

ANGKORIAN STONEWARE CERAMICS ALONG THE EAST ROAD FROM ANGKOR TO BAKAN AT TORP CHEY VILLAGE

Ea Darith
APSARA Authority

1. INTRODUCTION

Recently, many Angkorian stoneware kiln sites have been identified in the Angkor capital, and along the ancient royal roads from the capital to the provinces – namely, the roads to Phimai, Sdok Kak Thom, and Bakan (known as Preah Khan at Kampong Svay).

Kiln sites at Angkor were excavated by the APSARA Authority, Sophia University Angkor International Mission, the National Research Institute for Cultural Properties Nara (NRICPN), Ōsaka-Ōtani University, and the National University of Singapore from 1996 until 2010. Excavated kilns of this area exhibit a similarity of structure in kiln shape and ceramic production. Typically kilns are of similar oval-shape, divided into fire box, firing chamber and vent, with total lengths between 6 to 9m and widths from 1.8 to 3.6m. The ceramics are principally green-glazed wares of small dimensions and unglazed wares in larger sizes.

However, the kiln sites located along the ancient roads from the Angkor capital to other provinces are dated later. In this period, brown-glazed ceramics were introduced and became more popular in both small and large-size wares.

The excavations during the 1980s by the Thai Fine Arts Department of brown-glaze kilns along the northwest road from Angkor to Phimai in Buriram province showed many kilns sited on mounds and sharing side walls. The length of these kilns is longer than those at Angkor.

A recent excavation from 1 December 2011 to 10 January 2012 conducted as a joint research project between the APSARA Authority and Institute of Southeast Asian Studies (ISEAS), Singapore

of a brown-glaze kiln along the east road from Angkor to Bakan at Torp Chey reveals a different structure from previously excavated kilns. This paper discusses the Angkorian brown-glaze stoneware ceramics and kiln at this site.

2. PREVIOUS KILN RESEARCH

Research of kilns in northeast Thailand is earlier than similar studies concerning Cambodian kilns.

From the 1980s, new development projects in northeast Thailand destroyed many ancient structures such as ancient roads and kiln mounds. More than 100 kilns had been identified prior to the construction of the Lam Prathia dam. Later, only 7 kiln mounds remained after construction of the dam (Chandavij 1990). Kilns were built on artificial mounds, usually within the ubiquitous flat rice-field landscape (Hein 2008). In 1984, there was an excavation at Kok Lin Fa kiln in Lahan Sai district by the Thai Fine Arts Department (Khwanyuen 1985). During 1987-88, this department resumed excavation work at Nai Jian and Sawai kiln sites. The results of excavation research on the structure of the kilns and ceramics were published (Khwanyuen 1985, Srisuchat 1989, Chandavij 1990). The Sawai kiln measured between three and four meters in width, with up to three parallel fire boxes and a wide vent system at the upper end of the firing chamber to allow exit of the draft. This vent extended straight across the upper width of the kiln, but as the upper part of the kiln mounds is usually eroded, this detail is lacking (Hein 2008).

Following the discovery of kiln sites in the Angkor area in 1995, the study of Khmer ceramics on the basis of the kilns and artifacts in Cambodia emerged for the first time through a joint research project between the APSARA Authority and other international teams; the National Research Institute for Cultural Properties, Nara (NRIKPN), Sophia University Angkor International Mission, Ōsaka-Ōtani University, National University of Singapore, and Nalanda Sriwijaya Centre of Institute of Southeast Asian Studies. Three kilns at Tani, two kilns at Anlong Thom (Thnal Mrech), one kiln at Sar Sei, three kilns at Bang Kong, and one kiln at Torp Chey were excavated between 1996 and 2012. The structure of kilns and nature of ceramic production are well documented (Aoyagi et. al. 1998-2001; Sugiyama et al. 2001, 2005; Tabata 2004; Chhay et. al. 2007; Nakamura et al. 2009, 2010).

Other researchers who studied kiln sites in Cambodia are: Sumida 2000; Ea 2000, 2005, 2006, 2009; Chhay and Chap 2002; Phon 2002; Tabata 2003, 2004, 2008; Tin 2004; Em 2005; Sok 2007 and San 2008.

3. TORP CHEY KILN SITE

The Torp Chey site is located in Torp Chey village, Beng Mealea commune, Svay Leu district, Siem Reap province. The UTM at the site is X = 429797 and Y = 1486544. The site is located between two mountains located east-west from each other and approximately 30km apart. The mountain to the west is Kulen and to the east is Khtum. The natural slope from the west and the east created a river named Chikreng, and the Torp Chey site is located on the west side of the Chikreng River approximately 7km from the Ta Ong Bridge that is constructed across this river.

The Torp Chey kiln site stands on a slight rise approximately 40-50 meters above sea level. About 2 kilometers south of the Torp Chey temples and kilns, there is a small plateau running east-west with a depression to the east of Torp Chey. This depression is an ancient pond that is also named Torp Chey. Northeast of Torp Chey kiln site, there are two sources of water; one coming from Kulen Mountain via Beng Mealea stream and another one coming from Kaun Damrei stream to the east. These two streams meet at Bok stream near the ancient road that is located close to the Torp Chey kiln site and provides the source of water to Torp Chey pond and surrounding area.

The site was found in early 2007 when a survey was conducted along the Angkorian period east road from Beng Mealea to Bakan. Beng Mealea is a large temple built during the Angkor period (12th century) and later, the temple and surrounding area were modified in the Bayon period, especially during the reign of Jayavarman VII (1181–1220 CE). This temple complex was considered an important place; with a great deal of infrastructure, such as a rest-house, hospital, and a large water reservoir to the east that suggest large communities lived nearby. To the south of Beng Mealea, there were ceramic kilns and temples.

Beng Mealea is also considered an important node in the distribution of economic products, especially iron, to the capital and throughout the empire from at least the early 12th century (Hendrickson 2007). Additionally, Bakan is also a major temple complex with large water reservoir, temples, and iron smelting sites. Bakan is considered to be a location for iron forging to supply weapons and other metalwork to the Angkor capital and other locations. Halfway between Beng Mealea and Bakan there is an iron smelting site at Khvav. Five iron smelting mounds were identified at the site and two mounds were excavated by an APSARA Authority team. The excavation confirmed iron smelting through the presence of tubes for forcing air into the kilns, burned clay, and slag.

At about 15 to 17 kilometer intervals, many rest-houses were constructed along the east road from Beng Mealea to Bakan. In addition, there are also ancient bridges, ponds, and occupation mounds. Torp Chey Touch is situated approximately 17km to the east-southeast of Beng Mealea and is the first sandstone rest-house along the east road to Bakan. Torp Chey Touch is built close to the east road and to Torp Chey Thom. Twelve ceramic kiln mounds are located close to each

other near both Torp Chey Touch and Torp Chey Thom. Among these, ten kiln mounds remain, although two very clearly have evidence of looting on top of the mounds (Figure 1).

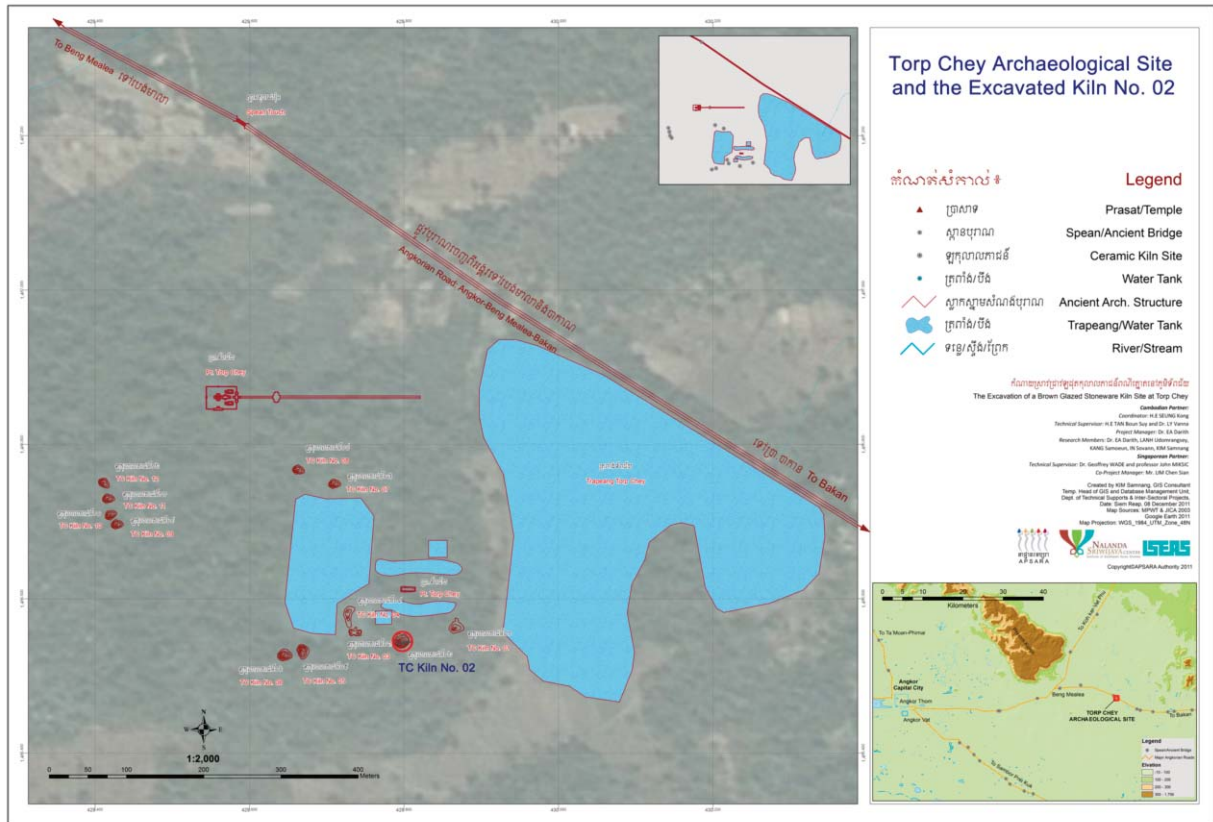


Figure 1: Torp Chey archaeological site and the excavated Kiln no. 2.

The Torp Chey site consists of two temples, a large pond and other small ponds around Torp Chey Touch, and twelve kiln mounds. Those two temples are Torp Chey Touch and Torp Chey Thom. Torp Chey Touch was termed *temple d'etape* and considered as a rest-house constructed in the reign of the king Jayavarman VII, and Torp Chey Thom was termed *gites d'etape* by French researchers (Parmentier 1948) and said to have been constructed during the reign of king Suryavarman II in the 12th century. Torp Chey Thom is located approximately 300m northwest of Torp Chey Touch and 200m south of the ancient road from Beng Mealea to Bakan. The large pond named Trapeang Torp Chey is located to the south, close to the ancient road, and measures approximately 300m by 300m.

