CHAPTER-III: LITHOLOGY AND PETROGRAPHY OF JAikan SECTOR

A. General Features:

The greater part of the area mapped around Jaikan is covered by felspathic schist. To the north of it occur chlorite-mica schist, mica schist. South of it are banded ferruginous quartzite and cherty quartzite, conglomerate, grit and gritty chlorite phyllite.

Due to paucity of exposures and high degree of weathering, the boundaries between different units are often conjectural.

Felspathic schist is white to light gray, often with alternations of dark green biotite-rich and light quartzo-felspathic bands. The proportion of felspar within the rock is variable and accordingly the appearance of this rock varies. Sometimes augen of felspar can be recognised in hand specimen and the rock looks like a granite. With decrease in felspar content towards north, it grades into chlorite-mica schist. Because of lack of sufficient exposures, its boundary to the south remains conjectural.

In the present area banded ferruginous quartzite and banded cherty quartzite occur as several discontinuous ridges trending northwest-southeast, from Tirla in the west to Ukam in the east. To the southeast of Jaikan the quartzite is cherty in appearance. This cherty quartzite is white in colour, often with a vitreous appearance and has alternate thick white and thin black bands. The banded ferruginous quartzite occurring to the northwest of Jaikan consists of alternate opaque-ore and quartzose bands, the thickness of individual bands usually varies from a few mm. to a few cm. A few thin bands of black slate occur interbedded with banded ferruginous quartzite.
There is practically no exposure of schistose rocks immediately to the north and south of banded ferruginous quartzite. Near Chotta Kunabera, a thin band of conglomerate occurs along the boundary of the Singhbhum granite. The matrix of the conglomerate is grit and gritty chlorite phyllite. The pebbles are mostly of massive quartzite, but a few banded hematite quartzite pebbles are present. To the south, i.e. near the contact with granite, pebbles constitute about 20% of the bulk volume, but towards north and east the proportion of pebbles gradually decreases, and conglomerate grades into grit and gritty chlorite phyllite.

To the north of felspathic schist occur light to deep green chlorite schist and chlorite-mica schist. Near Basurda, the rocks are fragmental in nature and may be an original tuffaceous sediments or a 'tectonic breccia'. Near Dudra alternations of white quartz-rich and dark green chlorite and mica-rich bands are prominent. Chlorite-mica schist grades towards north into mica schist.

A few isolated outcrops of schistose and banded quartzite occur within felspathic schist and mica schist. Near Chhota Kunabera, a small patch of granite body occurring to the south of conglomerate has been studied. It represents the northern extremity of Singhbhum granite. The granite in this area is highly deformed.

B. Mineral Assemblages:

1. Felspathic schist:

It consists mainly of quartz, sodic plagioclase, K-felspar, muscovite/sericite, chlorite and biotite. Chlorite is confined to the northern part of felspathic schist, at the contact with
chlorite-mica schist.

Quartz occurs either as small granular xenoblastic grains with polygonal outline or as coarser grains with elliptical or irregular grain boundaries. The quartz grains are often strained and show undulose extinction and deformation band.

Plagioclase forms large subidioblastic porphyroblasts. It is also present in the fine grained groundmass. It is highly altered to sericitic materials and also to granules of epidote-clinozoisite which are dispersed throughout its body. Both simple and complex twinning are present. Inclusions of quartz and sericite-muscovite are common.

Aggregates of minute sericite needles form thin films or slightly thicker sinuous bands. Individual flakes are often not discernible. Tiny needles of muscovite are often interleaved with biotite.

Chlorite is rare. It is absent in the inner zone of felspathic schist and occurs only near the gradational contact with chlorite-mica schist. It occurs as tiny needless and larger flakes. Very commonly it occurs along the cleavages and margins of biotite. Hence, at least majority of the chlorite, if not all, represent retrograde product.

Small grains of opaque-ores are quite common, at places they are abundant. The accessory minerals are epidote and apatite. Epidote mostly occurs as small granules and apatite forms tiny prisms. Sphene is rare and occurs as rounded or lozenge shaped small grains.

2. Conglomerate, gritty chlorite phyllite and grit:

The mineralogical composition and texture of the matrix of
conglomerate are essentially the same as that of gritty chlorite phyllite. Again the gritty chlorite phyllite grades into grit with the increase of the amount of quartz. The groundmass of grit is composed chiefly of fine grained quartz while that of gritty chlorite phyllite is extremely fine grained phyllosilicate-quartz aggregates.

In these rocks, large porphyroclasts of quartz are embedded within fine grained xenoblastic matrix. These quartz porphyroclasts are usually ellipsoidal, often highly flattened and show evidences of deformation and polygonisation. The finer quartz grains in the groundmass are recrystallised grains and have polygonal grain boundaries.

