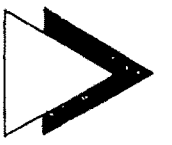
BACKGROUND INFORMATION REVIEW



BACKGROUND INFORMATION REVIEW

INTRODUCTION

The Pre-Cambrian terrain of North Gujarat and Rajasthan has attracted the geologists for more than half a century. The observations accruing out of these investigations of this complex terrain have provided valuable data on the various aspects of the geology of this area. In the pages that follow, an attempt has been made to summarise the main findings of the previous workers and this serves as an important background for the present study.

Sharma & Nandy (1936)

These workers classified the basic intrusives of Danta area according to their structural and mineralogical characteristics and suggested three phases of basic igneous activity in this area during the Post-Aravalli period (Table II-1). The oldest intrusives are more metamorphosed than the younger ones and have been divided into epidiorites, hornblende schists and pyroxene granulites.

The second phase of basic intrusion is marked by the metagabbro and metadolerite rocks which occur respectively as intrusive masses and dykes in the granitoid qneisses. These rocks are far less metamorphosed than the older intrusives.

The third phase of igneous intrusives in this area is absolutely free from any metamorphism and indicates olivine dolerites and olivine basalts, which are found as dykes or sills traversing the calc gneisses of the Aravalli and Delhi system. They are probably Post Erinpura granite in age.

TABLE II-1

1.	Oldest Intrusives (Post Aravalli,but Pre-granitoid gneisses)	Pyroxene granulites, epidiorites,hornblende schists
2.	Older Intrusives (Post-granitoid gneisses)	Metagabbros and meta dolerites
3.	Younger Intrusives (Post-Erinpura granite)	Olivine dolerites and olivine basalts

Deshpande et al., (1970)

According to these authors, the mineral assemblages of Danta area indicate conditions transitional between hornfels and granulite facies, within the Japan type of metamorphism of Hietanen's metamorphic facies series. The pressure range between 2000 and 3000 bars and temperature of about 700° C is indicated. The existence of conditions transitional between the granulite facies and the hornfels may probably be due to the emplacement of Erinpura granite that outlasted the regional metamorphism.

Crawford (1970)

He proposed that, metamorphism is most intense along the Aravalli lineament, where it is of amphibolite facies near Ajmer (Rajasthan) increasing to 'granulite facies southwards into Gujarat.

Desai et al., (1978)

These workers opined that, the metasediments exposed around Balaram-Abu Road area, located north of Danta i.e. the present area are not Delhis but are older rocks, belonging to Bhilwara Supergroup of Raja Rao (1967). While the olivine and hypersthene bearing rocks do not represent any Post Erinpura granite activity, but constitute a high grade metamorphic assemblage of charnockitic affinity and associated with calc granulites and pelitic granulites. They have given the following sequence.

TABLE II-2

Post Erinpura granite	-	Basaltic dykes
Erinpura granite	-	Granites
Delhi Supergroup	-	Calc schists and calc gneisses with amphibolitic layers.
Pre-Delhi Supergroup (Aravalli or older)	-	Charnockitic rocks with associated pelitic and calc granulite layers.

Powar & Patwardhan (1984)

These authors, suggested that the Ajabgarh Group which are dominantly calcareous and pelitic represent deeper water conditions.

