CHAPTER 1

INTRODUCTION

The differentiation of the earth into layers of contrasting physico-chemical characteristics from an assumed, homogeneous parent has been of evergrowing interest to earth scientists. Insight into the processes involved have been sought using all possible techniques. One of the reasons for the interest in the evolution of the planet is that the life-supporting crust and all its materials probably are the consequences of large scale earth differentiation processes. The crust and the core may have evolved from a parent similar to mantle of intermediate characters between the two, concentrating different elements at different layers of the planet. Thus, the processes operated and still operating on the differentiating earth may be of direct importance to better utilization and exploitation of crustal resources. The formation and the evolution of the continental crust is a first order geological problem. This is not only because of its resources on which we depend. Also, these processes provide raw materials for the surface processes to act upon and further differentiate into a wide spectrum of earth materials, some of which became materials of paramount importance for life on the planet to start and evolve.

The nature of earth's mantle and the processes operating within it cannot be directly studied because the regions are inaccessible. Samples of the mantle found in the form of nodules in mantle derived rocks are used to
understand the nature of their source regions. But the scarcity of such samples compels us to resort to more commonly occurring mantle products. Mantle derived rocks have been widely used to decipher the physico-chemical conditions and nature of their source regions. The information gathered from mantle derived rocks are used to understand the degree of homogeneity of the source regions and their evolution with time. The physico-chemical conditions and the internal processes of mantle control the formation of the earth’s crust to a great extent. Smaller masses of mantle derived materials get accreted to the pre-existing somewhat stable crust by later tectonic processes to form large continental masses. This Phanerozoic style of continental crustal growth seems to have taken place even as early as late Archean (e.g. Krogstad et al. 1989). It is not known, however, if the plate tectonic processes in its entirety have been operating since Archean. This calls for detailed and integrated studies of vast areas of the Precambrian continental crust.

A very large portion of the present continental crust probably were stable landmasses before their break up during late Paleozoic. Because of this, the understanding of Precambrian crust, its formation and evolution have become very important. The Indian continent has a very large part of its landmass made up of Precambrian rocks. These include rocks of Rajasthan, Singhbhum, Jaipur-Bastar and Dharwar cratons. More detailed modern geochemical studies on the Precambrian rocks in India have been done on the rocks of
Dharwar craton. This has led to relatively better understanding of the evolution of the crust in this part.

The Dharwar craton (Fig. 1-1) includes variably and multiply deformed granitic gneisses (Peninsular Gneisses) with disconnected and linear belts of supracrustal rocks (schist belts). The supracrustal successions of the western part of the craton with respect to the central Closepet granites, are thought to have been deposited on a dominantly ensialic setting followed by multiple deformation and metamorphism, especially around 2600-2000 Ma. and 2000-1500 Ma. ago (Radhakrishna and Naqvi 1986). All the metavolcanics of the schist belts are considered by Drury (1983) to be derivatives from one parental ultramafic liquid and it was suggested that this parental magma was generated by shallow angle northward subduction of lithosphere. Rajamani (1990) suggested an alternative model for the formation of the schist belts based on the following observations:

1) Schist belts include metabasites formed from different mantle sources, 2) both asthenosphere and lithosphere provided magmas for these metabasites, and 3) no significant gradational lateral (E-W) variations in the nature of the metabasites or their sources.

Therefore, a plume related model for the genesis of metabasites in the schist belts was suggested, provided the schist belts are contemporaneous. Rajamani (1990) suggested that with more and better quality geochemical data on the metabasites from all the schist belts of the craton, the
Fig. 1-1 Geological map of south India, showing Dharwar craton, granulite terrane and younger covers. RSB denotes Ramagiri Schist Belt, and KSB, Kolar Schist Belt.
plume model for the metavolcanics as well as for their tectonic environments can be tested.

Compared to the western part, the eastern part of the Dharwar craton has fewer number of schist belts, all aligned roughly subparallel and some of them, along strike to each other. Several of these belts have known gold mineralization. We have been studying the Kolar schist belt and surrounding areas aiming at better understanding of the development of this part of the craton and the mechanisms of crustal genesis in the early history of the earth.

