Chapter 1
Introduction

1.1 Ceramics in the North of Thailand[1]

Lampang, a province in North Thailand, has many kinds of important ceramic raw materials, for example, white clay, pottery stone, plastic clay, lime stone etc. In this area, there are interesting deposits of white-burning clays and feldspar-stone. These raw materials are mined in different quarries and have been used for many years for the manufacture of ceramic products. The area of Kao Pangka where there are two remarkable mines is especially interesting. In one mine of approximately 1,520,000 m^2, approximately 325,000 tons of materials have been mined during the period between 1974 and 1995. A second mining area of about 750,000 m^2 began mining in 1965. Today, ceramic industries in Thailand are expanding rapidly. Lampang had approximately 500 factories in 1997. Most factories produce tableware and giftware. Lampang white clay and pottery stone from Lampang are increasingly used both in Thailand and in other countries.

1.2 Geographical facts conceming Lampang deposits of raw materials for the ceramic industry.[2]

The mineralogy committee of the Government has reported that, Lampang has many areas with clay mineral and pottery stone which are suitable for use by ceramic industries. These are identified by in Figure 1.1. Lampang has a total of 11 mines, but only 2 mines are currently working. Mine closures were due to unsolved problems of quality control. If there were additional qualified man power to blend the raw materials before selling, production could be expanded greatly. Lampang has rock which originated from the Silurian period to the Quaternary period. Most of the rocks distributed in Lampang are from the Permian and Triassic periods. Permian rocks are found in the East and Triassic rocks are found in the West. Silurian-carboniferous rocks have been found in a narrow zone in the rim of West. Tertiary rocks found in this rim and are mined.

Lampang has been using its clay-minerals for the past 40 years (Kao Pangka, Bansa, Jaehom). Many areas with clay-mineral have been found. In 1970, Lampang had 5 open mines and produced clay-minerals totaling 6,482 metric tons, which is 75 % of production in the North and over 40 % of production in all of Thailand. In 1995, Lampang had 11 open mines and produced 313,828 metric tons of clay-minerals. This includes 5,625 metric tons which were refined and 308,203 metric tons that were not treated. That was over 70 % of production in the North and more than half the production of the whole country. (Appendix 1)

The hill of Kao Pangka has been extensively mined. The largest mine is 1,520,000 m^2 and began operation in January 1974. By the end of 1995, 325,000 metric tons of material had been removed. The second largest mine is 750,000 m^2, it started operation in 1995. (Figure 1.1)

The mineral committee of Thailand found that the white clay deposit in Kao Pangka was approximately 3,200,000 metric tons and pottery stone deposits in Kao Pangka were approximately 6,660,000 metric tons. Both white clay-mineral deposits and pottery stone are on the tip and south-west hillside of Kao Pangka and far from North-East Lampang. (Figure 1.2)

Kao Pangka is a hill that stands alone approximately 600m. wide and 1.5 km. in length measured in a north-south direction. Kao Pangka is approximately 520 m. above sea level and 140 m. above surrounding flat land. The Thai Kaolin area in the western part of the hill is a little lower, being approximately 478 m to 446 m above sea level.

