CHAPTER - 7
RECAPITULATION

This chapter summarizes the conclusions of each chapter in the present study.

The southern peninsular India is made up of northern lower grade granite-greenstone terrain and southern high-grade granulite terrain.

The granite-greenstone terrain, referred to as “Dharwar craton” encompasses several NW-SE to NNW-SSE trending supracrustal belts, the chief among them being Holenarsipur, Bababudan, Chitradurga, Shimoga, Sandur, Kolar and Hutti belts.

The Dharwar craton is divided into eastern and western blocks, the separation marked by a mylonite zone coinciding with the eastern margin of the Chitradurga schist belt.

The supracrustal rocks of the western block have been classified into an older Sargur group and a younger Dharwar supergroup, and the latter is subdivided into older Bababudan group and younger Chitradurga group.

The Sargur group is represented by shelf facies quartzite-carbonate-iron formation, interlayered with ultramafic-mafic and gabbro-anorthosite complexes. The Bababudan group is composed of platformal facies quartz-quartzarenite sequences, interlayered with ultramafic-mafic and
mafic-felsic volcanic suite and younger BFC/BIF horizons. The Chitradurga group overlies the Bababudan group and is composed of mafic-felsic volcanic rocks, greywacke-phyllite sequences, carbonate (stromatolitic at places) and BIF/BFC.

The supracrustal rocks of the western block show secular variation in their development from volcano-sedimentary deposition in intracontinental basins to accumulation in arc-related basins.

The supracrustal belts in the eastern block are dominated by volcanic rocks with subordinate sedimentary units, the former were probably derived from a mantle source.

The Bageshapura area forms part of the Archaean granite-greenstone terrain in the western part of the Dharwar craton. It is adjacent to the eastern limb of the Holenarsipur schist belt and is surrounded by the Nuggihalli schist belt to the east, the Shigegudda belt to the west and the Bababudan belt to the north.

The rocks formations in and around Baghesapura can be divided into an older Kalyadi formation and a younger Bageshapura formation. The Kalyadi formation is comparable with the older Sargur supracrustals made up of relatively smaller stratigraphic units occurring as bedded lenses and generally devoid of clastic sediments, indicative of volcanosedimentary origin. The Bageshapura formation, comparable with the younger Bababudan group of the Dharwar supergroup.
comprises of massive stratigraphic units essentially made up of metavolcanics and banded iron formations in a linear schist belt.

The lithounits of the Kalyadi formations are encountered in the ridges of Belligutti, Muddulingana Koppal, Nayakanakere, Devikere and Haranahalli. The lithological succession consists of basal units represented by biotite-garnet-staurolite schist, garnetiferous amphibolite/gruneritic quartzite that grade upwards into chlorite-actinolite schist and actinolitic amphibolite. These formations are succeeded by quartz chlorite biotite schist, quartzite and oxide facies iron formation.

The rocks of the Bageshapura formation are encountered along the Doddagudda hill and extends northward up to the Desani granite. To the northwestern part of the Doddagudda hill, small outcrops of the Bageshapura formations are spatially associated with the older Kalyadi formations.

The Bageshapura (and the spatially associated Kalyadi formations) witnessed multiple events of deformation. The Kalyadi formation bears signatures of five episodes of deformation, while the Bageshapura formation records three episodes of deformation; the difference in their deformational histories is attributable to an unconformity separating the two formations.
The Bageshapura formation commenced with the extrusion of subaerial, mafic volcanic flow in a rift-controlled basin and concluded with a massive oxide facies iron-ore cycle, comparable with the Bababudan cycle. The formation consists of metabasites (represented by amygdaloidal amphibolites, chlorite actinolite schists), gneisses, oxide iron formation (BIF II), granite, younger dolerite dykes and laterite formations.

Steatite mineralization is hosted in the Bageshapura formation and mining is carried out in the Jadaghatta and Kargunda areas. Mineralization does not exhibit any relationship to structural features such as faults, joints of the host rocks.

