CHAPTER - 2

GEOLOGICAL SETTING
Majority of the schist belts in Eastern Dharwar Craton are bimodal type with basic and acid volcanics and minor ultramafics, pyroclastics-tuffs and Banded Iron Formations (BIF). The Kadiri Schist Belt is unique in having larger area occupied by meta-acid volcanics and hence represents the higher stratigraphic level in Anhaeusser et. al., (1969) greenstone model, the rocks encountered in the southern part of the schist belt is grouped into three major units.

1) Schist belt litho-units comprising metabasalt, metaandesite, rhyolite, quartz porphyry, quartz-feldspar porphyry and volcanic conglomerate.
2) Granitoids and,
3) Dyke rocks.

The stratigraphic position of metabasalt and metaandesite is very clear from field evidences. The enclaves of metabasalts are seen in TGM and MS suites. From this it is clear that the schist belt components are older than granitoids.

There are three granitoid suites found in the order of sequence viz., Tonalite-Trondhjemite-Granodiorite gneiss (TTG), Tonalite-Granodiorite-Monzogranite (TGM) and Monzogranite-Syenogranite (MS). TTG represents a distinct contrasting topography characterized by plain to low undulatory terrain dotted by linear hillocks and ridges. It is the oldest suite intruded by TGM and MS suite of rocks. The cross-cutting relationship of pink granites with the granitoids suggest the last phase of granitic injection which perhaps may be correlated with pegmatite veins present abundantly in granitoids.
Tonalite Trondhjemite Granodiorite gneisses contain linear bands/patches of supra crustal rocks. Profuse injection of Trondhjemites into tonalite-diorite-amphibolite suite giving banded structure and remobilized trondhjemite veins showing folded structure is quite common. The TGM suite has conspicuous micro granitoid enclaves and dykelets. The MS suite granites intrude into TTG and TGM suites. The TTG and TGM suites occur as enclaves in MS suite.

All the litho formations of the area are traversed by profused mafic dyke swarms, representing the last phase of igneous activity in the area. The quartz reefs forming high hills in the area show abrupt end at the schist belt-granite contact indicating their tectonic nature.

There is no direct field evidence to suggest that the greenstones were laid on sialic basement. Presence of granitoid clasts in volcanic conglomerate (indirect yet strong evidence) points to the existence of sialic crust on which the components of the schist belt were deposited. There are three generations of gneisses recorded in this area viz., oldest (mafic dioritic-amphibolitic gneisses with minor ultamafics, magnetite quartzite and trondhjemite followed by tonalite-trondhjemite-granodiorite gneisses and finally by trondhjemite gneisses. The oldest diorite/amphibolitic gneisses with early trondhjemites (migmatitic) occur as irregularly oriented enclaves in younger banded TTG. The clear-cut structural discordance of these gneisses indicates the oldest deformational imprint prior to the Dharwarian orogeny, suggesting the existence of sialic basement for the Dharwars.

The Stratigraphic succession of of southern part of Kadiri Schist Belt and its adjoining granitoids has been worked out with the help of field studies and the available reports / published work.
STRATIGRAPHIC SUCCESION:

Mafic Dykes
Pegmatite, Quartz veins
--------- Intrusive Contact ---------
Monzogranite-Syenogranite Suite
--------- Intrusive Contact ---------
Tonalite-Granodiorite-Monzogranite Suite
--------- Intrusive Contact ---------
Quartz-Plagioclase Porphyry and Quartz Porphyry
Rhyodacite with volcanic Conglomerate and Rhyodacite
Meta-basalt and Meta-andesite
---------Tectonic Contact ---------
Tonalite Trondhjemite Granodiorite gneiss Suite
(Basement ?)

