Angkor Monuments, Tani Kiln Excavation Survey Results and Environmental Improvement Policies

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1. Angkor Monuments, Tani Kiln Excavation Survey Results and Environmental Improvement Policies

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I Introduction

The Tani Kilns are located on the eastern side of the Angkor Monuments which are themselves located to the northwest of Lake Tonle Sap in the Angkor District of Seam Reap Province in the northwest of Cambodia. The kilns themselves are located 17km to the east of Bayon, the center of Angkor Thom, and 3km east-northeast from the center of Phnom Bok in a plain with small mounds. Although it has been known since the end of the 19th century that kilns exist at Phnom Kren, a distance of 30~40km away from Angkor to the east-northeast, the historical significance of the discovery of the Tani Kilns on flat land between Phnom Kren and Angkor is immense.

The 1st Survey of the Tani Kilns commenced on August 1, 1996. From the time of that first survey until the 7th survey, which was carried out in August 2000, six excavation surveys and one survey of the surrounding area were carried out. During the 1st Survey, two trenches were dug in order to verify whether or not kilns were located in the Group B Mound 1 area. As the existence of kilns in this area was verified, this was designated as Tani Kiln B1. Results of the 2nd Survey revealed five groups of kilns, which were designated as Tani Kiln Groups A~E. During the 3rd Survey, a trench was dug in the area of the kiln itself to verify the location and specifications of Kiln B1, making it possible to discover the alignment of the main axis of the kiln and the outline of the upper portion of the firing chamber. A survey area was established using the position of the trench from the 1st Survey. Although a survey was carried out of the lower portion of the firing chamber together with the combustion chamber during the 4th Survey, it proved difficult to obtain a clear idea of the detailed structure of the combustion chamber. The 5th survey was carried out in order to discover the structure of the combustion chamber, as well as to examine the surrounding facilities, such as the waste heaps and workshops, etc. Furthermore, a trial excavation of Mound 4 was carried out as a means of obtaining material to act as a comparison with Kiln B1, and the existence of Kiln B4 was verified. The survey of the surrounding facilities, such as the waste heaps and the workshops, etc. continued in the 6th and 7th Surveys during which a further examination was also made of the structure of Kiln B4.

II Tani Kiln B1 (Mound 1)

1. Overall Shape

In plan view, the body of Kiln B1 is an elongated oval with a single chamber, slightly enlarged across the middle. Although it is thought that the kiln was probably made up of four sections?a flue section, firing chamber, flame passage hole and combustion chamber?no trace remains of the flue section. The ceiling section is also no longer in existence but it appears to have been supported by several clay columns. The combustion chamber is rather low and the floor of the firing chamber is inclined. Between the combustion chamber and the firing chamber is a large step, and the combustion chamber is set much lower than the firing chamber. In many ways this kiln is similar to those found in northeast Thailand.

The width inside the chamber of Kiln B1 in areas where the inner wall is still in existence is approximately 2.8m, with the width increasing to an estimated maximum of 3.0m based on a survey of the remains of the foundations. The total length of the kiln body (from the combustion chamber to the flue section) is estimated to be approximately 8m. The internal area of the kiln is estimated to be approximately 20.5m^2, consisting of 16.8m^2 for the firing chamber (including the flue section), 1.5m^2 for the flame passage hole section, and 2.2m^2 for the combustion chamber. The B1 site actually contains the remains of two kilns, one older than the other with restoration of each of them having been carried out at least once. As a result, the floor of the firing chamber has four layers, as does that of the combustion

chamber. Both the older and newer combustion chambers have two stoking ports at the front of the combustion chamber, one on the right and one on the left, with an air hole in the middle at the bottom. The newer of the two kilns is the larger of the two. The newer kiln that had undergone large-scale improvement was designated as B1A while the older kiln hat existed before restoration was designated as B1B. The floor of the firing chamber was plastered with clay to provide an almost constant slope as far as the combustion chamber.

2. Firing Chamber

(1) Scale

It is only possible to estimate the scale of the firing chamber for Kiln B1A. The width of the combustion chamber in areas where the inner wall is still intact is 2.84m and it is estimated from the blackened condition of the inner wall that the maximum width was 3.0m. The length, including the flue section, is estimated to be approximately 6m. The internal floor area is estimated to be approximately 16.8m^2.

