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Title: Reconstruction of the late first millennium AD harbor site of Sembiran and analysis of its tradeware

Authors: Ambra Calo, Ian Moffat, David Bulbeck, Marie France Dupoizat, Kleanthis Simyrdanis, Chester P. Walker, Rochtri Agung Bawono & Bagyo Prasetyo

The site of Sembiran on the northern coast of Bali was an important trading harbor with demonstrated intensive links to the Indian subcontinent, the Western Indian Ocean, and Mainland Southeast Asia between the second century BC and the second century AD. Using a combination of excavation and geophysical survey, we have newly mapped a dense network of subsurface structures, which we interpret to be foundations for harbor infrastructure dated to the eighth to ninth centuries AD that were subsequently covered by shoreline aggradation. An assemblage of eighth to twelfth centuries AD Chinese tradeware in dated contexts from our excavations of these shoreline structures and additional trenches further inland suggests a renewal in trade activities at Sembiran, coinciding with the growth of Chinese maritime trade in Island Southeast Asia.

Introduction

The site of Sembiran on the northern coast of Bali, Indonesia has long been known as an ancient harbor based on its unique evidence for multiple and intensive prehistoric trans-Asiatic contacts with the Indian subcontinent, the western Indian Ocean, and Mainland Southeast Asia from the second century BC to the second to third centuries AD (Ardika 1991, 2008, 2013; Ardika and Bellwood 1991; Calo et al. 2015). The site's strategic central location along the Sunda Island Chain maritime route favored such long-distance contacts. While little archeological evidence remains for activity at the site between the fourth and seventh centuries AD, here we document a renewed phase of trade activities at Sembiran from the eighth to ninth centuries AD. The location of the site at the estuary of the Pangpang River, which was likely wider in antiquity (Kalb 2008), would have favored docking and harbor activities since the earliest phase of the site during the second century BC (Figure 1). However, evidence for the reconstruction of a possible harbor comes from excavated stone structures dated to the eighth century AD and associated tradeware.

Figure 1. Map of the Sembiran and Pacung sites with Bali insert and location of Bali in the region (A, A1), and approximate ancient shoreline at ca. 2000 years ago indicated by the broken line. Above right (B) locations of the 1987 Sembiran (SBN) II-III and Bangkah (BKH) I trenches along a 1.6km distance west of the Sembiran river mouth. Site and Bali maps modified from templates by CartoGIS, ANU College of Asia and the Pacific.

Our excavations (2012-2013) and geophysical survey (2014) at Sembiran have revealed a series of stone walls or foundations along a 200m tract of the shoreline (Figures 1 and 2). The same type of structures were excavated in previous trenches along the shoreline of Sembiran and also of the Bangkah site (Figure 3), located 1.6 km west of the river estuary (Ardika 1991: 20-32, Tim Jurusan 1994). This suggests the possibility of significant infrastructure along 1.8 km of the shoreline. The early phase of these stone foundations can be dated between the eighth and tenth centuries AD, based on two accelerator mass spectrometry (AMS) radiocarbon dates from our SBN XXI trench: 2013, which match an associated Tang Dynasty Chinese ceramic sherd found embedded in the walls. These foundations are also associated with an assemblage of Chinese tradeware, which provides evidence of a growth in Chinese maritime trade during this period. The collection of 18 tradeware sherds from our 2012-2013 excavations at Sembiran and the adjacent site of Pacung (PCN) that date between the eighth and twelfth centuries AD also supports the epigraphic evidence from 20 copper-plate inscriptions from Sembiran. The inscriptions describe the town of Julah, just east of Pacung, as a prosperous port with international links during the tenth to twelfth centuries AD (Ardika 1991: 20, 138-49; 2013; Hauser-Sch€aublin 2008: 11–15).

Figure 2. Above left: present shore wall. Above right: shoreline location of SBN XXI. Below: Stone foundations excavated in trenches Sembiran (SBN) XXI-XXII: 2013 along the shoreline.

In this paper we discuss the investigation of the stone foundations and their significance for understanding the evolution of this important trading harbor site. We also describe the Chinese tradeware assemblage in detail (Table 2) and discuss the implications for the continuing significance of northern Bali in late first millennium AD trans-Asiatic networks.

