

CHAPTER-2

GEOLOGY OF TAMILNADU

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2.1 INTRODUCTION

Tamil Nadu with an area of 1,30,058 square kilometers, is situated in the southeastern part of the Indian Peninsula between north latitudes $8^{\circ} 00'$ and $13^{\circ} 30'$ and east longitudes $76^{\circ} 00'$ and $80^{\circ} 18'$. Bay of Bengal in the east, Kerala state in the west, parts of Andhra Pradesh and Karnataka states in the north and Indian Ocean in the south are the political demarcations for the state of Tamil Nadu. At present the state has been functioning with 29 Districts (Fig.2-1).

Several workers including King and Foote (1864), Blandford (1885), Holland (1900), Krishnan (1958), Subramaniam (1959), Narayanaswamy (1976) and recently several others have described the geology and structure of Tamil Nadu. As a preamble, brief description of the geology of the state is given in this chapter. The stratigraphic succession of rocks in Tamil Nadu is shown in table (2-1) and a geological map of Tamil Nadu is shown in figure 2-2.

Precambrian rocks with mineral assemblages of high temperature and pressure are well exposed in Tamil Nadu. A variety

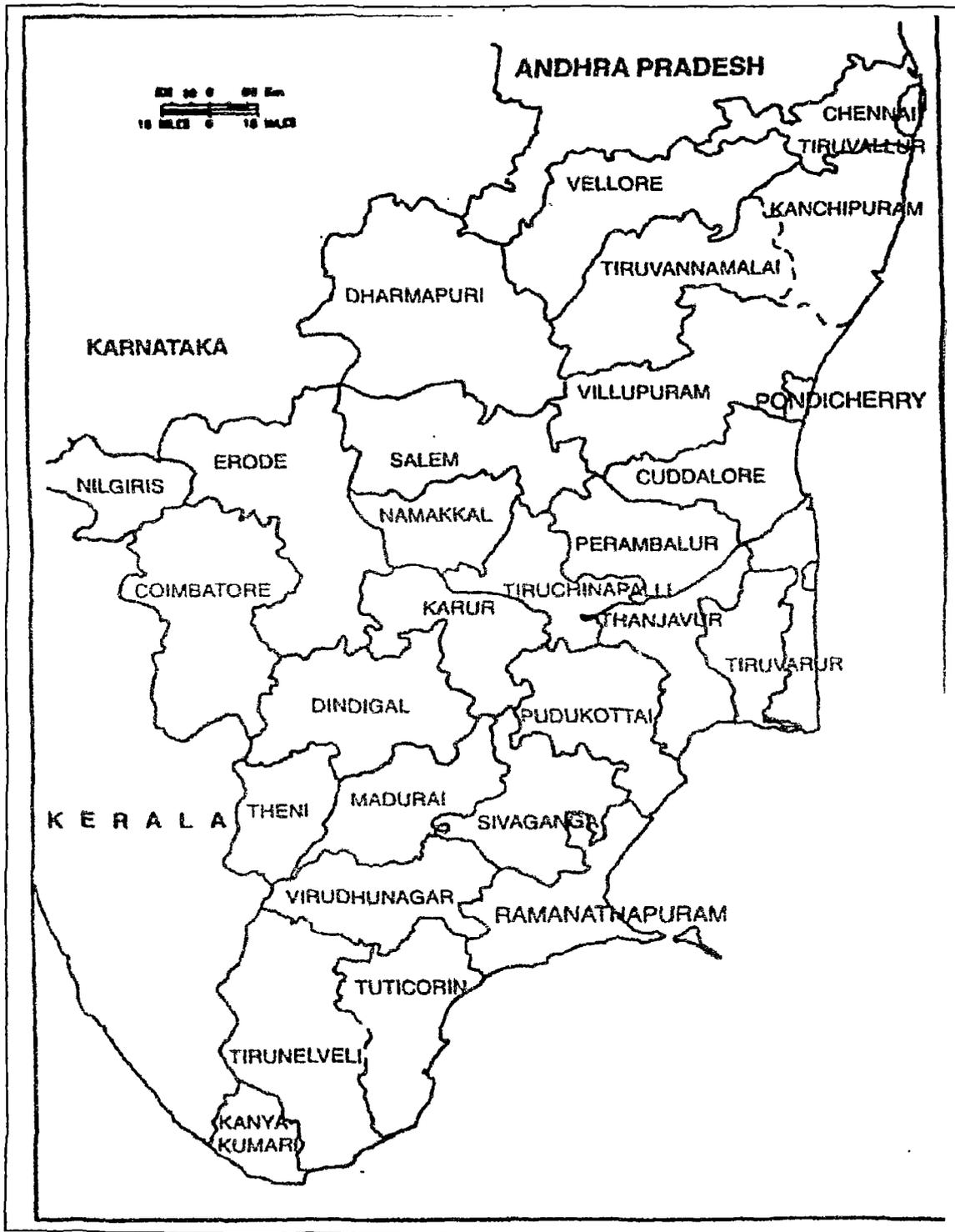


FIGURE 2.1 DISTRICTS OF TAMIL NADU
Source: Geological Society of India

TABLE-2-1
STRATIGRAPHIC SUCCESSION OF TAMILNADU

| | | |
|---|--------------------------|--|
| 1 | CENOZOIC | Alluvium, Black soils, Laterite, Cuddalore Sandstone |
| 2 | MESOZOIC (CRETACEOUS) | Niniyur Formation Ariyalur Formation Trichinopoly Formation Utatur Formation |
| 3 | MESOZOIC To PALAEOZOIC | Gondwana Plant Beds |
| 4 | PROTEROZOIC | Granites Charnockites Alkaline rocks and Carbonatites Ultramafics Basic dykes |
| 5 | PROTEROZOIC TO ARCHAEAN | Migmatites Complex Granites Charnockite Group |
| 6 | ARCHAEAN | Anorthosite Complex Kolar Group Khondalite Group Bhavani Gneissic Complex Sathyamangalam Group |

