SYNOPSIS

The Precambrian terranes of Southern Peninsular India have been central to discussions to the history of formation and breakup of supercontinents. Of particular interest, is the Proterozoic high grade metamorphic orogen, popularly known as the Southern Granulite Terrane (SGT), located at the southern tip of the Indian shield. The SGT not only preserves important records of lower crustal processes and lithospheric geodynamics, but also carry imprints of the tectonic framework related to the assembly of supercontinents: Rodinia and Gondwana. The SGT exposes windows of middle to lower crust with well-preserved rock records displaying multiple tectonothermal events and multiphase exhumation paths.

Recent geological and geophysical studies across the SGT have led to the recognition of discrete crustal blocks or terranes separated by major shear zone systems, some of which represent collisional sutures. The SGT depicts several important features such as fold-thrust tectonics, regional granulite facies metamorphism of up to ultrahigh-temperature conditions in some cases, multiple P-T paths, development of lithospheric shear zones, emplacement of ophiolites, presence of alkaline and anorthositic complexes, development of crustal-scale “flower structures”, transpressional strains, and reactivation tectonics. Recent understanding of subduction, accretion and collisional history together with a long lived transpressional tectonic regime imply that the SGT witnessed multiple tectonic regimes at different times in Earth history, but the present structural architecture might have been built during the final assembly of the Gondwana supercontinent.

In view of the significance of the SGT, in general, and the Cauvery Shear Zone (CSZ), also described as Cambrian suture, in particular, a small corridor between Namakkal and Mohanur occurring in the south central part of the CSZ, has been chosen for detailed structural and geological study. The main focus is on the newly built ~6 km
long Rail cutting section between Namakkal and Mohanur, and the study area hereafter will be described as NMC.

The important rock units along the NMC are: mafic-ultramafic assemblages, amphibolites, hornblende gneisses, charnockites, granitoids and pegmatites. Pyroxenites, gabbros, peridotites, hornblendites, serpentinites form mafic-ultramafic assemblages which occur in the form of bands, lenses and pods. These are intercalated with minor thin bands of chert and Plagiogranite/trondhjemite. All these rocks trend WNW-ESE and are isoclinally folded with gentle to moderately dipping foliation fabrics to north. Based on field observations, a series of north dipping thrust/shear zones associated with imbricate thrusting are interpreted from the geological cross section.

A variety of structural features are well brought out with large scale sketches displaying different structural styles and mutual relationship of distinct rock types. The presence of sheath folds of different sizes are also well exposed in this section and with gently and southerly dipping thrusts. Well defined north dipping shear zones, horizontal foliations and deformed sheath fold structures are well preserved in association with south verging thrust planes. The presence of tectonic mélanges is also a striking feature displaying the chaotic assemblage of fragments of pyroxenites, websterites, amphibolites and syenitic gneisses. The rail cutting section has been divided into 6 zones based on distinct lithological assemblages and the presence of important shear zones. Each zone is characterised by the predominance of distinct lithological association and are classified as follows: Hornblende gneiss-Pegmatite association (Zone I), Charnockite-Pegmatite association (Zone II), Charnockite-Pyroxenite association (Zone III), Granulite (Felsic & Mafic)-Amphibolite-Pyroxenite association (Zone IV) and Metagabbro-Amphibolite-Pegmatite association (Zone V). A regional structural cross section presents a range of structural features such as foliation fabrics, fold styles, shear zones and interpreted thrust
planes and associated imbricate structures. From north to south, the dominant structural features are inferred as recumbent structures in Zone I, folded curvilinear axial planes in Zone II, tight isoclinal fold structures in Zone III, very tight isoclinal folds in Zone IV and folded axial planes with near recumbency in Zone V. All the zones are separated by south verging imbricate thrust zones marked by mylonitic fabrics. It is also possible that all these imbricate thrusts are linked to roof and floor thrusts suggesting that they could be duplex structures. The lithological and structural details of each zone are presented in the thesis.

Petrological studies of important rock units from NMC show that the rocks have experienced various degrees of alteration and metamorphism, as indicated by the presence of chlorite, epidote, variable amounts of calcite, and variably high loss-on-ignition (LOI) values (2–6 wt %). Petrography of ultramafic rocks and hornblendites shows well preserved cumulate texture revealing a uniform crystallization of magma. The observed mineralogy and textural characteristics of amphibolites indicates that their protolith represents basaltic flows. The presence of garnet in some of the amphibolites reflects their variation in original bulk rock composition and development in different pressure-temperature conditions.

