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Structural And Metamorphic Evolution Of The Melur Migmatites, In Melur Region, Madurai District,Tamil Nadu.

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ABSTRACT : *The Southern Granulite Terrain (SGT) is one of the best-exposed granulite terrains suited to address some fundamental problems concerning the origin and development of granulites. The contact between Dharwar craton and the SGT is marked by a series of crustal zone shear zones like the Moyar Bhavani-Attur shear zone to the south of the regional orthopyroxene isograd. Geochronological studies reveal that the PCSZ forms a major divide between older Archaean granulite crust in the north and the younger supracrustal dominated crust in the south (Harris et al., 1994, 1996; the major Proterozoic domains in India fall in the SGT and comprise of the Nilgiri Block (NB), the Madras Block (MB), the Madurai Granulite Block (MGB) and the Trivandrum Block (TB) (Hariss et al., 1994; Jayananda and Peucat, 1996; Braun and Kriegsman, 2003). The major shear zones demarcating these blocks are, the Moyar shear zone (between the transition zone and the Nilgiri block), the Moyar Bhavani and the Palghat-Cauvery shear zone (between Madras/Nilgiri Blocks and the Madurai Granulite Block) and the Achankovil shear zone the local scenario it can be noticed that the gneisses show wide variations. They are sometimes migmatitic gneisses, garnet-biotite gneisses or simply biotite gneisses. The intrusives are generally elongated or elliptical bodies having sharp contacts with the country rocks and are always associated with major lineaments in the block.The study area has a late orogenic structural evolution produced the main D3 folding, which transposed previous structures into a NE-SW trend. The doubly plunging fold axis produced dome-and basin structures. The attitude of the F3 folds varies from upright or slightly overturned to locally recumbent towards the NW. Granite dikes were intruded along S3 axial planes. Large D3 fold limbs are often strongly deformed, intensively migmatized and intruded by garnet- and cordierite-bearing granites.The present study involves most of the structures identified for the study area and it has been classified for the different regions. This structures are relates with the major shear zone in the SGT. The temperature variation during the crystallization and the structural trends are also mentioned for this study.*

KEY WORDS: *SGT, migmatite, fold, shear zone*

I. INTRODUCTION:

The concept of different tectonic blocks in the SGT (Southern Granulite Terrain) separated by extensive Proterozoic shear zones came in to discussion at the early eighties (Drury and Holt, 1980; Drury *et al.*, 1984). The MGB (Madurai Granulite Belt), which is located between the Palghat-Cauvery Shear Zone (PCSZ) and the Achankovil Shear Zone (AKSZ), generally comprises of charnockites in prominence associated with retrogressed or synmetamorphic gneisses. Charnockites are concentrated more in the western side of the block while the eastern side is dominated by gneisses - hornblende-biotite gneiss. They are sometimes migmatitic gneisses, garnet-biotite gneisses or simply biotite gneisses. The intrusive are generally elongated or elliptical bodies having sharp contacts with the country rocks and are always associated with major lineaments in the block. A detailed mapping of the terrain different types of field relationships between the rock types were traced out by GSI.The structural interpretation presented below is based on field observations of bedding, folds, cleavages, faults and magmatic intrusions following the methods discussed, e.g. by Hobbs et al. (1976). In general, early sub horizontal structures are complexly by later upright folding and faulting. The earliest observable structure is the lithological layering, so, which is well preserved in relatively weakly deformed domains. In the hinge zones, layering and foliation are perpendicular to each other and the former, therefore, is regarded as the primary depositional bedding.

The nature of the deformation, orientation and overprinting relationships: D1 and D2 are both related to crustal shortening, at different orientations, and regions dominated by D2 are characterized by a well-defined, folded early lineation trending at high angles to the D2 fold axis. D3 and D4 are both extensional at high angles to one another, both D1 and D2 folds, and D4 is better developed and D3. D1 involved thrusting and isoclinal folding with main fabric deformed by subsequent deformations. D1 structures earlier structures, but we interpret this to be related to the evolution of the same shortening event, where new gently dipping thrusts steepened locked thrusts and folds. In places (Six Mile Lagoon, 6ML6), banded migmatites are transposed in a zone over 50 m wide and trend parallel to the axial plane of D1.

