2D Resistivity Method to Determine the Groundwater Zone for Agricultural use in Perlis, Malaysia

Oleh:

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ABSTRACT

The efficiency of the use of water in Malaysia is very low (40 to 50 percent) and in order to take the advantage from during floody the irrigation system designed as open system. In this study, groundwater is suggested to supplement as an alternative source of water for irrigation. In Malaysia only less than 2% of the present water used is developed from groundwater. In order to determine the existence of usable groundwater, 2D resistivity imaging is used. This method is the most commonly method that been used for groundwater exploration. The groundwater found is used for irrigation purposes. The arrays used in this study are Wenner Schlumberger and Pole dipole. The results of the study showed that there is an aquifer. The water filled cavity occurred in an isolated manner at an approximate depth of 7.7 m. It was further observed that the cavity did not allow the harnessing of this resource to the fullest capacity. At a depth of 5 m there is bedrock and from a depth of 27 to 30 m there is a fractured zone. This is indicating that fractured zone in this area has occurrence of groundwater. Groundwater is already detectable at a depth of 15 to 18 meters.
Keywords: 2D resistivity, Wenner Schlumberger, and Pole Dipole.

Introduction

Water is one of the most basic needs and vital source of life for all living beings, especially for agricultural use. The increasing number of population of Peninsular Malaysia and the reducing of clean water caused the groundwater exploration is more necessary. Groundwater in Malaysia is an important resource that is yet to be exploited on a bigger scale to meet the increasing demand for various uses.

In order to determine the existence of usable groundwater for agricultural purposes in Perlis, 2D resistivity method with two different protocols Wenner Schlumberger and Pole Dipole array is used. The purpose of this research is to delineate a source of groundwater for agricultural use in Peninsular Malaysia especially in Perlis.

Experimental Protocols

Electrical Imaging system is now mainly carried out with a multi-electrode resistivity meter system (Fig. 1).

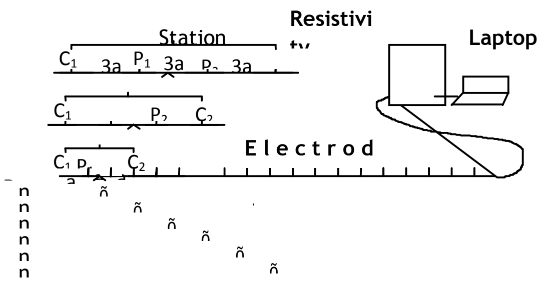

Figure 1. The arrangement of electrodes for a 2D electrical survey and the sequence of measurement used to build up a pseudosection.

Such surveys use a number (usually 25 to 100) of electrodes laid out in a straight line with a constant spacing. A computer controlled system is then used to automatically select the active electrodes for each measure. Throughout the survey conducted in the proposed site, the Wenner - Schlumberger and Pole Dipole arrays have been used with the ABEM SAS 4000 system.

The Wenner Schlumberger is a hybrid between the Wenner and Schlumberger array (Fig.2).

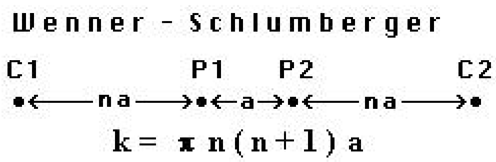

Figure 2. Wenner Schlumberger array (Loke,M.H., 1999)

This array is a good compromise between the Wenner and dipole dipole array. Its depth of investigation is about 10 times greater than that of Wenner array for the same current electrodes separation. Each deeper data level has two data points less than the previous data level unlike the loss of three data points with each deeper level in Wenner array. Thus its horizontal coverage is slightly better than the Wenner.

The pole-dipole array (Fig.3) also has relatively good horizontal coverage, but it has a significantly higher signal strength compared with the dipole-dipole array.

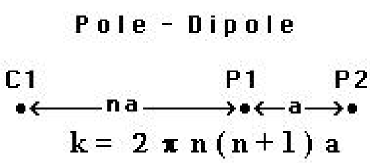

Figure 3. Pole Dipole array (Loke,M.H., 1999)

Results And Discussion

The groundwater exploration in Perlis area uses two different protocols to determine the groundwater. This was done to compare between the results obtained from different protocols to obtain more accurate results. Protocols used in Perlis are Wenner Schlumberger and Pole dipole. Then the result obtained will be compared with the result from the borehole. Six lines are carried out in this survey area (Fig 4).

