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The Impact and Influence of Geologic Structures on Groundwater Potentiality in Crystalline Rock Terrains- A Case History from Gudimangalam Block, Udumalpet Taluk, Tiruppur District, Tamilnadu

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Abstract:- Water is one of the most basic components of human existence and socio-economic development, but its availability is usually taken for granted. Groundwater is a key natural resource in many parts of the world. Equally groundwater is important in specific climate and hydrological contexts such as arid and semi-arid areas, where it is commonly the only safe source of water. Groundwater occurrence in crystalline rock terrains is highly influenced by geological structures. These geological structures, unless mapped with precision, groundwater exploration may end up with low yielding or dry boreholes. This study aims to evaluate geologic and structural influences on groundwater. The present research is important for understanding the factors influencing the distribution, flow, and yield of groundwater. The area of investigation confines to the crystalline rock terrain of Gudimangalam block of Udumalpet taluk in Tiruppur district, Tamilnadu, which being a drought prone area. The total areal extent is about 100sqkms and aquifer mapping project for both irrigational and drinking water needs has been carried out. Systematic geological, hydrogeological investigations followed by surface geoelectric exploration by 1D VES [vertical electrical sounding] were done to delineate the fracture/ joints/lineaments of the subsurface. Totally 51 bore wells have been drilled. Iso apparent resistivity maps and bore well yield contour maps / aquifer potential mapshave been generated to study lineament pattern of the area. The Iso apparent resistivity map, electric log of a deep borewell and the aquifer yield contour maps throw light on the tectonic history revealing that this zone is tectonically disturbed with faulting, shearing and shattering of the subsurface lithology. The high potential aquifers confine to the lineament-Poolavadi-V.Vallakondapuram lineament and from these research it may be concluded that the occurrence, distribution and movement of groundwater are influenced and impacted by geological structures which have a direct control. The study clearly shows that there are three sets of lineament, the main being the one with north east-south west trend.

Keywords:- *Aquifer mapping; 1D VES; Iso apparent resistivity map; electrolog; lineament.*

I. INTRODUCTION

Water is the most important component of the development of any area. Human settlement depends to a large extent on the availability of water resources in close proximity to the settled localities. The geologic structure is important for understanding the factors influencing the distribution, flow, and yield of groundwater [8]. The study also endeavors to determine any relationship between geological structures and groundwater occurrence using surface geoelectric techniques [4]. 1D VES is a commonly used geophysical technique of groundwater prospecting and a noninvasive technique used for a long time in groundwater exploration [4].Limited structural knowledge in the study area has made groundwater exploration difficult and groundwater exploitation expensive. Better understanding of groundwater systems and the occurrence go a long way in increasing the success rate of drilling boreholes in the area [4].

A. Problem statement

Due to periodic droughts and over extraction of groundwater resources resulted in depletion thus making the investigation more complicated. In yester years, geoelectric explorations have been restricted to shallow depths and drilling of wells too to lesser depths, as the scenario was different with comparatively shallower water levels and demand was less. But in the present scenarioof dwindling water levels with adverse seasonal conditions, it is necessitated to go for deeper exploration &drilling. The 1D VES techniques aid in delineating deep fractures/ lineaments to target the potential aquifers. This research has improved our understanding of groundwater occurrence and distribution [4].

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B. Aim and objective of this research

The aim of the study is to investigate how geological structures influence the occurrence of groundwater in the study area, which will enable identification of future drilling sites of boreholes for water use.

C. The specific objectives are;

- Identify and delineate geological structural elements from 1D VES techs.
- Assess the inter-relationship between geological structures and borehole yield
- Assess the role of geological structural framework on variability of groundwater occurrence

II. AREA OF INVESTIGATION

The area falls in parts of Gudimangalam block of Udumalpet taluk in Tiruppur district, Tamilnadu. The areas are bounded by Poolavadi in east, Iluppanagaram in the west, Ammapatti in the north And Varadharajapuram in the south. The total areal extent is about 100 sqkms. The area confines to Poolavadi-V.Vallakondapuram lineament running almost to10-12 kms in north east- south west directions.

