CHAPTER - III

FIELD PETROLOGY
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3.1 INTRODUCTION

Geological studies reveal that the area is covered dominantly by granite gneiss. The grey porphyritic granite occurs in the form of plutons which sometimes bear intrusive relationship with the granite gneiss. Off-shoots of grey porphyritic granite are frequently seen to occur as dykes and sills. The fine-grained granite is rarely present. The pegmatite and the quartzo-feldspathic vein appear as dykes and sills. The granite gneiss, the grey porphyritic granite, the fine-grained granite, the pegmatite and the quartzo-feldspathic vein rocks are all leucocratic and can be grouped as quartzo-feldspathic rocks. The amphibolite and the biotite schist which are mesocratic can be grouped as basic and pelitic rocks. A good number of migmatitic outcrops, and rare occurrences, of calc silicate rocks are also present (Map No.1).

Thus the various rock units of the area can be grouped as follows:

Quartzo-feldspathic rocks:
- Granite gneiss
- Grey porphyritic granite
- Fine-grained granite
- Pegmatitic veins
- Quartzo-feldspathic-and quartz-veins

Basic rocks:
- Amphibolites
Pelitic rocks:

- Biotite schist

Calcareous rocks:

- Calc-silicate rocks

Migmatitic rocks

3.2 QUARTZO-FELDSPATIC ROCKS

3.2.1 Granite gneiss

Granite gneiss is the dominant rock type of the area. It is characterized by the alternating layers of felsic and mafic minerals. On the basis of the colour the granite gneiss can be grouped into two types mainly the grey granite gneiss and the pink granite gneiss.

The granite gneiss is very well foliated and exhibits (Photo 4,5) a composite appearance of alternating light and dark coloured bands. The light band is characterised by rough parallelism of feldspar and quartz. The dark band is characterised by preferred orientation of biotite. The thickness of the bands vary from fraction of a millimeter to a few centimetres (Photo 6).

Interfoliation of the granite gneiss with the basic and the pelitic rock units is very common (Photo 7). These are very often folded (Photo 8,9). Amphibolites and biotite schist occur as enclaves (Photo 10,11). The mineral lineation in the enclaves and the granite gneiss show a definite parallelism (Photo 11). The contacts of the basic and the pelitic rock units with the granite gneiss are very sharp (Photo 10,11). Grey porphyritic granite occurs as pluton in
granite gneiss exhibiting a discordant relationship. Pegmatitic-, quartzo-feldspathic- and quartz-veins are very common which possess concordant and discordant relationships with the country rocks (Photo 12,13,14).

The granite gneiss is very dominantly seen at Basistha, Lalungaon, Kukatipara, Moinakhulung, Pamohi, Maghopara, Devchatal and Rani. At Ganeshpara, Manpara, Katabari, Gorchug and Saukuchi the granite gneiss is less dominant.

At Basistha granite gneiss is the dominant rock unit, with well developed compositional layerings (Photo 7). Inclusions of biotite schist and quartzo-feldspathic- and pegmatitic-veins are common. Different varieties of folding are exhibited by the granite gneiss (Photo 12). Sometimes very minor faulting is conspicuous (Photo 15).

At Lalungaon inclusions of biotite schist and amphibolites are seen in granite gneiss (Photo 11). Folded quartzo-feldspathic veins are seen. At places intermixing of granite gneiss, amphibolite and quartzo-feldspathic vein takes place giving rise to migmatitic rocks. Biotitisation, feldspathisation (Photo 16) and segregation of felsic and mafic minerals are observed. Compositional layerings of amphibolites, biotite schist and granite gneiss are very common exhibiting open folding (Photo 8,9).

At Kukatipara amphibolite and biotite schist occur as inclusions in the granite gneiss. The inclusions show concordant relationship with the host rock unit. Pegmatite veins show cross-cut
relationship with the foliations of the granite gneiss. Biotitisation 
and feldspathisation are very common.

