AQUIFER MAPPING OF HARD ROCK TERRAIN IN PARTS OF DINDIGUL DISTRICT, TAMIL NADU

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ABSTRACT

There is anurgent need for scientific planning in development of ground water under different hydrogeological situations and to evolve effective management practices with involvement of community for better ground water governance. Aquifer mapping is a multidisciplinary scientific process wherein a combination of geological, hydrogeological, geophysical, hydrological, and quality data are integrated to characterize the quantity, quality and movement of ground water in aquifers. One of the important aspect of the aquifer mapping programme is the synthesis of the large volume of data already collected during specific studies carried out by Central Ground Water Board and various Government organizations with a new data set generated that broadly describe an aquifer system. The data are to be assembled, analysed, examined, synthesized and interpreted from available sources. These sources are predominantly non-computerized data, which has to be converted into computer based GIS data sets.

Key words: Aquifer mapping, geological, hydrogeological, geophysical, hydrological, and quality data

INTRODUCTION

Ground water is being increasingly recognized as a dependable source of supply to meet the demands of domestic, irrigation and industrial sectors of the country. The development activities over the years have adversely affected the ground water regime in many parts of the country. There is a need for scientific planning in development of ground water under different hydrogeological situations and to evolve effective management practices with involvement of community for better ground water governance. The main objective of the National Water Mission, under National Action Plan for Climate Change is conservation of water, minimizing wastage and ensuring its more equitable distribution across the whole

country through integrated water resources development and management. As India is the largest user of ground water in the world, there is an urgent need for an accurate and comprehensive picture of ground water resources available in different hydro-geological settings through aquifer mapping which will enable preparation of robust groundwater management plans for this common pool resource

Aquifer mapping at the appropriate scale has to be devised and sustainable management plan to be prepared and implemented for this common-pool resource. This will help achieve drinking water security, improved irrigation facility and sustainability in water resources development in large parts of rural India and many parts of urban India. It will *also* result in better management of vulnerable areas. In the present scenario, the ground water assessment and management is broadly based on administrative boundaries. In some of the states, surface watershed boundaries are used to collate the information on regional geology, hydrogeology, aquifer characteristics and These facts underscore the need for 3-D picture of demarcated aquifer systems of the country.The aquifer maps are the 3-D maps depicting aquifer disposition, giving lateral and vertical extension. The maps will also provide information on the quantity and quality. Aquifer mapping is a multidisciplinary scientific process wherein a combination of geological, hydrogeological, geophysical, hydrological, and quality data are integrated to characterize the quantity, quality and movement of ground water in aquifers.

METHODOLOGY

Large volume of data already collected during specific studies carried out by Central Ground Water Board and various Government organizations with a new data set generated that broadly describe an aquifer system. The data are to be assembled, analysed, examined, synthesized and interpreted from available sources. These sources are predominantly non-computerized data, which is to be converted into computer based GIS data sets. There is also a strong need for generating additional data to fill the data gaps to achieve the task of aquifer mapping. This would be achieved by multiple activities such as exploratory drilling, geophysical techniques, hydro-geochemical analysis, remote sensing etc besides detailed hydrogeological surveys.