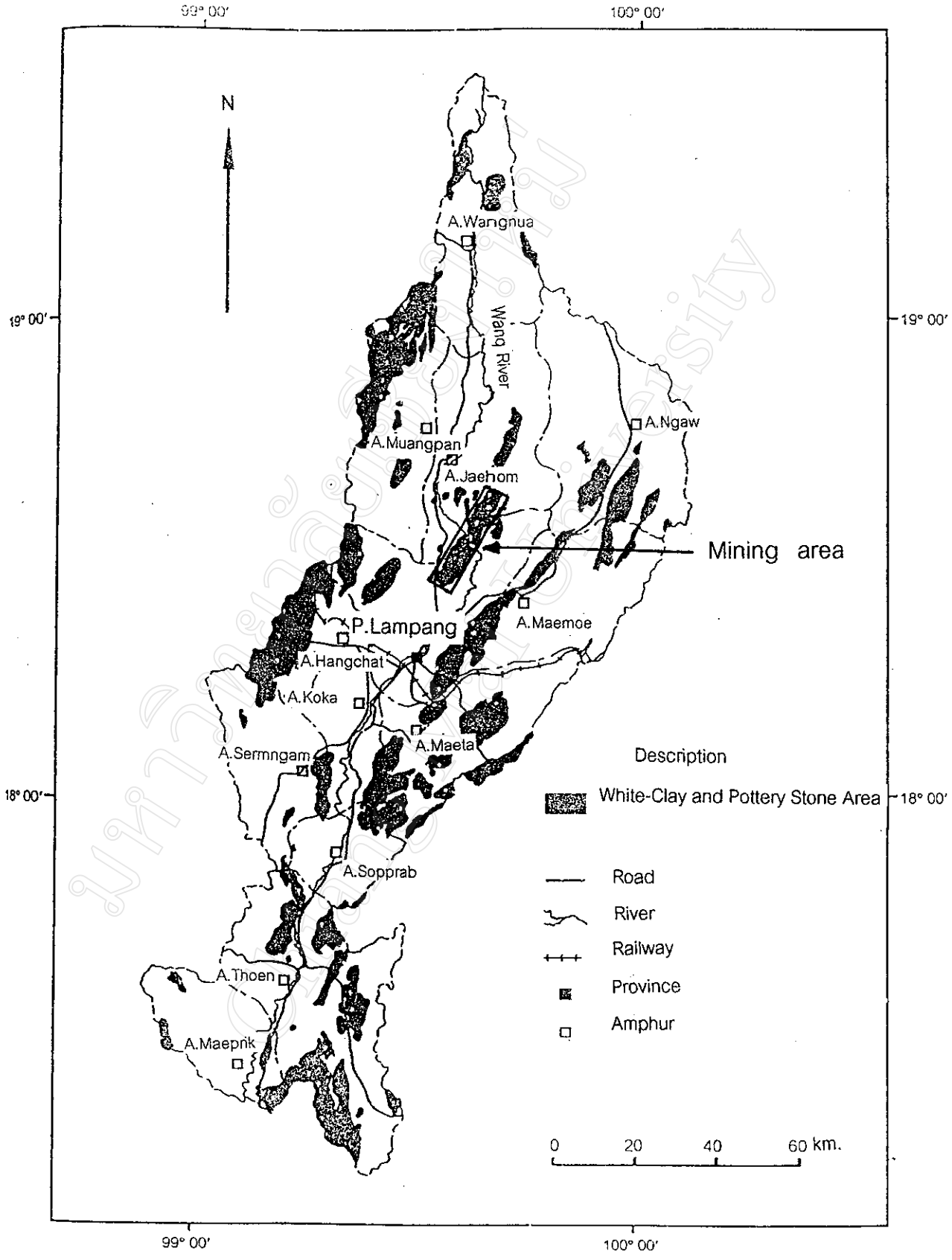

Figure 1.1 : White clay and pottery stone deposits in Lampang province.

