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Original Research Paper

Earth Science

EVALUATION OF AQUIFER PARAMETERS OF THE CRYSTALLINE ROCKS OF DINDI RESERVOIR CATCHMENT AREA OF MAHBUBNAGER AND NALGONDA DISTRICT OF TELANGANA STATE, INDIA

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ABSTRACT Understanding of the nature of aquifers and their properties to a great extent help in groundwater developmental activities in an area. Systematic studies of the aquifer characters give better insight into the existing groundwater regime. Aquifer studies can be used to have better well design to improve the yield. Pumping tests were conducted and the data obtained are utilized to calculate aquifer parameters deploying different methods developed by various hydro geologists. Aquifer characteristics can be determined only when the time drawdown and distance drawdown relationship is established by conducting certain pump tests. Main objectives of pumping tests are to determine the well functions and aquifer characteristics. The hydraulic characters can be determined in a particular area by conducting pumping tests. In Dindi River basin a total number of Four pumping tests were carried out at Venkatapur, Machinepally, Raviched and and Mahadevpur villages. In order to determine transmissivity, storage co-efficient. The transmissivity (T) values of the formations computed by using In Cooper-Jacob method transmissivity is varies from 3.7 square meters per day to 51.7 square meters per day; and Storage Coefficient is varies from 1.738x10-12 per unit area to 3.386x10-12 per unit area. The estimated transmissivity in thesis method varies from 3 square meters per day to 57 square meters per day; and Storage Coefficient is varies from 1x10-4 per unit area to 8.43 x10-7 per unit area. The aquifer here is sub artesian conditions with unconfined conditions and potentiality at the medium depths. The data revealed that in the there is good yield in the bore well that implies the fractures in the sub surface has been well developed in the sub surface.

KEYWORDS : Pumping test, Aquifer parameters, Unconfined aquifer, Dindi reservoir

INTRODUCTION:

Growth and development of nation is indeed to accomplish its water needs. Good scientific and technical capabilities for the assessment and substantial development of the country for water resource potential particularly the groundwater. To develop the existing groundwater potential in the country, the first attempt is to identify the main different surface and subsurface geological and hydro geological environments of the study area and to characterize the aquifer systems of different geological formations [1, 2, 3]. Pumping tests are help to determine the hydraulic characteristics, yield and draw down and provide information of designing the well in future. In hard rock areas groundwater storage capacity depends on the extent and thickness of the weathered layers, degree of development of secondary porosity such as joints, fractures [4, 5, 6, 7]. Aquifer test or pumping test is performed by pumping a well at a constant rate and observing the resulting changes in hydraulic head in the aquifer to determine the aquifer hydraulic properties [8, 9]. Knowledge of aquifer parameters is essential and important for management of groundwater resources. Usually, these parameters are estimated through pumping tests often conducted to obtain aquifer parameters which are necessary information for groundwater studies carried out on water wells [10, 11, 12]. A pumping test is a process of pumping from a well, while at the same time measuring aquifer responses in the form of head (water levels) variations. Selection of appropriate analytical and numerical models is a key part of calculating the hydraulic characteristics, such as hydraulic conductivity, transmissivity, and storage coefficient of the aquifer [13, 14].

STUDY AREA

Geographically the study area is located longitude between 78°19'31.2"E and 78°54'35.8"E to latitude between 16°50'40.6"N and 16°11'24.9"N; covering survey of India toposheet numbers 56L/5, 56L/6, 56L/7, 56L/10, 56L/11, 56L/14, 56L/15. Figure 1 shows the location map of study area. The study area lies at the north and south of Dindi reservoir covering part of Dindi River catchment which is tributary of Krishna River. Geographical area of the study area is 14, 840 sq.m. Administratively it could be found in Mahabubnagar district of Telangana state, India which is about 115 kilometres by the road from the Hyderabad to Kalvakurthy at Dindi Village, boarder of Nalgonda district on east.

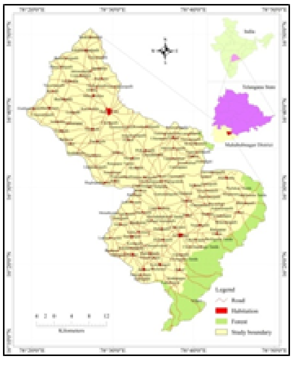


Figure : Location map of the study area

Geology

Large portions of the study area consist of Peninsular Gneissic Complex of granite, gneisses and migmatites of Archean Era laid under most geological formations. Table 1 shows the geological succession of the study area. There are three types of hard and massive intrusives present above the granitic gneisses including closepet granites, dolomite basic intrusives and quartz reef/vein of palaeo to Mesoprotorozoic era.

