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HYDROGEOLOGICAL HYDROGEOPHYSICAL HYDROGEOCHEMICAL STUDIES IN SANDUR AREA BELLARY DISTRICT KARNATAKA

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ABSTRACT

Sandur is a chronically drought prone area in the underdeveloped Bellary district of Karnataka. Sandur schist belt chiefly consist of iron-formations and epidiorite surrounded by peninsular gneissic complex. Structurally it is a canoe-shaped doubly plunging synclinorium with many fault zones. The rocks are highly fractured and jointed and are exposed to intense weathering and climatic vicissitudes resulting in deep weathered zone which helps in the storage and movement of groundwater. Groundwater in the Sandur area occurs mainly under water table conditions. Electrical resistivity surveys were carried out to understand the subsurface hydrological conditions. The vertical electrical soundings (VES) conducted at selected points revealed typically 3-layered situations where the second layer is the thick weathered zone (10-30m) with low resistivity (10-105 ohm-m) and is interpreted as the saturated zone. It is found from resistivity survey as well as from field observation that the shallow dugwells and dug cum borewells are more successful than the deep tubewells.

Few water samples collected from iron-formations and epidiorites were chemically analysed to test the quality of water and to establish the relationship between the chemistry of water and the major rock types. Chemical analysis of water samples from epidiorites show a high degree of concentration of ions compared to the waters from iron-formations. When total dissolved solids (TDS) are plotted against ratios of Na+K/Na+K+Ca and $Cl/Cl+HCO_3$ in Gibbs variation diagram, it is found that the quality of water is mainly controlled by the major litho units of the area. Since the chemical constituents are within the permissible limits, the waters of Sandur area is suitable for drinking, domestic and agricultural purposes.

INTRODUCTION

Sandur, a small town and mining centre of Bellary district is drought hit area and has been facing an acute scarcity of water for drinking, domestic and agricultural needs. Since the occurrence, movement distribution and quality of groundwater are mainly controlled by the hydrogeological, hydrogeophysical and hydrogeochemical characters, an attempt is made here to study the same since not much work has been done on these aspects of Sandur area.

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Groundwater in Sandur area occurs mainly under water table condition. The well developed structures like the fractures and joints in the major rock types of this area viz., epidiorite and iron-formation helps in the storage and movement of groundwater. The resistivity survey suggests that there is a thick weathered zone which is saturated. The chemical analysis of water samples shows that the water is suitable for drinking, domestic and agricultural purposes since all the dissolved chemical constituents are within permissible limits. It also indicates that there exists a relationship between the chemistry of water and the major rock types of Sandur area.

GEOLOGY

The schistose rocks of Sandur schist belt form the high mountain ranges capped by massive banded hematite quartzites and manganese ore deposits. The Sandur valley is mainly composed of epidiorite (trap rock) which is hard and massive often showing spheroidal weathering at surface. A few dolerite dykes of various width and length are also observed in the area.

Structurally, the Sandur schist belt is a canoe-shaped doubly plunging synclinorium (Shivakumar and Naganna, 1975). The zone between Obalagendi and Bhimanagandi gorges in the Sandur valley is a major fault zone along which the Narihalla stream flows. The major rock type in the valley viz., epidiorite is highly jointed and fractured and exposed to intense weathering and climatic viscissitudes resulting in deep weathered zone with large storage of groundwater.

MODE OF GROUNDWATER OCCURRENCE

Groundwater in the Sandur area occurs mainly under water table conditions. The main source of groundwater is rainfall which is about 787 mm per year. The rocks of the area are weathered upto a depth of 15 m and at the increasing depth they are traversed by a few joints and fissures and at very deep levels they become free from structural weakness. The weather zone together with the pebbly bed along the Narihalla stream forms the aquifer. The soil and the weather rock is sufficiently porous and a good portion of the rain water soaks in and augments the groundwater storage. The depth to water table varies varies from 15 to 20 m and the depth of the dug wells in the area ranges from 8 to 25 m while the tubewells are 45 to 60 m deep.

RESISTIVITY SURVEY

Electrical resistivity surveys are carried out to understand the subsurface hydrological conditions. A number of vertical electrical soundings (VES) are conducted at selected points employing Schlumberger electrode arrangements. The resistivity spacing curges are interpreted using curve matching technique (Rijkswaterpaat,1975) and the results are tabulated in Table I.

TABLE I Resistivities and corresponding thickness as interpreted from field curves, Thickness in metres and resistivity in ohm-metres.

