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Groundwater Potential Assessment and Exploration in Bangalore South Taluk, Bangalore Urban District, Karnataka

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Abstract
Bangalore south taluk is a part of Bangalore urban district. Bangalore south taluk is categorised under Over-exploited as per the dynamic groundwater resource assessment carried out in 2022. Detailed study on aquifer potentiality will be helpful for management and improvement of groundwater resources. The evaluation of groundwater in crystalline terrains is complex due to various factors affecting the aforesaid resource. Groundwater exploration studies are utilized as primary tool to understand the hydrogeological condition of an area to know the aquifer potential. The data generated through exploration studies was utilized to understand the aquifer characteristics and GIS platform was used to depict the aquifer disposition viz. 2D, 3D cross-sections and Fence diagrams. The yield of exploratory wells ranges from 0.0 to 8.4 litre per second. The fracture depth analysis show that potential fractures lie in the depth range of 30 to 100 m below the surface. The highest yield encountered is 8.4 litre per second(lps) that correlates to the presence of high lineament density. The weathering thickness is higher in the North and Eastern part of the study area. The combination of field knowledge, GIS & exploratory data is crucial to locate high yielding, potential borewells; alongside ensuring sustainable management of deeper groundwater resource.
Key words: *Groundwater exploration, Well yield, Lineament density, Fracture zone.*

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I. INTRODUCTION

Central Ground water Board (CGWB) has been carrying out exploratory drilling activities since 1954. To understand the groundwater conditions the drilling activity is helpful to unearth the aquifer capability of yielding water of suitable quality and in economic quantities for domestic, irrigation and industrial purposes. The demarcation of water potential zone can be done through spatial analysis of exploratory data using geographic information system. In the present, the groundwater exploration studies are carried out in Bangalore south taluk of Bangalore urban district as a part of annual assignment. The Ground water Exploration study in Bangalore South taluk is carried out due to its over exploited nature with respect to dynamic groundwater resource assessment with 108 % (Ground Water Resource assessment 2022) of stage of development marking the Bangalore south taluk is water stressed. The groundwater exploration studies are mainly used in the present study for better understanding of groundwater scenario in Bangalore taluk.

The Bangalore south taluk is covered under National Aquifer Management studies (NAQUIM). The Objective of Aquifer Mapping is to define the aquifer geometry, type of aquifers, ground water regime behaviours, hydraulic characteristics and geochemistry of multi-layered aquifer systems on 1:50,000 Scale, delineation & disposition of aquifer for formulating Aquifer Management Plans.

In the present study, the groundwater exploration studies is carried out to understand the hydrogeological significance in groundwater potential of deeper aquifers as an alternative to over-exploited shallow aquifer system using planned management strategies. The increasing population in the urban areas leading to an alarming situation for sustainable management of groundwater resources.

II. STUDY AREA

Bangalore South Taluk, Bangalore Urban district of Karnataka state covers an area of 342 Sq km and located between North latitude 12° 51' 53.61" to 12° 53' 024.40" & East longitude 77° 33'27.74" to 77° 34' 35.60" (Fig.1). Geology of Bangalore South taluk comprises of Banded Gneissic complex which is known as peninsular Gneissic complex and Fractured granite which content the secondary porosity and lineament. Geomorphologically, the Bangalore South taluk belongs to southern maidan region with undulating topography and hills. The Hilly areas in the taluk occupying in some patches in western, central and southern part of taluk.

Shimsha and Kanva rivers of Cauvery Basin are the major rivers in study area and Vrishabhavathi river also flowing in the taluk. The Climate of the taluk comes under Eastern Dry Agro-Climatic zone. Actual Rainfall encountered in 2022 is 1495mm (Source-KSNDMC).

