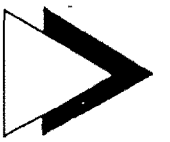
GEOLOGICAL SETTING



GEOLOGICAL SETTING

INTRODUCTION

The study area forms an extension of a part of southern portion of Delhi synclinorium and consists of the rocks belonging to Ajabgarh Group, the upper division of Delhi Supergroup. The main lithological units are represented by pelitic and calcareous components that are associated with basic and acid igneous intrusives. In this chapter, an attempt has been made to give a concise picture of the distribution and field characteristics of the various rocks encountered and the geological evolution of the study area.

The systematic mapping by the author has revealed that, the structure and metamorphic episodes witnessed by these rocks are more varied and complex than as visualised by Heron and Ghosh (1938) and other previous workers. From the geological map (Fig. III. 1) it is clear that in the study area though the NNE-SSW folding is evidently dominant, a closer scrutiny shows effects of three fold episodes, (a) trending NNE-SSW (F_1) (b) NNW-SSE (F_2) and (c) N-S directions (F_3) respectively. The interference of these folds has given rise to the existing outcrop pattern.

The metamorphic episodes coeval with various deformations have left clear imprints though imperceptible. The emplacement of granites in post orogenic times has further brought about the thermal metamorphism. The present area thus offers a striking case of polymetamorphic terrain.

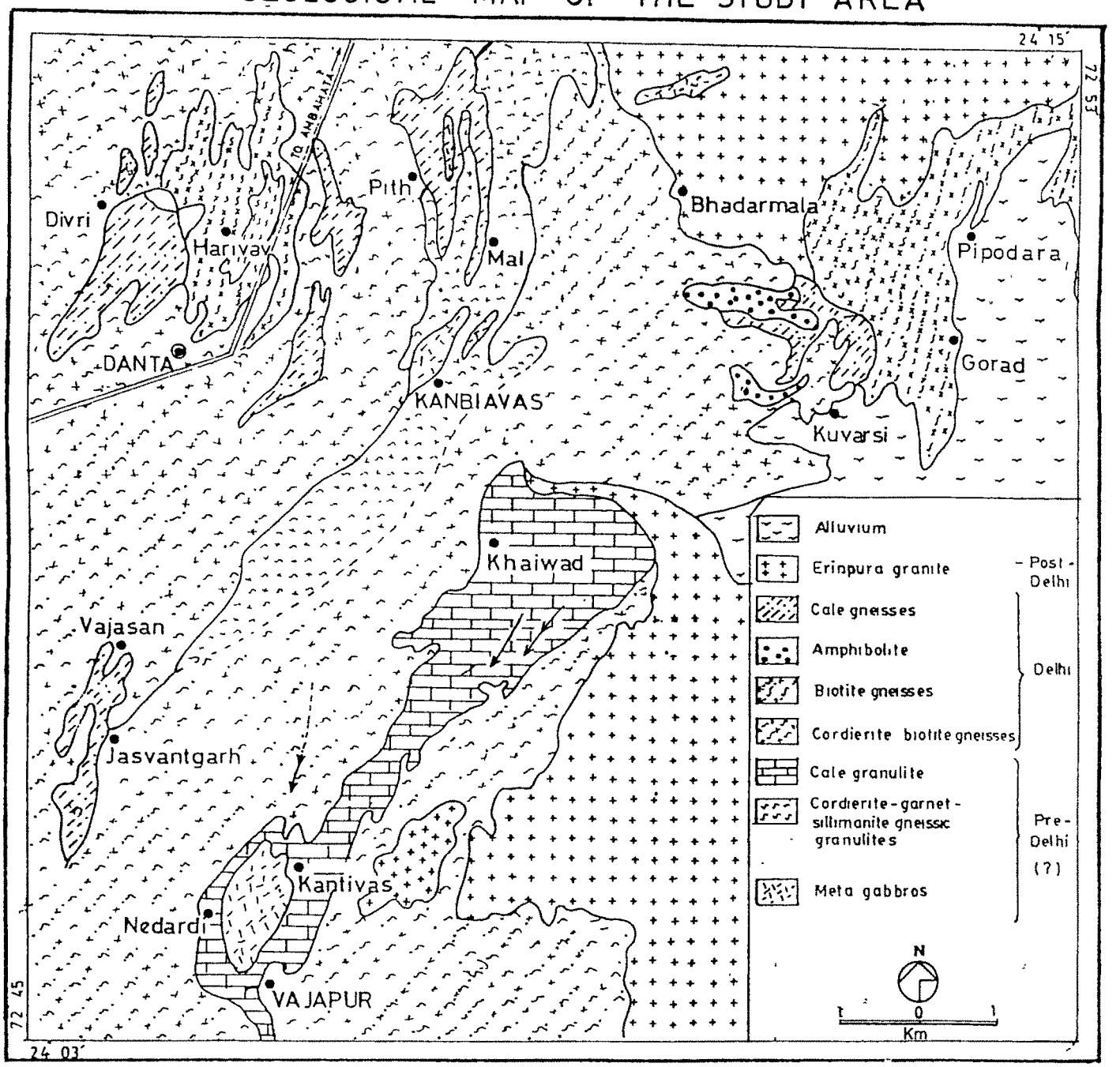
The present study has enabled the author to obtain an altogether new and revised geological picture of the area in particular and Ajabgarh Group in general.