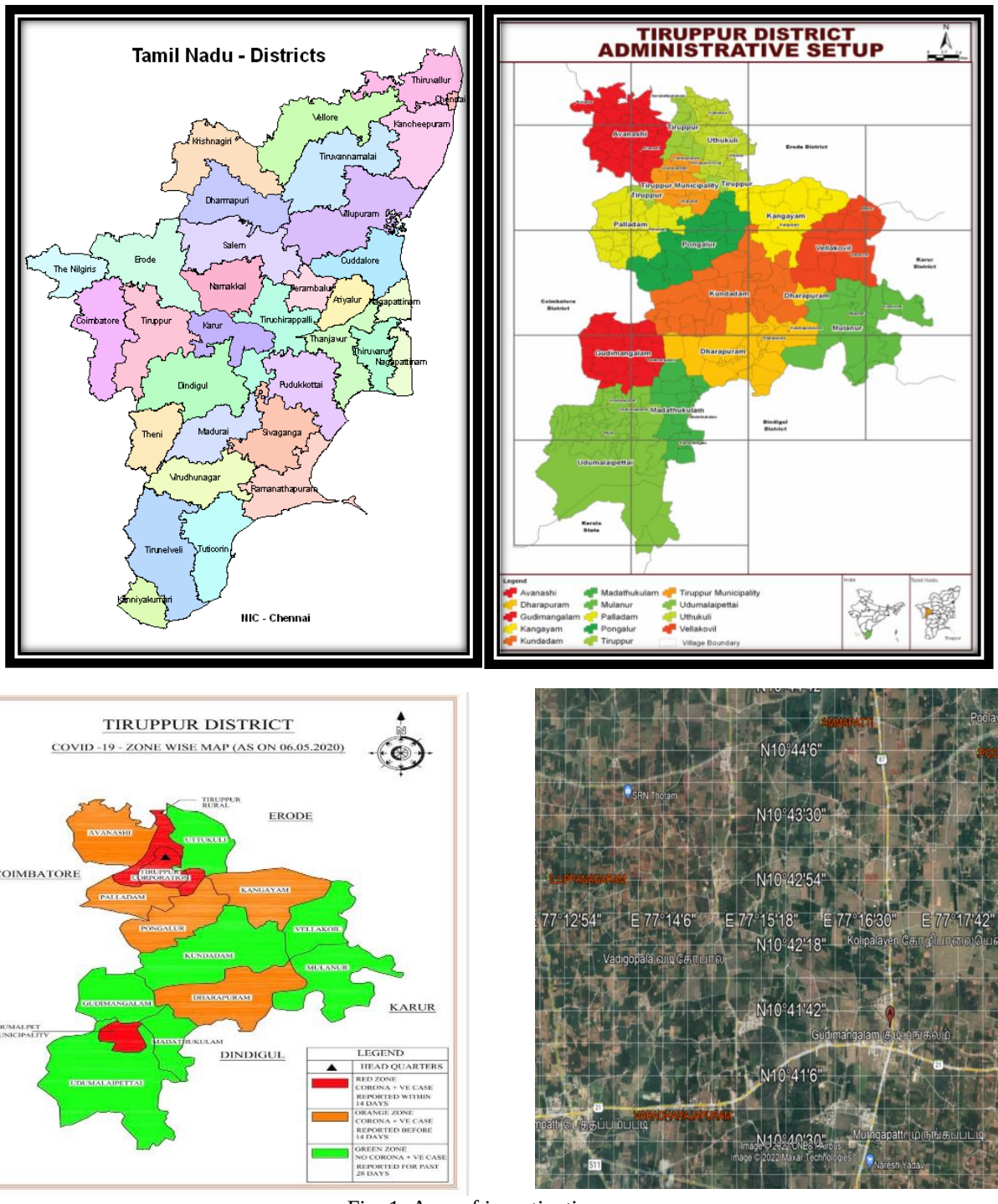

Fig. 1: Area of investigation maps

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A. Generalgeology and geomorphology of Tiruppur district

Tiruppur district is bounded by North latitudes 10°14'00 to 11°20'00'', east longitudes 77°27'00 to 77°56'00''. The areal extent is 2296 square kilometers. The southern part of the district is covered by hill ranges of Western Ghats mainly Anamalai hills. The district is underlain by wide range of metamorphic rocks of peninsular gneissic complex of Archean age. The major rock types comprising the area are charnockite, garnet biotitte gneiss, fissile hornblende biotitte gneiss, pink migmatites, hornblende biotite gneiss, pyroxene granulite, garnetiferous quartzofelpathic gneiss, anorthosite, Nepheline syenites, corundum syenites&ultra-mafic complex. The gneissic rocks are intruded by granites & magnetite quartzite. Pegmatite and vein quartz are seen traversing the migmatites throughout the area. Most of the area is covered by brown and red brown soil. Brown soil is probably derived from the acidic rocks while the red brown soil is derived from the basic rocks.

