

CHAPTER I

INTRODUCTION

Carbonate rocks, especially limestone and dolomite are valuable industrial raw materials, particularly for uses in the construction industry, namely as a raw material for cement manufacture, crushed rock aggregate and a building stone. It is also utilized in wide range of other industrial sectors, including steel, glass, chemicals, paper and plastic industries and in agriculture.

In Lao PDR, the carbonate rocks are not systematically explored to assess the stone resources for further development planning process. At present, the utilization of these rocks for economic purpose is small. There are some quarries of limestone, such as, limestone around Vangvieng district that have been exploited for a small cement plant, limestone quarries of artisanal scale for lime production in the north of Thakhek district, and many crushed limestone production plants in the vicinity of Thakhek so-called for local high way construction and for export to Thailand. According to the present Five-year Socio-economic Development Plan (2001- 2005), the use of domestic materials for cement industry, dimension stone, ceramic industry, etc are among the top priorities to promote import substitution.

Geologically, the carbonate rocks which have greatest distribution throughout the Lao PDR have been dated as Upper Paleozoic of which the Permo-Carboniferous has been mainly recognized. These rocks are widely exposed in almost all parts of the country. In the northern part, the carbonate rocks are well distributed in Luang Prabang, Oudomsay, Xieng Khouang and Houa Phan provinces. These rocks are also commonly in karstic form in the central part, particularly in Vientiane (Vangvieng), Bolikhamsay and Khammouane provinces, whereas in the southern part of the country the rocks are relatively less abundant and mainly cropped out in the Saravan province

In the future, the demands for construction materials in the Lao PDR will apparently on the increase, particularly for infrastructures, housing, industrial, and agriculture development. Therefore, the systematic exploration of carbonate rocks in order to determine the quality and quantity of carbonate resource for different uses is indeed important and necessary.

1.1 The Study Area

The study area is situated in the central part of Lao PDR, south of Pha Houa Xang, Ban Nadou, Khammouane province, covering approximately 13 square kilometres between latitudes of $17^{\circ} 26' 07''\text{N}$. to $17^{\circ} 27' 13''\text{N}$. and longitudes of $105^{\circ} 00' 32''\text{E}$. to $105^{\circ} 03' 20''\text{E}$ (Fig.1.1). The study area can be conveniently accessed from Vientiane municipality southwards to Khammouane province along the road no. 13 , then following the road no. 12 to the east (Thakhek – Gnommalat) about 25 kilometres. Besides, it can be accessed from Bangkok (Thailand) to Changwat Nakhon Phanom by plane or by car, then traversed cross the Mekong river by boat to Mouang Thakhek (Lao PDR).