PELITIC MEMBERS

The pelitic members chiefly constitute (a) cordierite - garnet - sillimanite gneissic granulites (b) cordierite - biotite gneisses (c) biotite gneisses.

Fig. III-1

GEOLOGICAL MAP OF THE STUDY AREA



(a) Cordierite -garnet -sillimanite gneissic granulites

These melanocratic rocks are mainly exposed in the northwestern part of Danta town. These members occur as lenticular ridges in close association with calcareous members. They are exposed near Danta school as well as near Harivav on the way to Danta - Ambamata road. In general, these narrow bands show NNE-SSW to NE-SW trend, but near Danta school they show swing to NNW-SSE to N-S because of mild cross folding (Plate III.1). They are bluish grey to reddish brown in colour depending upon the variation in proportion of cordierite, garnet and biotite. These are studded with rusty brown garnet porphyroblasts. The presence of biotite foliae often results in gneissic appearance. At places the gneissic granulites occasionally show presence of quartzo felspathic veins oriented parallel to foliation. The similar rocks which are exposed near Harivav are analogous to those occurring near Balaram - Abu Road area, north of Ambamata (Desai et al.,1978).It is interesting to note that such rock types exposed in the study area are absent in other areas under investigation.

(b) Cordierite - biotite - gneisses

The cordierite biotite gneisses are exposed in the immediate vicinity of cordierite garnet sillimanite

Plate III.1 Well developed microfolds (F_1) in cordierite - garnet - sillimanite - gneissic granulites (Loc. Harivav, N. of Danta).

Plate III.2 Quartzofelspathic veins showing minor folding (F_1) cordierite - biotite- gneisses on way to Danta - Ambamata road.

gneissic granulites and are exposed on either side of Danta - Ambamata road. Megascopically, they are medium to coarse grained and light grey to dark brown in appearance. These gneisses consist of more quartzo felspathic material and show same trend NE-SW as cordierite - garnet - sillimanite - gneissic granulites. These rocks indicate considerable migmatization and show lit par lit injection of the quartzofelspathic material. (Plate III.2)

(c) Biotite gneisses

Biotite gneisses are pink to light brown and dark grey in appearance. In the area east of Danta, the regional NNE-SSW trend swings to N-S and NW-SE and back to NE-SW. This indicates second and third phase of folding. In the east, these occur as continuous outcrops forming hill ranges near Kanbiavas, Vadvera and Jharivav. Around Kanbiavas, greyish coloured biotite gneisses show well defined augen structure where biotite forms discontinuous layers along the foliation. The hand specimens show the presence of cordierite and biotite. Here the lineation recorded are 25° / vertical while in the south the various localities, west of Nedardi, eastnortheast and south of Vajasan, the biotite gneisses are well exposed and show foliation with two trends EW/80° N and WNW-ESE/12° SW(Plate III.3). The presence of these two trends supports the fold generation

