

## CHAPTER IV

### GEOLOGY OF THE KHANOM GNEISSIC COMPLEX UNITS

#### Introduction

On the bases of differences in mineralogical composition, microstructure together with the enhanced air-borne geophysical data mentioned in Chapter III, the Khanom gneissic complex can be classified into five units and delineated in the map.

The first unit is referred herein as the **Haad Nai Phlao Gneiss**, and crops out mainly in the central portion of the main mountain with additional minor masses occurring in the northeastern part of the area and at the upper parts of the highest mountains.

The second unit is referred to as the **Khao Yoi Schist**, is well exposed at the western rim of the main mountain.

The third unit herein called the **Laem Thong Yang Gneiss** and occurs chiefly in eastern and southern parts of the mountain.

The fourth one is referred as the **Khao Dat Fa Granite**, which is well-outcropped at the peak of the main mountain in the central part of the area. Finally, the fifth unit, herein called the **Khao Pret Granite**, is largely observed in eastern and western parts of mountain.

Distribution of these five units is shown in Figure 4.1. No major break is recognized between the metamorphic units and are inferred to be conformable. There

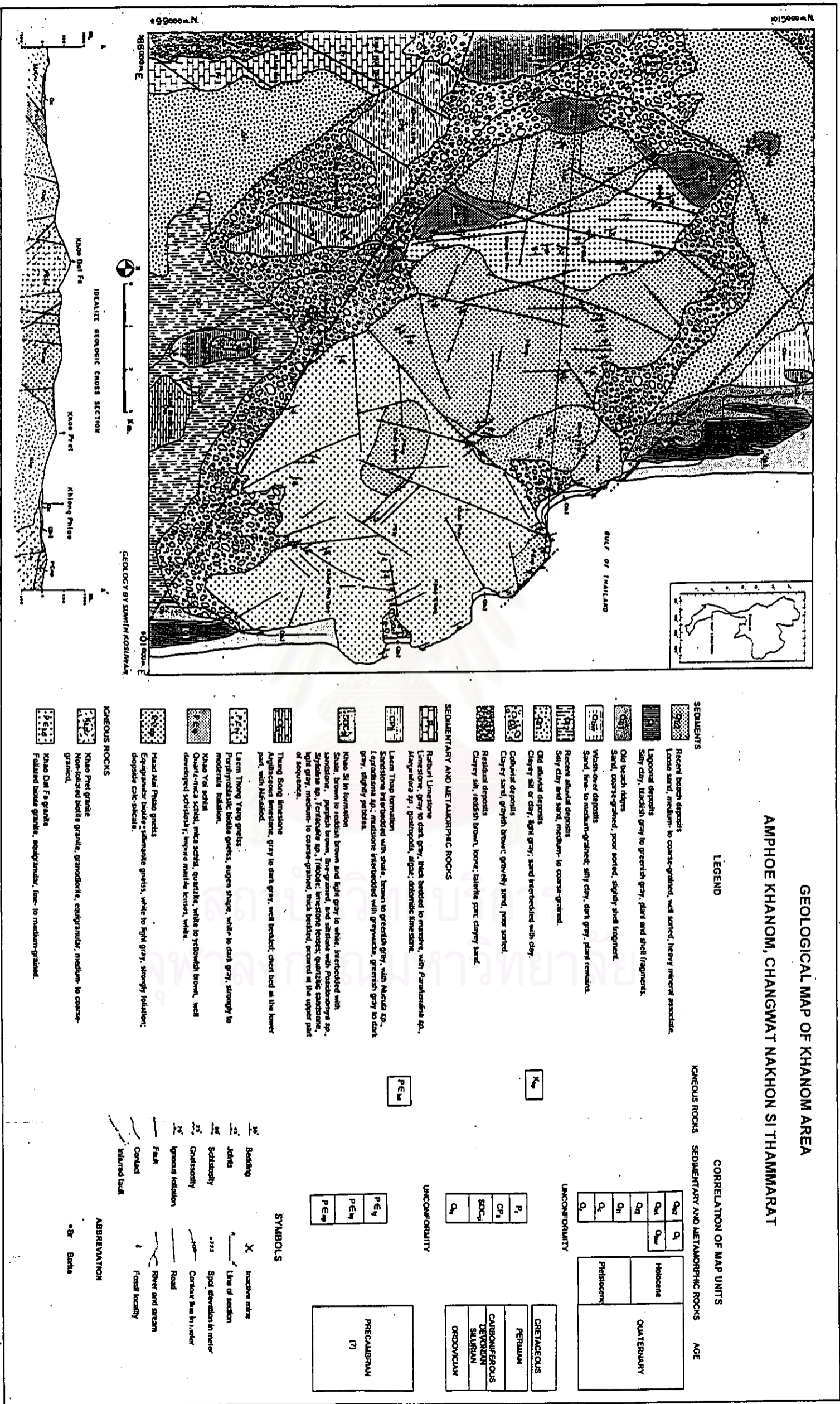


Figure 4.1. Geological map of the Khanom area (for Quaternary geology modified after Chaimanee, 1992).

