CHAPTER 5

PETROGENESIS AND TECTONIC SETTING
There is a considerable controversy as regards to the origin and evolution of Precambrian greenstone belts and their relation to neighboring granitoids and gneissic terrains. Early models were based on apparent geochemical similarity of greenstone volcanics with modern type of oceanic crust and island arcs. The lack of field evidence for pre-greenstone crust prompted the idea that the greenstone belts evolved ensimatically (i.e. intra oceanic domain) (Glikson, 1976b, 1979, Viljeon, 1971, Anhaeusser 1969). However, in subsequent years numerous localities were discovered in most shield areas where greenstone belts are seen to rest on older granitoid crust. In this context generation of information on the eastern greenstone belts of Dharwar Craton and associated granitoids with a lucid account on stratigraphy, structure, petrography, petrochemistry, plutonism and metamorphic history will be a great contribution to the petrogenesis and evolution of the granite greenstone terrane of Eastern Dharwar Craton. It is with this aim the petrogenesis and tectonic setting of the litho-units of the study area which forms a part of the Kadiri Schist Belt has been dealt in detail based on the field and petrochemical signatures.

It is not the intention of the author to project ideas regarding crustal evolution based on the information obtained from a small study area in the peninsular shield of India. However, it is well known that detailed studies of small areas provide background for building up relevant models for crustal evolution at a future date. As such, an attempt is made in this chapter to discuss the crustal evolution based on the information provided in the preceding chapters, and the information available on Karnataka-Andhra Pradesh craton in general and of the thesis area in particular.

Petrogenesis of schist belt litho units: Before attempting the petrogenesis of study area an attempt has to be made to review several geodynamic
models that have been proposed to explain late archean magmatism, metamorphism and structural patterns of the Dharwar Craton. In short two main groups of models are worth mentioning.

1. Active margin models have been proposed by Chadwick et. al., (1997), Krogstad et. al., (1989, 1995) and Hanson et. al., (1995) to explain structural and petrological features of the Eastern Dharwar Craton in terms of subduction, magmatic arcs and back arc basins.

2. A plume model has been proposed by Peucat et. al., (1993), Choukrouine et. al., (1995) and Jayananda et. al., (1995) interpreted diapiric structures, late Archean Juvenile magmatism and hot metamorphism in Dharwar Craton in terms of rising mega-plume beneath a mature Archean lithosphere. Jayananada et al., 1995, attributed that highly enriched mantle and ancient TTG crust is the source for the 300 km long linear Closepet Granite batholiths, enriched mantle and TTG crust for the Bangalore granites, c.a. chondritic mantle source for the granitoids of Hoskote-Kolar and the quartz-monzonites for the granitoids of western kolar schist belt (KSB) and slightly depleted mantle for granodiorites on the eastern margin of the KSB. In terms of plume model he interpreted all these variations. The centre of the plume would be an enriched 'hot spot' in the mantle that lies below the present exposure level of the Closepet batholiths. Melting of such an enriched mantle hot spot produces high temperature magmas (Closepet Granite) that penetrate overlying ancient crust where they strongly interact and induce partial melting of the surrounding crust. These magmas cool very slowly as the hot-spot maintains high temperatures for a long time thus they appear younger (2518 ma) on the contrary to the east, the plume induces melting of c.a. chondritic or slightly depleted mantle that produces relatively colder and
less enriched magmas which show less or no interactions with the surrounding crust and cool rapidly and appear slightly older (2552-2534 ma). This plume model can also account for late Archaean geodynamic evolution, including juvenile magmatism, heat source for reworking, inverse diapirism and granulite metamorphism in the Dharwar Craton. The heterogeneity as well as other features of the late Archaean domain of Southern India can be interpreted in terms of a rising of mega-plume.

