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HYDROGEOCHEMICAL STUDIES IN PARTS OF ARIYALUR TALUK, ARIYALUR DT., TAMILNADU, INDIA.

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ABSTRACT

Water potential in crystalline rocks is within 100 m from the surface. In sedimentary formation, porous rocks yield water at depths more than 2000 m. The concern today is the shrinking ground water resource, falling water tables, increased flooding and droughts and water budgets that are badly out of balance. With these views Marudaiyar – Ariyalur mini watershed area of Ariyalur district was chosen for the study to know the ground water potential and quality of the groundwater. The area is mainly composed of Cretaceous, Tertiary and Quaternary formation which includes calcareous sandstones, shell limestones and alluvium. To understand the geochemical quality of groundwater in the study area, water samples were collected at 45m to 50 m depth bore holes drilled by Tamilnadu Water and Drainage Board (TWAD). The groundwater of the study area in general is colorless and odorless. Analytical data shows that most of the groundwater of the region is suitable for irrigation and domestic purpose with few abnormal concentrations exceeding the maximum permissible limit. Regarding the condition of the drinking water nearly two third of the samples are within the limits. One third of the samples, which falls in the North Eastern and Eastern side of the study area, were having values above the limits. The water from the south and south eastern area which belongs to alluvium formation is suitable for drinking purpose. The hydro geochemical studies of EC and TDS also reveals that two third of the samples fall in Fresh water category. However, one third i.e. twelve numbers of samples falls in brackish water category. This is due to the successive action of weathering and dissolution process based on the lithology of the area which includes limestone and shale

Keywords: Sedimentary, limestone, calcareous, dissolution, lithology, weathering.

1.INTRODUCTION

Safe drinking water is essential to human beings and other life forms even though provide no calories or organic nutrients. Access to safe drinking water has improved over the last decades in almost every part of the world, but approximately 1 billion people still lack access to safe water and over 2.05 billion lack accesses to adequate sanitation.

There is clear correlation between access to safe drinking water and gross domestic product per capita. However, some researchers have estimated that by 2025 more than half of the world's population will be facing water based vulnerability, a report, issued in November 2009; suggest that by 2030, in some developing regions of the world, water demand will exceed supply by 50%. During the last decade many cases of ground water pollution in India were due to the urban effluent inputs due to agricultural activities besides sea water intrusion.

These have demonstrated the need for better protection necessities along with understanding the ground water potential, geochemical nature and interaction has been widely used for identifying the solving of ground water problem in the past decade. As the concern over ground water quality receives increase attention world over, an attempt existing in documenting the hydrogeology, hydro geochemistry of ground water in parts of Ariyalur area.

2.STUDY AREA

The study area comprises of 15 locations in and around Ariyalur area. An area of 227.96 square kilometers has been taken as the study area. The area lies between $78^0 11'$ to $79^0 11'$ east longitudes and $11^0 2'$ to $11^0 8'$ north latitudes in Tamilnadu state. Before the advent of the human activities the area was submerged under the sea water. Later due to the marine regression, the sea water receded towards the east and thus emerged the present day land made of metamorphic

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rocks belonging to the gneiss family. The rocky soil is made of sedimentary and gypsum rocks that belong to different geological periods. These changes took place around 15 million years back at the period of Cretaceous age. The study area represents a part of coastal sedimentary plains & river basin. The study area is drained by Marudaiyar river flowing south easterly and is a seasonal tributary to river Pennar, which flows towards east to the Bay of Bengal ultimately. The study area geomorphologically divides into alluvial plains, Buried pediments, low land Cretaceous and lineaments.

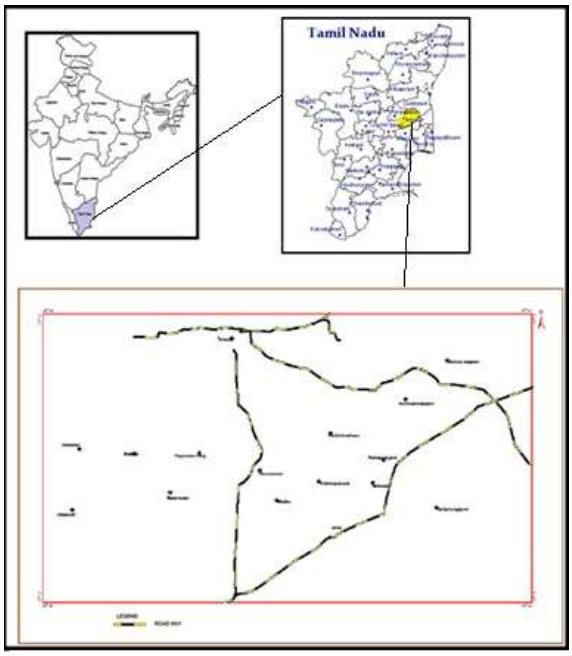


Fig. 1 Study area map

DRAINAGE:

