CHAPTER - II Geological setting

II.1 Geological set up of the alkaline - carbonatite complex

The Samchampi - Samteran alkaline carbonatite complex occurring within the Precambrian gneissic rocks is almost circular in shape. The complex is represented by ijolite-melteigite, alkali pyroxenite suite of rocks, shonkinite, magnetite + apatite rock, syenites, alkali syenites, syenitic fenites, carbonatites, phonolite, tuff and phosphatic chert breccia.

The inner core of the complex is occupied by magnetite rock with or without apatite covering an area of approximately 1 Sq.Km. Similar outcrops are also found in a very limited extent in the southern and western part of the complex. (Fig 1). The outer rim of the complex is occupied by ultramafic suite of rocks in an arcuate shape which is not exposed in the southern part. The mafic - ultramafic rocks are closely associated with syenitic fenites and carbonatite.

Syenitic fenites occupy the major portion of the area, intimately associated with both alkali silicate and carbonatite and form a screen in the outer rim of the complex. However, small isolated outcrops of this rock noticed throughout the complex. Pyroxenites are smaller in dimensions often not mappable, show extensive intercalations with carbonatites and feldspar veins. Shonkinites, foidal
syenites and alkali syenites occur as late intrusives and as small bodies within the complex. The carbonatites are ubiquitous in the area and found in association with almost all the rock types. Isolated outcrops of partly fenitized granites are also noticed within the complex. Volcanic tuff noticed in the southwestern margin of the complex while the phonolite occurs in the northern boundary as very small isolated patches. Thus the Samchampi-Samteran Complex exhibit a wide variation of rock types in a very limited area. Similar alkaline-carbonatite association recorded at Sung Valley, Meghalaya (Krishnamurthy, 1985; Chattopadhyay and Hashimi, 1984). Two more such complexes have been recorded from Karbi Anglong district, Viz Jashra (Mamalan et al. 1994) and Barpung (Dutta et al. 1993-94)

II.2. Distribution and description of the litho units.

The area is under thick foliage and soil cover and only 20% of the total rock volume is exposed. Here the description of the rock units have not been strictly adhered to the order of abundance.

II.2.1. Magnetite-hematite+perovskite+apatite rock.

Circular and tabular bodies of this rock type is exposed in the central part of the complex as well as in the western and southern part. There are four such bodies mapped in the area. These are described as per their size and shape:
the largest body described first and smallest in the last.

A) The largest outcrop of this rock unit is exposed about 1 km NNE of Ganjang village. It is elliptical to semicircular in shape with exposed length of about 1000m and approximate width of 300m. It occurs in a small E-W trending ridge. Good exposures are found at the ridge crest.

B) At the vicinity of the Ganjang village, on the ridge crest, large boulders of magnetite-hematite rock are noticed. The length of the total bouldary outcrop is about 100m with average width of 10m.

C) In a tributary of Thedong nala just north of Ganjang village, an elliptical outcrop of this rock have been noted. The dimension is about 10m by 50m.

D) Large boulders of this rock noticed near East of Thulbung village at the new road cutting trending NNW-SSE. Similar rocks are also noticed to the west of Thulbung in a nala section.

In all these localities the magnetite rocks do not have strike continuity and are independent in their mode of occurrence. Due to thick soil cover in the area no direct contact relationship of this rock exists with the other members of the complex. However, alkali pyroxenite, pyroxenite, syenitic fenites and carbonatites occur in the vicinity of this rock.

Megascopically the rock is deep reddish brown in colour with white yellow patches occurring as spots (Plate 5).
The rock is very coarse grained, composed mostly of magnetite, hematite and little apatite. Perovskite is identified only under microscope. Limonitization is intense at places. White patches in the rock attributed to the apatite and at places earthy due to alteration. Magnetites are easily identifiable by magnetic property and the crystals attain the size up to 5cm in length.

II.2.2. Alkali pyroxenite-ijolite-melteigite suite:

This suite of rocks occur as arcuate shaped body in the northern periphery of the complex. It also occurs in the western and eastern part. However, exposures of much smaller dimensions are noticed in the central part also. In all these areas the suite is associated with the syenitic fenite and carbonatite. Good exposures of alkali pyroxenite have been observed along the northern margin, western part and in the eastern part of the complex. Small outcrops of pyroxenites are observed north of Ganjang and south of Samchampi.

Alkali pyroxenites occur as xenoliths within carbonatites and as schlierens in the syenitic fenites. In the carbonatites the length of xenoliths vary from 2cm as much as 30 cm (Plate 6 and 7).

The alkali pyroxenite is black to greenish black in colour (melanocratic), hard, compact, coarse grained and at places has nodular appearance. It consists of coarse pyroxenes with very little nepheline (identified from greasy
look) and little feldspar. Profuse development of phlogopites have been noticed due to the phlogopitization of pyroxenes. Phlogopites occur as clots at places. Alkali pyroxenites in association with ijolite melteigite exhibit a gradational relationship between them.

Ijolite- melteigite rocks are not only closely associated with the alkali pyroxenite but also with the carbonatite and often with syenitic fenite. These rocks are best exposed along a stream in the northern periphery following an E-W trend which swings to NNW-SSE direction near Samteran. The trend of this unit is NE-SW in the western part of the complex. Small exposures are also noticed as isolated outcrops. A good zone of ijolite - melteigite rock occurs in the nala section east of Samteran village. Fenitization is intense at places and veins of feldspars are noticed to engulf the rock. Besides, veins of carbonatite, dykes of alkali syenite, foidal syenite are seen to intrude into the ijolitic and alkali pyroxenite rocks.

Megascopically the melteigite is melanocratic and ijolite is mesocratic. In hand specimen stumpy pyroxenes and grey nepheline can be identified. Patches and clots of phlogopite are noticed in these rocks. Veins of calcite, potassium feldspars are commonly seen. The ijolite - melteigite and alkali pyroxenites are so intricately associated that they can not be mapped separately.
II.2.3. Carbonatite:

Carbonatites of varied dimensions occur in the area of study. These bodies vary in size from a few centimeter to as much as 5m wide and length from 1m to 100m. Best exposures of carbonatites are noticed along the stream that is flowing in the northern boundary and near Samteran, 1 km north and west of Ganjang. The carbonatites are trending in NW-SE, N-S, NE-SW and ENE-WSW directions.

Based on the physical characters, grain size variation and mineral composition, the carbonatites of the area are classified into four groups. However, these classifications do not corroborate with chemical analyses and are purely field terminology.

1. Milky white, medium to coarse grained with poor mafic banding.
2. Banded.
3. Intermediate between 1 and 2.
4. Fine grained brownish in colour.

The milky white, medium to coarse grained type (1) noticed near Samteran, north of .576 hill, near Ganjiang and at the western part. This variety is dirty brown or weathered surfaces. Though it is milky white, yet it contains patches of mafic minerals like phlogopite, biotite, pyroxene, olivine and mafic fragments. In the poorly preserved mafic bands the preferred orientation is marked by phlogopite.

The second type is seen along the stream in the
northern part, near Samteran and 1Km west of Ganjang village. The length of the outcrops vary between 2 and 30m and width between 1 and 1.5 m. In all these occurrences, profuse development of banding have been recorded. The individual lamellae are made up of magnetite, phlogopite, pyroxene, olivine and apatite which together form the darker bands, while the lighter bands are made up of calcite and dolomite. At places the darker or mafic bands are thicker than the lighter bands. The width of these bands (both lighter and darker) vary from a few millimeter to as much as 5 mm. At places these darker and lighter bands are diffused together and no banding observed (Plate 22). The third variety carbonatites are closely associated with the first and second types and gradational to each other. The fourth variety occurs as thin veins which cut across the carbonatites of first types and mafic- ultramafic rocks. The width of these veins do not exceed 5 mm. Such veins are dirty brown in colour and consists essentially of calcite.