Context and dating of the stone foundations at Sembiran

Our 2013 excavations near the shore at Sembiran have revealed stone structures in trenches SBN XXI: west, XXII: east, and Test Pit 1: between the two main trenches. Similar features have also been located during previous excavations at Sembiran and at the site of Bangkah (Figure 3), located 1.6 km west of the Sembiran river mouth, in trenches SBN II-III: 1987, BKH I: 1987 (Ardika 1991: 20-32), and SBN X-XI: 1993-94 (Tim Jurusan 1994). None of these features are located more than 30m inland of the modern shoreline. We have also obtained two AMS dates from charcoal in the stone walls of SBN XXI in association with a Tang Dynasty Chinese ceramic sherd that date the initial phase of the structures between the eighth and tenth centuries AD. The SBN XXI dates from charcoal, at 1.9–2.02m and 2.6–2.7 m depths dated to cal AD 876–989 (S-ANU 37109), and cal AD 780–984 (S-ANU 37110), respectively. S-ANU dates have been calibrated against SHCal13 (Hogg et al. 2013) in OxCal v.4.2 (Bronk Ramsey 2009; Fallon, Fifield, and Chappell 2010) (Table 1).

Figure 3. Electrical resistivity tomography (ERT) anomalies and lines over a 200_30m area along the Sembiran shoreline.

Table 1. Radiocarbon dates discussed in the text.

Charcoal sample context	Lab code ¹	$\delta^{13}\text{C}$ ²	¹⁴ C age (BP)	Calibrated date (95.4% probability)
SBN-XXI-sq.A-1.9-2m	S-ANU 37109	-25 ± 2	1180 ± 25	cal AD 876–989
SBN-XXI-sq.A-2.6-2.7m	S-ANU 37110	-27 ± 2	1195 ± 25	cal AD 780–984
SBN-XIX-sq. D1-2.1-2.2m	S-ANU 33210 ³	-20 ± 2	1015 ± 30	cal AD 1020–1150
SBN-VI-2.5m	ANU 7218 ⁴		1010 ± 110	cal AD 861–1279

Notes. (1) All dates have been calibrated against SHCal13 (Hogg et al. 2013) in OxCal v.4.2 (Bronk Ramsey 2009). For the AMS protocol, see Fallon, Fifield, and Chappell 2010. (2) $\delta^{13}\text{C}$ measured by AMS is not comparable to IRMS results. (3) Calo et al. 2015. (4) Ardika 1991: 17.

The stone foundations in the trenches SBN XXI and XXII (2_1m each) were laid out in rows (Figure 2), which began at 50 cm depth and ended at 2.0–2.2m depth, revealing walls with a maximum height of 1.7 m. In SBN XXI, the fully exposed walls were laid out on a north–south axis into three rows at a distance from each other ranging between 15 and 35 cm, and two other aligned stone walls were visible into the eastern and western walls of the trench. An eighth to ninth centuries AD Chinese Tang Dynasty Changsha sherd of a bowl base was found embedded in the stones in SBN XXI, at 1.8–1.9 m depth. In SBN XXII, the stone walls were laid out in irregular square formations. Test Pit 1 (1_1m) was opened in between SBN XXI and XXII. It produced the same type of stone assemblages, but they were not clearly recognizable as walls because of the small size (1_1m) of the pit. Another eighth to ninth centuries AD Chinese Tang Dynasty Changsha ceramic rim, very similar in type to the base found in SBN XXI, was found in Test Pit 1 at a depth of 1.75–2.0 m, just below a thicker rim of a ninth to tenth centuries AD

Chinese storage jar (discussed in more detail in the following section). A possible ancient mangrove environment is suggested by the presence of bituminous soil in the lowest stratigraphic layers of these trenches close to the shoreline. This is further indicated by the fact that the culturally sterile lowest stratigraphic level of trench SBN XIX, located directly inland from SBN XXI, produced widespread calcified roots. Instead, the lowest level of the PCN IX inland trench, to the east of Sembiran, gave significant amounts of Neritidae shells and coral, indicating a beach environment without any evidence of possible mangrove.

Table 2. Sembiran (SBN) and Pacung (PCN) tradewares excavated in 2012-2013.