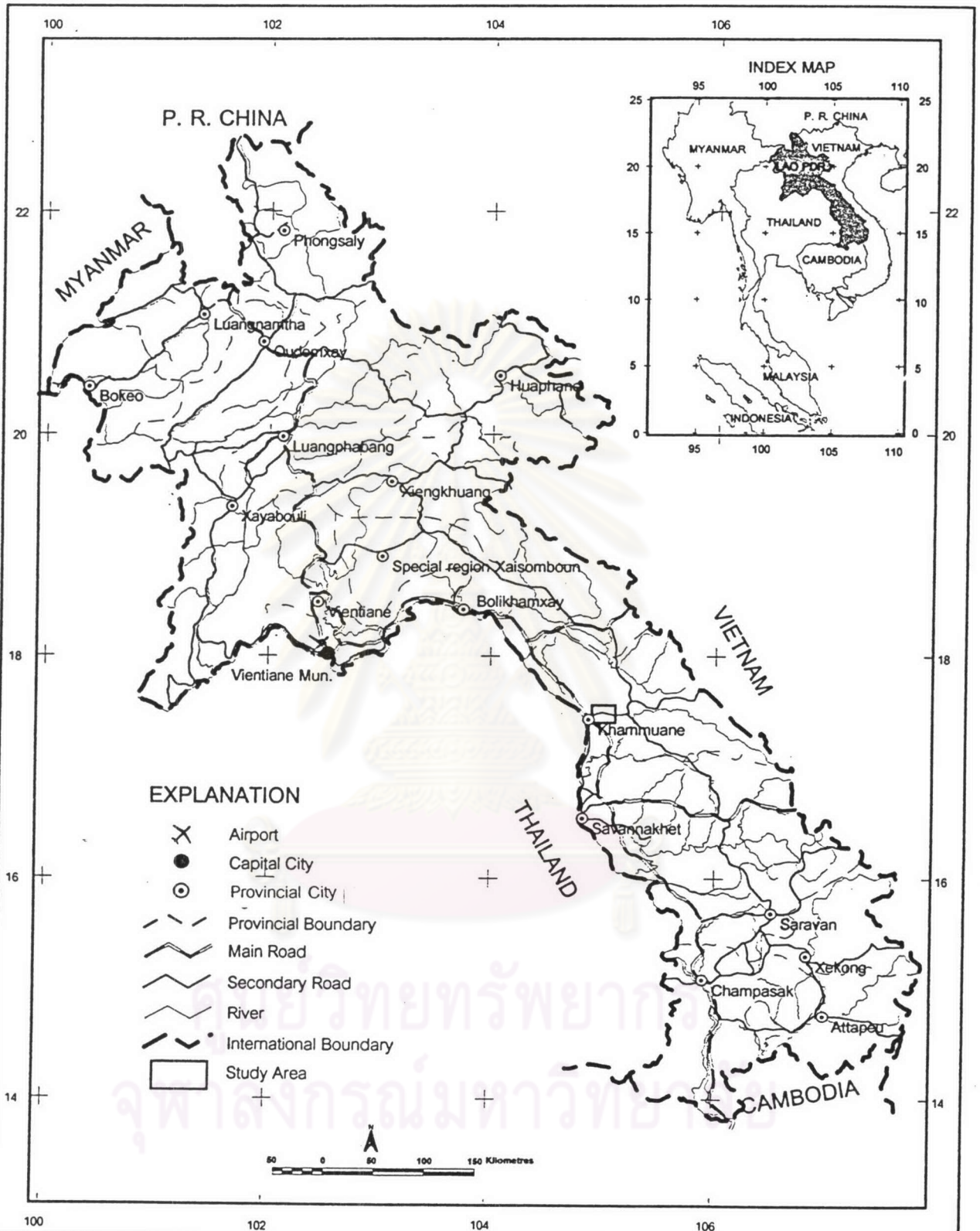
The study area is illustrated by the topographic maps of Thakhek sheet E-48-90, with a scale of 1: 100,000 (Fig.1.2) and Ban Mahaxai sheet 6043 IV Series L 7015, with a scale of 1: 50,000 (Fig.1.3).

1.2 Objective of Study

The objective of the study is to conduct a geological and chemical investigations and evaluation of carbonate sediments for their potential utilization as industrial raw materials in accordance with the future demand of the national industries

1.3 Methodology and Scope of Work

The methods used in this study are divided into 5 main steps consisting of literature review and preliminary preparation; field investigation, laboratory analyses; and interpretation, evaluation of the potential utilization.