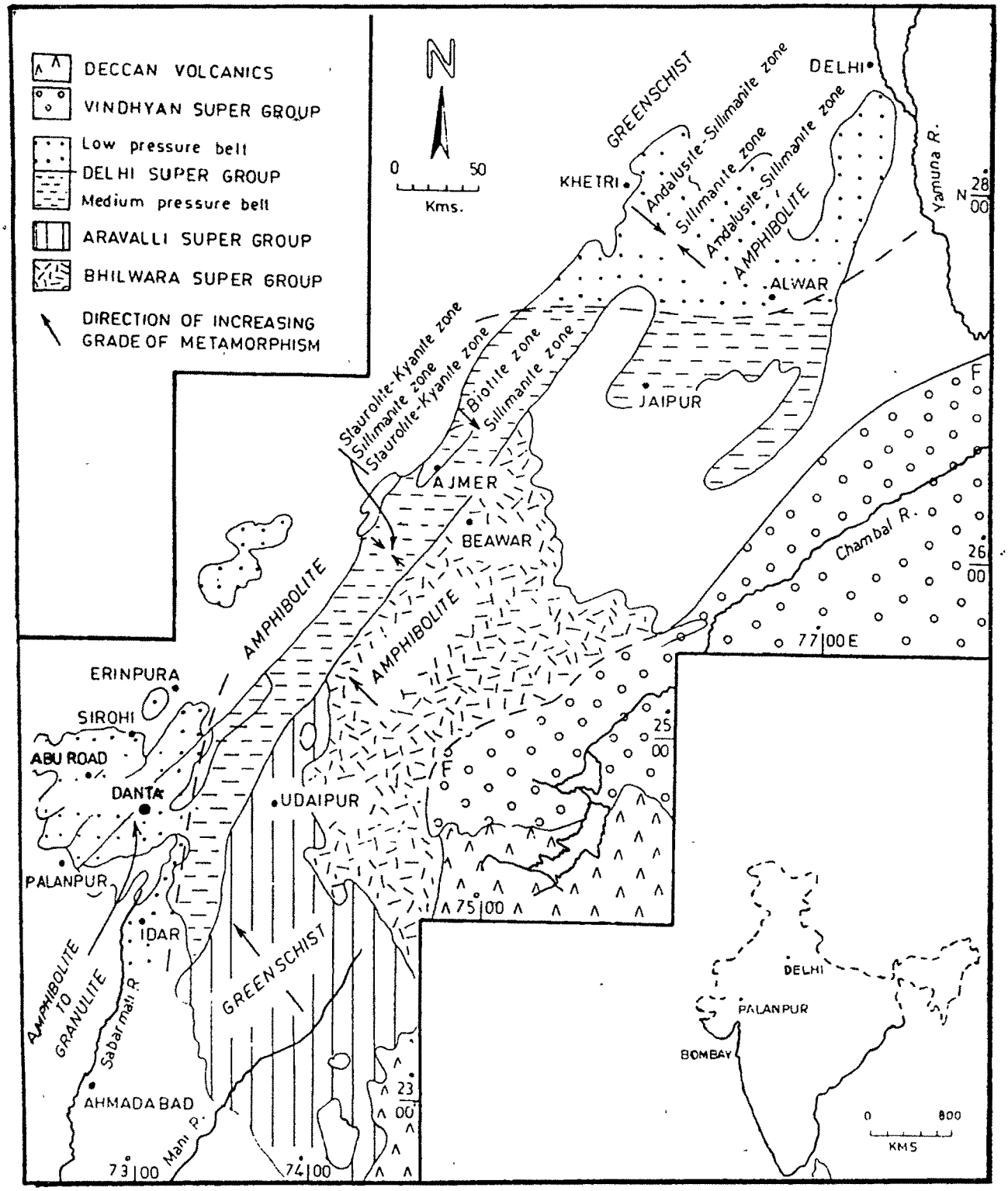
In the southern part where the Ajabgarhs are dominant, the evidence of sedimentation has been obliterated by high grade metamorphism and accompanying magmatism.

Structurally, the Aravalli and Delhi Supergroup have been subjected to a complex history of folding and dislocations. The earliest phase of folding (F_1) is marked by isoclinal and reclined folds with fold axes plunging W to WNW. On these are superimposed (F_2) folds that trend N to NNE and also coaxial folds (F_3) of smaller dimensions. The (F_2) and (F_3) folds are the most persistent and the cross folding on E-W to WNW-ESE trending axes (F_4) has resulted into the development of doubly plunging structures.

Metamorphic conditions show that the rocks of the Delhi SuperGroup reveal imprints of metamorphism coeval with deformation and low pressure regional metamorphism is developed in the west, central and central parts of the belt while only low pressure regional metamorphism is recognised in the northern and southern parts of this belt (Fig.II.1).

Fig. II-1

MAP OF THE ARAVALLI-DELHI BELT SHOWING DISTRIBUTION OF TYPES AND ZONES OF METAMORPHISM



(After Powar & Patwardhan, 1984)

In the Abu Road - Danta - Palanpur region at the southern end of Delhi Aravalli belt, dominantly calcareous metasediments of the Ajabgarh Group are profusely intruded by Erinpura granites. In this region the critical mineral assemblages are quartz - sillimanite - biotite - garnet - cordierite - k - felspar - spinel in the pelitic rocks. While calcite - forsterite - scapolite - phlogopite in carbonate rocks. Clinopyroxene - pargasite - tremolite - hornblende - plagioclase are found in metagabbros. Powar and Sharma (in press) estimated that during regional metamorphism, P-T conditions of 600° c to 630° c temperature and 3 kb. pressures suggest upper amphibolite facies of regional metamorphism.

Sychanthavong & Merh (1984)

These authors have divided mafic rocks of Delhi Supergroup in Banaskantha and Sabarkantha districts of North Gujarat on the basis of their modes of occurrences and petrology. They are of the opinion that, (1) Ortho amphibolites and granulites occupy the fold cores of the macroscopic anticlinal folds. (2) Ortho amphibolites and pyroxene/hornblende granulites occupy the NNE-SSW trending zones of longitudional dislocations and occur in close association with serpentinites and peridotites

(3) Olivine gabbros, olivine dolerites and andesites occupy the zones of NNE-SSW as well as WNW-ESE trending fractures.

Fold core Ortho amphibolites and Granulites

In North Gujarat, these rocks are exposed as major and minor domal structures below the pelitic gneisses. The root zones of the major exposures are occupied by metagabbros around Kanpura (north of Danta) and north of Nedardi and are seen gradually changing to hornblende granulites nearer to the contact with metagabbros. These metagabbros have been described as charnockites by Desai et al., (1978) around Balaram - Abu Road area. In many exposures around Ranpur, Jamburi, Songarh and Khedru villages of North Gujarat, where the metagabbros are not exposed and the core of the domes reveal hornblende granulites.

