CHAPTER VI

SUMMARY AND CONCLUSIONS
The area under investigation, which lies in between the western part of the Cuddapah basin and the eastern part of the Dharwar Craton, is situated in Penilli-Ranagiri schist belt. An area about 120 square kilometres around Jallipalli (Lat. 14° 45'-14° 50' 24" N and Long. 77° 20'-77° 23' 15" E), Anantapur district, Andhra Pradesh, is geologically mapped. The area seems to have experienced a long geological history right from early Archaean to middle protarsozoic. The rocks encountered in the area of investigation are granite gneisses and their enclaves, schistose rocks, quartz-plagioclase porphyries, grey granites, pink granites and dolerites.

About 370 specimens representing various lithologic units are collected and equal number of thin sections are made for mineralogical and petrographic descriptions; about 100 modal compositions and 44 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 types. The mineralogical determinations are confined to the exclusive optical studies making use of Leitz 4-axes universal stage. The modes of various rocks are determined on Leitz 6-Spindle Integrating stage. Chemical analyses of rocks are carried out following the methods outlined by Shapiro and Brannock and Shapiro. Trace elements Co, Cr, Ni, V, Pb, Cu, Zn, Rb, Sr, Ba and Zr are estimated for these rocks by Parkin-Elmer 303 Atomic-Absorption Spectrophotometer. The details of the various techniques employed in the present study together with a brief survey of the previous literature on the area, and the nomenclature employed are presented in the chapter on 'Introduction'.

The schist belt rocks constituting chlorite schists, quartzites ferruginous quartzites and amphibolites account for one-eighth of the area. Chlorite schists are represented by chlorite schist and chlorite-epidote-actinolite schist; quartzites by pure quartzites (with minor mafics); ferruginous quartzites by quartz-grunerite-magnetite rock; and amphibolites by amphibolite (containing hornblende and plagioclase), actinolite amphibolite, actinolite-epidote amphibolite, augite amphibolite, actinolite-augite amphibolite and ultramafic rock. The parent material for chlorite schists is pelite-dolomite mixture, for the quartzites sandstones, for quartz-grunerite-magnetite rock iron-rich siliceous sediments, and
for amphibolites the basic volcanics (basalts). The metabasalts are considered to be oceanic tholeiites of the MORB type; some critical ratios of major and trace elements however indicate an affinity to NDB rather than MORB. The metabasalts of the thesis area are similar to depleted Archaean tholeiites (DAT) rather than enriched Archaean tholeiites (EAT). The DAT is inferred to be formed from 25-35% melting of lherzolite or 10-25% melting of plagioclase peridotite. The ultramafic rock is similar to komatiite and inferred to be formed, high degree of melting of mantle. These parent materials on experiencing amphibolite facies of metamorphism gave rise to various types of rocks presently seen in the area. The retrogression into greenschist facies along shear zones are noticed.

The granitic rocks of the thesis area include granite gneisses, grey granites and pink granites. The contact between amphibolite and gneisses is sharp. hornblende-biotite-plagioclase rock, cordierite-biotite-sillimanite rock and anthophyllite-cordierite-sapphire-spinal rock are noticed as enclaves in the gneisses. The grey granite has a knife-sharp contact with amphibolite (in the schist belt) on the eastern side and with quartzite on the western side. No thermal effect of granite is observed either on amphibolite
or on quartzite. The absence of thermal effect is explained by the continued movement of the granite even after crystallisation thereby eliminating the thermally altered quartzites and amphibolites and the marginal granite at the present level of erosion. The amphibolites, granite gneisses and plagioclase porphyries occur as enclaves in grey granite. Tongue-like extensions in the schist belt and highly involved and ragged boundaries of enclaves may support magnetic origin of the grey granite. Pink granites are of two types based on their occurrence — the massive, coarse porphyritic type occupying a hill (stock type) and medium- to fine- grained type that cuts across the grey granite (Vain type).

The granitic rocks are classified based on their modes; the granite gneiss into tonalites and granodiorites; the grey granites into granodiorites, adamellites and granites; and pink granites into adamellites (stock type) and granites (Vain type). The plots of quartz, potash feldspar, plagioclase and mafic index and their attributes one against the other have shown significant correlation at (95 per cent) confidence level indicating probable magnetic origin of grey granites.