The three major geomorphic zones arei] plains, ii] pediments iii] hills & plateaus. The district consists of varied landforms like shallow flood plain, pediplain, moderate, deep and buried pediplain, pediments, pediments-inselberg, linear ridge, residual, denudation &structural hills [3].

B. General Hydrogeology

The normal rainfall of the district is 702.2mm. The major rivers under Cauvery basin draining are Noyyal & Amaravathi. The Chinnar and Thenar rivers are the main tributaries of Amaravathi River which is the main source of irrigation in the district. Nallar & Palar Rivers come under Parambikulam-Aliyar river basin. Both Amaravathy & Thirumoorthy dams are the main source for irrigation whereas Uppar dam which receives water from seasonal rainfalls. Weathered and fractured crystalline rocks constitute the important aquifer systems. The ground water occurs mainly under water table conditions in the weathered mantle, joints and fractures. Ground water is developed mostly by deep bore wells & by open wells. Due to periodic monsoon failures the district frequently reels under drought conditions. Owing to depletion of ground water resources and deep decline of water table, farmers resort to deep bore well drilling. Generally ground water is suitable for domestic and irrigation purposes. Excess total hardness, nitrate & fluoride constituents are the common scenario. Excess fluoride is commonly noticed in Gudimangalam block of Udumalpet taluk which may be attributed as a geogenic problem.

III. STRUCTURE AND TECTONICS

The ground water occurrence, movement and potential in hard rock terrain is controlled by geological structures like fault, shear, folds which are commonly referred as lineaments. The district is endowed with 3 sets of lineaments criss crossingnorth east-south west, North West- south east & north-south directions. Dykes and intrusive are also noticed. The regional strike of foliation of the rocks varies from east north east [ENE] to west south west [WSW] through EW to WNW-ESE with moderate to steep dips on both sides indicating a number of anti-forms and synforms. On the basis of minor folds observed in the field, four sets of folds belonging to different periods have been recognized. They are referred as F1, F2, F3 & F4 folds. Joints are predominant in charnockite and migmatites in Poolavadi & Gudimangalam areas along two major directions i] NE-SW with steep dips towards SE (ii) NW-SE with steep dips towards NE [10].

A. Lineaments

A lineament is a large scale feature express itself in terms of topography and an expression of underlying geological structural features which include fault zone, fracture [joint] zone, fold axes and linear igneous intrusion [2]. Lineaments are often located by means of detailed study of geomorphological maps, aerial photographs and satellite imageries [7]. The ground water potential and movement are governed by the geological structures like fault, shear zones / lineaments which play a vital role in the tectonically disturbed zones.

B. Poolavadi- V.Vallakondapuram Lineament

All the rock types in this area show moderate to well pronounce vertical to sub vertical gneissic foliation. The regional trend of foliation being north east-south west. A minor plunging synclinal structure is observed along the stream course. Both synforms&antifoam have been deciphered [10] in Periyapatti, Poolavadi, Gudimangalam areas by the Geological Survey of India [GSI]. Plunge of the synforms may be towards east and the fold axis may be almost parallel to the regional strike. The pegmatite and quartzite veins west of Sanuppapatti area show drag folding indicating tectonic disturbance. Especially the south, south western and south eastern areas are extensively disturbed. Both the country and intrusive rocks show high grade weathering and the formations are highly sheared and shattered with good developments of strike joints and fracture systems. Presence of deep seated fractures below 110 m is confirmed by the occurrence of good productive aquifers with good yield. The litholog of bore wells also confirm the deep seated fractures. Granite and gneissic boulders as high as 40 mm size are encountered at deeper depths indicating extensive shearing and faulting. The area of extent influenced by the major tectonic disturbance is very extensive. The influence due to this deformation can be observed in the areas of Muthusamudhram in the east extending to V.Vallakondapuram- Sanuppapatti-Lingamanaickenpudur, Maalaikoil, and V.Vallakondapuram in the west. The area of extent of this disturbed zone is about 10 to 12 km from Poolavadi in the east to V.Vallakondapuram in the west. This is a major lineament with a trend of northeast-southwest. Totally 51 bore wells have been drilled. The discharge of the bore wells drilled in this area is as high as 130 to 482 lpm. There is only one poor yielding bore well and the minimum yield is 23 lpm that too only nine in numbers.