The Marudaiyar River is the major river flowing through the area finally joining to Kollidam River in the east. The river runs towards east for a distance of about 170km covering an area of about 9.178 square kilometers helping for the irrigational and industrial purposes. It has an ample amount of alluvial plains at its low reaches but is dry in summer as the river is seasonal or ephemeral. The Kundiyar river, Mettal Odai, Champan Odai, Kallar river, Vanchiyam and Uttankal Odai join the main river know as Marudaiyar river which flows towards the east. Other minor rivers are Ottan Odai, Uppu odai etc.

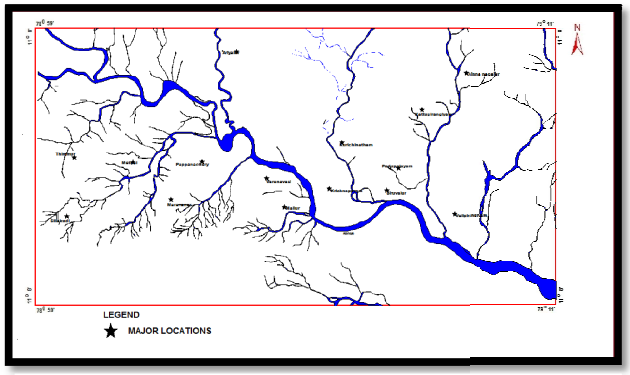


Fig. 2 Drainage Map

GEOLOGY

Ariyalur formation is divided into the following three members:

Upper Kallamedu sandstone member
Middle Kallankurichi limestone member
Lower Sillakudi sandstone member

The lower Sillakkudi member rests over the Garudamangalam formation with an unconformity and occupies very large areal extent. This member comprise, lower calcareous fine to medium grained sandstones and an upper soft, friable sandstone which is unfossiliferous, whereas the calcareous sandstone is fine to medium grained is fossiliferous. This member is well exposed in a stream section near Sillakudi village and exposures present in Kilapaluvur and Melmathur. The thickness of the member is 210 mts.

The Sillakudi member is unconformably overlain by Kallankurichi limestone member. The limestone is buff to yellow in colour and is packed with abundant bioclasts such as exogyra, gryphea, allextronia, inoceramus, productus and echinoids are the common varieties found. The buff coloured bioclastic packstone/grainstone are deposited in shallow open marine high energy conditions. The near shore sands are occasionally admixed with the carbonates giving rise to thin arenaceous packstone beds. The limestone is exposed in Kallankurichi, Periyanagalur, Kattuparangiyum and Pudupalayam villages. Thickness is above 14 m to 40 m.

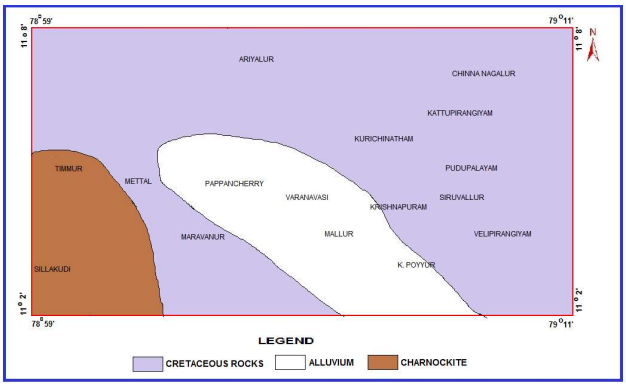


Fig. 3 Geology and Sample Location map

Kallankurichi limestone member is conformably overlain by a sequence of arenaceous sediments known as Kallamedu members. This member comprises fine to coarse, whitish to light green, micaceous, argillaceous, soft sandstone with thin bands of hard calcareous sandstone. The sandstone is texturally immature with poor sorting. This remains of dinosaurs bones are scattered in this member. The sandstones are unfossiliferous except for the presence of dinosaur bones. These sandstones were probably deposited in occasionally marginal marine to nonmarine settings. It is well exposed in the stream section near Ottakovil and Kallamedu. The Niniyur formation conformably overlies this member. The age of Ariyalur formation is Campanian to Maestrichtian.

