Direction Recommendation Drilling Location Utilization Of Groundwater Under The Interpretation Of Data Electrical Resistivity

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Abstract. In order to provide clean water source infrastructure in the area of the planned housing complex construction in Kayumalue Kelurahan, Kota Palu, a recommendation is needed regarding the location of potential groundwater drilling points. Efforts to meet these targets are carried out by means of exploration using themethod *electrical resistivity* (ER). The equipment used is *resistivitymeter* the AGI Supersting R8 / IP. In the field setting, we measured 2 trajectories by applying the Wennerconfiguration *imaging* 2-Dat 56 number of 6 m spaced electrodes, where the data modeling used the EarthImager 2-D v.2.4.0 software. In this study, we also utilized geological information and performed survey the existence of groundwater utilization wells that are around the location. The results obtained that around the location are composed by water-saturated sedimentary rocks, which are needed by the presence of groundwater wells of residents who obtain groundwater with a slightly salty and fresh taste, at a shallow depth between 3-5 m. By doing so, the two preliminary data have provided additional confidence in the process of interpreting the ER data, that there is groundwater around the site as an initial description of the local hydrogeological conditions. Furthermore, based on the ER data modeling obtained high conductivity values> 100 mS / m and low resistivity values <20 Ohm-m, which we interpret as subsurface layers that are saturated or saturated with groundwater, as a potential area for obtaining groundwater. It is this result that we make the basis for recommending the ideal location for groundwater drilling. Among them are 3 points on line 1, and 4 points on line 2, at varying depths at each point that are between 5-10 m, 20 m, and 40-50 m.

Keywords: groundwater, ER method, resistivity, conductivity.

1. Introduction

In general, the people of Palu City choose groundwater as a source of clean water, because there is no affordability of clean water services in all areas carried out by the Government through the Regional Water Company (PDAM). In fact, in recent years the use of land (space) in the city of Palu which is destined for settlement continues to grow. This means that the need for clean water will also continue to increase, which is not balanced with the resources of its suppliers. Utilization of residential space is carried out by developers who build houses in a complex residential area. One of the developers is a private company that will facilitate the supply of clean water and other infrastructure, which this time is at the location of the planned housing complex development in the Kayumalue Kelurahan, Palu City. By looking at the phenomenon of scarcity of clean water sources, so the company plans to use groundwater as a source of clean water needs.

In order to obtain information about an ideal groundwater drilling point, the company uses our services (*geophysicist*) in order to estimate the presence of groundwater carriers (aquifers) or a saturated zone that is considered to have groundwater potential. The aquifer exploration method that we use is *electrical resisitivity*(ER), which is one of the exploration techniques or methodologies in the field of applied geophysics in hydrogeology. This ER method utilizes the resistivity signal of subsurface rocks, as a reference interpretation of the possibility of aquifer anomalies, either bypresentation techniques *imaging* 2-D(Ratnakumasari, et al., 2012; Yeh, et al., 2014; Nazaruddin, et al., 2017) or with *vertical sounding* 1-D(Abbas, et al., 2004; Araffa., 2014; Okiongbo and Akpofure 2012; Yadav, et al., 1997; Abd El-Gawad, et al., 2017;

Mahmoud, et al., 2017). Even for obtain results with a more convincing level of confidence, often the two techniques are integrated (Muchingami, et al., 2012; Khaled, et al., 2016; Metwaly, et al., 2009).

The rock resistivity value is closely related to changes in hydrogeological conditions if there aregroundwater *freshwater* and *saltwater*,media *porous* between *softrock* or *hardrock* that is conserved, orlayers *permeable* and *impermeable*(Kirsch, 2009). Therefore, among all surface geophysical methods, the ER method is very good in investigating groundwater (Zohdy, et al., 1974; Todd and Mays, 2005; Singhal and Gupta, 2010). However, this ER method has been widely known and successfully used for investigating aquifers, where the success of its application is more efficient than using exploration drilling techniques at a high cost rate. So in an effort to prepare recommendations for the location of groundwater use drilling for prospective housing complexes in Kayumalue Kelurahan, Kota Palu, we refer to the ability of the ER method as its exploration method.

