Geomorphology, Archaeo-stratigraphy, and ^{14}C Ages of Sambor Prei Kuk Pre-Angkorean Site, Central Cambodia

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Abstract

We conducted three trench excavations at the Sambor Prei Kuk archaeological site in Kampong Thom Province in Central Cambodia in 2008. The site is located on an upland facing the floodplain of the Stung Sen River, a major tributary of Lake Tonle Sap. The test trench was 3.5 m deep, while the other trenches dug, trenches C-1 and B-7, were approximately 2 m deep each; in total, nine layers (0-VIII) were detected. On the basis of the excavated artifacts, layers 0 and I can be classified as modern; layers II to IV, containing Khmer and Chinese ceramics, as Angkorean; and layers V-VII, exhibiting red-painted pottery and other artifacts, Pre-Angkorean. Moreover, three ^{14}C dates demonstrated extremely good agreement with the archaeological results: Sample No. 1 below layer VII gives a result of 6th or 7th century CE (early Pre-Angkorean); a sample from layer V (No. 3) gives 7th century (Pre-Angkorean), and a sample from layer IV (No. 2) gives Angkorean (8th–9th century). This is the first paper that applies both stratigraphy and ^{14}C dating at the Sambor Prei Kuk Site.

Key words: Pre-Angkor, Chenla, excavation, artifacts, radiocarbon dating

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I Introduction

Sambor Prei Kuk Archaeological Site is located in Kampong Thom Province, Central Cambodia (**Fig. 1**). While a number of Angkorean monuments have been investigated to date, Sambor Prei Kuk is one of the most important Pre-Angkorean (c. 7th to 8th centuries CE) sites in Cambodia. The site is said to be the correspondent of the ancient city *Isanapura* (伊奢那城), the capital of the kingdom of *Chenla* (真臘) described in the Chinese chronicle *Suishu* (隋書), or *The Book of Sui*, in the 7th century CE.

At Sambor Prei Kuk, hundreds of brick Hindu temples remain. Among them, there are three main walled temple complexes: Prasat Sambor (or, the North Group), Prasat Tao (Central Group), and Prasat Yeai Poeun (South Group). Some of the brick temple towers have remarkable reliefs of flying palaces on the walls. Most of the brick towers have square bases, although some have octagonal shapes (**Photo 1**).

Sambor Prei Kuk was investigated by French scholars in the early 20th century. EFEO (École Française d'Extrême-Orient) published detailed reports on the site (cf. Permentier, 1927). Sculptures of the site are exhibited not only in National Museum in Phnom Penh, but also in the Musée Guimet in Paris. During the 1970s and 1980s, the Cambodian Civil War disrupted the investigation and preserva-

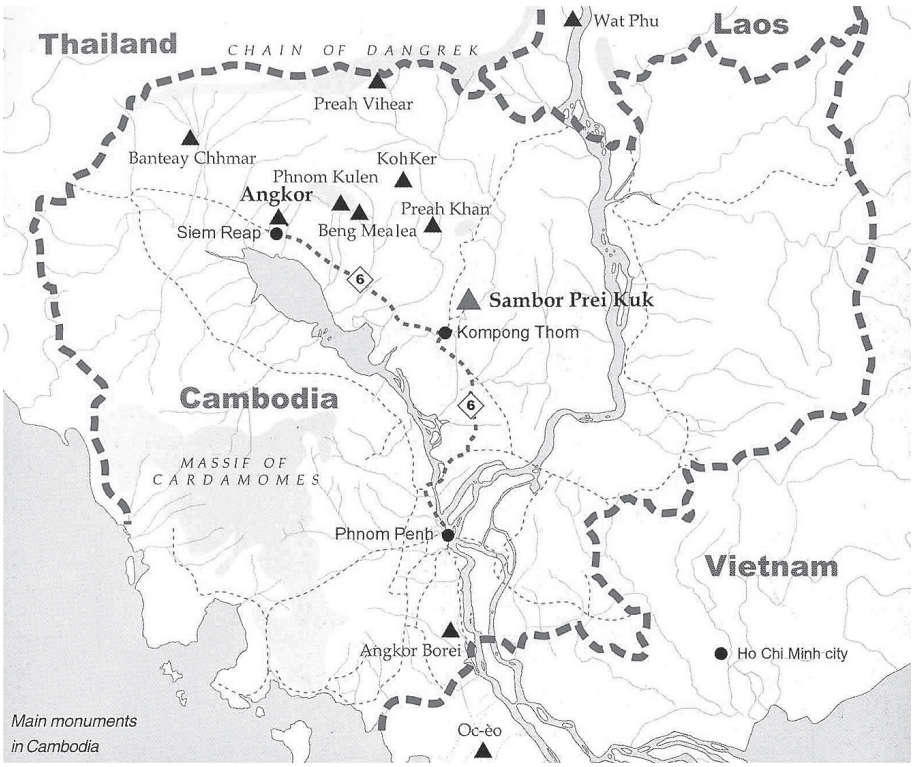

Fig. 1 Study area (SPK conservation Project, 2004)

Photo 1 An octagonal temple in Sambor Prei Kuk Site (Prasat Yeai Poeun)

tion of this site, like all other sites in Cambodia, and the site was devastated and covered with dense vegetation.

A joint team from the Cambodian Ministry of Culture and Fine Arts and Waseda University in Japan started working to investigate and conserve the site in 1998. Since then, projects have included preparation of an inventory of monuments, geomorphological survey around the site, archaeological survey and restoration of buildings, etc. (Sambor Prei Kuk Conservation Project, 2004). These projects have also included activities to support local village people and develop of tourism.