- **D1 involved thrusting and isoclinal folding with main fabric deformed by subsequent deformations. D1 structures overprint earlier structures, but we interpret this to be related to the evolution of the same shortening event, where new gently dipping thrusts overprint steepened locked thrusts and folds. In places (Six Mile Lagoon, 6ML6), banded migmatites are transposed in a zone over 50 m wide and trend parallel to the axial plane of D1. D1 gave rise to an intense fold axis parallel lineation that tends to plunge either gently NNE or SSW as it is folded around D2 open folds.**
- **D2 is dominated by gentle, upright folds trending N60-80W, locally leading to transposition of pre-existing fabric (VB2 area) in melt-rich area, very similar to the pattern in D1 but in a different orientation. L1 is folded around the hinges of metric D2 folds, associated with intrafolial isoclinal F1 folds with the same fold axis.**
- **D3 gently to steeply dipping N-S trending normal shear zones intruded by narrow leucosomes parallel to C-S fabric (VB6).**
- **D4 moderately to steeply dipping normal and dextral oblique shear zones, either intruded by pegmatites or associated with sheared diatexites. There is a large zone of diatexite (Six Mile Lagoon, 6ML1) characterized by N60E-trending dextral-normal shearing during melting that is ascribed to D4 based on orientation and movement sense, and lack of later overprinting.**

This section is divided into descriptions of different areas where key relationships are best exposed.

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Structures of the study area: The typical texture of metamorphic rocks does not show a sequence of formation of the individual minerals like that evident in igneous rocks. All grains in metamorphic rocks apparently recrystallize at roughly the same time and they have to compete for space in an already solid rock body. As a result, the new minerals grow in the direction of lowest stress. Most metamorphic rocks thus have a layered, or planar, structure, resulting from recrystallization. A few foliations has either developed as an axial planer crenulation cleavage or as in the subsidiary shear zone, by complete transposition and obliteration of the earlier cleavage. By repeated isoclinals folding the rotated earlier cleavages on fold limbs and the newly formed axial plane cleavages have become subparellel while, because of the extreme stretching down the dip of the rotated earlier lineations and the newly formed stretching lineations on the axial plane cleavages have become nearly parallel in most places(Ghosh,1990).

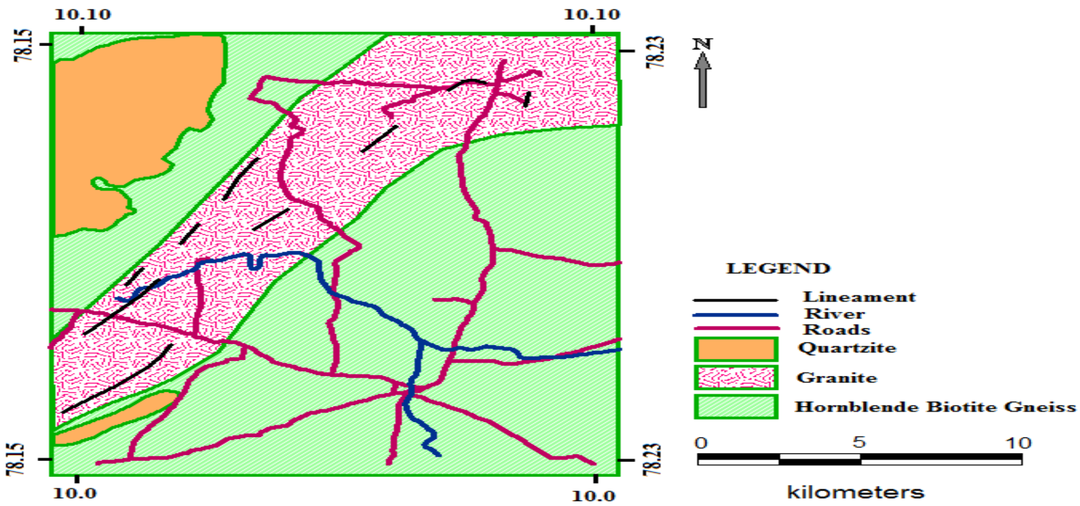


Fig.1 Geology and Structure of the study area.

The rounded grain with in shear plane. Its shape like sigma and tails from the beginning and the end of that grain so it is called as σ−type shear. σ−type (sigma) wedge shaped tails do not cross the reference plane of shear may represent slow grain rotation relative to tail growth (Kevin P.Hefferan, 2004).The study area Minor faults were identified in many exposures most of them are normal to reverse fault trending NE to SW(Fig.2f). Fold trains may successively form upwards from this location with continued shear.

