CHAPTER-V

THE SHILLONG GROUP OF ROCKS

5.1 Introduction

The Precambrian Gneissic Complex of the Shillong Plateau is unconformably overline by the Proterozoic Shillong Group of rocks (metasediments), which have suffered low grade metamorphism. The group contains the rocks like quartzites, metapelites and conglomerates. The metapelites can be classified as phyllite and mica-schist. The dominant rock type of the area is the quartzite. The quartzite occurs in well foliated layers (0.3m to 2m thick) and interlaminated metapelites showing repetition of strata in northwestern part (western limb of the synform) of the area. In the southeastern part (eastern limb of the synform) of the area the quartzites are interlaminated with phyllites and conglomerates. Two intraformatoinal conglomerate horizons are observed interbedded with quartzites.

5.2 Quartzites

5.2.1 Megascopic characters

Megascopically quartzites are mostly light dirty to grey in colour and fine to medium grained in nature. They are hard and compact. But they are friable when weathered. Quartzites are of two verities. One is pure quartzite and the other variety is micaceous quartzite. Micaceous variety is dirty grey to brown in colour with minute flakes of muscovite. The brown colour is mainly due to the iron minerals percolating along the foliation and joints plane of the rock.

The quartzites are well bedded and they are mostly characterized by current beddings and ripple marks. The quartzites, near to intrusive bodies, are very hard and compact. The trends of the foliation are NE-SW and dips to the SE or NW.

5.2.2 Microscopic characters

Thin section study reveals that the most abundant constituent mineral is quartz dominating upto 80-90% of the rock (Table-5.1).The chief constituent mineral of the quartzite is quartz.

Quartz : It is the dominant mineral of the rock. The quartz grains are present in varying sizes. The size varies from fine to medium, only few grains are coarse. The grains are granoblastic to xenoblastic in nature. However, nearer to the intrusive bodies the quartz grains are subidioblastic with partially developed faces and showing sutured margins (Fig-5.1a, Photo-5.1a) and interlocking quartz grain (Photo-5.1b). Sometimes, the quartz is idioblastic with the development of the triple prints (Photo-5.1c). In micaceous quartzites quartz grains are more or less elongated and arranged in a linear order due to recrystallisation and quartzites grade into quartz schist (Fig-5.1b, Photo-5.1d).

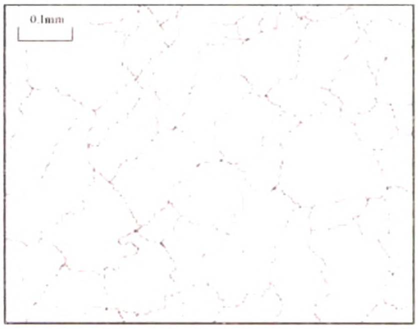

Fig 5.1a Quartz grains showing sutured margin in quartzite. Locality- Puriang.

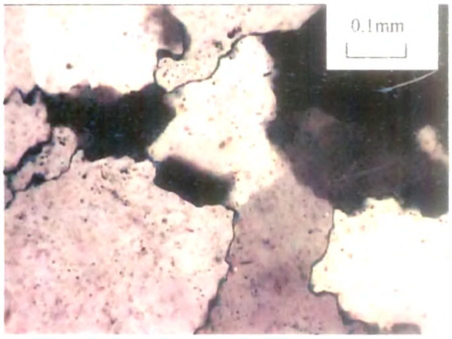

Photo-5.1a: Sutured contact between quartz grains in quartzites cross polars x10 (Locality: Puriang

Quartz grains are colourless to dusty in appearance. The dusty appearance is due to the presence of fine opaque inclusions that occur irregularly in the quartz grains. Some quartz grains developed a secondary growth and forms a clear rim around the periphery of the original grains (Photo-5.2a). Inclusion of muscovite and sericite are often observed through fractures (Photo-5.2b).

The first order grey interference colour, uniaxial positive figure and wavy extinction shown by the grains are the important distinguishing characters of the mineral. The quartz grains constitute more than 85% of the rock volume.

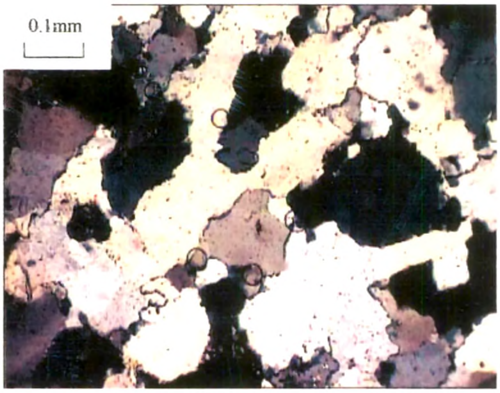

Photo-5.1b: Interlocking quartz grains in quartzites, cross polars x10 (Locality: - Puriang)

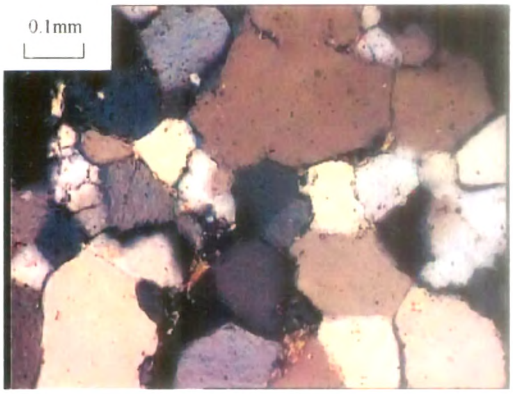

Photo-5.1c: Well recrystallized quartz grains with straight grain boundaries meeting in triple points in quartzites, cross polars x10 (Locality: - Puriang)

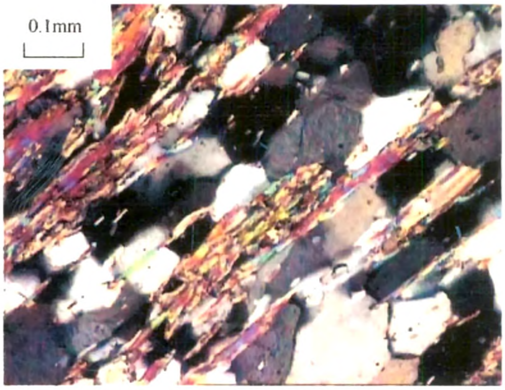

Photo-5.1d: Quartz, muscovite and sericite in parallel order in micaceous quartzites, cross polars x10 (Locality: - Ksehpongdeng)

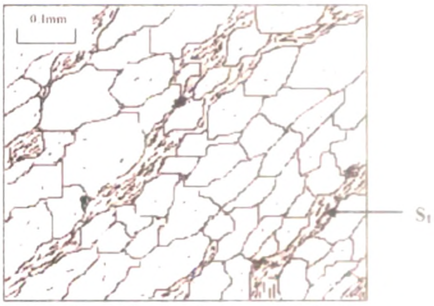

Fig.5.1b Elongated grains of quartz arranged in linear order and parallel to foliation (S_1) in micaceous quartzite (quartz schist) Locality- Ksehpongdeng