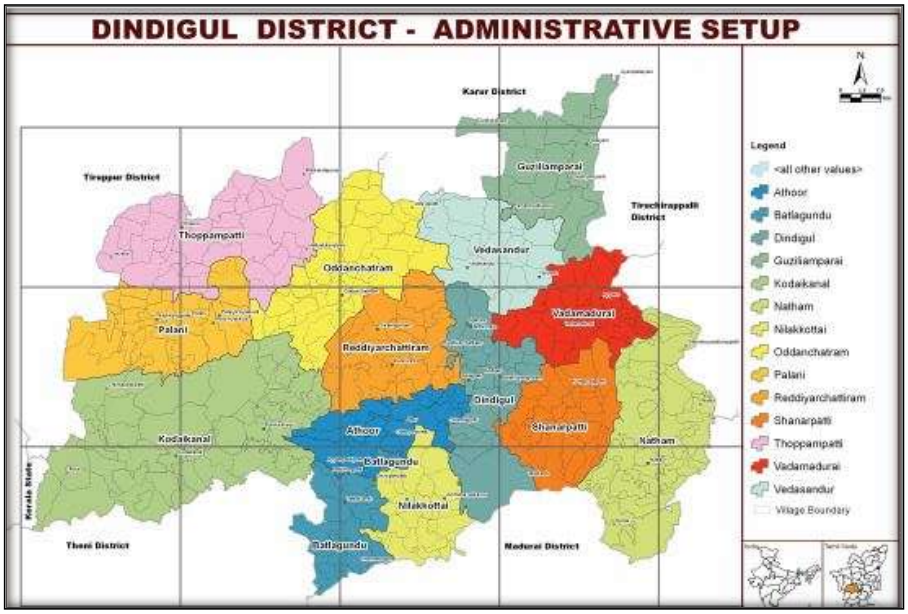
AIM AND OBJECTIVES

The objectives of the aquifer-mapping project can be broadly summarised as

- ✓ To define the aquifer geometry, type of aquifers, ground water regime behaviors,
- ✓ 2. Hydraulic characteristics and geochemistry of multi-layered aquifer systems on 1:50,000 on a 3-D section and
- ✓ 3. To develop an Aquifer Information and Management System for sustainable management of ground water resources based on the aquifer maps prepared.

STUDY AREA

Aquifer mapping studies were carried out in the mid-western part of the Tamil Nadu state covering major parts of Dindigul Attur, Reddiyarchatram blocks of Dindigul talukdindigul district and parts of Oddanchatram block of Oddanchatram taluk, in 58 F/15 to posheet and in p arts of Nilakkottai and Vattalakundublocks of Nilakottai taluk (Fig.1).The study area lies between the latitudes N 10 00’ 00”-N30 00’00” and longitudes E 77 45’ 00”-E78 00 falling in Survey of India toposheets 58 F/15, and 58 F/16.The results obtained in toposheet 58 F/15 are dicussed in this paper.



Geomorphology

Differing resistances of the geological formation has given rise to various land forms, viz., structural hills, residual hills, linear ridges and pediment terrains in the district. These are found well developed in northern part of Palani Hills, southern part of Kodai hills and Nattam hills. The valley fill sediments are found to occur in Oddanchatram, Reddiyarchatiram, Sanarpatti and Nattam blocks and the southern slopes of Kodaikanal hills. Structural hills are the major land forms in the district. The major part of Kodaikanal and Palani hill occupies structural hills. Similarly, it is also found in parts of Nilakottai, Nattam, Vadamadurai, Oddanchatram and Guziliamparai blocks. Shallow buried pediments and pediments are the results of denudationalland forms and are encountered in major parts of the area. Flood plains of recent origin are found along the river courses. (Fig.2)

