Radiocarbon Ages and Stratigraphy in the City Area of the Sambor Prei Kuk Pre-Angkor Archaeological Site, Cambodia

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Abstract

The Sambor Prei Kuk archaeological site in central Cambodia is known as one of the primary cultural and political centers of the Pre-Angkor Period in Indochina. The main part of the site is situated on a sandy upland along the Stung Sen River floodplain and is divided into the city area and temple area by the O Krou Ke River (creek). The temple area comprises the three major walled complexes of Prasat Sambor, Prasat Tao, and Prasat Yeai Pouen and a number of Hindu brick towers. The city area is demarcated by moats, which are found in the west of temple area. This archaeological site is considered the ancient capital city of Chenla called *Isanapura* and constructed by King Isanavarman I in the early seventh century, as described in the Chinese ancient chronicle of *Sui-shu*. However, investigations thus far have mainly targeted temple complexes, whereas clear evidence exhibiting the prosperity or chronological framework of the archaeological site has been scarcely reported. In February 2012, we discovered a 1500 m long section in the city area that was revealed during road construction. Subsequently, recording of the stratigraphy, analysis of cultural deposits, and survey of the western city moat were conducted. Radiocarbon (AMS ^{14}C) dates of the layer containing structures were from the fifth to seventh centuries and the fourteenth century (road cut section, Trenches B and H), while the moat floor dated to the sixth century (moat section, Site 1). These dates suggest that the construction of Sambor Prei Kuk dates to the Pre-Angkor period. Further investigations are required to confirm the foundation age of the city area and to reveal the relationship between Sambor Prei Kuk and ancient *Isanapura*.

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1. Introduction

The Sambor Prei Kuk archaeological site located in central Cambodia (Fig. 1a) is known as one of the primary cultural and political centers during the Pre-Angkor Period. Many foreign explorers and researchers have been attracted to the abundant Hindu remains and mysterious engineering works such as moats, ponds, and canals at the site. After several basic studies conducted by French researchers from late nineteenth to early twentieth centuries, the initial comprehensive reports on the site were published by the École Française d'Extrême-Orient (EFEO) (*e.g.*, Parmentier, 1927). Consequently, the site's cultural value has been widely recognized (*e.g.*, Coedes, 1947; Briggs, 1951). Although investigations and research activities at Sambor Prei Kuk were discontinued during the Cambodian civil war (1970s to 1980s), the Ministry of Culture and Fine Arts (Cambodia) and Waseda University (Japan) established a joint team named the Sambor Prei Kuk Conservation Project. Scholarly investigations and conservation practices have been undertaken since 1998 (*e.g.*, Kojo and Kubo, 2003; Sambor Prei Kuk Conservation Project, 2004; Shimoda and Nakagawa, 2006; Nagumo *et al.*, 2010).

The main part of the site comprises the eastern temple area and western city area bordered naturally by the O Krou Ke River (Fig. 1b). Impressive archaeological and architectural remains including brick towers have been found surrounding the three walled temple complexes of Prasat Sambor, Prasat Tao, and Prasat Yeai Pouen in the temple area (Fig. 1c). In contrast, few remarkable remains other than those of engineering feats such as moats, canals, and ponds were found in the city area. Therefore, most early stage research of the conservation project has been conducted at the temple area, but clear evidence exhibiting the city's past prosperity and construction age is still insufficient (Sambor Prei Kuk Conservation Project, 2004).

In February 2012, a development program by the Cambodian government and the United Nation's World Food Programme (WFP) undertook road construction within the city area. This work yielded abundant artifacts and building remains along the side ditches. After the Sambor Prei Kuk Conservation Project requested the construction be stopped, it conducted immediate investigations after the side ditches were cleaned. In parallel, infill deposits of the city moat were observed. This paper reports the results of those investigations.