STRUCTURE:

The validity of the stratigraphy exists only when it bares relevance to observed structure. The terrain shows effects of three phases of deformation. The earlier two deformations gave rise to the NNW-SSE to NW-SE trending penetrative fabric marked by the general schistosity, and major faults and shear parallel to it. The third deformation produced broad warps along E-W to ENE-NSW trending axes. The penetrative deformational fabrics were recorded and all these recorded data were used in the structural interpretation of the schist belt and adjoining granitoids.
Color banding in rhyolites, compositional banding in BIF and pillow structures in metabasalts are some of the primary structures present in the study area. Metabasalts show deformed pillows (tens of cm long and few cm wide) and comprises amygdules and vesicles. The alternately arranged volcanic conglomerate/agglomerate bands in dacite indicating flow banding with pyroclastics and alternately arranged dacite-amygdular basalt probably indicate different cycles of eruptions. BIFs show alternately arranged few millimeters to centimeters wide banding made up of chert and iron ore and in the granitoid suites, porphyritic and poikilitic textures, alignment of phenocrysts, phase banding, schleiren banding, folding in schleirens, resorbed and irregularly arranged phenocrysts, orbicular textures, etc., are commonly seen as primary structures. In TTGs, trondhjemite injections also can be taken as primary feature. In TGM suite, presence of synplutonic microgranitiod disrupted dykelets and enclaves indicate primary igneous features.

SECONDARY STRUCTURES:

The general foliation in Kadiri Schist Belt trends in NNW direction with swerving of foliation into N-S and NNE-SSW towards south is noticed. Kadiri Schist Belt contacts are invariably affected by brittle-ductile shears. The schist belt has been affected by NNW-SSE trending shears with sinsistral sense of movements. Swerving of contact shears to NNE-SSE along with schist belt is conspicuous as seen between Kandukuru to Papaghni River. Early foliation is traversed by a fracture cleavage at an acute angle. Kadiri Schist Belt shows a minor northerly/north-westerly plunging antiforms and synforms. Locally S asymmetry of secondary folds
is noticed. Early formed shear foliation is also folded along with the silicified veins. Both the contacts of the schist belt along with intrusive granodiorite has been affected by a narrow zone of ductile-brittle shears. The area has been affected by conjugate sets of fractures/brittle shears in NNW-SSE, NNE-SSW, ENE-WSW, WNW-ESE directions. Drag folds are developed in schist belt. WNW-ESE/NW-SW trending fractures/faults show sinistral shifts while ENE-WSW/NE-SW trending shows dextral shifts. Major faults/quartz reefs trend in NNW/NW, NE-SW and ENE/NE-SW directions. One of the regional scale faults is seen affecting the shear zone as well the western contact of the schist belt. Most of the quartz reefs were formed prior to the emplacement of MDS while some of them reactivated during post MDS and some of them even reactivated during Post-Cuddapah times. The schist belts show three phases of folding viz. the early tight isoclinals as first phase of folding resulting into development of regional scale penetrative foliation. The first folds occur in minor scale. The refolding of first folds resulted in the formation of co-axial second phase of tight to open moderately plunging folds which occur on regional scale. The final phase of folding is represented by broad warps and also resulting into plunge reversals of second folds. The major shape of the schist belts is controlled by the second phase of folding which represents as tight to open low to moderate plunging minor to large scale folds. They are near coaxial to first folding. Commonly on mesoscopic scale are seen ‘Z’ and ‘S’ asymmetries. Reversals of plunges is also noticed due to cross folding. E-W trending broad warps or swerves in the foliation or gneissosity represent third phase of folding. Most of the gneisses show around 75° dip due WNW or ESE with NNE-SSW strike. Locally they show swerving of gneissosity into NE-SW and NNW-SSE directions. A minor phase of early kinematic leucotonalite (trondhjemite) injections emplaced into Kadiri Schist Belt was
subsequently co-folded along with the schist belt rocks. The TGM and MS suites of granitoids were emplaced during the second phase of folding of Kadiri Schist Belt. TGM suite of granitoids occurs in and around the Kadiri Schist Belt with intrusive contacts with the Kadiri Schist Belt. They constitute huge hills with big boulders and often they exhibit koppe type of structure due to jointing (*PLATE - 1. Fig. 1*). It occurs as minor plugs and plutons within Kadiri Schist Belt. The lithologies of KSB display NNW-SSE trending foliation with steep dips towards ENE and WSW directions. Changes in trend of foliation to N-S and NNE-SSW are common. The foliation is traversed by a fracture cleavage at an acute angle.

