

ARCHAEOLOGY OF EAST ASIA

# Kilns in East and North Asia

*The adoption of ceramic industries*

EDITED BY

TOMOKO NAGATOMO, MARIA SHINOTO  
AND DAISUKE NAKAMURA

BAR INTERNATIONAL SERIES 3082

VOLUME 7



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## Part I

### **Overview: Kilns and kiln research in East Asia**



## Introduction

*Tomoko Nagatomo, Maria Shinoto, Daisuke Nakamura*

**Abstract:** The purpose and content of the book are briefly introduced, covering the 18 chapters that are presented in four parts based on regions and chronology. The terminology and classification of kilns and firing techniques in East Asia are discussed in order to clarify choices for terminology in the various chapters (a unification of terms and names is provided in a glossary at the end of the book). In other words, the introduction summarizes the history of research on kiln classification in China, as well as in Korea and the Japanese archipelago, and presents a proposal to classify East Asian kilns according to a unified standard (without imposing this standard on the authors), as an attempt to create standard terminology over this wide region for future research.

**Keywords:** Kilns in East Asia, research history, regions, terminology, classification, overview

### 1.1. About this book

The beginning of ceramic industry by kiln firing in East Asia is often accompanied by pottery mass production, increasing social complexity, and social interaction over wide regions including the movement of potter groups. While the globally known “flat kiln” construction is used in North China, another construction, well known as the “dragon kiln” from Chinese contexts, was later developed in South China and spread to its northern peripheries, Mongolia, the southern Russian Far East, the Korean peninsula and the Japanese archipelago including the Ryūkyū Islands, where it became the only known type of ceramics firing kiln.

This book will introduce early stages of the establishment of a kiln industry in East Asia and in particular in those regions that are peripheral to China and that experienced social and technological change of varying intensity during the spread of kiln-firing technology. Questions about “why”, “how” and “where” will be answered on the one hand in smaller case studies, introducing excavations, technological studies, and on the other hand with some broader studies on historical, economic or social backgrounds as well as on the kiln technology itself. The combination of archaeological and scientific methods and the international cooperation of researchers combining ideas and methods of different research traditions are an important part of this research field, and we shall introduce some newer trends.

The 18 chapters of this book are collected in four parts, beginning with a presentation of some general ideas and methods used in East Asian kiln research in the first part, while the second part discusses the early advancement of kiln manufacture and trade in China. The third part

deals with subsequent developments in the North and Northeastern continental periphery including the Korean peninsula, and the final part shows the expansion to the islands of the Japanese and Ryūkyū archipelago, closing the cycle almost two millennia after its beginning in South China (see front map).

In the general part, Tomoko Nagatomo (Chapter 2) discusses the diffusion of kiln technology from China to the Korean peninsula and further to the Japanese archipelago. These East Asian kilns, normally just vaguely described as spreading to peripheral regions, will be introduced as a genealogy of several traditions, being influenced from different times and appearing in differing types while spreading to different regions. Masa’aki Kidachi (Chapter 3) explains the importance of kilns (“flat kilns” and “climbing kilns” or *anagama* in his terminology) without ceiling construction in East Asia, their structure and its relation to the firing process. He introduces experiments and analogies from folklore studies. In an essay that sums up experiences from several interdisciplinary research projects and years of research coordination in the Nakadake Sanroku project introduced in Chapter 17, Maria Shinoto (Chapter 4) discusses different approaches to interdisciplinary research and introduces the concept of agility. This is an explicit approach to the frequent and flexible adaptation of research to new insights from the ongoing research process in order to gain better results and new perspectives in the course of a project rather than after its end. In the final chapter (Chapter 5) of this part, Johannes Sterba discusses another ubiquitous topic in kiln research: provenancing with scientific methods. He discusses several methods and introduces the common application and additional potential of a well-established combination of Neutron Activation Analysis and subsequent statistical analyses

that has been developed particularly with the problems of pottery production in mind.

The second part starts the regional discussions with a focus on China and its immediate periphery: the climbing kiln developed from the latter half of second millennium BC in the Jiangnan region. It is important in the history of the Chinese ceramics industry, and although its structure looks “primitive” at first sight, it has a structure that is superior to even the most refined “flat kiln” that is built of tiles or similar material because the heat is better kept inside the kiln chamber. Therefore, excellent ceramics like stamped hard pottery and proto-porcelain continued to be produced in this kiln type, and finally celadon was produced in these kilns. Jianming Zheng (Chapter 6) argues, while reviewing the major kiln complexes in the Jiangnan region, that the Dongtiao River Basin centering on Deqing area was outstanding in antiquity, in the size of its kiln complexes, the high firing temperatures, and the quality of its products, and occupied a highly significant position in the history of Chinese ceramics. He also points out that the steady technical basis for the emergence and development of celadon in the Han dynasty was established in this area. Michèle Demandt (Chapter 7) interprets the development of proto-porcelain in this region and time as a deliberate replacement of bronze goods by ceramic skeuomorphs in the Yue state. While replacement of raw materials is often interpreted as a necessity caused by inaccessibility of the original raw materials – bronze in this case – the Yue case is different and leads to a better understanding of the social role of ceramics in Chinese society. This proto-porcelain had been increasingly exported during the Western Han period and is nowadays discovered in burials in the Shandong area and in elite burials in the Lelang commandery on the Korean peninsula.

On the other hand, the “flat kiln” is used in North China, and Yūsuke Mukai (Chapter 8) describes its development, discussing how craftspeople began to divide into groups working for pottery kilns and those working for roof-tile kilns. The firing chamber of flat kilns is easy to widen and enlarge, which is appropriate for firing goods used in architecture like tiles and roof tiles. As the kiln shape and structure that were perfected during the Han period continued to be used for centuries without major changes mainly in northern China, the influence of roof-tile production technology and kiln structure had widely spread to East Asia. He presents the important view of a history of kiln technology in China that differs from the history of porcelain- and celadon-producing kilns. Daisuke Nakamura (Chapter 9) finishes the second part with a paper on the use of kiln-fired pottery in long-distance trade around the Yellow Sea and the East China Sea during the period from the third century BC to the third century AD. He discusses a potential value change in pottery and concludes as follows: The first widespread distribution was of large containers for transport, produced in the Liaodong and Shandong peninsulas. However, after the development of proto-celadon in the Jiangnan region, medium-sized long-necked jars were exported to other

regions from the Han Dynasty onwards. In short, the wide distribution of pottery changed from pottery for transport to high-quality ceramics as trade goods. In addition to the rising value of ceramic itself, it seems to have been highly valued for drinking and spread to the high strata of societies.

In the course of the following centuries, the flat kiln spread to the north and was used in the steppe. Introducing the few examples yet known, Isao Usuki (Chapter 10) covers North Asia, especially the kilns of the Xiongnu empire from the end of the Western Han to the beginning of the Eastern Han period. These kilns were presumed to have emerged under the influence of kilns in the northern rim of the Han Dynasty. Among them, the Khustyn Bulag site that Usuki shows is of particular significance as this is the location of the first kilns whose detailed structure is known north of the Han Dynasty territory. Irina Zhushchikhovskaya (Chapter 12) describes the situation in the Primor’e region further to the East from earliest firing devices in prehistoric times, potential relations to the Korean peninsula in the first half of the first millennium AD to fully developed kilns of the Bohai period and later, covering a period between the first millennium BC and the thirteenth century AD. Her investigations include archeometric studies and discuss firing conditions and temperatures in flat kilns as well as climbing kilns – which both appear in this region and show interesting potential for understanding the relation to neighboring regions. Katsuhiko Kiyama (Chapter 11) picks up the period of the latter stage of Zhushchikhovskaya’s paper, and finishes the discussion of North Asia with a regionally broader overview of developed flat kilns of the Khitans, introducing studies on the structure of flat kilns and the pottery produced. Based on a detailed examination of the pottery, Kiyama shows that the pottery production at Chintolgoi Castle built by Khitans was an amalgamation of pottery traditions of different origins, such as those of the Bohai and Uyghur.

The next two chapters discuss the spread of kiln technology and complex developments on the Korean peninsula. Kiln technology was introduced to the Korean peninsula during the Chinese Han period. In contrast to North Asia, kilns were introduced in order to produce pottery rather than tiles and roof tiles. It is a characteristic of pottery fired in kilns on the Korean peninsula that there is a gradual increase of firing temperature over time. The production of kiln-fired pottery starts in the Proto-Three Kingdom period (P-TKP) and stabilizes at the beginning of the Korean Three Kingdom period (KTKP). Sungjoo Lee (Chapter 13) states that the technology of kiln and potter’s wheel were introduced in the early P-TKP and replaced the former, long-term and continuous ceramic technology tradition, a process that differed in each regional part of South Korea. Unlike in the Han River basin, where kilns were introduced late and different types of pottery were produced by different organizations, in the Nakdong River basin integrated production of Wajil ware (grey-colored and kiln-fired earthenware) mainly for offering in burials, and Yeonjil ware (orange-colored and mostly open-fired

earthenware) for daily use at an early stage can be observed. These aspects are the background to the regional differences in pottery production during the KTKP. Finally, Takafumi Yamamoto (Chapter 14) suggests, based on the political situation, that regional differences between the pottery styles and the borders of the kingdoms overlap each other, that the system of pottery production might have differed between these entities as well. Baekje adopted a dispersed production/urban accumulation system, while Silla adopted a centralized production/regional distribution system. It can be concluded that this distinction between the two states originated from differences in their social characteristics, political systems and ritual customs, including burial practices.

Kiln technology came to the Japanese archipelago at the end of the fourth century via the Korean peninsula; the kilns are all of the tunnel/climbing kiln type, which originated in Southeast China and is typical for East Asia. Tomoko Nagatomo (Chapter 15) describes the process by which, at first, a single line from Mahan-Baekje, preceding the emergence of the tunnel kiln type, enters the archipelago. However, only when kiln technology from Gaya was introduced again did it become established in the archipelago. The kilns are administered under the central political power that would become the Japanese state and develop constantly, diffusing all over Japan. Masa'aki Kidachi (Chapter 16) examines the structure of tunnel kilns (long chamber kiln) introduced to the Japanese archipelago as follows: During the early period in the Japanese archipelago at the end of fourth century, these tunnel kilns can be divided into a sunken or underground kiln and a semi-sunken or semi-underground kiln. The choice of sunken or semi-sunken kilns depended on the topography and geology in which the kiln was constructed. Sunken kilns are not easy to heat up but have the advantage of keeping the heat well. On the other hand, semi-sunken kilns – like surface kilns – have the advantage of being more efficient at raising temperatures while being responsive to the heat supply, which means that the temperature in the firing chamber rises and falls considerably. In the second half of the seventh century, these tunnel kilns developed the capability to draw the fire deep into the kiln with the invention of the upright flue.

Parallel to the expansion of the Ancient Japanese state to the south, the southernmost Sue kiln site center in Japan was established as one of the latest of its kind around AD 800 in today's Kagoshima prefecture. This region is particularly interesting because of its remote location and unique prehistory and historical development, in which the establishment of a Sue kiln site is of interest because of its social and political implications and its relation to the southern islands of Ryūkyū. Recently, questions and methods new to traditional Japanese Sue research have been introduced and combined with traditional methods and ideas in a larger international project, which is introduced by Naoko Nakamura (Chapter 17). This study bridges time and region to the last kiln site cluster, which is

introduced by Akito Shinzato (Chapter 18), the Kamuiyaki kiln site center on Tokunoshima in the Ryūkyū Islands, a National Historic Site in Japan. Chronologically, the kilns bridge ancient Japan and the Middle Ages, displaying relations to the Korean peninsula in the North and islands south of Okinawa in the midst of vibrant international seafaring and exchange in the Middle Ages.

## 1.2. Terminology and transliteration

The final part of this book is a glossary that aims to unify the names and terms used in this book in such a way that the various research traditions are respected but the meaning is clear and shows the relation between the same phenomena with different names in different languages and traditions. Also, emphasis is on correct transliteration and writings in the original writing system. For Korean, Revised Romanization from South Korea is used; for Chinese, Pinyin without tone indicators; while for Japanese, Revised Hepburn is implemented with consistent declaration of long vowels like *ō* or *ū* in terminology as well as place names and personal names. Russian and Mongolian are transliterated according to the suggestions of the authors in a consistent way.

In order not to impose certain terminology on the authors, we leave the choice to the authors in their chapters, but in the glossary each term may redirect to another term that we suggest as standard. Where necessary, this entry links to the alternative entries. The editors chose terminology according to the following principles:

1. Avoid misleading translations.
2. Favor English terminology that conveys the meaning in the original language or the constitutive characteristics.
3. Avoid the application of names borrowed from one language in another cultural context.

We hope that the glossary, though short, may serve as a means to standardize terminology and naming in East Asian kiln research. Kiln terminology in a narrower sense is a complex problem because classification and terminology depend on different traditions and principles. This book cannot offer standardized terminology in that respect, but the following overview of research history and classifications in different research traditions may provide some orientation for readers.

## 1.3. Overview of the history of kiln construction and kiln research

### 1.3.1. Research history and classification of kilns in China

*A History of Chinese Ceramics* shows the change in pottery, kilns and their distribution from the appearance of pottery to the Qin dynasty period, resulting from accumulated research on the history of ceramics (edited by the Chinese Society of Silicates 1991). According to this book, early kilns with holes dug in the ground shifted from

side-hole (*ce kong shi*) to pit-type kilns (*tong xue shi*) (An & Zheng 1991: 5) (Fig. 1.1b), and later, the Mantou kiln (*mantou yao*), the circular kiln (*yuan yao*), and the dragon kiln (*long yao*) were developed.

Incidentally, around the 1920s Shinobu Komori was posted to China for work and investigated kilns all over China (Komori 1936). Komori classified Chinese kilns into two main categories, named in Japanese: the flat ground kiln (*hiragama*) in the north and the inclined kiln (*keishagama*) in the south. In addition, since the mixture of both types was seen in Jingdezhen (*Keitokokuchin*), it was defined as the Jingdezhen type. He changed the traditional name of Mantou kiln to the flat ground kiln (*hiragama*) and the climbing kiln in the southern area to the inclined kiln (*keishagama*), emphasizing the importance of the angle of the kiln floor. In addition, Komori argued that the southern kilns developed sequentially from the single-chamber tunnel kiln (*anagama*) to the large kiln (*ōgama*), the snake kilns (*jagama*), the double-chambered split bamboo kiln (*waritake-gama*) and the double-stokehole climbing kiln (*renbō-shiki noborigama*).

On the other hand, Zhenqun Liu focused on the flame flow in the kiln and categorized them according to a clear criterion (Liu 1982) into three categories: updraft kiln, with flame rising from the bottom to the top; semi-downdraft kiln, from the bottom to the ceiling and back to the smoke outlet near the floor; and flatdraft kiln, with flame flowing horizontally from the firebox to the firing chamber and down to the flue.

Haitang Xiong who is well versed in Japanese kilns, attempted to classify the kilns and investigate the diffusion of kilns in East Asia, including China, the Korean peninsula and the Japanese archipelago (Xiong 1995) (Fig. 1.1a). In particular, he focused on flatdraft kilns and presented a clear subdivision plan. It is important to note that this type of kiln, considered an advanced version of a flatdraft dragon kiln (type II), was classified as a semi-downdraft climbing kiln (type IV), which is different from a flatdraft kiln.

Masato Ozawa (1993) examined the updraft kiln, which Liu and Xiong did not subdivide. He focused on the passage (fire-way) length between the firebox and the firing chamber, in addition to the positional relationship between them. Ozawa divided the updraft kiln into three types (Fig. 1.1c) and introduced the semi-downdraft kiln to the four types as follows. Type A has a long fire-way that connects the firing chamber and the firebox. Type B has the firebox, dug deeply and distinguishable from the firing chamber and connected by multiple fire-ways. Type C has the firing chamber, which is located above the firebox, and the flame holes serve as the fire-ways. Type D has an integrated firebox and firing chamber and does not connect to a fire-way. After the transition from Type A to Type B and then to Type C, the emergence of Type D was shown to occur during the Western Zhou period.

Yoshiki Fukasawa attempted to classify kilns (Fukasawa 2011) from another perspective and focused on the presence or absence of an oven floor in the firing chamber that draws the flame from the firebox into the firing chamber. He categorized the updraft kiln as a kiln with oven floor. After dividing kilns with oven floor by the presence or absence of fire-way, the type with fire-way was divided by the shape of the fire-ways, and the type without fire-way was divided by the number and location of the supporting pillars for the oven floor. This classification clarified the structural problems with the oven floor. In other words, the larger the firing chamber for production of pottery and the larger the fire-way for providing heat, the more weakened the oven floor becomes. Another unique point of Fukasawa's classification is that it grouped the flatdraft dragon kiln and the semi-downdraft kiln as a kiln without oven floor, and furthermore, subdivided by the ratio of width to length: the broad-short kiln and the long-body kiln. It is quite different from division according to the flame flow (Liu 1982; Xiong 1995) or the slope of the firing chamber (Komori 1936; Ōkawa 1985). A broad-short kiln has a length equal to the width of the firing chamber, and a narrow-long kiln has a length of 2 to 16 times the width of the firing chamber. The latter was classified into two categories: round kilns that were almost flat with a firing chamber of round shape, and long-body kilns that were five or more times as long as the width of the firing chamber.

### 1.3.2. Classification of kilns on the Korean peninsula

The number of kilns excavated on the Korean peninsula has increased over the last few decades because of the increase in excavations associated with the development. Since the 2000s, the transition of kilns in the Baekje, Silla and Gaya regions has been studied in detail from various perspectives (e.g. Park 2001, Kim 2004, Kim 2007, Lee 2008, Zheng 2008, Choi 2010). However, while specific changes and differences between kilns of the same type within individual regions have been elucidated, because of the limiting focus on regions and time periods little attention has been paid to the differences between various regions, such as the difference between Silla and Baekje for example. Suggestions for a solution are discussed in the contributions of Chapters 13 and 14 in this book. Systematic classification of kilns covering a wide range of time and space in the Korean peninsula is scarce, and the Japanese classification of kilns has often been used, or categories based on the plan form have been proposed. Nevertheless, Lee Sungjoo has attempted to redefine the kilns of the Korean peninsula by using the Chinese classification based on the flame flow as described above (Lee 1991).

### 1.3.3. Classification of kilns in the Japanese islands

The terms “climbing kiln” (*noborigama*) and “flat kiln” (*hiragama*) have commonly been used for ancient kilns in the Japanese archipelago. However, Tsugio Mikami and

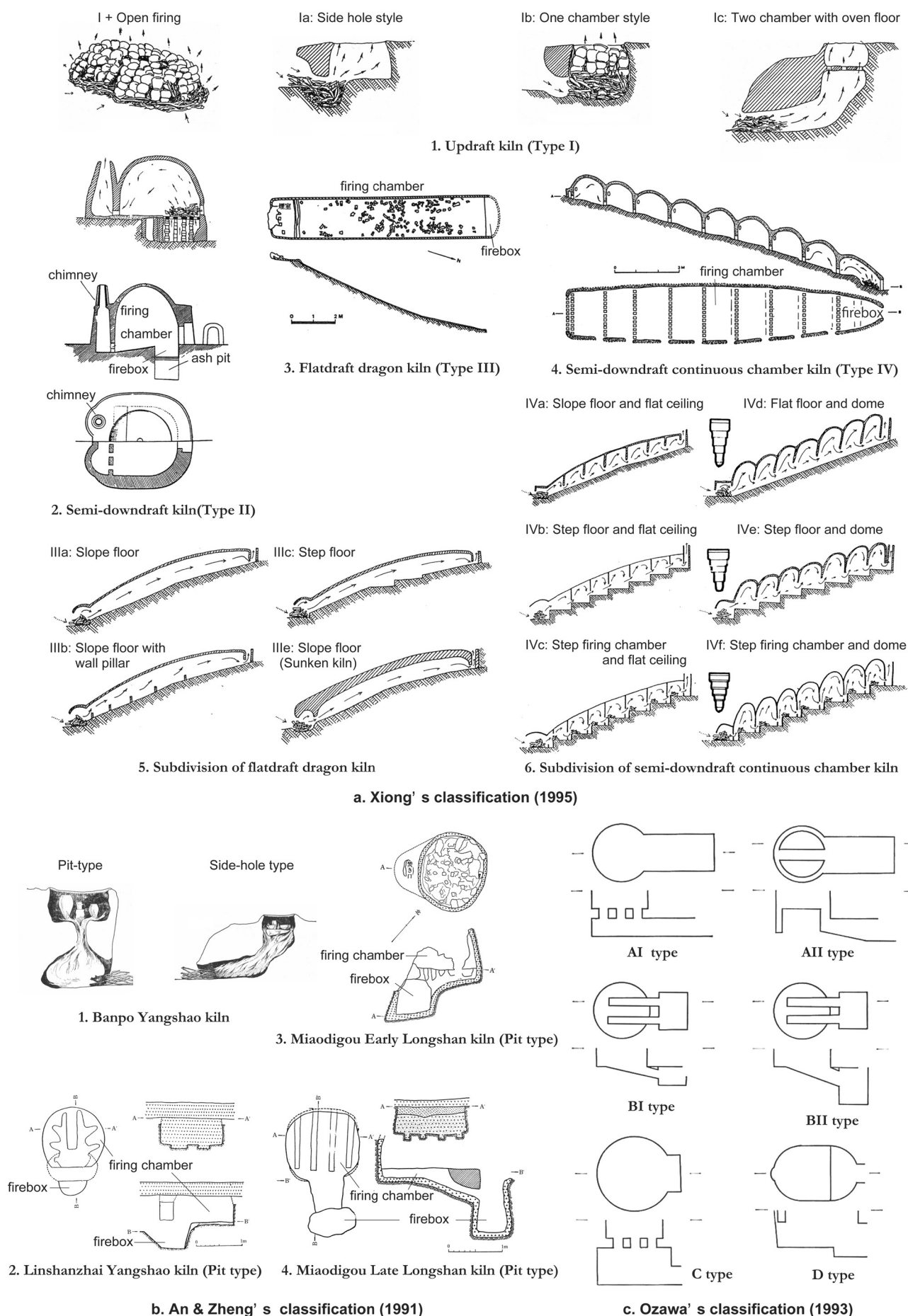


Figure 1.1. Kiln classification of previous studies.



Shōichirō Yoshida used the term “tunnel kiln” (*anagama*) instead of “climbing kiln” to avoid confusion since “climbing kiln” was used for a type of kiln with numerous connected firing chambers by ceramic researchers. Shinobu Komori, on the other hand, called a tunnel kiln one constructed underground. In addition, he included this kind of kiln as an inclined kiln (*keishagama*) which is constructed on the slope (Komori 1936).

Later, the Kiln Research Society collected information on Sue ware kilns and defined the term “tunnel kiln” (*anagama*) to distinguish them from the climbing kiln (Kiln Research Society 2004). This society supported Ōkawa’s approach (Ōkawa 1985) and classified tunnel kilns into a type with wall and ceiling construction, also called “surface type” (*chijōshiki*), a type with only a ceiling construction, called “semi-sunken kiln” (*han-chikashiki*), and a type dug out completely without constructions, called “sunken kiln” (*chikashiki*). Furthermore, he divided them into several types according to the parts in their structure.

#### 1.3.4. Classification of ancient kilns in East Asia

As described above, kilns have been classified according to the flame flow in China, and kilns in Japan have been classified according to the angle of the kiln floor and the kiln construction position (underground or surface). The differences in classification perspectives reflect the differences in kilns in each region, and neither of these classification standards is sufficient to cover all of East Asia. Therefore, the authors would like to propose classifying kilns based on the Fukasawa classification, considering the ancient kilns of China, Korea and the Japanese archipelago, using the unified criteria described below, based on an attempt offered by Nagatomo (2020) (Fig. 1.3, 1.4). After classification of kilns according to the presence or absence of the oven floor, kilns without oven floor are divided according to the definite but straightforward criteria of width and length of the firing chamber. Figure 3 shows the classification of ancient kilns in China, the Korean peninsula and Japan. Pit kilns and oven-floor kilns (updraft kiln) and kilns without oven floor

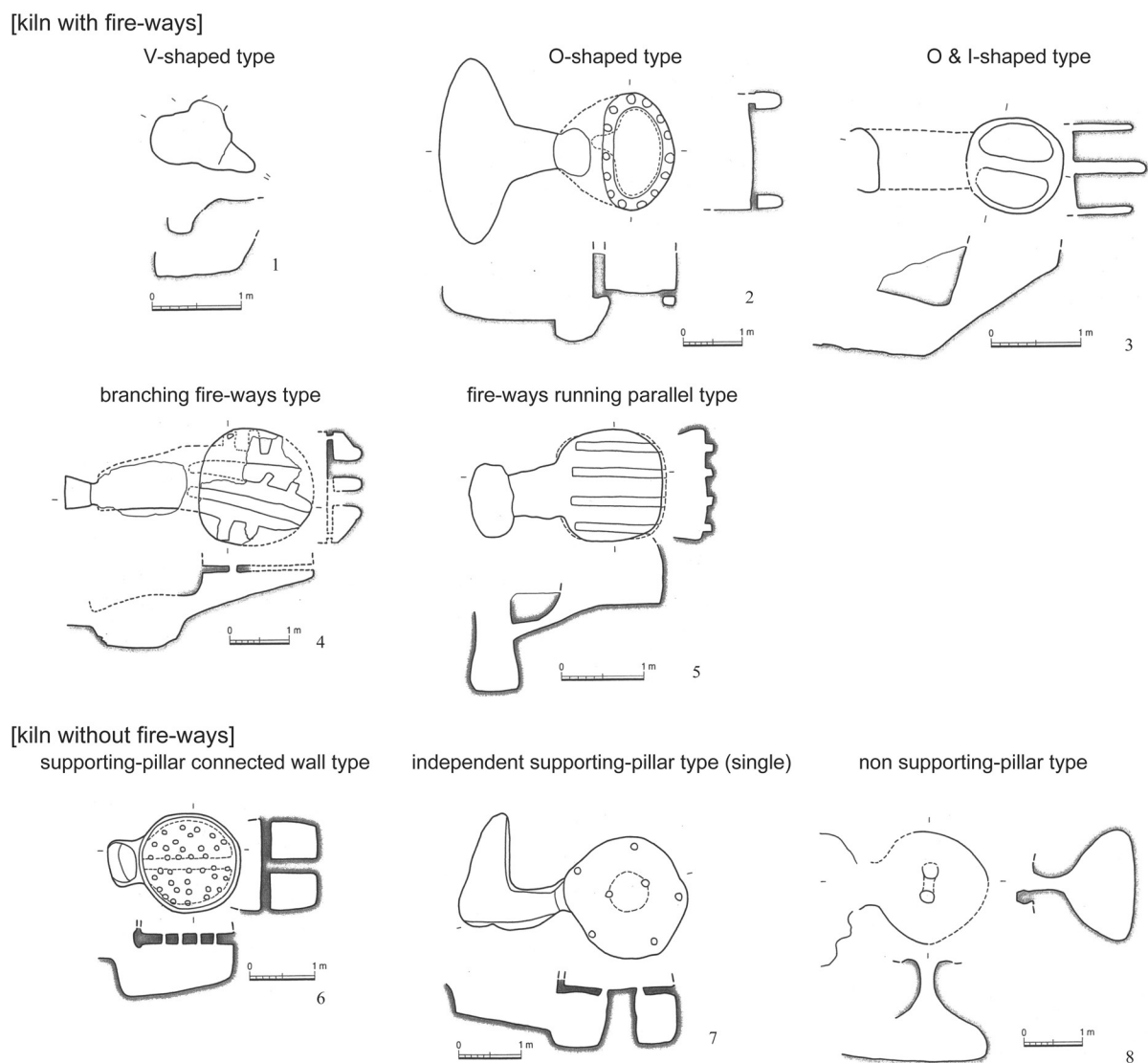


Figure 1.2. Examples of kiln with oven-floor types (after Fukasawa 2011).

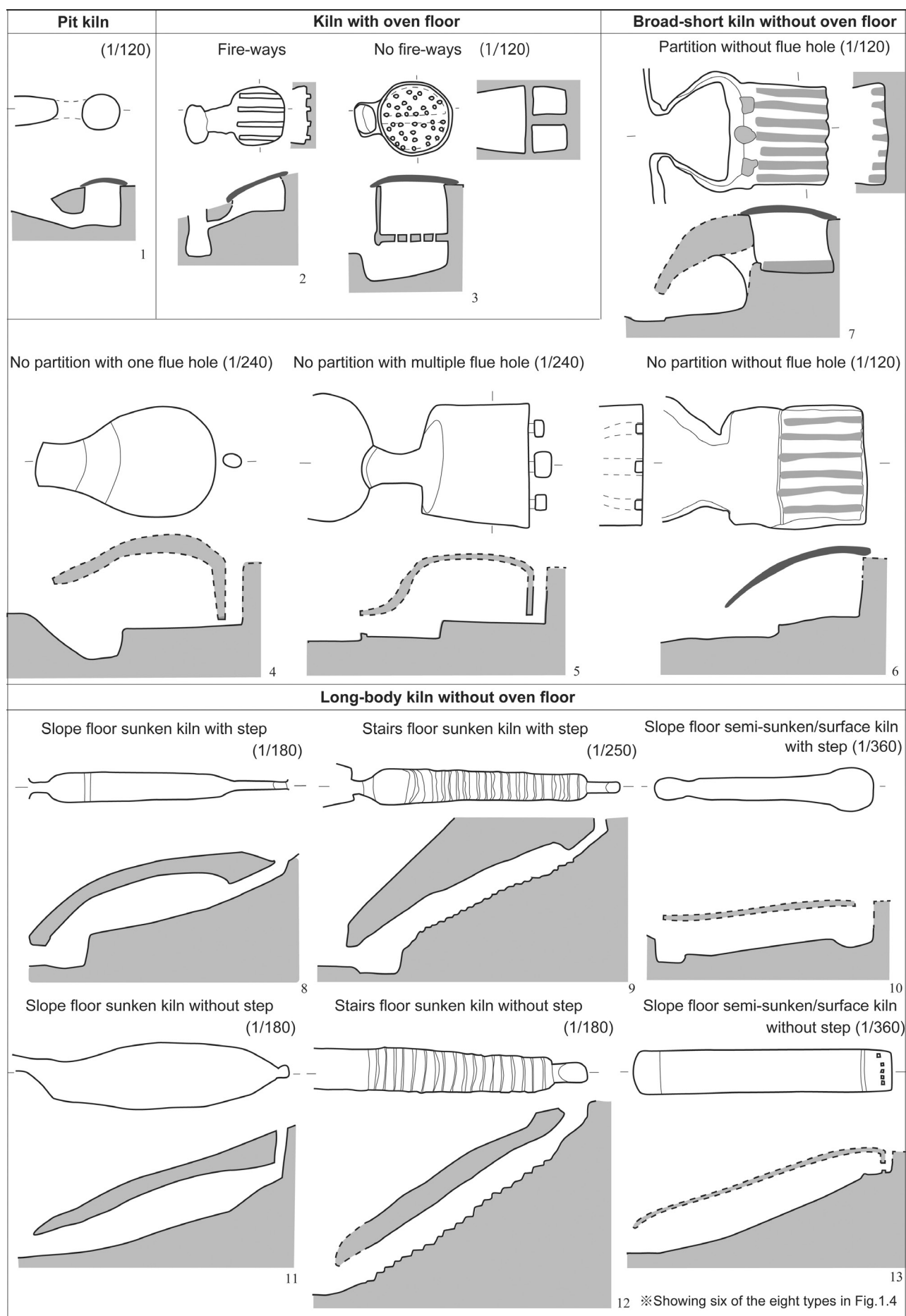


Figure 1.3. Classification of kilns (corresponds to Fig. 1.4) (Nagatomo 2020).

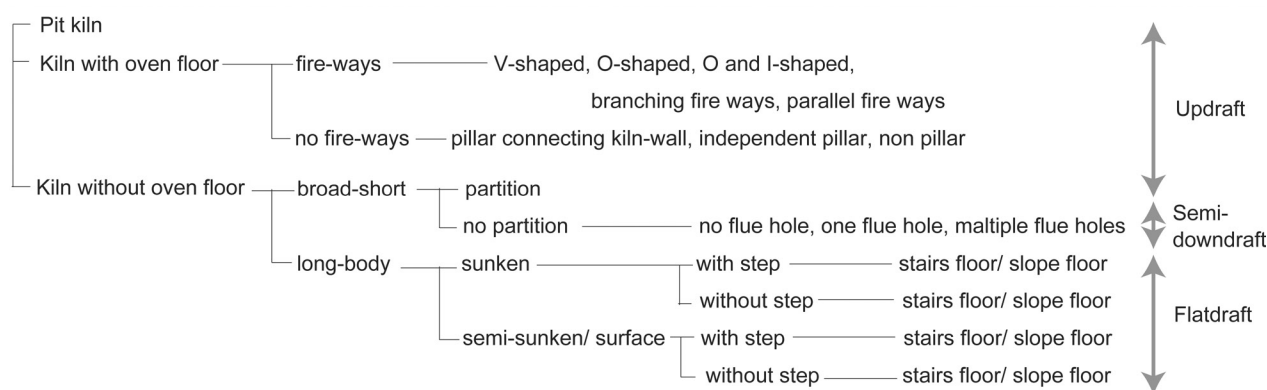


Figure 1.4. Classification of kilns in East Asia.

are broadly classified, and the kilns without oven floor are further subdivided into the broad-short kiln (flat kiln including semi-downdraft and updraft) and the long-body kiln (flatdraft dragon kiln).

### Pit kiln

This type of kiln is constructed on a slope by digging a hole with an L-shaped cross-section (Fig. 1.3: 1). It is assumed that the lower horizontal hole is the stokehole and the vertical hole is the firing chamber. Fukasawa categorized this type as a round kiln among narrow-long kilns. Still, after examining the period of appearance and the structure in this paper, it has been independently categorized as a pit kiln.

### Kiln with oven floor

This type corresponds to a typical updraft kiln without a fixed ceiling, which has an oven floor between the firebox and the firing chamber. Products are carried in and out of the kiln through the ceiling. The subdivisions follow Fukasawa's study (Fukasawa 2011). This type of kiln can be divided into two: a type with fire-ways (Fig. 1.3: 2) and a type without fire-ways (Fig. 1.3: 3). Furthermore, kilns with the fire-ways also are divided into three: two-way type (V-shaped, Fig. 1.2: 1) in which a single fire-way connects to a single firing chamber; ring type along with kiln-wall (O-shaped and O and I-shaped, Fig. 1.2: 2 and 3); multi-way type. Regarding the multi-way type, some have branching fire-ways (Fig. 1.2: 4), and others have fire-ways that run parallel to each other (Fig. 1.2: 5). Kilns without fire-ways are divided into the supporting-pillar connected wall type (Fig. 1.2: 6), the independent supporting-pillar type (Fig. 1.2g), and the non-supporting-pillar type (Fig. 1.2: 7). The independent supporting-pillar type has a single pillar or double pillar.

### Broad-short kiln without oven floor

Basically, the space between a firing chamber and the firebox is one piece, and the length is up to twice the width of the firing chamber (Fig. 1.3). Most examples of this kind of kiln have a step between the firing chamber and

the firebox. The kiln is divided into the sunken type and the semi-sunken/surface type. The latter can be subdivided according to the presence or absence of partition wall and flue (Fig. 1.3: 4–7). Those with partitions do not have a fixed ceiling (Fig. 1.3: 7), and those without partitions include kilns without a fixed ceiling (Fig. 1.3: 6). Therefore, some of the broad-short kilns without oven-floor show the flame flow from bottom to top, as in an updraft kiln. On the other hand, the flame flow in a broad-short kiln with a fixed ceiling is a semi-downdraft.

### Long-body kiln without oven floor

This kind of kiln is flatdraft in flame flow (Fig. 1.3: 8–13). It is divided into the sunken type and the semi-sunken/surface type. The firing chamber and firebox are one unit, and the length is at least twice the width of the firing chamber. In addition, the presence or absence of a step between the firebox and the firing chamber can be observed, besides the presence or absence of a stairway on the floor of the firing chamber.

Although each chapter of this book uses a standard classification for the field, if the classification presented in the present chapter is kept in mind, this classification may help in understanding the structure and lineage of the kilns discussed in each case. The authors hope this will help in the reading of this book.

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## Kilns in East Asia and Their Characteristics

Tomoko Nagatomo

**Abstract:** This essay discusses the introduction of kilns on the Korean peninsula and the Japanese archipelago, focusing on the differences in firing temperatures and distribution areas between ‘flat’ and ‘tunnel’ kilns. The flat kiln was first introduced in the Korean peninsula and originated from North China. Then, as the relationship between South China and the Korean Peninsula deepened, the tunnel kiln, a more advanced kiln that can fire higher, was introduced. There were three regions on the Korean peninsula at that time: the Midwest, the Southeast and the Southwest, and the differences of kiln style arose in these regions because of such differences as preceding societies and interaction with the state in South China. Furthermore, based on the examination results in the Korean peninsula, the earliest kilns in the Japanese archipelago were directly influenced by the kilns in the southwestern part of the Korean peninsula, but this did not form the basis of Japanese kilns. The kilns in the southeastern part of the Korean peninsula were introduced again and spread to Japan.

**Keywords:** flat kiln, tunnel kiln, firing temperature, southern China, northern China, Baekje and Mahan, Gaya and Silla, Korean peninsula, Japanese archipelago

### Introduction

High-temperature firing in kilns was a highly advanced technology in the peripheral areas of China, and it was introduced into the Japanese archipelago from China via the Korean peninsula. In the regions where open-fired<sup>1</sup> pottery was used, the introduction of kilns enabled potters to make sophisticated tableware and storage equipment.

On the other hand, there is a wide variety of kilns in China, and the diffusion of kilns should be discussed in consideration of the diversity. In this paper, we will investigate the diffusion of kilns from China to the Korean peninsula and the Japanese archipelago, focusing on the kiln structure, after we comprehensively examined the kilns in China.

Incidentally, the first kiln-fired stoneware in Korea and Japan, which originated from China, was gray in color. Currently, gray stoneware has a unique name in each country, as follows: It is called *hui tao* in China, which simply means “gray stoneware”. A layer of ash was applied to *hui tao* pottery, which was fired in high-temperature kilns of the Shang dynasty, resulting in a natural glazed gray finish. In Korea, gray pottery is called

Wajil ware (low-fired stoneware) and Dojil ware (high-fired stoneware). Wajil ware appeared in the Proto-Three Kingdoms period (P-TK, first century BC to mid-third century), and Dojil ware appeared in the Korean Three Kingdoms period (KTK, late third century to seventh century). Japanese gray pottery is called Sue ware (stoneware), which appeared in the middle Kofun period (the end of the fourth century). Dojil ware and Sue ware sometimes bear a natural glaze.

### 2.1. Current issues

#### 2.1.1. Sue ware and its kiln

Kilns were introduced into the Japanese archipelago at the end of the early Kofun period, the end of the fourth century. The Suemura kiln group (SKG) began to operate in this period; it was the largest long-term running kiln cluster from the Kofun to the Heian period. The study of Sue ware starts with the investigation of SKG, and has thus far shown great results.

At the beginning of Sue-ware studies, many researchers believed that the kiln-building technique spread from the SKG to the other local kilns (Tanabe 1971, 1981). However, when several early kilns were excavated in the Setouchi region and the coastal area of Osaka Bay, some researchers started to think that kilns were introduced and managed in various regions in the same early stage of SKG (Hashiguchi 1982, Saito 1983, Fujiwara 1992, Takesue 1993). And then, TG No. 232 kiln was discovered

<sup>1</sup> Open firing used in the absence of a permanent facility to fire pottery. There are various methods of open firing with different degrees of sealing in Southeast Asia. Some use a cover of rice straw; others use one of rice straw and mud. The latter can make more rigid pottery than normal open firing, but it is not a kiln.

in SKG, which is one of the oldest kilns in Japan (Okado eds. 1995, 1996). At present, the importance of SKG in the process of kiln development has resurfaced (Ueno 2002, Tanaka 2002, Hishida 2007, Nakatsuji 2013) due to the following facts: a) it contains some of the oldest kilns in Japan; b) it surpasses other kilns in scale and continuity; c) the presence of *futatsuki*, a small bowl with a lid that is the most common vessel type of Sue ware from the fifth century (Yamada 1998: 80).

There is no doubt that the Sue-ware kilns in Japan originated from the Korean peninsula. From comparing early Sue ware and Dojil wares, it is clear that the former was strongly influenced by the latter and the influence originated from the Gaya kingdom. However, there are some types of pots, such as wide-mouthed pots and wide-mouthed vessels with a small hole, among early Sue ware that compel some researchers to assume that early Sue ware was partly influenced by Baekje and Mahan ware (Sakai 1994, 2004). Regarding wide-mouthed vessels with a small hole, Nakakubo indicated that they were formed in Japan (Nakakubo 2017:108). However, there are few studies on the origin of the kiln itself. Among them, Ueno Kōzō presented the corpus of examples of the kiln in the Korean peninsula and insisted that the Deai kiln and TG 232 type kiln are similar to the ones in the Baekje and Mahan regions by emphasizing a planar form (Ueno 2017), but since the origin of early Sue ware was mainly in the Gaya region, the origin of Sue ware and that of the aforementioned kilns do not coincide.

### 2.1.2. Kilns in the Korean peninsula

In the P-TK period in Korea, the western region was known as Mahan, the eastern part as Jinhan, and the southeastern part as Byeonhan. Jinhan became Silla and Byeonhan became Gaya in the KTK period. The Mahan region is somewhat more complicated; Baekje formed in the present Seoul area and covered a peripheral area called Kyeonggi. However, the southern part of Manhan did not become the territory of Baekje but continued to be called Mahan until the end of the sixth century.

New vessel shapes and techniques such as round bottoms and forming by paddle were introduced in the P-TK period. It was believed that Wajil ware in southeast Korea was formed by external influences from the stoneware of Lelang commandery (Shin 1982). In addition, the stoneware with a paddled pattern on the surface in central to southwest Korea was also formed in the second century with influence from Lelang stoneware (Park 1989). Furthermore, some researchers have presumed that Wajil ware was fired in a flat kiln (Yang 1984) and Dojil ware in a tunnel kiln because Dojil ware was fired at higher temperatures than Wajil ware (Takesue 1985, Shin 1986).

On the other hand, in the Baekje and Mahan regions, a large kiln group known as the Samryongri/Sansuri kilns, which began at the end of the P-TK period, has been excavated (Choi et al. 1986; Choi B. 1988). As a result, Choi Byonghyeon estimated that kilns in the whole

P-TK period were not flat kilns because Samryongri/Sansuri kilns have sloped floors (Choi 1992). Lee Seongju suggested that Wajil ware was influenced by the stoneware production technique of the Warring States period in China because the cord-paddling pattern was seen more often than the slanting lattice-paddling pattern<sup>2</sup> (Lee 1991). Also, he classified the kilns as dragon-shaped, round-shape, dome-shaped and rectangular-shape, and made them conform to Liu Zhenquin's classification (Liu 1982) based on the direction of the fire: updraft type, flatdraft type, semi-downdraft type, downdraft type. Lee Seongju argued that the kilns in the P-TK period resembled the round-shaped kiln of the flatdraft and semi-downdraft type in China. He concluded that it developed into a kiln in the Three Kingdoms period. He also believed that TK 73 of SKG in Japan succeeded the structure of the Samryongri/Sansuri kilns. As a result of Lee Seongju's study, it became a common view that the round-shaped kiln of the flatdraft and semi-downdraft type was introduced to the Korean peninsula and brought to the Japanese archipelago.

Research on kilns progressed in each region, such as Baekje and Mahan (Park 2001, Lee 2008, Jeong 2008, Choi 2010), Silla and Gaya (Kim 2004, Kim 2007). Five kilns per group appeared from the third to the fourth century in the Baekje and Mahan regions, but the number of grouped kilns increased from the end of the fifth century, especially in the southern area (Lee 2008). In addition, considering Oryangdong at Naju was the kiln site for firing jar-coffins (Choi et al. 2004, Yeon et al. 2011, Jeong 2012), peculiar developments in kiln-making were seen in Mahan region.

In the Silla region, a large and continuous kiln group consisting of more than 40 per group, such as Seongokdong, Hwasanri, Uksudong and Oksandong appeared in the latter half of the fourth century and reached their peak after the middle of the fifth century. As some of these were located around the royal capital of Silla (Ueno 2015), it is assumed that stoneware production was controlled by the regime (Yamamoto 2018). In contrast, no large kiln groups have been found in the Gaya region.

### 2.1.3. Issues with the regional diversity of kilns

Several issues can be identified from the above studies. First of all, the terms and contents of classification have still not been examined thoroughly enough. Secondly, an increase in kiln excavation shows the regional diversity of kilns in the Korean peninsula. However, when discussing

<sup>2</sup> The paddling technique to make round bottoms was new in the P-TK period. It was presumed that the technique was brought from the Lelang commandery, but there are several differences in the shape and type of stoneware. Therefore, Jeong Inseong explained that the short-necked jar fired by a kiln in the P-TK period originated from the Yan type stoneware in the early or middle Han dynasty. In short, he insisted that the short-necked jars were developed before the establishment of Lelang commandery (Jeong 2013). However, Takaku Kenji opposed to the idea judging from the parallel relationship between burials in Lelang commandery and those in South Korea (Takaku 2018). The beginning of the P-TK period seems not to date back many decades before the establishment of Lelang commandery.

the origin and development of kilns in the whole Korean peninsula, regional differences are not taken into account, and when discussing each region, comparisons with other regions are often not made. Kilns in the Japanese archipelago are said to have inherited the structure of Samryongri/Sansuri kilns in Baekje and Mahan but most early Sue ware came from the Gaya region. There is thus a contradiction in the origin of kilns and stoneware.

The number of excavation and research cases increased in China 37 years after the study of Liu Zhenqun (1982). Recently, Fukazawa Yoshiki compiled a corpus of Chinese kilns that used a slightly different classification system from Liu (Fukazawa 2011), emphasizing three-dimensional structures. The author and colleagues focused on the firing temperature of stoneware and are advancing research on the determination of the kiln type by this measure.

Therefore, in this article, the author will focus on the relationship between the kiln structure and firing temperature, while considering the lineages of kilns in the Korean peninsula and the Japanese archipelago and paying particular attention to regional differences in kilns on the Korean peninsula.

## 2.2. Kiln variety and firing temperature in China

### 2.2.1. Kiln structure

According to Fukazawa Yoshiki's (2011) study, kilns can be classified into two types by oven floor: the kiln with oven floor type (type I, chapter 1, section 1.3, Fig. 1.2) and the kiln without oven type (type II). Furthermore, type I is divided into two types: with fire-ways (type Ia, Fig. 1.2.1: 1) and without fire-ways (type Ib). Type II is also divided into two types by shape: a broad-short type<sup>3</sup> (type IIa, Fig. 1.2.1: 3) and a long-body kiln type (type IIb and IIc). The former's ratio of length to width is around 1:1, and the latter's ratio of these is from 2 to 16:1. In type IIa, as the end of a firing chamber is dug and changed into a firebox, usually, a step is seen. Type IIb is shaped round and its ratio of length to width is less than 5:1 (Fig. 2.1: 2). Type IIc is shaped like a long oval and its ratio of length to width is 5 to 16:1 (Fig. 2.1: 4). Regarding the step of types IIb and IIc, there are two styles: with a step and without a step. In addition, there is a group that is a hybrid of the two previous types from the Spring and Autumn period to the Warring States period of north China; it shows the transition from type Ib to IIa in a particular region.

Firing chambers and firebox are vertically separated in kiln type I, while these are horizontally separated in kiln type II. In kiln type I, the firebox makes heated air that rises to the ceiling through the stoneware in the firing chamber. In kiln type II, heated air made in the firebox flows sideways to the flue on the opposite side of the firing chamber, through the pottery. Consequently, type II can make a stronger flow of fire and heat than type I.

In the case of kiln type Ia, it is difficult to conduct the heat to the stoneware due to the narrow path of heat, but its kiln structure is solid. On the other hand, type Ib can easily conduct heat to the stoneware due to its wide path, but its structure is vulnerable. It turns out that there is a limit of quantity when firing stoneware in a type I kiln.

Kiln type II has a very small temperature gradient between the firebox and flue because of the short length of the firebox. In other words, it can fire stoneware at a uniform temperature. Kiln type IIa corresponds to the draft and round-shaped kilns of semi-downdraft type in previous studies. Kiln type IIc corresponds to the tunnel kiln. Since the strength of the flame depends on the difference in elevation between the firebox and the flue, in the case of the short firing chamber, we can observe the same degree of flame strength regardless of whether its bottom is flat or sloped. Regarding kiln type IIa, the slope of the firing chamber is related to the ease of stoneware placing but it can be said that it does not greatly affect the firing itself.

### 2.2.2. Period and distribution

Kiln type I appeared in the middle Neolithic period and continued until around the Warring States period. Kiln type IIa appeared in the Western Zhou period and became more common when type I declined. Kiln types IIb and IIc appeared earlier than type IIa, and type IIb continued to be built from the Neolithic to the Bronze Age; type IIc was built from the Erlitou period until the Jin Dynasty (Fukazawa 2011).

Kiln type I was distributed in the upper and middle Yellow River basin. Kiln type IIa was mainly distributed in the middle Yellow River basin, but also distributed in the middle Yangtze River. Kiln type IIb was mostly seen in the middle Yellow River, and type IIc was distributed mainly in the lower Yangtze River and the coastal area of south China. Therefore, it is indisputable that type IIc kilns, with their long firing chambers, were developed only in the southern part of China. Fukazawa suggests that Sue-ware kilns in the Japanese archipelago originated from type IIc kilns in this area of China. Early kilns in China are very rare, and it is difficult to grasp the kiln structure at that time because most of the ones excavated had only the bottom and had lost their upper structure.

### 2.2.3. Correlation between firing temperature and kiln structure

When the firing temperature of kiln-fired stoneware was examined, the range was from about 800 up to nearly 1300 °C. There is a certain relationship between the structure of the kiln and the firing temperature<sup>4</sup> (Nagatomo 2017). Since the firing temperature can be analyzed from

<sup>3</sup> Beginning in the Western Zhou period, kilns started to have flues.

<sup>4</sup> It is necessary to distinguish between experimental and actual high temperatures. In the case that a low-temperature operation is common in practice, there is the possibility that firing at a low temperature is preferred, to avoid the disadvantage of a high temperature, even if using higher temperatures is feasible.



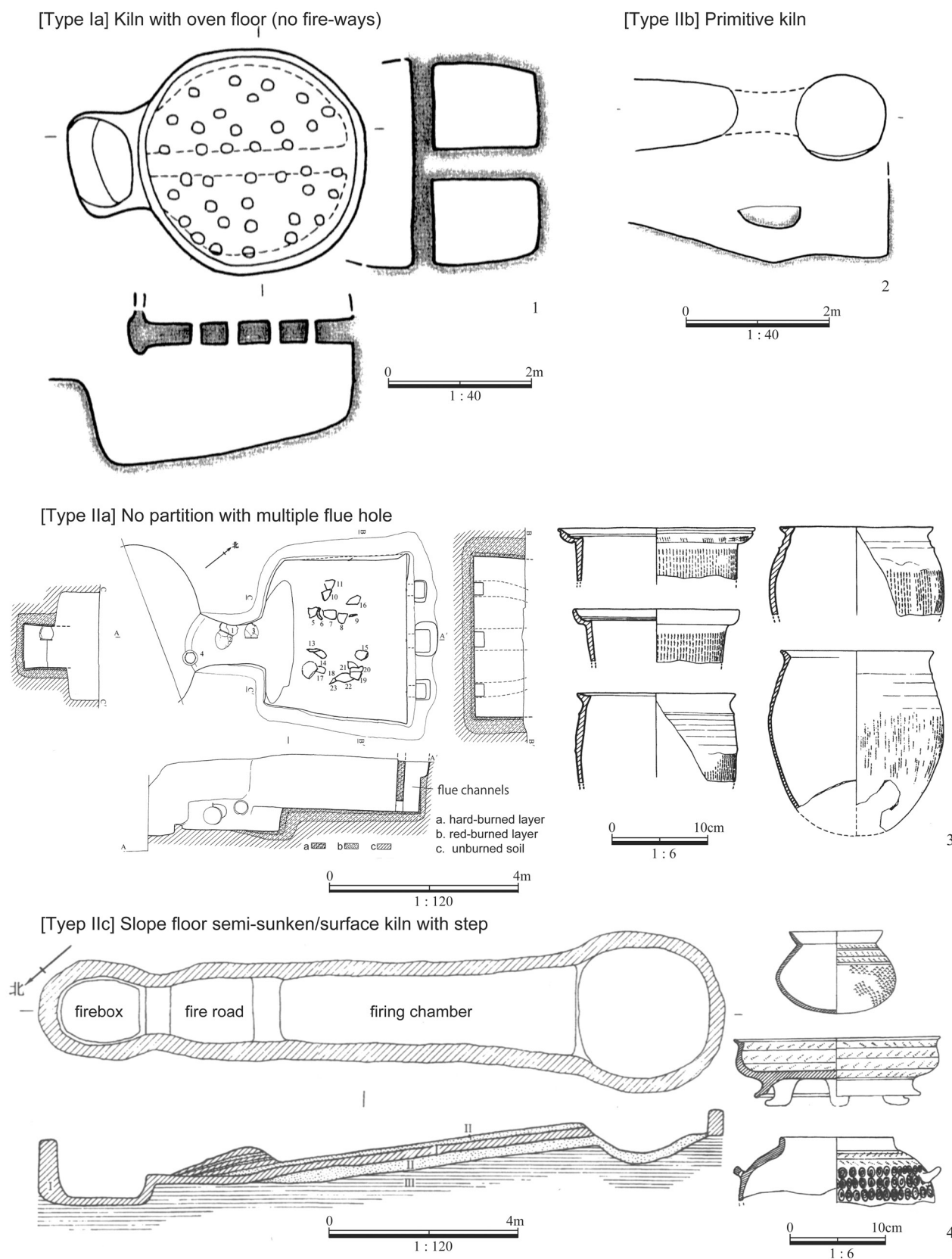


Figure 2.1. Kiln types in China.

stoneware, this method can compensate for the lack of preserved kilns from this period.

The author and research colleagues analyzed seven pieces of Yan state stoneware from the third century BC fired in a type IIa kiln (Fig. 2.1.3). Vitrification and amorphous clay minerals were observed with a polarizing microscope, but no minerals like mullite, which is formed over 1000 °C, were found among them. This result showed this stoneware was fired at between 900 and 1000 °C (Table 2.1, Kanegae et al. 2017). Similar results were obtained for the firing temperature of Lelang stoneware excavated from the Korean peninsula and the Japanese archipelago (Cho 2006, Kanegae and Fukuda 2006). Additionally, although these

are examples from the seventh to the tenth century in the Bohai period, examination with a polarizing microscope found that roof tiles were fired at between 800 and 900 °C or a slightly high temperature in a type II kiln at the Kraskino site in the Russian Far East (Zhushchikhovskaya and Nikitin 2017). These kilns were 12 in number and varied in size: about 1.0 to 1.7 m in width and 3.3 to 5.1 m in length, including firebox, firing chamber and flue.

On the other hand, in the lower Yangtze River, gray stoneware with natural glaze was fired at a high temperature in type IIc kilns. The natural glaze proves the use of the high temperature at which fuel-ash is melted. Ceramic was stably fired at a very high temperature, around 1200 °C: 1160 to 1310 °C in the Later Han Dynasty, 1240 °C in the Three Kingdoms period, 1180 to 1300 °C in the Western Jin Dynasty, 1130 to 1270 °C in the Eastern Jin Dynasty, and 1190 °C in the Southern Dynasty (Table 2.2). The gray stoneware in the Meihuadun kiln from the late Spring and Autumn period (Fig. 2.2.) is estimated to have been fired at 1270 °C, as was determined by the reheat thermal expansion coefficient measuring method (Institute of Cultural Relics and Archaeology of Guangzhou 1998), which shows that Type IIc kilns reached firing temperatures exceeding 1100 °C before the Warring States period.

Based on the comparison of the firing temperature in each kiln type, we may conclude that type IIc kilns can reach a higher temperature than Type IIa kilns. As the distance from the firebox to the flue of kiln type IIa is

**Table 2.1. Firing temperature of pottery from the Pulandian Piziwo site**

No.	period	form	FT
1	10th to 9th century BC	steamer	900-1000 °C
2	10th to 9th century BC	steamer	900-1000 °C
3	10th to 9th century BC	steamer	900-1000 °C
4	4th to 3rd century BC	pot	900-1000 °C
5	4th to 3rd century BC	pot	
6	4th to 3rd century BC	steamer	900-1000 °C
7	4th to 3rd century BC	short-necked jar	900-1000 °C
8	4th to 3rd century BC	short-necked jar	900-1000 °C

**Table 2.2. Firing temperature of ceramics in Zhejiang Province (based on Ye et al. 2008)**

area	site or artifact	form	period	FT	note
Shangyu	Xiaoxianyun kiln	Celadon no-necked jar with paddling patterns	Eastern Han	1160±20	
Shangyu	Xiaoxianyun kiln	Celadon no-necked jar with paddling patterns	Eastern Han	1310±20	
Shangyu	Xiaoxianyun kiln	Celadon shallow bowl	Eastern Han	1270±20	
Shangyu	Xiaoxianyun kiln	Celadon straight-necked pot	Eastern Han	1260±20	
Shangyu	Zhangzishan kiln	Black-glazed ceramic	Eastern Han	1220±20	
Shangyu	Zhangzishan kiln	Black-glazed ceramic	Eastern Han	1200±20	
Shangyu	Zhangzishan kiln	Black-glazed ceramic	Eastern Han	1240±20	
Shangyu	Zhangzishan kiln	Celadon bowl	Three Kingdoms	1240±20	
Shangyu	Longquan tang burial	Celadon	Western Jin	1300±20	made in Yue kiln
Shangyu	Longquan tang burial	Celadon	Western Jin	1180±20	made in Yue kiln
Shangyu	celadon	Celadon	Western Jin	1220±20	
Shaoxing	Western Jin burial	Celadon jar with four handles	Eastern Jin	1270±20	made in Yue kiln
Deqing	Dequin kiln	Black-glazed ceramic	Eastern Jin	1150±20	
Yuhang	Yuhang kiln	Black-glazed ceramic	Eastern Jin	1130±20	
Jinhua	Jinhua Wùzhōu kiln	Celadon	Eastern Jin	1180±20	
Shangyu	Zhangzishan kiln	Celadon small bowl	Southern Dynasty	1190±20	

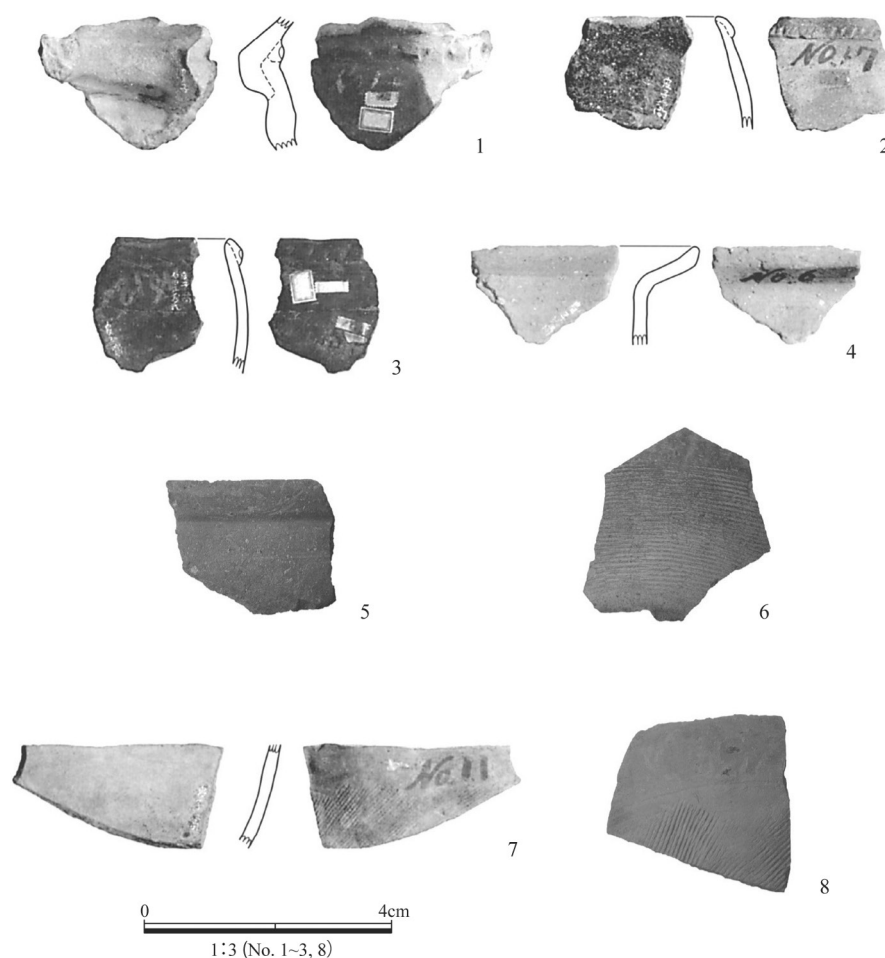


Figure 2.2. Analyzed pottery from the Pulandian Piziwo site (Kanegae et al. 2017).

short, the temperature gradient of these is not large. In other words, heat can easily escape from the kiln via the flue. In contrast, as type IIc kilns have longer firing chambers, the temperature gradient is larger. As a result, the flame and heat flow become strong, and the maximum firing temperature tends to increase in the firing chamber because heat can stay there for a long time.

## 2.3. Kilns in South Korea

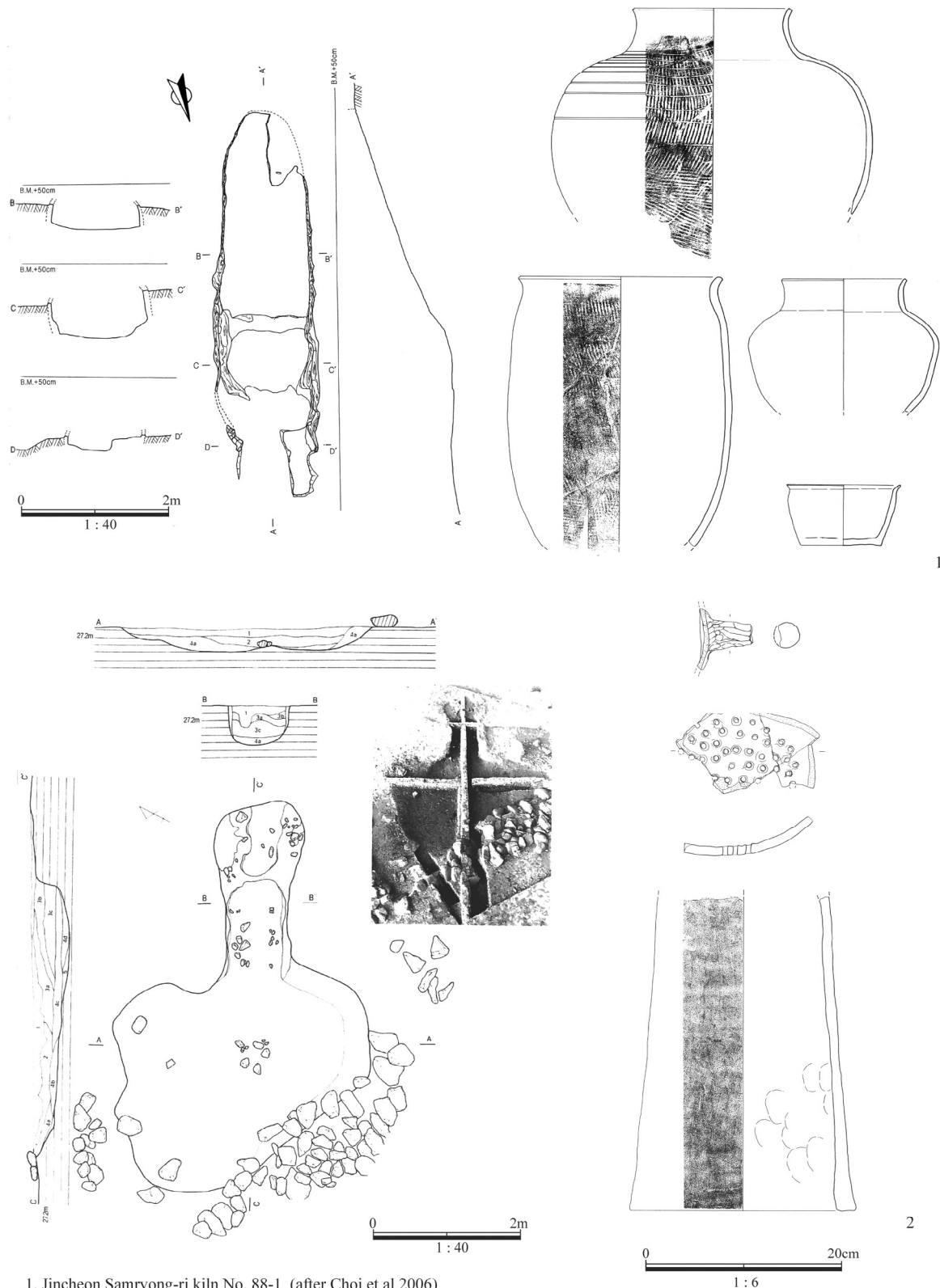
### 2.3.1. Early kiln and stoneware

Kiln-like remains have been found dating from the Bronze Age onward (Kang 2005). They are round or ditch-like, and their bottom face was often burnt, or a certain amount of stoneware sherds were found. However, it is difficult to regard these remains as kilns due to the lack of decisive evidence; the upper structures and burnt side walls have not survived, and stoneware found there does not have a rigid body. After all, it was not until the P-TK period that sure examples of kilns were found. Moreover, grouped kilns of more than ten per group have been found at the Samryongri/Sansuri kilns (Choi et al. 2006).

The Samsuri/Samryongri kilns continuously operated from the third to the fourth century, and they correspond

to a transitional time from the P-TK to the KTK period in the Baekje and Mahan regions. These kilns are characterized by a deep firebox and have steps between the firing chamber and the firebox (Fig. 2.3: 1). The bottom of the firing chamber has a short slope. This conforms to the IIc type of kiln. Most of the stoneware found nearby was short-necked jars; the others were deep pots and steamers. According to the report on the Samryongri/Sansuri site kilns, the kilns were divided into five stages, and tray-shaped stoneware appeared starting in the fifth stage. However, there are no examples of pieces with sharp concave-sectioned lines and vessels with three legs, such as those found in Pungnap fortress. It is possible that the stoneware shapes found at the Samryongri/Sansuri site kilns were influenced by Baekje stoneware at the final stage, but these are typologically different from the examples from the Pungnap fortress and Mongchon fortress in central Baekje. The other characteristic of Samryongri/Sansuri site kilns is that they manufactured a blast tube for forging iron and provisioned the Seokjangri iron-making site (Nagatomo 2008).

Kilns were found in the Hwanseongdong site in the Gyeongju area of Jinhan region; this site was known as the iron production site (Fig. 2.3: 2). Although most of the firing chamber of the kilns did not remain, there are steps



1. Jincheon Samryong-ri kiln No. 88-1 (after Choi et al 2006)  
 2. Gyeongju Hwanseong-dong No. Na-13. (after Lee et al 2000)

**Figure 2.3. Kilns in the Korean peninsula (1).**

between it and the firebox. One of them was reported as a type IIa kiln: a draft kiln (Lee et al. 2000). Takesue Junichi insisted that this kiln was used for firing the clay core for casting ironware (Takesue 2002), but no clay core has been found at the kilns.

Made in the Jinhan and Byeonhan areas, Wajil ware has a variety of colors: light gray, light brown, white<sup>5</sup> (Society for

<sup>5</sup> The term “Wajil ware” was often used to refer to the stoneware with loosed reduction firing (Terai 2017); some researchers call the kiln-fired

Korean Archaeology 2013). Some unique types are seen, such as a jar with a pair of horn-shaped handles, jars with no necks, and short-necked jars with paddling pattern. In late stages of Wajil ware, the rate of types of pottery with short legs attached to round bottoms increased, such as small, wide-mouthed dishes with short legs and jars with short legs.

On the other hand, in the Baekje and Mahan regions, the findings consisted of rigid plane-stoneware, stoneware with paddling pattern, fired oxidation firing or reduction firing, and dark gray stoneware (Park Sunbal 2003). It is believed that the dark gray stoneware appeared under the influence of Lelang stoneware from the middle stage, which divided the P-TK period into three, besides stoneware with paddling pattern appeared at the same stage. Rigid plane-stoneware was composed of a deep pot, a cover and a bowl, which are characterized by a flat bottom and outward-opened rim. In addition, hand-strokes for smoothing the surface were observed on the lower body of this stoneware. Rigid plane-stoneware originated from a previous local culture. Stoneware with paddling patterns comprises a deep pot, a long oval-shaped pot, a steamer and a bowl. These have a round bottom or a flat bottom without hand-strokes on the lower body.

Stoneware in the P-TK period was diverse in each area, but an important point is that all the pieces have the common feature of a round bottom made by paddling. Judging from the observation of the paddling pattern on the round bottom, these were at one stage formed in a cylindrical shape. Next, the body was inflated by the paddling method, and then the bottom was reformed as round. By the paddling method, the walls of the stoneware are tightened and transformed at once. Therefore, the time required to make stoneware with the paddling pattern became shorter than for rigid plane-stoneware, which was made by piling up clay bands while adjusting the body shape to ensure there were no gaps. In short, the technique of making stoneware greatly changed in P-TK period (Nagatomo 2010). Since stoneware bodies became rigid, these were fired by kiln, even when the kilns themselves have not been found. It can be said that these new types of stoneware were accepted along with the introduction of kiln building technology.

### 2.3.2. Kilns of the Three Kingdoms period

Most of the kilns in the Baekje and Mahan regions are type IIc, with a step between the firing chamber and the firebox. The ratios of length to width of almost all the firing chambers is around 2:1, and the fireboxes are short. Some of the kilns are wider, more than 3 m. In the southern tip of the Mahan region, a kiln with part of its ceiling

remaining was found at the Gunkok-ri site from the fourth century (Fig. 2.4: 1, Mokpo University Museum 1989). It is oval and short. The kiln has a slight step between the firing chamber and the firebox, and the bottom of the firing chamber has a gentle slope. Most of the other kilns in the Mahan region have a step and their firing chamber's length is two to three times their width. In the sixth century, kiln type IIa, with a nearly flat firing chamber and a high step between the firing chamber and the firebox, reappeared as a kiln for firing tiles. Since the Jeongamri site in the Baekje region has a new structure in which the fuel hole is made on the side and there are three flues, it is found that Kiln type IIa was introduced again as a new renewal style.

In the Gaya region, kilns of the fourth century were found, such as at the Myosari, Ugeori and Yeochori sites. They have a long, narrow shape with no step between the firing chamber and the firebox: a typical type IIc kiln. The firebox of the kiln is nearly horizontal and connects to the steeply sloping firing chamber in Yeochori section A (Fig. 2.4: 2). And then, the new shape of kiln appeared, in which both sides of the firing chamber are rounded and bulge out slightly, but the back wall rises vertically. However, these kilns consistently have no steps (Yamamoto 2018), and the maximum width of the firing chamber was 2 m or less. No wide-shaped kilns have been found.

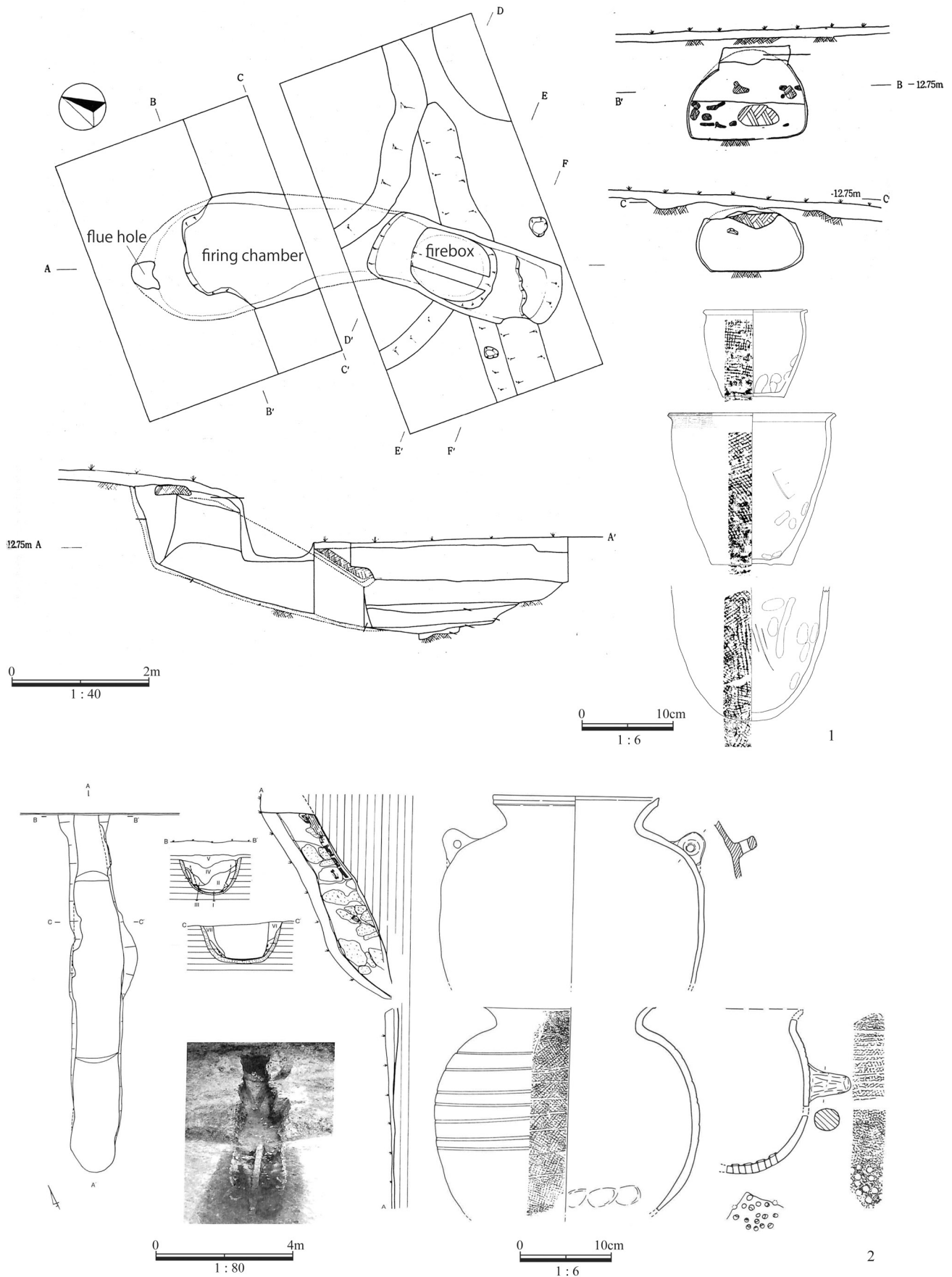
The proportion of tableware came to increase rapidly in Baekje, Silla and Gaya during the P-TK period. Shallow bowls and dish-like tableware appeared in Baekje. These vessels often had three legs attached, which is like the Chinese style. In addition, some patterns were drawn on the upper body of jars with short, straight necks and black jars with a polished surface from the KTK period. Baekje interacted with the Southern Dynasty of China and imported celadon jars with chicken-headed spout and large urns. The appearance of black jars with a polished surface reminds us of the relationship with porcelain in the Jiangnan area of central China. The rapid change in the composition of vessels from the P-TK period to the early Baekje period is closely related to the influence of Chinese stoneware.

On the other hand, the composition of Silla stoneware also changed significantly. The number of cups with a leg increased, and the ratio of tableware increased. Regional-style stoneware decorated using comb-shaped tools appeared, and large stands were also made. In Silla and Gaya, the custom of using a large amount of stoneware as burial goods began, which mainly consisted of tableware like cups with a leg. In contrast, the amount of stoneware used in graves is small in Baekje. It should be considered that the difference in demand for stoneware affected the improvement and enlargement of kilns involved in mass production.

### 2.3.3. Transition of firing temperature

The firing temperature of stoneware in the Baekje and Mahan area was analyzed by Cho Daeyeon (Cho 2006),

stoneware in the Baekje and Mahan regions "Wajil ware" (Kameda 2008, Terai 2017, Nakakubo 2017). However, in Korean archeology, it is common to use this term to refer only to stoneware in the Jinhan and Byeonhan regions in the P-TK period (Society for Korean Archaeology 2013). This paper will follow this usage.



1. Henam Gungokri Kiln (after Mokpo University Museum 1989), 2. Changnyeong Yeochori (after National Jinju Museum 1992)

**Figure 2.4. Kilns in the Korean peninsula (2).**



Figure 2.5. Results of the firing-temperature analysis for pottery in the Korean peninsula (based on Cho 2006).

and Fig. 2.5 shows the result. Regarding the stoneware of the Kwanchang-ri site in the Bronze Age, one sherd of stoneware was fired at around 1000 °C and two sherds were fired below 700 °C. However, most of the stoneware was fired at the maximum firing temperature of 750 to 800 °C. Examples from the Jinjuk-ri and Jukjeon-ri sites also showed the low firing temperature: below 800 °C.

In the third to fourth centuries, a lot of stoneware was fired at high temperatures, over 1080 °C, as in the Samryongri kiln. However, it should be noted that the frequency of stoneware fired at 800 to 1000 °C also increased, and a certain amount of stoneware was fired at 700 to 800 °C. Also, in Punnap fortress in central Baekje, there were examples fired at a high temperature of more than 1080 °C, but the rate of stoneware fired at around 700 to 900 °C was high. Since Punnap fortress is a residential area, it had a higher percentage of open-fired cooking stoneware than the Samryongri kiln site. Therefore, there was more stoneware fired at a low temperature in Punnap fortress than in the Samryongri kiln. In the Misa-ri and Singeum fortresses, there were examples fired at around 700 to 800 °C.