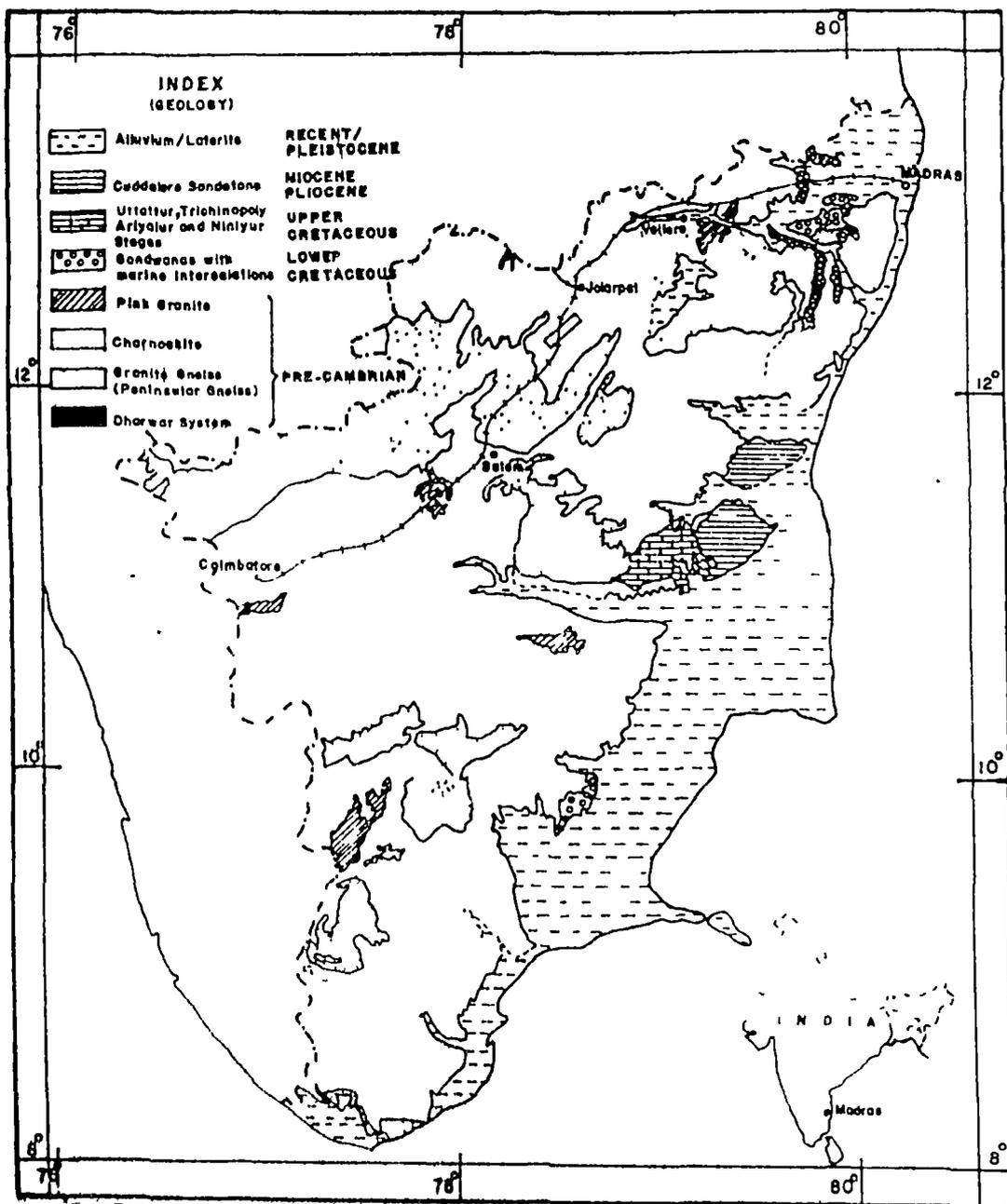


Fig 2.2 GEOLOGICAL MAP OF TAMILNADU, INDIA Scale - 50 25 0 50 Km
 (SOURCE: Dept. of Mines and Geology, Tamilnadu)

of older rocks (acid, basic and alkaline) have interacted with the preexisting rocks, resulting in the formation of new rock types with large variations. Granulites are the most abundant rock type among the Precambrian rocks of Tamil Nadu and are broadly subdivided into Eastern Ghat Mobile Belt (EGBM) and Stable Cratonic Granulite (SCG) (Divakara Rao, 1982). Apart from the above rocks, lithounits belonging to Gondwana, Cretaceous and Mio-Pliocene ages are also present in the coastal regions of Tamil Nadu. The geological map of Tamil Nadu is given as figure 2-2.

2.2 THE ARCHAEOAN ROCKS

Most of the Precambrian rocks in Tamil Nadu belong to Archaean age, and are classified into six major stratigraphic units namely: (1) Khondalite group, (2) Charnockite group, (3) Migmatite complex, (4) Sathyamangalam group, (5) Bhavani Gneissic complex and (6) Kolar group. These Archaean rocks represent a mobile belt, bordering the rocks of Dharwar craton. The Khondalite group and the Charnockite group form a super group known as Eastern Ghat Super Group (Narayanaswamy, (1971) and Basement Sub Committee (GSI, 1975). Among these, the charnockite group is considered to be the oldest and the gneisses the youngest (Murthy, 1973). The charnockite

group consisting of Granulites and Khondalites are considered to be high-grade metasediments (Sugavanam, 1978).

2.2-1 EASTERN GHAT SUPER GROUP

The Eastern Ghat Super Group consists of charnockites, khondalites and gneisses and forms the basement of the Dharwar rocks (Gopalakrishnan, 1972).

2.2-1.1 CHARNOCKITE GROUP

This group of rocks, consisting of charnockite, two pyroxene granulite, banded magnetite quartzite and pink quartzo feldspathic granulite, are extensively developed in the north eastern parts of the state and are exposed very much in Javadi, Shevaroy, Chitteri, Kalrayan, Kollimalai, Pachaimalai and Nilgiri hills. The pyroxene granulites of this charnockite group are considered to represent mafic or basic volcanics; the banded magnetite quartzite indicates a volcanic exhalative origin, while the pink granulites are interpreted to represent the associated acid volcanics (Sugavanam et.al, 1978).

