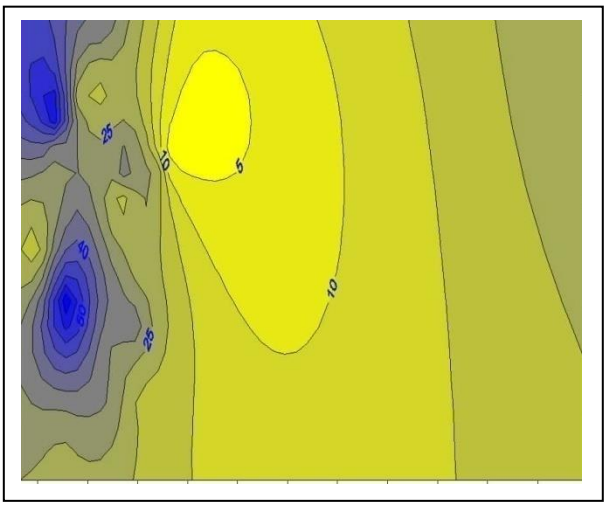
Formasi Medan (Q pme) = Chunks , gravel , sand , silt and clay
Tufa Toba Unit (Qvt) = Tufa riodasit and some terlaskan
FormasiJuluRayeu (QTjr) = sandstone, conglomerateand mudstone

IV. CONCLUSSION

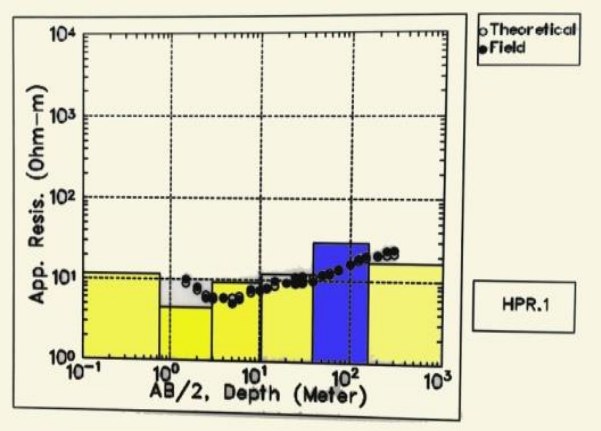
From the field observation and geo-electric measuring result can be concluded and suggested that:

1. Based on the field observation therefore the morphology unit of research area, in the form of land, that is used as the residence land, farming, and marshes with the basic rocks of silty sand unit, gravel, with small to medium sized of sand with the shade of white-gray and gray dark;
2. Stratigraphy of the research area can be observed in the field are in the form of silty sand unit, sand and gravel with the small sized of sand with the white-gray and dark gray shade. These unit are seen to be spreaded in the reseacrh area;
3. Based on the outcrop rocks that can be found in the research area, the dominant rocks are silty sand, sand and gravel along with soft to medium sized of sand with the shade of white-gray and the porocity is considered to be good. These rocks are acted as the aquifer towards the digging well. To the depth drilling, it can be predicted that the aquifer includes sandstone from Julurayeu formation.
4. The geo-electrical mesuring result towards the 3 (three) measuring points, the rocks are acted.
5. As the shallow aquifer as well as the depth aquifer or with the other hand the shallow aquifer to the deep. The analysis is conducted to every points but on this reserach it is on mentioned and taken from one sample only, it is HPR.1 measuring point

HPR.1 Measuring Point From the geo-electic measuring result, on the depth 39,40 –≥ 157,70 meter with the 29 and valid vertical resistivity 17 Ωm is rocks with the good level of porocity, the physicmeter with the solid vertical resistivity is 29 and 17 Ωm is rocks with good porocity level, unsolid rocksphysics, medium – high level of porocity, can be acted as a productive shallow – deep aquifer, pore sized water accumulation. Good water quality, ***Tufalithology from Tufa Toba unit and layering sandstone, conglomerate and mudstone*** **from Julurayeu Formation.**



Pict : ISORESISTIVITY Map:
L/2 = 10 meter



HPR.1

No.	Resistivity	Thickness	Depth
1	12	0.8	0.0 – 0.8
2	5	2.2	0.8 – 2.9
3	9	7.6	2.9 – 10.6
4	12	28.8	10.6 – 39.4
5	29	118.3	39.4 – 157.7
6	17		157.7 –

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