2. Study area

2.1. The Sambor Prei Kuk archaeological site

Sambor Prei Kuk is situated on the sandy upland approximately 5 m higher than the adjacent floodplain of the Stung Sen River (Fig. 1b). The upland surface is covered with white to pale orange quartz-rich sand and is subdivided into upland surfaces I, II, and III based on relative elevations and land use

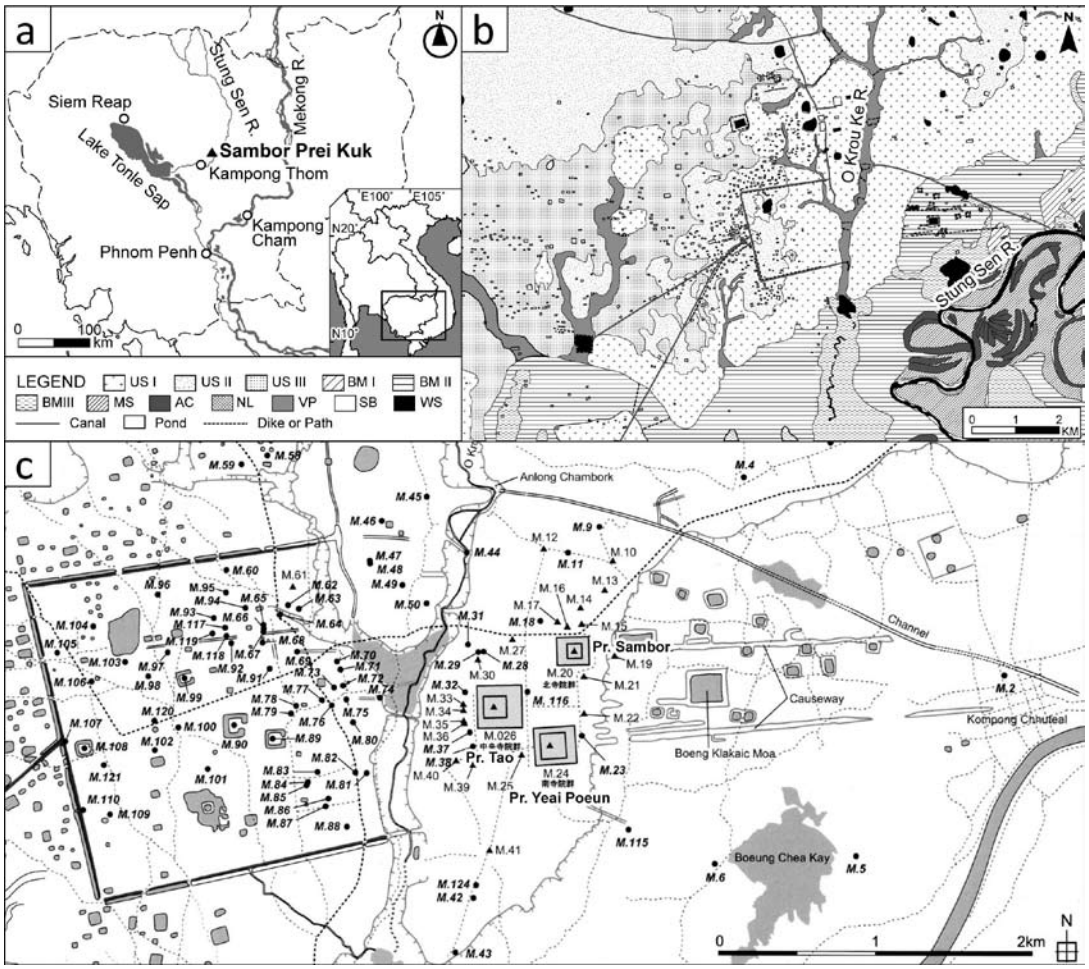

Fig. 1 Location of Sambor Prei Kuk (a), Land classification map of surrounding Sambor Prei Kuk (b), reproduced from Kubo et al. (2012), and distribution of archaeological remains in the core area of Sambor Prei Kuk (c) reproduced from Shimoda and Nakagawa (2006). US I (Upland Surface I), US II (Upland Surface II), US III (Upland Surface III), BM I (Back Marsh I), BM II (Back Marsh II), BM III (Back Marsh III), MS (Meander Scroll), AC (Abandoned Channel), NL (Natural Levee), VP (Valley Plain), SB (Sand Bar), and WS (Water Surface).

characteristics (Kubo *et al.*, 2012). Upland surface I is the highest surface around the site and is covered by forest; upland surface II is partly covered by vegetation, and upland surface III is almost barren land with lower moisture content. The temple complexes of Prasat Sambor, Prasat Yeai Poeun, and Prasat Tao are situated within dense forest on upland surface I facing the floodplain. Two causeways from Prasat Sambor and Prasat Yeai Poeun reach close to the Stung Sen River, and an artificial canal from the O Krou Ke River Valley also approaches the river (Fig. 1b and 1c). The city moats of the north, south, and west sides with embankments define the *ca.* 2×2 km city area together with the O Krou Ke River.