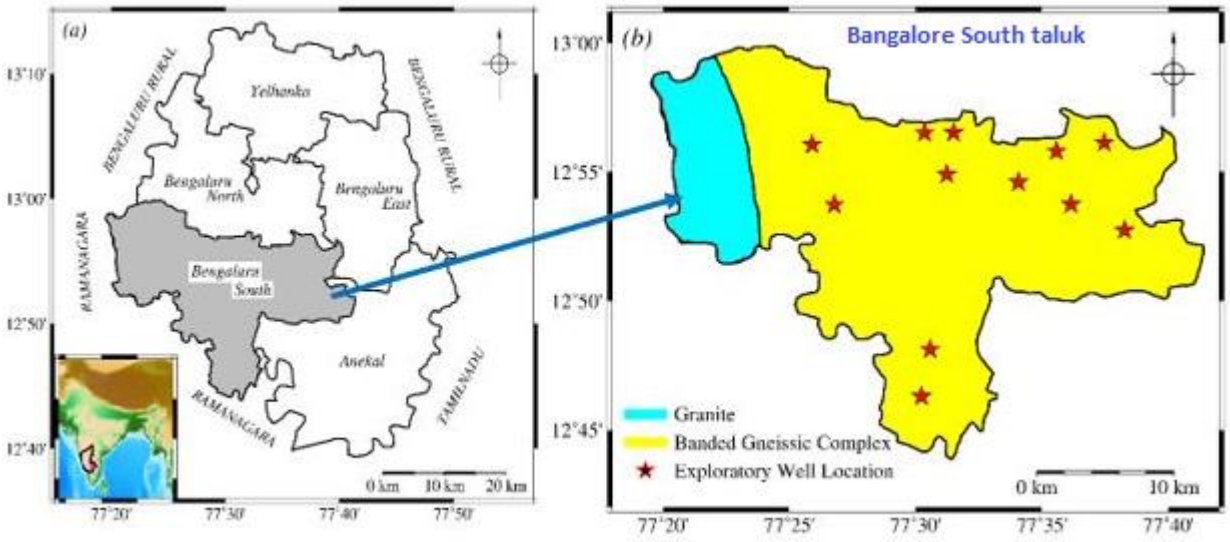

Figure1: The figure shows the location of study area (Bangalore South taluk)

III. DATA USED AND METHODOLOGY

Bangalore South taluk lies in Hard rock terrain, due to hard rock, secondary porosity plays an important role in accumulation of water. The taluk is categorised as over exploited in dynamic ground water resource assessment study. Reconnaissance surveys carried out in field for studying geology, geomorphology and hydrogeology of area.

The Exploration drilling is carried out by CGWB during 1995-96, 2011-12 and 2021-22 in Bangalore South taluk followed by field study during the year 2022. 4 no's of exploratory wells are drilled during the year 2021-22 as part of yearly assignment of groundwater exploration. The Previously available exploration data of CGWB which was drilled in 1995-96 and 2011-12 in Bangalore South taluk included 9 wells is also used in the present study. The detailed data sheet is given in Table-1. Overall, 13 number of Exploratory borewell drilled in Over-exploited Bangalore South Taluk till 2022.

The present study is carried out to understand the hydrogeological significance in over exploited Bangalore south taluk. The methodology involved the groundwater exploration though drilling of borewells after proper site selection and hydrogeological survey of the study area. Analysis of exploratory data for better understanding of hydrogeological conditions in Bangalore South taluk and to know the aquifer potentiality in South Bangalore taluk.

IV. RESULTS AND DISCUSSIONS

4.1 Ground Water Exploration

The Exploration drilling data of combined 13 wells drilled by CGWB in Bangalore South Taluk is used in the present analysis (Fig. 2). The exploratory data of the wells is given in the Table 1. It is observed from the data that drilling depth of exploratory well ranges from 100 m to 265m. Static water level of the wells measured from 5.36 to 30.8 m and Drawdown of the wells is ranges from 3.35 to 28 m. The weathered zone and casing of the taluk ranges from 12 to 40 m (Fig. 3). The thickness of weathered zone ranges from 0-20m found in patches in eastern, western and southern part of taluk. 20-30m ranges of weathered thickness observed in all over the taluk and >30m weathered thickness observed in north and northern east part of taluk. During drilling of borewells, fractures zone encountered which show the discharge and yield of the zone in particular area. Fractured zone during exploration encountered between 25 to 258 m which predicted the discharge and yield from 0 to 8.4 litre per second (lps) in the Over-exploited taluk. The most common fractured zone is from 100 to 250 m. The Transmissivity of wells showing 2 to 280 m^2/day. The summarised data is given in Table 2.