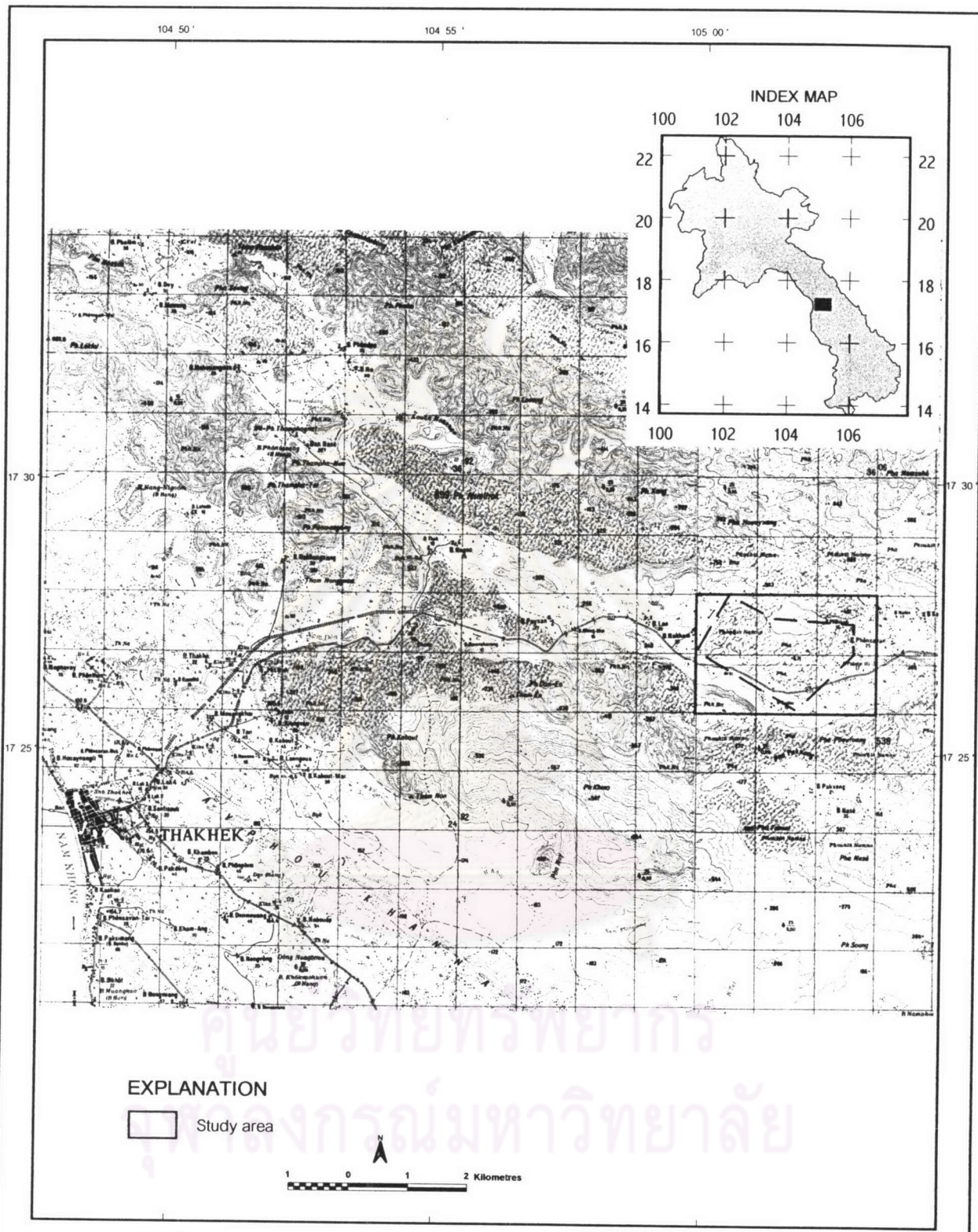
GEOLOGICAL ASSESSMENT OF SOME PERMO-CARBONIFEROUS CARBONATE SEDIMENTS IN THE SOUTHERN PART OF THE PHA HOUA XANG RANGE, MOUANG THAKHEK, KHAMMOUANE PROVINCE, THE LAO PDR.

Figure 1.1 Administrative map of the Lao PDR.