Several archaeological mounds are found in this enclosed city area. Furthermore, characteristic small tanks (ponds) and paddy field structures are also distributed outside of the city (*e.g.*, Kojo and Kubo, 2003; Shimoda and Nakagawa, 2006).

The adjacent Stung Sen River floodplain develops into a meander belt comprising meander scrolls and abandoned channels, which suggest past changes in water flow route. Nagumo *et al.* (2013) identified the accumulation of back marsh deposits at the rate of approximately 0.5 mm/yr during the Holocene, and the present micro-topography seems to have been established after *ca.* 5.5 ka along with the Mekong-Tonle Sap connection. Therefore, the flow route and floodplain environment of the Stung Sen River during the Pre-Angkor and Angkor periods was likely similar to today.

Considering the limited number of reports of previous archaeological research at the site, artifacts excavated by the French archaeologist B. P. Groslier in the 1960s in the northern section of Prasat Yeai Poeun are important for identifying ancient structures and construction ages of the temple area. Thus, Y. Kojo reexamined Groslier's artifacts and reported the presence of unglazed potteries, Khmer and Chinese ceramics, flat roof tiles, stone artifacts, bronze rings, berg crystals, and iron products (Kojo and Kubo, 2003). Shimamoto *et al.* (2008) report on the artifacts shows that the excavated Khmer and Chinese ceramics derive from the late eighth to fourteenth centuries (Angkor Period), also noting that abundant earthenware examples have similar characteristics to those found at other Pre-Angkor archaeological sites. Additionally, the Sambor Prei Kuk Conservation Project re-excavated Groslier's site in 2008 and detected nine archaeological layers; based on artifacts such as Khmer and Chinese ceramics, stoneware, red-painted pottery, and spouted jars (*kundi*), these layers date to the Pre-Angkor and Angkor periods. AMS ^{14}C dates also support this stratigraphy, indicating continuous use of the temple area during the sixth to seventh centuries (Pre-Angkor Period) at least until the eighth and ninth centuries (Angkor Period) (Kubo *et al.*, 2012).

Architectural investigations based on decorative elements, inscriptions, as well as excavations around the main tower of Prasat Sambor and walls of the complex also indicated that those buildings were initially constructed in the seventh century and had been modified several times for use as an important regional center until at least the tenth century (Shimoda and Nakagawa, 2008).

2.2. Locations of investigated sites

This paper reports on field investigations conducted at two locations: the road cut and moat sections in the southeast and southern parts of the city area, respectively (Fig. 2). Details of each site are explained in the following sections.

