

CHAPTER I
INTRODUCTION



1.1 General

Among economic minerals commercially produced in Thailand, tin has long been and remained the most important mineral. Phuket, the largest Island off the Andaman coast in the southern part of Thailand has been called the birthplace of tin mining in Thailand. Several historical evidences indicate that tin mining in Phuket has been going on for at least 450 years. In the olden days, Phuket was the trading post for tin, amber and pearl in Asia controlled largely by Dutch, Chinese, French, British and Portugese merchants.

Tin ore from Phuket Island is entirely in the form of cassiterite, SnO_2 . Almost all of the cassiterite deposits which had been exploited in the past were believed to be of secondary origin or placer deposits. Within these placer deposits, cassiterite occurs as stable heavy mineral associated with other detrital minerals. These detrital minerals, which many of them are called heavy minerals (specific gravity greater than 2.898), are mainly liberated from the granitoid rocks and their derivatives under the influence of tropical weathering.

The economic importance of a tin ore within Phuket Island is apparently illustrated in terms of the total production of 374,716 metrictons of tin concentrates between 1871-1982. Besides, there are other economic heavy minerals, namely, wolframite, monazite, zircon, rutile, columbite-tantalite, xenotime, etc. being produced as by-product of tin mining.

Despite the fact that tin ore as well as other heavy minerals have considerably contributed to the economy of Thailand, very little has been done on the scientific aspect regarding these minerals. It is realized that with each technological improvement in the beneficiation, older deposits will be returned to production in a very near future. Besides, there will be an increasing new demand for by-products. In this regard, several areas of scientific study on heavy minerals which are of totally ignorant might be at once apparently needed. The present investigation is therefore considered to be most appropriate not only for the purpose of scientific innovation, but also for the future economic development of mining industry. Furthermore, the design of the study programme will be more or less suitable for similar investigations elsewhere with the same geological setting in Thailand.

1.1.1 Purpose of the study

The general purpose of the present investigation is to study the heavy mineral associations of 15 tin-mines in Kathu valley and neighbouring area of Changwat Phuket. Additional attempt has been made to describe the physical properties of each mineral, grain-size distribution, degree of abundance, and their interrelationships. The synthesis of mineralogical data and information will be used as guide lines to the primary sources and the origin of heavy mineral associations concerned.

1.1.2 Study area

Kathu Valley is located in the central part of Phuket Island covering an area of approximately 10 square kilometres. The valley is elongated in the northwest to the southeast direction, with approximately 3 kilometres in width and 5 kilometres in length. The average ground elevation of the Valley varies within the

range of 10 to 12 metres above mean sea-level.

The Valley is bounded by Khao Che Tra and Khao Bang Nieo Dam in the north, Khuan Wa and Khao Mai Thao Sip Song in the west, Khao Na Kha in the south and Khao Phanthurat in the east. The Valley itself is the junction for all of Klong Bang Thong tributaries which eventually form Klong Ket Ho and Klong Bang Yai flowing eastwardly and southwardly passing through Phuket city center, respectively. (Fig. 1.1.2)

The geomorphology of the Valley floor is generally flat to slightly undulating with a regional slope of the ground surface dipping towards the southeast direction. Almost all of the area in the central part of the Valley is the rubber plantation, pineapple plantation, derelict land of tin-mines, and a few active tin-mines. Urban and suburban areas of Amphoe Kathu are confined along the secondary road number 4020 which runs around the border zone of the Valley.

The climate of the area is tropical monsoon with heavy annual rainfall (2400-2800 mm.), fairly uniform high temperature (26-28°C). Through all the year, there is at least 6 months of heavy rainfall without distinct dry and cold season. The wind speed varies within the range of 4-6 knots in the northeast/southwest and east/west directions. The average annual relative humidity is 75-80%, and the annual evaporation is 800-1,000 mm.

1.1.3 Previous investigations

The first brief geological reconnaissance of Phuket Island was made by Lee (1923) for the Department of State Railways. An investigation of wolfram deposit at The Khao To Se granite near Phuket was reported by Buravas (1941), and other details of tin mineralization in Phuket and Phangnga was given in an unpublished

98° 15'

98° 30'