As a part of this project, we carried out archaeological excavations in February and March 2008 at one place located in the eastern part of Sambor Prei Kuk, where B. P. Groslier, a French archaeologist, conducted excavations in the 1960s, and which in 1999 was re-excavated by the late Y. Kojo of Waseda University, Japan with his Cambodian students. In the excavation by Groslier, a number of Pre-Angkorean and Angkorean artifacts were unearthed. The Kojo excavation was uncompleted; artifacts were scattered and lost, and the reports of these excavations went unpublished (Kojo and Kubo, 2003). Therefore, we re-excavated the same site. The purpose of our excavation was to confirm the stratigraphy of the area and collect artifacts such as earthenware and Khmer and Chinese ceramics based on the results of the stratigraphy. Accelerator mass spectrometry (AMS) ^{14}C dating of unearthed charcoals was also carried out.

II Geographical Setting

The Sambor Prei Kuk Site is situated in the middle reach of the Stung Sen River drainage basin. The Stung Sen River is the largest tributary of the Tonle Sap river basin in Cambodia, flowing into the

southeastern side of Lake Tonle Sap. It has an approximately 16,000 m^2 drainage area and is approximately 500 km long. During the monsoon season from May to October, inundation occurs in the bulk part of floodplain and the water level of the river rises about 7 m.

Sambor Prei Kuk Archaeological site is located in the floodplain of the Stung Sen River and neighboring upland.

The fluvial plain is classified into areas of back marsh, valley plain, natural levees, meander scrolls, abandoned channels, water surface, and sand bars (Nagumo *et al.*, 2010; **Fig. 2**). The lower part of the back marsh is submerged during the monsoon season. Abandoned channels and meander scrolls are prominent along the present channel of the Stung Sen River. They indicate a history of frequent channel shifts.

Natural levees are not well developed along the main channel. According to analysis of topographic maps and aerial photos, the Stung Sen channel changes frequently on a decadal scale. The floodplain is mostly composed of silt and clay (Nagumo *et al.*, 2010; 2011).

The upland where Sambor Prei Kuk temples are located is several meters higher than the flood-

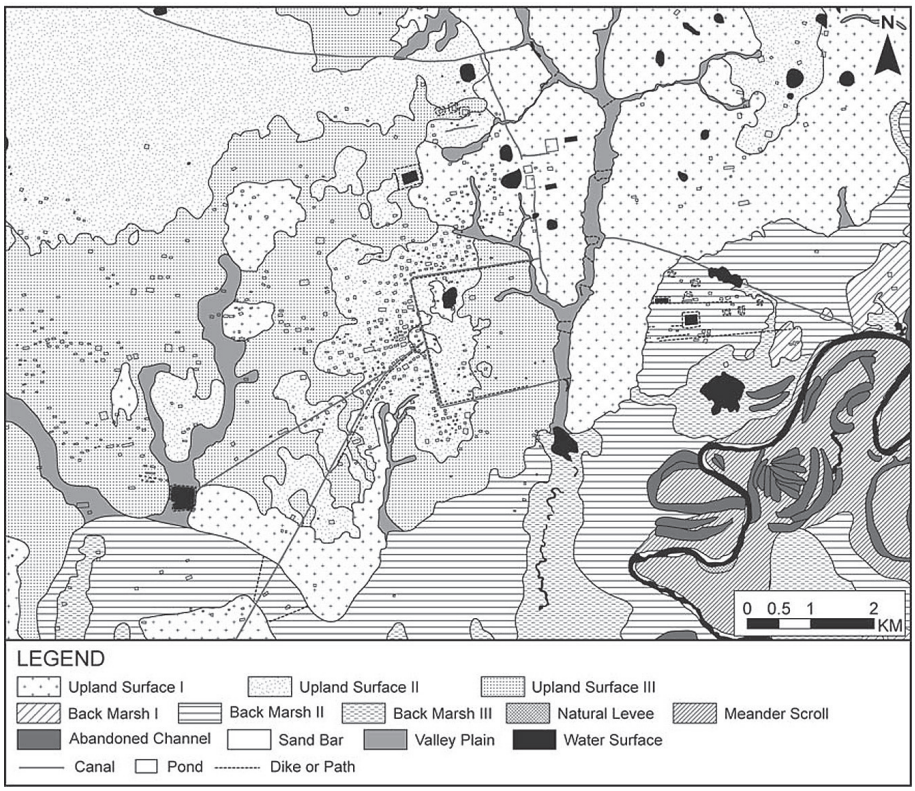

Fig. 2 Land classification map (Nagumo *et al.*, 2011)

plain. The upland surface is slightly undulated, containing higher areas covered by forest (upland I) and lower flat surfaces (uplands II and III). Sediments of uplands around Sambor Prei Kuk are mostly of medium to fine -grain sand, more than 90% of which is quartz grains with low roundness, almost translucent and colorless. Observation by scanning electron microscope (SEM) suggests that the quartz originated from weathered sandstone and was transported a rather short distance (Nagumo *et al.*, 2008).

Upland surface sediments are coarser than the back marsh sediments, suggesting that uplands along the Stung Sen River were probably formed under different geomorphic conditions, possibly by erosional process (Nagumo *et al.*, 2010).

III Excavation Results

We originally set up a test trench and two other trenches (C-1 and B-7)*[1] in the excavation area (**Figs. 3 and 4**). The excavation proceeded from February 24 to March 21, 2008.

The test trench was set up inside Groslier's excavation area in order to observe stratigraphy on the wall (**Photos 2 and 3**). Trench C-1 was located to the north of the previous survey area, while trench B-7 was to the south of Groslier's survey area. We named these trenches according to their position on