The twelve kiln mounds are described as follows:

Kiln no. 1 is located approximately 70m southeast of Torp Chey Touch. The mound size

measures east-west 25m, north-south is 15m, and is 4m high. The mound is higher on the west and gradually slopes to the east. The top of the mound was looted through a trench approximately 1m by 2m, exposing the kiln floor and wall. On top and surrounding areas of the mound, there are many pieces of brown-glazed jars and basins, together with pieces of kiln roof.

Kiln no. 2 is located approximately 60m to the south of Torp Chey Touch. The mound size is similar to Kiln no. 1, east-west measures 25m, north-south 15m and it is 4m high. The mound is preserved in a good state. On top and surrounding areas of the mound, there are many pieces of brown-glazed jars, roof tiles and pieces of kiln roof.

Kiln no. 3 is located approximately 40m to the west of Kiln no. 2. The mound size; east-west is 20m, north-south is 15m and it is 3.5m high. The mound is higher on the west and gradually slopes to the east. On top and surrounding areas of the mound, there are many pieces of brown-glazed jars and sections of kiln roof.

Kiln no. 4 is located approximately 70m on the southwest of Torp Chey Touch. The mound size; east-west is 20m, north-south is 35m and it is 5m high. The mound is higher on the north and gradually slopes to the south. On top and surrounding areas of the mound, there are many pieces of brown-glazed jars, basins and pieces of kiln roof.

Kiln no. 5 is located approximately 60m on the southwest of Kiln no. 3. The mound size; east-west is 17m, north-south is 14m and it is 3m high. The mound is higher on the west and gradually slopes to the east. On top and surrounding areas of the mound, there are many pieces of brown-glazed jars and sections of kiln roof.

Kiln no. 6 is located approximately 10m to the west of Kiln no. 3. The mound size; east-west is 18m, north-south is 12m and it is 3m high. The mound is high on the west and gradually slopes to the east. This kiln was looted on the western and southern parts of the mound. On top and surrounding areas of the mound, there are many pieces of brown-glazed jars, basins, roof tiles and pieces of kiln roof.

Kiln no. 7 is located approximately 120m to the northwest of Torp Chey Touch. The mound size; east-west is 13m, north-south is 10m and it is 2m high. The mound direction is higher on the east and gradually slopes to the west. On top and surrounding areas of the mound, there are many pieces of brown glazed jars, roof tiles and fragments of kiln roof.

Kiln no. 8 is located approximately 30m to the west of Kiln no.7. The mound size; east-west is 15m, north-south is 8m and it is 1.5m high. The mound is higher on the east and gradually slopes to the west. On the top and surrounding areas of the mound, there are many pieces of brown-glazed jars and pieces of kiln roof.

Kiln no. 9 is located approximately 120m to the northwest of Torp Chey Thom. The mound size; east-west is 17m, north-south is 12m and it is 4m high. The mound is higher on the east and

gradually slopes to the west. On top and surrounding areas of the mound, there are many pieces of brown-glazed jars and pieces of kiln roof.

Kiln no. 10 is located approximately 6m to the northwest of Kiln no. 9. The mound size; northeast southwest is 15m, south-east north-west is 8m and it is 1.5m high. The mound is higher on the north-east and gradually slopes to the south-west. On top and surrounding areas of the mound, there are many pieces of brown glazed jars, basins and fragments of kiln roof.

Kiln no. 11 is located approximately 6m to the north-west of Kiln no. 10. The mound size; east-west is 15m, south-north is 10m, and it is 2m high. The mound is higher on the east and gradually slopes to the west. On top and surrounding areas of the mound, there are many pieces of brown-glazed jars and basins.

Kiln no. 12 is located approximately 10m to the north-west of Kiln no. 11. The mound size; north-west south-east is 25m, south-west north-east is 17m and it is 4.5 m high. The mound is higher on the south-east and gradually slopes to the north-west. On top and surrounding areas of the mound, there are many pieces of brown-glazed jars, basins and pieces of kiln roof.

4. EXCAVATION

The Kiln no. 2 was selected for excavation. The mound was covered with grass with small and large trees growing on top. The shape of the kiln is oval, lying from the west (top) to the east approximately 25m, and from the north to the south about 15m. The mound is still preserved in excellent condition without disturbance. The upper part of both side walls of the kiln appeared around the top of mound in a semicircular shape. After cleaning the mound, a reference '0' point was set up on the middle top of the kiln. Then east-west axis and north-south axis were set up across the '0' point and 5m grids were set up around the mound that measured 30m east-west and 20m north-south. Each 5m grid was named from the '0' point by counting the number from '0' to the east, west, north and south. For example, E0S0 grid is located at the southeast corner of the '0' point and S0W0 grid is located at the southwest corner of '0' point.

A systematic surface collection was done by grid in order to understand the distribution of artifacts around the mound. Many pieces of kiln roof were found on top of the mound as the result of the roof collapsing onto the floor. Evidence of this event can be found all over the floor of the kiln and it seems that no-one disturbed the interior from this time to the present. In addition, some pieces of brown-glazed jars and roof tiles were also found on the mound.

Excavation units

Seven units were excavated on the mound and surrounding area of Kiln no. 2. Unit 1 (1m x 10m) was set up north-south across the kiln body in grids S0E0 and N0E0 to find both walls of the kiln and the slope of the mound. Unit 2 (4m x 5 m) was set up to the east, next to Unit 1 in grids S0E0 and S0N0 to follow both walls. Unit 3 (3m x 10m) was set up to the east, next to Unit 2 in grids S0E1 and S0E2 to follow both walls and right-half of the kiln body.

Unit 4 (4m x 5m) was set up to the west, next to Unit 1 in the grids S0W0 and N0W0 to follow the upper part of both walls and vent. Unit 5 (2m x 4m) was set up to the east of Unit 3 in the grid S0E3 to find the fire box and eastern section of the fire box.

Unit 6 (2m x 3m) was set up at the north of Unit 3 about 50cm in the grid N0E1 to find the deposit of wastage. Unit 7 (1m x 2m) was set up to the west of Unit 4 in the grid N0W1 to see the deposit at the west of the vent. The excavation was carried out on only half the kiln from Unit 1 to 5 in order to see the stratigraphy of the kiln floor (Figure 2).

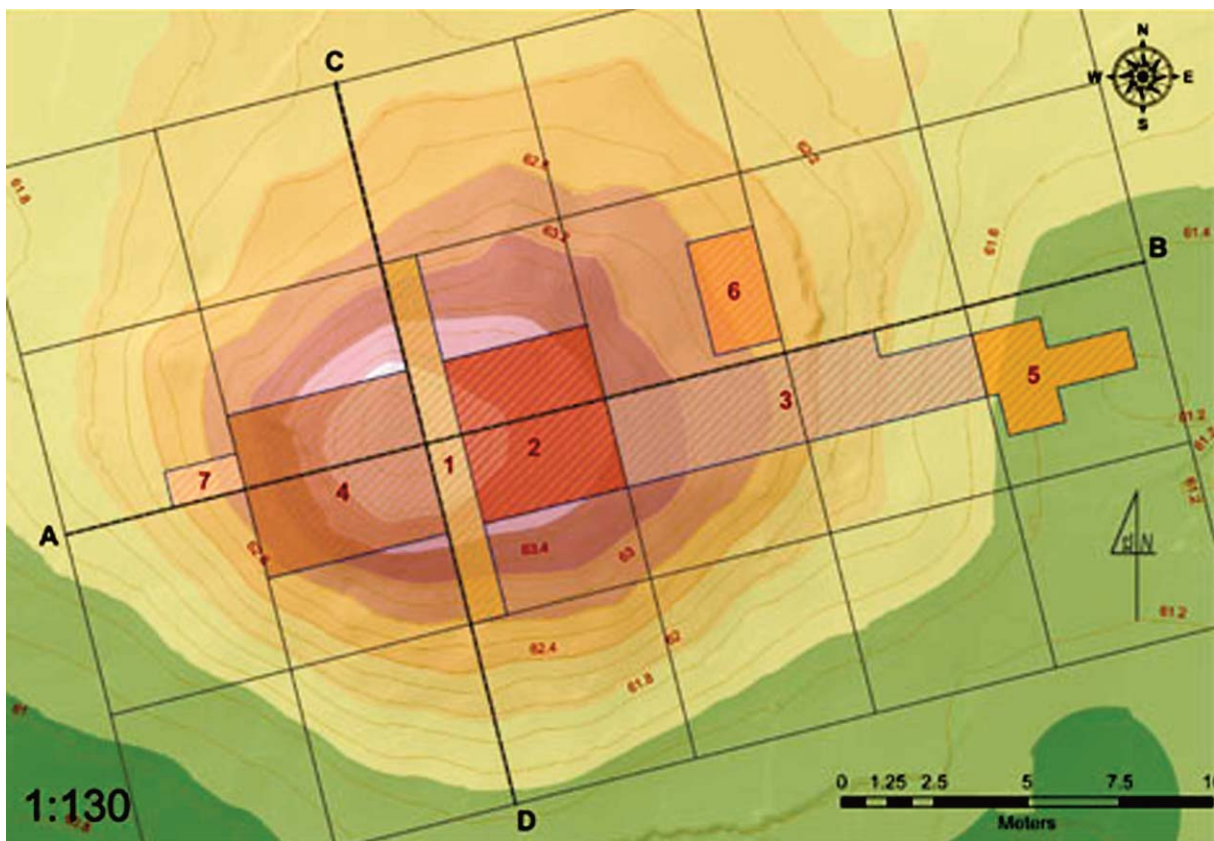


Figure 2: Mound of Torp Chey Kiln no. 2 and the excavation units (units 1 to 7).

Structure of the kiln

The kiln extends from west to east. The structure is unique and different from other excavated kilns in the Angkor period in the Angkor area and those at Buriram. It was built of clay at an inclined angle on a mound, of approximately rectangular plan widening slightly towards the higher end. The kiln has a single fire box, four separate firing chambers, three secondary firing trenches, one loading doorway, and an air vent toward the back of the kiln with three smoke holes. The three firing trenches located between the firing chambers may suggest side-stoke ports where additional fuel (that is, wood) and oxygen could be added in order to manage the temperature and atmosphere inside the kiln. Other features of the kiln include one pillar on the floor of firing chamber no. 3 and two pillars on the floor of firing chamber no. 4. There are at least three kilns constructed overlapping each other and their overall dimensions slightly differs.

