J. Ind. Geophys. Union ( October 2008 )
**Vol.12, No.4, pp.157-163**

# Resistivity studies to delineate structural features near Abhishekapatti, Tirunelveli, Tamil Nadu, India

**Y.Srinivas, D.Muthuraj[1] and N.Chandrasekar**
Center for Geo-Technology, Manonmaniam Sundaranar University
Tirunelveli - 627 012
[1]Department of physics, The M.D.T.Hindu college Tirunelveli - 627 010
E.mail: drysv@yahoo.co.in

**ABSTRACT**
Geophysical survey using electrical resistivity method was carried out near Abhishekapatti, Tirunelveli district, Tamilnadu in order to delineate the possible structural features of the subsurface. A detailed survey was carried out using an indigenously made resistivity meter. Electrical resistivity profiling using Wenner configuration and vertical electrical sounding with Schlumberger configuration were carried out. The present study area is covered of thin soil underlain by crystalline massive metamorphic rocks of high resistivity. The inferred resistivity structure from Wenner and Schlumberger method yield significant insight into the resistivity distribution of the area. Vertical and lateral extension of low resistivity features, resistivity pseudo section and apparent resistivity contour map indicates the existence of a contact zone approximately in east west direction.

## INTRODUCTION

Geophysical surveys near Abisekapatti (E77° 39′ 18″ and 8° 45′ 58″ ) 10 km NW of Tirunelveli Town, Southern Tamilnadu, India (Fig 1) are carried out to understand the structure and tectonics in this region. The area lies within the WNW-ESE striking Achankovil Thamiraparani Shear Zone (ATS). The rock melt extrusion, neotectonic activities, micro seismic activities in and around this area were reported by earlier workers (Rajamanickam & Chandrasekar 2000; Manimaran, Sivasubramanian & Settiappan..2001; Drury et al., 1984; Sacks, Nambiar & Walters 1997). To understand the causes for these events and the possible link with lineaments in this region are studied by electrical resistivity method.

While geological studies can provide information on the surface manifestation of the shear zones, only geophysical investigations can provide significant depth information, especially regarding the nature and extension of geological contacts, fault zones at different depths. Resistivity method can be applied to structural investigation such as the location of geological contacts, fault planes, fractures, shear zone etc; in addition to ground water investigation (Sharma & Baranwal 2005, Singh et al, 2002), petroleum exploration and civil engineering application. Electrical resistivity method was applied to establish the contact between biotite gneiss and sandstone for groundwater studies (Sundararajan et al., 2006). In view of this, the resistivity study has been attempted here to un derstand the geological condition.

## GEOLOGY OF THE AREA

The south India shield consists of fragments of different crustal blocks joined or bounded by proterozoic mobile belt / shear system. The tectonic frame work of south India shield region (SISR) has been studied by various Geological and geophysical methods and reviewed by various workers (Drury & Holt 1980;Drury et al., 1984; Radhakrishnan & John Mothai, 2004; Chetty 1996; Ramakrishnan 2003) These studies have identified major shear zones within SISR namely Palghat Cauvery Shear zone (PCSZ) Mayar -Bhavani Shear zone (MBSZ). Mettur Shear zone(MTSZ) and Achankovil Shear zone (ASZ) .

Tirunelveli district of Tamilnadu is the southern part of the Indian Precambrian Shield comprising a wide variety of geological formations ranging from pre Cambrian to recent period. The present study area Abhishekapatti near Tirunelveli in the southern Tamilnadu falls in the ATS. Different type of Charnockitic rocks and metasedimentary gneissic formations are distributed throughout the Tirunelveli district. They can be classified into granitoid, non-garnetiferous mica, hornblende gneisses and mixed gneisses associated with migmatities. Migmatitic assemblage of garnetiferous biotite gneiss (khondalitic), garnetiferous quartzo – felspathic granulites (leptynitic) and non garnetiferous quartzo – felspathic granulites (alaskitic) in south and south west part of the district. The central part of the district is reported with predominant zone of quartzite beds and associated crystalline limestone and calc gneiss

