CHAPTER I

INTRODUCTION

1.1 Location

The area under study covers the middle part of the Phuket Island (Figure 1), about 900 km south of Bangkok on the west coast of peninsular Thailand. It is bounded by lattitudes 7° 52' 12" and 7° 57' 36" N and logitudes 9° 15' 24" and 9° 26' 48" E, encompassing an area of approximate 210 km^2. This includes three major districts, namely Amphoe Muang Phuket, Amphoe Thalang, and Amphoe Kathu. The mapped area covers the middle part of 1:50,000 topographic map of Changwat Phuket, sheet no 4625 II, series L 7017.

1.2 Physiography

Landtype : There are two major kinds of landtypes predominating in the area, the upland and the lowland. At least two-third of the studied area belongs to the first landtype including mountains and hills, intermontane basins and narrow deep valleys. Two trends of mountains and hills are recognized. The first is N-NE extending from the west part to the south-central part. The steep slopes of hilly topography are formed by granite complexes. The second one forms a rolling topography of small patches of isolated, low and less steep, hills trending N-S. This trend is confined to the eastern part and is composed of granites and sedimentary rocks.

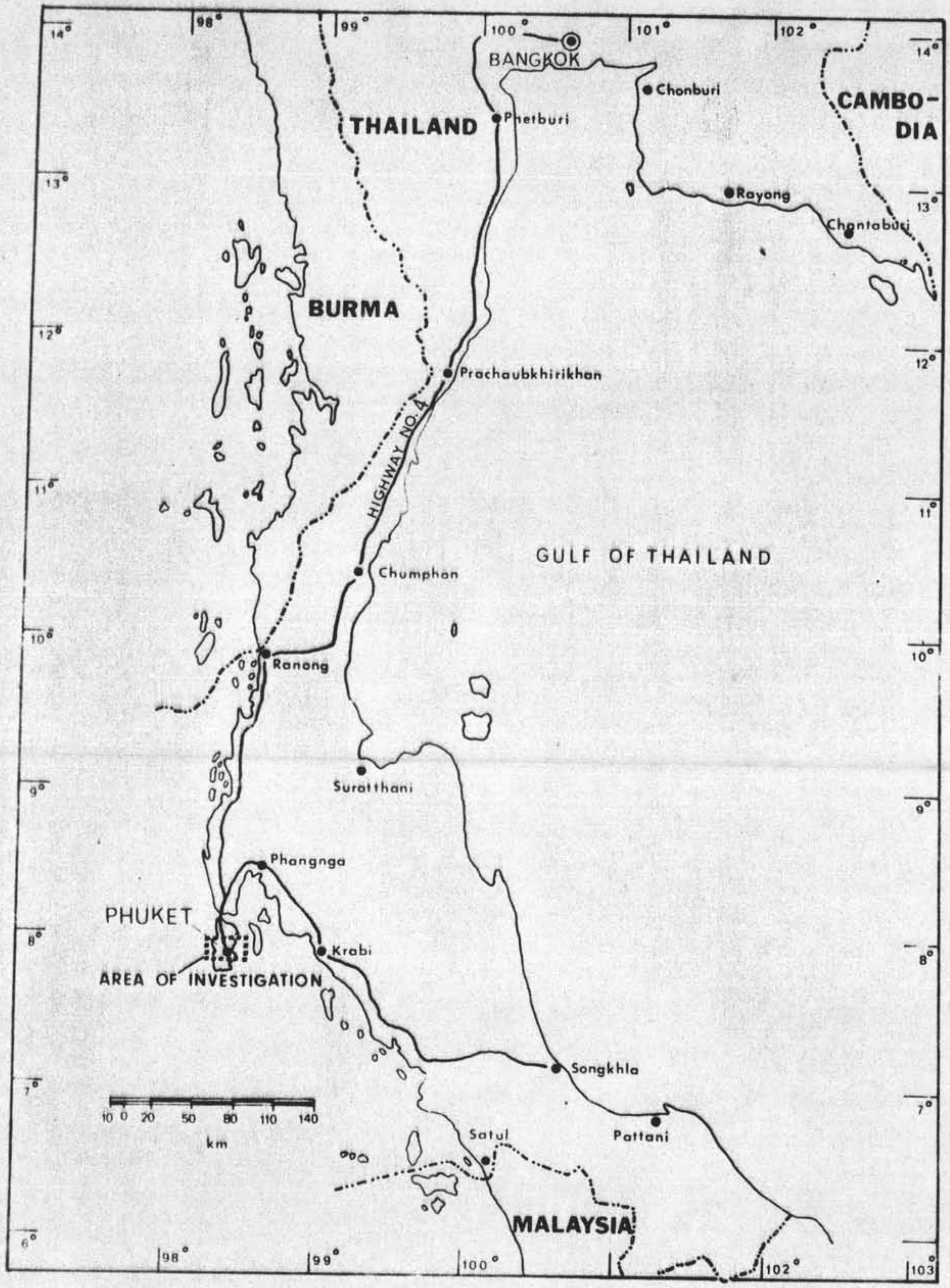

FIGURE 1. LOCATION OF THE STUDIED AREA.

The maximum elevation is 529 m at Khao Mai Tao Sip Song. Numerous mountains have their height exceeding 100 m above mean sea level. Broadly speaking, the physiographic features are strongly influenced by faulting and granite emplacements.

The lowland part of the area includes colluviums, flood plains, beach deposits and mangrove swampy areas. Major alluviums appear in the central part, especially around Phuket Town whereas sand and gravel beach deposits, and mangrove swamps of tidal flat develop near the western and eastern shorelines, respectively.

Drainage : Short branches of streams in the western part of the area, where mountains and hills are the main features, form a dentritic pattern. Also short streams received water from higher catchment and flow westerly. In the central and eastern parts where more extensive plains develop, they are drained by permanent streams and river, Klong Ket Ho, Long Bang Yai, and the Phuket River. All flow south easterly passing through Phuket town. Due to several steep slopes of the mountains, many small beautiful waterfalls occur (such as Kathu Fall, Wang Chi on Fall) which are main tourist attractions.