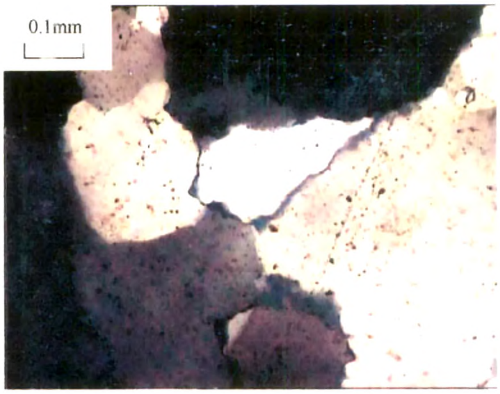

Photo-5.2a: Secondary groeth of quartz in quartzites, forming a rim around the periphery of the original grain, cross polars x10 (Locality: - Puriang)

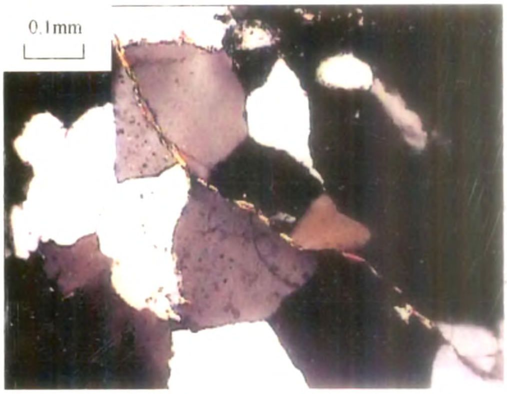

Photo-5.2b: Inclusion of muscovite and sericite through fracture in quartzites of Shillong Group, cross polars x10 (Locality: - Puriang)

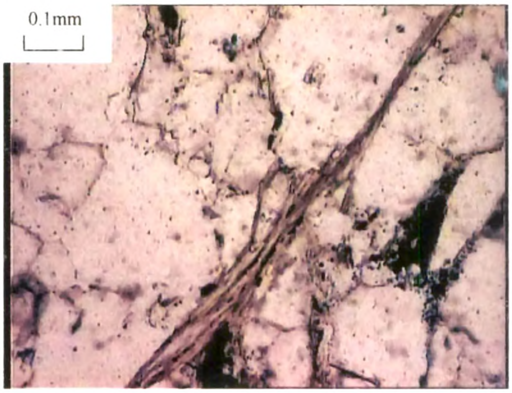

Photo-5.2c: Magnetite, muscovite and sericite as cementing material in quartzites, under polarised x10 (Locality: - Shormo)

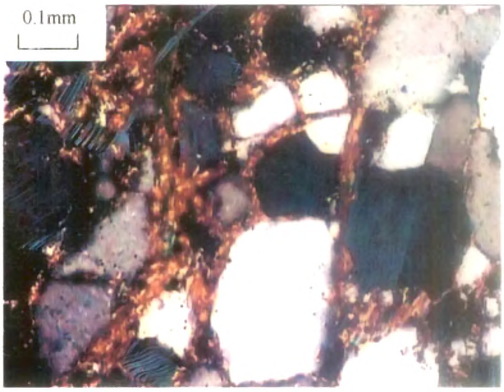

Photo-5.2d: Xenoblastic quartz floating on a sericite matrix in micaceous quartzites, cross polars x10 (Locality: - Thangshalai)

Sericite : They occur in the interspaces between quartz grains. Most of them are found in scaly aggregate and also often in minute flakes. Usually they are colourless and show higher order interference colour. The percentage of sericite is less on the quartzites occurring near the intrusive body.

Muscovite: Muscovites occupying interspaces between quartz grains. They era small tabular colourless grains and show high order interference colour. The grains have low relief and low refractive index. The extinction is straight.

They are usually surrounded by sericite and found to have developed by transformation of sericite

Magnetite : Magnetite occurs as inclusion in quartz grains as well as cementing materials (Photo-5.2c). They are opaque and show metallic lusture in reflected light. It is frequently altered to haematite which is reddish brown in reflected light.

Haematite : It occurs as thin flakes with yellowish brown colour and as opaque grains and occurs in the interstices of the quartz grains. It is at places as altered product of magnetite.

Zircon: Zizcon is colourless to pale brown and appears as minute oval shaped inclusions in the quartz. It shows high order interference colour and straight extinction.

5.2.3 Texture

Quartzites are essentially fine to medium grained rock and show much textural variations especially in the mode of interlocking of the quartz grains, grain size and shape. The rock shows a xenoblastic texture in which the quartz grains are generally fine to medium grained and lying apart from each other and the intergranular space being filled up by fine grained sericite (Photo-5.2d). Sericite and muscovite rich quartzites are foliated and defined by the orientation of the lenticular quartz and flkes of muscovite and sericite in parallel order (Fig-5.1b, Photo-5.1d).

However, nearer to the intrusive bodies the quartzites show a granoblastic texture consisting of quartz grains with rather straight grain boundaries with the development of the triple prints (Fig-5.1c, Photo-5.1c). The size of the quartz grains are larger than the others and many quartz grains are strained which show pressure lamellae

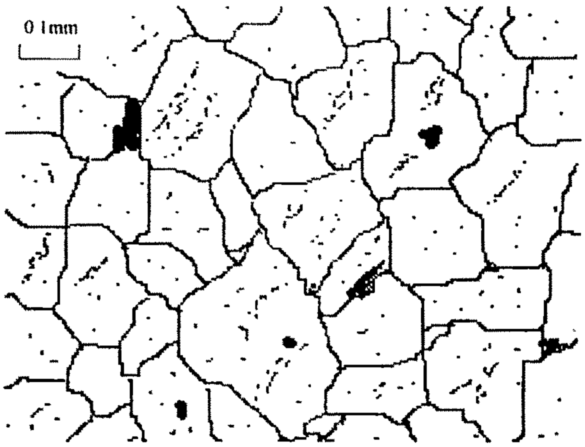

Fig.5.1c Well recrystallized quartz grains of quartzite of the Shillong Group Locality- Ksehpongdeng.

5.2.4 Model analysis of quartzites

The percentages (by volume) of the individual minerals are obtained and the variations in mineralogical composition are studied in the mineral assemblages of quartzites. The following classes can be recognized from the study.

Quartz: Clear, colourless unit grains, shows low relief and low birefringence.

Matrix: These include aggregate grain of micaceous minerals and clay minerals are included in this group.

Others: These include iron oxides and other heavy minerals.

Results : The average percentages of quartz, matrix and others of the different localities are shown in the table-5.1. The percentage of quartz varies from 80.76% to 93 40%, matrix varies from 5 12% to 16.60% and others (iron oxides and heavy mineral) vary from 1.30% to 2.64% (Table-5 1) Quartz percentage is highest in Puriang (field spot) and lowest in Shormo (field spot), where the percentage of matrix is highest in Shormo and lowest in Puriang.