Tradeware in the SBN XXI & Test Pit (TP) 1 trenches along the shore: 3 Sherds	
(1) SBN TP1, spit 8 (175–200 cm). Eighth to ninth centuries AD (Figure 5).	Changsha bowl rim sherd (4.8 × 3.5 cm). Brown underglaze-painted decoration with cursive designs on a pale green glazed body. On the outside, the glaze stops high above the base.
(2) SBN XXI, square B, spit 19 (1.8–1.9 m depth). Eighth to ninth centuries AD (Figure 5).	Changsha bowl base sherd (2.4 × 2.6 cm). Brown underglaze-painted decoration on a pale green glazed body. The inner base is unglazed.
Sherds 1 and 2 come from the Changsha kilns of Hunan province in southern China (Changsha Yao 1996: pl. 118, 120). Changsha wares were produced in the Tongguan kilns of Hunan during the Tang dynasty (AD 618–906). They have been exported to Southeast Asia, and notably to Indonesia, as early as the eighth century. A number of Changsha wares with brown painted decoration have been recovered from the Tang Dynasty Belitung ship wreck off southeastern Sumatra.	
(3) SBN TP1, spit 7 (150–175 cm). Ninth to tenth centuries AD (Figure 6A).	Rim sherd (10 × 6 cm) of a storage jar with a short straight neck, a gray stoneware body and a pale-green glaze. It belonged to a large jar with ovoid shape and sloping shoulder. A number of this type of jars have been excavated as part of the cargoes of the ninth-century Belitung wreck, and of the tenth-century AD Cirebon wreck. They have also been recovered in temple contexts in Central Java, and some are on display in the Museum Pusat, in Jakarta and in other museum collections in Central Java (Harkantiningih, Wibisono, and Miksic 2010: 18; Krah 2010b: 234, Figs. 43-44).
Tradeware in the SBN XIX inland trench: 6 Sherds	
(1) SBN XIX, square A4, spit 30 (2.9–3.0 m depth). Possibly an eighth to tenth centuries AD Middle Eastern ceramic (Figure 7).	Even if very small (0.5 × 0.4 cm), this earthenware sherd with dark turquoise-green glaze could belong to the tradition of Middle East pottery of the eighth to tenth centuries AD. It may be a tiny part of a jar for storage and transport. Jars of this type were notably excavated at the ninth century AD sites of Ko Ko Khao and Laem Pho on opposite sides of the Thai Peninsula (Bronson 1996: 185); at the site of Prei Monti in Cambodia, which was probably the site of the royal palace of the first Angkorian capital during the eighth and ninth centuries AD (Pottier et al. 2012, Fig. 9); and at the site of Si Pamutung in the Padang Lawas temple complex on north-central Sumatra (Perret and Surachman 2014: 229-242, Pls. 1-2). Middle Eastern jars of this period were also found in southern China, where they testify for the presence of Persian and Arabic merchants in trade centers such as Yangzhou or Fuzhou (Salmon 2004: 35).
(2) SBN XIX, square C4, spit 28 (2.7–2.8 m depth). Ninth to tenth centuries AD (Figure 8C).	Sherd (2.8 × 3.0 cm) of a bowl with a thick out-turned lip. The pale grayish-white, fine-grained, porcellaneous body is covered with a greenish-white glaze. Originating from kilns in Jiangxi or Guangdong provinces in southern China. Similar ceramics have been excavated at various sites in north Sumatra, such as at the port site of Lobu Tua in Barus, and at Si Pamutung, in the Padang Lawas temple complex (Dupouzat 2003: 128, Fig. 3; 2014: 10-11).
(3-5) SBN XIX, square A1, spit 26-27 (2.5-2.7 m depth): 3 sherds. Possibly ninth to twelfth centuries AD.	Due to the small size of these three sherds (average 0.8 × 0.9 cm), it is not possible to be confident as to their dating or provenance. However, they may be attributed to the ninth to eleventh centuries AD. The first sherd has a pale-grayish body and a shiny "apple-green" glaze. It could be related to the ninth century white wares with green-colored spottings from Gongxian kilns in Henan province, or to the eleventh to twelfth centuries wares with the Xicun kilns in Guangdong province (Guangzhou Xicun 1987: pl. 41). The second sherd is a light-gray stoneware covered on both sides with an eroded pale yellowish-green glaze. The thickness (between 0.2 cm and 0.3 cm) suggests a small bowl. The third, also very small, has a pale, eroded greenish glaze on one side.