Pre-Dharwar folding is difficult to be identified in the TTG belt as the Dharwar imprints and polyphase migmatisation have totally obliterated earlier imprints. The NNE-SSW trending B. Kothakota banded TTG belt located at the triple junction of Kolar-Veligallu and Kadiri Schist Belts is a truncated antiformal structure exhibiting dominantly Z asymmetries of fold pattern (preserved limb of antiform) (*PLATE - 1. Fig. 2*). The truncation was due to synkinematic emplacements of voluminous TGM and MS suites of granitoids.

The tight isoclinal banded gneisses of B.Kothakota area were refolded into open to tight low plunging antiform during second deformation resulting in conjugate Z and S asymmetries of F2 fold (*PLATE - 1. Fig. 3*). During F2 folding, another event of trondhjemite generation took place. Syn F2 migmatisation has resulted into thicker trondhjemite injections emplaced along gneissic planes following F2 fold surfaces which are in conformity to Z and S asymmetries. Intrafolial asymmetries of rich trondhjemite leucosomes are evident. They show intrafolial open warps also. Emplacement of last phase of trondhjemite injections took place dominantly
along NW-SE strain slip cleavages (locally at NE-SW direction). The NW trending wedge shaped/tear shaped/almond shaped trondhjemite bodies were formed with gradation from migmatite through gneisses. The biotite schleirens are ubiquitous and show flow folds. The strain slip cleavages also cause drag slip folds. In smaller trondhjemite bodies, the biotite schleirens show folds across the width of the bodies. The emplacement of trondhjemites in TTG was almost synchronous with the emplacement of synkinematic calc-alkaline TTG suite. Emplacement of hornblende-diorite and mafic rich microgranitoid dykelets of TGM suite was synchronous with the formation of trondhjemite. Similarly, trondhjemite veins intrude into these dykelets (back veining). The injections of trondhjemite in hornblende-diorite causes agmatite looking magmatic breccias. The microgranitoid dykelets at places gradually mix with the trondhjemite, forming schleiren bands. These dykelets intrude into the last phase of migmatisation but not separating two generations of gneisses.

The northern part of truncated anti-formal TTG belt is affected by a major regional scale WNW-ESE trending Papaghni fault with sinistral shifts; it has shifted Kadiri Schist Belt, TTG belt and associated granitoids. It is a segmented type fault running across several tens of kilometers forming a major lineament. Parallel to this fault, a number of minor faults are developed thus forming a shear zone.

Besides, a notable NE-SW trending fault in Kandukuru at the southern part of Kadiri Schist Belt is prominent, where it has off-set the belt right laterally. In general, ENE and NE-SW trending faults show dextral shifts while NW/NW/WNW trending faults show sinistral shifts.
The overall grade of metamorphism of rocks of Kadiri Schist Belt is synchronous to first phase of folding and green schist facies regional metamorphism is characteristic. The mineral assemblage of the rocks of the schist belt is characterized by wide variation in lithology giving rise to different mineralogical assemblages of metamorphism as listed below.

The mineral assemblages of different schist belt litho-units:

| a. Meta basalt | Actinolite-albite-epidote-chlorite-opaques (in medium grained variety, at the contact zones is seen presence of hornblende). |
| c. Rhyolite | Quartz-biotite-plagioclase feldspar-potash feldspar |
| e. Metatuffs/volcanogenic sediments (the litho units were counted and studied during the course of regional traverse mapping across Kadiri Schist Belt). | 1. Cordierite – quartz – biotite garnet, in high Mg-Fe rich portions. 2. Anthophyllite – garnet – quartz in Mg rich bands 3. Andalusite – garnet in high Al rich bands |

During regional metamorphism cordierite–garnet–anthophyllite was formed. Andalusite post dates other metamorphic minerals and is a product
of thermal metamorphism superimposed on regional metamorphism and its growth possibly coincides with the upliftment of the terrain during the emplacement of late to post-kinematic granitoids, i.e., under low pressure regime.

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Fig. 1: KOPPE STRUCTURE IN TGM SUITE

Fig. 2: TTG gneisses exposed in B. Kothakota, gap area between Kolar, Kadiri and Veligallu schist belts.

Fig. 3: Refolded Banded gneisses near Kothakota showing deformation