Chapter -VI

Summary & Conclusions

The area under study, which lies in the southern part of the Cuddapah basin and the eastern part of the Dharwar craton is situated on the eastern side of Kadiri schist belt. It lies between North Latitude 14°2'30" and 14° 10'30" and East Longitude 78°25' and 78° 30' in the Government of India Toposheet No.57 J/8 and is geologically mapped on 1:50,000 scale, and includes an area of 375 sq.km in the northern part of Veligallu schist belt in parts of Anatapur District, Andhra Pradesh. The area seems to have experienced a long geological history right from early Archaean to middle Proterozoic. The rocks encountered in the study area are granite gneiss and their enclaves, schistose rocks, bedded tuff /metaacid volcanics, banded iron formation, volcanic conglomerates, grey granites, pink granites and younger intrusives. The stratigraphic succession of the rocks has been worked out based on the field observations and the reports of the earlier workers.

Nearly 300 rocks samples of various lithounits are collected and thin sections made for mineralogical and petrographic studies; 63 modal compositions and 54 chemical analyses are carried out for the purpose of classifying and discussing the origin of the rocks. A good deal of information regarding the optical data on various minerals is obtained and presented under the respective rock type. The optical properties of the minerals like 2V, Z^c and Nz-Nx are determined with help of Leitz-- 4 Axes Universal Stage. The modal compositions of various rocks are determined on Leitz-- 6 Spindled Integrating Stage. Chemical analysis of rocks are carried out following methods outlined by Shapiro and Brannock and Shapiro. The trace elements are estimated for all these rocks by Varian-Techtron Atomic Absorption Spectrophotometer and Direct current Plasma Spectrophotometer. The details of the various techniques employed in the present study together with a brief survey of the previous literature on the area, are presented in the chapter on' Introduction'.

The northern part of Veligallu schist belt is unique having been occupied by bedded tuff/metaacid volcanics when compared to metabasic volcanics. The bedded tuff includes quartz-chlorite–sericite and quartz-muscovite-sericite schists; the metaacid volcanics are rhyodacite and rhyolite; the basic volcanics are mainly metabasalt and metagabbroes (amphibolite). Most of the amphibolites (metabasalts) display well-developed schistosity and at places they are massive. Pillow and amygdaloidal structures are also noticed in metabasic volcanics. Metaultramafic rocks occur as isolated patches in metabasic volcanics. A volcanic conglomerate horizon is traced all along the eastern side of the schist belt. Impersistent bands of banded iron formations within metaacid volcanics occur as

ridges (Mallaiah konda) slightly above the ground level. A conformable band of pyrophyllite (width 1 to 8cm) occurs associated with bedded tuff.

The structural features indicate that the lithounits of the schist belt had suffered three episodes of deformation--F_1, F_2 and F_3. The lithounits are folded and refolded into upright isoclical folds with NNW-SSE trending axes during second phase. During third phase more folds are formed with axial planes trending ENE-WSW and superimposed on the earlier folds. A major N-S trending faults and brittle/ ductile shear zone are noticed along the eastern margin of the belt

All the lithounits of the schist belt indicate crush and strain effects in thin sections. Alteration, twinning and zonig of minerals are more common. Bedded tuff exhibits well-developed schistosity with preferred orientation of platy minerals, whereas metaacid volcanics show flow structure, cataclastic texture and crude foliation. Quartz and plagioclase commonly occur as phenocrysts set in a fine-grained matrix of quartz, muscovite, chlorite and sericite. Metabasalts exhibit textures like schistose, nematoblastic and occasionally granblastic and ophitic textures. In metabasic volcanics, hornblende is the main mineral followed by plagioclase, quartz, clinopyroxene, calcite, apatite and sphene. Banded iron formations essentially consist of quartz, grunerite and magnetite. The conglomerate based on the nature of the pebbles is classed either as oligomictic or as polymictic.

The metavolcanics of study area display contrasting major element compositions for each rock type. Basic volcanics contain more MgO, CaO and FeO and less SiO_2, Na_2O and K_2O when compared to acid volcanics. Trace element compositions like Co, Ni and Cr are present in basic rocks .The basic volcanics are generally classified as basalt and basaltic-andesite and the acid volcanics as dacite and rhyolite as per the LeBas et. al., diagram. The geochemical data suggest that the volcanics is sub-alkaline and show two different affinities i.e., tholeiitic and calc-alkaline. It is suggested from various observations on different diagrams that the volcanic suite has been derived from initially tholeiitic magma giving rise to early basaltic suite and later calc-alkaline suite of rocks. This view is supported by field evidence like the presence of metabasalt enclaves in adjacent granitic rocks. Further the petrographic and chemical variations diagram indicate a clear differentiation of these volcanic rocks from a single magma. The metavolcanics have M-values ranging from 26 to 48 with mean 43 suggesting that they are mantle-

derived evolved magmas. The metaultramafic rocks have M-values ranging from 56 to 60 with mean of 58 indicating that they are mantle-derived primary magmas.