The chemical classification of the granitic rocks give more or less the same divisions as obtained by modes. The granite gneisses are of magnetic origin and their invasion
into ancient supracrustals resulted in migmatites, and fragmented and engulfed them as enclaves. The granite gneisses might have been originated through equilibrium fractional crystallisation of basic magma or partial melting of basic crust or by two stage mantle melting. The plots of normative quartz-orthoclase-albite, and orthoclase-albite-anorthite, indicate the grey granites may have been crystallised from melt. The interpretation of the chemical data on the variation diagrams reveals the evolutionary trend of granite through magmatic differentiation. The magma of the grey granites is of calc-alkaline nature which may have a mantle derivation, and crystallised at 605°C-703°C at 2 kb pressure. The stock type pink granites form last phase of felsic igneous activity of the area. This may correspond to the last phase of closepot granite (2100 m.y). The vein type pink granite is considered to be formed by the anatexis of grey granite.

The hornblende-biotite-plagioclase rock, cordierite-biotite-sillimanite rock and anthophyllite-cordierite-sapphire-spinal rock are considered to have been formed by the sediments derived from mafic/ultramafic source. The relatively higher grade metamorphism of these rocks in comparison to schist belt rocks may be as a result of combined regional and thermal effects.
From among the enclaves in gray granites, the amphibole- and granite gneiss show minimum change, while a conspicuous change is noted in quartz-plagioclase porphyries. Those porphyries are hornblende-bearing, and biotite-bearing having transitional ones in between. The hornblende-bearing one corresponds to andesite, and the biotite-bearing and transitional ones are derived by the assimilation of enclaves at their margins through granite influx.

Dolerites represent the last phase of basic igneous activity in the area. They range in composition from olivine-bearing to micropogonite-bearing varieties. They are formed by fractional crystallization of tholeiite magma derived from the partial melting of the mantle having earlier and middle differentiates. They are continental tholeiites and emplaced into the crust of 25-40 km thick.

Finally, a discussion on crustal evolution is attempted thus:

The hornblende-biotite-plagioclase rock, cordierite-biotite-sillimanite rock and anthophyllite-sapphire-spinel rock are the enclaves in granite gneiss. These are considered to be derived by a thin 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 dolerites have emplaced.
PLATE - I

1. A steeply dipping chlorite schist displaying well-developed schistosity.

2. A sharp contact between chlorite schist and amphibolite.

3. An outcrop of closely folded quartzite with intercalation of chlorite schist.

4. Ferruginous quartzite exhibiting compositional layering and minor folds.
PLATE II

1. A general view of the amphibolitic terrain in schist belt.

2. An amphibolite exhibiting steeply dipping foliation in schist belt.

3. A sharp contact of amphibolite with granite.

4. An amphibolite band cuts across the granite gneiss.
1. The mineral assemblage of Chlorite-epidote-actinolite schist - crossed Nicols, 56 x.

2. Variable grain size and shapes in quartz in quartzite - crossed Nicols, 56 x.

3. Quartz-grunerite-magnetite rock exhibiting layering - quartz (grey), grunerite (brown) and iron ore (black) - Ordinary light, 35 x.

4. A schistose amphibolite showing alignment of hornblende grains in a matrix of plagioclase and quartz - Ordinary light, 35 x.
Amphibolite exhibiting sieve texture; inclusions are plagioclase and quartz - crossed Nicols, 35 x.

Imperfect multiple twinning in plagioclase of amphibolite - Crossed Nicols, 35 x.

Actinolite amphibolite displaying non-modal texture - Ordinary light, 56 x.

Actinolite-epidote amphibolite showing banded nature with alternate bands of actinolite, epidote (black), quartz and plagioclase (light) - Ordinary light, 35 x.
1. Coarse hornblende encloses augite (gray) in augite-amphibolite - Crossed Nicols, 100 x.

2. Granoblastic texture in Actinolite-augite amphibolite - Crossed Nicols, 35 x.

3. Clusters of augite amidst actinolite grains in actinolite-augite amphibolite - Ordinary light, 35 x.

4. A ultramafic rock displaying so-called spinifex texture. The needles are tremolite and iron ore (black) - Ordinary light, 100 x.
1. A oval-shaped hornblende-biotite-plagioclase rock enclave in granite gneiss.