KEO KHAMPHAVONG
2003

DEPARTMENT OF GEOLOGY, FACULTY OF SCIENCE
CHULALONGKORN UNIVERSITY





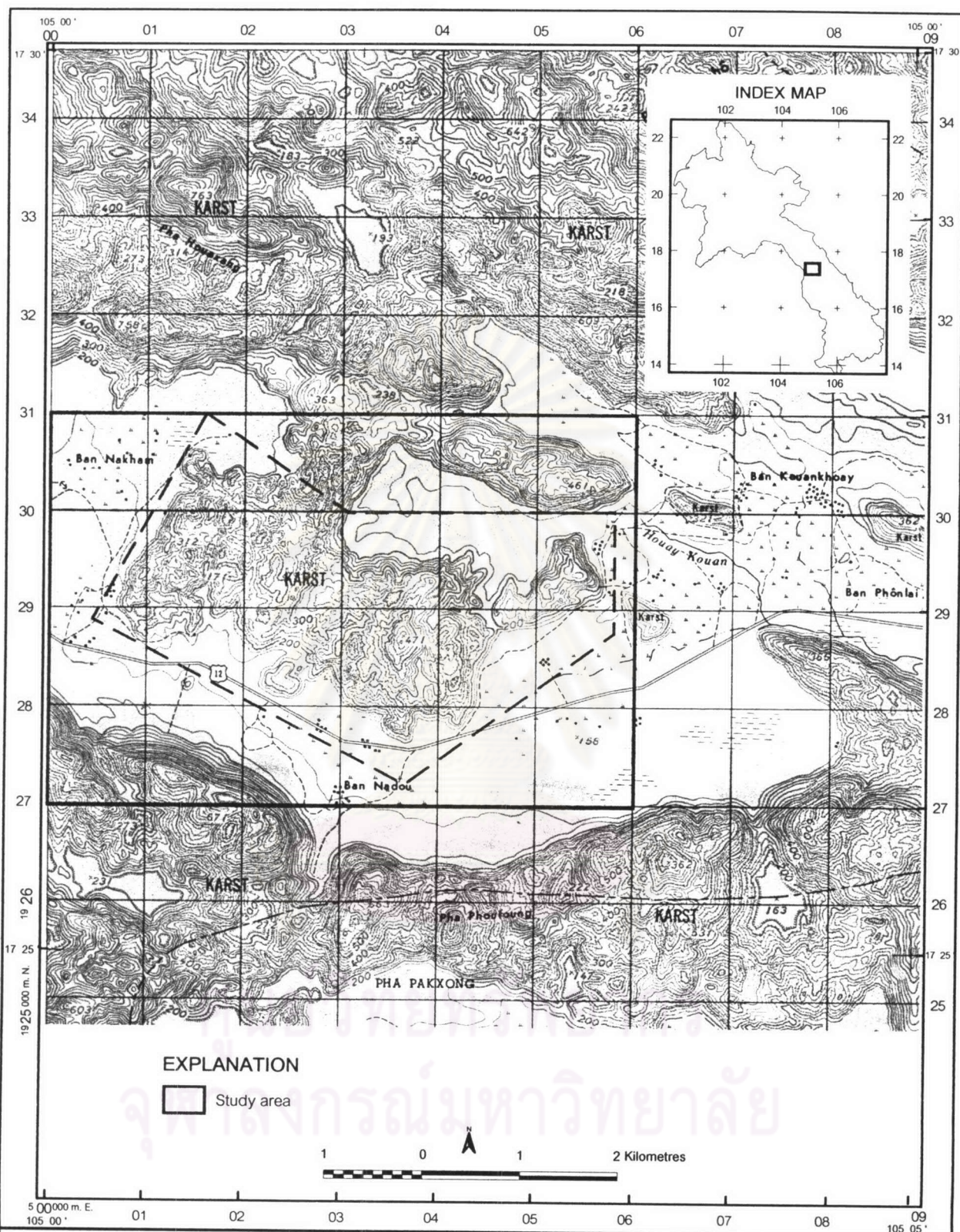
GEOLOGICAL ASSESSMENT OF SOME PERMO-CARBONIFEROUS CARBONATE SEDIMENTS IN THE SOUTHERN PART OF THE PHA HOUA XANG RANGE, MOUANG THAKHEK, KHAMMOUANE PROVINCE, THE LAO PDR.

Figure 1.2 Topographic map of the study area and its vicinity.

KEO KHAMPHAVONG
2003

DEPARTMENT OF GEOLOGY, FACULTY OF SCIENCE
CHULALONGKORN UNIVERSITY





GEOLOGICAL ASSESSMENT OF SOME PERMO-CARBONIFEROUS CARBONATE SEDIMENTS IN THE SOUTHERN PART OF THE PHA HOUA XANG RANGE, MOUANG THAKHEK, KHAMMOUANE PROVINCE, THE LAO PDR.

Figure 1.3 Topographic map of the study area.

KEO KHAMPHAVONG
2003

DEPARTMENT OF GEOLOGY, FACULTY OF SCIENCE
CHULALONGKORN UNIVERSITY



1.3.1 Literature Review and Preliminary Preparation

The initial stage the research work concerns with the critical review of geologic reports of the study area and its neighboring areas in order to serve as the background of the present study. Then, the photogeological study of the study area has been carried out to delineate the geomorphological features, the macro-geological structures, and potential sites for further study.

In addition, the literature review concentrating on the theoretical background, concepts, techniques and utilization in industry of the carbonate rocks are conducted extensively to assist the subsequent stages of work.

1.3.2 Field Investigation

The field investigation can be divided into two steps as follows:

(a) The first step is the reconnaissance field investigation on the geological setting of the study area and its vicinity. This step have been carried out in order to obtain the direct geological information, such as, landform, lithology, stratigraphy and geological structures for further detailed survey. The field work was carried out for 5 days during 18-22, April, 2001.