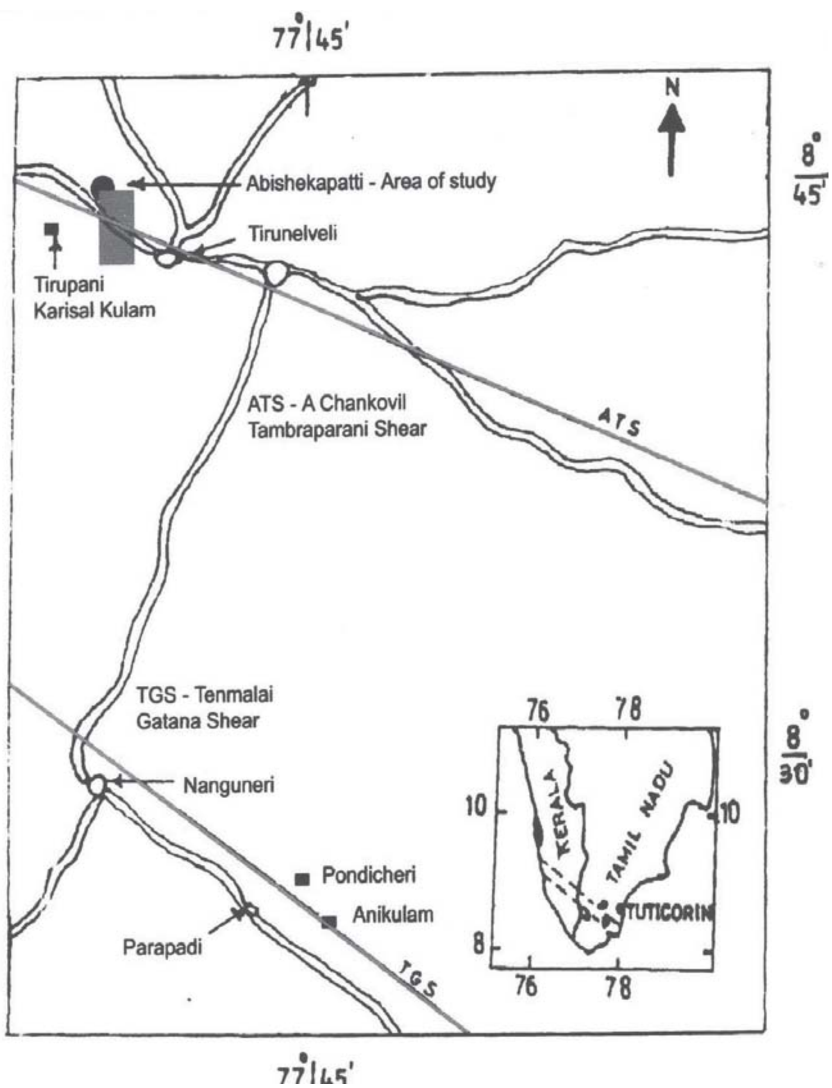


**Figure 1.** Location map of the study area (After Manimaran et al.).

with intercalated layers and bands of pyroxene granulites within the quartzite beds (Narayanaswamy & Lakshmi 1967).

The major lithostratigraphic units in the study area include garnet bearing charnockites, garnet and sillimanite rich metapelitic gneisses (khondalitic) and garnet-biotite-quartz-feldspar gneiss underlain by black cotton soil (Braun, Montel & Nicollect 1998; Shabeer et al., 2005).

## GEOPHYSICAL INVESTIGATION

Electrical resistivity methods are useful in delineating lateral and vertical variation of sub surface geology. Detailed Geophysical investigations with electrical resistivity investigation were carried out along four profiles at constant traverse spacing of 250 meter and station interval of 25 meter making a constant grid of approximately 1 sq. Km. The direction of traverse was chosen to cut the major lineament i.e., the ATS which is passing through the present study area having a length of one kilometer. An indigenously developed direct reading resistivity meter (DDR-3) of Integrated Geo Instruments & Services [P] Ltd. Hyderabad, India was used in the survey and electrical profiling was carried out with the Wenner electrode configuration with inter electrode separation of a = 25 meter. Steal electrodes were used to pass current into the ground and non-polarized porous pots with (CU –CU $SO_4$) to measure potential difference.