Geochemical analysis of Peridotites show high Mg# (82.65-85.72) and high Ni contents with primitive magma characteristics. The depletion of Nb, Rb and Sr and enrichment of Ba might be products of the subsequent granulite facies metamorphism witnessed by these rocks. The geochemical data of amphibolites obtained suggest that their protoliths consist of basaltic rocks with calc-alkaline differentiation trends. The standard tectonic discrimination plots (Y vs Cr, Zr vs Ti, V vs Ti) of amphibolites show Island Arc Tholeiitic (IAT) signatures; Normalized MORB spider plots reveal the enrichment of LILE and depletion of HFSE with clear negative Nb anomalies. These characteristics are typical of oceanic crust formed in a suprasubduction zone (SSZ)
environment similar to many SSZ ophiolites world wide. The geochemical characteristics of mafic dykes/amphibolites form Manamedu Ophiolitic Complex (MOC) and Devanur Ophiolitic Complex (DOC) in the adjacent region of NMC also show similar characteristics implying suprasubduction zone tectonics. The existence of SSZ-type tholeiites with strong geochemical signatures are indicative of pre-melting subduction influence, which provide evidence for the development of arc-like crust by melting of a mantle source above the subduction zone.

The amphibolites from NMC show slight LREE enrichment and HREE flat patterns with positive Eu anomalies. The Lu/Hf vs La/Sm ratio plot represents the protoliths were derived from spinel-lherzolite mantle composition. The plagiogranite intrusions within the NMC are leucocratic trondhjemitic in nature characterized by low potassium (< 1wt% K2O; except one sample) and high sodium (4.9–7.1 wt% Na2O) contents. The very low potassium content has been suggested as a diagnostic feature of oceanic and ophiolitic plagiogranites. The rare earth elements (REE) show relatively low absolute concentrations and flat chondrite normalized patterns (3–30 × chondrite) with distinct, but variable, +ve Eu anomalies represent the feldspar involvement during fractionation of magma. The geochemical features described above are consistent with the hypothesis that the arc-related calc-alkalic and tholeiitic basalts typically show moderate degrees of light rare-earth-element (LREE) enrichment, and flat heavy rare-earth-element (HREE) profiles, indicating an origin in a shallow (spinel-lherzolite) mantle and more evolved magmas exhibiting positive Eu anomalies, consistent with low pressure plagioclase fractionation.

These results are correlated with the recently discovered Precambrian ophiolite complexes of Manamedu (MOC, 780Ma), Devanur (DOC, 2.5 Ga) and Agali (AOC, 2.5Ga) from the CSZ. The field observations and the geochemical signatures of NMC and
other ophiolite complexes suggest that these rocks were derived from a suprasubduction tectonic setting. They also represent the remnants of the Mozambique Ocean crust developed during Rodinia breakup and was destroyed during Cambrian period at the time of Gondwana amalgamation. They provide a unique opportunity to unravel the different stages of Wilson cycle of the Mozambique Ocean as well as the tectonics. Further, these rocks, together with the occurrence of eclogite facies rocks with garnet+omphacite+quartz and diagnostic ultrahigh-temperature assemblages with sapphire+quartz, spinel+quartz and high alumina orthopyroxene+ sillimanite+quartz (indicating extreme metamorphism), in the region, suggest that the rocks of the CSZ witnessed the subduction-collision processes during Neoarchean as well as Cambrian-collisional orogenies at the southern margin of Dharwar Craton, India.

The results of present study are described in the form of six chapters in the thesis. *Chapter I* deals with the introduction of the present study, highlighting its significance in understanding the mafic-ultramafic rock association in the CSZ, in general, and the Namakkal-Mohanur corridor in particular. Features like significance of regional granulite facies rocks, brief review on Precambrian granulite terranes, scope, principal objectives of the proposed study, methodologies adopted, hypothesis to be tested, and a brief outline of the thesis are detailed.

*Chapter II* provides brief history of the geology of Southern Granulite Terrane (SGT) giving details of different lithological units and some broad aspects of the tectonics, magmatism, metamorphism and tectonic blocks, and also brief description of three important Precambrian ophiolite complexes from the CSZ. *Chapter III* describes geological and structural setting of NMC, and provides an account of regional geological and structural setting of eastern part of the CSZ. Several large-scale field sketches,
structural cross sections, analysis of deformational history of the region are described zone wise.

Chapter IV describes the petrographic details of all important rock units in the study area, such as peridotites hornblendites pyroxenites, garnet-clinopyroxene rock (ultramafic rock) garnet-clinopyroxene-plagioclase rocks (metagabbros), amphibolites, banded iron formation (BIF), plagiogranites/trondhjemites, quartzo-feldspathic gneisses. 

Chapter V discusses about the results of whole rock geochemistry of ultramafic rocks, mafic rocks: hornblendites, amphibolites, hornblendites, and amphibolites, felsic rocks: plagiogranites/ trondhjemites and a detailed study of tectonic significance have been attempted.

Chapter VI summarises all the results obtained from the present study in terms of the evolution of ophiolites, the oceanic remnants within the Cauvery Suture Zone (CSZ) considering the field geological settings, structural architecture and laboratory studies. The results of NMC are correlated with the other reports of Proterozoic ophiolites of the CSZ and the regional tectonic perspectives such on subduction-accretion and collision are presented.