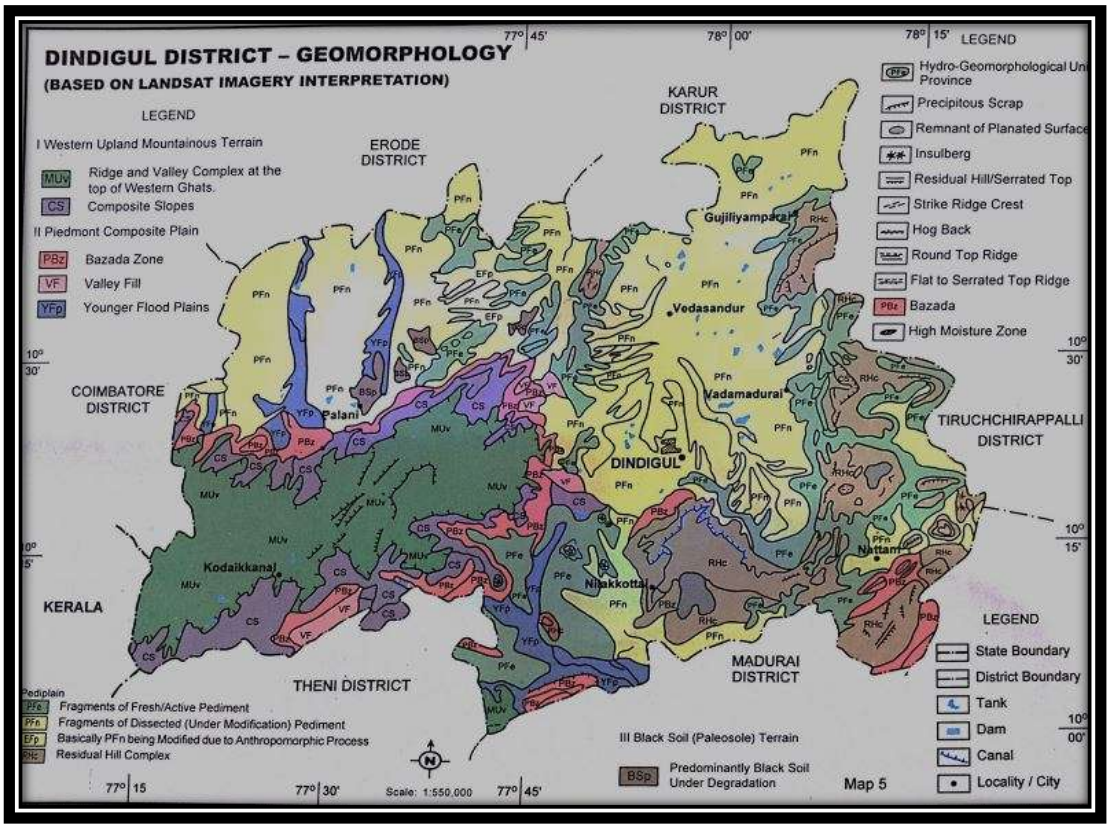


Fig.2. Geomorphology Map

Soils

The major soil types in the district are 1. Red soil , 2. Red sandy soil and 3.Black Cotton soil. Red soils are prevalent in Palani, Nattam and Oddanchatiram, while Red sandy soils are prevalent in Nilakottai, Dindigul and Vedasandur. Black soils are found in all taluks except Kodaikanal.(Fig no 3). The chief irrigation sources in the area are the open wells, followed by tanks, and tube wells. Canal irrigation is highest in Palani block.

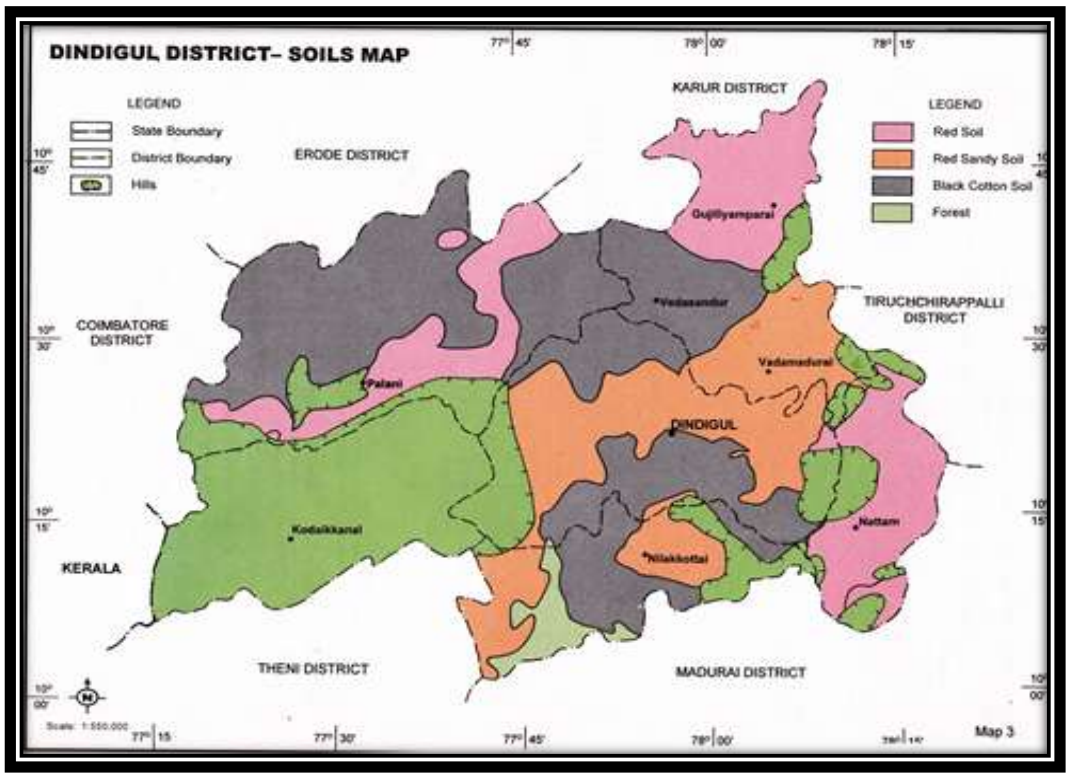


Fig.3 Soil Map

Hydrogeology

The major part of the district is underlain by Archaean crystalline metamorphic complex The important aquifer systems encountered in the district are classified into

