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RESEARCH ARTICLE

A REVIEW OF GEOLOGY AND GEOMORPHOLOGY OF NAMAKKAL DISTRICT, TAMILNADU

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ABSTRACT

Namakkal is a district of Tamilnadu, the main objective of this study is to give an account the geology and geomorphology of the region, to trace the source, their concentration and effects on utility. In order to bring out the various types of rocks, mineral, ore bodies, fault, fold, joints, lineaments, soil types, lithology and hydrogeology in the study area, analysed various maps on Arc view software.

INTRODUCTION

Geology, the study of rocks, minerals and the physical make-up of the solid earth, determines the environment and natural resources and, thence also, the industrial potentials and wealth of a nation. After climate, geological factors exert, perhaps, the greatest impact on economic activities, since soils, water supply and vegetation are, to a large extent, influenced by the nature of the underlying bedrock. Namakkal is well endowed with substantial mineral resources and a high geological potential which is yet to be fully explored and exploited. Namakkal currently produces different types of minerals and rocks. The gap between projected demand and supply is widening in respect of number of minerals. Though Namakkal exports a number of raw processed minerals and rocks.

Study Area

Namakkal district is bounded by Salem district on the north; on the east by Attur taluk of Salem district, Perambalur and TiruchirapallI District's; by Karur District on the south and on the west by Erode district.(Namakkal District profile, SouthIndia Online) Namakkal District comes under the North Western Agro climatic zone of Tamil Nadu. It is situated in the dividing portion of two watersheds between Cauvery and the Vellar System with the Taluks of Attur, Rasipuram and Namakkal on the East and Salem, Omalur and Mettur on the West. Tiruchengode taluk alone is placed under Western Agro-climatic zone Namakkal District, Govt of Tamil Nadu Besides the above two zones, Kolli and a few isolated hills and ridges are scattered over Namakkal, Rasipuram and Tiruchengode and along with the valleys and rolling hills, make up the characteristic topography of the district. The Namakkal District lies in the interior of Tamilnadu between the North Latitudes 11° 00' 00" to 11° 36' 10" and East Longitudes 77° 40' 00" to 78° 30' 00". The total geographical area of the District is 3404.3 sq. km. The district has been is divided into four taluks namely, Namakkal, Thiruchengode, Paramathi and Rasipuram and fifteen administrative blocks. The location of the study area is shown in the Figure 1.

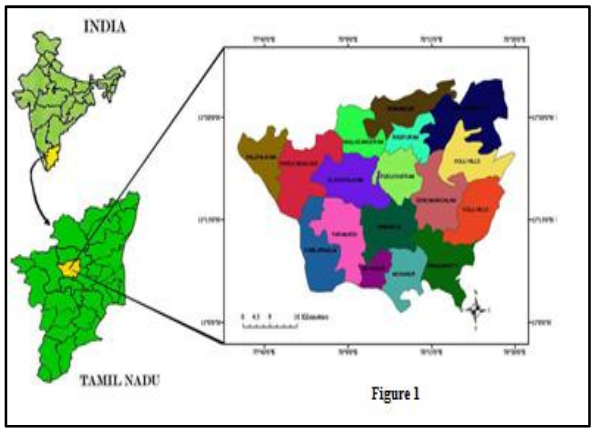

Figure 1

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Database

The source maps for soil, geology, geomorphology, lineament are published maps of state ground and surface water resources data centre, Chennai in 1:500000 scale. Contour map is derived from the Survey of India (SOI) topographical maps bearing no 58E/11, 58E/14, 58E/15, 58E/16, 58I/2, 58I/3, 58I/4, 58I/6, 58I/7 and 58I/8 in 1:50000 scale. The source maps are scanned and digitized. The final hard copy out-put is prepared using Arc View software.

Geology

Namakkal District is mostly underlain by the archaean crystalline and metamorphic complex. The geology of the district is complicated due to recurring tectonic and magmatic activities occurred during pre Cambrian period. The famous Sithampoondi complex which is known for its complex geology is situated in this district. Gneisses are the oldest rocks in four taluks of the district. It is present widely in plains. The gneisses are highly weathered upto 30 m at some places. The Charnockites are coarse grained and their colour is bluish dark to grey. They are the second largest rock type present in the district. They are massive and less weathered than the gneisses. They exhibit 2 to 3 distinct set of joints and most of them are vertical with steep dips. Iron ore deposits associated with quartz felspathic gneiss and garnetiferous quartz gneisses are present in some areas. These rocks are highly folded and jointed and less weathered (PWD 2001).

