CHAPTER V

CRUSTAL EVOLUTION
Based on information provided in preceding chapters, a discussion on the crustal evolution of Karnataka-Andhra Pradesh craton in general, and of the thesis area in particular is attempted here.

**INTRODUCTION**

The granite-greenstone belts have been well developed in Karnataka and Andhra Pradesh in South India. Extensive work has been carried out on these belts in Karnataka, while that is limited in Andhra Pradesh. The so-called Peninsular gneiss containing various granitic phases, and greenstone belts and their relics are present in both the states. To arrive at the crustal evolution, these two units of both the states are treated together, and the term Karnataka-Andhra Pradesh craton is applicable to the centrally situated block forming the older part of the Indian Shield.

The relative antiquity of greenstone belts and the surrounding gneisses and granitoids is of prime consideration in understanding the crustal evolution of the area. The high quality chronological data on gneisses and greenstones are
wanting to pin point the successive events. Nevertheless, four to five successive stages of greenstone and gneiss development is recognised (Sagvi, 1981).

**GEORHEONOMY AND ITS SIGNIFICANCE**

The recent review of the available chronological data on granites and gneisses (Crawford, 1960; Venkatasubramaniam et al., 1971; and Beckinsale et al., 1982) by Swaminath and Ramakrishnan (1981) has brought to light three superevents in the crust. These superevents are dated at 3300 m.y., 3000 m.y., and 2600 m.y. The first event is attributed to intrusion of tonalites into early greenstone belts of Sargur and Kol kannur Groups by Sagvi (1981) and to an event older than Sargur Group by Ramakrishnan (1980), the dated Gour Gneiss forming a basement to the Sargur Group. The latter view is found limited acceptance and remained as minority view. The Rb-Sr frequency distribution curve for Archaean of Australia, Africa and India has revealed two peaks one at 3000 m.y. and another at 2600 m.y. (Glikson, 1982). These ages correspond to the latter two superevents in the crust. The 3000 m.y. event is very widespread in the crust (Venkatasubramaniam, 1974), which has been correlated with the invasion of tonalites into Sargur Group. This global event relates to Chalogenic (Shield-forming) cycle of Sutton (1963), Panterctogenesis of Swaminath et al. (1976), the Continental Accretion Differentiation Superevent (CADS)
of Moorpath (1977 and 1978). This event is of significance to differentiate the greenstone belts into (1) older greenstones, which are affected by gneiss invasion and migmatization and (2) younger greenstones to which gneiss forms the basement. The 2600 m.y. event corresponds to the ages of later potassic granites like Chitradurga, Arasikere, Banavara and Bangalore and to Peninsular gneiss sensu stricto of Crawford (1980).

Besides the events discussed above, Venkatasubramanian et al. (1971), have obtained an age of 2000 ± 80 m.y. for the typical porphyritic closepet granite. A 3800 m.y. U-Pb zircon age for low-Tb Cauvery-Hassan gneiss is given by A.B. Odom (quoted by Devaraj et al., 1982). Samu et al. (1981) refer to quartz and muscovite-bearing pelites which contain occasional zircon grains in G.R of Singhbhum betholith as an evidence of 3800 m.y., granitic crust. This 3800 m.y. event corresponds to the oldest event so far recorded in the Indian Shield.