VES No.	Location	Type curve	1	h_1	2	h_2	3	h_3	4
1	P.G.Centre,Nandihalli (Near Hostel)	A	9.5	0.82	95	24.6	∞		
2	P.G.Centre,Nandihalli (Near Cricket pitch)	H	32	2.2	10	13.2	192		
3	P.G.Centre,Nandihalli (Near Guest House)	H	16.5	0.9	11	10.8	∞		
4	P.G.Centre,Nandihalli (Near Canteen)	H	88	1.0	58	30.0	528		
5	Sandur	H	17	0.8	5.6	6.4	∞		
6	Sandur	H	70	0.5	23	15	∞		
7	Sandur	H	20	1.0	10	12	∞		
8	Bhujangnagar	KA	17.5	1.0	105	6.0	17.5	14.0	660
9	Bhujangnagar	H	36	1.05	12	12.6	900		
10	Bhujangnagar	A	9	0.9	13.5	18.0	∞		
11	Bhujangnagar	A	5	0.35	7.5	10.5	∞		
12	Sandur	AH	14.5	1.1	23	2.4	7.65	7.2	

The field curves recorded are typically 3-layered with an occasional 4-layered situation. The geoelectrical section has been translated into a geological section. In 3-layered situation the first layer represents a thin soil cover (1 m) having a resistivity range of 5 to 88 ohm-m. This is followed by a weathered zone which has a resistivity range of 10 to 105 ohm-m. Since the resistivity is low (10 to 105 ohm-m) and the thickness is large (10 to 30m) this zone is interpreted as the saturated zone. This is further confirmed from the field observation that the shallow weathered zone is comprised of weathered epidiorite which is highly fractured and jointed. Therefore, this zone is taken as water bearing and is important for groundwater extraction. The third layer with high resistivity is not important for groundwater prospecting. In the 4-layered situation, the fourth layer constitutes the massive bedrock devoid of water. Therefore, the resistivity survey and field observations suggest that the shallow dugwells and dug cum borewells are more successful than the deep tubewells.

WATER QUALITY

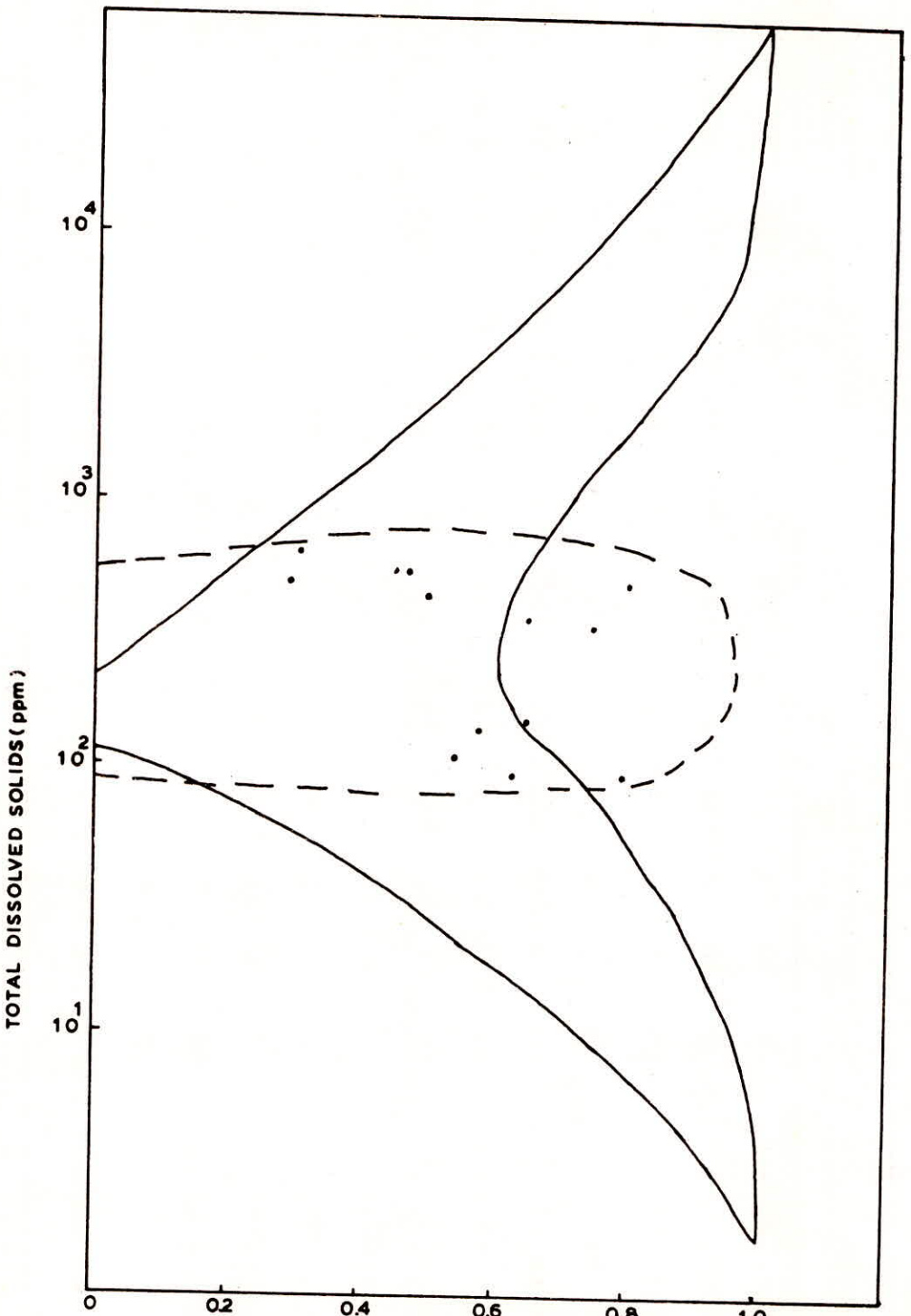
In order to test the quality of water for drinking, domestic and agricultural purposes and to establish the relationship between the chemistry of water and the major rock types, a few water samples were collected from the epidiorites and iron formations of Sandur area and were chemically analysed. Out of the thirteen samples collected, five are from the iron formations, five are from epidiorite and three from Narihalla stream. Various chemical constituents are determined (Table II) by routine volumetric methods (Rodler,1975).