- ✓ Fissured, fractured and weathered crystalline formations consisting of Charnockites, Granite Gneisses and
- ✓ Valley fill sediments (Unconsolidated Sediments) comprising clay, sand, silt and kankar

Valley fill sediments have been observed along valley portions in the depth range of 35 to 40 m bgl in Nattam and Sanarpatti blocks. They are characterized by deeper water levels showing high fluctuations. Groundwater occurs under water table condition. In general, dug wells are used to extract groundwater from these zones and the wells can yield about 200 Cu.m per day and can sustain pumping of 3 – 4 hrs in a day. In case of crystalline formations, groundwater occurs under water table condition in weathered and shallow fractures and under semi-confined to confined conditions in deeper fractures. The depth of weathering varies from place to place from less than a metre to a maximum of 40 m bgl. The number of saturated fracture zones varied from 1 to 6 occurring at depths between 10 and 164 mbgl. The groundwater exploration in deeper aquifer reveals that in about 11 per cent of the wells drilled, the yield was more than 180 lpm, whereas in about 15 per cent of the wells, the yield ranges from 60 to 180 lpm. A few of the wells have been abandoned due to poor yield. Dug wells are used to extract groundwater from weathered formation while deeper fractures are tapped through bore wells and dug cum bore wells. The yield of open wells in the district tapping the weathered mantle of crystalline rocks generally ranges from 100 to 400 lpm for draw down ranging from 2 to 4.5 m. The dug wells can sustain a pumping of 3 - 4 hrs in a day.

The wells tapping the deep seated fracture system can yield about 60-300 lpm and can sustain a pumping of 6-8 hrs a day. The depth to water level during pre monsoon (May 2014) in the the district varied from 5.0 to 20 m bgl. Out of 32 wells 22% of wells had depth to water level in the range of 5- 10 m bgl, 28% wells are in range of 10 – 15 m bgl, 50% in the range of 15-20 m bgl. A map showing the DTW during pre monsoon in the district shows depth to water level during post monsoon (Jan 2014) in general varied from 2.0 to 15 m bgl and out of 32 wells, 20% of wells had depth to water level in the range of 2- 5m bgl and 50% of the wells had depth to water level in the range of 5-10mbgl ,30% wells are in the range of 10-15 m.bgl. .

Rainfall and Climate

The normal annual rainfall over the district varies from about 700 to about 1600 mm. It is minimum around Palani (709 mm) in the northwestern part and Vedasandur (732.4mm) in the northeastern part of the district. It gradually increases towards south and southwest and

reaches a maximum around Kodaikanal (1606.8 mm)The district enjoys a tropical climate. The period from April to June is generally hot and dry. The weather is pleasant during the period from November to January. Usually mornings are more humid than afternoons. The relative humidity varies between 65 and 85% in the mornings while in the afternoon it varies between 40 and 70%.

RESULTS AND DISCUSSION

Based on the Hydrogeological investigation aquifer mapping in tope sheet No 58/15&58/16 a total of 28 sites were selected and referred to geophysical survey in Dindigul&Madurai district. Vertical Electrical Soundings (VES) were carried out by employing the Schlumberger Electrode configuration where maximum spread length (AB/2) is 200mts. with a view to delineate the nature of subsurface and to recommend the sites for drilling bore wells &data gap analysis for and aquifer mapping. The obtained VES data was in the form of curves on double logarithmic graph paper of modulus 62.5mm. in the field. The obtained field data were input for the iterative VES interpretation technique with the aid of personal computer. The interpreted results indicate 3 to 4 layered geoelectric sections in which the last layer is massive formation.Based on the interpreted results and nature of the VES curves the sites are recommended for drilling, also recommended thickness of soil, weathered formation &fractures depth for aquifer mapping, village vise. .

