Technical aspects on Khmer stoneware ceramics from the Tani kiln site

Yukitsugu TABATA
Institute of Asian Cultures, Sophia University

I. Introduction

Recent discovery of the ancient kiln sites in Cambodia enabled us to start detailed studies on Khmer ceramics. So far, the excavation of Tani kiln site and the Sar Sei kiln site have been carried out and numerous artifacts shows distinguished and unique skills of ancient Khmer potters.

The Tani Kiln site is one of the kilns, which are located in the eastern part of Angkor area. The Tani kiln site is determined to consist of five kiln groups, identified as Area A through E. The excavation at area B (kiln B1 and B4) has been carried out by Sophia University Angkor International Mission as a cooperative project with authority (another Japanese team, the Nara National Research Institute for Cultural Properties, has also excavated in this site). The purpose of the excavation is to clarify the variation of the artifacts and structure of the kiln, which provide basic data for the future research, preservation, and public presentation of the site.

In this paper, the author would like to introduce the structure of glazed stoneware kiln, variety of the products and techniques for stoneware making that became clear thorough the excavation of the Tani B4 kiln.

II. Structures of the Tani kiln (Figs. 1-2)

General plans

The kiln consisted of a single rectangular-shaped firing chamber slightly enlarged across middle section, combustion chamber and, by inference, an exhaust port or chimney. The structure was made from unfired clay. The ceiling was destroyed and not found. The kiln body was approximately two meters wide in the firing chamber and eight meters long from front to the rear. A vertical wall of about one meter separated the combustion chamber from the firing chamber. Along the center axis of the firing chamber, several round pillars were found.

The overlapping layers of hard-fired soil on the floor were observed. In firing chamber, six layers were identified as Floor a1, a2, b, c, d and e. Five overlapping layers (Floor a, b, c, d and e) were confirmed in combustion chamber. Floor a1 and a2 in firing chamber and Floor a in combustion chamber compose newest kiln (kiln B4a). Floor b in firing chamber and Floor b in combustion chamber is same floor of older kiln (kiln B4b). Kiln B4c, which is older than kiln B4b, consisted of Floor c in firing chamber and Floor c in combustion chamber. The correspondence of other floors is not clear.

Firing chamber

Kiln B4a and B4b had rectangular-shaped firing chamber. Kiln B4c has similar plan, though the upper part of the firing chamber had slightly widened. The estimated length of firing chamber is 6m
(kiln B4a and B4b) and 4.8 m (kiln B4c). The width of firing chamber is 2.3 m (kiln B4a), 1.8 m (kiln B4b), 1.7 m (kiln B4c, lower part) and 2.2 m (kiln B4c, upper part). Each floors of the main part of the firing chamber has been burnt to a red color. The slope of kiln B4a is approximately 18 degrees and the slope of kiln B4b is 18 to 20 degrees.

The present sidewalls remaining in the firing chamber are low in height and standing verticality to the surface of the floor or leaning slightly outwards. The walls are estimated to be 15 to 30 cm thick. The inner part of the wall was burnt to a red color and the outer side of the wall was changed white to orange color.

At least three cylindrical pillars made of clay have been observed on the Floor b of the firing chamber. On the Floor c, three clay cylindrical pillars were confirmed. Only the traces of clay cylindrical pillar have observed on the Floor a. Probably, the ceiling was supported by these cylindrical pillars. The estimated diameter of the pillar is 30 to 40 cm and these pillars were settled at intervals of about one meter along the center axis of the firing chamber.

It was unable to find any trace of the entrance. Though the stoking ports would be too narrow for access, and since charcoal and ash were detected in layer 8th at side trench on the mound, the entrance or exit might have been in the firing chamber.

**Combustion chamber**

Approximately one-meter vertical wall separated the combustion chamber from the firing chamber. The width of combustion chamber is 2.1 m (kiln B4a), 1.9 m (kiln B4b) and 1.7 m (kiln B4c). The length of combustion chamber is 1.1 m (kiln B4a and B4b) and 1.0 m (kiln B4c). Comparing these three kilns, newer kiln has large firing and combustion chamber than older ones. The kiln might be expanded when it was revised.