Calcite quartzites and crystalline limestones are exposed in patches in north and central parts of the district. The thickness of these bands varies from a few metres to ten metres and the length extends to few kilometres. Massive and poorly jointed anorthosites bearing rocks are also found. They are associated with wide range of Chromite, Pyroxenite, Anthophyllite, Diopside, etc. There are number of basic intrusive of Dolerite dykes present in the study area. Granites and Syenites types of rocks are found in some parts of the district. They are massive and jointed poorly (PWD 2001). Thin veneer of alluvium is found along the course of the Cauvery and Thirumanimuthar. However, alluvium of few metres thickness is found near the junction of river Thirumanimuthar and river Cauvery. Several faults and shears are occurring mostly with north east-south west trend. They are expected to influence the course of groundwater movement, its storage and developmental potentials in the district (PWD 2001). The geological map of the study area is shown in Figure 2. The different types of geology of the study area are summarized in Table 1.

Table 1 (PWD 2001)

S.No	*Types of Geology Rocks*	*Area in Sq.Km.*
1	Zone of Breciation	26.40
2	Ultrabasic with Magnesite	12.79
3	Pyroxene Granulite	195.77
4	Granitoid Gneiss & Granitoid Gneiss with Pegmatie	96.02
5	Dolerite	5.66
6	Charnockite	1052.88
7	Alluvium	196.43
8	Gneissic Rocks	1812.46
	Total Area	3398.40

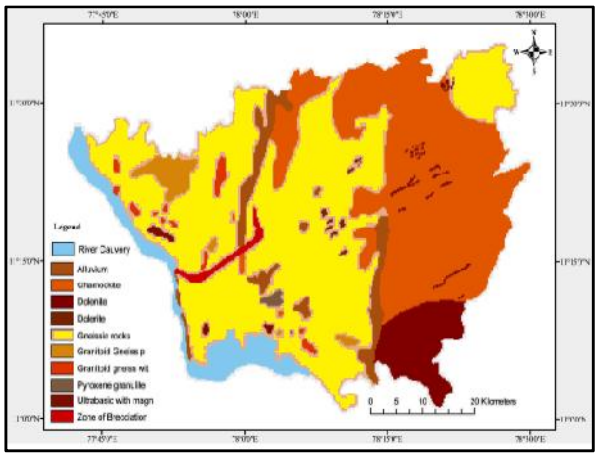

Figure 2 Geology Map

Rocks And Minerals

Black Granite and Multi Color Granite

The Black Granite (Dolerite) is a ferromagnesian mineral bearing rock, due to the presence of high specific gravity mineral in the rock type it has heavy weight and dark colours. In this District, only two leases were granted for Black Granite both leases are in currency, but not in operation. The Multicoloured Granite rocks are mainly available in Paramathi-Velur, Kabilarmalai areas. It is a light coloured, less weight rock (when compare to Black Granite) 6 leases were granted to extract colour Granite. In this District, out of 6 leases, two leases are mainly functioning at present.

Gneisses

The gneisses are perhaps the oldest rocks (Fundamental gneisses) in the namakkal occurring widely in the plains. The general direction of foliation varies from E-W to ENE-SWW with a high magnitude dip towards north or south east. Segregated Quartz-felspathic and mafic layers give rise to banded structure at some places. The Gneisses are highly weathered up to 30m at places and are intruded by sevaral Ultramafic and basic rocks parallel to the direction of foliation of the gneisses.

Charnockites

The Charnockites, Namakkal area thalamalai coarse-grained and bluish dark to grey in colour, have the second largest occupying area. They are exposed in the Shevaroys hills. Some of the Charnockites are garnetiferous and are massive and less weathered than the gneisses. They show two to three distinct sets of joints most of which are vertical with steep dips.

Magnetite-Quartzites

These rocks occur in the Valayapattilai(vaalasiramani) Magnetite-quartzites are major non-ore deposits and are associated with Quartzo-felspathic gneisses in the area. These rocks are highly folded and jointed.

