CHAPTER I

INTRODUCTION

One of the most serious safety problems in the open-pit mining is to maintain the stability of pit slope and waste bank throughout the mine life. A proper solution to this slope-stability problem will certainly improve the working condition, thus, enhance the economical efficiency of the mining operation.

The Mae Moh lignite mine in Lampang, northern Thailand is experiencing such problems. There occurred several wedge and bedding plane failures and some land slides on the pit walls, the first serious failure was recorded back in 1980. However, there is still no particular investigation on slope stability done in detail in this mine. This finding together with the availability of other supporting information plus the economic importance of the mine make it an ideal case for a detailed study, i.e. for the present work.

Owned and operated by the Electricity Generating Authority of Thailand (EGAT), the mine supplies the source of energy for the lignite - fuelled power generation. The open pit here is the largest of its kind in Thailand. It has a serious problem of slope stability on the pit slopes, especially on the northwest and southeast flanks. The most serious one is perhaps on the northwest flank slope which locates only about 400 meters east of the operating power plant (Figure 1). This

Figure 1. Mae Moh lignite power plant. The northwestern flank slope of the mine is in the foreground.

northwestern slope is 45 to 50 meters high, 1,000 to 1,500 meters long, with the overall slope angle varying from 35° to 45° and has a history of several events of down slope mass-movement. Meanwhile the bedding plane slides on the southeastern slope also threaten the mine operation.

In March, 1980, the first local wedge failure occurred on the northwestern slope (Pramote Pornrattanapitak, 1980, personal communication). The wedge grew larger and the tension cracks formed on the upper part of the slope in July, 1981. Then in August, 1981, a landslide occurred. The sliding mass had a length of 250 meters along the slope face. Concurrently several block failures had been noted on the southeastern slope. The blocks may be as big as 10 X 20 X 2 cubic meters. These blocks slid down the bedding plane into the pit and threatened the equipments and miners' life. These phenomena hence proclaim the necessity of a careful slope-stability study while the authority is taking an immediate solution by remodifying the problematic slopes.

1.1 Scope of Present Study

In a stability study, it is essential to understand the general geological conditions, the controlling factors of rock/soil slides and their failure mechanism, and the fundamental soil and rock mechanics. In the other word, the stability of a specific slope is controlled by the local geological condition of and adjacent to that slope, the geometry of the overall slope, the local groundwater condition and other controlling factors which may occur there. Therefore, the stability of slope must be analysed from these understandings.

The scope of this study is thus to collect information about the already-occurred landslides and the nature of present pit slopes of Mae Moh lignite mine, and to evaluate the effect of the controlling factors on different portions of the slopes thus to analyse the stability of these portions.

1.2 Location of the Study Area

Mae Moh lignite mine is located approximately at Latitude 18° 18' 12" N and Longitude 99° 44' 00" E, about 25 kilometers east of the town of Lampang along the Lampang - Phrae Highway (Figure 2). The highway provides the best accessible land communication from Lampang to Mae Moh mine along a side road at KM 9. The mine can also be reached via another side road between KM 34 and KM 35 on Paholyothin Highway, or by train.

1.3 Climate

The climatic condition of northern Thailand, which includes the Mae Moh area is of the tropical with the rainy season normally ranges from May to October, while the rest of the year is relatively dry. The heaviest rainfall generally occurs during the months of August and September with average montly rainfall of 200-260 mm while the annual precipitation is 1,212 mm.

The annual mean temperature of the area is 25° C. The hottest month is April with the mean temperature of 30.5° C, maximum 40.9° C and the coolest January with the mean temperature of 21° C, minimum 6.8° C.