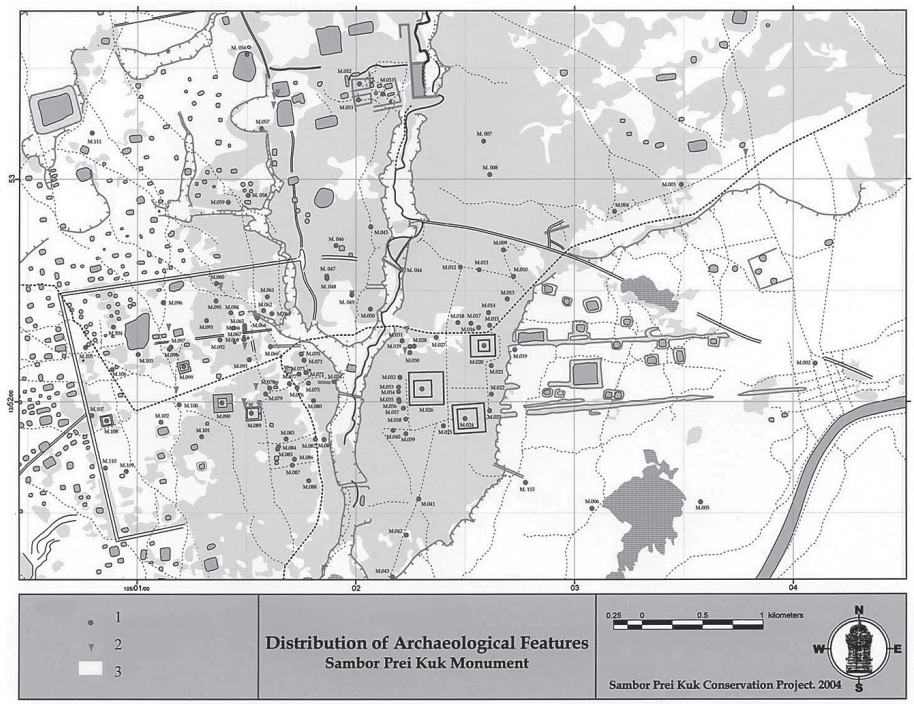

Fig. 3 Map of SPK Archaeological Site (SPK Conservation Project, 2004)
1, trace of monument; 2, scattered ceramics; 3, forest

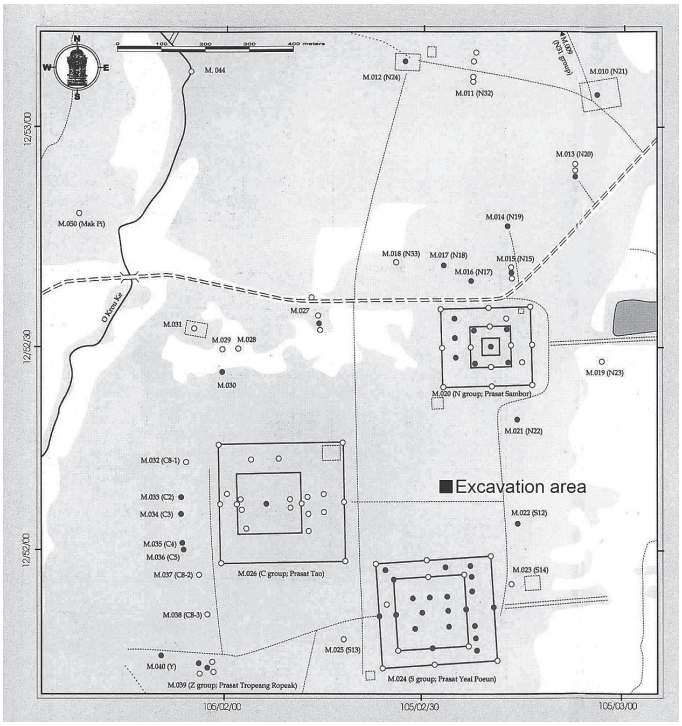

Fig. 4 Map of SPK temple area (SPK Conservation Project, 2004)

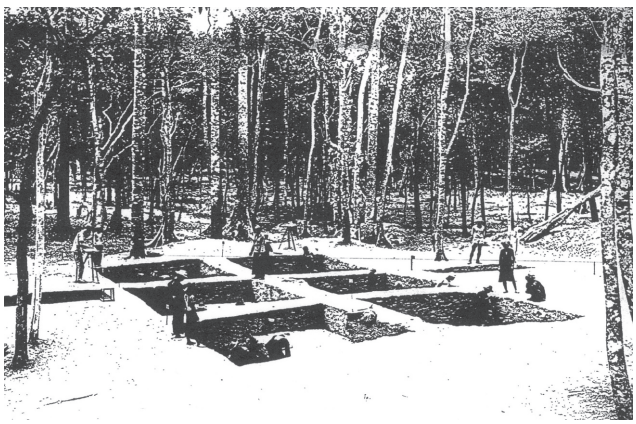

Photo 2 Excavation by B. P. Groslier in 1960s (EFEO)

Photo 3 Test trench (front) and C-1 trench (back)

the grid that we set up for the measurement of the excavation area (**Fig. 5**). The aim of the C-1 and B-7 excavations was to compare the stratigraphy on both sides of the area and to obtain artifacts, especially earthenware and ceramics in each layer.

Subdivision of layers and characteristics of major artifacts found are summarized as follows.

III.1 *Stratigraphy*

III.1.1 Test Trench

This trench, approximately 1 m^2 in size, is set up inside Groslier's excavation area in order to observe stratigraphy on the north wall. The total depth was 3.5 m from the ground surface. In total, eight layers have been confirmed at this trench (**Fig. 6**).

The Surface layer (0) is characterized by brownish silt with sand, and it contains a large amount of plant roots. The first layer (I) consists of brownish silt with sand. These layers are looser than the lower layers and include only a few artifacts.

The second to fourth layers (II-IV) showed dark, yellowish- or grayish-brown silt with sand. These layers contain a large quantity of artifacts; the number increases dramatically. The majority of the findings were earthenware, but some ceramics and porcelains were also unearthed. The fourth layer (IV) was subdivided into IV-a and IV-b, where IV-b contained ceramics and more blocks and chips of brick and laterite than IV-a.

