

INVESTIGATIONS OF THE TANI KILN SITE: GEOPHYSICAL PROSPECTIONS, EXCAVATIONS AND SITE PRESENTATION PROPOSAL

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Joint research between the Nara National Cultural Properties Research Institute and the APSARA Authority has its roots in March 1993 when initial visits were made to the newly discovered site. Plans were then made to develop a complete research project with cultural protection and promotion development objectives in mind. This meant beginning with ground surface observation, ending with preservation and landscaping, and integrating training of Cambodian students and young professionals into all aspects of the project.

Investigations began in earnest in 1996 with ground surface observation, followed by a topographic survey of the site. The ground surface and topographical surveys allowed us to establish two important points: the basic distribution patterns of the kilns and differences in kiln shapes. The site's fifteen ancient kilns could be largely divided into two groups, one on the northern portion of the Tani dike, and a second in its southern portion. The northern group could be further subdivided into two groups. Of the nine kilns in the northern area, five were seen to be located closely together while the others were set apart from these. In the southern part, on the other hand, six kilns were concentrated in an area spanning a distance of about 80m from south to north. This initial research showed, that the kiln mounds were either circular or oval in shape. These two types of kilns were observed in both the southern and northern groups. The circular kilns were a little smaller than the oval ones. At that time, we inferred that this difference in shape would reflect a difference in the structure of the kilns. However, as explained below, this theory was disproved by our excavation work which revealed that all of the kilns had the same type of structure. This first stage of research was reported in detail in the first issue of *Udaya*.² In the following, we will present subsequent project phases, to then conclude with propositions for project completion.

Geophysical Prospection

The next project component consisted in non-destructive geophysical prospection aimed at

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² "Recent Research on Kiln Sites in the Angkor Area," *Udaya* 1: 217-234.

obtaining information on mound interiors. This included use of magnetometry and Ground Penetrating Radar (GPR). The magnetic survey was carried out with a Geoscan FM 18 Fluxgate Magnetometer of British make. This machine measures vertical components of geomagnetism in the order of 0.1 NT (Nano-Tesla). For the GPR survey, we used a US-made GSSI SIR-2 type control unit with either a 300MHz or 700MHz antenna, depending on the time and place the survey was conducted.

In 1996, geophysical prospection was conducted in both the southern and northern groups. While the prospecting did not cover all the kilns, some important discoveries were made in the southern group, such as the detection of what seemed to be two kilns in the A01³ Kiln Site, the largest site in this group. Here, we would like to discuss the results of the geophysical prospecting conducted at the A06 kiln site of the southern group as it is this kiln which was subsequently excavated.

While both the magnetic and the GPR surveys were conducted in an area spanning a south-north distance of 24 m, the GPR survey covered an east-west distance of 14 m, 2 m longer than the magnetic survey (Figure 1).

In the magnetic survey, significant anomalies were observed from the peak at the center of the mound to the west of it. The GPR survey

also detected abnormal reflections around the same area, although the location was a little further west. This difference is attributable to the characteristics of the pulse radar system which could not collect sufficient information on conditions just below the ground surface (Figure 2).

Excavation work

The A06 kiln site was selected for excavation. The Sophia University team had at that point already begun excavations of a circular kiln in the northern group; our choice of A06, an oval-shaped kiln in the southern group, was made in view of complementing

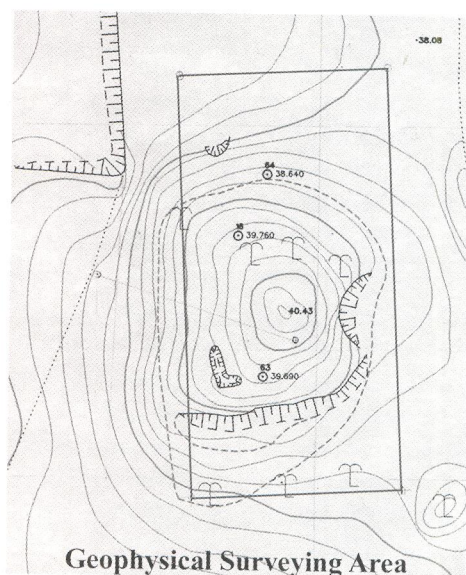


Figure 1. Overall geophysical survey area of kiln A06.