2. A migmatised gneiss displaying stromatic structure.

3. Btygastic folding of the felsic layers in migmatised gneiss.

4. A view showing the sharp contact between grey granite and amphibolite.
PLATE VII

1. Grey granite cutting across the granite gneiss.

2. Intrusive contact of granite with amphibolite.

3. An amphibolite xenolith in granite having ragged outlines. Granite material penetrated can be observed as veins in it.

4. The amphibolite xenolith relics in granite.
PLATE VIII

1. A quartz-plagioclase porphyry showing regular orientation of plagioclase phenocrysts.

2. Vein type pink granite, cutting across the grey granites; displacement of the vein can be seen.

3. Brecciated pink granite in a matrix of grey granite (stock type).
1. Biotite-hornblende tonalite showing gneissosity and mineral assemblage - Ordinary light, 35 x.

2. Plagioclase lath with inclusion of hornblende and quartz in biotite-hornblende tonalite - Crossed Nicols, 100 x.

3. Biotite flakes imparting foliation to biotite tonalite - Ordinary light, 35 x.

4. A quartz replacing zircon grain in biotite tonalite - Crossed Nicols, 100 x.
1. Quartz replacing hornblende in magnetised gneiss - ordinary light, 35 x.

2. A deformed quartz grain enclosed in hornblende in magnetised gneiss - Crossed Nicols, 56 x.


4. A microcline replacing plagioclase along twin planes in granodiorite - Crossed Nicols, 56 x.
1. A plagioclase inclusion in quartz - Crossed Nicols, 100 x.

2. Allotriomorphic-granular texture in adamellite variety of granite - Crossed Nicols, 35 x.

3. Plagioclase with albitic rim in perthites in adammellites - Crossed Nicols, 35 x.

4. A cauliflower-like myrmekite in adammellites - Crossed Nicols, 35 x.
1. Muscovite replacing the plagioclase grain in adanellites - Crossed Nicols, 35 x.

2. The plagioclase inclusions in microcline show myrmellite and albite rims in adanellites - Crossed Nicols, 35 x.

3. The blebs of plagioclase coalesce giving rise to vein perthite - Crossed Nicols, 35 x.

4. Hypidiomorphic equigranular texture in adanellite (stock type) - Crossed Nicols, 35 x.
1. Plagioclase showing twinning and zoning in
adamellite (stock type) - Crossed Nicols, 35 x.

2. Clusters of hexagonal coarse quartz grains in
adamellite (stock type) - Crossed Nicols, 35 x.

3. Plagioclase inclusion in microcline in adamellite
(stock type) - Crossed Nicols, 35 x.

4. Plagioclase inclusions in microcline, are nyme-
ritized and have albite rim in granite (vein
type) - Crossed Nicols, 35 x.
1. Albite rim developments only at the contact of microcline in granite (vein type) - Crossed Nicols, 35 x.


1. Mineral assemblages of anthophyllite-cordierite-
sapphire-spinel rock - ordinary light, 100 x.

2. Deformed anthophyllite in anthophyllite-cordierite-
sapphire-spinel rock - ordinary light, 100 x.

3. Mineral assemblages of amphibolite enclave -
crossed Nicols, 56 x.

4. Foliation exhibited by granite gneiss enclave -
crossed Nicols, 35 x.
1. Panidiomorphic texture exhibited by quartz-plagioclase porphyry — Crossed Nicols, 35 x.

2. Subhedral apatite and zircon grains inclusions in hornblende in quartz-plagioclase porphyry — Ordinary light, 100 x.

3. Epidote development at the expense of biotite in quartz-plagioclase porphyry — Crossed Nicols, 56 x.

4. Sphene crystals in quartz-plagioclase porphyry — Crossed Nicols — 56 x.
1. Sharp contact between dolerite and granite.

2. Dolerite dyke showing zig-zag pattern.


4. Polikilitically enclosed olivine grains in clinopyroxene and plagioclase in olivine-orthopyroxene dolerite - Ordinary light, 35 x.
1. Plagioclase showing interpenetration twinning
   in normal dolerite - Crossed Nicols, 35 x.

2. Vitrophyric texture in orthopyroxene-micropegmatite
dolerite - Crossed Nicols, 35 x.

3. Oligoporphyritic texture in orthopyroxene-
micropegmatite dolerite - Crossed Nicols, 35 x.