Table 1: Geological succession of the study area

Age	Formation	Geology	Nature of the rock Characteristics
Meso protorozoic	Cuddapah Super Group	Srisailam Quartzite with shale	Whitish to brownish massive/ flaggy
Eparchaean unconformity			
Palaeo-to-Mesoprotorozoic	Intrusives	Quartz reef/vein	Hard and massive
		Basic intrusives (Dolerite)	Hard and massive
		Closepet granite	Pinkish to whitish, hard massive
Archaean	Peninsular gneissic complex	Granite, gneisses and migmatites	Hard massive

Figure 2 shows the geological formations of the study area. Pinkish to white closepet granites are the oldest formations occurring north of the area; above this, dolerite dykes and with quartzite veins occurs. There is an unconformity called Eparchean unconformity formed above the quartz vein followed by whitish to brownish massive/flaggy quartzite with shale of Srisailam quartzite of Cuddapah super group of Mesoprotorozoic era formed along south and east of the study area.

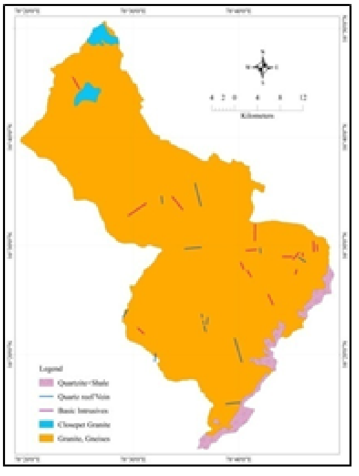


Figure 2: Geology of the study area

Geomorphology

Major part of the study area is categorized as pediment and pediplain with isolated residual hills called insulberg above the well developed plains resulting in erosion and long-term weathering in the various rates of degradation activity on land surface. It is steep sided and rise abruptly form in gentle slope terrain or level surrounding plain which acts as run off zone. Isolated residual hills are spread over the study area where as denudation hills develop on East Side Plateau with dissected hills and escarpment slope forms along the South and south east platform as run off zone. Pediment insulbergs occurs in the pediment zone characterized by limited extent in recharge and weather zone. Pediments with limited possible recharge and weather zone as well as pediplains with good recharge zone along with fractures forms on the hill slopes of the area on either side of the Dindi River. Valley fills of with sediments transported by the tributaries of the Dindi River along the stream course filled with loose material acts as a good recharge zone. Bajada develops with the alluvial material that is transported by the weathering of denudational hill slopes on south and east side of the study area extended from the escarpment slope to the pediplain. This area forms good recharge because of assorted nature of material. Concentration of the magma intrusions with dolerite occurs at the east side trending to north and south including remaining part of the area that act as a barrier for groundwater zone might be treated as run-off zone.

METHODOLOGY

Four pumping tests were carried out covering the entire study area. Detailed procedure adapted for the analysis of pumping test is given below.

Thesis curve matching Method

Thesis solution is determining the transmissivity and storativity from the data collected from an aquifer test is widely used [15, 16, 17]. The test data are a series of drawdown values in the observation well, each matched with a time since pumping began. The approach involves plotting the field data on one graph, which is overlain on type curve plotted at the same scale. Thesis equation obtained T and S from the using log-log graph paper of the data.

$$T = \frac{Q}{4\pi s} \text{ x } W(u) = m^2/day$$

$$S = \frac{4Tu}{r^2/t}$$

Q = discharge, T= Transmissivity, S = Aquifer storativity, W (u) = Coordinate value of the match point on the type curve, r = Radial distance from pumping well, t = Time since pumping began and s = drawdown.

Procedure

1. Values of drawdown are plotted against r2 on logarithmic paper of the same scale as that used for the type curve.

2. In the field observed time-drawdown data are superimposed on the type curve, keeping the co-ordinates axis of two curves being held parallel to locate the position of best match between the data plot and the type curve.