Preliminary studies of the profiling curve shows (Fig.2) a variation in resistivity through out the region with low and high resistivity zones. The resistivity is suddenly decreasing between the stations 15 and 20

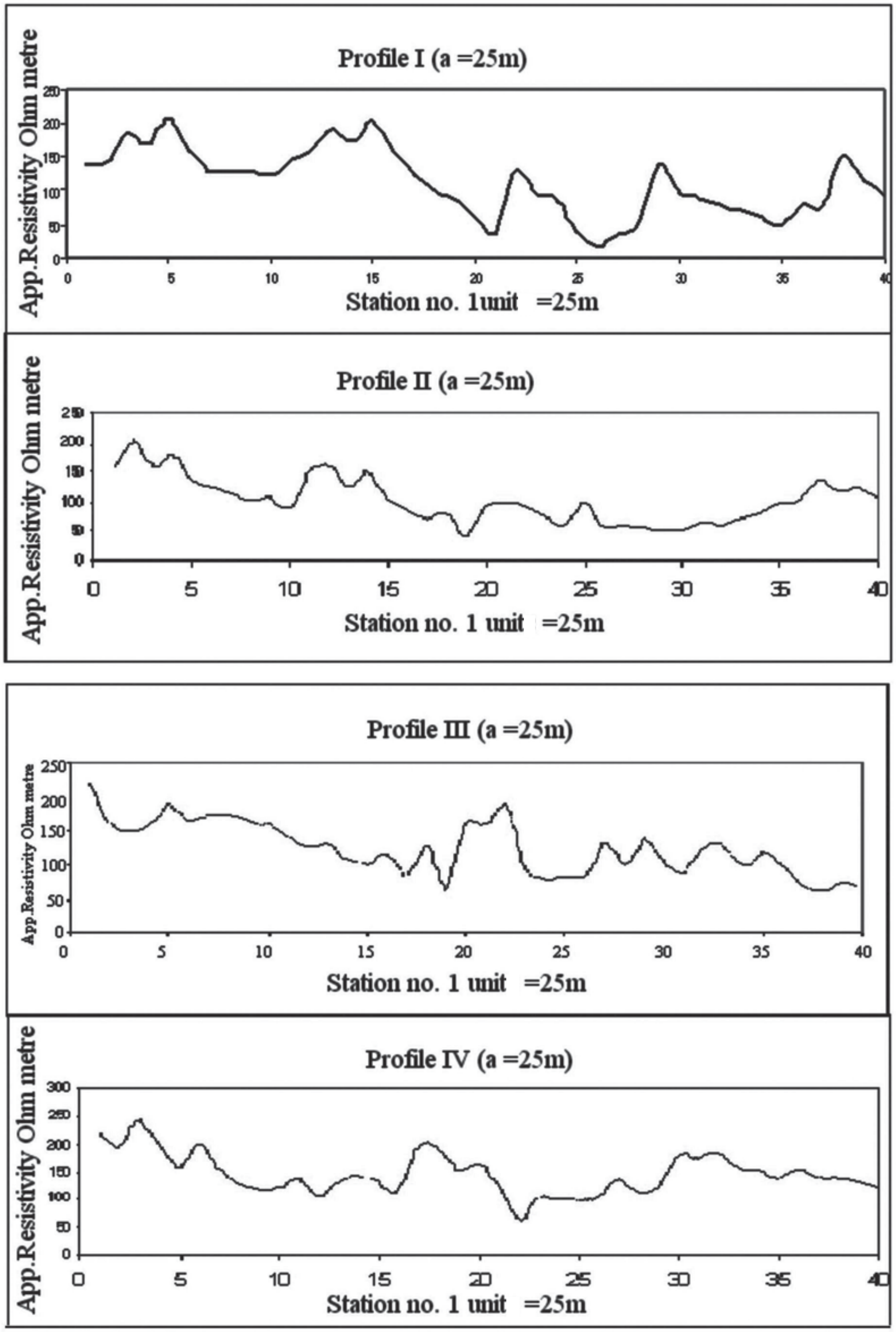


**Figure 2.** Resistivity profiles of the study area.

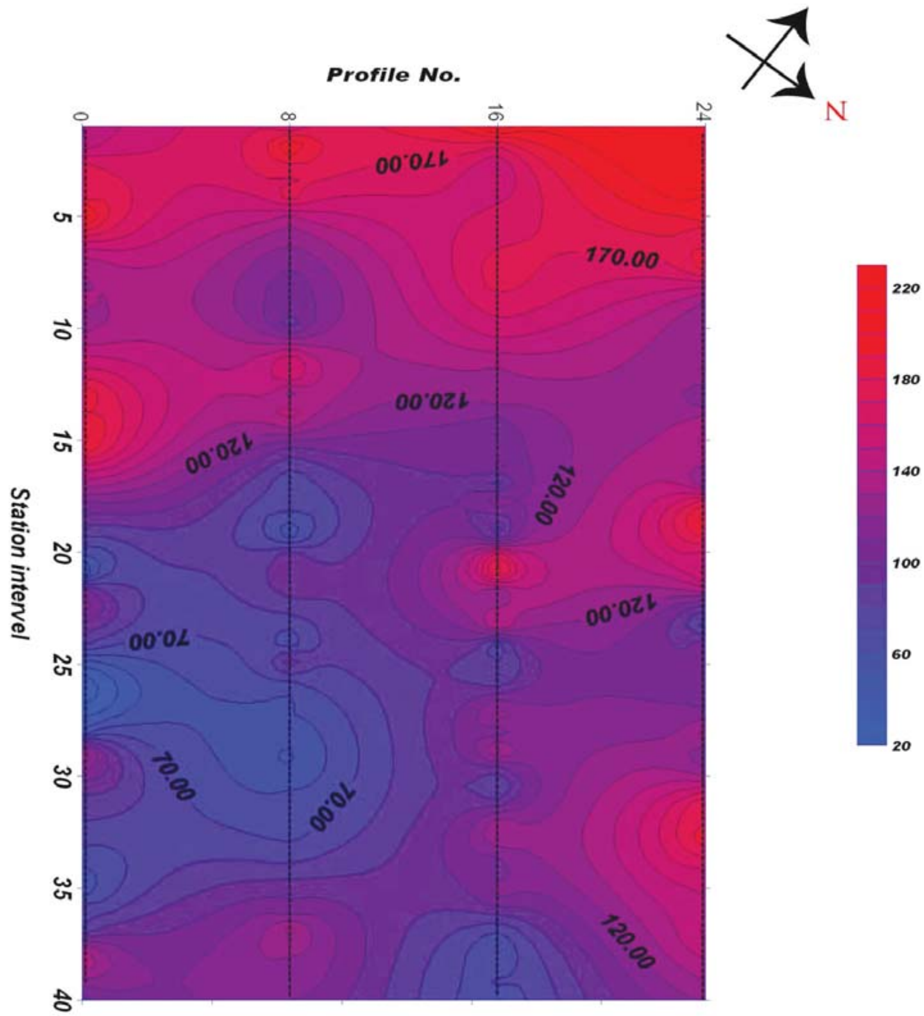


**Figure 3.** Contour map of the apparent resistivity.

in all the profiles. This may be due to the contact associated with two distinct geological formations. The surface indications also confirms the variation of geology on either side of these stations. The interpretation of resistivity profiling is generally qualitative. The results drawn from profiling studies were assessed to select the most suitable locations for vertical electrical sounding.

Schlumberger resistivity soundings were carried out at 8 locations with half current electrode spacing (AB/2) up to 100 m over the selected profiles. The four electrodes collinear Schlumberger set up was used for all sounding measurements, preliminary studies of the sounding curves show complex variation in resistivity throughout the region.

## RESULTS AND DISCUSSION

Apparent resistivity contour map (Fig.3) reflects the lateral resistivity variation roughly with in the depth of 25 m. The contact between the two formations viz., gneiss and limestone is traced based on the trend of resistivity contours, the limestone formation is exhibited a uniform resistivity from 20 to 90 ohm-m where as the gneissic rocks have the apparent resistivity from 120 to 220 ohm-m.

The VES data analysis is based on the qualitative and quantitative methods. In the qualitative methods one can inspect directly the manner in which the apparent resistivity values increases or decreareases with increase of electrode separation plotted on double log graph. One-dimensional inversion of the VES data was carried out using an interactive inversion code IPI2Win for quantitative analysis. Here IPI2Win provides the opportunity to choose a set of equivalent solution and among that have chosen the one best fitting the geophysical model with least fitting error between the observed and inverted data. The one dimensional-inverted resistivity model for representing VES data for four soundings is shown in Fig.4.