Table 5.1 Model composition of quartzites of the area vol.%

	Thangshalai	Ksehpongdeng	Shormo	Puriang
Quartz	90.40	87.40	80.76	93.40
Matrix	8.20	10.50	16.60	5.12
Others	1.30	2.10	2.64	1.48
Total	100.00	100.00	100.00	100.00

5.3 Metapelites

5.3.1 Phyllites

5.3.1.1 Megascopic characters

Phyllites are soft and friable rocks which are easily breakable. They are easily getting weathered and get mixed with soil. The soapy feel and shining surfaces are the important megascopic character of the rock. Cleavage and schistosity are well developed in phyllite and the parallel arrangements of the flaky minerals are well observed. Phyllites are seen greenish to grayish in colour and sometimes brownish. These phyllites are characterized by very fine grained texture. Phyllites are generally interbanded with quartzites in the area.

5.3.1.2 Microscopic characters

The rock is essentially composed of sericite, chlorite, muscovite, quartz Magnetite and zircon occurs as accessory minerals.

Sericite: It occurs as scally aggregates and also often in minute flakes. Sericites are shining and feebly pleochroic. The fibrous aggregates show a cloudy appearance. The flow of the sericitic minerals along the grain boundaries of quartz which act as rigid body, mark the foliation of the rock. The flakes show cleavage and characterized by high order interference colour.

Chlorite: It is flaky in habit with high relief and refractive index. It is green in colour and strongly pleochroic from green to yellowish green. The mineral shows high order interference colour. The extinction is straight.

Muscovite: Some of the grains are flaky and often are tabular in habit. The flakes show planner arrangement. Grains are colourless and show high order interference colour. One set of cleavage is present and is characterized by straight extinction.

Quartz: Grains occur as xenoblasts with low relief and refractive index. They are fine grained and associated with sericite and muscovite. They are colourless with grey interference colour. Grains are usually medium to fine grained with curved to straight grain boundaries and varying amount of elongation.

Magnetite: It is a dark coloured mineral. The mineral usually occurs as xenoblast as well as inclusions in quartz. It also occurs as small grain along and across the border and cleavage of sericite and chlorite. The later variety of magnetite may be the altered product of sericite and chlorite. The mineral is opaque. It shows metallic lusture under reflected light.

Zircon: A few zircon grains are observed. Zircon is colourless to pale brown and appears as minute oval shaped inclusions in the quartz. It shows high order interference colour and straight extinction.

Pyrite: It is brassy yellow in colour. The mineral is opaque. It shows metallic lusture under reflected light. It occurs as cubic to skeletal at places (Photo-5.3a).

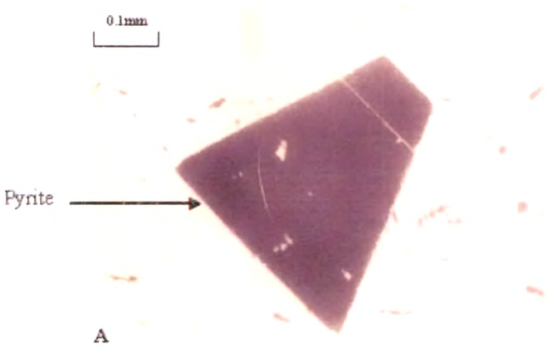

Photo 5.3a. Pyrite crystal in phyllites of the Shillong Group, under polarized X40 (Locality- Mawryngkneng)

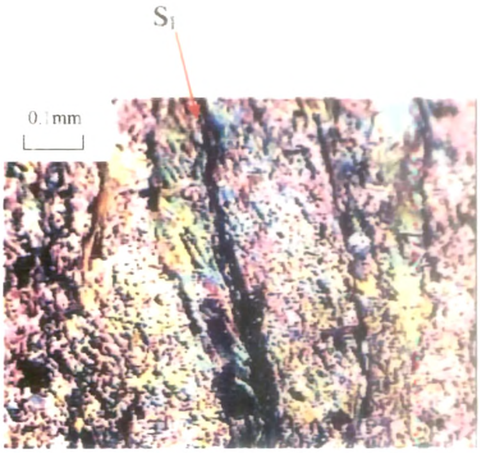

Photo 5.3b. Parallel arrangement of muscovite, sericite chlorite and quartz grains in phyllites of Shillong Group, cross polars X5(Locality-Ksehpongdeng)

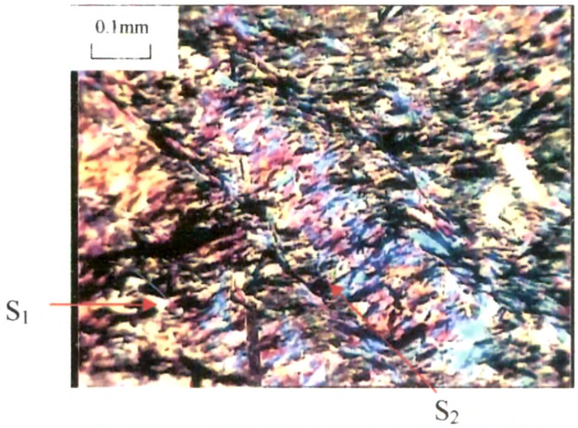

Photo 5.3c. Crenulation cleavage developed in phyllites of the Shillong Group, under polarized X5 (Locality- Ksehpongdeng road)

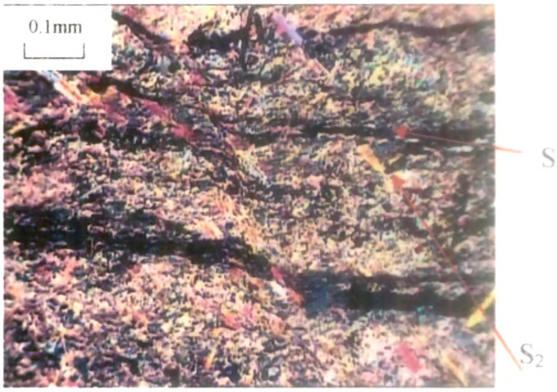

Photo 5.3d. Development of dissecting cleavage S_2 at high angle to dominant foliation in phyllites, cross polars X5 (Locality- Ksehpongdeng road)

5.3.1.3 *Texture*

The rock is fine grained. It shows schistosity due to parallel arrangement of muscovite, sericite and chlorite. Lenticular quartz grains are often arranged parallel to the mica flakes (Fig-5.2a, Photo-5.3b). Crenulation cleavages are developed due to effects of stress on the schistosity of the rock and forms (S_2) cleavage intersecting (S_1) foliation at a very high angle (Fig-5.2b, Photo-5.3c, Photo-5.3d). The schistosity surface shows a shining character given off by the lusture of the muscovite, sericite and chlorite. Quartz veins through the phyllites parallel to the schistosity (S_1) are composed of well recrystallized quartz grains (Fig-5.2c, Photo-5.4a).

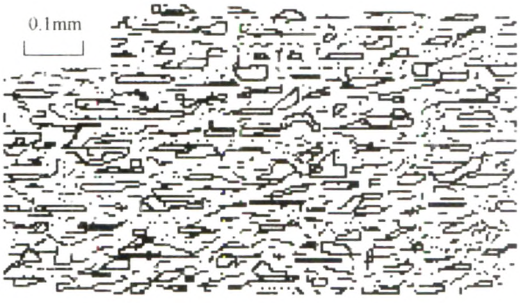

Fig.5.2a Development of phyllite structure with dominant foliation (S_1) in metapelite of the Shillong Group. Locality- Pamlyer.