(continued)

Tradeware in the SBN XXI & Test Pit (TP) 1 trenches along the shore: 3 Sherds

(6) SBN XIX, spit 3 (80–120 cm depth).

Possibly tenth to eleventh centuries AD.

Sherd (1.7 × 1.9 cm) of a bowl. Gray stoneware body covered on both sides with a finely crackled olive-green glaze. There is no decorative feature to support a precise provenance and secure dating. However, the gray, rather compact body could point to production in tenth to eleventh centuries AD Yue kilns in Zhejiang province, as well in Xicun kilns in Guangdong province.

Tradeware in the PCN IX inland trench: 9 sherds

(1) PCN IX, squares A3–A4, spits 29–30 (2.8–3.0 m depth).

Ninth to tenth centuries AD (Figure 6B).

Rim sherd (6 × 3.5 cm) of a stoneware jar with thick wall and broad rim. The coarse, gray body is covered on the inside and outside with a green glaze. It could belong to the coarse green glaze wares manufactured in Meixian in northeastern Guangdong province during the late Tang Dynasty (AD 618–907) (Archeological Finds 1985: Fig. 99).

(2) PCN IX, square E4–E5, spits 29–30 (2.8–3.0 m depth) (a).

Ninth to tenth centuries AD.

Sherd (6.5 × 5 cm) of a large bowl or a basin with a hard gray stoneware body. Inside there is a spur mark over an eroded glaze. Outside, the glaze stops high above the flat base. Similar wares with spur marks were widely produced in Yue kilns in northeastern Zhejiang and Guangdong provinces. They have been excavated at the ninth-century AD site of Ko Kho Khao, on the western coast of Peninsular Thailand; in the tenth-century AD Cirebon ship wreck; and at the site of Lobu Tua, in Barus in north-central Sumatra (Dupoizat 2003: 124; Harkantiningih, Wibisono, and Miksic 2010: 23; Ho 1994: pl. 2–C).

(3) PCN IX, squares E4–E5, spits 29–30 (b).

Tenth to eleventh centuries AD.

Sherd (1.6 × 1.2 cm) of a bowl with a pale-gray body with a shiny slightly crackled bluish-green glaze. This fragment could belong to bowls sometimes decorated with carved lotus petals. They were notably manufactured in Xicun kilns of Guangdong. Similar bowls have been excavated at the Lobu Tua site in Barus, in Sumatra (Dupoizat 2003: 137).

(4) PCN IX, squares E5–E6, spits 29–30.

n.a. Sherd (2 × 1.8 cm) of an unglazed jar or a bowl without decorative features.

(5) PCN IX, squares A1–E1, spits 31–32 (3.0–3.2 m depth).

Probably ninth to eleventh centuries AD.

Sherd (3.5 × 2.7 cm) of a bowl with thick wall, a cream-color body and a shiny ivory-white glaze on both sides. It could belong to the northern Chinese kilns of Xing and Ding in Hebei province.

(6) PCN IX, square E4, spits 31–32 (3.0–3.2 m depth) (a).

Ninth to tenth centuries AD (Figure 8A).

Sherd (3 × 2 cm) of a small jar with a fine, dense, slightly pinkish body. Outside, vertical line through a brown glaze. This brown-glazed ware with a fine body texture might be related to late Tang Dynasty productions of Gongxian in Henan province.

(7) PCN IX, square E4, spits 31–32 (b).

Eighth or ninth century AD (Figure 8B).

Rim sherd (3 × 2 cm) of a bowl with a rather coarse body. The green, eroded glaze stops below the rim on the outside. Probably from Guangdong kilns (Archeological Finds 1985: Fig. 95). A bowl of this type was recovered in the foundations of Candi Sewu, Central Java, and is kept in the collection of Kantor Suaka, Prambanan (Dupoizat 2006: 106, Fig. 2).