At Ganeshpara, Manpara, Katabari, Gorchug and Saukuchi the 
granite gneiss is present in minor amounts found sometimes as enclaves 
in the grey porphyritic granite (Photo 17), and sometimes arching 
around grey porphyritic granite. The pink and the grey variety are 
present, the former dominating over the latter. Inclusions of 
amphibolite and biotite schist are seen. The lineation of the 
inclusions parallels the lineation of the granite gneiss. In some 
cases, it is interfoliated with amphibolite. The contact of granite 
gneiss and the grey porphyritic granite is sharp. The foliation of the 
granite gneiss parallels the flow layer of the grey porphyritic 
granite (Photo 18). The granite gneiss is arched around the 
porphyritic granite, the foliation of the granite gneiss is 
prominently curved along the contact. The granite gneiss and the grey 
porphyritic granite exhibit concordant and discordant relationships.

Slickensided structure and micro-faults are sometimes seen. 
Along the fault surfaces, epidote occurs. Rare occurrence of 
chalcopyrite (Photo 19) and minute cubic and octahedral grains of 
magnetite are found.

At Pamohi, Maghopara, Devchatal and Rani, granite gneiss is the 
major rock unit. Biotite schist and amphibolite occur as inclusions. 
The compositional layerings of biotite schist and amphibolite (Fig. 1) 
parallel the compositional layerings of the granite gneiss. The 
lineations of the enclaved schists and of the granite gneiss bear
parallel relationships. The foliation is very well defined. Sometimes streaks and patches of biotite define the foliated structure. Sharp contact of granite gneiss and schist is observed. The rock unit exhibits different folded structures (Photo 20). The rock unit is injected by veins of small dimensions which mostly run parallel to the foliation (Photo 21) but at places the veins also bear a cross-cut relationship. Sometimes the quartzo-feldspathic material exhibit irregular structures. The quartzo-feldspathic vein is often seen to follow the folding nature of the granite gneiss (Photo 20). Injection of quartzo-feldspathic material is seen along the axial planes of the folds. Ptygmatically folded veins of quartzo-feldspathic material occurring along and across the foliation of the gneiss are very commonly seen (Photo 22,23). Minor faulting in the granite gneiss are sometimes observed. Slickensided structures with biotite and chlorite mineralisation are noticed.

3.2.2 Grey Porphyritic granite

The grey porphyritic granite is seen at Ganeshpara, Manpara, Katabari, Gorchug and Saukuchi.

Alignments of feldspar phenocrysts is very prominent which reflect flow lines (Fig. 2,3,4). Flow layerings in the grey porphyritic granite are shown by the parallelism of feldspar grains and micas. The alignment reflects laminar flow of the intruding pluton (Fig. 3).
Disc-shaped to spindle-shaped amphibolites (Fig. 2,5) and biotite schist represent absorbed xenoliths. Inclusions of biotite represent segregation of mineral. Xenoliths with irregular margin (Photo 24) are observed parallel with flow layerings.

The feldspar phenocrysts in porphyritic granite sometimes result in schlieren structure (Photo 25). Here the grains are concentrated in ways that have given rise to flow layerings.

The porphyritic granite in general has an intrusive relationship with the granite gneiss and the amphibolite (Photo 26). It sometimes shows discordant relationship (Fig. 5). The granite gneiss is sometimes found inside the porphyritic granite (Photo 17) and generally seen arching the latter. The contact of porphyritic granite with the granite gneiss and the amphibolite, is very sharp. Very often at the discordant contacts the potash feldspar phenocrysts show parallel alignment along the contact (Fig. 6). Dykes and sills of porphyritic granite cut the granite gneiss, the biotite schist and the amphibolite. The mineral lineations of the granite gneiss and amphibolite are mostly parallel to the flow lineations of the porphyritic granite (Photo 18).

Pegmatitic and quartzo-feldspathic veins mostly occur in porphyritic granite exhibiting a cross-cutting relationship with the flow layerings (Fig. 7).

Various kinds of joints have developed in the porphyritic granite (Photo 27, 28). The grain boundaries of the feldspar phenocrysts are generally sharp (Fig. 8,9,10,11). The grains show
carlsbad twinning (Fig. 9,10). Criss-cross twinning is also seen in some grains (Fig. 11). The length of some of the feldspar phenocrysts measures up to 7 cm (Photo 29). Sometimes inclusions of biotite and magnetite occur inside the feldspar phenocrysts.

At the contacts of the porphyritic granite with amphibolite and the granite gneiss, migmatisation is often observed (Photo 30, 31). Again augen-shaped feldspar at the contacts of the porphyritic granite with the granite gneiss and the amphibolite is sometimes seen. Biotite concentration is seen around the feldspars.

At Ganeshpara, the contact of amphibolite and porphyritic granite is very sharp with flow lines in granite and lineation in amphibolite, paralleling each other. Intrusion of porphyritic granite is observed inside the amphibolites. At places at the near contact, the feldspar phenocrysts with different orientations occur inside amphibolite (Photo 32). Concentration of chalcopyrite is seen in quartz vein inside the porphyritic granite. The rock is highly jointed (Photo 28). Weathering along the joint planes are observed. There are low-dipping fault surfaces marked by striations that trend in the direction of flow lines.

At Manpara sharp contact of porphyritic granite with amphibolites is seen. The porphyritic granite shows intrusive nature. At the near contact migmatitic structures are present (Photo 33).

The porphyritic granite at Katabari exhibits an intrusive relationship with the pink granite gneiss and the amphibolite. Various types of joints are well developed in the rock unit. Schlieren
structure is formed by feldspar phenocrysts (Photo 25).

Migmatite is seen along the contact of porphyritic granite and amphibolite where the feldspar phenocrysts are augen shaped and biotite segregation occurs along the borders of the feldspars. The pushing and uplifting nature of the pink granite gneiss by porphyritic granite is prominent.

At Garchug the dominant rock type is grey porphyritic granite. Amphibolite occurs as inclusion inside the porphyritic granite (Photo 34). The porphyritic granite is highly jointed. Slickensided structure is observed in grey porphyritic granite where chalcopyrite and biotite mineralisation is seen (Photo 35). Granite gneiss is seen to occur inside porphyritic granite.

At Saukuchi intrusions of grey porphyritic granite in granite gneiss and amphibolite are prominent. The tongue-like intrusions of grey porphyritic granite in amphibolite (Photo 24, 26) and sharp and smooth contacts with granite gneiss are well displayed (Photo 18). It is observed that the feldspar phenocrysts in porphyritic granite are pink near the contact of pink granite gneiss, whereas away from the contact the colour changes to grey. The flow line of porphyritic granite and the lineation of granite gneiss are paralleling each other (Photo 18), but at places the flow line is oblique to the lineation of the granite gneiss. A discordant relationship with biotite inclusions is often observed (Fig. 12).

Augen-shapef feldspars in migmatites with biotite concentration around feldspars, are well displayed near the contact of
Porphyritic granite and pink granite gneiss (Fig. 13). Segregation of biotite is observed along the contact of the quartz-feldspar-rich matrix in the porphyritic granite. The elongation of the inclusions of amphibolite (Fig. 2) and biotite schist (Fig. 4) inside the porphyritic granite is parallel to the flow lines.

3.2.3 Fine-grained granite

The fine-grained granite is very rarely seen. It is found at Basistha, Maghopara, Devchatal, and Rani. It is hard and compact. The rock is fine-grained and sometimes have a spotted appearance due to segregation of biotite or concentration of magnetite. The rock exhibits a cross-cut relationship with the granite gneiss and the grey porphyritic granite. It is grey in colour, but around Rani it sometimes shows pink colour. At Rani segregation of amphibolitic material gives the rock a spotted appearance (Photo 36). Here a concordant relationship is observed with the country rock.

3.2.4 Pegmatite veins

Pegmatite is a common rock unit in the area. It occurs as lenses and veins. The veins are either concordant or discordant (Photos 37, 38, 39). The pegmatites sometimes show intermixing with the metamorphics and give rise to migmatites. Very often the pegmatite veins possess small veinlets. The pegmatites are composed of medium to coarse grained minerals, and are associated with all the rock units and have sharp contacts along which remification of biotite is common.
At Ganeshpara, Katabari, Manpara, Gorchug and Saukuchi, the grey porphyritic granite is intruded by pegmatitic veins. The pegmatite veins show both concordant and discordant relationship with the grey porphyritic granite and very often are ptygmatically folded.

At Basistha the pegmatite veins exhibit both concordant and discordant relationship with granite gneiss. Mostly the pegmatites are ptygmatically folded which do not have any relation with the folding in granite gneiss, but some veins are seen to follow the folds of the granite gneiss.

At Kukatipara pegmatites are observed intruding the granite gneiss, intermixing of which produces migmatites.

At Pamohi, Maghopara, and Devchatal pegmatites are rare. The veins are of small dimensions measuring 3–4 cm in breadth. The pegmatite veins show ptygmatid folding (Fig. 14E and 14F). Various deformations are shown by the pegmatite veins (Fig. 14).

At Rani intermixing of pegmatites with granite gneiss, amphibolite and calc-silicate rock form migmatites.

3.2.5 Quartzo-feldspathic veins and Quartz veins

The quartzo-feldspathic and the quartz veins occur as intrusive inside the granite gneiss, the grey porphyritic granite, the metabasic and the metapelitic rock units. Though quartzo-feldspathic and quartz material mostly occur as veins (Fig. 15), lenses (Fig. 16), dykes, sills, and irregular bodies; lit-par-lit injections (Photo 2) and multiple injections are common. Some quartzo-feldspathic veins
have developed following the folds in the metamorphics (Photo 48), while others are folded but exhibit a discordant relationship (Photo 41). The ptygmatic veins (Photo 22) do not bear any relation to the folds. The intermixing of the quartzo-feldspathic vein with the granite gneiss has given rise to migmatites.

At Ganeshpara, Manpara, Katabari, Gorchug and Saukuchi, where the dominant rock type is porphyritic granite, quartzo-feldspathic veins exhibit concordant and discordant relationship and sometimes exhibit ptygmatic folding. Segregation of biotite is observed in quartzo-feldspathic bodies which in turn occur inside amphibolite (Photo 42). Mixing of quartzo-feldspathic material with amphibolite give rise to migmatites.

At Basistha intermixing of quartzo-feldspathic material with biotite schist is observed (Photo 43). The quartzo-feldspathic veins very often show discordant relation (Photo 44) with the granite gneiss, and the veins are sometimes seen along the axial planes of folds in granite gneiss (Photo 45). Very often the quartzo-feldspathic veins are ptygmatically folded.

At Lalungao and Kukatipara the quartzo-feldspathic veins show lit-par-lit injections in biotite schist (Fig. 17) and are also seen to have developed following the folds in granite gneiss (Fig. 18). Again quartzo-feldspathic veins are sometimes seen along the axial planes of folds in granite gneiss (Photo 13).
At Pamohi, Maghopara, Devchatal and Rani, the quartzofeldspathic veins exhibit various structures. The veins possess both concordant and discordant relationships with granite gneiss. Intermixing of quartzofeldspathic veins with granite gneiss, biotite schist, amphibolites and calc-silicate rocks form migmatites.

3.3 META BASIC ROCK

3.3.1 Amphibolite

The basic rock is mainly amphibolite. This occurs as patches, lenses, dykes, sills, etc. in granite gneiss and porphyritic granite. Inclusions of amphibolite are found in granite gneiss and grey porphyritic granite. They exhibit concordant relationship with the granite gneiss. The compositional layering $S_0$ of amphibolite is parallel to the compositional layering $S_1$ of the granite gneiss (Photo 46). The contact of amphibolite with the granite gneiss and the grey porphyritic granite is very sharp (Photo 33). Schistosity of the rock is well pronounced. Lineation is distinct due to the parallelism or subparallelism of the hornblende and biotite. Intermixing of amphibolite with grey porphyritic granite in places has given rise to migmatites (Photo 30,31,33).

At Ganeshpara, Manpara, Katabari, Gorchug and Saukuchi, the contacts of amphibolite and grey porphyritic granite are clear and sharp, sometimes the contacts are irregular (Photo 24). Tongue-like intrusions of amphibolite in grey porphyritic granite are often observed inside the amphibolite (Photo 26). The lineation of
amphibolite is in conformity with the flow line in grey porphyritic granite (Figs. 2,3,4). Sometimes near the contact of amphibolite with grey porphyritic granite, feldspar phenocrysts with different orientations occur in the former rock unit (Photo 32). Intrusions of grey porphyritic granite in amphibolite and mixing of the two rock units give rise to migmatites (Photo 30,33,47,48). At Katabari along a joint plane, contact of grey porphyritic granite and amphibolite is observed, and mixing of these two rock units give rise to migmatites where the feldspars are augen shaped with biotite mineralisation along the borders. At Saukuchi, pink granite gneiss and amphibolite are seen inside grey porphyritic granite exhibiting folded structures. Xenoliths of amphibolite are observed inside pink granite gneiss (Photo 49). At Ganeshpara, migmatites are found at the contact of grey porphyritic granite and amphibolite (Fig. 19).