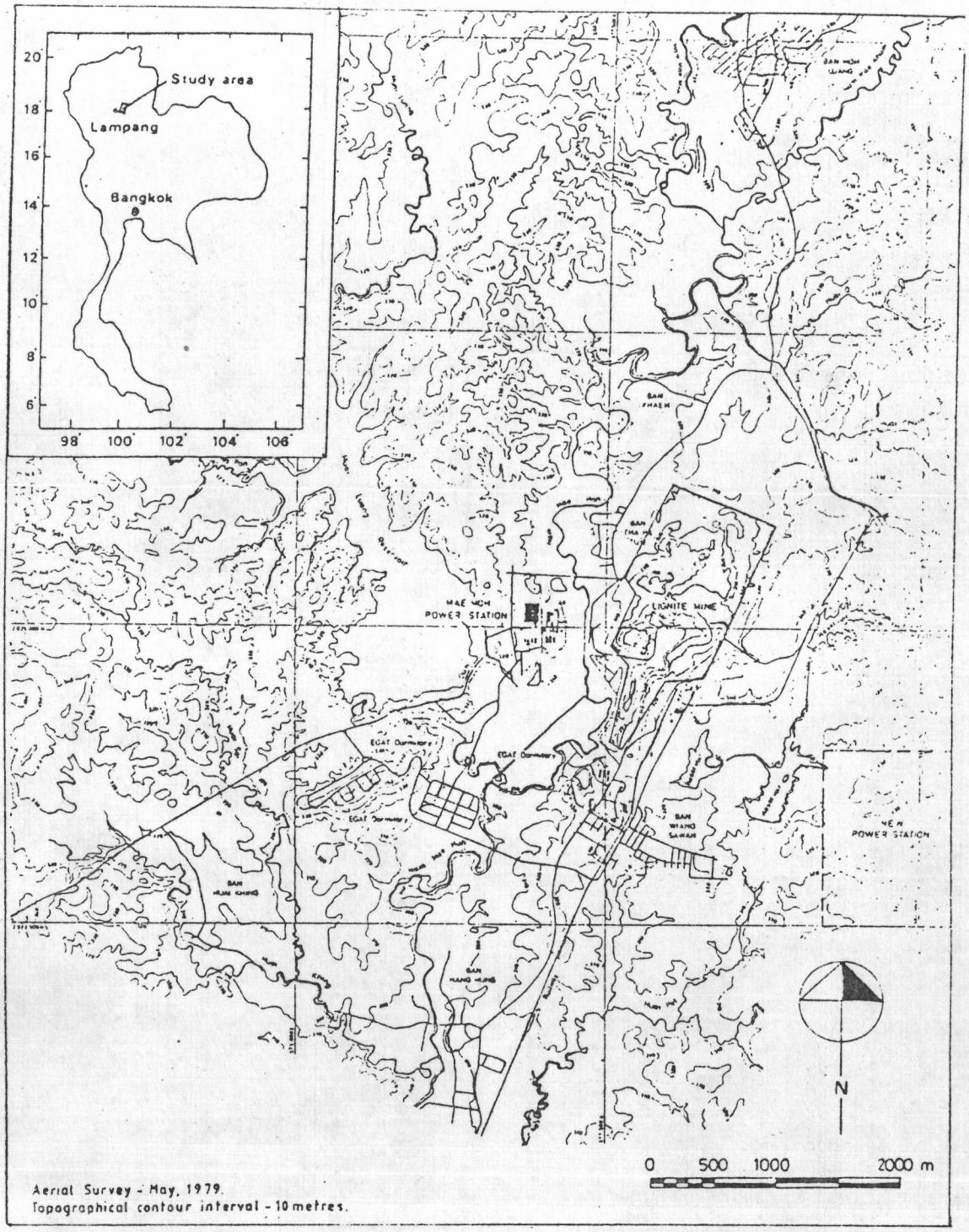


Figure 2. Location of Mae Moh lignite mine.

1.4 Geography of the Study Area

The study area locates in a generally flat, rolling terrain which is a portion of the valley of Nam Mae Moh and its tributary system. In this area, the valley is bounded to the east and west by subparallel, rugged, NNE - trending mountain ranges. These ranges merged into each other to the north of the Mae Moh area and changed their course of trending to more northeastery direction. The bounded terrain is hence generally elliptical, some 18 kilometers long and 8 kilometers wide.

The valley floor which has an average elevation of 320 meters (above the mean sea level) is underlain mostly by the soft, easily eroded Tertiary sediments deposited into Mae Moh Basin. South of the study area, however, a basalt flow had covered the original valley floor for its entire width while the surrounded foot - hill areas are underlain by the more - resistant, horizontally - lying Triassic rocks. The areas of the Lower Mesozoic rock exposures are 0.3 to 2.5 kilometers wide (Longworth - CMPS, 1981).

Nam Mae Moh, its main tributary, Huai Luang, and other smaller tributaries have a substantial flow in a moonsoon season. In a dry season, they are dry or almost dry. Water to be used is thus obtained from two reservoirs built on the two main streams.