Plagioclase (oligoclase-andesine) occurs as subidioblastic porphyroblasts, highly altered to sericitic materials. Evidences of postcrystalline deformation are undulose extinction, bending of twin lamellae, marginal granulation and rugged grain boundary.

Aggregates of sericite flakes form thin films parallel to schistosity. Very few minute flakes of chlorite are interleaved with sericite.

3. Chlorite-mica schist:

It consists essentially of quartz, chlorite, sericite, biotite and opaque-ores.

Quartz is mostly fine grained and either polygonal in outline or elongated. Evidence of straining of coarser grains is less than in the rocks occurring to the south.

Chlorite, muscovite and biotite usually occur as interleaved fine flakes parallel to schistosity. Stout flakes of muscovite are randomly oriented. Besides, tiny or coarser flakes of these minerals are occasionally parallel to fracture cleavage.
Chlorite is pleochroic from pale green (X) to deep green (Z). Sometimes chlorite occurs as retrogression product along margins and cleavages of biotite. However, all the chlorite grains have same optical property and it is not possible to distinguish between pro-grade and retrograde chlorite. Locally chlorite is completely absent.

Biotite is strongly pleochroic from deep brown (Z) to pale yellowish brown (X).

Opaque-ores are locally very much prominent and occur as large, rounded, square or euhedral crystals. Pressure shadow against opaque-ores is common and growth of fibrous quartz has taken place parallel to schistosity in the "shadow" region on either side of opaque-ores.

Accessory minerals are tourmaline and rutile.

4. Mica-schist:

It consists of quartz, muscovite, chlorite, biotite and garnet.

Quartz is mostly polygonal in outline, sometimes elongated parallel to schistosity.

Chlorite occurs as small as well as larger flakes, the former variety often interleaved with biotite. Pseudomorphs of chlorite after garnet have also been noticed. Chlorite is mostly parallel to schistosity, but, at places, shows atwart growth or is aligned parallel to fracture cleavage. It is pleochroic from pale green (Z) to deep green (X). Elongation negative.

Muscovite and biotite flakes occur as interleaved grains mostly parallel to schistosity. Biotite shows the following pleochroic scheme.
Z = Dark brown.
Y = Brown or dark brown.
X = Pale yellowish brown.
Z > Y > X

Stout grains of muscovite and biotite are athwart to schistosity. Besides, small flakes of muscovite parallel to fracture cleavage are also present. Biotite is often altered to chlorite along margins and cleavages.

Garnet occurs as idiomorphic grains. It is smaller in size at the beginning of garnet zone but elsewhere occurs as porphyroblasts. Pale pink in colour. It contains inclusions of quartz grains, but no definite pattern could be recognised. It is altered to chlorite along margins and cracks.

Epidote granules, small tabular grains of tourmaline and opaque-ores are the accessory minerals.

5. Schistose and banded quartzite:

Quartz occurs as medium to fine polygonal grains.

Tourmaline is locally common and concentrated along bands. It is pleochroic from dark yellowish brown (O) to pale yellow (E).

Apatite occurs as coarse, rounded to irregular grains confined to quartzose bands. Small granules of apatite are present within tourmaline-rich bands.

Phyllosilicates are rare in banded quartzite. Small flakes of muscovite are aligned parallel to schistosity. But in schistose quartzite, chlorite and muscovite-rich bands occur parallel to schistosity. Muscovite and chlorite flakes parallel to fracture cleavage have also been noticed.
Fig. 68: Flattened quartz grain with elongation parallel to schistosity. Crossed nicols, mag. X 27.

Fig. 69: Photomicrograph of gritty chlorite phyllite, showing larger quartz grains within fine grained matrix. A thin rim of smaller grains around some larger grains. Crossed nicols, mag. X 27.
6. Granite (Singhbhum granite)

It comprises of quartz, plagioclase, microlite and sericite.

Quartz occurs as very large as well as finer grains within groundmass. The larger grains bear the evidences of strong post-crystalline deformation, viz., undulose extinction, deformation bands, elongation parallel to schistosity and progressive stages of polygono-nisation etc. Fine grained quartz within matrix is usually crystallised with polygonal outline.

The plagioclase grains are also highly strained, as evidenced by bending of twin lamellae, displacement of lamellae along microfault.

Aggregates of sericite form thin films aligned parallel to schistosity.

Epidote occurs as small granules, mostly as altered product of felspar.