3. Select an arbitrary match point on the over lapping portion of the two sheets of graph paper and record the co-ordinates of match point W(u), sand r2 or t. Substitute Q and these values in to the following equation

$$T = \frac{Q}{4\pi s} \text{ x } W(u) = m^2/day$$

Cooper-Jacob Straight line method

Cooper and Jacob (1946) simplified and modified the Theis equation to obtained T and S from the using the convenience of a semi logarithmic graph of the data [18, 19, 20]. The T values obtained from the slope of the line, values from the zero drawdown intercepted the previously calculated T value.

$$T = 2.3 \text{ x } \frac{Q}{4\pi s} = m^2/day$$

$$S = 2.25 \frac{Tt_0}{r^2}$$

Where
T=Transmissivity in m2/day
Q= Pumping well discharge in m3
S= Slope on a semi- logarithmic time drawdown graph=L
t0 = extending the straight line to intersect the line of the zero drawdown
r = Radius of the pumping well

Procedure:

1.Plot drawdown versus time on semi-log graph paper, with on the X-axis as a logarithmic scale and drawdown on the Y-axis as an arithmetic scale , often, zero drawdown is at the top of the Y axis.

2. Fit a straight line through the data points.

3. Choose the t1 and t2 one log cycle apart, for example t1=10 min and t2= 100 min to give s or drawdown per log cycle. It can further be solved the following equation $T = 2.3 \text{ x } \frac{Q}{4} \text{ x } s = m^2/day$

Results and discussions

Pumping test data interpretation

In the present study area four pump tests were carried out at Machinenipalli, Mahadevpur, Ravichedu and Venkatapur villages. Location map of the pumping test wells has shown in figure 3.

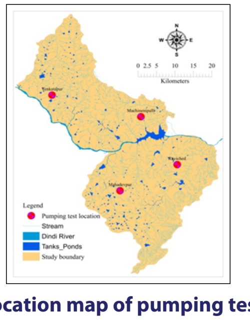


Figure 3: Location map of pumping test wells

In the present study to obtain aquifer parameters such as permeability and transmisivity done on single well located in the study area. Pumping tests have been carried out in the study area to know the aquifer parameters like hydraulic conductivity, transmissivity, storage coefficient and other aquifer parameters. Pumping well, also considered as observation well. The location of the pumping wells is shown in the Table 2.

Table 2: Location and other particular of the pumping site

Sl.No	Village	Longitude	Latitude
1	Machinenipalli	78.6253	16.5854
2	Mahadevpur	78.5743	16.3984
3	Ravichedu	78.7139	16.4644
4	Venkatapur	78.4085	16.6399

The Pumping test data is analysed and interpreted by using WWW software with Thesis and Jocob methods and recovery results have been analysed by fit method and calculated the transmissivity and storage coeffiencies. The pumping test data is carried out for 1000 minutes duration and recovery test up to 90 percent of the recovery of static water level (Table 3). The pumping rate varies from 2.15 litres per seconds to 4.9 litres per seconds. The observation time (t) is 1000 minutes for all tests and draw down (s) varies from 7.25 to 24.44 meters.

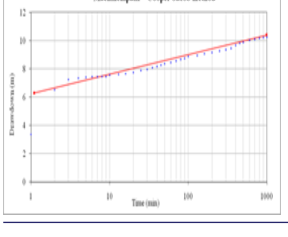
Table 3: Location and other particular of the pumping site

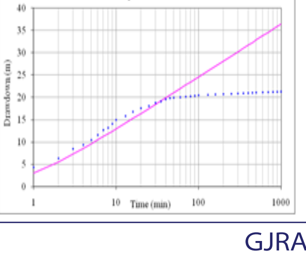
Sl.No	Village	Discharge		Time 't' in minutes	Drawdown 's' in meters
		Minimum	Maximum		
1	Machinenipalli	4.15	4.90	1000	7.25
2	Mahadevpur	2.15	2.30	1000	17.25
3	Ravichedu	3.33	1000	16.25	
4	Venkatapur	3.32	4.00	1000	24.44

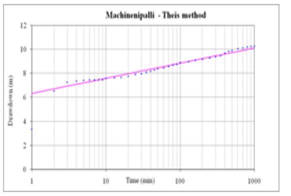
Table 4 shows the parameters of pumping test. From the curves and equations In Cooper-Jacob method transmissivity is varies from 3.7 square meters per day to 51.7 square meters per day; and Storage Coefficient is varies from 1.738x10-12 per unit area to 3.386x10-12 per unit area. The estimated transmissivity in thesis method varies from 3 square meters per day to 57 square meters per day; and Storage Coefficient is varies from 1x10-4 per unit area to 8.43 x10-7 per unit area). The aquifer here is sub artesian conditions with unconfined conditions and potentiality at the medium depths. The data revealed that in the there is good yield in the bore well that implies the fractures in the sub surface has been well developed in the sub surface.