Table. 1 Results of gathered from electrical resistivity study

Sl. No	Village(Location)	Soil thickness(m)	Thickness weather formation (m)	Fracture depth range (m)
1	Sri Rampuram	0-2	2-25	30-40,50-60
2	Malayandipuram	0-3.5	3.5-40	120-150
3	Kannivadi	0-2	2-25.25-40	-
4	Adilakhmipuram	0-5	0.5-45	-
5	Athoor	0-5	5-16	60-70
6	Sithayankotti	0-3	3-30	100-120
7	Chittaravee	0-7	3-45	150-160
8	Ayyanpalam	0-3	3-25	50-100
9	Peetiveeranapetti	0-4	4-40	80-85,120-125
10	Vatalakundu	0-3	3-30	60-71,100-120
11	Nilakkottai	0-3	3-20	-

Sl. No	Village(Location)	Soil thickness(m)	Thickness weather formation (m)	Fracture depth range (m)
12	Bttalagudu(TNSID)	0-2	2-10	-
13	Chellyiapuram	0-2	2-40	100-150
14	Annaipatti	0-3	3-35	-
15	Viruveedu	0-2	3-10	50-150
16	T.Andipatti	0-2	2-10	15-40,120-200
17	Gaulpatti	0-2.5	2.5-8,8-40	50-100
18	Vilmpatti	0-2	2-10	-
19	Chettiyapatti	0-3	3-30	-
20	DevarAiagirpati	0-2	2-10	10-100
21	Narasingapuram	0-6	6-30	-
22	Bhudipuram	0-3	3-30	120-140
23	Malaikadaniatti	0-2	2-10	-
24	Michalplayam	0-2	2-25	-
25	Uttappanayakkanur	0-2	2-15	100-150
26	Sholavandan	0-5	5-35	45-50,100-150
27	Dindigul	0-2	2-50	100-150
28	SirumalaiPudur	0-5	-	15-25

The disposition of aquifer system is difficult to define in hard rock areas, especially where the thickness of weathered zone is limited and the occurrence of fractures at depths vary from point to point. However, based on the earlier exploration and the exploration carried out during the data generation period, a generalized 3 layer geometry is inferred, viz.; top-weathered and fractured zone (phreatic), middle-first fractured zone and bottom-second fractured zone. Two cross-sections are prepared based on the occurrence of fracture zones in the bore wells drilled down to a depth of 200m bgl and further down below. Aquifer geometry is shown in 2 D cross section in fig 4 and 5 and 3 D view in fig no 6 and 7. Based on the cross-sections prepared and on the analysis of fractures zones Vs corresponding yield pattern of TWAD Board bore wells the following points are inferred about the Geometry of Aquifer system in the study area.Groundwater occurs universally in the phreatic zone, where ever this zone extends down below the static water level. The thickness of the weathered zone is in the range of 5 to 20m bgl in the bazada zones of A.Vellode- Chettiyapatti-Gandhigramsection.Akkaraipatti-Paraipatti-Dharmattupatti-Kannivadi-Srirampuram-Nilamalakottai section(NNE-SSW, at the slopes of Palani hill range); This area forms a productive aquifer with higher transmissivities. But the storage is very less due to the limited

extent and thickness of the aquifer unit, as a result depth to water levels deplete at faster rate during post monsoon periods.