is also a some minor intrusion (see also Figure 4.7.) which is minerallogically equivalent to leucocratic granite (shown in Figure 2.1) but its aerial extent is so small that it cannot be delineated in the map (not shown in Figure 4.1). In addition this granite is very friable and exhibits foliation parallel to the schist, making the classification of this granite more difficult. Petrography and geochemical studies are not able to be made because of its high weathering.

Modal analysis (10 samples) was carried out only on samples selected for chemical analysis. On an average, the granitic rocks are composed principally of 30% quartz, 50% alkali feldspar, and 20% plagioclase. The modal analysis was performed on the stained rock slabs using the technique described by Allman and Lawence (1972) (see also Appendix B). The results of analyses are plotted on the ternary system quartz (Q) - alkali feldspar (K) - plagioclase (P) following the recommendation of Streckeisen (1973), shown in Figure 4.2a. The modal compositions in the Q-A-P diagram reveal that nearly all the ( 9 ) samples have granitic composition (syenogranite and monzogranite).

#### Haad Nai Phlao Gneiss

The Haad Nai Phlao Gneiss occupies much of the central part of the metamorphic terrain extending from Khlong Tha towards the south at Khlong Tha Mun Si and Haad Nai Phlao in the east and the top of the Khao Luang. The Gneiss occupies approximately 25 km<sup>2</sup> (or about 10% of the total area mapped). Good exposures are found along the beach of Haad Nai Phlao.

The rock is mainly biotite gneiss and biotite-sillimanite gneiss, occurring in alternating layers, which posses differences in grain size (ranging from fine to coarse grains). The internal layers range in thickness from a few tens of centimeters to a few meters. It is noteworthy that the medium- to coarse- grained gneiss is remarkably