The present study area, i.e., Kadiri Schist Belt, lies beneath the plume affected basement area of cuddapah basin. Regional characters and associations have been taken into account for arriving at the evolutionary history of the terrain. Therefore, the geochemical data is used with other relevant field and petrographic observations to further probe into the petrogenesis of the metavolcanics of the schist belt. In addition, the correlation of Kadiri Schist Belt with other Eastern Greenstone Belts is also attempted to throw light on crustal evolution.

The following are some of the salient characteristic features of the eastern greenstone belts in general and Kadiri Greenstone Belt in particular:

1. No basal conglomerate which reflects basement-cover relationship is seen in any of the schist belt:

All the eastern greenstone belts do not exhibit any basement-cover relationship. The moot point is that, no conglomerate is seen at the base of these belts. Based on the absence of any quartzite and considering the metachert as the precursor of the thin quartzite bands, the primitive crust was considered to be basic (Naqvi, 1978).
2. *No basement is recognisable for these belts:*

In the eastern part of Dharwar Craton there always exists basement-cover problem. At present most of the gneiss belts are in tectonic contact with the schist belts though at places, intrusive nature is noticed due to remobilization. The original basement gneisses are not preserved because of large scale remobilization of the crust. Sometimes, it appear as if there was no basement exists at all for the greenstone volcanics such as MORB or back arc basalts and most of the belts could be "floating arcs" subsequently accreted together. The oldest gneisses now occurring as remnants could possibly be the relict basement for the greenstone belt. Typical metasediments in the eastern greenstone belts are very low in proportion and some of the units which have been identified as metasediments are basically volcaniclastics/tuffs. However, thin quartzite bands of discontinuous nature are seen at the base of few eastern greenstone belts pointing to the ensialic nature of the basement.

The present work identified the components of oldest gneisses forming the basement for Dharwar schist belts and also trondhjemite bodies (TTG). The TTG suite shows incipient migmatisation accompanying deformation. The original basement – cover relationship is masked by migmatisation. Geochronological work is recommended to know the oldest litho units and solve basement – cover problem of Dharwar greenstone belts and also the cratonisation ages. Some workers like Krogsad (1995) believe existence of basement gneisses which now occur as relics amidst granitoids. Some other workers like Chadwick et. al., (2000) believe that there is no basement exists for greenstone belts and they were evolved floating arcs later accretioned together.
3. Well-defined volcanic cycles are prominent compared to sedimentary cycles which are negligible.

The sedimentary cycles, which are conspicuous in the western greenstone belts, are negligible in the eastern greenstone belts. This is a major constrain in working out the stratigraphy. However, the volcanic cycles are common and prominent and they are established with the help of petrochemistry. Mg Numbers are calculated which in turn point to the primitive and evolved nature of the volcanics. It is found that basic volcanics with higher Mg Number (>60) gradually grade into volcanics having lower Mg Number (<60) and again followed by volcanics of higher Mg Numbers; and this cycle is repeated. These volcanic cycles are more in the lower and the middle stratigraphic levels and are comparatively less in the higher stratigraphic level as the incidence of basic volcanics is less. Viewed in this context, Kadiri Schist Belt represents the higher stratigraphic level in Anhaeusser greenstone model as it is dominated by acid volcanics and their Mg Number ranges between 29 and 60. Primary magma is characterised by Mg Numbers greater than 60 (Irving and Green, 1976). In course of its ascent and cooling, the primary magma undergoes differentiation and evolves into melts with lower Mg Numbers or M-values (Huges, 1982).

4. Ultramafic component is comparatively less:

Ultramafic rocks of komatiitic affinity are seen only in the lower stratigraphic levels of the eastern greenstone belts like Kolar and Ramagiri. In the present study area no ultramafics are exposed, thereby indicating the higher stratigraphic level in the triple division of classic greenstone belts of Anhaeusser et al., (1969).
5. **Volcaniclastics and tuffs are very common:**

Volcaniclastics and tuffs are noticed in the higher stratigraphic levels. These are best seen in Kadiri, Gadwal, Hungund and to a lesser degree in Ramagiri, Raichur and Hutti- Maski belts. These are generally associated with rhyolites and dacites, which are conspicuous again in the higher stratigraphic levels. Though volcanlastic reflect the primary features like fining upward and cut-fill structure as seen in the study area which impart sedimentary outlook in the field; the presence of opalescent quartz, volcanic bombs, and angular phenocrysts with uniform extinction in a fine grained matrix, all support the pyroclastic nature.