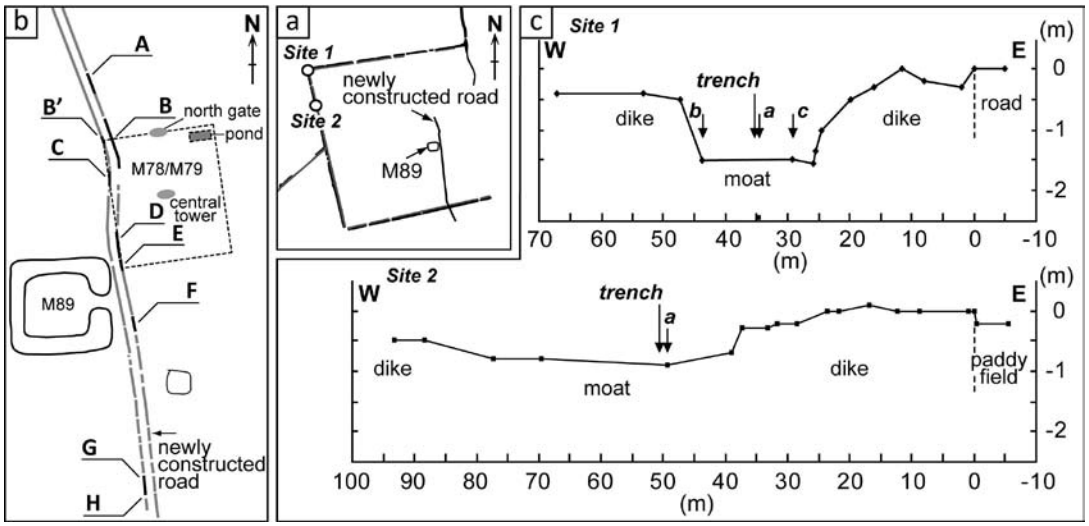

Fig. 2 Locations of road-cutting and moat sections (a), layout of road-cutting trenches reproduced from Chhum et al. (2012) (b) and horizontal cross-sections of Site 1 and 2 in moat section (c).

1) Road cut section (Photo 1, 2)

This location includes the cleaned walls of side ditches measuring almost 1 m deep along the newly constructed 1500 m long road (Fig. 2a and 2b). During the road construction, archaeological remains such as brick structures, laterite, and pottery fragments were exposed on the walls of side ditches. Therefore, urgent architectural and archaeological investigations were conducted at nine sites (A, B, B', C, D, E, F, G, H) after deep trenches were excavated and ditch walls were cleaned. Regarding archaeological artifacts, Chhum *et al.* (2012, 2013) reported a total of 2162 excavated artifacts including potsherds, roof tiles, and spouted jars, among others. They also found piled bricks in the B, B', C, D, and E trenches and identified them as parts of the peripheral wall on the western side of the M78/79 site (Fig. 2b).

We observed cultural deposits in the trenches of B, F, and H. Samples were collected to reveal the stratigraphy and geomorphological background of the site as well as to use in AMS ^{14}C dating. A tool known as the Handy Geoslicer was also used for soil sampling in the F trench.

2) Moat section (Photo 3, 4)

The ancient city moats identified in aerial photos (Kojo and Kubo, 2003) are rain-fed and remain marshy in some areas even during the dry season. In the well-preserved section, the moat is almost 1.5 m deep and more than 20 m wide, whereas embankments on both sides of the moats are almost 1 m high (Shimoda and Nakagawa, 2006). We selected two sites in the western moat (Site 1 and 2) for

Photo 1 Trench F of road cutting section

Photo 2 Trench H of road cutting section

Photo 3 Site 1-Trench

Photo 4 Drilling of Site 2-a

excavating less than 1 m-deep trenches to observe the moat infill sediments and collect samples for ^{14}C dating. The Handy Geoslicer was used to collect undisturbed sediments, while a boring stick and hand auger were also used for test drillings.

3. Methods

Physical and chemical properties of the deposits were analyzed in the field and laboratory at the University of Tokyo. Magnetic susceptibility was measured by SM30 (GH Instruments) at 5 cm intervals at the section. Sediment color was measured by SPAD503 (Minolta) for flat core surfaces at 2 cm

intervals using the L*a*b* color specification system. Sediment samples were collected to determine the particle size by a laser diffraction particle size analyzer (SALD-3000S, Shimadzu). Additionally, samples from the moat section (Site 1-a) were analyzed with an X-ray analytical microscope (XGT-5000WR, Horiba) to observe the contents of chemical elements (Si, Al, Ti, Fe). The ignition loss was measured by dry ashing processes at 600°C for 3 hours using a muffle furnace (FO510, Yamato) at 5 cm intervals.

AMS ^{14}C ages were measured at the Institute of Accelerator Analysis Ltd., Japan, and conventional ages were calibrated into calendar ages (2σ cal yr BP) using OxCal version 4.1 (Bronk Ramsey, 2009) and by applying the IntCal09 calibration database (Reimer *et al.*, 2009).

4. Description and results

4.1. Road cut section

1) Trench B

Measuring almost 35 m wide, Trench B is situated in the eastern side of the road and divided into three sections. The first section is part of the waterway, whereas the second section is part of peripheral wall at the M78/79 site. Here, over 1000 archaeological relics such as pottery sherds were collected. Drillings were conducted at three adjacent locations in Section 3 (B-a, B-b and B-c), comparable to the inner area of the M78/79 site (Fig. 3).