(b) The second step is the detailed field mapping in order to obtain geological data and information on the distribution of various rock types, geological structures, the measurement of rock sections by approximate method of traversing lines across the study area. Detailed semi-systematic collecting rock samples are concurrently undertaken for further detailed study. However, whenever there is a change of lithology , the samples have been taken with approximately distance of 50 metres. Altogether 9 traverse lines, perpendicular to the regional and local strike direction, a of totally of about 3,000 metres in length are carried out. All 67 rock specimens have been collected from those 9 traverse lines. The observation in the field reveals the information regarding the

sedimentary sequence, lithology, thickness, fossils, sedimentary structures, attitude of bedding, etc. The simplified diagram showing the investigating methods is illustrated in (Fig.1.4).

In this study, terminology of beds are followed those of Ingram (1954), as is shown in Fig.1.5.

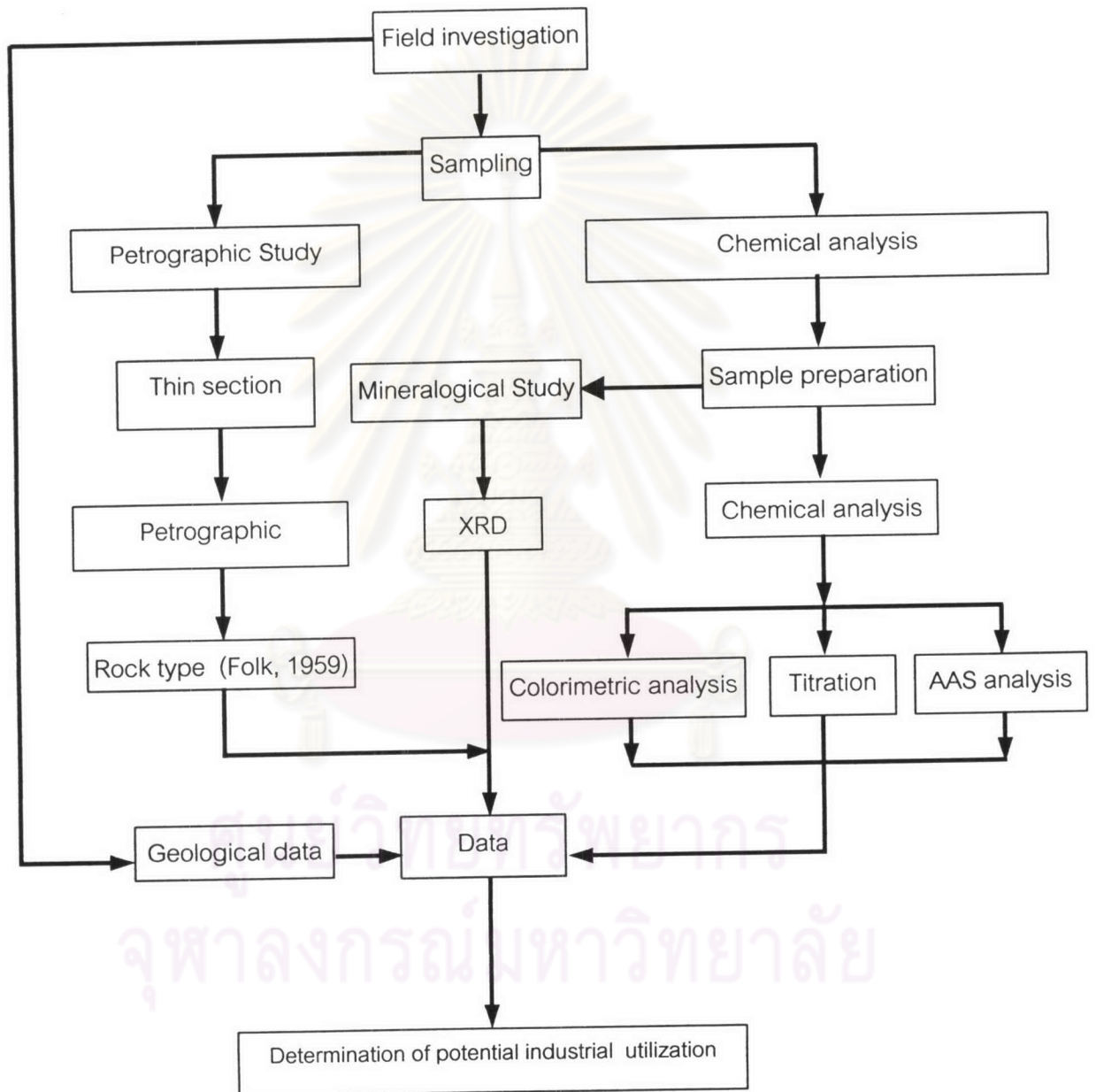


Fig. 1.4 Laboratory analyses and evaluation of carbonate rock specimens of the present study.