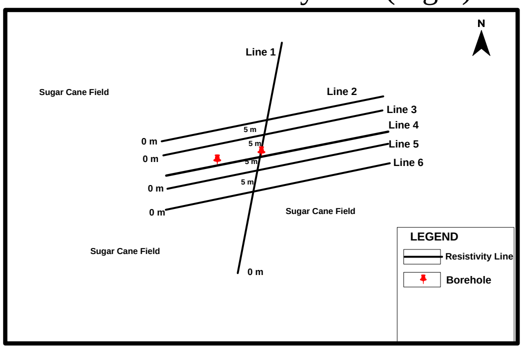

Figure 4. Resistivity Survey Lines in Perlis

Line 1 was oriented in parallel direction to the general geologic strike (i.e. south-north direction) and with 200 meters by using pole dipole protocol. The objective of this line was to determine whether or not the cavity has any structural relationship with the general geologic strike in the area thus the length of the line was 200m as this was considered enough to achieve the objective. The center of this line coincided with the delineated water-filled cavity on line 4 where borehole 1 and borehole 2 were also located. The other four lines (lines 2, line 3, line 5 and line 6) were oriented in a parallel direction to line 4 with inter-line spacing of 5 meter. These five lines are using Wenner Schlumberger protocol. All protocols have the electrode spacing 5 meters. The instrument used for the data acquisition was the Terrameter Signal Averaging System/4000

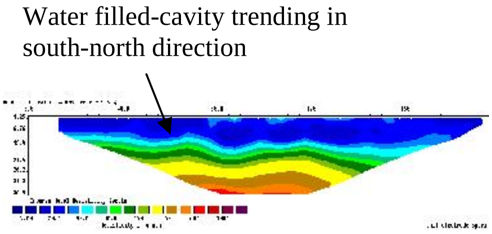

Figure 6. Resistivity section of Line 1

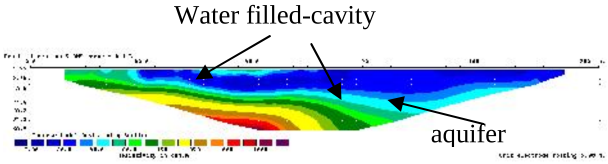

Figure 7. Resistivity section of Line 2

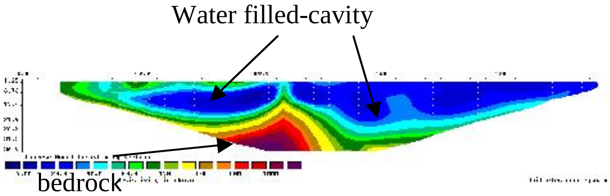

Figure 8. Resistivity section of Line 3

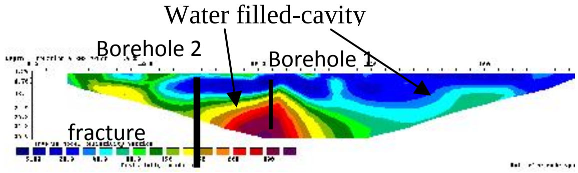

Figure 9. Resistivity section of Line 4

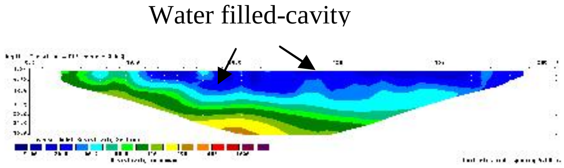

Figure 10. Resistivity section of Line 5

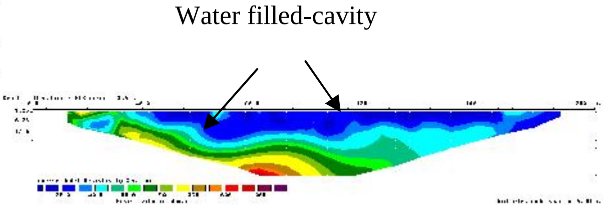

Figure 11. Resistivity section of Line 6

The two boreholes (Fig.12) were drilled on the same site is shown with vertical lines at points on their exact location on the inverse model resistivity section for line 4.

