

CHAPTER 1

Introduction

Kiln sites are important archaeological and historical resources of Thailand. In the upper north of Thailand, known as Lanna region, 13 ancient ceramic kiln sites have been found (Prishanchit and Pengtako, 1990).

The Intakhin kiln site was firstly discovered in 1994 by Mr. Duangdee Jaitanong when renovating his house and found a kiln. This site is located at 81 Moo 11, Baan San Patong, Intakhin Sub-district, Mae Taeng District, Chiang Mai Province (Figure 1.1). Later in 1996, Saraswadee Ongsakul and Pasakorn Tonawanig re-surveyed the area. The excavation was done by Sayan Prishanchit of the Fine Arts Department in November and December of that year (Figure 1.2) (Prishanchit and Pengtako, 1997).

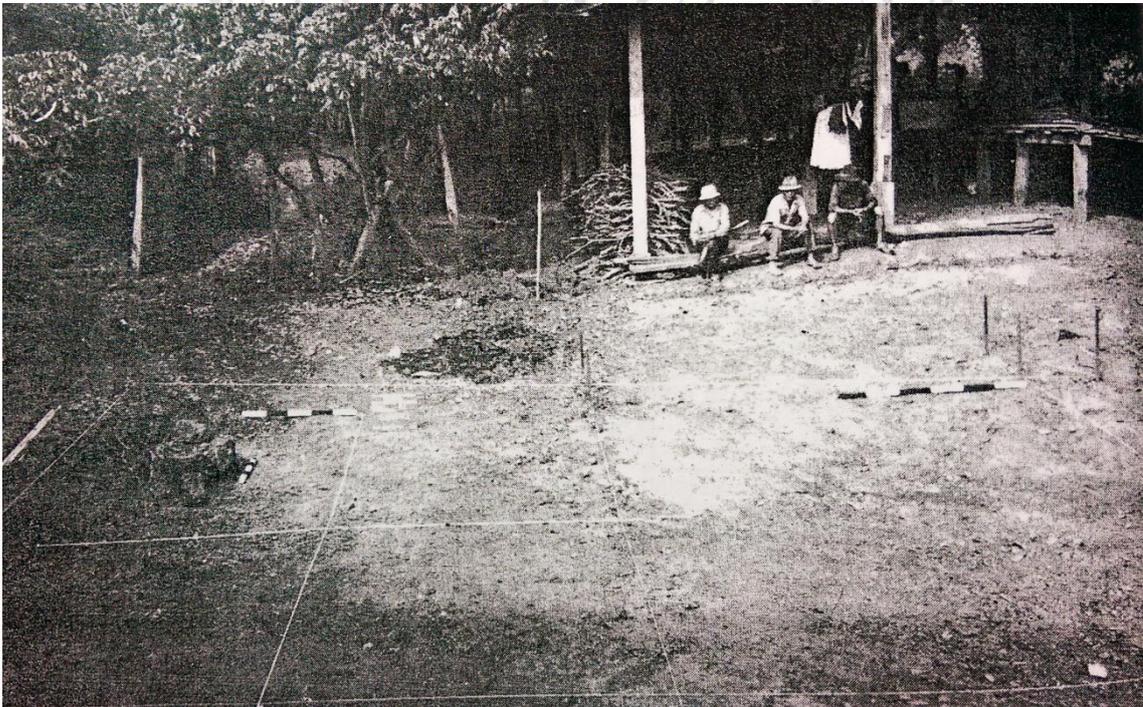


Figure 1.1 Trace of ancient kiln in the house of Mr. Duangdee Jaitanong
(From Prishanchit and Duangsakul, 1997).



Figure 1.2 Excavated kilns at Mae Taeng District, Chiang Mai Province.

Concerning the age of the ‘Intakhin Kiln Site’, there is no absolute date of the site, but it is predicted to be in the Lanna region. The chronology of the kilns and products in this region is dependent upon relative methods which compare the dates of other archaeological finds, architectural and artistic styles, and other related literal evidence. One kiln site that has been archaeologically dated is the Sankamphaeng site, which has approximately been recorded as activated during the early 13th – mid 17th century A.D. In addition, the Phaen or Pong Daeng Kiln Site is dated from the 15th – 16th century A.D. (Prishanchit and Pengtako, 1990).

In this study geophysical surveys are applied to find anomalies in the underground at the Intakhin area to help determine locations and depths of kilns. It is hopeful that detected anomalies will be useful for deciding whether or not to excavate.

1.1 Purpose

The purpose of this thesis is to use magnetic gradients and 3D resistivity imaging techniques for archaeological investigations at the Intakhin kiln site, Intakhin Sub-district, Mae Taeng District, Chiang Mai Province.