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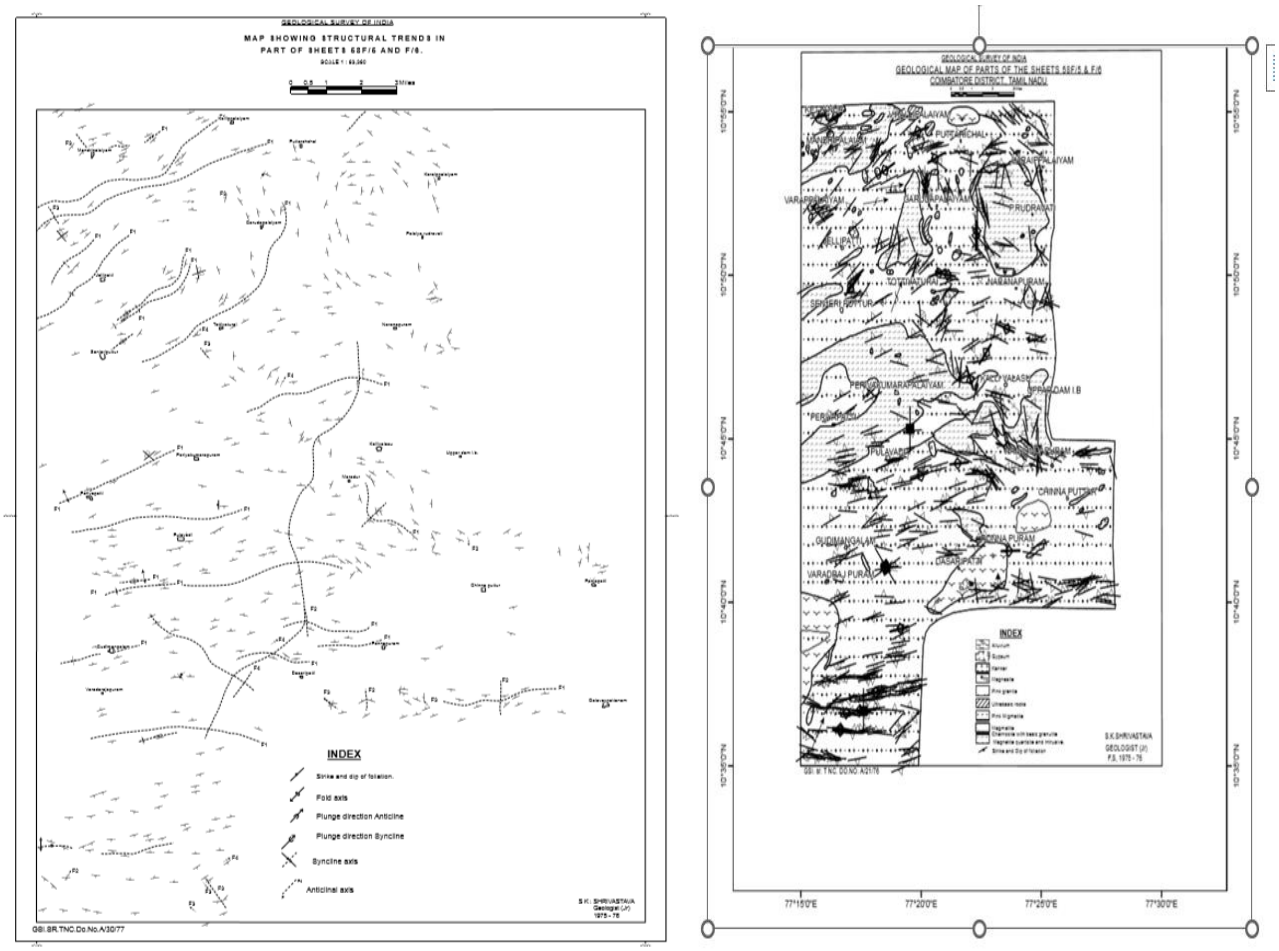