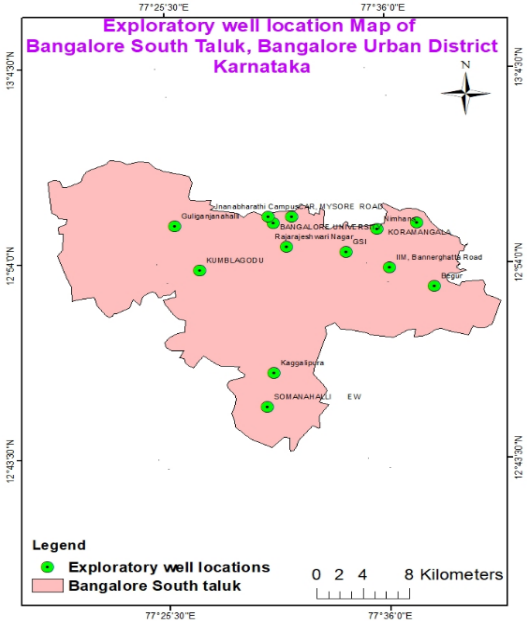

Figure 2: The figure shows the exploratory well location of study area

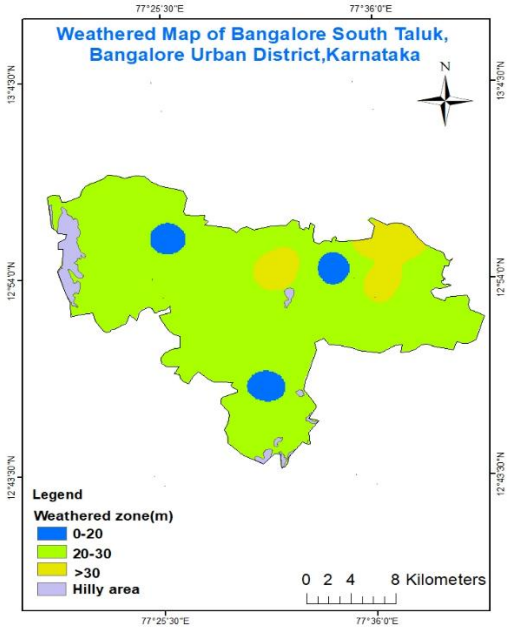

Figure 3: The figure shows the weathered thickness of study area

Table 2: Table showing the details of exploration in Bangalore South taluk

Taluk	Bangalore South Taluk
No of well drilled	13
Depth drilled(m)	100-265
Casing(m)	12-40
Fracture zone(m)	25-258
Static water level(m)	5.36-30.8
Discharge(lps)	0-8.4
Drawdown(m)	3.35-28
Transmissivity(m2/day)	2-280
Lithology	Granitic gneiss with Pegmatitic vein, Quartz veins Hornblende and Dolerite dyke

4.2 Hydrogeological Prospect

Geology of the Bangalore South taluk is Predominantly Banded Gneissic Complex and Granite (Fig. 4). The water bearing formation is fractured Granitic Gneiss. In Hard rock terrain, groundwater deposit under fractured Granite which formed due to secondary porosity. In general, the granitic terrain contains good aquifer as compared to gneiss, schist, phyllite, slate, pegmatites, dolerite, volcanic (Igneous) rock. Lithology of this study area are mainly Pegmetitic veins, Quartz veins, Hornblende granitic gniess and Doleritic dyke which act as a Carrier of water. Pegmetitic veins and Quartz veins indicate good potential of water zone. There are 2 types of aquifers, weathered or phreatic aquifer comprises of weathered granite and fractured aquifer contains joints and Fractures. Weathered zone of study area is upto 40 mbgl and Fracture zone is upto 258mbgl. Depth range of Occurrence of Fracture is from 100 to 250 mbgl. Based on studies, it is found that the Occurrence of fracture in less than 30m depth is 6%, from the depth of 30-100 m is 58% and from the depth of 100-200m is 36% (Fig. 5).