Charnockitic rocks also occur in the northwestern parts of the state in Dharmapuri and Erode districts forming the hills to the west and northwest of Mettur. These are derived from prograde metamorphism of the peninsular gneisses and associated supracrustal

rocks of Dharwar Craton. In the southern parts of the state, charnockites, pyroxene granulite and pink granulite were found to occupy the hills such as Kodaikanal, Palani, Sirumalai, Agasthiyarmalai and knobs around Nagercoil. These charnockites are found to be different from the other two types, exposed in northeast and northwest parts of the state. Intrusions of, anorthosites, dunites, peridotites, pyroxenites, gabbros and dolerite dykes are found to dissect the charnockites cropped out in several places (Sugavanam et al, 1978). Incipient charnockitisation is also reported from different parts of the state (Whigtman, 1988, Nathan et al. 1996). The geochronological data recorded for the charnockites of Tamil Nadu assigned ages varying from 3000 to 500 million years.

2.2-1.2 KHONDALITE GROUP

Walker (1902) proposed the term khondalite series for an intensely metamorphosed suite of sedimentary rocks including argillaceous, arenaceous and calcareous members. Khondalite group of rocks is exposed predominantly in the southern part of the state. It essentially consists of rocks of sedimentary parentage such as quartzites, calc granulites, calc- gneiss, crystalline limestone, garnetiferous quartzo feldspathic gneisses and meta-pelitics. These

are interbanded at places with mafic granulites, amphibolites and charnockites. The entire lithological assemblage indicates a distinct continental shelf facies/platformal environment for its formation. Notably, this khondalite group of rocks, seldom exposed in northern part of the state, occupies the synformal keels within charnockites. Gopalakrishnan (1994a) opine that these metasediments have been probably formed under a different tectonic setting in contrast to the platformal khondalites of southern Tamil Nadu.