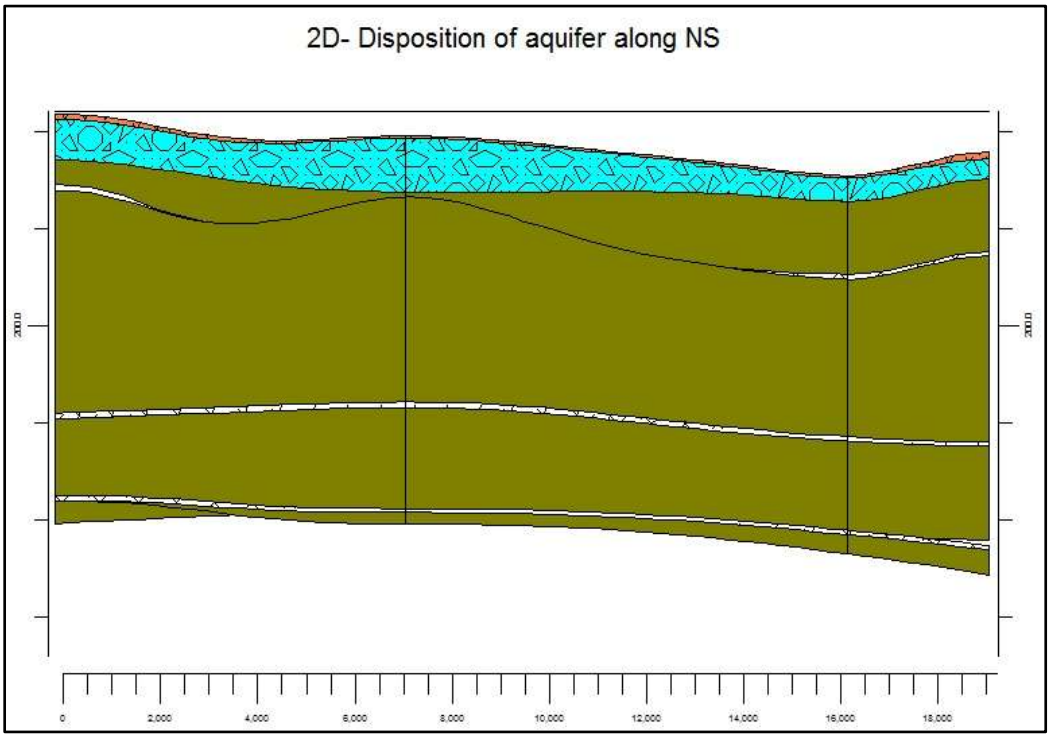


Fig.4. 2D cross section along North-South direction

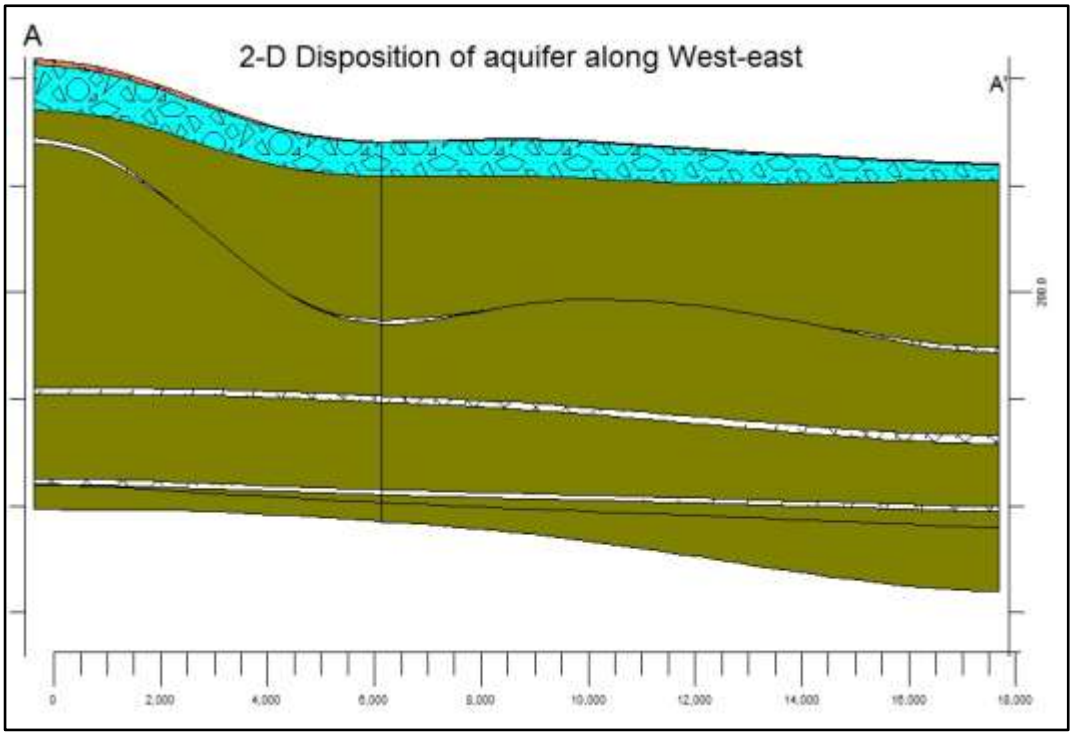


Fig.5. 2D cross section along West-East direction

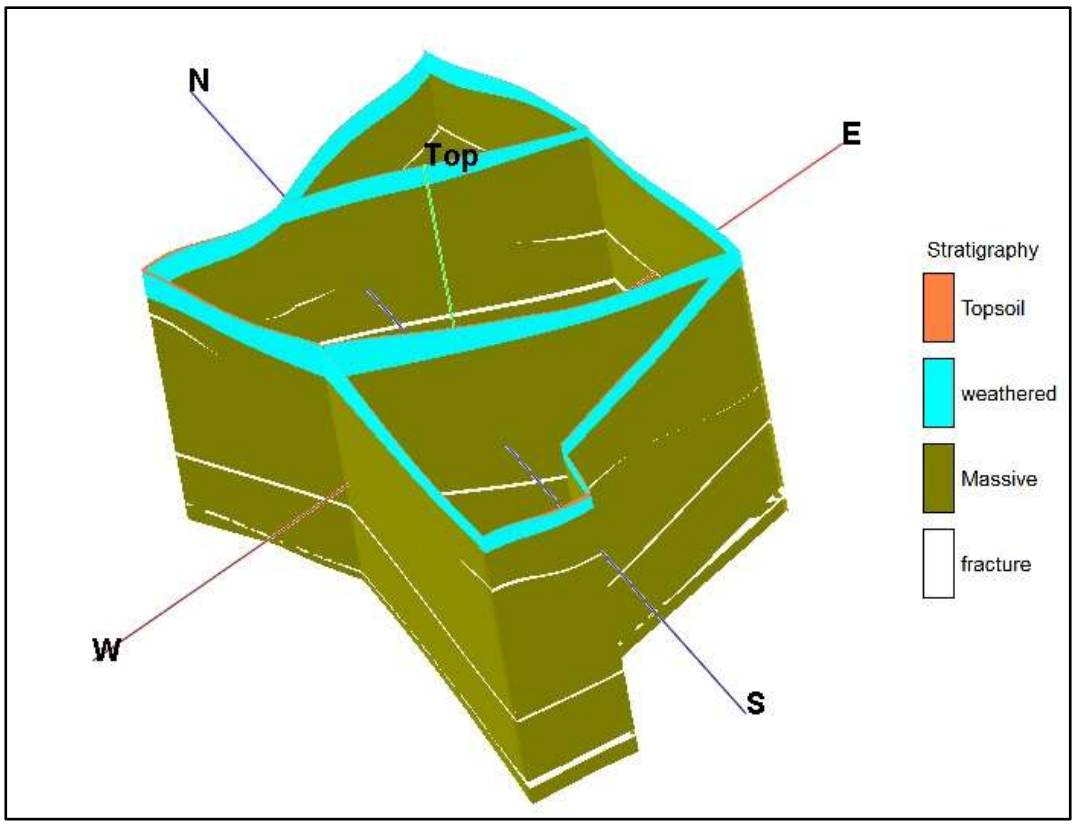


Fig.6. 3D aquifer cross section

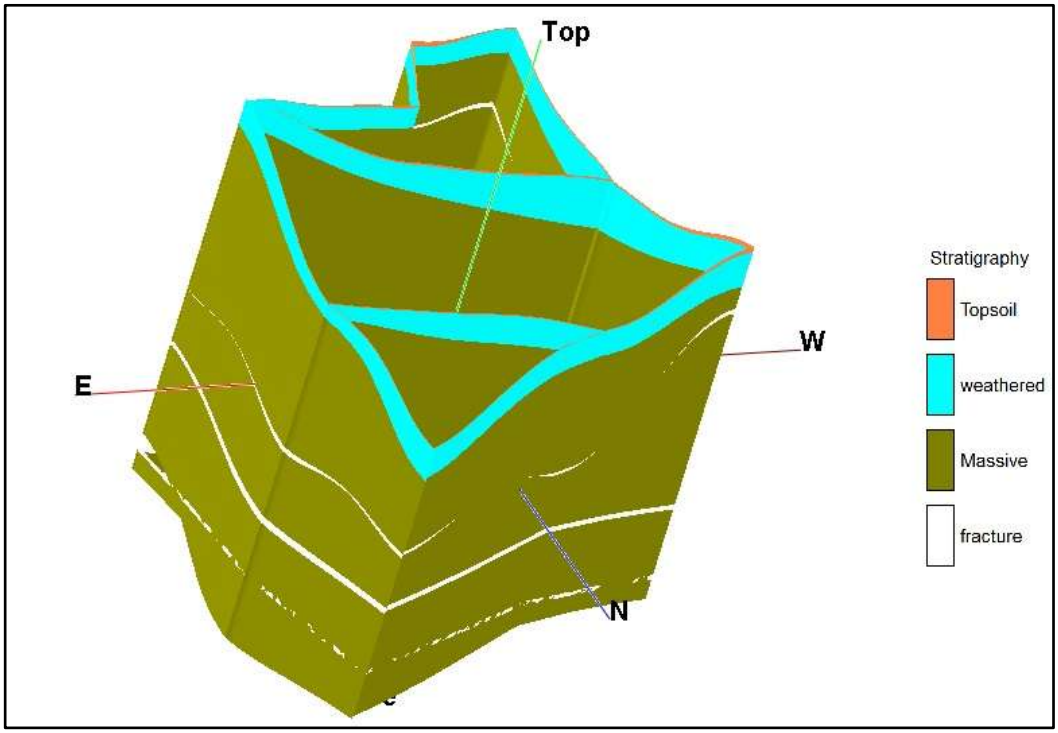


Fig.7. 3D aquifer cross section

The middle-first fracture zone occurs between the phreatic zone and the bottom fracture zone. The cumulative thickness of this zone is 90m (maximum) with fracture openings at different depths. The fracture aperture openings are limited to few centimetres to a maximum of 2m in the study area. However, the well discharges are not proportional to the fracture widths rather than the hydraulic gradient and extent of the fracture openings. Hence, no rational correlation could be done with the two dozens of exploratory well data for the entire 720 sq.km study area. The bottom-second fracture zone occurs from 90mbgl to 200m bgl.(as the aquifer mapping is limited to 200mbgl in the scheduled study). About 50 percent of the wells drilled encountered the second but the discharges vary from traces (Chattarpatti EW) to 5.41 lps (Srirampuram EW). The low discharges at deep seated fracture zones may be attributed to isolated nature of fracture zone with limited connectivity to the surrounding fracture system.