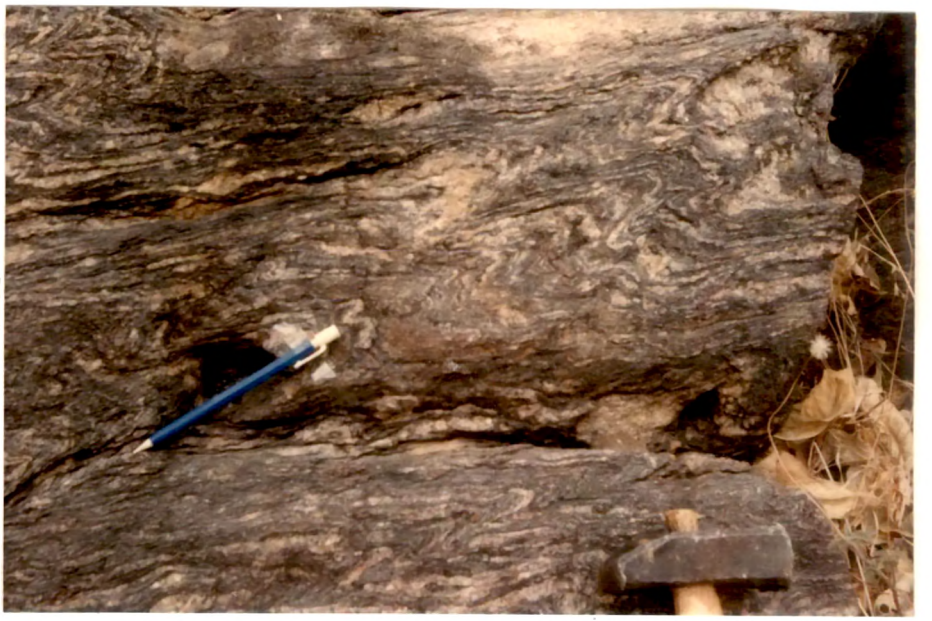


Plate III.3 F_2 trend in folds in biotite gneisses (Loc. Piplavali Vav, N. of Danta).

Plate III.4 Contact of amphibolites with biotite gneisses (Loc. Ambamata, S. of Danta).

episodes of second and third generation. The commonest form of lineation observed in these gneisses is a ribbon or striped on a foliation plane. There is no megascopic elongation in this direction but it is marked by local seqregations of certain mineral or coarse grained stripes in foliation planes. This lineation is marked by its WNW trend (300°) with plunge of 12° related to (F_2) deformation. Southeast of Danta these ridges are surrounded by bouldary outcrops of Erinpura granite and at places intruded by metamorphosed basic rocks along foliation planes (Plate III.4).

The gneisses show much variation in their characters from almost massive quartz rich to well foliated biotite quartz rock which is dependent upon degree of alteration. They are traversed by quartz veins which occur as thin lenses and bands and are folded along with the cordierite biotite gneisses.

CALCAREOUS MEMBERS

Covering the major portion of the study area, the calcareous members form the upper unit of the stratigraphic succession. They are divisible into two major rock types. 1) calc granulites with marbles, 2) calc gneisses. It is difficult to show the exact boundaries of calc gneisses and calc granulites on the map but petrographic characters help in distinguishing one from the other.

Calc gneisses

These rocks form the most prominent formation and occur as lenticular patches within granite gneisses. These calc gneisses show considerable variation in dips varying from 30° to as high as 80° to vertical indicate folding (Plate III.5). Good exposures of various refolded folds are very well seen around Divri, north of Danta. Northeast of Danta, these rocks are well exposed near Pith and Mal. East of Danta they form isolated outcrops near Kanbiavas and Kuvarsi. South and southeast of Danta, these form prominent exposures near Vajapur, Kanbiavas and Nedardi.

The exposures around Vajapur exhibit well developed folds of different generation (Plate III.6). The fold axes are trending 50° to 55° with subhorizontal plunge while its related lineations trending south (F_3) plunge 64° near Nedardi village. In these exposures the quartz veins are folded along the calc gneisses.

