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GROUNDWATER PROSPECTING USING GEOELECTRICAL METHOD AT KG GANA, KOTA MARUDU, SABAH

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ABSTRACT

Geoelectrical method is proven as an efficient method to identify and locate water bearing formation at Kg. Gana, Kota Marudu, Sabah. This study used Terrameter SAS 4000 to acquire the resistivity value. The study area is underlain by the Oligocene turbidite sequence, the Crocker Formation.

1. INTRODUCTION

Geophysical studies are non-destructive methods of exploration. It uses minimal effort before a construction takes place in the desired area. Geophysical methods using electrical resistivity are the most effective and easiest methods for locating groundwater. The setup is simple and does not damage the physical condition of the study area [1]. The specific resistance value of earth materials indicates the occurrence of groundwater inside soil or rock formation saturated with water called aquifer.

2. STUDY AREA

The study area is located at Kg Gana and about 38 kilometres from Kota Marudu town (Figure 1). This village is a combination of ten scattered villages from surrounding area and Sabah State Government has directed and placed the village into a centralized area. This settlement also has primary school, mosque and church. There are 450 house which held approximately 3000 villagers [2]. The land area for this study area is approximately one square kilometre, located on almost flat area with elevation approximately 700 meters above sea level. It is underlain by the Crocker Formation, dated Oligocene, composed of interbedded sandstone and shale (Figure 2).

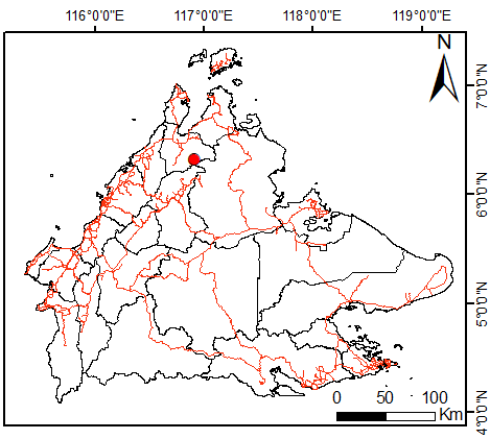

Figure 1: Location of study area.

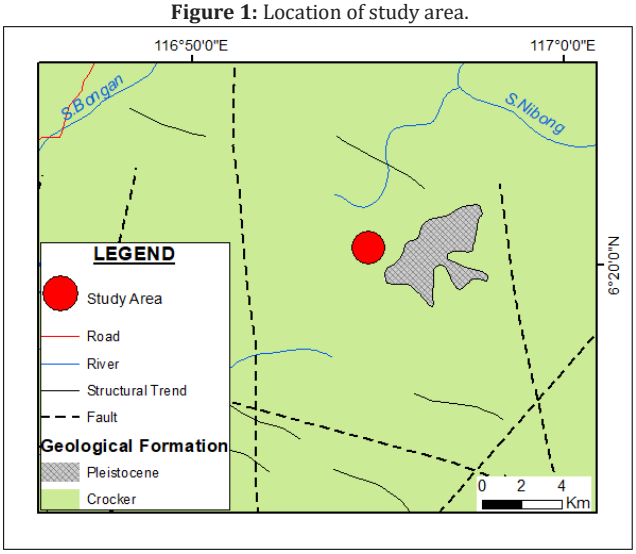

Figure 2: Location of study area (Sabah Geological Map, 2015)

3. OBJECTIVES AND METHODOLOGY

The objectives of this study are to differentiate electrical properties of rock types and to determine groundwater potential in unit rocks in the study area. Terrameter SAS 4000 were used in this study. This equipment utilise Ohm's Law to obtain soil and rock resistivity values. The way this equipment obtain resistivity data is by injection using controlled electric current that transmitted through multicore cable and steel electrode to measure the resistance for the earth materials. The equipotential for this electric current then measured and recorded by Terrameter SAS 4000. The result processed using Res2dinv software shall produce two-dimension cross section called pseudosection. This method also known as Electrical Tomography Imaging (ERT). This resistivity values will be used to estimate the thickness and location of the aquifer. This survey using pole-dipole electrode array to achieve the maximum penetration, good horizontal coverage, higher signal strength and not sensitive to telluric noise [3].

4. RESULTS

A total of seven survey lines were stretched in the study area consisting of interbedded sandstone and shale of the Late Eocene from Crocker Formation (Figure 3). The summary for all survey lines is shown in Table 1. Most of RMS error is more than 50% due to the geometrical factor of pole-dipole array [4]. Three types of resistivity values can be considered in this study. Low resistivity 0-10 Ω.m, medium resistivity 10-120 Ω.m and high resistivity 200 Ω.m above. To identify the water bearing formation value, medium resistivity value is referred [5,6].