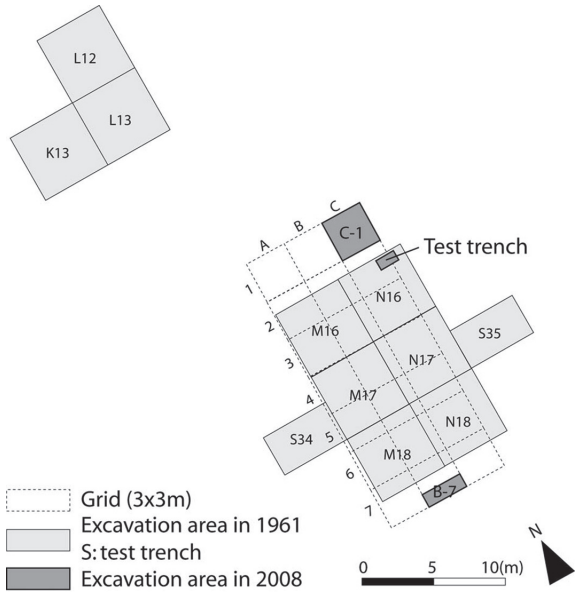

Fig. 5 Excavation plan

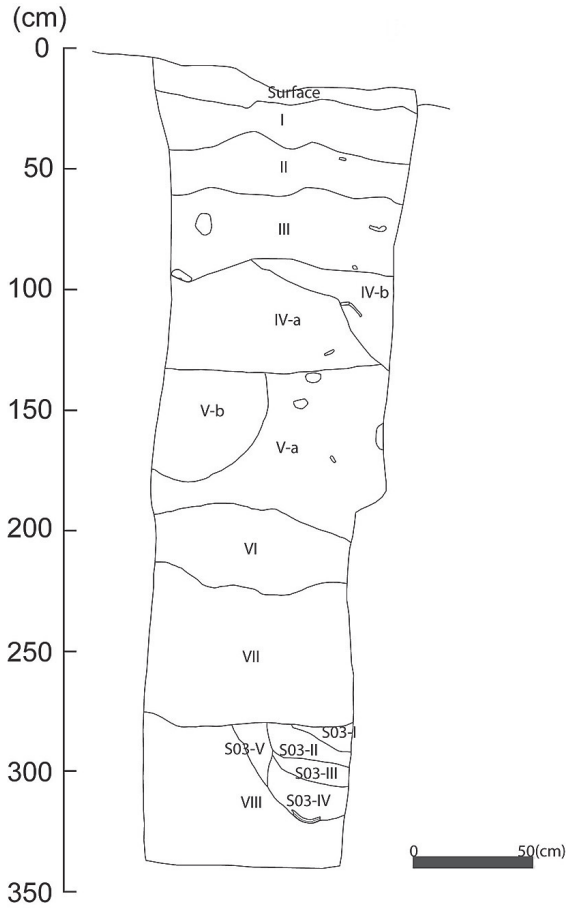

Fig. 6 Section of northern wall at Test trench

The fifth layer (V) consists of brownish silt with sand. This layer contains a large amount of chips and blocks of brick and laterite. Earthenware from this layer is the same as that from the second to fourth layers, but ceramics are not found. It is subdivided into V-b that is dug into V-a on the western side of the trench. It is a pit filled with loose soil, similar to IV-a.

The sixth layer (VI) is yellowish- to grayish-brown silt with sand and contains less artifacts and chips of brick and laterite than the fifth layer. The seventh layer (VII) shows bright yellowish-brown sandy silt. The soil becomes coarser at this depth and its color becomes lighter than in the upper layers. This layer does not contain artifacts.

The eighth layer (VIII) is made up of light yellowish-brown, coarse sandy soil. This layer is considered a natural layer, as no artifacts were found. One pit (pit S3), approximately 40 cm in depth, is dug into this layer. This pit is filled with fine sand with much charcoal, and a burnt cooking pot and spout from a spouted jar called *kendi* are found at the bottom. This pit infill is truncated by layer VII.

III.1.2 Trench C-1

Trench C-1 is 3×3 m in area and 2 m in depth. At this trench, seven layers in total have been confirmed (**Fig. 7**). This trench is located around 1 m north of the test trench, so it was easily correlated with layers 0 to VI of the test trench.

The surface layer (0) and first layer (I) are the same as those in the test trench. These layers are not stiff and contain few artifacts.

The second layer (II) is made up of brown sandy silt. The third layer (III), also dark brown sandy silt, starts approximately 60 cm from present ground level. In these layers, the soil becomes very hard and contains a lot of artifacts. The third layer (III) is divided into two parts, III-a and III-b, according to the quantity of dark grayish-yellow patches. III-b resembles III-a in the basic characteristics of the soil but includes more patches. Observation of the patches suggests that they were formed by ground insects.

Most artifacts found in layers II, III-a and III-b are earthenware. Bluish-white porcelain was found in layer II (**Photo 4**). Some green-glazed and non-glazed stoneware is also found (**Photo 5**), but brown-glazed wares are rare.