In general, these rocks are massive, medium to coarse grained in nature and light grey to green in colour and consist of alternating carbonate rich and silicate rich layers. The carbonate layers comprise calcite and dolomite while silicate layers constitute diopside, tremolite, scapolite, sphene with lesser proportion of quartz and felspar. The higher content of

Plate III.5 Calcgneisses showing steep dips (Loc. Kanbiavas, NE. of Danta).

Plate III.6 A close up view of F_2 folds in calcgneisses (Loc. Vajapur, SE. of Danta).

silicates and quartz, has rendered the layers more resistant to weathering. The differential weathering of various layers on account of heterogeneous hardness imparted the rocks a characteristic ribbed appearance. The rocks have been extremely plastic during folding and consequently reflected into random orientation (Plate III.7). The shapes of these outcrops which are controlled by fold style and topographical features regionally reveal lensoid pattern.

BASIC ROCKS

The small lenses and bands of metabasic rocks occur within pelitic, calcareous members and Erinpura granites. They have been metamorphosed alongwith country rocks and are seen in present form as amphibolites, migmatized amphibolites, hornblende granulites and rarely metagabbros. The basic rocks occur as xenoliths of various shapes and sizes in porphyritic to non - porphyritic granites. The metabasics occurring in association with pelitic components are altered and not as fresh compared to the metabasics that occur within calcareous members. The basic rocks occur sporadically as narrow ribs, streaks, lenses and boudins, appear to be of Pre-Erinpura age. Thus the basic rocks show two phases of intrusions which are either Pre-Delhi or synchronised with Delhi deformation.

Plate III.7 Calcgneisses showing F_2, F_3 folds near Kuvarsi.

Plate III.8 Quartzveins in massive amphibolites (Loc. Jasvantgarh, S. of Danta).

The previous workers Sharma and Nandy (1936), Heron and Ghosh (op.cit.), Bhan (1972) have proposed three fold as well as two fold classification for basic rocks occurring in Danta and its neighbourhood. They are of the opinion that they are either older than or younger than Erinpura granites.

Sharma and Nandy (op.cit.) made a reference of oldest intrusives represented by pyroxene granulites, epidiorites and hornblende schists but considered the metagabbro and dolerite to be of Pre-Erinpura granite in age. The youngest Post-Erinpura granite intrusives were represented by olivine dolerite and olivine basalts which completely escaped metamorphism. Heron and Ghosh (op.cit.) did show the presence of hornblende schists and amphibolites derived from calcareous sediment also but the present author's work in the study area has revealed that these basic rocks occur as amphibolites, metagabbros and to some extent show even granulitic texture under microscope. The classification of metabasics in the study area clearly indicates that these metabasics are transformed into amphibolites during Delhi deformation. The metagabbros and hornblende granulites could be still older. Thus this basic activity appears to be not only Pre-Erinpura but even Pre-Delhi.

In the area around Danta these metabasics occur at different places in association with metasediments as well as granites.

North of Danta, near Harivav the pelitic metasediments are seen to be closely associated with dark coloured foliated amphibolitic rocks. These amphibolites are in contact with cordierite garnet gneissic granulites which are impregnated by light coloured leucocratic veins of quartz and felspars (Plate III.8). This perhaps indicates the migmatization or granitisation of amphibolites. It is very characteristic to see the distinct light and dark bands in the amphibolites. The foliation measured in these amphibolites is NE-SW/ vertical dips.

Further on way to Danta - Ambamata road, within the calc gneisses, amphibolites are exposed near Harivav village. The foliation observed in them is NNE-SSW with a dip of 22° to 30° towards SW and west.

On proceeding further near Tarsulighati, dark grey coloured rocks, fine grained massive in nature occurring within biotite gneisses are quite important. They exhibit granulitic or granoblastic texture under microscope. Their contact with biotite gneisses is sharp.

The basic rocks east of Danta town can be grouped as amphibolites and metagabbros and are associated either with biotite gneisses or with calc gneisses.

Near Kanbiavas village, the dark grey coloured, foliated amphibolites are exposed and show the presence of ptygmatic folding in quartz veins. The amphibolites are associated with calc gneisses. Near Kuvarsi on either side of the road, coarse grained, dark green coloured metagabbros occur in association with biotite gneisses. These exhibit ptygmatic folding as well as pinch and swell structures (Plate.III.9,10).