1.2 Scope of the Study

The study area was divided into two areas, both $5 \times 20 \text{ m}^2$ at the Intakhin kiln museum (red dashed line), as shown in Figure 1.3. The kilns were investigated using magnetic gradients, magnetic field data and 3D electrical resistivity surveys. The magnetometer used had 2 sensors to obtain vertical and horizontal gradients, and the sensor separation was 0.5 m and 1.0 m. The 3D electrical resistivity survey used the configuration of a 3D dipole-dipole array. The data of magnetic survey was displayed by mapping, and the 3D resistivity survey was displayed using realistic model sections and volumetric representations. The results of both methods were integrated for interpretation.



Figure 1.3 The boundaries of the Intakhin museum (red dashed line).

1.3 Location of the Study Area

The Intakhin kiln site is located in the Intakhin Subdistrict, Mae Taeng District, Chiang Mai Province (47Q 497880E / 2121640N) (Figure 1.4). From Chiang Mai, it is a distance of 50 km to the Mae Taeng District, and the Naresuan military camp is located at the entrance of the Intakhin area, 2 km away.

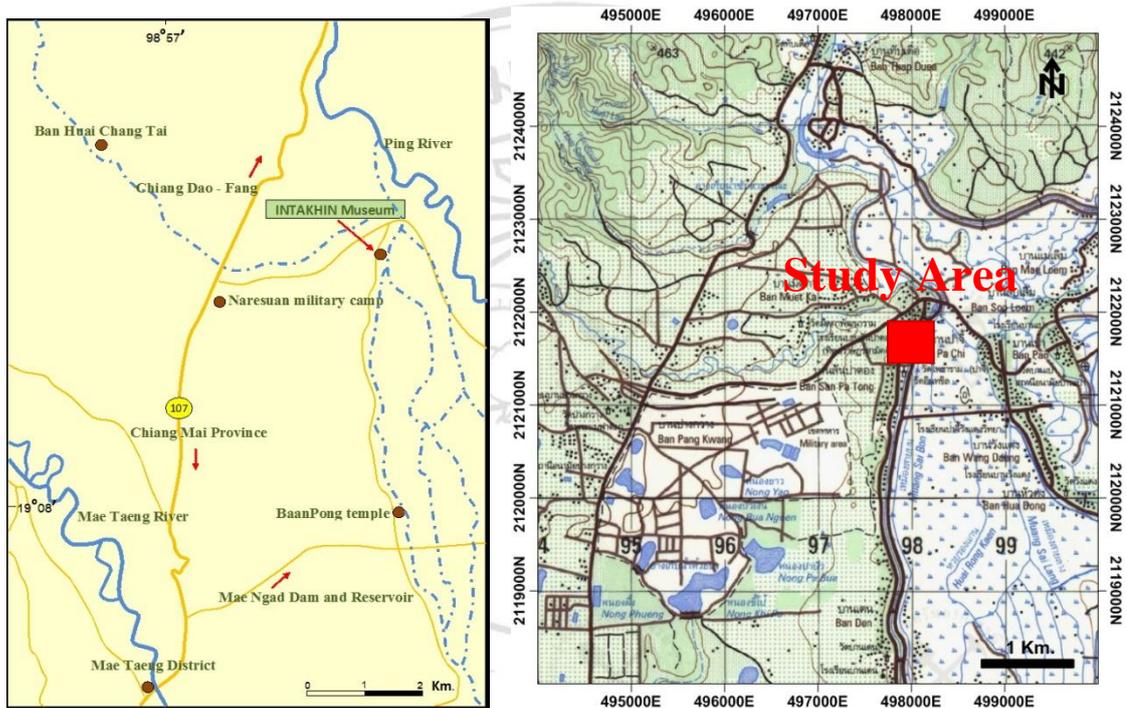


Figure 1.4 Location map of the Intakhin kiln site, Mae Taeng District, Chiang Mai Province.

At present, the Intakhin area has been established to hold the Intakhin museum (Figure 1.5). This is an important discovery in history, and the history of Lanna. These are also of great archaeological importance, because this discovery offers complete kilns and sample debris of crockery, and the North of Thailand has never found any source as complete as this.



Figure 1.5 The Intakhin kiln site (Museum) displaying kilns and debris crockery.

1.4 Study Area

The study area was surveyed with the aim of detecting other kilns buried at the Intakhin kiln site. The planned consideration worked in 2 areas, and the study area was $5 \times 20 \text{ m}^2$ for both areas.

Area 1 was chosen to the southwest of the museum, because this area is close to the place of Intakhin which was excavated before, and the dimensions of the area are sufficient for investigation. One important thing to note is that in some areas the ground has collapsed (red circle) underneath, and is thus likely to collapse because of other underground kilns (Figure 1.6).