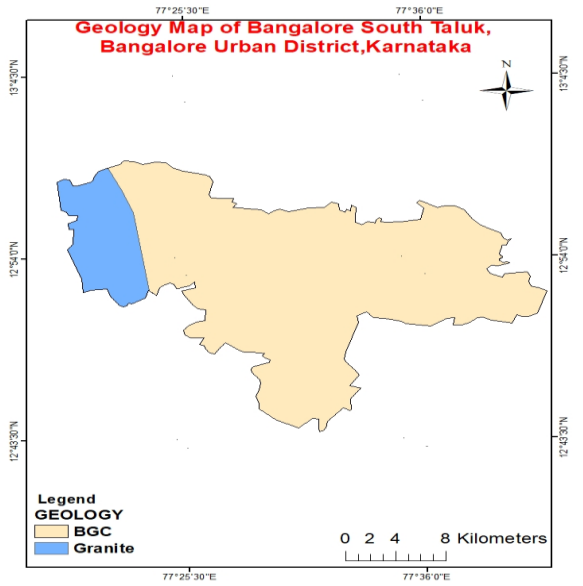

Figure 4: Geology of study area showing BGC and Granite

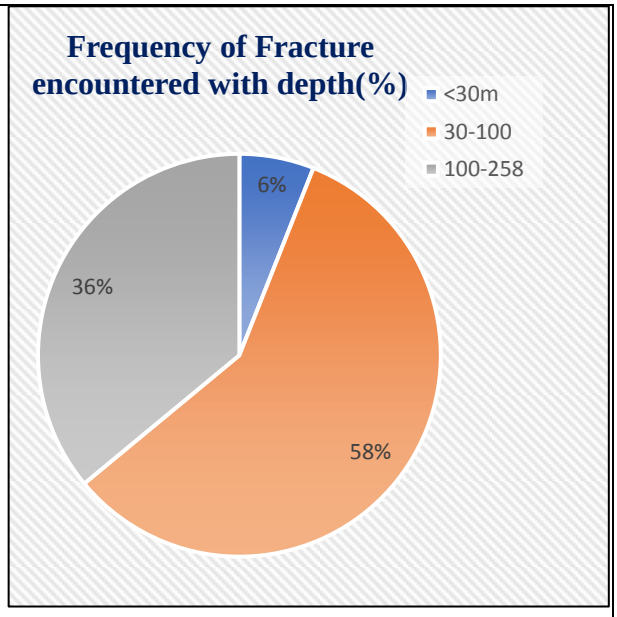

Figure 5 : Frequency of fractures with depth of well

In Hydrogeological Prospect, the Yield and Discharge of any well showing the water holding capacity of aquifer. The yield is induced by presence of lineament which enhance the potential zone. During the drilling of wells, we have evaluated the yield of study area. In Bangalore South taluk, the yield of well estimated from 0 to 8.4 lps. The hydrogeology map is given in the Fig. 6, It is observed from the figure that, the high yielding zone of > 3lps is observed in north western and southern part of the study area yield value of 1 to 3 lps found in central and South west part. The thematic layer of lineaments (KSRSAC data) is superimposed in hydrogeology map, it shows the higher lineament density in North, South and Western part of the study area. The high yielding wells are also found in the Northern part of the study area i.e., in Bangalore University with yield of 6.44 lps & 8.4 lps, Guliganjanahalli showing 5.41lps of yield etc., in general the positive correlation is observed in areas having good yield with higher lineament density and weathering thickness.

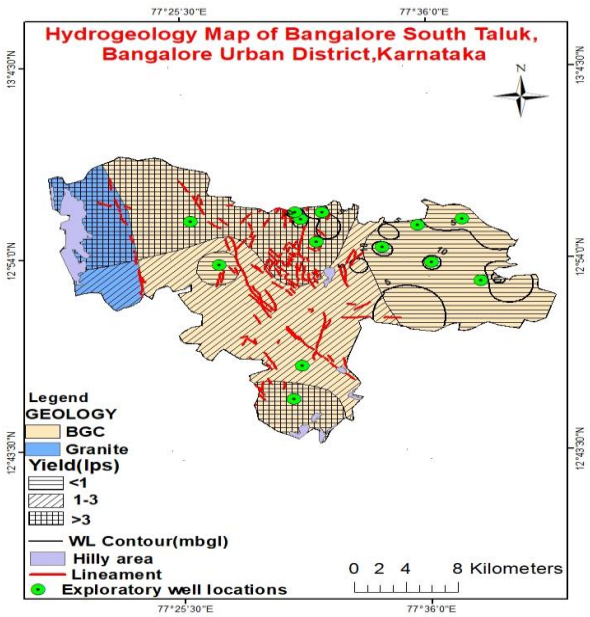

Figure 6: The figure shows the Hydrogeology of study area

4.3 Aquifer Disposition:

The sub-surface aquifer disposition of the study area in 2D and 3D is prepared along with fence diagrams/models through Rock works software (Fig. 7, 8 &9). To study the aquifer disposition in detail, various hydrogeological cross section indicating aquifer geometry has been prepared viz. A-A' representing North – South direction, B-B' representing West-East respectively (Fig. 7).