Near Tundia char rasta before Gorad village amphibolites are fine to medium grained and dark grey in colour associated with calc gneisses. The foliation in these rocks shows 10° / with vertical dip, this planar structure (S_1) related to earliest Delhi deformation. The ribbon lineation in the associated calc gneisses is however northwesterly 310° with vertical dip. This linear structure (L_2) related to (F_2) folding of Delhi deformation.

East of Danta, on way to Samiya from Dholapura, light to dark green coloured basic rocks are coarse grained metagabbros which are associated with calc granulites.

Plate III.9 Ptygmatically folded quartzvein in amphibolites on way to Danta - Kanbiavas road.

Plate III.10 A close up view of boudinage structure in amphibolites (Loc. N. of Kanbiavas).

South of Danta, very conspicuous outcrops of dark grey coloured amphibolites are seen within quarry faces near Jasvantgarh. These amphibolites are associated with biotite gneisses and show foliation of 70° / 25° SSE. These amphibolites are impreqnated with numerous quartz vein which show folding at number of places but it is difficult to measure the axes of the folding because of compact nature of quartz veins. Within the amphibolites specks of chalcopyrite, bornite and pyrite mineralization are visible.

A fairly large body of metagabbro is surrounded entirely by calc gneisses showing radial dips. This body is exposed NE of Nedardi near Kantivas village. These basic rocks are light to dark green in colour and contain green to black coloured pyroxenes. The contact of these basic rocks with calc gneisses is quite sharp. Although these are quite compact and massive but at places alternate layers of plagioclase felspars and pyroxenes are common (Plate III.11).

This suggests cryptic (rhythmic) layering and closely corresponds to igneous layering or cryptic layering reported by Desai et al., (op.cit.) in Abu Road. The presence of coarse pyroxenes and leucocratic felspars in the form of alternate layers indicates that these are layered igneous bodies and therefore, invite comparison with (i) metamorphosed layered complex in

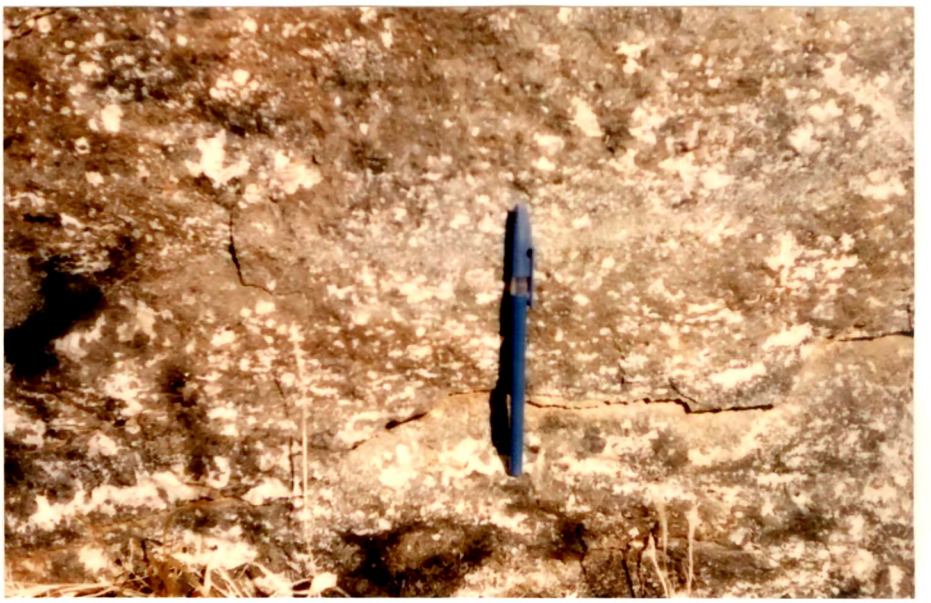


Plate III.11 Rhythmic layering in metagabbros (Loc. Nedardi, SE. of Danta).

Plate III.12 Characteristic 'Tor' weathering in granites near Divri.