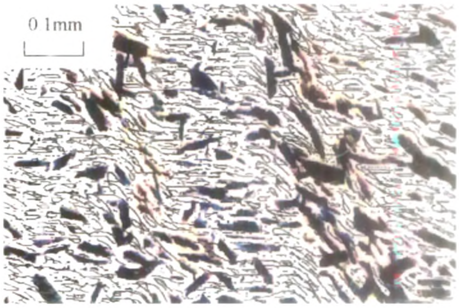

Fig.5.2b Crenulation cleavage developed in the metapelites of the Shillong Group, manifesting foliation (S_2). Locality- Ksehpongdeng road

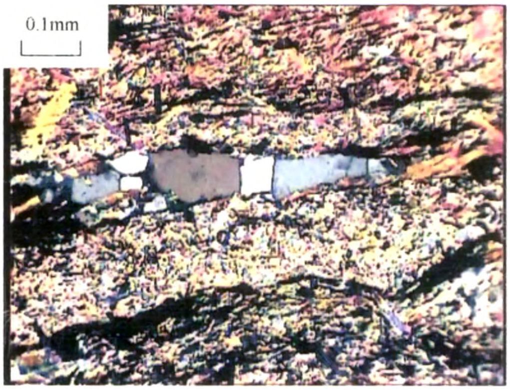

Photo 5.4a. Quartz vein along the foliation in phyllites of the Shillong Group, under polarized X5(Locality- Shormo)

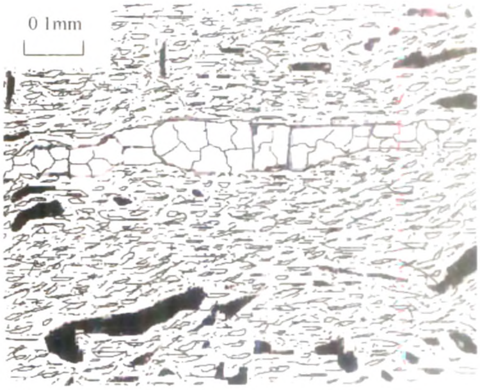

Fig. 5.2c Quartz vein through phyllite, parallel to schistosity (S_1). Locality- Shormo.

5.3.2 Mica- schist

5.3.2.1 Megascopic characters

Mica-schist present in the area are seen grey to brown in colour and fine grained in nature. It is composed mostly of quartz and muscovite. Quartz grains are of variable in size and muscovites are in flakes. The flaky minerals show perfect alignment and schistose structure. Grains are generally found interbanded with quartzite in the area. The rock is schistose and weathering action imparts a reddish colour on the surface of the rock.

5.3.2.2 Microscopic characters

The rock is composed of muscovite, quartz, biotite with minor sericite, chlorite and magnetite.

Muscovite: It occurs as flakes with low relief and low refractive index. The mica flakes show preferred orientation. They show the foliation and mark parallelism with the other flaky minerals. One set of perfect cleavage is observed. The grains are colourless with high order interference colour. The extinction is straight.

Quartz: Quartz occurs as xenoblast with low relief and low refractive index. The grains are colourless and show first order grey interference colour. The grains show weavy extinction. Inclusion of apatite and zircon are observed. Few grains show pressure lamellae. Flattened grains of quartz show preferred orientation defining foliation along with the other flaky minerals.

Biotite: Biotite occurs as fine prisms along with sericite-muscovite and quartz paralleling the schistosity. They are fine to medium grained and colour is yellowish brown and shows a pleochroic scheme x=yellowish brown y=z=dark brown to greenish brown. The extinction is straight.

Sericite: They occur as fine scaly aggregates in the intergranular spaces of quartz. They are generally cloudy in appearance and usually show anomalous interference colour. It occurs as alteration product of muscovite.

Chlorite: Chlorite is present in minor amounts along with sericite. It also occurs as alteration product of associated biotite.

Magnetite: This is dark coloured mineral. It also occurs as small grain along and across the border and cleavage of sericite and chlorite. The mineral is opaque. It shows metallic lusture under reflected light.

5.3.2.3 Texture

The texture is characterized by relative coarseness of the constituent mineral than phyllites. Well developed schistosity is shown by parallel arrangement of muscovite, sericite and elongated quartz (Photo-5.4b). The quartz grains possess well developed faces which sometimes meet in triple points indicating high degree of recrystallization of the constituent mineral (Photo-5.4c). Some mica schists have a tendency to segregate into bands rich in quartz in one band and muscovite, sericite and chlorite on the other band (Photo-5.4d).

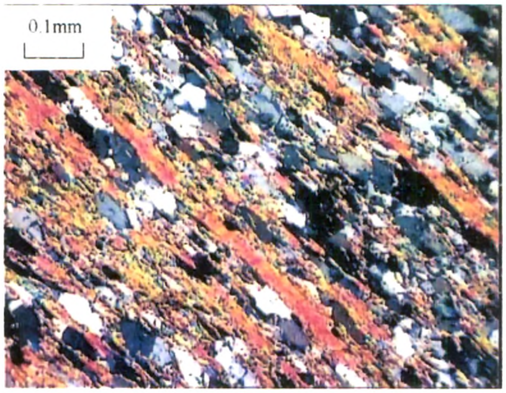

Photo5.4b. Schistosity S_1 due to parallel arrangement of muscovite, sericite and quartz in mica schist, cross polars X5(Locality- Thangshalai)

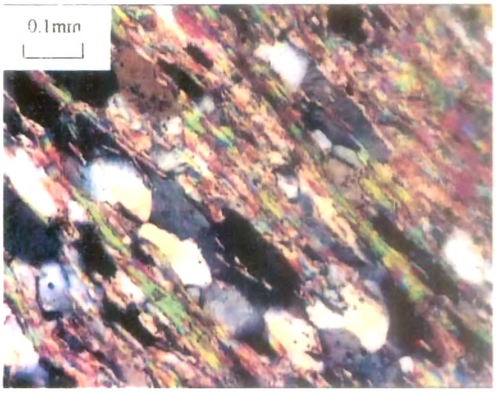

Photo 5.4c. Smooth grain boundaries meet in triple point due to recrystsllisation of quartz in mica schist, cross polars X10 (Locality- Puriang)

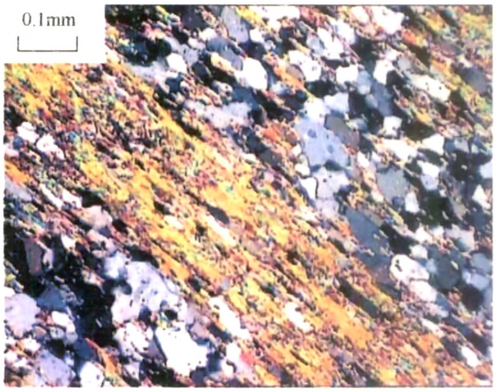

Photo5.4d. Alternate layers of quartz and mica in mica schist to form dominant foliation S_1, cross polars X5 (Locality- Ksehpongdeng)

5.3.3 Petrochemistry of metapelites

The analytical data of metapelites is given in Table-5.2. The presentation of the diagrams is based on bulk chemical composition of the metapelites. Total four samples have been chemically analysed.