Fig. 2: Maps showing structural trends

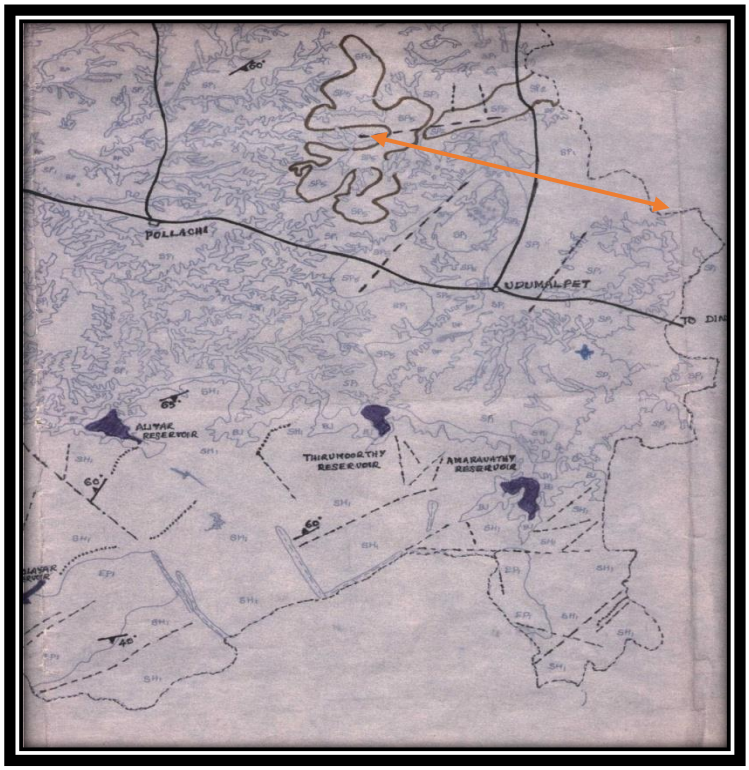

Fig. 3: Hydrogeo morph map, Cbe dist- study area lineament

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IV. GEOELECTRIC EXPLORATION

A. *Electrical Resistivity Techniques- 1D Vertical Electrical Soundings [Ves]*

Resistivity is a physical property of a substance which can be defined as the resistance offered by a unit length of a substance of unit area, to the flow of electric current governed by the Ohm's Law, R = V/ I. Resistivity is the inverse of conductivity. A series of measurement of resistivity are made by increasing the electrode spacing [AB/2] in a fixed point along a tract and this method of vertical exploration in known as resistivity sounding or 1D VES. VES data have been acquired by IGIS make DC resistivity meter & SSR-MP-AT-S employing Schlumberger array with AB/2 separation of 100 to 340m. The VES curves were interpreted and analyzed by Resist & Inverse slope software. At Sanuppapatti Koilthottam one deep bore well drilled to a depth of 110m has been electrically logged [LN-64''] to decipher the fracture density [Fig-11].