(2) Floor

The floor of the firing chamber has been reconstructed at some stage. The floor areas of the firing chamber in Kiln B1 are designated as a1 and a2 while the floor areas of the firing chamber of Kiln B1B are designated as b1 and b2. The slope of Floor Area a2 in the upper part of the firing chamber is approximately 15~18 degrees, while the slope of Floor Area b2 in the lower part of the firing chamber is approximately 31 degrees. The slope of Floor Area b1 in the firing chamber is approximately 27 degrees, the slope of Floor Area a2 in the firing chamber is approximately 22 degrees and the slope of Floor Area a1 in the firing chamber is approximately 24 degrees.

3. Flame Passage Hole

The flame passage hole is located where the combustion chamber and the firing chamber meet. The flame passage in Kiln B1A is approximately 2.5m wide and 0.6m deep with a floor area of approximately 1.5m^2. The flame passage hole for Kiln B1A has a single pillar for dividing the flame. The fire-dividing pillar supported the ceiling of the kiln. The middle of the flame passage hole shows evidence of a cylindrical clay pillar having stood there, the length of which was at least 0.8m.

4. Combustion Chamber

(1) Scale

The width of the combustion chamber of Kiln B1A is approximately 2.5m at the back while the length of the wall with the air hole is approximately 1.3m. The length of the line joining the centers of the two stoking ports is approximately 1.8m long and the depth at the center is approximately 1.0m. The internal area of the combustion chamber is approximately 2.2m^2. The width of the combustion chamber of Kiln B1B is more than 1.8m and it is estimated that it has an area of approximately 2.3m^2. The length of the wall with the air hole is approximately 1.0m while it is estimated that the chamber has a depth of approximately 1.2m. The internal area of the chamber is definitely more than 1.7m^2 and is estimated to be approximately 2.2m^2.

(2) Floor

The floor of the combustion chamber of Kiln B1A consists of Floor Area a1 and Floor Area a2 while the floor of the combustion chamber of Kiln B1B consists of Floor Area b1 and Floor Area b2. The oldest area of floor is Floor Area b2, with this area being the original floor from the time when Kiln B1B was constructed. There is a slight slope in the direction of the firing chamber. Floor Area b1 of the combustion chamber is the most recent area of Kiln B1B and parts of this area are still in existence. Floor Area a2 of the combustion chamber in Kiln B1A is the lowest area in the kiln while Floor Area a1 is the most recent area of Kiln B1B.

(3) Back Wall and Side Walls

The height of the back wall in Kiln B1A ranges in height from 0.9m to 1.0m, being approximately 1.2m high in Floor Area a2 and approximately 0.9m high in Floor Area a1. Evidence in the form of finger marks testifies to the fact that clay was hand-plastered onto the wall. It was also possible to verify the width of the wall on the right hand side of the combustion chamber of Kiln B1B. This was approximately 0.35m in the area of the stoking ports and approximately 0.45m at the bottom of the rear wall of Kiln B1B.

(4) Stoking Ports

There is a stoking port on each side of the front wall in both Kiln B1A and Kiln B1B, with the stoking ports being aligned to open slightly to the left and right. The foundation under the floor of both kilns is made of whitish-gray clay. The width of the stoking ports within the combustion chambers of both Kiln B1A and Kiln B1B is approximately 0.4m.

(5) Air Holes

A single air hole is located in the middle of the wall at the front of the combustion chamber of both kilns. The air hole in Kiln B1A is in good condition right up to the top and is 0.28m wide and 0.15m high. On the other hand, it is thought that the air hole of Kiln B1B had already collapsed at the time when Kiln B1A was constructed and only the bottom of the hole remains. Although it is estimated that this air hole had a width of approximately 0.20~0.25m, the height is unknown.

5. Products

Products included both glazed and unglazed ceramics, as well as unglazed tiles. Glazed ceramics include many bowls with lids, as well as bowls, small open-mouthed bottles, and small bottles. Unglazed ceramics included many jars and pots. There were relatively few examples of decorated tiles and the majority of the tiles were half round tiles.