The chlorite-actinolite schist consist of the actinolites that occur as fibrous radiating aggregates and rarely altered to talc. The quartz grains are fine-grained and some chlorites show evidence of transformation from biotite. The common accessory minerals in the schists include clinozoisite, epidote ± albite and opaques, mainly represented by magnetite and goethite.

Amphibolites are essentially composed of hornblende with subordinate amounts of plagioclase feldspar and quartz. Hornblende grains define the schistosity. Plagioclase feldspars exhibit extensive saussertization.

Quartzofeldspathic gneiss constitutes the dominant variety in the area and is composed of quartz, plagioclase feldspar, microcline, orthoclase,
biotite, chlorite, epidote, and hornblende with minor magnetite, sphene and garnet.

Metabasites are composed essentially of plagioclase feldspar and amphibole with minor amounts of chlorite, epidote and magnetite.

Desani Granite forms a part of the larger Arsikere porphyritic granite. The prophyries comprise mainly of plagioclase feldspars and the ground mass consists of biotite, muscovite, chlorite, epidote, sphene and iron oxide.

Younger dykes mainly dolerites exhibiting typical ophitic texture with laths of feldspar enclosing pyroxene grains; the latter exhibiting chloritization.

Steatite mineralization in the study area is of the massive type. Talcified rocks forming steatite are essentially chlorite-bearing metabasite, carbonate-bearing ultramafic/mafic rock, and actinolite schist. Talc forms as an alteration product of chlorite, carbonate and actinolite/tremolite. Opaque minerals in the steatite are essentially composed of goethite, magnetite and pyrite.

X-ray data of the steatites reveal that talc is associated with the primary minerals of the parent rocks, viz., chlorite, actinolite and carbonate, and this corroborates the results of petrographic studies that talc formed from these minerals.
Monophase and biphase inclusions are present in the quartz grains of the gneisses. These inclusions have an initial melting temperature (Tm) of -7.3°C to -8.1°C corresponding to salinity values of 11.2 to 12.2 wt% NaCl. Homogenization temperature of the biphase inclusions ranges between the values 142.2 - 231.2 °C, yielding densities of 0.996-0.900 g/cc. Temperature of homogenization (Th) data indicate a mean peak temperature between 140 – 165 °C which corresponds to the density values of 0.994 – 0.976 g/cc.

Fluid inclusions in the quartz grains of the granites are secondary and record temperatures of melting in the range of -10.8 to -17.3 C, corresponding to salinity values of 15.5- 21.0 wt% NaCl equivalent. The temperature of homogenization ranges from 229.0 to 235.0 °C yielding density values of 0.904-0.895 g /cc. The histogram plot of these biphase inclusions indicate mean peak between temperatures of 210 – 240°C, yielding density values of 0.922 – 0.893 g/cc.

Fluid inclusions in pegmatite are both monophase and biphase at room temperature. The monophase inclusions crystallize between the temperature range of -100 to -120°C and yield melting temperatures of - 64.5° C indicating their deviation from carbon di oxide inclusions. Homogenization of these inclusions occurred in the temperature range of 9.5 to 29.5°C, corresponding to density values of 0.875-0.75 g/cc, indicating they are low density CO2. Mean peak densities range between 0.81 – 0.75 g/cc.
Inclusions in Quartz from the quartzo-feldspathic veins traversing mineralized ultramafics are either monophase or biphase. The monophase inclusions are randomly distributed and they record a melting temperature of -64.5°C, indicating that the monophase CO₂-bearing inclusions are admixed with other fluid species like CH₄, N₂ etc. The temperature of homogenization ranges from 16.2 – 28.9 °C, yielding density values of 0.832-0.793 g/cc. The mean peak temperatures are in the range of 15 - 22°C, corresponding to density values of 0.85 – 0.778 g/cc. Bi-phase inclusions melt in the temperature range of -7.5 to -8.4°C indicating they are saline aqueous inclusions. Their salinity values range from 11.5 – 12.5 wt% NaCl equiv.; they record a homogenization temperature of 123.0 to 222.9°C, corresponding to the density values of 1.010 – 0.905 g/cc. The mean peak temperature ranges from 120 - 160°C yield density values of 1.005 – 0.976.