Kanpura area, north of Balaram (Desai et al., 1978) (ii) those of Fiskenaesset complex of Greenland (Myers, 1973) and (iii) metamorphosed layered igneous complex in the Lewisian Scotland, U.K. (Davis, 1974).

In general way, the basic rocks occurring in association with calc gneisses show sharp contacts but those occurring with biotite gneisses usually show transitional contacts and the amphibolites, occurring in association with biotite gneisses only, show convincing evidences of migmatization or granitisation.

ERINPURA GRANITES

The last phase of igneous activity witnessed by the area is the occurrence of coarse porphyritic, foliated, unfoliated varieties and forming bare knobs. These granites are correlatable with the Post- Delhi Erinpura granites which occur extensively in and around Ambamata area, north of the study area. A perusal of geological map (Fig. III. 1) will reveal that these granites form very prominent outcrops to the north, northwest, east and southeast of Danta, Southwest of Danta, the granite outcrops form prominent hills that range in height from 500 m to 800 m.

These granitic rocks follow NNE-SSW regional pattern and occur in association with calcareous and pelitic members. All along the margin of granites and

metasedimentaries it is very characteristic to see the development of gneissic rocks formed from either pelitic and calcareous members. Because of this Erinpura granite activity, considerable development of transitional types showing a complex amount of intermixing has been visible. These granites ribs on the low grounds exhibit the outcrops of sheets interbanded with older amphibolites, in which they are intrusive and sometimes form composite gneisses (migmatized amphibolites) with them. In hand specimen, granites from all the exposures, are identical showing grey to pink colour and having the same proportion of quartz, felspar and micas as essential and iron ores as accessories. By and large they are medium to coarse grained and massive.

In west and northwest of Danta the prominent granite outcrops are exposed around prominent villages like Divri, Vasi Road and Pethapur. While in northwest they form prominent outcrops near Vav and in the east granite occur near Pipodara, Kuvarsi, Bhadarmala and Bheda. Here granites occur mostly in association with calc granulites. The south and southeast of Danta the granite outcrops are seen near east of Vajasan, north of Nedardi, south of Khaiwad, south of Jasvantgarh and north of Aderan.

It is important to note that the foliation in granites wherever measured is NE-SW i.e. essentially

parallel to strike of the country rocks. This broad arrangement thus indicates the granite as a "grain" running NE-SW.

It is also seen that in the field a fine grained granite and the foliated biotite gneisses grade into each other and to the slightly later unfoliated granites. Throughout the area the granites are characterised by typical topography where tor weathering is conspicuous (Plate III.12).

Numerous acid pegmatite veins occur in the area, particularly in calc gneisses and cordierite garnet sillimanite gneissic granulites. Two generations of aplite and pegmatite veins have been observed in the area. The earlier pegmatite veins have been observed in the area. The earlier pegmatite veins are coarse grained and consist of quartz and felspar with very little micas. Aplites have got similar composition but are fine grained. These veins are partly interbanded with gneisses forming composite gneisses or lit -par -lit gneisses. In some cases they are wholly composed of grey felspars with very little quartz and ferromagnesian minerals. These veins have generally sharp contacts.

In the calc gneisses few pegmatite veins occur parallel to the bands. Near the contact with the pegmatites these show pinch and swell structure. They

have been emplaced before folding as they are folded at places and in few cases they have been broken into lensoid body.

South and southeast of Danta town, granites run out into the alluvium as irregular fingers continued by isolated hills as far as Sudasna in the south.

In the vicinity of granites, the pelitic members as well as calcareous members show the development of contact metamorphic minerals but the development of true hornfelsic rocks is difficult to be confirmed in hand specimens on account of recrystallisation and compactness of the rocks otherwise so common in hornfelses.

The stratigraphic succession of the study area worked out by the author is as follows.

Table III.1 STRATIGRAPHIC SUCCESSION

Grey and pink porphyritic, non-porphyritic granites with aplite and pegmatite veins	Post-Delhi (Erinpura)
Calc gneisses Biotite gneisses Cordierite biotite gneisses, with amphibolite layers.	Delhi Orogeny
Calc granulites with marble lenses Cordierite garnet gneissic granulites. Hornblende granulites, Metagabbros.	Pre-Delhi(?) Orogeny