CHAPTER III

GEOLOGY OF METASEDIMENTARIES

SECTION A: Nature of metasedimentaries and their distribution.

SECTION B: Petrography of metasedimentary units.
As described in the previous chapter the metasedimentary flanking the Dalma volcanics belong to Iron Ore stage (Dunn and Dey, 1942). The southern boundary of the lava is remarkably regular and runs straight but near Chakraśharpur, base of the lava is seen to overlap the beds of the Iron Ore stage and even rests on the mica schists of the Chaibasa stage. Subsequently the Iron Ore stage of Dunn and Dey (1942) as found to the north and south of Dalmas, were described as Dhalbhum Formation, though of younger stratigraphic level (Sarkar and Saha, 1962). This Dhalbhum Formation with the Chaibasa Formation towards base together constitute the Singhbhum Group of Rocks (Sarkar and Saha, 1977). The metasedimentary pile adjacent to the Dalma greenstone assemblage and the basal tuffaceous member of the volcanics are grouped together as Lower Dalma Formation by Gupta et al. (1980). On the basis of metasedimentary units developed in different sectors mapped it is observed that the grade of metamorphism does not normally exceed the development of phyllites and slaty phyllites with minor exception towards east in Kuńchia Sector (Fig. 1A. 2) where these rocks grade to mica schists exhibit comparatively higher grade of metamorphism. Dunn and Dey (1942) suggested that the metamorphism of the area must be regarded as regional and it might have some relation to folding mechanism of the area.
Lithological distribution

The metasedimentaries occurring as country rocks in the area consist of phyllite, quartzite, mica schist and marble bands but phyllites are the most prevalent type. This includes sericite-phyllite, chlorite phyllite, carbonphyllite, purple phyllite and haematitic phyllites and they occasionally grade to slaty rock on the one side to mica schists on the other. In addition there are various types of banded cherty quartzites, ferruginous quartzites and banded haematite quartzites with opaques. The distribution of the rocks are shown in the reference map of the area (Fig. 1A. 1) modified by Dunn (1929) and Dunn and Dey (1942).

Broad topographic control by the metasedimentaries has already been described in the previous chapter. The phyllites, carbonphyllites and cherty micaceous quartzites form the peaks to the north and south of the Dalma volcanic suite. All the metasedimentary units in the area trend in an east-west direction.

Phyllites often occurs as carbonphyllites, very often grade, in plades, to a massive black cherty rock by replacement. Many of the carbon phyllites grade into slates, distinguishable even in hand specimens. To the north of Dalma volcanic belt, phyllites and carbon phyllites are interbedded with each other. Some of the phyllites are ferruginous which occur along
the edges of the Dalma lavas. To the east of Chandil near Kunchia the carbonphyllite grades to normal phyllites and mica schist. (Fig. 1A. 2). Impersistent bands of quartzite occasionally ferruginous, are found within the phyllite terrain. Towards north and south of Dalmavolcanics the quartzite outcrops form ridges which run parallel to the Dalma volcanic belt.
The metasedimentaries may be grouped into four broad units viz., phyllites, mica schists, quartzites and carbonate rocks.

Phyllites

Phyllites are somewhat variable in character. Typical phyllite is ash coloured well cleaved with characteristic sheen on cleavage but it may grade to more compact rock in which thin rhythmic compositional bands are well marked. The rock often assumes a pale yellowish green or greenish grey colour and occasionally buff or purple coloured. In folded units the cleavage makes low to moderate angle with composition banding. Local small scale displacement of the compositional bands are seen, the miniature faults being filled by silica.

