Journal of Physical Science, Vol. 30(1), 17–23, 2019

Shell Mound Investigation at Guar Kepah (Penang, Malaysia) Using 2-D Resistivity Imaging for Archaeological Study

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Published online: 25 April 2019

To cite this article: Rahman, N., Ismail, N. A. & Saidin, M. (2019). Shell mound investigation at Guar Kepah (Penang, Malaysia) using 2-D resistivity imaging for archaeological study. *J. Phys. Sci.*, 30(1), 17–23, https://doi.org/10.21315/jps2019.30.1.2

To link to this article: https://doi.org/10.21315/jps2019.30.1.2

ABSTRACT: *Recent finding of "Penang Woman" skeleton in Guar Kepah, Penang, Malaysia has triggered researchers to discover more archaeological remains inside the area. Some part has been excavated, exposing some shell mound where the skeleton was found. It is believed that the shell mound remarks the burial place of people in early age civilisation. More excavation processes need to be conducted in the area to see if any more skeleton, monument and pottery could be found. 2-D resistivity method was carried out in the study area to determine resistivity value of shell mound and locate another possible shell mound. Pole-dipole array was used along four survey lines where one of the survey lines is conducted on the existing shell mound while the rest are on undisturbed ground in the study area. The data were processed by using Res2Dinv software. The results show that the resistivity value of the exposed shell mound is within the range of 100 Ωm to 200 Ωm. This value was used as the reference in predicting possible shell mound on the other survey lines. Some part of the other survey lines shows the same resistivity value as the existing mound. Therefore, it can be predicted as shell mound.*

Keywords: Archaeology, resistivity, shell mound, prediction, Guar Kepah

1. INTRODUCTION

Recent excavation at Guar Kepah, Penang (Malaysia) has shocked the country and world at large with the finding of a 5710 years old buried skeleton known as "Penang Woman." The skeleton was found under a shell midden, together with different types of shells and pottery. Based on these findings, further studies and research are needed to see if there are more archaeological remains in the study area. Various methods can be used in identifying archaeological remains. One of the methods is geophysical resistivity survey which was adopted in this research paper. This method has been chosen because it is non-invasive, cost efficient and very effective according to Lynott.[1] Besides, this technique provides more data qualitatively and quantitatively compared with traditional site discovery techniques as referred to Kern.[2] This method can also provide a clear view of anomalies under the surface which possibly indicates presence of archaeological remains. The main interests of this study are to determine the resistivity value of excavated shell mound and to find another possible buried shell mound within the study area. The data from this survey will be very useful and help to speed up the excavation process in the area. This is because the resistivity method is able to detect the position of anomalies in the subsurface. Instead of carried out randomly, the excavation process can be concentrated only to where anomalies are located.

2. EXPERIMENTAL

2.1 Study Area

Guar Kepah is an integral part of Seberang Perai district of Penang, Malaysia. The site covers an area of about 150 m^2 (Figure 1), located at 8 km from coast line and 0.5 km from Muda River which is the border between Penang and Kedah. Guar Kepah is situated on a stranded beach ridges, deposited around mid-Holocene sea transgression, which is about 4000–5000 years ago as explained by Tjia.[3] Most of Seberang Perai area is underlain by pre-Quaternary granite and sedimentary rocks of Sungai Petani and Mahang Formations referring to Courtier.[4] The coastal areas are underlain by Simpang Formation, Gula Formation and Beruas Formation of Quaternary age according to Hassan.[5] The Simpang Formation is composed of gravel, sand, clay, silt and peat by terrestrial fluvial deposit. The Gula Formation is composed of silt, clay, sand, gravel, peat and often shell fragment deposited within an estuarine and shallow marine environment. The Beruas Formation consists of clay, silt, sand, gravel and occasional peat. Figure 2 shows the geological map of Guar Kepah.

