CHAPTER IV

STRUCTURAL SETTING OF THE STUDY AREA
CHAPTER IV

STRUCTURAL SETTING OF THE STUDY AREA

4.1 INTRODUCTION

Structural patterns in the high grade terrain of Tamil Nadu and parts of Karnataka has been worked by many Geologists and only recently the detailed geological mapping in parts of Tamil Nadu and Karnataka has brought out vast areas occupied by charnockites is intensely co-folded with supra-crustal group of rocks represented by khondalite, magnetite, quartzite, pink granite, pyroxene granulite and layered ultramafics. Structural map of the study area are shown in Fig.7.

4.2 Structural Analysis by Early Workers

Fermor (1936) demarcated the South Indian region into charnockite and non-charnockite regions. Narayanaswamy (1964) modified the earlier views and presented charnockite and khondalite of the southern granulite terrain and the eastern ghats representing the oldest stratigraphic units. The geological survey of Indian officers did a commendable job in organising a group discussion on granulite facies terrain during the year 1976. The papers on

i. Geology and whole rock chemistry of granulites,

ii. Structural, tectonic and metamorphism, magmatic activities and metallogeny in parts of Tamil Nadu (Sugavanam et.al, 1976, 1988) gave a comprehensive view on the polymetamorphic multi-structural
STRUCTURAL MAP OF THE STUDY AREA
Archaean complex of peninsular India exposing rocks of diverse origin. The study area, Konganapuram is a part of this region and therefore a review is made here on the various types of structural patterns observed by geological survey of Indian officers.

4.2.1 F₁ FOLDS

F₁ folds are longitudinal folds with their axial plane in the direction of NNE to SSW. They are regional in characters and are essentially isoclinal asymmetrical in nature. They have steep westerly dipping axial planes and are comprised of broad synforms with narrow tightly pressed antiforms.

4.2.2 F₂ FOLDS

F₂ folds are generally kinks on the limbs of the longitudinal folds F₁.

4.2.3 F₃ FOLDS

It is parallel to the N-S direction with low plunge to south and very much restricted in their development and a real extent. Highly brecciated and mylonised rocks constitute shear zone closely connected with F₃ deformation.

4.2.4 F₄ FOLDS

It is impact on regional scale is more significant when it interferes with earlier said folds of F₁, F₂ and F₃ resulting in the formation of structural basins and domes.

4.2.5 F₅ FOLDS

It is co-axial with earlier F₁ fold and parallel to almost N-S direction. They are the youngest formed folds showing cataclastic nature. They are well
developed over large areas forming prominent dextral en echelon folds on the limbs of the earlier folds. Due to this fold, a rock bank of ten appears as several parallel bands.

4.2.6 RELATION BETWEEN $F_1$, $F_2$, $F_3$, $F_4$ AND $F_5$ FOLDS

In the study area, we find $F_1$, $F_2$ and $F_3$ folds. Only when the study is made on the regional scale, the relationship between all the folds can be deciphered. Further, it is also important to note that the general strike direction in Tamil Nadu takes a swing from E-W to NE-SW. Therefore, the directions of $F_1$, $F_2$, $F_3$, $F_4$ and $F_5$ folds are only arbitrary.

4.3 JOINTS

Well developed joints, both across the foliation and parallel to the foliation are observed in the study area. They are very useful in transporting ground water from one zone to other.

4.4 REMOTE SENSING TECHNIQUES UNDER STRUCTURAL ASPECTS


4.4.1 GRADY (1971)

Grady's research paper on deep main faults in South India using aerial photographs was a turning point in understanding the structure of South India. The United Nations Photogeologist in the project for mineral development in India
carefully studied the aerial photographs of South India and recognised several deep main faults shown in (Fig.8). A clear distinction between the South tectonic plateau and Eastern Ghats, Nilgiris and Tamil Nadu hills were presented in the article. His observations generated extensive work on the tectonics of South India.