The buff or purple coloured variety occurring to the south-east of Bansa (86° 01' ; 22° 54') is soft and fine grained with well marked cleavage / schistosity defined by sericite. The other constituents are quartz, limonite and granular opaques. There may be gradation from buff or greenish grey phyllite to normal phyllite in which distinct flakes of micas are discernable. The buff coloured phyllite in thin section shows sericite, chlorite, quartz from a very fine grained mosaic with chlorite forming the base in which fine needles
are oriented with a checkered pattern. Numerous needles of tourmaline are distributed evenly throughout the rock. The greenish grey phyllite under microscope reveals quartz, biotite, sericite and chlorite as the major constituents forming a granular mosaic. Fine sericite/muscovite and occasionally biotite define the schistosity along with partly recrystallised quartz. Biotite often occurring as discrete coarser grains. Quartz is oval or slightly flattened along the schistosity plane. The colour bands are defined by relatively biotite and opaque enriched layers alternating with quartz rich bands. The adjoining bands are associated with thin sinuous quartz septa occurring across the colour bands filling microfaults.

Carbon phyllites occur in all the sectors (Kunchia, Chandil, Khunti and Kunderkuti) associated with the metavolcanic belt near Baman Buru (85° 41' ; 22° 51') and are associated with other litho-members like quartzite, buff/purple phyllite near Gangokocha (85° 59' ; 22° 54'). Towards the north of metabasalts carbon phyllites crop out in a number of disconnected areas as near Senkebasa (86° 27' ; 22° 48'), and Jamdihi (86° 24' ; 22° 57') and further west. At Chandil (86° 04' ; 22° 57') two hill ranges of carbon phyllite run parallel to the metabasalt. In its westward journey along the northern boundary of metabasalts the carbon phyllites gradually change over to normal phyllites of purple to buff colour. These are fine grained rock with carbon and sericite
as chief constituents along with quartz which also may define compositional bands. Amount of carbon and thus the colour shade varies from exposure to exposure as also along the same band. The carbon phyllites vary from almost homogeneous grey rock with weakly developed cleavage to rocks with well marked colour banding. The banding is defined by alternate carbonaceous and arenaceous layers. The carbonaceous bands apparently equal in thickness to arenaceous parts but on close examination very thin lamellae of arenaceous material are seen with carbonaceous bands. Both the layers often maintain uniform thickness for considerable length. At places the rock is transformed to compact dark cherty variety with thin silica rich stringers. Angular relation between colour bands and cleavage is often detectable in samples from suitable structural sites.

At Kunki, south of Chandil (86° 04' ; 22° 57') along the southern bank of Subarnarekha river chlorite phyllite is found to be intimately associated with metabasalts. The rock showing very good phyllitic sheen and schistosity defined by flakes of chlorite. The rock is mainly composed of chlorite, opaques and calcite along with quartz pellets and very rarely with chloritoid showing a linear arrangement on the primary foliation (Fig. 3B. 1).
Mineralogy of phyllites

Quartz: It occurs as fine disseminated granules or clustered in bands with irregular outline. The quartz grains are mostly flattened to a subelliptical shape with their long axis being parallel to schistosity (Fig. 3B. 2). The regional and dominant schistosity (S2) in the rock is the site of the elliptical quartz grains along with other flaky minerals. Such quartz grains often show undulose extinction. Flattened quartz grains are often marginally crushed might be of predeformational. Rarely quartz grains have grown in the pressure shadow region (Fig. 3B. 3) of coarse opaque grains and also occur as halos around opaque prisms. Few xenoblastic unstrained quartz grains are also developed and may be post deformational. Small elliptical granules of quartz are found to be included within biotites along the elongation direction forming trails. Quartz also occurs as veins, within the phyllites (Fig. 3B. a), with their growth perpendicular to the vein walls.

Biotite: Biotite is almost always present in the phyllites. It occurs in two distinct habits viz. large porphyroblasts and tiny flakes. The stumpy porphyroblasts often show sieve structure for the included quartz blebs forming trails within biotite. The tiny flakes control the schistose fabric within the rock. But in massive phyllitic rock it forms a mosaic rather than to define schistosity. Biotites of both the habits are strongly pleochroic from deep brown (X) to pale
yellowish brown (Y). A green variety of biotite also occurs as stumpy porphyroblasts and as smaller flakes. This type is also strongly pleochroic from deep greenish yellow (Z) to pale greenish yellow (X) via pale yellowish green (Y). This green biotite when associated with opaques is much more bleached than the other biotites.

