Journal of Applied Geophysics 138 (2017) 23–32

Contents lists available at ScienceDirect

Journal of Applied Geophysics

journal homepage: www.elsevier.com/locate/jappgeo

Integrated geological and multi-electrode resistivity surveys for groundwater investigation in Kampung Rahmat village and its vicinity, Jeli district, Kelantan, Malaysia

Dony Adriansyah Nazaruddin *, Zafirah Sakinah Amiruzan, Hamzah Hussin, Mohamad Taufiq Mohd Jafar

Geoscience Programme, Faculty of Earth Science, Universiti Malaysia Kelantan (UMK), Jeli Campus, Locked Bag No. 100, 17600 Jeli, Kelantan, Malaysia

ARTICLE INFO

Article history:
Received 23 January 2016
Received in revised form 15 July 2016
Accepted 10 January 2017
Available online 12 January 2017

Keywords:
Geological survey
Multi-electrode resistivity method
Aquifer
Groundwater exploration
Jeli district
Kelantan

ABSTRACT

The integration of geological and multi-electrode resistivity surveys has been carried out in Kampung Rahmat village and its vicinity, in Jeli district, Kelantan, Malaysia as part of the groundwater resources exploration for rural water supply. A geological survey in the study area has shown that the area consists of some topographic units: mountainous area, hilly area, and low-lying to undulating area. The study area is lithologically composed of granitic rocks (megacrystic biotite granite porphyry) overlain by Quaternary alluvial deposits (with weathered granite). For the multi-electrode resistivity survey, the Schlumberger array with a maximum electrode spread of 200 m was conducted by employing three resistivity survey lines, where data were collected by using the ABEM Terrameter SAS 4000 and ABEM LUND ES464 electrode selector system, and processed by using RES2DINV software. The images were presented in the form of two-dimensional (2D) resistivity profiles providing a clear view of the distribution of granitic rock basement and alluvial deposits (with the weathered granite) as well as potential groundwater zones. The results show that the study area has potential groundwater resources existing in the alluvium which become the unconfined aquifers. The combination between these two methods is reliable and successful in identifying potentially favorable zones for obtaining groundwater in the study area.

1. Introduction

Water is a unique property of the Earth and very important to every living organism. Water is found in many places in the world including oceans, rivers, lakes, polar ice, rain, and groundwater. In addition to the volumes represented by oceans and polar ice, groundwater is another most significant source. Groundwater makes up only 0.61% of the total distribution of the world water supply and is approximately 50 to 70 times more plentiful than surface water (Fetter, 1980).

In Malaysia, <10% of the present water use is developed from groundwater resources. The use of groundwater for domestic purposes is mainly confined to rural and remote areas, where there is no piped water supply. The exception is only in the state of Kelantan where groundwater supplies >70% of the public water supply of the state (Abdullah, 2010). Since the state of Kelantan is still facing some water problems, such as low quality of surface water resources, the groundwater demand increases significantly. Rural areas in Kelantan, such as Kampung Rahmat village and its vicinity which become the present study area, also need groundwater for their daily uses by obtaining it from shallow dug wells.

Many research works on groundwater investigation using a multi-electrode resistivity survey have been carried out so far all over the world until the last decade, such as Owen and Gwavava (2005), Ewusi et al. (2009), Muchingami et al. (2012), and Redhaounia et al. (2016). This study aims to determine the potential groundwater zones by using a combination of geological survey and multi-electrode resistivity survey in the study area. This study is important as the demand for the clean water supply is increasing due to the population growth of the area.

2. Study area

The study area is Kampung Rahmat village and surrounding villages located in Jeli district, just near the border of Jeli district and Tanah Merah district, in the state of Kelantan, Malaysia (coordinates: 5° 45′ 55″–5° 48′ 35″ N, 101° 53′ 00″–101° 55′ 50″ E). The study area is also close to the Malaysia–Thailand border (Fig. 1). This study area is a sparsely populated rural region with underdeveloped infrastructures

* Corresponding author.
E-mail address: dony_geology@yahoo.com.my (D.A. Nazaruddin).