Dunities and Peridotites

The rocks appear in the areas of Sithampoondi Villages of Namakkal, which are known . Charnockites occur as lenses within the ultramafic and hence it can be said that these intrusive are of post Charnockite period. Dunite have undergone enormorus mineralogical change, firstly to serpentine and secondly Magnesite, Chalcedony etc. Magnesite occurs in the forms of veins. These ultra basics cut across the Foliation planes of the gneisses and are highly weathered and talc occurs at many places as economic deposits. The Talc-schist, Flespathic-schist and Hornblende-schist formed by deformation of basic igneous rocks are also seen in a few places in study area.

Pyroxenites

Pyroxenites occur in rest and south of the Sithampoondi, and also massively and poorly jointed in the Nagarmalai. Pyroxenites patches occur in one most of the place in the Chalk hills. The contact between the Pyroxenites and Peridotites in not clearly identified.

Doloerite Dykes and other Intrusives

There are a number of basis dykes intruding in the country rocks. They are massive and running in NE-SW to NNE-SSW direction in general, parallel to the foliation direction of the gneisses. They are a few meters in thickness and a few kilometers in length. Their contact with the country rock is sheared at many places.

Granites and Syenites

The granite and Syenites are massive and poorly jointed. There are two Pegmatite intrusions in the Sithampoondi noticed and locally called as "WHITE ELEPHANT ROCK'' .

Laterites

The physical weathering and leaching in the flat-topped hillocks of have given rise to laterites rich is alumina. There are also a few pockets of bauxite in these hills. The weathering is 10to15 m deep.

Alluvium and Talus

There is a poor deposit of alluvium along the course of the Cuvery,as it runs mostly on high land and rocky floor. So is the case with Tirumanimuttar river which also flows on rocky floor

Anorthosite

Sithampoondi villege Tiruchengode block area cromite mineral ,and corundum, olivine dunite in the rock.

Limestone

The crystalline variety of Limestone is mainly available in this District in parts of Namakkal, Tiruchengode and Paramthi-Velur Taluks. 1. High-grade Limestone 2. Medium grade (or) Cement grade Limestone and 3. Low-grade Limestone. Out of the above 3. Varieties, the High grade Limestone of Calcite and cement grade Limestone are available in Tiruchencode Taluk areas. The mineral calcite (a High grade Limestone variety) is being used in chemical and Leather Industries. Low grade Limestone are used for the manufacture of animal feeds.

Bauxite (Aluminum ore)

Bauxite is a hydroxide of aluminium. It occurs mainly in the Kolli hills. The total reserves of Bauxite in Kolli hills have been estimated to be around 2.75 million tonnes.This ineral is available in a huge quantity on the Kolli hills.

Magnasite

Magnesium rich corbonate rocks are otherwise called as Magnasite. Inferior variety of Magnasite Mineral is available in Seerappalli, and Sithampoondi Villages of Paramathy Velur Taluks and Mangalamedu Village in Rasipuram Taluk.

Quartz and Feldspar

Silica rich quartz and pottcesium Alumina and silica rich Feldspar minerals are available in this District in parts of Namakkal, Thiruchengode and Paramthy-velur Taluks. These type of minerals are mainly formed in the pegmatite band which is occurring in several villages of the above mentioned Taluks. At present, 25 mining leases for these minerals are in currency.

Rough stone

The "Charnockite" and Granite Biotite gneiss rocks types of this District is mainly used for Roughstone (Jelly). The Chakkais of Granite Biotite gneiss occurring in the area of Kaliyanor. Sowthapuram villages are used as filling material in the basement bottom of the building construction. Charnockite is a hard Black with Blue tinges bearing rocks, hence it is called as "Blue Metal". It is mainly used in Stone crushing units and size reduced in to ½ , ¾ and 1½ inches Jelly which are mainly used in road and building construction purpose.

Gravel

It is a mineral, admixed with soil (hard soil produced by crushing of loose rocks) and fragments of weathered (easily broken) rock pieces. It is mainly used for Road making and filling purpose. It is mainly available in all parts of the District.

