CHAPTER VII

SUMMARY AND CONCLUSIONS

The present thesis contributes to the geology of the Lodhikhera area forming southern parts of the Sausar tahsil of Chhindwara district and the northern part of Nagpur district respectively of Madhya Pradesh and Maharashtra. The thesis incorporates the results of detailed geological investigations including geomorphological, structural and petrological studies. A summarized account of the important observations and conclusions, presented in the earlier chapters, is given in the following paragraphs to provide a comprehensive picture of the geology of the area.

About 90 sq.miles of an area included in the topographic sheet No. 55 K/14 and roughly lying between 21°32′ - 21°45′ N; and 78°47′ - 78°58′ E has been covered by the present investigations. The area is largely constituted of the Precambrian rocks, and in fact forms the westernmost part of the 'Sausar belt' of central India. Amongst the few geologists, contributing to the geological knowledge of this region, Fermor was the first to study this area in the early
part of the present century. In the late 1950's the officers of the Geological Survey of India including Narayanswami, G.V. Rao, and others studied only a part of the present area and mainly provided attention to the manganese ore deposits occurring in the region. In the subsequent period, however, little or no geological attention was paid to the Lodhikhera area.

The Precambrian metasediments of the Sausar Group and associated granitic rocks and amphibolites; sedimentary rocks (Lametas) belonging to the Upper Cretaceous period and basaltic rocks referable to the Deccan Traps of the Cretaceous - Eocene time constitute the Lodhikhera area. In addition, the Older and Younger alluvium constituting fluvial sediments of the Quarternary period cover at many places the older rocks.

The various metasediments belonging to the Sausar Group are correlated with Bichua, Junewani, Chorbaoli, Mansar and Lohangi formations of Narayanswami et al and the associated granitic rocks form equivalents of their Tirodi Gneiss.

The various petrographic types recognised in the area are as under:

1. Granitic rocks: (i) Granite (ii) pink, grey and transitional
type Granitic gneisses (iii) Migmatites (iv) Aplites and Pegmatites.

2. Metasediments: (i) Pelitic schists and gneisses including sillimanite and kyanite bearing assemblages (ii) Calc rocks including various marbles, calciphyres, calc-gneisses, and calc-granulites (iii) Para-amphibolites (iv) Psammitic rocks including feldspathic quartzites, micaceous quartzites, quartz-mica schists and gonditic quartzites.

3. Metabasics: Ortho-amphibolites

4. Sedimentary rocks: Cherty and gritty limestones

5. Volcanics: Basalts

The area studied is thickly forested and presents gently undulating topography with a fairly broad alluvium filled valley in the central part and gently rising low altitude hills flanking the river course. The main drainage system is constituted by the river Kanhan and its tributaries. The pre-Cretaceous topography of the area was covered by the Lameta sediments and subsequent outpouring of basaltic lavas during the Cretaceous-Eocene periods. The present topography is the result of weathering and erosion postdating Deccan Trap volcanic activity. The high grounds in the area are
largely made up of intensely folded Precambrian metasediments and their associates, and the Deccan Trap lava flows providing flat tablelands in the NE and the SW part of the area. The altitude ranges are of the order of 1000' to 1850' above MSL with more than 55% of the area being covered between 1000 and 1350 feet. The altimetric analysis indicates planar surfaces at 1150, 1400, 1550 and 1750 feet levels. The one at 1150' is a floodplain level of the river Kanhan, and the surfaces at 1400, 1550, and 1750 feet levels are the result of spasmodic horsting movements in the Deccan Trap period and thereafter.

The broad valley flanked by the thick alluvial cover deposited by the river Kanhan and its tributaries is indicative of an Old stage of the landscape and the features such as oxbows, cut-off meanders, levees, terraces, yazooos, etc. observed in the area indicate that the drainage development has reached its Old stage. This fact was verified from a quantitative estimate, where Hypsometric Integral was calculated for the higher order streams. The range of 11 to 34% of the Hypsometric Integrals provides support to the conclusion that the Monadnock stage (Old stage) of the drainage system has been reached. An analysis of the stream ordering in the area shows that the streams up to 6th order are encountered and out of these 743 are of the first
order, 189 of the second order, 41 of the third order, 99 of the fourth order, 5 of the fifth order and one of the sixth order. The bifurcation ratio averages 3.8989, displaying a variation from 2.2 to 4.6. In case of the higher order streams this ratio deviates considerably from the value of the lower order streams as well as from the average to suggest a strong structural control in the channel development. The stream length frequency analysis also results into a sinuous curve instead of a straight line of the graph of log of the total stream length to the log of respective stream order. This is also suggestive of a dominant structural control on the channel development by headward erosion.

It is observed from the topographical sheet No. 55 K/14 that the river Kanhan and Jam Nala have cut through their own alluvium and at many places the bed level of these streams is lowered by about 45 feet. Further, the features such as entrenched meanders, alluvial cliffs and bluffs along with both the river Kanhan and the Jam Nala are common and indicate that the river system is rejuvenating as a result of Neotectonism. Floodplain features such as sandsplays, ox-bows, meander cut-offs, abandoned segments and typical Yazoo courses of the tributaries to the main river courses are noticeable all along
the river Kanhan and the Jam Nala.