Adequate geochronological data are not available for the khondalite group of rocks in Tamil Nadu. However, similar rocks in the adjoining Kerala state have given Rb/Sr whole rock age of 3065 ± 75 million years (Crawford 1969).

2.2-2 MIGMATITE COMPLEX

The khondalitic and charnockitic rocks in the state are mobilized to varying degrees, resulting in retrogression and transformed into migmatites. They are grouped under migmatite complex and comprise of different types of gneisses such as biotite-gneiss, hornblende-gneiss, augen-gneisses, etc. Generally they are gray colored, but in several places late stage K-metasomatism has converted them into pink migmatites. All the above varieties of

gneisses in migmatite complex are collectively termed as peninsular gneiss.

The origin of migmatites is a matter of controversy. Bulk of the gneisses in the state actually represents reworked khondalites, which are migmatized by alaskitic granite (Narayanaswamy & Purna Lakshmi, 1967, Narayanaswamy, 1971). Several complexes of granitoid gneisses with enclaves of charnockites are considered as regional migmatites (Gopalakrishnan et al., 1976 & Sugavanam et al., 1976 a, 1978).

Eventhough the migmatite complex consists of components of different ages, generally they have been assigned Mid-Archaean age. However, the migmatites east of Coimbatore, (Crawford 1969) and the Gingee migmatites (Balasubramanian et, al. 1979) have been dated as 2100 and 2250 million years, respectively.

2.2-3 SATHYAMANGALAM GROUP

This group of rocks consists of mica schist calc-granulites, para amphibolites and crystalline limestone. The fuchsite + kyanite bearing assemblages are characteristic key members of the Sathyamangalam group. They are considered to be equivalent (Gopalakrishnan et.al, 1975) of Sargur schists of Karnataka, which are designated as ancient

supracrustals (Radhakrishna and Vaidyanadhan, 1997). These rocks occur in an east-west trending linear belt in central Tamil Nadu occupying parts of Coimbatore, Erode, Salem, Namakkal and Dharmapuri districts.

Two distinctly contrasting occurrences, one the funnel shaped gabbroic anorthosite body of Kadavur and another chromite bearing anorthosite of Sittampundi are included in this supergroup (Gopalakrishnan and Ramachandran, 1994). Sathyamangalam group of rocks with their associated members of ultramafics is found to be emplaced in reactivated shear zones. Recent geochronological studies on Sittampundi anorthosites by National Geophysical Research Institute indicate an age of 3000 Million years by Sm/Nd systematic and 2500 Million years by Rb/Sr systematic (Bhaskara Rao et al., 1974).

2.2-4 KOLAR GROUP

The Kolar schist belt breaks up into three arms and extends as disconnected lenses and linear patches within peninsular gneisses of Tamil Nadu. This schist belt is made up of greenstone rocks designated as Kolar group comprising biotite hornblende schist, amphibolites, banded ferrugeneous quartzites and acid volcanics

represented by quartz sericite schists. Geochronological data indicate an age of 2900 million years for the Kolar group of rocks (Bhalla et al., 1978; Hansen et al., 1988).

2.2-5 BHAVANI GROUP

This group is comparable to the peninsular gneisses of Karnataka and is a mixture of gneisses of varying composition and texture. Rocks, which are highly fissile including, banded mica gneiss, quartzo-feldspathic gneiss, augen gneiss, hornblende gneiss, biotite gneiss, etc. are found in this Bhavani group. Parts of these gneisses are considered to be para as well as ortho gneisses and parts are their migmatitic equivalents. These rocks are well exposed in the central part of Tamil Nadu, especially in the districts of Erode, Coimbatore, Salem Namakkal, Tiruchirapalli and Perambalur. Around Krishnagiri, these gneisses form different textural types of various hues and colors. This phase of the Peninsular gneiss has been assigned an age of 3000 million years (Krogstad et al., 1988), indicating Mid-Archaean age.

2.3 PROTEROZOIC FORMATIONS

Lithounits of this period in Tamil Nadu are characterized by granulitic facies of metamorphism with charnockite formation and

concomitant anatexis of earlier rocks. Numerous granite plutons have been emplaced during this period.

