Locating groundwater resources for Aboriginal communities in remote and arid parts of South Australia

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Abstract

Aboriginal communities in remote areas of South Australia require access to bore water for their non-potable supplies due to the aridity of the region. This water is often found in deep, fractured rock aquifers. Due to the anisotropic and heterogeneous nature of fractured rock aquifers, there is a significant risk of drilling costly dry bore holes in the attempt to find water. This project is a pilot study to gauge the effectiveness of magnetotellurics - a geophysical method that images the distribution of electrical conductivity in the subsurface - in mapping and characterising fractured rock aquifers in order to reduce the risk of drilling dry bore holes. This survey was carried out in the Nipapanha Community, in the Northern Flinders Ranges, South Australia. There is a need for an increase in bore water supply from the local fractured rock aquifer. Geophysical, hydrogeological and structural research has been carried out in the area, which will act as a guide for this survey, so that knowledge and techniques learned may be applied in poorly constrained areas.

Magnetotelluric data were recorded at 3000Hz and 500Hz over 40 sites around the target area in order to create a series of 5 2D profiles as well as a map of phase tensors at various frequencies. Controlled source magnetotelluric data from a previous survey carried out by Zonge Engineering were obtained and reprocessed and inverted to create a series of 6 inversions in order to increase coverage of the survey. Interpretation of the inversions and phase tensors in conjunction with hydrogeological information was able to identify areas of anomalous apparent conductivity, possibly corresponding to increased water content. Predominant directions of conductivity, corresponding to fracture orientation throughout the area were also identified.

Introduction

Many Aboriginal communities in remote and arid parts of South Australia currently rely on groundwater resources located in deep aquifers (>50m to the water table) in fractured rock for non-potable water supplies. Rainfall in these areas is highly variable, ranging from periods of drought to occasional very high rainfall events. The quality and quantity of water available from fractured frock aquifers is variable on a small scale, with unsuccessful bores drilled within metres of productive bores.

Due to the remoteness of these communities, drilling dry boreholes can be a very costly exercise and it is hoped that the use of magnetotellurics (MT) will be able to reduce this risk. This was achieved by using magnetotelluric data in a grid over prospective aquifers to image two dimensional slices and phase tensor profiles through the geology to better understand the dimensionality of electrical conductivity in the sub-surface. By then applying Archie's Law, which describes the relationship between conductivity, pore space and water salinity, we can better define the flow and distribution of water in the subsurface.

Fractures within the aquifers can be difficult to detect for a combination of reasons: