

CHAPTER I

INTRODUCTION



Changwat Saraburi is the largest source area to supply the vast volume of rocks as indispensable raw materials for the development of construction industries. Among these, in 1998 there are 54 quarries and crushing plants of limestone as crushed rocks with the total production of 54 million metric tons, or the values of 4,590 million baht. Besides, 35.35 million metric tons or the values of 3,004 million baht of limestones and 2.82 million metric tons or the values of 254.2 million baht of shale were produced for the cement industry. In addition, 18,000 tons of limestone with the values of 1.53 million baht were produced for lime and other industries, and 3,757 tons of marble with the values of 13.15 million baht were produced for dimension stone industry in the same year (Department of mineral resources [DMR.], 1998). The record of productions and values of these four main industries are summarise in Table 1.1.

For the cement industry, the total national production in 1997 is 45.14 million metric tons of cement with the approximate value of 67,700 million baht. Among these, 36.9 million metric tons or 82 per cent were produced in Saraburi area. Altogether these are five manufacturers, namely, the Siam Cement Plc. with the installed capacity of 14.2 million metric tons, the Siam City Cement Plc. with the installed capacity of 12.3 million metric tons, the TPI Polene Plc. with the installed capacity of 5 million metric tons, the Asia Cement Plc. with the installed capacity of 5 million metric tons, and the Saraburi Cement Co. Ltd. with the installed capacity of 0.4 million metric tons (Utharoon, 1998). It is noted that all of the limestones, shale, and marble produced from Saraburi area for the construction industries are entirely rocks of Permian age. Therefore, the detailed geological study of the Permian rocks in this area is important and desirable for both scientific and industrial aspects.

Table 1.1 The record of productions and values of limestone, shale, and marble for four main industries.

| Year Type of industries | 1994 | | 1995 | | 1996 | | 1997 | | 1998 | |
|------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| | Million tons | Million baht |
| 1) Crushed limestone | N.A. | N.A. | N.A. | N.A. | 0.519 | 44.08 | 1.390 | 118.11 | 2.801 | 238.08 |
| 2) Cement industry | | | | | | | | | | |
| - Limestone | 37.629 | 3198.44 | 41.182 | 3500.43 | 45.159 | 3838.54 | 50.872 | 4324.13 | 31.269 | 2657.90 |
| - Shale | 3.095 | 278.55 | 3.806 | 342.50 | 3.983 | 358.47 | 4.757 | 428.13 | 2.528 | 227.49 |
| 3) Lime and other industries | 0.602 | 51.16 | 1.460 | 124.13 | 1.181 | 100.37 | 0.835 | 70.98 | 0.018 | 1.53 |
| 4) Dimension stone industry | 0.013 | 45.84 | 0.019 | 66.98 | 0.014 | 49.08 | 0.003 | 13.15 | 0.006 | 20.63 |

(Source; Mineral Statistic of Thailand, Statistic Section, Technical and Planning Division, Department of Mineral Resources, Thailand.)

Changwat Saraburi, with the total area of approximately 1,436 square kilometres, is underlain with sedimentary sequences of Permian age of about 40 per cent. However, this area is a portion of the best exposures of formerly Ratburi Limestone (Brown et al., 1951), and the Ratburi Group (Javanaphet, 1969). In 1981, Bunopas proposed the type section for the Ratburi Group at Sai Yok district, Changwat Kanchanaburi, consisting of three formations, namely, Tha Madua Sandstone, Ratburi Limestone, and Khao Muang Krut Sandstone, respectively, in descending order. Besides, he proposed the Saraburi Group for a succession consisting dominantly of very thick-bedded and bedded limestone, some shale and sandstone which further divided into three formations, namely, Pha Dua or Dan Sai Shale, Saraburi Limestone, and Tham Nam Maholan, respectively, in descending order. Later on, Hinthong (1985) proposed six formal formations of Saraburi Group with type sections mostly located in Saraburi area. They are Phu Phe Formation, Khao Khwang Formation, Nong Pong Formation, Pang Asok Formation, Khao Khad Formation, and Sab Bon Formation, respectively, in ascending order.

The Khao Khad Formation consists of very dark grey to black limestone, argillaceous limestone, dolomite, nodular and bedded cherts intercalated with shale and sandstone. The Khao Khad Formation is designated to be Lower Permian (Artinskian-Kungurian) and is distributed in the area of Phetchabun range and northwest of the Khorat plateau. The type section is at Khao Khad, Amphoe Phra Phuttabat, Changwat Saraburi with total thickness of 1,812 metres (Hinthong, 1985).

1.1 The study area

The study area is situated at Khao Chan, Ban Saphanhin, Amphoe Muak-Lek, Changwat Saraburi, covering approximately 24.75 square kilometres between latitudes of $14^{\circ}37'32.27''\text{N}$. to $14^{\circ}39'58.64''\text{N}$. and longitudes of $101^{\circ}07'58.60''\text{E}$. to $101^{\circ}11'02.38''\text{E}$. (Figure 1.1).



Figure 1.1 Topographic map of the study area and its vicinity (Sheet ND 47-8)

It is illustrated by the topographic map of Amphoe Kaeng Khoi, sheet 5238III, series L7017S, edition 1-RTSD, with scale of 1:50,000 (Figure 1.2).

The study can be conveniently accessed from Bangkok to Changwat Saraburi along the Highway No.1, Phaholyothin road, then took the Highway No.2 to Amphoe Muak-Lek. The study area is located northwards of the Highway No.2 between Km.28 to Km.33. The total distance from Bangkok to the study area is approximately 136 kilometres (Figure 1.3).

1.2 Objective of study

Basically, the geology of Muak-Lek area particularly regarding the Permian rocks have been assessed in order to serve as the background of the present study. The primary objective of the study is to define the lithostratigraphy of the Khao Khad Formation in the area of Khao Chan, Ban Saphanhin, Amphoe Muak-Lek, Changwat Saraburi as compared with the type section of Khao Khad Formation in Khao Khad, Amphoe Phra Phuttabat, Changwat Saraburi. Additional attempt will be made to determine the sedimentary facies and reconstruct the depositional environment of the Khao Khad Formation in the study area.

1.3 Methodology and scope of works

The methods used in this study can be divided into four main steps, consists of the preparation stage, the field investigations, the laboratory studies, and the final evaluation including report preparation.

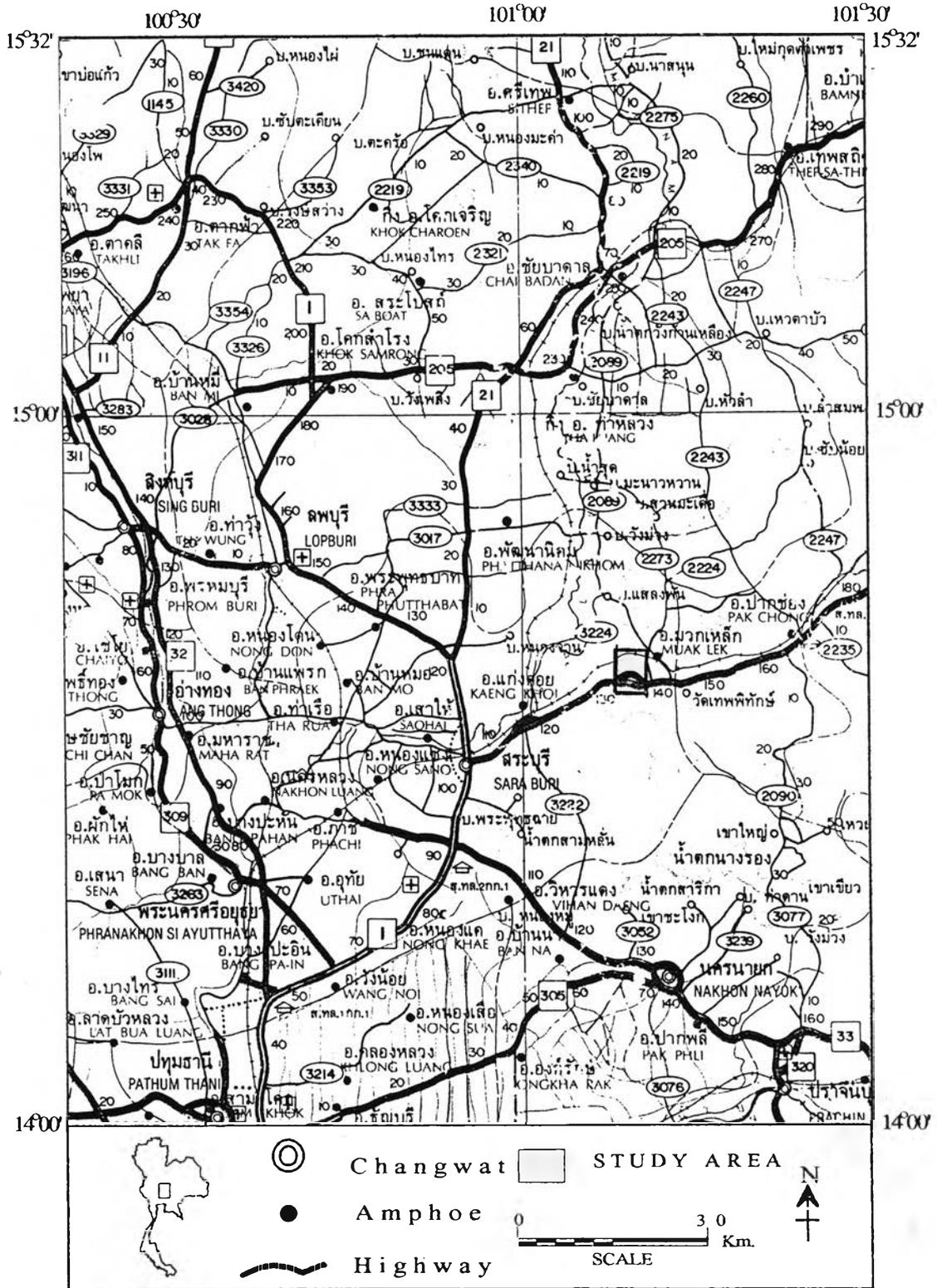


Figure 1.3 Location of the study area and its vicinity illustrating the net work of the national and provincial highways. (Highway Department, 1996)