Pioneering studies by Holland (1900) and Vredenburg (1919) on origin of charnockites are noteworthy. Contributions of Howie (1955), Subramaniam (1959), Naryanaswamy and Purnalakshmi (1967), Gopalakrishnan et al, (1976), Sugavanam et.al, (1978), have added valuable literature to the Proterozoic charnockites of Tamil Nadu. Pichamuthu (1961) noted the conversion of gneisses to charnockite in Karnataka. Similarly views of Selvan and Janardhan (1979), Nathan et al, (1996), and GSI (1998), on origin of charnockites and associated basic rocks are noteworthy. Three distinct groups of Proterozoic granulite belts were identified by Janardhan (1999) in Tamil Nadu. Newton et al, (1980) have recorded the role of carbonic fluids in the formation of granulites in the Peninsular India. The subsequent studies by Srikantappa (1987), Hansen et al, (1988), Asha Manjari (1993), Wickham et.al (1994), Santhosh and Radhika (1994), have helped to understand the mechanism of granulite formation in this part of the world. In general, the metamorphic temperature and pressure conditions of these rocks range from 650° C to 680° C and 7 to 9.4 Kilobars (Raith

et al, 1983). The protoliths of these granulites might have been emplaced 2700 million years (Nilgiri granulite) ago and the peak period of metamorphism was around 2500 million years back (Krishnagiri granulites), as reported by Janardhan (1999).

2.3-1 DYKES AND SILLS

Basic dykes are numerous in the northern area, than in the southern part of Tamil Nadu. Five phases of dyke activity have been recognized in the northern part and of these the earliest phase is represented by meta-norites (Subramanian and Selvan, 2001). In the central part of the state, the dyke activity is seldom found and represented by an end phase of ultramafic activity in the terrain. Dykes of southern Tamil Nadu are very poor in frequency and distribution. However, a few meta-doleritic sills have been reported from Tirunelveli.

2.3-2 ULTRAMAFIC AND ALKALINE BODIES

The ultramafics of Tamil Nadu are confined to the NNE – SSW and E-W trending tectonic zones. The chalk-hills in Salem district, the Kanjanor ultramafic complex near Samalpatti, Dharmapuri district, and ultramafic complex of Thenmudiyanur, South Arcot district are significantly aligned along the NNE-SSW tectonic zone.

The Sirappalli complex south of Sittampundi in Namakkal district is aligned along E-W tectonic zone. The Elagiri syenite complex, Pikkili syenite complex, Sivamalai syenite complex and Putteti syenite complex are of Proterozoic age and are the notable syenite complexes of the state. A few carbonatite complexes of Proterozoic age are also reported from Tamil Nadu. They are Sevattur complex, Samalpatti complex, Hogenakal, Jogipatti complex, Pakkanadu complex and Kudangulam complex. Younger granitic plutons including Gingee granite (2,250 million years – GSI 1978), and Sangari granites, have been reported from the state.

2.4 MESOZOIC ROCKS

The Mesozoic rocks of Tamil Nadu are represented by the upper Gondwana formations (Late Jurassic to Early Cretaceous) and by the marine cretaceous rocks. The lower Gondwana formation is well developed in the Palar basin in the northeastern part of the state. The upper Gondwana rocks occur in three sub basins; near Sivaganga, near Terani and Uttatur and near Sriperumpudur. The marine late cretaceous rocks are distributed in Tiruchirapalli and Vriddhachalam areas. Their rich fossil remains and calcareous deposits characterize these cretaceous rocks.

2.5 CENOZOIC

Above the cretaceous rocks, the sandstones of Paleocene age are resting comfortably (Sundaram 1980). Rocks of Mio-Pliocene age (Cuddalore formation) occupy large areas and rest over the crystalline basement. The Cuddalore formation contains large quantities of fossil wood and near Tiruvakkarai, a 'National Fossil Wood Park' has been established by Geological Survey of India. Post Pliocene rocks are represented by calcareous mud; clay and sandstones are exposed in Theni and Madurai districts (Murthy 1969). Heavy mineral deposits of coastal and fluvial origin are widely distributed within the state.

2.6 STRUCTURES AND TECTONICS

The detailed structural mapping carried out in the state of Tamil Nadu by the Geological Survey of India has revealed the existence of five generations of folds, with concomitant metamorphism and anataxis, in the Precambrian rocks. The first generation folds (F_1) are isoclinal, trending NNE-SSW and subtending the open folds (F_2) trending ENE-WSW all belong their limbs. The third generation fold (F_3) is marked by a shear related N-S axial trends. A regional warp

along WNW-ESE defines the fourth generation fold (F_4), responsible for the development of most of the structural domes and basins. The final phase of folding, rather the F_5 folds are related to the shears trending NNE-SSW and are well documented in the Syenite, Carbonatite and ultramafic complexes of the state. The tectonic map of Tamil Nadu is presented in figure 2-3.