3.HYDROGEOCHEMISTRY

The suitability of natural water for a particular purpose depends upon the standards of acceptable quality for that use. To assess the quality of natural waters for irrigation, a number of parameters are taken into consideration (Yamuna Singh, 1999). The quality of groundwater varies from place to place

and stratum to stratum. Further, the quality of water depends on the specific need. Hence, the assessment of the quality of water in any area is a prerequisite. (Sankara Pichiah and Srinivasu, 1999) The chemical quality of water, whether it is of extraneous, or underground nature should be studied extensively to determine its usability. In the groundwater resource evaluation, the quality of groundwater is very important as the quantity, in as much as the usability of groundwater available is determined by its chemical, physical and biological properties. Hence, in the present study the quality of groundwater for domestic, industrial and agricultural uses were discussed with major ion chemistry.

The study on geochemistry of natural waters has been initiated four decades back (Chebotarev, 1955, Back, 1961, 1963 and Badrinath et al., 1964) and attained its momentum in 70's to understand geological control over the water chemistry, geologic history, origin, boundary condition of aquifer and the recharge area and flow mechanisms (Beck et al., 1985; Rao, 1993; Drishnappa and Shinde, 1986). In India the geochemical studies on ground water has been undertaken from 1970 onwards all over the country(Handa, 1977, 1978; Balasubramanian, 1986; Ramanathan et al, 1996 a & b), Srinivasamoorthy et al.,(2008) Studies on groundwater for agriculture were discussed by Eaton, (1950). Diagrams for the agriculture purpose were developed by USSL (1954) and Doneen(1948). Similar studies were carried out by Sondhi and Ramprakash(2000) and Puranik and Abbi(2000). The impacts of mining and other anthropogeic activities have also done by different authors Krishnappa and Shinde 1980 and Anandhan(2005) were proved to affect the quality of groundwater. Water quality effects due to industrial effluents were studied by Rajaram and Ashutosh Das(2008).The impact of filling an abandoned open cast mine on groundwater quality was studied by Prasad and Mondal(2008).Computer progrqmme WATCLAST for hydrogeochemicql studies from surface and subsurface waters of selected countries was studied by Chidambaram et al.,(2004). Rock water interaction for groundwater hardness was studied in Port Harcourt city, Southern Nigeria limestone area by Abraha et al., 2011).

The ground water in the study area is colourless and odourless in most of the places. Higher value of pH is observed as 7.9 in location 14 and the lower value is observed as 7.2, in location 9. Higher value of EC is observed as 2342 in location 14 and lower value of EC is observed as 455.5 in location 10. A general classification of water based on dissolved solids content in ppm shows that most of the waters fall in Fresh water category. Only 4 samples fall in slightly saline category.

Table 1 showing Results of the water analysis

S.NO	LOCATION	Ca	Mg	Na	K	Cl	HCO3	SO4	NO3	pH	EC	TDS	TH	SAR
1	TIMMUR	230	22	85	2	33	483	19	14	7.6	1388	888	664	1
2	SILLAKUDI	232	24	80	2	36	462	22	18	7.6	1369	876	678	1
3	MARAVANUR	205	24	13	2	54	336	34	21	7.4	1077	689	610	0
4	METHAL	210	20	12	2	64	310	24	16	7.6	1028	658	606	0
5	PAPPANCHERI	219	24	15	2	61	370	33	22	7.8	1166	746	645	0
6	KURICHINATHAM	215	24	94	3	65	413	31	19	7.8	1349	864	635	2
7	VARANAVASI	204	23	11	3	54	325	35	22	7.7	1057	677	604	0
8	MALLUR	208	22	12	2	54	340	34	21	7.7	1082	693	609	0
9	KRISHNAPURAM	8	12	89	5	30	127	14	13	7.2	466	298	69	5
10	K.POYYUR	6	10	84	6	34	115	21	16	7.4	455	292	56	5
11	CHINNANAGALUR	419	16	32	2	23	648	47	24	7.8	1890	1210	1110	0
12	KATTUPIRANGIYAM	447	48	30	4	27	762	48	30	7.9	2181	1396	1311	0
13	SIRUVALLUR	5	9	93	5	33	112	22	14	7.3	458	293	536	0
14	PUDUPALAYAM	495	48	31	4	27	818	47	29	7.9	2342	1499	1432	0
15	VELI PIRANGIYAM	432	48	16	1	29	705	82	30	7.6	2099	1344	1275	0

Analytical data shows that most of the groundwater of the region is suitable for drinking and domestic purpose with few abnormal concentrations exceeding the maximum permissible limit. Chloride concentration exceeds the maximum limit in certain location indicating the anthropogenic influence or ion exchange.

In the study area On the basis of Sodium percentage (Wilcox, 1955) 9 samples fall in excellent category. 3 samples fall in Good category. Only 2 samples fall in Doubtful category and only 1 sample fall in Unsuitable category. According to Wilcox the study area waters of irrigation purpose, during the study period only 13samples falls in permissible category and 2 water samples falls in Useful category.