1.5 Previous Geologic Studies

The regional geologic study which included the Mae Moh area was investigated by Gardner (1967), and the broader and more detailed inves-

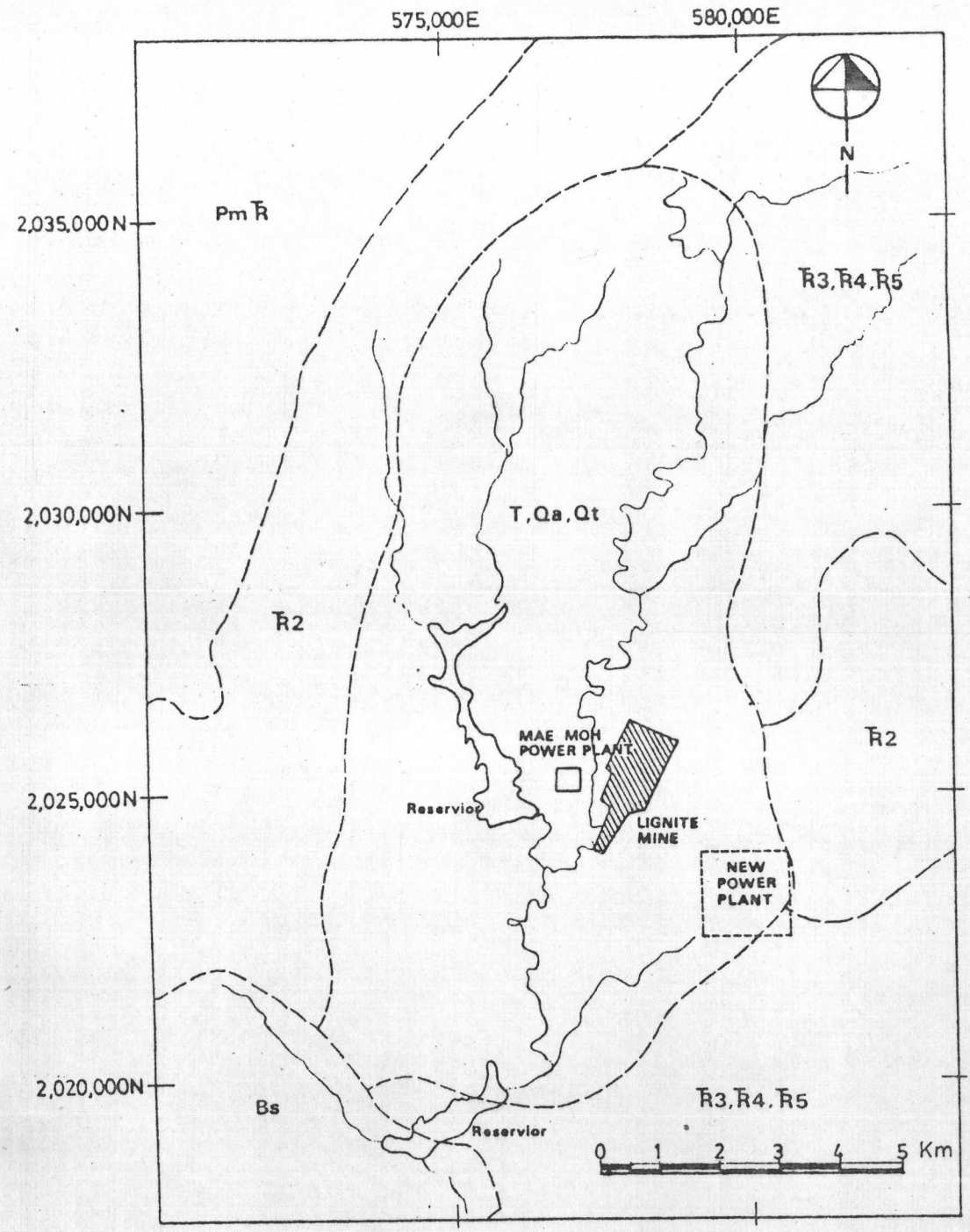
tigation was done later in 1972 by Piyasin. His work, the geologic map of Lampang sheet NE 47-7 on the scale of 1:250,000, is still accepted for the best background knowledge.