Sericite: Sericite is the dominant constituent of phyllites and carbon phyllites occurs mostly as fine flakes as discrete grains or as aggregate of fine granules. These are distributed evenly and also define the schistose structure in the rocks. The mineral shows feeble pelochroism and mottled extinction.

Muscovite: It is the minor constituent of the normal phyllite, occurs mostly as tiny flakes concentrated within the matrix having insignificant control in defining the schistose structure in the rock. Stumpy porphyroblasts, showing sieve structure, are also common. In some cases these are intimately associated with biotite, suggestive of their simultaneous crystallization. Muscovite crystals are colourless with high birefringence and characterised by mottled extinction.

Chlorite: Occurs in aggregates of tiny flakes and needles mainly in association with the micaceous minerals. The elongated chlorite grains occur parallel to the dominant schistosity (S2) planes (Fig. 3B. 4) showing feeble pleochroism from pale green to almost colourless. The mineral is optically positive with consistently low birefringence.
Opaque: Opaques occur in variable amounts and habit ranges from dusty grains to large plates arranged either parallel or oblique to the schistosity. They also occur as cubes and blocks. Inclusions of quartz and sericite are common. Most of the opaques are likely to be iron ore as limonitic stain is characteristic.

Carbonaceous materials: These occur dominantly in the carbon phyllites and as minor consistent in phyllites. The carbonaceous materials are black and opaque and characteristically define colour bands in the rock along with fine elongate blebs of quartz and some other micaceous minerals.

Mica schists

Mica schists occur next in abundance to phyllite. Along the southern margin of metabasalts the parallel ranges of phyllites often grading into mica schist and frequently they are so intimately associated with outcrops of amphibolites that it is difficult to map them separately. In the eastern extremity of the investigated area near Kunchia (86° 28' ; 22° 47' 12") and towards west near Kunki, south of Chandil (86° 04' ; 22° 57') and Sonapet valley (85° 35' ; 22° 50') the rocks contain crystals of garnet indicating higher grade of metamorphism. The rocks show a prominent foliation which is puckered with the formation of crenulation cleavage. Megascopically the rocks are fine to medium grained with a glistening appearance due to the presence of mica flakes. In the thin section the
rock is composed of muscovite, biotite, quartz, carbonates and opaques. Besides these minerals, garnet, sericite, chlorite present as accessory minerals in variable proportions.

Mineralogy of Mica schist

Muscovite: It is the major constituent of the mica schists and occurs as colourless flakes arranged in a parallel fashion along with sericite grains defining the prominent schistose structure in the rock. Porphyroblasts with sieve structure are also common. Ferrimuscovite is also reported from some areas characterised by brownish colour and feeble pleochroism.

Biotite: It occurs in significant amount. The mineral is coarser in size with respect to other micaceous minerals. Tabular grains showing strong pleochroism from dark yellowish brown (Z) to pale straw yellow (X).

Quartz: The quartz grains are xenomorphic and elongate. These are aligned parallel to the schistosity. Except some quartzose banding the equant grains are intermixed with the micaceous minerals and opaques. Very fine quartz lenses appear to be strongly drain out in en-echelon pattern. Small grains of spongy recrystallised quartz also present (Fig. 3B. 5). Narrow quartz ribbons also occur as cross foliation in the rock.

Garnet: Rhombohedral grains show haphazard orientation and associated with opaques. Grains are finer in size, colourless
and isotropic. Small inclusions of quartz and sericite are present.

Carbonates: Occur in minor amount as anhedral grains. Colourless, non-pleochroic grains show twinkling effect.

Opaque: Opaque grains are developed in two types, of which one is occurring as large elongate grains forming a megascopic lineation and the other type is occurring as grains arranged along the schistosity of the rock.