Hydrogeological cross section A-A', represents North – South direction. It is observed from the cross section that, the weathering thickness is constant throughout the cross section followed by fractured aquifer and massive rock formation. The thickness of Aquifer-I (shallow aquifer) is constant but the Aquifer-II (deeper aquifer) thickness is more between Kumblagodu and Jnanabharathi. Near Koramangala the direct contact of weathered and massive formation is clearly observed from the cross section.

Hydrogeological cross section B-B' represents West to East direction. It is observed from the cross section that, the weathering thickness is constant throughout the cross section followed by fractured aquifer and massive rock formation. The thickness of Aquifer-I (shallow aquifer) is constant but the Aquifer-II (deeper aquifer) shows variable thickness followed by massive rock formation. The highest thickness of Aquifer-II is observed near Kaggalipura village.

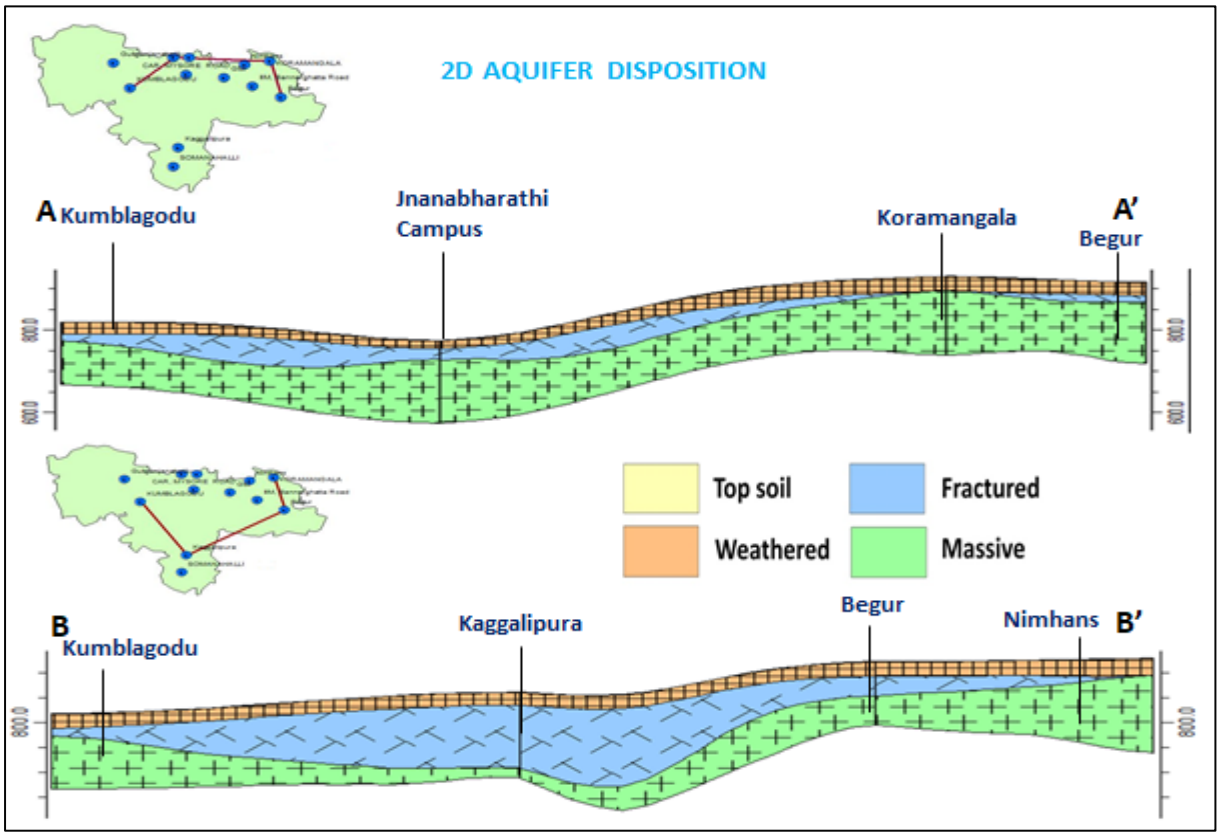

Figure 7: 2D Aquifer Disposition showing the cross-section of study area in variable direction

The fence diagram indicating the disposition of various aquifers is presented in Fig. 8. The fence diagram represents variability of thickness of weathered, fractured and massive formation. It is matching with the 2D cross sections. The fence diagram represents the constant weathering thickness throughout the study area followed by variable thickness of fractured zones overlaid by the massive formations.