Shorelines and their developments : Regionally, the numerous features of shorelines in Phuket seem to be rather complicated in their genesis. As suggested by Brown and others (1951) the shorelines are probably of submergence type which are the same as in the entire western coast of the peninsula. This is evidenced by the appearance of the drowned river courses and valleys at certain bays. On the other hand, Hummel and Phawandon (1967) reported that there exists evidence of previous high sea level caused by glacial retreat. There are several small exposures of dark coloured shales and mangrove remains which lie above the present coast line particularly at Ban Sapam area. These are favoured for the emerg ent evidence. However, it is now believed that those features indicative of previous high sea levels are possibly result of Quaternary eustatic oscillations.

1.3 Climate

The Phuket-Island climate can be classified as the tropical rainforest climate (as illustrated by Trewartha (1954) in his world climate map) with fairly uniform high temperatures and heavy rainfall throughout the year without distinct dry-cold season. The statistics produced by the Royal Thai Meteorological Department for Phuket during 1951 to 1975 reveal that the highest and lowest temperatures are about 36.2°C and 16.9°C, respectively. There are at least 6 months of heavy rainfall which are predominated by southwest monsoon rather than northeast monsoon. The yearly average rainfall is about 2,379 mm. The two highest rainfall peaks develop during the periods of transitional directions of monsoons.

1.4 Accessibility and Communication

Accessibility of the studied area is moderately good. The Highway No.4, a good metalled road, is the main artery connecting the island to the mainland and further to Bangkok (Figure 1). There are two main roads reaching outlying areas from Phuket Town to Ban Kamala in the north, and to Kathu district and Haad Patong in the west. There are many soft-surfaced roads which at times, especially in rainy seasons, may not be passable for conventional vehicles. Most of them lead to larger mines, and some to rubber plantations. Other secondary tracks lead to logging operation-sites, rice fields, pineapple plantations, and smaller mines. These roads can be used only during the so-called dry season. Most of the steeper and seldom-used tracks have long been abandoned. They are in poor condition and many of them are largely overgrown. In some places, particularly the northwest mountaineous areas, there are only a few trails in dense forest. This mades it difficult to do detailed systematic geologic mapping and sampling in those areas.

