A preliminary study of geothermal resources in the Rokan Hulu Regency, Riau, Indonesia

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Abstract. Renewable energy is a must in the future. One of them is produced from the geothermal resources. A preliminary study has been done on the geothermal resources in the Rokan Hulu Regency, Riau, Indonesia. In this study, the Google Earth Pro 7.3.1.4507 has been used to map the possibility of the source of groundwater in supplying the hot springs. The 2D geoelectrical resistivity survey with Wenner configuration has been conducted to image the subsurface around the hot springs. The Google earth shows that the water resource of the hot springs is predicted from the highland in southwest part of the study area. The highland is spread from several meters to about 8 km from the hot springs. This area is consisted of the igneous rock with elevation from 100 to 911 meter above mean sea level, whilst the hot spring is located at the elevation of 86 meter above mean sea level. Resistivity values show the possibility path of the groundwater seeping from the rock fractures through the hot rocks of igneous rock to the hot springs. However, the detailed study needs to be conducted to investigate the geothermal resources of the study area.

1. Introduction

Energy is the basic principal in doing a national development. The availability of energy is absolute source to carry out various activities in our lives. According to some experts, they argue that with the pattern of consumption as now, then within 50 years of fossil fuel reserves will be exhausted, this can be seen from the rising of the oil prices in the country and the unstable oil prices in the international market [1].

Mostly the energy needs are supplied by fossil energy, energy consumption in world tends to increase every year. But again, the increase is dominated by fossil energy sources. In fact, if viewed from the aspect of potential, some countries have a potential energy for the development of geothermal energy, because it is located on the point of fire (ring of fire) [2, 3]. Furthermore, the excessive use of fossil energy eventually leads to new effects, namely global warming or climate change.

Google Earth is a virtual globe program actually called Earth Viewer and created by Keyhole, Inc. This program maps the earth from the superimposition of images collected from satellite mapping, aerial photography and 3D GIS globe. Google earth as the medium for the imaging of the earth surface appearance can be used to analyse the surface water runoff and the possibility of the crack pattern in the
The subsurface of the certain area. It is often used also in analysing the altitude of an area and also possible patterns of the magma intrusion zone in the past of the geologic time long ago.

Whilst, the geoelectrical resistivity is one of geophysics method that use the electrical current and voltage difference to investigate the subsurface through the electrical characteristic of the earth material. The geoelectrical resistivity is widely used in the environment field, such as in the investigation of heavy metal in the aquifer system [4], and to investigate the potential and quality of the groundwater in the agriculture area [5, 6]. In the other field, geoelectrical resistivity method can be used to investigate groundwater problem in the coastal area [7, 8, 9, 10]. It includes determining the possibility of salt water intrusion, and the groundwater reserve for certain purposes. Moreover, the geoelectrical resistivity method is possible to monitor and analyse the fate nitrate phenomenon in the agriculture area [11, 12].

In this study, the Google earth and geoelectrical resistivity survey are employed as a preliminary study for the geothermal resources investigation. The research area is located in the Rokan Hulu Regency, Riau, Indonesia as given in Figure 1. The surface topography of the study area is undulated with average elevation of 90 m above mean sea level.

2. Methodology
The study area is located in the Rokon Hulu Regency, Riau. The hot springs are situated at 0.830380° N ; 100.270467° E and 0.825370° N ; 100.256920° E, which are about 150 km from Pekanbaru, the capital of Riau Province. This research is a preliminary study of the geothermal resources investigation. The research was done through analysis of the topography obtained from Google earth and a line of 2D resistivity survey. The Google earth analysis was conducted in order to obtain the possibility surface water runoff and the possibility of fracture in the area of igneous rock.

Prior to 2D resistivity survey, several direct surface resistivity measurements were conducted at the several outcrops in order to obtain the true resistivity value of the rock samples. The measurement was done using Wenner configuration with the small electrode spacing of about 5 cm apart so that the data
The reading will be a true resistivity value of the material assuming the material is homogeneous [13]. The data obtained from these measurements were used for 2D resistivity profile interpretation. The interpretation was referring to the direct surface resistivity measurement.

2D Resistivity survey was conducted with the home-made resistivity equipment. The Wenner array was used as the configuration in the data acquisition. The raw data obtained from the field was processed with the Res2DInv software. In the interpretation process, the result from direct resistivity measurement was used as the guidance in the interpretation of the 2D profiling data.