II.2.4. Syenitic Fenite:

This is the most abundant rock type which constitutes about 70% of the total rocks exposed in the area. It is in general leucocratic and composed of feldspars and pyroxenes. Good exposures are seen at many places. A complete gradation from alkaline mafic to syenitic fenite has been noticed at a number of places particularly in a small stream 2 km NE of
Ganjang and near Samchampi. These gradations are generally associated where the alkaline mafics lie in close proximity with the carbonatites.

The field criteria upon which the syenitic fenites are identified are:

1) White leucocratic rock.

2) Presence of mafic schlierens and their arrangement in preferred orientation in syenitic background.

3) Abrupt coarsening of the feldspar grains in the syenitic mass in a single outcrop within a distance of few millimeters.

4) Presence of crude foliation and tight intrafolial folds in the rock possibly representing original structures.

5) At a number of places when the exfoliated surface of the syenitic mass is broken, an inner core of mafics have been noticed (? concretionary body).

6) Numerous aegirine and aegirine augite veins criss crossing the syenitic mass.

7) Heterogeneity in texture.

8) Shattering of the original fabric of the rock.

Keeping in view the above facts the syenitic fenites of the complex have been studied. In general the syenitic fenites are medium to coarse grained and show banding in places. The individual bands of lighter minerals do not exceed 3mm. However, mafic bands are common. The development
of mafic streaks and shattering of the fabric have been observed in the northern peripheral stream, SW and west of Samteran Village, where the mafic schlierens do not exceed 10 - 15 cm in length and crudely oriented. The larger mafic patches gradually grades into the streaks of pyroxenes in the rock. The exposures in the 1 km west of Ganjang village exhibit almost uniform grain size. Foliation is present and the rock is cut across by numerous aegirine veins. Near the contact with the country rocks and the carbonatite bodies a good zone of fenitized rocks are developed. Here, the rocks are very coarse grained and almost entirely composed of alkali feldspars. Excellent out crops of this rock units noticed north of Samteran and in the north western part of the complex. The rock is very hard, medium grained with the presence of gneissosity and relics first folds at places.

II.2.5. Foidal Syenite.

Small intrusive bodies of foidal syenites are found to the NE of Ganjang in a small hillock that trends NE-SW and south of Samteran village. The length varies from 10m to 20m and width from 1 m to 1.5m. The rock is light coloured with brownish stain on the surface, coarse grained and composed of potassium feldspars and alkali pyroxenes. Mesocratic variety is also found as small body in the northern peripheral stream and in the southeastern part of the complex. In the mesocratic variety the nepheline is identified by grease look and contain substantial amount of
pyroxenes besides alkali feldspar which is the main mineral phase.

II.2.6 Phonolite

A small exposure of this rock is found at Samcharpi Samteran foot track in between south of .876 hill and north of the northern peripheral stream. The exposure length is about 2m and width of 0.3m and seen amidst thick soil cover, therefore, its actual extent of exposure could not be ascertained. The rock is hard and dark green in colour, fine grained and porphyritic. The feldspar phenocrysts are set in a fine grained aphanitic groundmass.

II.2.7 Alkali Syenite.

Dykes of alkali syenite have been encountered at the river bed NW of Samteran and NE of the same village. The exposed length of the rock is about 5m and width of 0.3m and trend NNW-SSE direction. It intrudes into the fenitic ijolite and the contact between them is very sharp. No metasomatic effect is seen at the contact (Plate 16). The rock is hard, compact, coarse grained and leucocratic. It consists of potassium feldspar with little nepheline which can be identified from its greasy look in the hand specimen.

II.2.8 Shonkinite.

Isolated small outcrops of this rock not exceeding more than 2m in length are seen in the nala section in the northeastern part of the complex. It is closely associated with the syenitic fenite. The rock is fine to medium
grained, green coloured (mesocratic). The identifiable minerals are pyroxene, nepheline and feldspars. Some black clots (?) rock fragments) are also noticed in the rock.

II.2.9. Volcanic tuff.