1.5 Previous Work

Numerous studies of geology, mineralogy, and mineral deposits in Phuket region have previously been done by many geoscientists. Brief describtions of geology and general review of mineral deposits of Phuket were early reported by Lee (1923) and Brown and others (1951). Aranyakanon (1965) described the discovery of diamonds at Ban Kathu area of Phuket Island. In 1965, Bleackly confirmed the diamond found by determining the heavy minerals in sixteen samples collected from tin mines and dredges.

The first report on the systematic survey of the geology and mineral deposits of Phuket mining district with a geological map (scale 1:50,000) was completed by Hummel and Phawandon in 1967. On reconnaissance scale, samples from various beaches and mines have been examined by Noakes and Poothai (1967) and subsequently by Macdonald (1969,1971), Poothai and others (1969) in order to make a preliminary study and evaluation of heavy mineral prospects. In addition, the investigation of the source of the diamonds (probably from Phuket Group) and a photogeological map

(1:125,000) were published by Stephens and Bateson (1966).

A more detailed study of stratigraphy and economic geology in Phuket Phangnga and Takua Pa region has been done by Garson and others in 1968-1969. They also published the geological map of this region at a scale of 1:125,000 and the anomaly maps for W, Ni, As, Cu, Pb, Zn, etc. of the same scale in 1975. Ridd (1971), in "The Phuket Group in peninsular Thailand", firstly reported against Brown and others (1951) that the Phuket Group was not of Cambro-Ordovician age. Bignell (1972) studied the geochronology of the peninsular Thailand's granites (including Phuket) and concluded 3 possible major intrusions; of Cretaceous, Triassic and Carboniferous ages. Subsequently, detailed studies of the distribution of heavy minerals, both in tin ores and beach deposits in Phuket have been carried out by Israngkoon (1973). Study of the petrochemistry of probably Triassic coarse-grained porphyritic, leucocratic granite from the western off-shore islands, nearby Phuket was firstly accomplished by Rasrikriangkrai (1976).

Recently, Suensilpong (1977) had made a field-study of the granites around Phuket Island, and suggested that by applying a plate tectonic model for tin deposits, Tertiary would probably be the age of tin mineralization in the area. In order to reveal the behaviour of heavy minerals associated with cassiterite for the application of geochemical prospecting methods for tin deposits, Gocht and others (1978) have studied the placer tin deposits in Phuket and Ranong. Also several samples of granites were collected and geochemically and petrographically studied. Traub and Moh (1978), Gocht and Pluhar (1979) and Arndt

(1979) have further analyzed spectrochemically the trace elements contained in some tin ores in Phuket. Recently, Mantajit and others (1979) make a detailed study of the Phuket Group, particularly along the eastern part of Phuket Island. Beckinsale (1979), Beckinsale and others (1979), Suensilpong and Putthapiban (1979) have presently described some aspects of tin-bearing granite and its relations to tectonic setting and also concluded that the tin-bearing granite is of sedimentary-derived origin and can possibly be classified as younger granite.

1.6 Scope of Investigation and Method of Study

The aim of this thesis is to study in detailed petrology, mineralogy and geochemistry of granite and certain closely related minor intrusives in the central part of Phuket Island. The study also covers the behavior of tin in part of the granite sequences. In addition, it intends to determine the proper phases and characteristics of mineralized tin-bearing granites. This will lead to the explanation of the related tin deposits which consequently can be applicable to tin exploration in other areas. From this study, the granites in the area can be further delineated and subsequently the geologic map, scale 1:25,000, is present in a greater detail.