In Karnataka, a time span of about a billion years is involved in the Dharwar-gneiss-granite terrain development. There is a raging controversy about the relative antiquity of the Dharwar SuperGroup and Peninsular gneiss in Karnataka Craton. One school thinks that Peninsular gneiss is the basement for the Dharwar SuperGroup and is intrusive into
the Sargur Group, a group older than the Dharwar Supergroup (Swaminath and Ramakrishnan, 1961 and Reddakrishna, 1962). The other school contends that there are no rocks recognisable older than Dharwar sequence and the so-called Sargur Group is a part of Dharwar sequence and the Peninsular gneiss is intrusive into the Dharwar sequence (Srinivasan and Groenveld, 1972; Srinivasan et al., 1975 and Pichamuthu, 1982). Glikson (1982) states that "To date, whenever U-Pb and Sm-Nd age determinations of spatially associated gneisses — early greenstones were conducted, the latter was found to be the older — Pilbara (Western Australia), Barberton (Transvaal), and Isa (Greenland)". In Dharwar craton, several greenstone successions and granitic phases are recognised during Archaean-early Proterozoic period; the greenstones are invariably found to be older than the associated granites. This has helped Haqvi (1981) to devise a model of interfingered stratigraphy of successive greenstone belts and generations of the gneisses. Holenarsipur Group (3.5 b.y) is intruded by Gorur gneiss (3.3 b.y), Javanahalli Group (3.3 - 3.2 b.y) by grey banded gneiss (3.2 b.y), Bababudan Group (3.1 - 3.0 b.y) by grey gneisses (2.8 - 3.0 b.y), Chitradurga (2.5 b.y) by Chitradurga granite (2.5 b.y) and Renibennur by Cloosopet granite (2.0 b.y).
Rishamuthu and Srinivasan (1982) consider that during 1000 m.y. time span, the greenstone belts are evolving and dying, and the gneisses evolved synkinematically with these events. This interpretation is similar to that implied by Naqvi (1981) in his model of interfingered stratigraphy of gneisses and greenstones. This also set at rest the controversy to a great extent regarding the relative antiquities of Dharwar Supergroup and Peninsular gneiss; the earlier phases of gneiss formed the basement to the schist, while the later phases are intrusive into them.

CRUSTAL EVOLUTION OF THE TISSAR AREA

In the present area, tonalites and the associated migmatites are the older phases which hold enclaves of hornblende-biotite-plagioclase rock, biotite-cordierite-sillimanite rock and anthophyllite-cordierite-sapphire-spinel rock. The chemistry of the rocks indicate that, they are sediments derived from mafic/ultramafic source. So it is reasonable to consider the earliest crust was mafic and oceanic in character. There is no direct, indirect or circumstantial evidence indicating the existence of the aialic crust during that period. The basement for the greenstone was dominantly aialic (Naqvi, 1978 and 1981) although may have contained some aialic component (Srinivasan and Sreenivas, 1972 and Rishamuthu and Srinivasan, 1982). The tonalitic gneisses invaded fragmenting and engulfing
these rocks as enclaves of ancient greenstone relics. The sedimentary-volcanic sequence of the schist belt (which is called as Panidi-Ranagiri schist belt), differs from Kolar belt is not having the dominant ultramafics, but corresponds to the Bababudan belt (Naqvi, 1982) in the proportional distribution of their lithologies. The geochemical nature of these lithologies indicate a mixed source of igneous and sedimentary rocks of earlier period (Naqvi and Hussain, 1972 and Naqvi, 1973). The schist belt has been intruded by the 2600 m.y. grey granites which contain components varying from granodiorite to granite. The present aerial distribution of the lithologies in this terrain indicates that the grey granites is the major unit which contributes most for the crustal accretion. It appears that this 2600 m.y. event is the most widespread in Bharvar craton (Crawford, 1969; Dhanamuthu and Srinivasan, 1982) and the crust is estimated to have attained the thickness of 35 km with this event (Dhanamuthu et al., 1981).

Partial melting of these granites at places has given rise to the vein type pink granites, and the porphyritic pink granites of the stock type corresponds to the last felsic invasion (2000 m.y) into the crust. Based on the above information, it is surmised that thin mafic oceanic type of crust has been successively invaded by tonalites, grey granites and pink granites, resulting in the stabilisation and the cratonisation of the crust. The
processes that bring in sino-sial transformation during the Archaean period are episodic and unique, and they have never repeated during the subsequent periods (Naqvi, 1982 and Olsson, 1982). This is perhaps the reason to consider that geochemical-geotectonic correlation for Archaean litho-units by analogy with phanerozoic ones are untenable. Such correlations imply the operation of the Uniformitarian principle throughout the geological record. Dolerites have been intruded in the stabilised thick crust marking the last phase of igneous activity in the area.

A more enlightened discussion with the crustal evolution during Archaean period can be entered into and many intriguing problems can be resolved through an intensive geochronological program by Rb-Sr, Sm-Nd and Pb-Pb methods covering localities where unequivocal field relationships are defined by large scale mapping and backed by adequate petrochemical studies (Ramakrishnan and Viswanathan, 1982).