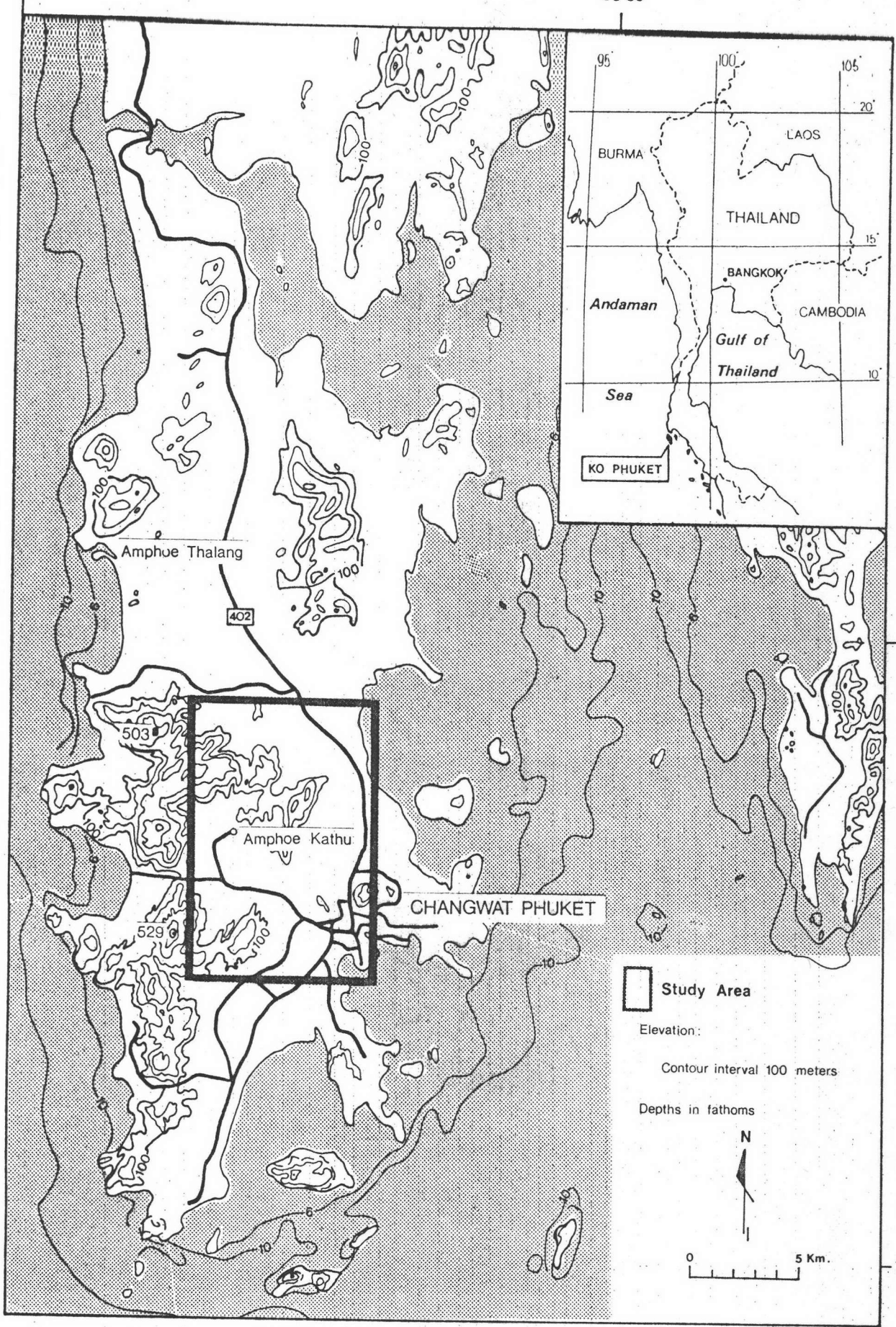


Figure 1.1.2 Map showing the study area: Kathu Valley in the geographical setting of Changwat Phuket.

report by Kaewbaidhoon and Isarangkoon (1948). Later on, Buravas (1951) gave a short review on the geology of Phuket Island with special emphasis on tin and tungsten mineralization and tin mining. Besides, the occurrences of "Eophyton" indicating a doubtful Cambrian age for the Phuket Group on Phuket Island was reported in Brown and others (1951). The distinctions between an Older Granite Series of Triassic age which are mainly hornblende-biotite-granites and Younger Granite Series of late Cretaceous age consisting of muscovite-biotite-granites with tin and tungsten mineralization was also reported.

Aranyakanon (1955) reported the discovery of diamonds in the Ban Kathu area of Phuket Island. Later, Bleackley (1965) confirmed the diamond found by determining the heavy minerals in 16 samples collected from tin mines and dredges. The geology and mineral deposits of the Phuket Mining District was comprehensively reported for the first time by Hummel and Phawandon(1967).

The first joint investigation of heavy minerals other than tin in the Phuket and Phangnga regions between Department of Mineral Resources and CCOP was conducted and reported by Noakes (1967). This report particularly referred to tantalum and niobium pentoxide concentrated in slags at the tin smelter regarding to ore of tantalum and niobium from tin mines. Subsequently, Macdonald (1969), a technical advisor on detrital heavy mineral deposits under the Government of Commonwealth of Australia made a preliminary assessment of potential valuable heavy minerals associated with tin mines for further recovery. Emphases were given to all low grade tin placers along the coast of Phuket Island. Poothai and others (1969) conducted geological investigation of the heavy minerals of alluvial and beach deposits along the coast of southern Thailand and in some gravel pump mines of Phuket-

Phangnga areas.