Faults and fractures in five well-defined directions have been deciphered in the state. Anorthosite, carbonatite and granite emplacements characterize the Moyar-Bhavani-Attur and the Palghat-Cauvery faults. They have been aligned along E-W to WNW-ESE directions. The Metupalayam-Bhavanisagar fault, striking in the vicinity of Nilgiri hills trends in a NNE-SSW direction. The Pambar and Cheranmahadevi faults trend N-S, while the Achankoil fault trends NW-SE. In the central part of Tamil Nadu, however, meso-faults trending NW-SE are frequent.

Srikantia (1999) recognized four tectonic blocks, including Southern Karnataka -North Tamil Nadu block, Coimbatore-Salem block, Madurai block and Trivandrum block. The Madurai block, bounded by the Palghat – Cauvery fault in the north and the Achankoil fault in the south is the same as the Pandyan Mobile Belt

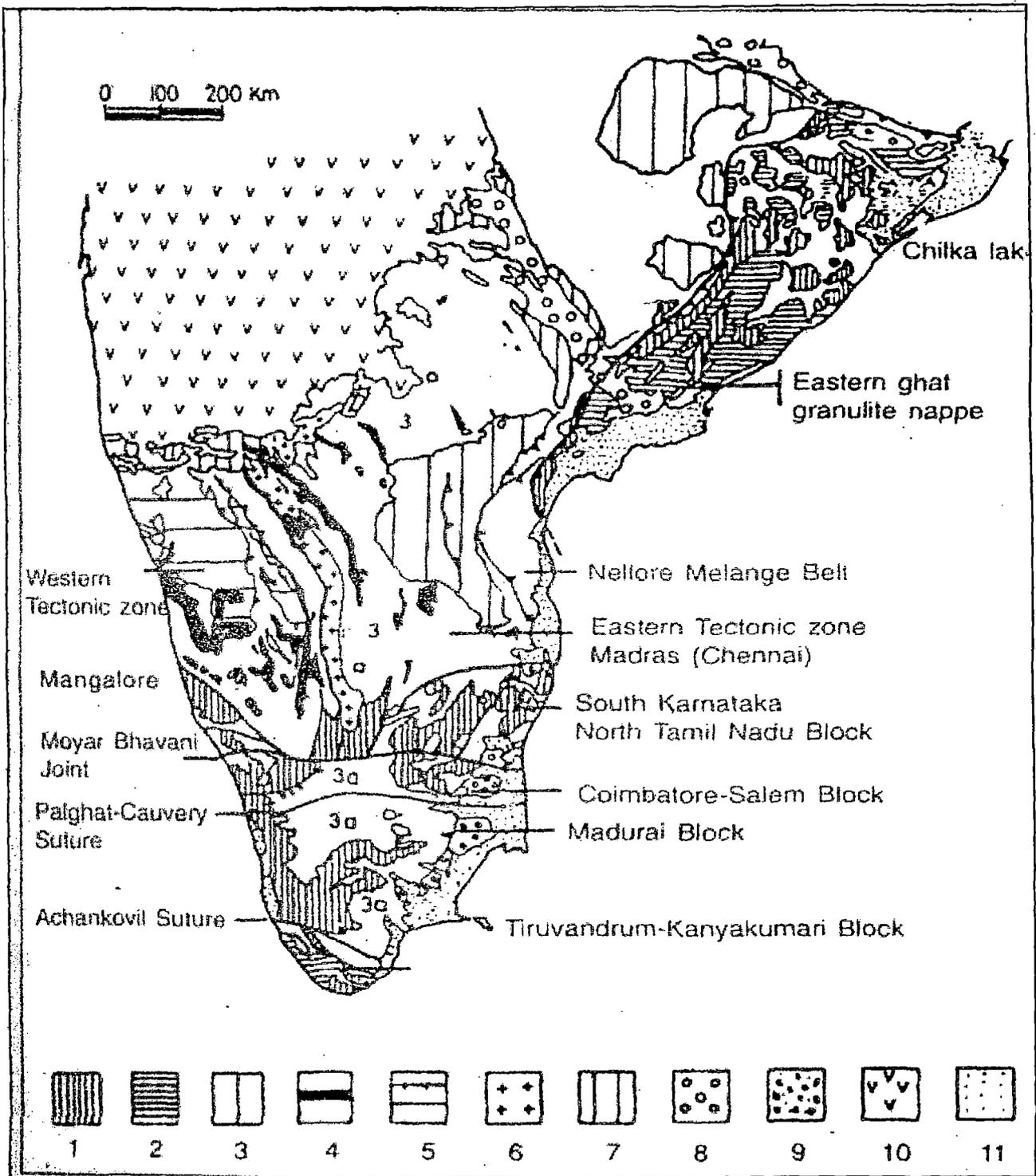


FIGURE 2.3 TECTONIC MAP OF SOUTH INDIA

Source : Geological Society of India

(Ramakrishnan, 1994). However, Janardhan (1999) considers the entire terrain to the south of the Palghat Cauvery fault as a single unit. Gopalakrishnan et.al, (1990) have recognized independent tectonic blocks, separated by linear belts (Fig. 2-4). The area proposed for the present study is a part of Precambrian terrain characterized generally with ductile shears (Mahadevan, 1999) and falling in the vicinity of Palghat – Cauvery shear zone with gneisses and supracrustals (Ramakrishnan 1988). The general physical features of Tamil Nadu are depicted in figure 2-5.