Based on the above, the stoneware was fired at a temperature of 800 °C or lower by the open firing in the Bronze Age. From the P-TK to the KTK period, stoneware fired at a temperature of over 1080 °C appeared. However, as most of the stoneware was fired at 700 to 1000 °C even after the introduction of kilns, it seems to have taken a long time to acquire the skill to fire in kilns at high temperatures.

Lee Seongju believes that the production of early Dojil ware starting in the middle of the third century parallels the late Wajil ware (Lee 2005). As mentioned above, he assumed that Wajil ware was fired in type IIc kilns. Although the firing temperature of Wajil ware sometimes went up to 1000 °C, most of these were reduction-fired at a low temperature of 800 °C or lower. In contrast, the firing temperature of Dojil ware was around 1200 °C. In the Silla and Gaya regions, the firing temperature increased gradually over time.

#### 2.3.4. Change and development of kilns

In the P-TK period, kilns were built with a step between the firebox and the firing chamber across the regions. The kiln in Hwangsong-dong has such a step, although the firing chamber is as yet unrevealed; the Samryongri/Sansuri kilns have a deep firebox and a short firing chamber although they are type IIc kilns. It can be said that the former corresponds to kiln type IIa and the latter is kiln type IIc improved from kiln type IIa. This estimation agrees with the examination of stoneware firing temperature.

While the feature of a step between the firebox and the firing chamber was maintained even after the fourth century in the Baekje and Mahan regions, the type IIc kiln became the norm, considering that the firebox became slightly longer and the sloped bottom of the firing chamber appeared. Given the drastic change in the composition of stoneware including the vessel with three legs influenced by Chinese stoneware and the fact that a lot of celadon made in the Jiangnan area were acquired during this period, it is difficult to determine the change of kilns by internal changes. It is appropriate to consider the influence from the type II kilns in the Jiangnan area of Central China.

On the other hand, in kilns in the Gaya region from the fourth century onward, there was no step between the firebox and the firing chamber. At that time, the firing chamber changed from near horizontal to a strongly sloped shape to improve fire and heat flow. In other words, the bottoms of the firing chambers became bow-shaped (Ueno 2015). Moreover, kilns with a total length of more than 10 m appeared. Unlike kilns in Baekje, the complete style of the type IIc kiln was adopted in the Gaya region. It can be said that type IIc kilns in the Gaya region do not represent an improved kiln on the basis of the former one, type IIa.

From the early third century and later, 20 melting furnaces for casting iron were found at the Hwangsongdong site, and the refining of iron was also conducted there. With the prevalence of ironware, the presence of the Silla

and Gaya region became larger in East Asia due to its rich iron resources. It has been found that opportunities of interaction with southern dynasties increased via intermediate areas. Incidentally, the rise of iron-making in the Silla and Gaya regions was reorganized at the end of the first century. From that period onward, a lot of potash glass made from India to southern China was brought to the southern part of the Korean peninsula (Nakamura 2015). There is a possibility that new kiln techniques were introduced from southern China after the end of the first century, but they have not been found. At present, as sure examples of type IIc kilns appeared from the latter half of the third century to the fourth century, this was brought about by the beginning of the interaction with the Southern dynasty at the time of the establishment of Baekje.

The step between the firebox and the firing chamber is the most notable difference between the Baekje-Mahan region and the Silla-Gaya region. Although there are type IIc kilns with a step in China, it would be easier to understand the influence of the former type IIa kilns rather than to assume different kiln types were introduced to Baekje and Silla-Gaya. Therefore, in the southern part of the Korean peninsula, after the kilns appeared at the time around the establishment of Lelang commandery, they were newly affected by the Jiangnan area in China. In short, under the influence of multiple kiln types in China, kilns in the Korean peninsula appeared and changed.

## **2.4. Origin and features of kilns in the Japanese archipelago**

### **2.4.1. Earliest kilns**

Many researchers consider the Deai kiln in the city Kobe, located at the western end of Kinki area, the earliest in Japan. Although the firing chamber is mostly lost, it was short and had a step between it and the deep firebox (Fig. 2.6: 1). The commonality with kilns in the Mahan region has been pointed out from the shape of the kiln (Kameda 1989, 2008). The clay of ceramics excavated from the Deai kiln is similar to that of the P-TK period, and the firing temperature is estimated to be not very high.

The ceramics comprise such kinds as a short-necked jar, a dish-like vessel and a steamer. As both tableware and the storage container were found at the Deai kiln, it is different from the early kilns of SKG, which mainly produced storage containers. In the studies of stoneware at the Deai kiln, the similarity of the stoneware of the Mahan region has been pointed out (Kameda 2008). Among these, Terai Makoto limited the origin to the region to the Hoseo area of the northern Mahan region based on the rim shape of the short-necked jar (Terai 2017). The steamer has a straight mouth and round holes in the flat bottom (Kameda 1989). Based on examination of the shape features, the origin of the steamer from the Deai kiln originated in the western area of the Gaya region to Mahan. However, the absence of cups with a high leg and the presence of dish-like vessels shows that the stoneware at the Deai kiln most

likely originated from the Mahan region. Besides, the earliest kiln in Samryongri, kiln No. 88-1, is earlier than the Deai kiln, since the steamer of the former has a round bottom with smaller holes (Fig. 2.3).

### **2.4.2. Early kilns and SKG**

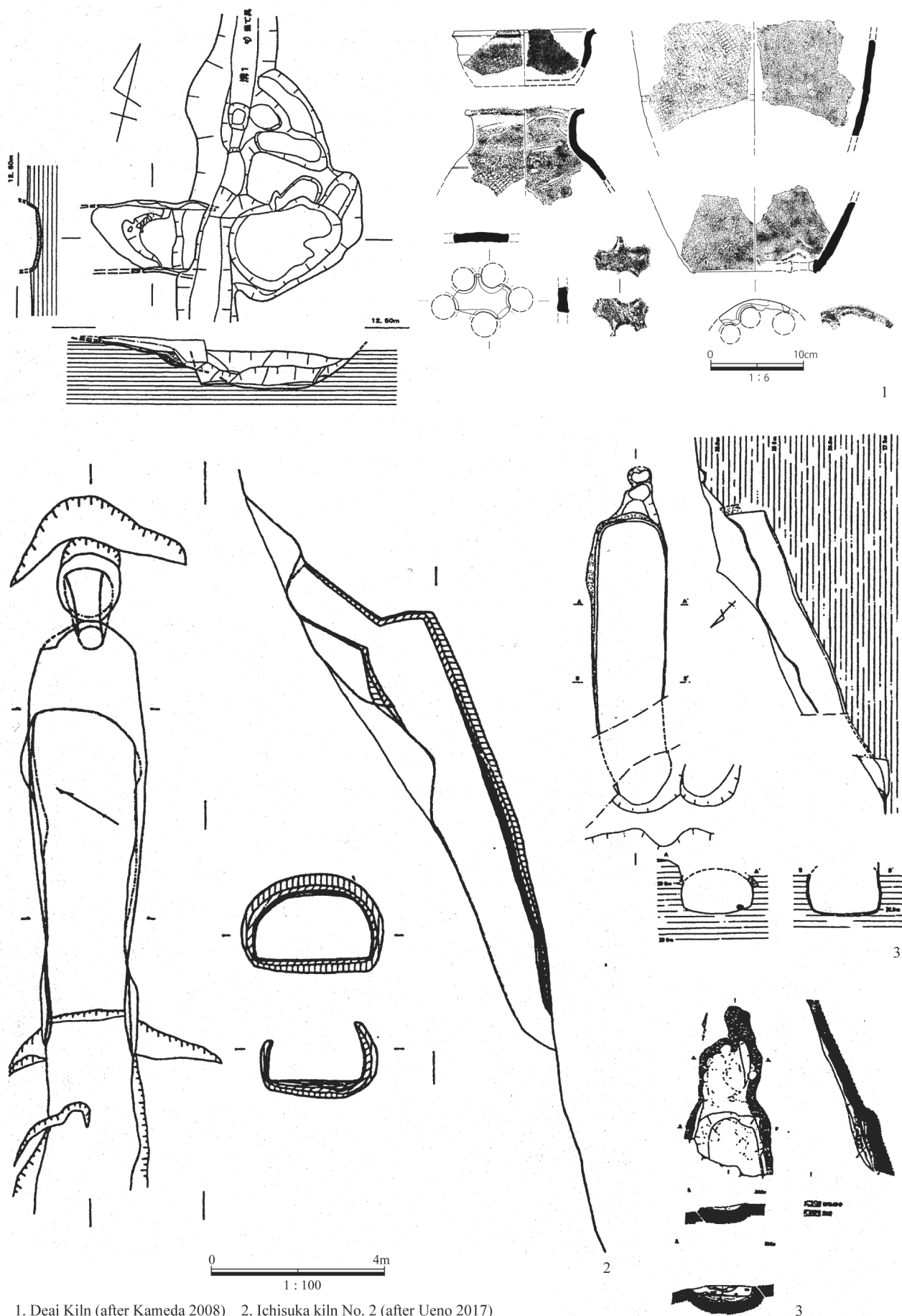
The confirmation of a certain number of kilns started during the period of TG 232 in SKG with such kilns as the Asakura kiln and Iyashiki kiln in the Kyushu area, West Bank kiln of Mitani-Saburoike in the Shikoku area, Okugatani kiln in the Setouchi area, and SKG, Suita No. 32 Kiln, Ichisuka No. 2 Kiln in Kinki area. In addition, the presence of kilns is assumed in the southern and western end of the Kinki area because of the distribution of the characteristic early Sue ware (Nakatsuji 2013). The distribution of kilns shows that kilns were introduced along the inner sea corridor from northern Kyushu to Osaka Bay.

As briefly mentioned in section 2.2, Ueno Kozo considered the southern Mahan area a possible origin place of Japanese kilns. He emphasized that early kilns in Japan have a small and linear planar shape, despite the difference in the presence or absence of a step between the firebox and the firing chamber (Ueno 2010, 2017). Fujiwara Manabu compared the kilns in the southern Korean peninsula from the late fourth to early fifth century with those in the Japanese archipelago (Fujiwara 1992). In consideration of the shape and size of the Samryongri/Sansuri site kilns, he found kilns in the southern Korean peninsula to be 4 to 15 m in length, 1.3 to 3.0 m in depth, and 10° to 30° in incline. Also, the vertical location of kiln-building was classified as underground, semi-underground and aboveground. Furthermore, Fujiwara determined that kilns were introduced to the Japanese archipelago when a huge, narrow kiln was formed in the Korean peninsula. Referring to these studies, let us begin our examination of the early kilns in Japan based on the previous analysis in this chapter.

The possibility of a step between the firing chamber and the firebox in the Iyashiki Kiln has been pointed out (Fujiwara 1992), but other than that the early kilns in the Japanese archipelago have no step. The firing chamber remained in Suita No. 32 kiln and Ichisuka No. 2 kiln. They are type IIc kilns, which have a slightly long firebox and a round flue (Figs. 2.6: 2–5). Besides these examples, most of the kilns in the period of TG 232 in SKG do not have a step. This fact shows that the early kilns in Japan were not descended from the kilns in Mahan and Baekje but were descended from kilns in the Gaya region. It was pointed out that the early Sue ware is similar to the stoneware of the Gaya region, such as that of the Haman, Changwon, Gimhae area. Since the early Sue ware has the quality and color of the body fired at high temperature in a reducing atmosphere, it can be understood that it was fired by a consummated type IIc kiln from the beginning of the introduction.

Incidentally, the amount of stoneware fired by oxidation firing that was distributed in the Korean peninsula,





1. Deai Kiln (after Kameda 2008) 2. Ichisuka kiln No. 2 (after Ueno 2017)  
3. Iyashiki Kiln (after Ueno 2017) 4. Okugatani Kiln (after Ueno 2017)

**Figure 2.6. Early kilns in the Japanese archipelago.**

including cooking utensils such as a steamer and a deep pot, increased in settlements without kilns such as the Nagahara and Shitomiyakita sites in the Kinki area starting in the fifth century. Based on the characteristics of the steamer, it is obviously related to the Baekje and Mahan regions (Terai 2016). It seems that specialists from the Baekje and Mahan regions introduced other new technologies, along with kilns, to the Japanese islands.

## 2.5. Conclusion: Spread of kilns in East Asia

As the author examined above, the diversity in the peripheral areas around China is closely related to the regional differences of kiln types in China, which can be roughly divided into north China along the Yellow River and central

China along the Yangtze River. In north China, updraft kilns appeared first, and then flat kilns (type Iia) appeared in the Warring States period. In central China, tunnel kilns

(type Iic) appeared around the Erlitou period and continued for a long time through the Qin and Han dynasties.

Kilns appeared earlier in Northern China, but were difficult to fire stably at high temperatures (more than 1000 °C), judging from the firing quality of the stoneware and structure of the kiln. Low-temperature kiln firing was adopted instead of open-field firing in order to adapt to the cold climate, in which firing temperatures do not rise easily, and the limited forest resources. On the other hand, central China is warm and humid. People could fire stoneware by open firing with a stable temperature from 800 to 900°C, but kilns started to be used for high-temperature firing in order to obtain more rigid stoneware. As a result, celadon was created there.

In the Qin and Han dynasties, a flat kiln of short-wide style (type Iia) was widely used in the Yan state area, which is adjacent to the Korean peninsula, just before the kiln and its technology were introduced to the Korean peninsula. Considering that Wajil ware was fired at a low temperature

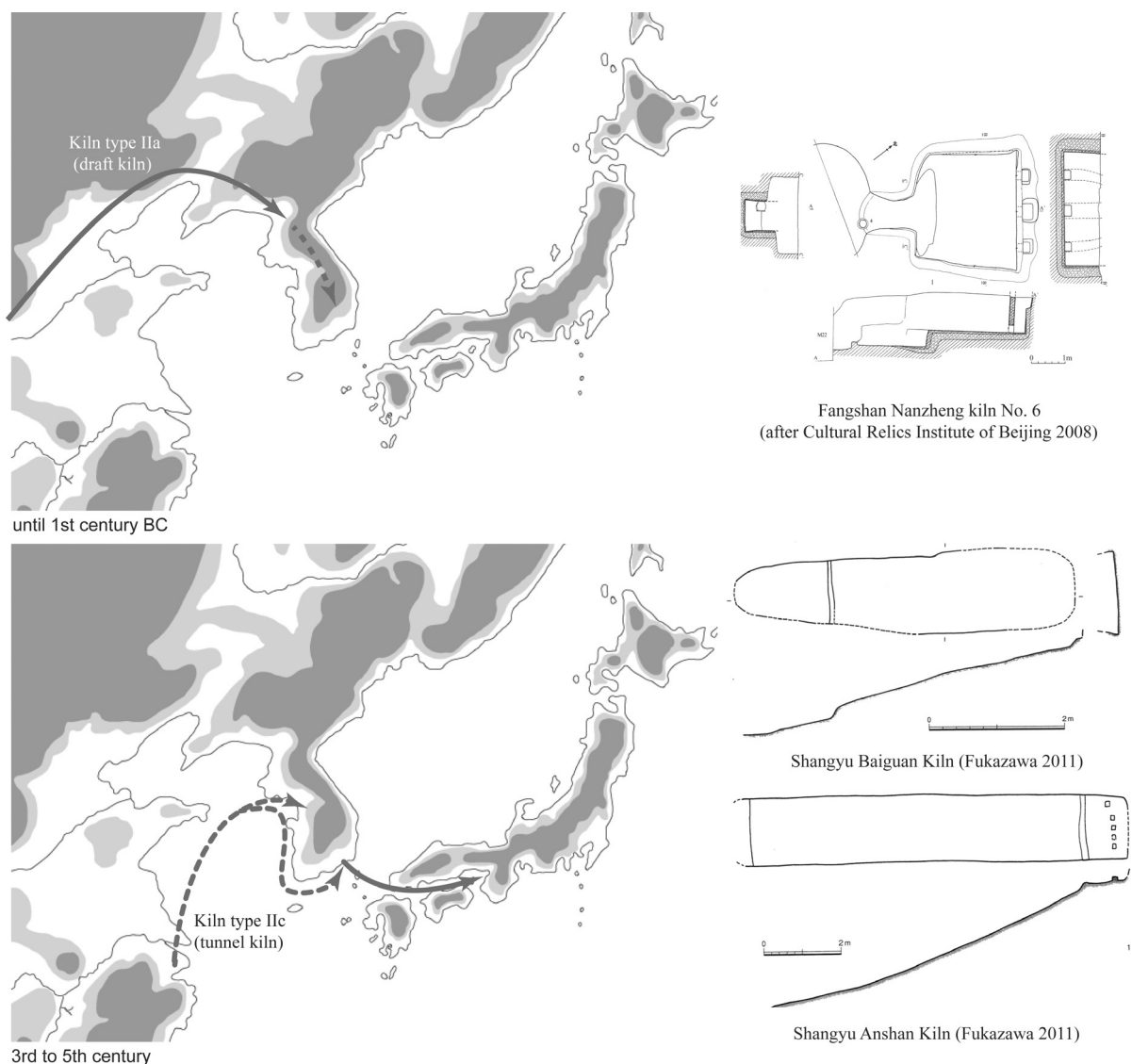


Figure 2.7. Spread of the two types of kiln.

(under 1000 °C) according to the analysis of the clay (Kanegae and Fukuda 2006), there is a high possibility that the flat kiln was introduced to the Korean peninsula from the neighboring area.

With the arrival of the technique and structure of the tunnel kiln of long-body type Iic in the KTK period, people who were already using kilns of the former style succeeded in improving them or accepting the new style. Kilns were built on the slope and had a long firing chamber to improve flame flow. As a result, the maximum temperature of firing became higher than 1000 °C and stoneware came to have a more rigid body. However, the structure of kilns was not uniform and had great regional differences. The broad-short style with a step between firing chamber and firebox was maintained in the Baekje and Mahan regions, while kilns were changed to tunnel types without a step in the Gaya and Silla regions. It is significant that kilns were introduced to the Korean peninsula twice, in different periods (Figs. 2.7).

The Deai kiln, which was the earliest kiln in the Japanese archipelago, was influenced by kilns in the Baekje and Mahan region, but it was short-lived. In the period of the TG 232 kiln of SKG, the kiln and its technology were introduced in the range from the northern Kyushu area to Osaka Bay by sea again. The style of kilns was strongly influenced by kilns in the Gaya region, which is a narrow-long tunnel kiln.

The introduction of kilns and their attendant techniques is always related to political interaction in East Asia. The first spread was the spread of flat kilns through technological diffusion at the time of the establishment of the Lelang commandery. In the second spread, of tunnel kilns, Baekje began to build a stronger relationship with the state of the Southern dynasty in China against a northern rival, Goguryeo. Also, in the case of the Japanese archipelago, there were conflicts among Japan, Silla, Gaya and Goguryeo, which was pushing southward. It can be said that the introduction and development of kilns was complicated in combination with the activation of interaction, the change of trade networks, and international competition.

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## The Basic Concept and Appearance of Tunnel Kilns: Ethnoarchaeology and Sue-Ware Kilns from the Point of View of Experimental Archaeology

Masaaki Kidachi

Translation from Japanese into English: Robert Sträter

**Abstract:** The author describes the principle of the kiln drawing flames from the basic design of the kiln, the inclination angle of the floor, the relationship between the volume of the firing section and the opening area of the firing and smoke outlet, and the temperature of the room. Furthermore, the points to be noted when excavating a kiln are described separately for the firing port, the combustion and firing sections, and the ceiling of the firing section. In addition, from the results of experiments on Sue-ware *anagama* kilns, the color tone and temperature difference, stress on the kiln itself, refractoriness of the soil and fuel consumption are explained.

**Keywords:** Structure of kiln, tunnel kilns, flame ignition, inclination angle, temperature difference, color tone, stress of Sue-ware kilns

### 3.1. Firing principle of tunnel kilns: about “pulling the flame”

Climbing kilns are made and built on slopes. However, depending on the construction of the kiln type, the choosing of a site changes significantly. Construction and site conditions of a kiln are in a symbiotic relationship.

#### 3.1.1. The ignition and extinguishing of embers (*oki*)

When modern potters fire with tunnel kilns or multi-chambered climbing kilns (*Renbō-shiki Noborigama*, Fig. 3.1), they pay attention to the intensity of the flame. They may notice a stagnation of temperature during the firing, perhaps because the fire does not burn well even though plenty of fuel has been added. Potters describe this state as “pulling the flame.” To ensure the correct temperature, different measures must be applied. For instance, by mixing and piling up the accumulated charcoal in the firebox and supplying oxygen to the smoldering charcoal, the firing is accelerated. Other measures include shifting the thrown-in burning material, exchanging large pieces of firewood with fast-burning scantlings, or closing and opening the flue.

If the fuel burns well, the firewood ignites, and after heat emission, it turns to embers. The embers cover the entire floor of the firebox and keep the interior of the kiln warm. Nevertheless, if too many embers accumulate, adding the next batch of firewood makes the space smaller, which causes a hard burning of the firewood so that the embers are scratched out from the firebox. Regarding the color of the

embers, some potters differentiate between “bad embers” (extinguished embers) and “good embers.” “Bad embers” are dark and never burn out well. “Good embers” are bright, burn down smoothly, become ash, and the speed at which the next firewood is replaced by new embers is fast. We can say that the renewal of firewood and embers is the decisive factor for the temperature rise in the kiln. On the other hand, if the embers, which kept the kiln warm, are scratched out, the temperature of the interior of the kiln will fall suddenly. This does not mean that it returns to zero, because the entire kiln has already accumulated heat, but it wastes time and fuel.

According to modern potters, the ignition of embers can be good or bad. The reason is not only the kiln’s construction; some other causes like changes in the environment or the kiln firing may be assumed. Not all causes can be made clear, but first, the basic concept of kiln firing should be explained.

#### 3.1.2. The principle of the flame’s ignition

If the supply of oxygen and carbon dioxide is optimal, even when the space is closed, the burning will be accelerated. A tunnel kiln was dug like a tunnel in a slope, and air flows one way from the stokehole to the flue hole. This flow becomes proportionally faster if there is a significant difference in height between the stokehole and the flue hole. If the stokehole’s outlet area and the flue hole are large, it becomes proportionally faster.

**Inclination angle of the floor and basic design of kilns.** Takuma Yogo points out the importance of the ratio of the



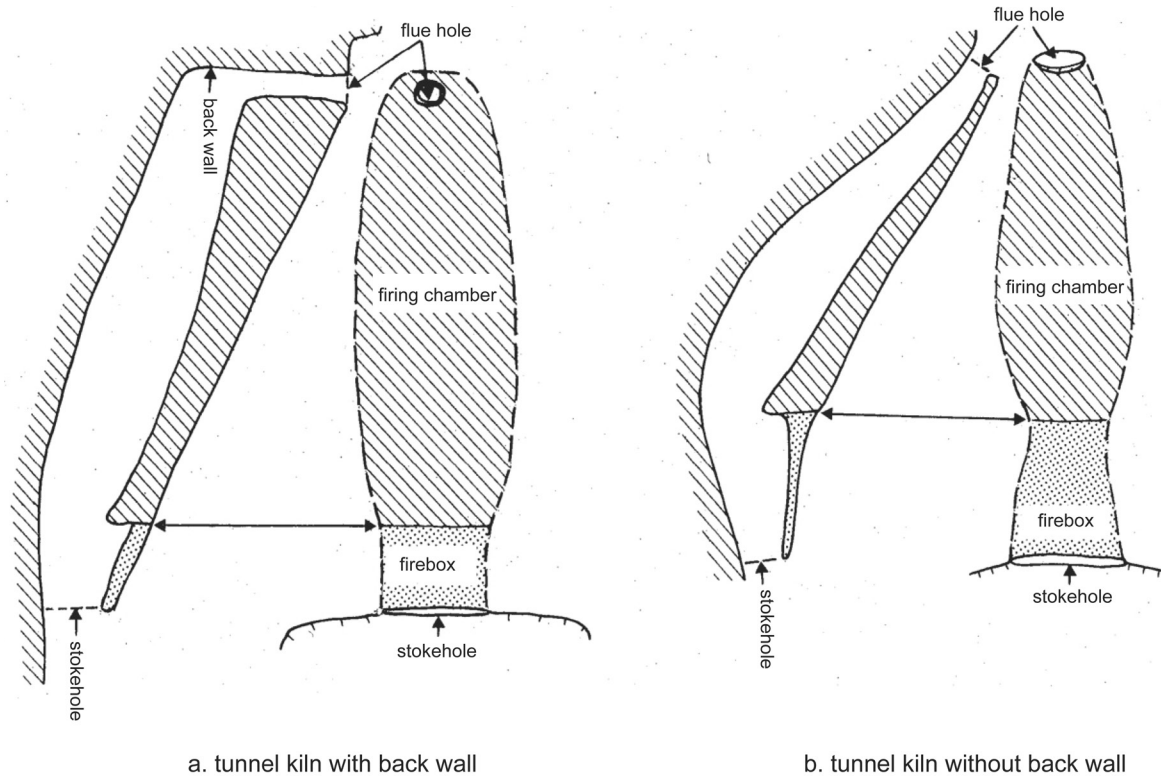


Figure 3.1. Terms for parts of a tunnel kiln (Kiln Research Society 2010).

difference in height between the stokehole and the flue hole, and their horizontal distance (Yogo 2010: 102). The decisive point of the kiln's construction is not the floor's inclination angle, but the difference in the height of the stokehole and the flue hole, and the horizontal distance is interrelated.

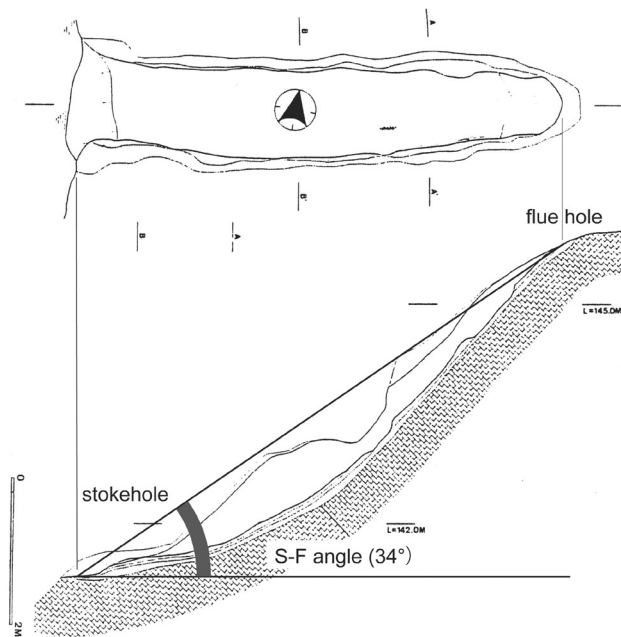
If this is the case, then the supposed angle, which is a connected line between the floor of the stokehole and the back side of the flue, influences the power of the flame. Let it be called the "S-F angle" provisionally (Fig. 3.2). Because there are some cases where the flue remains, it is possible to compare and examine the flame's ignition by the difference between the elevation near the stokehole and the elevation of the flue, and their horizontal distance (Kidachi 2019: 34–35).

Today's potters increase the flame's ignition through the height of the chimney, but the products are in the kiln, and because of this, they make the floor of the firebox as horizontal as possible, and so it is necessary to increase the S-F angle via the chimney. There are no verifications of chimneys through Sue-ware (Japanese stoneware) kiln excavations. The slope of Sue-ware tunnel kiln floors are steeper than today's tunnel kilns. There is a big difference in height between the stokehole and the flue hole of the kiln. The kiln itself is considered to have played the role of the chimney.

**Capacity of the firebox and aperture size of the stokehole and flue hole.** The essential factor determining the surface area of the firebox's aperture

and the flue is the capacity of the firebox (Furutani 1994: 38–39). Because a tunnel kiln is a room where the firebox and firing chamber are located next to each other, distinguishing the boundary is not easy. Nevertheless, by detailed observation of the burning state of the walls and floor and the charcoal and ashes from excavations, it is possible to confirm the combustion's extent. However, when more than half the ceiling has collapsed, it is challenging to figure out an exact calculation of the firebox's volume. Besides, it is arduous to explain the surface area of the apertures of the firebox and the flue through excavations. In particular, it is complicated to determine the opening area at the time of firing because the firing mouth is repeatedly created and destroyed each time it is operated. It may be possible to estimate the size of the opening from the area of the burned part.

As above, due to the S-F angle of a tunnel kiln, the flame's ignition is strong. Furthermore, depending on the increase and decrease of the firebox's surface area and flue hole's aperture, the degree of this strength can be controlled. Modern tunnel kilns use this concept, and all is planned according to the clay, the form of the product, the amount of available fuel, and feeding time. The balance is determined by various factors such as the firebox's size, the fuel's opening surface area, or the chimney's length. However, because of weather and atmospheric pressure, conditions are rarely, if ever, identical. When the balance between natural conditions and kiln firing crumbles, a stagnation of temperature rise can be assumed.



**Figure 3.2. Measuring method of S-F angle (Koyanagi No.1 kiln in Kyoto Prefecture) (adapted from Kiln Research Society 2004).**

### 3.1.3. Temperature differences in the kiln

The flame in the firebox stretches out widely, but it cannot heat the whole firing chamber, which is several meters long. There are high temperatures in parts, which face the firebox (in front of the fire). However, the temperature falls rapidly in parts near the flue. Because the fire rises to the ceiling, the floor's temperature is low, and that of the ceiling area becomes high.

We can say that the tunnel kiln has a structure whose primary purpose is to raise the kiln's temperature rather than homogenize the temperature. The temperature difference inside the kiln cannot be avoided in the upper construction. Nevertheless, by taking enough time for the roasting step and continuing the heating, the temperature difference can be reduced. Once the temperature is raised, the temperature difference cannot be reduced (Furutani 1994: 129).

### 3.1.4. A flame that requires heat

If there is a temperature difference in the kiln, the flame flows to the warm part, avoiding the cool part. Once the flame's flow has started, it cannot be easily changed. To heat the inside of the kiln without any temperature difference, consideration must be given to the fuel input location and the air passages.

If the difference in height between the entrance and exit is large, the flame's pulling will be intense. If a chimney is constructed during firing, the S-F angle increases noticeably. However, the cooled chimney does not show the expected effect. If the chimney is installed from the beginning, because the kiln firing warms the chimney at

the same time, the original effect is maintained (Furutani 1994: 39).

A temperature difference inside the kiln is unavoidable in the upper construction of a tunnel kiln, but by a moderate rise in the temperature of the whole kiln, the difference in temperature can be reduced. That is why the beginning of kiln firing is particularly important. At first, a small fire is lighted outside the stokehole, and when the outer wall heats up, the flame will get progressively closer to the inside of the stokehole. If the warmed firewood burns directly inside the firebox, the high temperature inside the kiln rises immediately, and stonewares may be damaged. If the firing part of the kiln takes time, it can be heated later, but if the entrance is not heated at first, it will not be sufficient. Furthermore, if the stokehole's outer wall is not heated at first, it will be difficult to warm the kiln's back. If the first roasting is incomplete, the required temperature will not be reached. Modern potters say that it is essential to slowly warm the temperature in order from the entrance to the flue hole by roasting for a long time, to eliminate temperature irregularities inside the kiln and unevenness of the flame (Furutani 1994: 126–29).

### 3.1.5. Eructation of the kiln

In modern kilns, flames may spout out from the firebox. Some potters call this phenomenon “eructation,” which is a bad sign for the flame's pulling. This phenomenon is produced because the flame's flow, which should face towards the flue, does not grow favorably. When the rising of temperature is not going well, or when the firewood is thrown in too fast, the phenomenon will be excited. In modern tunnel kilns, there are numerous cases in which soot sticks to the firebox's surroundings. It is not a “burp,” but happens because the flame often leaks to the outside of the stokehole.

## 3.2. Evidence of kiln sites

### 3.2.1. Stokehole

The stokehole is the entrance of the kiln, where the firewood is added during the firing stage. In ethnological examples, the stokehole is built after the kiln is filled, and at the moment of taking everything out, it will be destroyed. Therefore, it is difficult to confirm a stokehole at the site unless the conditions are excellent. The detected “stokehole” is likely to be only a trace of a broken stokehole (Kidachi 2010: 126–27).

**The beginning of kiln firing from the ethnological perspective.** In ethnological examples of Japan, it was necessary to remove humidity from products and the kiln, so at the beginning of kiln firing, a large amount of firewood was thrown in to let the humidity volatilize gradually. Today's potters call firing by kiln “kiln burning.” It is a fact that the kiln is burnt to bake the products but, if the kiln is not burnt, products cannot be burnt. In order to fire a product, the temperature of the whole kiln should

be raised, and the radiant heat should be used to fire the product. The temperature is increased from the outside to the inside of the firebox, and then to the firing section.

**The unique entrance of the kiln: the entrance of the chevron shape.** At the kiln site in Hyogo prefecture, the kiln entrances are in the shape of a chevron, which is often burnt red. No similar fireboxes can be seen in other ethnological cases. Some assumptions about the firing of an empty vessel at the beginning at the kiln's construction were made, whether the surroundings of the kiln's entrance were widely burnt or the roasting opened a large aperture, and the stokehole narrowed successively. It is supposed that the stokehole narrowed. Generally, it is believed that the stokehole did not change from the beginning to the end of firing. However, the possibility should be considered that the shape of the "stokehole" and the firing section's position have changed. By this token, the chevron-shaped entrance could not entirely be a unique case.

**The process of detecting a stokehole.** It is necessary to comprehensively investigate the preservation of the remains which are recognized as a stokehole at the excavation site, from detailed observation and the distribution of the collapsed kiln wall and black coal layers. As one indicator for identifying the stokehole, there is a method that verifies the distribution area of the charcoal layer. However, it is necessary to note the next point. During firing, a large amount of embers may be scraped out to extinguish the fire if necessary, as they may have accumulated as charcoal. Moreover, immediately after emptying the kiln, a large amount of charcoal produced by reduction cooling of the kiln-fired burning material should be left, but the product cannot be taken out without removing the charcoal. It is assumed that large charcoal pieces were reused as fuel. Hence, a loss of information is possible after the charcoal was scratched out because it is left spread out on the floor. The charcoal would have been trampled into fine fragments and dust by the kiln removal work.

An even more effective indication for determining the location of the stokehole is the distribution area of the red burned soil, which was detected in the charcoal's lower layer. It is presumed that the area of red burned soil developed when the flame spread into the kiln after the beginning of firing and roasting outside the firebox. If we verify the movement's extent, we can probably conclude the place of the first firing. Nevertheless, if the firebox is destroyed at the time of the kiln's discharge, these fragments will accumulate as red burned soil. It is necessary to distinguish between red burned soil burned *in situ* and red burned soil of secondary deposition.

Furthermore, it is possible that the ceiling construction of the firebox area collapsed and accumulated on the floor – that the collapsed ceiling of the firebox part slipped down the sloped floor. There are many examples in which collapsed kiln wall fragments have tumbled down and accumulated because the firebox parts are almost flat.

For that reason, although we have excavated around the firebox area, it is difficult to identify which part is the collapsed kiln wall fragment, and observing the ceiling wall fragment's burning state will ensure accuracy. In the firebox area, the temperature increases even more, and there are many confirmed cases with glaze. It is expected that the temperature becomes gradually lower at the kiln's back than in the firebox part. Through conditional comparisons, we can reconstruct the original location.

**The ceiling of the firebox area's entrance.** The sunken kiln was a dug-out ceiling; however, entire parts of those are not dug out, and most of the stokehole is constructed on the ground. The carved ceiling is that of the firing chamber. The sunken kiln type's firebox at the Karimata site in Ogōri in Fukuoka prefecture has a constructed ceiling. At the time of excavation, the whole ceiling was collapsed, but by detailed observation of the side walls, a provisional ceiling construction has been confirmed (Mochizuki 2010: 41–42). The ceiling construction of the firebox section may be closely related to the shape of the stokehole. In this way, based on the stokehole, it is assumed that the firebox part would collapse on to other parts and be destroyed at the moment of the kiln's discharging. Hence, it is difficult for it to remain. Nevertheless, there are examples that confirm those collapsed remains directly above the floor. Sometimes there are traces left on side walls as changes in the burn color. At excavation sites, detailed observation and documentation are necessary.

The precise observation of detectable remains like side walls and the floor allow us to set a certain standard. However, if the verification of the collapsed ceiling fragment's preservation state moves forward, it will help in understanding the remains of the firebox's provisional ceiling and the stokehole.

**The situation of the stokehole's front area.** At sunken kilns, the soil is thrown outside the stokehole to construct a flat surface in front of it. On the other hand, temporary storage for production use should be considered. In the case of a sunken kiln, a large amount of dug-out soil is discharged, but at the beginning of digging, it is assumed that a vertical precipice was scraped out. Perhaps a horizontal hole was dug into the near-vertical wall. Independent from the scratching out of the wall, some flat areas are formed. In the case of a steep slope, the discharged soil slips down the slope and forms no flat surface. If there were no steep slopes, the discharged soil would form a flat surface. The flat surface would have been made lower than the kiln so as to improve efficiency and keep out rainwater. It is necessary to pay attention to the topographical modifications nearby and around the time of the kiln's construction.

In case of a semi-sunken kiln, the amount of dug-out soil is small, and the discharged soil would be used to form a ceiling. Thus, it is assumed that the amount of discharged soil was scarce. It is possible to dig down the

kiln's surroundings and float its body, but the topography's modification in front of the firebox area is not apparent.

Besides, many semi-sunken kilns at the Ushikubi kiln site in Fukuoka prefecture were constructed on steep slopes, and the front parts were carved out. An embankment cannot be confirmed. In this case, dug-out soil as well as the failed products and the charcoal were thrown away below the slope. There are many cases in which such sloped topography is used in the sunken kilns, but even in the case of semi-sunken kilns, there are some confirmed and selected examples.

### **3.2.2. The firebox and firing chamber**

In the case of a tunnel kiln, the firebox and the firing chamber follow one after another, and it is often difficult to differentiate between them. In the case of a tile kiln, there are prepared steps (Ōkawa 1985: 30), and examples can be confirmed in which the firebox and firing chamber are divided. However, in the case of a Sue-ware kiln, it cannot be divided in general. When some of the fuel is left as charcoal or ash, it is assumed that its distribution area reflects the firebox's size, but attention should be paid to the fact that the distribution extent of charcoal and ash changes with each firing. It is possible that the range of the firebox section moved with each firing, just as the stokehole might have moved during firing. In that way, The size of the stokeholes identified in the excavations would then be the overlap of the burning areas experienced in multiple kiln firings.

**The firebox's ceiling.** The ceiling of the firebox part is where, in general, the temperature becomes higher inside the kiln. Air enters the stokehole, the flame of the firebox part rises diagonally to the firing chamber's ceiling, and the part which is in the combustion zone but quite near the firing chamber becomes hottest. Hence, this part of the ceiling inside the kiln was the easiest to damage, and it may have had to be repaired after each firing.

When temperatures become high, as in ash-glazed stoneware kilns, the ceiling cannot withstand the temperature, so columns, called pillars, are erected to prevent it from collapsing. It was thought that they were installed to divide the flame evenly. However, to achieve that, it would be enough to arrange the position of large products during the kiln filling. According to a thermal simulation conducted by the Japan Atomic Energy Agency, "Technical Exchange Meeting on Echizenyaki Stonewares," the ceiling temperature of that portion is the highest when there is no pillar. Conversely, when a pillar is set up, the pillar takes away the heat of the kiln (Technical Exchange Meeting on Echizen Ware 1998; Kidachi 2010: 122). It cannot be said that it played no role in "dividing the flame," but it cannot be thought that it had no role except to support the ceiling.

In conventional excavation research, sufficient attention has not been paid to the restoration condition of the

burning stability of the firebox's ceiling. If a collapsed ceiling remained on the floor, these fragments would become a crucial factor in knowing how to repair and burn. Usually, we try to verify repair traces of tunnel kilns by cutting open the side walls and the floor, but in this part of the kiln's inside the temperature is low, and it is a part that does not need so many repairs. The part that is indispensable for knowing the firing temperature is the fragments, and observation of these is essential. This is a principle that is not only limited to tunnel kilns.

### **3.2.3. The flue hole and the accompanying facilities in the kiln's and chimney's surroundings**

**The flue hole and the chimney.** For controlling the flame's ignition in modern kiln firing, the flue hole is opened and closed during the firing. It is possible that such work was also performed on Sue-ware kilns, but because a cooling reduction was conducted at Sue-ware kilns, it was necessary to seal the flue hole and stokehole completely airtight after the kiln firing was finished. If there is a flat surface in the flue hole's surroundings, it is assumed that an opening and closing were used. Because it is impossible to look through the stokehole to the end of the kiln during a firing test, the firing situation is often observed at the flue hole during firing. Since the firing mouth is narrowed down, the closer to the final stage, the worse the kiln's visibility from the firing mouth. By observing both the flue hole and the stokehole, the firing situation of the kiln's inside can be estimated.

In the case of a Sue-ware kiln, in order to avoid the accumulation of water at the flue hole, which runs on the surface, there is sometimes a drainage ditch that encloses the flue hole. It is assumed that the flat surface around the flue hole was not just a work surface, but also functioned as just such a water barrier. There is a sunken kiln with a groove in the smoke exhaust part, which is part of the Sue-ware kiln. It is presumed that the flame's flow blown out can be estimated by the firing state and the construction of the fuel to accelerate or suppress the smoke emission. The idea that different works like accelerating or suppressing the smoke can be conducted around the flue hole is fascinating. For this reason, detailed observation at excavation research sites is necessary (Mochizuki 2010: 60–61).

That the height difference between flue hole and stokehole is important for the flame's ignition has already been mentioned above. However, due to the ditch, which is fixed at the flue hole, the height difference between stokehole and flue hole would be smaller than the height difference of the original ground surface and would have suppressed the flame's lighting.

Because a kiln with a ditch has a hollowed-out form, the difference in height must be enormous. Besides, the temperature on the floor is reduced, and the fuel consumption increases. Various measures are required, such as narrowing the opening area of the flue hole and the

stokehole to prevent fuel consumption and heat loss due to smoke exhaust. It also depends on the location's condition, like terrain, but it is assumed that the main reason for installing the ditch at the flue zone is the idea of reducing the efficiency degree, even though it is a sunken kiln type.

#### **The accompanying features of the kiln's surroundings.**

In the case of a semi-sunken kiln, many cases can confirm extensive changes in the environment of the kiln. Remarkably, a continuous pit was laid around the ditch to allow rainwater to escape the surroundings while protecting the exposed kiln ceiling. This not only let the rainwater flow off, but also became a stairway or a passage for applying the flue hole, and it is possible that it was used during the repair of the exposed ceiling. If a crack forms in the ceiling zone, air can leak out from it. As reduction cooling would lead to oxidation, modern Daruma kilns were cooled after firing by adding muddy water to the entire kiln, filling in the cracks. Similar work was necessary. Furthermore, there are also cases where the slopes around the kiln have been modified like terraced fields to provide flat surfaces. This area may have been used as a fireplace or a simple workshop. Ethnoarchaeological studies of people who lived in the mountains are indispensable in clarifying the supply lines of the potters at that time, such as the passage to the kiln and the locations of the mountain paths. Ethnological examples of modern charcoal kilns should be consulted (Fujiwara 2020).

Near the kiln, the workshop or the pit for clay mining can be detected, and there are also good examples for reconstructing the supply ways. However, from a multitude of Sue-ware kilns in western Japan, there are many cases in which only the kilns can be detected in the mountainous regions, and in contrast, it is highly possible that the workshops were built in the plain's settlements. In the east of Japan, both kilns and workshops were generally built in mountainous regions. It is becoming clear that there were significant regional differences, but it is assumed that these differences indicate whether the Sue-ware production system was relatively independent of the local community. Even if the kilns are similar, the facilities around them may differ depending on the difference in the social systems that supported them.

### **3.3. Firing experiment with Sue-ware tunnel kilns**

#### **3.3.1. An experiment with temperature difference and color tone**

**The atmosphere that determines the color of Sue ware: experiment with cooling and firing.** Because the soil's components decide the color of the finished product, the firing and the cooling, the color tone of stonewares is diverse. Experiments have revealed that Sue ware has a blue-gray color and is cool and reduced (Sasaki & Yogo 2004, Yogo 2010).

Therefore, I would like to introduce the experiment with the firing and construction of a Sue kiln conducted by

the Kiln Research Society (Kidachi 2010). By observing the fired products from the experiment, it was found that many of the pieces placed in contact with the firebox were bluish-grey and firmly baked, and the natural glaze was melted. The black color of the stonewares which were arranged near kiln's back wall had faded, and although ash fall is confirmed, it does not melt. Ash falls down on the whole firing zone, but there is only a small part in front of the fire that melts. It can be said that the firing temperature was high enough to melt the ash only in the limited part in front of the fire. Ashes move from the front of the fire to the kiln's back and gradually change their appearance due to the temperature difference, thus: "melting (vitrification) → solidifying and adhering (welding) → mere powder ash." Depending on the kiln firing, the atmosphere inside the kiln changes precipitously. During the stage of removing the moisture from the kiln by roasting and gradually raising the kiln's temperature, an oxidizing atmosphere is maintained in the kiln. After reaching a specific temperature, we finally enter the "offensive fire" stage.

The firewood will suddenly remove the temperature of the firebox zone if put in the high-temperature firebox part. The firewood, which absorbs the kiln's heat, will begin to burn rapidly. At first, it produces a situation of oxygen deficiency, then dark black smoke rises, and the kiln's inside part turns into an airtight atmosphere. Due to the oxygen deficiency, the goods in front of the fire will be directly covered with dark black smoke, i.e. the warm air of a reduced atmosphere. By throwing in the next load of firewood without changing the state of reduction, this state can be kept, but the kiln's inside temperature will not rise. If the reduced state declines, it turns into an oxidative atmosphere, black smoke turns into flames, and high temperatures result. The burning of firewood is accelerated, and depending on the oxidative flame, the temperature of the inner kiln rises. After a while, the view into the flame-filled kiln widens and the products glowing from the heat become visible in white. The oxidative atmosphere stage is the moment of the highest firing temperature. If this moment is passed by, the kiln's inner temperature will begin to fall. Burned firewood turns into embers because a large amount of heat will no longer be generated. These embers take on the role of the firebox's heat insulation, but they do not raise the temperature of the firing chamber. This is because the embers do not generate long-stretching flames.

Just before the temperature inside the kiln begins to drop gradually, one adds new firewood. In this way, through a change in reduction and oxidation, the temperature rises, and offensive firing is conducted by balancing the timing when firewood is thrown into the kiln and the amount, the oxidative atmosphere; in the other way, the reduction atmosphere can be prolonged.

When the desired temperature is finally reached, a large amount of firewood is thrown in, and the kiln is sealed entirely airtight. The firewood tries to burn in the high

temperature, but since the air inlet and outlet are completely closed, this deprives the kiln of oxygen. From the kiln wall to the products, it burns by consuming all of the oxygen, but it cannot burn out and turns into charcoal. A high temperature produces a strongly reduced atmosphere, and while maintaining this atmosphere, it successively cools down the kiln, so that the Sue ware shows its reduction color. It is not only the product but also the inner walls of the kilns, the ceiling, the floor, and all turn to that reduction color.

After the kiln is closed, the walls shrink, causing fissures. Therefore, to avoid air leaks, mud and muddy water are put on the whole kiln to cover the crevices. Directly after occlusion, the kiln's inside spits out a large amount of smoke caused by the burned firewood, and because the pressure becomes higher, smoke is emitted from the kiln walls, the stokehole and the flue hole. The work of putting mud and muddy water on parts where smoke is rising and covering crevices must be done repeatedly. If the work eases off and the pressure is low, oxygen enters the inner kiln through the crevices, and it turns to an oxidative atmosphere so that the color tone becomes red. This post-occlusion treatment is thus essential for producing a blue-gray tone.

**The formation of the ash pile.** In the experiment, reduction cooling could not be performed successfully. Due to the foundation, there is a limit in the kiln's fire resistance, and at the moment of the kiln's closing, a large amount of firewood could not be thrown in. Hence, at the moment of the kiln's cleaning, a large quantity of the added firewood burned out to ash in the firebox, and there was very little charcoal left. Despite the firing experiment having been performed for ten years, this did not form a disposal area of ashes and burnt-out charcoals (*haibara*) like at the Sue kiln excavated around the experimental kiln. The excavated ash pile sometimes exceeds 1 m. It contains charcoal, but most of it is a powdery, black soil. The actual composition of the ash pile is an accumulation of charcoal powder and black charcoal.

Of course, charcoal can accumulate if the act of scratching out the embers is repeated often during firing. However, it is possible to reduce such loss by devising a method for heating sufficiently, and it is not clear why this work was done in the Sue kiln or why a thick coal accumulation layer was formed. It becomes clear that the ash pile is an important source that indicates the conditions of the firing method, but at the same time, it also becomes apparent that its formation mechanism is unclear.

**Reducing flame firing.** As described above, although the reduction cooling has not been sufficiently successful, in the firing experiment, it was possible to fire the reduced color *sueki*. Through observation of the firing stage, it turned out that only the part exposed to the intense flame was discolored.

After the added firewood starts to burn, a large amount of black smoke is spat out, but its temperature is still low. It gradually oxidizes and turns into flames, but during this transitional stage, the goods may turn into a reductive state. Once it was fired at high temperature, even if an oxidative state was reached at a lower temperature, it would not return to the oxidized color. Nevertheless, it is difficult to obtain a perfect reductive color. Furthermore, in order to observe the product's burning state, a photograph was taken during the firing process. When around 1000° is surpassed, and the oxidation progresses, the flame inside the kiln turns transparent, and a white glimmer can be easily seen on the products. At that moment, the hot part of the product shines brightly on the protruding parts, and the slightly dented parts become darker. When it was left as it was and the temperature inside the kiln began to drop, the protruding parts on the contrary changed to a dark color tone and the slightly dented parts began to shine white. Because cold air enters from the stokehole, the protruding parts would directly hit the cold air. Since the cold air cannot directly hit the hollow portion, it seems that the heat was still stored, and the temperature seemed to rise relatively. After that and because firewood was thrown in, it became impossible to observe the kiln inside. The air directly hits the protruding parts in front of the fire, slightly reducing the high temperature, then the cold air has a slightly oxidizing effect. It is assumed that the differences in temperature and atmosphere strongly influence the product's firing condition and also its color tone.

It is presumed that the color tone of Sue ware is determined by reducing the cooling stage's atmosphere and the influence of the reducing flame. In addition, many of the early examples of Sue ware have a sepia-colored cross-section and are fired firmly. It is the coloring by high-temperature firing in an oxidative atmosphere that turns the cross-section sepia-colored. It is assumed that the product was fired at a high temperature while maintaining the oxidation state, and the reduction cooling was performed after the temperature decreased in the final stage. Since the reduction cooling temperature is low, it is assumed that the reducing atmosphere was not able to break into the cross-section that had been fired at high temperature. In many cases, only the surface is reduced and cooled, with a dark bluish color. Therefore, in the early stage of the kiln introduction, it is possible that the offensive firing maintained an oxidizing atmosphere, and that the reducing atmosphere used in the experimental kiln did not occur.

**Baking of products and the kiln-filling position – the actual state of temperature difference.** When fired in an experimental kiln with a total length of about 7 m (no refractory bricks used), the kiln's chimney's temperature was about 200° lower than that of the firebox. Even in the Sue-ware experimental kiln (made of refractory brick) at the Ogōri City Archaeological Center in Fukuoka prefecture, a temperature difference of about 200° was confirmed even though it was a small kiln of about 4 m. In these experiments, the temperature near the ceiling

was measured using a 50 cm thermocouple, but similar temperature differences were confirmed in the experiments measured with a 1 m long thermocouple. This is the case not only in front of and behind the fire of the firing chamber; it has also been confirmed that similar large temperature differences in the kiln's inside near the ceiling and the floor occur (Technology Exchange Meeting of Echizen Stoneware 1998). It was also confirmed that in the case of large goods, the hot wind of the high temperature near the ceiling hits the products' rims and blows into the inside of the product. Because the hot wind's temperature near the floor is lower than near the ceiling, a huge temperature difference between the product's inside and outside occurs. Inside large ancient Sue-ware pots, even though firing near the rim is well done, there are many cases where the bottom's outer surface is poorly fired and is whitish gray and soft. Observations of the inside and outside surfaces of large goods are rarely done, but it would be important to understand the form and height of the ceiling of course, depending on the kiln-filling position and the shapes of the rim and body portion of a massive product, both when hot air is easily blown and when hot air is not blown.

Since it is a fact that a temperature difference occurs inside a kiln, it is necessary to reduce the difference a bit by devising a firing method, such as prolonging the firing time or performing "intermittent firing." The temperature difference between the areas in front of and behind the fire will spread widely if the firewood is rushed. The floor surface is where it is particularly difficult to store heat. The flame inevitably rises, and the temperature near the ceiling rises.

After the firing experiment was continued for over ten years, the kiln was fired continuously for three days and nights. It was changed to "stop the fire" that interrupts the kiln at night. The advancing age of the participants made it difficult to work continuously for an extended time, but as a result of this experiment, it seems that the entire kiln will accumulate heat due to the leftover embers, and the temperature difference will decrease, and the flame of the kiln will crawl on the floor. Although the number of days of firing increases and the loss of firewood fuel is unavoidable to a certain extent due to stopping the burning, it is an effective means of reducing the temperature difference. However, it is not possible to confirm by excavation research whether this procedure was conducted.

**The form and temperature difference of the kiln's rear.** In the firing experiment kiln, it is assumed that the firing of the products, which are packed in the rear area, was relatively weak, and the firing temperature was low. The construction of kilns in which only the rear of the kiln is sharply narrowed, and the slope is strengthened, is due to the fact that the heat was concentrated to make the kiln's temperature uniform. Nevertheless, the positioning of goods in the kiln's rear area on a steep slope is difficult.

If a temperature difference of about 200° between the part in front of the fire in the firing chamber and behind the

fire at the kiln's rear area is supposed, and the temperature in the rear zone was raised (or it was attempted to raise it) to 1150°, then the firing temperature of the foremost part of the firing chamber must have risen to 1350°. In that case, the temperature in the ceiling's vicinity should have become higher than in the vicinity of the floor on which the products were placed. This high temperature requires a considerable amount of fuel, and the ceiling can collapse. Furthermore, from the experiences of the firing experiments, it is assumed that the temperature rising to 1350° would exceed the limits of the kiln's fire resistance and stamina, and a temperature rising to this extent was problematic. It is assumed that the kiln was fired while maintaining the temperature balance between the kiln firing section and the kiln rear.

In modern kiln-packing, products that are to be fired at a high temperature are placed in the front of the firing section. The medieval (Kamakura and Muromachi period in Japan; 1199–1573) stoneware kilns were constructed in the same way, and even in the early modern (Azuchi-Momoyama and Edo period in Japan; 1573–1868) multi-chambered climbing kilns, the temperature difference inside the room was unavoidable, so the products and glaze were changed depending on the kiln filling position and height (Kinkodō Kamesuke 1830). It is assumed that even at the Sue-ware kilns, vessels for liquid storage like jars, bowls and narrow-necked jars, which are sorts that must not leak due to firing failures or cracks, were placed in front of the fire and tableware that does not need high firing temperatures was placed near the kiln's rear.

### 3.3.2. *The stress of Sue-ware kilns*

**Stress concerning the temperature difference.** Due to the location conditions of the kiln's construction, geological features like terrain and water become essential. When the bedrock is stable, a sunken kiln cannot be built, and if it is too fragile, there is the danger of cave-ins. Fire resistance is also important. Notably, the ceiling part of the firing chamber is where the temperature rises the most, and if it cannot endure the high temperature, the ceiling collapses. If the ceiling temperature is more than 200° higher than the floor surface, and someone wants to bake the product at 1150°, the combustion ceiling will be as hot as 1350°. Not much base soil can withstand such high temperatures.

**Contraction stress concerning the sintering.** Clay is said to shrink by 10 per cent when dried and by 10 per cent more when sintered at 1100° or higher. If the ground is good, the ratio will decrease, but the shrinkage due to drying and firing will be 10 per cent. If the wall surfaces of the kiln have the same clay, a 5 m long tunnel kiln will shrink about 50 cm and a 10 m long kiln about 1 m. Since it touches the ground, a gap is created between it and the ground, and it does not shrink so much due to cracking, but the kiln itself also receives immense shrinkage stress due to firing. Products are not fired several times, but kilns are heated over and over again. Therefore, the already-fired material is added and kneaded into clay to suppress

the shrinkage as much as possible to build the kiln wall's surfaces.

**Fuel consumption and the soil's fire resistance.** Even in modern brick kilns, old bricks that have already been baked are preferred. In the case of new materials such as firebricks, the fire resistance is high, but since a large amount of heat is required to burn the bricks, older firebricks that have been baked are most effective (Furutani 1994: 49). Even modern potters reuse materials from old multi-chambered climbing kilns instead of firebricks to economize fuel. The fire resistance of modern firebricks is high, and a large amount of fuel is necessary to heat them, but traditional clay bricks are already baked, so they warm up quickly and save on fuel (Furutani 1981: 105). If such information is applied to the Sue kiln, it is not always necessary to select a ground with extremely high fire resistance. Although it is necessary to have a degree of fire resistance and stability that can prevent a ceiling collapse, if the degree of fire resistance is too high, fuel consumption will increase. It is better to choose the right ground. There is also the opinion that kilns made of soil of the same clay quality as potter's clay are suitable (Ōgami 1981: 26).

In the Sue-ware tunnel kiln, it was common to mix chopped straw with a length of 3 to 5 cm into the ceiling frame. A similar mixture of clay and *susa* (straw) is used for the clay walls of modern Japanese architecture. In modern earth walls, it is sometimes explained that the *susa* fibers play the role of connecting clay. However, in Sue kilns, the effect is only temporary because the plant fibers are burned out by the fire. As a result of measuring the shrinkage rate of clay mixed with straw, it can be confirmed that the clay that the shrinkage by about 20 per cent depending on drying and firing is reduced by 10 per cent (Kidachi 2010: 113). Because there are few experimental cases, it is necessary to confirm the effect with a large amount of soil.

### **3.4. The whole life of a kiln: the reuse of a "tunnel kiln"**

#### **3.4.1. The diversion of kiln walls**

There are examples of kiln sites where the floor of the kiln has been planed. Moriuchi Shuzo thought that the burnt floor might have been planed off to be used as a material for the kiln walls. (Moriuchi 2002). General excavations focus on the construction and operation of kilns but have not fully considered the post-abolition phase. The remaining evidence is not only from the construction to the abolition, but also contains all from the abolition to the present, so the life history of a kiln should be investigated and considered an important point. According to Tsunejiro Ito, who has traditional skills in charcoal-making and slash-and-burn cultivation, charcoal-making craftsmen excavated the old Sue-ware kiln site, collected the kiln walls, and crushed and mixed them into the new charcoal-made kiln wall soil. The sand-like "fired powder" from the kiln wall had already been burned and contracted. If

this were included, the kiln would become solid, and the shrinkage rate of the kiln walls would be minimized. For charcoal-making craftsmen, Sue-ware kiln sites become valuable sources of knowledge (Kidachi 2012: 26–27).

Such conversion was probably not only limited to present-day charcoal kilns. From cases where the floor of Sue-ware kiln sites was scratched off, it is supposed that collapsed ceilings and side walls were brought out from where they belonged. It is necessary to check not only the floor leveling but also the preservation of the kiln wall pieces buried in the soil. Although it is challenging to specify when the material was taken out, it should be considered whether it was immediately after the kiln was abolished or after some time had passed.

#### **3.4.2. Analysis to exclude mixed objects**

The more detailed the examination, the more the possibility that the ceiling has been taken away for reuse, as described above, becomes clear, but it is limited to the sunken kiln type. Most of the ceiling frame constructions left little room for investigation because the ceiling collapsed quickly. Excavation location information is no longer sufficient for analysis in the kiln. It is possible that some of the artefacts on the floor are newer than when the kiln was in operation, and detailed observation of the stratigraphic deposits and accompanying artefacts is essential. However, there have been few attempts to reconstruct various activities from the kilns' buried condition. There are even cases where the soil layer pattern in the kiln is not available, and even if it were, there are many cases where no consideration has been given to its meaning. Even when the excavated material from the floor is reported, it is necessary to think about various situations that may have arisen after the abolition of the kiln.

Even if it was confirmed that there was no prospective mixing, and in the case that the old stoneware fragments were used as a fired pillar at the time of the final kiln firing, the concept of reliable floor material would collapse. It is important to note that kiln artifacts may have been relocated, whether they are in the ash pile or inside the kiln.

The "mixed products" themselves are evidence of reuse of the kiln, which is also historically accurate. A detailed examination should consider the time of reuse and the method of the investigation itself. The life history of the kiln cannot be analyzed only through the perception that it was disturbed.

#### **3.4.3. The kiln's life history**

In traditional Japanese archeology, the reliable extraction of artifacts at the beginning of the operation without prospective mixing was an essential viewpoint for investigation. However, the actual condition cannot be approached unless the life of the kiln is investigated. Why was a kiln built there? Who and where did they get the



bases for placing the pottery in the kiln? Where was the clay collected, and where was the workshop? How can the flow lines related to kiln firing be restored? What was the nature of the surrounding environment before, during and after the kiln operation? After the kiln was shut down, was it left alone, or was it reused? In the future, it will be necessary not only to discard artifacts of different ages from the kiln as mixed products but also to ask why they were mixed.

We have turned away from that analysis and focused only on the time the kiln was operating. From now on, we need to look a little further. It is possible that the state that we had assumed for the appearance of the kiln at the time of operation was the result of reuse after its abolition. If we do not pay attention to the kiln's whole life, including the time after abolition, we cannot reconstruct the appearance at the time of operation.

The tunnel kiln is a simple construction, but various types of knowledge and information are used in making it. The excavated Sue kilns on the Japanese archipelago are numerous (Kiln Research Society 2010). To investigate the actual situation in detail, it is necessary to carry out firing experiments and detailed observation of the remains while keeping in mind the basic principles of the kiln described above. If we do not have the technology to fire a kiln, we cannot clarify the meaning of the kiln structure. We have been forced to experience it by repeating firing experiments (Kidachi et al. 2010). This is only an interim report on the research, but we hope it will help to observe the remains of the kilns and consider their function.

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## An Essay on Interdisciplinary Kiln Research and Agile Research Design

*Maria Shinoto*

**Abstract:** Archaeological research on kiln sites involves a wide range of additional disciplines in order to answer questions that archaeologists pose on their material and findings. Since kiln research typically poses questions on material used and processed, on the construction of kilns and firing technology which can only be solved with methods from natural science and engineering, kiln research is interdisciplinary in the first place. This essay summarizes the experiences of a decade of decidedly interdisciplinary research at the Nakadake Sanroku Kiln Site Center and other projects, tries to categorize the various patterns of collaboration and emphasizes the importance of an “agile” approach, which turned out to improve the results significantly as compared to traditional interdisciplinary research patterns.

**Keywords:** Agile Research, Interdisciplinarity, Archaeometry, Natural Sciences, Engineering, Research Process, Communication

### 4.1. Kiln research and interdisciplinarity

Archaeology benefits greatly from methods, theories and tools borrowed from other disciplines. Our sources are material remains of human life uncovered from the soil. Our method is excavating and documenting with words, drawings, photography, structured data and 3D data. The technology for excavating and documenting is getting increasingly sophisticated in the course of technological evolution in other disciplines, and recent developments are breathtaking. But excavation and documentation alone does not create a sensible narrative for understanding the past, the society, or whatever we are looking for to understand. Archaeologists need knowledge, ideas, methods, and tools from other sciences in order to make sense of their sources.

Kiln research is one of those fields of archaeological studies that are particularly dependent on interdisciplinary work. The construction and material of a kiln, the firing process and the firing material have to be understood from the point of view of an engineer as well as a potterer, excavated materials have to be handed over to mineralogists and other specialists in material sciences in order to understand the heat stress on the material and draw conclusion about temperatures and firing duration. Geologists can help finding sources of raw materials and, together with mineralogists, can offer hypotheses about the processing of the raw materials into an intermediate product that is then fired in the kiln. Of course, experiments under strict scientific observation and in cooperation with potterers and other practitioners – whose expertise

from another non-scholarly angle is highly valued – can help solving this problem from an additional angle. This is in contrast to a more archaeocentric and discipline oriented understanding, an understanding that is more focussed on problems, and which adds methods from various disciplines and even non-scientific knowledge to a project when needed. Thus, the constellation of disciplines involved in a problem may change in the course of the ongoing research due to new insights. However, the archaeologist stays in the center since research on kiln sites as such almost always starts with the finds and findings – the typical matter of archaeological study.

The interdisciplinary aspect in kiln research is not limited to questions of materials and technology: The social and political organisation of the craftsmen, accessibility of material and distribution of products as well as their role in the historical development of the region are another important aspect. In these cases kiln research is more leaning towards the humanities and collaboration with historians, sociologists, economists – to mention only the most obvious relations. This book introduces studies that deal with parts of all of these aspects in different regions and times, but this essay shall concentrate on cooperation regarding the technological and material aspects rather than on cooperation with researchers from other disciplines in the humanities. Cooperations between archaeologists and researchers from the natural sciences or engineering departments can pose problems on a research project because of the different “cultures” or traditions in these departments as compared to the humanities.

This essay is mainly based on the authors' experience of coordinating research and continuous discussion and exchange between researchers from various disciplines and nations in the Nakadake Sanroku kiln site center in South Japan (Shinoto et al. 2015, see also chapter 17 in this volume) among several others. Intermediate reflections on these experiences were presented at International Conferences. A first talk during the WAC8 conference in Kyōto (Shinoto 2016) stressed the roles of attitudes like curiosity, incomprehension, indifference, while the second talk on the SEAA8 in Nanjing (Shinoto 2018) discussed advantages and dangers of agile research design.

Rather than introducing the content of interdisciplinary research, this essay shall focus on the why and how.

## 4.2. Types of interdisciplinary research

Typically, an interdisciplinary research project is understood as successful when all contributions are integrated in the result and form a vital part in the final discussions. However, the integration of all contributions and vital participation of all researchers in the course of the whole project from its outset to the final stages leads to more, deeper, and even unexpected insights as compared to an approach where the archaeologist poses certain research problems to a research group and waits for the results to be presented at the end of the project.

The intensity of mutual exchange or the integration of different disciplines may differ significantly in different research projects, and it is important to keep in mind that the circumstances for kiln research vary as they do in every archaeological project: There are rescue excavations that leave no time for discussion but require the excavators to save information for later that is at danger to be lost and therefore just organize separate scientific investigations. A short term project may be focussed on a limited question with a small group of researchers that does not need any formal discussions and exchange. Finally, long term projects with a wider range of research questions and larger groups of researchers from various disciplines may need some consideration of how research should be organized in order to gain really new, unexpected insights. The following classification keeps this variety of circumstances in mind but is most closely related to the latter scenario, the long term project which is predominant in kiln research as soon as production centers are concerned.

Looking at how research is done in the real world, a classification with four levels of integration seems applicable. Each level has its merits and demerits that have to be discussed and understood when designing research on a kiln site or a kiln site cluster.

### 4.2.1. Multidisciplinary or parallel research

Multidisciplinary research describes a rather parallel kind of working, with no real exchange between

the fields. One may think of a project with several unrelated subprojects: Dating of features or layers with radiocarbon dating in one group and thermoluminescence dating in another group, creating a geological map for material research in a geological sub project, while doing research on chemical and mineralogical characteristics of the products in another subproject and mapping archaeological prospections by archaeologists, to name some examples.

In most cases, each of these subprojects finishes with a report that may be published separately as a journal article or as a chapter in a final, comprehensive report on the larger project. Nobody from the different subprojects or disciplines will understand what happens or what could be learned from each other before the final publication. In some cases, all results will be integrated in an overview by a project leader in the final stage of a project as another chapter in the report, in other cases, the reports from the respective disciplines stand only for themselves without further integration.

This kind of research design can often be found in excavation reports, where scientific studies like biological determination of species from wood or bone remains, or results of material analyses or scientific dating is added as a separate report of data without further discussion. Such parallel research is good practice as long as excavations or investigations into cultural heritage are to be documented urgently and left for later, advanced and integrated research. Each of the disciplines – archaeology included – offers information and data from its own research for further usage without offering overall “sense”.

The relation between the disciplines may be characterized by the terms “indifference” or “ignorance”, and while each subproject seems to be autonomous, the overall concept is hierarchical: Every discipline serves one central person or institution that will later use the data for whatever purpose – without discussing with those who provided the data. While this is inevitably part of research reality, these characteristics seem to be the root of problems in interdisciplinary research that can be observed frequently. These are (a) missing out of synergy effects and new learning as well as (b) lack of satisfaction or enthusiasm for the overall research.

**(a) Synergy effects and learning:** To start with an example from kiln site research, it is obvious that a geological map integrated with a historical map and distribution maps from archaeological prospection will inevitably lead to new insights and better options for the interpretation of findings in each of those maps. Exchange between geologists working on the geological map with mineralogists who analyse the material of kilns or ceramics is clearly necessary in order to understand the interaction of landscape and people. In a parallel research design, everybody keeps his or her own results separate, and a distribution map of archaeological finds alone for example

will not help understand how geology contributed to a certain distribution pattern as long as the geological map is created, presented and discussed separately, without informing the archaeologists creating their distribution map from surveys.

Deeper understanding is not always the aim of a project, however, academical research should aim at overall understanding, new insights, and relations that were unknown in the past.

**(b) Satisfaction:** As long as each researcher is just treated as a provider for data that are generated with well established methods in his or her discipline, this research will be considered more a kind of service rather than research on its own by either side: researcher and project leader. The reality in archaeological research is that archaeologists often seek for additional, scientific data to back up their own findings. For example, dates derived from typology, cross dating or stratigraphy shall be backed up with scientific dating, or pottery that seems to stem from a certain site judged by archaeological typology needs to be provenanced with chemical data – to name the two most common cases.

Aside from institutions that offer these analyses as a paid service, there is not much academic attraction in performing such a role – a role that in archaeological projects is often given to researchers based in disciplines from the natural sciences. On the other hand, as long as the scientist does not have any interest in the specific archaeological problem or cannot expect scientifically interesting developments or results for his or her own field of study, cooperation in archaeological projects of this kind is of little interest for the scientist.

Although “satisfaction” is a term that does not necessarily relate to the academic work, experience from several interdisciplinary projects shows that satisfaction of researchers with their contribution to an interdisciplinary project and the acceptance of these contributions by the other partners in the project is one of the most important factors for excellent research process and results. It may even become difficult to find a scientist willing to contribute to an archaeological project without mutual interest and comprehension and satisfaction.

Kiln research in particular depends on the contributions from natural sciences, thus, it is imperative to replace – on both sides – *indifference* and *ignorance* with *interest* and a certain *comprehension* of the expertise of the other discipline in order to start a fruitful discussion.

#### 4.2.2. Phased exchange

A slightly more integrated approach is what may be called “phased exchange”: While in parallel research, the results are presented to colleagues and the public simultaneously at the end of a project and influence research only

afterwards, with phased exchange, intermediate results are presented to colleagues in the course of a project, often provided with intermediate reports in workshops on an annual basis, after “half time” or towards the end of the project.

These workshops may become an inspiring platform for exchange, adjustments and progress. On the other hand experience shows that due to time constraints these workshops often turn out to be a mere exchange of results in order to confirm that everybody is “on track”. It is more important to get the own presentation done and well rather than incorporating ideas and results from other work. In order to escape this trap, a good organisation that encourages discussions and adaptation to new insights in the next phase is necessary. This is the responsibility of the project leaders, but more than that, researchers participating from different disciplines need a certain amount of *curiosity* towards and *understanding* of the other disciplines as well as an *interest in the overall project* and its aims in order to react flexibly on research going on in various sub projects.

Although “phased exchange” in interdisciplinary research does still allow for mutual incomprehension between the disciplines, in order to really stand out from “parallel research”, on the side of the participants it needs to overcome indifference toward the other disciplines involved and to the overall project aim. Not at last, it demands a certain understanding of all disciplines from the side of the project leader in order to monitor the exchange during workshops and other phased events. Since the organisation depends on these qualities of the project leader, interdisciplinarity with phased exchange may still be characterized as hierarchical. It should be obvious though, that phased exchange if done well may encourage a certain progress in the course of the project and will prevent the lack of satisfaction mentioned in relation to parallel research.

#### 4.2.3. Continuous integration

*Continuous integration or cooperation* may be the most fruitful form of research, where specialists from each field do not only exchange their final results but almost continually exchange and discuss intermediate insights and problems arising during the course of the whole project. In this case, research design evolves on common grounds, based on a comprehensive understanding of new results from various disciplines. In the continuous process of exchange, research design may be altered, new questions may turn up while other questions may be abandoned – because they are valued as “solved” or due to new insights from the ongoing research process which show that these old questions are not relevant. New interdisciplinary cooperations between researchers or groups may form according to these changes. This is where agile research design comes into play, which will be discussed below.





**Figure 4.1.** On a tour guided by archaeologists in the forests of the Nakadake Sanroku Kiln Site Center; a geologist and a potterer take the lead and discuss potential raw materials and their change in quality during natural or artificial processing. (Foto M. Shinoto 2016).

To expand on the example from above: Geologists may map an area with a certain soil quality that is not suitable for building kilns and report this to the archaeologists who could then shift their prospections and search for distribution of kilns to a more suitable area; the archaeologist in this case is not a hierarchically higher person that needs to be reported to, but rather a partner for solving a thematic problem who needs this information in order to adjust the activities. In the same project, researchers creating a historical map may better understand certain patterns thanks to insights on soil quality and hypothetical kiln distribution that they receive as soon as possible from their partners in the departments of geology or archaeological prospection. In other cases, a historical map may reveal historical activities that have destroyed areas in the kiln site cluster, and together with geologists and 3D surface data, the whole group of researchers working on different maps may attempt to set up hypothetical models about the original distribution of kiln sites in the region.

In an ideal world, all participants discuss on equal ground, but experience from the Nakadake Sanroku project shows that a *managing part* is often necessary in order to keep the discussion going and to give all researchers a voice.

Language, research tradition, personal preferences, or character form barriers that cannot be overestimated. The *managing part* can understand its own role hierarchically, but rather than transferring well defined research problems to subprojects or collecting results from a higher position like in phased exchange, the managing part should facilitate discussions and encourage mutual development of ideas and common research problems among the researchers from various fields. These researchers may ideally form independent ad-hoc groups if an opportunity for exchange arises.

This stage of continuous integration will encourage identification of each researcher with the project as a whole, the ongoing process will lead to a certain degree of mutual understanding, and an ideal outcome can be described as follows: (1) Research problems and processes that could not be envisioned at the start of the project will turn up in the course of a project and thus significantly promote knowledge and understanding. (2) Like in the saying “the whole is more than the sum of its parts”, final results reflect a knowledge that exceeds the capabilities of separate “sub projects” and of a single project leader; they lead to a new and comprehensive understanding.

There is another side of the coin, and this is the danger of working with immature, intermediate research results. Before a whole project abandons certain questions or focusses on a new perspective, it is important to assure that the intermediate results are valid to state a new hypothesis. A gradual adaptation, starting with some tentative collaboration among a small group of researchers is a good starter for such adaptations; and the continuous exchange about the chosen paths with the managing part is imperative.

#### **4.2.4. Incorporation**

Incorporation is the most integrated form of interdisciplinary research. In this case, one person covers several disciplines and acts as an archaeologist and as a scientist of one or more disciplines at the same time. Archaeologists may perform chemical analyses with pXRF on site, they may specialize on the use of a microscope for mineralogical analyses, others may specialize on wood as the object of their research. These kinds of incorporation of several roles in one person can be fruitful and dangerous at the same time.

Archaeologists have incorporated new technologies since the early stages of the discipline; the documentation of findings with photography may be one example. In the beginning, and in some cases even until today, photographic documentation was the job of specialists, but in the course of the decades, the technology became easier to use and archaeologists, though not specialized on photography, are now in the position to incorporate this technology into their own workflow. A similar trend can be seen with 3D documentation. Ultimately, incorporation of the technique by the archaeologist can be helpful in these cases, since the archaeologist sees what has to be documented, and rather than discussing this with a specialist, it may be easier to execute the task oneself. On the other hand, the fruitful discussion between experts with different backgrounds gets lost in this case.

While these are examples of possibly successful incorporation, others which are closely related to kiln research may illustrate negative side effects. In recent years, chemical analysis of pottery with portable XRF performed by the archaeologist is increasingly popular, but a chemical analysis is more than just looking at numbers produced by a random machine. An understanding of the weaknesses and limits of the technology and the applicability of the outcome to a certain research problem have to be understood as well as the meaning of certain elements in the mineralogy and the ceramic system.

After all, the incorporation of foreign methods, technology, and research topics like chemistry by the archaeologist is an extension of archaeological tools, but it is imperative that the archaeologist has sufficient knowledge about (1) the nature of the measured object and (2) the limitation of the method used in comparison to alternative methods.

Finally, recent decades show a trend of archaeologists being trained as experts in certain fields or technologies like pollen analysis, analysis of wooden artefacts, scientific pottery analysis to name just a few. Certainly, the expertise of two disciplines unified in one person, the accumulation of knowledge about archaeological research on wood only e.g. has great potential. As long as the researcher is not just “trained to use a machine” but has an equal expertise in archaeology as well as the other field and is able to follow the research development in the related disciplines, this approach is most promising and as such also valuable in a project oriented at “continuous integration”.