Fig.2 Shows that the Structural Evidence for the Augen structure shear folding, shear folding with and structure of the Pegmatoidal Gneiss, Granite Intrusion, Older Gneiss, A big crystal of K-Alkali Feldspars.

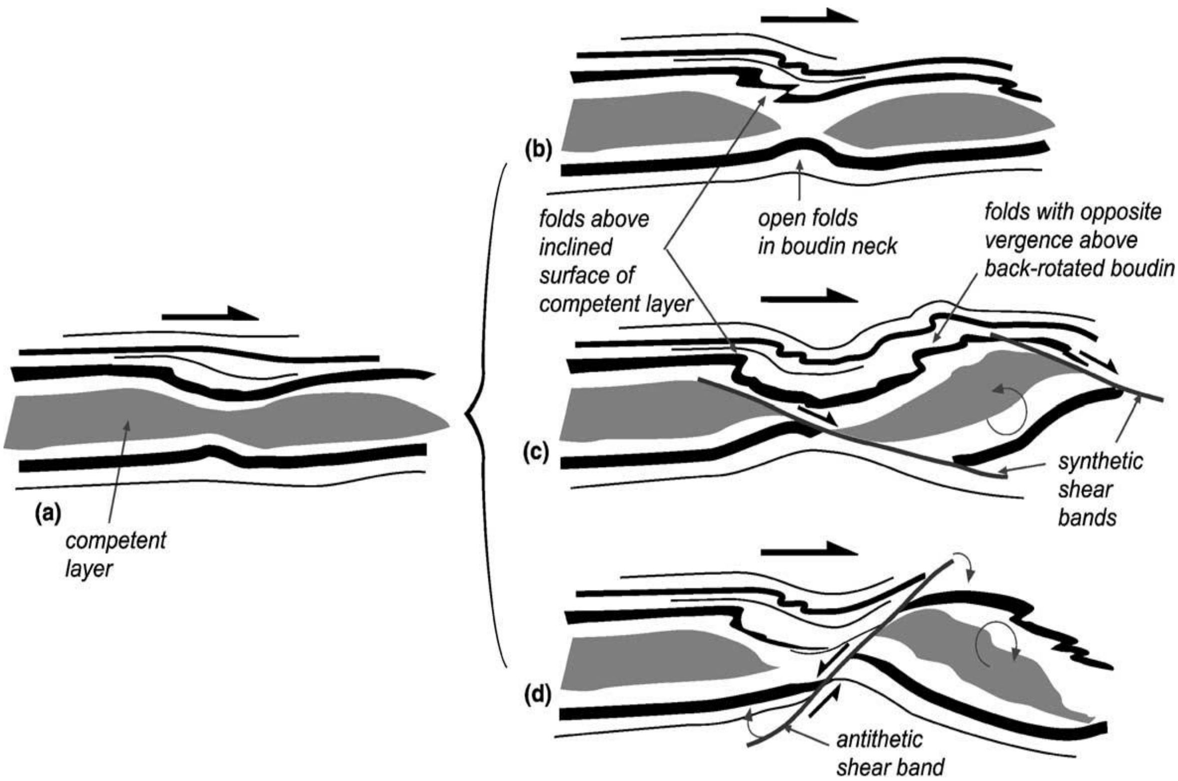


Fig.3 Structures associated with bounding in extensional detachments.

(a) Necking of competent layer. Initiation of overturned and open folds in adjacent layers.
(b) Foliation curving ahead of bounding or tectonic lenses is likely to become folded due to differences in flow rate over the bounding (Illustrated by Brun and Merle, 1988, fig. 3).
(c) Folds with the opposite vergence to the bulk sense of shear result from the back-rotation of a bonding between synthetic, secondary shear zones.
d) Folds with the same vergence to the bulk sense of shear develop ahead and in the leading edge of the bounding due to forward-rotation of a bounding. Antithetic secondary shear zones are likely to forward-rotate with progressive deformation (Fig.4).