Brick Earth

This is reddish in colour, loose in nature it does not contain fragment of rock pieces etc pure reddish soil is mainly used for the purpose of Manufacturing of Bricks. It is mainly available in all parts the District.

River sand

The River sand is available only in River bed. In this District, in cauvery River several stretch contains sand heaps.

Soap stone

Soapstone is composed of Talc and stealite, which is a hydrated silicate of magnesium. It occurs in parts of Rasipuram taluk.

Geomorphology

Namakkal district forms part of the upland plateau region of Tamil Nadu with many hill ranges, hillocks and undulating terrain with a gentle slope towards east. The prominent geomorphic units identified in the district through interpretation of Satellite imagery are 1) Structural hills, 2) Bazada zone, 3) Valley fill, 4) Pediments, 5) Shallow Pediments and 6) Deep Pediments. A number of hill ranges are located in the eastern and northeastern parts of the district, whereas the southern, western and northern parts of the district are plain to undulating, dotted with a few isolated hillocks. The important hill ranges in the district are Kollimalai hills, Bodamalai hills, Naraikinaru hills and Pachamalai hills. The highest peak in the district is the Kollimalai hill peak with an elevation of 1293 m. above MSL. Other important peaks are Kedda Malai (1284 m) and Melur hill in the Bodamalai hill range.(Table 2 CGWB,2008)

Table 2 Area of different types of geomorphology

S.No	*Types of Geomrphology*	*Area in sq.km*
1	Structural Hill	513.35
2	Plateau	237.519
3	Flood plain	179.936
4	Composite Slope	275.366
5	Bazada zone	82.79
6	Shallow Pediment	2115.339
	Total Area	3404.3

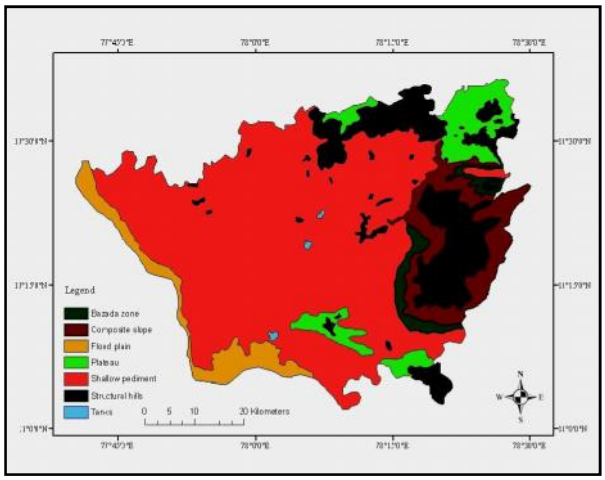

Figure 3 Geomorphology Map (PWD)

Structural Geology

Structural Features denote geologic structure that are formed by internal deformation forces in the earth crust. The structure features such as folds, fault and joints etc.

The structure of the study area is highly tectonised and is complex is structure. As described earlier gneisses show well foliation in the NE-SW to SSW direction with sub vertical to vertical trending NNE-SSW and NE-SW direction in the eastern part. There are a number of folds, faults, shears and joints in the area, with has experienced at least three district phase of the tectonic movement.

Fold

The Salem-Namakkal Fold Thrust Belt consists of number of low-angle south-dipping thrust sheets demarcated by ductile shear zones (Fig. 1b inset). In many places they have been steepened by refolding, i.e. along the L. Kanavaipatti Shear Zone south of Namakkal (Fig. 4a). Mylonites are prominently developed in the foothills of Godumalai and Kanjamalai hill. These show kinematic indicators, mainly S-C fabrics, rotated porphyroclasts and intragranular faults, suggesting thrust-related tectonics with N to NE verging shear (Fig. 4b, c, d). However, in many instances the mylonites have undergone static recrystallisation (Fig. 4e). The mylonitisation is post-kinematic with granulite facies metamorphism. Peak granulite metamorphism has occurred during the F1 stage of folding, which is characterised by isoclinal folds developed in bedding planes, represented by BMQ layers in quartzofeldspatic gneisses. The F1 fold have produced penetrative gneissic fabrics and are coaxially refolded by open to tight upright F2 folds producing type 3 interference patterns. The F2 folds are accompanied by shear bands along the limbs that show mylonitisation and rootless folds in quartzite bands (Fig. 4f). Thus it is interpreted that the mylonitisation is synkinematic with F2 stage of folding. The mylonitic foliation has been refolded by F3 folds, which have probably removed the shear fabric to a large extent due static recrystallisation.