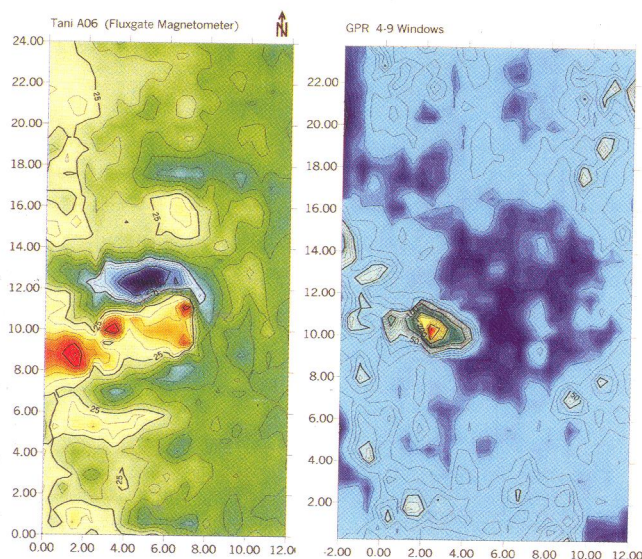


Figure 2. Geophysical survey results of kiln A06.

³ Information regarding labeling of the individual kilns can be found in the *Udaya 1* report cited above.

this ongoing research. A06 excavations began in the summer of 1999 and ended in August 2000. A total of three missions were carried out during this period.

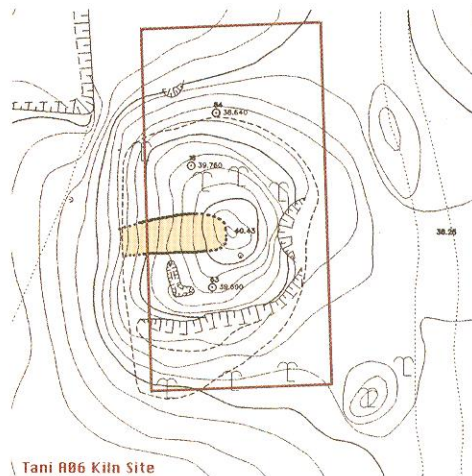
Prior to conducting excavations, we established a record of land conditions by means of a photogrammetric survey, detected the possible kiln location within the mound by means of geophysical prospecting, and, finally, conducted a photogrammetric survey around the exact site to be excavated. A Hasselblad MKW-E metric camera was used for the photogrammetric survey both before and after excavation. To take aerial photographs, we attached a camera to a rope tied between two trees on either side of the kiln; the camera was thus suspended over the site and could be moved as needed. We also took ground photographs along a fixed base line to draw an elevation of the site.

The fact that large quantities of earthenware potsherds and pieces of kiln walls were discovered at the southern end of the mound, along with the kiln hearth, initially led us to believe that the main part of the kiln would lie in a south-north direction. However, geophysical prospecting indicated that the kiln was located on the west side, and lay from east to west. Excavation plans were based on this latter finding. The kiln was indeed discovered to the west as indicated by the geophysical prospecting (Figure 3).

This is significant in that it confirms the effectiveness of geophysical prospecting at least in the investigation of the kiln groups subject to our study. It is now possible to develop hypothetical understandings of the inner structures of other kilns as well by combining data obtained from the excavation and geophysical prospecting of A06. Details of the excavation follow.

The Mound

The kiln remains have survived as an elevation in the shape of a mound. While varying according to the portion of the mound, at its thickest point it is more than 1 m above the ground surface, and consists of man-made strata containing kiln walls, vessels, and tiles. The reason for the formation of the mound is thought to lie in the practice of breaking the rear portion of the kiln to extract the finished products with each firing. It is believed that as a result of throwing away fragments of the broken kiln walls and other artifacts to both sides from the top of the mound, and towards the mound's front, the mound gradually increased in height while simultaneously spreading horizontally outward on both sides of the firing sector, and to the northwesterly and southwesterly directions from the fire box. Accordingly, it is possible to infer that a great number of operations of the kiln must have been conducted for the mound to reach its present size. Also, it is thought that the location of the kiln was initially chosen to make use of its relatively high elevation in the natural landscape.



Tani A06 Kiln Site

Figure 3. Actual location of A06 within the survey area.

The Kiln (Figures 4-6)

The scale of the kiln, as can be reconstructed from the final floor utilized, was 8.5 m in overall length, and 2.8 m across at its widest point. The structure of the kiln was in the shape of a tunnel. It is estimated that from eighty to ninety percent of the kiln was a free-standing structure, built above the ground surface.

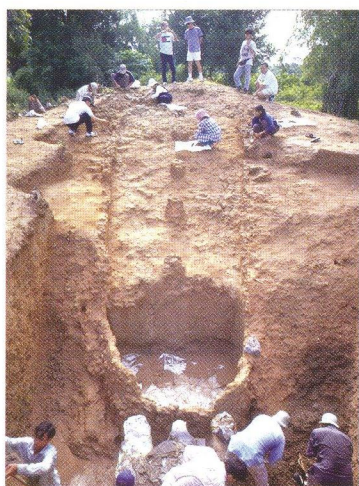


Figure 4. A06 kiln under excavation.