Kiln no. I (earliest kiln) is located directly under Kilns no. II and III. The excavation confirmed only the vent structure appears with holes and a wall between the holes. The wall is 51cm in length and located 80cm from the wall of vent of Kiln no. II. Therefore, Kiln no. II was enlarged 80cm longer than Kiln no. I.

Kiln no. II was constructed on Kiln no. I. The excavation confirmed a fire box, three firing chambers, three secondary fire trenches, two pillars and vent.

Kiln no. III was constructed on Kiln no. II and its dimensions are probably similar. The excavation confirmed the fire box, three secondary fire trenches, a pillar and four firing chambers. However, the vent had disappeared, but it may have been constructed on the vent of Kiln no. II according to the curve of both walls of firing chamber no. 4. The kiln measured a remarkable 21.45m in length. The widest section is 3.2m (near the vent) and the narrowest is 1.4m (near the fire box) (Figures 3, 4, 5 and 6).

Fire box

The fire box of Kiln no. III is almost rectangular shape as mentioned above. The length is 3m. The width in front of fire box is 1.4m and the width near the wall of firing chamber no. 1 is 1.8m. The height of wall in front of fire box is 98cm and the height of wall near the firing chamber is 1.25m. The inclination from the floor of the firing chamber to the base of fire box is 40cm. This section gives more details about its dimensions. The overall size of the kiln suggests it was not designed for use without the aid of the secondary fire trenches. Stoke-holes and the air-hole in front of the fire box are not evident. There is another wall of a fire box constructed close to the outside of the fire box of Kiln no. III and this may suggest the wall of Kiln no. II. The wall of the fire box near

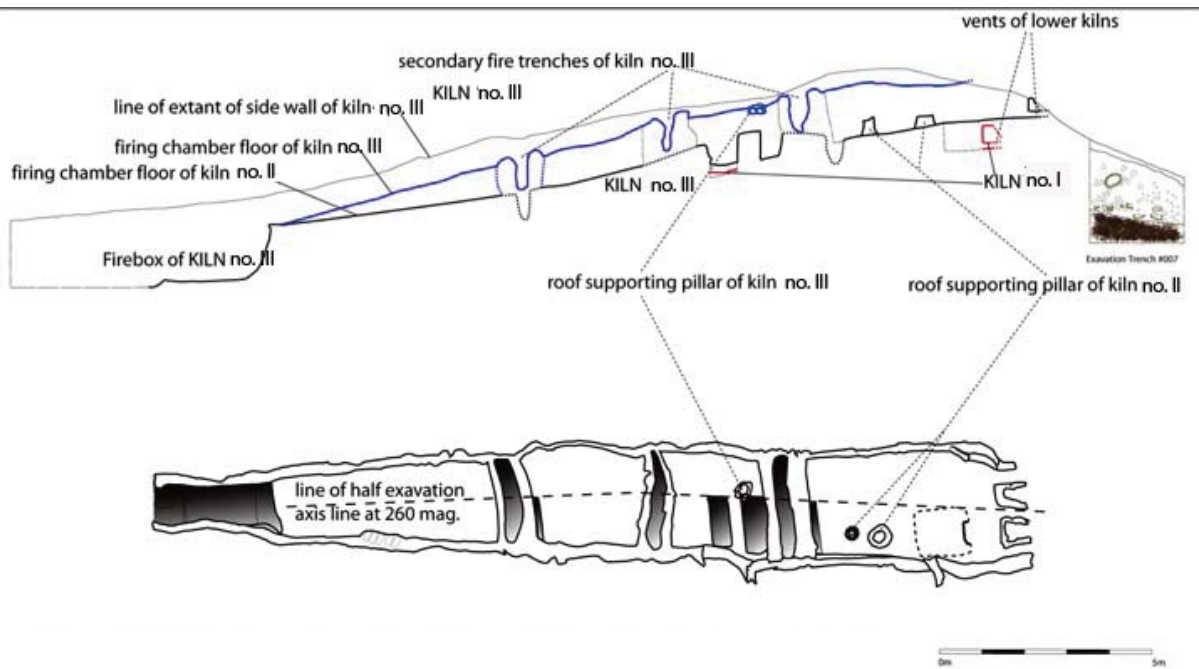


Figure 3 & 4: Structure of Torp Chey Kiln no. 2, three kilns in plan and elevation.

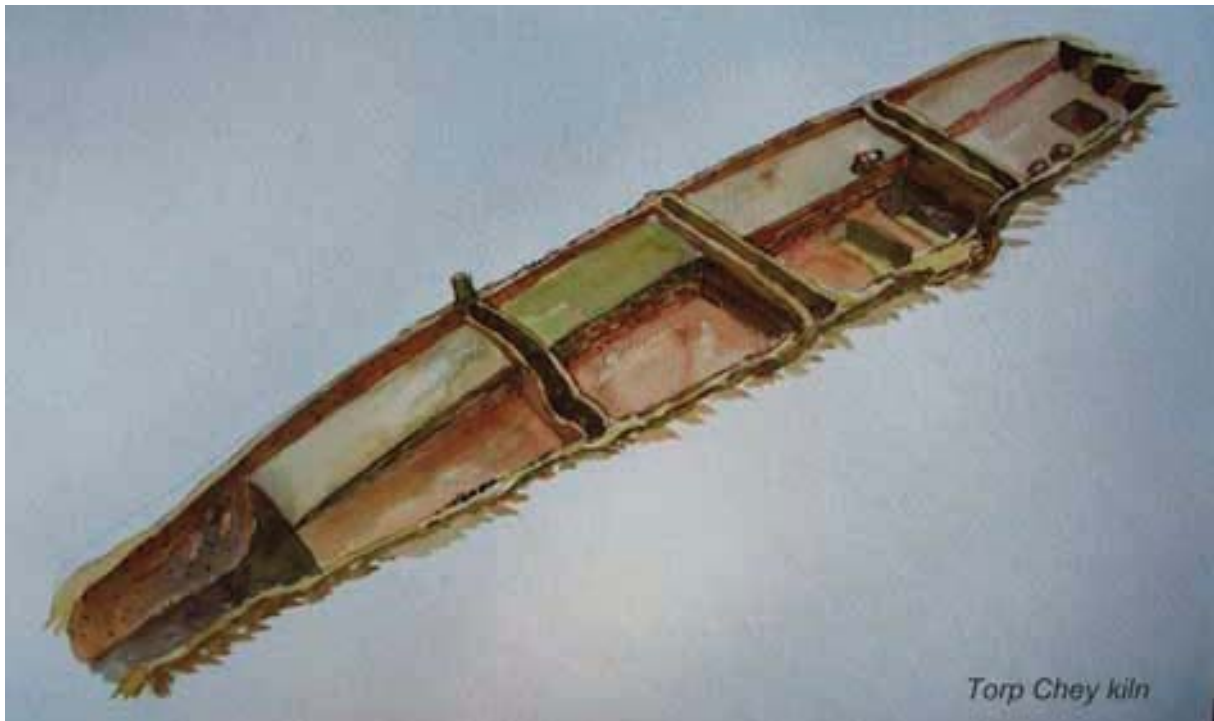


Figure 5: Drawing of structure of Torp Chey Kiln no. 2.



Figure 6: Structure of whole kiln no. 2.

the firing chamber is inclined approximately 40cm from the top to the base. The southern wall is damaged near the stoke-hole. The walls of the fire box are not smooth; several pieces of clay were pasted roughly on the walls. Several operational fire box floors appeared to exist but their definition would require further excavation. The floor of the fire box was black and charcoal remained with the soil. The fire box was constructed under the natural layer approximately 50cm down. Many fragments of kiln wall and roof and ceramics were discarded around the fire box.

Firing chambers

The most unique structure of this kiln was the presence of secondary fire trenches in the uppermost kiln, dividing the floor of the single firing chamber into four parts. Firing chamber no. 1 extends from the wall of fire box to the secondary fire trench no. 1 and the firing chamber no. 2 is located between the secondary fire trenches no. 1 and no. 2. Firing chamber no. 3 is between the secondary fire trenches no. 2 and no. 3. The last firing chamber no. 4 is between the secondary fire trench no. 3 and the vent. Firing chamber no. 1 and no. 4 are almost the same size; more than 4m in length, while the other two firing chambers (nos. 2 & 3) are almost the same size at more than 2m in length (Figure 7).

The excavation was conducted on the right-side of the kiln and the profile of all floors of the firing chambers can be observed very clearly from the surface through floors of Kiln no. III to the last floor of Kiln no. II. The stratigraphical layers clearly show the formation of Kiln no. III overlapped on Kiln no. II. To make the firing chamber of Kiln no. III, mixed soil includes rough sand and a small portion of burned clay added from Kiln no. II to make the base of a floor. Then, fine sand with clay covered approximately 3cm from the base over the entire area of the firing chamber to make the floor surface. Finally, sand was added on the floor surface in order to level the bases

of ceramics during the firing process. This is the construction of floor no. 1 of Kiln no. III and other floors were made in a similar way. The excavation confirmed three floors of Kiln no. III.



Figure 7: Firing chambers no. 1 of Kiln no. 2.

Secondary Fire Trenches (SFT)

Three SFT's of Kiln no. III were clearly confirmed within the firing chamber. These three SFTs existed in the uppermost section of the kiln, dividing the floor of the firing chamber into four parts. All of the SFTs are of curved shape and have two walls. The walls of the SFTs added were increased following the construction of the new floor of the kiln. SFT no. 1 clearly exhibits three phases of construction associated with the three phases of kiln floors. The first phase of the SFT was made by yellowish clay approximately 23cm height, the second phase of SFT made by orange clay about 15cm height and the last phase made by yellowish clay about 25cm in height. The top of SFT is higher than the floor of kiln by about 13cm. The walls of SFT were made by pieces of clay and smoothed using thin layer of clay. The top of the SFT is curved from walls to floor of the kiln. The inner walls of the SFT are dark gray as a result of firing. Inside the SFT, are many pieces of charcoal, ash and pieces of kiln roof. Other SFTs also have similar construction and only vary slightly in sizes according to the width of the kiln. The length of the SFT is from 2.5 to 2.9m. The

width is from 30 to 40cm. And the depth is from 68cm to 160cm (Figure 8).

The three SFTs of kiln no. III show very clearly, however, that under the floor of firing



Figure 8: Secondary fire trenches no. 2 and firing chambers no. 3 of Kiln no. 2.

chamber no. 3 of kiln no. III appears two trenches located close together with much wider dimensions. The eastern sectors are smaller than the western sectors. The base of both trenches contains ash and charcoal that can confirm the purpose of firing, but their function could not be positively determined. The western trench has a western wall similar to a sloping fire box wall and on its upper face there are pieces of clay pasted over the wall suggesting repair. The newly repaired area did not show evidence of firing discolouration. This strange structure cannot clearly be explained, but it may be suggested that a large fire box was made that was later abandoned as the space was too large and only half required. On the side of the SFT, there is a doorway about 1m wide that was probably made for loading pots and adding firewood to this fire box.