(continued)

Tradeware in the SBN XXI & Test Pit (TP) 1 trenches along the shore: 3 Sherds

(8) PCN IX, square E5, spits 31–32 (3.0–3.2 m depth).

Ninth to eleventh centuries AD.

Sherd of a bowl with a straight rim, a grayish-white porcelain body and white glaze with greenish tinge. From Guangdong or Jiangxi kilns in southern China.

(9) PCN IX, squares D6–E6, spits 27–28 (2.6–2.8 m depth).

Ninth to eleventh centuries AD (Figure 8D).

Rim sherd of a bowl with a thick round rim, a grayish-white porcelain body and a white glaze with greenish tinge. From Guangdong or Jiangxi kilns in southern China. Several parallels for sherds #8 & 9 were excavated at the site of Lobu Tua, in Barus, Sumatra. (Dupoizat 2003: 128).

All the inland trenches at Sembiran and Pacung (located between ca. 150–50m from the shore) contained a fine-grained soil layer containing volcanic ash (5–10%) at 2–2.1m depth. This ash layer is associated with the volcanic activity of the nearby Batur volcano, located ca. 15 km southeast of Sembiran, and is dated to the eleventh to twelfth centuries AD based on two AMS dates on charcoal (Table 1). One charcoal sample came from immediately below the ash layer, at 2.1–2.2 m depth in Sembiran XIX, and gave cal AD 1020–1150 (S-ANU 33210) (Calo et al. 2015). The other sample came from 2.5m depth in trench SBN VI: 1989 (Ardika 1991: 17) dated to cal AD 861–1279 (ANU 7218). The ash layer was not found in any of the shoreline trenches that contained stone foundations. This suggests that the locations of these trenches and the base of the stone foundations they contained were subaqueous during the eleventh to twelfth centuries AD. This supports our geoarchaeological interpretation of a coastal aggradation rate of approximately 70m per 2000 years, based on differences in the depths of clay silt and volcanic sand deposition observed from analysis of 58 auger cores taken by Mike Carson (ANU) in 2012 at Sembiran and Pacung. Deposits of dark volcanic sand in the cores located beyond the calculated ancient shoreline (shown by the broken line on the map in Figure 1) toward the sea, began at higher depths than in the cores located immediately inland from the ancient shoreline. The combined evidence suggests that the excavated stone structures were partly underwater in antiquity.

Figure 4. Above: trench SBN XXI, with section and plan drawings. Below: electrical resistivity tomography (ERT) Line 14 showing 8 resistivity features (highlighted with a white dotted line) which are interpreted as stone features in the subsurface.

Electrical resistivity tomography survey

To map the distribution of the stone wall features between excavations, we undertook an electrical resistivity tomography (ERT) survey (Figures 3, 4). ERT is a geophysical technique where a constant electrical direct current is passed through the subsurface from a series of probes attached to the ground, allowing the electrical field potential to be measured (Loke et al. 2013). ERT locates features of interest by identifying variations in the resistivity values of the subsurface, and is sensitive to both geological and anthropogenic targets. This technique has been used for a range of archeological investigations, including mapping tombs, reconstructing palaeolandscapes, and locating material culture items (Papadopoulos et al. 2010, 2014).

The survey at Sembiran was undertaken using a ZZ Flash-Res Universal resistivity/ induced polarization (IP) system with 64 electrodes spaced at 0.5 m. Line spacing was 10m in the western portion of the site and 20m in the eastern. Data were collected using the ZZ mixed array. Data were preprocessed and converted to a Res2D format using ZZ software before being inverted where the smoothness constrained (Occam) least squares approach was used (Loke and Barker 1995). A large number of high resistivity features (>1137 ohm.m) were identified in the profiles and plotted in plan view using ArcGIS (as shown in Figure 3). These features have a resistivity value, which is too elevated to represent unconsolidated sediment of any lithology and, in combination with the excavation results, are interpreted to represent stone structures. This relationship

is demonstrated in Figure 4, where we compare material from excavation SBN XXI (including a section drawing, a plan view drawing of spit 12 (representing a depth of 1.1–1.2 m) and a photograph of the wall features in the excavation) with ERT line 6 which runs over this excavation. Both the wall in the photograph and the resistive feature in the ERT data are clearly visible across the excavation in a N-S from a depth of ~ 60 cm to a depth of ~ 1.5 m.