#### **4.3. Agile research**

When it comes to continuous cooperation like in the third stage of interdisciplinary integration, an agile research process is most appropriate. The following sections will discuss what this means, why it is appropriate, discuss its strengths and pitfalls, and not at least, share some ideas on the process and tools in an international academic environment, where people from different cultures, with different languages and from different time zones cooperate on a common goal with different methods.

Since 2013, a group of nearly twenty researchers from various disciplines and countries work in a cooperation in Japan's southernmost Sue kiln site center, Nakadake Sanroku in Kagoshima prefecture (see chapter 17). The planning phase started on a smaller scale in 2012, and while it was the intention from the outset to design the whole research process as an integrated process according to Stage 3 as described above, the growing number of researchers and disciplines involved posed some serious challenges to the organization. Such organization was the task of the author who is also involved in digital applications and developments, therefore choosing the agile concept was an option that suggested itself. This chapter will introduce incentives for choosing an agile approach, the research design and tools as well as the conclusions the author draws from experiences in several interdisciplinary projects. After all, the strength of this approach – the speed and dimension with which knowledge increases and new perspectives arise – is significant. But there are pitfalls to be aware of, which might be balanced with a well thought-out set of rules and tools.

##### **4.3.1. The concept**

The idea of “agile” was first introduced by software developers in 2001 in the “Manifesto for Agile Software Development” (“Manifesto...” 2001) with a set of values and twelve related principles. Although it can be assumed that the ideas have been practiced naturally earlier in a less formalized way and in a variety of businesses, the manifesto made the idea explicit and paved the way for a more fundamental and standardized implementation. The idea spread from software development to other business fields, and a whole industry of consultants dealing with “agile” and related approaches like “kanban”

Table 4.1. Values and principles in the Agile Manifesto

Values in the Agile Manifesto	Contrasted traditional values	Keywords to corresponding principles
Individuals, interactions	Processes, tools	Continuity, collaboration, motivation, simplicity, self-organisation (1, 4, 5, 10, 11)
Working software	Comprehensive documentation	Results, sustainability (7, 8)
Customer collaboration	Contract negotiation	Collaboration, motivation, face-to-face conversation (4, 5, 6)
Responding to change	Following a plan	Flexibility according to changing circumstances, frequent delivery, sustainability, adjustments at regular intervals (2, 3, 8, 12)

and “scrum” has developed since, creating a sometimes rigid formalization. Not at least because of this over-formalization, “agile” has become heavily criticized and is even considered “dead” at times. Some of the first and best known statements in that regard were made by Dave Thomas in 2015 (Thomas 2015).

Such a reaction of insiders in the software industry should be of no concern in the context of interdisciplinary research. First of all, as mentioned earlier, “agile” is the explicit formalization of natural ways of interaction in collaboration that had previously existed, and thus can be expected to be a durable concept in the future as well. Secondly, as long as the formalization process is not overdone for the sake of itself, it is worth considering and drawing conclusions about the process of interaction in interdisciplinary academic collaboration. A look back to 2001 when everything started with enthusiasm may help to get some ideas. The values and principles of the original manifesto are summarized in table 1.

Obviously, the focus in the Agile Manifesto is on software development and customer relationships. In kiln research, these may be replaced with *research* on the one side and *internal interdisciplinary collaboration and public communication* on the other – which may become more obvious below.

Not all of the principles mentioned in the manifesto are of interest for research teams, but mainly *continuous exchange among individuals* as well as *highly motivated individuals that continuously communicate about their results and demand results from others* seem to be responsible for unexpected progress in unforeseen directions. Also, the more motivated an individual is the more he or she is willing to self-organize smaller groups and exchange ideas directly with other researchers.

Starting with the last pair of contrasting values in table 1 – either *responding to change* or *following a plan*

– the parallels to interdisciplinary research are obvious. Projects are mostly planned out in the outset, funding is closely linked to certain institutions and selected research partners from beginning to the end of the project, and they are supposed to work on a fixed range of research problems and material that is estimated at the beginning of the project. The project will follow this plan if it is designed with an interdisciplinary integration of level 1 (parallel research) or level 2 (staged exchange) in mind. In certain cases, a researcher or a single research group may change the course of a certain analysis or method applied just in their realm of methods – mostly in case of unexpected problems and in order to keep up with the original plan and adapt the procedure to achieve the original goals. Obviously, continuous *interaction between individuals* is the easiest way of information exchange and for adaptation of goals and research design. However, conversation in larger groups needs rules and some form of formalization as well as standardized tools; these will be discussed below.

The second value pair of *working software* in contrast to *comprehensive documentation* cannot easily be converted to the world of research. Although “working software” may stand for “meaningful research” or “acceleration and broadening/deepening of research”, thorough documentation is certainly demanded and thus in no contrast in the case of research.

The third contrasting pair of values – *customer collaboration* versus *contract negotiation* is less obvious in their relation to research design. Although contract negotiation has its counter part in project applications, it is difficult to decide whether the customers are the foundations or institutions that donate to research, or whether the academic and non-academic public that finally receives the research results should be considered the customers. The important point is to ensure that applications do not lead to fixed workflows that cannot be adapted to new insights; and where possible, sporadic exchange about the course of the project with the donating institutions may help in changing directions and re-direct funds.

The 12 principles published on the website of the agile manifesto give some more detailed ideas of how the values may be implemented and summarized.

- Individuals are motivated and able to continuously collaborate and spontaneously self-organise and to adapting a complex research problem to changing circumstances and new insights.
- Frequent delivery and exchange of intermediate results for discussion, and in order to receive ideas from those with a different expertise, face-to-face communication and adjustment of plans in regular intervals is key to achieving the utmost goal: insights. This relates to insights that were envisaged in the planning stage of the project, but also those that come to the surface unexpectedly.



### 4.3.2. Advantages

Advantages of agile research management are similar to those in software development: New insights in one area or by a group of related researchers are immediately accessible to the project, which can in turn react upon the insights accordingly. Developments adapt to research results in a significantly shorter period of time, particularly, adaptations occur in the course of the project rather than after the submission of all isolated results after the project is closed.

### 4.3.3. Constraints and problems

The agile idea of teamwork was based on the reality in office work in 2001: Sharing the same office and having face-to-face communications on a day to day basis. But not only in software development this is not the reality any more in 2021, and it was never true in interdisciplinary research. It is well known that the earliest developments in asynchronous communication over the internet were implemented by researchers at the CERN, and the overlap between research and software development has continued ever since. Teams can form with members on a global scale, both in the software industry and business as well as in research. Technical problems can be overcome.

However, there is a decisive difference that separates teamwork in research from teamwork in business: The human factor has a larger impact because researchers with special expertise are rare, only few individuals or institutions can replace each other, while software engineers with similar backgrounds are distributed in almost all regions of the world. Therefore in research, it may be necessary to bend the principles of agile to time zones and the personalities involved – rather than expecting personalities with experience and well established routines to adapt to the principles of agile. Worldwide distribution of researchers, traditional biases towards other disciplines, different background as regards culture, society, language, and personality of a researcher may hamper continuous exchange on equal grounds.

Another pitfall of agile research design may be immature reasoning and decision making in cases where new findings are adopted without sufficient critical examination.

The worldwide distribution of researchers is a problem that can be solved with a mixture of focussed meetings and the use of the internet, as will be explained below. However, biases between disciplines or methods do exist, and it is sometimes impossible to encourage the conversation between members of opposing camps. Of course, choosing the appropriate research partners from the start is one solution to the problem, but not always possible.

Furthermore, an interdisciplinary project brings together people of different native language, cultural and social behaviour, academic traditions and the different thinking

and behaviour common in their respective disciplines. All these factors are even obstacles to the implementation of a smooth conversation whenever people with these backgrounds meet somewhere face to face. However, they become more serious whenever a conversation has to be kept alive over the long period of a project and over several continents and time zones without personal meetings.

English is the *lingua franca* in nowadays academia, but still not felt as a natural means of conversation or discussion in certain academic communities. Language can keep people away from the discussion, and it is particularly difficult for persons of a more introvert character to actively take part.

Finally, in a larger project some research progresses quickly for whatever reason while other research needs longer to produce results that will be useful for the whole group. It needs mutual understanding and trust to keep all members actively contributing to the community and waiting for those who need more time.

## 4.4. Implementation of continuous integration and agility

Continuous integration can be the most fruitful approach to interdisciplinary research, and an agile research design with clear communication of rules, duties, and rights is the appropriate way to reach or get beyond original research goals and to create a project that is driven by common excitement about the subject and its development. Such success does not come naturally, and the following paragraphs discuss experience with some tools for communication and organization. Unfortunately, there is not yet a comprehensive solution that fits to all potential scenarios.

The recent years are characterized by an overwhelming dynamic in the development of communication tools in and outside research, but also – in the realm of scientific research – by the development of new value systems as regards open and fair data in the European Union (2016) and elsewhere (e.g. “Forschungsdaten.info” 2021), as well as the increasing demand for transparency of the whole research process – even in the documentation of archaeological excavations (e.g. Boyd et al. 2021). Additionally, formal contracts between researchers or research groups are increasingly enforced by universities in interdisciplinary research.

Both phenomena will be important factors for the successful implementation of agile research processes in the future for two reasons. Firstly, with open and fair data becoming the norm in thinking about research data, the wide spread understanding that data are the property of the researcher who produced them, is becoming a minority’s view which can be excluded from agile research processes in the outset while the majority will accept sharing data and insights during the research process as a natural concept. Secondly, with explicit contracts being the norm, writing down clear rules and potential sanctions is becoming just



another natural step at the beginning of a research project rather than a sign of “lack of trust” as it might have been interpreted earlier. On the other hand, this change in research culture and common sense still seems limited to some regions or disciplines, and it has to be seen how and with which pace archaeological research in East Asia will evolve.

With these developments in mind, the following ideas about cooperation, based on technology available at the time of this writing, may give some ideas of how to – or how not to – organize kiln research or other interdisciplinary projects with agility in mind.

#### 4.4.1. *An organizing hub*

In a small project, the project leader will have an overview over all research questions, methods, and researchers involved. But in projects with a wide range of research questions and methods, assistants serving as a facilitator may become necessary. They need a certain understanding of the whole project and of the methods or disciplines involved, and should be able to draw new links between research questions and results, methods and researchers – in order to create cooperations that overcome the limitations of isolated work on a certain problem. Furthermore, a certain command of the language of the counterparts is helpful, as well as personal acquaintance of the researchers – which is not always possible.

The workload of a facilitator cannot be overestimated, and there is an aspect of self sacrifice. On the one hand it is inspiring to think across the borders, implement new ideas and encourage the specialists to give new ideas and cooperations a try. On the other hand, fact is, the results are presented by others, and the scholarly value of the contribution of a facilitator or organizer may be disputed. While this is finally a question of mutual respect as regards the contribution of the rôle of each participant, it is always a good idea to discuss expectations and commitments clearly at the beginning of the project.

#### 4.4.2. *Formal implementation of conversations*

The best conversation happens naturally and in person. At least annual meetings seem to be necessary to keep up the dynamics among the group members, but they are not easy to implement due to financial or time constraints. Meetings at the start of a project and before summarizing the results at the end seem to be a good compromise that should be part of the project finance plan; in longer projects intermediate meetings are desirable. But how to keep the conversation going between these highlights?

**Video conferences** have become a replacement of personal meetings in many cases in the course of the pandemic that started in 2020. It already has become obvious beyond doubt that video conferences will help greatly in further implementations of agile research design. In the Nakadake Sanroku project, they are now covering a large amount of

the interdisciplinary discussions between the continents. Not at least the option to chat in the course of the verbal discussion helps with language problems. Together with a rigid track of the contents of discussions in written protocols, video conferences have largely improved the agile workflow.

**Email** being spontaneous, direct, and asynchronous, is convenient and the most popular means of communication – at least, we all know it very well and use it daily. Unfortunately, it is a mess when it comes to get organized, since with emails it is almost impossible to track who was part of which conversation and what the final decision was in a certain case. Except for short term consultations on a particular, preferably non scientific topic between two persons where email is still the most convenient tool, email should be replaced by other tools for serious discussions.

A modern **conversation platform** like SLACK demands constant access to the software, in many cases immediate reaction in order not to fall behind in a group, and due to the noise that comes with it, is not as transparent as needed. The author has been part of several attempts from several sides on various occasions to introduce such a platform to an academic conversation, but it never lasted. Not at least, most conversation platform software is proprietary with all its demerits and should be avoided for this reason alone. In the future, better organized OpenSource tools may replace these solutions which then may also replace the next suggestion: a forum.

**Forum** software is not only OpenSource, easy to implement and transparent to all members. It offers (1) sub forums on sub topics or temporal topics for a more closed conversation between members of varying access rights, it serves as a (2) self-documenting system without need for protocols, and not at least, it offers (3) asynchronous participation with all its merits like in email. The author is an avid supporter of the forum solution, but unfortunately, at least in the Nakadake Sanroku project, this approach was equally unpopular as the modern conversation platforms mentioned above. Reasons may be as follows: (a) The necessity to open a browser and log in as well as doing this regularly in order to actively participate in the conversations seems to be too much of a barrier for most of the researchers. A forum thread needs serious thinking and writing because it is semi-public and stays open to the forum members, while an email can be written more leisurely.

A **wiki** is a solution similar to a forum, it has the advantages of being OpenSource and offering various access rights for users as well, but the focus of a wiki *per se* is less on the ongoing conversation but rather on presenting results of a conversation. So despite being a solution to create a final report, it is not suited for ongoing conversations.

A **distributed version control system** like git with options like **GitLab** or **GitHub** and **Bitbucket** should

not be ruled out as a tool of communication in such a research project. They offer a range of tools for conversation and problem solving; and of course, since git was introduced to create software, it combines well with agile project management. But a distributed version control system with its fixed rules and technical aspects may be too much for most members of a project from the humanities department. In the experience of the author during the last years, distributed version control can only be implemented in an interdisciplinary workflow with smaller groups of researchers with experience in programming at this point in time but serves the purpose well where it is chosen.

After all, in order to include the technically less inclined, the author suggests the combination of a forum and video conferences for the project or sub projects in combination with sporadic email exchange between two or three persons on matters of no public or scientific interest as a means to compensate the lack of personal meetings on a frequent basis. An explicit agreement on the conversation style between all participants at the beginning of the project may help getting over the first time where this approach is not yet familiar.

#### 4.4.3. Integration of members and formal agreements

As mentioned above, integration of all researchers into the discussion can be a problem due to a variety of reasons. It is the job of the project leader or facilitator to keep the discussion going and guarantee fair usage of research data. An agreement on the form of conversations and on the frequency of the conversations may be an additional means, but it is difficult to enforce a discussion with rules. However, rules may be a means to raise awareness regarding conversation in the beginning.

#### 4.5. Conclusion

Archaeological kiln site research requires the integration of methods and knowledge from a variety of disciplines based in the humanities, in engineering, and in natural sciences; not at least it requires knowledge and experience from practitioners.

The most fruitful research is done when all members of a project are in constant exchange regarding ideas, newly arising problems, and upcoming results on equal terms, thus offering precious insights to other members and influencing the course of the whole project before final reports are written. Such vivid exchange is a chance, but it inevitably consumes more time and effort than isolated research on a fixed problem. Furthermore, it bears the problem of unbalanced contribution of the participating researchers due to a variety of factors.

Each of these potential problems has to be considered when setting up clear rules and agreements at the start of the project and whenever another researcher joins in the course of a project. A central figure needs to monitor the

behaviour of the participants; this central figure will in most cases be the project leader or a researcher in charge of organizing the interdisciplinary part, never being above but always being a partner of the researchers. An important responsibility of such a central figure is to keep the conversation between the research groups going, to be aware of chances, new topics arising and to stimulate new cooperations in the project. A certain command of the languages of the researchers involved, some knowledge of the various methods and materials is essential for this role, while active participation of each researcher with as little interference as possible by organizers is most desirable.

After all, broader and deeper insights, even unpredictable insights can be expected from a project that is driven by enthusiasm and cooperation of all participants and which benefits from an agile approach.

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## Provenance Studies and Beyond

*Johannes H. Sterba*

**Abstract:** Provenancing of ceramics, i.e. the establishment of a ceramics physical origin, greatly enhances our understanding of ancient civilizations, their cultural development, exchange and movement patterns. Basing provenance studies on objectively measurable and reproducible data like the chemical composition of the material offers important insights in this respect. Various multivariate statistical methods are in use to analyse the large datasets produced by analytical methods like Neutron Activation Analysis (NAA). Of those statistical methods, a well established method using a modified Mahalanobis Distance that takes measurement errors as well as dilution effects (best relative fit factors) into account has repeatedly proven its usefulness specifically for the provenancing of ancient ceramics. Three examples from recent studies, two from East Asia and one from Northeast Africa show what the combination of NAA and this statistical approach can provide beyond simple establishment of a ceramic sample's origin.

**Keywords:** Neutron Activation Analysis; Best relative fit; Provenancing; Ancient ceramics; Statistical analysis

### 5.1. Introduction

Provenancing of ceramics is important for understanding ancient civilizations, their cultural development and their exchange and movement patterns. Provenancing by archeological means alone presents difficulties because typologies, changes in form or pattern, and even production techniques can be exchanged between sites. Basic raw materials like clay, however, are very rarely exchanged over significant distances. Objectively measurable and reproducible data, like the chemical composition of the material, provide additional information on the raw materials used in production which can lead to a much clearer understanding of provenance and cultural exchange (e.g. Jones 1986).

Provenancing, i.e. the assignment of a sherd to its production site based on chemical composition, relies on three basic premises:

1. The object under investigation is chemically homogeneous.
2. All objects within one group or provenance preserve and share their chemical composition.
3. Objects from a different origin have a clearly distinguishable chemical composition.

Reliance on those three premises is a challenge and provides an opportunity to go beyond the mere localization of ceramics. An important part of the first premise, the homogeneity within one sample, is that

the sample size under investigation needs to be large enough to be representative of the sample as a whole and represent the bulk chemistry while ignoring surface contaminations. The second premise refers to the fact that different production techniques, or recipes that require e.g. mixtures or cleaning of raw materials, can potentially lead to different chemical compositions, allowing for more than one group or chemical fingerprint within a single production site.

Differentiation of changes to the chemical fingerprint due to changes in production techniques are usually small but systematic (e.g. Garcea et al. 2020; D'Ercole et al. 2017). Thus, recognizing such changes and correctly assigning analyzed ceramics not only to a production site, but to a specific production technique or period within the production site, requires statistical analysis of the compositional data specifically suited to detecting those minute changes. A ceramic-specific multivariate statistical filter that is able to reduce the variation introduced into the dataset by inconsistencies in the paste production was developed in Bonn in the 1980s (Mommsen, Kreuser, and Weber 1988; Beier and Mommsen 1994). Provenancing based on chemical composition as described above puts several restrictions on an appropriate analytical method to measure the chemical composition. The method needs to be able to measure a multitude of elements, especially many of the minor and trace elements, to be able to “see” such minute changes in the composition as would be expected from e.g. differing mixtures or the introduction of a coloring agent.

Furthermore, the precision and reproducibility of the measurement itself needs to be high. This is due to the fact that the comparison of measurement values needs to take measurement errors into account. It is obvious that two values of  $4 \pm 1$  and  $5 \pm 1$  are indistinguishable, whereas  $4 \pm 0.1$  and  $5 \pm 0.1$  are very clearly different.

Finally, the analytical method needs to be able to report bulk chemical composition, i.e. penetrate beyond the surface of the object and be relatively insensitive to minimal inhomogeneities.

All of the requirements on the analytical method mentioned above are easily fulfilled by Neutron Activation Analysis (NAA) (Greenberg, Bode, and De Nadai Fernandes 2011).

## 5.2. Materials and methods

### 5.2.1. Neutron activation analysis

Neutron Activation Analysis (NAA) is a radiochemical method for elemental analysis. To perform NAA, the sample under investigation is irradiated with neutrons, thereby producing radioisotopes from stable isotopes contained in the sample (activation). After activation, the radioactivity of the sample is measured by gamma spectroscopy. Interpretation of this gamma spectrum leads to the identification of the radioisotopes produced in the sample by activation as well as to the determination of their abundance (activity). Since the radioisotopes can, in most cases, only be produced from a specific stable isotope, their existence is indicative of the stable isotope being contained in the sample. The abundance or activity of the radioisotope is directly related to the abundance of the stable isotope before activation. By irradiation and measurement of reference samples of known composition, comparison of the activities measured leads directly to the elemental concentrations in the sample.

Due to the nature of neutrons and their interaction with atomic nuclei, no information on the oxidation state of the elements measured can be obtained. However, since the penetration depth of neutrons in regular matter is on the order of several centimeters, the elemental concentration values obtained represent the bulk chemistry of the sample. Main elements like Hydrogen (H), Oxygen (O), Nitrogen (N), Carbon (C) and Silicon (Si) are hardly activated or don't produce an easily measurable radioisotope, thus those elements could be described as being "invisible" to the method. In the case of the analysis of biological and geological material, this is an asset since the matrix (i.e.  $\text{SiO}_2$  in the case of geological material) does not interfere with the measurement. Other elements, specifically many of the rare-earth elements that are usually only contained in minute traces, activate quite easily, resulting in very low detection limits for those elements on the order of ng/g. This is another asset for the application of NAA to provenancing, since the trace elements contained in a sample are especially highly characteristic of its composition.

As described above, NAA directly relates elemental concentrations in a sample to a measurement of radioactivity. Since even low amounts of radioactivity can easily be measured, the total sample mass needed for this type of analysis is usually on the order of 50–150 mg. However, during sampling, great care has to be taken that the sample is representative of the full object under investigation, which can make it necessary to take larger sample amounts of up to 500 mg.

In summary, to perform NAA on a ceramic object, a small sample of 50–500 mg needs to be taken off the object. This sample is then irradiated in the neutron flux of a reactor and subsequently measured on a gamma spectrometer. Usually, at least two subsequent measurements are done to be able to gain precise data on short- and long-lived radioisotopes. This results in a total time requirement of three to five weeks from irradiation to results. For this reason, NAA is usually performed in batches of 30–100 samples. The elemental concentrations measurable are Na, Mg, Al, Cl, K, Ca, Sc, Ti, Cr, Mn, Fe, Co, Ni, Zn, As, Rb, Sr, Zr, Sb, Cs, Ba, La, Ce, Nd, Sm, Eu, Tb, Dy, Yb, Lu, Hf, Ta, W, Th and U. Not all of those elements are of equal importance for provenancing, so usually a smaller selection of about 25–28 elements is chosen for analysis. For detailed descriptions and more information see e.g. (Minc and Sterba 2017; Sterba 2018).

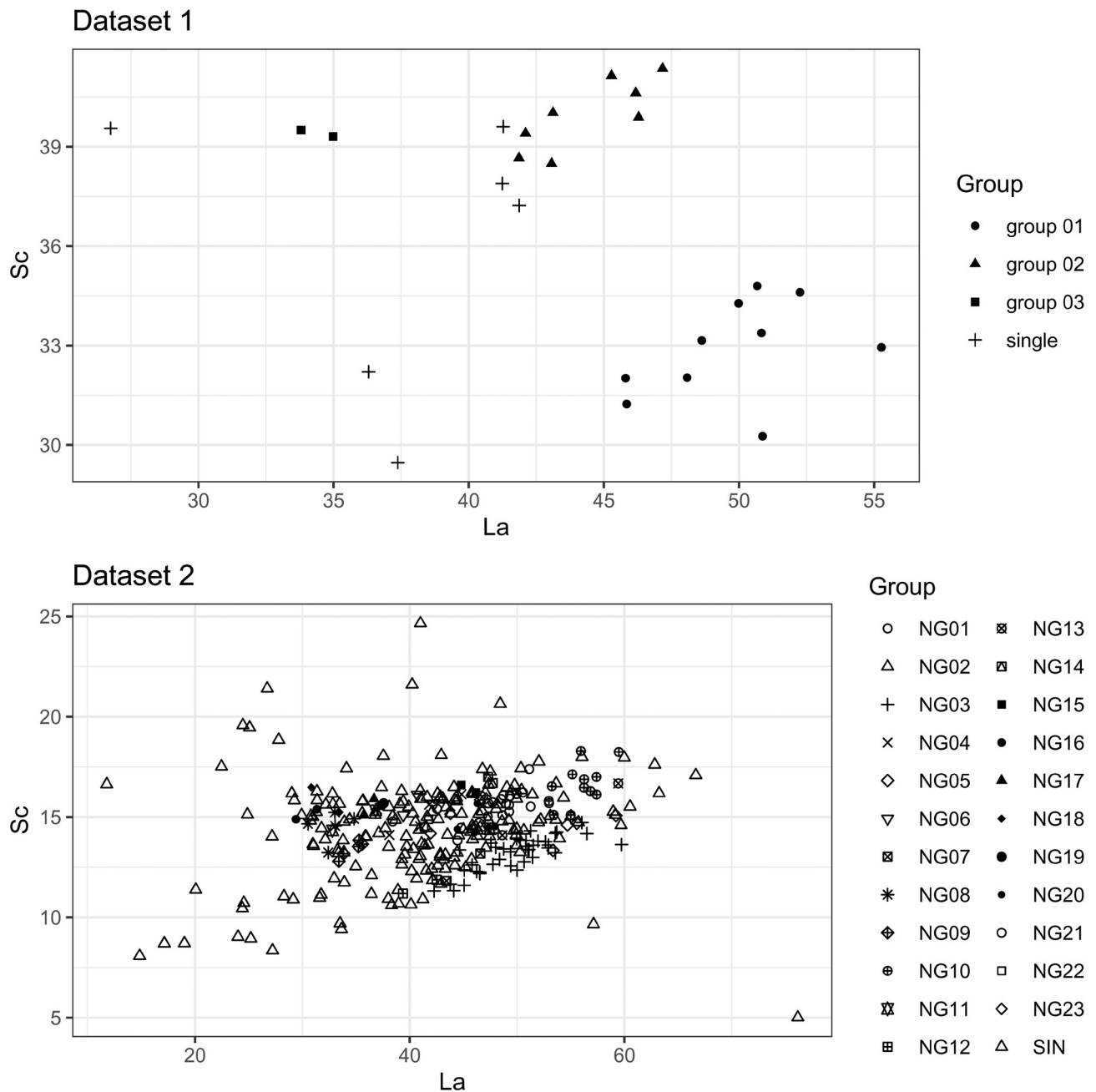
### 5.2.2. Statistical analysis

Once the chemical composition of a sample, often called its chemical fingerprint, has been established, it is necessary to compare the sample's fingerprint to other chemical fingerprints, either of other unknown samples or of already established groups. To compare two chemical fingerprints, all elemental concentration values are compared to each other, ideally taking the associated measurement error into consideration. If all elemental concentrations of two samples are sufficiently similar, the two samples are considered to be made from the same material, and thus from the same origin or provenance.

Since the number of measured samples as well as the number of potential candidates for comparison is usually very large, a comparison by hand is, if not impossible, at least extremely inefficient. Thus, different multivariate statistical methods are usually applied to process a large number of samples more quickly.

### Bivariate plots

A very simple exploratory method is to use bivariate plots of datasets. In this method, two to four (if using ratios) elements are selected from the dataset and each sample is plotted onto an area spanned by those elements (see Fig. 5.1). Careful selection of the elements (or ratios) used can lead to visible grouping of the points representing samples.



**Figure 5.1.** Comparison of bivariate plots of two datasets of ceramics, previously grouped by NAA and subsequently by statistical analysis. Lacking this analysis, no grouping information would be available. While, in the top figure, a visible separation into three groups occurs, the same set of elements leads to no visible groups in the second plot.

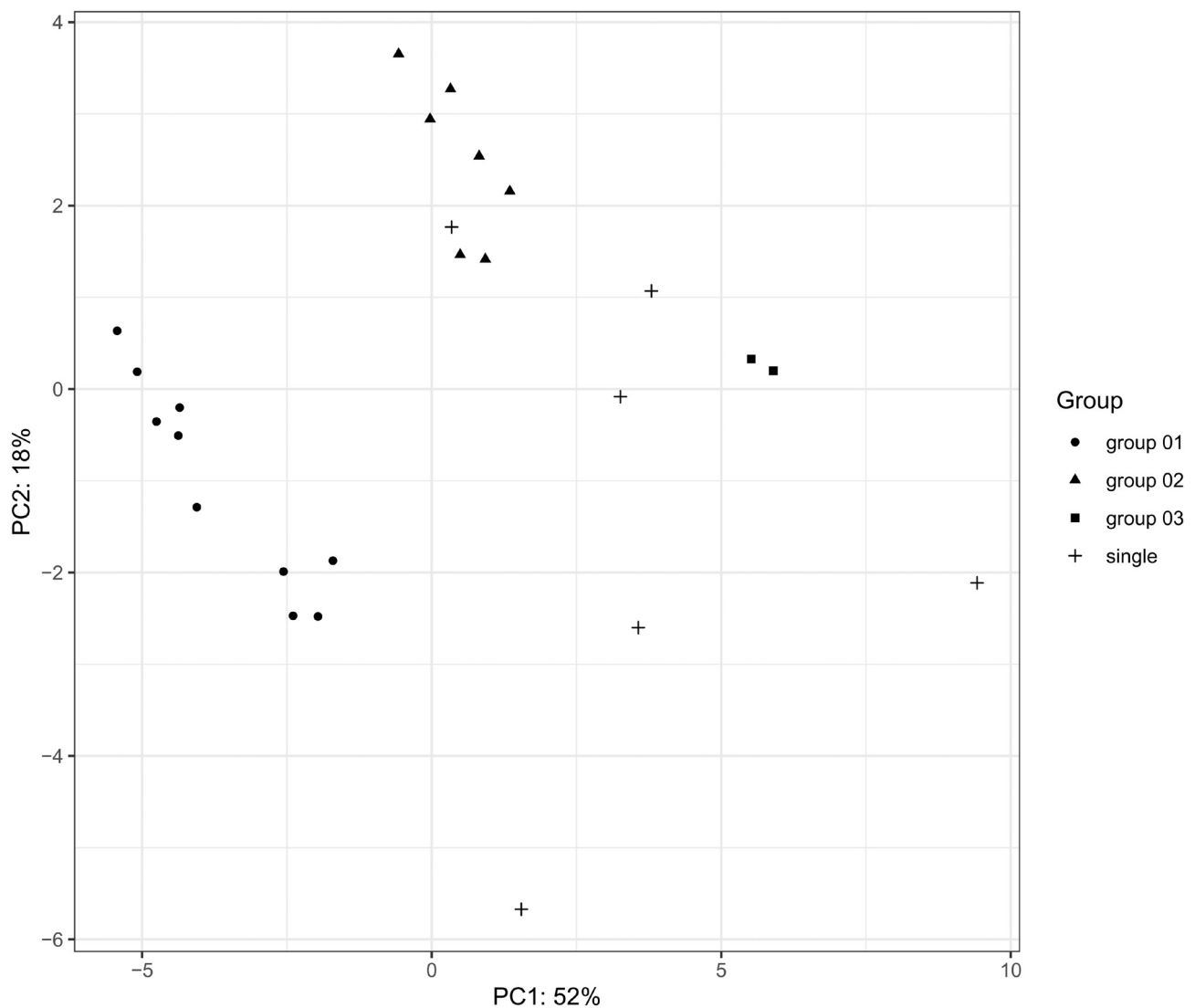
While this strategy is sometimes useful for specific datasets and sets of elements, it lacks several important features:

1. It uses only a small subset of the information available (i.e. at most four elements out of a total of more than 20).
2. It ignores measurement errors, potentially showing stronger separations than the data allows.
3. It is usually possible to find some combination of elements to plot that show some grouping, sometimes finding several groupings that cannot be correlated with each other.

4. It is an exploratory method only; decisions on the exclusion or inclusion of samples at the border of visible groups can hardly be founded on statistical measures.

### Principal component analysis

A method related to bivariate plots is Principal Component Analysis (PCA), a statistical method that finds the linear components in a dataset that express the most variation, resulting in a reduction of variables necessary to describe the dataset. After PCA calculation is done, the first few principal components are then used to produce similar plots



**Figure 5.2. Principal Component Analysis (PCA) of the same dataset as in Fig. 5.1 (top part). The grouping is visible, however, especially along the borders of the groups, it is not clear if samples belong to a group or not.**

to bivariate plots, again sometimes showing groupings. Fig. 5.2 shows a PCA of the dataset also used in Fig. 5.1 (top plot). The grouping that was apparent in the bivariate plot is still clearly visible. However, it is not obvious how the singles should be handled (specifically the one single “inside” of group 02), and there seems to be a separation between the samples belonging to group 01. Without the different shapes of the data points in the figure, it would not be clear how to group them.

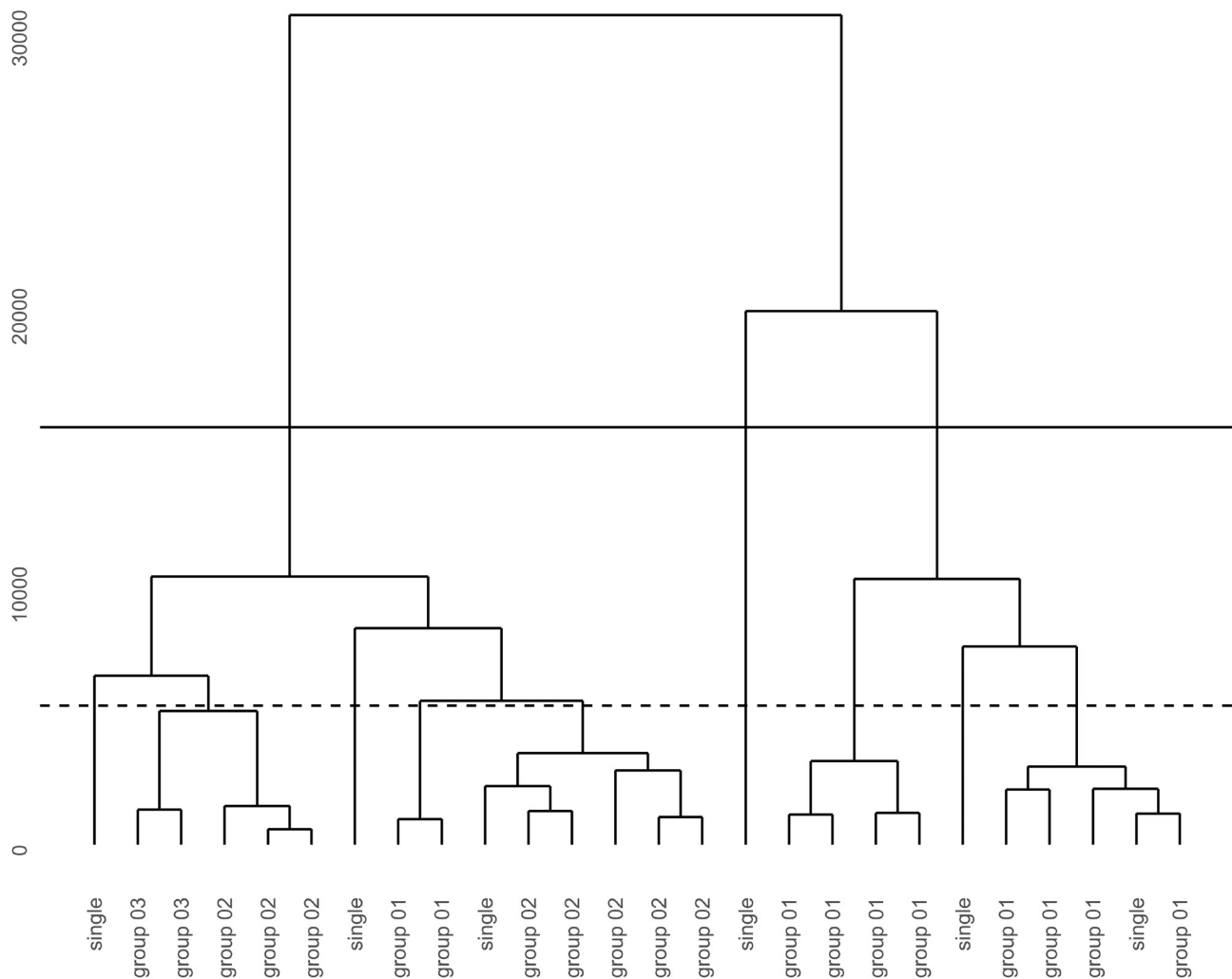
Depending on the dataset and the number of outliers or singles therein, a PCA can lead to usable groupings. However, similarly to bivariate plots, no information about measurement errors is used. Furthermore, PCA is again an exploratory method; handling of samples along the borders of visible groups is not straightforward.

### Cluster analysis

Cluster analysis is a statistical method that uses distance measures (e.g. the euclidian distance) to calculate closeness

or similarity between samples. In an iterative algorithm, the samples are then grouped by their respective distances. This leads to a visualization that is called a dendrogram, where the dataset is represented in a tree-like structure. The samples forming the leaves and their closeness along the stem represent their distance (Fig. 5.3).

To use a dendrogram for grouping, a cut-off distance is defined and all samples linked below that distance are grouped together. In the example of Fig. 5.3, a cut-off distance of 15,000 leads to two large groups and one single sample, whereas a cut-off distance of 5000 results in five groups and several singles. Thus, the grouping produced by cluster analysis relies on the distance measure, the linking method used to connect samples, and the cut-off distance applied. While there are some general best practices on how to select those three components, no definitive rules exist. This makes it possible to reach different groupings by trial and error. Furthermore, as in both methods mentioned above, no information on the measurement error is included in cluster analysis.



**Figure 5.3.** Cluster analysis and subsequent dendrogram of the dataset used in Fig. 5.2 and Fig. 5.1. Distances are calculated as euclidian distances, and clustering is done by the complete linkage method. Instead of sample names, group names are used to make comparison of the grouping methods more visible. The grouping done by NAA and statistical analysis (group01, group02 and group03) agrees with the archeological grouping of this dataset; the grouping that would follow from the dendrogram cannot be related to archeological groups.

### A ceramic-specific approach

From the examples above it is clear that it would be preferable to have a statistically valid method for grouping ceramics with respect to their chemical composition, potentially allowing statistical testing or prediction. This method needs to 1) include measurement errors in the analysis, and 2) find a way to overcome additional spread introduced into the dataset because of dilution effects during paste production (Mommensen and Sjöberg 2007).

Dilution in this case means that some component is added to (or removed from) the raw clay that does not contribute to the elemental composition. For example, the addition of quartz sand during tempering would increase the total mass of the sample; however, since both silicon and oxygen (Si and O) are usually not measured, the relative concentration values of all other elements wouldn't change. Similarly, the use of an organic compound

would only result in a dilution. Such a dilution results in additional spread that is introduced into the dataset, for the simple reason that between batches of paste produced by the potters, slight differences are highly likely. Fortunately, such a dilution can be easily corrected for by introducing a "dilution factor," i.e. a single number by which all elemental concentration values of one sample are multiplied, to reduce the apparent difference to another sample.

To illustrate this process, Fig. 5.4 shows the comparison of a dataset before (left) and after (right) dilution correction. It is the same dataset used in Fig. 5.1. As can be seen, just by correcting for the dilution factor, the group members come much closer to each other. Samples classified as "single" don't change their position, because dilution correction can only be applied against another sample or group mean. In Fig. 5.4, dilution correction is done for all samples belonging to one group against their common mean.



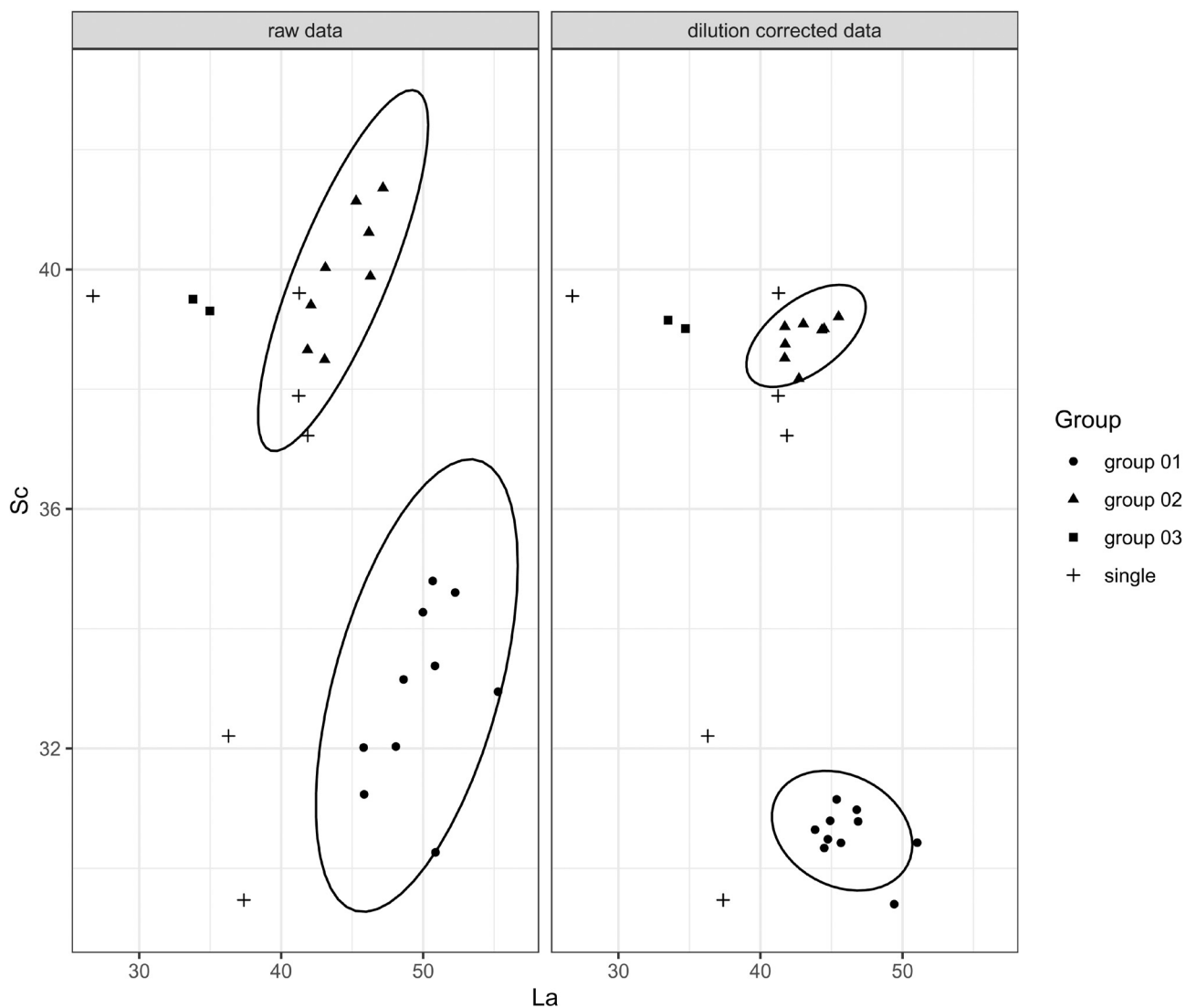


Figure 5.4. Comparison of a dilution corrected dataset before and after correction.

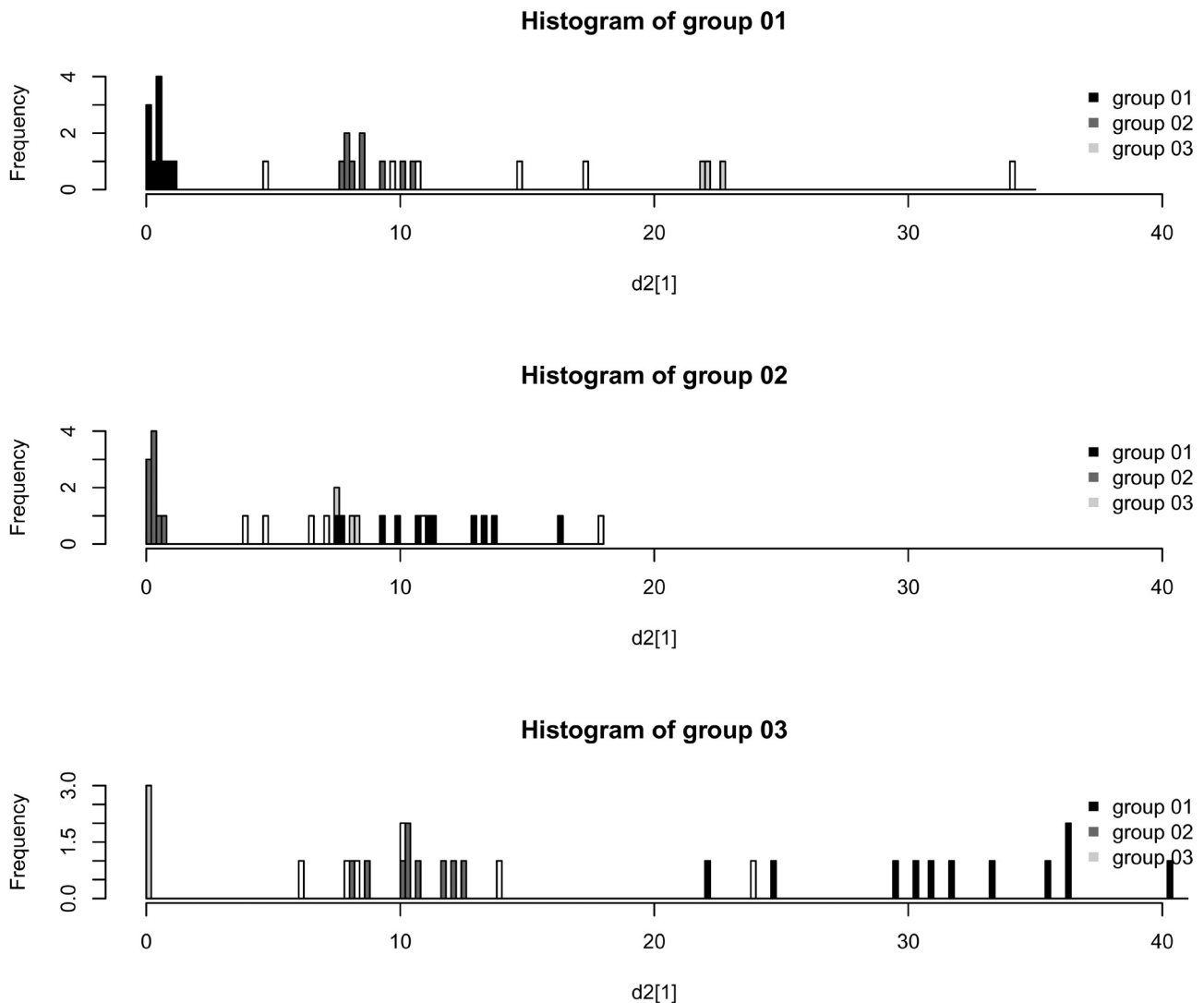
Interestingly, such a correction of the raw data can easily be done mathematically and, from a statistical point of view, leads only to the reduction of the number of degrees of freedom by one. This means that the corrected data can still be analyzed by all multivariate statistical methods, as long as the number of degrees of freedom is reduced by one.

However, it would be preferable if the similarity between two samples could be described numerically. Ideally, this numerical value would take into consideration the dilution factor mentioned above as well as the measurement errors. Such a measure was developed in the 1980s in Bonn (Mommensen, Kreuser, and Weber 1988; Beier and Mommensen 1994; Sterba et al. 2009). It used a modified version of the so-called Mahalanobis distance, which in its original form could be described as calculating the distance between two vectors in units of their standard deviation. By replacing the standard deviations with the measurement errors and minimizing the distance with respect to the dilution factor, this modified Mahalanobis distance provides a statistically

valid means of defining the similarity of two chemical fingerprints.

With the calculation of the modified Mahalanobis distance between each possible pair of samples in a given dataset, it is possible to reach a first grouping of a subset of samples with small distances. From this, a group mean can be calculated as well as the modified Mahalanobis distance from all samples in the dataset to this group mean. From this calculation, more samples can be added to the group, if they are sufficiently close to the mean, leading to a modified group and a modified group mean. By iteratively repeating this process until no more samples come close to the group mean, groups can be formed.

Fig. 5.5 shows the modified Mahalanobis distances between the group means and all samples in the dataset already used repeatedly. It is clear to see that between the last sample belonging to a group and the first sample not belonging, a gap exists. This is usually a good indication of a complete group.



**Figure 5.5. Histograms of the modified Mahalanobis distances between the group mean and all other samples for three groups in the dataset. It is important to note that only the distance from 0 is relevant; interpretation of the distances between samples marked in the histogram ignore the multidimensional nature of the Mahalanobis distance.**

It is important to note two properties of this grouping process: Firstly, once a group is defined in the way described above, new samples can always be compared to this group and, if suitable, added, changing the group mean. Once a group reaches a large enough size (several tens of samples), the group mean stabilizes. Secondly, because of the properties of the Mahalanobis distance, the modified Mahalanobis distances are distributed according to the  $\chi^2$ -distribution (if the reduction in numbers of degrees of freedom is taken into account), making predictions or statistical tests possible.

### 5.2.3. Beyond provenancing

The process described above, i.e. the combination of NAA and a ceramic-specific statistical approach to grouping, offers a reproducible and statistically sound way of comparing and grouping ceramic material. Due to the dilution factor, a large component of the spread usually visible in such datasets is removed, allowing an

unobstructed view of the similarities and dissimilarities of the samples. With this, it becomes possible to associate samples not only with a region of origin but with a specific recipe in use in a spatially and temporarily delimited region. This takes the usual approach of provenancing beyond its traditional borders by providing information on temporal shifts in recipes or transport routes, as well as on changes in the recipe connected to technological or cultural choices.

### 5.3. Case studies

The potential of the approach to provenancing described in the previous section is best demonstrated in case studies. Three significantly different outcomes from systematic research based on NAA are introduced, and while two of these case studies from East Asia are presented in this volume as well – the Nakadake Sanroku kiln site center and the Kamuiyaki kiln site center, the third, complementary case study is taken from Northeast Africa.

### 5.3.1. Kamuiyaki Kiln Site Cluster

The Japanese National Historical Site “Kamuiyaki kiln site center” is located in the south of Tokunoshima Island and is understood to have been the production center of a specific pottery type that resembles traditional Sue ware. Its discovery (Hirose 1933) has been dated to the Gusuku period of the Ryūkyū islands, mostly equivalent to the Japanese Middle Ages (National Museum of Japanese History 1997). Pottery from the Kamuiyaki kiln site center is widely distributed throughout the Ryūkyū islands. Within the site, two chronologically significant typological groups can be distinguished (Satō 1970, Shinzato 2018).

In a preliminary study (Sterba et al. 2020), 20 vessels from a specific context were selected for NAA and subsequent data analysis. Of the 20 samples, 10 vessels each were selected from the aforementioned typological groups A (older) and B (younger). All vessels but one were found within one ash heap associated with several kilns, the two groups found in two different layers with a distinct separation layer without any finds. Typological and stratigraphical assessments agree.

NAA was performed on the 20 samples at the TRIGA Center Atominstitut of TU Wien, applying standard procedures (Sterba 2018) and subsequent statistical data analysis. Application of dilution correction and grouping of the samples with respect to their chemical fingerprint resulted in two groups of ten and eight samples, respectively, as well as two singles. The two groups could clearly be separated according to their chemical differences, mainly in the metals and metalloids Sc, Cr, Fe, Co, As and Sb. Furthermore, the two groups clearly correlate to the two chronological/typological groups already established, even though no *a priori* information was used in the chemical grouping. Every vessel from the older group A was chemically grouped into one group, whereas all eight samples from the second chemical group belong to the younger typological group B. The two singles (samples that cannot be chemically assigned to a group) also belong to the older group.

The most obvious conclusion from this result is that the typological and chronological grouping can be confirmed by chemical analysis. Thus, future finds of pottery fragments that have no clear stratigraphy or that show no distinguishable typological features can still be assigned to one of the two groups by chemical analysis. With this, NAA and statistical analysis not only yield information on provenance but also chronological information within the production site.

More importantly, however, this result indicates that the two periods of production at this subcluster of the Kamuiyaki kiln site center applied different recipes to the production, either by selection of different raw materials or through different preparation of the paste. Further investigations of other subclusters could potentially yield

either a better definition of the two chemical fingerprints or additional chemical fingerprints corresponding to more recipes.

### 5.3.2. Nakadake Sanroku – a complex kiln cluster

The kiln cluster at Nakadake Sanroku, close to Minamisatsuma City in Kagoshima Prefecture, southern Japan, was a production center for Sue ware during the ninth and tenth centuries AD. It contains more than 50 Sue kilns and covers an area of over 6 km<sup>2</sup> (Nakamura and Shinoto 2015; Shinoto and Nakamura 2016).

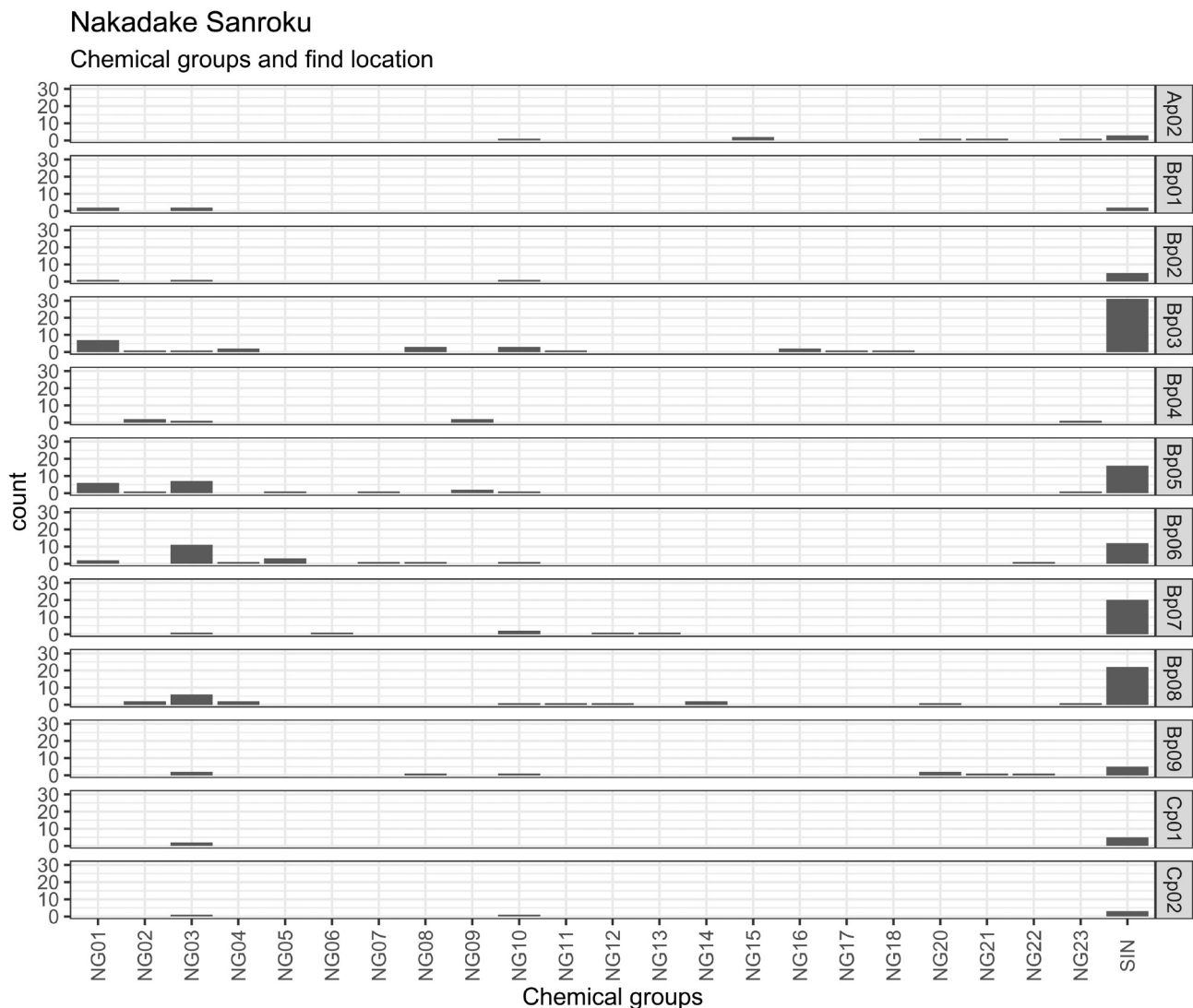
Sue ware was widely distributed throughout Japan, including the southern islands. Hence, more than 200 samples of Sue ware found at the kiln cluster were analyzed by NAA with the prospect of defining a chemical fingerprint for the production center (Sterba 2015). The samples were collected from several different contexts; more than 60 samples are clearly from kilns or associated wasters (haibaras), while most of the remaining sherds were collected along the brooks within the kiln cluster. The kilns are distributed along the side of Mt. Nakadake on steep slopes. In ongoing studies, the find locations of the samples are tentatively associated with three major drainage basins, denoted A, B and C. Within the basins, geographical sublocations along watersheds can be defined, resulting in sublocations Ap02, Bp01 etc.

Statistical analysis of the chemical fingerprints of the samples yielded 23 chemical groups, which are often chemically similar but clearly distinct, as well as a large number of chemical singles that probably indicate numerous other small groups where only a single sample was found.

Considering the geographical situation of the kiln cluster, associations of the chemical groups with the sublocations or at least with the main drainage basins would be expected. However, a comparison of the find locations and the chemical groups, as can be seen in Fig. 5.6, show a much more complex situation.

As can be seen in Fig. 5.6, the two chemical groups NG03 and NG10 cover almost all geographical sublocations, while chemical groups NG16, NG17 and NG18 can only be found in the sublocation Bp03. Some sublocations yield only one or two chemical groups (i.e. Cp01, Cp02 and Bp01), while others contain a multitude of chemical groups (i.e. Bp03 or Bp08).

Compared to the situation described above (Kamuiyaki kiln site center), a clear assignment of external samples to Nakadake Sanroku seems much more complicated or even impossible. However, it is important to note that for two of the chemical groups (NG03 and NG06), corresponding samples were found on the islands Tanegashima and Kikaijima, both to the south of Nakadake Sanroku (Sterba 2015). On Tanegashima, the much closer island, only samples from the chemical group NG06 were found; on Kikaijima, only samples from the chemical group NG03



**Figure 5.6.** Comparison of the chemical groups found in the *Sue*-ware corpus of Nakadake Sanroku with the geographical find locations, based on watershed divides. A, B and C denote the major drainage basins with sublocations along minor watersheds.

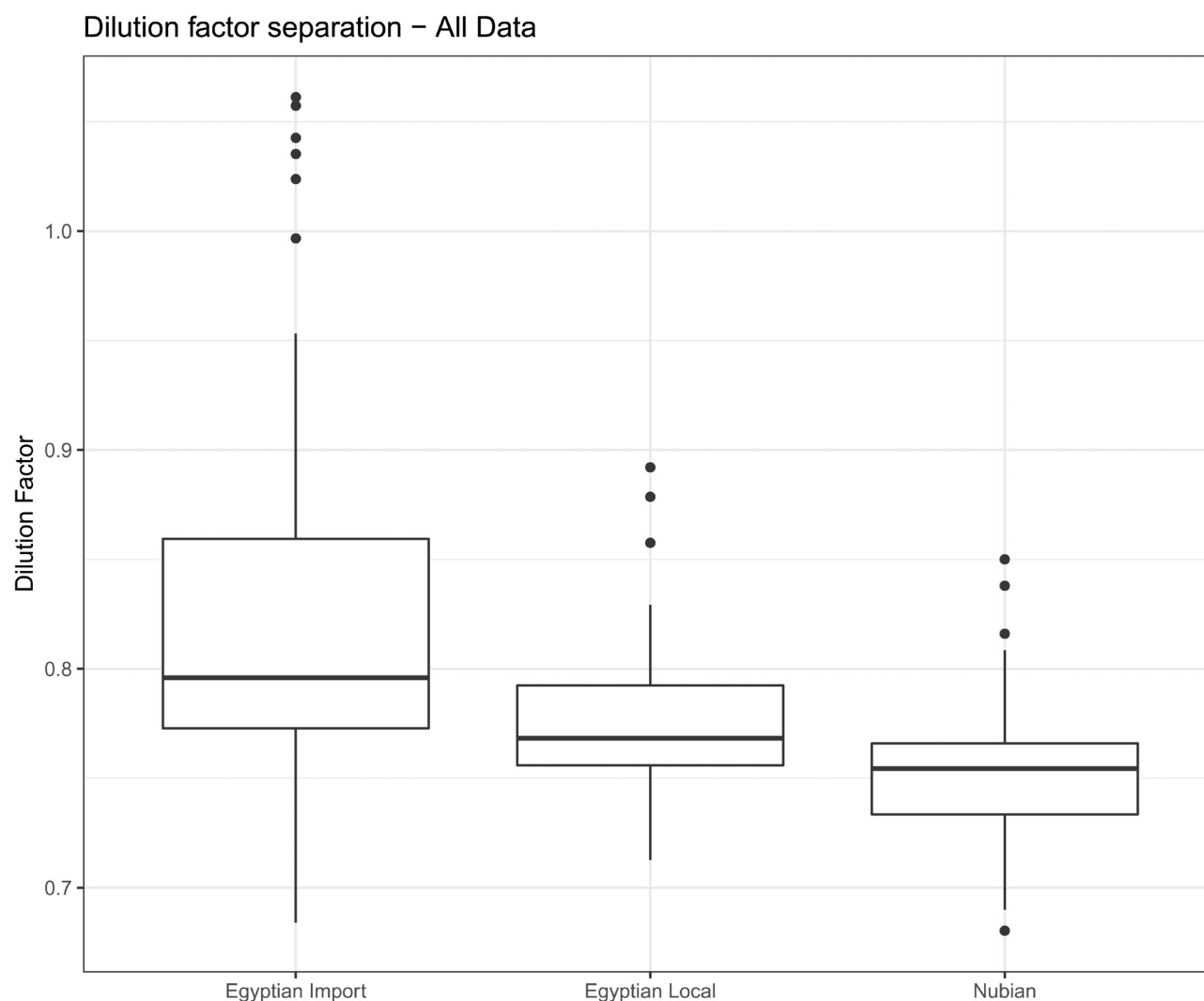
were found. Chemical group NG06 only has representative samples in sublocation Bp07 at Nakadake Sanroku, whereas samples from chemical group NG03 can be found in most sublocations.

While the total sample number in this specific case is very small (only two samples each on the two islands), the distribution might hint at complex distribution patterns of the products from Nakadake Sanroku. It is also important to note that, due to the archeological context, the chronological development and typology in Nakadake Sanroku is mostly unclear. This means that the distribution of the samples over the different geographical locations lacks the chronological information that could help to explain the distribution of the visible chemical groups.

### 5.3.3. The cooking pots of Nile clay

In the course of the European Research Council Across-Borders project (Budka and Auenmüller 2018), over

300 ceramic samples from Sai Island in northern Sudan were investigated by Neutron Activation Analysis (NAA) (D'Ercole and Sterba 2018). Sai Island, a border settlement between Upper Nubia and Egypt, was repeatedly under different political influence, which included the establishment of an Egyptian town during the New Kingdom (ca. 1539–1077 BC). Preliminary investigation of the chemical composition of the ceramic samples quickly resulted in a large group (more than 100 pieces) of ceramics made from Nile clay. Since Nile clay as a raw material is chemically very homogeneous, and thus is not necessarily local to Sai Island but could be from any point along the Nile River, additional and more careful statistical analysis of the compositional group was performed. Typologically, this group could be separated into “Egyptian-Local,” “Nubian-Local” and “Egyptian-Import” wares, i.e. ceramics made in Egyptian style but most probably locally made, ceramics made in Nubian styles but most probably locally made, and material in Egyptian style but most probably not produced locally.



**Figure 5.7.** Boxplot of the dilution factors for the three different typological categories found within the ceramics made from Nile clay. While the distribution of the imported samples has a large range of dilution factors, the range for the other two typologies is much smaller, indicating a more standardized production.

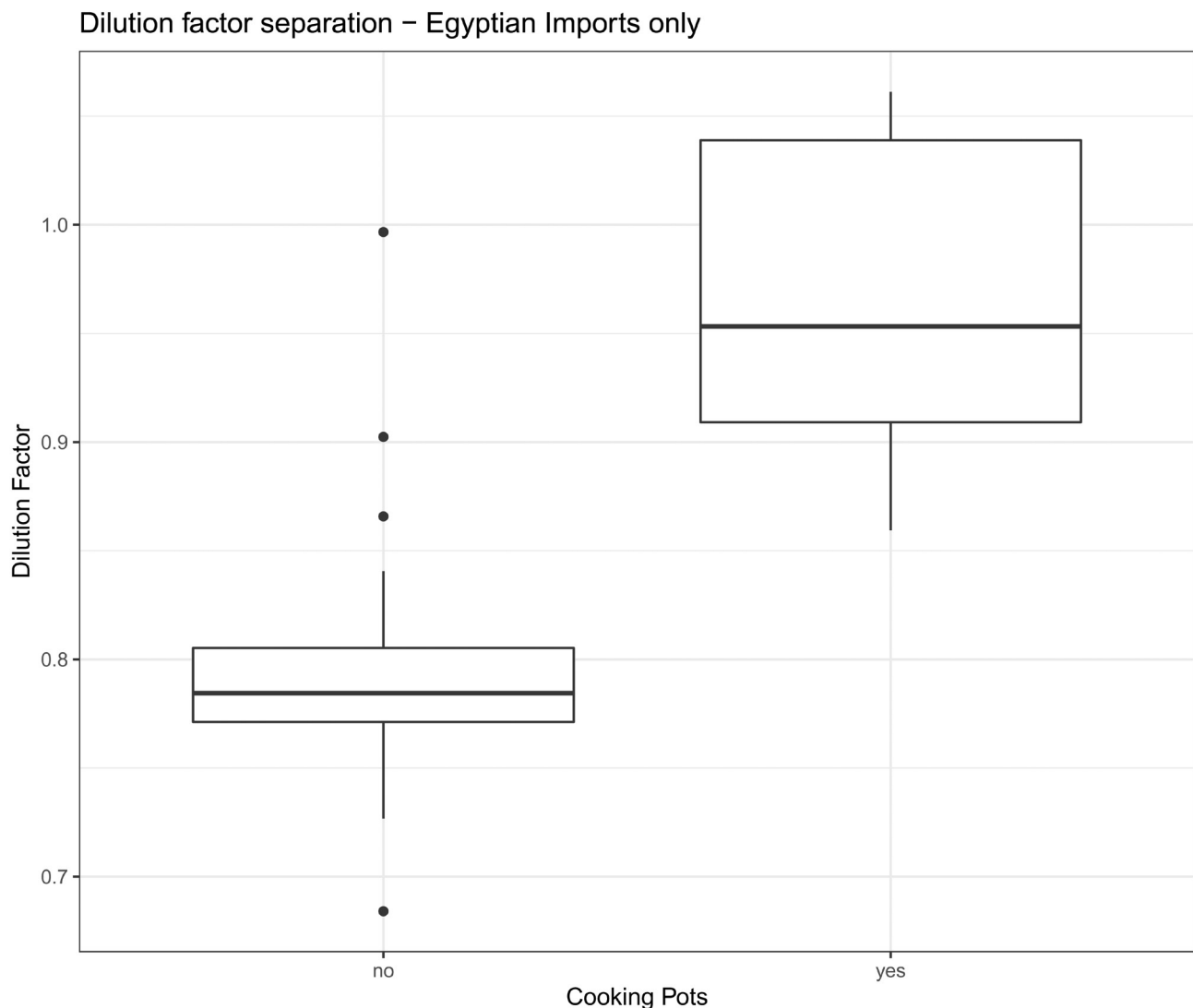
A comparison of the dilution factors of the three different typological categories (Fig. 5.7) yielded some interesting information: The distribution of the dilution factors within the three groups is different. While in the two groups that were most probably locally made from Nile clay found close to or on Sai Island, the dilution factors vary only in a small range, in the samples most probably from somewhere else along the Nile, the dilution factor distribution covers a much larger range. This can be explained by the locally produced ceramics having a much smaller range of different amounts of additives (organic material or sand) because they all were made within a community and within a fairly small area. The ceramics produced elsewhere show a much larger range of amounts of additives used, since they came from many different workshops along the Nile.

Taking this approach one step further, a closer look at the dilution factors of samples typologically categorized as Egyptian Imports is shown in Fig. 5.8: Some of the

samples could easily be recognized as cooking pots. Their dilution factors are, in general, larger (closer to 1) while the dilution factors of all other samples are much smaller (around 0.8). This indicates a difference in the amount of temper, be it sand or organic matter, that was added to the two groups, although both used the same raw materials. Considering the technological demands on cooking pots, this is a clear indication of a conscious decision of the potters to use different mixtures of the same raw materials to achieve different technological properties.

#### 5.4. Conclusion

Moving from purely archeological provenancing to archeometric analysis to support typological data with measurable chemical data allows the application of statistical methods, and thus leads to a more reproducible approach to the establishment of the provenance of ceramic material. Applying chemical analysis, specifically Neutron Activation Analysis (NAA) to provenancing



**Figure 5.8. Boxplot of the dilution factors for the samples made from Nile clay and classified as Egyptian Imports. The samples that could clearly be identified as cooking pots are shown separately, showing a significantly different average dilution factor from all other samples. This strongly indicates a conscious choice to reach necessary technological properties.**

of ceramics is well established and has been producing meaningful results and support for archeology since the 1970s (Perlman and Asaro 1969; Yellin et al. 1977; Jones 1986; Mommsen et al. 1995; Hein, Mommsen, and Maran 1999; Mommsen and Maran 2001; Sterba et al. 2009; Zuckerman et al. 2010; Moreno Megías et al. 2020).

Taking into consideration the case studies provided above, it can be seen that, with careful statistical analysis of the chemical data and in combination with archeological information, traditional provenancing can be pushed beyond the establishment of a single source of production. It becomes possible to establish different recipes employed within a single production center. In cases where reliable dating information is available, not only can the physical location of origin be established, but the time frame or sequence of production also comes within the method's reach. Changes in recipes become visible and provide information on changes in production techniques or use of raw materials.

In comparison to the macroscopic viewpoint provided by traditional methods of provenancing, NAA and subsequent statistical analysis offer a microscopic scale on which to interpret and contextualize archeological findings.

### Acknowledgements

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## Part II

### **Advances of Kiln Manufacture in China**



## Porcelain Manufacturing of the Pre-Qin Period in Zhejiang

Jianming Zheng

**Abstract:** This essay offers a perspective on the main kiln complexes in the Jiangnan region. Among them, the Dongtiao River Basin, centering on the Deqing area, was outstanding in its antiquity, the size of its kiln complexes, its high firing temperatures and the quality of its products, and occupied a highly significant position in the history of Chinese ceramics. Particularly crucial are the following research results: a) providing a material basis for exploring the origin, development, and maturity of porcelain; b) finding the place of origin for some of the proto-porcelain products unearthed anywhere; c) providing a wealth of material information for the establishment of the chronology of proto-porcelain of the Pre-Qin period in Taihu area; d) enriching the research on the archeological culture of the Shang and Zhou Dynasties in the Taihu area. These led us to realize that the firm technical basis for the emergence of developed celadon in the Han Dynasty was established in this area.

**Keywords:** Proto-porcelain, dragon kilns, Deqing, Dongtiao River Basin, celadon

### 6.1. Introduction to proto-porcelain of the Pre-Qin period

The Pre-Qin period saw the origin and early development stage of porcelain; the porcelain of that period is called proto-porcelain, another name for original porcelain. Because proto-porcelain is mostly celadon, it is sometimes called proto-celadon.<sup>1</sup> Proto-porcelain or proto-celadon is generally considered to be the celadon product in its original state, made of a porcelain clay body, coated with lime glaze, and fired at a high temperature above 1100°C. After the clay body has sintered, it is grayish white or brown, and it can make a crisp sound when it is tapped (Feng ed. 1998). Proto-porcelain is the product of the transition from pottery to porcelain. It can also be said that proto-porcelain is porcelain that is still at a lower stage. In the practice of firing pottery, the ancient Chinese people created the proto-porcelain while constantly improving the selection and treatment of raw materials as well as increasing the firing temperature and glazing the surface of the pottery (the Chinese Ceramic Society ed. 1982). Proto-porcelain appeared in the late Xia Dynasty, matured in the early Shang Dynasty, developed initially in the early Western Zhou Dynasty, flourished in the early Warring States period, and declined in the late Warring States period.<sup>2</sup> It

was distributed in Henan, Hebei, Shandong, Shanxi and Gansu in the north, Zhejiang, Jiangsu, Jiangxi, Hubei, Hunan, Fujian and Guangdong in the south and other areas, mainly concentrated in Zhejiang and other areas adjacent to Zhejiang, including southern Jiangsu, southeast Anhui, northeast Jiangxi and northwest Fujian (Fig. 6.1). It has been widely unearthed in the tombs and ruins of those periods. Among proto-porcelain vessels, ritual vessels accounted for a considerable proportion, including the Zun vessel, Dou vessel, tripod, Gui vessel, You vessel, Tilianghe kettle and Jian vessel. In the Warring States period, there appeared similibronze musical instruments, such as the Yong bell, Bo bell, Chunyu, Goudiao and Zheng, as well as weapons, tools and farm implements, etc., which covered all almost kinds of bronze wares, except for chariot fittings and harnesses. There were also some daily utensils.

The proto-porcelain kiln sites of the Pre-Qin period, in which the proto-porcelain was fired, are currently concentrated in the south, mainly in Zhejiang, including Jiangxi, Fujian and Guangdong, which are adjacent to Zhejiang. Throughout China, up to the present, proto-porcelain kiln sites have been found in Zhejiang, Jiangxi, Fujian, Guangdong and other provinces.

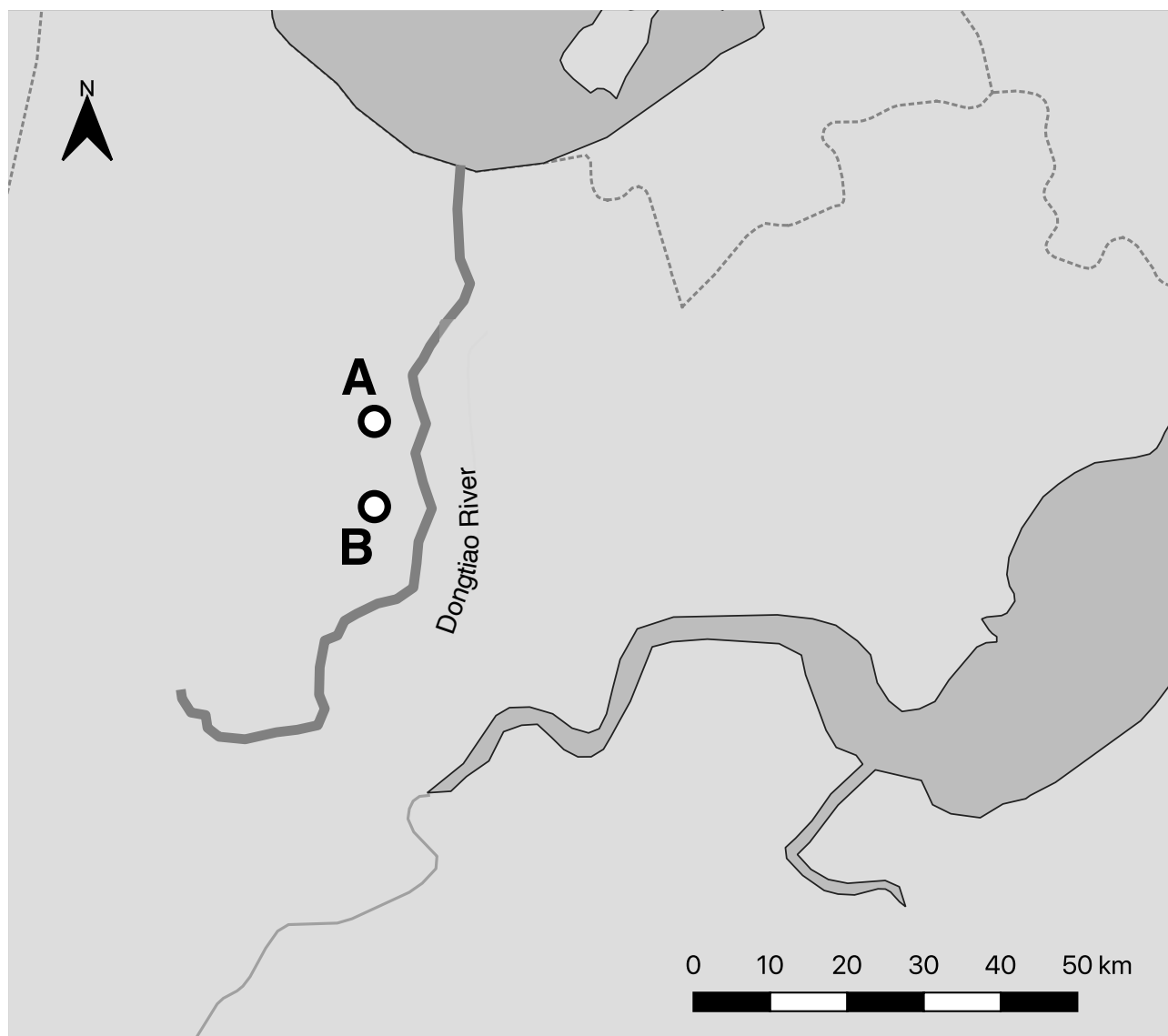
### 6.2. Proto-porcelain kiln sites of the Pre-Qin period in the Dongtiao River Basin in the north of Zhejiang

To date, the vast majority of proto-porcelain kiln sites discovered through archeology have been located in

<sup>1</sup> The proto-porcelain is mainly celadon. However, in addition to celadon, there is also some black glazed porcelain. Black glazed porcelain is mainly distributed in the mounded tombs in central and western Zhejiang. Due to the lack of unearthed materials, the context of the formation, development and decline of black glazed porcelain is not very clear.