4.4.2 DRURY ET. AL (1984)

Drury’s Landsat imagery interpretation in South India is given in (Fig.9). His main contribution is the identification of the major Moyar lineament, 20 km, wide and 200 km, long, a major shear complex with a dextral movement.

4.4.3 KATZ (1978)

Fig.10 shows the general tectonic map of the pre-Cambrians of South India - Sri Lanka showing craton-mobile belt relationship by Katz. He recognised three sub-belts on the basis of aulocogenes. The sense of movement along the bounding lineament is dextral in regard to the NE trending Salem and Madurai sub-belts.

The schematic evolution of high grade mobile belt from fundamental fracturing to tensional tectonic stage and the development of aulocogenes and finally to transform tectonic stage is given by Katz (Fig.11).

4.4.4 SUBRAMANIAM ET. AL (1979)

Using lineaments, Subramaniam et.al (1979) demarcated the ultramafic emplacement in Salem district (Fig.12). It can be noticed that there is a paucity of lineaments in the un sheared ultramafic intrusives.
DEEP MAIN FAULTS IN TAMIL NADU
(After Grady, 1971)

FIG 8

SCALE
Figure 9. Tectonic map of South India. Bold dot-dash line indicates the western limit of a positive Bouguer gravity anomaly (Kaila and Bhattacharya 1981). The mid-Proterozoic Cuddapah and Kaladgi basins are indicated by CB and KB. Late-Proterozoic zones of high strain are: N-V: Nalluramba-Velukonda; M-B: Mysore-Bhadravati; A: Attri. P-Ca: Pochampalli-Cauvery; A: Achankovil; lower case letters a-g are granulite masses referred to in the text: a—Ganga; b—Baligirintangan (B-R); c—Shivsnar; d—Nilgiri; e—Kollimalai; f—Arambol; g—Palm. The inset shows the main Archaean blocks in South India: EG—Eastern Ghats; SB—Southern Block; WSB—Western Sub-block; ESB—Eastern Sub-block; SB—Southern Block.

(After S.A. Drury et al., 1984)
Figure 10. General tectonic map of the Precambrian of South India-Sri Lanka showing craton-mobile belt relations. In the craton the granite belts (dark) and the Closepet granite (crosses) are adjacent to the mobile belt boundaries. Younger rocks are shown in a stippled pattern. Scale 1:12,000,000 (after Swami Nath and Karnataka Circle, 1974).

(Source M. B. Katz, 1978)
Figure 12. Schematic evolution of high grade mobile belts from A) fundamental fracturing to B) tensional tectonic stage and the development of aulacogens to finally C) transform tectonic stage with internal secondary rifting and external large-scale rifting and spreading in the craton. Strain ellipses define structures in the mobile belt as a result of dextral simple shear. (after Katz, 1976c).

(Source M.B. Katz, 1978)
Figure 12. Lineaments across Shevaroy-Chitteri-Kalayan-Kollaimalai & Pachaimalai Hills (based on Landsat imagery interpretation)

(After K. S. Subramanian et al., 1979)
4.4.5 MISHRA (1988)

Bouger Anomaly map (Fig.13) of high-grade terrain of South India prepared by NGRI (1978) coincides with the exposed charnockite region. The northern gradient of Bouger high coincides with Bhavani fault, almost parallel to Palghat - Trichy line suggesting its extension to very great depth.

4.4.6 REDDI (1988)

Aeromagnetic study in the granulite terrain of Tamil Nadu and Kerala suggested a junction of profound structural dislocation between the granulite terrain and the Karnataka terrain (Reddi et al., 1988). Fig.14 shows a total intensity magnetic map suggesting deeper schematic layer and therefore the “moho” by implications. They suggest that the area is composed of independent crustal blocks of relative vertical movements.