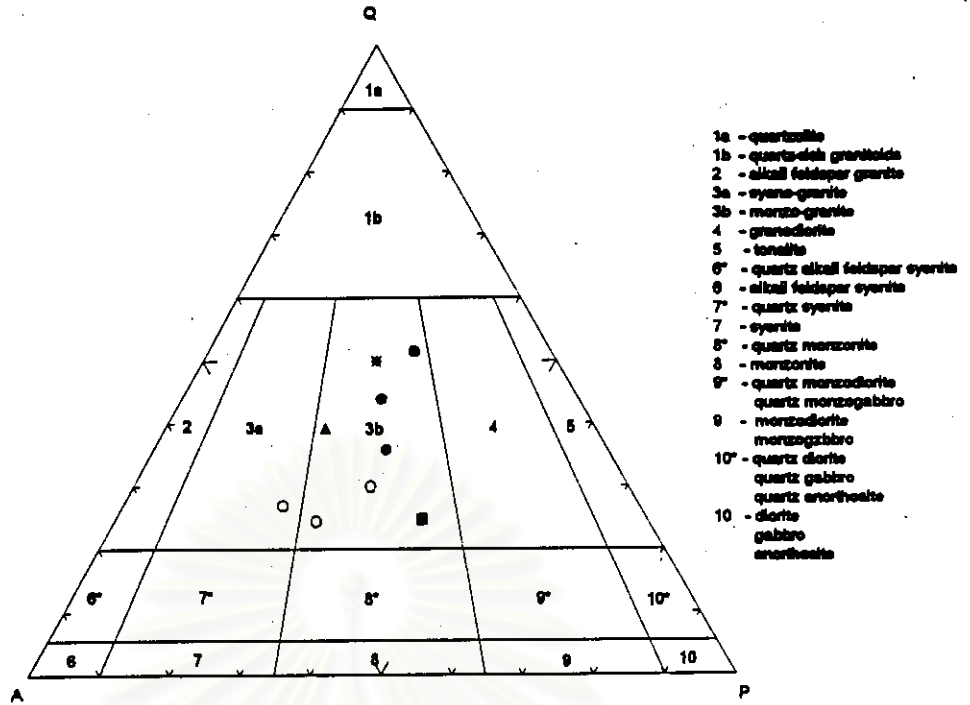


Figure 4.2a Modal quartz (Q), alkali feldspar (A), plagioclase (P) of the Khanom granitic rocks plotted in the classification diagram of plutonic rocks (Streckiesen, 1973).

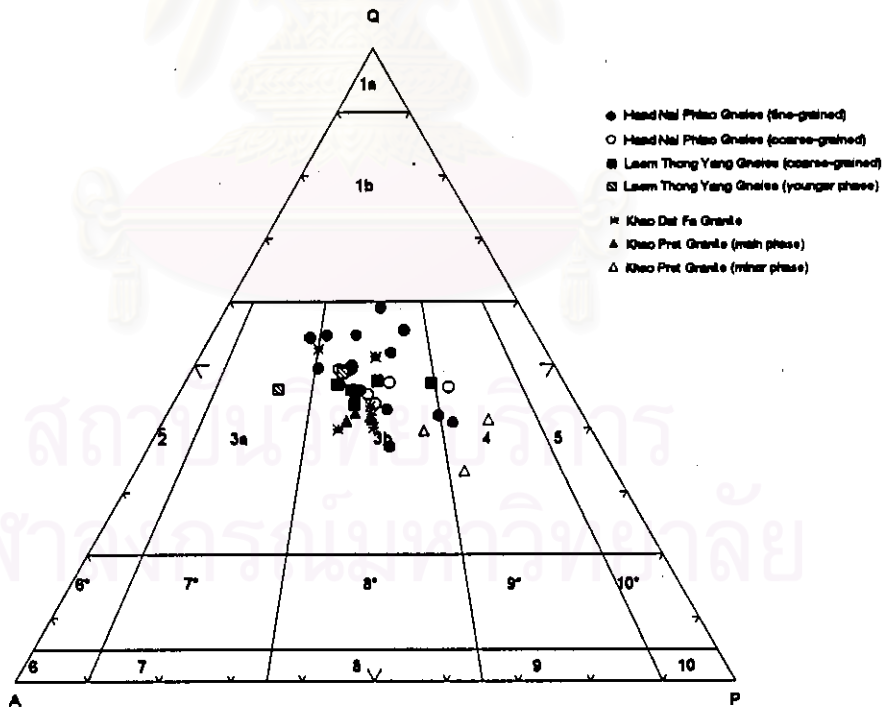


Figure 4.2b. Mesonormative quartz, alkali feldspar and plagioclase of the Khanom granitic rocks plotted in Q-A-P ternary diagram for comparison result to Figure 4.2a (Le Maitre, 1989).



porphyroblastic texture whereas the fine-grained gneiss is commonly equigranular affinity (Figure 4.3). These gneisses are cut by deformed pegmatites and aplites. The pegmatites, ranging in thickness from 10 to 150 cm, consist principally of large crystals of quartz, K-feldspar and muscovite with sparsely distributed fine- to medium-grained garnet (maximum size about 2 cm). The aplites, varying from 2 to 50 cm thick, comprise similar mineral constituents to the pegmatite. The aplites usually exhibit fine-grained texture and sometimes spatially associated with pegmatites. In a number of occurrences, the gneiss is outstandingly founded interlayered with calc-silicate rocks (see Figure 4.4). Calc-silicate rocks are fine-grained, finely laminated, with white to green and purplish-brown lamellae.