<sup>2</sup> During the period between the decline of proto-porcelain in the late Warring States period and the emergence of mature celadon represented by such kiln sites as Shangyu Dayuanping and Xiaoxiantan in the late Eastern Han Dynasty, a kind of celadon ware was popular in Zhejiang. Its glaze was similar to that of the proto-porcelain of the Shang and Zhou dynasties, but there were great changes in the texture of the clay body. It was traditionally called high-temperature glazed pottery, which is called

proto-porcelain by some scholars. There are great differences between such ware and the proto-porcelain of the Shang and Zhou dynasties in terms of the clay body, the glaze and the types of vessels. Its inheritance from the proto-porcelain of the Shang and Zhou dynasties remains to be studied further.



**Figure 6.1. Kiln sites of the Shan Dynasty period in the Dongtiao River Basin. A: Huzhou Qingshan area, B: Deqing Longshan area.**

Zhejiang. The proto-porcelain kiln sites discovered in Zhejiang are distributed in two areas: the Dongtiao River Basin, with Deqing as the center, and the Puyang River Basin, with Xiaoshan as the center, while the former is the main distribution area.

The Dongtiao River is located on the western edge of the Hangjiahu Plain in the north of Zhejiang Province. It originates at the southern foot of Tianmu Mountain in Lin'an District, Hangzhou City. It flows from northwest to southeast into Qingshan Lake in Lin'an District, flows eastward through Liangzhu Town and Pingyao Town in Yuhang District, then flows northward into Deqing County, runs through the central area of Deqing County and enters the urban area of Huzhou City, where it joins the Xitiaoxi River and flows northward into Taihu Lake. To the west of the Dongtiao River are the Tianmu Mountains, while to the east is the Hangjiahu Plain. Deqing County and southern Huzhou City, which the Dongtiao River passes through, represent a hilly area in the transition between

the western mountainous area and the eastern plain. With undulating low mountains and crisscrossing rivers and lakes, the area is rich in porcelain clay and fuel, and the water transportation there is convenient, which is very favorable for making porcelain.

Up to now, a total of more than 140 kiln sites of the Pre-Qin period have been discovered, which can be classified into two large groups of kiln sites: the Longshan group of kiln sites in Deqing County and the Qingshan group of kiln sites in Huzhou City, with the former as the main body.

The Longshan group of kiln sites in Deqing County are mainly located at the south and east foot of Longshan Mountain, which is the boundary mountain between Huzhou City and Deqing County. The south foot of Longshan Mountain is mainly located in the former Longshan Township (current Wukang Town in Deqing County), and part of it is located in Luoshe Town, while the east foot of Longshan Mountain is located in Daixi Town,

Huzhou City. So far, a total of more than 120 kiln sites have been discovered in this group; the periods when these kilns were built include the Xia Dynasty, the Shang Dynasty, the Western Zhou Dynasty, the Spring and Autumn period and the Warring States period. The Qingshan group of kiln sites in Huzhou City is located in the former Qingshan Township (current Donglin Town) in Huzhou City, with a total of more than 20 kiln sites built mainly in the Shang Dynasty. The products of both groups of kiln sites are mainly proto-porcelain, and also include a certain number of pottery products with impressed patterns. The kiln sites excavated in this area so far include Piaoshan kiln site, of the Xia Dynasty; Nanshan kiln site and Nigushan kiln site, of the Shang Dynasty; Huoshaoshan kiln site, developed from the Western Zhou Dynasty to the Spring and Autumn period; and Tingziqiao kiln site, of the Warring States period.

### 6.2.1. Piaoshan kiln site

Piaoshan kiln site is located at Piaoshan Mountain, Donghong Village, Daixi Town, Huzhou City (Zhejiang Provincial Institute of Cultural Relics and Archaeology, etc. 2015). It is distributed across two locations, about 400 m apart, facing each other across the gully. Area II of Piaoshan kiln site was excavated in 2012 (Fig. 6.2: 1). The distribution area of Piaoshan kiln site is not very large, at about 300 m<sup>2</sup>. The kiln remains and rich stratigraphic accumulation have been cleaned up (Fig. 6.2: 2). The kiln site has abundant accumulation, about 1 m thick at the thickest point, which can be divided into two periods: the early period corresponds to the late Xia Dynasty, and the late period to the Shang Dynasty. A large number of product specimens have been unearthed. One kiln which was discovered and cleaned up had been seriously damaged (Fig. 6.2: 3). The kiln tail did not exist. Part of the firebox was preserved, but the walls on both sides were not well preserved and were almost completely destroyed. The residual length of the kiln is 4.2 m, the width of the uphill end to the west end 2.9 m, the width of the downhill end to the east is 2.2 m, the direction is 105 degrees, and the slope is 22 degrees. The unearthed product specimens are basically proto-porcelain and stamped hard pottery. The shape of the proto-porcelain is very original, and the clay body is consistent with the hard pottery: The colors of clay bodies are darker, most of them being grayish black, cinerous, purplish red and earthy yellow and not pure. Most of the clay bodies resemble a sandwich biscuit, grayish black inside and earthy yellow outside, or earthy yellow inside and cinerous outside, etc. The texture of the clay bodies is loose, with a large number of pores of different sizes and a high water absorption rate (Fig. 6.2: 4). The clay bodies are harder due to higher firing temperature. Except for some under-fired clay bodies, almost no soft pottery has been discovered. The types of vessels mainly include the bowl, tripod plate, long-necked jar, large jar with a folding rim, Dou vessel, sinker-shaped clay objects, pad and clapper. The glazed part is mostly the upward part of the vessel, such as the inside of the tripod plate and the

shoulder and rim of the jar. The thicker glaze layer tends to be concentrated on one side of the vessel, such as the shoulder and neck of the jar or one side of the handle of the Dou vessel. The glazing line is not clear, and the glazing thickness gradually thins from the glazed part to the non-glazed part. The glaze layer of most vessels is very thin. Only in a small area of local glaze is the glaze layer thicker, gradually thinning at the perimeter and showing a very thin spot shape. The glaze was not well distributed in the area with thick glaze, showing a spot of coagulated glaze. The degree of vitrification is high and the glass texture is strong, but the glaze peeling is severe due to poor combination of the glaze with the clay body. The glaze color shows darker black-brown, tan or cyan (Fig. 6.2: 5). For the unglazed part of the vessels, including hard pottery, the surface shows a darker black-brown or tan coat or membrane. There are two kinds of hard pottery: plain hard pottery and stamped hard pottery. These are basically the long-necked jar and the jar with a folding rim, with zigzag decorative patterns. For both the proto-porcelain and the stamped hard pottery, the inner belly of the large small-mouth jar is uneven; there are many pits in it, and the pits in the stamped hard pottery are denser and deeper. The outer belly of the proto-porcelain is bright and clean. Many vessels can be seen with very fine lateral smear marks on the outer belly, and most of the spiral patterns along the rim are regular, though some are also irregular. It can be determined that such vessels were formed by dishing up hand-made clay strips. Small vessels, such as bowls, are bright and clean inside and outside, so they were probably formed by wheeling clay.

Piaoshan kiln site is the earliest proto-porcelain kiln site discovered and excavated so far. It can be dated to the late Xia Dynasty. The porcelain excavated from this kiln site is quite primitive in both clay and glaze. These characteristics are very similar to those of hard ceramics, and it is possible to understand the process by which hard ceramics were transformed into primitive porcelain.

### 6.2.2. Nanshan kiln site

Nanshan kiln site is located in Nanshan Village, Donglin Town, Huzhou City (Zhejiang Provincial Institute of Cultural Relics and Archaeology, etc. 2015). Thanks to the excavation, the remains of three kilns and two ash pits were exposed, and a large number of proto-porcelain wares were unearthed. The remains of all three kilns represent long-strip sloped dragon kilns (Fig. 6.2: 6). Kiln no. 3 is the best-preserved one, with an inclined length of 7.1 m and a width of 2.2–2.4 m. The kiln is considerably original: The whole kiln body is short; the firebox is long and narrow, while the firing chamber is short. The floor of the firing chamber is uneven, and there is no bottom sand in it. It is from the early stage of the development of the dragon kiln, and it is also the earliest proto-porcelain dragon kiln excavated so far. The specimens of unearthed products are all basically proto-porcelain. The types of vessels represented include the Dou vessel, jar and lid, Gui vessel, Zun vessel, basin, plate, bowl and vase. Most





Figure 6.2. Kilns and ceramic in the Dongtiao River Basin 1 (Courtesy of Zheng Jianming).

of the vessels would have been intended for use as ritual vessels. The texture of the clay bodies of most vessels is relatively fine and firm. The soil for the clay body was carefully selected, but the clay body contained a certain amount of impurities, the treatment of which needs to be further improved. The traces of artificial glazing are obvious: A small number of vessels are full of glaze inside and outside. The glaze color is green. The glaze layer is well distributed, the clay body is well combined with the glaze, and the glass texture is strong, but the glaze layer of most vessels is very thin, and its color is uneven. The body of the vessels was only partially glazed, and the glazing technology was still at the exploratory stage. In terms of shaping, forming by wheeling clay was combined with manual scraping (Fig. 6.2: 7). Nanshan kiln site started its firing in the early Shang Dynasty and lasted until the late Shang Dynasty.

### 6.2.3. Nigushan kiln site

Nigushan kiln site is located in Zhaiqian Natural Village, Shacun Village, Luoshe Town, Deqing County. In 2012, nearly 200 m<sup>2</sup> of Nigushan kiln site were excavated; the remains of one dragon kiln were cleaned up (Fig. 6.2: 8), and several product specimens were collected. The kiln was not well preserved, and only the firebox remained. The pot shape is sunken, with a gray sintering surface. The upper half of the firing chamber was entirely absent. Based on the morphological analysis, it would have been a dragon kiln. The accumulation of this kiln site was seriously damaged. The stratum is not thick, and the preserved area is not large. There are a large number of sintered clay agglomerates and a small number of product specimens in the preserved stratum, including plain hard pottery and stamped hard pottery, and no proto-porcelain has been discovered. Therefore, this kiln would have fired the pure pottery instead of proto-porcelain. The types of stamped hard pottery wares represented mainly include various kinds of pots or jars. The clay bodies are mainly reddish brown (Fig. 6.2: 9). The stamped decorative patterns are mostly thick and large rhombic cloudscares, diamond patterns or broken line patterns (herringbone patterns), but there are also small and shallow fine rhombic cloudscares. Some of the vessels are plain, with a very thin glaze layer on the surface, and the clay body is close to that of the hard pottery. Based on the decorative patterns and types of the products and other aspects, the era of the kiln site was around the Shang Dynasty.

So far, this is the only hard pottery kiln site of the Shang Dynasty to have been cleaned up in the Dongtiao River Basin in Zhejiang Province. The main observation to note is that some products have an extremely thin glaze layer, which is of great significance for understanding the pottery firing technology in this area and the relationship between the pottery firing technology and the proto-porcelain, and also adds a new type to the porcelain production in the Pre-Qin period.

### 6.2.4. Huoshaoshan kiln site

Huoshaoshan proto-celadon kiln site is located at both ends of the dam of Juebuling Reservoir, Longshan Village, Wukang Town, Deqing County (Zhejiang Provincial Institute of Cultural Relics and Archaeology, etc. 2008). It is an ancient kiln site for firing proto-celadon dating from the late Western Zhou Dynasty to the late Spring and Autumn period. Thanks to the excavation, three kilns and more than 10 ash pits were exposed (Fig. 6.3: 1). All the kilns discovered were located on the hillside, with a certain slope and length which meet the basic conditions of the dragon kiln. The products of this kiln are extremely abundant, but almost no stamped pottery has been discovered. It is a kiln site purely for firing proto-porcelain. The products mainly include bowls, plates, jars, water vases, pots and basins, which are used as practical utensils, and they also include You vessel, tripod (Fig. 6.3: 2) and Gui vessel shapes, which are bronzeware-imitated pottery for ritual. From the end of the Western Zhou Dynasty to the early Spring and Autumn period, this kiln was in its heyday. Its products were rich in variety, exquisite in production and decorated with a large number of decorative patterns, and the glaze color was excellent. Bronzeware-imitated pottery for ritual discovered mainly dated to this period, and their bellies are often decorated with elaborate decorative patterns, mainly including: connected cloud patterns, fine disordered cloud patterns, double-hook line “S” shapes, cloudscares and symmetrical arc patterns. The decorative patterns are large in size, extensive in style and disorderly in arrangement, and often overlap with each other (Fig. 6.3: 3). During this period, although the phenomena of under-firing and glaze peeling were the most severe and the clay body was not well combined with the glaze, the glaze layer was thick, the glaze color was dark, and the glass texture was generally strong.

After the middle Spring and Autumn period, bronzeware-imitated pottery for ritual vessels almost disappeared, the bowls absolutely dominated, and a small number of plates and jars were also produced as practical utensils. Both the number and range of decorative patterns decreased sharply, and basically only two kinds of decorative patterns, the symmetrical arc pattern on the jar and the longitudinal fine water-ripple pattern on some bowls, were retained. The style was fine and orderly, and the overlapped stamping phenomenon was rare. Compared with the early period, the texture of the clay body was more compact, finer and smoother; the glazing technology was obviously improved; the clay body was better combined with the glaze; the frequency of under-firing and glaze peeling decreased sharply; the glaze layer became thinner; the glaze was well distributed; and the glaze color became light and showed a light cyan color. In the late Spring and Autumn period, continuing the trend seen in the middle Spring and Autumn period, the number of vessels was further reduced; there were basically only two kinds of cup-type bowls, the bowl with a lid that fits tightly and the bowl with a sharp round rim, with a cylindrical body and a flat bottom. The production technology of the clay body and the glaze were also further



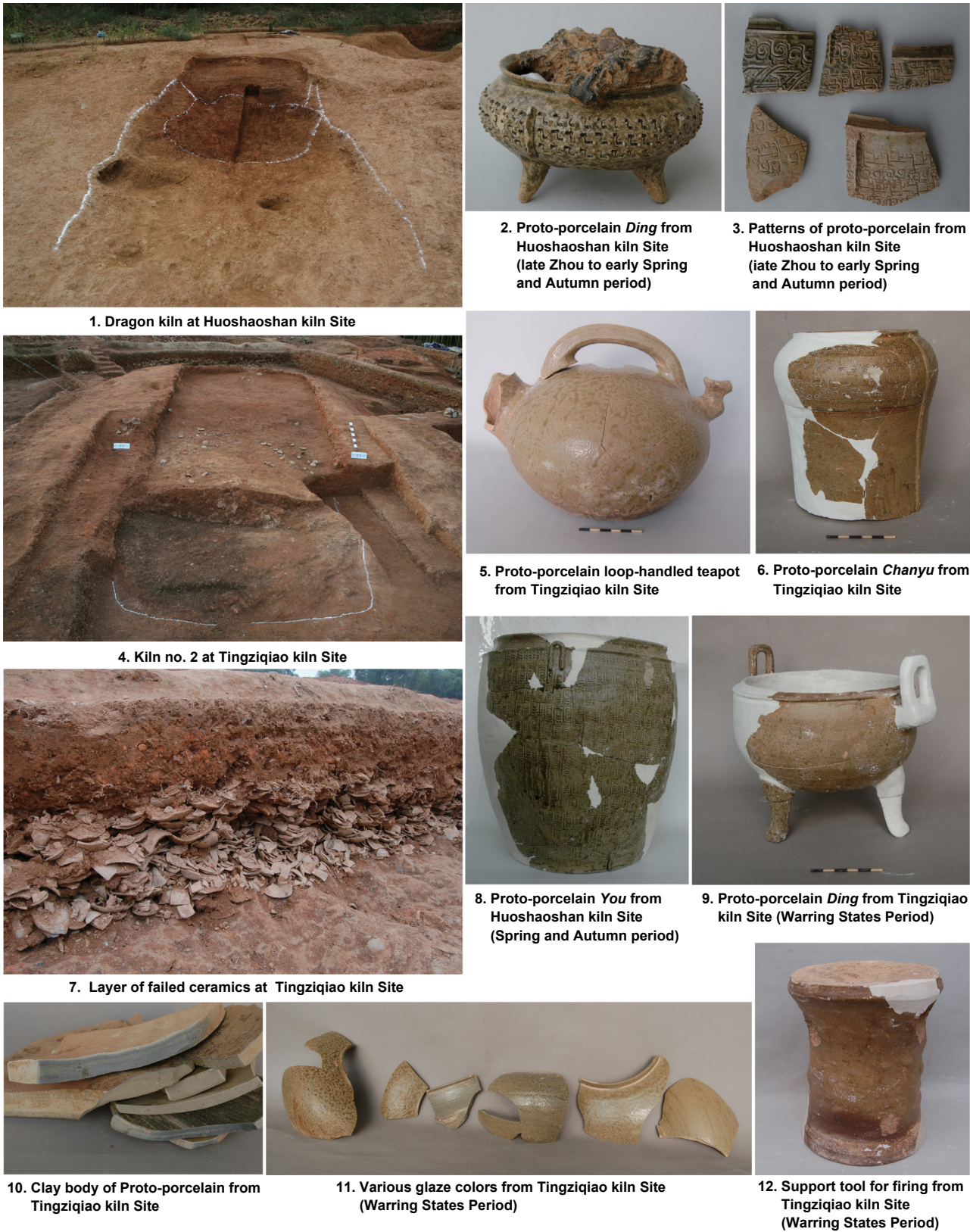


Figure 6.3. Kilns and ceramic in the Dongtiao River Basin 2 (Courtesy of Zheng Jianming).

improved. In terms of firing technology, a large number of nearly conical pottery supports dating to the middle Spring and Autumn period were discovered, and one group consisted of three beads used as spacers. Huoshaoshan kiln site is rich in strata and continued to be used for a long time. Through this excavation, it is possible to establish a

more detailed basic chronological sequence from the late Western Zhou Dynasty to the end of the Spring and Autumn period. Moreover, the place of origin has been discovered for similar vessels unearthed from Jiangnan mounded tombs, especially for bronze-ware-imitated pottery for ritual including the tripod, *You* vessel and *Gui* vessel.

### 6.2.5. Tingziqiao kiln site

Tingziqiao kiln site is located in Longsheng Village, Wukang Town, Deqing County. The remains of all seven kilns unearthed were built on the gentle slope of a small hill, with a long strip plane (Zhejiang Provincial Institute of Cultural Relics and Archaeology, etc. 2011). They are dragon kilns with southern characteristics, among which the remains of kiln no. 2 are the best preserved. The kiln floor and firebox are basically intact, with a thorough inclined length of 8.7 m. The kiln appears to be very wide, with a width of 3.32–3.54 m. Generally, it is short and wide, with local features (Fig. 6.3: 4). The kiln wall was not built with brick-shaped adobe, but was made of grass mixed with mud paste, with a residual height of 0.2–0.4 m. The firebox is rectangular. Tons of product specimens and kiln furniture have been unearthed. The products are mainly fired proto-celadon and a small number of fired stamped hard pottery wares. The proto-celadon vessels were formed by wheeling the clay. The shapes of the vessels are standardized. The texture of most of the clay bodies is fine, smooth and compact. There are some products fired at a high temperature, for which the texture is hard, the glaze is even and shiny, the glass light sense is strong, and the quality is superior. These products are comparable to the mature celadon of the Eastern Han Dynasty. In addition to the general bowls, plates, cups, handle-less cups, vases, pots, boxes and other daily utensils, the types of the vessels are mainly a large number of bronzeware-imitated pottery for ritual and musical instruments. The types of ritual vessels represented include the tripod, Dou vessel, basin, three-legged basin, plate, three-legged plate, loop-handled teapot (Fig. 6.3: 5), Tilianghe kettle, the flask with openwork pattern on its body, Zun vessel, Gui vessel, Lei vessel, jar, three-legged pot, Fang vessel and Jian vessel. The types of musical instruments represented include the Yong bell, Chunyu, Goudiao, a three-legged percussion instrument made of clay, a dangling bell and a hanging drum seat, with rich types and diversified forms. These bronzeware-imitated pottery for ritual and musical instruments are standardized and dignified in shape as well as exquisite and meticulous in workmanship. Most of them are large and heavy, appearing solemn and majestic. They can be regarded as the best among the proto-celadon in terms of molding technology, firing technology and product quality.

From the perspective of products, during the Warring States period, Tingziqiao kiln site was a kiln site mainly for firing high-grade bronzeware-imitated proto-celadon ritual vessels and musical instruments for the Yue region. As far as the whole southern region and even the whole country are concerned, it is the first example discovered of a kiln for firing these kinds of proto-celadon. This is an extremely important discovery in the archeology of porcelain kiln sites in China. Thanks to the discovery of Tingziqiao kiln site, the definite place of origin and kiln have finally been found for a large number of similibronze proto-celadon ritual vessels and musical instruments unearthed from the tombs of Yue nobles in the Jiangsu

and Zhejiang areas, indicating that the kiln for firing high-grade living and funeral porcelain for the Yue royal family and upper-class nobles during the Warring States period was in the current Deqing County, Zhejiang Province. At the same time, it also indicates that Tingziqiao kiln site was a kiln dedicated to the production of high-grade living and funeral porcelain for the Yue royal family and upper-class nobles, so it may to a large extent be something in the nature of an early official kiln. Among the proto-celadon unearthed from Tingziqiao kiln site, many products appear to have been fired at a high temperature. The texture of the clay body is exquisite and firm, the glaze is even and bright, the glaze color is blue and green, and the clay body is well combined with the glaze. The product quality has reached the level of mature celadon. In particular, among the products of this kiln site, there are a large number of well-fired large vessels with a huge and heavy body. From the molding process to the method of loading and firing and then to the control of firing temperature, there were high requirements for and difficulties associated with firing such large vessels with an extra thick clay body. The successful firing of these large vessels represents the highest level of proto-celadon production in Tingziqiao kiln site, and also reflects the fact that Tingziqiao kiln site had a relatively mature porcelain-making technology. Therefore, the excavation information from Tingziqiao kiln site in Deqing County is of great academic significance for recovering the important position and role of the proto-celadon of the Warring States period in the emergence of mature celadon, and for studying the development history of Chinese porcelain, especially the origin of mature celadon in China.

### 6.2.6. Changshan kiln site

Changshan kiln site is located in the north of Shizhai Natural Village, Luoshe Town, Deqing County. A total of four kilns in two locations were excavated and cleaned up, and a large number of exquisite specimens were unearthed. The kilns in one of the two locations were well preserved, and represented the superposition of three kilns one over another, numbered Y1–Y3, while the kiln in the other location, numbered Y4, was severely damaged. Among these, Y1 was the best preserved: The square firebox is about 20 cm lower than the floor of firing chamber. The dark gray sintering surface at the bottom of the firebox is obvious. The bottom of the firing chamber is covered with fine yellow sand. Y2 is located to the southeast of Y1, broken by Y1, and Y3 is located to the southeast of Y2, broken by Y2. In the southern section, the superposition relationship of the three kilns is clear. Y4 was basically destroyed, but judging from the preserved sintering soil, it was undoubtedly a kiln. A large number of proto-porcelain specimens were unearthed from the piles on both sides of the kiln, most of which were of high quality: The texture of the clay body is exquisite and firm; the clay body is excellently combined with the glaze; the glaze is well distributed; the glaze color is verdant or cyan; the glass texture is strong; and the clay body and glaze are close to those of the mature celadon of the late

period. In addition to the bowls used as practical utensils, there are also a considerable number of ritual vessels and musical instruments: tripod, pot, jar, Yong bell, Chanyu (Fig. 6.3: 6) and Goudiao, etc. These ritual vessels and musical instruments were discovered in large tombs, such as the Yue Tomb in Hongshan, Wuxi City, and were distinguished articles for nobles' use only. Changshan kiln site, like Tingziqiao kiln site, originated in the Warring States period. It is of great value for exploring the origin of Chinese porcelain, the evolution of China's kiln system and even the origin of the official kiln system. After a series of excavations of kiln sites and systematic investigation in this area, the profile of the kiln industry in the Dongtiao River basin is basically clear, and displays the following characteristics.

First, the kilns emerged early and lasted for a long time. The kiln sites emerged in this kiln area in the Xia Dynasty, and continuously developed during the Shang Dynasty, the Western Zhou Dynasty, the Spring and Autumn period and the Warring States period, almost without break. So far, this kiln site group is the earliest, longest-used and most complete Pre-Qin kiln site group known in China.

Second, the kiln sites were concentrated, with a large production scale. According to the materials available, there were nearly 150 kiln sites in this period. Many kiln sites, such as Tingziqiao kiln site, had a large distribution area and thick accumulation layer, and the product output had reached a considerable scale (Fig. 6.3: 7).

Third, there were many kinds of products. In addition to the production of bowls, plates and dishes for daily use, a large number of bronze ware-imitated pottery and musical instruments were fired and produced, which symbolized identity and status and had special significance. They included the You vessel (Fig. 6.3: 8), tripod (Fig. 6.3: 9), Gui vessel, Zun vessel, Dou vessel, kettle, Lei vessel, jar, pot, plate, basin, Jian vessel, three-legged plate, the flask with openwork pattern on its body, loop-handled teapot, Tilianghe kettle, gourd-shaped ladle and earthen bowl, which were used as ritual vessels, and they also included the Yong bell, Goudiao, Chunyu, Zhen and hanging drum seat, which were used as musical instruments. The production of these large ritual vessels and musical instruments has only been discovered in this kiln area so far.

Fourth, the quality of products is high. Many products from this kiln area, especially those from the Warring States period, are large in size, standardized in production, exquisite and firm in the texture of the clay body (Fig. 6.3: 10), verdant and smooth in the glaze color (Fig. 6.3: 11), and have well-distributed glaze and a strong glass texture, which are almost comparable to those of the celadon from the Eastern Han Dynasty.

Fifth, an independent kiln area emerged. Starting from the Shang Dynasty, a special kiln area was formed in the Dongtiao River Basin. At least starting from the

late Western Zhou Dynasty, the kiln area was basically specialized in firing proto-porcelain only.

Sixth, the kiln furniture has various shapes, and the loading and firing process was mature. During the Spring and Autumn period, a large number of support beads were used as spacers, which were small in shape and meticulous in manufacture, which could effectively protect the glaze and increase the quantity of loading and firing. During the Warring States period, a variety of support firing tools emerged endlessly: they were shaped like a straight cylinder (Fig. 6.3: 12), trumpet, tray, shallow plate, etc. Different support firing tools were used for firing different vessels, which successfully provided for the loading and firing methods of Yong bell and Goudiao instruments, and the loading and firing technology was quite mature.

Therefore, the kiln area of the Shang and Zhou dynasties in the Dongtiao River Basin, with Deqing as the center, is unique and outshines others in terms of production time, kiln-site scale, product category and product quality. It occupies a very important position in the history of Chinese porcelain. It is the first peak in the history of Chinese porcelain-making, and it is also the source of Chinese porcelain.

### 6.3. Proto-porcelain kiln sites in the Puyang River Basin on the south bank of the Qiantang River

The Puyang River takes its source at the south foot of Xianhua Mountain, Pujiang County, Jinhua City, central Zhejiang Province. It flows through the Zhuji and Xiaoshan areas, and joins the Qiantang River at the mouth of three rivers in Xiaoshan. It is the largest tributary of the Qiantang River, and it passes through low-mountain hilly areas.

During the Pre-Qin period, the kiln sites in the Puyang River Basin were mainly concentrated in the middle and lower reaches of the Puyang River, with Jinhua Town in the south of Xiaoshan as the center, including the adjacent Shaoxing and Zhuji areas. The kiln sites mainly include Maowanli kiln site, Qianshan kiln site and Anshan kiln site in Xiaoshan District, Fusheng kiln sites in Shaoxing City, and Tuoshanwu kiln site in Zhuji City, among which Maowanli kiln site is the largest. The kiln sites that have been excavated so far in the area include Qianshan kiln site and Anshan kiln site in Xiaoshan District as well as Fusheng kiln sites in Shaoxing City.

#### 6.3.1. Xiaoshan Qianshan kiln site

Qianshan kiln site is located in Shaojiata Village, Jinhua Town, Xiaoshan District, Hangzhou City (Zhejiang Provincial Institute of Cultural Relics and Archaeology, etc. 2005). Thanks to the excavation, two dragon kilns were exposed, and a large number of specimens of proto-celadon and stamped hard pottery were obtained. This is a kiln site for firing proto-porcelain and stamped hard pottery together, active during the Spring and Autumn period and



the Warring States period. Of the two dragon kilns, Y2 was well preserved; part of it was directly built on the raw soil, with kiln-protection soil on both sides. The firebox and the back wall of the kiln tail are basically in good condition. The head of the kiln is at the south and the tail at the north, with a direction of 184 degrees, a slope length of 13 m and a slope of about 15 degrees. The dragon kiln consists of the firebox and the firing chamber. The plane of the firebox is semicircular, and the bottom is slightly inclined from the back to the front. The back wall is 2.3 m wide and 0.6 m high, and it is 1.5 m away from the stokehole. The inner side, back wall and bottom of the firebox were sintered into a cinerous hard surface, and the sintering degree of back wall was higher. The inclined length of the firing chamber is about 11 m, and the width of the kiln bottom is 2.3–2.4 m, with almost the same width at both the rear and the front. The vault of the kiln has collapsed, but the collapsed block at the top of the kiln is basically flat at

the bottom of the kiln. The vault was made of clay mixed with straw. On the sintered surface of the top, inside the kiln, there are traces of tied branches and woven bamboo strips. The products mainly include stamped hard pottery and proto-porcelain.

According to the distribution of fragments in the dragon kiln, the front section of the firing chamber may have been used mainly for firing proto-porcelain, while the rear section of the firing chamber may have been used mainly for firing stamped hard pottery when the dragon kiln was firing these two types of products in the same kiln. Whether for proto-porcelain or for stamped hard pottery, the variety is relatively simple, and basically represents small daily utensils. Mainly two types of stamped hard pottery are represented, altars and jars, the mouth rims of which have been scraped by the wheel. The decorative patterns of the stamped hard pottery mainly include the



1. Proto Porcelain bowl from Qianshan kiln Site (Warring States Period)



3. Proto Porcelain *Zhong* from Anshan Kiln Site (Warring States Period)



4. Stamped hard pottery from Anshan Kiln Site



2. Dragon kiln at Anshan Kiln Site

Figure 6.4. Proto-porcelain kiln and vessels (Courtesy of Zheng Jianming).

checkered pattern, rice-sieve pattern and checkered filling line pattern. The proto-porcelain is another main product of Qianshan kiln site. The types of vessels represented include bowls (Fig. 6.4: 1), cups, dishes, plates and lids. They were all made by wheeling. The shapes are small and basically plain. A small number of curved bellied bowls have water-ripple patterns on the inner belly.

### 6.3.2. Xiaoshan Anshan kiln site

Anshan kiln site is located in Jinhua Town, Xiaoshan District, Hangzhou City (Shen 2009). Three dragon kilns (Fig. 6.4: 2) from the Spring and Autumn period and the Warring States period were excavated and cleaned up. Y1, built on the southeast slope of Anshan, is composed of the firebox and the floor of the firing chamber, with a total inclined length of 10.5 m. The plane of the firebox is a rounded rectangle with 2.75 m in width and 0.35 m in height. The rear wall is 1.25 m away from the stokehole. The connection between the rear wall of the firebox and the floor of firing chamber projects out in a slight arch. There are kiln-protection buildings on both sides of the firebox. Y2 and Y3 are located on the west slope of Anshan, and their structures are basically the same as those of Y1. There are two types of unearthened products: proto-porcelain and stamped hard pottery. The types of proto-porcelain wares represented include bowls, jars, dishes, plates and handleless cups (Fig. 6.4: 3). The texture of the clay body is fine and smooth. The glaze is blue or yellow. The stamped hard pottery includes jars (Fig. 6.4: 4) and altars. The decorative patterns of the stamped hard pottery include the large Hui character pattern, checkered pattern, rice-sieve pattern, Mi character pattern, water-ripple pattern, checkered filling line pattern, and Hui character crisscross pattern. The stamped hard pottery was fired at a higher temperature, to a hard texture. The period of producing the stamped hard pottery was from the middle to late Spring and Autumn period to the early Warring States period. The kiln furniture is mainly of the small, round support plate shaped spacer type. According to analysis of the unearthened remains, it is speculated that Y1 started firing and manufacturing the products in the middle to late Warring States period, Y2 started in the early to middle Warring States period, and Y3 started the earliest, in the middle to late Spring and Autumn period.

### 6.3.3. Fusheng kiln sites

The Fusheng kiln sites are located in Changzhuyuan and Zhujiashan, Fusheng Town, Shaoxing City (Shaoxing County Cultural Relics Management Committee 1979). Among others, after a simple cleaning of the Changzhuyuan kiln site, the remains of a kiln with a length of 3 m and a width of 2.42 m was exposed. The bottom of the kiln was covered with sand. It was a slope-shaped dragon kiln. Only the middle and rear sections of the kiln were preserved. A few fragments of proto-celadon, geometrically stamped hard pottery and flat round support beads were discovered in the kiln, demonstrating that the kiln was for firing stamped hard pottery and proto-celadon together. A large number of examples of proto-porcelain and stamped hard

pottery were unearthened in the stratum. The proto-celadon was made of porcelain clay, with a fine and hard texture and a high firing temperature. Most of the products unearthened were gray-white, while some of them were gray. The shapes of the vessels were standardized, with circles of fine spiral patterns on the inner bottom and numerous cutting-line traces on the outer bottom. A thin glaze with a yellowish tint was applied inside and on the outside of the vessels. The glaze layer was not well distributed, with obvious coagulated glaze, and most of the outer bottoms were not glazed. The types of vessels represented include bowls, plates, dishes, pots, lids and other small daily utensils, lacking variety. The geometrically stamped hard pottery includes containers such as jars and altars. The bone of the clay body is dark purple, purple-black or dark gray, and the texture of the clay body is strong. The outer wall of the pottery is stamped with geometric patterns such as rice-sieve pattern, Mi character pattern, checkered pattern, mat pattern and Hui character pattern. The period of production for these vessels was from the middle to late Spring and Autumn period to the early Warring States period.

### 6.3.4. The main kiln sites in this area, other than the excavated kiln sites described above

In terms of product category, this group of kiln sites mainly produced stamped hard pottery and a small number of proto-porcelain wares; in terms of age, this group of kiln sites started from the middle to late Spring and Autumn period, flourished in the early Warring States period, and declined in the middle Warring States period; and in terms of the types of proto-porcelain, this group of kiln sites basically produced small daily utensils such as bowls and dishes and occasionally produced small jars, but no large proto-porcelain ritual vessels or musical instruments have been discovered. This group of kiln sites must be a supplement to the group of kiln sites of the Pre-Qin period in the Dongtiao River Basin, with Deqing as the center.

The largest group of kiln sites in this area is located in Maowanli. Although it has not been formally excavated, the profile and distribution of this group of kiln sites have been basically clarified through several years of investigation: This group of kiln sites covers an area of about 20,000 m<sup>2</sup>. It is composed of several kiln sites in Qiujiashan, Shizishan and Wusongtui. It was mainly for firing stamped hard pottery and proto-porcelain together. The proto-porcelain mainly includes bowls, plates, dishes, pots and other daily utensils. No large ritual vessels and musical instruments have been discovered. The quality of the glaze and of the clay bodies of some vessels is high. The stamped hard pottery mostly includes jars and altars. Their decorative patterns are relatively simple, mainly including the checkered pattern, double Hui character and Shi character crisscross patterns, rice-sieve pattern and checkered filling line pattern. These vessels were fired in the dragon kiln. The kiln was relatively mature, and the use of space was reasonable. This area was an important distribution area of early dragon kilns. These kilns started

from the middle to late Spring and Autumn period and lasted into the Warring States period.

#### **6.4. Basic pattern and significance of proto-porcelain kiln sites of the Pre-Qin period in Zhejiang**

Among the proto-porcelain kiln sites of the Pre-Qin period in Zhejiang, the group of proto-porcelain kiln sites of the Pre-Qin period in the Dongtiao River Basin, with Deqing as the center, is unique and outshines others in China in terms of production time, kiln-site scale, product category, product quality and firing technology. It occupies a very important position in the history of Chinese porcelain. It was the first peak in the history of Chinese porcelain-making, and laid a solid technical foundation for the emergence of mature celadon in the Han Dynasty. However, the group of proto-porcelain kiln sites of the Pre-Qin period in the Puyang River Basin, with Xiaoshan as the center, is not only small in scale, but also has a relatively simple variety of products. The products of these kilns mainly included small daily utensils such as bowls and plates. The period of activity for these kilns was mainly from the late Spring and Autumn period to the early Warring States period. This group of kiln sites was an important supplement to the group of proto-porcelain kiln sites of the Pre-Qin period in the Dongtiao River Basin. Its emergence was closely related to the conflict between Wu and Yue in the middle and late Spring and Autumn period and the retreat of Yue culture to the south of the Qiantang River (Zheng 2019).

The group of proto-porcelain kiln sites of the Pre-Qin period in the Dongtiao River Basin has important academic value in the following respects.

##### **6.4.1. Providing an important material basis for exploring the origin, development and maturity of porcelain**

The proto-porcelain kiln sites discovered in this area can be traced back to the Xia Dynasty or the period between the Xia and Shang dynasties. In terms of the clay bodies, glaze and molding technology of the products and the loading and firing technology of the kilns, these kilns were both mature and original. The products of these kilns had the characteristics of an early form of porcelain. They are the “proto” porcelain. This provides important material information for exploring the origin of porcelain and the development history of China’s porcelain. The discovery of large-scale proto-porcelain kiln sites in the Dongtiao River Basin fully proves that this area is an important origin point for Chinese porcelain. And the continuous development of the proto-porcelain kiln sites during the Western Zhou Dynasty and Eastern Zhou Dynasty formed the first peak in the history of Chinese porcelain-making.

##### **6.4.2. Finding the place of origin for some of the proto-porcelain products unearthed elsewhere**

The proto-porcelain wares unearthed in Jiangnan and Northern China, including the Yinxu area and Zhouyuan,

are similar to the products from the kiln sites in the Dongtiao River Basin in terms of type, shape, clay body, glaze and other characteristics, and can be preliminarily identified as the products of this basin. Therefore, the investigation and excavation of a series of kiln sites in the Dongtiao River Basin provides very important information for exploring the place of origin for the unearthed proto-porcelain. The discovery of kiln site products of this basin in the capitals of the Shang and Zhou dynasties, such as Yinxu and Zhouyuan, not only proves that the proto-porcelain was a kind of high-grade vessel symbolizing identity and status during the Pre-Qin period, but also further proves that the northern proto-porcelain was probably produced in the south.

##### **6.4.3. Providing a wealth of material information for the establishment of the chronology of proto-porcelain of the Pre-Qin period in the Taihu area**

The proto-porcelain kiln sites of the Pre-Qin period in the Dongtiao River Basin lasted for a long time, and the evolution of the vessels was clear. From the Xia and Shang dynasties to the late Warring States period, a complete chronological sequence of the proto-porcelain of the Pre-Qin period in the Taihu area can be basically established. Considering that not many sites in this area have been excavated and dateable materials are not abundant, the age of the site could be disproved, which is conducive to establishing a more detailed chronology of Pre-Qin archeological culture in this region.

##### **6.4.4. Enriching the research on the archeological culture of the Shang and Zhou Dynasties in the Taihu area**

It is one of the most important characteristics of Yue tombs that proto-porcelain ritual vessels were buried with the dead instead of bronzes. Therefore, proto-porcelain plays an extremely important role in Yue and Pre-Yue culture. Its significance is similar to that of bronzes in the Central Plains, where the use of bronzes was a symbol of the identity and status of the user. The large-scale production of proto-porcelain during the Pre-Qin period showed that the proto-porcelain production at that time was no longer dependent on the kiln site, but formed an independent kiln area, which is an important basis for exploring the social division of labor at that time. The emergence of a large number of proto-porcelain ritual vessels, musical instruments, tools, weapons and farm implements reflects the unique ritual vessel system in the region. The emergence of the products of this kiln area in Yinxu, Zhouyuan and other capital cities provides an important clue for exploring the contacts between the Central Plains and the Taihu area.

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## Value Construction of Proto-Porcelain Skeuomorphs in the Yue State in Southeast China

*Michèle H. S. Demandt*

**Abstract:** Proto-porcelain, made of kaolin clay and fired at a temperature of 1100–1200°C, was the preferred medium for imitating bronze objects in Southeast China during the Yue Bronze Age (circa third to sixth century BC). This chapter firstly focuses on the characteristics of this special skeuomorphic tradition and explores the value construction of proto-porcelain vessels. Secondly, the process which transformed proto-porcelain into the main component of grave-good assemblages in the Yue region is analyzed. Proto-porcelain consumption seems to have been impacted by both complex socio-political processes on a transregional scale and socio-technical decisions on a local communal level. Moreover, the main component of proto-porcelain seems to have been sourced locally, was used over multiple generations, and can therefore be envisioned as a historical agent through which the inhabitants of Southeast China stressed their local “Yue” origin.

**Keywords:** Proto-porcelain, Bronze Age China, Yue State, skeuomorphs, ceramic production

### 7.1. Introduction

Since the Early Bronze Age (ca. 2000 BC), the river valleys of Zhejiang province in Southeast China have been inhabited by people who produced a diverse set of ceramic materials for both daily and ritual use. Far removed from the traditional center of power located in the Central Plain, this early ceramic tradition was remarkable for its highly specialized production of a new type of material, proto-porcelain, in locally developed dragon kilns. In particular, the Dongtiaoxi river valley, in modern Huzhou City, is often considered to be the birthplace of proto-porcelain due to the overwhelming archeological evidence of large-scale kilns producing a variety of proto-porcelain products. Stimulated by the unprecedented growth in ceramic production that took place in the Yue State (ca. 600/500–330 BC), the craft of proto-porcelain was brought to perfection through the practice of skeuomorphism. Proto-porcelain skeuomorphs, mainly imitating bronze objects, became a distinctive craft product and an essential part of mortuary rituals in the Yue State. This being said, the choice to select proto-porcelain as a medium for the production of key burial goods, instead of other “customary” materials representing status and wealth, is still not well understood and is often explained in terms of functionality and material scarcity. In addition, despite growing evidence of local autonomy and regionally coordinated developments, outside stimuli are still seen as the underlying cause guiding the consumption of proto-porcelain. This chapter will investigate this specific instance of material preference and attempts to provide an alternative explanation by considering different factors in tandem. Two main questions will be considered:

Why did people in this region consider proto-porcelain to be valuable? And why was proto-porcelain selected as a fundamental component of grave good assemblages? Through the analysis of the process of value construction of proto-porcelain skeuomorphs, and its relationship with the selected prototype and skeuomorphic material, it will be argued that proto-porcelain consumption was largely impacted by complex socio-political processes related to the display of power, status and regional identity on a transregional scale. Furthermore, the value of proto-porcelain skeuomorphs seems also to have been socially constructed on a local level and involved specific technical decisions. Moreover, the people that produced and used proto-porcelain might have envisioned proto-porcelain as a historical agent that stressed their local origin as inhabitants of the Yue land and recalled an emotional bond with the ancestral past, which was evoked by its material source, e.g. kaolin clay, and its consistent use over different generations in the Yue region.

### 7.2. Setting the scene: proto-porcelain and the Yue State

Proto-porcelain is a ceramic material, made of kaolin clay and fired at a temperature of 1100–1200°C, that started to circulate in various parts of China before and during the Shang Dynasty (1250–1046 BC) (Lu 2015: 354–55). Although its name and place of origins is controversial (Xie 2012: 69–71), proto-porcelain is often seen as occupying an intermediate stage on the evolutionary scale between earthenware and porcelain, and can be categorized as a special type of stoneware. Furthermore, the technical ability to produce proto-porcelain is seen as a



first and “essential” step towards the production of “real” porcelain, as happened during the Han Dynasty (206 BC–AD 220) and which would reach its apogee during the Yuan Dynasty (AD 1279–1368). However, while the craftsmanship and beauty of porcelain has been admired all over the world, the history of its stoneware “predecessor” has been obscure. This seems perplexing considering the overwhelming archeological evidence testifying to the prominent use of proto-porcelain in early China, and especially in the early societies inhabiting Southeast China.

Many scholars agree that the majority of proto-porcelain products were produced on the southeastern periphery, far removed from the dominant cultural realms situated in the Central Plain, and were superior in terms of appearance, hardness and porosity (von Falkenhausen 1999: 530; Shen & Zheng 2015: 13–22). More specifically, from the third millennium BC until the sixth century BC, the region comprising the Dongtiaoxi river valley, in modern Zhejiang province, was one of the most important production centers of proto-porcelain (Fig. 7.1). Currently, archeologists call this period the “Yue Bronze Age” and the people living in this area the “Yue people.” However, the “Yue” term first appeared in historical sources from the Central Plain, such as the *Zuo Zhuan* (*Zuo’s Commentary*), to denote a state that was founded in northern Zhejiang in the sixth century BC: the Yue State (ca. 600–333 BC). To complicate

matters even more, the concept of “Yue” has also been used to refer to people living in other peripheral regions in China’s southeast, such as the Minyue and Dongyue, and is “not limited to a single ethnicity or group” (Brindley 2005: 65). This chapter exclusively deals with historical events originally taking place in the region comprising modern-day Zhejiang province and, therefore, “Yue” will only designate the Bronze Age culture, region, people and state of this region (Fig. 7.2).

Until today the archeological cultures situated in the Central Plain have enjoyed the majority of the scholarly limelight, and the origin and development of the Yue State has received far less attention. Often considered to be of less importance in the grander scale of things that were happening during this period, the Yue State has often been described in very few words or lumped together with its neighbor: the Wu State. Reasons for this range from the restrictive focus of written sources, and the attraction of splendid artifacts found at Anyang (Loewe and Shaughnessy 1999: 14–15), to aspirations to prove the indigenous origin of Chinese civilization and the concentration of construction projects (Zhang 2006: 54). In regards to the Yue State, Eric Henry (2007: 1) has complained that “the history of Yue lies scattered and submerged, awaiting an exhumers to attempt some sort of reassembly.” Although the present study only touches the surface of the Yue cultural realms, it can offer some initial

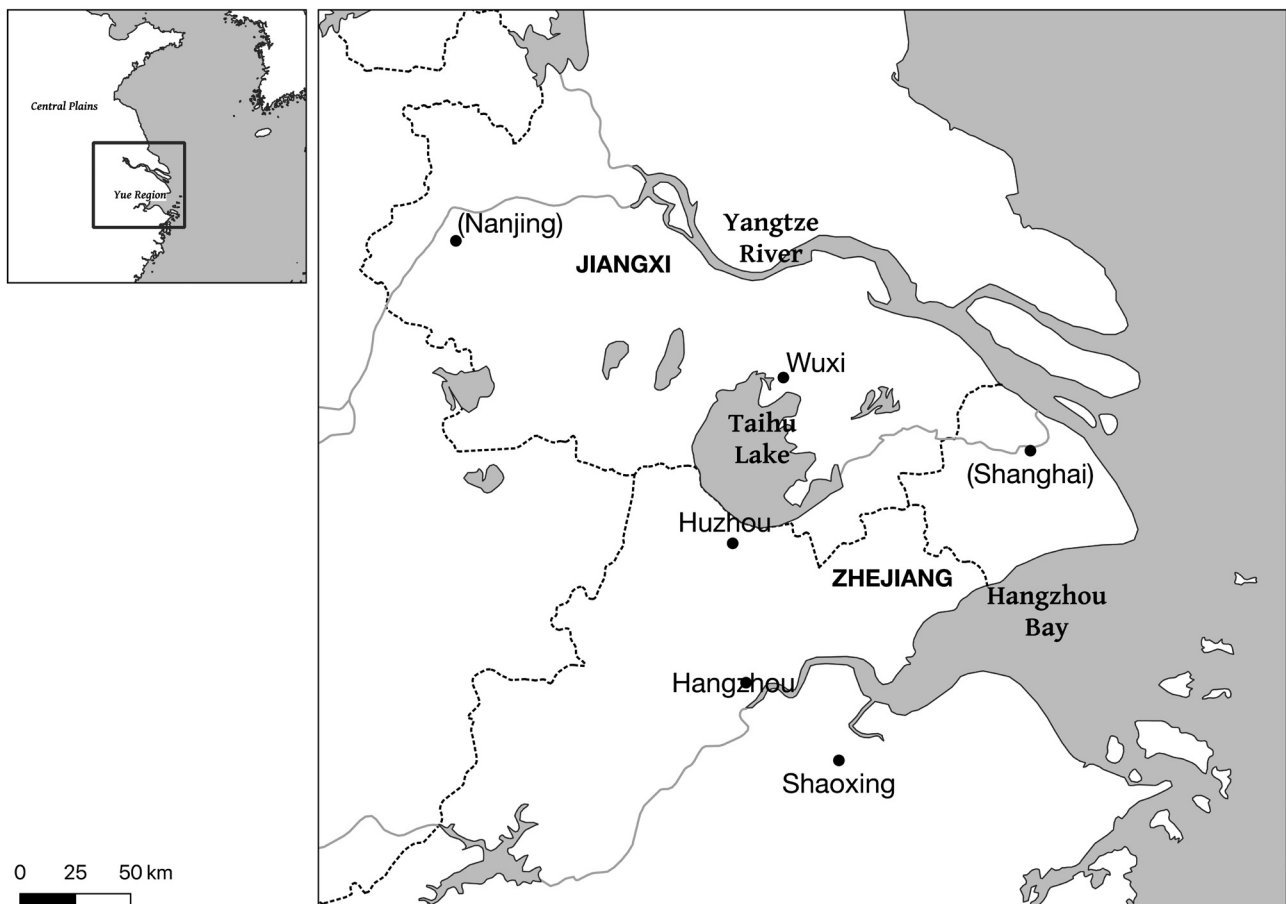


Figure 7.1. Map of Warring States China and the Yue State.

Central Plain	Northern Zhejiang
<b>Eastern Zhou (770 – 256 BC)</b>  Warring States (475 – 221 BC) Spring and Autumn (770 – 475 BC)  <b>Western Zhou (1046 – 770 BC)</b>  Shang (1250 – 1040 BC)  Erligang and Erlitou (1900 – 1250 BC)  Late Neolithic (3000 – 1900 BC) Middle Neolithic (5000 – 3000 BC) Early Neolithic (7000 – 5000 BC)	<b>Chu Occupation</b> (333 – 223 BC)  <b>Yue State (ca. 600 – 333 BC)</b> Middle – Late Period (473 – 333 BC) Early – Middle Period (ca. 600 – 473 BC)  <b>Yue Bronze Age (ca. 1200 – 600 BC)</b>  Maqiao Culture (1950 – 1250 BC)  <b>Pre-Yue Neolithic</b> Qianshanyang – Guangfulin (2500 – 2000 BC) Liangzhu (3300 – 2200 BC) Songze (3800 – 3300 BC) Majiabang (5000 – 3800 BC) Hemudu (5050 – 3050 BC)

**Figure 7.2. Chronology of the cultural sequence of the Central Plain and Northern Zhejiang (Liu & Chen 2012: 123, 169, 213, 253, 350, Meng 2010: 184–90, Cao 2015: 147, 149).**

insights on selected matters related to political complexity, interregional contact and internal social dynamics. More specifically, the reasons for selecting proto-porcelain over bronze and the process underlying the value construction of proto-porcelain will be discussed in greater detail.

Besides being used for the manufacture of simple ceramic forms, such as daily utensils and cooking vessels, proto-porcelain produced in the Yue region played an important role in burial customs. It often appeared together with low-fired earthenware and geometric stamped stoneware, as a third category of ceramic materials that were selected as a medium for burial assemblages. At the height of the Yue State, proto-porcelain production reached an unprecedented level, with the appearance of intricately crafted skeuomorphs that were often close imitations of imported bronze goods. This is evidenced by the discovery of individual elite tombs, such as Zhujiashan M1, Xiaojiashan M17 and Xiaohuangshan M13 in Shaoxing (Zhejiang Provincial Institute of Cultural Relics and Archaeology et al. eds. 2016: 54–127), and Bizishan in Huzhou City (Zhejiang Provincial Institute of Cultural Relics and Archaeology ed. 2009: 48–100), as well as several burial complexes, such as Hongshan in Wuxi City (Nanjing

Museum et al. ed. 2007), Huangheshan (Shen 2003: 27–29), Dongpoling in Huzhou City (Zhejiang Provincial Institute of Cultural Relics & Deqing District Museum 2018: 46–55) and Shangyu in Shaoxing City (Zhejiang Provincial Institute of Cultural Relics and Archaeology ed. 2002: 96–177), which contained a large variety of high-quality proto-porcelain skeuomorphs. Nonetheless, with some exceptions, the selection of ceramic surrogates as key burial goods was atypical in the regional burial rituals characterizing this period, often referred to as the Warring States period (475–221 BC). Although other states, such as Chu, Zhongshan and Yan, also produced and used ceramic skeuomorphs (Wu 1999: 729–32), the appearance and quality of these objects was quite different. For instance, ceramics found in Warring States burials of the Yan State often had a gray color and were covered by a blackish glaze. Moreover, on an intraregional level proto-porcelain seems to have ranked lower on the overall value scale of materials used to produce burial goods. For instance, elite tombs in other regions typically featured bronze burial goods, which were accompanied by a smaller selection of ceramics and sometimes other types of status goods, such as lacquerware and silk. On the contrary, the majority of Yue tombs discovered contained no bronze goods at all.

The decision to omit bronzes has often been explained as being the result of practical and economical concerns (Zheng 2007: 240–44). Moreover, when it was first discovered, archeologists did not even entertain the notion that the inclusion of proto-porcelain could have been a deliberate choice. Instead, it was believed to be the result of looting practices (Chen 2011: 33). Only recently, after the discovery of undisturbed tombs of the Yue State, such as Xiaohuangshan M13 and Bizishan (Zhejiang Provincial Institute of Cultural Relics and Archaeology ed. 2009), has it been accepted that burial assemblages solely consisting of proto-porcelains represent the original finding context. Another problem characterizing the study of the Yue State and its proto-porcelain is the belief that cultural contact with the core region of Warring States China, i.e. the Central Plain, was the main instigator of change. This has led to the dominant view that proto-porcelain consumption was strongly influenced by outside forces, and in particular by the political and ritual system of Central Plain states, which were formerly united under the Zhou Dynasty (Wang H. 2017; Zheng 2019). Although the impact of the Zhou cultural realms on the Yue State, often via its neighboring state Chu, cannot be ignored, it should also not be exaggerated. Instead, it needs to be acknowledged that local continuities and regional developments might have also played a role. Chen Yuanfu (2015) has tried to break with these research conventions and has offered a more nuanced explanation of the appearance of proto-porcelain. In addition to the impact of the ritual system of the Central Plain, he mentions the practice of *mingqi* or ritual articles, e.g. specially produced burial goods, and the persistence of local traditions as two additional causes. However, although his analysis should be commended and partially explains the appearance of proto-porcelain skeuomorphs, it lacks a detailed discussion and consideration of the socio-political climate and internal developments of the Yue State.

Finally, research about proto-porcelain has also been unbalanced in focus. Generally speaking, most research about proto-porcelain has concentrated on its technical features and glaze, and issues related to its provenance and chemical composition (Chen T. et al. 1997; Wu J. et al. 2011a; Wu J. et al. 2011b; Yin et al. 2011). In addition, several detailed studies exist about the construction and development of the specialized elongated kilns (so-called dragon kilns) which were used to fire proto-porcelain (Wang Y. 2010; Wang H. 2017; Xie 2012). These technology-focused studies are critical for understanding some aspects of the proto-porcelain phenomenon, but, on the other hand, they push aside research topics of equal importance. In particular, questions regarding the function of proto-porcelain and the reasons why it became a socially valued material have not been answered in a meaningful way. Therefore, this chapter hopes to introduce the topic of “proto-porcelain” and focus on both the technical and social features of this unique material. This will be done by reconstructing the value of proto-porcelain in early Southeast China, and more specifically in the Yue State.

### 7.3. Foundations of the Yue State: literary and archeological evidence

The Yue State’s origin is murky, and it first appears by name in the *Chunqiu* (Spring and Autumn Annals), which records events taking place from the mid-sixth century BC to 476 BC, and other literary sources, such as the *Shi ji* (Historical Records), *Zuo zhuan*, and the *Yuejue shu* (The Glory of the Yue). In chapter 41 of the *Shi ji*, it is recorded that the famous Yue king, Goujian (r. 496–465 BC), descended from Yu the Great of the “semi-legendary” Xia Dynasty, and founded a capital in Kuaiji, near modern Shaoxing in Zhejiang. The historicity of Goujian is confirmed by the discovery of a beautiful bronze sword inscribed with “Goujian, King of Yue” in a Chu tomb in Jiangling, Hubei (Lin 1987). Historical sources further note that the Yue State rose to power during the late Spring and Autumn period (770–476 BC) and became entangled in a bloody feud with its neighboring state, Wu. Several battles, led by King Goujian and King Fuchai of the Wu (r. 495–474 BC), were fought for control over precious rice-growing lands in the lower Yangtze region. From its foundation the Yue State was located in northern Zhejiang and centered in the Ningshao plain, the Hangjiahu plain and the Jinqu hills in Shaoxing. However, after their victory over the Wu in 473 BC, parts of Shandong, Jiangxi, Anhui and eastern Jiangsu were also integrated, and in 469 BC the capital of the Yue was moved to Langye in western Shandong (Meng 2010: 2–5). Although it is debated (See Henry 2007: 13–16; Brindley 2015: 92), conventionally, 333 BC, the year King Wei of the Chu state conquered and annexed the lands of the Yue, as recorded in chapter 41 of the *Shi ji*, is seen as the end date of the Yue State. However, their cultural influence did not end here, and some of the Yue people seem to have dispersed further south, possibly into present-day Fujian province.

In the last two decades, scholars have acknowledged the strong impact of local factors on state development in the lower Yangtze region, rejecting earlier theories that prioritized the role of outside stimuli, such as socio-political contacts with state-level societies in the Central Plain (von Falkenhausen 1999: 529–39; Zhang 2006; Brindley 2015: 13–20). As is the case for many pre-imperial cultures in South and Southeast China, the Yue and Wu are now recognized as independent states with a distinctive archeological repertoire. Their roots can be traced back to the Liangzhu culture (3300–2200 BC), situated in the Lake Taihu region, which was famous for its exquisite jade-crafting, early rice cultivation and large-scale urban planning (Ling and Liu 2020). The most distinguishable feature of the Yue and Wu is their preferred use of earth-mounded tombs (*tudun mu*) instead of the vertical pits popular in the Central Plain. These tomb structures started to appear during the Late Bronze Age (ca. 1200 BC–ca. 500/600 BC) and can be subdivided into two types: simple earthen mounds and mounds containing a stone burial chamber (von Falkenhausen 1999: 527). Because of these and other similarities, such as their mastery of bronze-casting, their use of “bird script” or

niaoshu (bird-shaped characters that are derivative of northern seal script) on bronzes and swords, and their consumption of geometric stamped ceramics, the Wu and Yue are often considered in unison as the “Wuyue” culture (Zhao 2017), and separate discussions about their cultural features are rare. However, the Yue’s large-scale ceramic production and special mortuary use of proto-porcelain sets it apart. Based on archeological evidence, the Yue State was likely already in existence before it became popularized in the written record. Moreover, before power became centralized, northern Zhejiang was already inhabited by different complex societies that were familiar with rice-based cultivation, sericulture, metallurgy and specialized craft production. These people also initiated burial customs that included proto-porcelain grave goods and mounded tombs.

To date, in the Dongtiaoxi valley, the “birthplace” of proto-porcelain, over 144 kiln sites have been discovered, which have yielded proto-porcelain made of local kaolin clay and which range in date from 1950 BC to 333 BC (Zhejiang Provincial Institute of Cultural Relics and Archaeology et al. eds. 2015: 20). Among these, Piaoshan and Nanshan in Huzhou are the sites with the earliest evidence of proto-porcelain made in dragon kilns (Zhejiang Provincial Institute of Cultural Relics and Archaeology et al. 2015). Other important kiln sites are Huoshaoshan and Tingziqiao, also located in Huzhou. At the Huoshaoshan site, dated roughly to between the ninth century BC and the fifth century BC, numerous kilns remains, fire pits, post holes and remains of small vessels, such as bowls, plates and jars with various colors of glaze, have been found (Zhejiang Provincial Institute of Cultural Relics and Archaeology et al. 2008). This kiln site has a clear stratification and was used continuously for four centuries. This site, therefore, provides important information about the evolution of stoneware types and proto-porcelain technology as it developed before the foundation of the Yue State. The Tingziqiao kiln site, dated to roughly between the fourth century BC and 223 BC, contained a large number of high-quality proto-porcelain objects, including ritual vessels, such as small eating and drinking vessels and large storage containers, but also a small number of musical instruments (Zhejiang Provincial Institute of Cultural Relics and Archaeology & Deqing County Museum eds. 2011: 148). Many of these objects are exquisitely crafted and are exact copies of bronze prototypes popular in the Central Plain. Moreover, it is believed that Tingziqiao might have been part of an official kiln complex that was supervised by the Yue administration and produced mortuary items for royalty and the upper elite class (Zhejiang Provincial Institute of Cultural Relics and Archaeology & Deqing County Museum eds. 2011: 149). This argument is also supported by the discovery of mounded elite tombs dated to the Yue State period which contained large amounts of proto-porcelain. The most important (and unlooted) ones are Bizishan, Xiaohuangshan M13, and the large burial complex of Hongshan (Zhejiang Institute of Cultural Relics and Archaeology ed. 2009; Nanjing Museum et al. ed. 2007).

#### **7.4. Skeuomorphism, technology and ceramic materials**

Skeuomorphism is the manufacture in one material of objects, i.e. the skeuomorph, intended to evoke the appearance of other objects, i.e. the prototype, regularly made in another material (Manzo 2003: 17). The first focus in this process of imitation lies on the material transformation and the nature of the medium selected for the skeuomorph. As a result, skeuomorphism has often been linked to economic factors and the desire to mimic a more prestigious material, such as metal, in a more common one, such as stone or ceramics (Vickers 1989). Based on this reasoning, raw materials used to produce a skeuomorph are almost always placed on a lower value scale than those of the original prototype. In particular, scarcity and the geographic distance that needs to be travelled to acquire certain materials are seen as critical elements in the value construction of the prototype, as opposed to the “cheaper” substitute material used for skeuomorphs. A second goal skeuomorphs fulfill is the signification of similarity. As a result of this, their appearance can be linked to certain aesthetic and stylistic demands (Blitz 2015). For instance, during the process of skeuomorphism, shapes and decorative motifs as well as physical attributes that reference the original material of the prototype are copied. In some instances, the complete appearance of a prototype is imitated. However, an explanation solely based on the origin and prestige of the imitated material or the visual appeal of the prototype does not consider the impact of the physical properties as well as the visual, social and stylistic qualities of the material selected for skeuomorphism.

Timothy Insoll (2015: 239) has argued that skeuomorphism “can indicate technical virtuosity superior to those needed to work in the original material.” Clay, in particular, is a material with technical advantages, because it can easily be used for both additive and subtractive technological purposes (Insoll 2015: 230). With a similar focus, Bhan et al. (1994) have suggested that certain craft products whose raw materials were relatively common or easy to obtain can also be considered valuable because of the complex character of the technologies involved. In particular, goods that involve elaborate pyro-technological processes, such as certain types of stoneware and their glazes, fall into this category. For instance, Arretine ware, a type of Roman fine ware with a red glossy slip, stood out among other ceramics due to its high quality and distinctive firing process, despite being made with plain, local clays (Bhan et al. 1994: 143). Naturally, proto-porcelain as well as other types of celadon and porcelain produced in later periods also belong to this category. In most of these cases, the final object was made of “common” and easily accessible raw materials but gained value through technically complex actions and the resulting physical properties.

Some of these properties were utilitarian, such as thermal shock resistance, permeability, durability and heating/

cooling effectiveness (Gille 1978; Skibo & Shiffer 2008), while others were of an aesthetic nature, such as texture, decoration patterns and surface color. Moreover, actions, such as creating certain colors, adding a specific motif or glaze, or polishing could have transformed ordinary skeuomorphs into more prestigious objects that possibly matched the value of their original prototype. On another level, ceramic materials could have also been imbued with stylistic and symbolic qualities that were socially constructed and could participate in processes of information exchange. This made ceramics suitable for broadcasting information about, for instance, relative identity and group affiliation (Wobst 1977; Wiessner 1983). Moreover, Knappett (2002: 108–10) has noted that “the relationship between skeuomorph and prototype is not restricted to the objects, but extends to those groups habitually using them, themselves symbolically represented by the vessels they consume.” In this way, skeuomorphs were part of the entire social structure of a society. Furthermore, possession of them might have conferred prestige and could have been used to legitimize and sustain power and authority, as well as to reflect group identities and social memory. Finally, the value of skeuomorphs might be completely unrelated to material or artistic considerations, and instead be connected to sympathetic magic (Knappett 2002: 111). In other words, the production of skeuomorphs could have been regarded as magical because the ability to transform one material into another showcases control over ritually transformative processes. For these reasons, the skeuomorphic material selected to imitate a prototype might have had a higher position on the value hierarchy, and craftsmen might have consciously employed specialized technological knowledge to acquire an end result that transcended the original meaning and purpose of the prototype.

## 7.5. Proto-porcelain skeuomorphs in the Yue State

### 7.5.1. Technically based value

From a technical point of view, the southern proto-porcelain tradition, originating in the Dongtiaoxi river valley, has three main characteristics: firstly, it is made of kaolin clay, which is not completely purified; secondly, it is covered by a thin layer of vitric glaze; and thirdly, it has a firing temperature between 1100°C and 1300°C (Wu et al. 2011a; Zhejiang Provincial Institute of Cultural Relics and Archaeology et al. eds. 2015: 247–50). The raw materials for making proto-porcelain were abundant and locally available in the river plains of northern Zhejiang. As early as the Maqiao period (1950–1250 BC), potters were experimenting with kaolin clay, mainly composed of low amounts of aluminum and high concentrations of silicate, until finally reaching a stable formula during the Yue State period (Zhou et al. 2015; Li et al. 2015). For instance, EDXRF analysis of samples from Huoshaoshan shows an aluminum content that is lower than 20wt%, a silica content of around 75wt%, and an LOI in the range of 0.93–5.65% (Xiong 2008). Although the iron content gradually decreased, some impurities were left in the paste recipes,

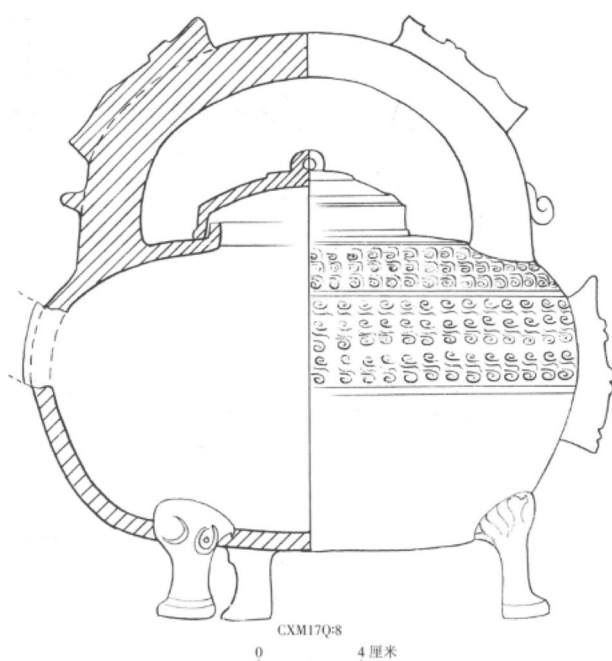
causing the difference between white-bodied “mature” porcelain and proto-porcelain featuring darker pigments (Wu et al. 2011a). There exist some color differences between products of different kilns in Dongtiaoxi, but we cannot know for sure if potters intentionally adapted and purified china clay for this reason. Glazes, on the other hand, were most likely the result of predetermined actions such as the deliberate application of ash from organic vegetation onto ceramic vessels. Technical properties that would result from adding glaze include water-tightness and mechanical strength (Wu J. et al. 2011b). Two types of glazes fluxed by calcium oxide have been recognized through chemical analysis of proto-porcelain samples from Tingziqiao and Huoshaoshan (Zhou et al. 2015). The first type is a high-fired glaze with a calcium oxide flux of between 10 and 20 percent that is found on the majority of studied samples. The second type is only found on five samples from Tingziqiao and has a relatively low calcium oxide content (between 2 and 6 percent). Scholars believe these differences might be related to the use of different sources of plant materials for the preparation of glaze recipes (Wu et al. 2011b). These improvements to the paste and glaze recipes were responsible for the technical as well as aesthetic superiority of proto-porcelain vessels as opposed to other ceramic types.

Proto-porcelain was fired in dragon kilns constructed on the inclined surface of a slope or hill and made up of a fire chamber, a firebox and a flue. The earliest remains of dragon kilns have been found at Piaoshan, dated to 2070–1600 BC, and Nanshan, dated to ca. 1200–1000 BC (Li et al. 2015). The Nanshan dragon kiln is quite well preserved: it is 7 m long with a 20-degree slope and a firebox occupying almost one third of the total kiln (Zheng 2019: 15). From the early Bronze Age to the period of the historical Yue State the dragon kiln structure evolved and reached a more mature stage. For instance, the seven dragon kilns found at the Tingziqiao site are between 8 and 10 m long with a 10-degree slope and a rectangular fire chamber (Zheng 2019: 15). The width of the firebox also increased at this site. For instance, kiln Y2 was between 3.32 and 3.54 m wide and had kiln walls as thick as 30 cm (Zhejiang Provincial Institute of Cultural Relics and Archaeology & Deqing County Museum eds. 2011: 152). In addition, also at Tingziqiao, archeologists have discovered kiln furniture and vessels being stacked together. This is not only the earliest evidence of this practice in China, but also testifies to the progress of setting techniques. For instance, there are unique pieces of kiln furniture that were specially designed to guarantee the even firing of musical instruments (Zhejiang Provincial Institute of Cultural Relics and Archaeology & Deqing County Museum eds. 2011: 148). Smaller utilitarian objects, such as cups and bowls, were stacked and positioned in lower areas, resulting in products that were not completely fired and of lower quality. The improved kiln design and the use of kiln furniture indicates that craftsmen understood how to control kiln temperatures and were aware that objects could be fired more efficiently when placed higher or inside other vessels.

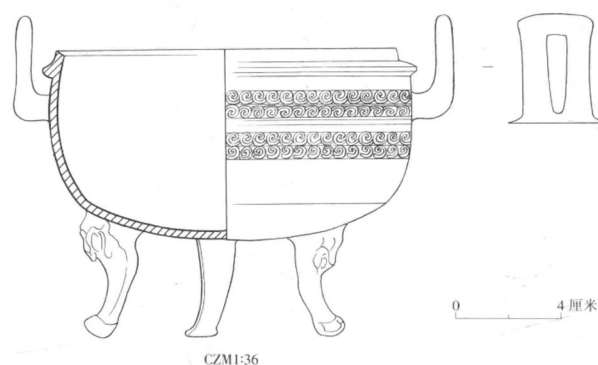
### 7.5.2. Funerary consumption of proto-porcelain skeuomorphs

The appearance of proto-porcelain skeuomorphs was part of a larger regional development influencing funerary rituals: in particular, the phenomenon of mingqi, which were imitations of burial goods having a utilitarian or ritual function. Although mingqi were usually made from ceramic materials, their value seems to have been less determined by medium or form, but was based on ritual function and symbolism (Wu H. 1999: 733). Moreover, mingqi did not have any real practical value and were specially produced to accompany the deceased in the afterlife. Proto-porcelain vessels seem to have shared some of these features. However, while mingqi are generally seen as a by-product that accompanied more valuable funerary goods, such as bronzes and jades, proto-porcelain skeuomorphs were the central component of Yue burials. Based on their function, proto-porcelain skeuomorphs can be divided into five different categories: 1) utilitarian vessels (Fig. 7.6), 2) ritual vessels (Fig. 7.3), 3) musical instruments (Fig. 7.4 & Fig. 7.5), 4) tools and 5) personal ornaments etc. Despite this variety, the majority of objects are vessels used for pouring alcohol, serving food or storage. There are a number of vessels that could be used in both ritual and ordinary occasions, for instance “ding” tripod vessels like Fig. 7.3b. In these cases, differences in quality and more elaborate decorations are thought to reflect ceremonial uses. In addition, due to their less frequent occurrence in burials, ritual vessels and musical instruments that imitate bronze prototypes from the Central Plain are also considered to be more valuable.

The majority of proto-porcelain skeuomorphs dated to the Yue State period have been discovered in elite tombs. These tombs, covered by a large earthen mound, are usually rectangular-shaped with a tomb entrance leading to the burial chamber, which contains a wooden coffin and is sometimes paved by cobble stones. Furthermore, it seems that status differences between Yue elites were often expressed through the scale of the tomb structure, as well as the amount and types of burial goods that were gifted. Higher-ranking tombs usually included larger numbers of high-quality jades and/or proto-porcelain skeuomorphs, including musical instruments and ritual vessels. For instance, at the Hongshan burial complex, seven Yue elite tombs have been excavated that can be divided into five levels (Nanjing Museum et al. eds. 2007). The Qiuchengdun tomb, belonging to level 1, was the largest and richest tomb of this complex and contained 1098 grave goods, of which 581 were proto-porcelains. These included both utilitarian goods and skeuomorphs of ritual goods and musical instruments, such as yongzhong bells like Fig. 7.4b. By way of comparison, the Laofendun tomb (belonging to level 5), contained only 52 goods, including five proto-porcelain cups, and no skeuomorphs. Of interest is the fact that sometimes a shallow pit for burial goods, including proto-porcelain skeuomorphs, is found outside the main tomb. For instance, in the Bizishan tomb 62 ceramic burial goods were found in the tomb chamber, and 47 in the outside pit (Zhejiang Provincial Institute of Cultural Relics and Archaeology ed. 2009: 57–93). Most of these were made from proto-porcelain and were imitations of large bronze musical vessels (Fig. 7.5). Additionally, only a small number of burials belonging to lower-ranking elites have been published, and usually these contain

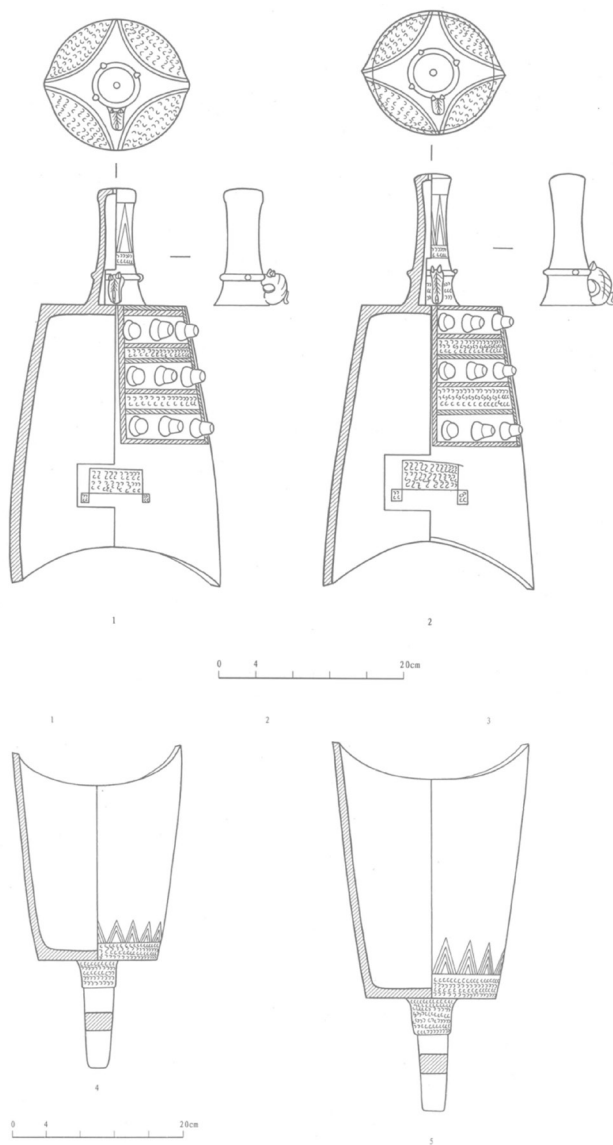


图II-3-3-8 小家山 M17Q 出土原始瓷提梁壶



图II-2-4-1c 祝家山 M1 出土原始瓷附耳鼎

**Figure 7.3. Proto-porcelain ritual vessels. a: He vessel from Xiaojaoshan M17Q Tomb b: Ding vessel from Zhujiashan M1 Tomb. (Zhejiang Provincial Institute of Cultural Relics and Archaeology eds. 2016: 85, 60).**



**Figure 7.4. Proto-porcelain musical instruments. a: Yongzhong bell from Qiuchengdun M1 Tomb. b: Jugou bell from Laohudun DI Tomb (Nanjing Museum et al. eds. 2007: fig. 185 & 109).**

fewer proto-porcelain vessels, and these are of a lower quality. Moreover, in these types of tombs the majority of grave goods are utilitarian vessels, made of other types of ceramic materials (Fig. 7.6a). At the Huangheshan burial complex, situated in Banshan, Hangzhou City, for instance, a number of burials contained fewer than 10 grave goods with only one proto-porcelain object (Shen 2003: 27–29). All of these goods were simple and small utilitarian objects.

### 7.5.3. Regional and historical contextualization of proto-porcelain value construction

As mentioned before, the reason why proto-porcelain was the preferred medium for mingqi in the Yue State is not well understood. Previous research has often stressed practical concerns, such as limited resources and labor, as the main motives for switching to proto-porcelain.