http://dx.doi.org/10.1016/j.jappgeo.2017.01.012
0926-9851/

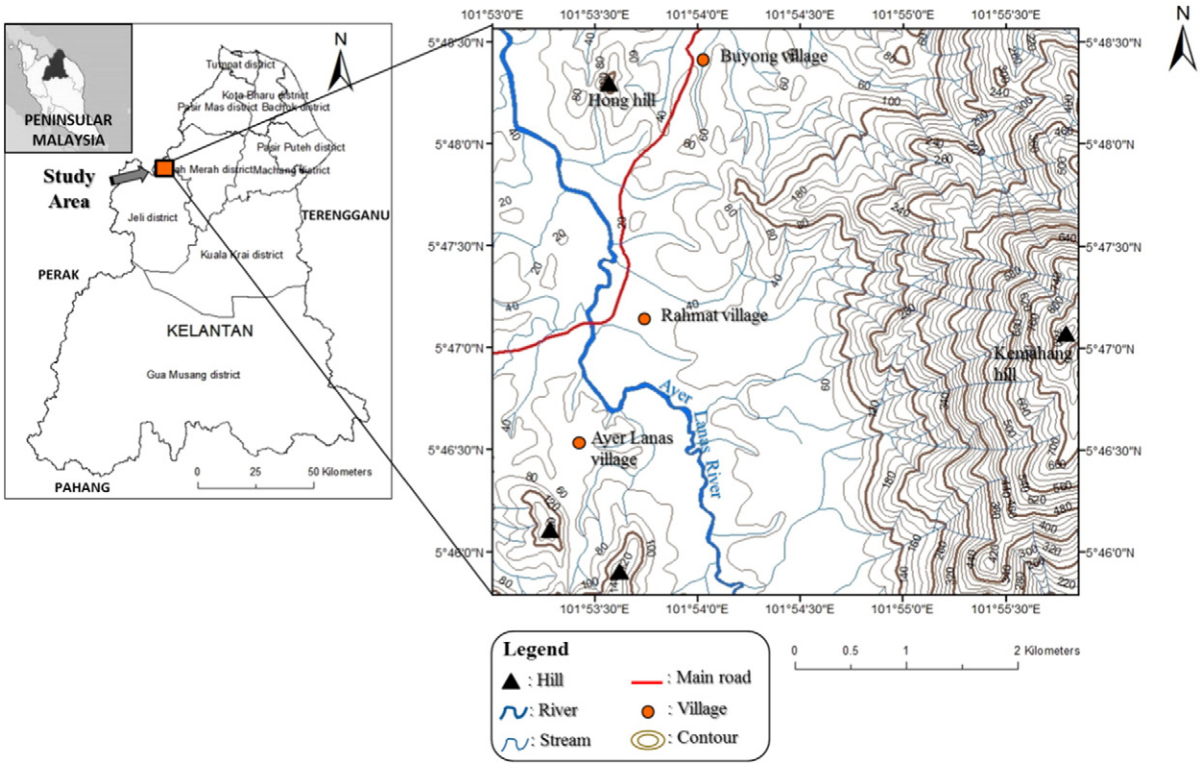

Fig. 1. Location map and base map of the study area.

and services and has been identified as a clean water shortage area especially during periods of drought.

3. Materials and methods

Geological and geophysical surveys were conducted in the study area to identify the groundwater potentials of the area. The geological survey was aimed at identifying and mapping the geomorphological and geological features, mainly landform units and lithologic units exposed in the study area. For geophysical investigation, the electrical resistivity survey is an effective method for groundwater investigation. This method is a geophysical approach based on conductivity/resistivity contrast which is used to determine the conductivity/resistivity distribution of the Earth materials in the subsurface, so that this method is very suitable for identifying lithological units and variations within lithological units as well as for groundwater and aquifer studies (Owen and Gwavava, 2005; Bowling et al., 2007; Redhaounia et al., 2016). In addition, this geophysical method is also a popular method due to its low cost, simple operation, and efficiency in areas with high contrasting resistivity (Muchingami et al., 2012). The multi-electrode resistivity survey (2-D geoelectrical imaging survey) was carried out by using an ABEM SAS4000 resistivity meter and ABEM LUND ES464 electrode selector system. This system is connected to 41 stainless steel electrodes, which were laid out on a straight line with a constant spacing via a multi-core cable (Fig. 2). The resistivity meter selects only four active electrodes used for each measurement. The Schlumberger configuration was used in this research (Fig. 3). The resistivity survey was conducted with an electrode spacing of 5 m which gives a spread length of about 200 m with the deepest penetration of about 40 m. Three survey lines were selected for this study, which were named as Line 1, Line 2, and Line 3, by considering the morphology

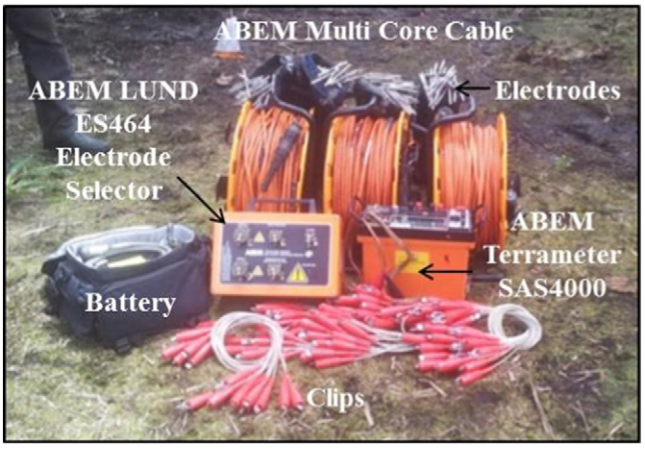

Fig. 2. The ABEM Terrameter SAS4000 resistivity meter and ABEM LUND ES464 electrode selector system.

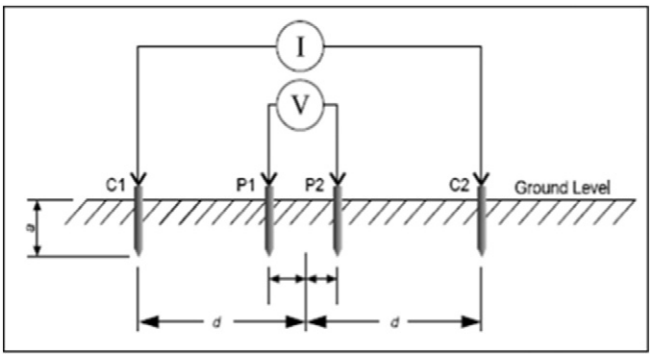

Fig. 3. Schlumberger configuration used in this study.