6. **Metasedimentary units are seen in the higher stratigraphic levels:**

Metasedimentary rocks like quartzites, Banded Iron Formations (BIF) and bedded cherts are generally seen in the higher stratigraphic levels as seen in the Hungund and Sandur belts. This is again in agreement with the triple division of classic greenstone belts of Anhaeusser et al., (1969). Discontinuous and impersistent bands of BIF showing alternately arranged banding made up of chert and iron ore are seen all along the Kadiri Schist Belt pointing to higher stratigraphic level.

7. **Diapiric plutons show fabric parallel to the fabric in the schist belt:**

The diapiric intrusive granitoids show fabric parallel to the fabric in the schist belt with more intensity along the margins; this feature is best seen in Kadiri Schist Belt. Regional structure of the schist belt is that of tightly folded synform with tightly folded isoclinals folds. Trondhjemite injections emplaced into the schist belt were subsequently co-folded along with the schist belt rocks. The TGM suite of granitoids occurs as minor plugs and
plutons with in the schist belt. Synkinematically emplaced diapiric granitoids (TGM and MS suites) also show foliations which are parallel to schist belt foliations with the same strike and dip.

8. *Diapiric intrusive granitoids forming domal structures are very common features:*

Archaean crustal architecture in most Archaean cratons consists of granitic domes and synformal greenstone basins. Voluminous emplacement of granitoids along regional scale antiformal closure caused preservation of linear ‘synclinal keels’ (tapering down to and being surrounded on both sides by granite diapirs). The keels may represent different preserved stratigraphic levels of the schist belt and the litho-associations may vary from belt to belt. This domal and basin architecture is interpreted in terms of either two phases of folding with orthogonal axis, or as the result of gravitational instabilities related to the density inversion following the emplacement of dense greenstone cover over a less dense felsic basement. Diapiric plutons forming domal features are best seen in the Ramagiri, Gadwal, Veligallu, Hungund, Gurugunta and Kadiri belts. The morphology of domes reflects the various phases of tectonic activity. Anhaeusser et al., (1969) (Fig. 36) considered that diapiric plutons are one of the characteristic features of classic greenstone belts.

9. *Granitoids are of intrusive nature and hold the enclaves of the schist belt components:*

All the granitoids situated in and around these belts are intrusive into the schist belts as noticed in Ramagiri, Kolar, Kadiri, Gadwal and many other eastern greenstone belts. Migmatisation of the schist belts is common along the margins. In the study area metabasalt enclaves of various dimensions are more frequent in the granitoids and these enclaves are more
in percentage along the margin of the intrusive granitoids. It is also seen that the adjoining granitoids send their tongues and apophyses into the schist belt rocks.

10. The eastern greenstone belts show greenschist to amphibolite facies of metamorphism:

In general, it is considered that greenstone belts in eastern block show low pressure greenschist facies of metamorphism. Grade of metamorphism is also attributed increasing from green schist to amphibolite from north to south and also from center to periphery of the schist belts. P-T conditions of metamorphism of the schist belt from southern part of the eastern block were estimated by Rajamani et al 1981. Grade of metamorphism from greenschist facies in the centre accentuated to amphibolite facies along the margins of the schist belts especially when they are in contact with intrusive granitoids is clearly reflected in all the eastern greenstone belts. However, Kadiri volcanics have also undergone greenschist facies of metamorphism.