The total fieldwork period is about three months, comprising three stages of investigation. Firstly, the regional reconnaissance survey was conducted at the end of April, 1978 . included selecting the target area and its accessibility. Secondly, the detailed field mapping was completed in part of May, July, November and December, 1978. The third stage was accomplished in April, 1980 and included field checking and mining-data collecting. Along with the fieldwork and also at the stage of field preparation, the aerial photogeological interpretation at a scale of 1:15,000 was carried out and the interpreted data were subsequently used during the field mapping.

The sampling technique adopted in this study is traversing across the granitic plutons and collecting samples at a rather random spacing (Map 1). This is due to the lack of good exposure and to the unequal distribution of outcrops. Of 250 samples collected, 200 are from exposures along the streams and creeks as well as on the spurs and ridges, and 50 are from quarry fronts. In some areas the granites appear to be weathered. In this case, to obtain fresh samples, blasting and sledging were needed. Nevertheless, those samples collected for the thin-section studies and particularly chemical analyses are quite fresh and they are representative of the whole area.

The laboratory work involved the microscopic study of approximately 100 thin sections. Anorthite contents of plagioclase were determined by Rittman Zone Method using the four-axis universal stage. Modes were determined in 2 different ways depending upon the grainsizes of the granites. For the coarse-grained varieties, it is obtained by counting averagely 1,000 equal spaced points on one side of 32 rock slabs. And for the fine-grained varieties, it is obtained on the basis of 2,000 point counts of 11 stained thin sections.

Applying the method modified after Norman (1974), feldspar could be distinguished from quartz. In this method, plagioclase was selectively stained as light yellow whereas potash feldspar as deep yellow which will be obviously distinct from the unstined quartz. All the rock-slab specimens were sawed at the Department of Mineral Resources in such a way that the surface area for modal counting, exctpt for those of the medium-grained varieties, exceed 70 cm^2. Of the mineral appearing in the slabs, biotite, opaque minerals and other accessories are quantitatively classified as mafic minerals and then summed up resulting in the total mafic mineral content of the specimens.

The fresh granite samples for chemical analyses were crushed by a jaw crusher and ground into powder by the disc mill with tungsten carbide vessels. The average weight of samples is about 1 kg. The major-oxide analyses were carried out by using the method of two-solution procedure revised by L. Shapiro (1975) and in this study a total of 25 granites were analyzed. There were 6 major oxides (SiO_2, TiO_2, Al_2O_3, FeO, TiO_2, MnO and P_2O_5) determined by colorimetry method and 4 of the alkalines (MgO, CaO, K_2O, and Na_2O) by the atomic absorbtion spectroscopy. In the latter method, the experiments were performed at the Chemistry Department, Chulalongkorn University.

Twelve trace elements of 29 rock samples were also analyzed at the Office of the Atomic Energy for Peace. All are determined by using an INAX instruments energy dispersive x-ray fluorescence analyzer with excitation by radioactive sources (Cd 102 for Rb, Sr, Zr, Y and Nb ; and Am 241 for Sn, Ba, La, Ce, Nd, Sm, and Sb). Other elements of economic interests (e.g. Au, Ag, Mo, W, U and Th) were not analyzed because suitable techniques of sufficient sensitivity were not then available in the laboratories of Chulalongkorn University. FeO was analyzed by wet titration method (Shapiro, 1975). The total H_2O and other volatile compoments were determined as lost on ignition (LOI) using the method discussed by hutchison (1972). These ignition lost values were obtained by heating 0.5 gm weighted power sample with 1 gm of 1:2 lighium borate ($Li_2B_2O_7$) and lithium metaborate ($LiBO_2$) up to 1,000°C. The temperature was maintained within this range for half an hour.

The accuracy of the determination was checked by calibration and comparision with the U.S.G.S. standard rocks of which the G-2, AGV-1, GSP-1 were used for most major-and trace-element analyses. In addition, the artificial standards were used in determining the total iron content. Data for the standard for all major, and most trace elements are from E.J. Flanagen (1974). However, there is an exception for tin concentration for which the values recommended by Smith & Barton (1972) were applied.