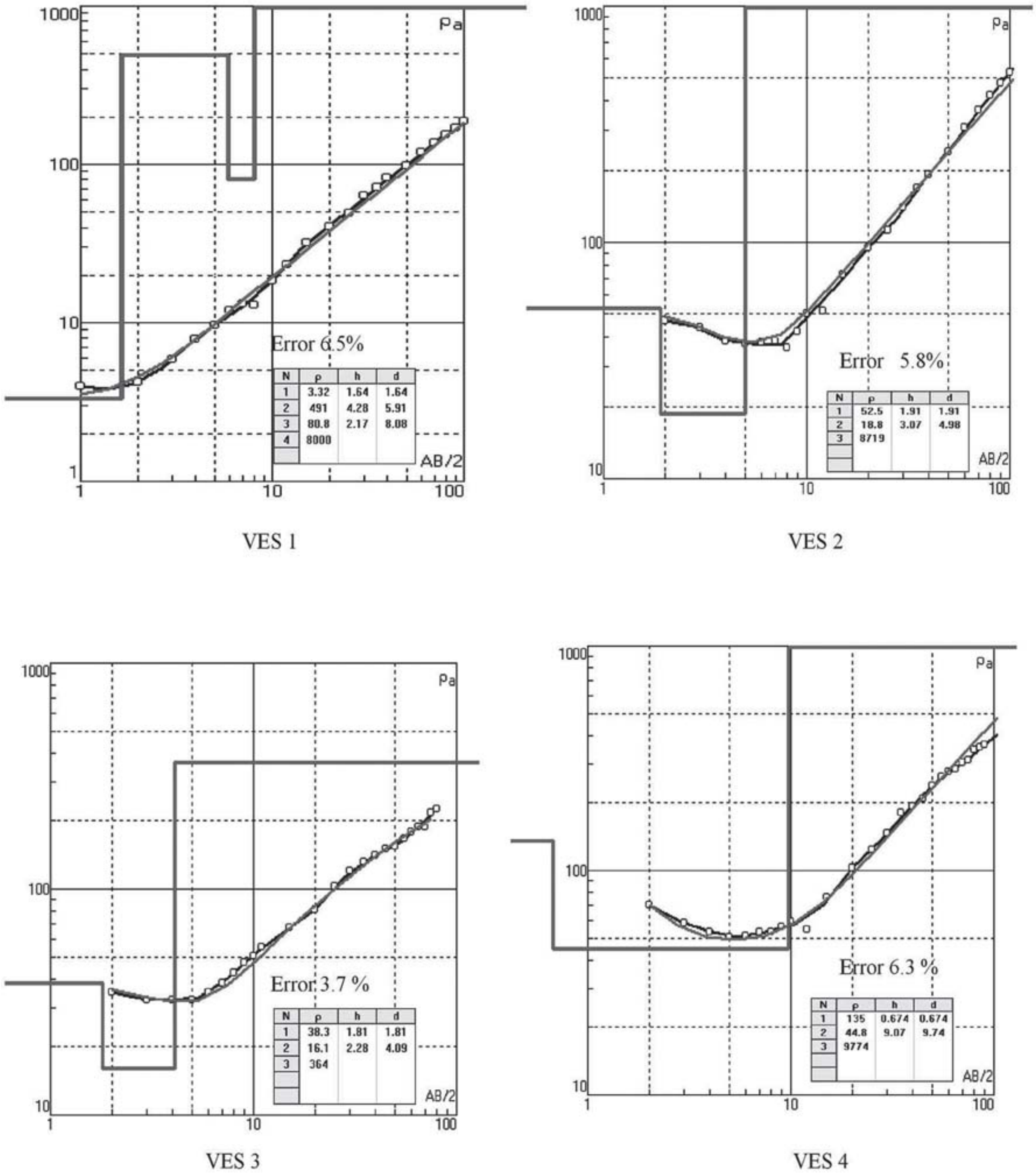


**Figure 4.** VES along the profile-I.

The interpreted resistivities and thicknesses of different layers are shown in Fig.4. Solid line represents the interpreted data and solid line with circles represents the observed data. The modeled layer parameters i.e. resistivity and thickness are also shown in the Fig.4. The fitting between the observed and inverted model is good and is less than 10% for all the soundings. VES2 and VES 3 are located in the high resistive zone. The interpretation of these sounding curves show that, the top two thin layers are under laid by high resistive metamorphic gneiss. The depth to the basement at the locations VES2 and VES3 is shallow compared to VES4 and VES1. The locations of VES2 and VES3 are covered with thin soil where as VES4 and VES1 are covered with black cotton soil followed by limestone.