During preparation stage, the literature reviews on the geology of Permian rocks embracing the stratigraphy, sedimentology and sedimentary petrography have been conducted to serve as a background knowledge for further detailed study. After that, the conventional photo-geological work has been undertaken to define the geomorphologic features, the macro-geological structures and potential sites for measuring of the rock sections.

The next step is the field investigation. The reconnaissance field surveys on the geological setting of the Muak-Lek area including the study area have been carried out in order to obtain the better geological framework for future detailed study. The latter works consists of the detailed measurement of rock sections. Altogether eleven measured rock sections, approximately perpendicular to the regional and local strike direction, of totally 8,603 metres in length have been made. The measurement of rock sections essentially aims at obtaining the information regarding the sedimentary sequence, lithology, thickness, fossils, sedimentary structures, bedding attitudes, etc. In addition, sampling of rock specimen from the measured section has been conducted whenever necessary for detailed petrographic studies.

For the third step, the data and information obtained from the geological field investigation and the measurement of rock sections have been compiled and presented as the geological map in the scale of 1:35,000 and the graphic representation of the sedimentary sequences, respectively. Regarding the collected rock specimens from the measured rock sections, various detailed petrographic studies have been conducted. These include the preparation of rock slaps, thin sections, and acetate peel (Carver, 1971) combined with staining techniques (Wolf et al., 1967). These studies will assist in the identifications of mineral composition, texture, and carbonate grain components. Besides, the X-ray diffractometry has been employed in the mineral identification and determination of calcite and dolomite ratio (Muller, 1967). The results of the detailed

laboratory studies will pave way to the application of suitable rock classification and nomenclature (Folk, 1959) of the sedimentary sequences under the study.

The final step involves the sedimentary facies analysis of the measured rock sections from the study area, as compared with the facies models (Reeckman, and Friedman, 1982; and Wilson, 1975). The difference of facies obtained from earlier study will be served as a basis for the subdivision of lithostratigraphic units of the Khao Khad Formation under the present investigation. After that, the lithostratigraphy of Khao Khad Formation at Khao Chan area will be compared with the type section of Khao Khad Formation at Khao Khad, Amphoe Phra Phuttabat, Changwat Saraburi (Hinthong, 1985). Finally, an attempt has been made to reconstruct the depositional environment of the sedimentary sequences of the study area.

1.4 Previous works

Since Lee (1923) made a geological reconnaissance across Kaeng Khoi - Pak Chong, no further work was done until Toriyama and Sugi (1959) conducted the study about Permian Fusulinids of central Thailand. Abele and Beeser wrote a report in 1963 on the geology of the Muak-Lek area.

In 1966, Borax and Stewart had conducted reconnaissance mapping in the area lying west of the Khorat plateau, including the present study area, and reported numerous Permian sections in various localities. Generally, the Permian sequence is characterised by interbedding or in part interfingering of limestones, shales, sandstones, and conglomerates. The limestones are grey, fine grained, generally detrital, and in some areas contain beds of limestone-pebble conglomerate, reef facies are present, a boulder bed of reef talus in a matrix of fine-grained limestone are also present. The measured thickness of the Permian limestones range between 452 metres and 2,568 metres.

Fossil are recognised almost exclusively in the limestone consisting of fusulines that range from Lower to Middle Permian.

After that the students from the Department of Geology, Chulalongkorn University, made a series geological mapping and geological reports on the outline of the geology of the Muak-Lek - Thap-Kwang area in 1970, 1972, 1983, 1984, and 1985.

Sawata (1985) reported the information collected during the field study from 1970 to 1972 with the staff and students of the Department of Geology, Chulalongkorn University. All of the illustrations and descriptions are concerning with the interesting sedimentary structures in the Saraburi - Pak Chong area at the south-western corner of north-eastern Thailand.

Wielchowsky and Young (1984) had conducted the field investigation of the carbonate and siliciclastic lithofacies in Lower and Middle Permian rocks of the Petchabun fold and thrust belt of north-eastern and central Thailand. They reported the carbonate facies representing six depositional environments, including, basin plain, basin margin, outer platform, platform interior, restricted platform, and marginal marine; and siliciclastic facies representing deep, shallow, and marginal marine depositional environments. In addition, they established the presence of three paleogeographic provinces, Early through Middle Permian, including a western carbonate platform, a central mixed siliciclastic-carbonate basin, and an eastern mixed carbonate-siliciclastic platform.