Figure 1: 2-D resistivity survey lines in Guar Kepah.[8]

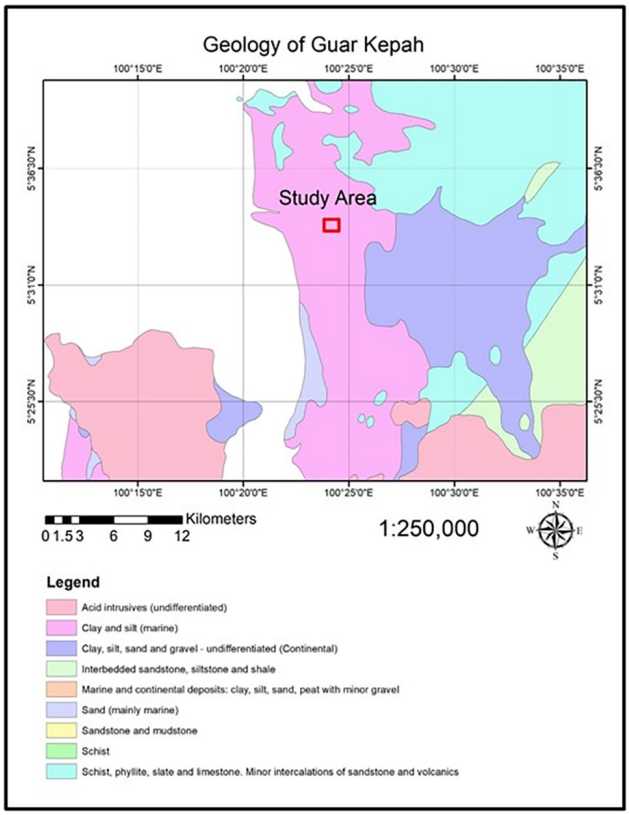

Figure 2: Geology map of Guar Kepah.

2.2 Methodology

Figure 3 indicates electrode arrangement for 2-D resistivity data acquisition for the simplest array arrangement, since we are only trying to induce the basic resistivity theory. 2-D resistivity method was implemented in this survey using pole-dipole array. Close line spacing of 1 m to 2 m was chosen specifically for archaeological study to obtain a more precise estimation of the subsurface according to Saad et al.[6] This study was conducted using ABEM SAS4000 instrument together with electrode selector along four profile lines with 0.5 m electrode spacing. The acquired data was processed using Res2Dinv and Surfer8 software.

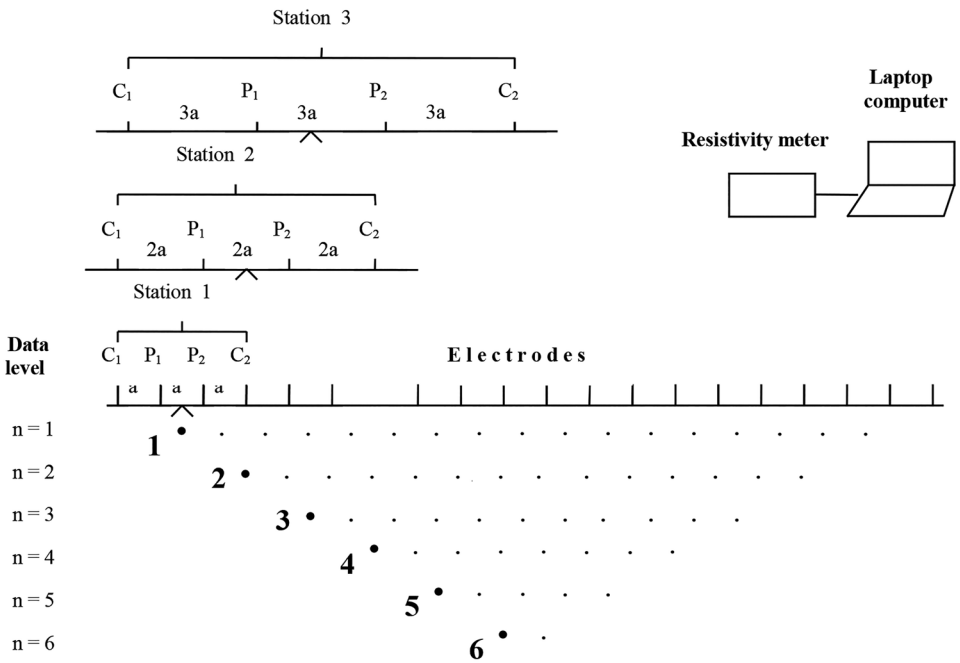

Figure 3: The arrangement of electrodes for a 2-D resistivity survey and the sequence of measurement used to build up a resistivity section according to Loke.[7]