Figure 5. Overview of A06 kiln, from the west. Firebox is seen in foreground. Pillars can be seen running west-east up the kiln elevation.

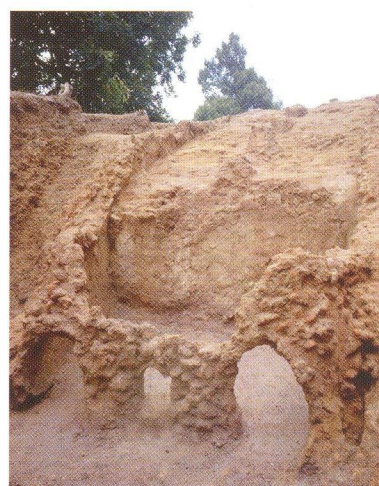


Figure 6. A06 seen from the south-west. Note successive wall layers on northern side.

At a point thought to correspond with the chimney, there was a region of the floor surface resembling hematite, which had received less heat and was slightly soft. In comparison to the slope of the final kiln floor, this region slopes a bit more gradually, suggesting that this constituted the floor of the chimney portion of the kiln. In other words, the floor of the firing sector extended upward in a straight line to the chimney, where it changed to a more gradual slope and thus descended to a slightly lower height.

As this portion of remaining floor surface was located 1 m to the north of the central axis of the kiln, if it is indeed part of the chimney, then the chimney itself would be at least 2 m in width at its base. Accordingly, some device for narrowing the space above the floor would have been necessary, such as making the ceiling very low, or erecting interior walls or a series of columns. It is possible that the air flow and firing process were regulated by using such a device.

The length of the firing sector alone was about 6 m, while the sidewall that sustained the least damaged measured about 50 cm in height.

Four columns which supported the ceiling were found inside the firing sector, and it is currently thought that an additional column was located in the area above these. The four are spaced at an even interval of about 1.3 m, and if it is assumed that an additional one was placed above these, and that the rear wall was another 1.3 m beyond that, the length of the kiln itself is reconstructed as 8 m. Adding the chimney into consideration, the overall length is estimated at about 8.5 m. This figure is confirmed by the position of the floor area thought to belong to the chimney, as discussed above.

The firing sector was repaired at least three times, and partially rebuilt once. Namely, there is one set of walls accompanying the final floor, composed of three layers of clay slabs each 3 cm thick and about 25 cm in length and width, and a differently aligned set of walls, together with an accompanying floor which starts to the east, or above the final floor, and extends under the latter. There is an intervening layer of earth about 10 cm thick separating the two floors. This layer is thought to have been laid intentionally, to adjust the floor height and slope. In addition to portions of the walls made with slabs of clay as mentioned above, there are portions where the walls were made with clay pasted on with the fingers. These variations seen in the walls are thought to indicate a difference between areas of localized repair with pasted clay, and areas of reconstruction with clay slabs where the walls had been broken to remove the finished products.

The columns within the firing sector are thought to have been placed there from a need to support the ceiling, due to the sector's width which reached 2.8 m, and not for the purpose of diverting the flames. The one closest to the combustion sector was the same thickness as the others at about 50 cm diameter, hence it can be said not to have been for diverting the flames.

In the upper portion of the firing sector, a number of tiles were found during the first excavation campaign in what is thought to be their original position, lined up standing in a horizontal row. While it is not possible to conclude from this that lining tiles horizontally was the method generally used, as the tiles have not been moved to any considerable degree, it is very likely that the rear portion of the kiln was used as a space for firing tiles.

The combustion sector was 2.1 m at its greatest width, and measured 1.7 m along the main axis of the kiln. The walls stood approximately 1 m high where best preserved. The floor was about 1.4 m below that of the firing sector, and thus the kiln is characterized by having a large difference in level between these two parts.

From the difference in level with the firing sector, it is not thought likely that heavy or large wares like vases, jars, or tiles were inserted and removed through the fuel ports. But it is possible that this area was used for small and light items. Possible examples include small lidded dishes or narrow-necked vases, and items having ash glazes. The likelihood is great that among glazed wares, small stoneware items were fired in the front portion of the combustion sector.

As it was stated above that the rear portion of the kiln was likely used for firing tiles, we may, rather boldly, speculate that the front was used for glazed stoneware, the rear for tiles, and the middle portion for unglazed jars, vases, etc. It can also be envisioned that the temperature within the firing sector was higher toward the front, and lower toward the rear.