**Figure 7.5. Proto-porcelain Yongzhong Bell from Bizishan M1Q Tomb (Courtesy of Zhejiang Provincial Institute of Cultural Relics and Archaeology).**

Scholars have further argued that the Yue State lacked the economic capacity and sufficient bronze resources to produce bronze burial goods and instead had to prioritize the manufacture of agricultural tools and weapons (Zheng 2007: 240–44). To some degree this explanation makes sense. For one thing, the production process of proto-porcelain compared to that of bronze goods was less expensive and less complex. Also, the raw materials for making proto-porcelain were widely available in the Yue region and therefore much easier to acquire than those for bronze. However, both historical and archeological sources testify to the military and economic strength of the Yue State. For instance, the Yue's victory over the Wu State and their mastery of casting bronze swords are mentioned in the *Yuejue shu* (chapters 1 and 13) and the *Shi ji* (chapter 41) (Milburn 2010; Sima 1959). The discovery of specialized kilns and large-scale mounded tombs is also inconsistent with the weak state theory. Moreover, if the Yue's economic ability was this limited, why were they producing so much proto-porcelain? Proto-porcelain surely required more effort and specialized labor than less demanding types of ceramics. The production of copies of elaborately decorated musical instruments would also not have been cost-effective. Finally, discussions often forget that the decrease in the number of bronze vessels in burial contexts was a regional phenomenon during the Warring States period and other states were also prioritizing the production of bronze weapons.





**Figure 7.6. Utilitarian Ceramics: a: Geometric Stamped Pot from Bizishan M1(21). b: Proto-Porcelain Pot from Bizishan M1(60)(Courtesy of Zhejiang Provincial Institute of Cultural Relics and Archaeology).**

Alternatively, the increased appearance of proto-porcelain skeuomorphs can be linked to certain technical properties of the material it is made of. Many scholars have acknowledged that clay is a substance that has been widely used for the creation of skeuomorphs because of its plasticity and malleability (Insoll 2015: 207). Thus, by using clay, the shapes and attributes of bronze prototypes could be easily copied and reproduced. Additionally, compared to other types of ceramics, proto-porcelain had some technical benefits. For instance, its impermeability mimicked one of the desired qualities of bronzes and made it so that proto-porcelain could perform similar functions to bronze vessels used for pouring and serving. While technical features played an important role in the value construction of proto-porcelain they were not the only determinants responsible for the selection of this specific material. If this were the case, we would have observed a more limited repertoire of skeuomorphs within the archeological record of the Yue State, but instead proto-porcelain was used for the reproduction of a diverse group of objects, some of which were specially produced for ritual reasons. In addition, at times proto-porcelain was also used as a surrogate for stone, jade and possibly organic objects (for instance horn-shaped objects). Therefore, an explanation that is based solely on economic or technical factors also does not hold up, and we need to consider additional reasons for the selection of proto-porcelain. As mentioned before, the appearance of skeuomorphs is closely linked to the social groups using them and the symbolic role attributed to them. Consequently, to understand how proto-porcelain as a skeuomorphic material involved enrolled in ritual consumption in the Yue State, we first need to consider in more detail the socio-political background of its consumption.

The Yue State rose to power during the Warring States period, which was characterized by intense social

turmoil and fragmentation, but also by an unprecedented flourishing of the arts, literature and intellectual life. After the collapse of the Jin State, whose inhabitants were the last remaining descendants of the Zhou Dynasty, in 475 BC, a number of territorial states rose to power, eventually being dominated by the Chu in the South, the Qi in the northeast and the Qin in the north. The Warring States period represented the decline of the Zhou political order based on feudal kinship and the beginning of an autocratic tradition of state building governed by hereditary kings. Although these territorial states had clearly demarcated borders, they were constantly competing over new territory and the title of hegemon (ba), a new structure of authority that had appeared during the Spring and Autumn period (Li 2013: 162–66). These waves of constant conquest and annexation would give the final blow to an already crumbling ritual system and its physical representation: bronze vessels. During the Western Zhou bronze vessels were important symbols of political legitimization and were mainly involved in rituals for religious communication and gift-giving feasts performed by the Zhou king, but starting from the sixth century BC this ritual system was challenged in a number of ways: firstly, local rulers no longer followed the strict ritual prescriptions outlining the types and quantities of bronzes that could be used as burial goods; secondly, bronze styles were being adapted to regional needs and new cultural influences; thirdly, rather than adopting the Zhou political ideology, bronzes became a tool for self-aggrandizement and expressing regional identity (Cook 1995). This resulted in bronze being used for the production of a very wide range of objects that represented luxury and elite life, including personal ornaments, horse-riding equipment, oil lamps etc. Moreover, over the course of the Warring States period, the use of Zhou-style bronzes diminished even more, and new types of status goods, such as gold, silver



or turquoise inlaid bronzes and finely painted lacquerware vessels became popular.

The more standardized and widespread use of proto-porcelain in the Yue State not only took place against this backdrop of political competition and territorial expansion, but also corresponds with the high point of political power of the Yue State, under the rule of King Goujian and his successors. Historical sources, such as the *Yuejue shu*, record that after annexing the Wu Kingdom in 473 BC the Yue moved their capital further north and strived to be recognized as hegemon among the states of the north (Henry 2007). Moreover, over the years the Yue kings used different strategies to curry favor with other states against the Qin, including pursuing alliances and sending tribute. For instance, in 312 BC, the Yue sent 300 boats, 5 million arrows, together with horns and ivory to the Wei State (Henry 2007: 13). Therefore, although often omitted in general discussion about the territorial states of the Warring States period, the Yue kings were clearly also engaged in interregional politics and power struggles.

The impact of the geopolitical climate on the identity construction of the Yue State clearly finds its expression in local burial practices. In particular, the shift in political loyalties that took place during the Warring States period and was replaced by a focus on the political and military accomplishments of regional rulers had an enormous impact. No longer being places for offerings and worship, burials were now centered around the practice of boasting and replicating the elite's lavish lifestyle. Besides mingqi and luxury objects, concrete evidence of this includes changes in the typology and arrangement of grave goods. For instance, as is the case with bronze burial goods in other territorial states, proto-porcelain skeuomorphs found in Yue burials no longer adhere to strict rules and are found in different quantities and combinations. Moreover, while tombs still contain a high number of musical instruments, and pouring and serving vessels, these seem to be part of the increased popularity of secular feasts and banquets (Cook 1995). Similarly, the discovery of different types of luxury objects mirroring local traditions also reflects trends towards self-aggrandizement. Another artistic development influencing burial customs in the Yue State was the use of alternative media to produce burial goods (Wu 1999: 684). For instance, in the Chu state there was the emerging prominence of other materials, such as lacquered wood and woven textiles, to challenge the supremacy of bronze as the material of choice and prestige (Cook & Major 1999: 34). Moreover, as mentioned before, the use of ceramic surrogates has also occasionally been observed in tombs of the Chu, Yan and Zhongshan states (Wu 1999: 729–32). This all indicates that the higher class of the Yue State expressed status and wealth in a similar way to other autocratic rulers: opposing ideas and materials associated with the former Zhou Dynasty and selecting new types of social valuables to legitimize their rule and display their wealth to rivals.

Although it is clear that the Yue followed some regional trends, they seem to be doing so in a very selective way.

Many contemporary autocratic rulers expressed their wealth and power through monumental burials and the internment of non-ritual and personal belongings made of valuable materials and decorated with elaborate motifs. Compared to this, the burial assemblages and tombs of the Yue elite seem to be more modest. Other status objects, such as bronze mirrors, lacquerware, inlaid bronzes and bamboo strips were also almost non-existent in these burials. Moreover, it seems that the Yue were less concerned with copying the extravagant lifestyle of their neighbors, and were more interested in expressing local systems of belief and tradition. The popularization of proto-porcelain in the Yue State seems to have been in line with this aim. Moreover, proto-porcelain, literally made of the land of the Yue, is not only a material symbolizing ownership, but can also be considered to materialize the long-distant past. Over centuries proto-porcelain as a physical substance and surrogate had been continuously produced and had also performed a prominent role in burial rituals. For instance, as mentioned in section 7.3, all over Zhejiang numerous tombs, dating to the Yue Bronze Age, have been found containing proto-porcelain vessels that loosely copied Western Zhou bronzes. Of interest is the fact that these tombs also seem to have lacked bronzes. Furthermore, in continuing this tradition it is likely that the Yue people were aware of the associated memory and history of proto-porcelain. This use of ceramics as historical agents has also been observed in other early states. For instance, the Aztecs might have legitimized their status in the basin of Mexico through the use of a Black-on-Orange pottery that was associated with the earlier Toltec civilization (De Lucia 2018). In a similar way, proto-porcelain as a reminder of the ancestral past of the Yue could have served political purposes and strengthened state identity. This argument can be taken one step further with the assumption, as suggested by Knappett (2002), that skeuomorphs might have been seen as magical imitations and been produced in order to take control of the original objects. In this way, pyro-technological processes might have been imbedded with a magical dimension because of the way they transformed foreign symbols related to political power into local indexes of power.

## 7.6. Conclusion

Situated on the southeastern periphery, the Yue people were culturally and ethnically different from other independent states dominating the Spring and Autumn and Warring States periods, in other words, roughly the eighth through third centuries BC. Another distinctive feature was their mastery of proto-porcelain, which was of superior quality in terms of appearance, hardness and porosity. After defeating the Wu State in 473 BC the Yue State extended their territory and became a strong contender for hegemony. This process of political consolidation was accompanied by another technical advancement in the proto-porcelain craft system, which was the creation of realistic and high-quality skeuomorphic burial goods. This chapter has argued that two types of decisions were involved in the production process of proto-porcelain

skeuomorphs. Firstly, decisions related to the selection of a prototype and the degree to which the original material and shape of this prototype should be referenced in the final product. It is known that during the production process of proto-porcelain skeuomorphs the materiality of the prototype was altered, but, at the same time, some signifying attributes and a certain degree of similarity was maintained. In this way, it has been argued that skeuomorphs could be utilized as surrogate objects for legitimizing power and might have been imbedded with specific stylistic and symbolic information courtesy of the prototype. Secondly, the decision to select proto-porcelain for the production of skeuomorphic goods, to the degree that it became the dominant medium, has been discussed. Proto-porcelain as a material was socially valued, and although its main component, i.e. kaolin clay, was not technically superior, it had certain technical properties, such as its plasticity and malleability, that made it very suitable as a skeuomorphic material. In addition, other properties, such as its mechanical strength, translucency and impermeability, might have been attractive for the Yue people. Nonetheless, kaolin clay also expressed aesthetic and symbolic qualities, whose importance extended beyond economic and material values. Proto-porcelain as a material had a long history in the Yue region and represented traditional values and materials that were socially imbedded and passed from one generation to the next. As a result, proto-porcelain might have evoked social memories and notions of a shared local history.

On an intraregional scale the custom of proto-porcelain skeuomorphs seems to have been in line with regional tendencies that prioritized individual status and ownership, as opposed to ritual and ancestor worship. This is especially obvious when considering the new developments in burial customs that were taking place all over the territorial states, such as the looser application of rules, an increased focus on locally produced status goods, and the inclusion of ceramic imitations of bronze goods. Although the value construction of proto-porcelain was impacted by these intraregional developments in Warring States China, and echoed some ritual practices of the former Western Zhou Dynasty, it was deeply grounded in the local territorial landscape of the Yue State and involved a complex chain of decision-making. Moreover, while clearly expressing stylistic and political information about their prototypes, proto-porcelain objects also acted as mnemonic devices and were able to highlight Yue identity through the use of local materials and decoration motifs. Therefore, the selection of proto-porcelain as the preferred material for copying bronze vessels was not solely based on economic or technical factors, but should be contextualized in the regional landscape as well as in the longer history of the Yue people.

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## Tile Kilns and Roof-Tile Production in Ancient China

*Yūsuke Mukai*

**Abstract:** This essay describes the development of roof-tile production, discussing how craftsmen began to divide into groups working for pottery kilns and those working for roof-tile kilns from the Western Zhou to the Han period. The firing chamber of flat kilns is easy to widen and enlarge, and so they are appropriate for firing goods used in architecture like tiles and roof tiles. The kiln shape and structure that were perfected during the Han period continued to be used for centuries without major changes, mainly in northern China. During this process, the influence of roof-tile production technology and kiln structure spread widely through East Asia. It is significant that a separate history of kiln technology was revealed, different from that of porcelain and celadon-producing kilns.

**Keywords:** Roof tiles, structural changes in kilns, division of labor, Western Zhou, Qin and Han period

### 8.1. Introduction

Most of the roof tiles disseminated throughout East Asia are well known to originate in China. There is evidence for the manufacture and use of roof tiles in China during the Western Zhou period, some 3000 years ago, and there are some reports of roof tiles dating back even earlier. In the Han period, 2000 years ago, Chinese roof tiles traveled as far as the Korean peninsula in the east and Vietnam in the south, spreading throughout East and Southeast Asia in subsequent centuries. The investigation of ancient Chinese roof tiles and their production is thus also an investigation of the origins of roof tiles throughout East Asia.

In recent years, ceramic objects that resemble flat tiles have been unearthed in the Shang city at Zhengzhou in Henan Province, and there are reports of their use as construction materials in palaces of the early Shang period (Henan Provincial Institute of Cultural Relics and Archaeology 2007). At the Taosi site in Shanxi Province, which dates back some 4000 years to the late Neolithic period, many sheet-shaped ceramic objects thought to be roofing materials have been unearthed in locations where the remains of large buildings cluster within the enclosure (Shanxi Archaeological Teams of the Institute of Archaeology CASS et al. 2005). Further, at the Qiaozhen site in the city of Baoji (Baoji Municipal Institute of Archaeology 2011) and the Lushanmao site in Yan'an City (Shaanxi Academy of Archaeology et al. 2019), both in Shaanxi Province, there have been reports of round and flat tiles from the Longshan period of the late Neolithic, increasing the possibility that partial use of roof tiles dates back to the late Neolithic period.

However, while scattered discoveries of roof-tile-like remains dating from the late Neolithic to the Shang period

have been made, such tiles were clearly not in continuous use. It is not possible to find a lineage that connects the roof-tile remains from the Shang period and earlier that have been discovered so far. Most likely, the roof tiles of this era were undergoing a process of trial and error in which they repeatedly appeared and disappeared. Likewise, because the kilns used to fire them have not been discovered, it is difficult to pin down the specifics of their production.

The full-scale production and use of roof tiles came into its own in the Western Zhou period (Owaki 2002; Mukai 2012). The only remains of kilns that were certainly used to fire roof tiles that have been reported so far date from the Western Zhou and later; therefore, this paper will address shifts in tile kilns from the Western Zhou to the Qin and Han periods in northern China, centering on the Yellow River area. Ceramic kilns were used in China well before the tile kilns that have been found, and the earliest roof tiles were fired in kilns that had the same structure as those used for ceramics. This paper will first briefly outline previous research on shifts in kiln forms, then discuss examples from each period, and finally consider workers and modes of operation involved in kiln-firing.

### 8.2. Structural shifts in kilns

The kilns used for firing roof tiles in ancient China, particularly during their earliest period, were structurally almost identical to ordinary ceramic kilns; in fact, roof tiles and other ceramics were often fired in the same kilns. Here, following the example of prior research, we begin with an overview of shifts in kiln structure, mainly in the Yellow River region.

The kilns that appeared from the mid-Neolithic Cishan period through the early Yangshao period used a structure

that guided the flame from the stokehole and firebox (fuel-burning space) of the kiln laterally or diagonally to the firing chamber (where ceramics or roof tiles were placed) and discharged smoke from a flue at the top. During the late Yangshao period, while the basic structure remained the same, a flame-passage hole was added in some kilns that led between the firebox and firing chamber (Fig. 8.1: 1). This became more widespread in the late Neolithic Longshan Culture. In the Shang period, kilns generally came to use a two-layer structure, guiding the flame from the firebox below through a flame-passage hole to the firing chamber above (Fig. 8.1: 2), and this remained widely in use through the Zhou period (Ozawa 1993). All of these were updraft kilns that conveyed the heat generated in the firebox upward or diagonally to the firing chamber and then discharged the heat and smoke upward from there.

By contrast, the kilns that appeared in the Western Zhou period were semi-downdraft kilns (Fig. 8.1: 3), called flat kilns in Japanese archeology due to their shape. The floor of the front half of these kilns is further depressed and forms the firebox, while the raised back half forms the flat-floored firing chamber. The heat that is generated in the former rises to the top of the latter and then is drawn down to the flue at the base of the back wall of the firing chamber for discharge. This structure likely made it easier to control the flame, allowing for the firing chamber to be enlarged. Tile kilns used this structure almost without exception from the Warring States period through the Qin and Han periods as they grew larger and larger.

### 8.3. Tile kilns and roof-tile production in the Western Zhou

Most the roof tiles found from the Western Zhou period (from the eleventh century BCE until 771 BCE) have been discovered around Zhouyuan in western Shaanxi. The plateau southeast of Mt. Qi on the north bank of the Wei River may be where the Zhou Gugong Danfu established his base at Zhouyuan. He built a castle and created a village

at the site. His grandson, King Wen, transferred the Zhou capital to what is now the southwest suburbs of Xi'an City, naming it Fengjing. Then his son, King Wu, brought down the Shang Dynasty and replaced it with the Zhou, building his capital city Haojing. The area of Chang'an County in Shaanxi where the Fengjing and Haojing remains are scattered has also yielded many Western Zhou roof tiles.

#### 8.3.1. Western Zhou period roof tiles

##### 8.3.1.1. Early Western Zhou roof tiles

Beginning in the 1970s, large architectural remains from the Western Zhou period have been discovered in the village of Fengchu, Qishan County, and the village of Zhaochen, Fufeng County, both in Shaanxi (Zhouyuan Archaeological Team in Shaanxi Province 1979; 1981). Investigation of these remains has clarified the state of early Western Zhou roof tiles, which were invariably flat (Luo 1987). In the Zhouyuan region, round roof tiles began to appear in addition to flat ones only in the middle Western Zhou period. Clay coils were built with paddles and anvils to form clay cylinders, and these were then cut into flat tiles. The flat tiles unearthed from the lower building levels in Zhaochen are 47 cm long, 30 cm by 29 cm wide, and 1.3 cm thick, showing traces of paddling with a rough cord-wrapped paddle on the sides and edges as well as on the exterior. Some of these tiles have cord marks on their interiors as well. It is likely that the clay cylinders were cut when still soft, and their insides and edges were adjusted. Additionally, some flat tiles have interior or exterior clay protrusions to facilitate their fixation on roofs. Some also have holes near both ends, and these are thought to be for string-threading to bind tiles together.

##### 8.3.1.2. Mid-Western Zhou roof tiles

The roof tiles found at the upper building levels in Zhaochen largely belong to the mid-Western Zhou period, with little material from the late period (Zhouyuan Archaeological Team in Shaanxi Province 1981). The major changes in

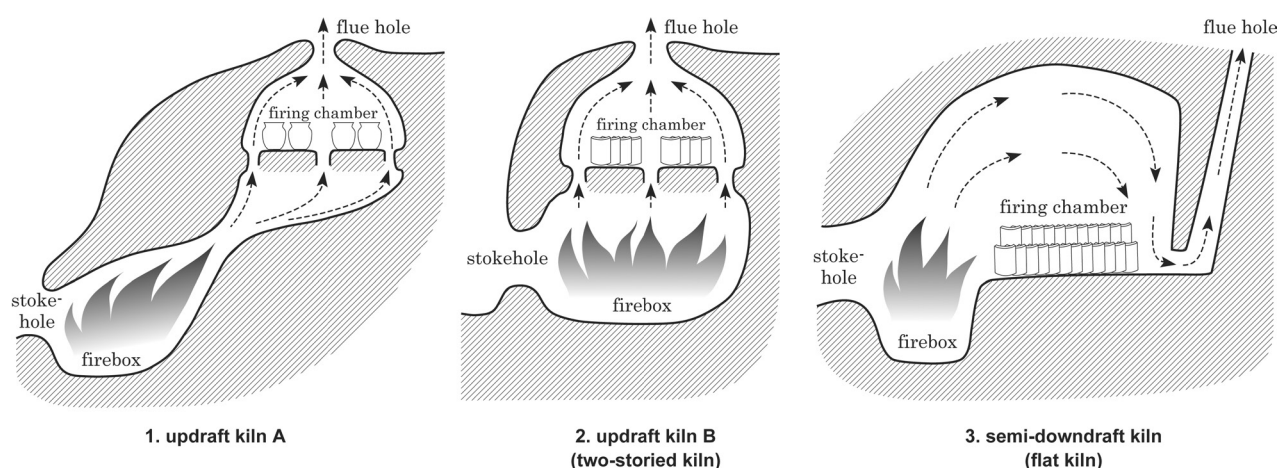
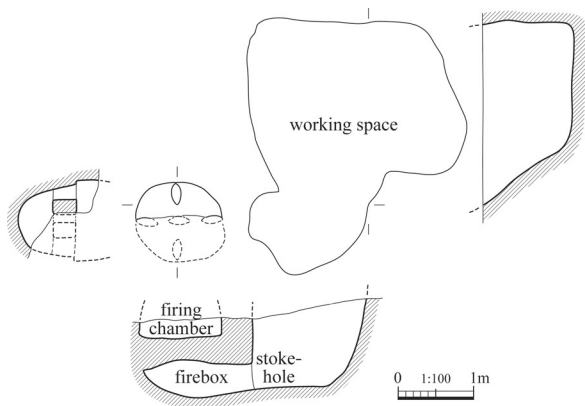


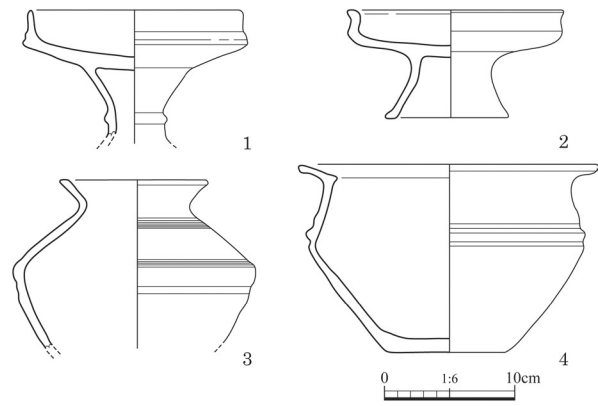
Figure 8.1. Structural shifts in kilns.

the middle period include the appearance of round tiles in addition to flat ones, as well as half-round eave-end tiles. Each type of roof tile appears in large, medium and small sizes, probably divided according to their intended

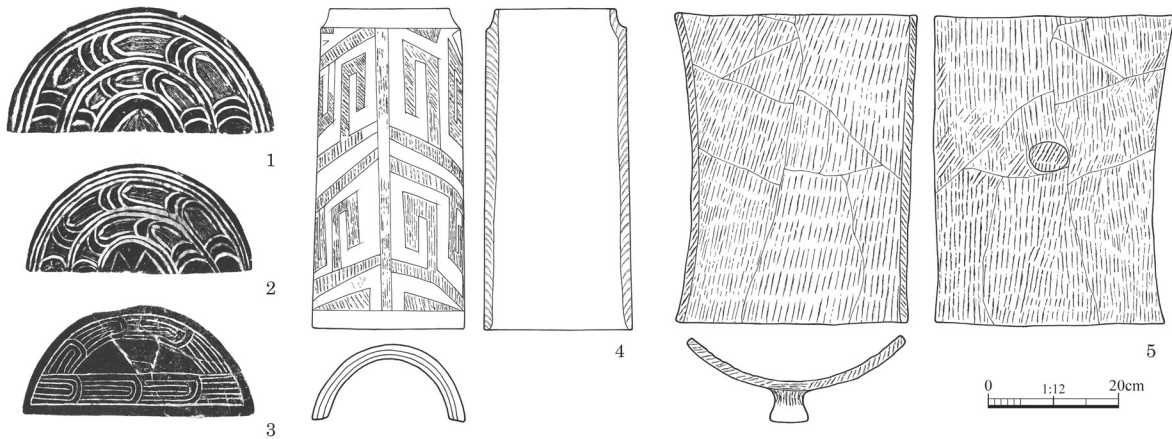
place of use. The half-round eave ends include some with patterns made by spatulas and some undecorated ones; the former display concentric arc patterns on the half-round eave-end side (Fig. 8.2: 3.1, 2, 3). Both round and flat



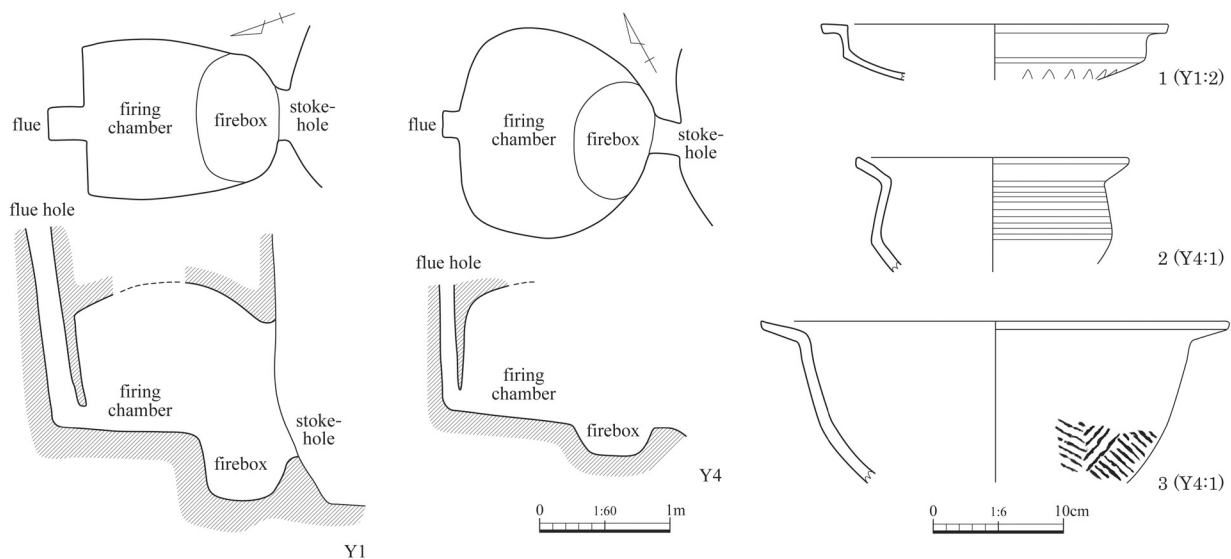
1. Western Zhou ceramic kiln (Y5) at Luoshui village



2. Western Zhou ceramics unearthed from kiln Y5



3. Roof tiles unearthed from Western Zhou building foundations at Zhaochen (1-3), Yuntang and Qizhen (4,5) in Fufeng



4. Kilns and ceramics unearthed at Liliavao site

**Figure 8.2. Ceramic and tile kilns from the Western Zhou to early Spring and Autumn period (traced from Feng Hao Archaeological Team 1963, Zhouyuan Archaeological Team 1981, 2002 and Sanmenxia Municipal Archaeological Team 1993).**



tiles were made by cutting clay cylinders formed with paddles and anvils, and cord-wrapped paddle marks were left on their exteriors. Some exteriors of round tiles have had their cord marks smoothed away and borders made by spatulas and geometric patterns added. The addition of protrusions to both flat and round tiles is even more common in the middle period, where tiles have conical, cylindrical or mushroom-like forms, and many also have loop handles.

### 8.3.1.3. Late Western Zhou roof tiles

Investigations conducted in 1999 and 2000 found two late Western Zhou period building groups in the villages of Yuntang and Qizhen, Fufeng County (Zhouyuan Archaeological Team 2002). The tiles unearthed from the sites were essentially the same as the tiles from the middle period described above. The half-round eave-end tiles had concentric arc patterns made with a spatula; the round tiles were undecorated on the inside and had geometric patterns on the outside. The flat tiles were marked on the exterior with a relatively fine cord-wrapped paddle, and they were undecorated on the inside (Fig. 8.2: 3.4, 5). There were no major changes in the types, forms or methods of production of roof tiles during the late Western Zhou, but tiles were thinner and more uniform than those of the middle period and had finer cord marks on the surface (Luo 1987). The late period also exhibited fewer protrusions for roof-fixing.

Overall, the major changes that occurred within the Western Zhou period were in its middle period: the production of round tiles began alongside flat tiles; eave-end tiles were produced for the first time; and buildings appeared whose entire roofs were covered with tiles. In other words, from the middle Western Zhou period forward, there was a clear increase in the types and number of roof tiles used in a single building. However, even so, the use of roof tiles was limited to the major architecture of the royal capitals, such as palaces and ancestral shrines. While there was demand for large numbers of roof tiles for new constructions at this time, such demand was not consistent; it is likely that the workers who normally manufactured ceramics would temporarily switch to roof tiles to meet the demand as it arose. The close ties between the production of roof tiles and ceramics during the Western Zhou period can be deduced not only from commonalities in their methods of production but also from their being fired within the same kilns.

### 8.3.2. Western Zhou period tile kilns

In the southwest suburbs of Xi'an, Shaanxi Province – the location of Haojing, one of the capitals of Western Zhou – an excavation in 1961–62 discovered six kiln remains from the late Western Zhou period in the western part of the village of Luoshui (Feng Hao Archaeological Team 1963). All of these were two-layer kilns with fireboxes below and firing chambers above, and had a work shaft that was dug in front of the stokehole (Fig. 8.2: 1). When the site

was excavated, the kiln body and shaft interior were found buried in earth mixed with ash, from which ceramic shards and roof tiles were unearthed, as well as raw clay pieces. Jars were the most common type of artifact (Fig. 8.2: 2), followed by pedestaled dishes and roof tiles, with a few pots (including three-legged pots). The other kilns appear to be in a similar state, with operations seeming to have been largely focused on ceramics while also including roof tiles.

In the village of Liulongzui, Qishan County, Shaanxi, two Western Zhou kiln remains were discovered in 1979 (2.5 km west of the village of Fengchu, where buildings from the early Western Zhou period have been found) (Ju 1989). The first kiln was 1.75 m in diameter; its upper structure is unclear, but it was probably two-layered. Many round and flat tile shards and unfired tiles were found, along with a few pieces of ceramics in the upper layer. The second kiln had a similar structure, and it revealed many jars and other ceramic artifacts. Researchers theorized that the first kiln was dedicated to roof tiles alone, and the second fired only ceramics, but the two were just 0.5 m apart and had the same structure. Even if the products to be fired were separated by type, it is inarguable that the production of roof tiles and ceramics took place in closely adjacent locations, if not in the same kiln.

At the Lijiayao site in Sanmenxia City, Henan Province, six kilns from the late Western Zhou or early Spring and Autumn period have been found (Sanmenxia Municipal Archaeological Team 1993). The flat type includes horseshoe and round shapes, and both small flat kilns are no more than 1.5 m long in total, with a single flue on the back wall (Fig. 8.2: 4). Many ceramic pieces, including pedestaled dishes, have been unearthed from the kiln remains and surrounding pits, along with many round and flat tiles, including half-round eave-end tiles without decoration. These roof tiles may have been supplied to Shangyang, the capital of the Western Zhou vassal Guo State.

## 8.4. Tile kilns and tile production in the Spring and Autumn and Warring States periods

Full-scale tile-roofed buildings developed in the Western Zhou period only in those regions that were directly governed by the Western Zhou Dynasty, such as Zhouyuan, Fengjing and Haojing. At this time, the use of tiles was monopolized by the Western Zhou Dynasty, and only scattered examples have been found in other regions. However, during the Spring and Autumn period of the early Eastern Zhou (770 BCE to 453 BCE), tile production and usage had spread to other major states, and diversely decorated tiles appeared widely in the Warring States period of the late Eastern Zhou (453 BCE to 221 BCE). Below, we describe the status of tile kilns and tile production in this period, with reference to states where evidence for tile production and use has been excavated: Qin, Zhou, Yan, Qi and Chu.

#### 8.4.1. Tile production in Qin Yongcheng

Roof tiles from Spring and Autumn period Qin have been unearthed mainly at the Yongcheng site in Fengxiang County, Shaanxi. Yongcheng thrived as the Qin capital for some 280 years, from 677 BCE, when Duke De acceded to his position and began building the city, until the capital was moved to Yueyang during the Warring States period. Excavations have found the remains of many large buildings within the Yongcheng enclosure, including palaces and ancestral shrines from the Spring and Autumn period. Outside, to the southwest, contemporaneous mausolea have been found.

Within the Yongcheng remains, the status of the roof tiles unearthed at the Majiazhuang No. 1 Building Group Site – which is thought to have been an ancestral shrine – is well known (Archaeological Team of Yongcheng 1985). The roof tiles that have been unearthed from around the site's central building include unusual flat tiles with a U-shaped cross-section. Some feature a triangular decoration that wipes out half of the exterior cord marks; these tiles are thought to have been laid on roofs with the decorated part projecting from the eaves. There are also half-round eave-end tiles that combine cord marks and arc patterns, as well as round tiles that have their exterior cord marks brushed away in patterns. It is also notable that many marks on the round and flat roof tiles from this site were inscribed with spatulas. According to the archaeological report, these marks appear on almost all of the round and flat tiles and are in 70 to 80 types. Their number and frequency indicate that they may be manufacturers' marks.

From late 2005 to May 2006, a roof-tile workshop that dates from the late Spring and Autumn to the Warring States period was excavated near the village of Doufu in northwest Yongcheng (Shaanxi Academy of Archaeology et al. 2013). This location, north of the area where major buildings such as palaces and ancestral shrines are found, is thought to be where the workshops were that supplied building materials, including roof tiles (Fig. 8.3: 1). Five flat kilns and many clay pits have been discovered (Fig. 8.3: 2). Around 2000 artifacts have been unearthed, including eave-end tiles, round tiles, flat tiles, bricks and terracotta figurines. Most of the eave-end tiles are round and bear animal decorations of deer, birds and tigers, as well as some cloud patterns. Many tools used for roof-tile production, such as ceramic antefix molds and anvils, have also been unearthed.

Round eave-end tiles with patterns of fauna have hardly ever been found in Yueyang, the capital from 383 BCE on, or Xianyang, built in 350 BCE: most of the roof tiles unearthed from the kiln remains are thought to be from the early Warring States period. We can thus conclude that workshops that specialized in roof-tile manufacture mainly existed at the Yongcheng site in the early Warring States period. These tiles were probably supplied to the palaces and ancestral shrines scattered within the site.

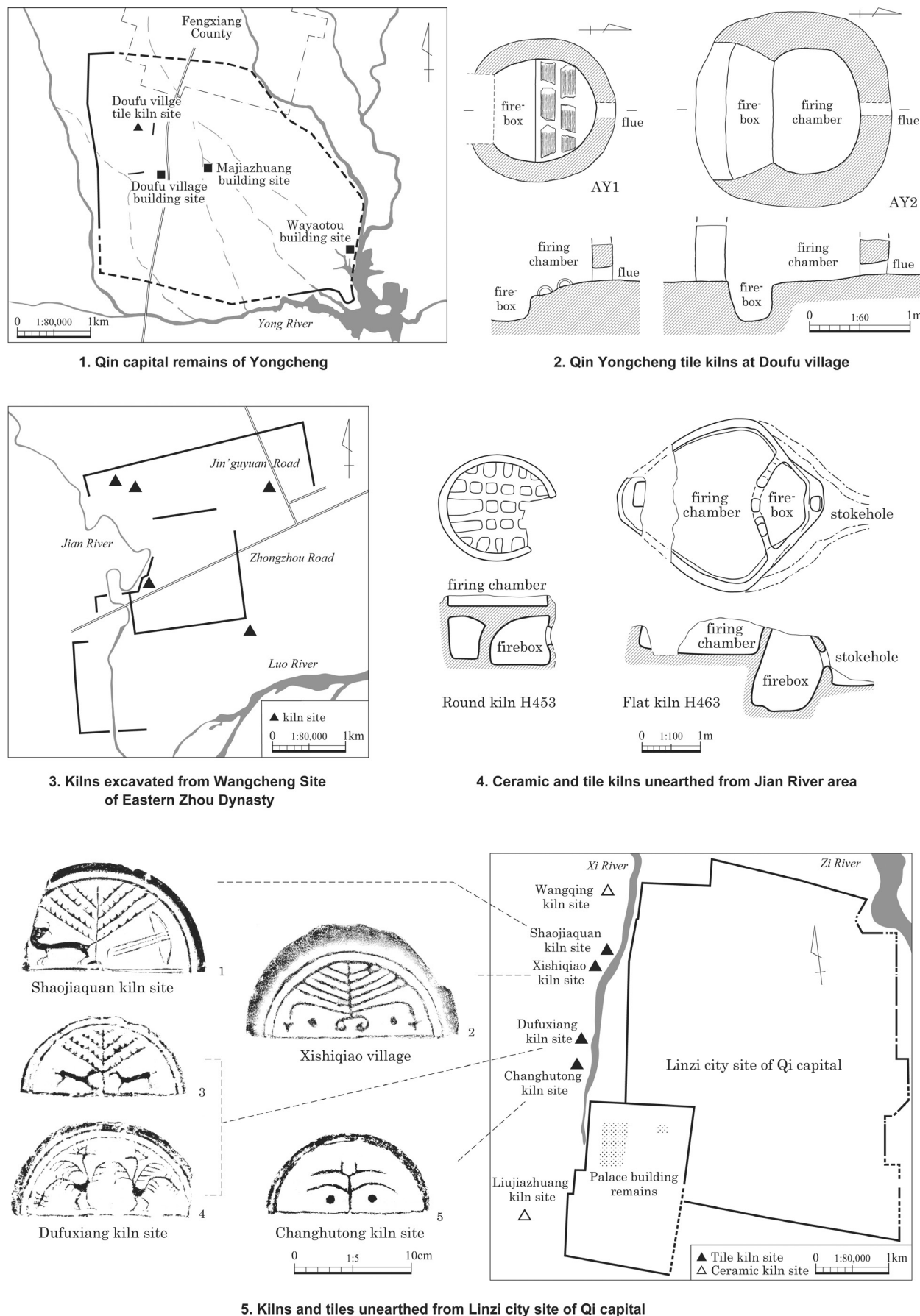
#### 8.4.2. Tile production at the Wangcheng site in the Eastern Zhou Dynasty

In 771 BCE, the Western Zhou Dynasty fell and was replaced, the following year, with the Eastern Zhou, which had its capital at Luoyang. However, the Western Zhou tradition of roof-tile production was not passed on to the Eastern Zhou. Roof-tiled buildings had developed in Western Zhou centers like Zhouyuan, Fengjing and Haojing, with patterned half-round eave-end tiles decorating the eaves, whereas only undecorated half-round eave-end tiles have been reported in Luoyang, royal capital of Eastern Zhou, during the Spring and Autumn period, and cloud-patterned tiles using molds appeared only in the Warring States period (Institute of Archaeology, Academia Sinica 1959). Undecorated half-round eave-end tiles were used in the Warring States and Qin and Han periods as well as in the Spring and Autumn period; the latter were somewhat softer and gray-brown or black-gray in color, while the roof tiles of the Warring States period were hard and blue-gray. Additionally, roof tiles with cloth-mark impressions on their interiors appeared during the Warring States period.

Kiln-group remains from the mid to late Warring States period have been found at the Eastern Zhou Wangcheng site (Fig. 8.3: 3, 4) within the northwest outer wall of Luoyang, east of the Jian River (Institute of Archaeology CASS 1989). In addition to antefix molds, many ceramic anvils and tools used for burnishing have been unearthed, showing that the roof-tile and ceramic workshops were probably adjacent. To the southeast of the kilns, there was a bone workshop, and to the south of that, there were gem and stone workshops. Copper molds have also been found, indicating that the area was a center for artisan workshops.

Of the 15 kilns, 6 are unclear in structure and 5 are ordinary flat kilns, with a flat oval shape, a vent in the back wall of the flat firing chamber, and a firebox and stokehole dug deeply at the front. Some of the kiln walls are made from sun-dried bricks. The products of these kilns include everyday ceramics, construction materials such as roof tiles, and funerary objects to be buried with the dead. These three types of product have been unearthed mixed at many kilns, in ratios that vary by kiln. The artifacts found in the flat kiln H415 and its surrounding pits were mostly ceramics, with a few roof tiles as well. Around H437, likewise a flat kiln, both roof tiles and ceramics have emerged in quantity. In contrast to these, the round kiln H453 has a two-layer structure, with its fire lit under the bottom firebox layer and reaching the upper firing layer through multiple holes for flame passage. Reports indicate that while both roof tiles and ceramics have been unearthed from H453 and its surroundings, it is not clear whether all of them were fired in that kiln.

In 1974, near Jin'guyuan Road at the northeast outer wall, 22 kilns from the Eastern Zhou through the Han periods were found (Work Team of Luoyang City on Cultural Relics 1983). Of these, two were ceramic kilns, and one was a roof-tile kiln, all from the Eastern Zhou period. Ceramic



**Figure 8.3. Kilns in the Warring States period (redrawn from Shaanxi Academy of Archaeology et al. 2013, Institute of Archaeology CASS 1989 and Zhang 2006).**

kilns No. 5 and No. 4 had different structures, but both were two-layer kilns: the former may date back to the Spring and Autumn period. The No. 1 roof-tile kiln was a flat kiln with an almost rounded firing chamber. The kilns that are considered to be from the Qin and Han periods are all typical flat kilns, with the smaller ones used for ceramics and the larger ones for roof-tile or brick firing. Ceramics stamped with “He Ting” and “He Shi” marks have been found, indicating that during the Han period, these kilns were controlled by the market management organization. In all of these kilns from the Spring and Autumn through the Han periods, ceramic and roof-tile kilns were separate, with two-layer kilns firing only ceramics and flat kilns only roof tiles.

#### **8.4.3. Roof-tile production at the Yan-Xiadu site**

Many Yan roof tiles have been unearthed from the Yan-Xiadu site in Yi County, Hebei Province, the site of the capital during the late Warring States period (Hebei Provincial Institute of Cultural Relics 1996). This capital is generally thought to have been built in 311 BCE; while theories on the chronology of the Yan-Xiadu roof tiles vary, we assume here that half-round eave-end tiles with Taotie designs first appeared during the Warring States period and further developed during the later portion of the period (Tani 2006).

The city of Yan-Xiadu was divided into eastern and western halves, with the palace located in the north-northeast of the eastern city and some foundations spreading north of the wall. Artisans’ workshops were built close to the area of the palace in the northern part of the eastern city. While ceramics and roof tiles have been found in the workshops to the northwest of the palace, they largely produced bronze and iron objects, mainly weapons; by contrast, the workshops south of the palace were dominated by roof-tile and ceramic production, with traces of bone products and coins as well. Workshops for arms and those for other products were essentially separated.

Roof tiles and ceramics unearthed were carelessly mixed around the Yan-Xiadu workshops. While the kilns themselves have not been discovered, roof tiles and ceramics were certainly manufactured in close proximity. However, the characters stamped on the roof tiles and ceramics make it clear that the artisans for each were clearly distinct, and that they were managed and organized separately. Although no definitive statement can be made without evidence of the kilns, it is clear that in Yan-Xiadu, roof-tile and ceramic production were independent of one another and that the two types of products were probably mixed when defective items were disposed of from adjacent workshops or kilns.

#### **8.4.4. Roof-tile production in Linzi, the capital of Qi State**

Qi roof tiles have emerged in large quantities from the old capital at Linzi, in the city of Zibo, Shandong Province.

While theories of their chronology vary (Nakamura 2007), it is certain that a range of patterns, including tree patterns, developed in the late Warring States period. Tile kilns have been found and examined here and there outside the old capital walls (Fig. 8.3: 5), with ceramic-firing kilns also discovered (Zhang 2006). In particular, the Warring States kilns where eave-end tiles, round tiles and flat tiles have been unearthed were all dedicated workshops for roof-tile firing and supply. However, no photographs or diagrams of these kilns have been published; reports indicate that they existed from the Spring and Autumn period through the Han period. While it is difficult to confirm the beginning and end of their operating periods, the center of roof-tile production was almost certainly the late Warring States period.

Unlike the bone, bronze and iron workshops scattered within the old Qi capital, the roof-tile and ceramic kilns were located outside the walls. The failure to discover tile kilns within the walls suggests that the five found outside the walls were officially managed workshops. On the other hand, the characters stamped on ceramic products have led to the theory that the ceramic workshops were run by private citizens. Both types of kiln were outside the wall, but their distribution does not match, suggesting a difference in modes of operation.

#### **8.4.5. Chu roof-tile production**

The site of Ji’nancheng, Jiangling County, Hubei Province, which is believed to have been the Chu capital, has produced undecorated half-round eave-end tiles, round eave-end tiles, and round and flat roof tiles that are dated to the late Spring and Autumn period through the Warring States period (Hubei Provincial Museum 1982). The majority of building foundations appear in the Songbai area, southeast of the center, which is thought to have been the heart of the palace area. Kilns used to fire roof tiles and ceramics have also been found there, with many tile kilns found north of the central palace area and ceramic kilns scattered to its west.

A tile kiln was found in 1965 in Fanjiayuan, within the Songbai area, and two more (He River Kilns Nos. II-1 and III-1) were discovered elsewhere in 1975. Little is known of the III-1 kiln structure, and the Songbai Fanjiayuan and II-1 kilns are typical semi-sunken flat kilns, having oval shapes and one flue at the back wall. The firebox is a shallow dugout in front of the flat firing area that is connected to the stokehole.

From the artifacts found around these kilns, they are generally thought to date from the mid-Spring and Autumn period or later. Five undecorated round eave ends have been unearthed from the Songbai Fanjiayuan kiln, indicating that it dates from the time when these came into use, likely during the Warring States period; thus, the kiln was clearly in operation at some point during the Warring States period.

By contrast, four Warring States flat ceramic kilns have been found at the Xinqiao site in western Ji'nancheng (Hubei Provincial Institute of Cultural Relics and Archeology 1995). The ceramics found there imply a date from the late mid-Warring States period through the beginning of the late Warring States period. Thus, the ceramic and tile kilns at the Ji'nancheng site operated at different locations and featured clearly differentiated production.

#### 8.4.6. Separation of tile and ceramic production

Tile kilns in the Western Zhou period made use of small-scale ceramic-firing kilns, with minimal structural differences between the tile and ceramic kilns, and likewise without separation between their workers (Owaki 2002). By contrast, through the Spring and Autumn and Warring States periods, the production of ceramics and of roof tiles became more and more distinct. By the Warring States period at the latest, the two were handled by different workers who rarely shared kilns. In response to this, roof-tile kilns in these periods became much larger than ceramic kilns, and structural differences appeared as well.

In the Warring States countries of Qin, Yan, Qi, Chu and others, roof-tile production was clearly separated from that of ceramics. At Qin Yongcheng and Chu Ji'nancheng, kilns dedicated to the firing of roof tiles were built near the interior palace areas in response to demand for the tiles. At the old Qi Linzi capital, however, iron, copper-casting and bone workshops were built within the outer walls, but dedicated roof-tile and ceramic-firing kilns were scattered outside the walls. Civilian-run ceramic kilns also existed. At Yan-Xiadu, workshops for arms, roof tiles and ceramics were concentrated near the palace area, suggesting that the national authorities were responsible for the management of these industries. Roof tiles were stamped with marks that represented control by central management, distinct from those marking ceramic artifacts. While roof tiles and ceramics have been unearthed together where they were disposed of, they were clearly separated at the production stage.

#### 8.5. Tile and ceramic kilns in the Qin and Han periods

From the Warring States through the Qin and Han periods, major changes appeared in methods of roof-tile production. First, techniques of patterning on eave-end tiles using molds began to be used, and they spread across various regions during the Warring States period. In some areas, molds were used to produce clay cylinders, creating cloth marks on the round and flat tile interiors. Roof tiles with cloth marks date back as far as the Eastern Zhou Wangcheng site at Luoyang, and appeared widely during the mid to late Early Han period around Chang'an (Tani 1984). Roof tiles, which were first produced using ceramic-based methods, were by this point being manufactured with specially developed techniques and tools. These

differentiated techniques and tools further accelerated the separation of the production of ceramics and of roof tiles, and the two became distinct professions. Large numbers of tile kilns have been found from the Qin period onward, and during the Han period in particular, making it difficult to characterize all of them in one discussion. Here, let us concentrate on three groups of dedicated tile-firing kilns found from the Qin period (221 BCE to 206 BCE) through the beginning of the Early Han period (206 BCE to 8 BCE), to identify the specific characteristics of tile kilns during this time.

##### 8.5.1. Tile kilns at the Mausoleum of the First Emperor

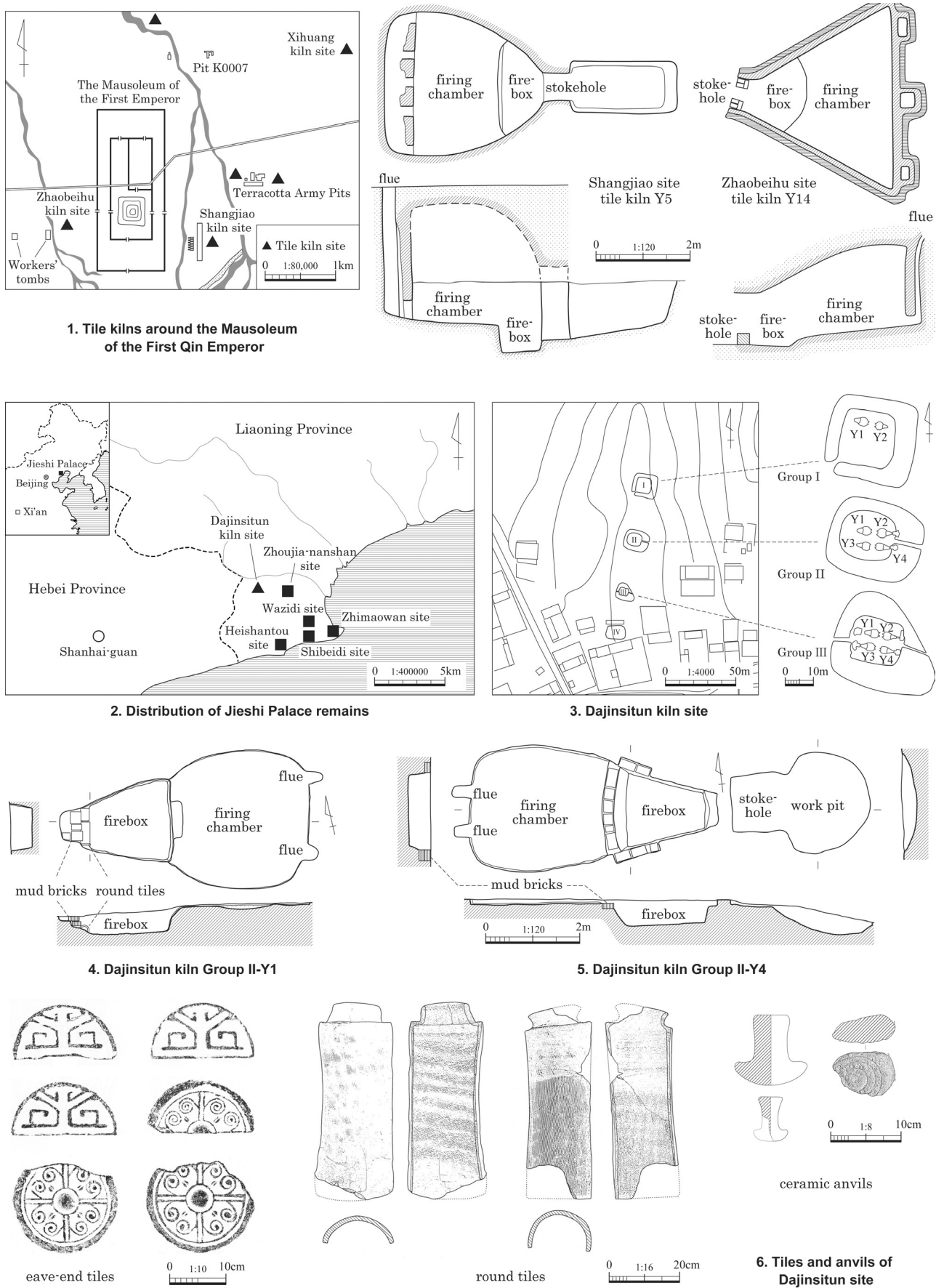
The Mausoleum of the First Qin Emperor is found in the eastern suburbs of Xi'an City, Shaanxi. It is recorded that its construction began in 246 BCE, and it became a massive mausoleum park construction project employing 700,000 workers after the unification of China in 221 BCE. The First Emperor died in 210 BCE and was buried there, but his palace and mausoleum were both destroyed after the Qin Empire fell in 206 BCE.

Investigations of this mausoleum have found multiple buildings in and around the mausoleum park, and many roof tiles have been unearthed from their remains. The kilns that produced this large quantity of roof tiles have been discovered in various places around the park (Qinyong Archeological Team 1985): in particular, three mainly tile-firing kilns have been found in the village of Zhaobeihu, west of the park, with three more near the village of Shangjiao, to the southeast (Fig. 8.4: 1). These kilns mainly produced roof tiles, together with a little ceramic. The Zhaobeihu kilns are triangular in shape and have three flues in the back wall, whereas the Shangjiao kilns are in the shape of a horseshoe or a round-cornered triangle; some have five flues in the back wall and show notable differences in shape.

During this period, the construction of the Qin palace and the Mausoleum of the First Emperor involved large numbers of civilians from all regions, together with workers from official workshops, as is made clear by the stamps engraved on the tiles and ceramics. In other words, the diverse shapes of the kilns found near the mausoleum, if they are dated correctly, most likely derive from the diverse origins of and techniques used by the kiln workers. By contrast, the tile kilns at the First Emperor's Jieshi Palace and at the Han Dynasty Northern Palace in Chang'an show a more uniform structure in their remains, suggesting that they were officially managed roof-tile workshops.

##### 8.5.2. Tile kilns at the First Emperor's Jieshi Palace

The Qin Dynasty resort in Jiangnüshi, Suizhong County, Liaoning Province, resembles the Jieshi Palace built by the First Qin Emperor (Fig. 8.4: 2). Records indicate that after



**Figure 8.4. Kilns for the First Emperor of Qin Dynasty (redrawn from Qinyong Archeological Team 1985 and Liaoning Provincial Institute of Cultural Relics and Archaeology 2010).**

unifying the country, the First Emperor took five imperial tours, visiting Jieshi to perform rites during his fourth tour in 215 BCE. The Shibeidi site is central to the Jieshi Palace, and features large tile-roofed building foundations with keystones at the Zhimaowan and Heishantou sites on its eastern and western capes. In the surrounding area, tile kilns have been found alongside buildings at the Wazidi and Dajinsitun sites, together with artifacts suggesting that these sites were related to the building of the Jieshi Palace (Liaoning Provincial Institute of Cultural Relics and Archaeology 2010).

At least four units (No. IV remains unexcavated) of two to four flat tile kilns, each encircled by ditches, have been discovered at the Dajinsitun site (Fig. 8.4: 3). The kilns are all similar in shape and structure and feature a trapezoidal firebox, oval firing area and two flues, the first depressed about 70 cm below the firing area (Fig. 8.4: 4, 5). They are semi-sunken kilns, built into the ground, plastered on the interior with mud mixed with fibers, and partially constructed of sun-dried bricks. The yard area outside the stokehole of the kilns includes a work pit. The work pit and outer ditch at No. II are linked, whereas the work pit at No. III is dug into a raised area within the ditch, suggesting that the ditch was used for wastewater and the disposal of defective products, rather than for work processes.

### 8.5.3. Tile kilns at the Chang'an Han Dynasty Northern Palace

The Northern Palace of early Han Chang'an is located in the north center. In a 1994 survey, 20 tile kilns were found outside its southern gate, of which 11 (Y31–Y41) have been excavated (Han Chang'an City Archaeological Team 1996). These are all flat oval kilns, standing in three rows of three to four kilns, each facing east (Fig. 8.5: 1).

The kilns are approximately 3 m long and up to 2.5 m wide, with fireboxes dug deeper than the firing chamber floors by 1 m or more. There are either one or three flues in the back walls, and rectangular work pits outside the stokeholes. These semi-sunken kilns are dug into the natural loess strata and have firing-chamber floors partially constructed of sun-dried bricks; their interior walls are plastered about 3 cm thick with mud mixed with fiber (Fig. 8.5: 2, 3, 4, 5).

The roof tiles and bricks unearthed in and around these kilns include undecorated and lattice-patterned, half-round eave-end tiles and cloud-patterned, round eave-end tiles (Fig. 8.5: 7); the accompanying flat tiles show cord marks on their exteriors and are either blank or anvil-marked inside. The stamp “dajiang” (great master), seen on round and flat tiles (Fig. 8.5: 6) in particular, is frequently found from the Qin through the very early Han periods, and uses characters close to those from the latter period. Therefore, these kilns are thought to have been in operation around the beginning of the Early Han period.

### 8.5.4. Changing tile-kiln shapes during the Qin and Han periods

In the early Warring States period, kilns were generally small and circular, with some still being two-layered, whereas in the mid to late Warring States period, flat oval kilns with a single flue became standard. Two-flue flat kilns appeared sometime later, and from the later Early Han period on, there was a rapid movement toward uniform, flat, horseshoe-shaped kilns with three flues (Li 2014; Wang 2011). The tile kilns of the First Qin Emperor's Jieshi Palace and the Han Dynasty Northern Palace at Chang'an exhibit this transition; however, the results of kiln excavations around the First Qin Emperor's Mausoleum also show that these changes were mainly seen in officially managed Qin and Han workshops, while contemporaneous civilian-run kilns continued to have diverse shapes.

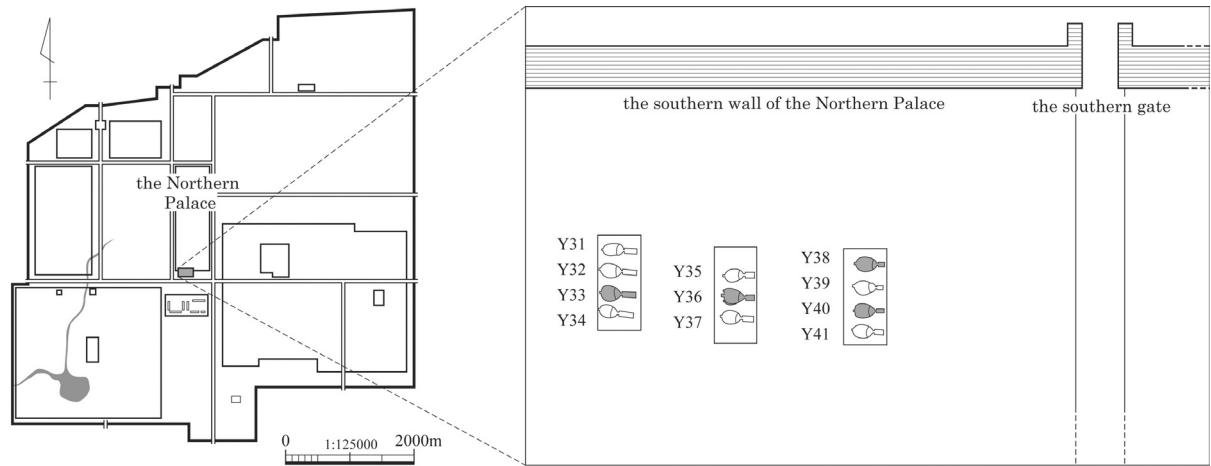
Structurally, tile kilns kept roughly the same structure from the Warring States through the Qin and Han periods. However, they steadily grew larger throughout this time, and the back-firing chambers in particular expanded. This enlargement enabled larger-scale production and the firing of larger products. The steadily increasing number of flues at the back wall of the firing chamber also supported larger tile kilns; the straight back wall with three flues at its base represented a means of retaining firing-chamber space while ensuring that products at the back were fully fired.

## 8.6. Conclusion

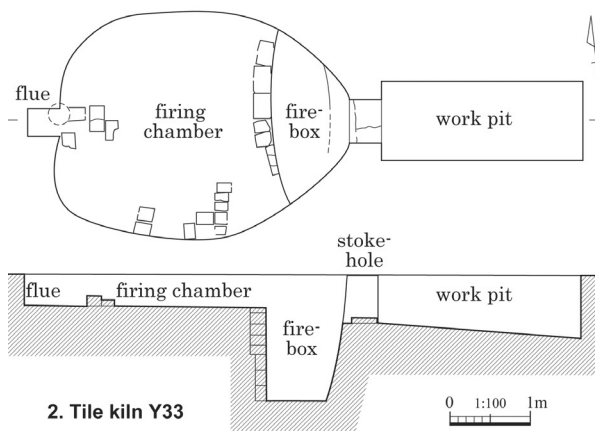
We have discussed the shape of and structural changes in tile kilns and roof-tile production from the Western Zhou through the early Han periods, together with their relationships to ceramic production. The conclusions of this paper are given below.

1) Tile kilns during the Western Zhou period and earlier used a two-layer structure, with ceramics and roof tiles being unearthed together in sites such as the village of Luoshui at Haojing. Examples of separate firing have also been discovered, such as at the two kilns found in the village of Liulongzui, Qishan County. However, in both cases, roof tiles and ceramics were produced and fired in extremely close proximity. This suggests that roof-tile and ceramic workers were not yet separated, and the same workers may have engaged in production of both forms.

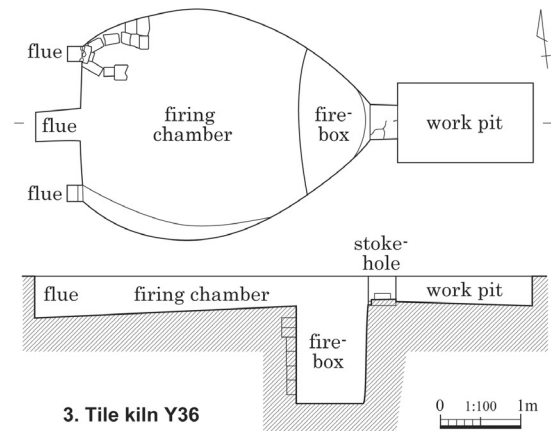
2) Much about roof-tile production in the Spring and Autumn period remains unclear, but it is clear that in Qin, Qi, Yan and Chu during the Warring States period, roof tiles and ceramics were produced separately by different workers. Unique roof-tile molds arose for use in antefix production, and as roof-tile consumption increased, the production of ceramics and roof tiles appear to have become separate. Large flat kilns for roof-tile firing came into widespread use, whereas ceramic-firing kilns remained small and two-layered until relatively late.



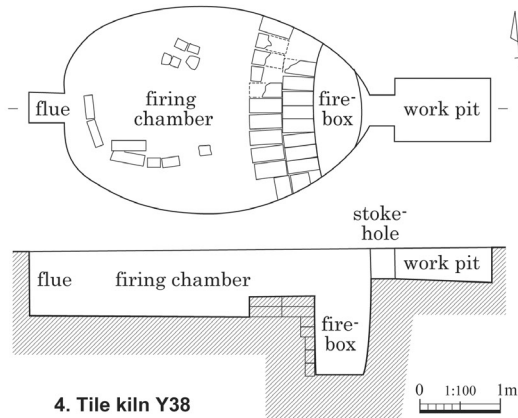
1. Tile kilns to the south of the Northern Palace in Chang'an city during the Western Han dynasty



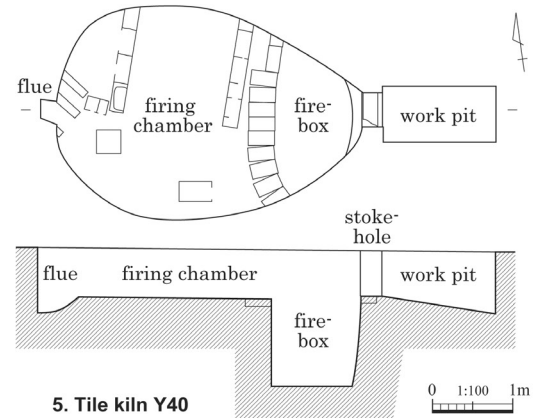
2. Tile kiln Y33



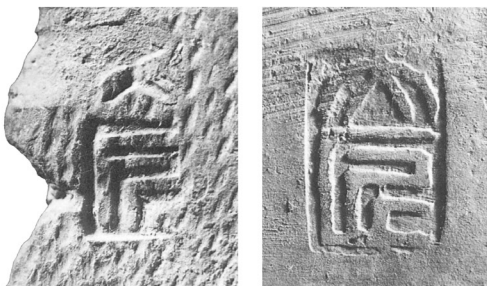
3. Tile kiln Y36



4. Tile kiln Y38



5. Tile kiln Y40



6. "Dajiang" stamp on tiles (Y41:3, Y31:8)



7. Eave-end tiles (Y36:2, 5)

Figure 8.5. Tile kilns in Chang'an City during the Western Han Dynasty (redrawn from Han Chang'an City Archaeological Team, 1A, CASS 1996).



3) This division of labor progressed further during the Han period, with roof tiles and ceramics being produced intensively in different workshops. This is clear from the large numbers of tile kilns that have been found lined up south of the Han Dynasty Northern Palace in Chang'an. Han period kilns all used the same flat structure for roof tiles, ceramics and terracotta figurines, but each kiln fired a specific model, indicating a division of functions.

The kiln shape and structure that were perfected during the Han period continued to be used for centuries without major changes, mainly in northern China. During this process, the influence of roof-tile production technology and kiln structure was felt throughout East Asia.

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## Pottery and Long-Distance Trade in East Asia: Coastal Areas Around the East China Sea and Yellow Sea During the Han Dynasty

Daisuke Nakamura

**Abstract:** Kiln-fired pottery was widely used for long-distance trade around the Yellow Sea and the East China Sea from the third century BC to the third century AD. This essay discusses a possible value change in that type of pottery. The first widespread distribution was of large containers for transport, produced in the Liaodong and Shandong peninsulas. However, after the development of proto-celadon in the Jiangnan region, medium-sized long-necked jars were exported to other regions from the Han Dynasty onwards. In short, the wide distribution of pottery changed from pottery for transport to high-quality ceramics. In addition to the rising value of ceramic itself, it seems to have been appreciated as a tool for drinking and spread to the higher strata of societies.

**Keywords:** Long-distance trade, Lelang commandery, Liaodong peninsula, Shandong peninsula, proto-porcelain

### 9.1. Introduction

The long-distance movement of pottery is occasionally seen in the Japanese archipelago starting in the Jomon period, which was a hunter-gatherer society. Although there are some cases of movement of more than 1000 km, such as Ōbora-type pottery in the Final Jomon period, the movement was mostly contained within the Japanese archipelago, except for the southern end of the Korean peninsula. However, from the Middle Yayoi period onwards, the pottery produced in the northern part of the Korean peninsula or farther away, such as Lelang pottery and Liaodong style pottery, was brought to the Japanese archipelago. These were the types of pottery produced with the flat kiln (see Chapter 8) that developed in northern China.

Regarding the acceptance of kilns, in the south of the Korean peninsula, people adopted not only the flat kiln but also the tunnel kiln that originated from the Jiangnan region (see Chapter 6). In the Japanese archipelago, people also adopted the technology of the tunnel kiln, which formed the basis for later pottery production. In both regions, however, solid kiln-fired pottery had been introduced by trade before the production of kiln-fired pottery began. In this chapter, the author will discuss the expansion of the trade network of the East China Sea and the Yellow Sea during the Han Dynasty that accompanied the use of kiln-fired pottery.

### 9.2. Current issues

Lelang commandery, which is the source of Lelang pottery, was established in 108 BC after the Emperor

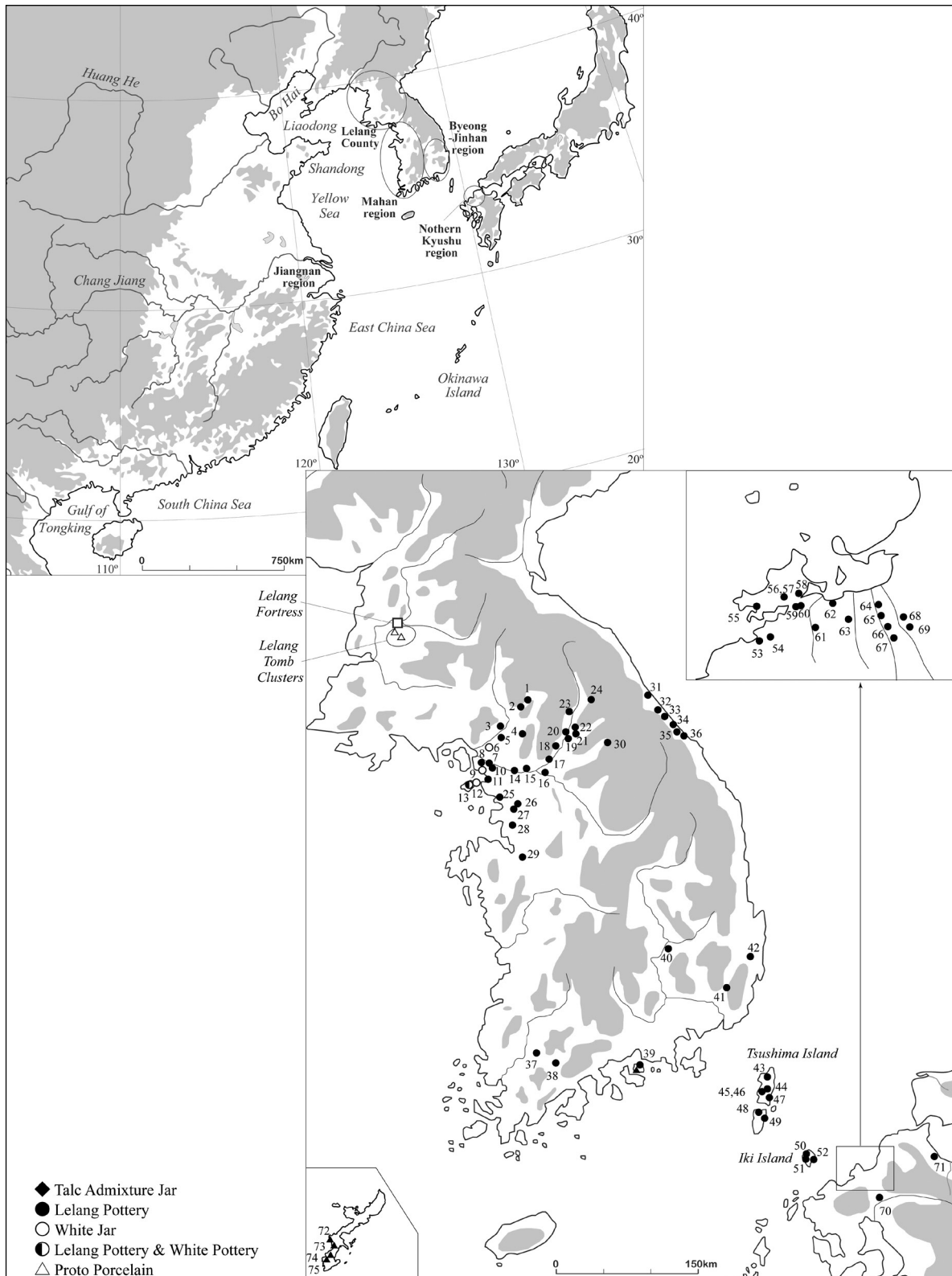
Wuhan defeated Wiman Joseon (Fig. 9.1, Table 9.1). The Lelang Fortress, located in present-day Pyongyang, as a capital almost dominated the Northern part of the Korean peninsula. In the Treatise on Geography of the “Hanshu,” there is a description as follows:

There were *Wa* people in the sea of Lelang, divided into more than a hundred countries. They came and contribute (to Lelang) in time. (Bangu, *Hanshu*, Treatise on Geography, 103 of last volume)

This text suggests that there was a close relationship between Lelang commandery and Japan (which was known as “Wa” in ancient texts), and archeological research conducted in the early twentieth century shows that diplomatic activities were carried out from this period, accompanied by bronze mirrors and gilt bronze products.

It has also been confirmed in the 1950s that Lelang pottery was brought to the Japanese archipelago (Mizuno and Okazaki 1954). However, it was not until Tani Toyonobu (1984–86) sorted out the pottery of the Lelang Fortress and clarified its composition that the study of Lelang pottery began to progress in earnest, which led to the identification and distribution of Lelang pottery mainly in the northern part of Kyūshū (Takesue 1991a, 1991b).

In parallel with the aforementioned studies, Korean researcher Shin Yongmin (1991: 47–50) sought the origin of Lelang tombs and mentioned the change of some types of pottery in his examination of a burial with wooden compartments and burial goods. Later, Takaku Kenji (1995) examined almost all the burial goods in Lelang tombs and



**Figure 9.1. Distribution of long-distance trade pottery to the south of the Liaodong region (modified from Nagatomo 2010).** 1. Wasuri, 2. Jeongokri, 3. Hakgokri, 4. Guemjuri, 5. Dangdongri, 6. Galhyeongri, 7. Unyangdong, 8. Yanggok, 9. Yanchon, 10. Bullodong, 11. Yeonhuidong, 12. Neundeul, 13. Unbukdong, 14. Pungnap Fortress, 15. Misari, 16. Yansuri, 17. Daeseongdong, 18. Daljeonri, 19. Geunhwa, 20. Shinmeri, 21. Ududong, 22. Yulmunri, 23. Georyeri, 24. Godaeri, 25. Oido, 26. Kianri, 27. Danghari, 28. Seodundong, 29. Galmeri, 30. Cheoljeiongri, 31. Gapyeongri, 32. Gyohangri, 33. Chodangdong, 34. Aninri, 35. Geumjinri, 36. Songjeongdong, 37. Shinchangdong, 38. Daegokri, 39. Nuekdo, 40. Pyeongchonri, 41. Pyeongsanri, 42. Dalcheon, 43. Kyōnokuma, 44. Kine/Yamabe, 45. Ōtobaru Yamoto, 46. Senosae, 47. Kannonbana, 48. Koshikizaki, 49. Shire'eura, 50. Karakami, 51. Toda, 52. Harunotsuji, 53. Fukae Imuta, 54. Magarita, 55. Mitoko Matsubara, 56. Ichinomachi, 57. Usui, 58. Motooka, 59. Urashi Ijiri, 60. Uruuji Tōkyū, 61. Mikumo, 62. Imajuku Gorōe, 63. Konori, 64. Hakata, 65. Hie, 66. Naka, 67. Takahata, 68. Sasai, 69. Shimotsukiguma C, 70. Hebonogi, 71. Jussō, 72. Ōkubo, 73. Nakagawa shell-mound, 74. Arachibaru, 75. Kajoū shell-mound, 76. Kasihima offshore, 77. Zannochi, 78. Aoki, 79. Monzen Ike.

**Table 9.1. Chronological division in East Asia from third century BC to third century AD**

	China	Korean Peninsula	Japanese Archipelago	Historical Events
220 AD	Three Kingdoms	Korean Three Kingdoms	Early Kofun period	239 AD Tribute from Himiko to Wei 202 AD Establishment of Daifang County Growth of Korean Han states and population outflow of Lelang County (Latter half of 2nd century)
	Middle and Late Eastern Han (M/LEH)	Final Proto-Three Kingdoms	Final Yayoi period	
89 AD		Late Proto-Three Kingdoms	Latter half of Late Yayoi period	
41 AD	Early Eastern Han (EEH)	Middle Proto-Three Kingdoms	First half of Late Yayoi period	57 AD Emperor Guangwu granted the Golden Seal to Wa
8 AD	Xin/Initial Eastern Han (X/IEH)			
48 BC	Late Western Han (LWH)	Early Proto-Three Kingdoms	Late stage of Middle Yayoi period	108 BC Establishment of Lelang County 111 BC Establishment of Nanhai County 119 BC State monopolies on salt and iron
	Middle Western Han (MWH)	Initial Proto-Three Kingdoms	Middle stage of Middle Yayoi period	
118 BC	Early Western Han (EWH)			
180 BC	Qin/Initial Western Han (Q/IWH)	Early Iron Age	End of Early Yayoi/ Initial stage of middle Yayo period	
221 BC	Late Warring States			

clarified their transitions. In northern Kyūshū, gray-colored pottery similar to Lelang pottery was also brought from Byeong-Jinhan in the southern part of the Korean peninsula, but the fragments are sometimes difficult to distinguish from each other. However, a study by Jeong Inseong (2004: 88–89) revealed differences between Lelang pottery and Wajil pottery in the inner pattern of pottery made by the anvils in paddling.<sup>1</sup> Furthermore, including this point, Terai Makoto (2007: 88) suggested three elements of difference between Lelang pottery and Wajil pottery.

As a result, the actual distribution of Lelang pottery is now understood in considerable detail. After the 1990s, the number of excavations in Korea began to increase rapidly, and Lelang pottery was unearthed in many places. At that time, the studies by Tani, Takaku and Jeong made a significant contribution to identification and chronology.

While the movement of Lelang pottery was taking place, White pottery from the Shandong peninsula was also exported to the Liaodong peninsula and Lelang commandery (Tani 2008). Particular White pottery has been produced since the Neolithic period in the Shandong peninsula, but it became widely distributed in the Han Dynasty. Those pieces unearthed in the Liaodong peninsula and Lelang commandery are basically large jars. In addition, proto-porcelain produced in the Jiangnan region has been excavated from the Shandong peninsula

and Lelang commandery. It is obvious from these findings that the Han Dynasty was a time when coastal trade in the East China Sea and Yellow Sea increased significantly (Nakamura 2015, 2017; Miyamoto 2020).

On the other hand, in recent years, research on the northeastern part of China has progressed and the development of the Warring States and Han dynasties in the Liaodong region has become clearer (Onuki ed. 2007). It is now evident that some pottery was moved long distances before the establishment of Lelang commandery (Jeong 2008; Nagatomo 2010). Talc was mixed into the clay in large amounts (hereinafter, this is called “talc admixture pottery”). Since this type of pottery was transported to the main island of Okinawa, it was also found that trade across multiple polities had begun before the establishment of Lelang commandery (Jeong 2008; Nakamura 2012).