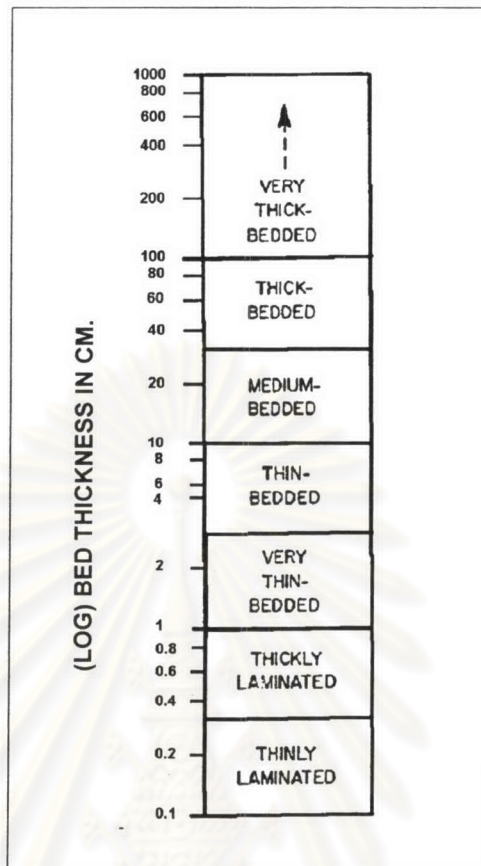


Fig. 1.5 Classification of bedding thickness (Ingram, 1954).

1.3.3 Laboratory Analyses.

The laboratory works involve the investigation of chemical, mineralogical, as well as petrographical characteristics of the carbonate rocks. The suitable techniques of sample preparation for the analysis are also considered.

The various stages of laboratory analyses are as follows:

(a) The sample preparation for the analyses of chemical and mineralogical properties of the collected samples, include crushing, splitting, and pulverizing.

(b) Some chemical composition, namely CaO, MgO, Al₂O₃, Fe₂O₃, SiO₂, P₂O₅, LOI, etc. are determined by colorometry, titration, and atomic absorption

spectrophotometry. The objective of chemical composition determination is useful in the assessing quality - grade of the stone.

(c) The mineralogical constituent of the samples is determined using petrographic microscopy and X-ray diffractometry.

Microscopically, the standard thin-sections are employed in the present study. Generally, sections cut for carbonate petrography should be slightly thicker than 30 microns to obtain deeper colour contrast (Harrison, 1992). The classification of carbonate rocks in the present study is based on the classification of Folk (1959, and 1962).

The X-ray diffraction is the qualitative analysis which commonly used for identifying compounds by their diffraction patterns. The compound of carbonate minerals, as calcite, and dolomite can be easily characterised. A slow chart speed scanning diffractograms of bulk carbonate sediments may be able to separate low magnesium calcite (LMC) from high magnesium calcite (HMC), (Rao,1996).

In addition, the brightness test is carried out using colorimeter: Photo Volt model 577 from Seradyn, Inc. USA.

1.3.4 Interpretation and Evaluation

After the field investigation and laboratory analyses, further steps could be carried out on the interpretation and evaluation of the results, namely the compilation of geological map of 1:50,000 scale including the preparation of cross- section in the study area, classification of carbonate rocks according to the properties and possibly group them under different utilization purposes, and the superimposed presentation of potential uses of carbonate rocks on the geological base-map.