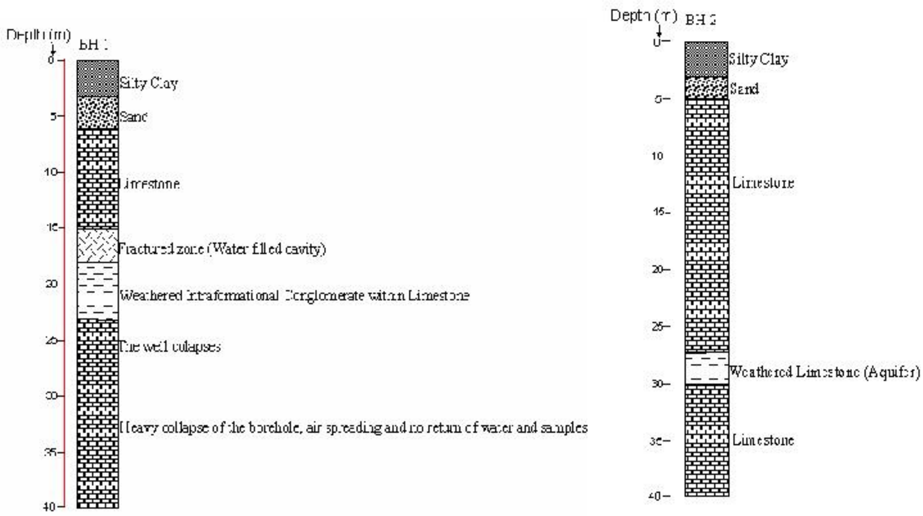

Figure 12 The lithological log of Borehole 1 and Borehole 2

From all of the images show the upper part of the section is dominated by low resistivity and that the resistivity increases with the depth. The low resistivity value can be interpreted as clay. The interpretation of these lines are based on the borehole information showing that the subsurface material in this area can be delineated into alluvium, gravel, sand and limestone hardrock formation. at the depth 2 m of subsurface the borehole shows that the subsurface consist of silt and clay at 3 m to 9 m of the depth the borehole show the subsurface consist of sand, and at the depth of 9 m to 70 m the borehole show that the subsurface consist of various limestone.

Inverse model resistivity section shows the spatial distribution of resistivity below the surface in horizontal and vertical direction and this allows the characterization of the subsurface to the various formations.

The water filled cavity identified on the inverse model resistivity section values of the relatively low resistivity that vary between 5 to 40 ohm-m. It can be concluded that this feature occurs in isolated manner. A near surface high resistive suspected to be boulders was identified at two points between 80 m and 160 m on line 1 at an approximate depth of 6 meters.

Borehole 1 is located at a distance of 100 m in line 4, at a depth of 6 m there is bedrock and from a depth of 15-18 m there is a cavity. Causing this cavity groundwater in this area can not be drawn because the groundwater is confined by the cavity and its absorbed down, therefore the groundwater can not be pulled upwards. Groundwater is detectable at a depth of 15-18 m. However, Because of the cavity the well collapse at a depth of 23 meters. Pumping Test done on the drill hole and the results show that the rate of discharge of drilling holes about 8000 gallons / hour (i.e 36,320 liters / hour). Attempt was made to drill further wells drilled to face the bedrock to ensure the firmness of the drill hole, but this led to the collapse of the borehole which resulted in heavy loss of water and because of the risk of losing life and property, drill hole was stopped and abandoned.

The second borehole was drilled in other locations and it is located at a distance of 50 m. At a depth of 5 meters there is bedrock, at a depth of 27-30 meters there is fractured zone. This is indicating that fractured zone in this area has occurrence of groundwater. In hard rock areas, groundwater is found in the cracks and fractures of the local rock. Groundwater yield depends on the size of fractures and their interconnectivity. Groundwater already detectable at a depth 15 m.

Summaries

The presence of cavity can not only post a danger to the development of borehole in any karst environment, but it can also lead to loss of significant quantity of water that ought to have been harnessed for useful purposes. Detecting the presence and shape of cavity in this geologic terrain has always been a challenge that often results in the application of different types of geophysical techniques. In this study, the efficacy of the 2D resistivity imaging to detect the location, the extent, and the geometry of cavity in the study area had been demonstrated. The study established that the cavity in the study area has an elongated structure and structurally controlled, furthermore, it was observed that althogh the aquifer in the area hosts significant quantity of water but the presence of the cavity did not allow the harnessing of this resource to the fullest capacity.

Acknowledment

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