From the chemical data ACF values are calculated and represented in Fig-5.3(after Fyfe *et al.*, 1958) and three samples fall in the pelitic field while one in the magnesian field (Fig-5.3).

In the trianglular Al_2O_3 – CaO – (FeO+MgO) diagram (Fig-5.4) all the samples fall close to the field of siliceous shale.

The plot of the Niggli values (al – alk) versus c values (after Leake, 1964) show that all the metapelites fall in the field of shale (Fig-5.5).

The plot of (al – alk) against c values in the variation diagram (after Leake, 1964) shows the all samples fall in the pelitic field (Fig-5.6).

In the 100 mg - c - (al-alk) plot (after Leake, 1964) all the samples fall in the pelitic field and away from the Karroo Dolerite trend (Fig-5.7).

The mg versus c diagram demarcates clearly the position of pelites, limestone, dolomitic limestone, dolomites and basic rocks. The plot of Niggli c against mg of the analysed metapelites fall in the pelitic, semi pelitic field below the igneous trend (Fig.5.8).

Table 5 2: Major element composition for the metapelites of the area (wt %)

Major Oxides	SP-01	SP-02	SP-03	SP-04	Average
SiO_2	64.61	65.51	63.68	74.45	67.06
TiO_2	1.16	1.22	1.08	0.57	0.88
Al_2O_3	16.64	16.75	18.14	13.16	16.17
Fe_2O_3	4.16	3.40	4.28	1.67	3.37
FeO	5.13	4.56	6.03	3.02	4.68
MnO	0.01	0.06	0.01	0.08	0.04
MgO	1.21	1.12	0.79	0.89	1.00
CaO	0.09	0.08	0.09	0.74	0.25
Na_2O	0.70	0.82	0.57	2.57	1.16
K_2O	6.21	6.41	5.31	2.81	5.18
P_2O_5	0.08	0.07	0.02	0.04	0.05

Niggli Values

al	47.50	48.68	51.34	46.57	48.52
fm	29.47	26.97	29.45	23.46	27.33
c	0.58	0.30	0.46	4.69	1.50
alk	22.44	24.05	18.75	25.27	22.62
si	313.28	323.58	305.45	447.00	347.32
k	0.34	0.35	0.31	0.87	0.46
mg	0.29	0.30	0.20	0.34	0.28
qz	123.52	127.38	130.45	245.92	156.81

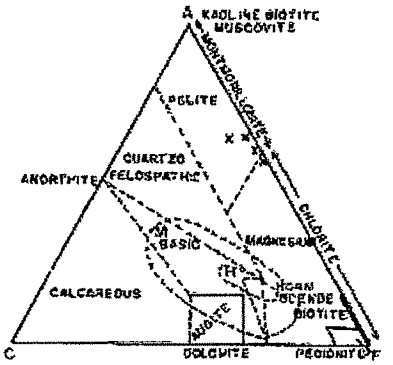

Fig.5.3 Plots of ACF values of metapelite on the triangular diagram after Kyfe *et al.1958.*

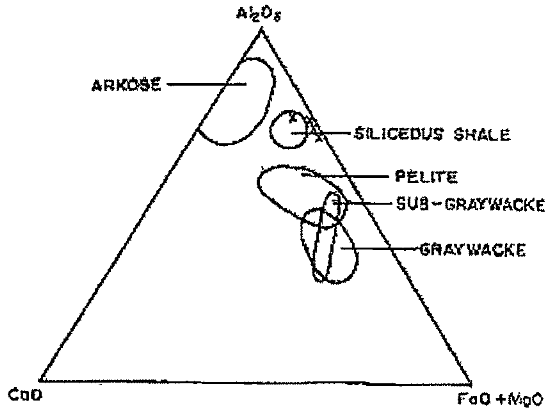

Fig.5.4 Al_2O_3-CaO-(FeO+MgO) triangular diagram (after Rao *et al.*, 1974) for the analyzed metapelites.

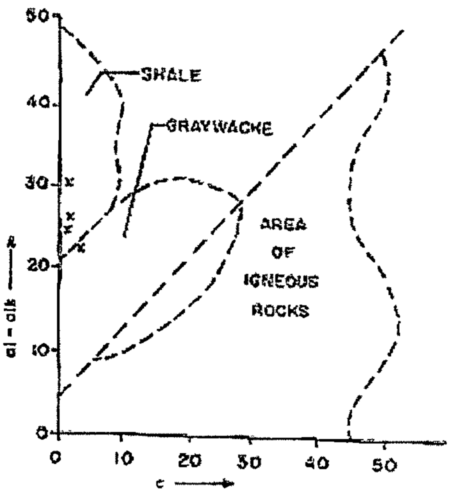

Fig.5.5 Plots of analyzed metapelites in Niggli c vursus (al-alk) diagram (after Leake, 1964).

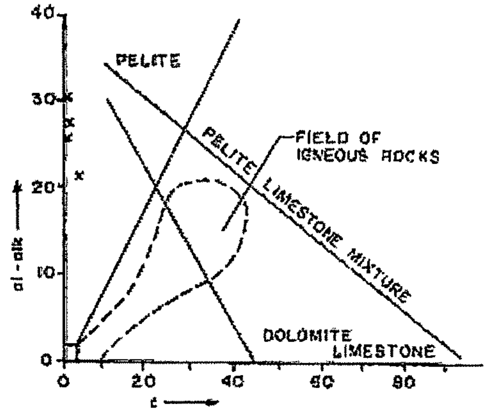

Fig.5.6 Plots of Niggli c against (al-alk) for the analyzed metapelites (after Evans andLeake, 1960). The approximate field of composition of Karroo Dolerites superimposed for comparison

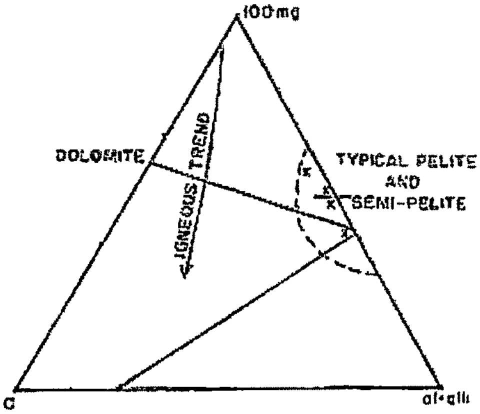

Fig.5.7 100mg - c - (al-alk) triangular diagram (after Leake, 1964) for the analyzed metapelites.

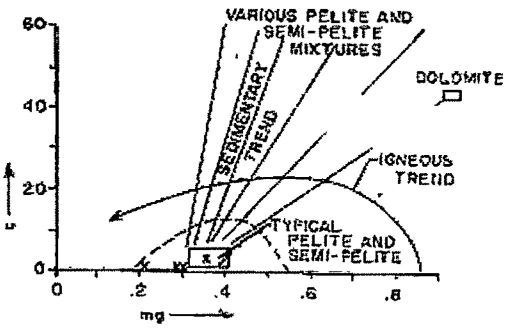

Fig.5.8 Plots of Niggli mg against c (after Leake, 1964) for the analysed metapelites.