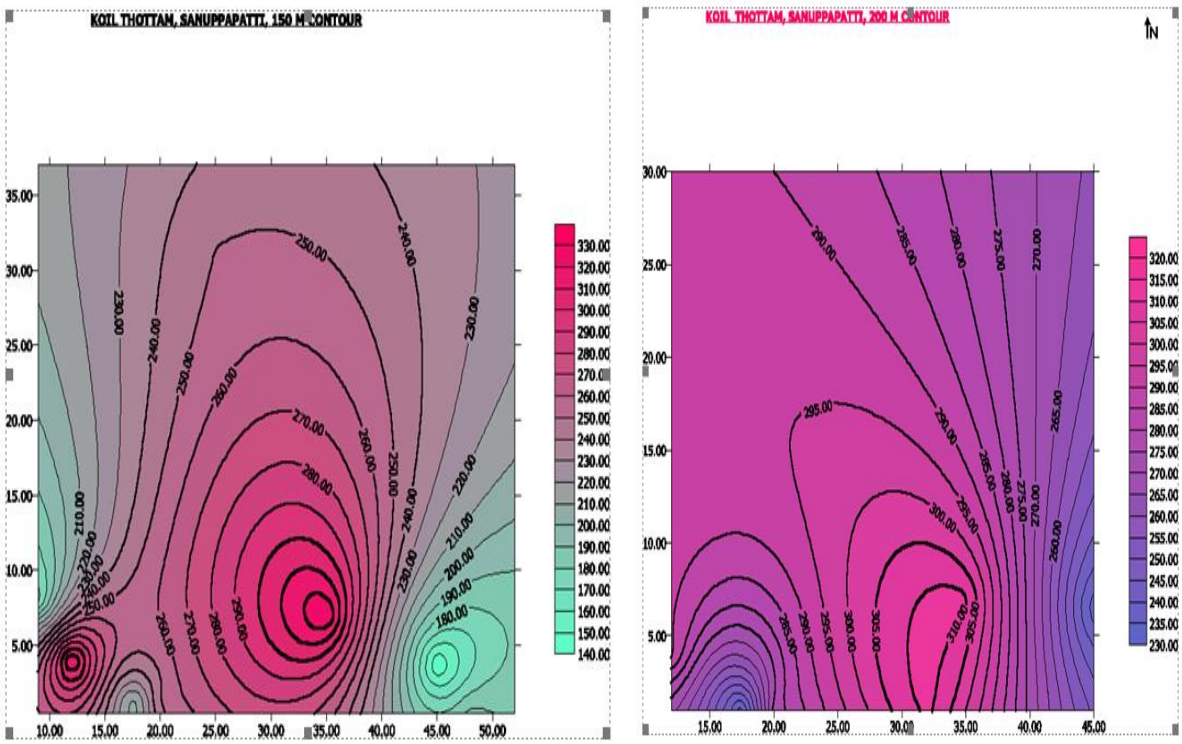

Fig. 4: Sanuppapatti, Koilthottam- Iso apparent resistivity maps-AB/2-150 & 200M

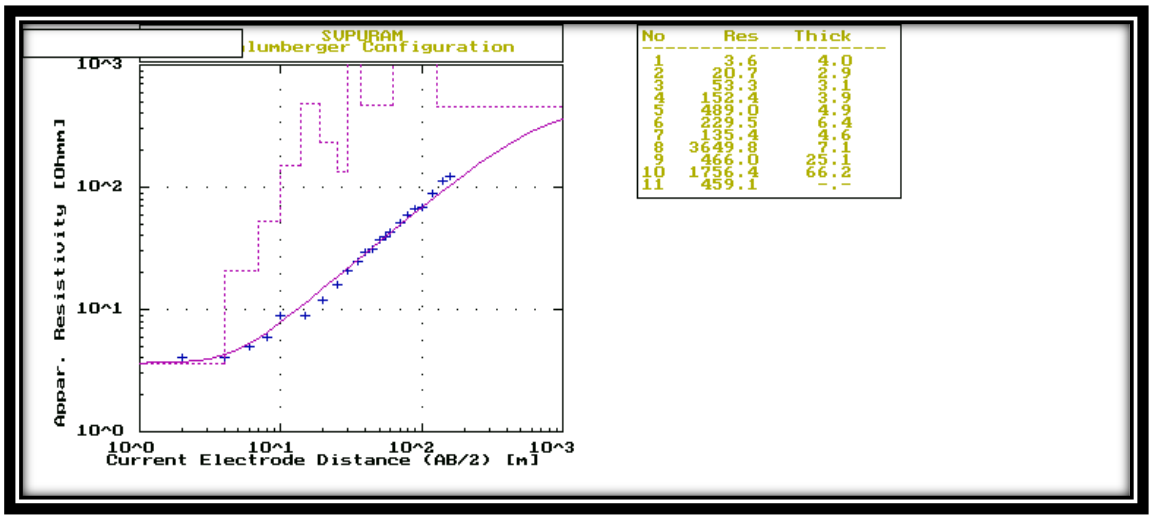