The purpose of constructing the secondary fire trenches was to increase the temperature inside the 21.45m long kiln, because the heat from the fire box alone was not enough to fire the pots in the upper part of the kiln.

Vents

The vent of Kiln no. I was found under the floor of Kiln no. II and located 80cm from the

vent of Kiln no. II. This means that Kiln no. II was enlarged in comparison to Kiln no. I. The vent of Kiln no. III has disappeared; however, its walls were built on the walls of Kiln no. III, by adding clay to repair from the inside. Therefore, the vents of Kiln no. III and Kiln no. II were probably constructed overlapping each other. The vents consist of three horizontal tube-like openings 20cm, 32cm, and 40cm in diameter positioned close to the floor at the blunt end of the kiln. They extended 50cm or so through the kiln mound to the end of the mound slope. Between the three holes, there are two walls measuring 53cm and 70cm wide and with a height of 50cm from the floor. Vents of this type have not been previously discovered in Southeast Asia (Hein 2012). The two walls between the three holes may function as a partial enclosure to prevent heat in the kiln from escaping (Figure 9).



Figure 9: Vent of Kiln no. 2 looking from the exterior.

Pillars

The roof-supporting pillars appear not as important for holding the roof of this kiln as they were for other previously excavated kilns in the Angkor area. The early kilns in the Angkor area have the pillars arranged at intervals of about 1.3m along the center-line of the kiln, whereas in the longer and larger Torp Chey kiln the arrangement of pillars on the kiln axis does not appear. The difference is probably the result of development of kiln technology, as the walls of the Torp Chey kiln are about 12cm thick, whereas the walls of early kilns in Angkor are 5-8cm thick (Ea

2009). On the floor of Kiln no. III, only one pillar was found in the firing chamber no. 3 close to the kiln's center line, suggesting at that point a single row of roof-supporting pillars was used. The three other firing chambers of Kiln no. III do not indicate the existence of pillars. Two other pillars were found on the floor of Kiln no. II on the right-hand side of firing chamber no. 4, a location coinciding with the vertical center of the ceiling where the cross-sectional arch would have been much shallower and in need of support. The two pillars are located 58cm from each other and 35-43 cm from the right hand wall. The sizes of pillars are different: one is 40cm and other is 57cm in diameter and 40cm in height. Those two pillars would have been matched by others on the left-hand side although no evidence of them was observed. The pillars are made of clay with holes in the center indicating bamboo sections or wood was used to stabilize the pillar during construction after which the vegetal material burnt out during use (Figure 10).



Figure 10: Pillars and wall of firing chamber no. 4 of Kiln no. 2.

Walls and roof

The walls of the kiln remain from 50cm to 110cm in height and 10-15cm thick. The thickness of the wall appears strong enough to support the roof of the kiln without pillars. The inner surfaces

of the walls are rough and show that clay was pasted on the walls over damaged parts by hand leaving finger marks. The surface of the inner walls of Kiln no. III was pasted with a thin layer of clay and the surface color changed to blue gray after the kiln was used. The paste can be seen on all the walls of the four firing chambers. After the walls were fired, the color of the walls changed from the inner part to the outer part. The surface of the inner part is gray, the middle part is dark red and the outer part is orange color (Figure 11).



Figure 11: South wall of unit 6 showing the sandstone chips in the natural soil.

Many pieces of roof rubble have a pattern on the inner surface from the impression into the raw moist clay of thatch that was used to cover the bamboo framework to support the clay construction until it dried. The nature of these impressions suggest the framework was burnt out rather than physically removed. The thickness of the roof rubble is approximately 12-15cm. The thickness of the roof could suggest the roof of the firing chamber was made without support pillars.

Loading doorway

A loading doorway was identified at the midpoint of the right-hand wall of firing chamber no. 3 of Kiln no. II. The loading doorway is located directly on the floor of Kiln no. II and the loading doorway of Kiln no. III has disappeared. In front of the loading doorway for approximately

3m, there is a small mound where fragments of ceramics, roof and ash were deposited. The doorway was approximately 1m wide but the height could not be determined. For strength the usual 15cm wall thickness at the lower part of the doorway was widened to about 30cm with the thickness diminishing with height. There was no evidence to show what kind of material was used to close the doorway for firing unless it was with rubble. Loading long kilns through the fire box is very hard and a door in the side of the middle firing chamber is more advantageous, especially in the case of kilns with secondary fire trenches that would need to be negotiated.

5. ARTIFACTS

The excavation unearthed brown glazed jars, bottles, roof-tiles, animal-shaped figurines and sandstone chips (Figures 11 and 12).



Figure 12: Sandstone chips excavated from unit 6.

Analysis of ceramics

The ceramics are mainly brown-glazed jars of many types, bottles, roof-tiles and animal-shaped figurines. Some shards are unglazed. The details of types of ceramics are as follows:

Cylindrical jars

The excavation uncovered many shards, typically in broken sections. Complete jars were not found during excavation, perhaps because of their large size, but comparative dimensions and shapes can be compared with jars from other collections. The sizes of fragments range from approximately 5 to 50cm and the thickness is about 2-5cm. Most shards have brown glaze but some are unglazed. A typical form of this jar is a cylindrical or oval body with a sloping shoulder, a very short neck, wide mouth, and flattened, everted rim. Sometimes this jar is called 'storage jar' or 'barrel-shaped jar' or 'wide-mouth vat' (Ea 2009). Generally, the form is tall in proportion to the width of the base. Moreover, there are some shards with short diagonal lines impressed between tiers of wavy lines and on the shoulder. The lugs were formed separately and attached, but in most cases they did not have a hole through which a cord could be passed, and the lugs themselves were small, indicating their main function was ornamentation. The jars have a great deal of decoration on the shoulder and above the base, with various patterns such as incised lines, decorative bands, wavy lines, lotus petal patterns, and star-shaped patterns. Generally, the cylindrical jars are divided into two main types; those with attached lugs and those without (Figures 13, 14, 15, 16, 17, 18, 19, 20 and 21).

Large-size jars

Jars with a large mouth and with the diameter of the mouth and body almost identical are called 'Large-size jars' or 'Wide-mouth jars' or 'Basins' (Ea 2009). There are a few tiers of decoration on the shoulder. These jars were produced in smaller numbers than the cylindrical jars. The diameter of mouth rims ranges from 16cm to 30cm. The jars are covered with brown glaze. The mouth rim is normally rolled and sometimes everted (Figures 22 and 23).

Baluster-shaped bottles

Many fragments of this type with brown glaze were uncovered. The form of this bottle is recognized by the shape of the neck and shoulder. The tall form has a baluster body, tubular neck, everted mouth rim, wide shoulder, and pedestal base. These are perhaps the most "typical" Khmer wares, especially in large sizes with brown and two-color glazes (Ea 2009). The vessels were also produced in a wide range of rims from approximately 20 to 50cm with various patterns decorating the body. Incised geometric bands on the shoulder characterize this shape. Some bottles also have lugs on the shoulder (Figures 24, 25 and 26).

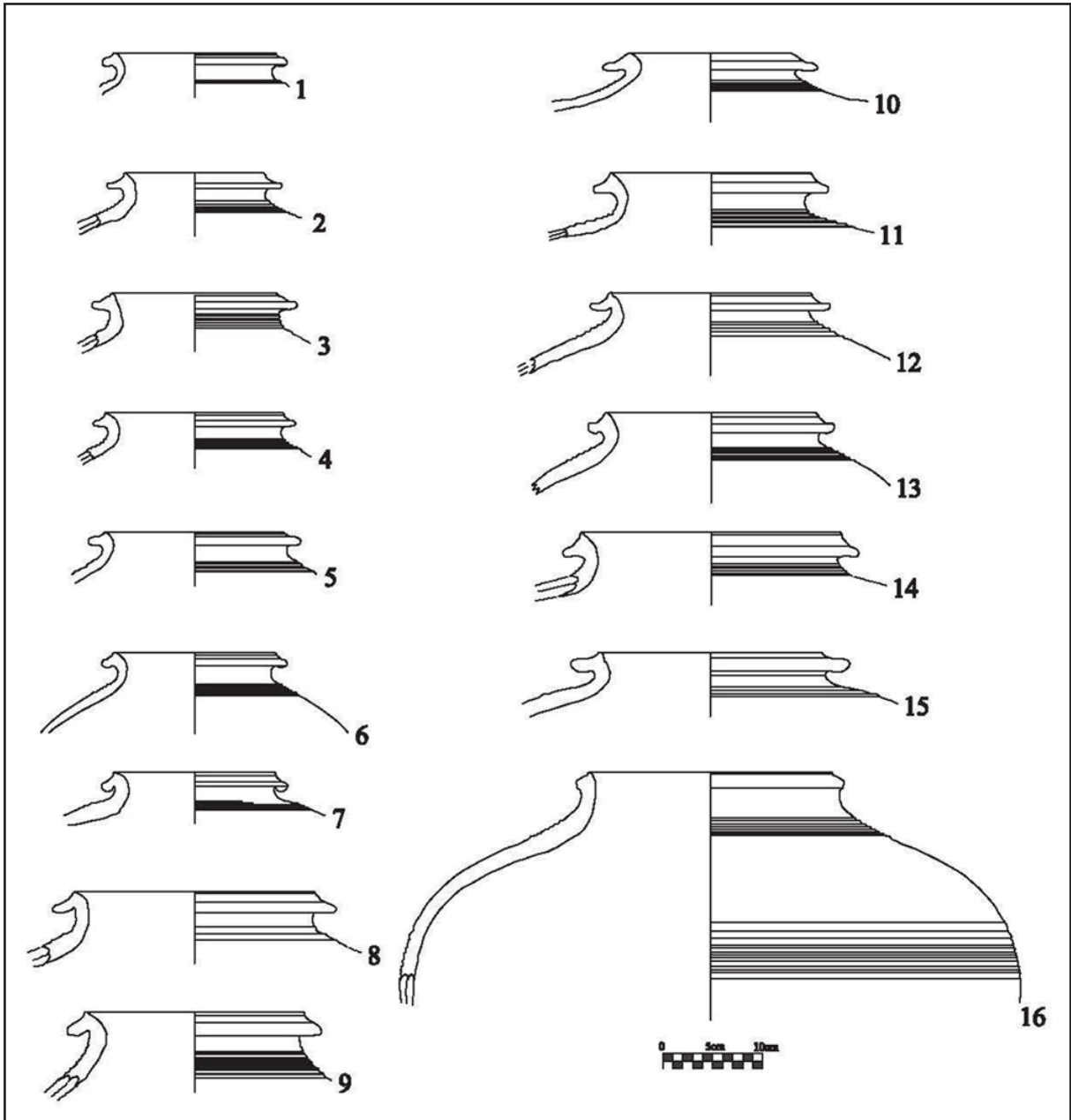


Figure 13: Drawings of cylindrical jars without lug on shoulder.