FAULT: The fault is mainly two types such as Normal Fault and Reverse Fault. This fault is during the tectonism. Slightly NW overturned asymmetric F1 folding with steep NW limb and gently dipping SE limb. Folds with the same vergence to the bulk sense of shear develop ahead and in the leading edge of the bounding due to forward-rotation of a bounding. Antithetic secondary shear zones are likely to forward-rotate with progressive deformation (Fig.4). Kinks have straight limbs between sharp to angular hinges whose axial planes define the kink band boundaries more simply termed kink planes. Short limbs define the kink bands. Kink bands occur in strongly anisotropic rock where the anisotropy is either beds with a finite thickness or foliation with very thin layers. Their particular geometry is controlled by the rotation through an angle of a set of thin layers within the kink bands. Ideally, kinking involves no internal strain in the layers, only rotation around the kink hinges. Therefore, flexural slip in the limbs is inherently linked to kinking to insure the continuity of layers across the kink band boundaries, (Folding, 2012).

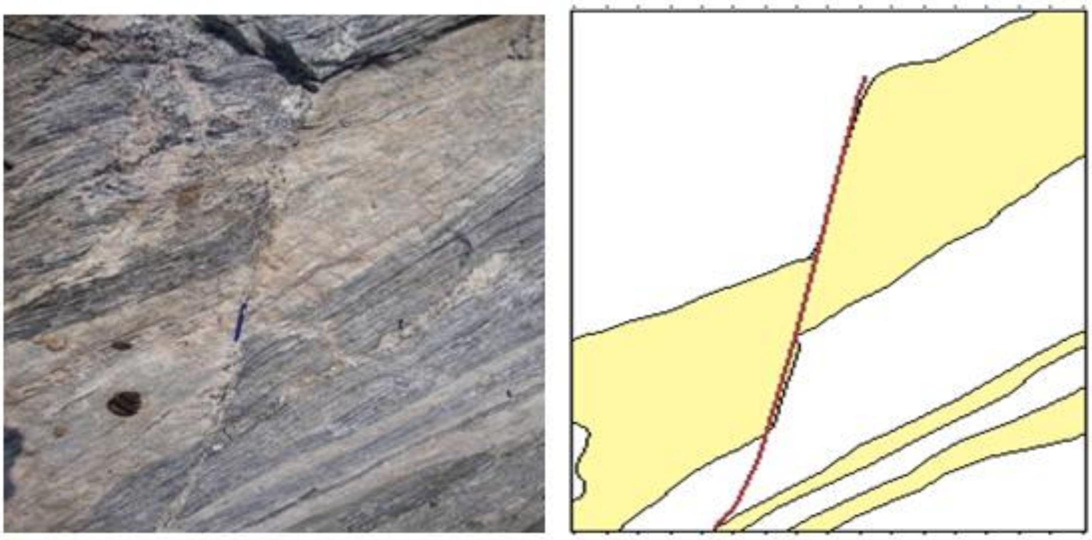
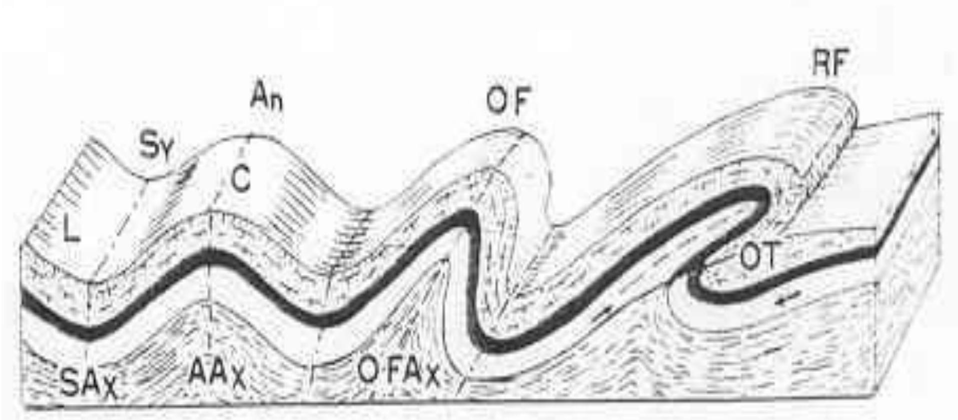


Fig.4 The Normal Fault in the study area and the interpreted image.

The Normal Fault in the study area for the force acting in the bedding younger Gneiss. Here the earlier formed rock is gneiss and the later intrusion of pegmatite vein. The shearing is also performed well because the xenocryst of alkali feldspars are carried one place to another place during the eruption. **En echelon** means "in step-like arrangement" and describes a consistently overstepping and overlapping alignment of sub parallel, closely-spaced structures that are oblique to the planar zone in which they occur. Such patterns are commonly related to potential faulting. The study area having the several en echelon folds/step like arrangement are observed. The folds are generally trend is NE to SW.