Floor a and b of the combustion chamber are almost flat, made of whitish-gray clay and blackened in places. The back wall rises straight up from the flat floor to join the flame passage hole above. Floor c of the combustion chamber rises slightly toward the back wall and covered with black soil that contains charcoal and ash.

The back walls of the combustion chamber of kiln B4a and B4b are about 100 to 120 cm high. It rises almost vertically from the floor and at the top it overhangs toward the front. The back wall of kiln B4c was almost destroyed during the construction of kiln B4b.

**III. Products of kiln** (Figs. 3-5)

The excavated artifacts filled roughly 450 large-size containers and exceeded four tons in weight. The representative artifacts are lidded boxes, tiles, bowls, bottles, jars and vats, and kiln tools. Because both tiles and other types of artifacts were excavated, and because both glazed covered boxes and glaze tiles were excavated, the kiln is interpreted as having been a mixed-use kiln producing both tiles and ceramics. Both unglazed and ash-glazed artifacts were uncovered. As a general tendency, the clay of the unglazed goods was dark reddish-brown to fray and of fairly coarse consistency. Among unglazed artifacts, jars and vats, dish-mouth bottles, and tiles were numerous. Among these, all the excavated jars and vats were unglazed. The ash-glazed artifacts were formed from light gray clay that was of finer grain that the clay body of the unglazed artifacts.
The transparent glaze ranged in color from olive gray to bright green and was thinly applied. On many artifacts the glaze was finely crazed, and many artifacts had severe glaze losses. Aside from the jars and vats, ash glaze could be found on virtually all artifact types. The clay body color and grain varied clearly between the ash-glazed and unglazed examples. There were some artifacts made of the clay body used for ash glaze that at first glance appeared to be unglazed, but closer study showed that in most cases the glaze had flaked off. This suggests that the artifacts were not fired twice. It would seem that pieces shown by careful examination to be unglazed but formed of the light gray clay body (although exceptions) most likely were made from the start to be unglazed. In this investigation no examples of dark brown glaze were identified.

**Covered boxes**

Both lids and bodies of boxes were excavated, and the type was subdivided according to the shape of the body into nearly hemispherical round boxes and cylindrical boxes having cylinder-shaped bodies. Whereas virtually all the cylindrical boxes has flat bases, the round boxes could be further divided into those with bases and those without bases. Both the round boxes and the cylindrical boxes ranged in size from those that at first glance seemed to be miniature to large pieces with a diameter greater than 10 cm.

Almost all the covered boxes bore ash glaze, but some unglazed examples were found. Moreover, many examples bore marks on the bases that might be interpreted as potter's marks. At present the relationship between these marks and the vessel shapes is not clear. Some pieces were excavated that had adhered during firing to vessels of other shapes, or where the lid and body has stuck together during firing.

**Round boxes**

Among the covered boxes, those with nearly hemispherical bodies were termed round boxes. As stated above, the round boxes were of two types, one with a base and one without a base. The lids can be divided into those with knobs and those without, but the relationship between the body forms and the lid forms is not clear.

**Cylindrical boxes**

It was not possible to subdivided the bodies of the cylindrical boxes on the basis of form. Almost none of the lids bore knobs. Without distinction between the round boxes and the cylindrical boxes, the bases of most of the bodies bore marks written with what appears to be the tip of a pointed tool. There were instances where round boxes and cylindrical boxes bore the same marks.

**Bowls**

Generally the bowls had everted walls and flat bases, and most were completely glazed with ash glaze. As with other shapes, some bore marks on the bases that appear to be potter's marks. Such bowls can be subdivided into those with everted rims and those with rolled rims. Some examples bear between one and three concentric groves incised on the rim, and others do not.
sum, there are four varieties of bowls: (1) those with everted rims and incised lines, (2) those with everted rims but without incised lines, (3) those with rolled rims and incised lines and (4) those with rolled rims but without incised lines.

Examples were also excavated on which were found scars of stacking spurs on the interior of the body or on the base. This indicates that bowls of the same shape were stacked together at the time of loading the kiln for firing. The technique of wiping off glaze was not used; instead, clay balls for stacking were placed directly on top of the glaze when the bowls were stacked.