### Khao Yoi Schist

The Khao Yoi Schist crops out mainly at the western rim of the metamorphic terrain. It extends from Khao Yoi, Khao Noi, Khlong Sarnak San, and Ban Khlong Leng. The Schist covers an areal extent of about 5 km<sup>2</sup> (or approximately 2 % of the mapped area). The unit consists commonly of schists and quartzites, with lenses of calc-silicate and marble (up to 2 m thick) occasionally intercalated in schist. The schist, which forms the lower part of the unit, comprise yellow coloured mica schist, light yellow muscovite-garnet schist and yellowish brown quartz-mica schist. The quartzites, the upper part, include greyish white to brownish yellow quartzite, brownish grey micaceous quartzite and dark brown fine-grained quartzite. The overall thickness of schist is about 10 m. Field investigations indicate that quartzites have been underlain by schists, and the actual contact between the two rock has been found at Khao Yoi quarry (earth open pitting, Figure 4.7). However, the contact with Haad Nai Phlao and the other gneissic rocks are observed.

The lower part of the Khao Yoi Schist is interrupted by unit occurring as fine- to medium-grained leucocratic granite intrusion, and the schist and carbonate lenses are thermally metamorphosed to become spotted schist, schistose hornfels and skarn

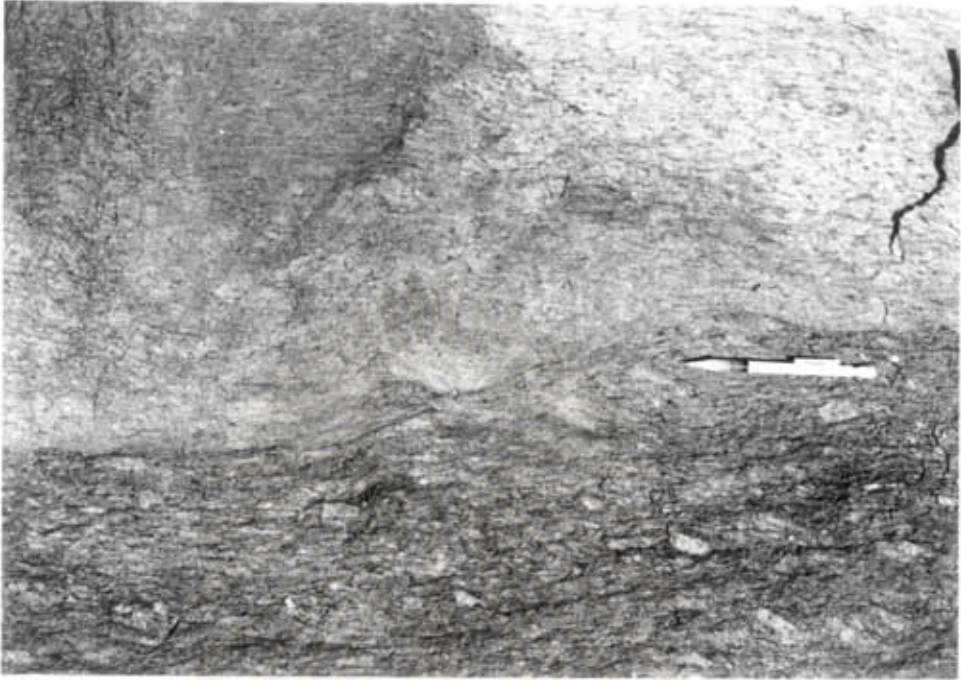


Figure 4.3. An wave-cut outcrop of the Haad Nai Phlao Gneiss, located 1 km east of Haad Nai Phlao, showing differences in grain size between fine-grained equigranular and porphyroblastic gneiss. Note a sharp contact between these two gneissic types.



Figure 4.4. Both equigranular and porphyroblastic gneisses, belonging to the Haad Nai Phlao Gneiss are cross cut by deformed aplite at Laem Nai Phlao area.



Figure 4.5. Parallelism of foliation in gneissic and calc-silicate rocks found in the Haad Nai Phlao unit at Nai Phlao seaview area with the attitude of  $325^{\circ}/60^{\circ}$ . The parallelism indicates that both rocks were emplaced under the same stress-strain environment.