1.3.5 Final Preparation and Presentation of the Thesis

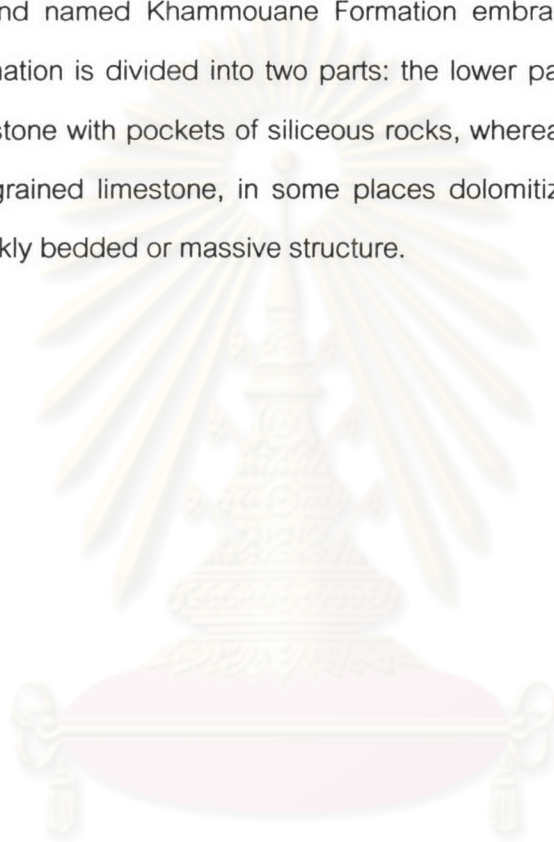
This stage consists of the preparation, writing and presentation of the thesis.

1.4 Previous Investigations

Prior to the present study, numerous investigations have been carried out in the study area and its vicinities regarding regional geology.

In 1915, Deprat studied some fossils of Khammouane province, based on outcrops in this region, and proposed Sakmarian age. Fromaget (1927) compiled a 1:500,000 scale geological map of Vinh sheet covering northeastern part of Laos. He described the non-metamorphosed Ordovician sediments bearing *Dalmanites cf.* in the upstream area of Nam Theun river. Fromaget (1937) synthesized the existing data to compile a 1:2,000,000 scale geological map of Indochina. Saurin (1956) studied and discovered some microfossils and corals in limestone at Ban Phit section and proposed Upper Viséan-Serpukhovian age. Saurin (1961) identified fossil corals from limestone in the area near Ban Nakhieu, Ban Nahi and Ban Louang of Khammouane region and the fossils indicate Lower Carboniferous age. Fontaine (1961) found a fascicular rugosa in quarry limestone at 13.5 kilometres from Thakhek along the road no 12 (Thakhek-Gnommalat) and proposed Carboniferous age. Peter Cook et al., (1991) compiled geological and mineral occurrences map of the Lao PDR from existing data. The rock unit located in study area consists of bedded to massive dark-gray to light-gray shallow marine limestone which form extensive karst tract and intercalated with siltstone, mudstone. The unit belong to Upper Carboniferous age. Pham Cu Tien (1991) compiled a 1:1,000,000 scale geological map of Indochina on the basis of existing data, satellite image, photogeological interpretation and field survey. He described a rock unit located in the study area comprising limestone, chert with Permo-Carboniferous age. Kondratiev et al.(1984) take interpretation of satellite image and aerial photo for compiling a 1:1,000,000 scale photogeological map of Laos. The study area and its vicinity are underlain by light to brown gray limestone, chert, shale, siltstone Permo-Carboniferous Age. Fontaine et al.,(1994) collected several samples containing microfossils of pseudoalgae (with abundant *Beresellids*), smaller foraminifera (*Globivalvulina*, *Climacammina*, *Tetrataxis*), fusulinids (with *pseudostaffella* and *profusulinella*) and bioclast (fragments of crinoids, brachiopods and bryozoans from the limestone quarry

near Ban Mouang Khai about 15 kilometres to southeast of study area. This assemblage of fossils indicates an Early Moscovian age. Siam Cement Public Company (1995) reported rock units in the study area and its vicinity which are composed of interbedded limestone and bedded chert light gray color; massive limestone light to brownish- gray; dolomite and dolomitic limestone with light-gray to gray colour. Tran et al. (2000) carried out mineral investigation and geological mapping a 1:200,000 scale of mid central region of the Lao PDR and named Khammouane Formation embraced the study area. The Khammouane Formation is divided into two parts: the lower part consists of black gray, thinly-bedded limestone with pockets of siliceous rocks, whereas the upper part consists of light gray, fine-grained limestone, in some places dolomitized limestone, with thick-bedded to very thickly bedded or massive structure.



ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย