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Study Of Geological Parameters Along The Coastal Area Of Arabian Sea, Kanyakumari To Colachel , South Tamilnadu, India

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ABSTRACT

The detailed study of structural and tectonic history indicates several episodes of deformation, which caused repeated folds, faults, joints and fracture systems. The basement rocks are overlain by red soil, lateritic soil, clayey soil, river alluvium and coastal alluvium, black, red and red sandy soils of thickness ranging from 1 m to 1.5 m in most places. The area is underlain by the peninsular gneissic terrain of India. Sediments of Miocene were also deposited and identified as the Warkalai sandstones. Also, the sands of recent origin are noticed along the coast.. Penisular Gneisses occupy the largest area in the study places. The basement of the study area consists of charnockite, granite gneiss, Leptinite, Leptinite Gneiss, Peninsular Gneiss, Laterite, Warkalai Sandstone, Variegated Clay, River Alluvium etc.

Most of the wells used for irrigation are shallow and partially penetrating because once a considerable depth of water column is reached, farmers stop further deepening of wells.

Study on Hydrographs indicate that the groundwater table tends to rises during October and December to reach peak and starts receding from February onwards to the end of August to September. However a slight raising trend is seen during July because of Southwest monsoon rain.

INTRODUCTION

Kanyakumari district is underlain by the peninsular gneissic terrain of Indian. Within the district, sediments of middle Miocene were also deposited and identified as the Warkalai sandstones. Also, the sands of recent origin are noticed along the coast. Rest of the district is underlain by the crystalline rocks.

The basement of the study area consists of charnockite, granite gneiss, Leptinite, Leptinite Gneiss, Peninsular Gneiss, Laterite, Warkalai Sandstone, Variegated Clay, River Alluvium etc.

MATERIALS AND METHODS

Geology and Hydrogeology

The basement of the study area consists of charnockite, granite gneiss, Leptinite, Leptinite Gneiss, Peninsular Gneiss, Laterite, Warkalai Sandstone, Variegated Clay, River Alluvium etc.

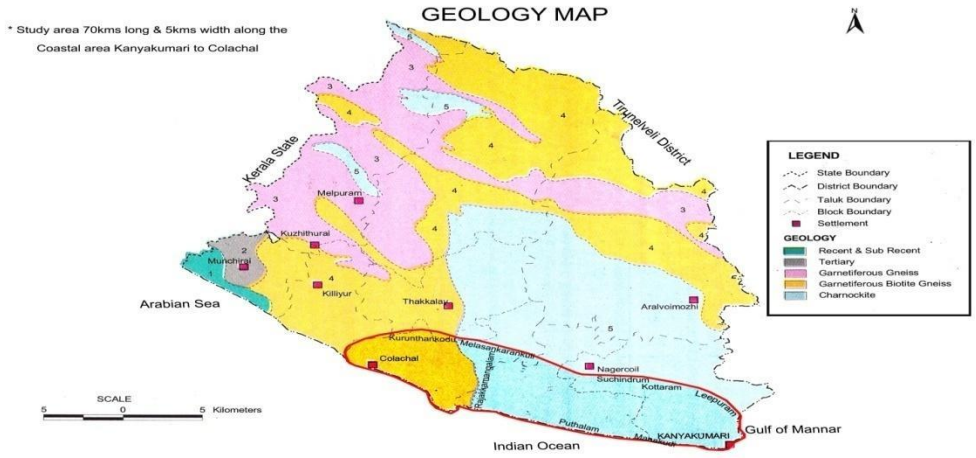

Fig.1. Geological map of Kanyakumari – Colachal coastal area.

The study of structural and tectonic history indicates several episodes of deformation, which caused repeated folds, faults, joints and fracture systems. The basement rocks are overlain by red soil, lateritic soil, clayey soil, river alluvium and coastal alluvium, black, red and red sandy soils of thickness ranging from 1 m to 1.5 m in most places. The area is underlain by the peninsular gneissic terrain of India.