The distribution of heavy minerals collected from dumps of tin mines in Phuket and Phangnga area was studied by Israngkoon (1973). The behaviour and application of heavy minerals in the geochemical prospecting for tin deposits was studied by Gocht and others (1978) in Phuket and Ranong areas. Later on, Gocht and others (1979) further analyzed spectrochemically the trace elements containing in some heavy mineral associated with cassiterite in Phuket including the evaluation of by-product heavy minerals in tin-mines. In addition, Gocht and Pluhar (1982) studied heavy mineral assemblages in tin-bearing pegmatites from some tin mines in Kathu valley in order to classify different types of tin-bearing pegmatites as well as to assess new resources for tantalum. Recently, Gocht and Strobel (1983) concluded that there are two main types of pegmatitic mineralization which can be characterized by mineral indicators. Besides, CCOP Project reported the sedimentological aspects of a series of open-cast tin mines in Phuket and further concluded that the occurrence of coarse-grained cassiterite are mainly beach gravel.

1.2 Geological Setting of Kathu Valley

Kathu Valley is mainly floored by surficial deposits of different origins including eluvium, colluvium and alluvium of Quaternary age. The term eluvium is used here to include those surficial deposits consisting of loose rock debris which has been weathered in place whereas, the term colluvium is very similar to eluvium in terms of sediment characteristic except the colluvial deposits usually occurs toward the base of slopes where gravity has been more important than running water in transporting the debris.

The most north-western part of the Valley is bordered by the coarse-grained porphyritic biotite granitic rocks of Khao Bang Nio Dam and Khao Khuan Wa. The granite terrain is invariably rugged which is characterized by steep-side valley with large accumulation of granite boulders and floats along the floor. Generally, the granites are highly weathered under tropical monsoon climate and dense vegetative cover. Most of the rocks are highly porphyritic and more or less lineated. The lineation in this case is defined by the arrangement of potash-feldspar phenocrysts and some mafic minerals of the groundmass, such as, biotite. The direction of lineation is approximately NNW-SSE. This type of granites is a major phase of the Phuket Plutons. The radiometric age of the granitic rocks from this area according to Putthapiban (1983) is 98 ± 7 ma. (Rb/Sr total rock isochron). It is noted that the southeastern boundary of granitic rocks of Khao Bang Nio Dam and Khao Khuan Wa is marked by a fault trending northeast to southwest.

The southwestern part of the Valley is flanked by another type of granitic rocks of Khao Mai Thao Sip Song. This type of granitic rocks is mineralogically and texturally different from the granitic rocks in the northwestern part of the Valley. They are characterized by medium-to coarse-grained biotite muscovite granite with distinctive foliation associated with fine-to medium-grained biotite muscovite granite. The radiometric age of these granitic rocks according to Putthapiban (1983) is 84 ± 1 ma. (Rb/Sr total rock isochron).

The southern part of the Valley is bordered by the coarse-grained porphyritic biotite granitic rocks similar to those in the northwestern part of the Valley. The granitic rocks at Khao Na Kha in the southern part of the Valley occur as minor pluton.

The northeastern part, some central part, and the proximate southwestern part of the Valley are marked by the presence of sedimentary rocks of Phuket Group. The sedimentary rocks are mainly exposed at Khao Phanthurat in the northeastern part of the Valley. The fault-contact between sedimentary rocks of the Phuket Group and the coarse-grained porphyritic biotite granite is very distinctive and oriented in a similar manner to the major strike slip faults in the peninsula, namely, Ranong Fault and Klong Marui Fault. The sedimentary rocks in the southwestern part of the Valley particularly at the footslope of Khao Mai Thao Sip Song and Khao Khuan Wa also show sharp fault-contact with granitic rocks. Field evidences indicate that the age of the faulting is post-dated the granitic intrusion. Within the central part of the Valley the sedimentary rocks of the Phuket Group sporadically exposed on the Valley floor.

The sedimentary rocks of Phuket Group are characterized by reddish brown to purple shale, siltstone and mudstone with scattered pebbles of mostly pegmatitic quartz and granite of various sizes. The beds are generally steeply dipping. In general, the attitude of bedding varies in strike direction from N to NE and in dip angle from 10° to 45°. These rocks have undergone metamorphism by igneous intrusion and in places by tectonic displacement. They are metamorphosed to some extent, as either light colour phyllite grading to reddish brown mica schist or dark coloured hornfelsic rocks. Along the contact zone, these rocks composed of greenish to brownish massive hornfelsic mudstone and locally by fine-grained brownish yellow quartzite with plexus of quartz veins and small pegmatites. The large pegmatites and other small intrusive bodies are quite abundant in these rocks. In the upper succession of the Phuket Group, fossils had been found at Laem

Mai Pai, Changwat Phuket (Hintong and Sinsakul, 1977).

