Summary

Over the past few decades considerable research has been done on "Granite Tectonics" and it is now widely accepted that extraction of granitic melts, their ascent and emplacement are closely linked with regional tectonics. The analysis of deformation fabric in granites is challenging because they do not always develop mesoscopically mappable structures. Therefore, field, microstructural and anisotropy of magnetic susceptibility (AMS) studies have been used in the past to identify deformation fabric in granites. The present thesis is based on such an integrated approach that was adopted to analyse the deformation fabric in the Godhra Granite, a 5000 km^2 pluton located in the southern parts of Aravalli Mountain Belt (AMB), northwestern India.

The regional tectonic setting of the Godhra Granite and its age is unique. It lies in the southernmost tip of the AMB and to its south lies the Central Indian Tectonic Zone (CITZ) that formed during the Palaeoproterozoic times due to accretion of northern and southern Indian shields. The age of the Godhra Granite is 955 ± 20 Ma, which is a Grenvillian orogeny age. Past geological studies have revealed that the CITZ underwent rejuvenation during Grenvillian times. Since the Godhra Granite has a similar age and also is located in proximity to the CITZ, there is need to evaluate the possible relationship between emplacement of the Godhra Granite and development of deformation fabric in it with regional tectonics. Past studies on the Godhra Granite have been restricted to only a fractional part of this huge granite and the present study takes into account the entire Godhra Granite. Field, microstructural and AMS data have been generated to determine the deformation fabric in the granite. Moreover, the granite is associated with older banded gneiss, which also occupies a large area of approximately 3000 km^2 and this has also been studied with an aim to compare the fabric in the granite with the regional deformation events in the southern parts of AMB.

The regional geology of the study area and previous studies on the region are discussed in Chapter 2. The details of the stratigraphic nomenclature followed by

different workers/groups of workers at different times are presented in tables with an aim to give the reader a comprehensive picture about the geology and stratigraphy of the study area. The oldest geological map of the granitoid terrain that was prepared by B. Rama Rao in 1931 has been redrawn and reproduced in this chapter and studies carried out in the vicinity of the Godhra Granite by previous workers are summarized.

Mesoscopic structures noted in the Godhra Granite and adjacent banded gneiss are described in Chapter 3. Structures noted in different parts of the granite as well as in the margin of the granite are documented. Magmatic shear zones and magmatic folds are described from the northern part of the Godhra Granite. Magmatic fabric defined by preferred orientation of feldspar laths is documented and a rose diagram indicating that this fabric trends NW-SE is presented. Theory of rheological behaviour of crystallizing felsic magma based on percolation theory is briefly presented and the mesoscopic structures in the Godhra Granite are interpreted in terms of strain rate ($\dot{\varepsilon}$), viscosity (η) and crystal fraction (Φ). Moreover, the structures noted in the banded gneiss are also documented and a structural history comprising three deformation events D_1 to D_3 is worked out. Interference patterns pointing to superposed deformation are documented and evidence of ductile shearing is presented. Field evidence pointing to melt extraction through ductile shear zones is also presented and it is demonstrated that there is a parallelism between orientation of axial plane of D_3 folds (AP_3) and the magmatic fabric noted in the Godhra Granite. Thus, it is concluded that the D_3 deformation resulted in magmatic state deformation in the granite and the development of magmatic fabric in it.

In Chapter 4 details of petrography and microstructures noted in the Godhra Granite are presented. Based on a study of 100 thin sections of granite it is shown that different microstructures dominate different parts of the granite. Several photomicrographs documenting the microstructures in the northern, central and southern parts of the granite are presented. A table summarizing the dominant microstructure in these three sectors and a microstructure distribution map of the granite is included. It is concluded that high temperature solid-state fabric such as chess-board pattern in quartz is present throughout the granite and is noted to have superimposed a magmatic fabric. Low-T fabric is such as kinked biotite dominates in the southern part of the granite and is absent in the northern part; the latter has only high-T solid-state fabric. Truncated zoning implying melt-present deformation is present only in the northern part of the granite. Subgrain rotation recrystallisation and bulging recrystallisation in the quartz are present in the central parts of the granite while deformation twins in feldspar dominate the southern part. Thus, based on the study it is inferred that the southern part of the Godhra Granite underwent deformation at lower temperatures than the northern part.

Results from AMS studies on the Godhra Granite as well as banded gneiss are presented in Chapter 5. AMS data from 248 sites within the granite and 69 sites within the banded gneiss are presented. It is shown that there is a parallelism between the magnetic fabric in the granite as well as gneiss. The magnetic foliation strikes E-W and is oblique to the NW-SE oriented magmatic fabric noted in the field. It is concluded that the Godhra Granite has a composite fabric. The magmatic fabric developed early during D_3 deformation when the emplacement and magmatic-state deformation of the granite took place. With continued D_3 deformation, the E-W fabric became dominant in the granite, thus resulting in a composite fabric.

In Chapter 6 a shape preferred orientation study of the Godhra Granite is presented. Degree of shape preferred orientation is analysed by statistically calculating the concentration parameter κ of von Mises distribution. The calculations are done in oriented thin sections prepared parallel to the magnetic foliation plane in 20 thin sections of granites located from the southern to the northern part of the granite. It is observed that there is a good correlation between κ and magnetic data. It is also noted that κ as well as magnetic fabric are stronger in the southern part of the granite than the northern part. This is inferred to indicate a positive increasing regional strain gradient towards the south, which is attributed to the proximity of the southern part of the granite to the CITZ.

Chapter-7 incorporates discussion and conclusions and the regional implications of the present study. Additionally, suggestions for future work are made.