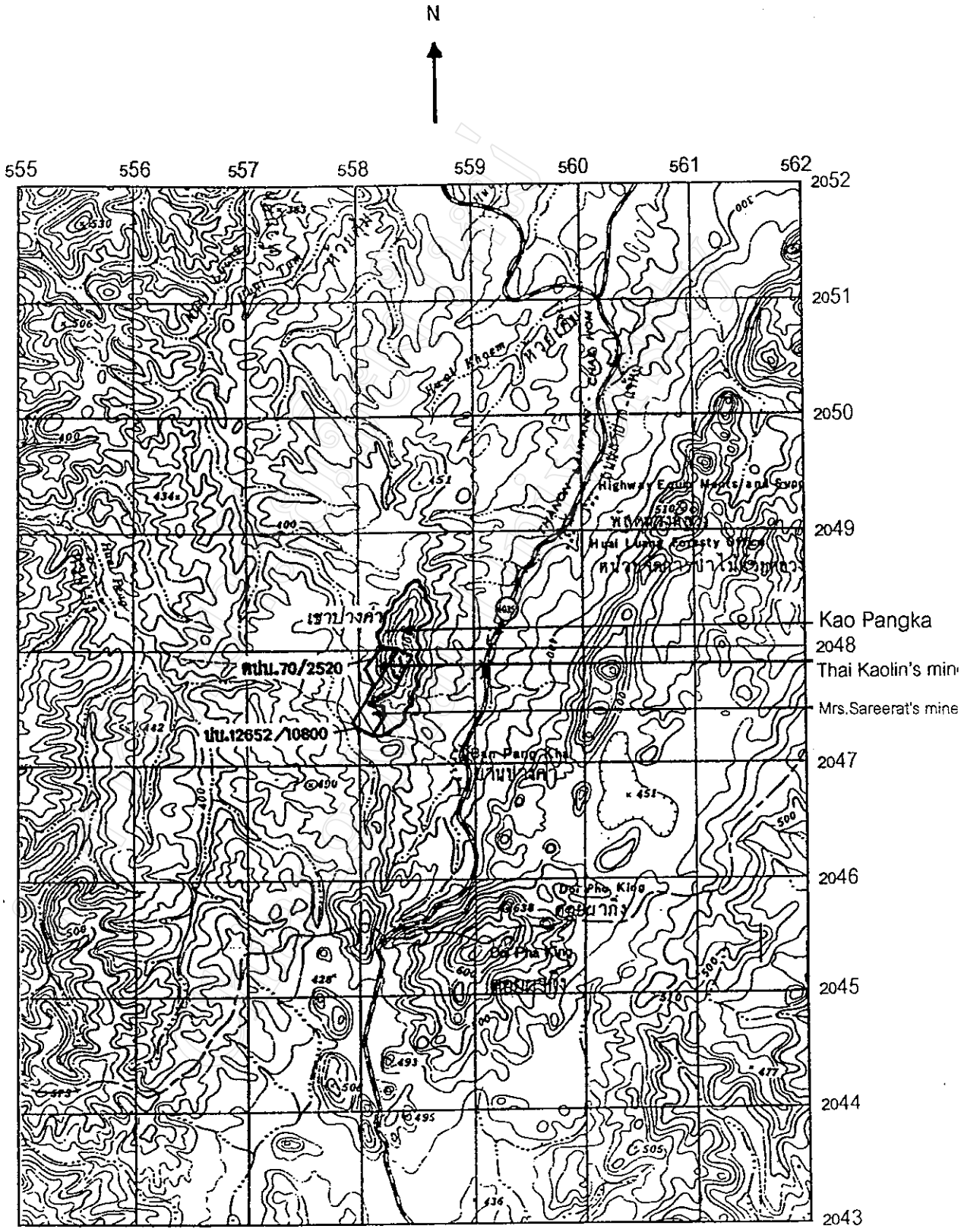

Figure 1.2 : Map ratio 1 : 50,000 explain the location of white clay and pottery stone of the Thai Kaolin's mine and Mrs.Sareerat's mine.

1.3 Geology of the Lampang clay deposits

Kao Pangka was originally Rhyolite rock and is now for the most part weathered to form clay. This clay penetrates the sedimentary rock composed of fine sandstone and talcum sandstone. In the middle-north area, most of local rocks are gray or gray-green sedimentary rocks, which weather to a brown-yellow color. Sedimentary rock can be seen in clearly defined rock layers. These rocks usually break by conchoidal fracture. The sedimentary rocks are usually fine sandstone and are mixed with gray talcum sandstone of approximately 1-10 cm thickness. Talcum sandstone is composed of sand between fine grain and middle coarse grain size. The layers of sedimentary rock, fine sandstone and talcum sandstone lie in the direction N 10^0 E -N 20^0 E and have approximately an angle of 35^0-80^0 to the north-east. Sedimentary rock, fine sandstone and talcum sandstone are Middle Triassic rocks.

Sedimentary rock, fine sandstone and talcum sandstone are penetrated by Ryolite rock. This Ryolite rock has a fine grain and is gray-green in color. Study with a polarizing microscope shows that this Ryolite is mainly composed of quartz and muscovite-sericite. The minor minerals are feldspar and iron oxide. The surface of the mine area shows many slide cracks cutting Ryolite rock in the direction area N 15^0 E, N 20^0 E, N 40^0 E, N 50^0 E, N 70^0 E. Most of the joints between Ryolite rock and sedimentary rock, fine sandstone, and talcum sandstone are in concordant contact. The fault direction is N 18^0 W.

On the surface of the mine area, white clay is found associated with Rhyolite rocks. White appears on the slope and hillside approximately 5 m. wide and approximately 20 m. length. A second area of white clay is found on the slope and hillside. This second area is approximately 10 m. wide and approximately 30 m. long. White clay in both areas is friable and easily broken with the fingers. These white clay deposits result from weathering of Rhyolite rock by a hydro-thermal process[3], which changes feldspar mineral, occuring in the Rhyolite rocks, into clay.