Figure 4.6. Garnet crystals (small reddish brown) within mica-garnet schist of the Khao Yoi Schist, at Khao Yoi area (grid 895118/4927 II ).





Figure 4.7. A small tractor-cut exposure of leucocratic granite (right) cut mica schist (black) at Khao Yoi quarry front (grid 892131/4927 II). Dr. Punya Charusiri as a scale.



Figure 4.8. A rock feature of the Laem Thong Yang Gneiss, located at Thong Yang bay, showing subrectangular to augen-shaped megablasts of K-feldspar. The rock is markedly porphyroblastic, strongly foliation and protomylonite of  $330^{\circ}/75^{\circ}$  attitude, indicating sinistral movement.



rocks. The granitic rock, itself, exhibits metamorphic fabric exemplified by a well-developed foliation parallel to schistosity ( $S_1$ ) of the schist. Leucocratic granite, as its name denotes, is typically whitish in colour because of lack of ferromagnesian minerals.

### Laem Thong Yang Gneiss

The Laem Thong Yang Gneiss is the most dominant rock unit of the study area, which is well outcropped in eastern and southern parts of terrain. It is found at Khao Phae, Khao Klang, Khao Phlai Dam and Laem Thong Yang. This gneiss outcrop occupies about 40 km<sup>2</sup> (or approximately 20% of the study area). This unit consist principally of biotite gneiss, with quite abundant alkali feldspar megablasts and moderate to strongly foliation. The matrix foliation, outlined mainly by elongate, lenticular aggregates of fine-grained quartz and biotite, wraps around the megablasts. Figure 4.8 shows augen tails of fine-grained, recrystallized mineral aggregates which indicate sinistral sense of movement. In the field at Laem Phlai Dam area, the deformed aplitic rocks (25 cm maximum thickness) cut porphyroblastic gneiss, and the late stage, veinlets of undeformed pegmatite cross cut both rocks as well as have pelitic xenoliths (biotite-feldspar inclusions) and quartz lumps. Composition of pegmatites consist of large grains of quartz, K-feldspar, muscovite and tourmaline. The aplitic rocks comprise similar mineral to the pegmatite, both veins with quite densely fine grained garnet. The porphyroblastic gneiss is cut parallel to subparallel with the main foliation by younger- phase fine-grained, equigranular, biotite gneiss, before deformation by early tectonic event (Figure 4.9).

So far the nature of the relationship between the Haad Nai Phlao Gneiss and the Laem Thong Yang Gneiss is not clear.



Figure 4.9. A natural outcrop of the Laem Thong Yang Gneiss, showing fine-grained biotite gneiss encloses and cuts porphyroblastic gneiss suggesting that the former is younger than the latter, at Laem Thong Yang area (grid 997066/4927 II).