6. Kiln Tools

The most common type of kiln tool found were clay firing supports, with thin disks and round tubes also being found. Various kinds of these clay firing supports were found, ranging in size from 5cm, 7cm, 9cm to 11cm, with 9cm being the most common. Many of these supports were round with a flat top and a sloping bottom that slopes at basically the same angle as that of the floor of the kiln.

III Tani Kiln B4 (Mound 4)

1. Overall Shape

In plan view, the body of Kiln B4 is a rectangle with a single chamber, slightly enlarged across the middle. Although we think it was probably made up of four sections?a flue section, firing chamber, flame passage hole and combustion chamber?no trace remains of the flue section. The ceiling section also no longer exists but it appears to have been supported by several clay columns in the same way as Kiln B1. The combustion chamber is low and the floor of the firing chamber is inclined. Between the combustion chamber and the firing chamber is a large step, and the combustion chamber is set much lower than the firing chamber. During the 6th Survey we discovered that two related floors existed, which were merely designated as Floor Areas a and b at that time. However, during the 7th Survey, five floors were detected in the combustion chamber and six in the firing chamber. Floors in the combustion chamber were designated as a, b, c, d and e and floors in the firing chamber were designated as a1, a2, a3, b, c and e, with a being the newest. It is not clear how to deal with such floors.

The width inside the chamber of Kiln B4 is approximately 2.3m and the total length of the kiln body (from the combustion chamber to the flue section) is estimated to be approximately 8m. The internal area of the kiln is estimated to be between 15~18m^2, consisting of 12~14m^2 for the firing chamber (including the flue section), 0.8m^2 for the flame passage hole section, and 2.4~2.7m^2 for the combustion chamber. The combustion chambers have two stoking ports at the front of the combustion chamber, one on the right and one on the left, with an air hole in the center at the bottom. The floor of the firing chamber was

plastered with clay to provide an almost constant slope as far as the combustion chamber.

2. Firing Chamber

(1) Scale

The width of the firing chamber of Kiln B4 at the back wall is 2.3m and the length, including the flue section, is estimated to be approximately 6m. The internal floor area is estimated to be approximately 12~14m^2.

(2) Floor

In many areas the floor of the firing chamber is made of whitish-gray clay. Areas that have been exposed to heat have turned red, with the color gradually changing from red to orange to white as the amount of heat that the clay has been exposed to decreases. Areas where repairs have been made to the floor using clay are obvious from the layers of hard red fired clay on the floor. The floor of the firing chamber slopes up at an almost uniform angle to meet the top of the back wall of the combustion chamber. The slope of Floor Area a is approximately 15~18 degrees while the slope of Floor Area b is approximately 18~20 degrees. The surface of the floor in the main part of the firing chamber is weak and has only been fired a reddish-brown. The floor of the firing chamber is approximately 3~6cm thick.

3. Flame Passage Hole

The flame passage hole is located where the combustion chamber and the firing chamber meet. The flame passage of Kiln B4 in Floor Area a1 is approximately 2.1m wide and 0.4m deep, with a floor area of approximately 0.84m^2. In the middle of the flame passage hole is a cylindrical clay pillar with a diameter of approximately 0.4m. This is the same as the cylindrical clay pillar located in the firing chamber.

4. Combustion Chamber

(1) Scale

The width of the combustion chamber of Kiln B4 is approximately 2.1m at the back, while the length of the wall with the ventilation hole is approximately 1.0m. The length of the line joining the centers of the two stoking ports is approximately 1.7m long and the depth at the center is approximately 1.1~1.3m. The internal area of the combustion chamber is approximately 2.4~2.7m^2.

(2) Floor

Five floor surfaces were verified in the combustion chamber. The new floors were designated as Floor Areas a, b, c, d and e. All of the floors were basically level and were made of whitish-gray clay which in places has become blackened.

(3) Back Wall and Side Walls

In the same way as with the floor of the combustion chamber, multiple back and side walls were discovered. The height of the back wall of the combustion chamber and firing chamber in Floor Area a is approximately 1.0~1.2m. The height of the side walls in areas that have been best preserved in Floor Area a is approximately 1.0m and continues to the side wall of the stoking port.