The hill ranges made up of Precambrian rocks generally exhibit linear stretches. A typical hogback is also observed in the Sangam hill which is capped by hard and resistant folded quartzites of the Junewani formation. The hills capped by Deccan Traps are generally flat topped, and due to lateral erosion typical conical hills have also been resulted as in case of Channi-Vanni hills.

Karstic features are mainly of the 'Karren' type. Rillenkarren, rinnenkarren kluttkarren, rundkarren etc. have been noticed in the metasedimentary calcrocks. These features are developed as a result of solution by surface waters and represent the youth stage of the 'Karst Cycle' of Cvijic.

The various geomorphic features and the landforms observed in the Lodhikhera area are thus the result of a complex interaction of lithology, tectonics, erosive forces and the stage of development in which structural control appears to be the most dominant factor.

The Lodhikhera area has been variously subjected to structural deformation since the Precambrian times. The
different structural elements recorded in the area are studied on mesoscopic, macroscopic and microscopic scales. The mesoscopic structures observed in the Precambrian rocks are as follows:

'S' structures:
(b) Bedding ($S_0$)
(b) Continuous cleavage ($S_1$)
(c) Crenulation cleavage ($S_2$)
(d) Fracture cleavage ($S_3$)
(e) Joints ($S_4$)

Folds:
(a) Open to isoclinal folds on $S_0$ ($mF_1$ folds)
(b) Small scale folds superimposed on the limbs of $mF_1$ folds ($mF_2$ folds).

Lineations:
(a) Axes of $mF_1$ folds ($L_1$)
(b) Axes of $mF_2$ folds ($L_2$)
(c) Axes of crenulations ($L_3$)
(d) Axes of elongation of tabloids ($L_4$)
(e) Intersection of $S_1$ and $S_2$ ($L_5$)
(f) Intersection of $S_1$ and $S_2$ ($L_6$)
Linear structures:

(a) Boudinage structure is the only mesoscopic linear structure observed in the area.

The bedding (\(S_0\)) is more prominent in case of calc rocks. It is usually parallel to continuous cleavage (\(S_1\)). However, near the closure of a fold it is seen to intersect \(S_1\) at high angles. The orientation patterns of \(S_0\) and \(S_1\) indicate a nearly WNW-ESE direction of the general strike and a structural homogeneity with respect to these elements. There is a general correspondence between the visible fold axes and those obtained from fabric diagrams. The style of folding observed in the Precambrian rocks shows that these are of 'Similar-type'. The patterns of the dip isogons suggest that these are flattened folds with a varying degree of flattening. In the granitic gneisses it varies from 5 to 50 % and in the calc rocks it is in the range of 50 to 80 %. The folds are thus considered to be the result of flexure slip folding and subsequent flattening. Refolding is indicated by the interference fold patterns. The microscopic studies yield near orthorhombic pattern for (001) in mica in case of granitic gneisses and pelitic rocks. The patterns of (0001) axes in
quartz are typically monoclinic in symmetry, though in few cases the symmetry is distorted and tends to be triclinic. The quartz patterns with 'ac' gridles are suggestive of an orientation mechanism involving forward rotational movement. The distortion of the symmetry of patterns may possibly be due to the influence of more than one phase of deformation.

The macroscopic structures observed in the area are folds, faults and lineaments. The important folds are Sangam hill anticline, Sapghota syncline and Kondasaori doubly plunging syncline. The plunging of the fold axes towards WNW and ESE suggests crossfolding on NNE-SSW axes.

Three prominent trends of lineaments viz. (i) WNW-ESE: characterized by strike faults and stream courses, (ii) NE-SW: mainly due to transverse faults, sympathetic fractures and stream courses and (iii) NW-SE: chiefly due to the long stretches of the river Kanhan and its tributaries and fracture traces parallel to these are observed in the Precambrian terrain. The minor strike faults are those in the Sapghota Reserve Forest area giving rise to a sort of a graben structure. Somewhat less prominent faults of this type are marked near Kondasaori and Bichhwa. The fold structures and the strike faults are,
at number of places, disrupted by the NE-SW trending transverse faults. Amongst the E-W trending faults those displacing the Lametas and the Deccan Traps indicate post Cretaceous movements.

The nature of deformational forces is inferred from the analysis of the fracture patterns observed in the area. The results are suggestive that a regional couple resulting in rotational stress caused the folding and fracturing of the Precambrian rocks. Three distinct episodes of deformation viz.

(I) The Precambrian polyphase deformation (Satpura orogeny)
(II) Post Deccan Trap deformation, and
(III) Neotectonism

are evident in the area under study.

A petrological study of the Sausar metasediments indicates that these rocks were subjected to intense degree of regional metamorphism in which the pelitic sediments gave rise to sillimanite and kyanite bearing assemblages. In Winkler's new classification these assemblages fit in the 'High Grade' of metamorphism more or less equivalent to the higher amphibolite facies of Hietanen.
The conditions of metamorphism were evidently suitable for the development of granitic melts by anatexis. The mineralogical and chemical studies of the various types of granitic rocks indicate that the majority of them are of anatectic origin. It may be surmised that the large scale anatectic melts originated in the deeper parts of the Sausar geosyncline and were permisively emplaced into the Sausar metasediments to give rise to the various granitic gneisses. The small granite bodies are the result of upward emplacement of the 'magma' within the gneisses and the metasediments. The metamorphic differentiation during the deformational phase of the Sausars gave rise to the migmatites, and the minor intrusions in the form of aplites and pegmatites took place during the later phases of the Precambrian episode of deformation.