All this long-distance transported pottery from the Han Dynasty period shares one characteristic: it was all fired in kilns, as mentioned in the introduction. This means that the solid and tough pottery moved further compared with the pottery in local areas of the Korean peninsula and the Japanese archipelago at that time. Furthermore, the pottery included large storage containers, which were not found in earlier long-distance transported pottery.

### 9.3. Pottery of long-distance movement

The pottery that moved long distances in the Korean peninsula and the Japanese archipelago was brought from a plurality of regions. In the following, the differences in

<sup>1</sup> Wajil pottery appeared in the southeastern part of Korea. Some of this was fired by open firing at first, but almost all of the vessels became to be fired by kilns, including gray-colored reduction-fired ones.

the characteristics of each will be discussed, with reference to the pottery that moved long distances across the East China Sea and the Yellow Sea during the Han Dynasty.

### 9.3.1. Talc admixture jar

In the Japanese archipelago, a talc admixture jar was the first long-distance trade pottery brought from further to the north than the middle part of the Korean peninsula. Pottery containing large amounts of talc is often found in the area from the Liaodong region to the Daedong River basin, and these were transported to the middle and southern part of the Korean peninsula as flowerpot-shaped pottery just before and after the establishment of Lelang commandery. Prior to this type of pottery, large neckless jars suitable for storage were produced (Fig. 9.2: 1–6).

Talc admixture jars have been found in Muyangcheng site, located at the tip of the Liaodong peninsula (Fig. 9.2: 1, 2), Neukdo site, located at the southern end of the Korean peninsula (Fig. 9.2: 3), and some sites in Okinawa (Fig. 9.2: 4–6). Since all sites are located in coastal areas, they are deeply related with ocean-based trade networks. Unfortunately, as only the mouth rims of these jars have been found, the shape of the jar is not clear. However, judging from these parts, it is likely they were nearly spherical in shape. The fact that they were fired in a kiln proves that they were not produced in the Korean peninsula, where kilns had not yet been introduced. Muyangcheng site in Liaodong peninsula was built as a fortress of Yan state in the late Warring States period and continued until the early Western Han Dynasty (from the third to the second century BC). Talc admixture jars were not found in the assemblage of Yan State pottery. Although there were various types of jars made from the Qin to the early Western Han periods, the production of large jars, almost as wide as they were tall, increased. Focusing only on the shape of the mouth rim, a similar jar was found in the Dajinsitun site (Fig. 9.2: 7), which related to the Qin temporary palace, but it does not contain talc. If a talc admixture jar has a flat bottom, it dates from the Qin period; if it has a round bottom, it dates from the early Western Han period, but there are no extant remains of jar bottoms. Therefore, it is reasonable to conclude that the talc admixture jar was created in the Liaodong region and influenced by jars from the Qin to the early Western Han period.

The Neukdo site at the southern end of the Korean peninsula contains a cemetery, a shell mound, and a dwelling. Not only a talc admixture jar was found there, but also Lelang pottery, which will be discussed below (Seo 2004; GARI 2003, 2006). A large amount of Yayoi pottery from the northern Kyūshū area was also found, as well as examples from the Setouchi and Sanin areas of Japan. For this reason, the nature of the Neukdo site as a trade center is evident (Shirai 2001). A talc admixture jar was excavated from the Na-No.136 pit accompanied by local pottery and Yayoi pottery from the first century BC to the first half of the first century AD (Li 2004). As a

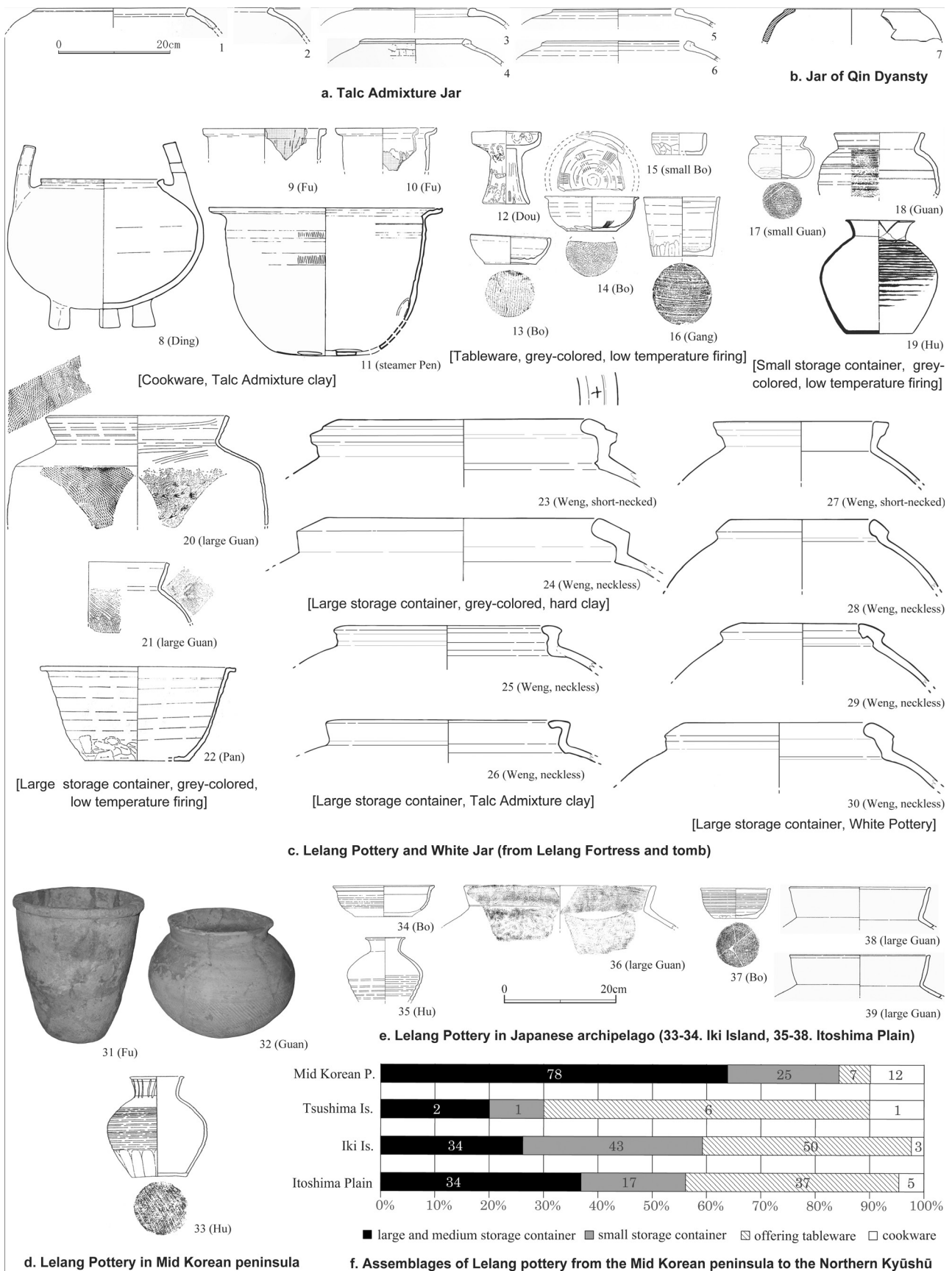
large amount of pottery from the second century BC has been excavated across the entire Neukdo site, including the Yayoi pottery of that time, the talc admixture jar seems to have been used for a long time, until it broke.

In Okinawa, examples have been unearthed at the Ōkubobaru site, Kajou shell mound, Nakakawabaru shell mound, and the Arechibaru site. Bronze articles such as a knife-shaped coin (*Mingdaoqian*) and a trilobate arrowhead have also been found. Talc admixture jars from the Kajou and Nakakawabaru shell mounds accompanied such Yayoi pottery as Takahashi type, Iriki type and Yamanokuchi type, which date from the third to first century BC in southern Kyūshū. In the Ōkubobaru site, this type of jar was found with Yayoi pottery such as Takahashi II type and Iriki II type, which date to between the end of the third and the second century (Shimada 1999: 22). Miyamoto Kazuo (2014: 81–82) suggested that the talc admixture jar and bronze artifacts were brought by refugees from the Liaodong region during the time from the fall of the Yan to the Qin in 222 BC to the establishment of Wiman Joseon in 195 BC. However, the talc admixture jar does not date from the fall of Yan. Even if there were refugees, it is unlikely that they would have arrived at a completely unknown place by accident. It is noteworthy that the relay type trade of artifacts was seen in such areas: from the western part to the southern end of the Korean peninsula; from the southern end of the Korean peninsula to northern Kyūshū; and from northern Kyūshū to the Okinawa Islands via southern Kyūshū. It should be assumed that Chinese artifacts were brought based on a trade network. What was in the talc admixture jar remains a mystery, but it is still informative as the first pottery used as a transport container in long-distance trade around the East China and Yellow Seas.

### 9.3.2. Lelang pottery

A large amount of Lelang pottery was brought to the Korean peninsula and Japanese archipelago after the establishment of Lelang commandery in 108 BC. As mentioned above, studies on pottery from the Lelang Fortress (Tani 1984–86) advanced the identification and understanding of Lelang pottery. Jeong Inseong (2003, 2008) and Kim Mujung (2004, 2007) have conducted extensive research on these discoveries in Korea.

Lelang pottery has been unearthed in large amounts from the fortress and tombs of Lelang, and consists of a wide variety of assemblages (Fig. 9.2: 8–30). Some of them are found all over the Han Dynasty, such as vats (*Pan*, Fig. 9.2: 22) for temporary water storage and eared cups (*Erbei*) for drinking, but some types of necked jars (*Hu*, Fig. 9.2: 19) and pots are unique, for example, the flowerpot-shaped talc-admixture pottery (*Fu*, Fig. 9.2: 9–10), which is distinctive of the region of Lelang commandery. It originated from the Yan-style pot (*Yan fu*), and was typologically changed in the Liaodong region; it took on its final form as it spread to the northern part of the Korean peninsula (Miyamoto



**Figure 9.2. Talc pottery and Lelang pottery (a: Ōnuki eds. 2007; Lee 2004; Nagatomo 2010, b: Tani 1984-86; Harada and Tagawa 1930, c: picture courtesy of Nagatomo Tomoko; Kim 2004, d: Nagatomo 2010, Takesue 2014, e: based on Nagatomo 2010; FCBE 2011; Furusawa 2016). 1–2. Muyangcheng, 3. Neukdo, 4. Kajō shell-mound, 5–6. Ōkubo shell-mound, 7. Dajinsitun, 8–18, 20–30. Lelang Fortress, 19. Seokamri tomb No. 205, 31–32. Daljeonri burial No. 2, 33. Songjeongdong, 34–35. Karakami, 36. Harunotsuji, 37. Fukai Imuta, 38–39. Mikumo (Banjo).**



2012). Specifically, the Lelang pottery includes a certain number of types that originated from Yan state and were transformed in the Liaodong region and in the Wiman Joseon. In Lelang commandery, a talc admixture jar (Weng, Fig. 9.2: 25–26) was also found, which had transformed from that of the Early Western Han period. Cups with a long leg (Dou, Fig. 9.2: 12)<sup>2</sup> and cylindrical cups (Gang, Fig. 9.2: 16) were found in the Lelang Fortress, and similar types of pottery were seen in Han tombs in the Liaodong peninsula but have not been unearthed in the Lelang tombs. Incidentally, judging from the Lelang pottery found from the midwestern to the southern part of the Korean peninsula and the White pottery (Fig. 9.2: 27–30) that is easy to assign to the period, the pottery from the Lelang Fortress is mainly from the late Western Han (the latter half of the first century BC) to the early Eastern Han (first century AD) periods. Pottery from the first half of the first century BC is not seen in the Lelang Fortress.

Reflecting the variety of the Lelang pottery, several kinds were distributed in the Korean peninsula and the Japanese archipelago. However, there is a deviation among the regions in their composition (Takesue 1991; Nagatomo 2010). Fig. 9.2f shows the variety of types of Lelang pottery in the midwestern part of the Korean peninsula located to the south of Lelang commandery, the trade centers of Tsushima and Iki islands, and the Itoshima plain, where many Chinese artifacts have been unearthed.

First, many storage tools have been excavated in the central part of the Korean peninsula. Among the medium and large storage tools, there were 42 vats and 36 short-necked jars. Seven of the short-necked jars were more than 30 cm in length, and the rest were medium-sized, less than 26 cm. At Gapyeong Daljeonri cemetery and Incheon Unbukdong site, the latter of which was a relay point for trading, Lelang pottery from the first century BC was excavated as early examples. The former site contained a set of flowerpot-shaped pottery and a short-necked jar (Fig. 9.2: 31–32), which influenced the burial goods of Mahan countries in the Midwest. This set came to be used as a standard of grave goods there. These grave goods include a large number of vats and some White pottery (Fig. 9.3: 12–15), which will be discussed below. Cooking steamers (Fig. 9.3: 18) are also included, and they suggest that the site was a base for a temporary stay. It is common to find a few medium and small jars (Fig. 9.2: 33) at other sites in the middle of the Korean peninsula dating from the first to the second century BC. Small jars to be used for storage are presumed to have been brought from Lelang commandery with some contents. This type of jar seems to have been regarded as significant, and was often imitated in the middle part of Korea (Nagatomo 2010: 18–20).

A large amount of Lelang pottery tableware (Fig. 9.2: 34, 37) has also been found on Tsushima Island, Iki Island and the Itoshima plain (Nagatomo 2010). Much Lelang

pottery has been excavated at the Haranotsuji site on Iki Island, and the proportion of small storage jars (Fig. 9.2: 35) is high. These jars are believed to have held some kind of liquid and been used locally as convenient containers. If they were used for a feast, it may have been a set of tableware. From Tsushima Island to the Itoshima plain, there are presumed fragments of large jars, but basically medium and large storage containers were short-necked jars (Fig. 9.2: 36, 38–39), of which there are only a few large ones. Some large jars with (over 40 cm) are found in Lelang commandery, and there were jars of White pottery of the same size. However, except for the White jars brought to Incheon Unbukdong site, as mentioned above, no other jars have been found to date in the Korean peninsula and the Japanese archipelago. Although the talc admixture jars from the early Western Han period spread without other kinds of pottery, the movement of Lelang pottery was different.

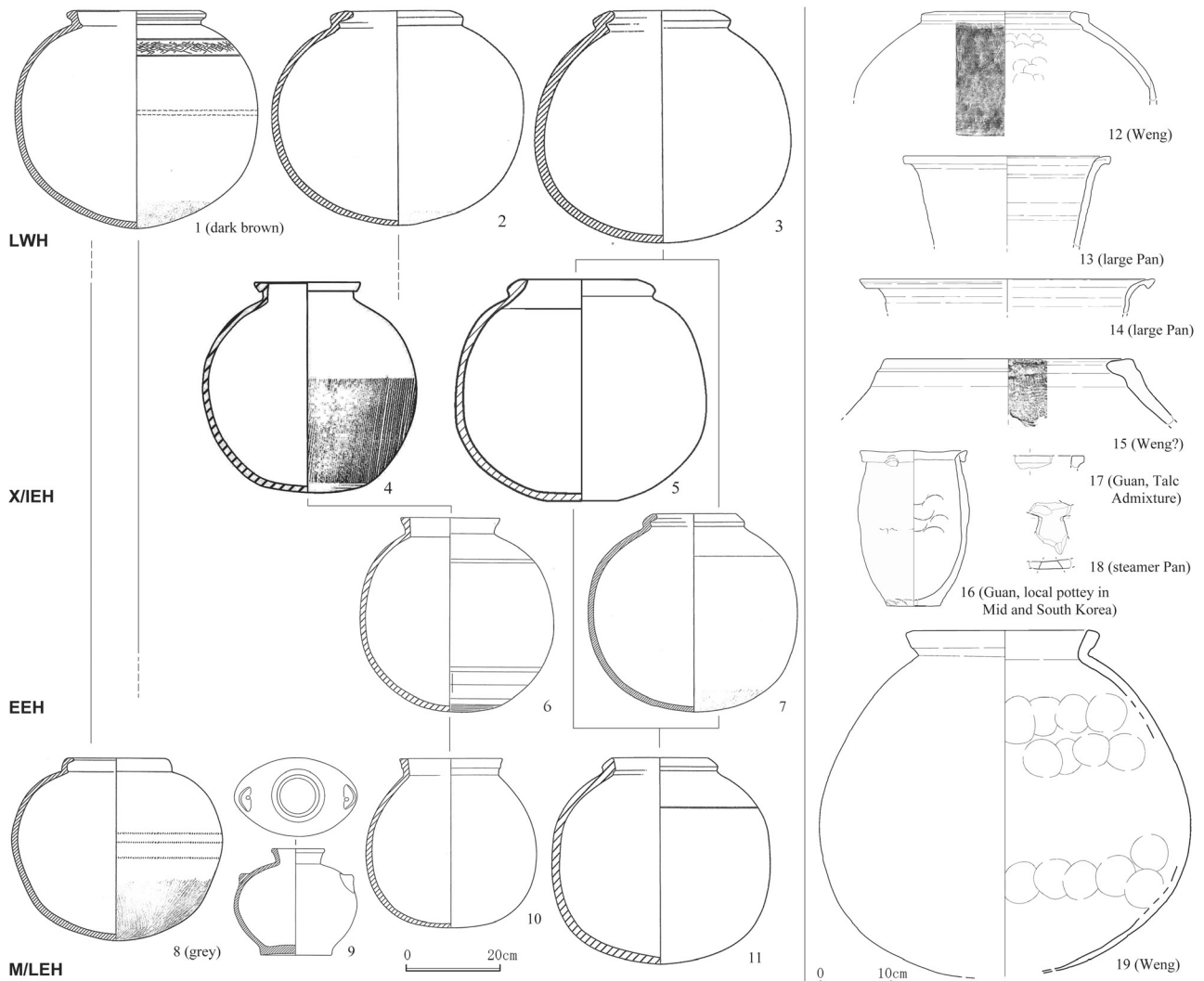
### 9.3.3. White pottery

Although White pottery jars used to be identified as a type of Lelang pottery, Tani Toyonobu (2008) demonstrated that these were produced in Shandong peninsula. White pottery was found in the Fuxia Wangjia kilns along with Wu Zhu coins, and therefore, they were made in the Han Dynasty (Hou Jiangye 2006), but a more detailed dating has not been attempted. However, the examples of the Jiangtun cemetery in the Liaodong peninsula showed that this kind of pottery appeared starting the late Western Han period (Xu and Zhang 2016). At present, it is believed that jars of White pottery were distributed around the Yellow Sea and that many of these were brought to burials in the Liaodong peninsula and the fortress and tombs in Lelang commandery.

White pottery at the Lelang Fortress includes two types: A) a neckless jar (Fig. 9.2: 28–30) and B) a short-necked jar (Fig. 9.2: 27), and there are sherds of reduction-fired gray pottery among Type A (Fig. 9.2: 23–24). Regarding the Lelang tombs, the earliest Type B jar was found in Jeongbekdong tomb No. 88 and dates from the late Western Han period (Takaku 1995: 57). Type A jars were found in Seokamri tomb No. 257 from the late Western Han period (Nakamura 2017) and Seokamri No. 9 from the Xin period (Takaku 1995: 57). Both types were imported to the Lelang commandery from the late Western Han Dynasty. Considering the cases of Jiangtun burial No. 41 (Fig. 9.3: 2–3) and Yingchengzi burial No. 2003–76 (Fig. 9.3: 5) on the Liaodong peninsula (Nakamura 2020), Type A jars in the Lelang commandery correspond to the late Western Han to Xin-Initial Eastern Han period. Additionally, according to the study by Xu Zheng and Zhang Miao (2016), Type B jars in Lelang commandery are presumed to date from the early Eastern Han period.

In the southern area of the Korean peninsula, several white jars have been found in the lower Han River basin. Several Type A jars of White pottery have been unearthed from pit No. 1 in section 5 of Incheon Unbukdong (Fig. 9.3:

<sup>2</sup> It is classified as a ‘Deng’ in the Han tombs of the Liaodong region, and it functions as a lamp.



**a. White Jar and Liaodong Style Pottery in Liaodong peninsula:** 1. Jiangtun burial (JT) No. 153 (Liaodong Style Pottery), 2-3. JT No. 41, 4. JT No. 19, 5. Yinchengzi burial No. 2003-76, 6. JT No. 10, 7. JT No.106, 8. JT No. 27 (Liaodong Style Pottery), 9. JT No. 73, 10. JT No.22, 11. JT No.21

**b. White Jar and Lelang pottery in Midwest Korean Peninsula:** 11-17. Unbukudong pit No.5-1, 18. Yangchon 3-Na, moat of tomb No.1

**c. Proto-porcelain from Jiangnan region to Lelang County:** 20-21. Laoheshan burial No. 98 (LWH), 22-23. No. 128 (EEH), 24-25. No. 129 (EEH), 26-28. Tushantun mound No. 4 burial No. 148 (LWH), 29-30. mound No. 4 burial No. 147 (LWH), 31. Jiuding Meihualing (EEH), 32. Toseongdong tomb No. 45 (M/LEH), 33. Namsari tomb No. 29 (M/LEH) \*LWH: Late Western Han, EEH: Early Eastern Han, MEH: Middle Eastern Han, Late Eastern Han

**Figure 9.3. White jar and proto-porcelain (a: LPICRA 2014; DMICRA et al. 2019, b: HICH 2012, c: Wang 2005, QMICHC et al. 2019, Yan 2006, ECIBRRK 1989).**

12), accompanying local pottery (Fig. 9.3: 16) and many Lelang vats (Fig. 9.3: 13–14). Wu Zhu coins were also found from other archaeological features. The typological characteristics of the jars and coins show that they definitely date to the late Western Han period. At Gimpo Yanchon tomb No. 1 of section Na-3, a Type B jar was excavated from an outer moat of the mound, which is dated to the second half of the second century.

A large number of large jars were offered in the Jiangtun cemetery in the Liaodong peninsula (Fig. 9.3a). White jars of Type A and black-brown short-necked jars were found from the late early Han period (Fig. 9.3: 1–3). Different from those in Lelang tombs, White jars of Type B appeared between the Xin and the initial Eastern Han period (Fig. 9.3: 4). Then, in the Middle and Late Han Dynasty, the edge of the mouth rim of Type A rose and became close to a right angle (Fig. 9.3: 11). Type B jars came to have a thickened mouth rim (Fig. 9.3: 10). In addition, the variety of large jars has increased, to include black-brown pottery, gray pottery (Fig. 9.3: 8) and White pottery during this period, and the oligopoly of White pottery among large jars seems to have been lost.

Since the White pottery in widespread use consisted of large jars and necked jars, Tani Toyonobu (2008) suggests that the pottery was associated with some kind of contents. The White jars in Lelang tombs were also mentioned by Harada Yoshito and Tazawa Kingo (1930: 48–49) as possible food and drink containers. It is reasonable to assume that they were used as both transport and storage containers. The distribution of white pottery is limited to the lower Han River basin in the Midwest of Korean peninsula, and short-necked jars made in Lelang commandery were exported to the southern end of the Korean peninsula and the West of the Japanese archipelago, which suggests that White pottery was not just a tool for transportation but was considered a commodity along with its contents.

#### 9.3.4. *Liaodong style pottery*

The Liaodong style pottery has a pattern of anywhere from one to several lines of cord on the body (Jeong 2003). Vessel types include large jars (Fig. 9.3: 1, 8), wide-mouth jars, long-necked jars and small vats, which were produced from the early Western Han period to the middle and late Eastern Han period. Since a certain amount has been found in the Shandong peninsula (Terai 2007), it is also called Shandong-Liaodong style pottery (Miyamoto 2020). However, the pottery form of the two areas is not the same.

Several Liaodong style pottery pieces have been found from the Harunotsuji site, and a wide-mouth jar among them attracted attention as being typical of the pottery before the establishment of Lelang commandery (Jeong 2008; Takesue 2016). However, as noted by Furusawa Yoshihisa (2016: 87–89), it is difficult to determine the date due to the lack of a mouth rim. As this type of wide-mouth jars appears in the middle Western Han period, which

begins from 118 BC as defined by Chinese archeology, the dating can hardly be traced back before the establishment of Lelang commandery. Regarding the Liaodong style pottery at Harunotsuji site, it is proper to consider that they were brought in during the late Western Han period when the number of such pottery increased. The small vat with a pattern of cord lines in the Harunotsuji site seems to hail from the Liaodong peninsula rather than the Shandong peninsula, taking into account the type of form. Rather, what is important for the Liaodong style pottery is the fact that the pottery from the Liaodong region had moved even after the movement of the jars of talc admixture. It shows that the trade at that time was not limited to the Lelang commandery, Korean Three Han (Mahan, Jinhan, Byeonhan) and Wa.

#### 9.3.5. *Proto-porcelain*

Proto-porcelain is known to have been produced since the Shang Dynasty and to have developed in the Yangtze River basin (Yuba 1999). This kind of pottery is considered porcelain in Chinese archeology, but a kind of ash-glazed ceramic in Japanese archeology. This gap in recognition comes from the difference in the definition of porcelain between Japan and China. In China, porcelain is considered to be glazed and fired at a high temperature, while in Japan, some Chinese porcelain is categorized as glazed ceramic, as the quality of the clay body is emphasized.

Even in China, there was a controversy over whether to use glazed ceramics or porcelain, but Guo Moruo suggested proto-porcelain as a compromise term in 1971, and the name became widely used (Wang et al. 2014: 87). In addition, Li Zhiyan (1973) used the term “proto-celadon” as satisfying the elements of porcelain, and Sekiguchi Koji (2002) also uses this term. In recent years, Wang Chang-Hu et al. (2014) have also argued that ash-glazed ceramics in China are the same as proto-porcelain and cannot be scientifically distinguished from celadon. Although the term “proto-celadon” is now used again for long-necked jars from the Western Han period (QMCHC et al., 2019), the term of “proto” seems to be used to distinguish it from later celadon with typical coloration. Also, Lin Shimin (1986) determined that proto-porcelains unearthed from kilns from the Middle and Late Han period of Ningbo in the Jiangnan region were made by the immersion glazing method and improved clay body. He regarded them as an early form of celadon. However, the ceramics excavated from kilns in Ningbo are a type of long-necked jar that kept being made from the Western Han period, and there was no large difference in the appearance and chemical composition of those of the Western Han and the Eastern Han. Furthermore, according to the work of Yin Min et al. (2015), differences in clay and glaze can be seen from the Warring States period. For these reasons, and also considering the difference from later celadon, this paper will use the term “proto-porcelain,” which is still in common use.

Proto-porcelain spread from the middle Yangtze River in the early stage and then did from the lower (Okamura

1995). It was also produced in the Guanzhong region during the Han Dynasty and buried as ceramics with unique forms in the graves. In the lower Yangtze River basin, the Jiangnan region, many mound tombs were constructed in the Han Dynasty in which many long-necked jars with twin ears are found (Fig. 9.3: 20–23, 25). A type of wide-mouthed jar for fermentation was also widely produced in this region which could be sealed by filling it with water between the cover and the mouth (Fig. 9.3: 24).

In Toseongdong tomb No. 45, a wide-mouth jar for fermentation was found dating from the Middle and Late Han Dynasty of the Lelang commandery (Fig. 9.3: 32), and a long-necked jar with twin ears was found in Namsari tomb No. 29 (Fig. 9.3: 33). They were certainly produced in the Jiangnan region. According to Wu Xiaoping and Jiang Lu (2016), long-necked jars with mouth rims that open outwards were also found in tombs in the middle Yangtze River basin. However, in the period from the middle Western Han Dynasty to the early Eastern Han Dynasty, this pottery was closely related to the Jiangdong area, that is, the lower Yangtze River basin. In light of this point, it may be considered the case that the proto-porcelain in the Lelang commandery came from the coastal area of the Jiangnan region.

On the other hand, the proto-porcelain was not brought directly from the Jiangnan region to the Lelang commandery, but passed through several transit points. Among them, the closest area to the Lelang commandery is the Shandong peninsula. Now, let us take a look at some examples.

In Qingdao Tushantun tomb No. 4, proto-porcelains were found in graves No. 147 and No. 148 (Fig. 9.3: 26–30). Originally, grave No. 148 had its own small mound, then it was enlarged and the new main part of the tomb was constructed (grave No. 147). A wooden tablet with the inscription ‘Yuanshou 2 year (1 BC)’ was found in grave No. 147, and according to the chronological study of Okamura Hidenori (1984), a Han mirror of around 30–20 BC was found in grave No. 148. However, there is no difference in type between the proto-porcelains of the two graves.

In Rizhao Haiqu tomb No. 2, which has many graves in a mound, Shandong-Liaodong style pottery was unearthed dating to the middle Western Han period. Starting in the late Western Han period, long-necked jars of proto-porcelain with twin ears came to be placed in the graves. Long-necked jars with twin ears were also excavated from Susia Guanlicun grave No. 1 and Haiyang Jiuding Meihualing dating to the Eastern Han period (Yan 2006, Fig. 9.3: 31).

Traditionally, exchange between the Shandong region and Jiangnan region began in the Warring States period. The crystal ornaments and ivory in the Linzi Fanjia cemetery in the fifth century BC (Wang and Li 2016) shows that the trade passed through the Jiangnan

region. In addition, as regards the style of burials, Qingdao Tushantun tomb No. 4 and Rizhao Haiqu tomb No. 2 were influenced by Tutunmu, which was the characteristic type of mound grave mainly distributed in the Jiangnan region.

#### 9.4. Long-distance trade pottery and kilns

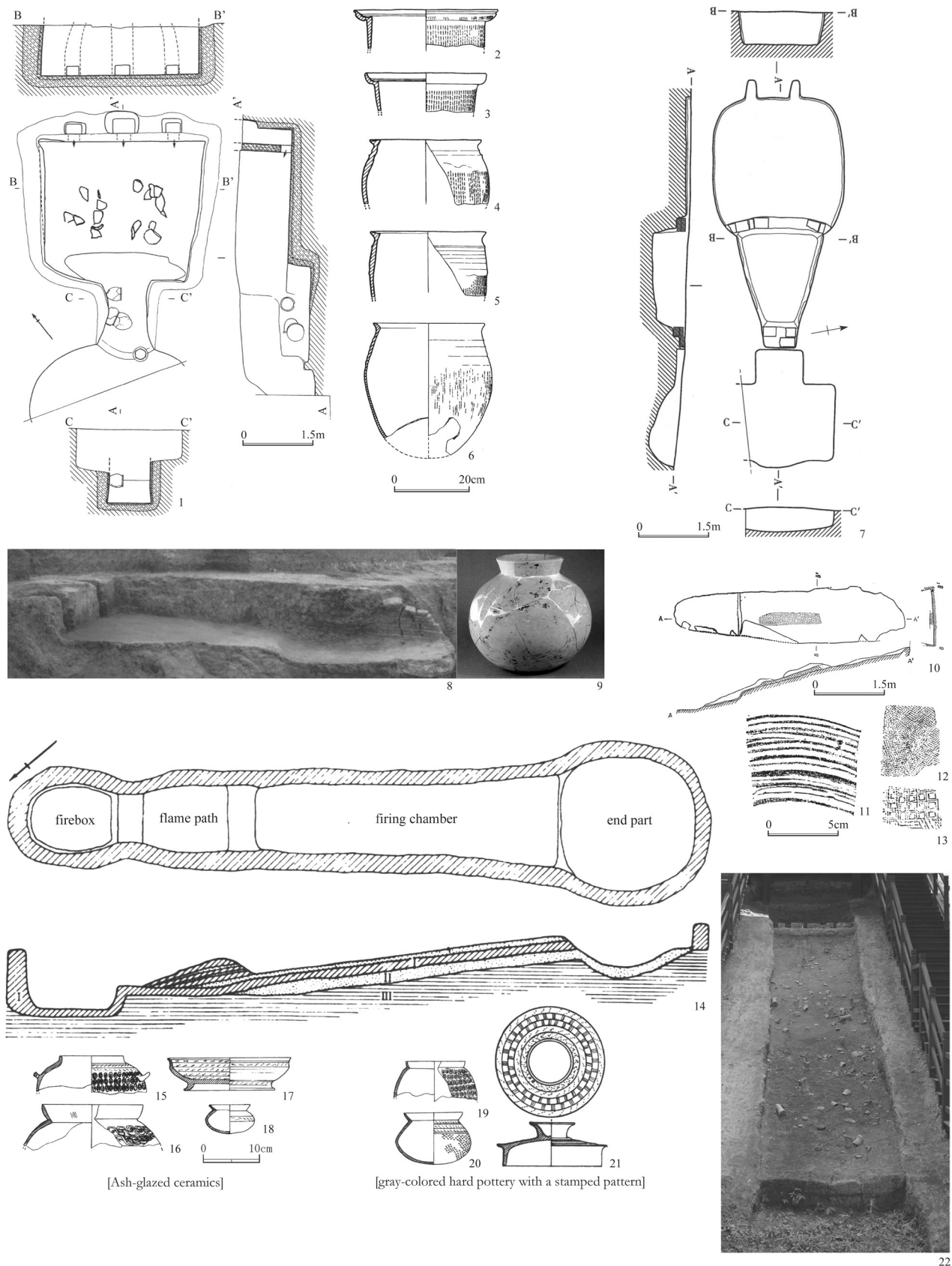
As mentioned in the introduction, all of the long-distance mobile pottery examined above was fired in kilns. The following discussion of the characteristics of each type of pottery will focus on the differences in kiln types.

First of all, as talc admixture pottery appeared from the eastern end of Yan State territory, the technology of the kilns used for firing surely originated from Yan State. Several kilns in which Yan-style pots were fired have been discovered at Fangshan Nanzheng in Beijing (Fig. 9.4: 1). A large-scale kiln site consisting of eleven kilns dating from the Qin period has been excavated at the Dajinsitun site (Fig. 9.4: 7) in the Liaoxi region, and the nearby Shibeide site had a kiln in the early Western Han period. These kilns are all of the same “flat kiln” type, despite differences in whether the firing chamber is rectangular or oval. Since the flat kiln style replaced the updraft kiln during the Warring States period and spread mainly in North China (Fukasawa 2011), these continued to be used without any fundamental change in the northern and northeastern parts of China even during the dynasty change from Yan to Qin and Qin to Han.

In regards to Lelang pottery, its vessel assemblage contains the talc admixture jars and the flowerpot-shaped pottery, which also descended from the lineage of the Yan State. It is highly possible that the Lelang pottery was fired in a similar flat kiln. Since even the firing temperature of the reduction-fired Lelang pottery is about 800–1000°C (Kanegae and Fukuda 2006), it is difficult to argue that the kilns in the Lelang commandery were acquiring new technology from other regions.

A kiln for White pottery has been reported, although only photographs are available (Hou 2006, Fig. 9.4: 8). It is a flat kiln almost the same as the Fangshan Nanzheng kiln. Therefore, the White pottery established its uniqueness not by the improvement of the kiln structure but rather by the use of kaolin-rich clay. In the Middle and Late Han Dynasty, not only large White jars but also the flattened jars and other types of White pottery were distributed (Fig. 9.3: 9). It can be seen that the production of new products began at a certain stage in the Eastern Han period. Unfortunately, White pottery continued to be produced until the beginning of the Three Kingdoms period, but when the trade of proto-porcelain began to reach as far north as the East China Sea, its production seems to have shrunk.

On the other hand, after the Warring States period, flat kilns came to dominate in North China, but in contrast to this, the dominant type in coastal areas of Central and



**Figure 9.4. Flat kiln and tunnel kiln from North to South China (CRIB 2008; LPICRA 2010; Hou 2010; Hu 1987; GPICRA et al. 1998; photo by author): 1–6. Fangshan Nangzheng kiln No. 6 (Beijin), 7. Dajinsitun kiln No. III-4, 8–9. Buxia Wangjia kiln No. 1 (Yantai, Shandong), 10–13. Shangyu kiln of Shang period (Shangyu, Jiangnan), 14–21. Meihuadun (Boluo, Lingnan), 22. Jinshan kiln of Eastern Han period (Shangyu, Jiangnan).**

South China is the tunnel kiln (Fukasawa 2011); it is called the “dragon kiln” in China. This type of kiln appeared in the late Shang period (late second millennium BC), and a long kiln has been excavated which has a 16-degree slope and boasts about 4 m of firing chamber, and was found at Shangyu in the Jiangnan region (Hu 1987; Fig. 9.4: 10). Gray-colored hard pottery with a stamped pattern was mainly unearthed from this kiln, and there was no proto-porcelain. It is still unclear what kind of kiln the early stage of proto-porcelains was fired in. However, it is known that these were found with gray-colored hard pottery in the Meifadun kiln, which dates from the late Spring and Autumn to the early Warring States period (GPICRA et al. 1998). This proto-porcelain is reported to have been fired at 1270°C and to have a clay composition similar to that of celadon. The proto-porcelains of the Han Dynasty period were fired by excellent tunnel kilns (Fig. 9.4: 22), and are furthermore both elegant and much more rigid than other pottery at that time. Solid and refined proto-porcelains have been found up to the Shandong Peninsula from the Western Han Dynasty and eventually came to be distributed to the Korean Peninsula during the Eastern Han Dynasty. The proto-porcelain had always been valued for its quality in the Yellow River basin. It can be said that this value was extended to the east.

### 9.5. Structure of the trade network and its expansion

The movement of pottery in the Yellow Sea and the East China Sea is a result of trade at that time. However, the Han Dynasty was quite different in terms of the developmental stages of polity and economic structure than the countries in the Korean peninsula and Japanese archipelago. It is well known that commerce and manufacture developed in China from the Warring States period to the Han Dynasty period, and merchants rose to prominence. According to Sahara Yasuo (1985), markets were held in cities and villages, and coins and cloth were the basic means of exchange. In the Korean Three Han and Wa, although coins have been excavated, they were not used as a means of exchange; the exchange was based on barter. The History of the Three Kingdoms describes how Jinhan countries produced iron and the Korean Three Han, Hui and Wa countries came to collect it. It also refers to iron used as currency (Chenshou, *Sangoushi*, Weishu Volume 30, Treatise on Han). Actually, at the Ulsan Dalcheonri site, where iron ore was produced in the first century BC, Lelang and Yayoi pottery has been unearthed. It is suggested that a market was held with iron as its focus (Nakamura 2015). Wa people are presumed to have exchanged cloth and local specialties for iron, but this will be discussed below.

Since Wa lacked iron-smelting technology until the latter half of the fifth century and copper-smelting technology until the seventh century, obtaining iron and bronze was crucial to producing not only tools and weaponry but also prestige goods. Before the establishment of Lelang

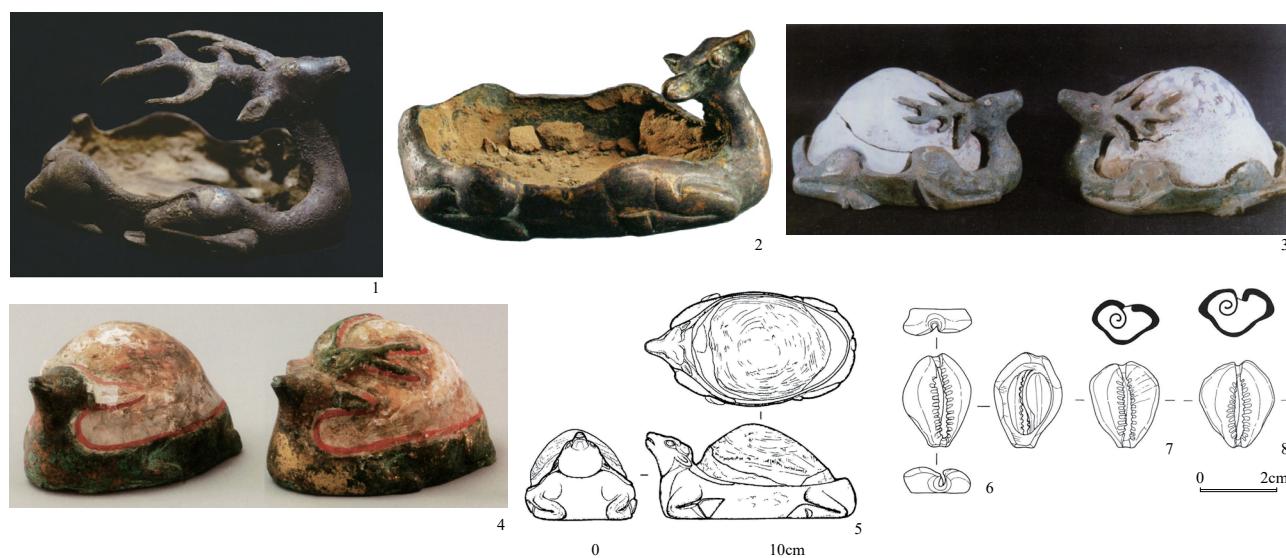
commandery, cast-iron tools and their fragments were brought from Liaodong commandery (Nakamura 2015), which seems to have been done by merchants of the Yan State and Han Dynasty. After the establishment of Lelang commandery, iron began to come in from Byeon-Jinhan in the southeastern part of the Korean peninsula to Wa, as described in the *Sanguozhi*. On the other hand, as a result of the establishment of diplomatic relations between Wa and Lelang commandery (Okamura 1999; Nakamura 2015), large and superior Han mirrors were brought and buried in the graves of the Japanese chiefs. Previously examined pottery such as the talc admixture jars, Lelang pottery and Wajil ware of the southeastern part of the Korean peninsula were not used as burial goods or ritual offerings on and beside burials. The fact that only prestige goods and weapons served as burial goods shows the value of long-distance mobile pottery as hard containers.

Takesue Junichi (2009, 2016) describes how a settlement located on the coast and relying heavily on maritime trade activities has been united with a regional capital as a social and economic unit.<sup>3</sup> Based on the unearthed artifacts of the Han Dynasty including the Lelang pottery and coins, the Northern Kyūshū countries undoubtedly connected with the Lelang commandery via such relaying bases as the coastal settlements in Japan, island counties of Iki and Tsushima, and Neukdo, which is a coastal settlement of Byeon-Jin Han. The relay trade along the coastline would be the concrete image of the trade network at that time.

Incidentally, in the period from the first century BC to the first century AD, Indo-Pacific Beads (IPBs) were distributed to such regions as the Nanhai commandery, the Lelang commandery, the Liaodong peninsula, the southern part of the Korean peninsula and the Japanese archipelago (Oga and Tamura 2013, Nakamura 2015). At the Khao Sam Kaeo site located on the Malay peninsula, archeologists found not only IPBs but also indigenous hard pottery which was produced from the Jiangnan region to the areas around the Gulf of Tongking, in addition to Brahmi script from India (Higham and Thosarat 2012: 184–85). These artifacts mean that the Jiangnan region was connected to India. The so-called Sea Silk Road had been in use since this period. It should be noted that IPBs are almost never unearthed in the Jiangnan region and Shandong peninsula, located between the Huanan region and Lelang commandery. However, as examined above, the proto-porcelains were distributed from the Jiangnan region to the Shandong peninsula, and a great deal of White pottery was distributed from the Shandong to the Liaodong peninsula and Lelang commandery. These pottery movements show

<sup>3</sup> Miyazaki Takao (2001) and Anraku Tsutomu (2013) used the term ‘Tsukushi Union’ to explain the social structure of this period. In addition, in the Fukuoka plain, Kusumi Takeo (2008) assumed that the Naka site functioned as a ‘trade center’ and the Sugu Okamoto site functioned as a ‘royal city’.





**Figure 9.5. Copper deer weights with a large shell and cowries in China and South Korea (Cheng 2017; APICRA et al 2007; Wei eds. 1998; Guo and Zhao 2010; LPICRA 2013; GARI 2006).** 1. Haihunhou Liuhe tomb (length: ca. 11 cm, Nanchang, Jiangxi), 2. Fangwanggang grav No. 1 (length: 10.2 cm, Chaohu, Anhui), 3. Babai grave No. 3 (length: both 10.4 cm, Hohhot, Inner Mongolia), 4. Huaershan grave No. 7 (length: 10.5 and 10.7 cm, Pulandian, Liaodong peninsula), 5. Jiangtun grave No. 41 (Pulandian, Liaodong peninsula), 6. Neukdo shell mound (Sacheon, Gyeongsang-namdo), 7. Neukdo grave No. Ka-95 (Sacheon, Gyeongsang-namdo), 8. Neukdo grave No. Ka-122 (Sacheon, Gyeongsang-namdo).

that the area from the Jiangnan region to the Shandong peninsula had a significant role as the site of relay bases.

There is good evidence in the Liaodong peninsula for when the trade of the East China and Yellow Seas connected to the Sea Silk Road. Copper deer weights with a large shell were found in Jiangtun grave No. 41, which is the shell filling grave in the Liaodong peninsula (Fig. 9.5: 5). The shell is *Cypraea tigris*, a species that lives in the South China Sea. Additionally, the shell filling grave is the local style of burial around the Yellow Sea, and IPBs have often been unearthed from these graves in the Liaodong peninsula (Nakamura 2020). Because of their date and materials, it is estimated that the copper deer weights with a large shell spread after the establishment of the Nanhai nine counties (111 BC, Cheng 2017) around the Gulf of Tongking, which may have led to a permanent connection with the Sea Silk Road from this time.

Meanwhile, although the shell filling graves had rich burial goods, they lack lacquerware, long swords and long knives; thus, they differ from those of the aristocracy of the Lelang commandery. Shell filling graves are estimated to have belonged to an affluent merchant class (DMICRA et al. 2019; Nakamura 2020). Furthermore, the shell filling graves and the Lelang tomb had gold belt fittings of the type that were sent to influential people in the periphery of the Han Dynasty. This demonstrates that the Liaodong peninsula and the Lelang commandery were not only closely related but also amassed a great deal of financial power. In particular, the aristocracy in Lelang commandery has long been noted for its wealth (Sekino 1968).

In ordinary trade, cloth and other specialties may have been exchanged for bronze and iron before and after

the establishment of the Lelang commandery. Japanese comma-shaped beads have been found in a Lelang tomb and Japanese bronze pikes in burials on the Korean peninsula, but not in large numbers. The distribution of Yayoi pottery is limited to the middle and southern parts of the Korean peninsula. It is controversial whether Wa people exchanged for much metalware and materials; among them, rice has often been mentioned (Choi 2006, Miyamoto 2020). However, unlike in Okinawa and the steppe areas where agriculture is not possible, it is easy to grow grain in both the Korean peninsula and areas in the Han Dynasty. More valuable goods that are difficult to find were shellfish and pearls. In China, cowries have been valuable since the Shang Dynasty, and the *Cypraea tigris* shells mentioned above were distributed as luxury goods from the South China Sea from the middle Western Han period. There is a strong possibility that the distribution of shellfish from the Nanhai commandery stimulated the demand for shellfish of Okinawa in the Lelang commandery and the Korean peninsula. In fact, cowries (Fig. 9.5: 6–8) have been unearthed at the Neukdo site, including shell mounds.

## 9.6. Concluding remarks

From the Qin and early Western Han period onwards, since large jars began to be distributed widely but these vessels were large in size and heavy when filled, trade by ship was a necessity. Firing in kilns was essential to harden the large pottery used as transport tools. White pottery was brought from the Shandong peninsula to the Liaodong peninsula and the Lelang commandery and was also offered in burials. The quantity of this pottery increased, especially from the late Western Han period to the initial Eastern Han period, and the number of IPBs in distribution

increased rapidly. The White jars and a large number of vats were found in Incheon Unbukdong, located on an island in the Midwest of the Korean peninsula. In addition, this was accompanied by a simple dwelling and pottery for cooking. This situation reminds us of the merchants from the Lelang commandery who were heading south via their coastal base.

Pottery fired in kilns, which was a novelty in the middle and late Western Han Dynasty, was brought to the Korean peninsula. Kilns were only introduced in the southeastern region, Byeon-Jinhan. However, the Wajil ware of Byeong-Jinhan was initially fired in a kiln as medium short-necked jars and small padlock-shaped jars. The emergence of large kiln-fired pottery was delayed. The kilns were introduced for reasons other than the need for rigid containers. As mentioned above, the Lelang pottery and Wajil ware was also brought to the Japanese archipelago, but it was not used as burial goods or for rituals. The main aim was transportation of their contents.

In the middle and late Eastern Han period, the number of IPBs decreased in the Lelang commandery and the Japanese archipelago and increased in the southern part of the Korean peninsula (Nakamura 2105: 44). It is evident that the distribution situation changed during this period. At the same time, proto-porcelains from the Jiangnan region were newly brought to the Lelang commandery. This indicates that the vast changes in coastal trade extended to the distribution of pottery. In addition, it is significant that the aristocrats of Lelang commandery, who had collected precious artifacts from all over the Han Dynasty, began to appreciate the value of porcelain. In Baekje on the Korean peninsula, porcelains from the Jiangnan region were imported from the early Eastern Jin Dynasty after the collapse of the Lelang commandery. Along with large ceramic jars, necked jars with a spout in the shape of a chicken head and small cups were also brought and became burial goods. These were valuable on their own as drinking vessels. The use of pottery from other states as burial goods has not been seen anywhere else except on the border of the Lelang commandery. In Baekje, it was treated as quite valuable. It can be considered that the sense of the value of the aristocracy in the Lelang commandery diffused around the time of its collapse. In this regard, the distribution of proto-porcelain of the Jiangnan region constituted the most significant innovation in the value of pottery in long-distance trade. It is also interesting to note that from this period on, the Japanese began to offer pottery in their burials from Gaya and found value in pottery from other countries.

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## Part III

### **Spread to the North and the Northeast**



## Introduction and Deployment of the Ceramic Industry in the Xiongnu Empire

*Isao Usuki*

**Abstract:** Xiongnu is the first nomadic empire in the eastern Steppe Zone. Unlike the nomads of the Mongolian plateau before them, they had innovative facilities such as earthen fortresses and kilns. The kilns emerged and were used not only to produce pottery, but also to produce the tiles and bricks that decorated the fortresses and their interior buildings. This essay introduces a few examples of the Xiongnu kilns so far known from the end of the Western Han or the beginning of the Eastern Han period, when kilns were introduced to the region. These kilns were presumed to have emerged under the influence of kilns from the northern rim of the Han Dynasty. Among them, kilns at the Khustyn Bulag site are of particular significance, as they are the first kilns whose detailed structure is known north of the Han Dynasty territory.

**Keywords:** Mongolia, Inner Mongolia, Altai Mountains, Xiongnu, nomadic empire

### 10.1. Introduction

The Xiongnu people established the first nomadic empire in the eastern steppes of Eurasia. According to *Shiji*, they appeared between the fourth and third centuries BC and often attacked states in China. At first the Xiongnu were harassed by the Yuezhi in the west and the Donghu in the east. After the rise of Modu Chanyu, however, they dominated the whole Mongolian plateau. Ultimately, they defeated the Han Dynasty, dethroned its emperor, Liu Bang, at the Battle of Baideng in 200 BC, and came to hold a hegemony in North and East Asia.

The initial Xiongnu period is not very evident in the archeological context. However, in the period from the first century BC to the first century AD, they built earthen fortresses and used roof tiles, unlike earlier nomadic people in this area. Although pottery production had been practiced before the emergence of the Xiongnu, the Xiongnu began to produce relatively uniform low-fired stoneware with kilns. Essentially, the ceramic industry did not fit the activities of a nomadic culture, because such kiln firing demands the consumption of large amounts of fuel and soil and thus requires being settled in the area of production. However, the Xiongnu pottery found from this era is regarded as evidence that various peoples in the steppe area belonged to the Xiongnu nomadic empire, because they were distributed not only in the territory of the original Xiongnu ethnic group (Mongolia, the northern China periphery and Zabaikalie) but also in Central Asia and South Siberia, which the Xiongnu Empire incorporated into its realm. In addition, it is believed that the system of Xiongnu ceramic industry was passed on to the steppe area by later peoples such as the Xianbei or the Kitai and others.

As mentioned above, despite the fact that scholars have recognized that the Xiongnu ceramic industry played an important role in the activities of the empire, scholarly research has not sufficiently clarified its production system and its technical characteristics. This paper aims to elucidate these more by examining the actual conditions of production sites.

### 10.2. Current issues in the ceramic industry of Xiongnu

The Xiongnu ceramic industry was surely recognized by researchers from the beginning of Xiongnu archeological study. As pottery found from Ivolga Fortress and burials in Transbaikalia region were classified by measurements and production method, their characteristics were revealed (Konovalov 1976; Khamzina 1982). The fact that Xiongnu pottery was fired by kiln is especially important, because it proves the existence of skilled, dedicated potters. Moreover, pottery and roof tiles found in Abakan Palace, located in southern Siberia, were presumed to have been made by Xiongnu; researchers started to take notice of the distribution range and production system of Xiongnu pottery (Kiselev 1951). In their studies of Xiongnu pottery, Konovalov (1976) and Davydova (1995) classified more details and revealed the compositions of the ware. Pan Ling (2007) advocated chronological division by burial goods, including Derestai- and Suji-type pots.

As stated above, although the study of pottery as commodities has developed, the study of Xiongnu kilns and production systems has not, due to production sites remaining undiscovered. Kiln-like remains were found in Ivolga Fortress but cannot be confirmed as such. Later, pottery kilns of the Xiongnu were found and investigated at the Ustyud site in the Altai region (Kubarev, Zhuraleva 1986).

Additionally, a kiln was found and excavated in the Khustyn Bulag site in north central Mongolia (The National Museum of Korea et al. 2001). As our research project team continues to excavate other points of the Khustyn Bulag site, we have been able to develop a study of the Xiongnu ceramic industry on the basis of concrete examples.

### 10.3. Kiln sites in the territory of the Xiongnu Empire

Although ceramic products such as pottery, bricks and roof tiles have been found in various places in North Asia, only a few examples of kiln ruins directly related to Xiongnu ceramic production have been discovered. They are discussed below (Fig. 10.1).

#### 10.3.1. Yustyd site (Kubarev, Zhuraleva 1986; Fig. 10.2, 3)

This site is located in the Koshi-Agachi district of the Altai Republic, Russian Federation. As the Altai Mountain area was located outside the homeland of the Xiongnu group, it is believed that it was a territory of another nomadic people, such as the Ge kun or Hu jie. It appears that pottery production was introduced while the Xiongnu Empire was bringing the surrounding area under its control. However, the nomadic archeological culture that inherited the tradition of the Altai Mountain area continued there at that time, and the Xiongnu culture did not replace it. Similar phenomena are also found in neighboring southern Siberia, in places such as Khakassia and Tuba. This would indicate the political influence of the Xiongnu Empire on the surrounding area.

The Yustyd kiln site is located on a slope descending from the east to the west on a terrace of the right bank of the Yustyd River. Two survey sectors were excavated there in 1978. In the first survey sector, the pit of the kiln remains was discovered. It is in the shape of an irregular circle with a diameter of about 3 m and a depth of about 90 cm in the center. Flat stones are placed along its wall, and a clay layer is stuck onto its inner wall. The bottom is slightly rounded. On the west side, there is a dugout passage. This is assumed to be the remains of a stoke hole. A large number of earthenware and charcoal fragments and a clay wall with handprints were excavated from the filling soil of the pit. Thus, it is estimated that products were discarded due to a failure of firing after the final firing of the kiln. In addition, another hole, which was thought to be part of the remains of another, earlier kiln, was found where the thick coal layer was deposited at the eastern end of the survey area, but no detailed excavation was made of it.

In the second survey sector, the remains of four kilns lined up along the east and west sides of the slope were found. All were supposed to be elliptical. The first kiln, located at the east end, is an elliptical pit with a major axis of about 3 m, with flat stones placed around it. Clay is stuck onto the bottom and the wall. Its depth is about 1 m. The second kiln was confirmed in the layer below the first kiln, and it is believed that the upper part of it was broken by the first kiln. Based on the deposition condition of the soil layers, its use period is believed to have been short. The third kiln was located to the west of the second kiln, and is estimated to be an elliptical pit of about 3.5 by 2 m. Flat stones were installed along the edge of the kiln, inside

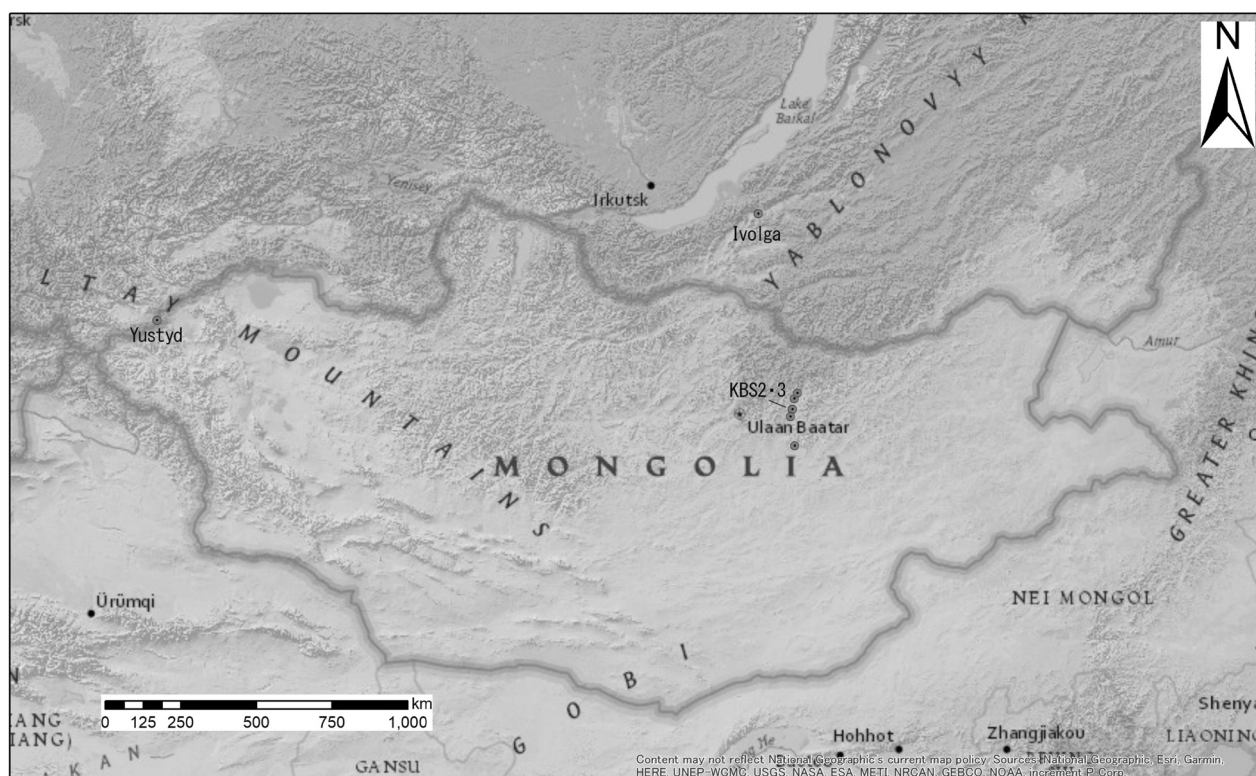


Figure 10.1. Location map of Xiongnu kilns and castle sites in the Kherlen River basin.

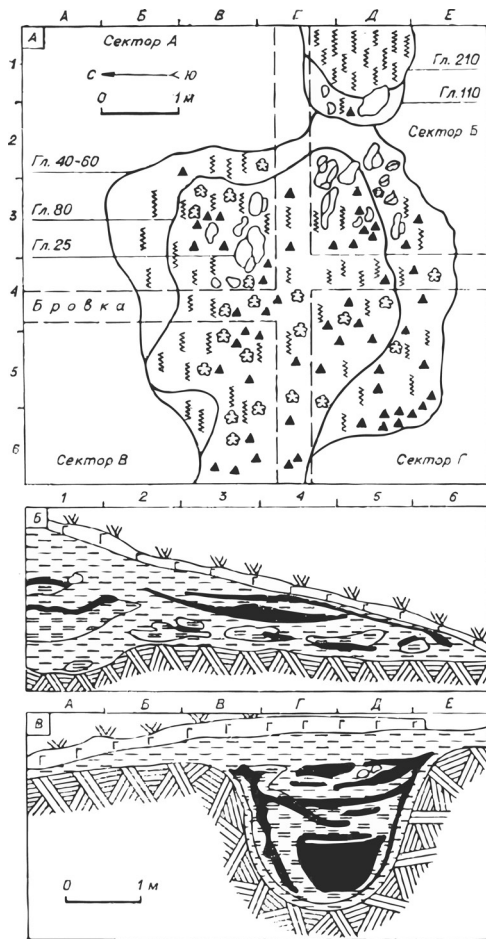


Figure 10.2. The kiln at the first survey sector of Yustyd site (Kubarev and Zhraleva 1986).

of which researchers discovered carbonized timbers and stuck clay. Because the third kiln destroyed the filling soil of the first kiln site, it is thought that this kiln was built later than the first kiln. The fourth kiln is located on the west side of the third kiln and has an oval shape of about 3 by 2 m in diameter. The same methods and materials were used to construct it as in the other kilns, such as the flat stone pavement and the stuck clay.

However, it is difficult to identify each of the above four kilns in the ground plan and stratum cross section. The basis for supporting the opinion of the excavator is not clear; therefore, the shapes of these remains are unclear. It can be judged that adjacent to the first kiln and the second kiln, between which there is a difference in height, are the firing chamber and the firebox of one kiln. The third kiln is also considered to have a two-chamber structure.

### 10.3.2. Ivolga castle site (Davydova 1995; Fig. 10.4)

The Ivolga castle site, which is a rectangular castle ruin that extends 348 m east and west, and 216 m north and south, was constructed on a river terrace located 16 km southwest of Ulan-Ude City, Buryat Republic, Russian Federation. On the edge of the river terrace, a rectangular earthen

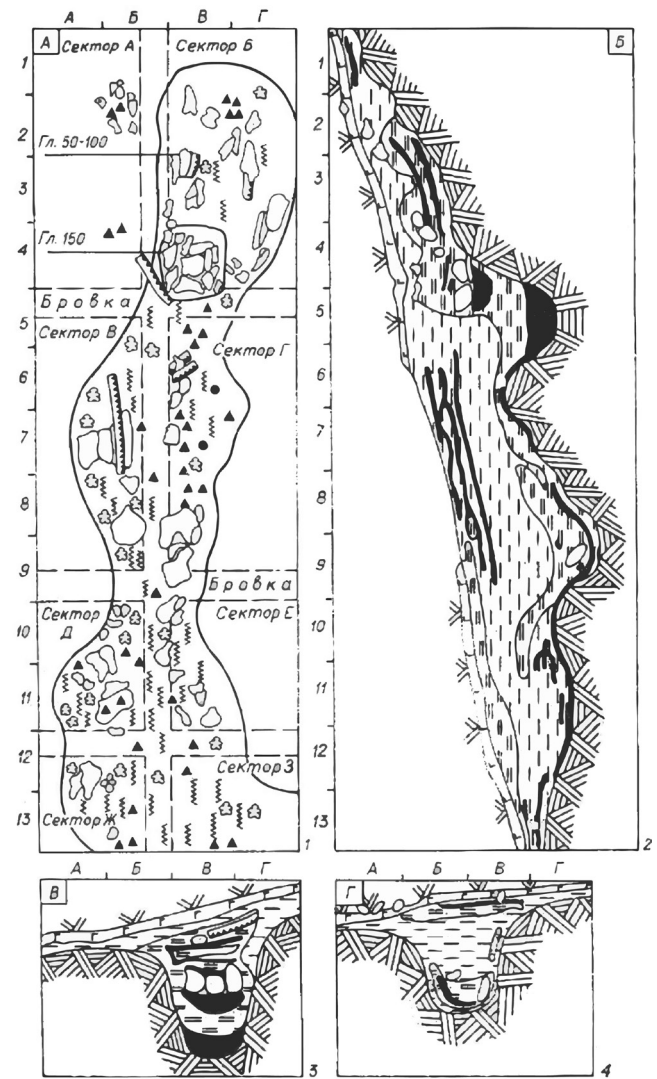


Figure 10.3. Kilns at the second survey sector of Yustyd site (Kubarev and Zhraleva 1986).

fort was built with ditches and walls, inside which many structures such as pit dwellings were built. Excavation in the southern part of the castle led to discovering many remains, such as a ground building, pit dwellings, a well and pits. Based on the excavated goods, it is presumed that the date of these remains is from the second century BC to the first century AD.

The excavator, Davydova (1995), pointed out that among these remains, pit No. 217 might have been a pottery kiln. This pit was dug near dwelling No. 49 and destroyed its entrance. Hence, the date of pit No. 217 is later than dwelling No. 49. It has an oval plan of 2.33 by 2.05 m and a depth of 1.15 m. The surface of its wall is pasted with clay lumps that were burned at a high temperature. Many fragments of burned timbers, charcoals and pottery were excavated from this site. Additionally, the skull of a woman buried in the wall was also found. The neighboring pit is separated by a thin wall extending from it, and it may have been fired from there. However, Dr. Davydova has not concluded that these remains were a kiln.



### 10.3.3. Khustyn Bulag 3 (KBS 3; Fig. 10.5)

The Khustyn Bulag site group is located in the upper basin of the Kherlen River in Tuv Aimag in Mongolia. It

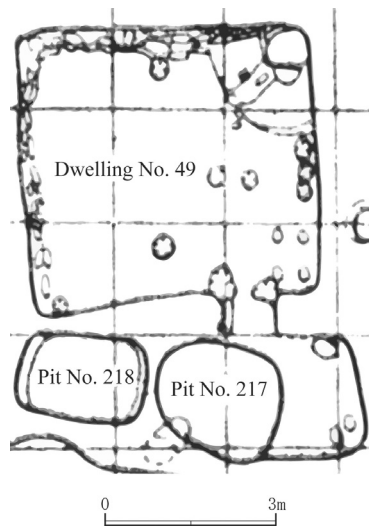


Figure 10.4. The kiln in Ivolga castle site, Pit No. 217 (Davydova 1995).

is located on a wide flat terrace on the northeastern shore of the Zuun Baidlag River, a tributary of the Kherlen River, and consists of many sites from the Paleolithic Age to the nineteenth century. In the Xiongnu era, large-scale iron-making and ceramics workshops operated in this area. The steel workshops are distributed over a range of about 1 km east–west at the western end of the terrace. Their operations continued from the third century BC to the first century AD. The ceramic workshops, in which roof tiles, bricks and pottery were produced, are located in the southeastern part of the terrace. There, kiln remains are distributed along the terrace cliff in the range about 1 km wide. We found the ceramics workshops at two locations (KBS 2 and KBS 3). <sup>14</sup>C dating confirmed that they operated from the first century BC to the first century AD.

At KBS 3, mainly roof tiles and bricks were excavated. Here an elliptical pit (about 6.7 m north–south and 6 m east–west), which is regarded as kiln remains, was found. Its excavation revealed that the lower portion of the pit has a pentagon-like plan as a whole. Its northwest part is a rectangular platform. The southeastern part is a triangular space, and an elongated small pit is located at

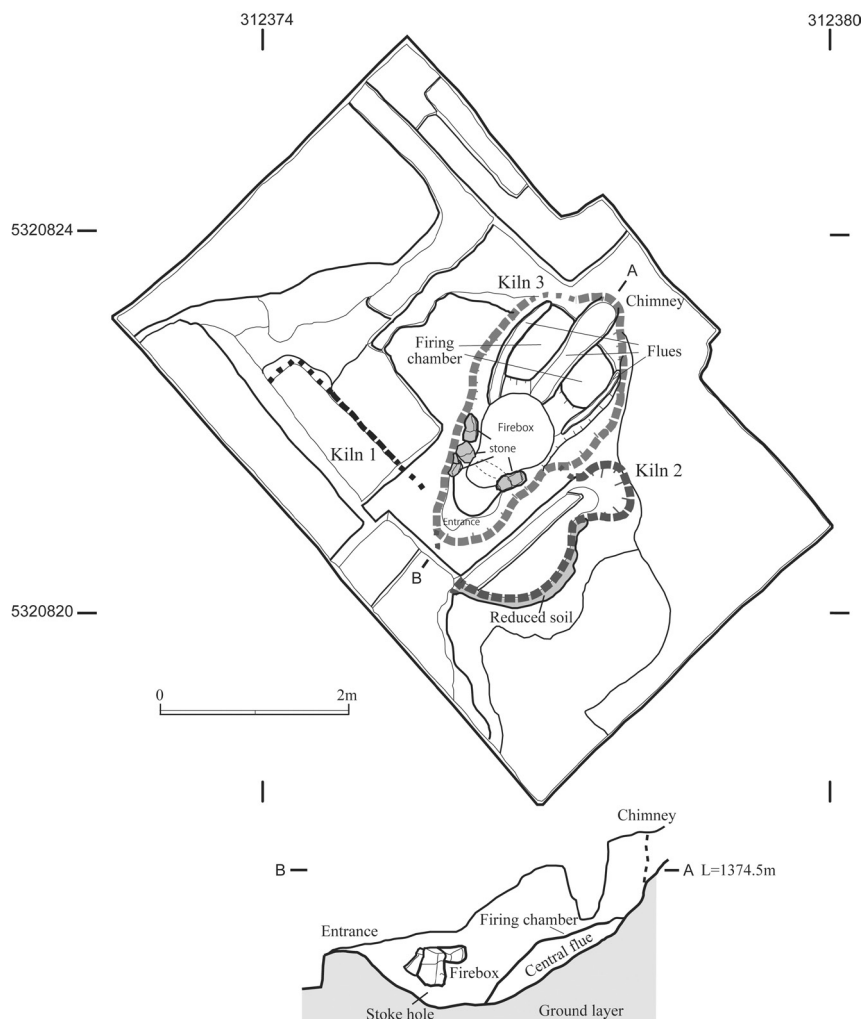


Figure 10.5. Estimated restoration of the kiln in KBS 3.

its tip. It is believed that these were the stoke hole, the firebox and the firing chamber of the kiln. On the north side of the pit, a vertical shaft and a horizontal shaft extending from the bottom of the vertical shaft to the elliptical pit were found. Those walls were burned hard. These are believed to constitute the chimney of the kiln. Another chimney was also detected in the east. Although there is uncertainty due to later destruction, another chimney would likely have been constructed in the west. An observation of the layer section of the firebox and the firing chamber revealed that the upper part of the kiln expanded into an elliptical shape after accumulations in the kiln built up after it was used several times. A large number of tiles, bricks, walls and carbide fragments had accumulated in the filling soil of the kiln. It is thought that these were intentionally left behind when the kiln was abandoned.

Based on the above, it is thought that this elliptical pit was originally a kiln that had a two-chamber structure and multiple chimneys, but that later it was reconstructed into an elliptical pit and unnecessary items and garbage were discarded there.

#### 10.3.4. Mon-Sol project sector of KBS (National Museum of Korea et al. 2001; Fig. 10.6a)

A joint expedition led by the Institute of Archaeology, the Mongolian Academy of Sciences and the National Museum of Korea discovered kiln remains at the ridge of Khustyn Bulag, to the east of the KBS 3 site, and partly excavated it in 1999. In this excavation, the stoke hole and the work space of the kiln were discovered. The remains of masonry were found at the stoke hole. This is believed to have been the closure equipment of the kiln. Although the whole kiln has not been excavated, it appears to be a two-room-structure kiln like KBS 3.

#### 10.4. Some characteristics of Xiongnu kilns

All of the above examples are semi-underground pit kilns. With the exception of the kiln of the Ivolga castle site, of which the details are unknown, it is thought that after the pits were dug, their walls and ceilings were constructed on the ground. Because the excavated fragments of pottery and wall pieces were fired with a reducing flame,

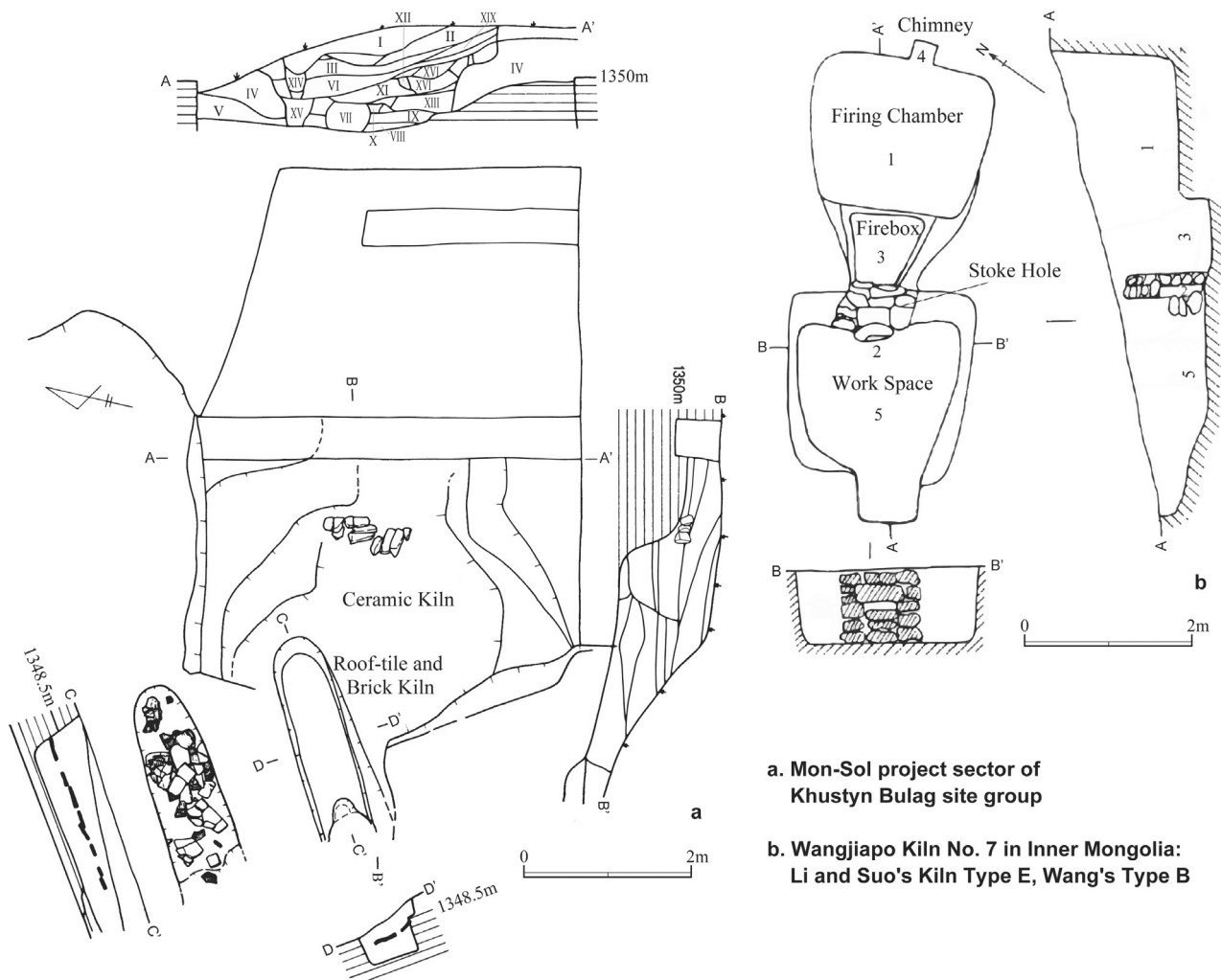


Figure 10.6. Kilns in Mongolia and Inner Mongolia (NMK et al. 2001, Wang 2011).

it can be assumed that the kiln was used in a sealed state. Furthermore, as mentioned above, some of the kiln remains of the second survey sector of the Yustyd site, as well as the kiln of KBS 3, are considered to be those of a two-chamber-type kiln.

In addition, the kiln of the second survey sector of the Yustyd site and KBS 3 have similarities, such as their location on the river terrace slope and walls constructed by pasting clay lumps, and they were intensely destroyed after firing. Based on the above points, it seems that they shared a common construction method and structure. However, as the kiln of KBS 3 has three chimneys, it seems that more advanced technology was introduced for it than for the kilns in the second survey sector of the Yustyd site.

In contrast, the kiln of the first survey sector of the Yustyd site is considered a whole kiln with a one-chamber structure. The inside of it was obviously burned. Furthermore, as it has points in common with the kiln of the second survey sector, such as flat stones at the wall side and clay lumps that show fingerprints, it is thought that it was a kiln. By the same token, the rectangular pit at the Ivolga castle site may be a similar kiln.

From the above findings, it is clear that there are two types of kilns in the Xiongnu ceramic industry. In the first type, firing is performed in one chamber. The second type consists of two rooms, a firing chamber and a firebox chamber, which are separated by a step. In the former, it is presumed that smoke was emitted from the ceiling, not the chimney. Also, the type 2 kiln has some variations in the number of chimneys or the shape of the firing chamber.

### 10.5. Chinese kilns from the Warring States period to the Han period

In the Mongolian steppes, pottery and roof tiles burned by a reduction fire were not made before the Xiongnu period, and such ceramic production obviously started under the influence of other areas. Moreover, the similarity in roof tiles and pottery between Han and Xiongnu shows the impact that the Chinese ceramic industry exerted. Indeed, the pottery and roof-tile-making technology, the paddling technique and the use of the potter's wheel began under Chinese influence. It is also necessary to consider the form of the Xiongnu kiln in comparison with the examples in China.

Regarding the construction of the ceramic kiln in the Han dynasty, Li Yufang pointed out that in the initial stage of the Former Han period, almost all kilns had an oval firing chamber, a single chimney and flue ditches along the wall, and that after the middle stage of the Former Han period, a rectangular firing chamber became common and a wall for separating flues or dividing flues appeared, and kilns with multiple chimneys increased (Li 1994).