Sediments of Miocene were also deposited and identified as the Warkalai sandstones. Also, the sands of recent origin are noticed along the coast.. Penisular Gneisses occupy the largest area in the study places. The general trend of the strike of the area is N-NW to S-SE. Garnetiferous Sillimanite, Graphite Gneisse and Garnetbiotite Gneiss are the two major groups identified in this area. The charnockite group of rocks is well exposed around Rajakkamangalam area.. The Warkalai beds of Tertiary age are exposed as the cappings, south – west region near the coast. Sub-recent origin of calcareous limestone is noticed near Kanyakumari. Lateral Deposits or Bay Deposits of sand, zircon, rutile, illemanite and garnet are very common phenomena along the entire sea coast of Kanyakumari. Near Manavalakurichi Monazite are deposited. The trend of foliation in gneisses is N 20 W – S30 E with steep dips on the eastern side. The peculiar deposition of feldspathic granites over a large portion of this area is suggestive of the fact that rocks have been sharply folded isoclinally causing repetition of bands. The trend of folds is aligned in NW-SE direction. Subsequently, this might have been subjected to cross folding. Also coastal sand area seen in the entire coastal belt of Kanyakumari coastal area. Borehole lithology records reveal that the thickness of alluvial deposits is more in bajada and valley fills (about 10–15 m). Weathered and fractured zones are areas for ground- water occurrence. Intensity of weathering is not uniform in space and depth. It is considerably higher in gneissic rocks than in charnockite. Weathered zone thickness of the study area generally ranges from 10 m to 35 m below ground level. The groundwater of the area occurs under unconfined conditions. Rainfall infiltration and seepage of water from surface water bodies are responsible for ground- water actuation.

Most of the wells used for irrigation are shallow and partially penetrating because once a considerable depth of water column is reached, farmers stop further deepening of wells. Hydrographs indicate that the groundwater table tends to rises during October and December to reach peak and starts receding from February onwards to the end of August to September. However a slight raising trend is seen during July because of Southwest monsoon rain.

The stratigraphical succession of the geological formations met with in this district is given below :

Table – 1 Stratigraphical succession of geological formations

ERA	AGE	STAGE	LITHOLOGY

Quaternary	Recent		Sand
Cenozoic	Middle Miocene	Cuddalore Sandstone	Warkalai Sandstones
Archaean			Peninsular gneisses charnockites, Khondalites, granites and Pegmatite's

Peninsular Gneiss

The peninsular gnesiss occupy the largest area in the district. The general trend of the strike of this ara is the N-NW to S-SE, Garnetiferous sillimanite, graphite gneisse and garnetbiotite gneiss are the two kajor groups identified in Kanyakumari District.

Charnockite

The charnockite group of rocks is well exposed around Padmanabapuram, Aramboly South, Kulasegaram, Thuckalay and Rajakkamangalam areas. Charnockite group consists mainly of Charnockite, pyroxene granulite and their associated migmatites. Charnockites also are exposed within the gneisses as bands and lenses. Granites and pegmatites are the derivations from the migmatites of the peninsular gneisses.

Warkalai Sandstone

The Warkalai beds of tertiary age are exposed as the cappings, Southwest of Kuzhithurai near the coast and South of Kaliyakkavillai and it is equivalent of the cuddalore sandstone.

Alluvium

Sub – recent of calcareous limeshell is noticed near Kanyakumari. All along the west coast from Kanyakumari, Kollangodu the border of Kerala States the area is covered by the thick lateritic soil dotted with a few rocky outcrops.

Around Medukkeneal, Turapuram, Pudukkadai area, the thickness of laterite increases with reddish brown in colour.

Beach Sands

Lateral Deposits or Bay Deposits of sand, zircon, rutile, illemantic and garnet are very common phenomena along the entire sea coast of Kanyakumari District. Near Manavalakurichi monazite is seen in addition to the above deposits.

Structure

The trend of foliation in gneisses is N 20^0W – S30^0E with steep dips on the eastern side. The peculiar deposition of feldspathic granites over a large portion of this area is suggestive of the fact that rocks have been sharpy folded isoclinically causing repetition of bands. The trend of folds is aligned in NW-SE direction. Subsequently, this might have been subjected to cross folding.

The straight west coastline without any break is itself suggestive of faulted one and faulting would have taken place during the Pliocene period. Similarly, changes in the course of Kodayar river, which is originally flowing in a northerly direction upto Tiruvattar, changes its course to NE – SW, which is an indication of faulting along the Kodayar river.

Among the various lineaments traversing the district, the one running from Kanyakumari to Mannar is worth mentioning.

Among the various joints in rocks, two sets of vertical joints are most widely prevalent in the district.