(4) Stoking Ports

There is a stoking port on each side of the wall at the front of the combustion chamber, with the stoking ports being aligned to open slightly to the left and right. The floor is almost level and the foundation under the floor is made of whitish-gray clay and has been blackened in places due to soot and smoke. The width of the stoking ports is approximately 0.4m and the internal height is estimated to be approximately 0.4m.

(5) Air Holes

A single air hole is located in the middle of the wall at the front of the combustion chamber between the two stoking ports. The air hole is approximately 0.23m wide and approximately 0.24m high.

5. Kiln Tools

Although various kinds and shapes of kiln tools were unearthed, in the same was as with Kiln B1, most of these were circular clay firing supports. Square clay blocks were used as firing supports for tiles. There is evidence that half round tiles were stacked on these square clay block firing supports and in some cases a broken tile was still in place. A tool for pushing the lids of bowls into lumps of clay was also unearthed. This may be either a tool used in firing or may be used as a mold.

6. Products

Products unearthed at this site included both glazed and unglazed ceramics, as well as glazed and unglazed tiles. Glazed ceramics included many bowls with lids, as well as bowls and small open-mouthed bottles. Unglazed ceramics included many jars and pots. There were relatively few examples of decorated tiles and the majority of the tiles were half round tiles or flat round tiles.

IV Angkor Monuments, Tani Kiln Excavation Survey Policy

The Angkor Monuments are not only an important cultural heritage that must be conserved for all of mankind but are an essential tool that must be used in the study and experience of the history and culture of Cambodia. As an integral part of these monuments, the Tani Kilns are an important window on the past that allows us to learn of the lives and production activities of people from that time. The Tani Kilns are a place where people can experience first-hand the daily lives of people of that long ago era depicted on the reliefs found on the walls of the temples of the Angkor Monuments.

Furthermore, as the Tani Kilns are made of clay, as opposed to the stone with which many of the monuments remaining in the Angkor sites are made of, this reveals another important aspect of Khmer culture?the fact that they did rely on building materials other than stone..

In recent years worldwide interest in Khmer ceramics has been increasing and the excavation of the Tani Kiln site is especially important in that not only is it the first ceramic kiln site that has ever come to light in Cambodia but more significantly it reflects influences from beyond the borders of southeast Asia.

1. Basic Policy

(1) Improvement Policy

The aim of this policy is to improve the environment of the Tani Kiln site in order to allow people to gain insights into the lives of people from the period in which it was operating and to develop the site into a comprehensive historical ceramic park.

(2) Establishment of the Scope of these Plans

The focus of these plans will mainly be areas A and B within which most of the kilns are located in a north-south direction over the distance of approximately 1km.

2. Work Policy

(1) Structural Improvement Policy

When considering improvement plans for the Tani Kiln site as a whole, such plans must be developed with adequate consideration being given to realizing a balance between displaying the kilns alone and displaying the site as a whole. Therefore, in the future it is thought that a variety of display techniques would be preferable. For example, a certain kiln could be shown in the state in which it was found after initial excavation, while another kiln could be restored to enable people to understand something of the kiln at the time during which it was in operation. Yet another kiln could actually be brought back into operation to show people how it actually worked. However, kilns cannot operate by

themselves, meaning that workshops and housing for the associated workers would be necessary.

(2) Exhibition Facility Policy

A facility that will enable people to gain an understanding of the Tani Kiln site as a cultural heritage and which would also provide information regarding ceramic production is desirable. In practical terms, this would include facilities that would provide an overview of Khmer ceramics, a simple understanding of ceramic production processes, kiln structure, and an outline of excavated artifacts, etc. The overview of Khmer ceramics could include panels showing photographs and associated information, while ceramic production processes could be shown by illustrating the processes associated with the molding, decorating, glazing and the firing of clay. It is preferable if people can be involved themselves in processes such as molding, etc. Photographs and models can be used to show the structure of the kilns and comparisons can be easily made with kilns discovered in other areas such as Thailand, etc. Excavated artifacts and kiln tools can also be displayed.

(3) Policy regarding the Improvement of Roads, etc. within the Site

Roads and signs should be effectively used to improve access to important areas and link them with exhibition facilities, etc.

(4) Management and Operation Policy

It is desirable for Cambodian staff to manage and operate the facilities; in fact there is no alternative but for them to do so. The cooperation of the local people is also essential and it is desirable for them to become involved in the management and operation of facilities.