Discussion

The above geochemical study together with the field, mineralogical and textural studies firmly establishes that metapelites are derivatives of sedimentary origin. The low value of Na_2O and higher K_2O concentration show affinity towards sedimentary parentage of the metapelite From the Niggli values (al-alk) versus c plots (after Leake, 1964) the sedimentary parentage is clear as all the samples plot clearly outside the igneous field. Affinity towards pelitic composition is also confirmed by the plots of (al-alk) against c, c against mg and mg - c – (al – alk) diagrams. The Al_2O_3 – CaO – (FeO+MgO) trianglular diagram (after Rao *et al.*, 1974) indicates the rock is shaly and rich in alumina.

5.4 Conglomerate

Two conglomerate horizons are met within the present study area and these are Lulung conglomerate and Mawryngkneng conglomerate. These conglomerates horizons form conformable litho-units in the quartzites and metapelites of the Shillong Group of rocks indicating no stratigraphic break and hence are intraformational conglomerate and are found interbanded with quartzite. Both the conglomerates occur at the eastern limb of the synform and the strike of the foliation NE-SW direction with dip 50^0 to 85^0 towards NW direction.

Lulung conglomerate is 4km away from Mawryngkneng police outpost towards Jowai. The thickness of this bed is about 100m. The conglomerate beds are composed mostly of quartz and quartzite pebbles (Photo-5.5a). The pebbles are mostly flat and rarely spherical.

Photo 5.5a. Quartz and quartzite pebbles in conglomerate bed of Shillong Group (Locality- Lulung)

The average thickness of the Mawryngkneng conglomerate is about 4 meters and strikes in the NE-SW direction and dipping 55^0-85^0 towards NW. The pebble bed are mostly of quartz and quartzites. The range of the length of long axis of pebbles varies from 0.5cm to 4cm. In both beds the pebbles are highly cemented, so they become hard and difficult to break by hammer. The long axes of pebbles are parallel and sub-parallel to the strikes of the beds. Mawryngkneng conglomerate shows alternating layers of conglomerate and quartzite.

5.4.1 Megascopic characters

The pebbles of the conglomerate are elliptical; have their longest axis being almost parallel to the strike of the bed. The pebbles of the bed are mostly quartz and quartzite. The pebbles are flattened and elongated into ellipsoid with axes of x,y and z (x>y>z) exhibiting distinct lineation and schistosity developed along the direction of pebbles lineation.

The matrix of the Lulung conglomerate is mostly siliceous with minor amount of micaceous mineral. It is made up of coarse quartz grains, white to grayish-white in colour and friable. The amoumt of micaceous minerals increases in the Mawryngkneng conglomerate with respect to Lulung conglomerate. The rocks are found to be clast-supported rather than matrix-supported.

5.4.2 Microscopic characters

It contains a framework of quartz and quartzitic pebbles in a arenaceous matrix containing mainly quartz and small amount of muscovite and sericite.

Pebble: Polycrystalline quartzs and quartzites pebbles are found in an arenaceous matrix (Fig-5.9a, Photo-5.5b). Quartz pebbles are coarse grained while quartz matrix are fine grained (Fig-5.9a, Photo-5.5b). Most of the grains of pebbles have sutured contacts but development of fairly straight margins and sometimes inclusion of minor micaceous mineral along the grain boundaries are observed (Photo-5.5c). However, straight margins of quartz grains in the pebbles are also observed with triple points (Photo-5.6a). Along the fracture of the quartz pebbles, inclusions of muscovite and sericite minerals are observed (Photo-5.6b). It indicates the multi phase deformation of conglomerates. Sometimes inclusion in the quartz by minute needles of muscovite is found in the pebbles of conglomerates (Fig-5.9b, Photo-5.6c).

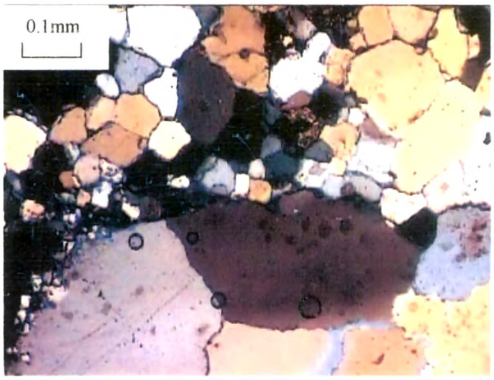

Photo 5.5b. Polycrystalline quartz pebbles in arenaceous matrix of quartz and amall amount of micaceous mineral, cross polars X5(Locality-Lulung)

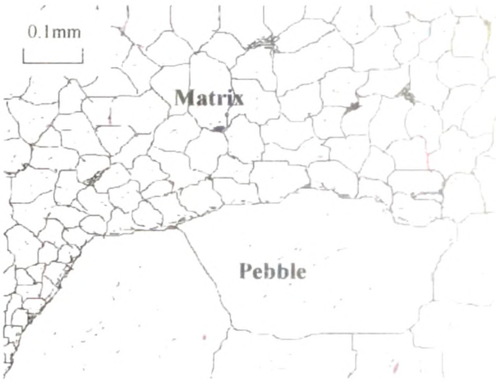

Fig.5.9a Recrystallized quartz grains making up pebble are set in an arenaceous quartz matrix. Locality- Lulung.

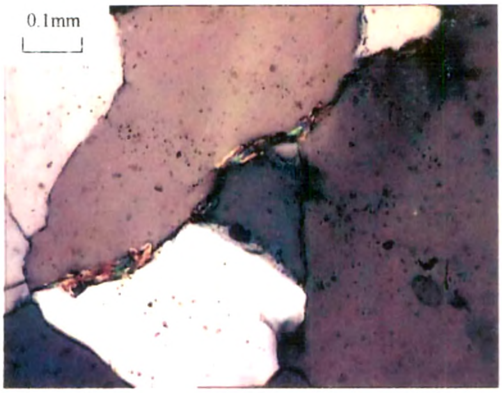

Photo5.5c. Inclusion of micaceous mineral along the grain boundaries of pebbles, cross polars X10 (Locality- Lulung)

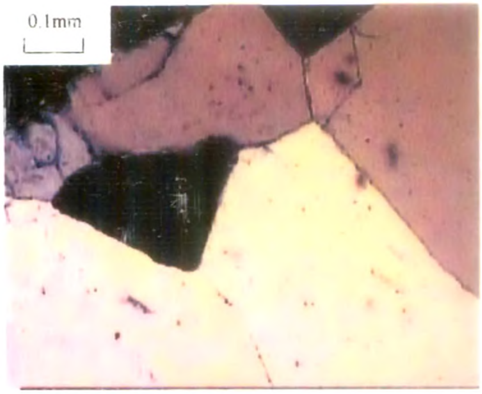

Photo5.6a. Smooth grain boundaries of quartz in the pebbles of the conglomerate of Shillong Group, cross polars x10 (Locality- Mawryngkneng)