The integrated structural, geochemical, isotopic and geochronological studies of Kolar area have brought to light several aspects of genesis of crustal rocks in this belt and the surrounding areas (e.g. Rajamani et al. 1981, 1985, 1989, Balakrishnan and Rajamani 1987, Balakrishnan et al. 1990, Krogstad et al. 1989, Mukhopadhyay 1989, Mukhopadhyay and Haimanot 1989), genesis of gold mineralization (Siddaiah and Rajamani 1989, Siddaiah et al. under review, Walker et al. 1989) and finally led to a proposal that Kolar may represent an Archean suture where two dissimilar crustal segments were brought together in the Archean closing the ocean separating them, probably by subduction related, east-west compression (Krogstad et al. 1989). The possibility of south-southwest extension of such a suture is supported by isotopic evidences from south-west and south-east regions of Biligirirangan-Nilgiri and Madras areas respectively (Vidal et al. 1988, Griffiths et al. 1987).
If the proposed subduction related tectonic processes were operating in this part of the craton at that time of the earth's history, the craton may have evidences for subduction related magmatism also. Plutonic rocks from the west of Kolar belt are shown to have geochemical characters of subduction related plutonism (Balakrishnan and Rajamani 1987, Krogstad et al. in preparation). However, mafic extrusive magmatism is also an important consequence of subduction related processes which is not observed in the Kolar and neighbouring areas. Also, it is not necessary that all the lithological associations of a particular tectonic setting should be present in any given area.

Some of the above mentioned important contributions towards understanding of crustal and ore genesis from Kolar area are strikingly similar to what has been observed in the present day too. For example, genetic relationship has been proposed between mesothermal gold mineralization and subduction related tectonic processes (Kerrich and Wyman 1990, Barley et al. 1989) for a large part of the earth's history. Thus delineating areas of discontinuity on crustal terranes may become useful in delineating areas of probable mineralization.

Thus, to check the nature and extent of the proposed subduction related suture, and its consequent magmatism, and to understand crustal- and ore- genesis in this part of the craton, an integrated study of a similarly mineralized Ramagiri schist belt of the eastern Dharwar craton has been
undertaken. In the present study, the mafic and ultramafic rocks of the belt are evaluated to understand their source characters with the help of their field relationship, major- and trace- element including REE data on them.

The data on major and trace elements and their ratios on rocks are widely used as quantitatively as possible to understand the conditions of parental magma generation and emplacement for the rocks under consideration. Quantitative modelling of the elemental abundances would lead to better understanding on the nature of the source areas and processes involved in magma genesis. Some of these informations would be useful in constraining the tectonic conditions of magma emplacement on comparison with rocks of present day tectonic environments, their typical magma types and emplacement.

During this work, field studies were conducted to better understand the field relations of various rock types present and well characterised samples were collected for geochemical studies. Within the existing constraints, best possible data were collected and a serious effort has been made at deciphering the overall meaning of the data.

The thesis is divided into the following portions: A general review of the work done in the Ramagiri schist belt, alongwith our observations, on the field relations of rock types, their features in the hand specimens and in thin sections forms the second chapter. This is followed by a detailed description of the data generation, the procedures
involved, the validity of the data and a review of the
geochemical characters of the belt rocks. The rocks have
been classified into different groups for detailed analysis,
on the basis of clear-cut differences in their chemistry.

The next chapter is a discussion on the dominant rock
type, the metatholeiites, to understand their petrogenesis.
Based on limited data, a small note is added on the
petrogenesis of the ultramafic rocks occurring in the area.
In the fifth chapter, source characteristics of the mafic
rocks of the belt are evaluated using major and trace element
abundances. With the help of the discussed geochemical
features of the metatholeiites, a probable tectonic scenario
for the extraction and emplacement of the parent magmas to
Ramagiri metatholeiites is proposed at the end of this
chapter, with reference to other better studied portions of
the eastern Dharwar craton. Based on the observed field
relations, lithological association, geochemical characters,
interpreted source characteristics and tectonic settings, it
is concluded that the parent magmas to the metavolcanics of
the Ramagiri area may have formed by subduction related
magmatic processes. Based on the discussed features and the
lithological association, the Ramagiri area appears like a
tectonic melange formed by collision tectonics, rather than a
'schist belt'.

8