J. Ind. Geophys. Union, 26(1) (2022), 1-8

2D-Electrical resistivity tomography for groundwater exploration in Archean hard rock terrain in villages of Ottapidaram Taluk, Thoothukudi District,Tamil Nadu, (India)

T. Jeyavel Raja Kumar*[1], P. Saravanan[1], C. Dushiyanthan[1], B.Thirunelakandan[2] and M. Senthilkumar[3]

[1]Department of Earth Sciences, Annamalai University, Annamalai Nagar – 608002, India
[2]Department of Geology, Jawahar Science College, Neyveli – 607802, India
[3]Department Geology, Presidency College, Chennai-600005, India
*Corresponding Author: tjeyavel@rediffmail.com; jeyavelgeo@gmail.com

ABSTRACT

Assessment of groundwater potential was done using Electrical Resistivity Tomography (ERT) in a part of hard rock terrain in Ottapidaram Taluk, Thoothukudi District of Tamil Nadu. The study area is located between 8º50´ to 9º00´ N and 78º05´to78º15´E. Geologically, the region comprises Archean gneiss, charnockite and quartzite intrusions. The ERT was carried out at four locations, Sinthalakatttai, Sillanatham, Mupplipatti and Saverimangalam. SYSCOL JUNIOR Switch-48 model resistivity meter is used and Wenner-Schlumberger configuration was adopted. Length of the profile is144 m and 48 electrodes were planted in straight line at an interspacing of 3 m. The measured resistivity data was interpreted using RES2DINV software and maximum depth interpreted was 26 m bgl. The interpreted resistivity model represented 4 layered subsurface geoelectrical structures. The overall resistivity varied from < 5 Ohm m to > 350 Ohm m. Low resistivity range was noted in Saverimangalam and high resistivity range in Sillanatham. The low resistivity observed is due to highly weathered or jointed rocks with water saturation, while the high resistivity may be related to poorly weathered rock with lack of water saturation. From the resistivity models, it is inferred that the study locations have fractured layer zones at shallow depth level up to 15m bgl at Sinthalakattai, Sillanatham and Mupplipatti locations, indicating favourable zones for groundwater occurrences. The existing bore well lithology matches with the interpreted resistivity model, indicating reliability of the ERT study for groundwater exploration.

Keywords: Groundwater, 2D Electrical Resistivity, Electrical Resistivity Tomography, Geoelectrical model, Groundwater Exploration

INTRODUCTION

Groundwater is the main resource of water supply for industrial, agricultural and domestic use in many semi-arid regions. In recent decades, requirement and dependency on groundwater is increased due to population, natural calamities, monsoon failure and development of low cost drilling techniques. The increasing dependency on groundwater has led to decline groundwater level and thus developing stress on aquifer due to over exploitation which has directly caused declining groundwater levels and consequently limited groundwater flow into deeper weathered/fractured zones (Rai et al., 2011; Kumar et al., 2011; Maiti et al., 2012). For a country like India, water scarcity will be hitting hard for sustainable development as it is still largely dependent upon rain fed agriculture and availability of fresh water is one of the foremost concern for the future (Mohanti, 2009). Thus, in the rural areas, most of the interventions have based on groundwater resources, accessed mainly through boreholes and hand dug wells. Success rates for drilling prolific wells have been variable, depending on the underlying geology. This situation is generally owed to the historical geology of the terrain and lack of adequate understanding of the hydrogeology. The hydrogeological characteristic of geology is influenced by the fractures and fault zones (Medeiros and Lima, 1990; Wyns et al., 1999; Taylor and Howard, 2000; Suski et al., 2008). Assessment of fractured rock aquifers in many parts of the world is complicated given their strong heterogeneity.

To study the subsurface geological formation and delineate groundwater potential, geophysical methods play a vital role. It is helpful to find out the hidden subsurface hydrogeological physiognomies adequately and accurately without drilling. Of all surface geophysical techniques, the electrical resistivity imaging (ERI) method has been applied most widely to obtain subsurface information due to the wide range of resistivity for different geological materials (Keller and Frischknecht, 1966; Bhattacharya and Patra, 1968; Koefoed 1979). Particularly, the imaging tomography method has been used effectively by a number of researchers for various applications including groundwater investigations (Owen et al., 2005; Sarma and Prasad, 2006; Pawar et al., 2009; Ratnakumari et al., 2012; Mondal et al., 2013; Rai et al., 2015; Gupta et al., 2015; Arsène et al., 2018; Thiagarajan et al., 2018; Mainoo et al., 2019; Archanakumari et al., 2021), saltwater intrusion problems (Satish et al., 2011; Hermans et al., 2012; Vann et al., 2020; Niculescu and Andrei, 2021) besides geothermal explorations (El-Qady et al., 2000; Kumar et al., 2011).

This technique is helpful in delineating top soil, weathered, fractured and bedrock zone for construction of suitable groundwater units, because in hard rock terrain, the weathered and fractured zone constitutes the potential location for groundwater flow. Thus, delineation of aquifers is the pre-requisite for the assessment of regional/local