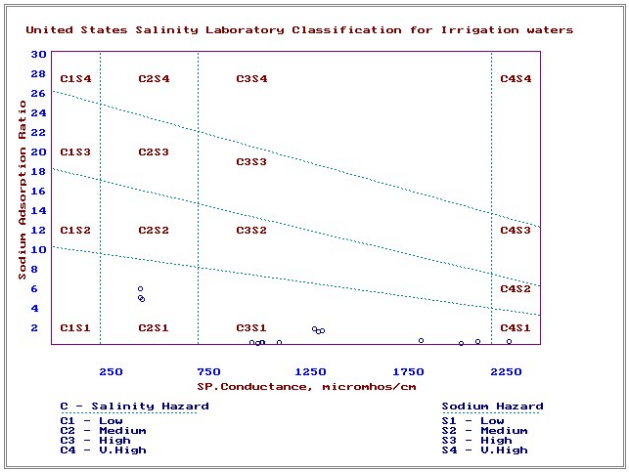
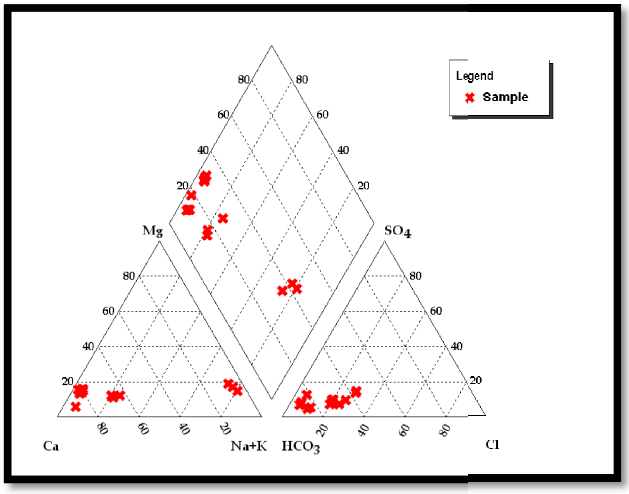


Fig. 4 Sodium absorption ratio

In this USSL diagram, Sodium adsorption ratio is plotted against specific conductance that waters can affect the soil in terms of salinity hazard. In the present study, twelve samples falls in C3S1 category and three samples falls in C2S1 category shown in the above fig.

Hydrochemical facies:

The evolution of water and the relationship between rock types and the water composition can be analyzed by trilinear diagram. For the aquifer in all seasons, the plot reveals that water samples fall in the study area of cation plot most of



the water samples falls in Calcium-Magnesium facies type and only few samples fall in Calcium-Sodium facies type, whereas in the anion plot it falls only in Chloride-Sulphate-Bicarbonate facies type. The diagram indicates that there is no systematic variation even though there are some variation in the actual concentration of major ions between the aquifers. The similarity of the chemical composition reflects the lack of significant geochemical sources. Further, it indicates that the considerable part of water in the deeper aquifer is derived from the shallow aquifers.

4.CONCLUSION

The meteorological study point out the higher amount of rainfall is during the north east monsoons. The temperature in the summer is higher in the region. The study draws out the following conclusions:

1. The electrical conductivity of the study area shows that it varies from 455 to 2342 µs/cm. But, most of the groundwater samples are having EC higher than 1000 µs/cm.
2. Magnesium is the dominant cation and chloride is the dominant anion in the study area.
3. Based on hardness, the groundwater samples are soft to hard in nature. But most of them are hard in nature.
4. 12 samples are in non carbonate hardness group and hence suitable for irrigation purpose.
5. According to the Wilcox classification of Na% of the study area waters during the study period, 13 samples fall in permissible category and 2 in useful category.
6. Based on the water quality standards, all the ions are present within the permissible limit except that of EC.
7. The quality of the groundwater is verified with WHO standards, which shows that most of the groundwater samples are well within the suitable drinking purposes.
8. The groundwater nature is explained by the Piper Trilinear diagram, which indicates that most of the groundwater samples come under Ca-Mg facies.
9. The quality of the waters for irrigation was estimated by the USSL classification and Na% showing that, 12 samples fall in C_3S_1 and 3 samples in C_2S_1.
10. In the Doneen plot, 12 samples fall in class-I indicating the water to be fit for irrigation purpose.
11. In Piper diagram, as for the cation plot, most of the samples fall in the Ca-Mg facies and a few falls in Na facies. And for the anion plot, all the samples fall in the chloride-sulphate-bicarbonate facies.
12. The corrosivity ratio indicates majority of samples fall under unsafe category.

The conclusions derived indicate that the water is relatively free from pollution and anthropogenic influences except in few locations and the geochemical process dominantly controls the groundwater chemistry of the region.

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