**Bowls with pedestal feet**

Bowls that resembled other vessels by having everted rims, but that were distinguished by having pedestal feet, were termed bowls with pedestal feet. Both glazed and unglazed examples were excavated. The pedestal forms were cut into four or five tiers with a tool. Compared to the diameter of the pedestal foot bottom, the diameter of the bowl mouth was large, and the bowl was fairly shallow.

**Cylindrical bowls**

Artifacts with an overall cylindrical form like the cylindrical boxes, but without lids were termed cylindrical bowls. All were unglazed, and the exteriors were reddish-purple with a metallic sheen. The clay body ranged from dark reddish-brown to reddish-purple, and was coarse. The trait was the degree to which they were well fired.

It is impossible to judge whether these objects were actual products or an unknown type of kiln tool (or a part of such a tool). For the purposes of the present report they are classed as products.

**Wide-mouthed small jars**

Vessels with rounded bases and with mouth diameters smaller than the largest diameter of the shoulder were termed wide-mouthed small jars. Almost all such objects were glazed, and the glaze covered them completely. Like other vessels, there were some that bore incised marks on the base. There are not many examples of this vessel form, and the largest are less than 10 cm in greatest diameter.

**Bottles**

Bottles could be divided into a small size of around 10 cm height and a large size with a height greater than 30 cm. In either case, the mouth rim was everted and stepped, forming a so-called dish mouth. The small size had rounded shoulders and the bases were lightly trimmed to form a flat foot. Because the neck was narrow, most of the examples had been broken at that point. Some had tiers carved into the shoulder with a tool. Some had two tiers, others three.

The seams of clay coils visible on the interior of the large size of bottle indicate that the bottles were formed by coiling. The shoulders thrust out and lacked the roundness of those on the small bottles. In contrast to the small size, almost all of which were glazed with ash glaze, the large bottles included some unglazed examples. Among the large size were examples where ridges were attached or tiers were carved out of the shoulder, and the tiers on the shoulder were particularly
numerous, typically 5 or 6 tiers. In addition, between the tiers on the shoulder, a pointed tool was used to incised "cross-hatch" designs composed of multiple diagonal straight or curved lines.

**Small-size jars**

Unlike the bottles, the jars had a wide range of sizes; for the purposes of this report they are divided into small-size jars with a mouth diameter less than 10 cm and a height less than 20 cm, and pieces with larger dimensions termed large-size jars. Almost all the small-size jars were glazed.

Objects thought to be the lids for such small-size jars were also excavated, and on the exterior and in the center interior of many of these pieces are scars of clay balls used for stacking. The scars on the interior show a hole corresponding to the position of the knob on the outside. These lid types were fired separately from the jar bodies, and lids of the same shape appear to have been stacked together for firing.

**Large-size jars and wide-mouth vats**

While there were many sherds of large-size jars and vats, few could be assembled into complete vessels. All the pieces were unglazed, but on a portion of the exteriors of such sherds were traces of kiln glost, which appears brownish-black in color. Since on all the natural glaze occurred on the mouth rim and onto the shoulder, these pieces must have been stacked for firing in the kiln with their mouths facing up. Many examples of vessels with mouth diameters of 30 cm, shoulder diameter around 40 cm, and estimated height around 30 cm were excavated, and these were classified as wide-mouth jars or vats. The others, with smaller mouths, were classified as jars. Among these large vessels were some with estimated heights of 70 cm or more.

The wide-mouth vats bore bands of several incised wavy lines on their mouth and shoulder. In addition, there were some examples with diagonal lines impressed between the tiers of wavy lines on the shoulder. Among the large jars were two types, with attached lugs or without them. Disappointingly, the scarcity of nearly complete sherds made it impossible to determine the total number of lugs, but they are estimated at 3 or 4. The lugs were formed separately and attached, but in most cases they did not bear a hole through which a cord could be passed, and the lugs themselves were small, indicating that their main function was ornamentation. A jar with a hole open in the base was also excavated. The hole was opened during the forming process, not after firing, but its purpose is undetermined.