Fig.5 A)The reverse fault in the fault plane.B) The minor faults present in the migmatite gneiss.C) The reverse fault and the displacement is nearly 15 cm.D) The joint patterns are the present in the migmatite gneiss (Horizontal fault, and Oblique fault).

FOLD: Outcrop photographs of different structural styles in the pelitic migmatites of the study area. a) Bedding (S0) and bedding parallel layering (S1) folded by isoclinal F2 that is openly refolded by F3. Patchy garnet-bearing leucosomes cut F2 folds.The use of drag folds can be misleading because curvature of opposite sense to the displacement, termed reverse drag, is common. Reverse drag is clearly independent of true drag effects but hardly distinguished from true drag when they appear separately. In addition, the orientation of such folds is often not controlled by the movement direction but rather the intersection between bedding and the fault plane. D1 thrusting and isoclinal folding: the features above overprint and refold small scale D1 folds.The type depends on the intensity of tectonic pressure. An is an anticline, with crest C and anticlinal axis, AAx. The two slopes are called limbs or flanks (L). The syncline (Sy) and its axis (SAx) indicate that the structure is symmetric. When the axial plane (O-FAx) is tilted, an asymmetric or overfold will result (OF). Continuous tectonic pressure will result in a recumbent or overturned fold (RF). This fold is usually connected with an overthrust (O-T) fault.Recumbent folds may become covers or nappes in intensively folded mountainous areas. , (Folding, 2012).



Source: (Folding, 2012).

The alternating layers have variable thickness and competence. Microstructural features of quartz, feldspar, biotite minerals associated with the mylonitic deformation constrain the temperatures of shearing during mylonitic fabric formation to greenschist facies-grade conditions (300—400) [12—14]. The common meso-and micro-scale kinematic indicators in the ductile shear zone are characterized by foliation deflection in metamorphic rocks, S-C fabric, asymmetric enclaves, biotite fish, asymmetric porphyroclasts, oblique foliation in quartz grains, fractured and displacement grains.Intensely folded stromatic migmatite, with leucosomes occurring in a fold axial surface Folded stromatic migmatite with coarse-grained leucosome. Locally, patches and small, transgressive to sheet-like intrusions of plagioclase-bearing microgranitic material, with small rectangular crystals of plagioclase, occur in the highest-grade migmatites. Pressure-temperature-deformation-time (*P-T-D*-t) paths for rocks of different grade in the migmatite have been suggested by Johnson & Vernon (1995a). However, a detailed prograde history cannot be inferred with confidence, because both these melting reactions and the andalusite-sillimanite transformation may all occur at practically the same temperature and pressure. For example, the first appearance of leucosome and prograde fibrous sillimanite at study occurs in the same rock. The metapelitic leucosomes appear to have formed by reaction of quartz + biotite and andalusite. Possible reactions are: Qtz + Bt + And = Crd + Kfs + melt or Qtz + Bt + And + Kfs + water = Crd + melt, depending on the availability of water vapour (Grant, 1985; Ellis & Obata, 1992).