GEOMORPHOLOGY AND LINEAMENTS

Remote sensing techniques using satellite and aerial photographs are effective modern tools for terrain analysis and for evaluation of natural resources. These techniques are applied to study the geomorphologic features and other technical features like lineaments. The thematic maps prepared on geomorphology and lineaments help to target good groundwater sources are macro level. Limited Geomorphological field checkup has been carried out in this district using 1:50,000 scale vide Geomorphology map

i. Geomorphological maps help to identify the various geomorphic units and groundwater occurrence in each unit. Selected and limited field checks are carried out in the field to verify the different geomorphic units.

ii. An overall appraisal of groundwater occurrence in each geomorphic unit and the significance of its hydrogeological characters are furnished.

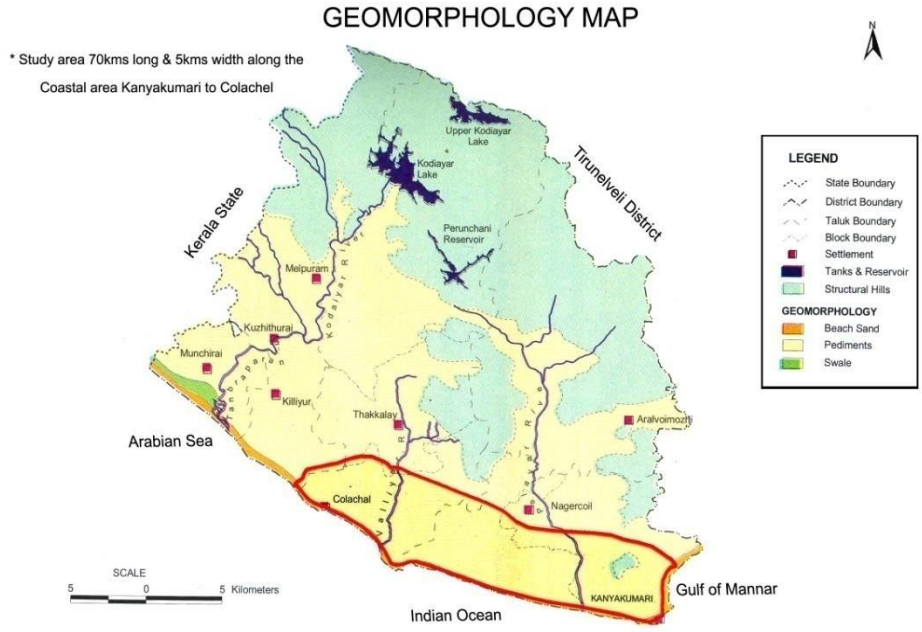

Fig.2. Geomorphology map of Kanyakumari – Colachal coastal area.

Table – 2 Description of land forms and groundwater occurrence

Geomorphic	Characteristics	Hydrogeology	Groundwater Potential
Structural Hill (SH)	Composed of composite ridges and valleys traversed by Structural features.	Run off zone, Little infiltration along Secondary featuers.	Poor

Bazada (BZ)	Coalescence of alluvial cones and fans formed at the break of composite slopes boundary	More infiltration recharge zone comprised of colluviofluvial materials	Very Good
Valley Fill (VF)	Comprised of cobbles, Pebbles and detridal materials like sand silt, kankar and friable clay. Formed in linear depression along the stream / drainage.	Infiltration is good – recharge is from stream and rivers	Good
Flood Plain (FP)	It is gentle plain adjacent to river comprising of river Alluvium. Indicate the Maximum flood level. Comprise both younger and older flood plain.	High infiltration recharge mainly from river and other Hydrogeological features	Good
Pediment (P)	It forms outcrops with or without soil cover	Run off zone	Poor
Shallow Buried Pediment (BPS)	Intermediate zone between pediment and deep buried pediment Weathering thickness is appreciable	Moderate infiltration – recharge, influened by hydrological featuers	Moderate
Deep Buried	Shallow depressed low relief area with good drainage	Infiltration moderate to good – recharge by hydrological	Good

Pediment (BPD)	networks. Weathering thickness is more.	feature storage complemented by Secondary fractures	
Coastal plain (CP)	Unstabilised and stabilized sand dunes and comprising of medium to fine sandy wind blown particles	Recharge zone with good infiltration	Good
Lineament (L)	Linear feature may be a geological contact / fault / sheare or fractured jointed zone.	Infiltration is good in fracture jointed lines and in geological contact.	Good

Even though the groundwater potential zones are demarcated based on Remote sensing techniques and the subsequent field checks, the present extraction of groundwater has to be taken into consideration before implementing further groundwater schemes.