The water samples from the wells and springs located in areas constituting eipdorite and iron formations of Sandur area show a considerable variation in their chemical constituents. The major cations like Ca,Mg,Na and K are more in the waters from epidiorite than in the waters from iron formations. The anions like Cl and So_4 are also high in the waters from epidiorite than in waters from iron formations. The high So_4 content in waters from epidiorite is contrary to the report by puranik et al (1981). But, however the concentration of the ions in both the formations are within the permissible limits specified by WHO (1963) thus rendering this water useful for drinking, domestic and agricultural needs. The TDS in waters of Sandur area are plotted against ratios of NA+K/NA+K+Ca and Cl/Cl+HCo_3 in Gibbs (1970) variation diagram(Fig 1 and 2). It is observed that the points confine to the central rock dominance field of the diagram, suggesting that the chemistry of the groundwater is mainly controlled by the rock types of the area.

TABLE II Chemical Analysis of Water Samples from Sandur area(in ppm)

Sl. No.	Constituents	Iron-formations					Epidiorite				Stream water			
		1	2	3	4	5	6	7	8	9	10	11	12	13
1.	Calcium as $CaCO_3$	38	12	56	36	32	380	260	230	360	220	80	70	85
2.	Magnesium(Mg)	2	38	4	34	48	140	50	160	120	240	78	76	229
3.	Sodium(Na)	24	18	30	16	18	72	78	36	118	82	58	82	122
4.	Potassium(K)	2	2	1.8	1.2	6	6	6	2.2	12	8.8	4	6	14
5.	Chloride as Cl	40	30	50	30	38	120	150	60	208	148	98	126	218
6.	Total Iron as Fe	NA	0.02	NA	NA	0.01	NA	NA	NA	0.09	0.08	0.03	0.03	0.06
7.	Bicarbonate(HCO_3)	110	NA	80	NA	75	440	350	163	450	395	140	130	298
8.	Carbonates(CO_3)	-	-	-	-	-	-	-	-	-	-	-	-	-
9.	Sulphate as SO_4	12	22	32	38	NA	102	228	296	NA	NA	NA	NA	NA
10.	Total dissolved Solids(TDS)	93	96	134	102	158	622	536	488	530	412	356	340	482
11.	Total Hardness(TH)	40	40	60	70	80	520	310	39	480	460	158	146	314
12.	pH	5.2	5.0	5.4	4.7	7.4	7.2	6.4	7.3	7.5	7.9	7.9	7.7	8.1
13.	Ec in micho mhos/ Cm at 25°C	143	151	168	120	176	744	762	582	742	586	265	283	545

Sample Locations: (1) Deogiri, (2) Harishankar, (3) Donimalai, (4) Bhimanagandi, (5) North East of Harishankar, (6) Nandihalli, (7) East of Bhujangnagar, (8) Nandihalli (9) Dharmapur, (10) Lakshmipura, (11) Narihalla, (12) Narihalla,(13)Narihalla (Near Bhimanagandi Gorge



Plotting of T.D.S. and Na+K / Na+K+Ca Values of Water Samples from SANDUR area in Gibbs '1970) Variation Diagram.