11. Presence of andalusite bearing schists:

Most of the eastern greenstone belts are characterised by the presence of andalusite bearing schists. In the study area quartz-biotite-sericite schist is occurring as a minor unit. It is fine grained light coloured, micaceous and consists of cordierite and andalusite. It is occurring as pocket deposit within the country rocks. At many places it is observed as thin bands within the schist belt, synchronous with other eastern greenstone belts.

12. The eastern greenstone belts are generally linear and their morphology is curved and controlled by the intrusive granitoids:

This is another moot point which reflects the possible continuity and the lateral link of these belts. Their linear, ribbon like configuration
indicates that they are relics of once united major sequence; the present isolation is due to the intrusive granitoid activity. Voluminous emplacement of granitoids along regional scale antiformal closure caused preservation of linear ‘synclinal keels’ (tapering down to and being surrounded on both sides by granite diapirs). In some cases, the presence of similar litho-assemblages would term it as to equate different belts belonging to part of the same belt earlier occurred as a bigger ones and subsequently truncated by diapiric granite intrusives and the large scale - crustal scale shear zones – faults. The Kadiri Schist Belt appears to be the northern continuity of the Kolar Schist Belt truncated by granitoids and faults; it can be correlated with Jonnagiri and Hutti-Maski belts of the eastern Dharwar Craton in structure and lithology.

13. Granitoid clast conglomerates are seen in the higher stratigraphic levels:

A conglomerate horizon is recognized in most of the greenstone belts of eastern Dharwar Craton like Kolar (Smeeth, 1915), Gadwal (Bhattacharya, 1975), Veligallu (Kaul, 1973) and Hutti (Krishnamurthy, 1963). The origin of conglomerate is debatable. Some workers considered this unit as autoclastic conglomerate as it occupies shear zone. Some others treated this unit as sedimentary because of the rounded nature of clasts. Later they recognized the volcanic matrix and attributed volcanic origin (Vijayam, 1969; Ziauddin, 1975; Kroner, et. al., 1981; Srinivasan, 2000).

In the study area, the volcanic conglomerate has the clasts include rhyolite, quartz-feldspar-porphyries, metabasalt and metagabbro supported with size of the clasts varying upto bombs. Majority of the clasts are foliated and highly stretched and elongated due to intense shearing and oriented at
acute angle to master shear fabric. The dominant shape is stretched hemispheroid with smooth surface but totally angular clasts. In volcanic environment, the roundness of the clasts is explained by the process of fluidisation (Cools; 1941). The same holds good for the well rounded clasts of conglomerate of the Kadiri Schist Belt.

The present of granitoid and acid volcanic clasts in matrix of acid to intermediate composition is indicative of violent vulcanian phreatomagmatic and phreatoplinian eruption (Walker, 1981; Self and Sparks; 1978) primarily of subaerial eruption from strato volcano (Sriramachandra Rao et. al, 2000). This is analogous to reported central type eruptions from Abitibi belt, Canada (Goodwin and Ridler, 1970). The presence of volcanic conglomerate and agglomerate in acid volcanic also suggest phrehato-magmato-plinian type eruptions in continental arc/margin tectonic setting wherein the TTG crust might have been subjected to subduction into basalt.

The known world occurrences of similar type of Precambrian phreatomagmatic and phreatoplinian vulcanian eruptions of intermediate to acid volcanics are from greenstone belts of Wabigoon sub province of superior province of Canadian Shield (Car and Ayres, 1991) and Welcome Well Complex, Australia (Giles and Hallberg, 1982). Such litho-unit in Finland greenstone belt was described as volcanic conglomerate (Kroner et. al., 1981). Similar litho-unit in the adjacent Veligallu Schist Belt was classed under volcanic type (Sreenivasan, 2000). Viewed in this context, the conglomerate unit in the study area can also be grouped under volcanic type.