Sediments in Section 3 are mainly composed of medium sand with silt. From the bottom to the depth of 150 cm, the median particle size is almost the same, $<2\,\varphi$, but it gradually decreases toward the ground surface. Sediments are hard and yellowish at the depth of 220–190 cm and yellow patchy patterns appear on the trench surface. Pottery and brick fragments are concentrated at the depth of 130–75 cm, and potsherds are scattered at approximately 55 cm and 30 cm from the ground surface. The value of magnetic susceptibility abruptly increases from 130 cm in depth due to the occurrence of these artifacts. Charcoals recovered at 40 cm in depth (B-c) were dated to 1349–1392 cal AD and 429–562 cal AD from 95 cm deep (B-b) (Table 1).

2) Trench F

Using the Handy Geoslicer, we drilled 80 cm beyond the depth of 190 cm in Trench F. The trench mainly contains coarse sand with silt with a median particle size of $1.5\,\varphi$; the magnetic susceptibility value is quite low at less than 0.1×10^{-3} SI units. At the time of investigation, sediments deeper than 94 cm became water-saturated, facilitating a more vivid illustration of color changes. Similar to Trench B, sediments are reddish or orange due to oxidation patches from the bottom to a depth of 120 cm (Fig. 3); changes in water content may have formed these patches. Silt concretions between 90 and 50 cm deep and black nodules between 170 and 140 cm deep are also recognized. Here we saw fewer artifacts than

