CHAPTER 3

LITHOLOGY

The present study has been carried out around the Phulbani town where the granulite suite is represented by aluminous granulite, calc-silicate granulite, mafic granulite, fine-grained charnockite, felsic gneiss and coarse-grained charnockite. The details of the outcrop-scale characters of these rocks are described below.

3.1 Aluminous granulite

At the western and the southeastern part of the study area the aluminous granulite bodies crop out as E-W trending and NW-SE trending ridges. In the latter case, the aluminous granulite bodies are intimately associated with calc-silicate granulite and both of these appear to be co-deformed. At the central part of the study area, aluminous granulite outcrops occur as N-S trending bands and lenses within the migmatitic felsic gneiss (Fig. 3.1a). In all instances, this rock is invariably gneissic in nature and the gneissic fabric is defined by alternate melanocratic and leucocratic bands. The melanocratic bands are dominantly composed of garnet, spinel, corundum, ilmenite, sillimanite and/or biotite while the leucocratic bands are made up of quartz, feldspar, sillimanite and biotite grains. Locally the garnet grains of the melanocratic bands are stretched to become parallel to the dominant fabric of the study area (Fig. 3.1b). At the western part of the study area, the aluminous granulite bodies are much weathered to give a reddish appearance of the rock and quartz-rich leucocratic bands crop out as ridges due to differential weathering (Fig. 3.1c). At the southeastern part, the leucocratic bands are discontinuous within the melanocratic bands and the latter bands dominantly form pinch and swell structure (Fig. 3.1d).

3.2 Calc-silicate granulite

Outcrop density of calc-silicate granulite is low and the rock occurs as discontinuous layers only at the southeastern and northern parts of the study area. This rock appears to be gneissic in nature and the gneissic foliation is defined by alternate greenish and grayish bands (Fig. 3.1e). The greenish bands are clinopyroxene-rich while garnet appears to be the dominant mineral in the grayish bands. At the southeastern part, the gneissic foliation of the calc-silicate granulite is dominantly folded (Fig. 3.1f). However, such folding is notably absent in calc-silicate granulite within the Ranipathar shear zone (RSZ) which is located at the northern part of the study area. In the latter case, the calc-silicate granulite bodies are characterized by outcrop-scale sheath folds (Fig. 3.1g).

3.3 Felsic gneiss

Felsic gneiss is the host rock of aluminous granulite and calc-silicate granulite and appears to be the most abundant rock type at the study area. The latter rocks dominantly occur as banded or lenses within the felsic gneiss which is medium- to coarse-grained and has differences in mineralogy to exhibit the gneissic foliation. In most instances, this rock is characterized by migmatitic foliation which is defined by garnet- and biotite-rich melanocratic layers and quartz-feldspar-rich leucocratic layers (Fig. 3.1h). Quartz and feldspar-rich leucocratic patches which are concentrated around garnet grains are also common in this rock (Fig. 3.1i). These leucocratic patches are occasionally stretched parallel to the dominant foliation and sometimes are disharmonically folded to develop ptygmatic folds (Fig. 3.1j). Because of the presence of such migmatitic structures, this rock is described as the migmatitic felsic gneiss in the following sections.

At the northern part of the study area i.e. near RSZ, another variety of felsic gneiss occurs in which the migmatitic foliation and related structures are notably absent (Fig. 3.1k). This latter rock is characterized by pink colored K-feldspar grains which is much larger (up to 5 cm along the maximum length) compared to the feldspar grains of the migmatitic felsic gneiss. Proportion of biotite in this rock is low and has a conspicuous mylonitic foliation (described as S_{5S} in chapter 4) which is defined by alternate quartz- and K-feldspar-rich bands. Due to intense shearing, the K-feldspar grains of this rock are augen shaped and henceforth described as felsic augen gneiss.

3.4 charnockitic rocks

Based on the field occurrences, chranockitic rocks of the study area are subdivided into two broad categories. Relatively fine-grained charnockite is gneissic and always occurs with the felsic gneiss and the two rocks appear to be co-deformed with preservation of the earliest recognizable foliation (described as S_2/S_3 in chapter 4). Mesoscopic-scale fold of fine-grained charnockite and aluminous granulite layers at the central part of the study area suggest that these two rocks are also deformed together. The gneissic foliation of fine-grained charnockite is defined by alternate pyroxene-rich and quartz-feldspar-rich layers (Fig. 3.1l). Another type of charnockitic rock is exposed at the study area which is coarse-grained and the feldspar grains of the same reach up to 3 cm along the maximum length. Although foliated in most cases, massive variety of this rock is also common (Fig. 3.1m). It is noteworthy that although the regionally recognizable gneissic foliation (S_2/S_3) is absent in the coarse-grained charnockite, a later developed foliation (described as S_4 in chapter 4) is present in most cases (Fig. 3.1n). This rock appears to intrude the aluminous granulite and calc-silicate granulite and fragments of the latter rocks are invariably present within this coarse-grained charnockitic rock (Figs. 3.1o, p). Fragments of aluminous granulite and calc-silicate granulite in all instances contain an earlier foliation which possibly formed prior to the charnockite intrusion. The field observations therefore suggest that there is a definite time gap between high-grade metamorphism and charnockite intrusion at the study area. The gneissic foliation of the coarse-grained charnockite is defined by alternate pyroxene rich and quartz-feldspar rich bands where the feldspar grains are elliptical and elongated parallel to the foliation plane.

3.5 Metasomatic rock at the contacts of calc-silicate granulite and coarse-grained charnockite

The contact zones of calc-silicate granulite and coarse-grained charnockite are characterized by the presence of a pegmatoidal rock (Fig. 3.1q). Patches of this metasomatic rock are additionally present in the calc-silicate granulite and the clinopyroxene and the K-feldspar grains of the former rock are clearly visible in outcrops (Fig. 3.1r). This rock dominantly occurs parallel to the later developed NW-SE trending S_4 fabric. It is important to note that the contact zones of the aluminous granulite and the coarse-grained charnockite do not have this type of rock which indicates that this rock must have developed due to metasomatic reactions between the calc-silicate granulite and the coarse-grained charnockite which is discussed in chapter 8.

3.6 Mafic granulite

Mafic granulite usually occurs as centimeter- to meter-scale fragments within coarse-grained charnockite and migmatitic felsic gneiss at the southern part of the Phulbani town (Fig. 3.1s).

However, deformed lenses of mafic granulite within the migmatitic felsic gneiss are also common in the same area and appear as boudins in outcrop-scale (Fig. 3.1t). Apophyses or tongue shaped bodies originated from the migmatitic felsic gneiss occasionally intrudes the mafic granulite and sometimes the garnet grains of the former are notably larger than usual at the contact of these two rocks (Fig. 3.1u). In most cases, the mafic granulite is foliated and the foliation is defined by alternate pyroxene + amphibole-rich and plagioclase-rich layers. It is however important to note that the lens shaped bodies of this rock hosted by the migmatitic felsic gneiss sometimes are fine-grained and the foliation is visible only at the contacts between these two. However, at the Putudi waterfalls area located within the RSZ, dyke shaped mafic granulite bodies are always associated with the sheared migmatitic felsic gneiss (Fig. 3.1v). Folded mafic granulite layers within the migmatitic felsic gneiss are also common.