A small exposure of this rock is exposed on the northwestern margin of the complex and about one and half kilometre SW of Ganjang village. The rock is light cream coloured, fine grained with well defined banding and juxtaposed with vein quartz and sheared rocks. The banding in the rock is due to light and dark coloured minerals. Where the thickness of the lighter bands are more than the darker bands. The light coloured portion is made up of feldspar and apatite while the dark coloured portion is represented by magnetite. Due to the presence of apatite in excessive amount the rock is sugary in appearance at places.

II.2.10. Granitic rocks.

Small exposures of very coarse grained pink granite and granitoid gneiss occur in the eastern part of the complex particularly around Ganjang, Samteran and Samchampi. These bodies do not have length more than 10m and width of 4m. They are thought to be the remnants of the older country rock that escaped metasomatism by the alkaline silicate carbonatite. These rocks show effect of deformation and silicification. Crude gneissosity present at places is defined by biotite grains.
II.2.11. Phosphatic chert rock.

Five phosphatic-chert rock bodies have been delineated from the complex. Out of five, three bodies lie near Samteran village and the other two near Ganjang village. The rock is made up of phosphatic material and chert fragments. The largest body occurs at Samteran village in a N-S trending linear ridge. The length of the outcrop is 200m and width of 25m. Similar outcrop is also noticed south of the village where the dimension is 2m by 1m. The third body lies about 1.5 km west of Samteran where the length is about 150m and average width is 5m. Of the other two bodies, one is about 1.5km NE of Ganjang the length of which is about 75m, width 5m and is closely associated with the fenitized rocks. The other body is about 1 km SSE Ganjang where the phosphatic pockets rest over the fenitized granite.

The phosphatic rocks of Samteran exhibit very good pisolitic and banded structures (Plates 27, 28).

II.2.12 Chert breccia/mylonites.

The complex is encircled in the southern and eastern part of the complex by chert breccia and mylonites. These rocks are closely associated with the fracture and shear zones and conformable with the lineaments that trend in NW, SW, N-S and ENE-WSW directions. The rock is very hard, smoky grey in colour and extremely fine grained. At places larger chert fragments are present in the aphanitic matrix.
II.2.13. Precambrian gneissic complex:

The Gneissic Group in the quartzo feldspathic gneiss which forms the basement rocks or the oldest rocks in the Karbi Plateau. The nature of the gneissic rocks were studied in an area lie outside the fenite zone of the alkaline-carbonatite complex.

The gneiss is represented by a finely banded quartzo-feldspathic gneiss, which at places acquire patchy and streaky appearance due to segregation of the ferromagnesian minerals, mainly biotite. The gneiss at places locally acquire a migmatic nature which may be termed as 'gneiss-migmatite (Mehnert, 1968.p.230).

The name quartzo-feldspathic gneiss is assigned to the rock in a sense that it is composed essentially of quartz and feldspar. Biotite is present as a major accessory mineral. It is fine to medium grained compact rock with light pinkish colour. Foliation or gneissosity is variable from the parallel orientation of slender flakes of biotite in thin bands alternating in the thick xenoblastic felsic bands. At places, the gneiss in certain bands, acquire a non foliated massive appearance where the ferromagnesian minerals occur in aggregates of spots (Plate 30). In the gneiss-migmatite, thin to fairly thick bands of quartzo-feldspathic or pegmatitic materials (neosome) are seen to have alternated with layers of mafic minerals, chiefly biotite.