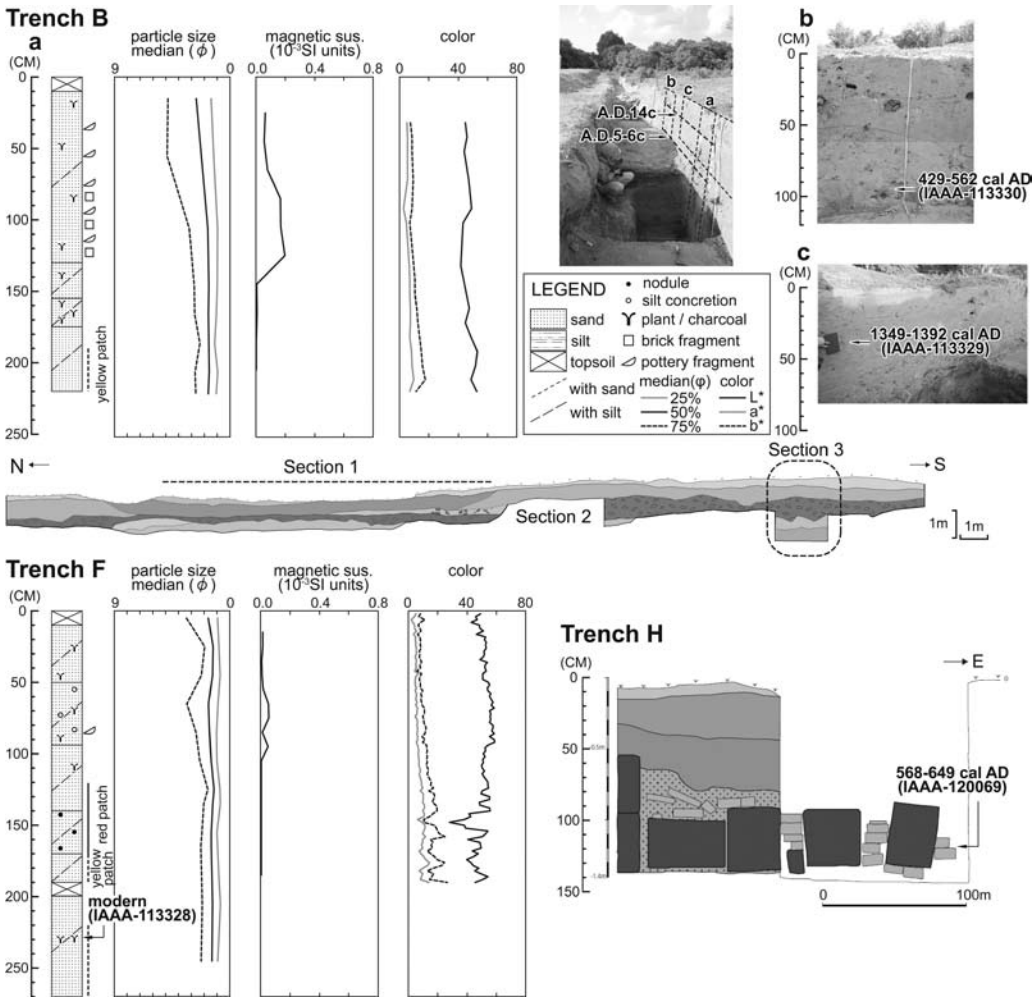

Fig. 3 Columnar sections of road-cutting sections (Trench B, F and H).

Table 1 Results of AMS-^{14}C analysis.

Lab code	section	location	depth	material	conventional age BP	calibrated age, 2σ, cal AD
IAAA-113328	Road-cutting section	Trench F	233 cm	charcoal	Modern	—
IAAA-113329		Trench B	40 cm	charcoal	650 ± 20	1284–1321 (41.9%) 1349–1392 (53.5%)
IAAA-113330		Trench B	95 cm	charcoal	1560 ± 30	429–562 (95.4%)
IAAA-120069		Trench H	120 cm	charcoal	1450 ± 20	568–649 (95.4%)
IAAA-113331	Moat section	Site 1 trench	60 cm	charcoal	1530 ± 30	432–495 (35.7%) 503–597 (59.7%)
IAAA-113332		Site 2 trench	53 cm	charcoal	1060 ± 20	898–920 (13.3%) 946–1023 (82.1%)
IAAA-113333		Site 2 trench	92 cm	charcoal	1140 ± 30	782–790 (1.8%) 809–979 (93.6%)

in Trench B, represented by a potsherd found at the depth of 95 cm. Charred material from 233 cm deep yielded modern dates (Table 1).

3) Trench H

Columnar-shaped laterite blocks and bricks are arranged in an east–west direction with piled bricks in Trench H (Fig. 3). Although no detailed description of the deposits is available, charred material from 120 cm deep yielded an age of 568–649 cal AD (Table 1).

4.2. Moat section

1) Site 1

This site is located near the northwestern corner of the city area, where moat and dike structures are well-preserved (Fig. 2). During the investigations in February (dry season), water still remained, and moat infill sediments were wet. Before digging the trench, sediment samples were collected using a hand-auger and the Handy Geoslicer (Site 1-a). Test pits (Site 1-b and 1-c) were made using a boring stick.

At Site 1-a, medium sand was found at the depth of 200–60 cm. The sand gradually becomes finer and resembles silt toward the ground surface. In concordance with the particle size change, sediment color becomes darker at around 90 cm in depth and reflects gradations of dark gray at around 30 cm in depth. The value of ignition loss indicates that this sediment color change derives from the content of humus materials. Those sediments are quartz-rich, and the SiO_2 content of about 80% at the bottom becomes more than 95% until the depth of around 40 cm. It then decreases again toward the ground surface, inversely proportional to the content of Al_2O_3, TiO_2, and Fe_2O_3. Site 1-b and 1-c show similar characteristics: white sand at the bottom gradually becomes darker and humus-like higher up, and the border is located at depths of 70 to 80 cm (Fig. 3). The square trench measuring 100 × 100 cm in Site 1 is located east of Site 1-a, and the border between the lower white sand and upper dark and humus-rich silt is situated at the depth of 60 cm. The radiocarbon age from the depth of 60 cm and upper limit of the white sand was 503–597 cal AD (Table 1).

2) Site 2

The moat and dike structures at Site 2 are less clear than at Site 1, and the relative elevation between the moat and dikes is <1 m at the largest part (Fig. 2). Similar to Site 1, the bottom part of the moat infill to the depth of 50 cm is medium white sand, but the upper part is less humus-rich and the particle size is larger than that of Site 1. The moat around Site 2 seems to have been buried comparable to Site 1. Therefore, less humus and fewer coarse sediments have accumulated in the upper part of Site 2-a.