Wang Chun Bin classified 69 kilns from the Warring States period to the Han dynasty into the following five types

based on the planar shape of the firing chamber: A (gourd), B (circle), C (oval), D (horseshoe), E (square), F (triangle) (Wang 2011). The type A kiln had a two-story structure, in which the ceiling of a firebox became the floor of a firing chamber. In the others, the firing chamber and the firebox were separated by a step. Almost all examples of type B had no chimney. Types C, D and E had single or multiple chimneys. As there is only one example of type F, it is a unique type. It is distinctive that the floor of its firing chamber surface was inclined. The date of each type is as follows:

**Type A:** Warring States period

**Types B and C:** Middle Warring States period–Early Han period

**Type D:** Late Warring States period

**Type E:** Final Qin period–Han period

**Type F:** Qin period

Type D is considered a transitional form of types C and E because the side wall of its firing chamber is curved. Therefore, the above dating is generally reasonable.

Li Wanqi and Suo Xiufen examined the kilns of the Qin and Han periods in the middle south region of Inner Mongolia, and explained their characteristics (Li and Suo 2015). They were divided into two types, A and B. In type A, firing was performed inside the single pit, and smoke was emitted from the ceiling. In type B, the firing chamber and the firebox were separated by a step, and chimneys are often installed. Type B approximately corresponds to Wang's types C, D and E. Li and Suo pointed out that, regarding chimneys, after the middle stage of the Former Han period, installations of multiple chimneys increased, and in particular the installation of three chimneys emerged after the late stage of the Former Han period.

### 10.6. Introducing the processes of ceramic-making technology into Xiongnu society

A comparison of the examples in China with Xiongnu kilns suggests that the features at the Yustyd first survey sector and the Ivolga castle site are the type A kilns defined by Li and Suo.

Other Xiongnu features are considered representative of the type B kilns by Li and Suo. Kilns at the Yustyd second survey sector are regarded as Wang's type B, because each firing chamber has an elliptical shape and no chimney. The kiln in KBS 3 is close to Wang's type E, because its firing chamber is nearly rectangular, and the overall shape is close to a pentagon (see Fig. 10.6b). Also, because the kiln of KBS 3 is thought to have had three chimneys attached, its characteristics place it after the middle Former Han period. Although the whole shape of the kiln at the Mon-Sol project is unknown, it may have features similar to those of KBS 3.

Xiongnu kilns have many characteristics in common with Chinese kilns from the latter half of the Warring States

period to the Former Han period. Generally, Chinese kilns are a little older than the estimated age of Xiongnu kilns.

It is certain that Xiongnu ceramic technology was influenced by China. But the date of kilns is estimated to be from the first century BC (middle Former Han period) to the first century AD (early Latter Han period), so clearly somewhat older ceramic technology than the contemporary Chinese technology was used except for KBS 3.

In addition, the masonry in front of the stoke hole of the kiln in the Mon-Sol project site is similar to examples of kilns of the Han dynasty in the Inner Mongolia area (see Fig. 10.6b), and it is thought that ceramic technology was introduced from the peripheral area of northern China. However, technology with China was introduced almost simultaneously for the kiln of KBS 3, and it seems that more advanced technology was introduced than in other areas of the Xiongnu Empire because it was constructed in the special area where castles were concentrated. It is also important to note that not only the form and the pattern but also techniques, such as the potter's wheel, paddling and polishing, were introduced from the Han.

Pan Ling (Pan 2011) pointed out that the shape and ornament pattern of Xiongnu pottery was closely related to the northern peripheral area of China, such as Inner Mongolia and Shanxi. In addition, Sagawa observed that the form of the kiln and the roof-tile ornaments are strongly related to those of Inner Mongolia (Sagawa 2018; Sagawa & Usuki 2020).

It is thought that the Xiongnu ceramic industry was initiated with the introduction of engineers and technology from the Han district, and that before long the manufacturing of roof tiles and bricks had already started. New pottery forms such as the pot, bowl and steamer were introduced. Because these are found at many Xiongnu sites, it can be inferred that they spread rapidly after the start of their manufacture. It is also important that large vessels for storing things emerged. These are not daily items in conventional steppe life; therefore, it can be concluded that they were not produced merely for daily necessity. Rather, it is thought that the Xiongnu Empire intentionally introduced ceramic products related to new institutions and lifestyles, and that their production and use subsequently spread within the Xiongnu territory.

The existence of roof tiles and bricks indicates that the Han architectural style was introduced. Tiles are used for large buildings inside the castle as functional and decorative elements. These structures are considered to have been political and ceremonial places, such as aristocratic residences or government offices. New forms of pottery show the influence of China in daily life. In particular, the emergence of large earthenware vessels suggests that food storage had expanded within Xiongnu society. These items imply changes in the political regime and food management of the Xiongnu Empire. Changes in politics and economy produced new demands, and the

ceramic industry was supposed to satisfy them and to strengthen the empire system. However, because people and technologies were introduced directly from adjacent boundary areas without interaction between states, it is generally thought that the most advanced technology in the central area at that time was not introduced into the Xiongnu Empire.

## 10.7. Conclusion

The introduction of pottery production by reduced firing in a kiln is believed to have started in the Xiongnu Empire in the third century BC. After that, many castles, Han-style architecture and large tombs were built in the empire around the first century AD. The production of tiles and bricks also began around this time. Products of the ceramic industry, such as pottery and roof tiles, were widespread in territories of the Xiongnu Empire, such as South Siberia. The existence of pottery production in the Altai region indicates that these products were locally produced in each area, and that the ceramic industry spread all over the steppe area. Kiln-fired pottery in the steppe area from after the Xiongnu era has some features in common with Xiongnu pottery in terms of technique and ornamentation; therefore, it is obvious that the Xiongnu tradition exerted a strong influence on the ceramic industry in the steppe area. In the future, it will also be necessary to clarify the transition process of the ceramic industry in the steppe area and the actual influence of the Xiongnu tradition in that area.

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## Ceramics-Firing Kilns of the Southern Russian Far East: Technological and Temporal Dynamics

*Irina Zhushchikhovskaya*

**Abstract:** The temporal dynamics of ancient kiln-type ceramics firing structures in the southern Russian Far East bordering China and the Korea peninsula are introduced. The development of ceramics-firing kilns was an important component of technological and cultural history in the region. The oldest evidence of simple kiln-like devices discovered are from the Paleometal period, dating to between 1000 BC and 1000 AD. An example of a vertical updraft firing kiln dates to the Pre-State period around 500 AD, and elaborated kilns have been discovered at sites from the Bohai State period (698–926) and the Jin Empire period (1115–1234). Bohai kilns are of a tunnel-like sloped type, and Jurchen kilns are of a one-chambered “*mantou*” type. The quality of ceramic products indicates that technical capabilities varied, and the examination of specimens fired in certain kilns with scanning electron microscopy and other methods are discussed.

**Keywords:** Kiln remains, updraft kiln, cross-draft kiln, temperature and atmosphere regimes, pottery, roof tiles, SEM, archeometric analysis

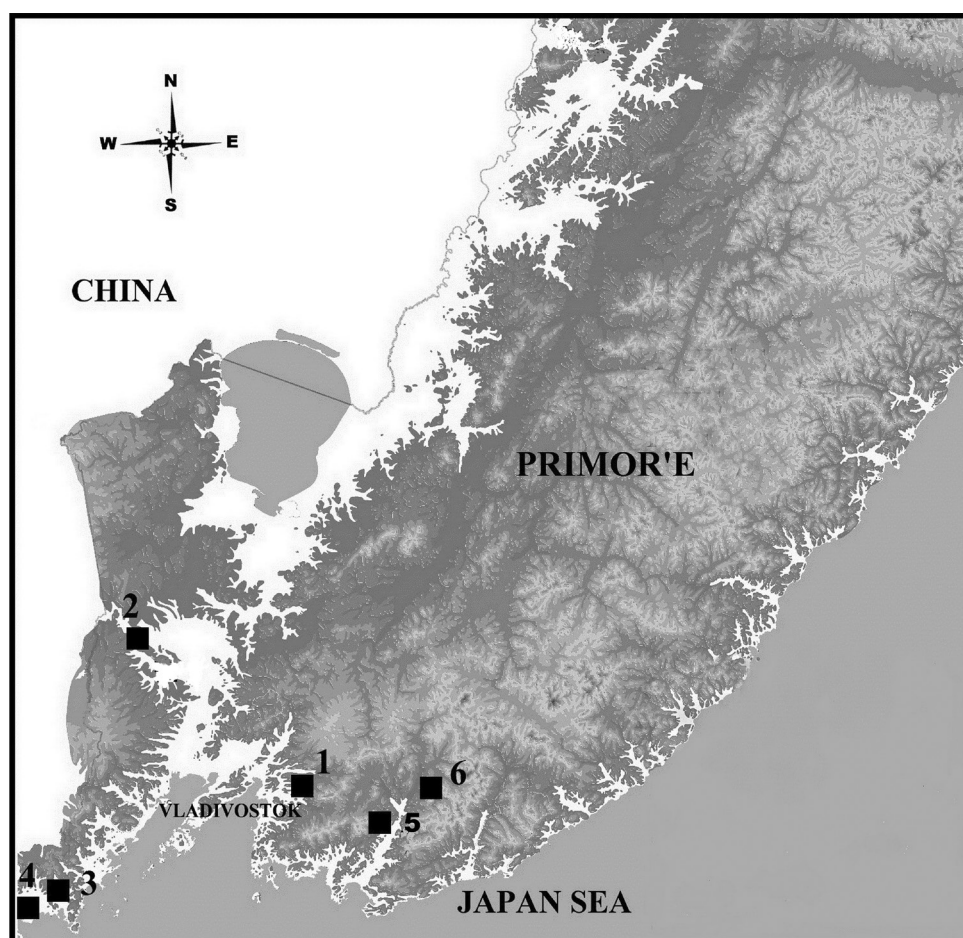
### 11.1. Introduction

This chapter introduces the development of kiln firing technology in the pottery-making of prehistoric and ancient populations of the southern Russian Far East. The research area is the Primor’e Region, lying to the south of the Lower Amur River and bordering northeast China to the west and the Korean peninsula to the south (Fig. 11.1). According to archeological data the earliest evidence of ceramics-making technology in this territory are dated to around 10,000–7000 BC, which is close to the time of the appearance of pottery in northern China, 10,000–7000 BC, and the southern part of Korean peninsula, ca. 8000 BC (Cho & Ko 2009; Jordan & Zvelebil 2009; Zhushchikhovskaya 2009). During the Neolithic, around 6000–1200 BC, ceramic wares became common, judging by the numerous pottery assemblages coming from archeological sites excavated at various localities in the Primor’e Region. The technology of pottery production at that time was relatively simple and undeveloped. In particular, there is no evidence of pottery firing in kiln-like devices. According to the results of archeological ceramics examination and experimental studies, bonfire (open firing) technology with average firing temperatures of 600–50°C seems to have been practiced widely during the Neolithic (Zhushchikhovskaya 2005: 76–77).

Obvious progressive changes in the physical properties and functional qualities of ceramics took place during the Paleometal period, corresponding primarily to the first millennium BC. These changes concern technological skills as well as morphological and decorative standards.

Among the most important changes were increased firing temperatures as a result of improved thermal processing techniques and technologies. The earliest archeological evidence of kiln-like structures in the southern Russian Far East is given in the fragmented remains of sites belonging to the Paleometal period. The remains of more complex, developed and better-preserved ceramics-firing kiln constructions were excavated at sites of the Pre-State period, fourth to seventh centuries AD, and especially at the sites belonging to the Ancient States period, eighth to thirteenth centuries AD. The research area at that time was initially part of the Bohai Kingdom, 698–926, and later part of Jurchen states – the Jin Empire and Dong Xia states – dating generally to 1115–1233 (Zhushchikhovskaya & Nikitin 2014, 2017).

For the Russian Far East as a whole, the Primor’e Region is the only one where the temporal sequence of excavated remains of early firing structures is known. These archeological relics give us important information about the temporal and cultural dynamics of the kiln firing technology applied to ceramics production in prehistoric and historic times. Various kinds of archeological evidence concerning kiln firing technology can be distinguished. The main evidence is, obviously, the excavated remains of firing devices, which are quite important for judgments about the type of kiln construction and its technical capabilities. The fired ceramics discovered inside the excavated structure or in close proximity are of great value for detecting a kiln’s working conditions such as temperature and atmospheric regimes, and the estimation of the quality of the finished product. The bulk of ceramic artifacts discovered at



**Figure 11.1. Research area and locations of referenced sites. 1: Malaya Podushechka; 2: Chernyatino-2; 3: Troitsa; 4: Kraskino walled settlement; 5: Sergeevka; 6: Lazovskoe walled settlement.**

archeological sites is used as an additional source of information on firing technology. In current research the set of methods, including testing by refiring, color analysis, water absorption testing, surface hardness testing, thin-section analysis and SEM-EDS analysis, is applied to determine the ceramics' features and properties brought about by the conditions of firing. These methods are commonly used in archeological ceramics studies (Shepard 1985 [1956]; Bjork 1995; Daszkiewicz & Schneider 2001, Daszkiewicz 2014; Day et al. 2006; Quinn 2009; Maniatis 2009; Gasparic et al. 2014).

Archeological data from the Primor'e Region on kilns for firing ceramics are considered a part not only of technical and technological history but also of cultural history. By tracing the origin and spatial spread of the types of kiln construction it is possible to identify cultural interactions and influences. The history of the research area has been closely connected with the history of other territories of East Asia and, in particular, China, which from the earliest times was the "native land" of many technological innovations. This concerns in great measure ceramics technology, especially firing devices such as long ("dragon")-type kilns and *mantou* ("steamed bun")-type kiln construction (Kerr & Wood 2004; Hein 2008; Gerritsen 2012).

This chapter considers archeological materials on ceramics kilns and the dynamics of firing technology in the southern Russian Far East in chronological and historical order, distinguishing the Paleometal period, Pre-State period and Ancient States period.

## 11.2. Paleometal period: the oldest firing devices

The Paleometal period is represented by a series of archeological sites within the temporal framework of the border of the second to first millennium BC and the early first millennium AD. That was a time when the first metals – bronze and iron – appeared in the southern Russian Far East almost simultaneously, with very short temporal separation. Metal artifacts are few at sites of the Paleometal period, and no sure traces of local bronze and iron metallurgy have been detected to date. Currently, in archeological studies of the research area the term "Paleometal" has been adopted to be more flexible and correct than the classic definitions "Bronze Age" and "Iron Age" (Zhushchikhovskaya 2018; Popov et al., 2020). The origin of the imported early Russian Far East bronzes – ornaments and knives – is strongly debated (Kon'kova 1989, 1996). The first iron items – axes, knives, arrowheads – are also viewed as imported. The territories of northeast China and the Korean peninsula may be considered as probable

regions from which the first bronzes and irons could have come to the Primor'e Region in the first millennium BC. The sites containing the most important evidence of the first bronzes are concentrated in the western and northwestern Primor'e Region and are dated around the tenth to seventh centuries BC. Prehistoric sites containing iron artifacts are grouped in two archeological cultures – the Yankovskaya culture, ninth/eighth to third/second centuries BC, and the Krounovskaya culture, fourth century BC to third/fourth centuries AD. The Yankovskaya culture area occupied mainly the seacoast of southern and partially southeastern Primor'e; sites of the Krounovskaya culture are situated mainly in the continental areas of the southern part of the Primor'e Region. Although evidence of local iron artifact production is not yet known, traces of “cold” and “hot” metalworking have been detected at some sites of the Yankovskaya and Krounovskaya cultures (Popov et al. 2020).

The Paleometal period definitely marks a new level in the historical development of the southern Russian Far East. Archeological records of the Paleometal period indicate obvious changes in cultural traditions, economy and mode of life in comparison with the Neolithic. In particular, numerous pottery assemblages discovered in Paleometal sites differ significantly in their technological, morphological and decorative features from Neolithic pottery. In turn, the sites of the Yankovskaya and Krounovskaya cultures provide evidence of the most developed technological standards of pottery production. It must be emphasized that the earliest remains of kiln-like structures for ceramics were discovered in sites of these cultures (Zhushchikhovskaya 2005: 76–79; Popov et al. 2020).

### 11.2.1. Yankovskaya culture

The remains of firing structures were discovered at a single site of this culture – the long-term settlement of Malaya Podushechka (translated as “Small Pillow”), located on a small pillow-like hill in a river valley about 20 km from the seacoast in the southern Primor'e Region (Fig. 11.1). This is a two-component archeological site. The lower component is represented by a settlement of the Yankovskaya archeological culture that was almost completely excavated in the mid-1960s. According to the settlement, about 1000 m<sup>2</sup> contained the remains of seven pit-dwellings and 15 ground burials scattered around. An assemblage of iron artifacts, including several axes, knives and arrowheads, was found during excavations of the Yankovskaya cultural layers. The site is dated to 480±50 BC (Andreeva et al. 1986: 39–50, 190).

Three localities of fragmentary remains of kiln-like firing structures were discovered within the settlement area. The remains looked like amorphous oval-like heaps of burned pieces of clay with inclusions of traces of coarse straw. The thickness of the heaps of the burned clay pieces was up to 0.3–0.4 m. The heaps were situated on smooth ground and were arranged in a row at a distance

of 3.0–4.0 m from one another. The horizontal plan of two heaps was about 3.0 m by 2.0 m, with one about 5.0 m by 4.0 m. At this largest location small pits were discovered around the burned clay heap – probably traces of a wooden canopy-like structure. At one locality the smooth ground under the heap of burned clay pieces was covered by a thin layer of burnt clay. Inside the heaps, assemblages of well-preserved fired ceramic vessels of mostly medium sizes were found. The number of vessels varied from 5 to 10 at different heaps. The bright color of the vessels' surfaces indicates an oxidizing firing regime.

In general, the firing devices discovered at the Malaya Podushechka settlement can supposedly be reconstructed as simple structures built of daub, i.e. clay mixed with chopped straw. No clear evidence of fuel and firing chambers, or separate areas, was detected. Kilns of this type usually have two holes – one for loading fuel and another for the draft. It seems likely that the presumed firing structures were similar to devices still employed in traditional pottery-making in some regions of the world (Bareš et al. 1982: 191–208). The remains of simple kiln-like updraft firing structures built of clay or daub have been excavated in several places in the world. These are cases of kilns unearthed at Neolithic and Bronze Age settlements in Czech territory (Thér 2004; Thér & Gregor 2011), at Eneolithic settlements of Central Asia, about the middle of the fourth to the middle of the third millennium BC (Khlopin 1964: 120–23), and at the Eneolithic Krašnja site in Slovenia, dated to 4750±35 BP (Gasparic et al. 2014).

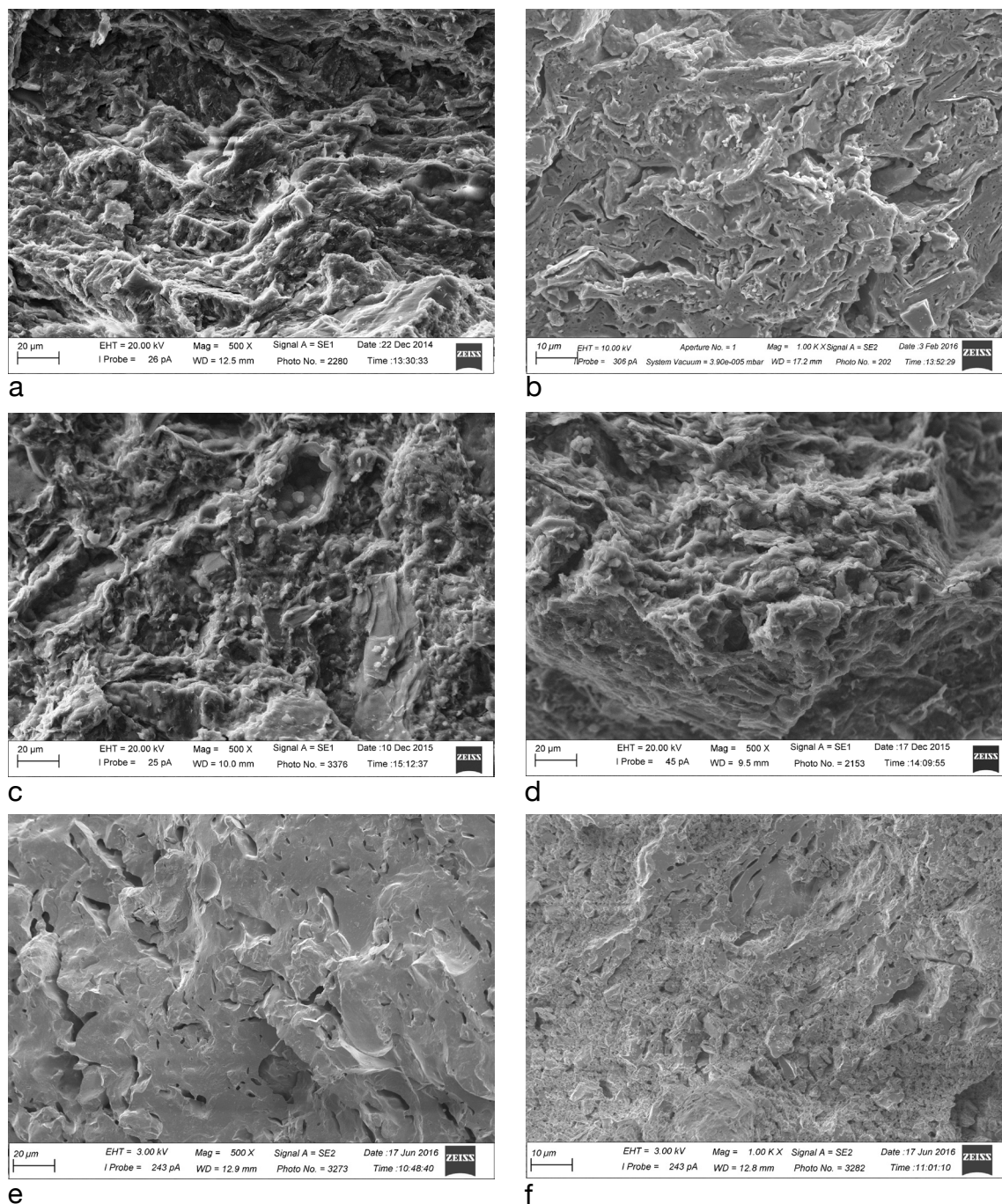
One cannot judge the temperature regime of the kilns discovered at the Malaya Podushechka site accurately, because the ceramics found inside have been studied by their morphology and external technological features but not with scientific analyses. However, the examination of pottery samples from various sites of the Yankovskaya culture provides some knowledge about the adopted firing technology. Previously, based on the results of re-firing testing and thin-section analysis of selected samples from several sites, it was supposed that the average temperatures of firing pottery in the Yankovskaya culture were 700–750°C (Zhushchikhovskaya 2005: 76–78). Such temperatures could be achieved in simple kilns or even in bonfires. Recent investigations are precisising this conclusion.

The average water absorption (WA) index for oxidizing-fired ceramics from several Yankovskaya culture sites (settlements) varies from 12.4 percent to 18.6 percent. The measurement procedure is well established and described e.g. by Shepard (1985 [1956]: 127) and Rice (1987: 351–53), and explanation of the data gained from the measurements is based on the scientific evaluation of the ceramics WA indexes. WA values of 5.0 to 7.0 percent and less are evaluated as very low ones, corresponding to a true dense ceramic body of high quality. The 5.0 to 15.0 percent values are estimated as moderate ones, corresponding to a ceramic body of satisfactory



quality. Values of 15.0 percent and more are high ones, corresponding to a porous, fragile and weak ceramic body (Avgustinik 1975: 221–22; Shepard 1985 [1956]: 127–30). So, it may be concluded that different average WA indexes of the pottery from various Yankovskaya culture sites indicate different quality levels of the finished products.

SEM-EDS examination of pottery samples from different sites shows various kinds of ceramic body microstructure, depending on the degree of clay sintering (vitrification) and correlating in general with the measuring of data on the WA index (Zhushchikhovskaya 2017). In the ceramics assemblages with moderate average WA indexes (12.4–13.5 percent) there are certain samples



**Figure 11.2. Electronic micrographs of ceramics body samples with different grades of vitrification. a:** Paleometal period, Yankovskaya culture, Solnechnyi Bereg: initial vitrification (Zhushchikhovskaya 2017). **b:** Paleometal period, Krounovskaya culture, kiln area in Chernyatino-2: extensive vitrification (Zhushchikhovskaya & Nikitin 2019). **c:** Paleometal period, Krounovskaya culture, kiln area in Chernyatino-2: initial vitrification (see b). **d:** Pre-State period, Troitsa kilns site: initial vitrification (unpublished). **e:** Ancient States period, Kraskino walled settlement: extensive vitrification (Zhushchikhovskaya 2017). **f:** Ancient States period, Kraskino walled settlement: initial vitrification (see e). **g:** Baekje period, Korea. Neungsanri saji. Microstructure with the evidence of almost total vitrification (see e). **h:** Ancient States period, Sergeevka kilns site: extensive vitrification (see e). **i:** Ancient States period, Sergeevka kilns site, microstructure with evidence of almost total vitrification. **j:** Ancient States period, Sergeevka kilns site, microstructure with evidence of extensive vitrification. **k:** Ancient States period, Sergeevka kilns site, microstructure with evidence of initial vitrification.

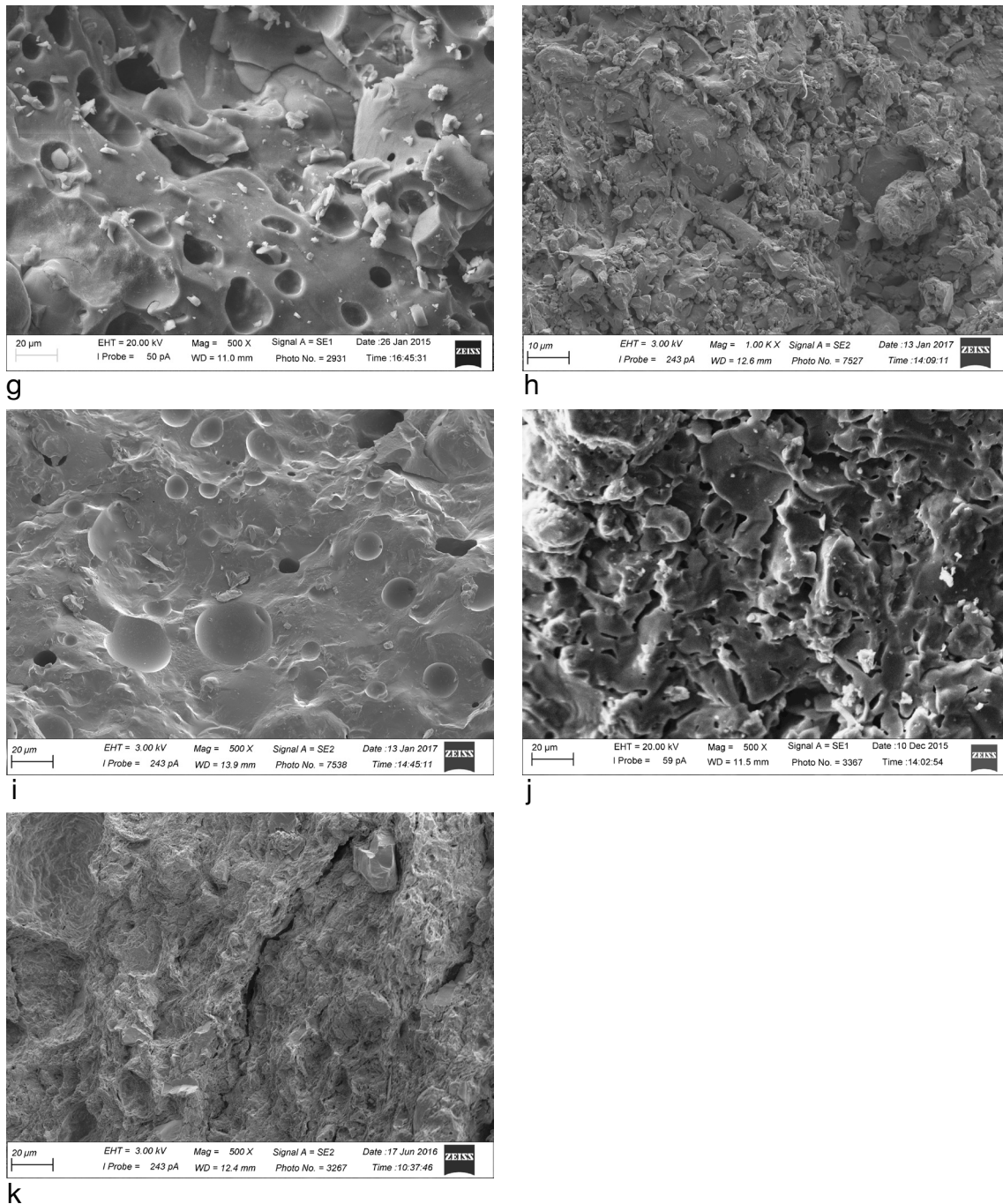


Figure 11.2. (Continued).

with relatively low WA values (8.4–10.5 percent) and traces of initial vitrification of the clay matrix (Fig. 11.2a). These observations indicate a probable firing temperature of 800°C and above for non-calcareous clays (Tite & Maniatis 1975; Maniatis 2009). For comparison, samples with WA values  $\geq 12.0$  percent show no evidence of clay matrix vitrification. According to research data a temperature up to 800°C may be achieved in the simplest prehistoric updraft kilns. This temperature is supposed for the Eneolithic kilns excavated at the Krašnja site in Slovenia (Gasparic et al. 2014).

Supposedly, the different qualities of ceramic bodies may be explained by some differences in firing technology.

Temperatures of 800°C and above correspond to kiln firing rather than a bonfire. The discovery of simple kiln-like remains at the Malaya Podushechka settlement and the data of ceramics examination indicate the usage of kiln firing technology. However, it seems likely that this technology was practiced sporadically, not being the uniform standard of pottery-making.

### 11.2.2. Krounovskaya culture

The only evidence of a pottery-firing kiln structure was discovered at the multi-layered site (settlement) of Chernyatino-2, located on the bank of the Orlovka River in the western Primor'e Region (Fig. 11.1)

(following a description of the findings according to Zhushchikhovskaya & Nikitin 2019). The remains belong to a layer of the Krounovskaya culture substantially destroyed by the activity of later settlers, though preserved in some parts of the site. Preliminary dating of this cultural layer is about third to fourth centuries AD. It was definitely noted that a firing kiln was located inside the Krounovskaya culture settlement area, in the vicinity of the pit-houses. It is possible to determine the main structural features of the firing kiln.

The kiln's floor, lying 0.20 m deep below the surface, was oval-shaped in contour, 2.30 m in length and of 1.90 m maximal width. The floor had traces of burning and was inclined at 10–15 degrees from the southeast to northwest, with a step-like separation between the lower fuel section (firebox) of about 0.50 m<sup>2</sup> and the upper firing section (fire chamber) of about 2.48 m<sup>2</sup>. Above the floor and on top of a thick accumulation of burned clay-straw mixture were heaped the remains of the destroyed above-ground part of the kiln. On some burned pieces impressions of a wooden framework were detected. It may be concluded that the firing structure was close to a type of tunnel-like sloping kiln with a dome-like upper part built of a clay-straw mixture on the wooden frame.

Few pottery fragments were uncovered inside the kiln, but many fragments were found in close proximity. Some fragments have visible traces of firing damage such as deformation, cracking and swelling. A few samples had a very fragile, crumbling structure indicating a low firing temperature that was not high enough to allow sintering of the clay. Examination of the pottery samples from the cultural layer where the kiln's remains were unearthed achieved the following results. The ceramics water absorption index rates were from 7.4 to 13.1 percent, with an average value of 10.7 percent. SEM has shown that some samples, in particular the ones uncovered inside and near the kiln remains, have a microstructure with evidence of initial and extensive vitrification (Fig. 11.2b, c). Taking into account that, according to SEM-EDS analysis, the ceramics were made of non-calcareous clays, the SEM data hint at firing temperatures in the interval 800–900°C (Tite & Maniatis 1975; Maniatis 2009). Judging by the pottery surfaces and fracture colors, the ceramics-firing was conducted in most cases under an oxidizing atmospheric regime. However, at the Chernyatino-2 site and other sites of the Krounovskaya culture, series of dark gray or black pottery are present. The refiring of these ceramics samples at a temperature of 500–550°C causes the color to change from black to yellowish, reddish or brown. This definitely indicates a “blackening” firing in a smudging, carbon-saturated atmosphere (Shepard 1985 [1956]: 88–90, 220). The accumulation of “hard” carbon micro-particles causes not only the appearance of a black or dark gray color but also decreasing porosity and water absorption. Within the above-noted range of WA indexes of Chernyatino-2 ceramics the lowest rates are detected for black pottery samples.

The main structural features of the excavated kiln are the elongated contour, slightly inclined floor and step-like separation between the fuel and firing sections. This was a simple structure not of large capacity though the achieved temperatures were enough for producing ceramics of a satisfactory quality. The closest spatial and territorial analogies for these kiln structures are connected with archeological sites of the Korean peninsula of the third to early fourth centuries AD. The earliest evidence of tunnel-like sloping kilns have been recognized at the sites of Sansuri, Daegokri and some others. These tunnel-like sloping kilns were larger and more developed than the kiln at the Chernyatino-2 site. The supposed firing temperature achieved in the Korean kilns is around 1000°C (Barnes 2001: 107–14; Kim 2003). Researchers suggest that the earliest Korean tunnel-like kilns are descendants in their construction type of long, or dragon kilns (Barnes 2001), first invented in China in the first millennium BC (Hein 2008).

In general, the Paleometal period was a time of progressive change in pottery-firing technology in comparison with the Neolithic. Certainly, kiln firing began to be adopted in the research area during the Paleometal period, resulting in firing temperatures increasing and ceramics quality improving. Archeological records indicate a certain synchronization between the appearance of the first metals and metalworking knowledge in the southern Russian Far East in the first millennium BC on the one hand, and an improvement in firing technology in pottery-making craft on the other. The thermal processing of raw material is the technological essence and main condition for the production of both ceramics and metals. The problem of connecting the thermal processes and technical equipment of pottery-making with those of metallurgy and metalworking is a complex study. The data from other world regions allow the supposition that the invention and development of metallurgy and metalworking were the “catalyst” for innovations and achievements in ceramics-firing technology (Kushnareva 1970; Shangraw 1977; Saiko & Terekhova 1981). In the southern Russian Far East there is no definite evidence of the development of local metallurgy or metalworking in first millennium BC (Popov et al. 2020). In spite of this, it could not be excluded that even restricted knowledge about thermal metal processing influenced – directly or indirectly – the technical and technological potential of pottery-making.

### 11.3. Ceramics kilns of the Pre-State period

This stage of the past history of the southern Russian Far East, dated from the fourth to the seventh century AD, is marked by complex cultural and demographic processes, in particular the coming of new population groups. These processes are described by Dyakova (2014) as follows: The Mokhe (this name is known based on old Chinese historical chronicles) tribes spread widely over northeast China, the Primor'e Region and the Amur River valley down to the coast of the Sea of Japan. Settlements and cemeteries attributed to the Mokhe cultural community are

numerous in the research area, especially in the central, western and southern parts of the Primor'e Region. Artifact assemblages from the sites indicate developed iron and bronze metalworking, elaborated military skills, jewelry craft and other productions and crafts. Horse- and cattle-breeding and agriculture were the main branches of the economy. The Mokhe tribes were an important ethnic component in the formation of the first state in Northeast Asia – the Bohai Kingdom (698–926). The cultural connections and contacts of the Mokhe tribes were very active and widespread, including in northern China and Central Asia.

Ceramic wares were common items in every Mokhe settlement of the Primor'e Region. Several local variants of pottery-making traditions differing in morphological and decorative standards can be distinguished, as well as technological standards (Piskareva 2005). Pottery assemblages from southwestern Primor'e sites show evidence of more accurate shaping, probably with the use of turn-table equipment, and higher-temperature firing in comparison with pottery from some other areas. A single kiln site was discovered on the margin of the southwestern seacoast, in Troitsa Bay (Fig. 11.1). The site, named Troitsa, was mostly destroyed. However, in the preserved part the remains of two kiln-like structures were detected and excavated in the early 1980s (Andreeva & Zhushchikhovskaya 1986; Zhushchikhovskaya & Nikitin 2014). According to the data from fieldwork, both structures can be reconstructed as two-leveled and of roundish horizontal plan. The furnace chamber (firebox) was embedded into the earth to a depth of about 0.80 m and had a fuel-loading hole at the side. The bottom diameter of the furnace chamber (firebox) of kiln N2 was about 1.50 m, and that of kiln N1 was 1.25 m. The bottoms and walls were formed of granitic slabs that had been burned intensely judging from the melting of quartz grains. The upper level of the kiln structure was the firing chamber, with a dome constructed of a clay-straw mixture, probably on a wooden frame. Multiple burnt pieces of the destroyed domes were scattered around the kiln remains. Some traces of a grate-like floor between the firebox and the firing chamber were detected at kiln N2. The floor was made of clay and small pebbles. Obviously, the direction of the hot air draft inside the kiln was vertical, from lower to upper level.

No samples of ceramic production were discovered inside the kilns but about 20,000 pottery fragments were found nearby. In some cases the evidence of firing damage was clearly visible on the fragments – surface cracks and deformation. Most of the pottery samples are of a light orange color on the surface and in the fracture, without a dark core. This indicates uniform oxidation of the clay body. In some cases the surfaces and fractures of ceramic samples are of a black color caused by smudging. Preliminary thin-section analysis executed after the excavations has shown that the pottery was produced from a clay paste containing calcite inclusions. In general, raw calcareous clays are not characteristic for the research area, and this

case of calcite-tempered archeological ceramic paste is the only one known for the southern Russian Far East. Recent SEM-EDS analyses of several pottery samples conducted by the author confirm a high content of Ca in the ceramic body composition. In the elemental chemical spectra the Ca content varies from 3.0 to 40.0 percent.

The results of the Troitsa kiln site ceramics examination are interesting as regards suggestions about the firing temperature regime. Thin-section analysis revealed evidence of some degree of destruction, or decomposition, of the calcite matter occurring upon the heating. However, the decomposition process was not completed. Under SEM examination, evidence of initial vitrification of the clay matter was recognized in some cases (Fig. 11.2d) (Andreeva & Zhushchikhovskaya 1986; Zhushchikhovskaya & Nikitin 2014). Recent WA indexes measured for ceramic samples fired under an oxidizing regime varied mostly from 12.8 to 15.5 percent, indicating a relatively porous body. WA indexes for black, or smudged, samples were from 10.0 to 11.2 percent. However, the surface hardness index of the pottery samples is around 6.0–6.5, indicating a relatively high strength for the ceramic material.

Researchers note (Tite & Maniatis 1975; Leicht 1977; Shepard 1987: 22, 30; Bong et al. 2008; Palanivel & Meyvel 2010; Liu et al. 2013) that precise statements about firing temperature are far from always possible in the case of calcite or carbonate tempered pottery. The thermal behavior of calcareous ceramic paste differs significantly from that of a non-calcareous paste. The decomposition of calcite matter develops between 650°C and 898°C. After passing 898°C the fast and immediate decomposition of calcite occurs. If the firing is short and rapid no visible evidence of calcite matter changes may be noted before 750–800°C. The clay matrix vitrification process in calcareous pastes begins at about 30–60°C below the temperature of non-calcareous pastes. During thermal processing a calcite-containing clay body acquires a porous structure unaltered at high temperatures. The increase in firing temperature up to 850–900°C and above provokes the risk of ceramic body damage resulting from the “popping” of calcite particles. But if the firing schedule is conducted correctly, especially at temperatures above 750–800°C, the finished product is undamaged and of good quality, and in particular of relatively high surface hardness. In general, a crucial condition of successful firing of calcareous ceramic pastes is special attention to regulation of the temperature regime, which demands a high level of skill on the potter's part.

Considering these assumptions about the firing process of calcareous clays, the above analyses of the material from the Troitsa kiln suggest firing temperatures not higher than 800–850°C. Inside the fuel chamber the temperature was raised to more than 1000°C, judging from the melting of quartz grains in granite slabs of the chamber's facing walls. Based on the degree of oxidation of the ceramic

bodies, one can suggest a sufficient duration of firing time, providing an even thermal processing of the entire thickness of the ceramic pots' walls. The finished ceramic product had a relatively porous but strong body. Obviously, the technological cycle of calcite-containing-ceramics firing in Troitsa kilns was executed efficiently.

No analogues of Troitsa two-leveled kilns are known in the research area or the neighboring territory of the Korean peninsula. In China updraft firing kilns were used during the Shang period, later being replaced by long-type kilns in southern China and *mantou* type kilns in northern China (Gerritsen 2012; Kerr & Wood 2004: 314–34; Hein 2008). The geographically closest region for the use of vertical updraft round kilns with a furnace chamber dug into the earth, and with a grate separating fuel and firing chambers, is Central Asia, where these kilns were the basic firing structures for ceramic production from the Bronze Age to the Medieval period. The vertical kilns of Central Asia (Saiko 1982) shared a common line of development in firing structures with the kilns of the Near East, where this type was invented by 6000 BC (Simpson 1997a, 1997b; Saiko 1982). Theoretically, the idea of vertical updraft kiln construction might have been imported by the Mokhe people from those regions where this type of firing device was used. Most likely the region of origin was Central Asia. An indirect argument for this scenario may be the traditional high mobility of the Mokhe tribes and the close connections of some of them with populations in the Steppe Corridor. Obviously this idea needs further research. In particular, northeastern China is considered a prospective area for the search for probable evidence of kiln remains used in Mokhe pottery production.

#### 11.4. Ancient States period: advanced kiln technology

##### 11.4.1. Bohai Kingdom stage

This stage of the Ancient States period in the history of Primor'e corresponds to the temporal framework of AD 698–926, when a large part of the research area was included as an administrative periphery in the territorial boundaries of the Bohai Kingdom. The capitals of the Bohai state were located in Manchuria, in modern northeastern China. However, archeological records of the Primor'e Region show evidence of a relatively dense population and active economic and social life in this remote district. The kinds of local archeological sites attributed to the Bohai Kingdom period are the remains of walled settlements, village settlements and temples (Boldin et al. 2012; Dyakova 2014; Ivliev 2010). Two large groups of ceramic products are present – pottery for various functions and needs, mostly produced with the pottery-wheel, and architectural ceramics including roof tiles, roof ornaments and bricks. At present, two sites of the Bohai period containing the remains of kilns are known in the Primor'e territory.

A famous site containing ceramics kiln structures is the Kraskino walled settlement located in southwestern

Primor'e, not far from the seacoast (Fig. 11.1) (Gel'man 2005, 2016). This was an important administrative, transportation and trading center that supposedly played a significant role in communication between the Bohai Kingdom and the Early States of Japan. The first evidence of Bohai period firing kilns was discovered at the Kraskino walled settlement in 1980. From 1980 to 2005 the remains of large ceramics kiln assemblages were excavated at this site (Boldin & Nikitin 1999). One kiln assemblage was situated on the margin of the northwestern part of the Kraskino site, quite close to the ancient town's wall. The assemblage of kilns was located around the remains of a small building interpreted as the pavilion of a Buddhist temple. The excavations discovered a square platform 3.8 m by 3.8 m formed of pebbles and soil, the remains of a collapsed tile roof, and some items connected with the Buddhist cult. An ancient well was also excavated in this area (Fig. 11.3).

The remains of several structures situated at some distance from one another were distinguished (N1, 2, 3, 11, 12), as well as a group, or cluster, of structures (N4–10) located quite close one to another, in some cases covering each other. This situation indicates that kilns were built and exploited not simultaneously but during some temporal interval. In some cases later kilns were built on the site of destroyed early ones. The nine excavated structures have been definitely identified as sloping tunnel-like firing kilns embedded in the ground (Fig. 11.4). Three objects (N3, 9, 10) in a poor state of preservation cannot be interpreted clearly.

The kiln floors were embedded in the earth 0.3–0.8 m and inclined artificially at an angle of 10–15 degrees. The walls of the tunnels are made from earth and were reinforced with stones. In the case of kiln N1, the lower parts of the tunnel walls were faced with broken tiles. Three functional parts of the kiln structure may be recognized: the fuel (furnace, firebox) section at the tunnel's lower end, the flue section at the tunnel's upper end, and the firing section (fire chamber) occupying the most space in the tunnel, between the fuel and flue sections. The flue section of most of the kilns contained a burnt soil layer and ash deposits. In some cases the spots of burnt soil could be traced to the floor of the firing section. In the cases of kilns N4, 6, 8, there was a partition between the fuel and firing sections constructed of pebbles and broken tiles. In most cases a round pit 0.3–0.5 m deep was located in front of the fuel section. At several kilns the remains of a tube-like chimney built of pebbles were discovered at the upper end of the tunnel. In the case of kiln N4, traces of two chimneys were unearthed. The length of the kilns, without the pit near the furnace, varied from 3.3 m to 5.1 m, and the maximal width varied between 1.6 m and 3.0 m.

The kilns' superstructures were totally destroyed. The large number of amorphous pieces of fired clay with the traces of burnt plant inclusions found around the kiln remains are interpreted as fragments of vault-like superstructures. The only excavated evidence of ceramics production

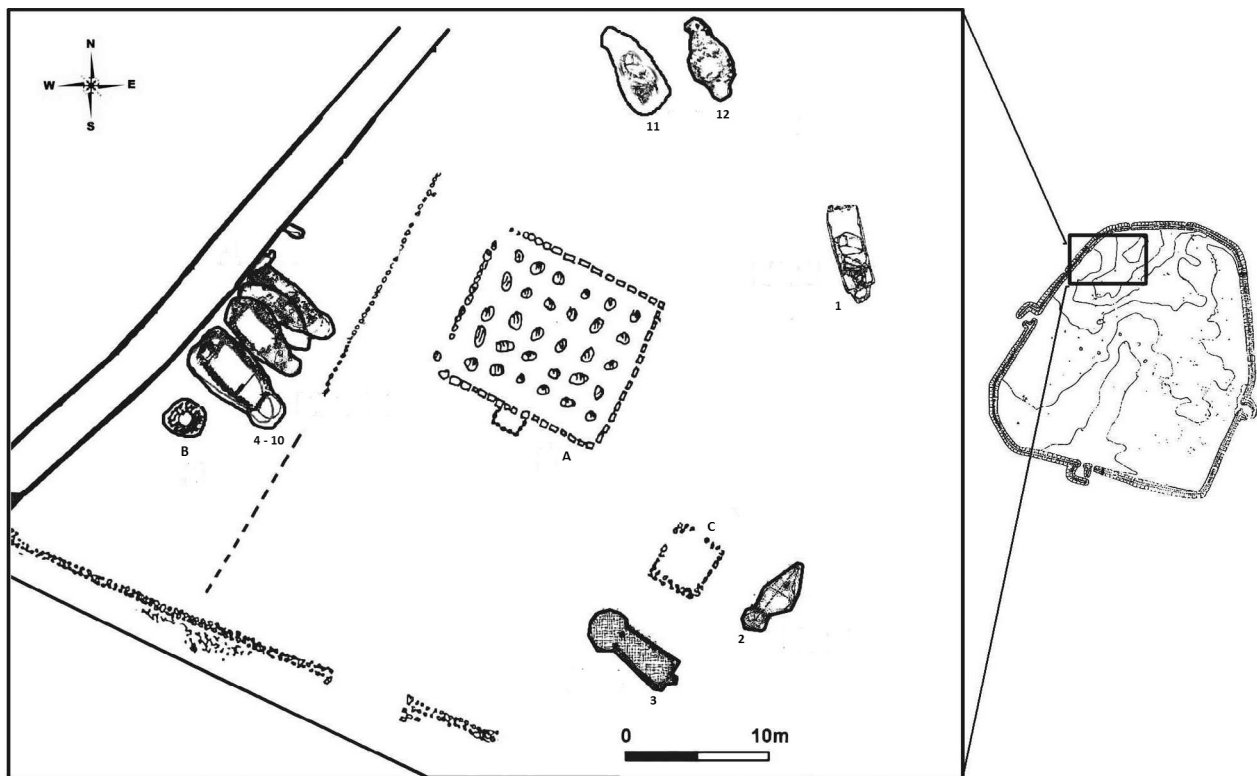


Figure 11.3. Kraskino walled settlement. Location of the kiln complex. 1–12: Kilns and kiln-like structures. A: Temple platform remains. B: Well. C: Remains of a small platform (from Zhushchikhovskaya & Nikitin 2014).



Figure 11.4. Kraskino walled settlement. Remains of kiln N4 in situ (from Zhushchikhovskaya & Nikitin 2015).

connected with the kiln remains are roof tiles. Samples of tiles – but not in large number – were found inside and outside kilns N1, 4, 5, 6, 8. A series of samples of ceramics spoilage were discovered. These are tiles with traces of deformation, cracking, swelling and surface melting. Tiles from the remains of the kilns are very similar in their morphological features to tiles unearthed in the area of the temple pavillion. The kilns were presumed to be destined first for serving the need for roof tiles for the construction and further restoration of temple buildings.

Some preliminary information about firing conditions in the Kraskino kilns, in particular the temperature regime, may be obtained from examination of the tile samples (Table 11.1). The correlation of data on WA testing, surface hardness measurement and SEM-EDS analysis will indicate temperature regimes applied in firing tiles. The highest temperatures are supposed for only a few samples – tile fragments of an even gray surface color and fracture, and with a relatively dense and hard body. The WA index of these samples is 6.2–6.5 percent. This is characteristic of a relatively low-porosity ceramic body produced by high-quality firing (Avgustinik 1975: 221–22). The surface hardness index of these samples is high – around 7.0. SEM-EDS analysis of a sample with a WA index of 6.2 percent indicated evidence of an extensively vitrified ceramic microstructure with a non-calcareous, low refractory clay matrix (Fig. 11.2e). Vitrification of this extent may be achieved in this kind of clay at temperatures of 900–50°C, or even somewhat above, under an oxidizing atmospheric regime. Under a reducing regime, vitrification processes occur at



**Table 11.1. Summary of properties of kiln-fired ceramics in Primor'e region, southern Russian Far East described in the text. Stars (\*) indicate sites with excavated kiln remains**

Period-Date	Culture-Site-Date	Physical Properties of the Ceramic Bodies				
		Degree of ceramic body vitrification (under SEM analysis)	Water absorption index (Open porosity index) %			Surface hardness (Mohs scale)
			High	Moderate	Low	
PALEOMETAL period, IX–VIII c. BC–IV	YANKOVSKAYA culture Malaya Podushechka site*	–	no data	no data	no data	no data
	YANKOVSKAYA culture Novyi Mir, Solnechnyi Bereg, Cherepakha-7 sites	No vitrification Initially vitrified	16.0 – 18.9	9.2 – 15.6		3.0–4.0
	KROUNOVSKAYA culture Chernyatino-2 site* (ca. 3rd–4th century AD)	Initially vitrified and extensively vitrified		7.4–13.1		no data
PRE-STATE period, IV–VII c. AD	MOKHE culture Troitsa kiln site*	No vitrified and Initially vitrified		10.0–15.5		6.0–6.5
BOHAI STATE period 698–926	Kraskino walled settlement*	No vitrified and initially vitrified Extensively vitrified		9.2–12.0	6.2–6.5	5.0–6.0 6.5–7.0
JIN/DONG XIA STATES period 1115–1234	Sergeevka kiln site*	No vitrified Initially vitrified Extensively vitrified Almost totally vitrified	14.5–19.1	10.0–14.2	4.2–5.8 0.7–3.0	4.0–5.0 no data 7.0–8.0

temperatures of no less than 50°C lower (Day et al. 2006; Maniatis 2009). So, in the case considered the supposed firing temperature is between 850 and 900°C or slightly above.

More common are gray and sometimes yellowish tiles with a “softer,” more porous body. The WA index of this series of samples ranges from 9.0 to 16.2 percent, that is, corresponding mostly to the moderate level. In most cases the surface hardness index is 5.0–6.0. SEM-EDS analysis of several samples with a WA index of 9.9 to 11.7 percent indicates that vitrification of a non-calcareous, low refractory clay matrix is in its initial stage (Fig. 11.2f), or not quite attested. The analyses show an initial vitrification in low refractory clays corresponding mainly to firing temperatures of 800–50°C under an oxidizing atmosphere, and a somewhat lower temperature under a reducing atmosphere. The absence of evidence of the vitrification process in the clay microstructure indicates firing temperatures under 800°C (Bjork 1995: 52–57; Day et al. 2006: 152–56; Maniatis 2009).

Thus, it may be supposed that the ceramics kilns of the Kraskino walled settlement worked mainly within the interval 800–900°C or a little above. This consideration is roughly confirmed by the examination of gray wheel-made pottery from the Kraskino site and some other Bohai sites of the research area (Zhushchikhovskaya 2017). Most common in pottery assemblages are samples with a WA index of 9.0–11.5 percent. Evidence of initial

vitrification of a non-calcareous low refractory clay matrix is revealed by SEM-EDS analysis, indicating probable firing temperatures around 800°C or a little above under a reducing atmosphere. In rare cases pottery samples have a low WA index of 5.8–8.2 percent, indicating probable higher firing temperatures. Certain samples show extensive vitrification of the clay matrix probably caused by temperatures of 850–900°C under a reducing atmospheric regime (see Table 11.1).

Another set of remains of Bohai period firing kilns was detected in the mainland part of the southern Primor'e Region, in the Krounovka River valley (Fig. 11.1). The fragmented remains of five firing structures were excavated near the river, close to a settlement (Korsakovskoe-1 site) and to a neighboring Buddhist temple (Korsakovskoe-2 site). Radiocarbon dates for the kiln structures closest to the temple are: 1500±160, 1030±40, 1090±35 BP (Kuzmin et al. 2005). All kilns were substantially damaged, though the main structural features can be recognized. These are the elongated plan, the slightly sloped floor deepened into soft alluvial soil to 0.7–1.3 m, and the structural division into three parts – fuel section, firing section and flue section. The maximal length of a kiln's tunnel was about 4.0 m in one case. In other cases the length varied from 2.5 m to 3.5 m. The floors and walls were covered with a layer of dense, burned clay. In two cases traces of a tube-like chimney formed of clay and pebbles were unearthed. In three cases the remains of collapsed domes formed of burnt clay mixed with straw were discovered. The inside area of the excavated kilns showed no signs of ceramics

production. However, some fragmented tiles were found near the remains of the kilns.

Sloping tunnel-like ceramics-firing kilns unearthed at the Bohai sites in Primor'e, at the Kraskino walled settlement, seem at first to be very similar in main construction principles to sloping tunneled, or climbing, kilns that were invented on the neighboring Korean peninsula in the third to fourth centuries AD, during the Three Kingdoms period, and widely used from that time up to the recent past (Rha 2006: 111–12; Kim 2013; Lee 2007, 2015; Barnes 2001: 92–124). As some researchers suppose, the main construction idea of Korean tunneled kilns goes back to long, or dragon, kilns that originated in the Yangtze basin in the first millennium BC. Later, this kiln construction was adopted in many regions of East and Southeast Asia (Kerr & Wood 2004: 347–64; Hein 2008). Kilns at Bohai sites in Primor'e may be considered the northeastern-most case of the spread pattern of the sloping tunneled kiln type.

Comparing the kiln structures excavated at the Bohai sites of the southern Russian Far East with the neighboring Korean sloped tunneled kilns, one can note certain differences in their sizes and firing conditions. The kilns of the third to sixth centuries, which are somewhat older than the Bohai kilns of Primor'e, had a tunnel length of 6.0–10.0 m (Kim 2013; Lee 2015). That is certainly more than the tunnel lengths of the Primor'e kilns described above. Also, the stable firing temperatures achieved in tunneled kilns of the Korean peninsula during the Three Kingdoms period were 900–1000°C, and sometimes up to 1100–1200°C. These kilns produced high-quality gray ceramics, which are considered similar to stoneware (Barnes 2001: 117–24; Rha 2006: 33–35; Lee 2015).

Our SEM-EDS examination of a small series of pottery samples from Baekje, the Neungsanri-saji site, dated to the sixth/seventh centuries, confirms the opinion of an advanced technical and technological level of firing process in ceramics kilns of the Three Kingdoms period. The samples show different levels of structural transformation and vitrification of the fired clay matrix, indicating a wide range of temperature regimes – from 750–800°C to 1050°C and somewhat above (Fig. 11.2g). Accordingly, the Baekje kilns produced ceramics of a different quality – ordinary earthenware with porous body and a “hard” ware with highly vitrified body (Zhushchikhovskaya 2017).

It may be concluded that the kilns of the Bohai sites in the Primor'e territory belonged to the same type as or a type very similar to the Korean kilns of the first millennium AD but were characterized by smaller sizes and less technical potential. It may be supposed that this indicates a later appearance and slower development of advanced firing technologies in the area considered.

#### **11.4.2. Jin/Dong Xia State stage**

From 1115 to 1233 the Primor'e Region was, first, included in the Jin Empire (1115–1234) that was

established by warlike Jurchen tribes as its northeastern peripheral boundary. Northern China, conquered by Jurchens, was the primary territory of the Jin Empire, where the political, administrative and economic centers were located. In the last stage of the Jin Empire a separate state formation named Dong Xia existed in Manchuria and the Primor'e territories from 1215 to 1233. In the research area the Jin/Dong Xia period is represented by numerous archeological sites reflecting various aspects of life in the Jurchen population. The remains of walled settlements, fortified settlements and temples belonging to the Jin/Dong Xia stage have been discovered and excavated throughout the research area. The remains of high-status courtyards, column-type buildings, metalworking workshops and commoners' houses were discovered in the walled settlements of Krasnyi Yar, Shaiga, Nikolaevka, Anan'evka and others. In a few cases the remains of isolated architectural complexes located outside the walled settlements and settlements were unearthed and recognized preliminarily as Buddhist temple sites. Features of Jurchen town planning, building and architectural standards and technologies were influenced greatly by Chinese cultural traditions. Artifact assemblages from Jurchen sites are rich in various kinds of metal tools, weaponry, ornaments, household utensils, coins, imported glazed stoneware and porcelains (Artemieva and Usuki 2010; Ivliev 2010; Li et al. 2018).

Ceramics artifacts of two main groups are common at Jurchen sites. The first group is day-to-day pottery mostly made on a potter's wheel: storage vessels, kitchen needs, table service and objects with technical functions. The second group is architectural ceramics that include roof tiles, bricks and sculpted objects for roof decoration. The concentrations of architectural ceramics are connected mainly with the remains of high-status buildings such as palaces, administrative offices and temples. Most of the ceramics of both groups are gray on the surfaces and in the fractures, indicating firing in special kiln devices under a reducing atmospheric regime. Obviously, the large amounts and qualities of day-to-day pottery and architectural ceramics from Jurchen sites indicate workshop production. Although archeological evidence for ceramics workshops has not been detected within the excavated walled settlements, single cases of ceramics kiln remains are known. The most interesting case is the Sergeevka site on the southeastern mainland of the Primor'e Region, in the valley of the Partizanskaya River, not so far from the two large Jurchen walled settlements of Shaiga and Nikolaevka (Fig. 11.1). The remains of several kilns were detected on the bank of Sergeevka Creek in the vicinity of the modern village of the same name and at a distance of about 2 km from deposits of high-quality potter's clay (Vasil'ev 2009; Zhushchikhovskaya & Nikitin 2017).

The remains of two fragmentarily preserved kilns (N1 and N2) situated at a distance of a little more than 6.0 m apart were excavated. Both are of the same construction type: a single firing chamber built of bricks with a “horseshoe”



horizontal floor plan. In the case of the better-preserved kiln N1, the brick walls of the firing chamber were traced to a height of up to 1.5 m. The firing chamber floors were formed of very densely packed earth. According to excavation data, the firing chamber floor of kiln N1 had a length of 1.97 m and maximal width of 1.67 m. The firing chamber floor of kiln N2 was partially preserved, with a length of 2.4 m. The maximal width of the firing chamber floor was 2.24 m. The inner surfaces of the brick walls were of a dark gray color probably indicating a carbon-saturated reducing atmosphere. No traces of melting activated by the long-term impact of high temperatures on the inner surfaces of the brick walls were detected. The yellowish and light orange outer surfaces were oxidized in the open air.

In the case of kiln N1, traces of a furnace chamber located at the narrowest side of the firing chamber below floor level were revealed. In the cases of both kilns, evidence of flue channels was unearthed at the bottom of the firing chamber's back wall. They were probably joined to a chimney tube at the back of the kiln. However, the areas behind the back walls of both kilns had been destroyed, and no traces of chimneys could be detected. In the case of kiln N2 the lower part of the back wall was better preserved. Six standard flue channels of 0.08 m in height and 0.16–0.17 m in width had been constructed under the floor. In the case of both kilns, several rows of the bricks were located longitudinally on the floor from the furnace chamber to the back wall of the firing chamber. The superstructures of both kilns had been completely destroyed. An accumulation of burnt clay pieces, fragmented tiles and bricks was unearthed at the level of the upper part of the firing chamber walls of kiln N1. Obviously, these were the remains of the kiln's superstructure, which may be supposed to be some kind of dome formed of bricks, tiles and clay.

The firing chamber of kiln N1 was completely filled with fired tiles arranged in piles situated on rows of bricks on the floor. These rows obviously served as supports for the piles of tiles during the firing process. The total number of tiles inside the firing chamber of kiln N1 was 1840. The tiles had not been unloaded, and it may be supposed that the firing process in this kiln had not been completed.

Along with the tiles found inside kiln N1, a large series of broken and sometimes whole tiles was collected in the vicinity of the kilns. The tiles from the Sergeevka site are similar in their morphological standards to tiles common for the Jin/Dong Xia walled settlements in the research area. The characteristic features are: semi-cylindrical shape, a length of 30–31.5 cm, a width of 20–21 cm, and in some cases one arc-curved end decorated by finger-stamped roundish and oval impressions.

An examination of the tile samples from kiln N1 and the tiles collected nearby provides data on temperature and the atmospheric regimes of firing (Zhushchikhovskaya &

Nikitin 2017). Most of the tiles from kiln N1 are of a yellowish and pale orange color on the surface and in the fracture, indicating an oxidizing firing regime. The WA index has high values of 14.5–19.1 percent, and the surface hardness index is 4.0–5.0. SEM-EDS analysis was applied to four samples. It was revealed that the microstructure of the ceramic body has an amorphous pattern without any evidence of a vitrified clay matrix (Fig. 11.2h). These data allow the supposition that the temperature during the last firing in this kiln was not above 800°C.

The tiles collected in the area of the kilns are mostly of a gray or dark gray color, sometimes of a light orange color and differing in their quality. Some of them have traces of firing damage, deformation, cracking and surface melting. Some samples have a very dense body with an even gray or bluish-gray color, looking like “stoneware.” The WA indexes of these samples are 0.7–3.0 percent, and the index of surface hardness is 7.0–8.0, indicating a high firing temperature. SEM-EDS analysis of four samples with WA indexes of 0.7–2.7 percent reveals microstructures with a highly, or continuously, vitrified non-calcareous clay matrix (Fig. 11.2i). Taking into account a reducing atmosphere for the firing, which accelerates the vitrification process, it seems correct to determine a firing temperature of around 950°C or somewhat above.

Two gray-colored samples with WA indexes of 4.2 and 5.8 percent indicate microstructures with an extensively vitrified non-calcareous clay matrix (Fig. 11.2j). The estimated firing temperature for low refractory clays under a reducing regime is around 900°C. Microstructures with an initially vitrified clay matrix were detected for series of samples with WA indexes of 10.0–14.2 percent (Fig. 11.2k). The supposed firing temperature in this case is 800–850°C or slightly above.

In general, the approximate interval for working temperatures in the Sergeevka kilns is thought to be from 800–850°C to 950°C or somewhat above. It seems likely that two atmospheric regimes – oxidizing and reducing – were applied to the firing process. The case of kiln N1 indicates that an oxidizing atmosphere was initially conducted for a certain amount of time during firing. However, in the final stage of the firing the oxidizing regime might have been changed to a reducing regime. This conclusion is based on the dark gray color of the inner surfaces of the brick walls in the firing chambers of kilns N1 and N2, like the gray and dark gray color of most of the tiles found in the vicinity of the kilns.

Data on the examination of wheeled pottery from various Jin/Dong Xia sites (Zhushchikhovskaya 2017) roughly confirm the above conclusions on firing temperature and atmospheric regimes. In only a few cases can one note samples of a relatively low WA index of 6.0–8.3 percent. The WA index for most is within the limits of 10.0–14.0 percent. For some samples with a WA of 10.0–11.5 percent, SEM analysis indicates initial vitrification of the clay matrix. Based on these data it may be supposed that

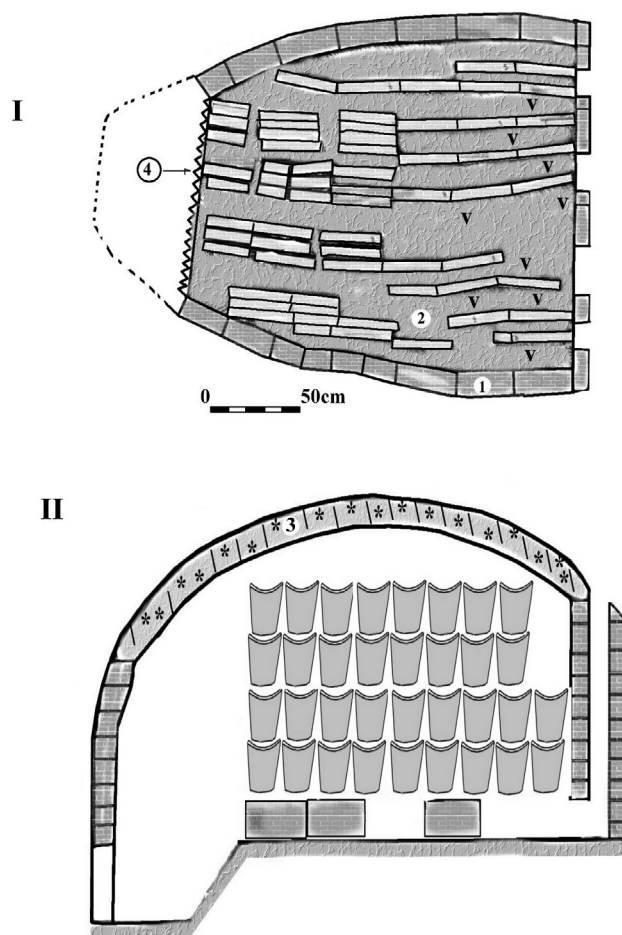
the potteries were usually fired at temperatures of 800–900°C, though in rare cases at higher temperatures. The gray color of most of the pottery samples at each Jurchen site indicates firing in a reducing atmosphere, at least in the final stage.

The results of excavations at the Sergeevka site and recent field observations in this area (Zhushchikhovskaya & Nikitin 2017) allow the supposition that a tile-making workshop, including an assemblage of firing kilns, was located in this place. An important factor favorable for the ceramics and tile-making is the close availability of good-quality clay raw material resources and coal deposits that can be considered as fuel resources for the firing process. This area of the Partizanskaya River valley is rich in coal deposits. In particular, these deposits are known in the vicinity of Sergeevka village, a distance of 3–5 km from the kiln site (Anert 1928; Zonn et al. 2016: 115). The Sergeevka kilns are quite similar in their structural features (Fig. 11.5) to the well-known brick-built *mantou* kilns first invented in northern China around the middle of the first millennium AD (Guo 2000; Kerr & Wood 2004: 314–34, 428–43). The *mantou* kiln type is characterized by a single firing chamber with a high dome-like roof and “horseshoe” horizontal plan. The firing chamber had a floor area of up to 10 m<sup>2</sup> and more. Hot air came in from the furnace

chamber located beneath the floor level at the front of the kiln, then moved up and down to the flue channels located in the bottom part of the back wall. The flue channels were joined to the chimney or pair of chimneys behind the back wall. Chinese *mantou* kilns operated at high temperature regimes of more than 1000°C, up to 1100°C for stoneware production, and up to 1300°C for porcelain production. Over the course of time this kiln type became widespread in the ceramic production of northern China, and was also adopted in southern China. According to archeological investigations in northern China, *mantou* kilns were located in clusters in areas with available potter’s clay resources. After about the tenth century coal replaced wood as fuel for firing ceramics, and the vicinity of this resource became a very important factor in the location of tile- and brick-making kilns.

Earlier, researchers noted that Haicheng in the Liaoning Province was the northeastern point of production by *mantou* kilns (Kerr & Wood 2004: 330). From this perspective, the Sergeevka site may be interpreted as the northeastern-most appearance of a *mantou* kiln. It may be supposed that firing kilns of *mantou* construction appeared in the Primor’e Region during the Jin Empire period (1115–1234) through influence from a northern Chinese culture of ceramics production. At present, the Sergeevka site is the only known evidence of a *mantou* production complex of kilns in the territory of Primor’e. Obviously, the combination of factors such as water, clay and fuel resources, and the proximity of large Jurchen walled settlements determined the choice of this place for the location of kilns for firing ceramics.

Evidence of structures that may theoretically be interpreted as firing devices was discovered at the Jurchen site of the Lazovskoe walled settlement located about 50 km north of the Sergeevka kiln site (Fig. 11.1) (Len’kov & Artemieva 2003). The remains of a probable workshop area were excavated inside the ancient town, on the hill slope. The workshop was a clearly demarcated 50 m by 50 m square area surrounded by an earthen wall with a gate-like break on one side. The remains of nine kiln-like structures were compactly located in the eastern part of the workshop area, near the remains of some subsidiary structures resembling a shed and a storehouse along with several pits. In the western part of the workshop area the remains of a habitation structure were recorded. All of the kiln remains are recognized as elongated trenches 6.0–7.0 m in length and 0.8–1.0 m in width, embedded in the ground to a depth of 0.5–0.6 m. At one end of each trench there was a furnace pit reinforced with stones, and a roundish pit for holding kiln waste products was joined to the furnace pit. Furnace pits and pits near them were filled with charcoal. The firing chambers had a length of 5.5–6.5 m and compact floors covered with a burnt clay layer 0.002 m thick. The flue section at the rear of each trench appeared as a pit 0.4–0.5 m in diameter and 0.6 m in depth; flues were clearly of a tube-like type. The floors of some kilns were slightly sloped, with the flue section at the upper level and the furnace section at the lower level. Other kilns



**Figure 11.5. Sergeevka kilns site. I: Plan of the floor area of kiln N2. II: Graphical reconstruction of the profile section of kiln N2 (from Zhushchikhovskaya & Nikitin 2015).**

had horizontal floors. The kilns' superstructures had been destroyed, but, judging from the fragmentary remains, they were built of clay on a wooden framework.

No ceramic production pieces or spoilage samples were found inside or outside the kiln-like structures. However, the burnt clay layer on the floor of the trenches and the presence of charcoal in the furnaces and pits in the furnace area indicate that the kilns were actually used for the thermal processing of certain products, probably ceramic items.

### 11.5. Concluding remarks

Archeological records of the history of kilns for firing ceramics in the southern Russian Far East date roughly to the period from the mid first millennium BC into the first half of the second millennium AD. In general, the development of the technique and technology of kilns was part of the cultural, social and economic history of the region. The dynamics of ceramics kilns are presented through their construction and technological features (Table 11.2, Fig. 11.6). It is important to note that the history of kilns presents not a gradual development of a certain construction type, or model, but rather the changing of various construction types.

Initially, kiln-like devices were invented and exploited in this area during the Paleometal period, which covered the first millennium BC and first centuries AD. The appearance and adoption of the earliest pottery-firing kilns were supposedly closely connected with the introduction of the first metal artifacts and some knowledge and skills in metalworking and thermal processing in the southern Russian Far East and neighboring areas of East Asia. The simplest tunnel-like construction of a pottery-firing kiln

excavated in the western Primor'e Region (Chernyatino 2 site) may be considered as evidence of some kind of cultural interaction with the population of the Korean peninsula, where tunnel-like firing kilns were exploited from the first half of the first millennium AD.

Further history of ceramics kilns demonstrates an abrupt change in the construction type of the firing device. Two-level updraft kilns discovered at the Troitsa site, attributed to the Pre-State period of the fourth to seventh centuries, belong to a construction model unusual in East Asian territory in the first millennium AD. A preliminary explanation for the appearance of this kiln type in the research area may be cultural impulses from remote territories of Central Asia, where this firing construction is a traditional one from the distant past.

The wide distribution of kiln-fired ceramics in the southern Russian Far East is connected with the Ancient States epoch, seventh to thirteenth centuries, when well-developed firing kilns with a reducing atmospheric regime and temperature regime of up to 900–1000°C were exploited. Two construction types of firing kilns are distinguished for the Ancient States epoch in the southern Russian Far East. The tunneled, or climbing, kiln was characteristic for the Bohai State period, then the *mantou* kiln appeared in the Jin/Dong Xia period. Both types may be interpreted as derivatives of firing-kiln constructions used in the ceramics production of the Korean peninsula and northern China in the first millennium AD. The processes of Ancient States formation and development in East Asia and the Far East also brought about some technological and technical innovations and inventions in peripheral areas. It may be noted that the kilns of the Bohai and Jin/Dong Xia periods in the study area were characterized by relatively small sizes in comparison with the kilns of

**Table 11.2. Types of old ceramics-firing structures from the southern Russian Far East**

Chronology - Cultural Context	Type of Firing Structure - Building Materials	Temperature - Atmospheric Regimes
Paleometal period – Yankovskaya culture – 9th/8th – 3rd/2nd centuries BC	Oven-like single-chambered, ground-level crossdraft kiln – clay on plant framework	approx. 700–850°C – oxidizing
Paleometal period – Krounovskaya culture – ca. 4th/5th centuries BC – 4th/5th centuries AD	Most simple variant of tunnel-like sloping crossdraft kiln – clay on wooden framework	approx. 750–900°C – oxidizing – smudging
Pre-State period – Mokhe culture – ca. 4th – 7th centuries AD	Two-level updraft kiln with underground fuel chamber and dome-like firing chamber – stone, clay	approx. 800–850°C – mostly oxidizing – smudging
Ancient States period – Bohai Kingdom – 698–926	Tunnel-like, sloping crossdraft kiln – stone, clay	approx. 800–900°C – reducing – oxidizing – smudging
Ancient states period – Jin/Dong Xia state – 1115–1234	Mantou type downdraft kiln – bricks	approx. 800–950°C – mostly reducing – oxidizing

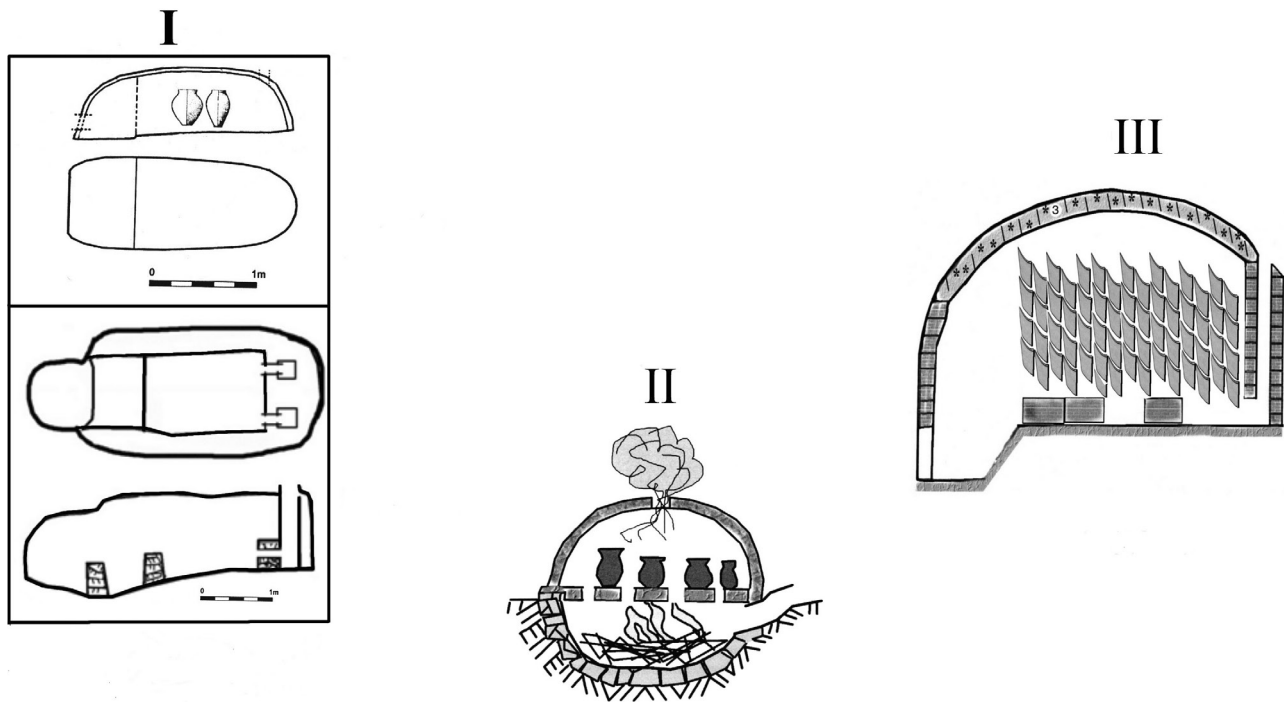


Figure 11.6. Construction types of ceramics-firing kilns in the southern Russian Far East. I: Tunnel-like cross-draft kiln. II: Two-level vertical updraft kiln. III: *mantou* type down-draft kiln (from Zhushchikhovskaya & Nikitin 2015).

the Korean peninsula and northern China. The technical potential indicated by the firing temperature regimes of tunnel kilns and *mantou* kilns in the territory of Primor'e seem to be inferior to that of kilns with a sloping tunnel of the Korean peninsula and the Chinese *mantou* kilns.