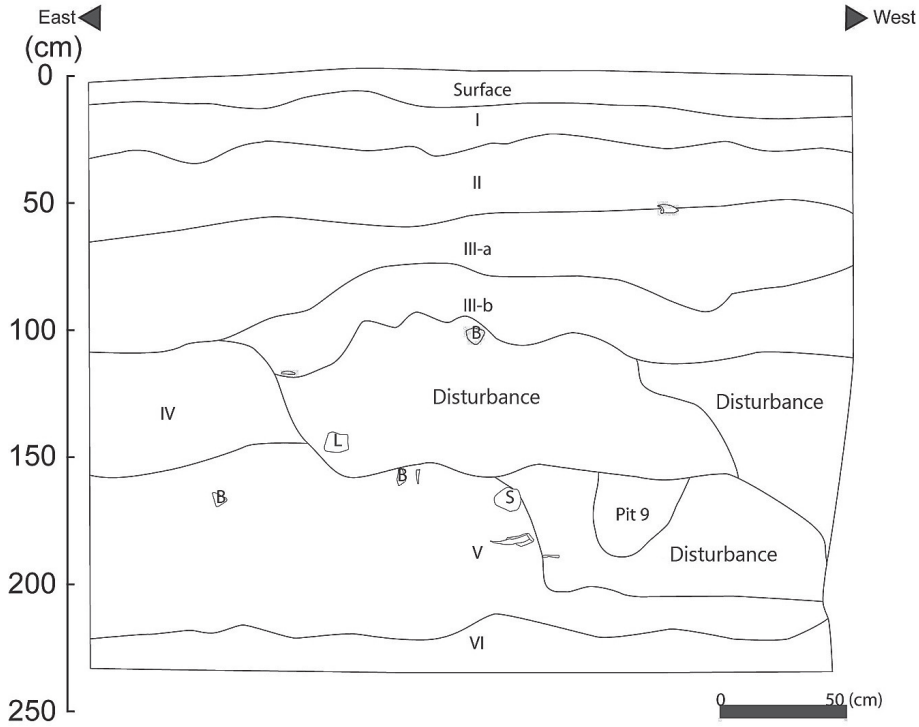

Fig. 7 Section of southern wall at C-1 trench

The fourth layer (IV) shows dull yellowish-brown sandy silt. The color becomes yellowish because of the quantity of patches. We still found quite a lot of earthenware, but its amount had decreased compared to layers II and III. In addition, a few potsherds with red paint on them were found in the lower part of layer IV (**Photo 6**). At the southern wall of the trench, a disturbed layer and pits were seen.

The fifth layer (V) starts approximately 160 cm from ground level. This layer is composed of grayish yellow-brown silt with sand. The disturbed layer is also seen here, at the southwest part. The number of earthenware artifacts has increased compared to previous layers. We did not find any ceramics, but did find *kendi* spouts (**Photo 7**) and some potsherds painted red. A flat roof tile was also found in this layer (**Photo 8**). At the lowest part of layer V, approximately 2 m from ground

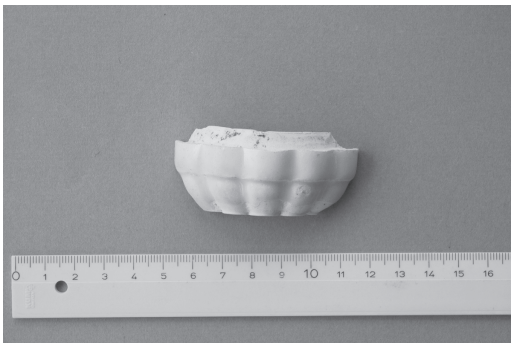

Photo 4 Chinese bluish white porcelain dated to 11-12c (C-1, II)

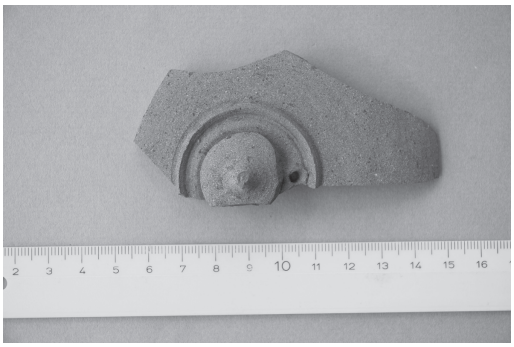

Photo 5 Stoneware, lid of box dated to Angkor period (C-1, II)

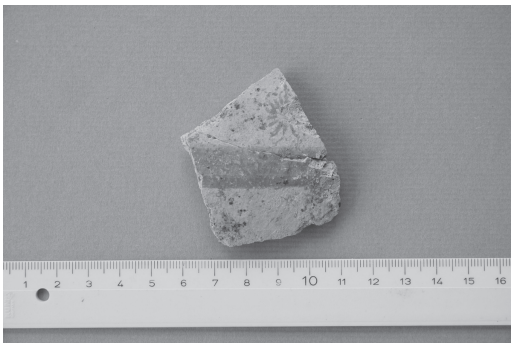

Photo 6 Fragment of red-painted earthenware dated to Pre-Angkor period (C-1, bottom of IV)

Photo 7 Spout of *kendi* (spouted jar) dated to Pre-Angkor period (C-1, V)

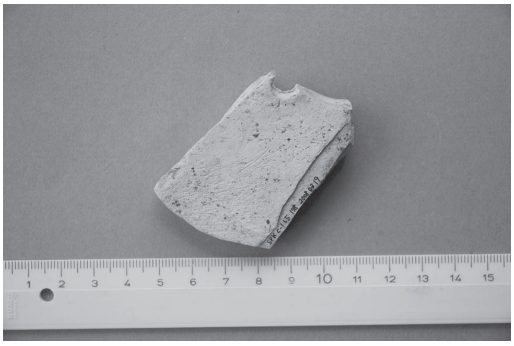

Photo 8 Flat roof tile probably dated to Pre-Angkor period (C-1, V)

level, the disturbed section ended, and around 20 cm below that, layer V ends. From the bottom of layer V, four pits (pits 16–19) were found (not shown in **Fig. 7**). These pits contained a few brick blocks and some earthenware. Some of the earthenware seems to remain in its original position; in particular, pit 19 features one such vase with a rim diameter of approximately 20 cm.

The sixth layer (VI) is dull yellowish-brown sandy silt and quite a bit looser than layer V. As this layer includes almost no artifacts, we finished the excavation here.

III.1.3 Trench B-7

This trench is 1×3 m in area and 2 m in depth. It is located about 20 m south of the test trench. Here, we confirmed the presence of six layers, similar to those in the other trenches (**Fig. 8**).

The surface and first layers are both dull brown silt with sand. They correspond to layers 0 and I as previously seen, respectively. We found a knife that seems modern in the first layer.

The second layer is made up of grayish yellow-brown silt with sand. In this layer, we found many artifacts, especially green-glazed ceramics, making it equivalent to layer II, but many more artifacts were found here than in trench C-1.

The third and fourth layers are made up of silt with sand, grayish yellowish-brown or dull yellowish-brown in color. They also contain a large amount of earthenware, some green-glazed ceramics (**Photo 9**), and porcelains. These layers correspond to layers III and IV as previously identified.