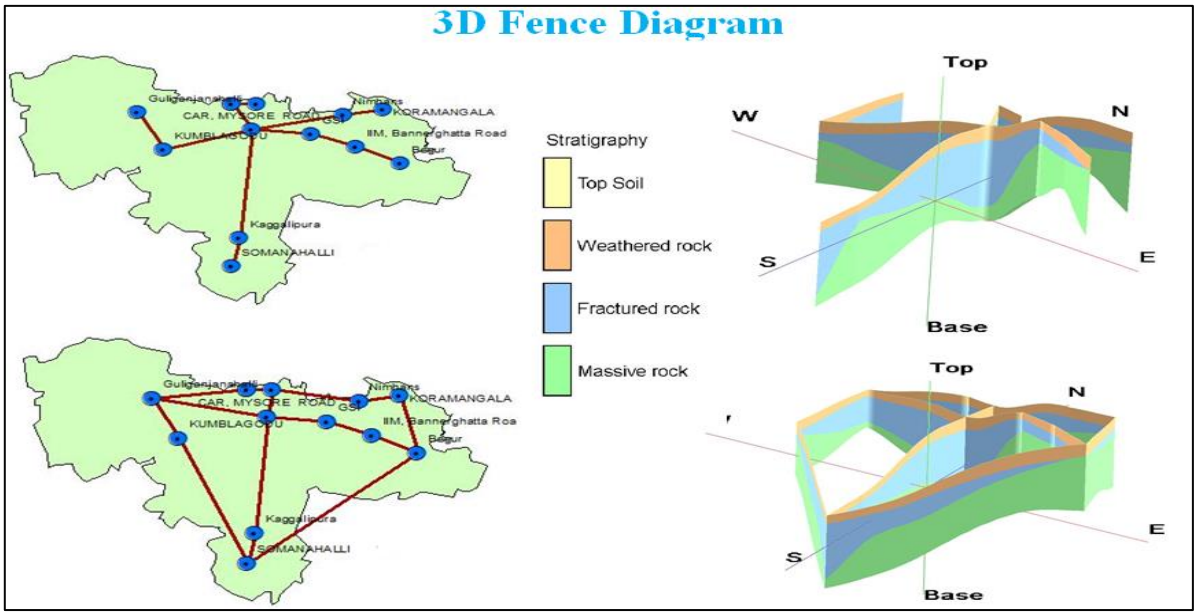

Figure 8: 3D Fence diagrams represent variability of thickness of weathered, fractured and massive formation

The 3D representation is presented in Fig. 9. The disposition of Aquifer-I and Aquifer-II followed by massive formation can be observed in the 3D aquifer disposition. The depth of weathered thickness is observed up to 40 m, which is followed by fractured aquifer which is disposed up to 258 mbgl depth followed by massive formation devoid of any ground water.