II.2.13.1 Petrography: In the quartzo-feldspathic gneiss,
Quartz occurs as colourless, xenoblastic to somewhat lenticular grains. It is also seen as inclusions in plagioclase. The mineral usually shows normal extinction but undulose extinction and development of pressure lamellae are also not uncommon. The quartz grains show interlocking, mosaic texture. Potash feldspar is present usually as xenoblastic to sub-idioblastic grains with distinct cross hatch twinning, characteristic of microcline. There are also some untwinned potash feldspars in the rock. They are identified from the typical kaolinitic type of alteration and from some obscure twinning. Perthitic intergrowth of the microcline and sodic plagioclase forming microcline-microperthite is seen. The sodic component usually follows the cracks and fissures, as well as the cleavage traces in the microcline to form string and vein perthites. Plagioclase is subidioblastic in nature. When fresh the mineral is colourless, but it often shows varying degree of alteration which gives the mineral a dusty appearance. Common alteration product is sericite. Inclusions of biotite, magnetite and quartz are seen. Plagioclase is mostly oligoclase (An₂₀-₃₀) and shows the characteristic lamellar twinning. Biotite occurs in slender prisms showing pleochroism from light yellow through light brown to dark brown or almost black. It has one set of perfect cleavage, shows straight extinction and second order interference colours. Inclusions of oval shaped zircons, iron ore and apatite are seen in the biotite.
Chloritization of biotite is active at places along the cleavage traces. Zircon occurs as sub-rounded to oval shaped grains. It is colourless to pale brown with dark margins. Zircon shows straight extinction along the length of the grain and high order interference colour. Iron ore is usually magnetite and occur as disseminated irregular opaque grains showing metallic luster under reflected light. Apatite is found as inclusions in biotite and plagioclase. Colourless needles and prisms of apatite show straight extinction and first order grey interference colour. Sphene occurs a in association with biotite. The golden brown mineral with irregular grain margins show high relief. Extinction is masked by the high interference colour. Garnet is very rare in the gneiss.

II.2.13.2 Textures and microstructures: The quartzo-feldspatic gneiss is usually fine to medium grained rock. Among the the major constituents quartz and potash feldspar occur as xenoblastic grains while plagioclase is sub idioblastic. The biotite flakes show a strong preferred orientation defining the dominant foliation (S) to which the lenticular quartz grains also show a rough parallelism giving the rock a gneissic texture. The gneissosity is also defined by alternate bands of granoblastic quartzo-feldspathic materials and thin bands of schistose ferromagnesian minerals. Another set of planar mineral growth, especially biotite, oblique to the main foliation
(S') is noticed (Fig. 4) in these gneisses and that is regarded here as a secondary foliation (S') suggesting later deformation.

II.2.13.4 Origin: The quartz feldspathic gneisses are well foliated and show the presence of original banding in them. A general abundance of quartz over other minerals is seen in these gneisses. Zircon occurring mostly in subrounded to oval shaped grains is a common accessory mineral in these gneisses. These characters indicate that the gneisses of the area were derived through sedimentary processes; hence paragneiss (Huang, 1962, p. 416-17). The sub-rounded and oval grains of zircon indicate that original sediments suffered transportation before deposition (Rahman and Borah, 1982).

II.3. Interrelationship of the rocks.

The lithounits of the study area probably emplaced in same space and time. Due to the following reasons the interrelationships drawn from the field evidences are not very clear. However, attempts have been made here to depict their interrelationship from the available data. The main hindrances are:

1) Thick soil and vegetation cover.
2) Only 20% of the rocks are exposed on the surface and along major stream courses.

The area exposes very limited rocks and that too, at places, are juxtaposed together. At the northern periphery,
carbonatites and alkaline mafics are exposed together in a single outcrop and suggests that the carbonatites are intrusive into the alkaline mafic-ultramafic suites. Fine grained variety of carbonatites seen to cut across both coarse carbonatite and mafic-ultramafic rocks (Plate-7). This suggests the carbonatites are later than mafic suite and (there are) two generations of carbonatites exist in the complex. Presence of mafic xenoliths also support this observation.

The core of the complex is occupied by magnetite rich rock and similar rock types are also noted in the southern and western part of the area. This unit closely associated with the mafic rocks and at places with syenitic fenites. The nature of the outcrop pattern suggest a ring dyke. The mafic-ultramafic suites occur as arcuate body in the northern part and as linear body in the eastern and western part and thus also conform a ring dyke like structure of the complex. The mafics and carbonatites at places form a complete hybrid rock that is carbonate silicate rock in the complex. The mafic and ultramafic rocks are gradational to each other and their individual distinction is not always possible. Foidal syenite, alkali syenite and shonkinite occur as late intrusives into the complex. No metasomatic effect have been observed at the contact of alkali syenite and the mafic suites though the contact is very sharp.