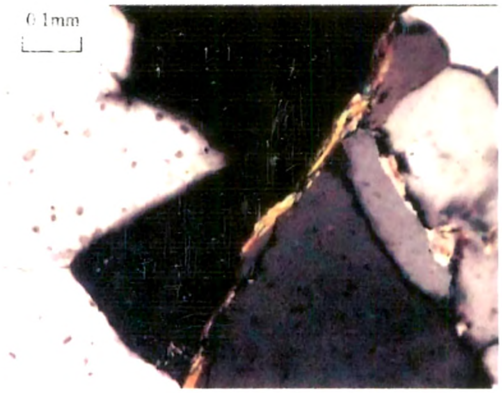

Photo 5.6b Fracture developed in pebbles of the conglomerates, cross polars X10(Locality- Lulung)

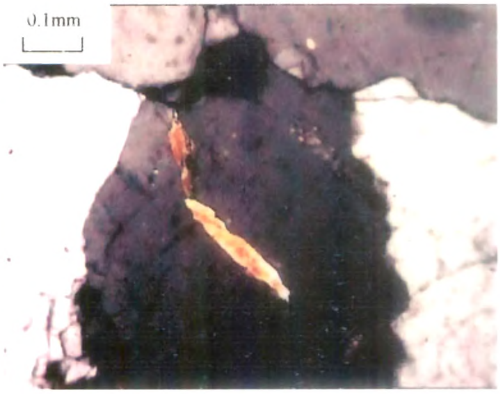

Photo 5.6c . Inclusion of muscovite needle into the quartz grain of the pebbles of conglomerate of Shillong Group, cross polars X10 (Locality-Lulung)

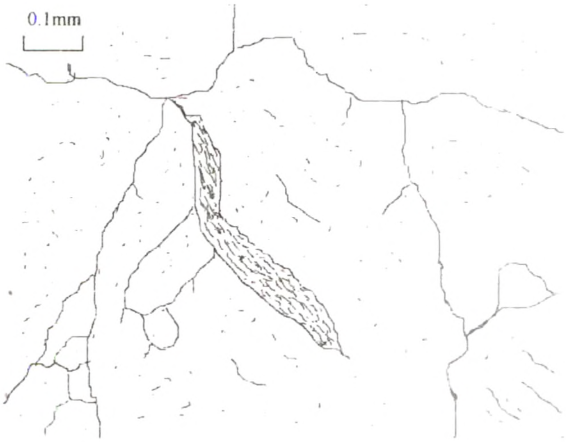

Fig.5.9b Inclusion of muscovite needle into the fracture of quartz grain of pebble in conglomerate. Locality- Lulung.

Matrix: Quartz and mica form the essential components of the matrix of the conglomerates. In the matrix amoumt of micaceous mineral are increases in the Mawryngkneng conglomerate with respect to Lulung conglomerate (Fig-5.9c, Photo5.6d and Photo-5.7a). Quartz in the matrix is highly fractured showing the evidence of multi-deformational phases (Photo-5.7b). Muscovite occurs as fibrous aggregate with minute flakes and shads of sericite in the interstices between the quartz grains of the matrix (Photo-5.7c). However, straight margins of quartz grains in the matrix are very common, meeting in triple points. Strain shadows are observed in some of the quartz belonging to the matrix; quartz of the pebbles are clear (Photo-5.7d). Iron oxides are found as small irregular dark linear patches mostly in the matrix.

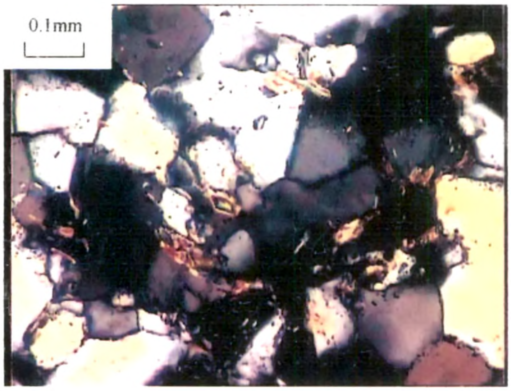

Photo 5.6d Siliceous matrix in Lulung conglomerate with minor amount of micaceous mineral, cross polars X10 (Locality- Lulung)

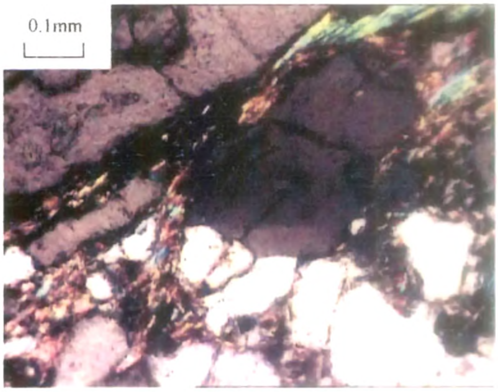

Photo 5.7a Micaceous matrix in Mawryngkneng conglomerate with fragment of quartz, cross polars x10 (Locality-Mawryngkneng)

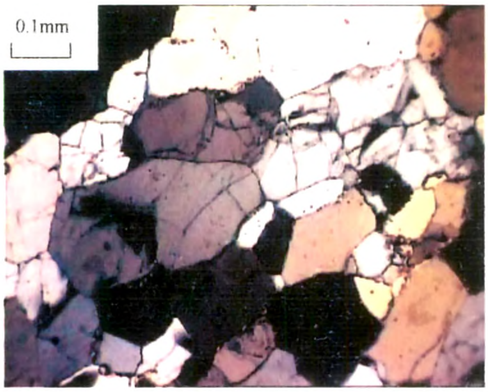

Photo 5.7b Highly fractured quartz grain in the matrix of the Lulung conglomerate, cross polars X10(Locality- Lulung)

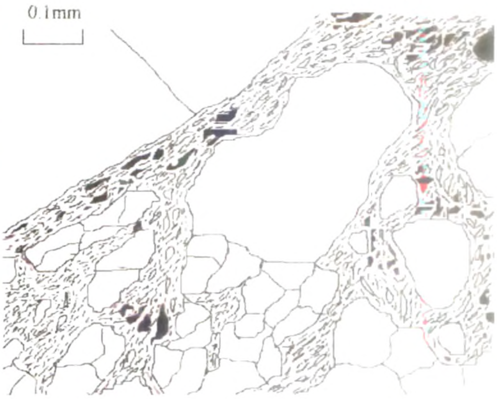

Fig.5.9c Pebbles of conglomerate set in a micaceous matrix. Locality- Mawryngkneng.