2. Methods

Measurement of rock resistivity using the ER method is done by injecting electric current into the ground through 2 current electrode stakes (C1 and C2), and measuring the potential difference caused by 2 potential electrode stakes (P1 and P2) for each particular electrode distance. In this activity, we use the Wenner configuration *imaging*, 2-D where the calculation of apparent resistivity is a function of the geometry factor and the resistance of rocks written as follows(Reynolds,1997):

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

Where:

A : Resistivity pseudo /*apparent resistivity*(Ohm-m)

W : factor geomteri 2πa, wher a spa ce elektorda (m)

ΔV : potential difference (mV)

I : electric current (mA)

Values obtained apparent resistivity is a response to the electrical signal that originates of all possibilities below the surface, in this case the earth is considered *homogenhalfspace*. To obtain a representative subsurface rock resistivity model from ER measurements, the apparent resistivity value was processed usingtechniques*inverse modeling*. Modeling is completed numerically using theoptimization method *smooth inversion model*which is also known as Occam's *inversion*(AGI manual intructsion, 2009). In this research, the inversion modeling process uses the help of EarthImager 2-D v.2.4.0 software. The best inversion modeling results are characterized by the small level of the *root mean square* (RMS) *error* in percent units which are defined in the following equation:

$$RMS = \sqrt{\frac{\sum_{i=1}^{N}\left(\frac{d_i^{cal} - d_i^{obs}}{d_i^{obs}}\right)^2}{N}} \times 100\% \quad)$$

Where N is the amount of data, d_i^{cal} data is calculated or predicted, and d_i^{obs} measurable data.

Figure 2 *Set-up* of ER measurements at research sites

3. Results

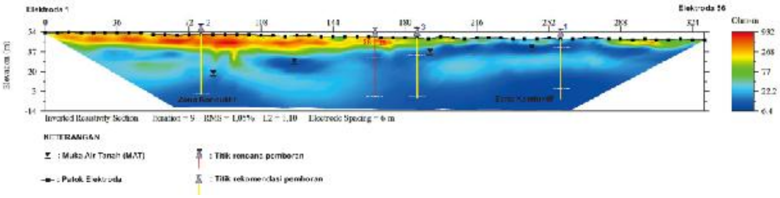
Field measurements usingequipment *resistivitymeter* AGI Supersting R8 / IP. Based on the geological map (Figure 1), the location of the investigation is at the boundary of the alluvium unit and the coastal sediment (Qap) consisting of gravel and sand, with molasses celebes sarasin (Qtms) consisting of conglomerates and sandstones, where both units are holocene (sandstone) Soekamto, et al., 1973). Thus, in the vicinity of the lithology research site, the composition is sedimentary rocks, where the characteristics are intergranular rocks which are generally not consolidated and / or slightly consolidated, the medium is*porous* and *permeable* to become a water-saturated layer (Todd and Mays, 2005). Furthermore, information on the use of groundwater around the location is a description of the actual condition of groundwater availability. The local residents' groundwater utilization wells found were 3 wells, which are around the ER measurement track (Figure 2). The depth of the well to obtain groundwater is shallow between 3-5 meters, where wells 1 and 2 are rather salty with an electrical conductance value> 1,000 µS, while the residents' wells 3 are tasteless with an electrical conductance value <500 µS (Table 1).