Figure 5. Left: rim of Changsha bowl from SBN Test Pit 1, sp. 8. Right: base of Changsha bowl from SBN XXI, sq. B, sp. 19.

The ERT survey identified 187 linear features with a mean apparent length of 1.51m, ranging from 0.13m to 7.83m (Figure 3). The walls that were recorded by excavation are orientated both N-S (SBN XXI) and E-W (SBN XXII) and have a thickness of 20-40 cm. This diversity of orientation suggests that the ERT lines are intersecting the walls at a variety of angles; however, the lower range of our apparent length is in broad agreement with observations made from excavations for thickness. The features are present throughout the 200-30m area surveyed by ERT, and are ubiquitous along almost the entire line in some profiles, although they are still organized as discrete packages rather than being continuous. Discrete areas with no stone structures are present within the survey area, including an area of at least 25-10m to the west of trench SBN XXI, and an area near trenches SBN XXI. The stone structures reach the extremities of the survey grid in all directions, suggesting they extend further beyond the area of our geophysical survey.

Previous investigations of these structures interpreted them as house platforms and correctly considered them to postdate the prehistoric remains found in the inland trenches (Ardika 1991: 20-32; Tim Jurusan 1994). The distance of the inland trenches from the shore ranges between ca. 50 and 200m (Figure 1). However, based on their dense distribution throughout the survey area and the fact that they were likely constructed underwater, we interpret these features as having functioned as foundations and/or platforms for maritime activities shelters and/or piers in antiquity. Their sea-facing side would have also functioned as a protective seawall for the incoming surf, possibly similar to the present seawall along the shoreline (Figure 2, above left), rather than having functioned as house platforms.

Figure 6. Rim sherds of stoneware jars. (A): from SBN TP1, sp. 7; (B) from PCN IX, sq. A3-4, sp. 29-30.

The accumulation of fluvial sediments as mouth bars, which may be reworked by wave action, has been documented in the region (Kalb 2008: 134). These bars may have served as a suitable substrate for the construction of these features. If the stone walls are maritime infrastructure, the area shown to be clear of foundations on the western end of the ERT survey may have been an eighth to tenth centuries AD harbor. The presence of these features at both Sembiran and Bangkah raises the intriguing possibility that the entire intermediate area of 1.8 km may have had similar features, although this is outside our area of geophysical investigation to date. If so, this could have been one of the largest known harbor infrastructures constructed globally during the eighth century AD.

Figure 7. Glazed sherd from SBN XIX, sq. A4, sp. 30.

Tradewares at Sembiran and Pacung

The 18 sherds of ceramics excavated in 2012 and 2013 at Sembiran and Pacung (Table 2) are of particular significance for their securely dated contexts between the eighth and twelfth centuries AD based on the two AMS dates from our 2013 trench XXII and from our 2012 trenches SBN XIX and PCN IX, as well as from previous excavations by Ardika (Table 1; Calo et al. 2015: Additional Data, Table S1). The dates from SBN XXII: 2013 are in chronological agreement with the sherds' stylistic identification as being from the Tang (AD 618–907) to the early Song (AD 960–1279) Dynasties. They provide new evidence for the early history of Chinese trade ceramics into Island Southeast Asia (ISEA) and also support the epigraphic evidence from the copper-plate inscriptions from Sembiran (Ardika 1991: 20, 138–49; 2013; Hauser-Sch€aublin 2008: 11–15). The main diagnostic categories of tradeware from the 2012–2013 excavations at Sembiran and Pacung include eighth to ninth centuries AD Changsha wares (Figure 5), ninth to tenth centuries AD white wares and stoneware jars, and eleventh to twelfth centuries AD Yue-type greenwares.

Figure 8. Above: partly glazed sherds) (A-B) from PCN IX, sq. E4, sp. 31-32. Below: whiteware rim sherds; (C) from SBN XIX, sq. C4, sp. 28; (D) from PCN IX, sq. D6-E6, sp. 27-28).