The fifth layer is dark brown silt with sand. From the bottom of the fourth layer to the top of the

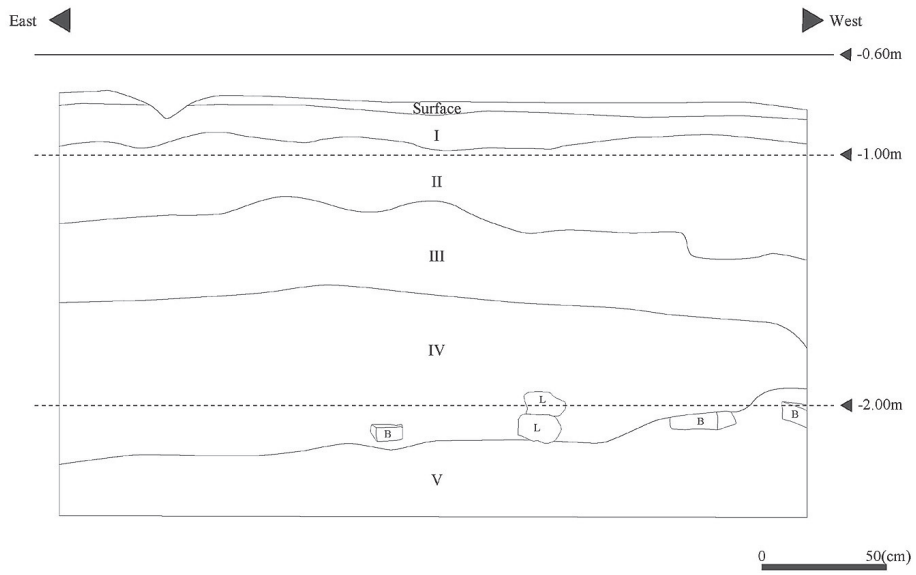

Fig. 8 Section of southern wall at B-7 trench

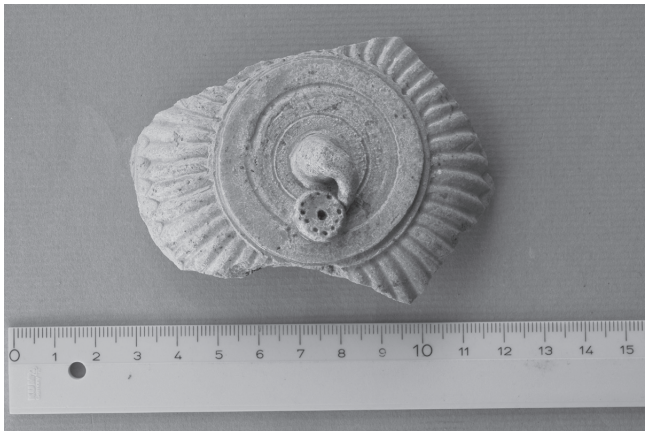

Photo 9 Khmer green glazed ceramic dated to Angkor period (B-7, IV)

fifth layer, several brick and laterite blocks have been unearthed with potsherds. This is comparable to layer V.

Thus, we confirmed from layers 0–V that the stratigraphy of trench B-7 was comparable to that of the others; therefore, we concluded the excavation.

III.2 *Artifacts from trenches C-1 and B-7*

In total, over 1000 potsherds were unearthed from trenches C-1 and B-7. Each of them was given a serial number in order to record the exact location and depth at which it was found. Though further analysis of these artifacts is required, some remarkable materials enabled us to establish the chronology of Sambor Prei Kuk.

III.2.1 Earthenware

Earthenware accounts for the majority of artifacts found by the excavation. They can be classified in two categories; hard earthenware fired at a high temperature, and soft ware fired at a lower temperature. A large amount of hard earthenware was unearthed from layers II to IV in trenches C-1 and B-7. Generally, it is in the form of vases, jars, cooking pots, and similar shapes, made by wheel or turning board, and decorated with incisions and impressions on the neck and shoulder.

Soft earthenware was found in larger amounts in layer V than in the upper layers. It consists of vases (generally with strongly everted rims), jars, cooking pots, and *kendi*. Some containers, especially cooking pots, had been burnt on the surface before being buried. Normally, decoration is limited to painting in red, and incisions or impressions were rarely seen. Sometimes, the whole of the outside of a piece is covered with red paint, or decorated with horizontal red lines on the rim, neck or shoulder.

III.2.2 Stoneware and green-glazed ceramics

Stoneware is also quite typical of the artifacts in layers II to IV. It comes mainly as vases (with strong eversion), jars, lidded boxes, and some other shapes. Some of the stoneware is decorated with incised horizontal lines or impressions. Some green-glazed ceramic fragments have been confirmed in layers II to IV. Brown-glazed ceramics are rarely found. Green-glazed products consist of bowls, vases, and covered boxes decorated with incised lines and impressed motifs. Most of them have been broken into small fragments, so it is quite difficult to restore their original shape.

III.2.3 Porcelains and celadons

From layers II and III of trenches C-1 and B-7, some high-quality ceramics were unearthed. A bluish-white box was found at layer II in trench C-1 (Photo 4). Several white porcelains, boxes, and vases and a few celadons were unearthed with the bluish-white porcelain.

III.3 *Radiocarbon ages*

Three AMS ^{14}C dates were derived from the samples in the test trench and trench C-1 (**Table 1**; Kubo *et al.*, 2009).

Sample No.1 was collected from charcoal adherent to a potsherd unearthed from a pit in layer VIII of the test trench. Sample No. 2 was collected from charcoal adherent to a pottery unearthed from layer IV of trench C-1. Sample No. 3 was collected from charcoal unearthed from layer V of trench C-1. Radiocarbon ages were determined at Paleo Lab Co. Ltd. Japan.

The samples were prepared and treated for AMS measurement. Calibrated ages applying IntCal04 data sets (Reimer *et al.*, 2004) are shown by OxCal 4.0 (Bronk Ramsey, 1995; 2001).