FIG. - 1

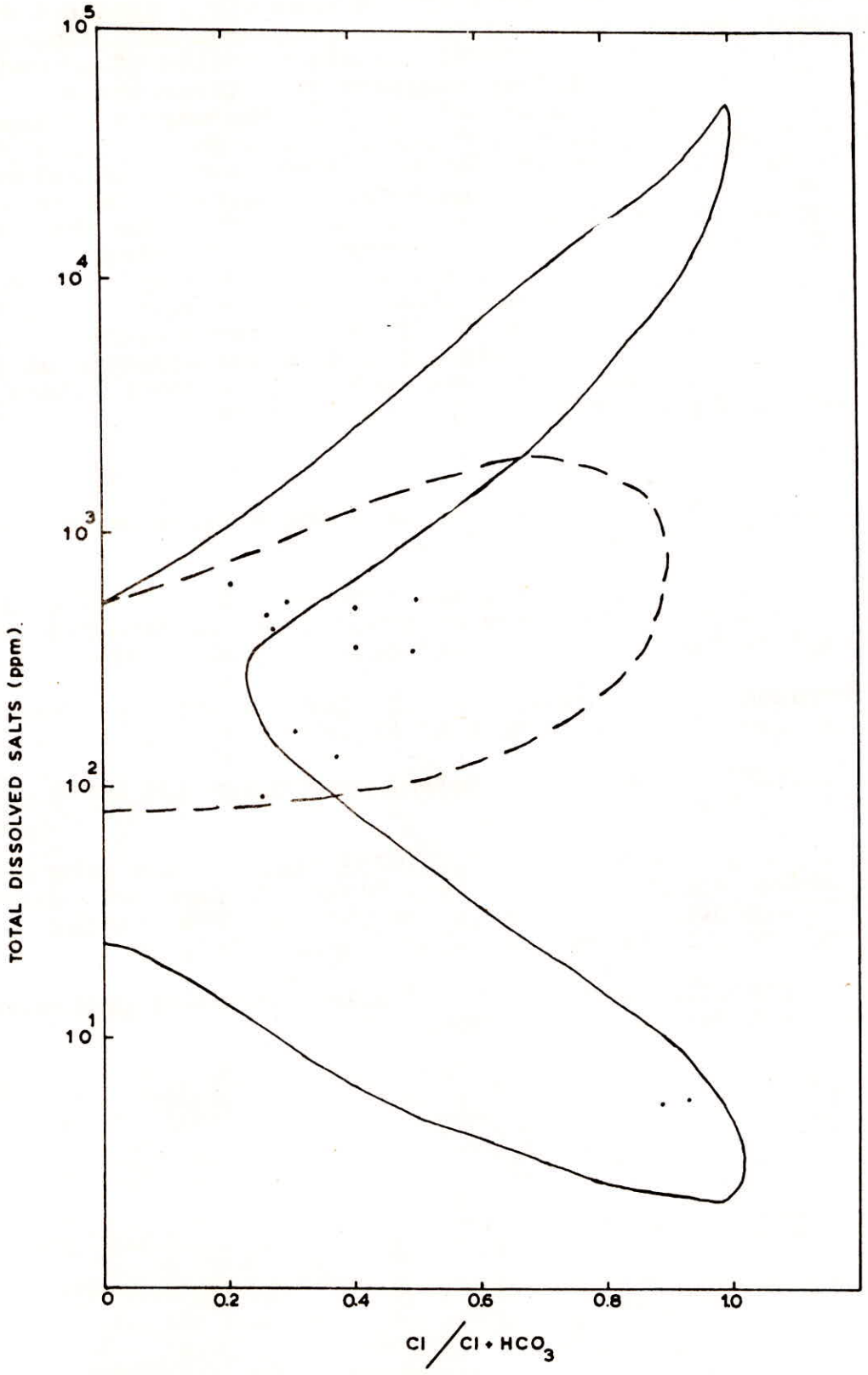

10^5
10^4
10^3
10^2
10^1
TOTAL DISSOLVED SALTS (ppm).
0
0.2
0.4
0.6
0.8
1.0
Cl / Cl + HCO_3

FIG.-2

CONCLUSIONS

Groundwater in Sandur area occurs mainly under water table condition. The major rock type of the area viz., epidiorite and iron formations are highly weathered, fractured and jointed and favaours the occurence, movement and distribution of groundwater. Electrical resistivity survey suggests that these are typically 3-layered situations. The second layer is the weathered zone with low resistivity (10 to 105 ohm-m) and high thickness (10 to 30 m) which indicates the saturated zone. This saturated zone is very important for groundwater extraction. The resistivity survey and field observations reveal that the shallow dug wells and dug cum borewells are better water yielding than the deep tubewells. The chemical analysis of water samples from epidiorite and iron formations showed that the water is suitable for drinking, domestic and agricultural purposes since all the dissolved chemical constituents are within the objectionable limits. It is also found that the chemistry of these waters is controlled by the major rock types of the area.

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