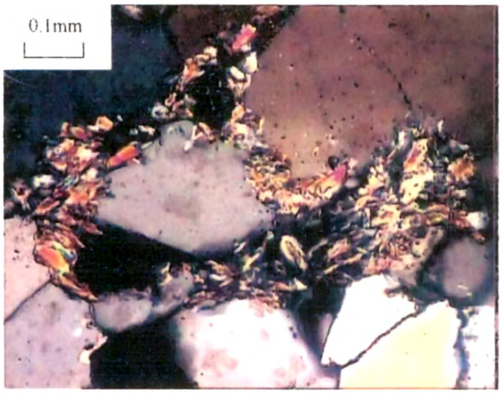

Photo.5.7c . .Fibrous aggregate of muscovite mineral with fractured quartz grain in the matrix of conglomerate, cross polars X10 (Locality-Mawryngkneng)

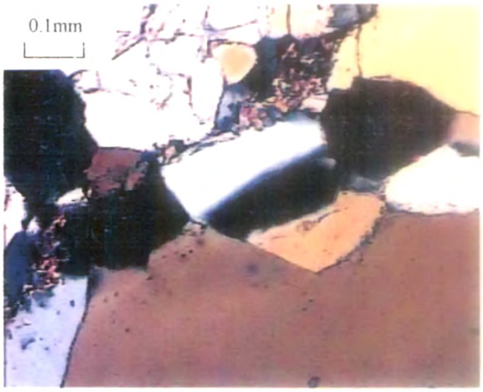

Photo.5.7d Strain shadow developed in quartz grain of the matrix of the Lulung conglomerate, cross polars X10 (Locality- Lulung)

5.4.3 Texture

Conglomerate is oligomictic in character with quartz pebbles enclosed in an aggregate of small quartz along with muscovite, sericite and iron oxides. At places the conglomerate is polymictic with pebbles of quartzite and vein quartz dominating the pebble concentration. The micaceous matrix makes the appearance of the rock semi-pelitic where rough cleavage is observed. Concentration of small needle and minute prisms of muscovite at the pebble margins and between the quartz grains as linear trails maintaining a parallelism of their long dimension giving some short of foliated appearance to the matrix. Both the pebbles and the matrix show good recrystallization. Th quartz making up the pebbles is completely interlocking, coarse, xenoblastic to subidioblastic grains with sutured contacts. However, the quartz making up the matrix is fine grained with straight margins, very often meeting in triple point.

5.5 Metamorphism of the Shillong Group of rocks

The quartzite is the dominant rock of the study area. The metapelites and conglomerate are found as interlaminated layers. Petrographic, textural and mineral transformation relationship indicates that the rock of Shillong Group of the study area had undergone regional metamorphism belonging to greenschist to amphibolite facies.

5.5.1 Quartzites

Quartzites are mostly composed of xenoblastic quartz embedded in a matrix of sericite, muscovite with minor amount of iron oxides. The quartz grains in sericite matrix, thus showing a granulose texture. The original clastic nature is still preserved and the original clayey matrix is transformed into a fine scaly aggregate of sericite and muscovite.

Nearer to the contact of the granite and amphibolite the quartzites of the study area show increasing degree of recrystallization. This is indicated by the development of secondary quartz grains, a general coarsening of quartz grains, transformation from xenoblastic to subidioblastic quartz and reducing sericite matrix by increasing muscovite matrix. The subidioblastic quartz are mutually interlocking. Sometimes it has muscovite matrix between the intergranular space. The interlocking quartz grains show the development of straight margins which met in triple points.

The mineral assemblages of the quartzite is :
Quartz +chlorite + muscovite+ iron oxides.

Quartz + muscovite + chlorite + epidote +iron oxides.

5.5.2 Metapelites

The mineral assemblages observed in metapelites reflect that they are product of low grade regional metamorphism of originally argillaceous sediments. Due to regional metamorphism, recrystallization of original pelitic rocks giving rise to fine aggregates of sericite, muscovite along with coarsening of original grains. Sometimes pyrite cubes are also developed in phyllites (Photo-5.3a). Schistosity is developed due to sub-parallel arrangement of the flaky minerals The development of crenulation cleavage bear witness to late strain imposed on the rocks in the area.

The development of small biotite prisms and needles in the schistosity plans alongwith muscovite, chlorite, quartz and potash-feldspar is indicative of typical low grade metamorphism (Winkler, 1974, p. 212). Dominance of muscovite and chlorite have indicate the pelitic rocks still belong to the greenschist facies of metamorphism.

The mineral assemblages observed in metapelite is :

Quartz +chlorite + muscovite/sericite +biotite+ iron oxides.

Quartz + chlorite + muscovite/ sericite+ epidote +iron oxides.

5.5.3 Conglomerate

The conglomerate was subjected to regional metamorphism and deformation due to which some of the pebbles were crushed or fractured. Later due to lateral compression the bed was compacted and the pebbles were elongated parallel to the bedding. Both the pebbles and matrix provide good indication to the degree of recrystallization of conglomerate. This is characterized by well developed quartz, absence of chlorite and the presence of muscovite and iron oxides. The quartz making up the pebbles are completely interlocking, coarse and subidioblastic grains with straight contact.

The mineral assemblage of the conglomerate is quartz + muscovite + iron oxides , which indicate low grade metamorphism (greenschist facies).

5.6 Origin of the Shillong Group of rocks

In metamorphosed and deformed formation, to ascertain the original nature of a rock is not a simple matter. Because, it is physically deformed, mineralogically recrystallized and chemically variable. However, field occurrence, mineral characters, texture, structure and geochemistry are considered to discuss the petrographic history of the rocks.

5.6.1 Conglomerates

The intra-formational conglomerate observed in the study area represents local break in deposition of sediments. The surfaces of the pebbles are smooth and lake of angularity. This indicates that the pebbles have undergone prolonged fluviatile transportation with high energy turbidity currents. The conglomerate was subjected to regional metamorphism and deformation due to which most of the pebbles were crushed or fractured .

5.6.2 Quartzites

Quartzite is the dominant rock in the area under investigation. They were derived from the sandstones deposited under shallow water condition. This is quite evident from the following factors:

i. It occurs as bed, like other beds of sedimentary formation covering many kilometers along and across.
ii. It is also very often interbedded with conglomerate and phyllites.
iii. Regular lithologic variation.
iv. The bedding are characterized by current bedding and ripple marks.
v. Presence of more than one planer and linear structures.
vi. It is composed of more than 80% of quartz.
vii. The original clayey matrix recrystallized into muscovite and sericite.

viii. Constituent quartz grains are subrounded and often elongated Nearer to the intrusive have greater degree of recrystallization and grains become coarser.

ix. Quartz grains are cemented by sericite and iron oxides, and are characterized by deformation lamellae.

In view of the above, it may be suggested that the quartzites of the area were deposited as sandstones and later due to deformation and regional metamorphism, thus became quartzite.

5.6.3 Metapelites

On the basis of field occurrence, mineral characters, texture, structure and geochemistry, the genesis of the metapelites are discussed as follows:

i. It occurs as bands covering many kilometers along and across.

ii. It is interlaminated with quartzites and conglomerate of sedimentary derivation.

iii. The schistosity planes marked by the flaky minerals.

iv. It is characterized by more than one planner and linear structures. Microfolds, brittle folds and kink bands are also present.

v. Under microscope metapelite shows crenulation cleavage.

vi. Molecular Al_2O_3 is in excess over $CaO + Na_2O + K_2O$.

vii. The metapelites fall in the sedimentary fields (Fig-5.4, Fig-5.5, Fig-5.6 and Fig-5.7).

viii. All metapelite samples plot away from igneous rock trends (Fig-5.7).

ix. Pelite and semi-pelite nature is indicated by the various Petrochemical plots of this rock.

In view of the above factors it is no doubt that the metapelite is sedimentary origin. It owes its origin to argillaceous sediments with sandstone and conglomerate. Due to regional metamorphism and deformation gave birth to metapelite. This is clearly indicated by the schistosity, marked by the flaky minerals like muscovite, sericite and chlorite, which are oriented along with the elongated quartz grains