4.5 STRUCTURAL PATTERN OBSERVED IN THE STUDY AREA

The area investigated around Konganapuram being a small part of high-grade mobile belt of South India shows complex structural and metamorphic history. Detailed geological and structural mapping have established two distinct phases of folding (F₁ and F₂). Further the study area has been affected by intrusive episodes, the resultant of which mafic complexes, alkali plutons are distributed. The distribution of biotite gneisses, granites, pegmatites and quartz veins are controlled by the deep and penetrative fractures including faults typical of many Archaean granulite mobile belts.
Figure 13: BOUGUER ANOMALY MAP OF HIGH GRADE TERRAIN OF SOUTH INDIA

(After D.C. Mishra, 1988)
Figure 14  A simplified geological map of Tamilnadu - Kerala region.

(After Reddi, A.G.B. et al., 1988)
The study area is bound on the north by Moyar-Bhavani lineament known as Grady’s main Noyil-Cauvery lineament. The presence of the Grady's main fault is inferred from the NE-SW alignment of carbonatite complexes, ultrabasic to alkaline intrusions, zones of metasomatic alteration and brecciation.

A zone of tension is inferred in the intervening region during the movement along these lineaments. Such a tension zone is favourable for the episodic igneous intrusions characterised by the Orikamalai batholiths, which extend to considerable depth or must have deep rocks.

The study area comprises lithologies of undoubted igneous, volcanic and sedimentary assemblages but only few of them retain its primary characters. Among the distinguishable structure following are the prominent features identified.

1. Fold
2. Joints
3. Foliation/banding
4. Shears
5. Fractures.

4.6 FOLD PATTERN
4.6.1 F1 FOLDS

The regional foliation of N35° - 45°E to S35° - 45°W with moderate dips towards ESE is the dominant 'S1' schistosity banding due to isoclinal 'F1' folds which have NNE-SSW axial trace. Isoclinal 'F1' folds have been recognised in
the area mapped at a number of places as major and minor folds.

In the study area ‘F₁’ folds (Plate XII, Fig.1) are seen at western side of the Olaggappanur. The isoclinal nature of F₁ folds is clearly brought out by the repetition of quartz and pegmatite veins particularly well seen. The dominant ‘S’ fabric is related to ‘F₁’ isoclinal fold has ESE moderately dipping (75º) axial plane and low to moderate plunges towards NNE.

4.6.2 F₂ FOLDS

‘F₂’ folds are more or less coaxial and coplanar with ‘F₁’ folds having NNE-SSW axial trace and low to moderate plunges towards NNE. The axial trace of ‘F₂’ are slightly oblique (<10º) to (‘F₁’ fold axis) ‘F₂’ folds have N40º - 45ºE to S40º - 45ºW axial trace and low to moderate plunge towards NE. Plate XII, Fig.2 shows the F₂ folds pattern is Olaggappanur.

4.7 JOINTS

Joints are very well developed in granite and other associated rocks. NNE-SSW aligned strike joints parallel to ‘S₁’ and ‘S’ . Besides, development of sub-horizontal sheet joints in granites have facilitated easy quarrying strike and cross-joints are steeply dipping to near vertical joints.

4.8 FOLIATION / BANDING

Foliation/banding is very well defined in all the lithological units mapped in the study area. It is very well exposed on the weathered surfaces of granite and biotite gneiss with contrasting felsic and mafic components.
Fig 1  The fold pattern 'F₁' found in Olagappanur.

Fig 2  The fold pattern 'F₂' found in Olagappanur.
4.9 FRACTURES

Fractures in hard rock terrain can be classified into two orders.

1. First order and
2. Second order fracture.

First order fractures are developed on a macro-scale while the second order on a micro-scale.

In Archaean rocks, such as found in this terrain joints developed due to consolidation shrinkage and also during folding. The author has observed that the horizontal joints when cut across by E-W as well as NE-SW lineaments bring about more ground water supply to that region.

4.10 SHEARS

Development of linear shear zones, parallel to the regional foliations is one of the most conspicuous structural factures observed along the central segment of the study area. Plate XIII, Fig.1 shows the minor shear zone near Reddipatti.
The minor shear zone near Reddipatti.