The south and southwestern part of the district is covered by Burried pediplain.Shallow pediments occur as small patches near Therkku Tamaraikulam and Kappiarai areas.The north and northeastern part of district is covered by Denudational hills.The Coastal sand are seen in the entire coastal belt of Kanyakumari District with valuable minerals.

Lineaments and Hydrofractures :

Lineaments weaker zone and are of good potential zone which have been identified by satellite imageries. Lineament Map of Kanyakumari District has been prepared from landsat and IRS FCC imageries of scale 1:2,50.000 by visual interpretation. Only limited field check has been carried out. The bore well, which is located in the lineament zone, yields good groundwater.

In Kanyakumari district there are three sets of lineaments, which are,

1) NW – SE Trending Lineament

2) E – W lineaments – 1

3) NE – SW lineaments

These three sets of lineaments are seen mostly in the northeastern , central, northwestern, and western part of the district.

Intersections of lineaments are proven potential zones of groundwater. A detailed investigation can be formulated to undertake detailed hydrofracture study in these zones. A base map is prepared from the imageries for field verification.

After the identification of lineament, EM – 34 survey is to be conducted to identify the zone width and depth. Further, geophysical resistivity survey is to be conducted to identify the suitable location for drilling the boreholes.

Almost the entire shallow aquifer zone is tapped for agriculture development in hard rock areas. Hence to meet the future demand for groundwater a detailed investigation is warranted in the fractured aquifer, for modeling the fracture density and development of secondary aquifer. At the same, the open fracture can be utilized for artificial recharge and for storing groundwater as subsurface reservoir.

OCCURRENCE OF GROUNDWATER

Groundwater occurs in almost all the geological formations in the district namely crystalline rocks, sedimentary formations, Quaternary alluvium and beach sands and is developed by dug wells, dug – cum – borewells and borewells.

Hard Rock Formations

The entire Kanyakumari District is covered by hard rock formation like charnockite and gneisses. The groundwater occurrence is limited to only weathered mantle of the hard rock. The weathered thickness ranges generally from 10m. to 35m. below ground level. The groundwater occurrence is also limited 10m. to 30m. below ground level.

Weathering is quiet higher in granite gneissic rock rather than charnockite. Hence the groundwater occurrence is also higher in gneiss than charnockite.

Bazada and Valley – fill Sediments

The ground water occurs under water – table conditions in valley – fill sediments area. These bazada and valley – fill area have alluvial deposit for a depth of 10 to 15m. followed b highly weathered formation upto 20 to 30m. below groundwater level. The water table is very shallow.

River alluvial deposits

In alluvial formation, the groundwater occur under water table conditions. These formations are highly porous and permeable. However the thickness of alluvium is very shallow.

Drilling of Boreholes

The occurrence and movement of ground water is restricted to open system of fractures, and joints in unweathered portion and also in the porous zones of weathered formation.

For investigation purposes, the State Ground and Surface Water resources Data centre has drilled more than 28 bore holes spread – over the entire district. Boreholes in Sedimentary area are very much limited because extent of the sedimentary area.

Generally in hard rock regions the occurrence of weathered thickness is discontinuous both in space and depth. Hence the recharge of groundwater is influenced by the intensity of weatherings.

In general weathering thickness is higher in gneissic rock than that of charnockite. It varies from 10m to 35m. below ground level. The lithological details of selected boreholes drilled in Kanyakumari District are shown in Annexure VI and Map – 7.

AQUIFER PARAMETERS

In order to evaluate the characteristics of shallow phreatic aquifer. Yield tests were conducted on selected open wells during the systematic hydrgeological surveys and the data are presented in Table – 12m. The yield of open wells varied from 150 to 200 m^3/day for a drawdown of 1 to 3 m. with a pumping period of 2 to 4 hours. From the yield tests, transmissivity of shallow phreatic aquifer is within the range of 3 to 15 m^3/d and the specific yield is around 1 to 4 percent.

Table – 12 Details of Yield Tests

S.No	Location	Specific Capacity (Ipm)	Transmissivity (m^2/d)	Specific yield (%)
1	Cherupalur	6.31	3.946	0.84
2	Aramboli	28.7	12.80	4.23
3	Thovalai	28.5	15.92	1.97

.Water table fluctuation

By establishing a network of observing wells spread – over the district, the fluctuation in groundwater level is monitored every month. The groundwater level reached the lowest level in the district or hottest periods after which it starts rising to reach highest peak, a little the end of rainy seasons. The rise and fall depends upon the amount, duration and intensity of precipitation, depth of weathering, specific yield of the formation etc.