3. RESULTS AND DISCUSSION

Figure 4 shows 2-D resistivity results of profiles L1 to L4 in Guar Kepah study area. Some of the area has been excavated since the discovery of the Penang Woman skeleton, exposing some shell mounds. Surrounding area is made up of clayey soil. Figure 5 shows that the shell mound is covered by shells in clayey soil layer. The inside of the mound is made up of sand. Profile L1 resistivity line was conducted

across top of a shell mound at distance of 4 m to 7 m as indicated by a black box in Figure 4, while the other profiles L2 to L4 were conducted on an undisturbed ground. The purpose of profile L1 being conducted specifically on the mound is to determine the resistivity value of the shell mound. This value can be used as a reference to locate other possible shell mounds at nearby area which has not been excavated yet. From the study, the resistivity value of the shell mound obtained is about 100 Ωm to 200 Ωm. For profile L2, it can be seen clearly that there is a suspected shell layers that cover more than half of the profile line at a depth of 1 m. In profile L3, the suspected shell mound is located at depth of less than 1 m near the starting point with length of about 2 m while in profile L4, the predicted shell mound is located at the same depth with length of about 6 m. The predicted shell mounds are denoted by black box in Figure 4.

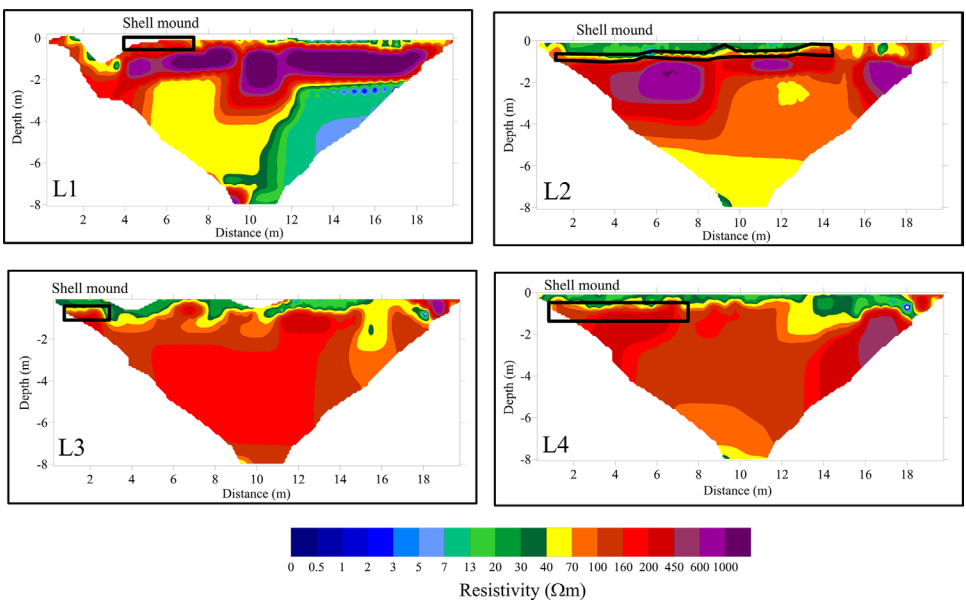

Figure 4: 2-D resistivity result of L1-L4 in Guar Kepah.

The interpretation to predict the possible shell mounds take into consideration a few aspects. Firstly, resistivity value of the existing shell mound obtained from resistivity profile L1 is 100 Ωm to 200 Ωm. Other survey lines that have resistivity value falling within the range have a high potential of containing shell mound. Secondly, the skeleton was found in a shell mound filled with fine sand. The resistivity value inside the shell mound should be higher than the shell layer that covers the mound because porosity of sand is a property that will give rise in resistivity value. Lastly, the existing shell mound was found at depth of 0 m to 1 m.

The prediction for new shell mound should be more or less same as the reference since the distance is very close and they have the same geological structure. So, the interpretation for shell mound prediction only focus on the top part of the resistivity profiles.

Figure 5: Exposed shell mound.

4. CONCLUSION

The 2-D resistivity method carried out in this archaeological area is very effective in targeting possible shell mound, as a source of archaeological remains including human skeleton. The resistivity value of shell mound obtained from profile L1 was ranging from 100 Ωm to 200 Ωm. This value was used to predict more shell layers or mounds nearby the excavated area of Guar Kepah. Resistivity results from profiles L2–L4 showed possible existence of new shell mounds near the excavated area. This study will be a complete guide in the excavation process where the depth and distance of the target is known.

5. ACKNOWLEDGEMENTS

The authors would like to acknowledge the contributions of technical staffs of geophysical laboratory, lecturers and postgraduate students involved in this study. A sincere gratitude to the Centre of Global Archaeological Research Malaysia (CGAR), Universiti Sains Malaysia for funding this project, under the grant number 1002/PARKEO/910328.

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