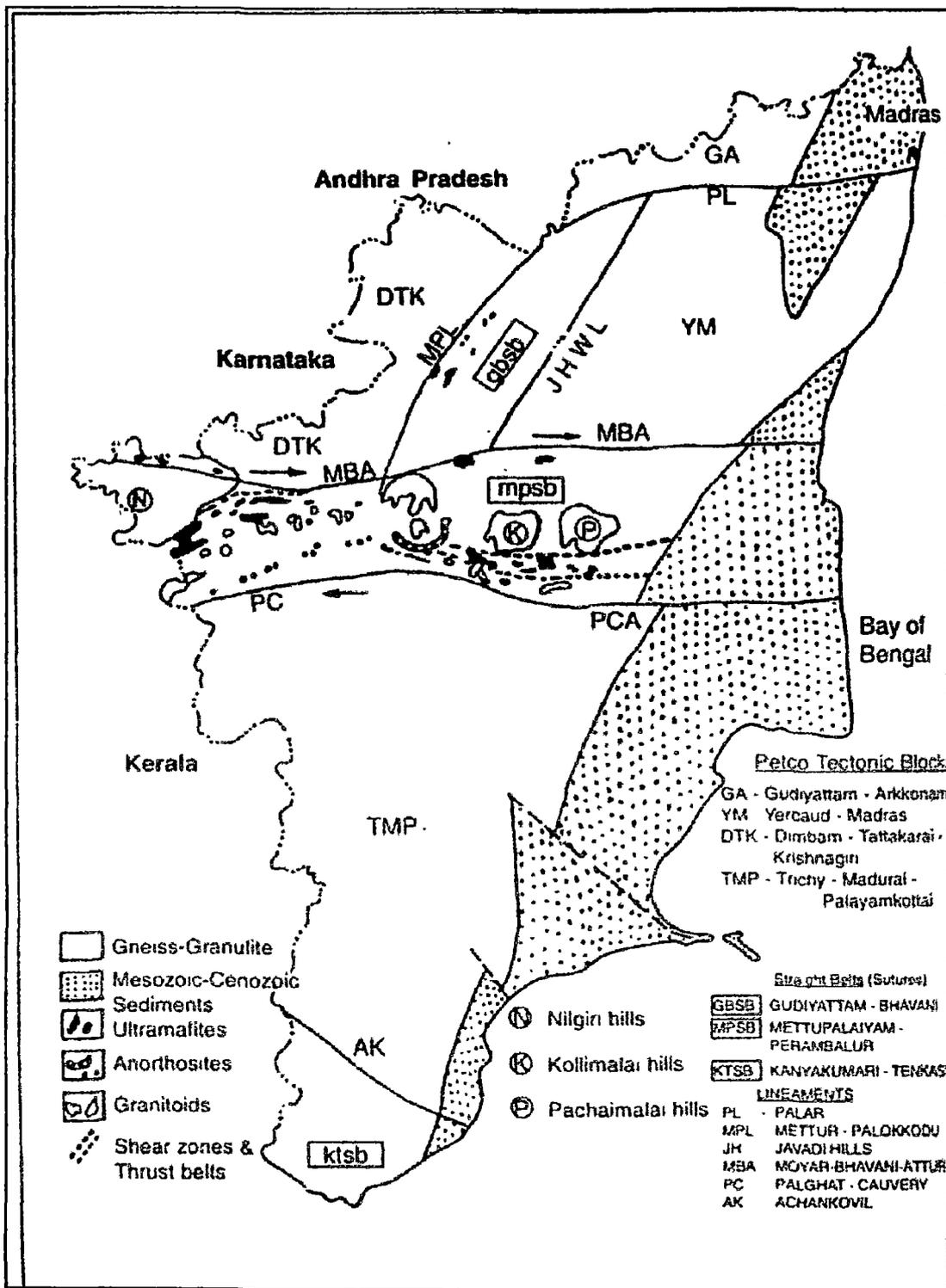


FIGURE 2.4 TECTONIC BLOCKS IN TAMIL NADU

Source: Gopalakrishnan et al. 1990