**Tiles**

The types of tiles excavated included round tiles, flat tiles, eave tiles, and ridge ornament tiles. There were glazed and unglazed versions of all these types, but because most examples were excavated as small fragments and few could be assembled to reconstruct whole pieces, it was not possible to ascertain whether glazed or unglazed tiles were more numerous in production. Only the faces of the eave tiles were made in molds; the rest were formed by coiling. The round tiles bore a round protuberance in the center of the interior surface, and the flat tiles bore a horizontal ridge-shaped protuberance.
Round tiles

Both unglazed and ash-glazed versions were excavated. They appear to have been formed by making a coiled cylinder that was sliced lengthwise into two or three sections. Most of the pieces have beveled edges. The glazed examples are made from light gray clay body, while the unglazed examples are made from orange or reddish-brown clay body. On the interior surface they bear round protuberances made by attaching clay pieces. Pieces with a maximum length around 30 cm and greatest width around 15 cm are common. There appears not to have been much variation in size.

Flat tiles

Like the round tiles, the flat tiles were found in both unglazed and glazed versions. They were formed by coiling, and in section they are shaped like a right-angle C. Glazed versions use light gray clay body, and unglazed versions use orange or reddish-brown clay body, like the round tiles, but the interior surfaces bear applied horizontal ridge-shaped protuberances. Pieces with a greatest length of around 30 cm and greatest width of around 20 cm are most common, and there appears to have been little variation in size.

Eave tiles

Tiles consisting of round tiles with attached round faces were termed eave tiles. Almost all such pieces excavated from the present site bore glaze, but a few unglazed examples were also found. The tile was formed by attaching the rear surface of the tile face to the end of the round tile and smoothing the join with a fingertip (or a tool). The designs on most tile faces consisted of a central lotus blossom bordered by flame patterns.

A mold thought to have been used to make tiles of this type was also excavated. The patterns of lotus petals and flame pattern were carved into one surface of a flat unglazed clay slab, and the relief areas are the reverse of the tile faces. No examples of tile faces that perfectly match this mold have been excavated yet (considering that the mold was excavated from the midden, it is possible that the mold itself was a failure and was not used to make tiles), but the design format suggests that it is appropriate to think of this object as an end-tile mold. However, there are sherds in which the flame pattern is formed by attached coils. Seemingly the tiles were made by combining molded portions and attached coils.

Ridge ornament tiles

Both unglazed and glazed ridge ornaments were excavated. The ash-glazed examples were formed from light gray clay and the unglazed pieces were formed from orange or reddish-brown clay, as was the case for the other types of tiles. They were formed by coiling and are hollow up to their tips.

Kiln tools

All the kiln tools are unglazed and formed from orange, coarse-grained clay. All were assumed to have been used inside the kiln during firing, but in terms of shape they include five variations:
(1) cylindrical column shapes, (2) round disk shapes, (3) thin round disk shapes, (4) pole shapes, and (5) block shapes with narrow grooves in the surface. The upper surfaces of the columnar tools are flat and the lower surfaces are slanted. This suggests that unfired lengths of clay were attached directly to the kiln floor, with the slanted lower surface reflecting the slope of the floor. On the upper surfaces of many of the round columnar tools and the round, flat tools are scars of the bases of products, indicating that they were used as supports, with the products placed directly on them.

It is unclear how the thin round disks and the pole-shaped tools were used, since there are no examples adhered to products by glaze or showing the scars of products. The probable use of these tools is a topic for future research.

Because the channels on the surfaces of the block-shaped tools match roof tiles in width and angle, it is thought that they were used to position tiles for firing. Since almost all were excavated as fragments, the overall shape is difficult to determine. It is believed that the upper and lower edges of tiles were positioned between tools of this type in order to position the tiles in the kilns on an angle or on the side, but this cannot be proven.

Acknowledgements

Chapter III of this paper is based on the excavation report of the Tani kiln site. Original paper is written by Yukitsugu Tabata and translated in English by Dr. Louise Allison Cort. Here I would like to express my gratitude to Dr. Cort for her translation.
Fig. 1 Plan of Tani B4 kiln
Fig. 2 Cross Section of Tani B4 kiln
Fig. 3 Artifacts from Tani B4 kiln
Fig. 4 Artifacts from Tani B4 kiln
Fig. 5 Artifacts from Tani B4 kiln
カンボジアの文化復興(22)
——アンコール遺跡および伝統文化復興の研究・調査

RENAISSANCE CULTURELLE DU CAMBODGE (22)

2005・2006年 合併号

上智大学アジア人材養成研究センター
Sophia Asia Center for Research and Human Development, Tokyo