The occurrence of profuse volcanic granitoid–clast agglomerate (volcanic conglomerate of polymictic type) and associated intermediate and acid volcanics constituting the distinct “formation” is conspicuous in most of
the greenstone belts including the Kolar, Kadiri, Veligallu, Julakalva, Gadwal, Raichur and Hutti belts. The presence of granitoid clasts in volcanic conglomerate (indirect yet a strong evidence) points to the existence of sialic crust on which the components of the schist belt were deposited.

CORRELATION OF EASTERN GREENSTONE BELTS:

The documentation in earlier paragraphs has shown that these belts reflect typical characters of classic greenstone belts. Hence, the correlation of these belts can be attempted by considering the Anhaeusser et al., (1969) model of triple division of classic greenstone belts. This model has lower ultramafic group (Um) middle greenstone group (Gst) and upper meta sedimentary group (Sed) (the terms lower, middle and upper are used in an informal way); and each eastern greenstone belt fits into one of these divisions (Fig. 37). Belts like Ramagiri and Kolar have all the three divisions while some have exclusively one or two divisions. Kadiri Schist Belt has mainly metasedimentary group.

The said observation clearly indicates that the present lithological assemblage is mainly due to their stratigraphic position in the triple division. It also reflects that these belts indicate a consolidated stratigraphy which forms the basis for their evolution.

The lithological setup of all the eastern greenstone belts indicate the broad sequence as detailed below:

**Sedimentary Group** : Tuffs, BIF, bedded cherts, quartz prophyry, quartz-feldspar porphyry, rhyolite, rhyodacite.

**Greenstone Group** : Metabasalts, amphibolite, BIF, tuffs.
**Ultramafic Group**: Ultramafics (pillowed), amphibolite, and tuffs, BIF, chlorite schist, metabasalt.

This sequence of the lithological units has helped in evaluating a model for the evolution of the eastern greenstone belts in general and Kadiri greenstone belt in particular. The lithological sequence of the Kadiri Schist Belt helps to correlate the belt with other eastern greenstone belts representing the higher stratigraphic level in Anhaeusser et al., (1969) greenstone model as it is characterised by dominance of acid volcanics, presence of volcaniclastic sands and tuffs and absence of ultramafic component.

**EVOlUTION OF THE EASTERN GREENSTONE BELTS:**

The evolution of the eastern greenstone belts can be studied in four phases (*Fig. 38*) as detailed below:

**I Phase**: Onto a thin ensialic basement, there was extrusion of the ultramafic magma followed by basic volcanics and very little acid volcanics. Granitoids mostly of TTG suite intruded into the setup.

**II Phase**: Localised upliftment and deposition of minor amounts of sediments and mostly pyroclastics. Formation of granitoids, conglomerates and eruptions of acid volcanics characterised the second phase.

**III Phase**: Gravity sliding and thrusting caused due to compression marks the third phase.

**IV Phase**: Final compression and vertical and transcurrent faulting, leading to upright structures, simultaneous granitoid intrusion, formation of gneissic rock, qualifies the fourth phase.
This setup is subjected to erosion which leaves the schist belts occurring as linear bands in gneissic and granitoid country. This also explains the variance in lithology in each belt. Some belts represent both acid and basic volcanics, while some others show dominance of a single phase. The study area is dominated by acid volcanics thereby representing the higher stratigraphic level. Thus, the present isolation of once united sequence and exposure of various stratigraphic levels in various greenstone belts is the result of the combined action of tectonism and erosion.

Accretionary model has been successfully demonstrated for the ‘Abitibi Belt’ of Canada (Kimura et al, 1993). It shows that accretion has been one of the major processes of formation of some of the greenstone belts. However, the intracratonic basin model cannot be ruled out. Thus plate-tectonic models for greenstone belts include (i) rifting on simatic; sialic crust, sagging and vertical tectonics, (ii) ensimatic island arcs, (iii) Back-arc marginal basins.