Fluid inclusion studies suggest that steatite mineralization in the study area is controlled by the CO₂ - and saline H₂O- fluid activity associated with quartzo-feldspathic vein post-dating granite emplacement. Trails of secondary inclusions are indicative of tectonic activity concomitant with acidic intrusion in the area. The range of temperature deciphered from temperature of homogenization of quartz grains in quartzo-feldspathic veins in talcified ultramafics is 123°C – 235°C, which is consistent with talc mineralization originating from hydrothermal activity.
The observed variation in the compositions of chlorite-actinolite schists is attributable to the varying proportions of chlorite, actinolite, epidote, sphene and iron oxide in the chlorite - actinolite schist.

The observed variation in the elemental contents of amphibolite is attributable to the variation in the relative proportions of amphibole, quartz, plagioclase, epidote, chlorite, and associated minerals in them.

The observed variation in the elemental content of granite and gneiss is attributable to the variation in the relative proportions of quartz, K-feldspar, hornblende, biotite, sphene and associated minerals in them.

There is a wide range of variation in the SiO₂, MgO and Fe₂O₃ contents in the steatites, which may be attributed to the variation in the parent minerals forming talc/steatite.

In the TiO₂ Vs Al₂O₃/TiO₂ diagram the amphibolites plot in the field of MORB (Mid-oceanic ridge basalt), chlorite-actinolite schist in the field of STPK (spinifex textured peridotitic komatiite) and steatites in the field of Sargur ultramafics (SUM).

In the ternary diagram the gneisses plot in the Trondjhemite and Tonalite fields, whereas the Desani granite plots in the field of granite, ademellite and granodiorite.
The triangular diagram plots of MgO-SiO2-Fe2O3 contents of the chlorite-actinolite schist, amphibolite and steatite indicate that steatite is comparatively depleted in SiO2 and Fe2O3 and relatively enriched in MgO compared to the parent rocks.

The MgO Verses Mg / Al2O3 plot of the amphibolite, chlorite–actinolite schist and steatite does not exhibit any major variation at low MgO contents, whereas at higher MgO concentrations the steatites exhibit wide variation in their Al2O3 contents. The observed high MgO contents and low Al2O3 contents in steatites is suggestive of the derivation of steatites from ultramafic rocks.

A plot of Cr verses Ni contents for the chlorite–actinolite schist, amphibolite and steatite reveals a positive correlation of Cr & Ni contents. It is concluded that Cr occurs in chlorite, chromite, tremolite and talc, whereas Ni is accommodated in the silicate minerals by its substitution for Mg and Fe.

In the MgO + Fe2O3 Versus SiO2 diagram the fields of amphibolite, chlorite–actinolite schist, talcified rock and steatite are clearly demarcated. Amphibolite and chlorite–actinolite schist do not exhibit wide variation in their SiO2 contents. But the plots of talcified rock and steatite show elevated MgO + Fe2O3 and SiO2 contents respectively which attests to the derivation of talc from the constituent minerals of
the above rocks and enrichment of MgO, Fe₂O₃ and SiO₂ contents in talc which may be either relative/absolute.

 Mineral analysis data of hornblende plots in the fields of actinolite and chlorite in the fields of clinochlore, penninite and talc-chlorite. A comparison of mineral chemistry data of chlorite, actinolite, carbonate and talc, reveals that conversion of actinolite/tremolite and chlorite to talc essentially involved increase in SiO₂ and a marginal increase of MgO. Conversion of carbonate to talc, on the other hand involved large-scale increase of SiO₂, Fe₂O₃ and MgO contents.

 On the basis of isocon diagram, it is contended that during the transformation of the parent rock to steatite in the study area, there was a general loss of other components except magnesium. It can be concluded that Mg was derived from the parent rock, which are apparently rich in Mg.