At Basistha, Lalungaon, Kukatipara, Pamohi, Maghopara, Devchatal and Rani, amphibolite is present as inclusions in granite gneiss. The amphibolite exhibits open folding characterised by thickening of hinges and thinning of limbs (Photo 8). The compositional layerings of amphibolite and granite gneiss are parallel to each other (Photo 8).

3.4 METAPELITIC ROCK

3.4.1 Biotite schist

Biotite schist is the only metapelitic rock of the area. It is medium-grained and black in colour and shows strong schistosity. The
schistosity is defined by the preferred orientation of biotite flakes. Sometimes small bands of quartz measuring about 10 mm is seen inside the biotite schist. The rock is usually folded.

At Saukuchi it occurs as inclusion in the grey porphyritic granite. These inclusions bear concordant relationship with the surrounding grey porphyritic granite. The rock is strongly foliated and shows well developed schistosity. The mineral lineation defined by the biotite flakes is in conformity with the flow line of the grey porphyritic granite. Sharp contact between biotite schist and grey porphyritic granite is observed (Fig. 4,12).

At Basistha biotite schist occurs as compositional layering (Photo 7) inside the granite gneiss. Intrusion of quartzo-feldspathic veins occur in biotite schist (Photo 43).

Inclusions and compositional layerings of biotite schist in granite gneiss are observed at Lalungao and Kukatipara (Photo 9). Litt-par-lit injection of quartzo-feldspathic rock is observed in biotite schist. Compositional layerings of biotite schist and granite gneiss often exhibit open folding (Photo 9).

At Maghopara, Devchatal and Rani, biotite schist occurs as compositional layerings and as inclusions inside granite gneiss (Photo 50). Small veins of quartzo-feldspathic composition are seen in biotite schist paralleling the schistosity of biotite schist. The mineral lineation in biotite schist and granite gneiss is parallel. At places mixing of quartzo-feldspathic rock unit and biotite schist forms migmatite. Folded quartzo-feldspathic material is observed in
biotite schist which is in turn present as inclusion in granite gneiss.

3.5 CALCAROUES ROCK

3.5.1 Calc-silicate rock.

The calc-silicate rocks occur as banded rock exhibiting a conformable relationship with the host rock, granite gneiss. This rock has a banded appearance and the bands show variations in colour. Different combinations of the constituent minerals give different colours to the bands: quartz bands are white, diopside and clinozoisite green, diopside, epidote and quartz pale green, and garnet, brown. (Photo 51).

The calc-silicate rock is very rare. These are seen in association with granite gneiss at Maghopara, and with amphibolite and granite gneiss at Rani. Intermixing of calc-silicate rock with quartzo-feldspathic veins forms migmatites.

3.6 MIGMATITES

Field observations reveal close association of migmatites with the amphibolite, the biotite schist and the granite gneiss. Migmatitic outcrops are though not many yet distinctly seen in the area. Migmatites are composite rocks consisting partly of the metamorphites and partly of the portions having a plutonic appearance (W. Johannes). Thus the term 'mesosome' (Johannes, 1983) is used for the gneissic or schistose portions, leucosome (Mehnert, 1968) is used for the
leucocratic plutonic part and 'melanosome' (Mehnert, 1968) for the selvage rich in mafic minerals (Photo 52,53,54,55).

The migmatites in the area are mainly metatexites with subordinate diatexite. At Basistha, Lalungaon, Kukatipara, Maghopara, Pamohi and Rani, migmatites are composed of layers of plutonic rocks namely pegmatitic, quartzo-feldspathic and quartz material (leucosome) separated by layers of mafic minerals (melanosome) and gneissic or amphibolitic composition (mesosome). These weakly banded rocks consisting of both mesosome and neosomes have all the characteristics of metatexites (Photo 56). The quartzo-feldspathic leucosomes are usually from several millimetres to several centimetres in thickness, banded by a biotite-rich melanosome or with scattered coarse mafic mineral concentrations. The metatexites when totally disrupted grade into diatexites. The diatexites, which is generally quite heterogeneous, comprise a quartzo-feldspathic igneous looking matrix with biotite rich schlieren (Photo 57).