3. Future Challenges

(1) Gathering of Foundational Reference Material

Although it has been possible to verify the basic form, structure and scale of the kilns through the excavation activities that have been carried out up until this time, many points remain unclear, such as the location of the actual entrance or exit points and the construction of the upper structure. Furthermore, the existence of a multiple number of kilns has been confirmed within single mounds and it is essential to clarify the processes involved in the restoration of the kilns. In order to restore the area surrounding the kilns as a whole, concentrating merely on the kilns themselves is obviously insufficient. It is necessary to identify the clay storage areas, workshops and waste heaps (ash heaps) used at the time during which the kilns were in operation. It is also essential to gather as much basic reference material as possible to be used in future detailed improvement plans.

(2) Conservation and Preservation of the Monuments

In the immediate future, it is essential that the monuments be preserved and protected until such time as detailed improvement plans can be carried out. At present, the most practical method of preservation is to bury them again. It will also be necessary to employ other methods in order to prevent both damage and theft. Furthermore, it is thought that such measures will help the local people to gain an understanding of the monuments themselves and their significance not only for Cambodia itself, but also for the world as a whole.

Angkor Monuments, Tani Kiln Site

Angkor Monuments, Tani Kiln Excavation Survey Results and Environmental Improvement Policies

Institute of Asian Cultures, Sophia University

History of Past Surveys

1st Survey
(Verification of the structure of the Kiln B around and the whether or not it contains any kiln.)

2nd Survey
(Verification of the state of distribution of kilns within the Tani Kiln site.)

3rd Survey
(Survey of the main axis and the firing chamber of Kiln B1.)

4th Survey
(Survey of the combustion chamber and the lower portion of the firing chamber of Kiln B1.)

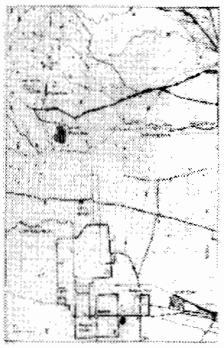
5th Survey
(Survey of the combustion chamber of Kiln B1, and verification of workshops, waste heaps and the existence of Kiln B4.)

6th Survey
(Excavation of Kiln B4, workshops, and waste heaps.)

7th Survey
(Excavation of Kiln B4, workshops, and waste heaps.)

Location of the Tani Kiln Site

East of the Angkor Monuments
17km East of the Bayon Temple
5km East-northeast of Phnom Bok
5km North-northeast of the Bakong Kiln Site



An Outline of Kiln B1

Length: Approx. 8m (estimate)
Width: Approx. 2.8m (estimate)
Area: Approx. 20.5m² (estimate)
(Firing Chamber) Approx. 16.8m²
(Flame Passage Hole) Approx. 1.5m²
(Combustion Chamber) Approx. 2.2m²

Slope of the Firing Chamber

(Upper Part) Approx. 15~18 degrees
(Lower Part) Approx. 24~31 degrees

Distribution of the Tani Kiln Site

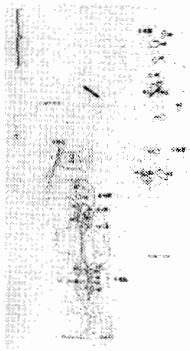
Five Areas Designated A~E
Area A (M1~M6)

Area B (M1~M7)
M1 = Kiln B1
M4 = Kiln B4

Area C (M1~M3)

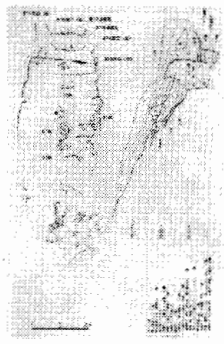
Area D (M1)

Area E (M1~M9)

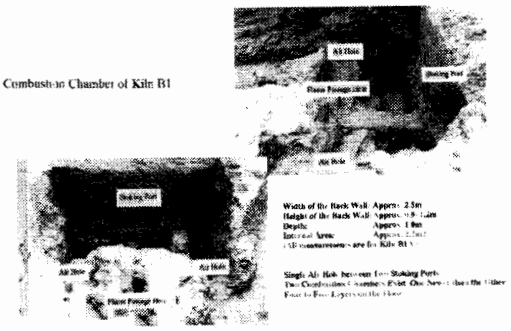


Kiln B1 Structure

Long single elongated oval chamber.
Consisting of four sections: fire section, firing chamber, flame passage hole, and combustion chamber.
Step between the firing chamber and the combustion chamber.
Two stoking ports and a single air hole.
A number of cylindrical pillars supporting the ceiling.
Two kilns, one older than the other.
Four layers on the floor of the firing chamber.