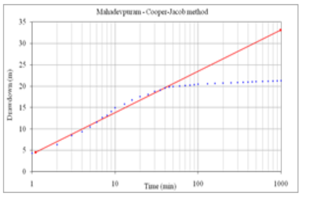
Table 4: Aquifer parameters

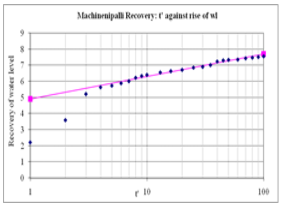
Sl.No	Village	Cooper-Jacob method		Thesis method		Recovery test
		Transmissitivity in m3/day	Storativity	Transmissitivity in m3/day	Storativity	Transmissitivity in m3/day
1	Machinenipalli	51.7	0.000399936	57.0	0.008430	51.2
2	Mahadevpur	3.7	0.338656596	3.0	0.000010	2.7
3	Ravichedu	27.3	0.000004214	20.0	0.001700	4.5
4	Venkatapur	31.7	0.000001738	35.0	0.000020	6.2

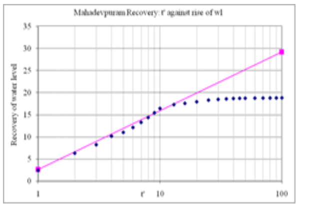


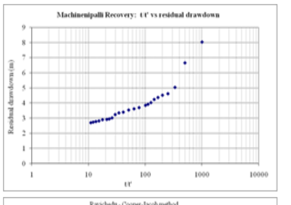


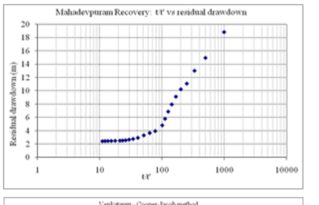


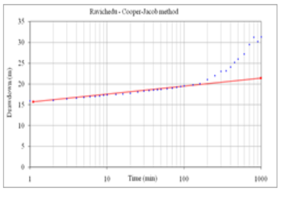


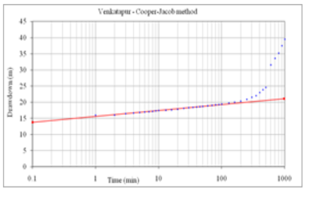


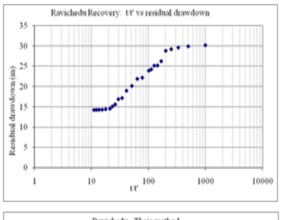


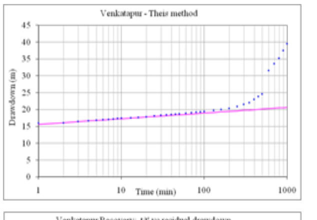


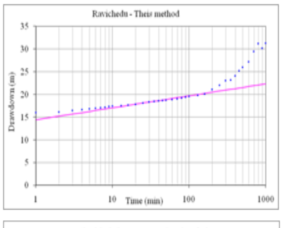


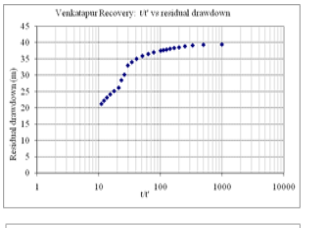


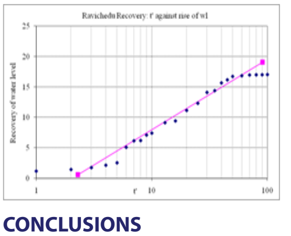


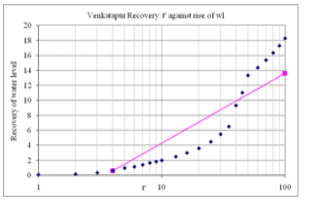












CONCLUSIONS

The study area is occupied by crystalline rocks consisting of granites, gneisses, the Precambrian sedimentary rocks represented by Cuddapah formations which occur at Northern hill ranges. In the study area Quartz reef/vein and basic dolerite intrusive control the flow of groundwater. Generally majority of the aquifer zones are encountered within the depth ranges of 15 to 25 meters below ground level (bgl). Groundwater in the crystalline rocks occurs under semi confined to unconfined condition in deeper aquifer. These zones are exploited bore wells at favourable conditions. In the present study area four pump tests were carried out at Machinenipalli, Mahadevpur, Ravichedu and Venkatapur villages. The aquifer here is sub artisian conditions with unconfined conditions and potentiality at the medium depths. The data revealed that in the there is good yield in the bore well that implies the fractures has been well developed in the sub surface.

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