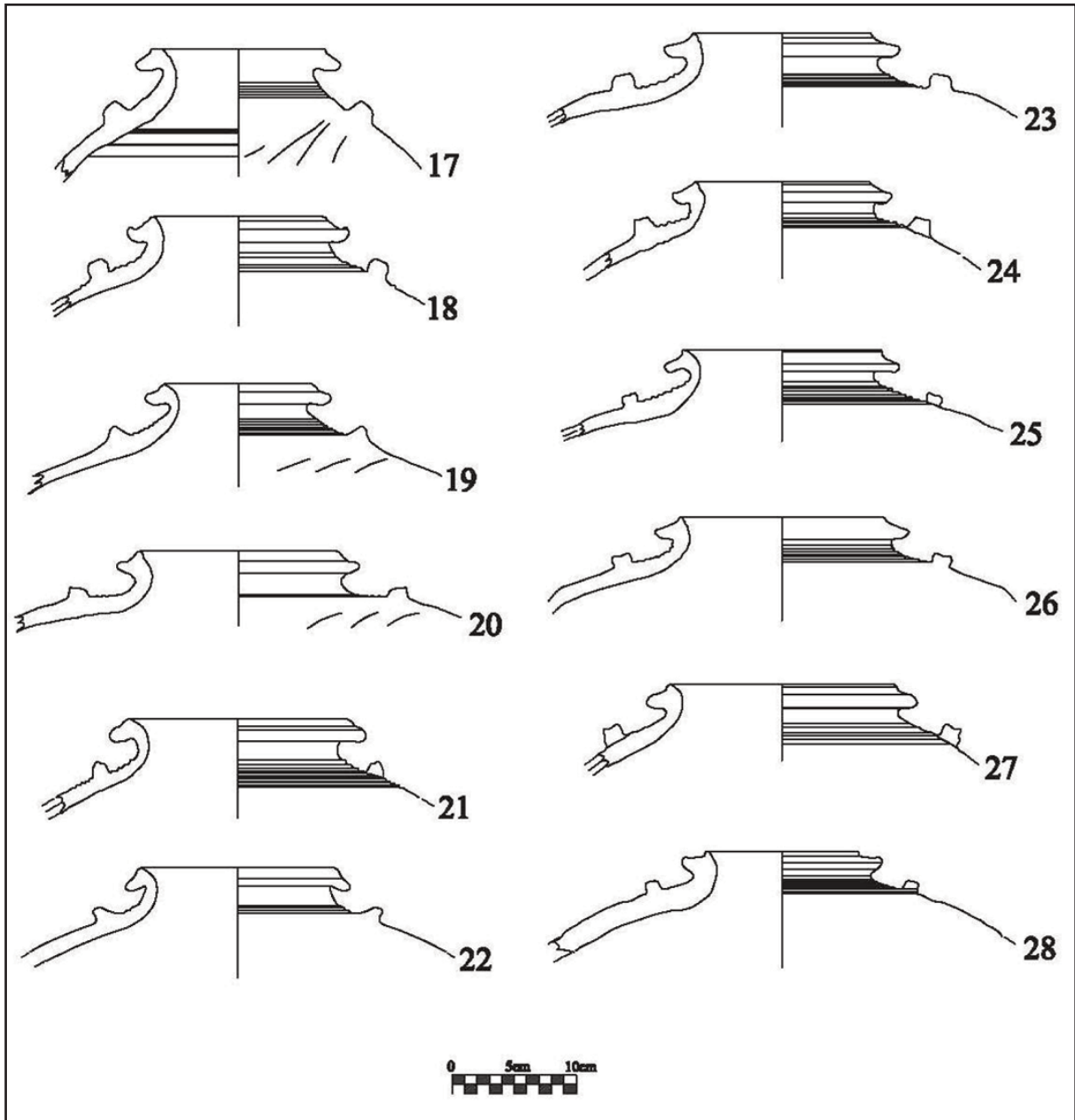


Figure 14: Drawings of cylindrical jars with lug on shoulder.

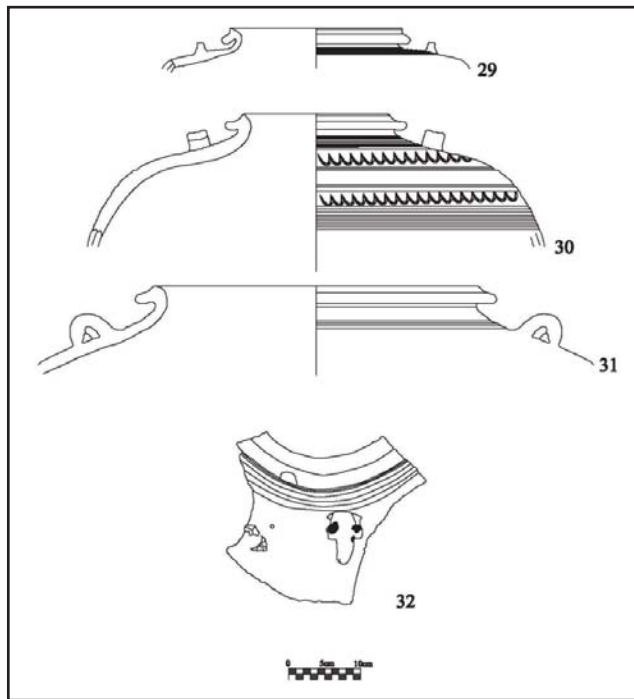


Figure 15: Drawings of cylindrical jars with lug and elephant head on shoulder.

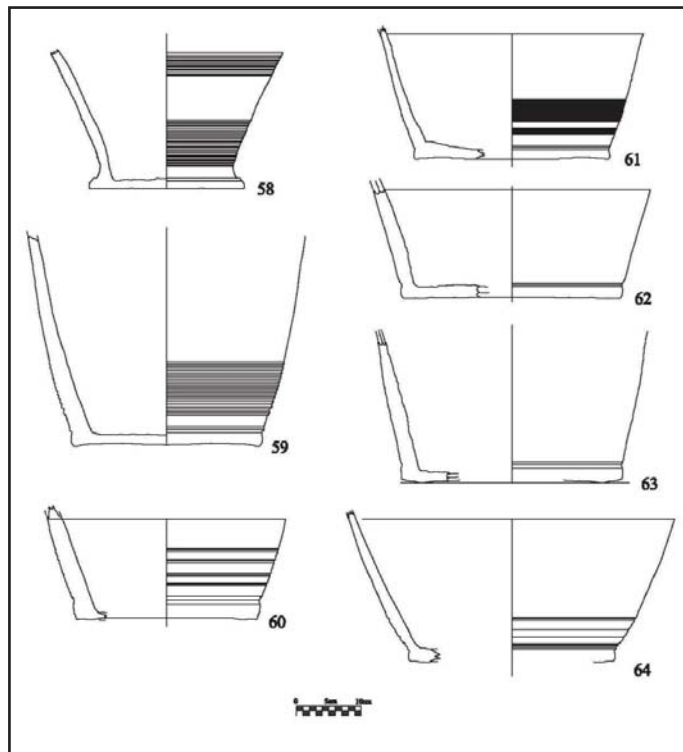


Figure 16: Drawings of base of jars.

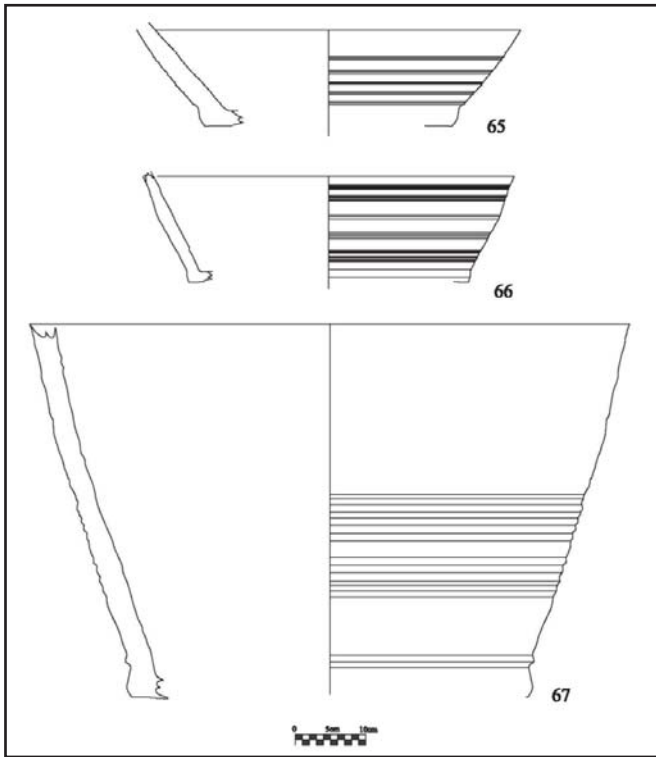


Figure 17: Drawings of base of jars.