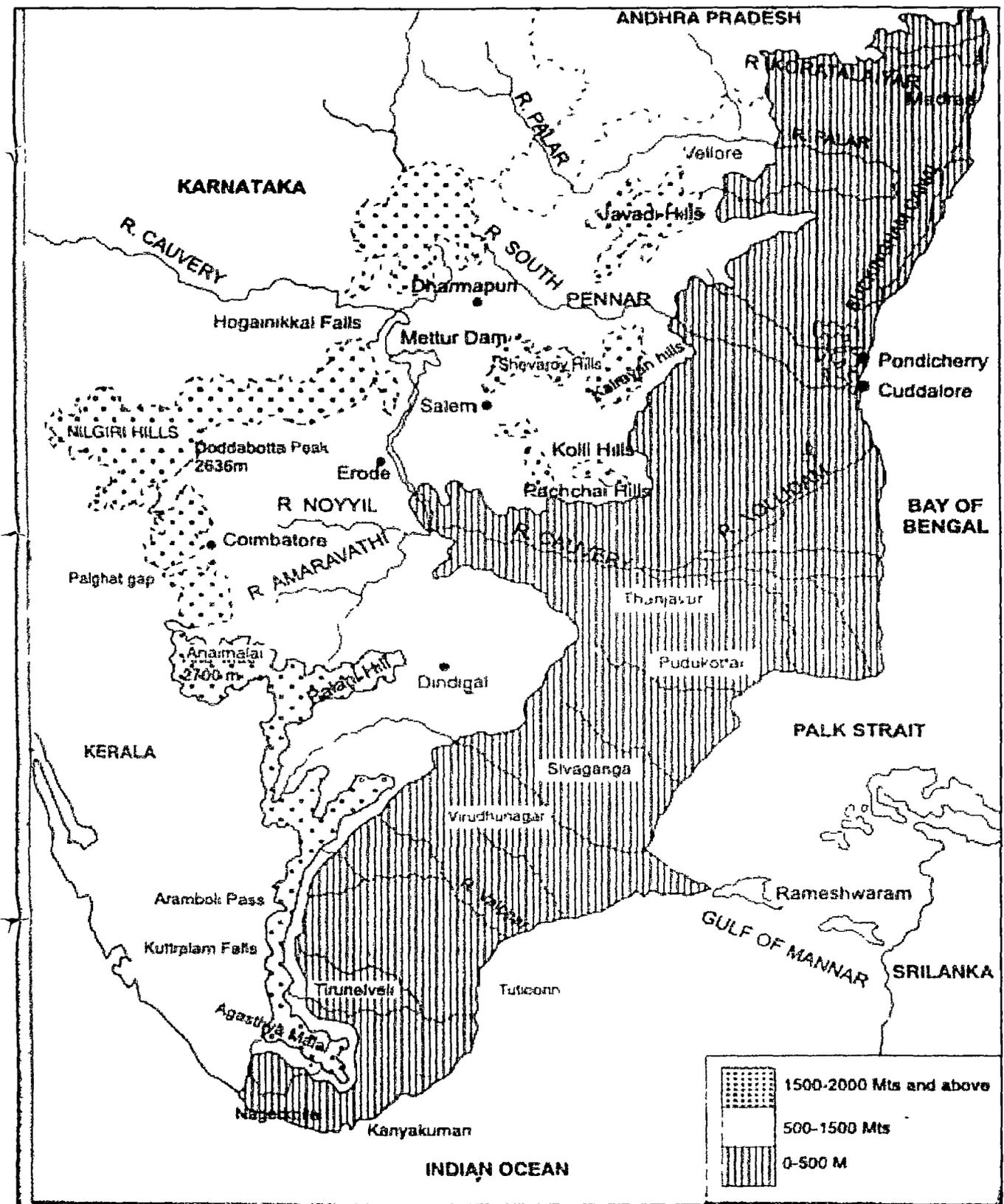


FIGURE 2.5 GENERAL PHYSICAL FEATURES OF TAMIL NADU

Source: Geological Society of India