At Ganeshpara, Manpara, Katabari, Gorchug and Saukuchi, the grey porphyritic granite by interaction with amphibolites has also given rise to migmatitic rocks characterised by the presence of feldspar phenocrysts in amphibolites and gneisses (Photo 47). By continuous inflow of granitophile substances, however, the reaction proceeds further into the amphibolitic resisters thus producing migmatitic rocks.

An account of the various megascopic structures exhibited by the migmatites of the area is given below.
Agmatitic structure: At Basistha, Pamohi and Maghopara, agmatitic gneissic and metabasic bodies are encountered. Here fragments of mesosome are surrounded by narrow veins of felsic leucosome quartzo-feldspathic-, pegmatitic-, and quartz-veins.

Schollen structure: At Pamohi, Maghopara and Devchatal, somewhat rounded fragments of biotite schist are observed floating like rafts in quartzo-feldspathic leucosome. The mesosome shows indistinct borders and these irregular and deformed inclusions are developed along the border zones of the leucosomes (Photo 57).

Phlebitic structure: Leucosome quartzo-feldspathic material in mesosome granite gneiss exhibiting phlebitic structure is observed at Basistha (Photo 58).

Stromatic structure: This is the most common migmatitic structure in the area. Quartzo-feldspathic leucosome with granite gneiss and amphibolite mesosome forms a layered structure (Photo 59). The leucosome layers thicken and thin out irregularly and are sometimes folded and contorted (Photo 60). These structures are observed at Basistha, Maghopara, Pamohi and Raul. These migmatites show alternate leucosome and mesosome layers. A thin zone of melanosome is often present between mesosome and leucosome layers. The leucosome is conformable to the enclosing gneiss and have biotite rich mafic rims (Photo 60). The melanosome are very thin. They are neither uniform nor present everywhere.
Folded structure: In granite gneiss, metabasic and metapelitic rocks, the leucosome of pegmatoid and quartzo-feldspathic material occur exhibiting folded structures at Basistha, Lalungaon, Pamohi, Maghopara, Devchatal and Rani (Photo 53, 55, 61, 62).

Ptygmatic structure: Highly disharmonic and extremely tortuous folds are very often exhibited by quartz-, quartzo-feldspathic- and pegmatitic-leucosomes. Some folds are termed ptygmatic structures and are present in mesosome granite gneiss, amphibolite and biotite schist at Basistha, Pamohi, Maghopara and Rani (Photo 22).

Opthalmitic structure: Opthalmitic structure is shown by leucosome, quartzo-feldspathic material in the shape of augen present in mesosome amphibolite (Photo 63, 64) with a thin biotite rich melanosome. This structure is observed at Rani and Maghopara.
4. Gneissosity defined by streaks of biotite and bands of felsic minerals in streaky gneiss.
   Locality: Pamoah

5. Gneissosity defined by light and dark bands in granite gneiss.
   Locality: Rani
Photo

6. Granite gneiss, where alternate bands of felsic and mafic minerals define gneissosity, the \( S_1 \) foliation.
   Locality: Basistha

7. Compositional layering of biotite schist in granite gneiss.
   Locality: Basistha

8. Open folding exhibited by interfoliation of amphibolite and granite gneiss characterised by broad hinges
   Locality: Lalungaon
9. Open folding exhibited by compositional layerings of biotite schist and granite gneiss. Note the thickening of hinge and thinning of limbs.
   Locality: Lalungaan

10. Inclusions of amphibolite in pink granite gneiss.
    Locality: Saukuchi.

11. Inclusions of biotite schist in granite gneiss. Note that the biotite schists are stretched apart along the foliation direction exhibiting a boudinage structure.
    Locality: Lalungaan
12. Tight isoclinal folding shown by granite gneiss. Note quartzo-feldspathic material inside the fold. 
Locality: Basistha

13. Tight isoclinal folding in granite gneiss. A quartzo-feldspathic vein is observed along the shear plane. Note that a slight displacement of the gneissic bands along the shear plane. 
Locality: Lalungaon

Locality: Basistha
15. Quartzo-feldspathic vein following the folding of granite gneiss. Faulting is exhibited by the displacement of the quartzo-feldspathic vein. 
Locality: Basistha

16. Biotite schist inside quartzo-feldspathic material.
Locality: Lalunguon

17. Granite gneiss inside grey porphyritic granite.
Locality: Gorchug
18. Sharp and smooth contact of pink granite gneiss and grey porphyritic granite. Flow lines in porphyritic granite. Flow lines in porphyritic granite and lineations in granite gneiss are parallel. A concordant quartzo-feldspathic vein is observed.