The depth variations are further highlighted in the geoelecrical section (Fig.5) obtained from individual one dimensional inversion of the sounding data carried out along the profile I. The sections are shown to the maximum depth of 10 m. The prepared pseudo section shows the apparent resistivity variation with

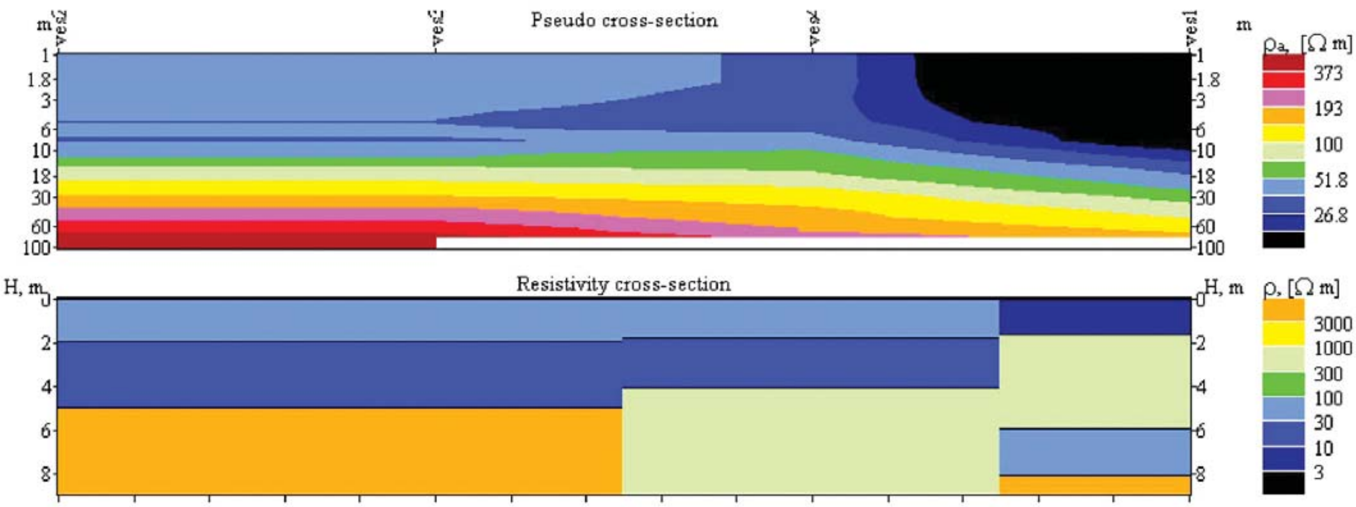


**Figure 5.** Pseudo cross-section and Resistivity cross section along the profile-I.

respect to the current electrode separation AB/2. It gives the general distribution of conductive and resistive features in broad way, providing vital information on its lateral extent, though not to the actual scale. The inverted resistivity cross section depicts high resistivity rocks below VES2 and VES3 of the section and low resistivity zone is observed below VES4 and VES1 along the profile.

## CONCLUSIONS

The resistivity variation due to gneissic formations overlain by thin soil and limestone formation overlain by black cotton soil is observed in the study area. The spatial contact between gneiss and limestone was identified based on the variation of resisitivity values. The resistivity cross section also confirms the high and low risistivity zones at depths. It is confirmed that the direction of this contact is similar to the lineament passing through this area.

## ACKNOWLEDGEMENTS

The authors wish to record their profound thanks to the two anonymous reviewers for their critical review and useful suggestions which helped to improve the quality of the paper.

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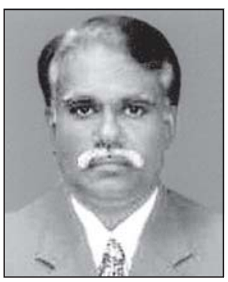
(Accepted 2008 April 20. Received 2008 March 15 1; in original form 2007 January 12)

Name : **Dr. Y. Srinivas**
Qualification : M.Sc (Tech)., Ph.D.
Designation : Reader
Working at : Center for Geo Technology, M.S.University, Tirunelveli
Research & Teaching Experience : 8 years



Name : **Dr. N. Chandrasekar**
Qualification : M.Sc Ph.D.
Designation : HOD and Dean of research
Working at : Center for Geo Technology, M.S.University, Tirunelveli
Research & Teaching Experience : 28 years

Name : **D. Muthu Raj**
Qualification : M.Sc M.Phil., PGDCA
Designation : Lecture in Physics (SG)
Working at : The M.D.T.Hindu College, Tirunelveli - 10
Research & Teaching Experience : 19 years

*Presently doing research in Geo-Physics at the center for Geo-Technology, M.S.University, Tirunelveli.*