### 3. Results and Discussion

Figure 1 shows three surface profiling that are stretching from the hills at the southwest to the northeast. The position of the arrow in the line is the same position in the profile. From this profile, it can be seen the level of ground level along the line. Figure 2 (top) shows the line with southwest - northeast direction and the arrow position is 131 meters above mean sea level. While in Figure 1 (middle), a profile line is stretching from southwest to northeast at the west position. The arrows show a height of 93 meters above mean sea level. Figure 1 (bottom) shows a profile that is closer to a hot spring of about 10 m apart. The arrows on this profile show a position of 79 meters above mean sea level.

Based on the profiles in Figure 1, the hot spring is located at the lowest zone compared to the surrounding area. The peak of the hill is located about 10 km to the southwest and the elevation of the hill is more than 700 meters above mean sea level. The direction of surface water runoff is predicted from southwest to the north east. The hill is consisted of the igneous rock that is formed from the cooling of the magma long time ago. The surface profile at the area of igneous rock informs that the possibility of fracture is very possible with the random direction locally. However, the main direction of the fracture is from northwest to southeast direction.

The outcrops at the surrounding area of the hot springs compose of the high grade of methsediment rock. This is indicating that there was a magma intrusion at the area long time ago. Whilst in the hill that is located around 8 km from the hill, the outcrops consist mainly with the igneous rock.

Table 1 is the result of resistivity measurement that has done on the surface using small electrode spacing. The resistivity value of the fresh methasediment is highest value found in the area. The second materials are the coarse and fine soil. The only both materials available in the study area. Based on the Table 1, the resistivity value is influenced by the types of material and can be reduced drastically when the water occupy the space between the matrix or on the rock surface.

Figure 3 shows the geoelectrical resistivity profile result of the line 1 (top) and line 2 (bottom) respectively. These lines were conducted at the side of road near to the hot spring 1. The line 1 was conducted on the undulating land as indicated in the resistivity profile. The geoelectrical resistivity value is relatively higher at the survey line 1, which is found in the depth below of 4 m down. The resistivity value indicates that the current is relatively hard to flow which is correlating to the hard rock. Based on the data in the Table 1, the zone is possible occupied with the fresh methasediment rock. In the line 1, the possibility of water accumulation is relatively low. This is indicated from the relatively higher resistivity value appeared in the profile.

In the resistivity profile of line 2 (bottom), average resistivity value is about 400 ohm.m found on the surface. This value is correlating to the relatively dry sand. However, at the certain location, the lower resistivity value of less than 150 ohm.m can be found. The zone correlates to the relatively wet soil. Whilst, in the middle of the line 2, relatively higher value of more than 1500 ohm.m is found at the depth of more than 10 m downward. This zone is correlating to the methasediment zone which the interpretation is also supported by the data in the Table 1. The possibility of water accumulation zone can be found in the left and right side of the methasediment zone.

In the Line 2, the possibility of subsurface water flowing from the hill to this zone as mentioned in the first and second paragraph is very possible. However, the others geoelectrical resistivity survey should be done in the future for the detailed investigation.
Figure 2. Surface profile of the study area.
Table 1. The resistivity value of several outcrop measurement

| No | Material                                      | Resistivity (ohm.m) |
|----|-----------------------------------------------|---------------------|
| 1  | Fresh high grade of methasediment (wet)       | 800-1500            |
| 2  | Fresh high grade of methasediment (dry)       | 4000-15000          |
| 3  | Fine Sediment (relatively dry)                | 320-1800            |
| 4  | Coarse Sediment (relatively dry)              | 440-820             |
| 5  | Fine Sediment (wet)                           | 60-160              |
| 6  | Coarse Sediment (wet)                         | 80-210              |

4. Conclusion
The use of Google earth and geoelectrical resistivity survey in the preliminary investigation of geothermal resources have been shown that the possibility of geothermal resources in the study area is relatively reasonable. The google earth clearly inform about the possibility of the water resources for the both hot springs. It also notify the possibility of the zone where the source subsurface heater coming from. The geoelectrical resistivity, however, it can inform the zone where the methasediment occurs and where the possibility of water accumulation in the subsurface. For the future research, more resistivity surveys should be conducted in order to trace the subsurface water flow and to search more detail of the geothermal resources.

Acknowledgment
We would like to thank to the Institute for Research and Community Service (LPPM) Universitas Riau, and to all the field crew.

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