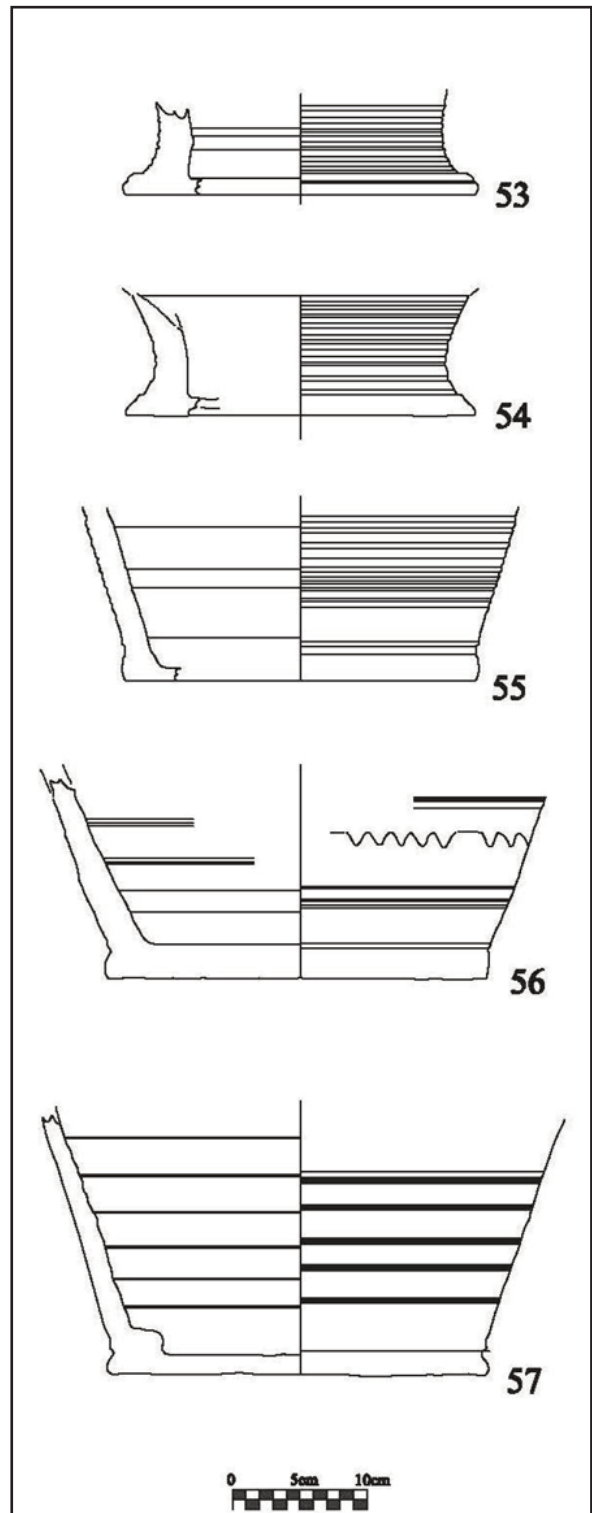


Figure 18: Drawings of base of jars.



Figure 19: Cylindrical jar without lug on shoulder.



Figure 20: Cylindrical jar with lug on shoulder.

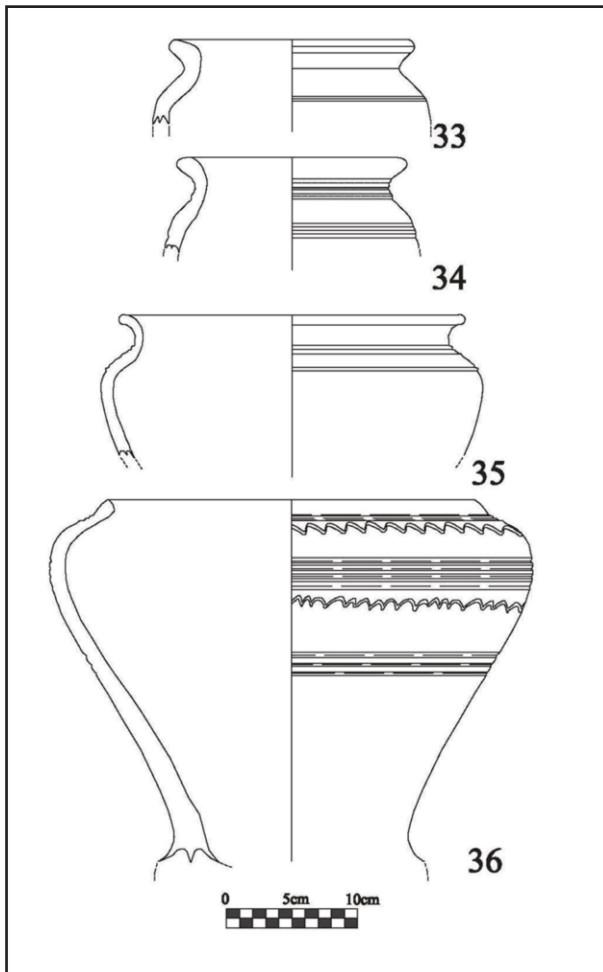


Figure 22: Drawings of large –size jars.



Figure 21: Base of cylindrical jar.



Figure 23: Large-size jar.

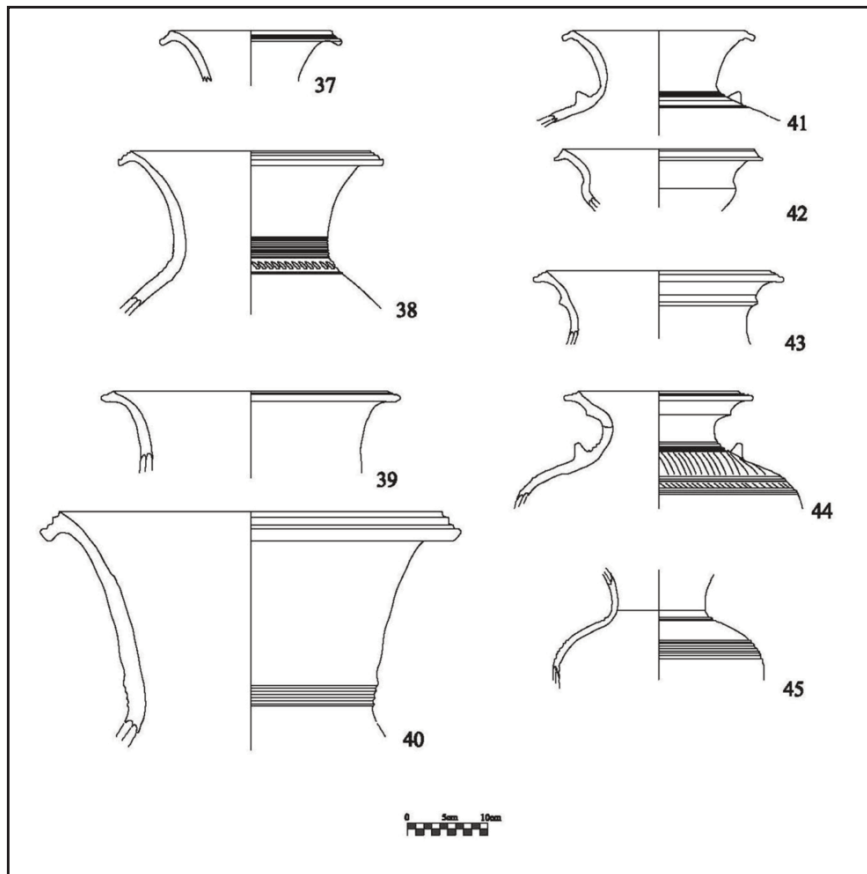


Figure 24: Drawings of baluster-shaped bottle without lug and with lug on shoulder.



Figure 25: Baluster-shaped bottle with lug on shoulder.



Figure 26: Baluster-shaped bottle without lug.

Roof-tiles

Three kinds of roof-tiles were uncovered; round tiles, flat tiles, and eave tiles. A ridge ornamental tile was not found from this site.

Round tiles occur in both unglazed and brown glazed versions, made from dark-reddish or orange clay body. They seem to have been formed by making a coiled cylinder with a shape narrower at one end and wider at the other, and finally cut lengthwise into two or three sections. Beveled edges are observed on most of the pieces. Round and pointed protuberances were made by attaching clay pieces and are seen on the smaller ends; used for holding the tiles in place. A difference from some early kilns in Angkor area is that the protuberance is attached at the center of the tile. The tiles are similar in size ranging from 24cm to 26cm in length, the larger width from 14cm to 15cm, and the smaller width from 10cm to 11 cm, with a height from 6cm to 9 cm (Figures 27 and 28).

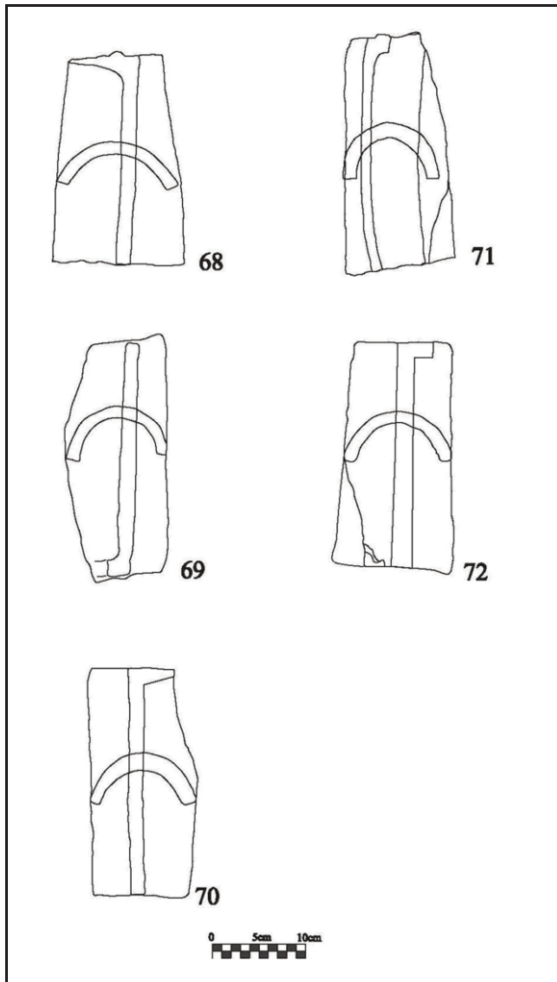


Figure 28: Rounded tile.

Figure 27: Drawings of rounded tiles.

The production techniques of flat tiles are similar to round tiles. These tiles appear in both unglazed and brown glazed versions. They are also formed by coiling and the shape is like 'C'. The exterior surfaces of the larger end bear applied horizontal ridge-shaped protuberances. The protuberance is also different from tiles from early kilns in the Angkor area, on which the protuberance is usually located in the center of the tile. The tiles were produced in closely similar sizes ranging from 24cm to 26cm length, the larger width from 17cm to 18 cm, the smallest width from 15cm to 16 cm, and the height from 4cm to 5 cm (Figures 29 and 30).

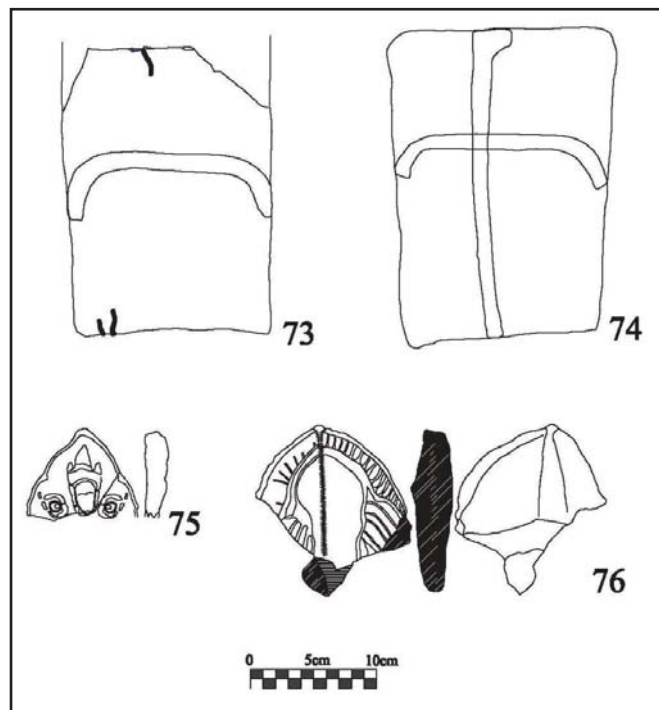


Figure 29: Drawings of flat and eave tiles with human face and patterns.