Table 1 Information on groundwater utilization wells of residents in the vicinity of the study site

No	Long (X)	Lat (Y)	Conductance electric water (µS)	Well depth (m)	Taste
1	119.8732	-0.7540	1,357	3	Somewhat salty
2	119.8731	-0.7539	1,886	5	Somewhat salty
3	119.87450.75	-0.7545	2.48	5	Bargaining

However, information on geological conditions and the availability of local groundwater utilization wells has sufficiently defined that in the vicinity of the study site there is groundwater, and strongly supports the process of resistivity data interpretation to obtain a recommendation point for drilling for ideal groundwater utilization. Generally, to interpret groundwater densities in resistivity data is characterized by low values (Fetter, 2001), usually in the range of values 0.05-100 Ohm-m or even up to 1000 Ohm-m, both for *freshwater* and *salinewater*(Telford, et al., 1990; Reynlods, 1997; Loke, 2004). In other words, that the conductive zone is an area that is likely to have layers saturated with groundwater below the surface. Based on the results of the ER investigation, we obtained a trend model for the pattern of the same resistivity structure between the two trajectories (Figures 3 and 4). We see that there are better groundwater utilization drilling positions compared to the initial drilling plan point (electrode position 28-29), which is characterized by high conductivity values> 100 mS / m and low resistivity <20 Ohm-m. Systematically and argumentatively, we describe these recommendations in tabular form (Tables 2 and 3).

(a)



(b)

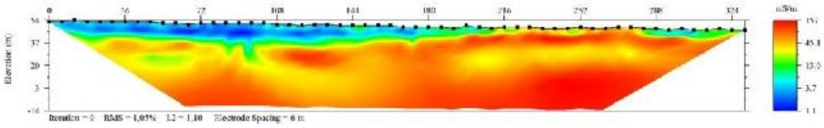


Figure 3(a) Conductivity cross section and (b) subsurface resistivity with groundwater drilling recommendations point on track 1

Table 2 Interpretation of ER data and information on direction of groundwater drilling drilling recommendations on line 1

No	Drill point	Description	Description
1	Drill plan	Approximately 168 m from 0, between electrodes 28 and 29.	1. h = ± 20 m, > 100 mS / m, coating state similar to drill recommendation 3.

2	Drill recommendation 1	About 258 m from 0, electrode 44. Drilling top layer does not show hard coating to the recommended target depth.	2. h = ± 5-10 m, > 100 mS / m, free groundwater, brackish 3. h = ± 40-50 m, > 100 mS / m, groundwater confined, allegedly tasteless, no visible layer of aquiklud (*impermeable*), covered by aquitar, and suspected potential groundwater location. 4. The drill point is a conductive zone as a groundwater potential point.
3	Recommended drill 2	About 186 m from 0, electrode 32. The upper layer shows a hard, waterproof coating.	h = ± 20 m, > 100 mS / m, it is suspected that a shallow groundwater level can be obtained. h = ± 50 m, confined groundwater, allegedly tasteless, no visible layer of aquiklud (*impermeable*), covered by

			aquitars, and suspected potential groundwater location.
4	Drill recommendation 3	About 78 m from 0, 5. electrode 18. The upper layer shows a hard, waterproof, non-conductive layer.	h = ± 40-50 m, > 100 mS / m, confined groundwater, allegedly tasteless, no visible layer of aquiklud (*impermeable*), covered by aquitars, and suspected potential groundwater locations.

h = depth, = electrical conductivity

4. Conclusion

Based on geological information that the research location is composed of water saturated sedimentary rock types, which are then validated by the presence of several groundwater utilization wells by surrounding residents whose depth is quite shallow between 3-5 m underground. This information has provided added confidence in the continued investigation of the ER method, to recommend the location of groundwater utilization drilling points for the planned area of housing complex construction. From the results of the interpretation of resistivity data, we obtained several locations of ideal groundwater drilling. Among them are 3 points on line 1, and 4 points on line 2, where the recommended drilling depth varies at each point, namely between 5-10 m, 20 m, and 40-50 m. This is justified by a high conductivity value> 100 mS / m and a low resistivity value <20 Ohm-m, assuming a relationship between a saturated or saturated subsurface layer with groundwater.

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