Quartzite

The rock occurs both as thin and thick bands along the strike length of the metavolcanic belt. Most of the exposures are discontinuous and forms high ridges. Two hill ranges running along northern and southern boundary of metabasalts near Kunchia (86° 28' ; 22° 47' 12") mainly composed of quartzite. The rock is fine grained, white or greyish white in colour and at places finely laminated. In places the quartzite is cherty and sometimes it grades towards phyllite through phyllilitic quartzite. The rock is highly affected by ferruginous materials. Fine grained quartzose rocks, containing some mica and iron ore arranged parallel to the very thin and delicate colour bands, occur at Kunchia (86° 28' ; 22° 47' 12") and highly ferruginous types occur around Chandil (86° 04' ; 22° 57'). The micaceous quartzite split easily along stratification and difference in grain size is discernible in different
laminae. Cherty quartzite (Fig. 3B. 6) and banded haematite quartzite (Fig. 3B. 7) occur near Balidih (86° 0' 40"; 22° 55' 35") as massive exposures. In general the schistosity in micaceous quartzites is formed by the parallel orientation of muscovite and biotite flakes and recrystallised elongate grains of quartz.

Under the microscope the rock is found mainly composed of quartz constituting about 80 - 90% of the total rock volume. Here the quartz grains are coarser than those in the phyllites. Grains are mostly xenoblastic and show undulose extinction. Elongate grains often define the crude planar structure within the rock. In individual rock fine quartz mosaic alternates with thicker band of relatively coarser grains. The finer laminations show very thin layers of carbonaceous (dusty) particles which reveals the colour banding in megascopics scale. Some sheared quartzites show cataclastic texture (Fig. 3B. 8) with finely crushed quartz aggregates, which some times envelope large quartz grains forming mortar structure. Very often the whole mass is recrystallised to form bands by thin pencils of quartz. Biotite comes next to quartz which occurs as flakes arranged in a parallel fashion. Biotite content increases in phyllitic quartzites than that in the pure quartzites. Opaques are generally of irregular habit, but some show distinct prismatic habit and these are parallel to the schistosity.
Carbonate Rocks

Carbonate rocks occur in a very small scale and few are as unmappable bands. Near Kunchia (86° 23' ; 22° 47' 12''), Hesadih (85° 21' ; 22° 47', though not included in the present study) and south of Kunti (85° 59' ; 22° 58') some calc-bands occur very close to the metabasalts. Crystalline limestone crops out near Harni Gara (85° 21' ; 22° 47'). This rock shows a dirty white appearance with radiating needles of amphibole. The rocks are well cleaved and pink carbonates developed along the cleavage planes. The marble bands near Kunchia are highly folded into small tight folds. Calc bands with well developed schistosity occurring near Kunti (85° 59' ; 22° 58') mainly composed of carbonates, amphibole and micaceous minerals.
Fig. 3B. 1 Photomicrograph showing chloritoid grains (Ct) in chloritoid schist (Polarised light, 90 X).

Fig. 3B. 2 Photomicrograph showing Quartz vein and flattened quartz (Q) grains. Individual grains are occurring parallel to the foliation in Carbon phyllite (cross polars, 56 X).

Fig. 3B. 3 Photomicrograph showing post deformational growth of quartz crystal perpendicular to the stumpy opaque grains. (cross polars, 36 X).
Fig. 3B. 4 Photomicrograph showing elongated chlorite grains (Cl) parallel to the schistosity (Cross polars, 0 X)

Fig. 3B. 5 Photomicrograph showing small grains of spongy recrystallised quartz (Q) (cross polars, 3X)

Fig. 3B. 6 Photograph showing massive exposure of Cherty quartzite.
Fig. 3B. 7 Photograph showing massive exposure of banded haematite quartzite.

Fig. 3B. 8 Photomicrograph showing calaclastic texture represented by granules of quartz and opaques (cross polars, 40 × ).