By 2-sigma age range, Sample No. 1 (PLD-11510) showed 535-624calAD (94.5%) and 470-479calAD (0.9%), placing it between the latter half of the 5th century and the first half of the 7th century. Sample

Table 1 Radiocarbon dating results (Kubo *et al.*, 2009)

No.	$\delta^{13}C$ (‰)	Calibrated age (yrBP ± 1σ)	^{14}C age (yrBP ± 1σ)	1σ Calibrated Age	2σ Calibrated Age
PLD-11510 (No.1)	− 25.16 ± 0.29	1501 ± 22	1500 ± 20	550AD (68.2%) 593AD	470AD (0.9%) 479AD 535AD (94.5%) 624AD
PLD-11511 (No.2)	− 25.99 ± 0.19	1173 ± 20	1175 ± 20	782AD (5.5%) 789AD 811AD (28.9%) 847AD 856AD (33.7%) 891AD	777AD (90.7%) 896AD 924AD (4.7%) 938AD
PLD-11512 (No.3)	− 27.02 ± 0.11	1397 ± 20	1395 ± 20	634AD (68.2%) 660AD	611AD (95.4%) 664AD

No. 2 (PLD-11511) showed 777-896calAD (90.7%) and 924-938calAD (4.7%), placing it from the latter half of the 8th century to the first half of the 10th century. Finally, Sample No.3 (PLD-11512) showed 611-664calAD (95.4%), placing it sometime in the 7th century.

IV Discussion

IV.1 *Correlation of Artifacts*

Various artifacts, including imported ceramics, green- and brown-glazed local ceramics, earthenware, stoneware and other clay products were unearthed. Here we try to compare these results with finds at Angkor and other areas.

IV.1.1 Imported ceramics

From layers II and III of trenches C-1 and B-7, some high-quality porcelain was unearthed. Its proportion to the total number of artifacts was very low, but it is still a very important find for the analysis of artifacts and establishment of ceramic chronology at Sambor Prei Kuk. This is because the progress made in classification and chronological study of imported ceramics (mainly from China) can provide us with exact dating.

Bluish-white lidded boxes are the majority of Chinese wares. Based on findings in the Angkor area, some of them have been identified as products of Dehua kiln（德化窯）and other kilns in Fujian Province（福建省）and Jingdezhen kiln（景徳鎮窯）in Jiangxi Province（江西省）. Based on the chronology of Chinese ceramics, most of them can be dated to between the 11th and 12th centuries (e.g. JSA, 2000).

Several white porcelains, lidded boxes and vases, and a few celadons are associated with the bluish-white porcelain. These imported ceramics are high-quality products that show the importance of Sambor Prei Kuk, even it was not the center of the empire in the Angkor period.

IV.1.2 Green- and brown-glazed ceramics

Green- and brown-glazed ceramics are often found at temple and kiln sites in the Angkor area. Therefore, in the study of ceramics produced in the Khmer empire in the Angkor period, they are called “Khmer ceramics” (Groslier, 1981).

In the case of Sambor Prei Kuk, quite a few green- and brown-glazed ceramics were found by the Groslier excavation in 1961 (Shimamoto *et al.*, 2008). During our excavation in 2008, some green-glazed ceramic fragments were confirmed from layers II to IV. Brown-glazed ceramics were rare. Green-glazed products consisted of bowls, vases, and covered boxes, decorated with incised lines and impressed

motifs. Most of them were broken to small fragments, so it was quite difficult to reconstruct their original shapes. However, at a minimum they indicate that the upper layers of stratigraphy in this excavation can be dated to the Angkor period, specifically the first half of this period, because green-glazed wares are thought to have been produced from the beginning of the Angkor period to the 12th century.

IV.1.3 Earthenware, stoneware, and other clay products

Hard earthenware was unearthed in layers II–IV, together with stoneware and Khmer ceramics. These characteristics strongly indicate that the hard earthenware can be dated to the Angkor period. In Angkor sites in Siem Reap, similar earthenware was unearthed by excavation (JSA, 2000).

On the contrary, soft earthenware was unearthed in layer V, lower than the Angkor layer, and without accompanying Khmer ceramics or Chinese ceramics. *Kendi* and red-painted wares show the similarity with earthenware of the Pre-Angkor period found at Angkor Borei and some other Pre-Angkor sites in Cambodia (Stark, 2003) and southern Vietnam (Hirano, 2005). Therefore, we can conclude that the soft earthenware can be dated to the Chenla period, and it corresponds to the age of brick building of Sambor Prei Kuk.

A flat roof tile probably dating to the Pre-Angkor period was found layer V in trench C-1.

IV.2 *Stratigraphy and Chronology*

We have confirmed the stratigraphy of Sambor Prei Kuk in cultural layers dating from Pre-Angkor to Angkor, with three AMS ^{14}C dates. The thickness of the layers reaches approximately 2 m.

Layers 0 and I seem to be modern, partly derived from the previous excavation by Groslier.

Layers II–IV are to be dated to the Angkor period by the existence of Khmer and Chinese ceramics. As mentioned, Dehua bluish-white porcelain boxes found in layer II at trench C-1 can be dated to the 12th century.

Earthenware found in these layers is hard, fired much better than that of the Pre-Angkor period, and *kendi*, a typical earthenware of the Pre-Angkor period, is not included.

The charcoal sample (No. 2) from layer IV of trench B-7 showed 777-896calAD; which almost belongs to the Angkor period, generally considered to start at the beginning of the 9th century (*e.g.*, Higham, 2001).

Lower layers than IV might belong to the Pre-Angkor period because of the lack of ceramics and well-fired earthenware and the existence of *kendi*.

The charcoal sample from layer V (No. 3) was detected as 611-664calAD, the same age as the city of Isanapura, founded in the 7th century. It also matches the characteristics of proximal artifacts.

Layer VI itself includes almost no artifacts, but at the bottom of layer V in trench C-1, 4 pits (pits 16

–19) were found. These pits contained a few brick blocks and some earthenware with typical features of that of the Pre-Angkor period.

Layer VIII in the test trench has similarly sandy soil to that in the natural layer at Prasat Sambor, confirmed by excavation there in 2004–2005 (Shimoda *et al*., 2006). Therefore, this layer is considered natural.