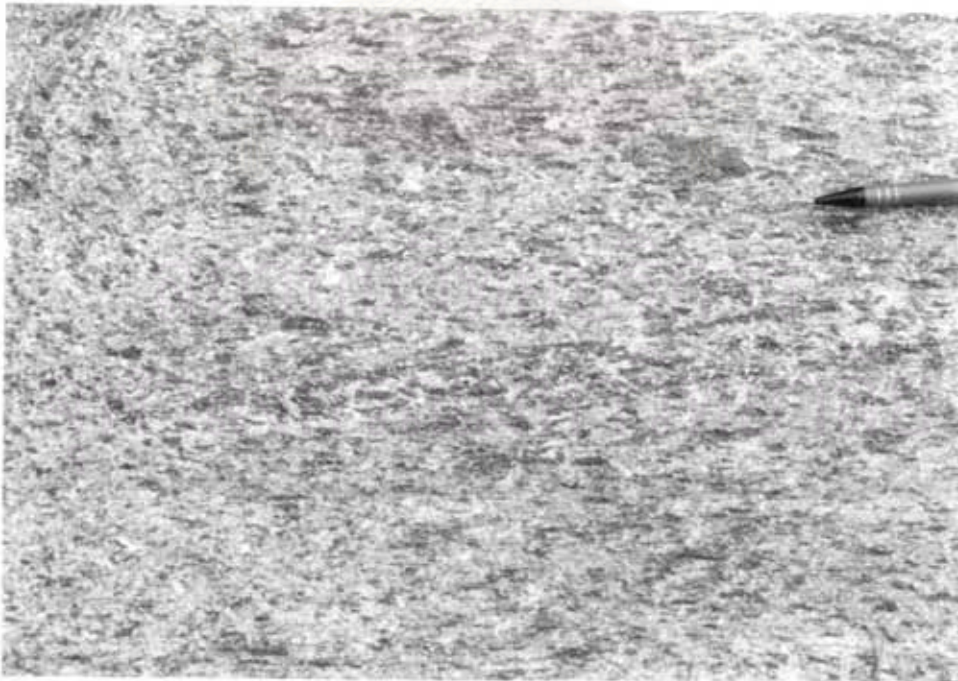


Figure 4.10. An outcrop of the Khao Dat Fa Granite, showing well-developed schistosity marked by parallel alignment of micas at Khao Dat Fa area.

### Khao Dat Fa Granite

Khao Dat Fa Granite, is well outcropped at the peak of the main mountain in the central part of the area, i.e., Khao Dat Fa. Well exposures are found as nature and artificial exposures along the road upward to the microwave relay station. The granite covers an areal extent of about 10 km<sup>2</sup> (or approximately 5% of the mapped area). It is generally characterized by well orientation of platy minerals (Figure 4.10) including biotite. The biotite is the major mafic mineral. In general Khao Dat Fa Granite is characterized by fine- to medium- grained, equigranular, biotite granite. Garnet pockets are commonly seen. The garnet is reddish brown in colour and its size varies from 3 to 5 mm. This rock is typically slightly foliation. Structural trends are generally north-south and moderately to steeply dipping. The pegmatites have been found cutting this granite. There is no evidence of foliation of platy minerals such as biotite and muscovite which indicates that the pegmatites must be emplaced after the strong deformation event.

### Khao Pret Granite

This unit is distinguished from the others by the non-foliated feature. Apparently it represents a new phase of igneous activity emplaced in this area. The youngest rocks in the complex area assigned as the Khao Pret Granite and can be geographically subdivided into 2 terrains, namely the western terrain - light grey biotite granite, and the eastern terrain - pale grey biotite granite gradational to minor- phase granodiorite (Figure 4.11), the latter collected from a float and interpreted as inclusions in granite. These rocks are usually fine- to medium- grained, phaneritic in texture.

From this current study it is considered that the Khao Pret Granite crosses cut the Haad Nai Phlao Gneiss and the Laem Thong Yang Gneiss, at Khlong Tha and Khlong Phlao, respectively. Unfortunately, it is quite difficult to observe the contact with the others, as Khao Dat Fa Granite, due to the scarcity of exposures and thick top