Fig. 5: Sanuppapatti, Koilthottam- VES curve

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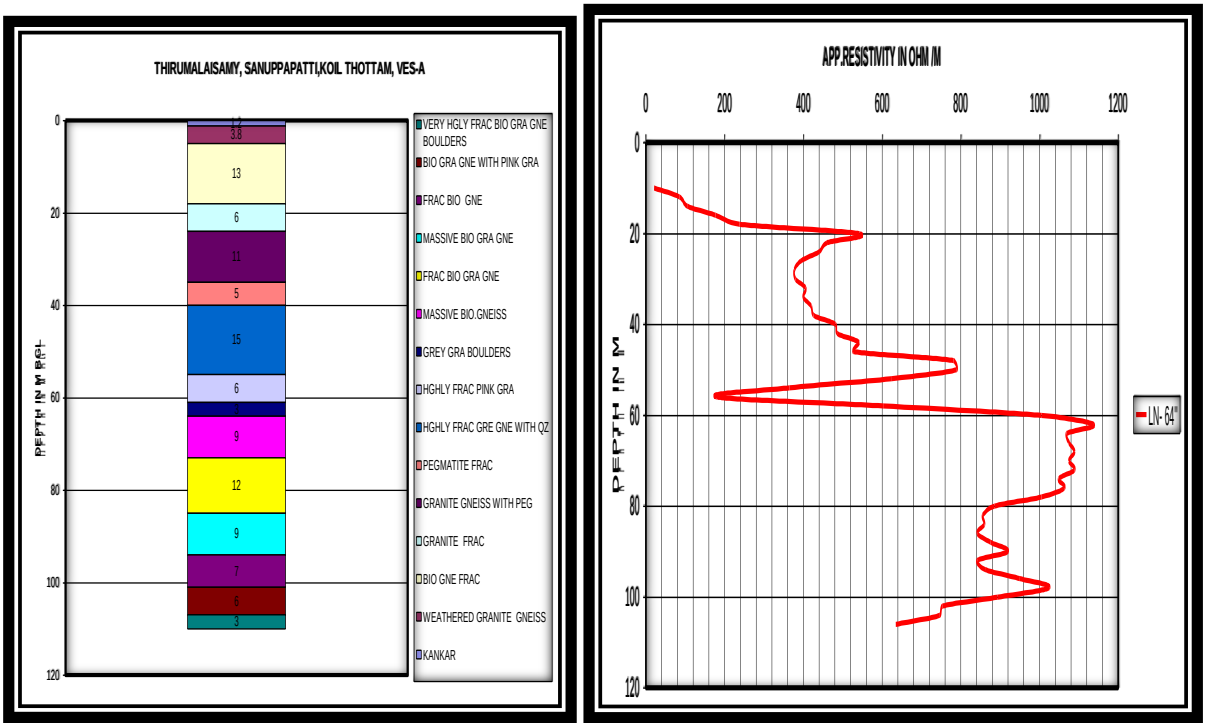