Radiocarbon dating of the charcoal sample from a pit in layer VIII (Sample No. 1) showed 535-624calAD, belonging to the Pre-Angkor period.

V Conclusion

Through our excavation in 2008, several important archaeological features of Sambor Prei Kuk have been confirmed. First, the research area, located in the eastern part of Sambor Prei Kuk, has rather thick cultural layers (more than 2 m from present ground level), and generally can be divided into upper and lower or Angkor and Pre-Angkor layers according to composition of artifacts. These estimated dates agree with the architectural and artistic chronology of Sambor Prei Kuk and inscriptions found at the site. Moreover, archaeological stratigraphy and ^{14}C dates for our excavation demonstrated extremely good agreement.

Khmer and Chinese ceramics found from layers II to IV indicate that these layers can be dated to the 11^{th} or 12^{th} century, the middle of the Angkor period. This result will help analysis and dating of earthenware found associated with the ceramics. The charcoal sample from layer IV (No. 2) shows Angkorean origin (8^{th}–9^{th} century).

For dating and establishment of chronology of layers lower than V, some typical types of earthenware such as *kendi* will contribute, especially for artifacts of the Pre-Angkor period. The charcoal sample from layer V (No. 3) gives a result of 7^{th} century (Pre-Angkorean). The lowermost sample (No. 1) gives 6^{th}–7^{th} century (early Pre-Angkorean).

This is the first result/findings of archaeostratigraphy with ^{14}C dating in the Sambor Prei Kuk area.

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Note

*1. These are the original names at the time the excavation was carried out. The test trench was later renamed trench A, trench B-7 was renamed trench C, and trench C-1 was renamed trench B, by present co-authors Shimoda and Shimamoto. The original contribution of the present paper is the provision of the ^{14}C dates from these trenches.

References

Bronk Ramsey, C., 1995. Radiocarbon calibration and analysis of stratigraphy: The OxCal Program. *Radiocarbon*, 37: 425–430.

Bronk Ramsey, C., 2001. Development of the radiocarbon calibration program OxCal. *Radiocarbon*, 43: 355–363.

Groslier, B.P., 1981. Introduction to the Ceramic wares of Angkor. In Stock, D. (ed.) *Khmer Ceramics: 9th-14th Century*. Oriental ceramic Society, Singapore, 9–39.

Higham, C., 2001. *The Civilization of Angkor*. Phoenix.

Hirano, Y., 2005. Earthenware in Mekong Delta, South Vietnam: mainly in spouted vessels and roof tiles (Part 2: Earthenware in Southeast Asia, Earthenware and Glazed Ceramics in Southeast Asia). *The Journal of Sophia Asian studies*, No.23, 161–178.

JSA (Japanese Government Team for Safeguarding Angkor) 2000. Preliminary Report on the Ceramics recovered from the Northern "Library" of the Bayon Complex, Angkor Thom. *Udaya* 1: 201–216.

Kojo, Y. and Kubo, S, 2003. A preliminary report of the investigations in Sambor Prei Kuk Archaeological site (7 th Century), Central Cambodia -Results in 1998 and 1999–. *Bulletin of the Graduate School of Education, Waseda University*, No.13, 15–31.

Kubo, S., Nagumo, N., Shimamoto, S., Him, S., So, S., Chan, V., Lun, V., Shimoda, I. and Nakagawa, T., 2009. Geomorphological condition, archaeological stratigraphy and ^{14}C ages of Sambor Prei Kuk Archaeological Site in central Cambodia. *Proceedings of the General Meeting of the Association of Japanese Geographers*, No.75, 230.

Nagumo N., Kubo S. and Sugai T., 2008. Consideration about the structure of pre-Angkorian ancient capital city in Cambodia, *Proceedings of the General Meeting of the Association of Japanese Geographers*, No.74, 147.

Nagumo,N., Sugai,T. and Kubo, S., 2010. Location of a pre-Angkor capital city in relation to geomorphological features of lower reach of the Stung Sen River, central Cambodia. *Geodinamica Acta* 23: 255–266.

Nagumo,N., Sugai,T. and Kubo, S., 2011. Characteristics of fluvial lowland in lower reach of the Stung Sen River, central Cambodia. Transactions, Japanese *Geomorphological Union* 32(2): 142–151.

Permentier, H., 1927. *L'Art khmèr primitif*, PEFEO, Paris, 45p.

Reimer, P.J., Baillie, M.G.L., Bard, E., Bayliss, A., Beck, J.W., Bertrand, C.J.H., Blackwell, P.G., Buck, C.E., Burr, G.S., Cutler, K.B., Damon, P.E., Edwards, R.L., Fairbanks, R.G., Friedrich, M., Guilderson, T.P., Hogg, A.G., Hughen, K.A., Kromer, B., McCormac, G., Manning, S., Bronk Ramsey, C., Reimer, R.W., Remmele, S., Southon, J.R.,

Stuiver, M., Talamo, S., Taylor, F.W., van der Plicht, J. and Weyhenmeyer, C.E., 2004. IntCal 04 terrestrial radiocarbon age calibration, 0–26 cal kyr BP. *Radiocarbon*, 46: 1029–1058.

Sambor Prei Kuk Conservation Project, 2004. *Conserving and Developing SPK*. Department of Culture and Fine Arts in Kampong Thom and Waseda University, 106p.

Shimamoto S., Yamamoto N. and Nakagawa T., 2008. Reexamination on the dating of ceramics of Sambor Prei Kuk found by B.P. Groslier, *Journal of Southeast Asian Archaeology* 28: 47–60.

Shimoda I., Him S., Seng K., Chang V., Chhum M, So S. and Nakagawa T., 2006. Preliminary Report on the Excavation Survey at the Prasat Sambor, Sambor Prei Kuk, 2004–2005, *Journal of Southeast Asian Archaeology* 26: 117–145.

Stark, M., 2003. Current Issues in Ceramic Ethnoarchaeology. *Journal of Archaeological Research* 11(3): 193–242.