Adding further interest to the assemblage is a sherd (SBN XIX square A4, spit 30: 2.9–3.0m depth, Figure 7) whose only possible identification, based on our experience with ceramics imported to Southeast Asia, would be a Middle Eastern earthenware with green glaze, datable to the eighth to tenth centuries AD. The 2.9–3.0m depth in trench SBN XIX: 2012 gave high concentrations of prehistoric Indian Rouletted ware, bronze artifacts and glass beads, including a unique red opaque bead made of soda-natron glass from the Roman world, with compositional parallels in south-central Vietnam and the Thai Peninsula (Calo et al. forthcoming; Lankton, Gratuze, and Lee 2018). One AMS date from charcoal from this 2.9–3.0m depth, which gave: 142 cal BC–AD 25 (S-ANU 37107. Square C1) (Calo et al. 2015, 381, Additional Data: 3-4, Table S1) is consistent with the finds, except for the potentially eighth-ninth century AD green glaze sherd. This early date from SBN XIX matches eight other direct AMS dates between the second century BC and the second century AD from comparable levels in the Pacung trench PCN IX: 2012, which gave concentrations of the same type of artifacts as the ones found at depth 2.9–.03m in trench SBN XIX (Calo et al. 2015, 383, Figure 4). However, two other samples of charcoal from this SBN XIX depth of 2.9–.03m also gave dates of cal AD 876–989 (S-ANU 37106. Square B3) and cal AD 790–987 (S-ANU 33928. Square D2). We had noted these dates as likely coming from charcoal intrusive from the 2.2–2.5 m depth sediment above dating to this period (Calo et al. 2015, Additional Data: 8, Table S1, Note 6). Although the context below the ash layer is undisturbed by human activity, this does not exclude the possibility of downward movement over ca. 1200 years of a section of the deposit due to seismic or other environmental factors such as the growth of roots. Middle Eastern ceramics in ninth to tenth centuries AD contexts are known from the site of Si Pamutung, in north-central Sumatra (Perret and Surachman 2014, 439–440, Pls. 1–2), at the sites of Ko Ko Khao and Laem Pho on opposite sides of the Thai Peninsula (Bronson 1996, 185), and at the site of Prei Monti in Cambodia (Pottier et al. 2012, Fig. 9), as well as in the ninth century AD Belitung shipwreck, found off southeastern Sumatra (Flecker 2001). All of these regions are documented to have been in contact with Sembiran from the second century BC to the early first millennium AD (Calo et al. 2015). One of the Belitung ceramic bowls bears an inscription on its outer wall corresponding to AD 826, establishing the earliest possible voyaging date (Krahl 2010a, 144).

Figure 9. Island Southeast Asia (ISEA) sites with ninth to eleventh centuries AD Chinese ceramics. Note: sites with no further classified or only Yue-type ceramics in southern Thailand, Sumatra and Java are too numerous to be individually labeled. Sources: Bulbeck 1996–7; Crick 2010; Dupoizat 2003, 2006, 2014; Edwards McKinnon 1994; Guy 1987, 1990; Harrisson 1972; Harkantiningasih 1994; Ho 1994; Koh Antique n.d.; Krahl 2010a, 2010b; Kwan and Martin 1985; Lam 1985; Lape 2000, 2002; Nik Hassan and Othman 1990; Niziolek 2015; Ridho 1994; Srisuchat 1994.

In the inland trenches SBN XIX and PCN IX, the tradeware came from below the ash layer, while the tradeware found prior to 2012 was found above this ash layer, and was identified by Bulbeck (1991, 182-216) as dating between the thirteenth and fifteenth centuries AD. The ash layer was not found in any of the trenches located within a 30m distance from the present shore, including the 2013 trenches which contained tradeware in association with stone structures (SBN XXI & Test Pit 1), pointing to this area being subaqueous at the time of the volcanic activity that caused the ash layer in all the inland trenches.