Area 2 was chosen to the northeast of the museum, because this area's dimensions were similar to area 1, were set away from Area 1 by about 50 m, and showed no evidence of possible collapse. Therefore, these areas were used to compare values after the survey (Figure 1.7).



Figure 1.6 Study Areas 1 (In upper red rectangles are boundaries of the study area and the red circle is the point of collapse of the ground).



Figure 1.7 Study Areas 2 (Red rectangles are boundaries of the study area).

1.5 Archaeology of the Kiln Site at Intakhin

Archaeological stratigraphy of the kiln site was studied while performing the excavation kilns, and was divided into 3 layers (Prishanchit and Duangsakul, 1997)

Layer 1 had depths from the ground to 0.5 m and comprised tight reddish brown loam mixed with some burned soil.

Layer 2 had depths of 0.5 – 1.0 m from the ground, and comprised moist black to dark reddish brown loam mixed with some charcoal.

Layer 3 had depths of 1.0 – 1.5 m from the ground, and comprised black to dark reddish brown soil mixed with ash, burned soil and charcoal, and this was found at the entrance to a kiln, which comprised dark reddish brown natural soil with massive laterite. This layer is the foundations of the kiln.

The kilns that have been unearthed are relatively complete in form and solid in structure. Parts of the kiln roof at the pot-chamber are not intact, and collapsed falling down onto each kiln floor. The kilns' shapes viewed from the top are similar to laid-jars, with a mouth-rim travelling down to the earth at low levels and its narrow foot-rim raise-up.

The shape of these kilns is 'Jar-Like-Kilns' or Tao Hai, and kiln dimensions and some information are listed as follows (Figure 1.8)

- Extreme length from entrance to back of chimney = 3,750 mm.
- Extreme width at fire-box = 2,200 mm.
- Length of pot-chamber (fire-wall to chimney) = 2,600 mm.
- Length of fire-box (entrance to fire-wall) = 1,150 mm.
- Width of fire-wall = 1,650 mm.
- Height of fire-wall = 650 mm.
- Width of fire-hole or entrance = 800 mm.
- Diameter of kiln chimney = 750 mm.

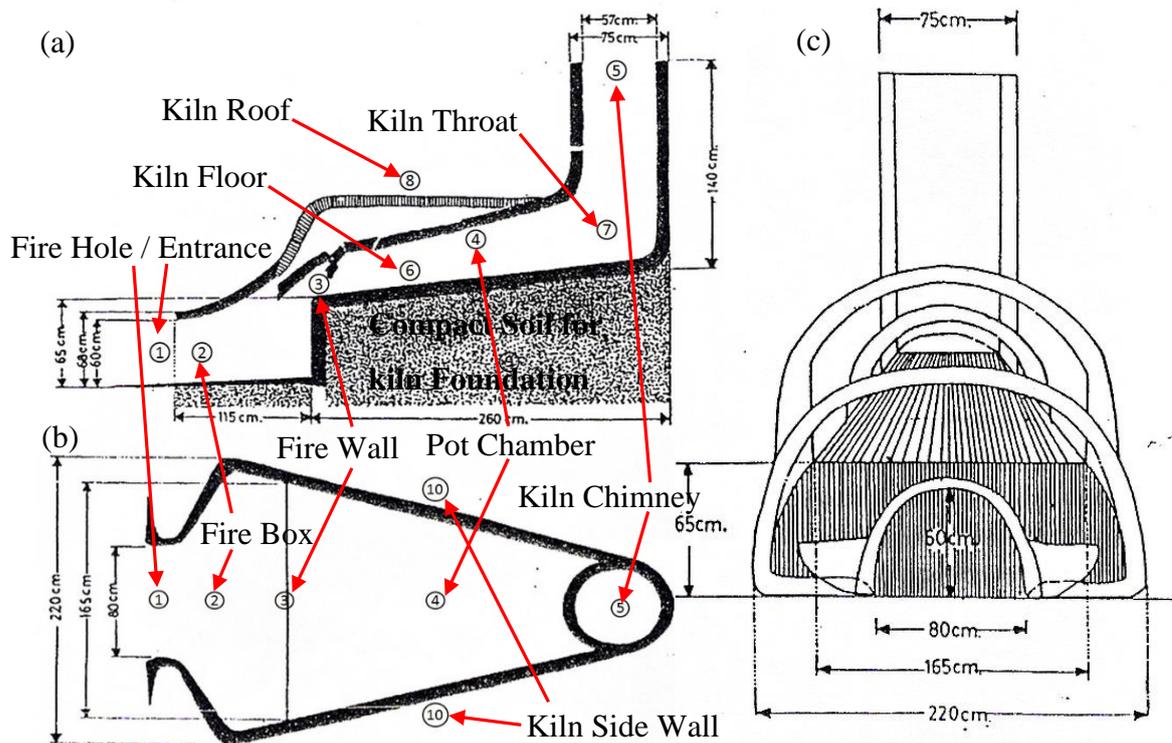


Figure 1.8 Drawing illustrating the ceramic kiln skeleton (a) Side section-view of Kiln, (b) Top view of kiln, and (c) Front view of Kiln (From Prishanchit and Pengtako, 1997).