The above said mechanisms holds good for the Kadiri Schist Belt also. For the evolution of schist belts, normally rifting and subduction processes re-attributed, i.e., horizontal tectonics, while dealing with the evolution of granites, vertical tectonics is applied i.e. plume origin. For the past one decade or so, many workers based on exhaustive geochemical studies of schists have been advocating accretion of mini-blocks on either side of the schist belt and also advocating for secular changes in different tectono-magmatic/sedimentary environs (or) domains for the evolution of same schist belt. Important contributions on these lines were made by Rajamani et. al., (1985), Walker et al (1989), Zachariah et. al., (1995), Naqvi, (1987), krogstad et. al., (1989, 1991, 1995), Balakrishnan et. al., (1990).
TECTONISM:

Ramakrishnan et. al., (1976) simply compared the ‘Eastern block’ Kolar type belts with the Keewatin group of Abitibi belt because of their similarities, i.e., volcanic dominated terrain. This need not imply that these belts were formed in same tectono-magmatic domains. In different cratons of the world, there are ‘greenstone and greenstone belts’ ranging in time – space lithology and tectonic settings and sites of intense geological activity under higher geothermal conditions and dynamics. However, the tectonic setting of greenstone belts is highly debated because rocks deposited at different tectonic settings are present side by side in these belts. Their genetic tectono-sedimentary models range from intracratonic basins, rift valleys, island arc and back arc basins to plumes. Combinations of MORB, subduction and plumes are proposed by different workers (Dewitt et. al., 1992).

The Dharwar greenstone belts / supracrustals preserves a record of about 1000 m.y. volcanosedimentary history (3.7 ba to 2.7 ba) and formation of different types of greenstone belts at different places by different processes took place, i.e., (i) impact basins on primitive crust – older supracrustals of Dharwar Craton consists of mafic – ultramafic komatites and high Al-rich sediments (ii) intracratonic basins such as Bababudan schist belt (iii) active continental margin basin such as Chitradurga belt and (iv) accretionary basin (Sandur) developed on a pericontinental shelf near an Archaean oceanic ridge.

As described in the preceding chapters, tholeiitic magma is the parent magma for Kadiri volcanic suite which displays tholeiitic to calc-alkaline spectrum of rocks ranging in composition from basalt to rhyolite. These
variations are due to several factors such as variation in source composition, partial meeting conditions, subsequent fractional crystallisation and thickening of the crust. Of these, crustal thickness seems to be the more determining factor next to source composition. Miyashiro (1974) suggested that the most important factor controlling the range in composition between tholeiitic and calc-alkaline association is the thickness of the crust. The chemical characteristics of the Kadir volcanic suite show that more tholeiitic associations occur on a thin, oceanic or transitional crust (15-20 Kms) while calc-alkaline associations occur on a thicker crust of continental type (20-30 Kms) (Jakes, 1972; Miyashiro, 1974). The calc-alkaline magmatism is invariably associated with island-arc tectonic setting. The association of volcanic conglomerate with acid to intermediate rocks possibly indicate island arc / continental margin environment for Kadir Schist Belt.

The evolutionary models proposed for the volcanics of Kolar Schist Belt are evolution in marginal basin environment (Balakrishnan, 1988, Shivakumar, 1985) and rifting in continental setting by plume tectonics (Rajamani, 1990). The regional evolution pattern as visualised by Chadwick et. al., (1996) – the eastern greenstone belts evolved in island arc environment with its marginal or back-arc basin in the western Karnataka during later Archaean plate convergence is more in conformity of all the above mentioned models for the rock distribution of the Kadir Schist Belt. The other eastern greenstone belts are also having profuse volcanic conglomerate possibly representing chain of precambrian continental arc system eroded to root levels; thus representing a continuous record of events during the crustal evolution of this segment.
Petrogenesis and Tectonic Setting of Granitoids:

The discussion on petrogenesis and tectonic setting of the Kadiri Schist Belt would be incomplete without involving the origin of granitoids adjoining the belt. A classification of granitoid rocks based on tectonic setting throws light on the various suites of granitoids and their petrogenetic sketch (Pitcher, 1983; Barbarian, 1990) is presented in the... However, as the studies on the granitoids are restricted only to field and petrography, an attempt is made in this chapter to utilize the field and petrographic data in identifying the processes involved in the magma generation and its evolution that resulted in the manifestation of the three suites of granitoids.