Figure 30: Flat tile.

Tiles formed as round tiles with attached lotus-bud-shaped faces are termed eave tiles. The lotus bud shaped faces were probably made in molds as some tiles are of similar shape and size. The faces of eave tiles uncovered here bore two patterns. One face of the eave tile has linear patterns and two other eave tiles have a human face wearing a crown with two flowers appearing on either side of the face. One eave tile was covered with brown glaze and the other, unglazed (Figure 31).



Figure 31: Eave tile with human face.

Bracelet

A broken half-circle of round solid clay was identified at unit 7, layer 5. The diameter of cycle is 7cm and diameter of the round solid clay is 1 cm. The other half had disappeared. This object may be a clay bracelet made of gray clay and unglazed.

Animal-shaped figurines

Three kinds of animal-shaped figurines in the shapes of elephant, horse, and cow were identified. The animals are made of dark-red or gray clay and coated with light yellow slip or brown glaze. The bodies of animals are solid (Figure 32).

Elephants

Six pieces of elephant were found; one head, three bodies, and two legs.

The head was broken from the body. It was found from unit 7, layer 4, and is 7cm in length and 5.5cm in width. The broken part has remains of a round piece of clay connecting the head with clay smoothed around it. This trace suggests the

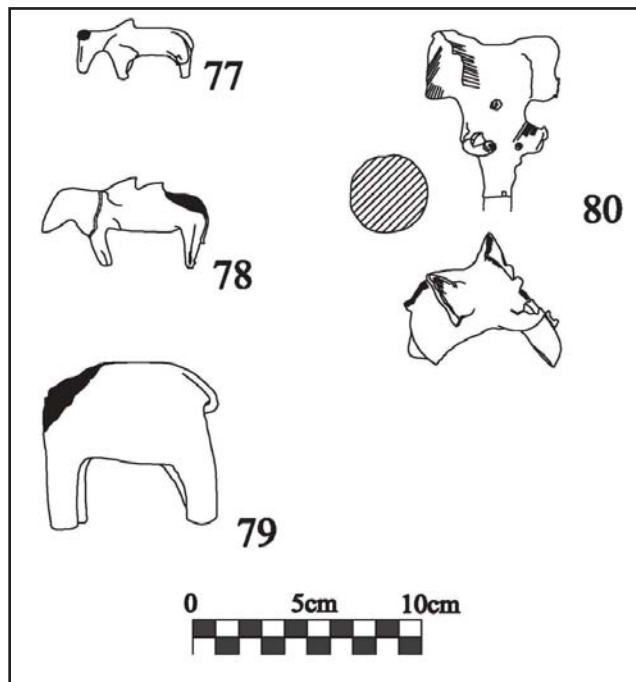


Figure 32: Drawings of animal-shape figurines (cow, horse and elephant).

head and body were made separately then joined together, finally adding clay to smooth the joint. Because of this technology, the heads of many elephants were separated from their bodies. The head has two large ears, two tusks, one nose broken at the lower part and coated with light yellow slip.

The three bodies were separated from the elephant heads. Body no. 1 was excavated from unit 6, layer 9, and is 8cm in length, 4.3cm in width and 7.8cm in height. The missing head retains traces of a join between head and body. The back left foot was broken at the lower extremity and the tail joins onto the upper part of the right leg. The body was covered with brown glaze. The body from no. 2 was excavated from unit 6, layer 10, and is 12.5cm in length, 4.1cm in width and 9.5cm in height. The head and left half of body are lost. The body is covered with brown glaze. Body no. 3 was excavated from unit 7, layer 4, and is 12cm in length, 3.5cm in width and 9cm in height. The head and half right section of body are lost. On the top of the neck, there is a round spot which is probably a trace of connection between head and body. The tail was placed from the back to left back leg. The elephant was made of gray clay pasted with yellow slip (Figures 32 and 33).



Figure 33: Animal-shape figure (elephant).



Figure 34: Animal-shape figurine (horse).

The two legs were broken from bodies. Leg no. 1 was made of gray clay coated with brown glaze and is solid. The size is 3cm in length and 2cm in diameter. Leg no. 2 was made of dark red clay and coated with slip. The leg shows the broken part from the body and was made separately from body. The size is 5cm in length, 1.7cm diameter at the base and 3.5cm diameter at the joint between leg and body.

Horse

One small horse made of solid clay was found in unit 6, layer 4; it is 8.4cm in length, 4cm in width and 3.2cm in height. The neck was broken from the body, but we reattached the two parts. The right legs and the top of the back are broken. There are two humps on the back. The tail is adhered to the leg. The horse made of solid gray clay without glaze (Figures 32 and 34).

Bulls

Two small bulls made of solid clay were found. Bull no. 1 was found in unit 2, layer 1, 5cm in length, 3cm in width and 3cm in height. The left horn was broken, the left leg was lost, the tail was stuck on the right leg. There is a hump on the back. The bull was made of gray orange clay, solid and unglazed. Bull no. 2 lost the head and lower part of the four legs. There is also a hump on the back. The bull is 5cm in length, 3.5cm in width and 4cm in height. The body covered with brown glaze (Figures 32 and 35).



Figure 35: Animal-shape figurine (cow).

6. DATING

Torp Chey Kiln no. 2 can be dated by two methods; one is relative dating of the sandstone chips excavated from the basement of Torp Chey Kiln no. 2 and those from Torp Chey Touch temple. A second method is radiocarbon dating of charcoal samples excavated from the Kiln no. 2.

Relative dating

Torp Chey Kiln no. 2 appears to be built on a foundation of sandstone chips carefully placed in an approximate 50cm layer directly on natural soil. Based on excavation pits to the north, east and west, the sandstone chip platform base extends outward at least 3.5m from the kiln wall. The full extent of the chip base is not known. It is assumed that this base extends under the firing chamber but not under the fire box which is set below the midpoint of the main section of the firing chamber.

The sandstone chip foundation and the nearby two temples, Torp Chey Thom and Torp Chey Touch, were surveyed for magnetic susceptibility in an effort to estimate a relative date for the kiln no. 2 based on the homogeneity of sandstone from at least one of the temples. Since the relative dates of temple construction are known based on the styles of the two temples: Torp Chey Thom, constructed in the reign of Suryavarman II (1113-1150 CE) and Torp Chey Touch constructed in the reign of Jayavarman VII (1181-1220 CE), magnetic susceptibility testing may provide added information as to the origin of the chips, and the quarry in which the original sandstone was procured

(Ea 2012).

Both Prasat Torp Chey Thom and Torp Chey Touch were sampled for their magnetic susceptibility, and compared to a sample of sandstone chips taken from Kiln no. 2. The sample from the Kiln no. 2 aligns closely with that of Prasat Torp Chey Touch. Given the propensity of the location of Prasat Torp Chey Touch to the Kiln no. 2, the probability of the sandstone chips of the foundation originating from the Prasat Torp Chey Touch is high. It is evident that sandstone was used as a basement and stabilizing platform for Kiln no. 2.

The result of analysis has linked the sandstone chips that formed the foundation layer on top of natural soil of Torp Chey Kiln no. 2 mound to those from Prasat Torp Chey Touch. The Prasat Torp Chey Touch functioned as a rest house during the reign of king Jayavarman VII. Therefore, the date of Kiln no. 2 can be related to the date of Prasat Torp Chey Touch during the reign of king Jayavarman VII (1181-1220 CE).

C14 dating

Beside relative dating, five charcoal samples from Torp Chey Kiln no. 2 were selected for C14 dating. Two samples (TC.03 and TC.05) were selected for radiometric plus standard service and three samples (TC.01, TC.02 and TC.04) were selected for accelerator mass spectrometry (AMS) standard service. The C14 dating analysis was done by Beta Analytic, Inc, 4985 S.W. 74th Court. Miami, Florida, USA 33155. The charcoal samples were selected from five different excavated units, five different layers, and two different methods of analysis in order to compare and measure the span of date. Details of samples is shown in the chart below.

Results reported using the AMS technique were derived from reduction of sample carbon (after treatment) to graphite (100%), along with standards and backgrounds, with subsequent detection in one of two AMS instruments. Results reported using the radiometric technique were analyzed

No.	Sample No.	Beta No.	Site name	Exca. Unit	Layers	Weights	Services
1	TC.01	328425	Torp Chey	T001N	8	20g	AMS
2	TC.02	328426	Torp Chey	T002	1	20g	AMS
3	TC.03	328427	Torp Chey	T003	3	80g	Radiometric
4	TC.04	328428	Torp Chey	T005	4	20g	AMS
5	TC.05	328429	Torp Chey	T006	2	50g	Radiometric

Chart 1: List of charcoal samples showing the excavated units, layers, weights, and services

by synthesizing sample carbon (after treatment) to benzene (92% C), measuring for C¹⁴ content in one of 53 scintillation spectrometers. If the Extended Counting Service was used, the C¹⁴ content was measured for a greatly extended period of time.

The Conventional C¹⁴ Age and related “percent modern carbon” (pMC) is the result after applying C^{12/13} corrections to account for isotopic fractionation differences between the sample and modern reference. Always cite both this age and the C^{12/13} ratio in the reports and papers. The Conventional Radiocarbon Age is cited with the units “BP” (Before Present). “Present” is defined as 1950 CE for the purposes of radiocarbon dating. Results are reported as pMC for samples containing more C¹⁴ than modern reference standard. pMC results indicate the materials was respiring carbon after the advent of thermo-nuclear weapons testing and is less than ~60 years old.

The Calendar Calibrations are included for applicable materials. If calibrations are not included for a result, it means it was too young too old, or inappropriate for calibration. The calibration database and mathematics used are cited at the bottom of each calibration print-out. The most approximation of age is the “2 sigma calibrated result”.