Table 1: Summary of Survey lines

No	Survey line	Length (m)	RMS Error (%)	Datum point	Penetration depth (m)
1.	Survey Line 1	400	67.04	1741	157.5
2.	Survey Line 2	330	43.09	1618	126.9
3.	Survey Line 3	600	68.37	3024	157.5
4.	Survey Line 4	400	70.48	1229	126.9
5.	Survey Line 5	200	77.28	525	63.5
6.	Survey Line 6	400	79.93	2174	157.5
7.	Survey Line 7	200	72.71	1057	80.8

Figure 3: Kg Gana, Kota Marudu survey lines layout.

4.1 Survey Line 1

This survey line stretched for 400 meters and penetrated 157.5 m in the middle of the survey line and cross perpendicular with survey Line 2 (Figure 4). The resistivity range detected on this pseudosection is 6.06-2102 Ω.m. Only small area with low resistivity 6.06 Ω.m detected and this can be interpreted as clay materials. Medium resistivity 10.87-112 Ω.m dominate under the survey line 1. This value can be interpreted as a saturated zone and the aquifer can be classed as unconfined. Only small portion of high resistivity 202-2102 Ω.m on the 335-370 meters along the survey line at 50 meters depth.

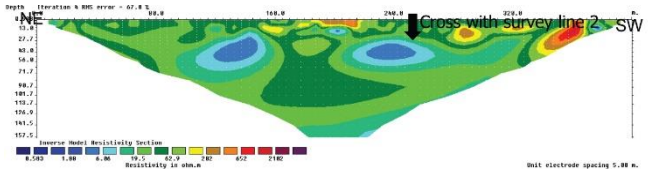

Figure 4: Survey line 1 pseudosection

4.2 Survey Line 2

This survey line stretched 330 meters and penetrated up to 126.9 meters depth and cross perpendicular with survey Line 1 (Figure 5). The resistivity values ranged between 0.602-23010 Ω.m. Only limited area with low resistivity, 0.602-5.77 Ω.m can have detected in this pseudosection and the most easily identify is at 120-140 meters along the survey line. Medium resistivity ranges 12.27-117 Ω.m and is from the surface in the middle of pseudosection that can be detected until 126.9 meters depth dominated this pseudosection. High resistivity 250-48890.38 Ω.m is located on the 305-325 meters along the survey line.

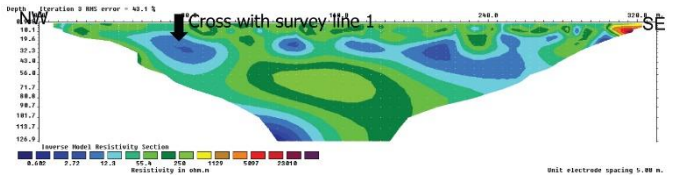

Figure 5: Survey line 2 pseudosection

4.3 Survey Line 3

This survey line stretched 600 meters with a maximum penetration of 157.5 meters. This survey line used roll-down techniques to provide horizontal continuous pseudosection (Figure 6). The resistivity values detected on this survey line range 2.58-1156.93 Ω.m. Only small portion of low resistivity 2.58-6.59 Ω.m was detected. Medium resistivity of 10.55-110.45 Ω.m dominate this survey line from the surface until 157.5 meters depth. On the right and left of this pseudosection show high resistivity of 176.69-1156.93 Ω.m that interpreted as a dry top soil and highly weathered sandstone.

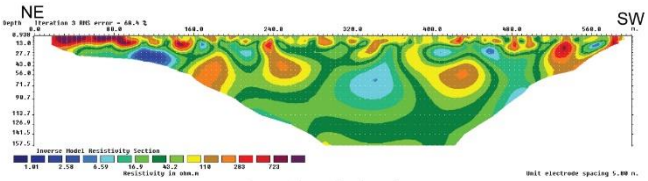

Figure 6: Survey line 3 pseudosection

4.4 Survey Line 4

This survey line stretched 400 meters with the depth of penetration up to 141.5 meters. This survey line crossed perpendicular survey line 5 (Figure 7). Resistivity values detected in this survey line ranged 2.34-1739.85 Ω.m. Low resistivity of 2.34-6.48 Ω.m can be detected at 30-40 meters, 95-135 meters and 235-270 meters along the survey line. Medium resistivity values ranged 10.77-82.34 Ω.m and dominate this pseudosection from 13 meters until 141.5 meters depth. High resistivity 136.91-1739.85 Ω.m can be observed from the surface until 13 meters depth interpreted as dry top soil.