C. Textural Relation:

1) Grit, gritty chlorite phyllite and conglomerate:

The cataclastic effect is locally conspicuous in these rocks. Highly deformed porphyroclasts of quartz are set in a fine grained matrix. These porphyroclasts are usually ellipsoidal or lensoidal parallel to schistosity and sometimes become highly elongated (Fig. 68) due to extreme flattening. Evidence of strain in the less flattened grains is diffused undulose extinction. The more flattened grains exhibit deformation lamellae, deformation bands parallel to schistosity. The plagioclase porphyroblasts also bear the imprint of deformation, viz., bending of twin lamellae, displacement of twin lamellae along microfault etc. All these larger grains are embedded
Fig. 70: Partial replacement of a larger grain by small recrystallised quartz grains. Crossed nicols, mag. X 27.

Fig. 71: Sericite films wrapping round polycrystalline aggregate of quartz. Crossed nicols, mag. X 33.
within fine grained mosaic of quartz grains or within extremely fine grained matrix of quartz-phyllosilicate aggregates. Often a thin rim of finer grains surrounded the quartz porphyroclasts. The texture of these rocks resembles "mortar" texture (Fig. 69). However, the finer grains are all recrystallised and schistosity defined by thin sericitic films can clearly be recognised within the groundmass. Partial to almost total replacement of a single large quartz grain by an aggregate of small polygonal strain-free quartz grains has been noticed (Fig. 70). In the initial stages of polygonisation, small clear polygonal quartz grains appear along fractures within porphyroclasts or along the margins. With the increase of the amount of smaller grains, the larger grains are divided into subgrains and ultimately only a small relict of the porphyroclasts can be seen.

Besides isolated porphyroclasts within fine grained groundmass, coarser quartz grains are also found concentrated along well-defined bands alternating with fine grained bands. The individual grains within the coarse grained bands are usually ellipsoidal and show undulose extinction, whereas those within fine grained bands are recrystallised with mostly polygonal outline.

2. Felspathic schist:

A conspicuous textural feature in this rock is mosaic formed by equant or slightly elongated small quartz-felspar grains, which often forms bands alternating with relatively coarser grained bands. Tiny flakes of muscovite and biotite and coarser porphyroblasts of felspar are present within very fine to fine grained mosaic of quartz grains with polygonal outline. Larger quartz grains within the coarse grained bands are usually elliptical in shape with slight
Fig. 72: Microbrecciated texture within felspathic schist. Criss-cross fractures within a large quartz grain. Plane polarised light, mag. X 27.

Fig. 73: Fragments of quartz aggregates (White clots) and opaque-ores embedded within chlorite-sericite patch. Plane polarised light, mag. X 27.
elongation parallel to schistosity. These coarser quartz grains are deformed and exhibit undulose extinction, deformation bands and concentration of small recrystallised quartz grains along grain boundaries. Occasionally an aggregate of small polygonal quartz grains has replaced the coarser grain. Concentration of tourmaline has been noticed along bands with relatively coarser but recrystallised quartz grains.

Thin films of sericite aggregates and small flakes of muscovite are aligned parallel to schistosity. The sericite films are sinuous, impersistent, and show thickening and thinning. It often splits up and wraps round the porphyroblasts and polycrystalline aggregate of quartz and felspar (Fig. 71).

Myrmekite texture formed by inclusions of ameboid grains of quartz within plagioclase porphyroblasts have been noticed in felspathic schist.

The felspathic schist occasionally shows microbrecciated texture (Fig. 72). The fragments of coarser quartz within it display criss-cross fractures. The hinges of rootless first folds can be identified in thin section of such rocks. The sericitic bands are, in general, parallel to schistosity but have anastomosing pattern. The matrix of this microbrecciated rock has diverse grain-size, varying from extremely fine to larger angular grains.

3. Chlorite-mica schist:

Two varieties can be recognised. In the first type exposed near Basurda, the rock exhibits a fragmental texture (Fig. 73), and the second and more common type is a banded chlorite-mica schist, banding being defined by alternate quartzose and phyllosilicate-rich
Fig. 74: Fractures sub-parallel to elongation within a large quartz grain. Few smaller quartz grains along the fractures. Crossed nicols, mag. X95.

Fig. 75: Secondary banding parallel to fracture cleavage. Individual muscovite flakes within phyllosilicate bands inclined to the banding. Crossed nicols, mag. X33.
Fig. 76: Cataclastic texture of granite.
Crossed nicols, mag. X 27.

Fig. 77: Photomicrograph of granite. The coarser grains are flattened parallel to schistosity. Partial replacement of a large grain by smaller grains.
Crossed nicols, mag. X 27.
bands. In the former variety fragments of fine grained quartozose aggregates are ubiquitous, this together with coarse opaque-ores are embedded in chlorite-sericite patches. Amount of quartz in the groundmass is much less than in normal chlorite schist in the neighbouring region. This may represent original volcanogenic sediments.