In order to have better understanding the fracture pattern of the study area drilling data has been collected from TWAD Board, Dindigul for 143 numbers of bore wells drilled in parts of 58F/15 toposheet and analysed. The fracture Vs yield study reveals that productive wells are constructed on western buried pediment zone extending from NW corner of the toposheet to the southern part of the sheet. In addition productive bore wells are constructed by TWAD along Mangarai Ari course, where the underlying rocks undergone mylonitisation. During earlier exploration programmes 18 exploratory/ observation wells were drilled down to a maximum depth of 300mbgl (Reddiyarchatram). In addition, during the study period ten more wells are drilled down to a depth of 200m bgl, based on the VES carried out. The specific capacity of the bore wells drilled are showing a discharge of 1.35 to 14.56 lpm/m/dd during PYT and APT test. The trasmissivity values range between less than 1m2/day to 12.83m2/day.Groundwater resources of the study area has apportioned from the district groundwater resources assessment -2009 on the basis of geographical area of administrative block ratios. The groundwater development is as high as 192% in Attur block of the study area followed by Reddiyarchatram (160%). The total groundwater development is at 167% of the annual groundwater recharge. The existing gross groundwater draft for irrigation is 13,610 ha.m and the gross area irrigated through groundwater is of 21,000 ha. The dug well density highest in Kummampatti (92/sq.km) and Kurumbampatti (121/ sq.km) villages of Attur and Dindigul blocks in the study area.

CONCLUSIONS

Aquifer Mapping for Delineation of Aquifer disposition in 3-D along with their characterization on1:50,000 scale falling in the Over-Exploited areas in parts of Dindigul district were carried out.Quantification of water availability and water quality parameters to formulate Aquifer Management Plan for facilitating sustainable management of ground water resources at regional and local level through participatory management approach with involvement of community and stakeholders are arrivedFor water security regulate and control the development and management of ground water resources are advised.

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