Combustion Chamber of Kiln B1

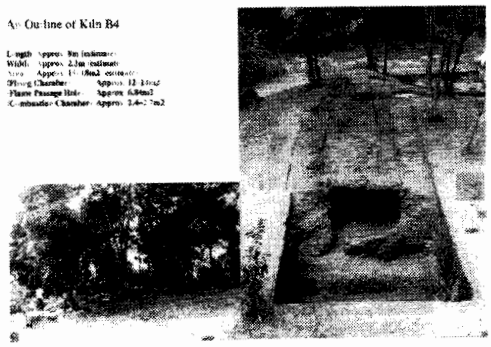


Width of the Back Wall Approx. 2.5m
Height of the Back Wall Approx. 0.9~1.2m
Depth: Approx. 1.0m
Internal Area: Approx. 2.2m²
(All measurements are for Kiln B1.)

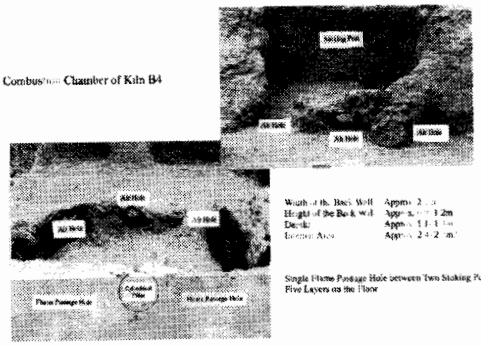
Single Air Hole between Two Stoking Ports
Two Combustion Chambers Exist, One Next to the Other
Four to Five Layers on the Floor

An Outline of Kiln B4

Length: Approx. 8m (estimate)
Width: Approx. 2.0m (estimate)
Area: Approx. 17.0m2 (estimate)
Firing Chamber: Approx. 12.1m2
Flame Passage Hole: Approx. 0.84m2
Combustion Chamber: Approx. 2.4~2.7m2



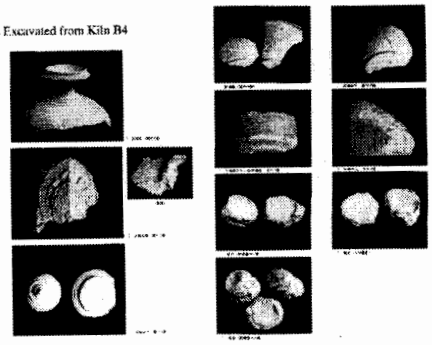
Combustion Chamber of Kiln B4



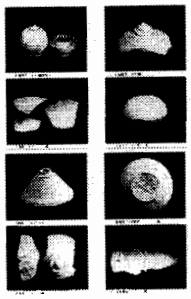
Width of the Back Wall Approx. 2.[illegible]
Height of the Back wall Approx. [illegible] 1.2m
Depth: Approx. 1.1~1.[illegible]
Internal Area Approx. 2.4~2.[illegible]m²

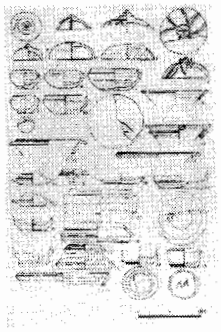
Single Flame Passage Hole between Two Stoking Ports
Five Layers on the Floor

Artifacts Excavated from Kiln B4



Artifacts Excavated from Kiln B1





Environmental Improvement Policies

Basic Policy
(1) Improvement Plan
(2) Establishment of the Scope of these Plans

Work Policy
(1) Structural Improvement Policy
(2) Exhibition Facility Policy
(3) Policy regarding the Improvement of Roads, etc. within the Site
(4) Management and Operation Policy

Future Challenges
(1) Gathering of Foundational Reference Material
(2) Conservation and Preservation of the Monuments