The different theories have been proposed on the origin of granites and their related rocks which fall in to the following three broad categories:

a) Granitisation of the pre-existing rocks by metasomatism due to influx of the ‘granitising’ fluids.
b) Differentiation by fractional crystallisation of mafic magma.
c) Partial melting of crustal or subcrustal rocks.

The last two phases envisage the formation of granite form the melt as against the first hypothesis according to which granites are formed by diffusing fluids. Progress of research in the fields of experimental petrology, geochemistry, geochronology and isotopic data techniques on sialic terrains has added to our knowledge to understand the problem. Wyllie (1984) advocated that siliceous granitic rocks of batholithic dimensions are not derived from the primary magmas from mantle or subducted oceanic crust but they represent the end products of subsequent stages. Mafic magmas
derived from mantle source may differentiate and may give rise to enormous tonalites. In some regions where the continental crust is thick, the mafic magma may assimilate the crustal components and fractionate to give rise to voluminous siliceous end products. It is envisaged that melting to produce granites is the result of regional metamorphism above subduction zones as a result of invasion of mantle generated heat and fluids.

Mineralogical and textural evidences: The order of crystallisation in the study area may be assumed as, TTG-TGM-MS-Post-orogenic granite sequences. This sort of crystallisation of more basic rocks ahead of the acidic ones imply some sort of differentiation compatible with that of the Bowen's reaction principle. Two important textural characters are noticed in thin sections namely perthitic intergrowth and myrmekitic intergrowth.

The perthitic intergrowth is generally developed in two ways, i.e., by exolution or by replacement. If the belbs in the host feldspar are confined to the centre of the grain without having any connection with outside plagioclase, it may be considered that the belbs are exolved during slow cooling. Normally the composition of such grains will be more acidic or albitic than the discrete plagioclase, as is the case in the present instance. Sometimes the exolved belbs coalesce and form bigger grains and migrate outside the K-feldspar due to deformation. This apparently gives connection with the external plagioclase which will be more acidic. But if the discrete plagioclase replaces K-feldspar, it becomes basic. The perthitic intergrowth in the present instance seems to be related to exolution as the plagioclase belbs are confined to the central portions leaving the portions of K-feldspar clear.

The myrmekitic formation is also explained in two ways, one by
replacement and the other by evolution. The advocates of replacement origin derive the required quartz by the replacement of plagioclase by potash feldspar or vice versa (Binns 1966; Drescher Kaden, 1948 and Osterwald, 1955).

Petrographically, granitoids of the study area show hypidiomorphic granular texture frequently. According to Turner and Verhoogen (1960) the hypidiomorphic granular texture combines some features inherited by magmatic crystallisation with others impressed by at least minor post-magmatic recrystallisation.

**MAGMA MINGLEING – MIXING EVIDENCES IN TGM SUITE:**

Mingling and mixing by mechanical and chemical interaction of the co-existing mafic and felsic magmas has attracted the attention of the granite petrologists since the early 1980's, although such interaction was postulated earlier dating back to late 19th century (Pitcher, 1997) injection of mafic magma into a crystallising granitic magma (Poli and Tommasini, 1991) of underplating of mantle derived mafic magma at the base of the granitic magma chamber and subsequent mingling, mixing/interaction has been recognized as an important process in bringing about the compositional heterogeny in many orogenic granites or the granites at the plate margins (Pitcher, 1997). The recognition of field and petrographic evidences indicative of the coexistence of mafic and felsic magmas are important for considering the role of magma mixing in the evolution of granites (Reid et. al., 1983; Marshall and Sparks, 1984; Bacon 1986; Didier and Barbarin, 1991) (Fig. 39).