The Sangakiri Shear Zone separates the Idapadi Block from the Salem Block. The shear zone shows mylonitic foliation nearly E-W trend showing dip towards north (Fig. 5c). The Salem Block shows the dominants of metagabbro/mafic granulite. The outcrop shows synformal structure. The mafic granulites have been retrograded to amphibolite near Mallasamudram. The mylonitic foliation strikes NE-SW and dips toward E (Fig. 5d). The amphibolite shows nappe structure over the granite gneisses. The Kanjamalai Shear Zone near Kanjamalai hill takes an easterly trend. The mylonitic foliation shows NNW dip (Fig. 5e). The Udayapatti Shear Zone has an E-W strike and dips toward north (Fig. 5f). The Udayapatti shear zone south of Godumalai shows extensive mylonite development. The mylonitic foliations are E-W and dip north and contain down dip stretching lineation (Fig. 5g). The Umayalpuram Shear Zone shows the emplacement of syenite and the mylonitic foliation shows the southerly dip (Fig. 5h). The L. Kanavaipatti Shear Zone is the southernmost shear zone. The mylonitic foliation shows both southerly and northerly dipping due to late stage folding (Fig. 5i). From the analysis of mylonites it is quite evident that the finite strain varies from one block to another. In Salem thrust sheet the static crsytallisation is very prominent while the Namakkal thrust sheet retains the assymetric fabric to a large extent. (Sundralingam *et al*, 2012)

Fault

A limited metamorphic study has been conducted on metagabbro/mafic granulites and from the namakkal Block. In Salem thrust sheet the static crsytallisation is very prominent

while the Namakkal thrust sheet retains the assymetric fabric to a large extent.

Several Faults and Shears occurring in the study area. The major shears noted are along SE face of the Shevaroys showing well marked strike-slip cleavage. Numbers of mylonite zones are found on the Western part of the rugumalai, 5km East of Salem, Parallel to the Attur valley and cutting across the Kollihills and achamalai hills. The shears and fault are more in the eastern part of the namakkal, bounding the hills.

Joints

The joint are well developed in the Charnockites, granites and ultra mafic and are moderately developed is other intrusive rocks. The major joints are vertical at places, showing step dips. There are a few joints trending parallel to the fold axis. Similar type joints with varying degree of dips and trends are found in the other parts of the study area.

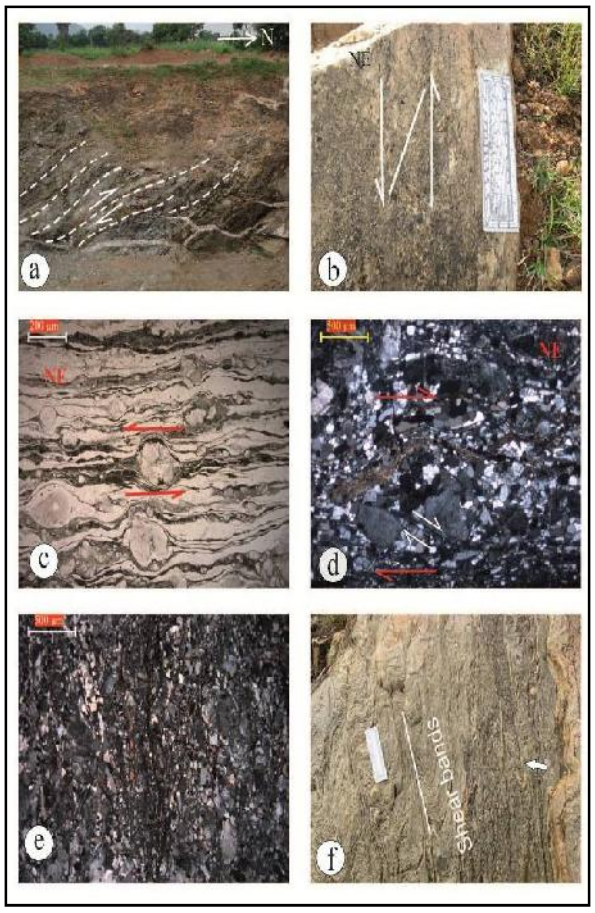

Figure 4 Sundralingam *et al*, 2012.