The trench is 96 cm deep and the sediments have similar characteristics to those at Site 2-a. The upper limit of the orange-white sand layer is at a depth of 54 cm. The layer gradually becomes darker at the depth of 54–40 cm and then becomes dark gray toward the ground surface with a topsoil at a depth of 10–0 cm. Brick and pottery fragments are found at the depth of 96–85 cm, and scattered charcoals were collected at 96–53 cm. The AMS radiocarbon age of the sample at 92 cm was 809–979 cal AD, whereas an age of 946–1023 cal AD was obtained from charcoal at the depth of 53 cm, almost at the upper limit of the white sand (Table 1).

5. Discussion

Since H. Parmentier surveyed Sambor Prei Kuk in the early twentieth century, people have identified the site as the capital city of the Pre-Angkor Chenla kingdom called *Isanapura*. The name *Isanapura* appears in the Chinese chronicle of the Sui Dynasty (*Sui-shu*). This places the Kingdom of Chenla southwest of *Lin-yi* (Champa) and the prince (Isanavarman I) resided in the city of *Y-che-na* (city of *Isana* or *Isanapura*), which sent an ambassador to the Chinese imperial court in 616 AD of the Pre-Angkor Period. Twentieth-century French researchers such as L. Finot and G. Coedès also identified that the initial construction of Prasat Yeai Poeun was by Isanavarman I in the seventh century (Shimoda and Nakagawa, 2006). Recent investigations of archaeological (*e.g.*, Shimamoto *et al.*, 2008; Kubo *et al.*, 2012) and architectural (*e.g.*, Shimoda and Nakagawa, 2006) remains indicated that construction of the temple area probably dates to the Pre-Angkor Period and that the site was used until the Angkor Period.

AMS Radiocarbon dates from the sixth to seventh centuries in Trench H of the road cut section probably indicate the construction age of structures made from piled laterite and bricks. Ages from Trench B are younger (fifth to sixth centuries) in the lower part of the layer containing brick and pottery fragments; that layer overlapped with the Angkor layer dating to the fourteenth century (Fig. 3). These ages suggest that the area around M78/79 had been occupied since at least the fifth to sixth centuries (Pre-Angkor Period) until the fourteenth century (Angkor Period). These dates support the interpretation of excavated structures from M78/79 as well as earthenware showing Pre-Angkor characteristics (Chhum *et al.*, 2013). However, Shimoda *et al.* (2014) reported the ages of 210–415 cal AD (CH3) and 484–536 cal AD (CH5) in the base of the peripheral wall (Trench B) of M78/79, whose dates vary widely between the third and sixth centuries. Therefore, the M78/79 site should have been constructed during the Pre-Angkor Period, but additional chronological evidence is necessary to confirm the exact age of construction.

On the other hand, in the well-preserved moat section (trench in Site 1), dates from the sixth century derived from the upper limit of the basal white sand of the moat, indicating that moat construction dates to the Pre-Angkor Period, and humic sediments probably accumulated since then. The layer with brick