A general overall view of the water level fluctuation suggests that the water level trends to rise during October to December to reach the peak an starts receding from February onwards to the end of August to September, hydrographs, Figure 3.1 to 3.6. However a slight raising trend is seen during July because of Southwest monsoon rain.

In Water Table contour Map 8.1 to 8.4 water table contours are shown indicating Water Level conditions during pre – monsoon and post – monsoon periods. In general water level conditions are improved in the month of January ie. In post-monsoon period. However general Water Level conditions during past 10 years are in declining trend, Annexure VII.

GROUNDWATER POTENTIAL

Estimation of Groundwater potential

The block wise groundwater potential and utilization of groundwater resources for irrigation as on January 2020 were estimated by the Groundwater wing of PWD in accordance with the methodology recommended by the Government estimation committee (1997) set up by Government of India. Out of the total Groundwater

recharge some amount is kept reserved to meet domestic and industrial requirements. The balance is earmarked as utilizable groundwater recharge for further development of irrigation. For Kanyakumari district, the details are given in the following Table – 13. The block wise land use and well census details are given in Annexure – VII and Map – 9.

Table – 13 Groundwater potential as on January 2020

Total Ground water recharge MCM	Net Ground water availability MCM	Domestic and Industrial Draft at Year 25 MCM	Irrigation Draft projected to Jan. 2020 MCM	Total Draft MCM	Balance Groundwater Available MCM	Stage of Development
						As on Jan. 2020
289.1803	260.2623	22.5098	19.5830	42.0928	218.1695	16%

The groundwater recharge, net extraction and balance groundwater available have been estimated separately for all the blocks. While assessing the dynamic groundwater resource, the different geological formation is considered as a single principal aquifer. The specific yield of geological formation in each Panchayat union has been worked out by taking into account the number of energized wells, diesel driven wells and other types of wells. Based on cropping pattern, the annual draft for each block has been worked out.

By deducing the draft from groundwater recharge, the balance groundwater potential for future development has been estimated. The probable number of wells feasible in each Panchayat union is evolved taking into consideration 65% of the balance groundwater potential available.

CONCLUSION

The basement of the study area consists of charnockite, granite gneiss, Leptinite, Leptinite Gneiss, Peninsular Gneiss, Laterite, Warkalai Sandstone, Variegated Clay, River Alluvium etc.

The study of structural and tectonic history indicates several episodes of deformation, which caused repeated folds, faults, joints and fracture systems. The basement rocks are overlain by red soil, lateritic soil, clayey soil, river alluvium and coastal alluvium, black, red and red sandy soils of thickness ranging from 1 m to 1.5 m in most places. The area is underlain by the peninsular gneissic terrain of India. Sediments of Miocene were also deposited and identified as the Warkalai sandstones. Also, the sands of recent origin are noticed along the coast.. Penisular Gneisses occupy the largest area in the study places. The general trent of the strike of the area is N-NW to S-SE. Garnetiferous Sillimanite, Graphite Gneisse and Garnetbiotite Gneiss are the two major groups identified in this area. The charnockite group of rocks is well exposed around Rajakkamangalam area.. The Warkalai beds of Tertiary age are exposed as the cappings, south – west region near the coast. Sub-recent origin of calcareous limestone is noticed near Kanyakumari. Lateral Deposits or Bay Deposits of sand, zircon, rutile, illemanite and garnet are very common phenomena along the entire sea coast of kanyakumari. Near Manavalakurichi Monazite are deposited. The trend of foliation in gneisses is N 20 W – S30 E with steep dips on the eastern side. The peculiar deposition of feldspathic granites over a large portion of this area is suggestive of the fact that rocks have been sharply folded isoclinally causing repetition of bands. The trend of folds is aligned in NW-SE direction. Subsequently, this might have been subjected to cross folding. Also coastal sand are seen in the entire coastal belt of kanyakumari coastal area. Borehole lithology records reveal that the thickness of alluvial deposits is more in bajada and valley fills (about 10–15 m). Weathered and fractured zones are areas for ground- water occurrence. Intensity of weathering is not uniform in space and depth. It is considerably higher in gneissic rocks than in charnockite. Weathered zone thickness of the study area generally ranges from 10 m to 35 m below ground level. The groundwater of the area occurs under unconfined conditions.Rainfall infiltration and seepage of water from surface water bodies are responsible for ground- water actuation.

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