These fossils have been identified by Waterhouse (Pers. Comm., 1981)
Martinia sp. and Brachythyrina (Carboniferous to Lower Permian).

The geological map of Kathu Valley and adjacent area, partly modified after Charusiri (1980) and updated by the present investigation, is illustrated in Figure 1.2

GEOLOGICAL MAP OF THE STUDY AREA

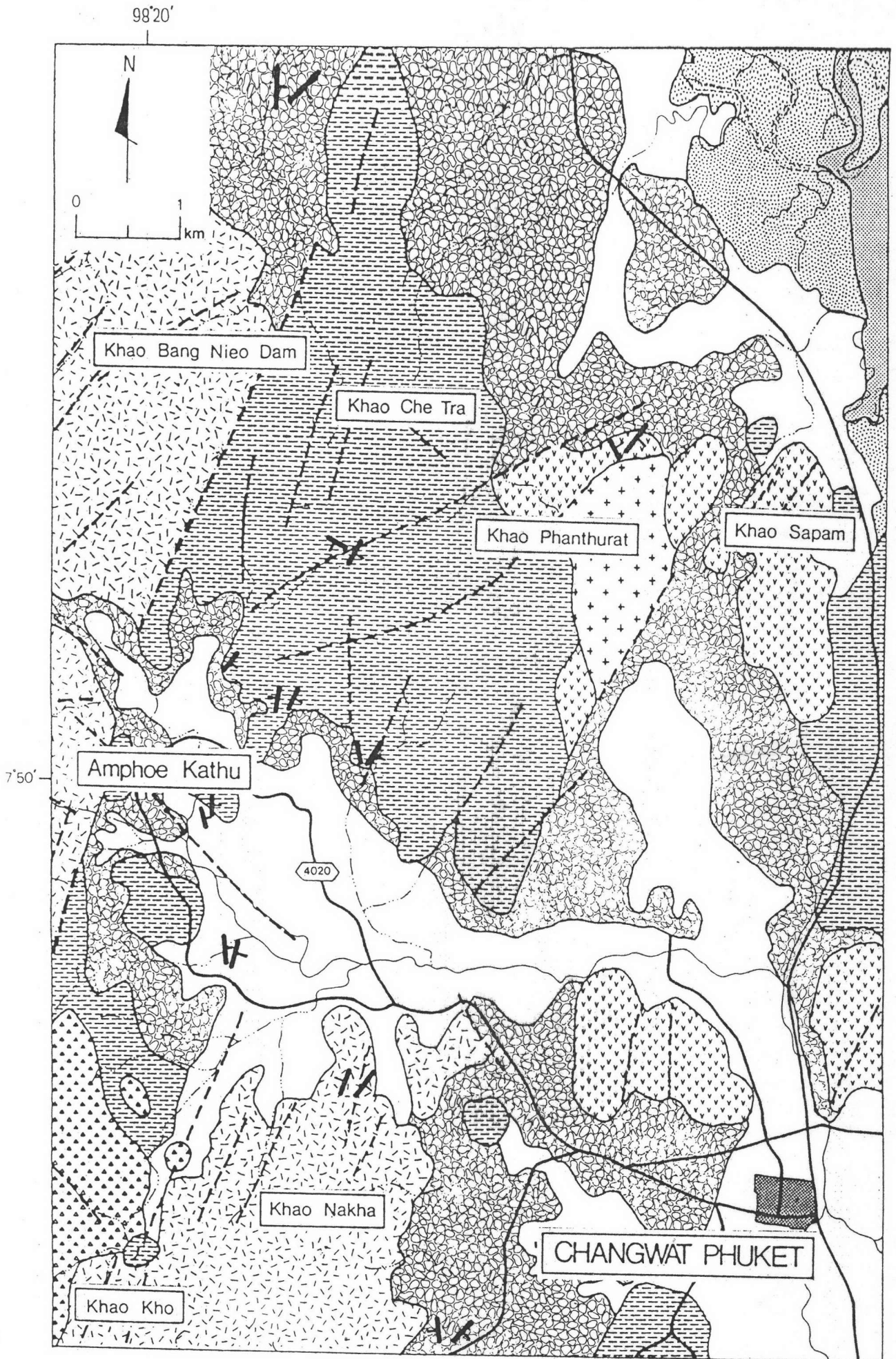


Figure 1.2 Geological map of the study area.
(partly modified after Charusiri, 1980)