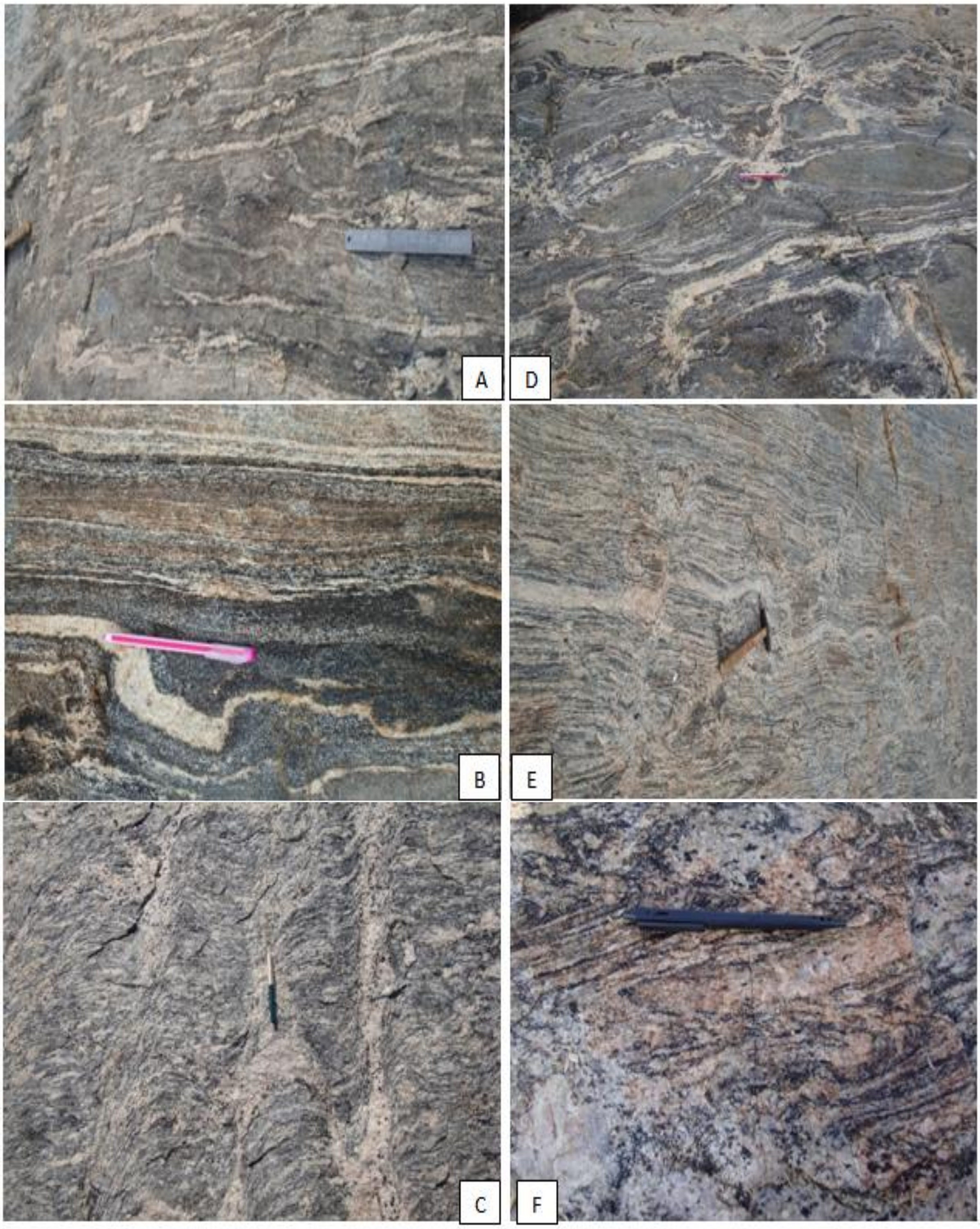


Fig. Types of folds. (A) Lensoidal structure in gneiss. (B) Shear fold in the High Grade gneiss with pegmatite Intrusion. (C) Step like fold (or) gentle fold during the crystallization. (D) Eye shaped enclave in younger gneiss. (E) Drag fold during the magmatic eruption and crystallization. (F) Cheveron fold in the Younger gneiss, the earlier formed folds are altered. Chevron folds are generally close to tight (interlimb angles 70 to 10 degrees) with straight limbs and small angular hinges. When the limbs become parallel to each other (i.e., the fold is isoclinal), no further shortening by limb rotation can occur. Dynamic, folding amplification stops but shortening may continue by homogeneous flattening of the buckled layer and matrix (Ramsay,1974).

II. CONCLUSION:

The study area is having major tectonic activity Achankoil shear zone and external zone in Cauvery Palaghat shear zone. The age of the rocks in the study area is Neoproterozoic. The rock types are mostly retrogressed and migmatised. The area having tectonically disturbed and the structures are highly developed during the crystallization. The observed elements of internal structure suggest existence of specific structures which contain intrinsic information about their origin and thus may evidence hi-story of deformation and blastesis of the rocks in which they occur. The presence of the net structures related to the micaceous laminae, suggests that the studied rock has undergone extension deformation. The structures and corrosion produced by the older cataclastic augen structures of the gneiss and the ribbon structures of quart, which encircle feldspar augen. Cataclastic augen structures were formed under dynamic metamorphism, when recrystallization of the crushing products was insignificant. Here the study area the n-number of folded structure, such as the normal fold, shear fold and the cheveron fold. Joints are the parallel joints, horizontal joints, oblique joints and two types of fault they are normal fault, reverse fault in the study area observed in the field. So the study area is highly disturbed during the Tectonism.

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