The synplutonic microgranitoid dykelets and enclaves present in the TGM suite are medium to fine grained hornblende rich and show chilled
margins/fine grained nature. The phenocrysts of multigrain hornblende and plagioclase feldspars are found in both these rock and associated host tonalite. Plagioclase feldspars show reverse zoning. The mixed zones comprise multigrain hornblende and euhedral crystals in tonalite. Compositions vary from diorite to granodiorite. Back veining is characteristic. Mixed zones form skeletal hornblende. Poikilitic potash feldspar crystals gradually increase towards monzogranite of TGM and hornblendite - diorite bodies are very coarse grained, locally show fractionation into mafic poor and plagioclase rich parts. Hornblende crystals are found to occur as porphyritic grains. Relict pyroxenes are formed at places. Plagioclase feldspars are more calcic rich and altered to epidote with or without calcite. The leucovariants locally contain interstitial myrmekite grain. Potash feldspars occur as poikilitic grains replacing plagioclase feldspars. Dioritic variants show gabbroic textures.

The hornblende proportion in TGM vary drastically over short distances, i.e., from mafic rich to mafic poor. Similarly, grain size variations vary drastically. The mafic rich early tonalitic phases are typically hornblende bearing while the fractionated portions like monzo to syenogranites are medium to fine grained and biotite is dominant. Potash feldspar is almost nil in early tonalitic phases while it is almost dominant in younger granitic variant. Similarly, quartz proportion increases. The hornblendite - diorite bodies are injected by variety of leucosomes like potash rich pegmatites to plagioclase rich diorite and leucotonalite/trondhjemite veins, quartzo - feldspathic veins and quartz - veins.

87
Rotation of enclaves and biotitisation at the peripheries (reaction feature) and formation of quartzo-feldspathic patches unmixing these enclaves (haloes) is another feature at places formed in granitoid suites. At places, swarms of microgranitoid enclaves with oval shaped rounded nature are noticed.

The petrogenetic and tectonic aspects of the Kadiri Schist Belt and surrounding granitoid suites point to validity of existence of different tectonic blocks on either side of the belt. But, simply based on some minor age differences and minor geochemical differences, it is not logical to put different tectonic blocks which were later on accretioned together. The field evidences do not indicate the presence of these types of different tectonic blocks. Any how, further clinching evidences, detailed studies, data acquisition and advance research are required to substantiate the accretionery model.

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Fig. 37: CORRELATION OF THE EASTERN GREENSTONE BELTS BASED ON LITHO-STRATIGRAPHY
EXTRUSION OF KOMATITIC TO THOLEIITIC VX
SCREW ACID VOLCANIC AND

PHASE-2: LOCALISED UPLIFT AND DEPOSITION OF
PYROCLASTS, CONGLOMERATES ETC. ALONG WITH ACID VOLCANIC

PHASE-3: INITIAL (?) CAUSING GRAVITY SLIDING AND POSSIBLE THRUSTING

DEEP SEATED FRACTURE - EMPLACEMENT OF CLOSSED G critic GRAIN

PHASE-4: FINAL COMPRESSION AND VERTICAL AND TRANSCURRENT FAULTING LEADING TO UPRIGHT STRUCTURES, SIMULTANEOUS GRANITOID INTRUSION FORMATION OF OBERINIC ROCKS GIVING FALSE IMPRESSION THAT THE SCHIST SLETS ARE Rift ORIENTED/GENERATED.

Fig.38: EVOLUTION OF THE EASTERN GREENSTONE BELTS
(>2000M.Y.)
Fig. 39: SYNTHETIC PETROGENETIC SKETCH FOR LATE-ARCHAEOAN GRANITES

(after Didier and Barbarin, 1991)