We believe that at least the front half of the combustion sector stood with its walls and ceiling openly exposed. Accordingly, as the combustion sector was thus free-standing, it is appropriate to call the entire structure an above-ground kiln.

The floor was covered with a fill of about 3 cm thickness of clay-like soil containing ash, charcoal, and fine sand. This shows that after the kiln was abandoned, soil from the firing sector accumulated in a gradual and even manner. Accordingly, it is thought that the operation of the kiln ended in a normal manner, and that it was not abandoned because of an accident. The following sequence of events may indeed be traced: kiln operation was finished after wares were removed from its inside; the kiln itself was abandoned in that state; and then filled in by natural collapse.

The external walls extending from the final combustion sector, on either side of the firebox, were observed to be made of three layers each. The combustion sector and fuel ports are thus understood to have been rebuilt at least three times, with their positions moving slightly inward and becoming more narrow.

The firebox has three ports, with those on the sides being large and the one in the center small. The central port is also positioned with its lower edge about 10 cm higher from the ground than the others. It is thought that these were used for inserting fuel for combustion, and for regulating the flow of air.

The bottom portion of the wall in which the ports were made was well fired and in the form of magnetite, but the upper portion was brittle, composed of blocks of clay and kiln wall fragments. This suggests that only the upper portion of the structure was broken to allow removal of the wares, with the bottom portion left untouched.

From the above it may be considered that, above the three remaining ports, there were other large ports in the upper part of the firebox which were possibly used for combustion up to a certain stage in the firing process. It is thought that those ports were later sealed, and the three lower ports continued to be in use. At this stage, the three ports are thought to have been used as described above, for controlling combustion and atmospheric conditions inside the kiln.

In front of the firebox, a rather hard floor surface extends toward the front of the mound over an area of about 30 cm. It may be possible that a firebox from an earlier time extended this far, or that some task was performed in which the floor surface was heated.

The ash and ash-bearing layer covering this area extended further from the fire box, forming a waster (ash pile in front of a kiln). The bottom surface of this layer is thought to lie on a depression deeper at the center and becoming shallow toward the sides, and descending in level toward the front of the mound. Yet, in order to ensure preservation of this feature, no excavation was made to ascertain this lower layer. It is nonetheless thought this area was intended to facilitate draining rain water away towards the front of the mound.

At least three layers of waster ash were recognized, each corresponding with one of the three wall surfaces observed on both sides of the firebox, but it is certain that there were more than three layers of ash. In other words these three layers do not represent the number of times the kiln was used. It is assumed that ash layers were formed with repeated operations, but were continually raked out and cleaned up.

Artifacts

As we are currently in the process of washing and analyzing recovered remains, we are not yet able to present a conclusive report on them. Nonetheless, the following points can be noted. The majority are roof tiles, unglazed vases, and unglazed pots. The objects recovered from the kiln comprise roof tiles, pots, vases, small-lidded boxes and jars. Of these, tiles, unglazed jars and vases are by far the most numerous, with very few ash-glazed items, probably representing less than 10 % of the total. Though a number of ash-glazed tiles were also noted, ash-glazed pieces were largely limited to small items such as lidded dishes and bottles. In the current excavation these were found in the fill on both sides of the firing sector.

Accordingly, while it cannot be definitively stated that these pieces were made at this kiln, this is highly likely. Three kinds of pattern applied to the antefix (front portion) of eave tiles and other items were identified. One of these includes some variations, perhaps constituting two separate patterns. Among the kiln furniture recognized thus far, lumps of earth in the shape of a horse's hoof are numerous. The small diameter of the upper surfaces of these pieces indicates that they were not used for items like vases and jars. It may be that kiln wall fragments and shards of pottery were used to support vases, jars, tiles, and so forth.

We have not completed a chronological study of these remains and therefore cannot affirm any datation. General object appearance allows us, however, to infer that the kiln under investigation dates to around the 10th century, or, to be more specific, from early to mid -10th century.

Proposal for landscaping and public exhibition

The well-preserved state of the excavated firebox allows not only for the study of the A06 Site but moreover for developing general understandings of the Tani Kiln Site as a whole. With this in mind, we are planning to open the kiln to the public as an outdoor exhibition for the dual purpose of preservation and pedagogical use. This plan includes:

- 1/ the establishment of a master plan for the preservation of the entire Tani Kiln Site;
- 2/ road improvement to enhance accessibility;
- 3/ chemical treatment of the kiln for preservation and construction of a roofed structure for protection and viewing purposes; and
- 4/ construction of a facility to exhibit uncovered remains and explain historical and technical aspects of kiln use (Figures 7-8).