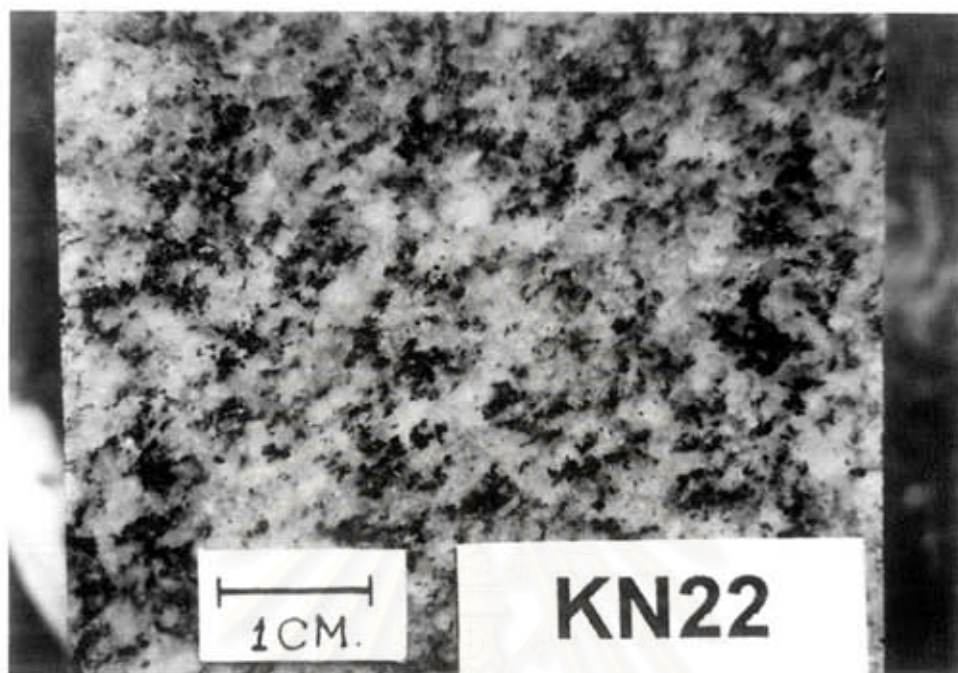


soils. Both granitic terrains occupies approximately the total area of 10 km<sup>2</sup> (or about 5% of the mapped area).

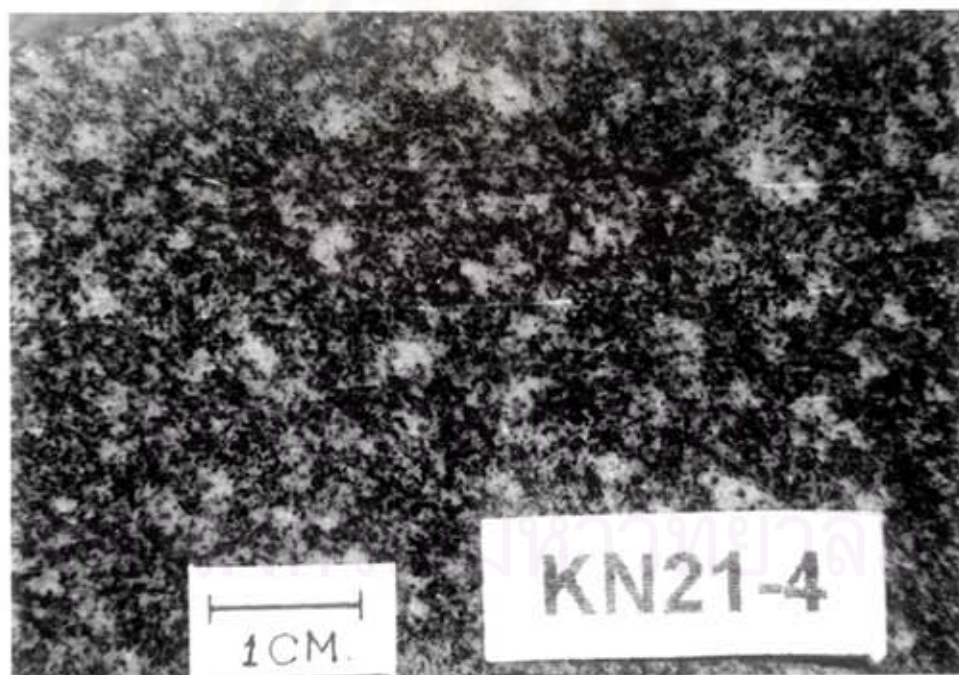
Among the other granitic rocks, Khao Pret Granite is considered herein to be the youngest phase of the Khanom area. It crosses cut the Haad Nai Phlao and Laem Thong Yang Gneisses in the eastern part of the mapped area. The Khao Pret Granite has a close field relationship, both temporally and spatially, with the undeformed pegmatite and quartz veins. These minor intrusives are mostly abundant in muscovite and barite. The latter has been mined intermittently til present, particularly at the southwestern contact zone between granites and country rocks. The major trend is in the NNW- direction and their thickness varies considerably from 0.2 to 1 m.



สถาบันวิทยบริการ  
จุฬาลงกรณ์มหาวิทยาลัย



(a)



(b)

Figure 4.11. The slabs of biotite granite, major phase (a) and granodiorite, minor phase (from float) (b) of the Khao Pret Granite, showing differentiation of dark minerals content in rocks.