The quartozose bands in the banded chlorite-mica schist are often composed chiefly of coarse grained quartz which occasionally shows marginal granulation and the progressive stages of subdivision into smaller grains (Fig. 74). However, such polygonisation is less pronounced in this rock than in grit and gritty chlorite phyllite to the south, and the overall texture of banded chlorite mica-schist is a recrystallised schistose texture.

Thin films of minute muscovite and biotite flakes are occasionally aligned along fracture cleavage. Fine quartz grains within such layers are often elongated parallel to fracture cleavage.

Pressure shadow against opaque-ores is common (Fig. 13). Growth of fibrous quartz has been noticed in the sheltered 'shadow' region on both sides of opaque-ores. These are aligned parallel to schistosity.

4. Mica schist:

The essential textural feature is a recrystallised schistose texture. Besides a secondary banding has developed parallel to fracture/crenation cleavage. This is manifested by alternations of muscovite-rich and quartz-rich bands. Individual muscovite flakes within such phyllosilicate bands are inclined to the banding and fracture cleavage (Fig. 75). Occasionally the earlier schistosity has been obliterated but more commonly it is preserved within
quartzose bands either as torn hinges of second folds or as straight or sigmoidal alignment of phyllosilicates inclined at high angle with fracture cleavage.

5. Schistose and banded quartzite:

It consists chiefly of fine to medium grained recrystallised quartz grains with polygonal grain boundaries. In banded quartzite, schistosity is defined mainly by small flakes or muscovite and biotite, but in schistose quartzite alignment of larger flakes of muscovite defines schistosity. Banding can be seen in almost all the rocks, but the nature of banding is of diverse types. The most common variety is quartzose bands alternating with other quartzose bands having different grain-size of the constituent minerals or with slightly different mineral assemblages. Tourmaline-rich quartzose bands have been found to alternate with almost pure quartz-rich bands. Here the tourmaline-rich bands are much finer grained than the tourmaline-free bands, and hence the finer grain-size of the tourmaline-rich bands appear to be the result of chemical granulation. Besides, muscovite-rich and chlorite-rich layers are also common. All these bands have been folded by second deformation.

Alignment of sericite laminae and a few larger flakes of chlorite parallel to fracture cleavage has been noted.

6. Singhbhum granite:

Only the northern margin of Singhbhum granite has been studied. Here it shows a highly deformed cataclastic texture (Figs. 76, 77). Coarse deformed grains of quartz and felspar are set in a fine grained matrix. The coarse quartz grains are irregular,
lensoidal, often flattened parallel to schistosity. These are often surrounded by smaller polygonal quartz grains along the embayed sutured margins. Progressive stages of replacement of larger grains by fine quartz aggregates are evident from the gradual increase of the amount of polygonal finer quartz grains.

The larger plagioclase grains are also deformed as evidenced by bending of twin lamellae and displacement of lamellae along fracture.

The matrix consisting chiefly of quartz and felspar is essentially recrystallised. Thin films of sericite are aligned parallel to schistosity.

D. Metamorphism:

The mineralogical assemblages of the rocks suggest a rise of the grade of metamorphism from chlorite zone to the south to garnet zone to the north. The boundary between chlorite and biotite zone could not be drawn due to the presence of felspathic schist in the central part of the area. The biotite within felspathic schist may be a product of felspathisation. The gritty chlorite phyllite occurring south of felspathic schist is devoid of biotite, but the chlorite-mica schist to the north of felspathic schist always contain biotite. Hence biotite isograd is expected to pass somewhere through the felspathic schist.

In the opinion of Gaal (1964), the rocks occurring immediately to the north of banded ferruginous quartzite belong to almandine-amphibolite facies and those to the south to highest green schist facies. But the present study of the mineralogical assemblages
indicate that the rocks belonging to greenschist facies continue much to the north of banded ferruginous quartzite.

The prograde phyllosilicates are parallel to schistosity indicating that metamorphism of at least up to the upper part of greenschist facies was coeval with first deformation. The dating of garnet has not been possible in this area as no definite inclusion trails has been noticed.

Neo-mineralisation during second deformation is evident from alignment of inequant quartz grains and flakes of sericite-muscovite and chlorite along fracture/crenulation cleavage.

Retrogression is common all through this area as indicated by alteration of garnet and biotite to chlorite throughout this region. There is no particular zone along which such retrogression is more prominent than in other regions. This retrogression cannot be tied to any deformation episode.