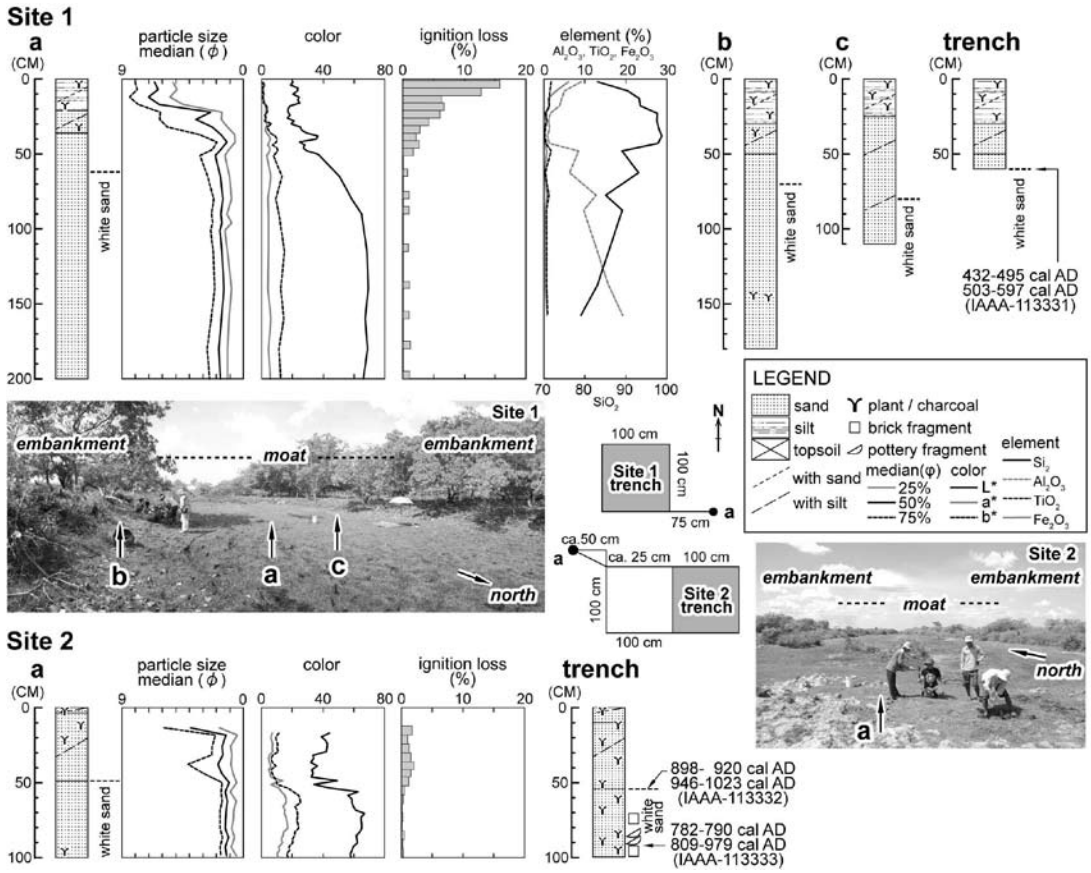

Fig. 4 Columnar Sections of moat section (Site 1 and 2).

and pottery fragments is dated to the ninth to tenth centuries, and the age of the base of upper humic soil dates to the tenth to eleventh centuries (Site 2) (Fig. 4). In contrast to Site 1, the white sand layer at Site 2 indicated an Early Angkor age. This is probably because the site has been affected by the collapse of the western moat or artificial modification, as the cross-sectional view (Fig. 2) suggests. Although these results indicate moat construction in the sixth century, Shimoda *et al.* (2014) obtained younger ages from the central part of the western moat: 400–500 cal AD (MT01, *ca.* 45 cm depth); 325–550 cal AD (MT02, *ca.* 30 cm depth); and 406–544 cal AD (MT04, *ca.* 45 cm depth). Therefore, detailed discussion is necessary to determine the exact age of initial construction in this case.

The dates of samples obtained from road cut and moat sections agree with results of archaeological and architectural investigations. They suggest that the city area was constructed during the Pre-Angkor Period and was utilized until the Angkor Period. This means that both the temple and city areas of Sambor Prei Kuk were possibly used over several centuries as an important cultural and political center

of Khmer society. However, younger ages were reported by Shimoda *et al.* (2008) at those sites. Further investigations considering archaeological and architectural characteristics in conjunction with radiocarbon dates of the city area are necessary to identify the exact construction age of each structure and obtain the proof that Sambor Prei Kuk is in fact the Pre-Angkor city of *Isanapura*, capital of the Chenla kingdom.

6. Conclusion

This paper reported on excavations at the Sambor Prei Kuk, an archaeological site considered to be the Pre-Angkor (seventh century) city of *Isanapura*, capital of the Chenla kingdom. We investigated the site's stratigraphy and acquired samples for AMS ^{14}C dating from the road cut and moat sections in the city area. Pre-Angkor and Angkor layers have been found at less than 1 m below the ground surface, and Pre-Angkor dates were obtained from samples below the layer yielding Angkor Period dates. However, several Pre-Angkor dates were slightly younger than the presumed foundation age of *Isanapura*. Further interdisciplinary investigations are necessary to reveal the initial construction ages and function of each structure in the city area. Such data will potentially prove that Sambor Prei Kuk is in fact the Pre-Angkor city of *Isanapura*.

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