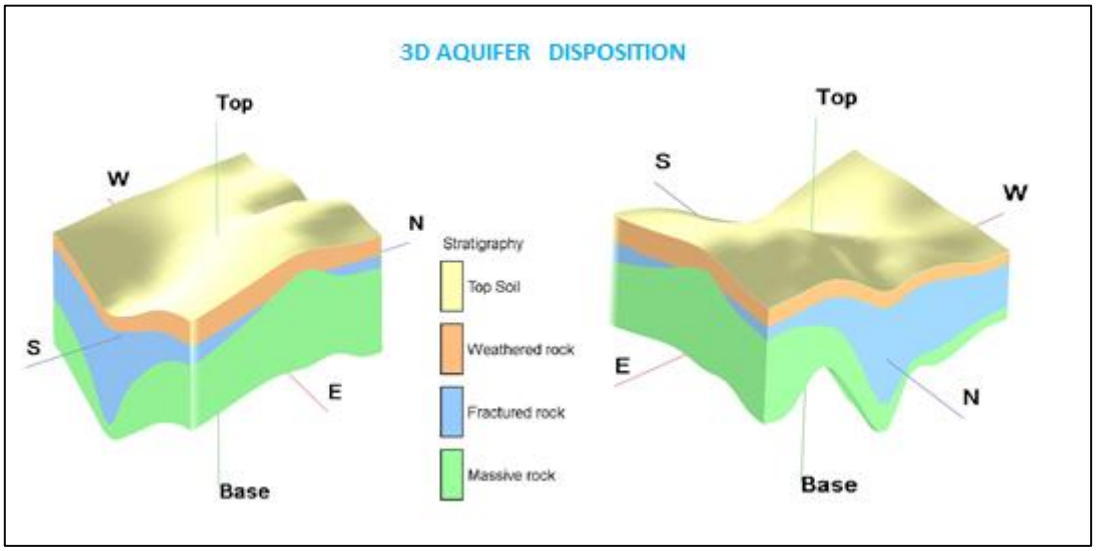

Figure 9: 3D Aquifer disposition represent the disposition of Aquifer-I and Aquifer-II

V. CONCLUSIONS

Bangalore South taluk has been categorized as an Over Exploited taluk with respect to dynamic groundwater resources, the Stage of ground water extraction has reached to 108% as per (Ground Water Resource assessment GWRA 2022). The over-exploition of first aquifer adds to the scarcity of water prevail in the study area. The groundwater exploration is used as a tool to study the phreatic aquifers representing the deeper aquifer system. Exploratory wells drilled by CGWB in study area in taluk is used for understanding the hydrogeological significance in Bangalore south taluk. The results show the presence of good yielding wells with discharge of about 8.4 lps. The Potential fracture zone revealed from the depth of 100 to 250 mbgl which have 2 to 3 sets of fractures with yield of 0.0 to 8.4 liter per second. The high yielding wells are found to be attributed by the presence of higher lineament density and more weathered thickness in the study area. To maintain the deeper aquifer, artificial recharge structure, grey water re-use practice and micro-irrigation i.e drip and sprinkle method can be used for groundwater management plan.

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Table 1: Detailed Exploratory well data of Bangalore South Taluk

S.N	District	Taluk	Location	Latitude	Longitude	Year of construction	Depth drilled (mbgl)	Casing	Lithology	Fracture Zones encountered	Discharge
1	Bangalore Urban	Bangalore South	Somanahalli	12.77155	77.50383	**1994-95**	210	**25**	Granitic gneiss	14-28, 38-40, 45-50, 70-73, 95-96, 102-106, 123-126, 182.5-183.5, 203-205	5
2	Bangalore Urban	Bangalore South	Kumblagodu	12.8668	77.41881	**1994-95**	150	**30**	Granitic gneiss	25-39	0.81
3	Bangalore Urban	Bangalore South	Bangalore University	12.94198	77.50595	**1994-95**	119	**24**	Granitic gneiss with Pegmatite	47-49, 54-58, 78-81, 106-112, 115-119	8.4
4	Bangalore Urban	Bangalore South	Koramangala	12.9356	77.6244	**1995-96**	215	**31**	Granitic gneiss	38.75-43.25, 34-43	1.2
5	Bangalore Urban	Bangalore South	Car, Mysore road	12.94205	77.52508	**1995-96**	265	**28**	Pegmatite Granitic gneiss	45-52, 75-78, 110-116, 211-213	3.5
6	Bangalore Urban	Bangalore South	Nimhans	12.93009	77.59287	**2011**	100	**32.5**	Granitic gneiss with pegmatite veins, dolerite dykes	47.40- 51.40, 68.68-72.32	1
7	Bangalore Urban	Bangalore South	IIM, Bannerghatta Road	12.89574	77.60249	**2011**	108	**32.5**	Granitic gneiss	51.4-55.04	0.22
8	Bangalore Urban	Bangalore South	GSI	12.90999	77.56783	**2011**	200	**12**	Granitic gneiss	32.12	0.51
9	Bangalore Urban	Bangalore South	Rajarajeshwari Nagar	12.91507	77.52055	**2012**	250	**40**	Granitic gneiss	225-228	4
10	Bangalore Urban	Bangalore South	Begur	12.87894	77.63772	**2022**	200	**28**	Granitic gneiss	0	0
11	Bangalore Urban	Bangalore South	Kaggalipura	12.80194	77.50952	**2022**	200	**18**	Granitic gneiss	20-22	2.1
12	Bangalore Urban	Bangalore South	Guliganjanahalli	12.9343	77.43171	**2022**	100	**18**	Hornblende granite	74.32-89.60	5.41
13	Bangalore Urban	Bangalore South	Jnanabharathi Campus	12.94198	77.50595	**2022**	160	**22**	Granitic gneiss	30.48-160	6.44