The radiocarbon dating results of the sample TC.01 in unit T001N from layer 8 (the charcoal sample was taken from the north part of northern wall, the lowest layer of the excavated unit, probably from the earliest kiln operation) shows the date from 1160 to 1270 CE. This dating probably shows

N0.	Sample No.	Excav. Units	Layers	Service	Measure Age	C¹³ /C¹²	Conventional Age	2 Sigma Calibration
1	TC.01	T001N	8	AMS-Standard	860+/- 30BP	-27.2 0/00	820+/- 30BP	Cal AD 1160 to 1270 (Cal BP 790 to 680)
2	TC.02	T002	1	AMS-Standard	660+/- 30BP	-27.8 0/00	610+/- 30BP	Cal AD 1290 to 1410 (Cal BP 660 to 540)
3	TC.03	T003	3	Radiometric PLUS Standard	710+/- 30BP	-27.2 0/00	670+/- 30BP	Cal AD 1280 to 1320 (Cal BP 670 to 630), Cal AD 1350 to 1390 (Cal BP 600 to 560)
4	TC.04	T005	4	AMS-Standard	1740+/- 30BP	-28.0 0/00	1690+/- 30BP	Cal AD 260 to 300 (Cal BP 1690 to 1650), Cal AD 320 to 420 (Cal BP 1630 to 1530)
5	TC.05	T006	2	Radiometric PLUS Standard	830+/- 30BP	-27.7 0/00	790+/- 30BP	Cal AD 1210 to 1280 (Cal BP 740 to 670)

Chart 2: Radio carbon dating results

the earliest date of kiln operation. The sample TC.02 in unit T002 from layer 1 (the sample was taken from the uppermost floor of firing chamber no. 3) show the date from 1290 to 1410 CE. This dating probably shows the last date of kiln operation. The samples TC.03 and TC.05 were taken from layers 2 and 3 between layer 1 and layer 8 of above samples. Two samples dated from 1280 to 1320 CE and from 1210 to 1280 CE show clearly that these samples were dated during the middle period of kiln operation. However, the sample TC.04 in unit T005 from layer 4 (the sample was taken from the fire box) dated from 260 to 300 CE that was much older than the four earlier samples. This sample was not accurate as it was taken from the fire box where many kinds of woods were used and the Beta Analytic result suggests old wood was probably used for firing.

The results of radiocarbon dating from sample TC.01 shows the date of beginning of kiln operation from 1160 to 1270 CE and sample TC.02 shows the date of last kiln operation from 1290 to 1410 CE. The sandstone chips used for the construction of basement of the Kiln no. 2 are linked to the date of Prasat Torp Chey Touch constructed in the reign of king Jayavarman VII (1181 to 1220 CE). Therefore, Kiln no. 2 probably operated for more than 200 years, which began from the reign of king Jayavarman VII, at the end of 12th century to the early 15th century.

7. CONCLUSIONS

Torp Chey kiln is unique in comparison with other Khmer kiln sites excavated in the Angkor and Buriram areas. Kilns excavated in the Angkor area such as Anlong Thom (Thnal Mrech), Sar Sei, Khnar Por, Bang Kong, and Tani (Figure 36) have almost identical structures and dimensions. The kiln structures can be divided into three parts: fire box, firing chamber and vent (chimney). The ceramics produced from the Angkor area are mainly green-glazed and unglazed in limited shapes.

However, the excavated kilns in the Buriram area (Figure 37) are different from those in the Angkor area. The kiln mounds are larger and there are many kilns constructed on a mound with shared kiln walls. The ceramics produced in this area are mainly brown-glazed wares with some unglazed and green-glazed wares. On the other hand, the Torp Chey Kiln no. 2 has a different structure from these two areas. The Torp Chey Kiln no. 2 is the longest, consisting of four firing chambers on a long single floor, and three secondary fire trenches heated by a single fire box. This discovery raises the question of how a kiln of this type came to be built at Torp Chey along the east road from Angkor. The kiln used the side-stoking method that is not known elsewhere in Southeast Asia, suggesting outside influence where such technology was used. China is a likely candidate. Such technology could have been introduced as an idea, a simple description of the side-stoke principle,



Figure 36: Structure of Tani A6 kiln.



Figure 37: Structure of Nai Jiang kiln.

and would not necessarily involve foreign potters (Hein 2012). The Cambodian potters probably developed a system to imitate the idea of secondary fire trenches.

Moreover, according to Dr. John Miksic (2009), a specialist in the field of Southeast Asian ceramics, the Khmers were second only to the Chinese in mastering the technique of producing stoneware and the ability to produce glaze. Archaeological evidence indicates that the Khmer potters were inspired by Chinese imports, but the Khmer developed the techniques of kiln construction and glazing independently. Torp Chey Kiln no. 2 structure shows the development of kiln technology by enlarging the length of kiln from 6-9m to 21.45m; inventing the four firing chamber kiln; adding three secondary fire trenches to increase the temperature in the long kiln; reducing the slope of firing chamber from 30-40 degree (early kilns) to approximately 15 degrees; developing the technology of supporting ceramics during the firing process with clay supports to a sandy layer that is more easily adjustable to level pots during firing; perfecting the thickness of the walls and roofs to replace the use of pillars in the kiln body in order to save space, and creating a loading doorway to enable easy access to the kiln in the upper section.

Based on research covering almost 20 years, the production of Angkor stoneware ceramics and kiln technology advanced in two stages as detailed below.

In stage 1, kilns were constructed and arranged on artificial dykes surrounding water structures. Kiln mounds were small, oval in shape and measuring approximately 10m in width, 15m in length and 2 to 3m in height. The structure of kilns was divided into three parts: fire box, firing chamber and chimney (vent) measuring approximately 1.8 to 3.6m in width and 6 to 9m in length. Kilns were reconstructed on top of each other when older kilns were broken and new kilns were required. Clay pillars were arranged in the middle of the firing chamber to support the roof. The slope of kiln was between 30 to 40 degrees and required kiln tools to level pots during the firing process. Ceramics produced in this stage are very limited shapes divided into two types: green-glazed and unglazed wares. The shapes of green-glazed wares were small in size such as; covered boxes, bottles, bowls, small jars, some roof-tiles and water jars. However, the shapes of unglazed wares are larger in sizes such as basins, water jars, cylindrical jars and roof-tiles. Kiln sites of this early stage are probably dated from the early 9th to 10th century and kiln sites are located in the Angkor region such as Anlong Thom (Thnal Mrech), Sar Sei, Tani, Bang Kong, and Khnar Por.

In stage 2, kilns were constructed and distributed on artificial mounds. The kiln sites are located more widely, along Angkorian roads from the capital to Bakan, to Phimai, and to Sdok Kak Thom. The sizes of the mounds are larger than those in stage 1 measuring approximately 20m in width, 30m in length, and 3 to 4m in height. The structure of a brown glaze kiln no. 2 at Torp Chey is different from those of kilns in stage 1. The length is 21.45m, and the width is 3.2m, divided into fire box, four firing chambers, three secondary fire trenches, and vents. Pillars to support the roof were not

necessary and used only in some places. The slope of the kiln was reduced and used sand to level the wares instead of kiln tools. Ceramics produced in this stage exhibit development of shapes of ceramics from stage 1 with a wider variety of shapes. Brown glazes were applied to both small and large shapes, and green-glazed wares still produced in limited amounts. The most interesting wares in this stage are small jars with animal figures and two colours used on a single pot. Kiln sites in stage 2 probably date from the 11th century to the end of Angkor period.

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សង្ខេប

កុលាសភាជន៍សម័យអង្គរនៅទំព័រជ័យ, តាមផ្លូវបុរាណពីអង្គរទៅបាកាន

អ៊ា ដារីថូ

អត្ថបទនេះបង្ហាញពីវត្តផលិតបានមកពីកំណាយនៅឡូកុលាលភាជន៍នៅភូមិទំព័រជ័យ ដែលស្ថិតនៅផ្លូវចេញពីបឹងមាលាឆ្ពោះខាងកើតទៅបាកាន។ ក្នុងចំណោមឡូជាច្រើននៅតាមបណ្តោយផ្លូវបុរាណនេះ ទំព័រជ័យជាឡូទី១ដែលឃើងបានដឹក ហើយដែលផលិតកុលាសភាជន៍មានស្រទាប់រលោងពណ៌ត្នោត។ ឡូនេះផ្តល់ទិន្នន័យមួយថ្មីទៀតដល់អ្នកស្រាវជ្រាវ ពោលគឺថាមានកូនបន្ទប់ភ្លើងបន្ថែមលើបន្ទប់ភ្លើងដែលសំខាន់ចាំបាច់នោះទៅទៀត ហើយដែលអាចជាឥទ្ធិពលមកពីក្រៅផង។ បច្ចេកទេសនេះធ្វើឲ្យគេសង់ឡូបានទំហំវែងលើសឆ្ងាយពីឡូនៅកន្លែងដទៃ។ តាមពិតទៅ ទំព័រជ័យជាឡូវែងបំផុតក្នុងចំណោមឡូដែលគេស្គាល់នៅអាស៊ីអាគ្នេយ៍។ បើតាមស្ថាន ក្រុមឡូដទៃទៀតតាមផ្លូវបុរាណនេះប្រហែលជាមានលក្ខណៈស្រដៀងគ្នាព្រមទាំងផលិតវត្ថុពណ៌ត្នោតដែរ។

Abstract

Angkorian Stoneware Ceramics along the East Road from Angkor to Bakan at Torp Chey Village
Ea Darith

This paper discusses findings from recent excavations of the Torp Chey kiln site along the ancient road leading east from Beng Mealea Temple to Bakan (Preah Khan of Kompong Svay) temple. Torp Chey is the first brown glazed kiln located along the east road to have been excavated, and presents new insights into ceramic technology in the late Angkorian period. The technology of a secondary fire used here is unknown in other Angkorian kilns sites, and suggests foreign influence. This technology allowed the construction of kilns notable for their length. The Torp Chey kiln is in fact the longest kiln to have been found in Southeast Asia up to date. Other kiln clusters located along this same road are likely to have exhibited similar characteristics, and to have produced similar brown stoneware.

Résumé

Céramique angkorienne à Torp Chey, village situé le long de la chaussée est, d'Angkor à Bakan
Ea Darith

Cet article présente les trouvailles provenant de la fouille de Torp Chey, site de fours de céramique à glaçure brune situé sur la chaussée est-ouest qui relie Beng Mealea à Bakan (ou Preah

Khan de Kompong Svay). Partant de Beng Mealea vers l'est, c'est le premier ensemble à avoir été fouillé, et qui nous apporte des éléments nouveaux quant à la technologie céramique vers la fin de l'époque d'Angkor. L'usage des chambres de chauffe secondaires trouvées ici est inconnu ailleurs, à Angkor, et fait penser à une influence étrangère. Cette technologie permet de bâtir des fours d'une longueur notable. A vrai dire Torp Chey nous livre les fours les plus longs connus à ce jour en Asie du Sud-Est. D'autres ensembles de fours situés sur la même chaussée présentent probablement les mêmes caractéristiques et la même céramique à glaçure brune.