Heron & Ghosh (1938), Heron (1953) and Sharma (1953) have described these mafic rocks as intrusives of Post - Delhi but Pre - Erinpura granite age. Obviously, the above authors differ from the previous observations. The metamorphosed mafic rocks are always seen occurring below the lowermost sub division (pelitic gneisses) of the Ajabgarh Series. If at all they were synsedimentary sills emplaced during the deposition of the Delhi rocks, they must have been randomly distributed in many horizons of these Ajabgarh Series.

Fault zones Amphibolites, Granulites, Gabbros and Peridotites

These rocks occur along the various longitudional fault zones. In the Chitrasani - Kui - Bijapur - Sewai - fault zones granulites and gabbros are exposed at Khunia and Chandravati in North Gujarat and to the south east of Abu Road in South West Rajasthan. About 40 km east of this fault zone, lies another dislocation (Nedardi - Songarh - Desuri - Phulad - Piplia - fault zone) along which continuous outcrops of amphibolites, hornblende granulites, eclogites (?) and serpentinites with grospydite xenolith are encountered.

Metamorphic Evolution

On the basis of petrographic studies, these authors have established imprints of three metamorphic events (M_1, M_2 and M_3) each connected with three successive deformational episodes (F_1, F_2 and F_3). The metamorphism of Delhi rocks show a range from epidote amphibolite subfacies to granulite facies.

Delhi rocks of Sabarkantha and Banaskantha district of North Gujarat i.e Posina - Kherod - Ambaji - Balaram - Abu Road - Bhatana - Kapasia show amphibolite and granulite facies metamorphism. Also the mineral assemblages show polymetamorphism too.

Further they mention that the low pressure high temperature belts show a very wide distribution in the Pre -Cambrian terrains of all the continents, while the intermediate or high pressure - intermediate or low temperature belts adjacent to them are only sporadic. The authors believe that they are related to and depend upon the Pre -Cambrian plate - tectonic mechanisms which controlled the folding and continental growth in those times. The high pressure-low temperature belt in this part of the Pre - Cambrian terrain has been obscured by later metamorphic episode of low pressure-high temperature belt remobilizing the early formed minerals to appear as the low pressure - high temperature mineral assemblages. There are some assemblages which have survived as relic minerals of the high pressure - low temperature character. These minerals are stable under the new conditions of such metamorphic event. This metamorphic superimposition has considerably obscured the original picture and brought about confusion in the recognition of paired metamorphic belts. The sporadic remnants of high pressure minerals, discussed above,no doubt betray the original presence of high pressure - low temperature belt in this Pre-Cambrian terrain of Gujarat and Rajasthan.

Patel, Desai & Merh(1985)

They believe that the metasediments of (Delhi Supergroup) i.e. Balaram-Abu Road area lie within three distinct lineaments and form triangular shaped outcrops.

Desai & Patel (1987)

While working in Sabarkantha and Banaskantha districts of North Gujarat, they have reported the inliers of high grade granulitic rocks in the amphibolite facies of Delhi System. These inliers, occur as lensoid bodies concordant to regional structure and are strikingly analogous to the hypersthene bearing granulites (Charnockitic rocks) and pelitic granulites (cordierite Sillimanite - bearing garnetiferous granulites) of Balaram - Surpagala area of Banaskantha district, the contact between these rocks is sharp. The authors strongly feel that these inliers represent the relicts of the Pre - Delhi rocks that formed the basement for the Delhi System rocks. The present disposition is on account of the folding of the Delhi-Pre-Delhi sequence and subsequent erosion. As a result, the Pre-Delhi metasedimentaries are seen to occupy the anticlinal fold cores, forming inliers of granulite facies rocks in Delhi amphibolite facies terrains of North Gujarat.

Drury (1990)

The Western Delhi metasediments i.e Ajabgarh Group occur on the western flank of the Aravalli hills, near the Ranakpur lineament. These highest grade (granulite facies) rocks possibly represent magma chambers from which the calc alkaline plutons were derived by fractional crystallization (Drury,1990). The Western Delhi terrain is interpreted as the tectonized root zone of the island arc, its associated calcareous sediments and the abundant clastics of Eastern Delhi (i.e Alwar Group) being described to a backarc basin (Sugden,1987).

Further, he has also inferred the occurrence of a layered diorite-gabbro-anorthosite body of granulite facies representing the deep crustal level exposed in the possible island arc assemblage of Western Delhi domain. Similar rocks outcrop along Ranakpur lineament as tectonically disrupted fragments.

Fareeduddin, Sharma & Bose (1991)

They have reported the occurrence of tectonic slices of high grade rocks in Pilwa - Chinwali - Arath area NNW of Ajmer. These occur in discontinuous strips over a distance of 25 km within the Alwar metasediments of middle amphibolite facies. As these granulite facies

rocks are involved in all the deformational phases of surrounding Delhi rocks, they suggest that the metamorphism and emplacement event took place during Delhi orogeny. Sharma (1988) is of opinion that deep crustal rocks of Sandmata emplaced within the Archean continental block of the BGC occur far away from Delhi fold belt and the granulite facies metamorphism is also an outcome of the Delhi orogeny.