No detailed study in Mae Moh area had been done until recently. In 1978, Duangduen studied the mechanical properties of claystones above and below the lignite K - seam in the Mae Moh mine. He reported the results of the laboratory tests for both physical and mechanical properties of sedimentary rocks and the effect of water on these properties.

Longworth-CMPS, an Australian consulting firm, redefined the limit of Mae Moh Basin and carried out a geotechnical investigation in the Basin in 1979-1980. The Basin limit and the distribution of rock sequences from Permo-Triassic, Triassic, Tertiary to Quaternary ages are shown in Figure 3. Their method of geotechnical investigation included boreholes drilling, field data collection on defect variations (i.e., discontinuities), permeability measurement and geotechnical laboratory testing to determine several preliminary mine design parameters such as limiting stable slope angles for cut face in the overburden, etc. The final report which came out in August 1981 gave the valuable suggestions in the slope stability aspects, to be followed later by the present work.

1.6 Methods of Investigation

The roughly rectangular mine plan has two basic slope alignments; trending generally northwest - southeast and generally northeast - southwest. The study was emphasized to the northwestern and southeastern slopes where mass-movement occurred and the southwestern slope which is generally stable.



Bs-Basalt (Pliestocene); T, Qa, Qt - Shale, lignite, terrace gravel and aluvium deposit (Tertiary to Recent); ₹ 3, 4, 5 - Shale, sandstone, limestone, mudstone (Hong Hoi, Doi Chang and Pha Daeng Formations; Triassic); ₹ 2 - limestone (Pha Kan Formation; Triassic); Pm ₹ - Tuff, agglomerate (Permo - Triassic).

Figure 3. Regional Geology of Mae Moh Basin.

(Simplified from Longworth-CMPS, 1981)

The methods of investigation are listed below.

For a comparison of the characteristics on the mine slopes and thus for the slope stability, five representative subareas were selected. The subareas have the different orientation of slope face and/or different homogeneity in their geologic character. They are Subarea 1 to 5.

Subarea 1 is on the southwestern slope of the mine. In this subarea the strike of bedding plane is essentially perpendicular to the slope trend.

Subareas 2, 3 and 4 lie respectively from southwest to northeast on the northwestern slope where the serious safety problems occurred. The bedding planes have their strike parallel to sub-parallel to the slope face and their dip away from the open-pit. The limit of each subarea is roughly at the line marking the slight change in slope orientation. The stratigraphic layerings in these subareas are only slightly different, but Subarea 3 has a history of significant down-slope mass movement.

Subarea 5 represents the southeastern slope in the area where bedding-plane slides occurred. The dip of slope and of the bedding-plane are in the same direction, that is, into the pit.

The methods of investigation employed in this study are as followed.

1.6.1 Field geological investigation

The field investigation of the study area was done in two periods, 23 March to 15 May, 1981 and 20 October to 25 December, 1981. The work

was composed of geological mapping, detailed discontinuities survey, resistivity survey and sample collecting.

Geological mapping of the whole mine area in the scale 1:2,000 and of the landslide area, scale 1:500, were done using EGAT's progress plan map and the reproduce contoured base map of landslide area. Detailed discontinuities survey was done on each subarea of study by measuring of the discontinuities along the traverse line parallel to the slope. And these discontinuities are described under the appropriate headings by type, orientation (strike/dip), spacing, separation, continuity, and other comments such as infilled material, seepage, etc.

Orientated intact rocks (10 X 10 X 5 $inch^3$) and soil samples were collected and sealed with wax to preserve the water content for further laboratory testing.

In the mean time, 2 slope profiles for each subarea of study were also measured using compass and measuring tape. The profiles are for the further stability analysis.

1.6.2 Hydrogeological investigation

Hydrogeological investigation comprising of seepage observation and electrical resistivity survey was carried out to establish water condition within the slope. Seven - year record of rainfall data in Mae Moh area was also collected from the Royal Irrigational Department and EGAT.

Resistivity survey was done during 2 to 11 December, 1981, by using the electrical sounding method as an attempt to find the groundwater table within the slope. The detail of resistivity survey and results are described in Chapter III.

1.6.3 Laboratory investigation

The intact rock and soil specimens were collected for laboratory testing which includes petrographic study of 8 thinsections of claystones, X-ray diffraction of 3 samples of claystones, determination of bulk density and water content and determination of direct shear strength test of 10 claystone samples. Other available laboratory data were also collected from the previous works.