Locality: Saukuchi

19. Occurrence of chalcopyrite in the fault surface, along which a quartz vein occurs, in grey porphyritic granite.

Locality: Saukuchi

20. Quartzo-feldspathic material mimicking the folding in granite gneiss. Thickening of hinges and thinning of limbs are observed.

Locality: Devchatal
   Locality: Devchatal

22. Ptygmatically folded quartzo-feldspathic vein in granite gneiss.
   Locality: Maghopara
Photo

23. Ptygmatic folding in granite gneiss exhibited by quartzo-feldspathic material.
   Locality: Pamohi

24. Inclusion of amphibolite in grey porphyritic granite is with irregular margin.
   Locality: Saukuchi
25. Schlieren structure in grey porphyritic granite.
   Locality: Katabari

26. Tongues of grey porphyritic granite in amphibolite.
   Locality: Saukuchi

27. Joints in grey porphyritic granite.
   Locality: Gorchug
Photo

   Locality: Ganeshpara

29. Flow lines defined by feldspar phenocrysts.
   Note that some phenocrysts measures upto 7 cm.
   Locality: Gorchug

30. Migmatites formed by mixing of amphibolite (mesosome) and grey porphyritic granite (neosome).
    Locality: Manpara
31. Intrusion of grey porphyritic granite in amphibolite forms migmatites.
   Locality: Ganeshpara

32. Feldspar phenocrysts inside amphibolite
   Locality: Ganeshpara

33. Sharp contact of grey porphyritic granite with amphibolite. Note that near the contact K-feldspar phenocrysts occur inside amphibolite forming migmatite.
   Locality: Manpara
Photo

34. Inclusion of amphibolite in grey porphyritic granite.
   Locality: Gorchug

35. Slickensided structure in grey porphyritic granite.
   Locality: Gorchug

36. Spotted fine-grained granite.
   Locality: Rani
37. Pegmatite vein exhibiting a concordant relationship.
   Locality: Rani

38. Two pegmatite veins exhibiting cross-cutting relationship of which one is ptygmatically folded in granite gneiss.
   Locality: Rani

   Locality: Hasistha
40. Quartzo-feldspathic material mimicking the open asymmetrical folding in granite gneiss.
Locality: Maghopara

41. Folded quartzo-feldspathic vein in amphibolite.
Locality: Manpara
42. Quartzo-feldspathic vein in amphibolite. Also note the contact with granite gneiss. The lineation of the former is in conformity with the latter rock unit.
Località: Saukuchi

43. Quartzo-feldspathic material in biotite schist. Biotite schist is present as inclusion in granite gneiss.
Località: Basistha

44. Ptygmatically folded quartzo-feldspathic vein in granite gneiss exhibiting a discordant relationship.
Località: Basistha
45. Ptygmatically folded quartzo-feldspathic vein in granite gneiss. Note the intrusion of quartzo-feldspathic material along axial planes of folds in granite gneiss.
Locality: Basistha

46. Compositional layering ($S_0$) of amphibolite is parallel to the foliation ($S_1$) in granite gneiss.
Locality: Basistha

47. K-feldspar phenocryst in amphibolite near the contact of porphyritic granite and amphibolite resulting to migmatisation.
Locality: Manpara
48. Intrusion of porphyritic granite in amphibolite causing migmatisation.
   Locality: Manpara

49. Inclusion of amphibolite in pink granite gneiss.
   Ptygmatically folded quartzo-feldspathic veins are observed in amphibolite.
   Locality: Saukuchi

50. Compositional layering of biotite schist in granite gneiss.
   Locality: Devchatal
51. Calc-silicate rock having a banded appearance where the bands show variations in colour.
   Locality: Maghopara