(Fig 4. Field photograph and photomicrographs of the rocks. a. Low angle thrust in the mylonites exposed in the railway section south of Namakkal, b. S-C fabric in the Umayalpuram shear zone, c. Rotated porphyroclasts in the Udayapatti shear zone south of Godumalai, d. tragranular fault, the main shear is opposite to intragranular shear, e. Static crystallization in the quartz grains of the mylonite, suggesting that the T (temperature) continued beyond deformation, f. Shear bands with mylonitisation associated with F2 folds.)

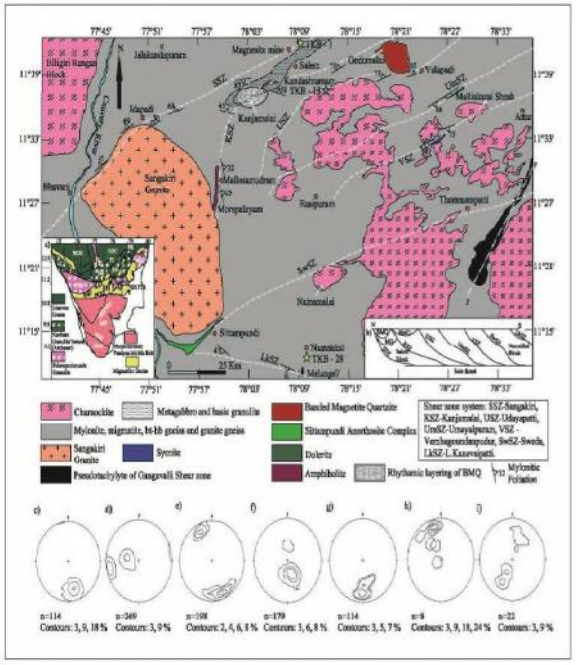

Figure 5 Sundralingam *et al*, 2012

(Fig. 5 **Inset a:** Simplified geological map of Dharwar Craton and Southern Granulite Terrains after Ramakrishnan and Vaidyanadhan (2008). Abbreviations: ASZ - Achankovil Shear Zone, BR-Biligiri Rangan, BSZ - Bhavani Shear Zone, C - Coorg, CG - Closepet Granite, EDC - Eastern Dharwar Craton, FL - Fermor's line, KH - Kanjamalai Hill, KKB - Kerala Khondalite Belt, KKPTSZ - Karur - Kambam -Painavu -Trichur Shear Zone, MB - Madurai Belt, MSB - Madras Block, MSZ - Moyar Shear Zone, NH - Nilgiri Hill, PR - Palar river, PCSZ - Palghat-Cauvery Shear Zone, SAT - Salem-Attur Thrust, SH- Shevroy Hill, SNFTB – Salem-Namakkal Fold Thrust Belt (Study area),WDC - Western Dharwar Craton. **Inset b:** A schematic cross section of the study area, showing imbricate thrusts. The Salem and Namakkal Blocks represent two ends of the nappe belts. **Inset c-i:** Stereoplots of mylonitic foliations from different part of the study area.)

Lineaments

The Lineament map of Namakkal district has been prepared from the LAND SAT and IRS imageries of scale 1:250000 by visual image interpretation Figure 6. Groundwater occurrences in most of the boreholes, located in the lineament zones are good. In Namakkal district, there are 3 sets of lineaments, they are, NE-SW trending lineaments 2. N-S trendinglineaments and 3. NW-SE trending lineaments.

The course of river Cauvery is controlled by NW-SE lineament sand the course of Tirumanimuthar is controlled by N-S and NE-SW lineaments. Zntersections of lineaments are proven as potential zones of groundwater. Almost the entire shallow aquifer zone is tapped for agricultural development in hard rock areas. The open fractures can be utilized for artificial recharge and for storing groundwater in the underground reservoir.