On the surface of the second mine mentioned, the Ryolite rock has changed into white and gray-white rocks. This is exposed in an area approximately 15m wide and 25 m in length. Those rocks came from weathered Ryolite rock. The weathering

process results in the formation of a white clay. These weathered rocks have less strength than the original Ryolite rock and can be used as a raw material for ceramic production in the same way as white clay. These weathered rocks are knows as pottery stone.

1.4 Composition of Lampang white clay and Lampang pottery stone.

K. Worakun and P. Nipon,[1] report research work on "White clay and pottery stone of Lampang", as follows:

Chemical Analysis : The chemical composition of the white clay and pottery stone from Kao Pangka are similar as can be seen from Table 1.1.

Table 1.1: Chemical composition of white clay and pottery stone from Lampang

%	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	K_2O+Na_2O	L.O.I.*
White clay	72.42	19.43	0.26	0.01	nil	0.01	3.79	3.43
Pottery stone	72.18	19.10	0.28	0.09	nil	0.03	3.94	3.18

* L.O.I. = loss on ignition

Physical Analysis : Mineral analysis by polarizing microscope reveals that pottery stone is composed mainly of quartz and muscovite-sericite with small amounts of feldspar and iron oxide. Mineral analysis by X-ray diffractometer shows that the white clay is mostly quartz, kaolinite, and illite.

Appearance: Color, melting and shrinkage after firing. After firing to 1200^{0}C, the white clay has a white color (average whiteness 42.08 units, matt) with an average shrinkage of 4.12 %; pottery stone has a white/cream color, average whiteness 31.26 units, a small amount of gloss and an average shrinkage of 10.58 %. The white clay and pottery stone become slightly colored by firing because of the presence of other minerals. In addition to kaolinite, pottery stone contains mica.[4] In the production of white ceramic ware, the use of white clay and pottery stone adds some unwanted

color to the products. One of the objectives of this study is to see if there is some simple way of getting whiter products.

Preliminary Summary and conclusion

Kao Pangka is the area of the interest because it has a large amount of white clay and pottery stone. An easily investigation[1] reports that the white clay found here has good quality and can be used as the principal raw material in the production of stoneware, low tension insulators, tile, sanitary ware and giftware. But, knowledge of Kao Pangka white clay is still incomplete, especially technological properties, such as : rheology of the slip, and casting behavior, plastic behavior of the moist clay, drying and firing behavior. Processed white clay from local mines does not have consistent quality; the treatment process is not adequate and not well controlled.

1.5 Evaluation of the present application[4]

Today, Lampang raw materials are used increasingly for ceramic production, especially in north Thailand. In addition, these materials are exported. The effects of the economic crisis in Thailand from 1998 onward has led to the promotion of export products, including ceramic products from the North. But the production sold in Thailand has decreased. These factors force an improvement in the quality of ceramic products and consistency of high quality. The number of ceramic factories has decreased but the amount of raw materials mined in Lampang has increased. We can see that increasing the productivity of Lampang raw materials requires better knowledge of these materials and knowledge about the most suitable production technology. Lampang raw materials could be of consistent high quality and better suited for use in ceramic production with more effective quality control.

1.6 Evaluation of the present situation[1]

The mining on Kao Pangka is by means of backhoe and truck. The truck transported the clay to a treatment center. Stone is transported to a crusher or to the buyer. Both white clay and pottery stone are used for stoneware production and some

of the factories used them to mix with imported kaolin and make porcelain. Clay-minerals are treated by the wet process. Factories use roller crushers and transport the clay with water in the big tanks. A spiral classifier is used to separate coarse stones. The clay-water slurry is poured through a coarse screen to separate wood and other coarse organic material. Then it is pumped to a one step (3 inch) metal cyclone. The fine fraction is sent to a sedimentation tank. Concentrated clay slip is pumped to the filter press and transported to the buyer without blending. Note: A one step cyclone is not good enough to make a high quality product.

1.7 Conclusions regarding present limitations

Knowledge about Lampang white clay and Lampang pottery stone is not sufficient at this time. Especially lacking is knowledge of how properties of these materials are related to specific grain size. This research work is an attempt to study this problem and generate some ideas about how to improve clay technology currently used in Lampang.