52. Migmatite constituting of mesosome (granite gneiss), leucosome (quartzofeldspathic material) and melanosome (biotite rich).
   Locality: Maghopara

53. Folded structure shown by migmatite where the mesosome, leucosome and melanosome are granite gneiss, quartzofeldspathic material and biotite rich selvage respectively.
   Locality: Basistha
54. Migmatitic rock constituting of amphibolitic mesosome and quartzo-feldspathic leucosome.
   Locality: Rani

55. Folded structure shown by quartzo-feldspathic material (leucosome) in amphibolite (mesosome).
   Locality: Pamohi

56. Weakly banded migmatite consisting of bands of quartzo-feldspathic material (leucosome) in gneissic mesosome.
   Locality: Lalungaon
57. Heterogeneous diatexite comprising of quartzo-feldspathic igneous looking matrix with biotite rich schlieren.
Locality: Maghopara

58. Phlebitic structure (migmatite) shown by quartz-feldspathic material (leucosome) in granite gneiss (mesosome).
Locality: Basistha
59. Stromatic structure (migmatite) shown by quartzo-feldspathic material (leucosome) in amphibolite (mesosome).
   Locality: Rani

60. Lit-par-lit injection of quartzo-feldspathic material (leucosome) in granite gneiss (mesosome). Note that the leucosomes are folded and have biotite rich mafic rims.
   Locality: Basistha

61. Folded structure (migmatite) shown by pegmatoid material (leucosome) in amphibolite (mesosome).
   Locality: Rani
62. Folded structure (migmatite) shown by quartzofeldspathic material (leucosome) in amphibolite (mesosome).
Locality: Rani

63. Opthalmitic structure (migmatite) shown by pegmatoid material (leucosome) in amphibolite (mesosome).
Locality: Rani

64. Opthalmitic structure (migmatite) shown by quartzofeldspathic material (leucosome) in amphibolite (mesosome).
Locality: Maghopara
Compositional layering of amphibolite and granite gneiss exhibiting open folding.
Locality: Paaohl

Enclaves of amphibolite in grey porphyritic granite. The alignment of the phenocrysts define the flow lines.
Locality: Saukuchi

Tongue—like intrusions of grey porphyritic granite in pink granite gneiss. Flow lines in porphyritic granite are defined by feldspar phenocrysts.
Locality: Ganeshpara

An elongated inclusion of biotite schist in grey porphyritic granite. The flow lines defined by feldspar phenocrysts in porphyritic granite and the lineation in biotite schist are parallel.
Locality: Saukuchi

Spindle-shaped amphibolite in grey porphyritic granite showing discordant relationship with the latter.
Locality: Saukuchi
Figure

6. Contact of grey porphyritic granite with granite gneiss. At the discordant contacts the potash feldspar phenocrysts show alignment parallel to the contact. Locality: Manpara

7. Quartzo-feldspathic vein in grey porphyritic granite. Locality: Saukuchi

8. A feldspar phenocryst of grey porphyritic granite with sharp edges and corners. Locality: Ganeshpara

9. A feldspar phenocryst of grey porphyritic granite with sharp edges and corners, showing twinning. Locality: Gorchug

10. A feldspar phenocryst of porphyritic granite showing twinning. Locality: Manpara

11. Distinct criss-cross twinning shown by two feldspar phenocrysts. Locality: Manpara

12. An inclusion of biotite schist in grey porphyritic granite. The flow lines in porphyritic granite is almost perpendicular to the lineation in biotite schist. Locality: Saukuchi

13. Contact of grey porphyritic granite with pink granite gneiss. At the contact, the feldspar phenocrysts are augen shaped and biotite segregation is seen. Locality: Saukuchi
Figure 14. Deformation structures shown by pegmatite veins.

Locality: Pamohi
Figures

15. A vertical quartzo-feldspathic vein across the foliation with branches of concordant veins which are ptygmatically folded in granite gneiss. Locality: Basistha

16. Lenses of quartzo-feldspathic material in amphibolite. Locality: Rani

17. Lit-par-lit injection of quartzo-feldspathic vein in biotite schist. Locality: Lalungaon

18. Quartzo-feldspathic material mimicking the tight asymmetrical folding in granite gneiss. Locality: Lalungaon

19. Migmatites formed at the contact of grey porphyritic granite and amphibolite. Locality: Ganeshpura