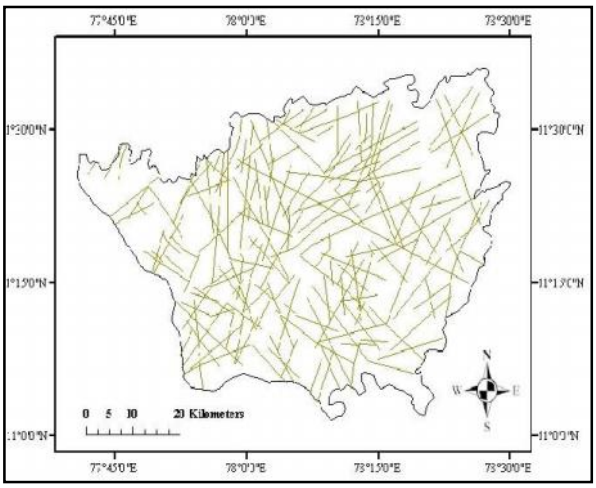

Figure 6 Lineament Map (PWD)

Shear Zone

The Palghat Cauvery Shear Zone (CSZ) is a major shear zone that possibly extends into fragments of Gondwanaland. In the present study mafic granulites occurring on either side of the CSZ in Namakkal area, southern India are examined. Textural features recorded in themaficgranulites are crucial in elucidating the metamorphic history of the southern granulite terrane(SGT).

Textural and P–T–study of rocks occurring on either side of the shear zone of the namakkal area has been attempted to understand its significance and relevance to the tectonic evolution of the area.The present study area is situated south of Namakkal comprising a segment in the eastern part of the CSZ (figure 1a). Here, the CSZ is marked by the presence of 2–3km wide E–W trending mylonitic (augen) gneisses, which are composed of augen shaped quartz and feldspar grains and also consist of mica and hornblende, situated on the northern bank of the Cauvery river.

Mafic granulite and granite migmatites occur on the northern part of the CSZ while granitic gneisses constitute the southern part. Mafic granulites usually occur as variably sized enclaves within the granitic gneisses of the south. Hornblende biotite gneiss occurs as a thin band sub-parallel to CSZ in the northern part.

Slope

Slope of an area is an indicator of the infiltration rate. The contact period of water with the surface is less where the slope is more and thereby the infiltration rate will be less. In places where the slope is relatively less, the terrain is almost plain and the contact of the run off water with surface is highand it results in good groundwater recharge. The contour map is prepared in 1:50000 scale from SOI topo sheets. TIN map is created from contour map. Based on the TIN map, slope map is prepared for the study area. The slope map of the study area reveals that the slope is high in hilly terrains which are present in north and east parts. The most part of the study area contains a gentle slope of 0- 1 degree. The slope map of the study area is shown in Figure 7.

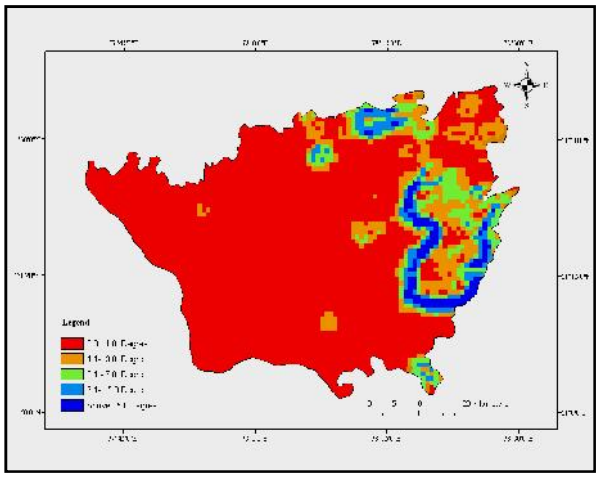

Figure.7 Slope Map (PWD).

Lithology

The subsurface order of existence of different geological stratum in a particular locality is described with the term called as lithology. The study area consists of top soil, weathered and fresh stratums of geneiss, charnockite, pyroxenite. The lithological details of the study area are known from the selected bore logs across the study area. The lithological details of different bore logs are given in Table 3.