The Banded Iron Formations (BIF) of the present area obviously corresponds in its characters to the Algoma-type and is represented by oxide iron-formation. The typical banding or layering is probably the only pre-metamorphic fabric that is yet preserved and metamorphism has only accentuated it. Micro and meso banding probably represent cyclicity and indicate seasonal alternations in deposition.

The conglomerate horizon having well-rounded clasts of granitic rocks set in rhyolitic to rhyodacitic matrix. In volcanic environment, the roundness of the clasts is explained by the process of fluidization, as is the case in the present study also.

Geochemical signatures of the schist belt lithounits suggest an island arc and active continental margin tectonic setting for the rocks of the study area. The mineral assemblages of the various lithounits of the schist belt indicate that they had experienced greenschist facies of metamorphism.

The granitic rocks of the study area include granite gneisses, grey granites and pink granites. The gneisses occur as isolated outcrops in the study area; often display migmatitic nature and bimodal composition. The grey granites occur as huge batholiths and also conical mounds around the schist belt besides in the central part of the study area. They have a knife-sharp contact with schist belt rocks, the random orientation of mafic enclaves, veining of mafic enclaves by granite, the tongues and apophyses of granites in the schist belt rocks are some of the field evidences to show to that the granites are of magmatic. This is further corroborated by the hypidiomorphic granular texture more frequently exhibited by the rocks.

The granitic rocks are classified based on their modes: the granite gneiss into tonalite and granodiorite; the grey granites into tonalite-granodiorite-adamellite (TGA) suite and adamellite-granite (AG) suite and the pink granites into granite and alkali-feldspar granite. The chemical classification of the whole gamut of granitic complex falls in the tonalite, granodiorite, adamellite and granite fields.

The petrological and chemical evidence regarding origin of granite gneisses shows them to be magmatic, metaluminous and calc-alkaline, thus grouping them under mixed origin. The granite gneiss is intrusive into ancient supracrustals resulting in migmatites, and fragmenting and engulfing them as enclaves. Various lines of evidence show that the

gneisses are a partial melt of the amphibolite of the schist belt which was recycled at the crust–mantle levels. The field, mineralogical and chemical signatures of grey granites reveal the evolutionary trend of granite through magmatic differentiation. The grey granites are metaluminous, calc-alkaline which may have been of crust-mantle derivation, and crystallized at temperatures between 688°C and 695°C and at 2kb pressure. In grey granites, the TGA suite has a wide spread occurrence in the eastern part of Dharwar craton, probably emplaced in a continental margin setting at an active subduction zone. The AG suite and pink granites are considered to be similar to Closepet granite, having been formed by anatexis of granite gneisses and TGA suite of rocks.

Dolerites represent the last phase of basic igneous activity representing mafic dykes. They range in composition from olivine-bearing to micro pegmatite-bearing varieties. They are formed by fractional crystallization of basaltic magma of mantle derivation. They are continental tholeiites and emplaced into the crust of 35-40 km thick. The numerous dykes and dyke swarms in and around the Cuddapah basin indicate periodic crustal dilation during middle Proterozoic to late Proterozoic period.

An attempt is made to discuss about the stratigraphy of the study area schist belt taking lithological, structural and chemical information. As all the eastern greenstone belts exhibit features similar to the classic greenstone belts i.e., Keewatian-type. The study area schist belt is also having typical Keewatian type of setting. The Keewatian characters are summarized and their correlation is attempted by considering the Anhaeusser model of triple division of classic greenstone belts. This model has lower ultramafic, middle greenstone and upper sedimentary groups. This sequence is used in the evaluating and evolution model which indicates higher stratigraphic level for the Veligallu schist belt as it is represented by the dominance of acid volcanics, presence of volcanoclastics and tuff.

From various observations, it may be inferred that all the greenstone belts of eastern Dharwar craton are once linked up and now seen as separate units. Thus, the present isolation of once united sequence and exposure at various stratigraphic levels in various eastern greenstone belts perhaps is the result of combined action of tectonism and erosion.

The various lines of evidences discussed in the aforesaid chapters indicate that the amphibolite enclaves in granite gneiss are considered to be derived by in the basic

oceanic crust. The granite gneiss invasion in the earlier primordial crust has resulted in the development of stromatic migmatites, fragmenting and engulfing them as enclaves. Then the rocks of schist belt (Dharwar Group) are formed, which have been successively emplaced by grey granites and pink granites. By then the crust would have attained its maximum thickness of about of 35 km, into which the mafic dykes have emplaced.