Chinese ceramics dated to the eighth to twelfth centuries AD in Island Southeast Asia

The tradeware ceramic evidence at Sembiran and Pacung highlights long distance trade at the sites between the late first millennium AD and the early second millennium. This possibly constituted a renewed phase of intensified trade, following a period of lesser cultural activities between the fourth and the seventh centuries AD, indicated by a rather abrupt lack of material culture in the deposits above the late prehistoric layers. The record of Chinese tradeware at

Sembiran and Pacung starts with Changsha bowl fragments (in trenches SBN XXI and TP1: 2013, which revealed the stone foundations discussed above) dating to the Late Tang Dynasty (AD 618–906). This is consistent with wider evidence for the eighth and ninth centuries AD as the watershed for China's entry into the ISEA ceramic market. Trade between ISEA and China grew during the Tang Dynasty and the Five Dynasties, and the following Northern Song Dynasty. China's main trading partners in ISEA included the Srivijaya maritime empire in southeastern Sumatra (AD 670–1025) and its contemporaries in Java and the Malay Peninsula (Crick 2010). ISEA products that reached China included pine, benzoin, and camphor resins from Sumatra; aromatic woods such as sandalwood from Timor; and spices such as nutmeg and cloves from the islands of Maluku (Hall 1992: 196). China's exports to ISEA were dominated by lacquer and textiles, especially silk.

Chinese ceramics dated between the eighth and twelfth centuries AD are documented widely across ISEA, from the Thai-Malay Peninsula and Sumatra in the west to the Philippines and the Banda Islands in the east (Figure 9). This widespread distribution suggests that, for the first time, Chinese ceramics can be used as a marker of the extent of the Chinese Nanhai (southern seas) trade networks in which the Sembiran/Pacung seafront would have been an important node.

Tang Dynasty Changsha wares are known mostly from western Indonesia and the Thai-Malay Peninsula, but they were also excavated in co-occurrence with early Song whitewares as far east as at the site of Banda Naira (trenches BN1-4, BN4), in the nutmeg-producing Banda Islands of Maluku (Lape 2000, 147-210, Figures 4.13, 4.48). Interestingly, the Banda Naira 1 site has also produced a glazed Chinese ceramic sherd from a context dated to cal AD 562–775 (BN1-3195; AA-33114), as well as evidence of a later basaltic rock seafront wall dated to around the thirteenth century AD (Lape 2000, 147–210; 2002, 59–60). Whitewares are also known from the Intan and Cirebon shipwrecks immediately north of Java (Harkantiningsih, Wibisono, and Miksic 2010). Other sites with similar concentrations of early Chinese ceramics as at Sembiran and Pacung are Surat Thani, Koh Kha Khao, Takuapa, and Laem Pho, located near the Isthmus of Kra on the Thai Peninsula; Bukit Seguntang and Sumberjaya in southern Sumatra; and the Belitung shipwreck (Flecker 2001; Krah 2010b).

Conclusions

Excavation and geophysical survey at Sembiran have significantly enriched our understanding of harbor facilities and long-distance trade relations during the eighth to twelfth centuries AD in Island Southeast Asia. The Sembiran stone foundations are interpreted here to represent the subaqueous construction of harbor infrastructure, which would have been a substantial feat of structural development for the period. This also in view of the potential extension of such structures beyond our survey area, along a 1.8 km section of the coast, based on the excavation of equally aligned stone walls at the Bangkah site, located west of Sembiran.

The eighth to twelfth centuries AD Chinese ceramics from dated contexts at Sembiran and Pacung testify to the sites' rising once again as an important node in long-distance maritime networks, which saw a new pulse during this period. The maritime transport of goods and Buddhist beliefs between the Indian subcontinent, particularly Sri Lanka, Indonesia, and China, increased during the late first millennium AD, in the lead-up to the rise of Srivijaya as a trade-based empire. Similar Chinese wares such as those excavated at Sembiran and Pacung have been recovered at various Southeast Asian sites, from the nutmeg-producing Banda Islands of eastern Indonesia to western Indonesia and the Thai-Malay Peninsula. These regions were

connected to Bali and Java by sea routes, which continued to Sri Lanka and southeastern India, and further west up to the Middle East. Although only a hypothesis due to the small size of the sample, the possible presence of a turquoise-green ceramic sherd from the Middle East at Sembiran echoes the evidence from the Belitung shipwreck for eighth to ninth centuries AD maritime trade between China and the Middle East through Island Southeast Asia.

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The authors declare that the research discussed in this paper has not been published elsewhere and is not being submitted simultaneously for publication elsewhere.

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ORCID

Ian Moffat <http://orcid.org/0000-0002-2171-7145>

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