1.6 Literature Review

Prishanchit and Duangsakul (1997) discovered the Intakhin kiln site in Intakhin Subdistrict, Mae Taeng District, Chiang Mai province, in 1994. It has been re-surveyed and excavated by Prishanchit. The site is located in 3 areas of approximately 2 km², IN which the site in Area 1 was excavated for 2 test pits, 3×5 and 4×5 m², respectively. The excavation in Area 1 revealed 4 kilns of 'clay-slab kilns of cross draught type', which are determined as the above-ground kiln group, and were named as kiln ITK1, ITK2, ITK3 and ITK5, except for kiln ITK4 which is located outside the excavated pit and still un-excavated.

Drahor (2006) applied integrated geophysical investigation, including magnetic and 2D resistivity, to the upper terraces of the Sardis archaeological sites of Western Turkey. Magnetic data were collected using gradient measuring techniques in an area that is about 2 ha. The magnetic data were processed using different signals and image processing techniques. Resistivity surveys were applied using a Wenner configuration

and ‘pole–pole arrays’ at three investigation levels, and the resistivity data were processed using 2D resistivity inversion. The resistivity data clearly revealed the magnetic gradiometer results; the results also showed a very good correlation between the resistivity inversion and the magnetic images.

Mohamed Ali (2007) carried out a magnetic gradient reconnaissance survey in the southern part of the Meroe city, in Sudan, to reveal the presence of archaeological fired-brick building structures. The parallel resistivity imaging sections in profiles, selected on the basis of magnetic results, were used to confirm any magnetic anomalies and to provide complementary information about the variation of sandstone anomalies in depth. Resistivity imaging profiles were also used to demonstrate the feasibility and reliability of combining 2D resistivity profiles into a 3D data set, for 3D resistivity inversion. The inversion results of the 3D resistivity data were displayed in the form of horizontal and vertical slices and a 3D block diagram. The integration of magnetic and resistivity imaging surveys succeeded in discovering archaeological buildings.

Shagrand and Fattah (2007) conducted archaeological observations using intensive magnetic and electrical resistivity surveys in an area located to the SW of Alexandria, Egypt. Based upon the preliminary magnetic information represented by the total intensity magnetic maps, two parts of the whole site were selected for further electrical resistivity investigation. Resistivity profiles were measured again using the Wenner configuration. The magnetic and resistivity results showed existence of wall remains and other hidden archaeological objects, such as kilns and Roman water wells.

Drahor et al. (2008) presented geophysical surveys in the north of the Sadak village of Satala; which is one of the last great military centers in the Roman East available for archaeological and historical investigations. The surveys proceeded in two stages: The first stage used magnetic gradiometer imaging studies carried out on 2.1 ha, measured using a Geoscan FM-36 fluxgate gradiometer with 0.5 x 1 m grid intervals. The second stage used resistivity tomography. The resistivity data collected a number of combined 2D resistivity in the eastern part of the area, which contained very regular magnetic anomalies. The 3D data were obtained by a combination of all survey lines collected from the 2D data sets. The results of magnetic imaging and electrical

resistivity tomography surveys showed that the combined use of these technical advances revealed buried archaeological structures located near to the surface.

Cardarelli et al. (2008) performed geophysical surveys in a case study area of a Sabine Necropolis, located at the National Research Council in Montelibretti, Rome, Italy. During the survey, two geophysical techniques were employed, namely: fluxgate gradiometry and electrical resistivity tomography (ERT). The results were compared, integrated and interpreted, indicating locations of unknown burial tombs. In the magnetic map, the negative anomalies corresponded to the conductive ones of the ERT profiles, while the positive magnetic anomalies corresponded to the resistive ones. Following the boundaries of negative anomalies, a probable shape of the burial structure was drawn onto the magnetic map. On the ERT map, the low resistivity anomalies probably corresponded to collapsed structures - partially filled by natural saturated soil; while any high resistivity anomalies probably represented the outer walls of the excavated area. In this case, the shape of the burial structure was drawn by limiting the lower resistivity anomalies

Karavul et al. (2010) examined a buried Adramytteion ancient city in the Balıkesir-Burhaniye-Ören district, located in the Western Anatolian region of Turkey. They used magnetic and resistivity techniques to delineate the edges of buried bodies, in order to estimate their susceptibility contrasts and to produce burial depth. From the results, a high total magnetic field value and a wall with high resistivity values were identified in this area. Both techniques were applied successfully to Adramytteion, in order to reveal buried items.

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