Table 3 Lithology details (PWD, 2001)

Name of the village	Longitude	Latitude	Lithology in m	
Koneripatti	78.19	11.46	GL.-2.0	Top soil
			2.0-14.0	Weathered gneiss
			14.0-45.0	Jointed gneiss
			45.0-65.0	Fresh gneiss
Thoppapatti	78.27	11.47	GL.-2.6	Top soil
			2.6-16.0	Weathered gneiss
			16.0-55.0	Jointed gneiss
Namakkal	78.18	11.23	GL.-2.0	Top soil
			2.0-45.0	Weathered pyroxenite
Muthugapatti	78.22	11.25	GL.-3.6	Top soil
			3.6-26.0	Weathered charnockite
			26.0-66.0	Fresh charnockite
Jambumadai	78.27	11.17	GL.-0.5	Top soil
			0.5-35.0	Weathered gneiss
			35.0-66.0	Fresh gneiss
Laddivadai	78.13	11.07	GL.-2.5	Top soil
			2.5-15.0	Weathered gneiss
			15.0-26.0	Jointed gneiss
			26.0-81.0	Fresh gneiss
Jedarpalayam	77.83	11.18	GL-2.0	Top soil
			2.5-15.0	Weathered gneiss
			15.0-81.0	Jointed gneiss
Nathamettupudur	78.00	11.13	GL.-2.0	Top soil
			2.0-17.0	Weathered gneiss
			17.0-55.0	Jointed gneiss
Karanthakadu	79.87	11.35	GL.-1.8	Top soil
			1.8-9.0	Weathered granite gneiss
			9.0-56.0	Jointed granite gneiss
Ayakatur	77.72	11.38	GL.-1.0	Top soil
			1.0-10.5	Weathered gneiss
			10.5-30.0	Fresh gneiss
Illupulli	77.98	11.37	GL.-1.5	Top soil
			1.5-33.0	Weathered gneiss
			33.0-72.0	Jointed gneiss

Soils

The soils of Namakkal district can be broadly classified into 5 major soils types viz., Red Soil, Black Soil, Brown soil,

Alluvial and Mixed Soil. Figure 8 & Table 4. Major part of the district covered by Red Soil. Block soils are mostly seen in Namakkal taluk. Brown Soil occupies only a small portion of Tiruchengode taluk and the Alluvial Soil is seen along the river courses in Namakkal, Paramathi and Tiruchengode taluks. Mixed soil is the second major soil type occurring all the taluks of the districts.(CGWB,2008)

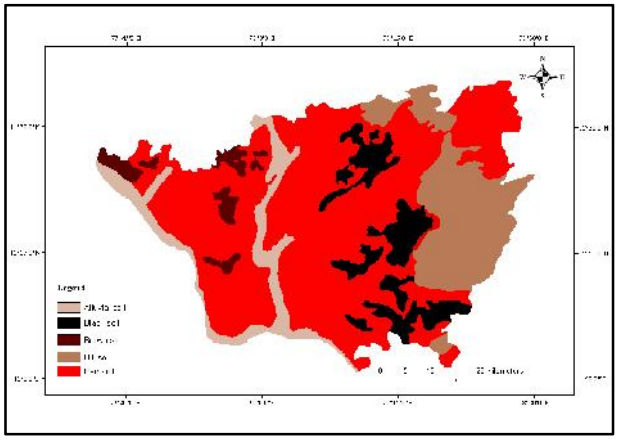

Figure 8 Soil Map

Table 4 Types of soil

S.No	Types of Soil	Area in sq.km.
1	Red Soil	2075.54
2	Brown Soil	98.99
3	Black Soil	359.89
4	Alluvial Soil	278.18
5	Hill Soil	591.71
	Total Area	3404.30

CONCLUSION

The major geology type of the study area is gneissic rocks and it is spread over 53.24% of the study area. The other predominant type of geology of the study area is charnockite. It is spread over 30.93% of the total area. Alluvium and Pyroxene Granulite are other two types of geology and they are spread over an area of 5.77 % and 5.75% respectively. The rest of the area contains geological types of Zone of Brecciation, Ultrabasic with Magnesite, Granitoid Gneiss, Granitoid Gneiss with Pegmatie, Dolerite and Tanks. The gneisses are highly weathered. The groundwater storage and recharge potential in this type of geology will be higher than any other types. The charnockites are massive and less weathered than the gneisses.

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