Syenitic fenites are the dominant rock types in the
complex. In the southeastern, southwestern, northwestern and in the northern part the syenitic fenites occurs in juxtaposition with the country rock. Carbonatite and mafic silicates occur in the near by areas. Presence of remnant foliation and intrafolial folds at places indicate the fenites are derived from the older Granitic gneisses (country rock). The presence of partially fenitized and unaffected granitic bodies within the complex also support the same observation. Fenitization is intense in the alkaline mafics when the carbonatite occurs nearby and there are intensive development of phlogopite in the mafic rocks. Away from the carbonatites the development of phlogopite also reduces. Feldspar and aegirine veins are common in the fenitized rocks.

Phosphatic chert breccias are secondary in origin as deduced from the presence of large pisolitic structures, secondary chert veins and vermiculite in the rocks.

The volcanic episode in the complex is represented by the presence of phonolite. Further, the presence of volcanic tuff enhance the evidence of volcanic activity associated within the complex.
Fig. 2.2: Mafic rocks in syenitic background carbonatite intrusion in the left near Samchampi.

Fig. 2.3: Preferred orientation of mafic patches in syenitic background near Samteran.

Fig. 2.4: Pattern of feldspar/syenitic veins in mafic near Samchampi.
Fig 2.5: Carbonatite veins (unsaded) of second generation engulfing the mafics in remifying pattern. Area with fine dots are mafics.
Fig 2.7: Transformation of mafics (m) into syenitic fenites (s). Note some mafic patches still remained in the syenitic mass, follow a crude alignment.

Fig 2.8: Carbonatites of two generations: C1 = first and C2 = second generations, m = mafics.
Fig. 2.6. Coarsening of grain size from left to right, Lanbrik river; black patches are of mafic rocks.
Fig 2.9: The interrelationship of carbonatite (C) and melteigite (m): Location: North of Thulbun at Langbrik river.
Fig 2.9

Fig 2.10 Mafic xenoliths in Carbonatites.

Fig 2.11 Folding in Carbonatites Thedangnala.
Fig. 2.12: - Interaction relationship of S₁ and S₂.

Fig. 3.1: - Interaction of F₁ and F₂ folds, just outside the complex, south of Ganjiang.
3. Quartzo-feldspathic country rock south east of the complex in Langbrik river.

5. Large boulder of magnetite rock; white patches are of apatite.

6. Xenoliths of pyroxenite in carbonatite.
7. Melteigite-alkali pyroxenite traversed by fine grained carbonatites as veins and white patches are also carbonatites, in the northern periphery of the Complex, Langbrik River.

8. Contact between melteigite and carbonatite, Langbrik river.

11. Nature of syenitic fenite outcrops in the complex. 1 km west of Ganjang village.

12. Transformation of ijolite-melteigite into syenitic fenite (Advancing fenitization), Langbrik river near Samchampi.
13. Syenitic fenite with aegirine vein and bands. Crude foliation still preserved, 1 km west of Ganjang.

15. Melasyanite/foidal syenite engulfed by carbonatite (white patches), Langbrik river, 3 km northwest of Samteran.

16. Alkali syenite intrudes into fenitized ijolite, Langbrik river near Samteran.

19. Banding in carbonatite, 1 km west of Ganjang at Thedong river. White bands are of carbonatites while the darker bands are of magnetite, phlogopite and olivine.

20. Folding in carbonatites. Location same as Sl. No.19.
21. Slip planes across the banded carbonatite in the Langbrik river (northern side).

22. Intermingling of carbonatite and mafics: greenish is pyroxene while the black portions are biotite, magnetite and phlogopite. Langbrik river south of Samchampi.
23. Weatherd carbonatite of the complex.

25. Carbonatite in fenitized ijolite in the stream east of Samteran.

27. Chert bands in phosphatic rocks, west of Samteran.

28. Pisolithic structures in phosphatic breccia, Samteran Village.