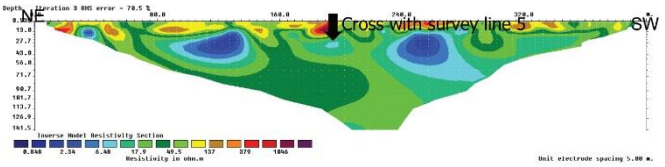

Figure 7: Survey line 4 pseudosection

4.5 Survey Line 5

This survey line stretched 200 meters and penetrated until 63.5 meters. This survey line crossed perpendicular with survey line 4 (Figure 8). Data coverage for this survey line is quite poor with only 525 datum points (Table 1). However, the reliability for this data can be used to interpret data from surface up to 20 meters depth with resistivity value ranged 213-711 Ω.m. The approximate thickness of 13 meters in this pseudosection with high resistivity values interpreted as dry zone. Only very small area of low resistivity 0.51-5.73 Ω.m for this survey line was detected. Medium resistivity 10.46-63.79 Ω.m also detected but not promising as a water saturated zone.

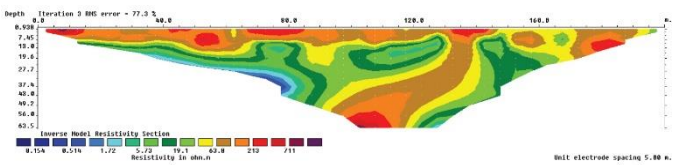

Figure 8: Survey line 5 pseudosection

4.6 Survey Line 6

This survey stretched 400 meters and penetrate 157.5 meters depth. This

survey line is a cross perpendicular survey Line 7 (Figure 9). Range of resistivity values detected in this survey line are 0.86-6091 Ω.m. Low resistivity values of 0.86-5.73 Ω.m at the interval of 230-295 meters along survey line at 56-100 meters depth. Medium resistivity of 10.8-72.23 Ω.m appear to be covered half of this pseudosection. High resistivity values of 136.1-6091.92 Ω.m can have detected on 200-400 meters along the survey line at 90.7-157.5 meters depth.

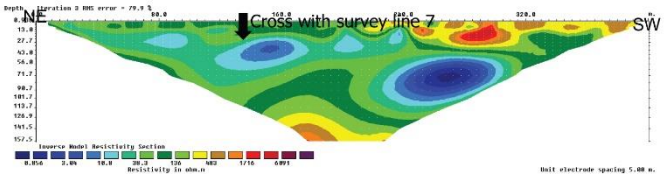

Figure 9: Survey line 6 pseudosection

4.7 Survey Line 7

This survey line stretched 200 meters and penetrated up to 80.8 meters depth. This survey line was a cross perpendicular Line 6 (Figure 10). Resistivity values range 0.37-1637.67 Ω.m can be detected on this survey line. Low resistivity 0.37-6.09 Ω.m appeared to be a small area detected in the middle of this survey line. Medium resistivity values of 10.66-99.87 Ω.m can be seen covered by higher resistivity values of 174.74-1637.67 Ω.m with approximate thickness of 13 meters.

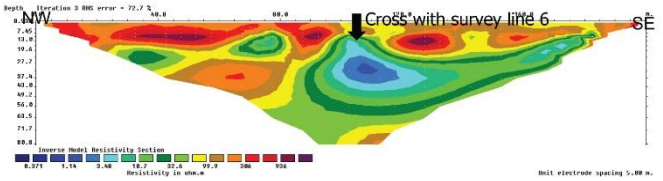

Figure 10: Survey line 7 pseudosection

5. DISCUSSION AND CONCLUSION

The summary for the survey lines is arranged in Table 2. From this study, it is interpreted that the dry top soil overlying the saturated layer is approximately 13 meters depth. There is also a permanent tubewell with 48.77 depth was constructed at SK Gana. This tubewell reveals that the water table is at 8.3 meters depth. The yield for this tubewell is 784.06 gph. The potential reservoir in the study area is expected in the fractured sequence of the Crocker Formation. Type of aquifer in the study area can be classified as unconfined aquifer. The water table of the area is expected to be at the interface between Quaternary deposit and the Crocker Formation.

Table 2: Summary of the resistivity survey lines

No	Survey line	Resistivity range (Ω.m)	Low resistivity (Ω.m)	Medium resistivity (Ω.m)	High resistivity (Ω.m)
1.	Survey Line 1	6.06-2102	6.06	10.87-112.82	202.5-2102
2.	Survey Line 2	0.602-23010	0.602-5.77	12.27-117	250-48890.38
3.	Survey Line 3	1.01-1156.93	2.58-6.59	10.55-110.45	176.69-1156.93
4.	Survey Line 4	2.34-1739.85	2.34-6.48	10.77-82.34	136.91-1739.85
5.	Survey Line 5	0.15-1298.6	0.15-5.73	10.46-63.79	213-711
6.	Survey Line 6	0.86-6091	0.86-5.73	10.8-72.23	136.1-6091.92
7.	Survey Line 7	0.37-1637.67	0.37-6.09	10.66-99.87	174.74-1637.67

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