Fig. 6: Sanuppapatti, Litholog of bore-110m depth & electrolog, LN-64

B. Sanuppapatti-Muthusamudram-Poolavadi Zones Yield & Lineament Map

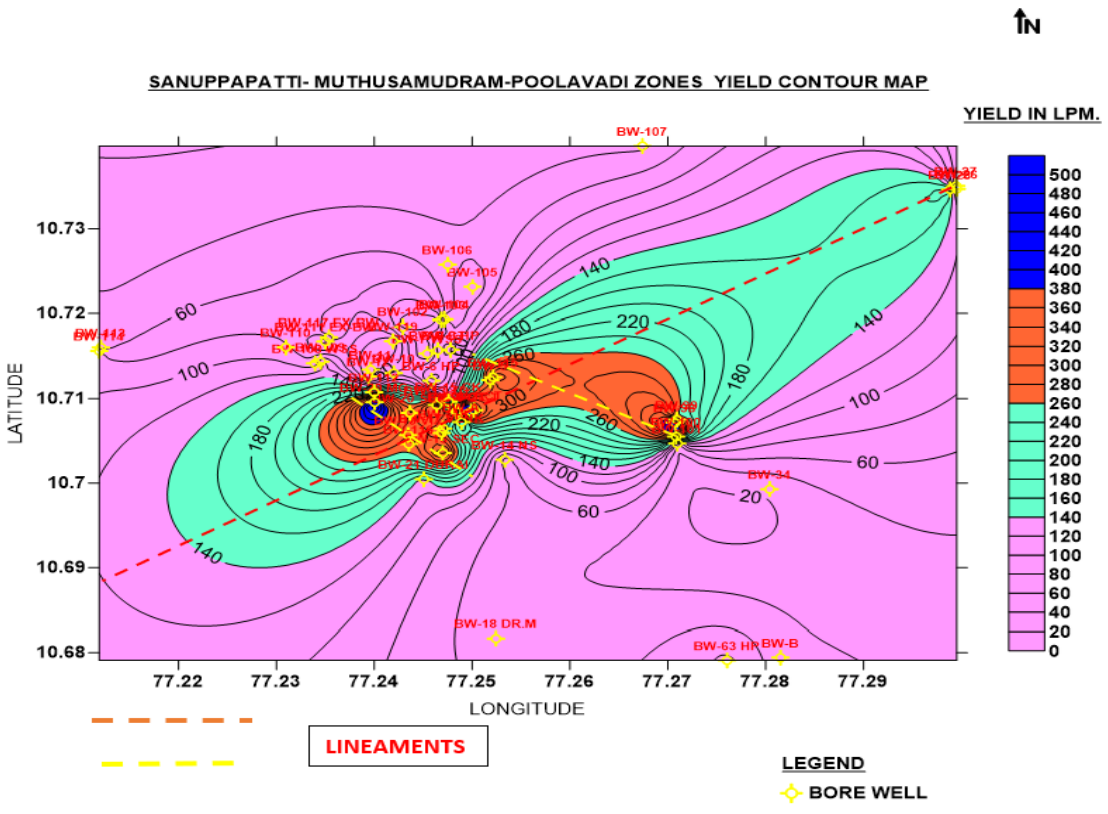

Fig. 7: Aquifer yield contour map

C. Sanuppapatti, Koilthottam, Iso apparent resistivity map

Iso apparent resistivity map of Koilthottam, Sanuppapatti for AB/2 separations-150 & 200 m [Figs-7 & 8] have been generated, as this zone being the core central part of the major lineament to study the low resistivity anomalies to indicate the deep high fractured potential targets.

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V. RESULT AND DISCUSSIONS

The Iso apparent resistivity map of Koilthottam, Sanuppapatti area [Figs-7 & 8] reflects well prominent low resistivity anomalies in the south eastern &western zones indicating highly fractured formations @ 150 & 200 m depths. The litholog / electro log [Figs: 10&11] reflects high density of fractures with low resistivity drops, below 50 to 58m, 62 to 80m & 90 to 110m confirm the deep fractures. This bore well with such deep fracture systems has been drilled in this low resistivity anomalous pockets.The aquifer yield contour map [Fig: 12] exhibits high yield anomaly zones [160-500 lpm] in the central part of the study areai.e the Koilthottam locations. The minimum and maximum yields are 20 & 500 lpm. From the contours it could be observed that three sets of lineament, one with north east-south west trend and the others two with north west- south east trends. The very high yield anomaly pocket [dark blue color] which forms almost central core part of the Poolavadi-V.Vallakondapuram lineament trending north east- south west may be the conduit for potential groundwater movement.

VI. SUMMARY AND CONCLUSIONS

The area of investigation of about 100 sq. kms falls in parts of Gudimangalam block of Udumalpet taluk in Tiruppur district, Tamilnadu where systematic geological, hydrogeological &Geoelectrical investigations have been carried out to map potential aquifers for irrigation and water supply needs. It is a typical crystalline rock terrain of drought prone nature. The Iso apparent resistivity map, electric log of a deep bore well and the aquifer yield contour maps throw light on the tectonic history revealing that this zone is tectonically disturbed with faulting, shearing and shattering of the subsurface lithology. The high potential aquifers confines to the lineament-Poolavadi-V.Vallakondapuram lineamentand from these research it may be concluded that the occurrence, distribution and movement of groundwater are influenced and impacted by geological structures which have a direct control. The study clearly shows that there are three sets of lineament, the main being the one with north east-south west trend.

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