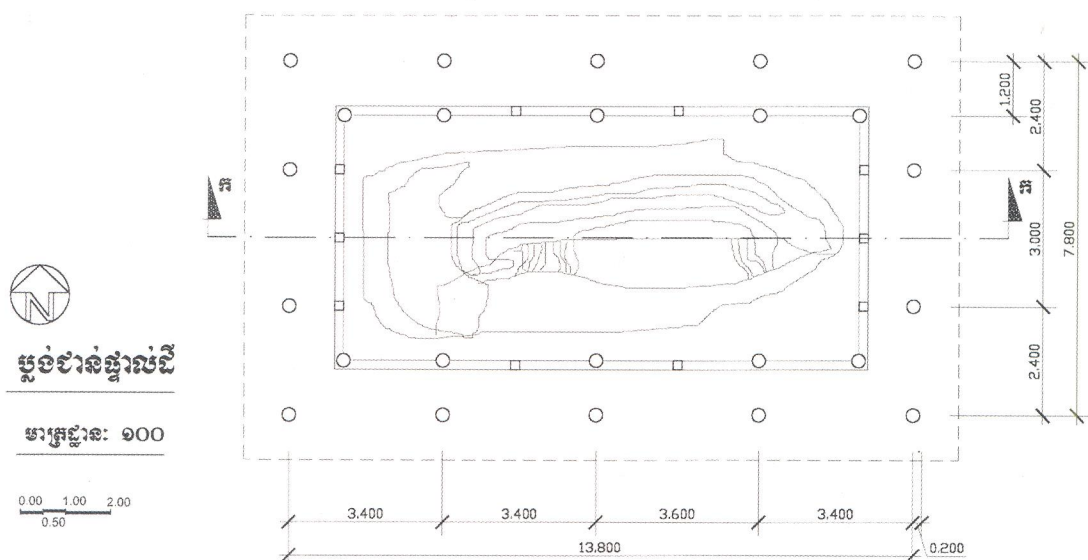


Figure 7. Ground plan for proposed protection and viewing structure over A06.

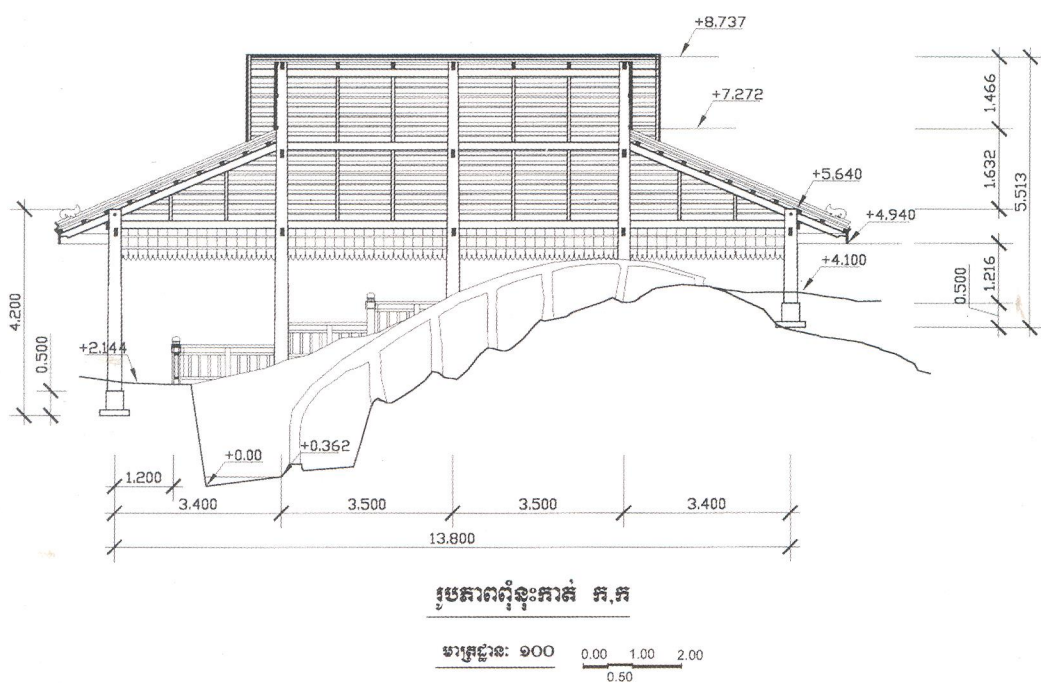


Figure 8. Section of proposed protection and viewing structure over A06.