All known cases of ceramics kilns dated to the Ancient States epoch in the territory of Primor'e are represented by the remains of kiln clusters, or workshops. The excavated kilns were directly related to the firing of roof tiles. It may be supposed that the primary reason for the development of firing kilns on the periphery of the Bohai Kingdom and later in the Jin Empire was the need for architectural ceramics (tiles, bricks and decorative features) for high-status buildings (administration offices, palaces and temples). It is likely that the ceramic ware serving various needs in daily life was produced locally and fired in the same or very similar kilns. Firing technology, including atmospheric and temperature regimes, was the same for architectural ceramics and pottery. The finished products – tiles and pottery – were similar in such characteristics as water absorption, density and hardness. It is to be expected that in the future direct evidence of kiln firing of pottery will be discovered.

Archeological records of the post-Ancient States period in the Primor'e Region are very poor and infrequent because of the desolation and depopulation caused by the Mongol conquest in 1234. The remains of large settlements attributed to the fourteenth to fifteenth centuries and later times are not known. Accordingly, there is no evidence of ceramics production and firing kilns for the periods following the fall of the Jin and Dong Xia states.

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## Pottery Kilns of the Khitans in Mongolia

*Katsuhiko Kiyama*

**Abstract:** After the Xiongnu Empire, new style kiln-fired ceramics were found from the Göktürks (552–744 AD) and the Uyghur Khaganate (744–840 AD). These may have been produced using kilns, but no production site has yet been discovered. It is possible that kilns were also used in other eras, but excavated items have thus far failed to confirm this possibility. For these reasons, it is difficult to conduct a diachronic study on pottery production in Mongolia at present. This essay provides an overview of our investigations of pottery kiln ruins at the site of the Chintolgoi Castle, built by Khitans, and discusses how this example should be placed within the wider context. Based on a detailed examination of the pottery, it is presumed that the pottery production at Chintolgoi Castle was an amalgamation of pottery traditions of different origins, such as those of the Bohai and Uyghur. It can be said that the relics of the material culture of the Khitan people reflected the state of “imperial” rule by which the Khitan people commandeered and reorganized the groups and technologies of other ethnic groups in the region as they expanded their territory.

**Keywords:** Mongolia, Khitans, Chintolgoi Castle, Bohai, Uyghur

### 12.1. Introduction

The ruins of only three types of pottery kilns have been found in Mongolia to date: those of the Xiongnu, the Khitans and the Northern Yuan dynasty. Since earthenware and stoneware were also found from the Göktürks (AD 552–744) and the Uyghur Khaganate (AD 744–840), these may have been produced using kilns, but no such ruins have yet been discovered. It is possible that kilns were also used in other eras, but excavated items have thus far failed to confirm this possibility. For these reasons, it is difficult to conduct a diachronic study on pottery production in Mongolia at present. This paper will provide an overview of pottery kiln ruins at the site of the Khitan Chintolgoi Castle, which we investigated, and discuss how we may position this example within the wider context.

Archeological research on the Khitans has concentrated on the study of the tombs of nobles and the city walls, and not on other products. The research on pottery has mainly focused on the chronology of pottery excavated from the tombs of nobles. The pottery of the Khitans is known to consist of soft earthenware, kiln-fired stoneware and porcelain. However, there has been no survey of the production sites of any of these pottery types, and an analysis of production techniques and a distribution have not yet been carried out. Therefore, the examination of the kilns at Chintolgoi Castle is of significance to the history of the Khitans. In addition, the kilns of the Khitans were more developed than those of the Xiongnu and Bohai, which is also meaningful when considering the changes in kilns in North Asia.

### 12.2. The advance of the Khitans into the Mongolian Plateau

In Chinese history books, the Khitans emerged around the fourth century AD. They were nomadic people inhabiting the basin of the Xar Moron and Laoha rivers, tributaries of the Liao River. The Khitan people had been divided into various groups, but Taizu (AD 872–926), also known as Abaoji, unified those groups and founded the Liao Dynasty (AD 916–1125). After assuming power, he extended his influence eastward, destroyed the Bohai (AD 926), and advanced southwards, eventually gaining control of the Sixteen Prefectures. He then advanced into the Mongolian Plateau. Because the Hexi Corridor (also known as the Oasis Route, or the Gansu Corridor) was controlled by the Western Xia (also known as the Tangut Empire), Taizu sought to establish a trade route with the countries to the west via the Steppe Route extending from the Mongolian Plateau. There was no unified Mongolian nation during this period, and the region was controlled by nomadic groups such as the Zubu and Yujue; the Khitans had to suppress these nomadic groups in order to establish the Steppe Route. To this end, in 1004, Emperor Shengzong of Liao established the Zhenzhou Military Base in what is now Bulgan Province, Mongolia, as well as three provinces, namely Zhenzhou (supervised by a military commissioner), Fangzhou and Weizhou (supervised by a provincial governor). He stationed 20,000 cavalries in the area, and placed 700 Han Chinese, Jurchens and Bohai settler households in the region to govern the Mongolian Plateau.

In the process of expanding his territory, the emperor settled groups from different cultural and social backgrounds,



such as the Han Chinese, Bohai people and Jurchens, in the newly conquered areas, and created a system which combined the traditions of the Liao Dynasty with cultures and systems of different origins. This system incorporated Buddhism, the Khitan script and dual apparatuses to govern nomads and settled agriculturists under different systems. The establishment of the governance and transportation structures under the five-capital system, prefectural and provincial systems was one of these features, and these provinces and prefectures have been preserved as the castle sites.

### 12.3. The site of Chintolgoi Castle as a colonial city

More than a dozen Khitan castle sites have been found on the Mongolian Plateau (Fig. 12.1). One of them, the site of Chintolgoi Castle, is located in Dashingchilen Aimag, Bulgan Province, Mongolia. Researchers assume that this was the most prestigious castle in Zhenzhou, functioning as the governmental center of the plateau. This assumption is based on the fact that the castle was named after the hill called Chintolgoi, located north of the castle ruins. “Tolgoi” means “hill” in Mongolian, and “chin” is similar in sound to “zhen.” Another basis for this assumption is that it is the largest of the Khitan castles on the Mongolian Plateau, with a circumference of 3840 m. Studies have determined that the size of Khitan provincial castles in China is proportional to their rank. The ruins of Khar bukh Castle and Ulaan kherem Castle, both in Dashinchilen Aimag, Mongolia, which were designated as provincial capitals supervised by a provincial governor,

have circumferences of 2780 m and 2040 m, respectively. It is likely that Chinese standards were maintained in the castles of the Mongolian Plateau.

If the Chintolgoi Castle site was Zhenzhou Castle, then it would have been built in 1006. The year it was ruined is unknown. Nevertheless, Qiu Chuji, who visited the area in 1188, confirmed that the castle of Khitan was in ruins at that time. Perhaps it lost importance when the Mongol Jin Dynasty exterminated the Khitans in 1125. Therefore, artifacts from the ruins of Chintolgoi Castle are considered to be from the early eleventh to twelfth century, mainly from the eleventh century.

The castle site is a flat rectangle with a north–south length of approximately 1260 m and an east–west length of approximately 660 m. An inner wall extends east to west near the middle of the interior, dividing the structure into north and south (Fig. 12.2a). This multi-layer structure is one of the characteristics of Khitan castles, and has also been found at Shangjing, Zuzhou Castle and Raozhou Castle.

The height of the castle wall is, currently, about 3 m. A moat between 10 and 12 m wide encircles the castle wall. Five spurs on the north–south side and nine spurs on the east–west side are attached to the walls at intervals of 65 to 70 m. The dimensions of the castle reveal that it was designed, measured and constructed based on grid partitions using the Tang chi (*shaku*) measuring unit (Usuki and Enkhtur 2009).

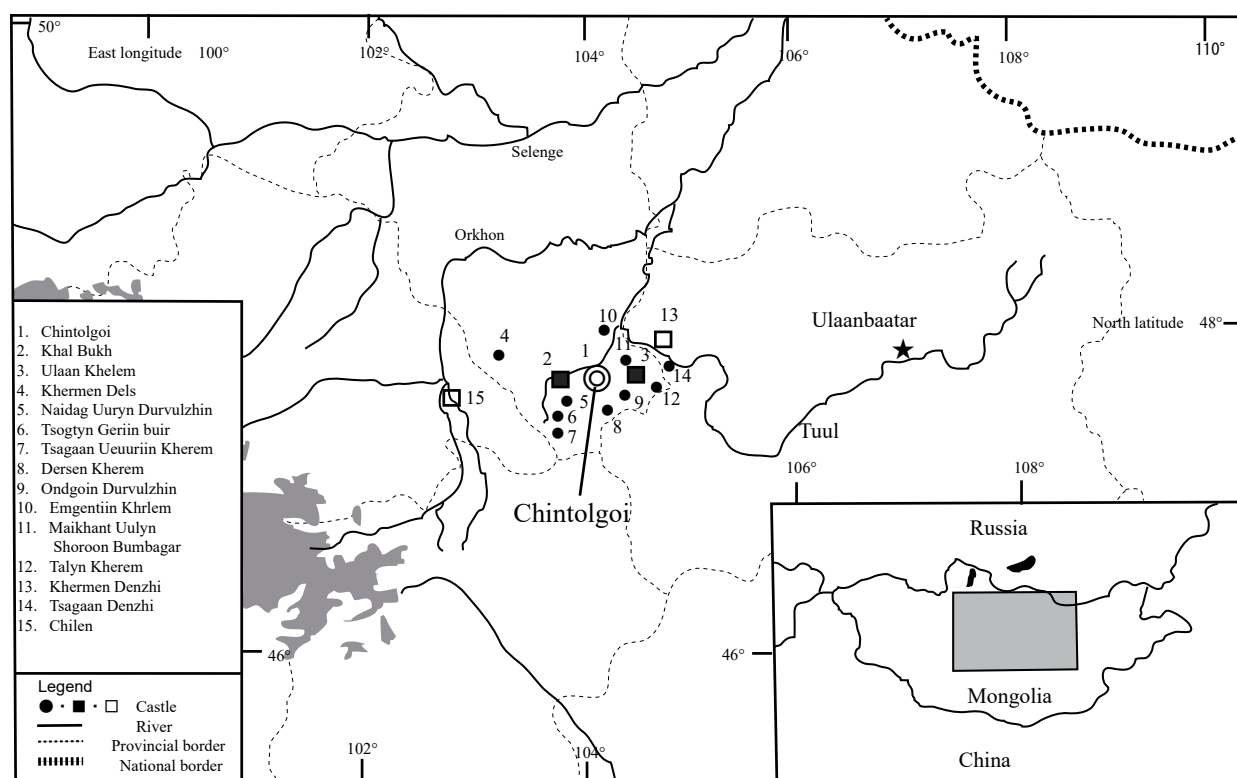


Figure 12.1. Khitan castle sites in the central part of the Mongolian Plateau (based on Ochir et al. 2005).

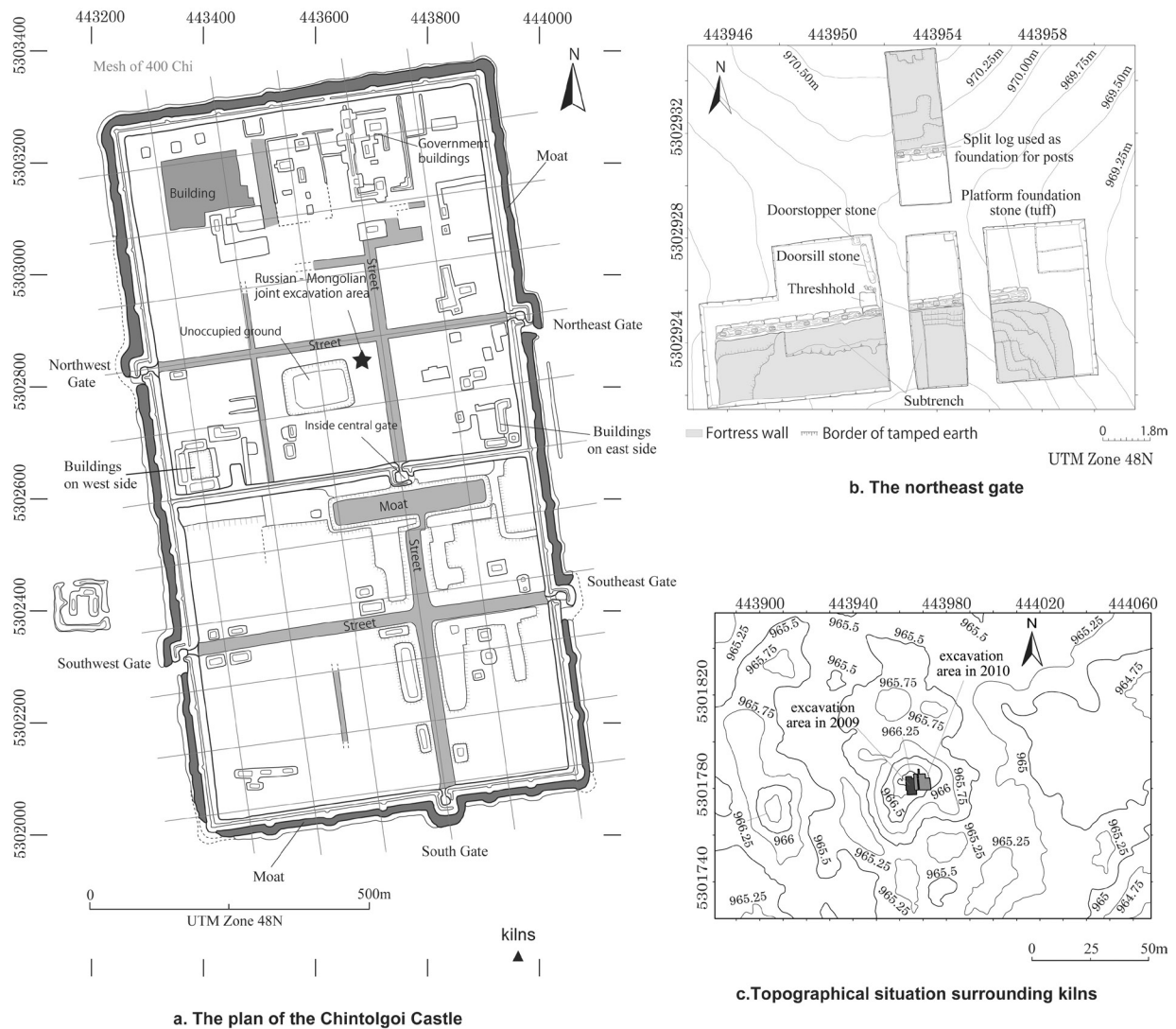


Figure 12.2. Chintolgoi Castle site (a–c: courtesy of Kiyama Katsuhiko, d: Shimada 1955, e: SIMAT, IACAA et al. 2011).

Both the north and south castles have gates in the south, east and west walls. These gates have a barbican, comprised of an L-shaped auxiliary castle wall projecting toward the outside. The northeast gate of the north castle has been excavated to examine its structure (Senda and Enkhtur 2011, 2015; Fig. 12.2b).

The gate path would have been about 11 m long and 5.8 m wide, cutting through the castle wall. The road was paved

with sandy white soil rather than stone or brick. On both sides of the gate path, excavators found a row of granite blocks surmounted by wood. In the center of the path were the gatepost foundation stones, as well as the stones that served as a threshold and the standing stone as a door stopper. The wood placed on the row of stones was a piece of square-edged timber with a width of about 25 cm, cut from a single tree with a solid, unbroken length of about 11 m. About every 70 cm, 15 square mortises were drilled

to support the insertion of upright pillars, while bars were piled in the soil below the castle wall to construct the body of the gate. Wave-shaped traces found in the soil suggest that hemispherical logs were used as bars. The side walls of the gate path were made of pine and stood vertically. Radiocarbon dating of debris from the exterior parts of the castle indicates the eleventh century, which is approximately consistent with the establishment date of Zhenzhou.

No remains of the gate ceiling and gate tower shed have been found, but since flagstones, tiles and bricks were excavated from the survey site, the gate tower was probably made of these materials. Many large flat tiles and pieces of antefix with gargoyles were also excavated, indicating that this was most probably an important, high-class structure.

The ruins of Zuzhou Castle and the Zuling mausoleum of Bairin Left Banner in the Inner Mongolia Autonomous Region of China are currently the only excavated examples of Khitan castle gates. The mausoleum is the tomb of the first Emperor Taizu of Liao, and the Zuzhou Castle was established in 927 as a castle site to protect the tomb. The inner gate of Zuzhou Castle (called the Xingsheng Gate according to *The History of Liao*) has three gate paths. The central path was excavated by Masao Shimada and others in 1943 (Shimada 1955; Fig. 12.2d). It measures 4.95 m in width and about 20 m in length, and in structure is similar to the ruins of Chintolgoi Castle. The Heilong Gate, the entrance to the Zuling mausoleum, was excavated and studied in 2010 by the Institute of Archaeology, Chinese Academy of Social Sciences and the Inner Mongolia

Institute of Cultural Relics and Archaeology. The study revealed that the gate structure was also similar to that of Chintolgoi Castle (Second Inner Mongolian archeological teams, IA, CAA et al. 2011; Fig. 12.2e). This gate also has three paths but was more carefully constructed than the ruins of Chintolgoi Castle, with masonry side walls and the brick-paved roads. However, the Heilong and Chintolgoi gates have width in common, both being approximately 5 m wide. Since this type of castle gate is not in evidence at the Tang Dynasty Daming Palace or Shangjing Longquanfu in Bohai, it may have been standardized by the Khitans.

Based on the above survey results, Chintolgoi Castle seems to have been a colonial city designed and constructed with techniques and workers already established in the area when the Khitans advanced into the Mongolian Plateau.

#### 12.4. Excavation of the pottery kilns at the ruins of Chintolgoi Castle

The urban ruins of Chintolgoi Castle have been associated with numerous production activities. The containers and tiles used in the castle were manufactured using the Chintolgoi kilns, which are located about 300 m south of the castle site on slightly elevated ground near the old river channel, which runs from the west to the south of the castle ruins (Fig. 12.2c). Analysis of materials collected from the surface and the magnetic survey in the area has revealed that there were several kilns. One of the excavations, that of Kiln 1, was carried out between 2008 and 2009 (Senda and Enkhtur 2010; Fig. 12.3).

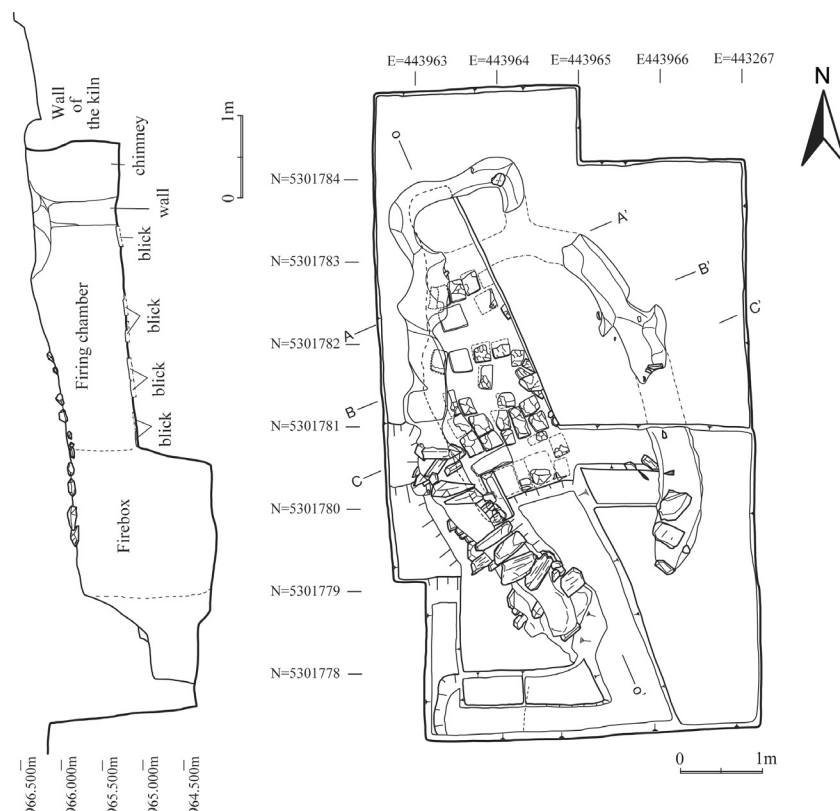


Figure 12.3. Pottery Kiln 1 at the Chintolgoi Castle.

As part of the research, the western kilns were excavated to understand their structure, while the eastern kilns were left unexcavated to preserve the remains. After excavation, the remains such as walls and floors were preserved and backfilled.

The kilns are flat and semi-subterranean, with a major axis length of about 5.2 m and a width of about 2.6 m. The ceiling is a semicircular dome. An oval pit approximately 1 m deep was dug in the raised part of the slightly elevated area along the river, and then the inclined part was also dug to set up a chimney and a firing chamber. The south side of the firing chamber was dug to a depth of about 1 m to construct the combustion chamber. The major axis runs in a north–south direction. There is a single chimney, and there is a clay partition between the wall and the firing chamber. The northern half of the firing chamber is made of sun-dried bricks, while the southern half of the firing chamber and the combustion chamber are made of clay and flagstones stacked to form a wall. Eave-end round tiles with gargoyles and unfired pot-shaped pottery were embedded in the southeastern part of the outer wall. The floor of the firing chamber is paved with brick. A square vestibule, which served as a working space, was dug into the front of the firebox of the kiln. The masonry on the wall seems to have been restacked, and the floor was definitely expanded. It was evident that a major renovation had been carried out. After the repair, the ash was not removed; the kilns appear to have been used at least 10 times after the repair. Since the kilns were buried once the products were removed following the final firing, only fragments of the walls and products had accumulated inside. On the east side of the kiln ruins, investigators found traces of pits and topographic alterations they considered to be related to kiln construction.

Unglazed pottery was produced in this site (Fig. 12.4a). The main types of production include storage vessels and tableware such as jars, bowls and large pots, but boiling tools including fringed kettles with tripod and deep bowls were also found. The principal products are jars, which account for about 40 percent of the total, while bowls make up about 20 percent. Although it is difficult to specify the period, it is assumed to have been operated in the early to mid-eleventh century, not long after the construction of Zhenzhou Castle.

From 2004 to 2008, a Russian–Mongolian joint excavation was conducted in the southwestern section of the site, near the intersection of the north–south central road and east–west central road in the north part of the Chintolgoi Castle (Kradin et al. 2011). In the excavation area, houses and storage cellars of various periods were discovered. Since the homes discovered were not particularly large, the area was considered to have been an ordinary residential quarter. A comparison between the material excavated in the castle (Figure 12.4b) and the material excavated from Kiln 1 indicates that the basic composition of the pottery remains is very similar. However, some types of vessels not produced using this kiln, such as short-necked long

bottles, vessel stands and inkwells, were also discovered (Fig. 12.4b: 23–25). In addition, a relatively large number of bowls and plates have been excavated in the castle, but most of these were not produced in kilns at Chintolgoi Castle. These items were also slightly different in shape.

What the compositions of the excavated pottery of Kiln 1 and the castle have in common is that Kiln 1 was a production site for daily utensils supplied to the castle. However, while bottles account for 40 percent of the pottery produced at Kiln 1, a certain number of bowls and plates were excavated in the castle. It is possible that the main types of vessels produced were different at each kiln.

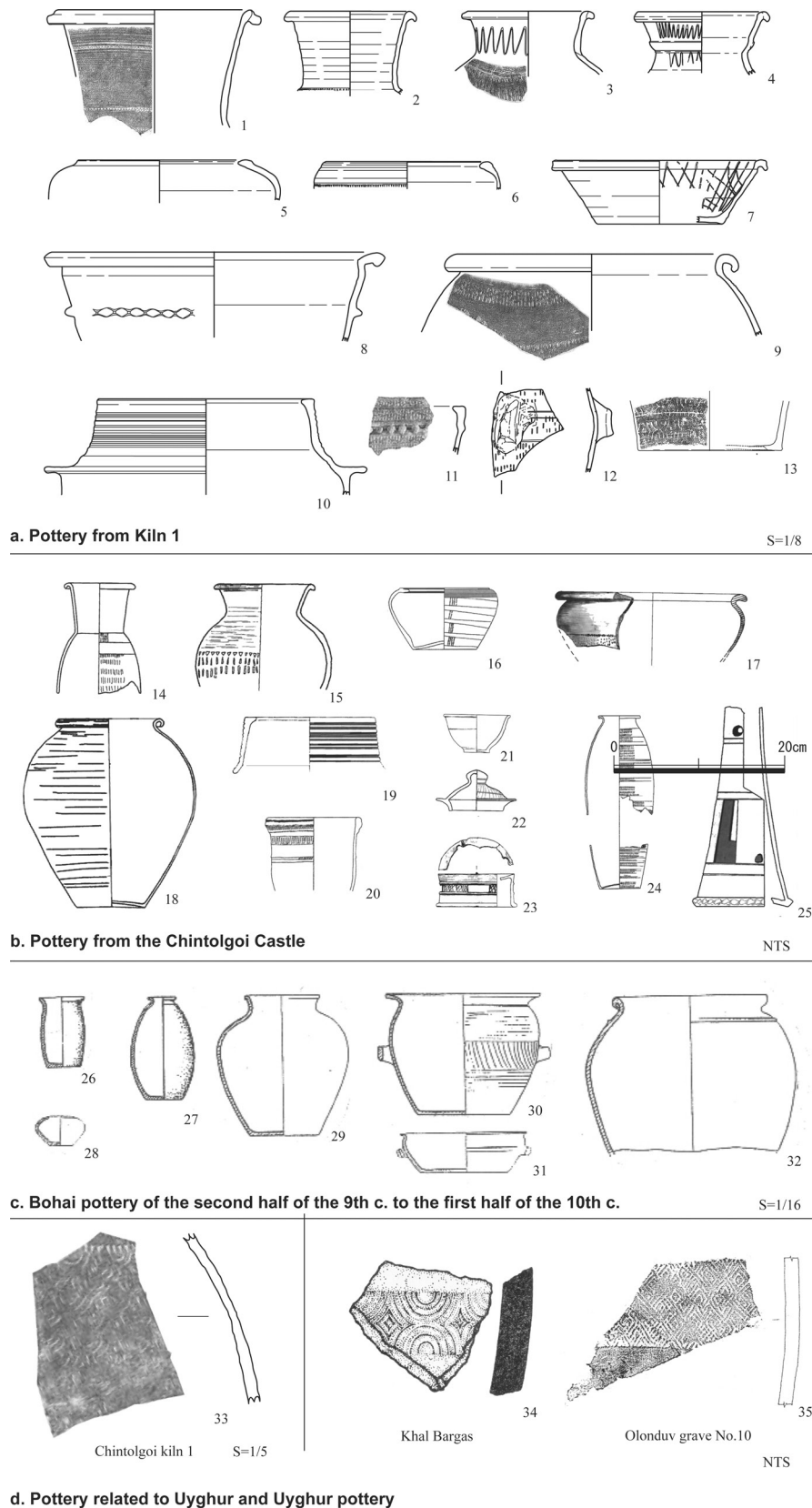
A certain number of pottery have been excavated in the castle, and it is also possible to collect the surface soil. Compared to ordinary Khitan pottery identified at other sites, the long-necked jars share similar features. However, not all types of pottery are earthenware and stoneware. These found does not include the most distinctive ornamental varieties, such as “Jiguan” (“cockscorn”) jars and “Jitui” (“chicken thigh”) bottles. No dishes (plates) have been found to date. By contrast, the pots, bowls, fringed kettles and deep bowls were not produced in porcelain. Some types of products were made of earthenware, while others were usually stoneware.

White porcelain is the main type of ceramics found inside the castle ruins, while black glazed wares, bluish-white porcelain and celadon were also discovered. Most of these ceramics were small bowls. Earthenware, stoneware, and porcelain may have been used in a complementary manner in the ruins of Chintolgoi Castle, but there are far fewer of the latter than the former two. There are kilns other than Kiln 1 that produced bowls and dishes as a mainstay or in relatively large numbers, and most of the castle’s daily utensils are thought to have been made of earthenware and stoneware.

The above suggests that the earthenware and stoneware used in the castle was produced in the nearby kilns, but that a small number of porcelains were imported from distant locations. Porcelains seem to have been a luxury item. Up until recently, the year of production for Khitan pottery was calculated based mainly on the materials excavated from aristocratic tombs, most of which were porcelains (Imano 2002, Peng 2003). Moreover, as the proportion of porcelains increased over time, the earthenware and stoneware production features, which served as daily utensils in each period, were unknown. Therefore, the results of kiln 1, the first survey on the pottery production site, become essential for future reference material.

## 12.5. Material culture artifacts indicating the “imperial” characteristics of the Khitans

After destroying the area around the Bohai in 926, the Khitans dispersed a large number of Bohai people to various locations within their territory. The geographic



**Figure 12.4. Pottery from the Chintolgoi Castle and related pottery (Usuki 2012, Kradin et al. 2011, Kiyama 2007, Khudyakov 1982, Erdenebat et al. 2011).**

description in *The History of Liao* also mentions that some Bohai people were brought to Chintolgoi Castle. Russian troops excavating the inside of the Chintolgoi Castle ruins determined that Bohai workers had been

transferred to the Chintolgoi Castle based on the similarities between the pottery excavated inside the castle and Bohai pottery (Kradin et al. 2011: 116–18; Ivliev 2020).

The shapes of long-necked jars and deep bowls which characterize the Khitan pottery are different to Bohai pottery. The frequently used pressed patterns are also different, but the shape of the rims of bowls (Fig. 12.4a: 1; b: 17; c: 30, 31), pots (Fig. 12.4a: 9; c: 32) and neckless jars (Fig. 12.4b: 16; c: 28) is similar. At the same time, the bridge-shaped handle as shown in Fig. 12.4a: 12 has an embossed pattern unique to Khitan pottery, but this kind of handle is common in Bohai pottery (Fig. 12.4c: 30, 31).

Although it is necessary to review this after becoming more familiar with the characteristics and composition of Khitan daily utensils manufactured before their advance into the Mongolian Plateau, the similarities they share with Bohai pottery at the ruins of Chintolgoi Castle are probably due to the fact that Bohai craftsmen were involved in their production. Tiles with the design of the Bohai Sea have been excavated at Zuzhou Castle, Liaoyang Castle and Raozhou Castle, which are locations to which Bohai people are known to have immigrated. This suggests a high possibility that Bohai immigrants were engaged in production activities at such locations (Shimada 1993: 140, Mukai 2011).

Khitan pottery kilns appear to have been discovered in Shangjing, but their details are unknown, and thus comparative studies cannot be conducted. Nevertheless, as discussed above, the design and construction of Chintolgoi Castle are assumed to have been directly transferred from the Khitan homelands, and since many of the items produced using the kilns are assumed to have been general daily utensils used by the Khitans, the techniques and systems of the production of pottery were probably established among the Khitans before they advanced into the Mongolian Plateau. Despite the involvement of Bohai craftsmen, perhaps those techniques and systems had already been incorporated into pottery production before their relocation to the area.

However, some cases cannot simply be explained by the transfer of techniques and systems from the Khitan homeland. The patterns on the pottery found at the Chintolgoi Castle ruins are mainly pressed patterns, cryptograms and ridges on the neck and the lower half of the body. Many pressed patterns feature long and short triangles and squares. There are also pressed patterns of overlapping half-arcs by the stamp, as shown in Fig. 12.4a: 13 and Fig. 12.4d: 33. These items were probably produced in a manner similar to that used to produce other artifacts on the site, as many were excavated at the site and they exhibit the same patterns as the other artifacts. However, these patterns were not found on the pottery in other Khitan territories. This type of pressed pattern is similar to a class of pattern variations found in Uyghur pottery (Fig. 12.4d: 34, 35). Although there is a gap of about 200 years between the downfall of the Uyghur Khaganate and the advancement of the Khitans into Mongolia – thus allowing room for further investigation – the similarity in the patterns suggests that earthenware and stoneware production workers from Chintolgoi Castle

remained in the region and associated with those who were involved in the production of Uyghur pottery.

To summarize the above aspects, the pottery production at the Chintolgoi Castle appears to be a fusion of pottery traditions of different origins. Artifacts of the material culture of the Khitans may reflect the state of “imperial” governance by the Khitans, requisitioning and reorganizing groups and techniques of other peoples in the area along with the extension of their territory.

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## The Production System of Kiln-Fired Pottery in the Korean Peninsula

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**Abstract:** This essay examines how the technology of the kiln and potter's wheel introduced in the early Proto-Three Kingdoms period replaced the long-term continuous ceramic technology tradition, and how the process of the replacement was different in each regional part of South Korea. Unlike in the Han River basin, where kilns were introduced late and different types of pottery were produced by different organizations, the Nakdong River basin integrated production of Wajil ware (gray-colored and kiln-fired earthenware) mainly for offering in burials, and Yeonjil pottery (orange-colored and mostly open-fired earthenware) for daily use at an early stage. This is the background to the regional differences in ceramic production during the Korean Three Kingdoms period.

**Keywords:** Proto-Three Kingdoms period, Han River basin, Nakdong River basin, Wajil ware, Dojil ware

### 13.1. Introduction

It was at the beginning of the Proto-Three Kingdoms period (P-TKP, 100 BC–AD300) that kiln firing was, for the first time, applied to the pottery production in ancient Korea. According to the Records of the Three Kingdoms (*Sanguozhi*), a Chinese historical record of the same period, during the P-TKP, 78 *Guk* (small-scale polities) were distributed in the southern part of the Korean peninsula and the Lelang commandery, which was established by the Han Empire, was located in the northwest. In this period, the polities of South Korea were able to participate in a network of close interaction with Chinese civilization through the commandery. Through this Northeast Asian network, the technologies of ceramic and iron production were introduced to Southern Korea and the new technology triggered the process of technological innovation in the indigenous society (Barnes 2015: 317–22). During the Korean Three Kingdoms Period (KTKP, AD 300–676), the early states, such as Baekje, Silla and the Gaya polity group rose in Southern Korea. Along with the sociopolitical development, the central workshops of some polities turned to large-scale industry; the ceramic production systems were hierarchically organized within both early states, Baekje and Silla. In this chapter, the process of technological innovation in pottery-making and the transformation of the production system will be discussed in the two regions, where Baekje and Silla rose up. It will be described how the kiln firing and potters' wheel techniques were adopted and connected to technological innovation and how this organized ceramic production in two different sociocultural contexts.

### 13.2. The pottery production system in Korea

Research on the organization of pottery production has been of interest to archeologists for quite a long time. This

usually started with the question of how it relates to social complexity, focusing basically on the economic aspects of pottery production. At first, archeologists interested in the organizations of production took the approach of classifying them into several types, taking into account the economic, social and political attributes of craft production. Since the early 1990s, Korean archeologists have also been discussing the organization of ceramic production, and attempts have been made to distinguish the types of production system according to the level of specialization, the degree of production and the scope of distribution (Lee S.1991; Choi G. 2000; Cho S. 2014).

The recent research on the organization of ceramic production has changed considerably. The problem with the formal approach has been pointed out: that by categorizing the production systems into several types in advance and fitting the various ancient organizations into them, one could ignore the various characteristics that appear in ethnological and archeological data (Costin 2001). Recently, from the perspective of relational ontology, the organization of ceramic production has been not seen only as a product of social processes. Instead, by understanding the organization of production as a result of the interaction of people, tools, artifacts, materials and animals, a new approach to it is required (Duistermaat 2017).

The pottery-firing features of the Jeulmun (8000–1400 BC) and Mumun periods (1400–100 BC) remain basically in the form of shallow, simple burnt pits that have mostly been found near villages (Kim H. 2002; Bae S. 2007). No research has yet been conducted on what quantity of vessels was produced from those open firing features near the villages and how widely the products were distributed. However, it is not too difficult to conclude that the products



of such firing features were not widely consumed, nor can it be admitted that there were specialized potters who were exclusively engaged in pottery production, because of their simple, rough forming skill and badly unstandardized shapes. However, in the KTKP, large-scale nucleated workshops (Peacock 1982) found near the capital and main settlements of Baekje, Silla and Gaya were composed of a number of tunnel-type climbing kilns (GNRICH 2004; Lee J. 2008).

It is, therefore, hard to deny that in the KTKP, a specialized mass-production organization emerged along with the development of a complex society, while the Jeulmun and Mumun period pottery production could be characterized by a low level of specialization. The most meaningful time in the process of the organizational development of pottery production is the P-TKP. At this time, the kiln of which the heating chamber was separated from the firebox was introduced from Northeast China, and technological innovation was carried out in the process of selecting raw materials, preparing bodies and forming vessels. In addition to these technological innovations, fundamental changes had also begun in the organization of production (Lee S. 2014).

Some studies focus on the development of production organization according to the sociopolitical changes, but others pay attention to the coexistence of different production systems in a society. In Baekje, the various organizations, which were divided depending on the function of the vessel, the social status of the consumer, the *chaîne opératoire* and the spatial range of distribution, coexisted and were closely related to each other. Choi Gyeonghwan classified the organization of production, analyzing the kiln remains of Baekje, into “small-scale,” “regional” and “governmental” workshops according to the scope of consumption and whether the government was involved (2000). The small-scale workshop equipped with one or two kilns was operated inside a village of dozens of households, where four to five types of vessels that commoners used in their homes were formed and fired at a relatively low temperature. The regional workshop had limited types of vessels, but with highly developed skill, produced in large quantities and supplied for a wide range of consumption. On the other hand, the governmental workshop operated directly by the central or local government was specialized in producing the vessels necessary for official activities and consumed by the ruling class (Choi G. 2000).

### 13.3. The development of kiln firing

Until the Mumun period, pottery had been produced by open firing methods. The firing process had been carried out in an oxidation atmosphere within shallow round pits or long trench-shaped features of which the floors were occasionally pebbled (Kim H. 2002, Bae S. 2007). The prehistoric open firing facilities had a structure that could not control the air, so the pottery fired in them was red or brown. The type of kiln which can control the flow of air

by separating the firebox and the heating chamber began to be used in the early P-TKP. Considering the emergence of the gray vessels produced in a reducing atmosphere in the settlement and pit-burials in the Han River and the Nakdong River basins from the first century BC, it can be said that pottery was already made in a workshop equipped with kilns. However, although in some archeological sites kiln remains have been reported, there are few well-preserved examples of the feature.

It seems that trench-type and round-pit-type open firing facilities were still in use for brownish-red, low-fired pottery until the P-TKP. In addition, there were other types of structures where grayish pottery was fired in a reducing atmosphere, but well-preserved kiln structures have never been identified. It is highly likely that various firing structures including kilns coexisted during the P-TKP (Kim J. 2007). Among them, there was the Ga-13 Kiln of a very interesting structure in Hwangseongdong settlement, Gyeongju. The settlement has been recognized for its importance as a large-scale iron production site of the P-TKP. The kiln was found in the middle of the settlement, where furnaces, smelting facilities and waste dumps were densely distributed along with a lot of pit-houses. The narrow and long firebox was built somewhat deep underground, but the heating chamber has a wide square plane. There is a study that points out that the structure of this kiln is similar to that of the semi-down-drift (*Bandaoyan*) type domical cover kiln (*Mantouyao*, Liu Z. 1982) that had been popular since the Warring States period in northern China (Nagatomo 2019). In the early P-TKP, the type of vessel fired in a reducing atmosphere which first appeared in southern Korea is a round pot formed by the paddle and anvil technique (Lee S. 2008). The form and paddling procedure of this pot originated from the technological tradition that had spread in Northeast China since the Yan State occupied the region. Therefore, it can be assumed that this kiln structure and firing technology, which had settled in Manchuria during the period from the end of the Warring States period to the Early Han Empire (the third and second centuries BC), was introduced to Southern Korea in the first century BC.

The firing structures of the KTKP in Baekje, Silla and Gaya belong to the category of the long, oval-shaped, tunnel-like climbing kiln. These structures were usually constructed on slopes and quite similar to the structure of the dragon kiln in China. This type of kiln is thought to have appeared at the end of the P-TKP (late third century AD). But in fact, there is no climbing kiln which actually belongs to the P-TKP, and a kiln dated to the early fourth century is the earliest example. In general, the climbing kiln of the KTKP consists of an underground or semi-underground long tunnel-type heating chamber and a short firebox attached to the front. All climbing kilns structurally belong to the horizontal-draft type and basically share common attributes, but each of them differs in plane shape, total length, degree of slope and the volume of the heating chamber.

There are two important examples of climbing kilns of the early fourth century, one of which was found in the Sansuri ceramic production site of Baekje, Jincheon (Choi B. et al. 2006) and the other in the Ugeori workshop cluster of Ara-Gaya, Haman (Lee J. 2007). Both started production in the early fourth century and are of the semi-underground style. The former, Sansuri type is characterized by a subterranean firebox installed much deeper than the heating chamber, while the latter, Ugeori type is constructed so that the floor of the firebox and heating chamber can be connected naturally without any difference in height. When fueling the former's firebox, the fuel would have been thrown from top to bottom, but in the latter, it would have been pushed in from the side. While the heating chamber of the Sansuri type is wide and short, the Ugeori type is long and narrow. The products of the Ugeori-type kiln were sufficiently heated up to 1200°C to cover their surface with natural glaze (Lee J. 2007), but those of the Sansuri type seem to have completed their firing process at much lower temperatures. In the fourth and fifth centuries, kilns in the Baekje area belonged to the Sansuri type, while the Ugeori type represented the structural features of Silla and Gaya's kilns. However, in the fifth century, workshops in Baekje also employed Ugeori-type kilns; this seems to have been for the production of hard-fired Dojil ware. Baekje built various types of kilns, even accepting Chinese kiln structures, but Silla and Gaya improved and developed only the Ugeori-type kiln.

The origin of the kilns in southern Korea can eventually be found in ancient kilns in China. Chinese ceramic researchers classify ancient kilns by two criteria: the way the flow of heat is guided and the shape of the plane. In the development of ancient Chinese kilns, researchers attach great significance to the emergence of the semi-down-draft, round kiln or domical cover kiln in North China and the invention of the horizontal-draft dragon kiln in South China (Liu Z. 1982; Xiong H. 2014: 49–74). Since more direct interaction between Korea and China began from the end of the Warring States period, it is possible that the firing technology and the kiln construction method of the Korean peninsula could have been influenced by the round kilns in North China and dragon kilns in South China. Some researchers say that the round kiln and its firing technology were introduced in the early P-TKP, leading to the production of soft gray pottery, Wajil ware (Lee S. 1992; Barnes 2001: 106; Nagatomo 2017). It is also claimed that at the end of the P-TKP, some groups in the southeast coastal area accepted the dragon kiln from South China and began producing hard-fired Dojil ware (Choi J. 1994; Shin G. 2012; Nagatomo 2017). However, there are also archeologists who think that the Dojil-ware kiln was not directly affected by the dragon kiln because it was quite different from that of South China at the same time and the paste and shape of the Dojil vessels were completely different from those of the Chinese products. They argue that the long oval-shaped climbing kiln of the KTKP was completed by improving China's round kiln, introduced in the early P-TKP, and constructing it on the slopes of hills (Lee S. 1992; Kim J. 2007; Gu Y. 2009).

### 13.4. The technological innovation in different contexts

In the early P-TKP, technological innovation begins in this region, as the *chaîne opératoire* of kiln-fired pottery was introduced to the communities of Southern Korea. It is thought that the role of potters who visited from Northeast China or Lelang was important for the introduction of technology. However, it would be indigenous potters who physically acquired it through learning and practice and applied it to the production of various vessels in practice to lead the innovation (Lee S. 2014: 243–48). The ceramic assemblages which illustrate the process of technological innovation, starting relatively early and slowly replacing the Mumun pottery group with the kiln-fired one, are found in the settlements of the Han River basin in the central part of the Korean peninsula and in villages and burials in the Nakdong River basin in the southeastern part.

In the early stages of technological innovation of both regions, the vessels related to the new technologies are limited to only one class of vessel, the round pot, which had not previously been seen in Mumun societies. For manufacturing the round pot, fine clay mixed with silt was prepared, and it was fired in a kiln that, though imperfect, could control the inflow of air under a low-temperature, reducing condition. So, the kiln-fired pottery of the P-TKP is basically characterized by a soft and gray fabric. Although the potter's wheel was used in the forming process, the turning method was applied to adjust the symmetry, reduce the variations in wall thickness and finish the surface of the vessel rather than to throw it. In the P-TKP, there was a tendency to make the bottom of a vessel round; the method used to complete a round-shaped vessel was the paddling and anvil technique. In the early stage of innovation, all these new technological elements can be identified only in round pots, and other vessel types used in every utilitarian and ritual context were all made with traditional Mumun techniques. However, the *chaîne opératoire* of the new technology was gradually extended to other traditional types of vessels. It can therefore be said that the new techniques did not quickly replace the traditional ones and that the technological innovation was made possible by the traditional Mumun potter who acquired the embodied skill of the kiln-fired pottery technology.

The process of technological innovation in communities in Southern Korea during the P-TKP shows very interesting regional differences. The communities in the Han River basin rarely built tombs, and therefore had no burial food offerings in which ceramic vessels were used. Thus, to explain the technological innovation of pottery production in this region, it is necessary to rely on the ceramic assemblages found in the settlement sites. Within each house, a considerable number of different kinds of pottery were used for the storage, transportation, cooking and daily meals in a household. Among the various utilitarian vessels, the new technology was limited to the production of only two types: the round pot and small flat-base jar. The

other various utilitarian wares were all produced based on traditional forming and firing methods. Therefore, they were brownish red and hardly standardized, and they were completely different from the round pot formed by the turning and paddling technique and fired in the kiln. It is difficult not to acknowledge that the two vessel groups, which were clearly distinguished in technological tradition, would have had a different organization of production. Until at least the early fourth century, the organization of ceramic production had been separated in two. Even though traditional potters had sometimes tried making round pots or small jars, it is hard to find any attempt to make traditional vessels with the new technologies during the separated period (Lee S. 2011). From the late fourth century, turning and paddling techniques began to be applied to the production of the most common utilitarian vessel types, i.e. the bowl, long egg-shaped jar and large storage jar, which had been produced with the traditional Mumun techniques. As the new technology is applied, the shape and size of each type of vessel is almost perfectly standardized (Lee S. 2011).

In contrast, in the Nakdong River basin the construction of tombs seems to have been very important sociopolitically. Inside a pit-burial, using funeral facilities, such as a wooden coffin or wooden chamber, a considerable number of ritual vessels was dedicated in various ways. In particular, depending on the social rank of the deceased, the size of the burial structure and the dedication of the grave goods, including ceramic vessels, were greatly variable. So, in the elite burials of the late P-TKP, a large quantity of the elaborately manufactured Wajil vessels was consumed to differentiate them from other tombs. On the one hand, Wajil ware was originally used to refer to the low-fired gray pottery tradition before the emergence of hard-fired Dojil ware, but on the other hand, it is also a concept used to refer to the elaborately made pottery group for burials.

In the early stage of technological innovation, the vessels manufactured on the basis of new technology in the Nakdong River basin, like in the Han River basin, were limited to round pots. However, the new *chaîne opératoire* of round-pot production, unlike in the Han River basin, was rapidly expanded to the production of traditional Mumun vessel types. In the first century BC, all of the utilitarian and ritual vessels, except round pots, were made with traditional Mumun techniques. However, after about a hundred years, new forming and firing techniques were widely applied to the production of traditional vessel types, the small carinated bowl, long-necked jar, bowl and long egg-shaped jar. In the Nakdong River basin, the traditional organizations of production and the new technology-based one were not separated, unlike the circumstances in the Han River basin. As soon as some indigenous potters learned the *chaîne opératoire* through the practice of round-pot production, the number of potters who acquired embodied skill increased and they began to produce traditional Mumun-ware vessels with new technologies. Especially in the southeastern part of Korea, the production system, which was organized based on new

technology, produced various vessels for consumption in the burial rituals as well as daily practice (Lee Sungjoo 2014: 243–54).

### 13.5. Regional variation of ceramic production systems in the Three-Kingdom period

So few ceramic production remains have been archeologically discovered that the production systems of the P-TKP must unavoidably be approached through sherds and vessels excavated from the consumption sites. As mentioned earlier, even within Southern Korea, there were differences in the date of new technology introduction, the limit of application, the products, consumption and organization of production regionally. It can be assumed that this difference was caused by the different economic and sociopolitical contexts of each region (Nagatomo Tomoko 2008, Lee Sungjoo 2014: 173–211). The processes by which the organizations of the production and distribution of P-TKP were formed had great differences from region to region.

During the KTKP, the early states such as Baekje and Silla rose in Southern Korea. The Gaya, located between the two states, was divided into dozens of small-scale polities the social complexity of which reached a considerable level despite their being small political entities. In organizing ceramic production, the small polity (*Guk*) was very important as a political and social background from the P-TKP (Lee S. 2014: 248–58). No matter how ceramic production was organized, it resulted from the sociopolitical engagement of the social agents of *Guk*. However, after Baekje and Silla achieved a wide political integration, the ceramic production systems were organized in different ways in the central and local areas of the two early states (Lee S. 2012).

The beginning of production using the Ugeori-type kiln is estimated to have been in the late third century. There is no kiln, as an archeological finding, of which the date has been determined back to the late third century. But since the burials where Dojil round pots produced in Ugeori-type kilns have been found belong to the late third century, the date of the Dojil-ware kiln can be estimated. Because those early Dojil round pots are almost exclusively found in the burials of Haman and Gimhae, it seems that the Dojil-ware kilns were first operated only in those two regions (Lee S. 2008). First of all, the products of Haman and Gimhae were not only fired at high temperatures that induced natural glaze. In addition, the forming procedure based on the distinctive methods of potter's wheel and paddle usage, being a *chaîne opératoire* that had not been seen so far, was very effective in the mass production of round pots (Lee S. 2014: 311–24). These early Dojil-ware workshops produced only one type of vessel, the round pot. The surfaces of the vessels had the mark of a Haman product because the dried vessels were piled up in a specific way inside the heating chamber to be fired (Lee J. 2007, Jung J. 2009). Tracing the vessels bearing the Haman marks allows us to recognize that the

Haman products were distributed in a fairly wide range of Nakdong River Valley.

The earliest Dojil-ware workshops operated only in a limited area of the southeastern coast of the Korean peninsula. However, the round pots of the Haman workshop were mass-produced for wide-ranging consumption. The potter who produced a limited type of vessel in large quantity was able to keep the level of his/her embodied skill fairly high and produce standardized vessels. By the middle of the fourth century, Dojil-ware workshops produced other types of vessels besides the round pot. They expanded their production list to include the mounted dish, cup, large jar, mounted jar, pot stand etc. previously produced by other organizations of production (Jung Juhee 2009, 2019). Although the number of vessel items increased, each type was highly standardized because the programmed forming process of each vessel type was carried out elaborately by full-time specialists (Lee Sungjoo 2012). It is also correct that the Dojil vessels were used in everyday life, but most of them were excavated from burials, and a large number were actually consumed in the burial rituals. In particular, some types of vessels, such as pottery stands and mounted jars, are rarely found in common people's houses, so they may not be related to their daily lives. They may have been produced because of burial ceremonies or demand from higher classes.

Although most of the defective products deposited at the dump in the kiln site are hard-fired Dojil ware vessels, a small amount of Yeonjil ware (soft-fired potteries) and utilitarian vessels are also included. The firing of utilitarian vessels seems to have been finished in an oxidizing atmosphere and at a low temperature, injecting relatively small amounts of fuel, because a perfect vitrification or very high hardness is not required for storage and cooking vessels. Since the utilitarian ware was generally low-fired, it had less frequent defects due to over-firing. Thus, the fact that a small number of Yeonjil utilitarian vessels has been unearthed from the Ugeori-type kiln's dump does not mean that its production was also low. In short, the Dojil-ware kiln of Silla and Gaya produced all the vessels consumed by the upper classes as well as ordinary people, and used in rituals as well as daily life. In a small-scale polity, only one kiln was operated within its area at any one period. This was different from Baekje, where a workshop equipped with one or two kilns operated in each large village. In an early state like Silla, a number of kilns are distributed within its territory, but they are concentrated in both state capital and local centers. Although Silla and Gaya also have small-scale ceramic production sites equipped with one or two kilns, they are usually found in locations unrelated to the village (Kim J. 2016), so they were not workshops for the village community. Judging from their products, they worked with greater emphasis on production for the demand of burial rites and the consumption for the upper class than for utilitarian usage in commoners' village life. Considering the distribution of the kiln remains, as mentioned so far, it is highly likely

that political power intervened in the whole organization of ceramic production in Silla and Gaya.

During the P-TKP, the utilitarian wares based on the traditional Mumun pottery techniques and the round pot and small flat-base jars, which were made with new technology, were produced by separate organizations. However, the firing structure in which the utilitarian vessels were produced in the settlement sites is not known until the early fourth century. Although it has not been confirmed through archeological excavations, it is assumed that the firing facilities of the Proto-Three Kingdom period villages would be open firing, similar to those of the Mumun period. As the potter's houses in which the clay body prepared for forming and carbonized wooden turn-tables are found have no differences from those of ordinary people in the village, it can therefore be said that the process of forming and drying was also carried out at a low level of specialization.

It was in the early fourth century that the climbing kiln appeared in the Baekje area and began to produce, almost exclusively, round pots. However, it was a little later that the climbing kiln was introduced into the village workshop and that the wheel-turning and paddling methods began to be applied to the forming of various utilitarian vessels. Unlike in the Silla and Gaya area, where the unified production systems which produced all the vessels to serve the demand of each polity were operated, this ceramic production, organized around several villages, continued in the Baekje area until the sixth century.

In Baekje, the workshops were organized separately by political power for the production of vessels different from the products of village kilns. The upper classes of Baekje imported and used various Chinese celadon items from the fourth century on. From the late fourth century, potters of the official workshop produced imitations of Chinese imported vessels of an earthenware quality. There are production organizations that manufactured and supplied the well-made vessels of fine workmanship and those needed by the central and local governments of Baekje. Hence, it seems that in Baekje, the production for commoners and that for the upper classes' needs were separated and organized hierarchically.

### 13.6. Conclusion

The technology of kiln and potter's wheel introduced in the early P-TKP replaced the long-term continuous ceramic technology tradition. The process of replacement was different in each regional part of South Korea. In this chapter, without explaining all the regional variations, the process in the Han River basin and that in the Nakdong River have been compared and discussed. At the settlement sites in the Han River basin, where more artisans, including potters, visited from the Lelang commandery, the new technology failed to spread rapidly to the production of traditional utilitarian vessels and was delayed for more than 300 years. The production organization of round pots

based on new technology had long been separated from that of the utilitarian-ware tradition. The Sansuri kiln cluster, which worked in the fourth and fifth centuries to produce a single type of vessel, the round pot, succeeded the tradition of the previous round pot production. However, in the Baekje area, there was another organization that produced the various vessels and the other ceramic products, which was controlled by the early state. In the Nakdong River basin, on the contrary, the indigenous Mumun potter who had acquired new technology from the immigrant potter applied his/her embodied skill in a relatively short time to the traditional types of utilitarian vessels. In the innovation process of Dojil ware, the production of the Wajil ware consumed for burial rites and that of the Yeonjil-ware vessels for domestic use were integrated by the potters who had acquired the technology of the climbing kiln and rapid wheel-turning.

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## Social Background to the Kilns and Pottery Production Systems of the Ancient Korean Peninsula

Takafumi Yamamoto

**Abstract:** Following the Proto-Three Kingdoms period, when pottery production based on kiln firing took root, pottery differing with each regional polity or state came to be used at the stage when ancient states were established throughout the Korean peninsula. In light of that situation, this essay shows that regional differences between pottery styles and the borders of the kingdoms overlapped in the Korean Three Kingdoms period, based on the political situation. The system of pottery production between these entities might have differed as well. Baekje adopted a dispersed production/urban accumulation system, while Silla adopted a centralized production/regional distribution system. It can be concluded that this distinction between the two states originated from such differences as the social characteristics, political systems, and differences in ritual customs, including burial practice. This regionality of the pottery production continued for a while during the Unified Silla period as well, but the “cultural rivalry” synthesized by the division into separate states vanished, and state involvement in the production of articles of daily use such as pottery faded.

**Keywords:** Korean Three Kingdoms period, Baekje, Silla, pottery production system, government management

### 14.1. Introduction

For pottery of the ancient Korean peninsula, in addition to conspicuous regional idiosyncrasies in vessel types, forms and so forth, variety can be seen in the shaping and trimming, and in the firing technology as well. Looking at the degree of standardization, and at the distribution and scale of the clusters of kilns, it can be supposed that even the systems for producing and distributing ceramics differed from region to region. Taking such a situation as its premise, the current contribution outlines relations between the polities of the Korean peninsula and pottery production for the Proto-Three Kingdoms, Korean Three Kingdoms and Unified Silla periods, and in addition to perspectives on the numbers of kiln groups and their compositions, based on the quality, distribution and consumption of pottery as a product, I endeavor to look at how social background influenced the manufacture of pottery, or conversely how the society of those times can be reconstructed based on ceramic production. In particular, each region was producing stoneware independently during the Korean Three Kingdoms period, and by comparing the various pottery styles and ceramic industries it is possible to elucidate the characteristics of handicraft production for each polity.

Regarding pottery kilns of the ancient Korean peninsula, for which striking increases in data have been seen, as compilations, investigations and reviews of the history of research have been published in Japanese as well (Ueno 2009, 2013, 2015), with advances made in assessing their

lines of derivation and examining relationships with kilns in Japan, those results have been heavily consulted in the current undertaking (Ueno 2017; Nagatomo 2018, 2019).

### 14.2. Archeological characteristics of the Three Kingdoms period of the Korean peninsula

Simultaneously with the Kofun period of Japan, in Korea it was a time when various states and forces were arrayed across the peninsula. In particular the states of Goguryeo, Baekje and Silla were in a powerful three-way contest, and because their rivalry is detailed in historical texts this time is called the Three Kingdoms period. In actuality it is known that in addition to these three states there were various other forces in coexistence, such as Fuyu (Buyeo), Woju (Okjeo), Hui (Ye), Gaya and polities in the Yeongsan River basin. According to the *Samguksagi* (History of the Three Kingdoms), the founding of the Three Kingdoms was in the first century BC, and in texts such as the *Weishu* (Book of Wei) of the *Sanguozhi* (Records of the Three Kingdoms), in the Han (Korea) section of the chapter “Dong Yi” (Eastern Barbarians), the “Han” groups of Mahan, Jinhan and Byeonhan are depicted as divided into small polities holding their separate territories in the southern part of the Korean peninsula until about the third century AD. This era, from around the start of the Common Era until the Three Kingdoms were firmly established, is called the Proto-Three Kingdoms or Samhan period.

In terms of archeology, over the span from the Proto-Three Kingdoms to the Three Kingdoms periods multiple



changes occurred, such as the construction of fortresses, the appearance of kingly tombs with large-scale mounds, the emergence of new pottery styles and the spread of metal prestige goods. There is a tendency to regard this time as the period of ancient state formation on the Korean peninsula, which dates to around the third to fourth centuries chronologically. The Three Kingdoms period continued until the latter half of the seventh century, when Silla unified the three states.

In the same manner as for the Kofun period of Japan, the Three Kingdoms period was when the largest mounded tombs were built in the history of the Korean peninsula, a period of great vigor in rendering authority visible. Also, walled capitals serving as bases from which to rule were built in various regions, and many upland fortresses were constructed in the border zones and at geographically strategic locations. During this time much handicraft production was organized under systems of specialization, and the manufacture of metal ornaments, armor and weapons, equestrian gear, pottery and so forth took on political overtones. As one basis for this observation, materials having differences from one polity to the next in their form and structure are recovered from Three Kingdoms period sites, and these are thought to have served as part of those states' political and cultural identities.

Among such artifacts, ceramics are particularly amenable to sensitive expression and possess forms fully reflecting the intent of those who made them, but behind such acts were the social demands about form as noted above. Variations seen in Three Kingdoms period pottery cannot be dismissed as insignificant regional flavors, but are comprehensive differences in style extending from individual vessel shapes to the composition of vessel types in the assemblage, and from their biased distributions are referred to as the pottery of Goguryeo, Baekje, Silla, Gaya, the Yeongsan River basin and so forth. It was characteristic for each region to have unique vessel types and shapes, as seen in the *ammun* pottery (having patterns of lines made by pressing the surface with a hard tool) of Goguryeo, three-legged vessels of Baekje, representational pottery of Silla and Gaya, and so forth. In Gaya, there were further minute differences in pottery styles from one subregion to another.

Now, why should differences for each region have emerged so clearly even in handicraft items such as pottery? While of course it must be taken as a major premise that the Korean peninsula of the Three Kingdoms period was divided into at least three states plus several regional powers, each with its unique culture, and that those distinctions would be reflected in material culture as well, there are in addition three main factors that can be cited here.

First, the production and consumption of pottery in this era were not self-sufficient, occurring completely within a single household or settlement, as manufacture had already become specialized, and there were extensive

networks of distribution. What is vital is that these spheres of distribution were likely contained within the separate territories, making them clearly distinct from the spread of pottery over mere cultural regions. As background, it is thought that politically motivated regulation of distribution was at work.

Second, these differences between pottery styles were not simply superficial distinctions or variations in outward form, but differences in the very organization of technology and systems of production used in their manufacture. In other words, the existence of differences from one region to the next in the systems for manufacture and the technology of handicraft production were the conditions behind the emergence of differences in material culture. As will be touched upon in this contribution, with regard to the technology and system of production for pottery, in the Silla and Gaya regions the technology of manufacturing tile-clay ceramics was the foundation, and due among other things to a need for mass-producing pottery for use as grave goods, the intensive production of highly standardized, refined pottery is thought to have become established from early on. In contrast, in the Baekje region large-scale kiln groups that would indicate intensive production have not been found, but rather a condition can be discerned in which pottery fired in dispersed fashion in various regions was collected at consumption sites such as the capital. As a result, Baekje pottery is thick-walled and low in standardization, giving an impression of lower skill at pottery-making itself in comparison with Silla and elsewhere. The degree of control and management over pottery production was probably weaker than in places like Silla. The same can be said for the pottery of Goguryeo. Thus, the fact that intensive production was not carried out in Baekje is regarded as one factor rendering the typological chronology of its pottery difficult.

Third, as the most significant premise for explaining the above, it is possible that in each state or region these mutual differences in culture were regarded as part of their identities. As seen in modern society as well, the distinctive cultures of separate countries serve as an element that increases their political and social autonomy. Even for polities within the same general region, the Korean peninsula, the maintenance of different cultures for such a long time can only be due to a notion at work that one's own culture differed from those of others.

Especially in the Three Kingdoms period of the Korean peninsula, utensils were used to assert one's own country's uniqueness, but this was closely related to the practice of importing differing foreign utensils as trade items from an early stage and using these as prestige goods. For example, Baekje expressed a Chinese-style aristocratic culture through the importation of high-fired ceramics from the Chinese mainland, while Silla asserted north Asian connections that it considered linked to its own origins by importing glassware and utensils of gold and silver via the Steppe Route. Powerful groups in Japan imported mirrors to emphasize their connections

with China, using them within their own territories as ritual prestige goods and as a means of control, but in addition to the internal and ideational conditions of the Japanese archipelago, this can also be interpreted as including an intent to make distinctions with other regions. This type of situation likely led to attributing to pottery, along with other handicraft products made within one's own region, the role of medium for making distinctions from others.

Let me introduce a representative example regarding differences in pottery styles among the three Korean kingdoms and powerful groups in their environs, and the political conditions existing within them. It involves a trend in archeological materials attending the expansion of Silla's might and the unification of the three kingdoms from the middle part of the sixth century. From the first half to the middle part of the century, the pottery style of Silla changed gradually, and a style called late Silla became established in which short-legged pedestaled dishes and pedestaled long-necked jars with wide, flared mouths comprised a set. These bear characteristics that clearly differentiate them from the straight-mouthed long-necked jars and pedestaled dishes with long legs seen until the first half of the sixth century. From the middle part of the sixth century on, the distributional sphere of this style broadened greatly to extend as far as the Wonsan Bay area in the northeast part of the peninsula, and from Chungju in North Chungcheong Province down the Namhan River to the modern city of Seoul in the Gyeonggi Province region. This was not only a trend in ceramics, but conforms with the acceptance and spread of horizontal stone burial chambers in Silla, telling of the expansion to the north and west of Silla's cultural sphere, which had been limited to the east of the Sobaek Mountains, and the policy of territorial expansion under King Jineung of Silla seen in historic documents has been pointed out as background.

As Silla's 24th monarch, King Jineung (r. 540–76 AD) changed the title of the country's ruler from the native term *maripkan* to the Chinese word for king (*wang*), and, building upon the base of his predecessors in the first half of the sixth century, Kings Jijeung and Bopheung, who promoted various reforms such as the adoption of Buddhism and the introduction of Chinese-style formal legal codes, he is regarded as a monarch who furthered the policies of centralization of authority and territorial expansion, pushing his territory beyond the Sobaek Mountains, establishing the capital of Chungwon-sogyong, and taking control of the Hanseong region, thereby extending Silla's presence to the western coast of the Korean peninsula and making direct connections with China possible. Through such bold encroachments into the regions of Goguryeo and Baekje, this period set the stage for the subsequent unification of the three kingdoms. Stone monuments commemorating tours of inspection by King Jineung give the most prominent witness to this situation, with four such stelae remaining at Maeunryeong, Hwangchoryeong, Bukhansan and Changnyeong. The locations where these were erected and their ages correlate

with the distributions of Silla tombs and pottery, and make visible Silla's aim for regions incorporated into its territory to be assimilated culturally as well.

From this it is also seen that during the Three Kingdoms period there were examples in which political trends and cultural tendencies were definitely in agreement, with culture likely serving as a means to distinguish clearly self from other, and the existence of some form of cultural policy can be surmised. This stands in contrast to the situation of the Japanese archipelago of the Kofun period, when clear regional differences are not seen in Sue ware, which was fired with newly introduced technology.

#### **14.3. Pottery transitions and ceramic industries of the Korean peninsula**

In this section, the author briefly traces out the history of pottery manufacture in the ancient Korean peninsula, ascertaining at what stage a technological change occurred to firing with the use of kilns. Soft, reddish-brown types of pottery were long made in Japan until the Early Kofun period, but with the transmission of technology from the Korean peninsula there was a transition to a stage where the production of a hard, bluish-grey pottery (Sue ware) was added. But on the Korean peninsula the change from the former to the latter type was rather complicated, with "transitional period pottery" made in forms that were idiosyncratic to each region.

In the Korean peninsula the manufacture and use of pottery began in the Neolithic period, represented by Yunggimun (raised design) pottery and Jeulmun (comb-pattern) pottery. These were all soft reddish-brown wares made by oxidation firing, and while they had a small degree of local color they shared common shapes and patterns over wide regions. These lines of pottery continued to the Mumun and Jeomtodae (clay-band rim) pottery of the Bronze and Early Iron Ages, and the Yeonjil (soft-fired) earthenware of the Proto-Three Kingdoms and Three Kingdoms periods, although theories positing the influx of culture from the outside for the changes in form in each period are persistent. Further, Mumun pottery of the Korean peninsula also influenced the Yayoi pottery of Japan, but this was related to cultural transmissions that included wet-rice agriculture as well.

Pottery of differing materials was produced in various regions in the Proto-Three Kingdoms period, with undecorated earthenware that, even while presenting a reddish-brown color, was relatively hard and high-fired (Gyeongjil earthenware, also called Jungdosik), or pottery decorated with paddle marks (Tanalmun) made in the central region of the peninsula, while in the southeast there was soft grayish earthenware known as Wajil ware, and so forth. Both open-air and kiln firing are posited for undecorated Gyeongjil, but Tanalmun pottery and Wajil wares are regarded as kiln-fired. At the Samryongri/Sansuri kiln site group in Jincheon in the central region, approximately 20 kilns where pottery was

fired from the latter half of the Proto-Three Kingdoms into the Three Kingdoms period (Baekje period) have been investigated, and represent valuable data for considering the specialization of pottery production in one region of the Korean peninsula. At the same time, the operation of groups of kilns with standardized forms has been empirically demonstrated for this period, although their derivation and the occasion of their introduction are uncertain.

On the other hand, as yet no kiln sites have been definitely confirmed relating to the Wajil ware of the same period in the southeastern region, for which standardization was advanced. But as the provision of large amounts of pottery as grave goods in mounded tombs progressed in this region from the Three Kingdoms period on, it is thought that the creation of a system of organized pottery production advanced at this time.

Although shapes and patterns of pottery were shared over broad regions of the southern part of the Korean peninsula until the Early Iron period, the beginning of diversification of pottery was in the Proto-Three Kingdoms period. As background for that, it is considered that small states and regional groups having the nature of confederations began to emerge in the central and southern parts of the peninsula, where moderate cultural integration had previously been maintained. In particular, the situation of the various states of the Mahan, Jinhan and Byeonhan confederacies recorded in Chinese historic texts starting to manufacture their separate potteries is evaluated as a turning point leading to the subsequent production of pottery along strict lines of regional polities. Further, the Chinese commandery of Lelang was established in the northern part of the Korean peninsula in 108 BC, and the influx of Han culture also had a great influence on changes in pottery and pottery manufacturing technology.

Passing through the Proto-Three Kingdoms period, when transitional pottery was made of various materials region by region, in the Three Kingdoms period the technology for making hard, reduction-fired pottery became established in the southern part of the peninsula. As noted above, material culture differed in the Three Kingdoms period for each state or wide region, but pottery provides data that most strikingly reflect this situation. That the distributions of pottery styles for each country are seen to expand or contract, in keeping with historical phenomena such as Goguryeo's southward advance or Silla's territorial expansion, shows prominently how the "regional political attribute of pottery" was clearly evident. This manner of regional difference in pottery styles was particularly great in stoneware. This is a manifestation of pottery production being managed on the basis of each state or polity, and that the pottery styles of Gaya, in comparison with Baekje or Silla, varied with each subregion indicates that no system had been devised for Gaya to unify pottery production on the scale of the region as a whole. That archeological materials have nomenclatures starting with the names of

states or regions, such as "Baekje pottery," "Silla pottery," or "Gaya pottery," is an indication that researchers tacitly share the above premise. However, as will be touched upon below, even while speaking of the management of pottery production on the part of states or monarchies, this does not always indicate large-scale operation of centralized kilns. The management is inferred to have assumed a variety of forms on a regional basis.

Historically, of the three kingdoms, Silla unified the Korean peninsula in the latter half of the seventh century by absorbing Gaya and annihilating Baekje and Goguryeo. While the representative ceramic of the Unified Silla period, stamped-design pottery, is thought to have appeared at the start of the seventh century, it permeated the former Baekje territory and elsewhere from mid-century at the latest. At this time all of the Korean peninsula was unified as a single ceramic cultural sphere, but whether there were changes in the production and distribution of pottery due to the regional expansion of political control has not been clarified. It is thought that the productive system for Silla pottery up to that time would not have been sufficient to supply pottery to the widened area of control. Judging from the standard of production of stamped-design pottery recovered from the former Baekje territory, the possibility that Baekje's ceramic production system was maintained while being utilized to fire stamped-design pottery should also be considered.

In Baekje and Silla around the time of the seventh century, green-glazed stoneware was being made in some locations. Many of these green-glazed items share vessel shapes in common with conventional pottery, and as the absolute numbers are not many, rather than there having been separate specialized kilns, it is surmised they came from kilns that doubled as ones for ordinary pottery or roof tiles.

After the stage of stamped-design pottery, a style of pottery known from the end of the Unified Silla to the start of the Goryeo period, and comprised of a variety of stoneware vessel types with various vases and bottles as the main component, permeated the Korean peninsula in its entirety, and at this time kilns operating on a large scale were seen in the regional areas as well.

#### **14.4. Traits of pottery kilns on the ancient Korean peninsula**

Following the stage of open firing of pottery, it is not clear under what conditions kilns as built structures were introduced in the Korean peninsula of the Proto-Three Kingdoms period. The earliest pottery thought to have been made by reduction firing is regarded as deriving from China or Lelang, and the kilns and technology for firing itself could very likely have been introduced through any region. There is the view that kilns of different types, such as those with level floors as well as climbing kilns, and of different lines of derivation diffused outward from multiple regions of China or Lelang, and considering the variability in materials and styles of the time this is a

reasonable opinion (Nagatomo 2019), and the discovery and investigation of verifiable examples of level-floor kilns are awaited.

Traces of pottery production through the operation of fully constructed kilns are seen at the Jincheon Samryongri/Sansuri kiln site group of the latter half of the Proto-Three Kingdoms to the start of the Three Kingdoms periods, where over 20 kilns have been investigated. The operation of this kiln group divides into five phases, for which a chronological spread of over 100 years is assessed, from the first half of the third to the middle of the fourth century, and all were built on the slopes of low hills. The structures were for the most part climbing kilns partly dug into the slope, with those from the oldest phase being small in scale, with a maximum width of 1.5 m for the kiln body and a length of 4 m (Samryongri No. 88-2), then growing larger in scale with the passing of time, with some reaching 2.5 m in width and 8 m in length (Samryongri No. 90-4). The slope inside the kilns at 13–16 degrees did not show regularity, but the horizontal plan had a common structure with the firebox greatest in width, then narrowing gradually from the combustion chamber to the smoke hole. Also, the firebox was in the form of a vertical pit one level below the stoke hole, so that fuel was fed into it in a downward manner. The trend toward kilns becoming larger at this time is thought to have been due to a need for mass production and distribution, rather than any advancement in firing technology. According to the site report, the circulation of products from these kilns is assessed as dividing into three stages, with their distribution expanding over time, and it is suggested that in the final stage they reached as far as Pungnap-toseong in Seoul, the base fortress where Baekje located its early-period capital, and were provided to the Seokchondong tomb group, which is thought to include the graves of kings (Choi et al. 2006).

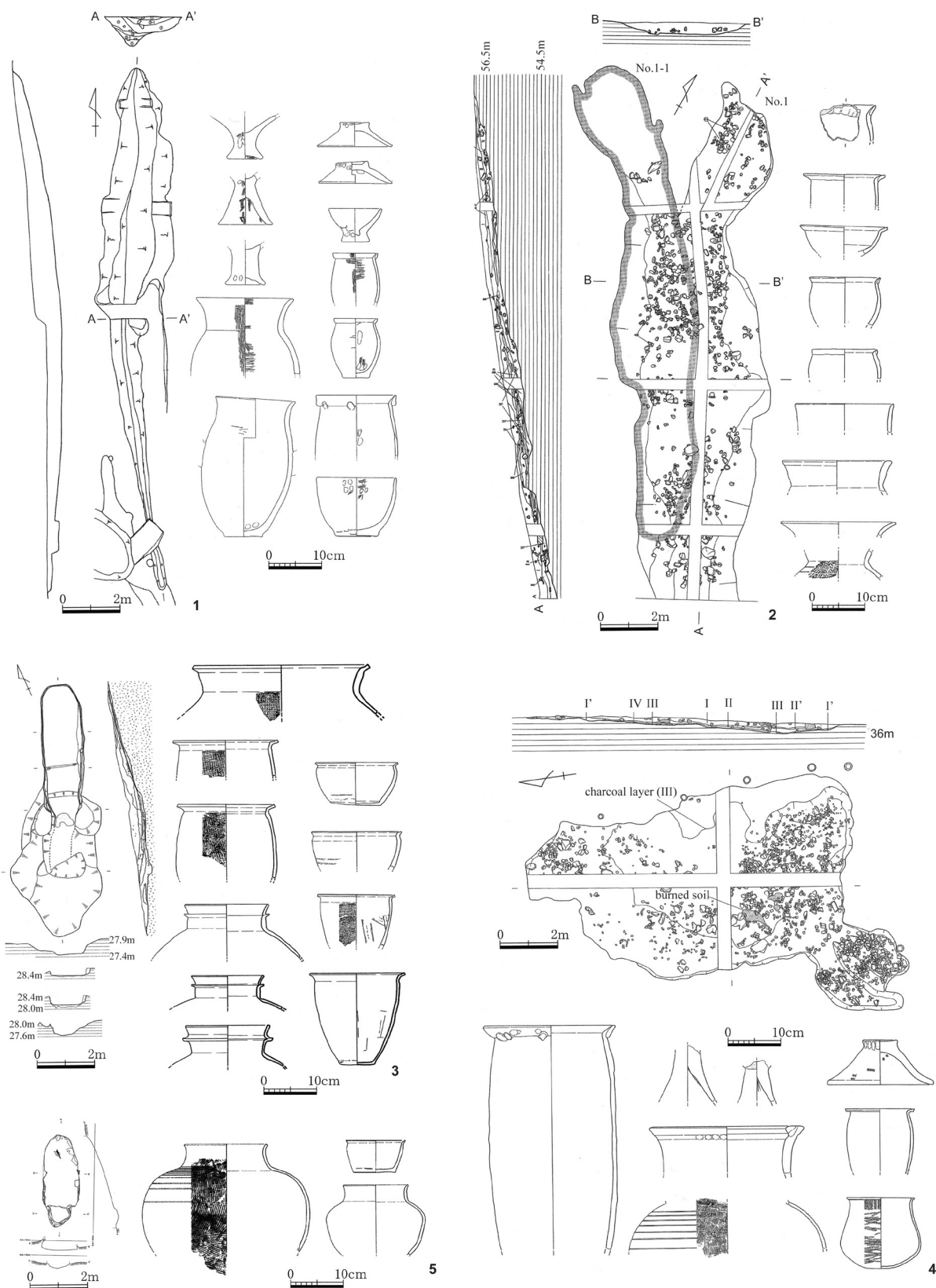
In addition, kiln features of an initial stage have been investigated for the Proto-Three Kingdoms period at the sites of Gajaeri in Hwaseong, Yongwonri in Cheonan, Yonggyedong in Daejeon and Gwisari in Gongju, and elsewhere in the region that would later become Baekje, and at Gundong in Yeonggwang and Gungokri in Haenam in the environs of the Yeongsan River basin (Fig. 14.1). Kilns for firing large thick-walled jars have been discovered at Gajaeri and elsewhere, so it is evident that kilns of this period could maintain temperatures sufficient for firing pottery. If all of these kilns that have been identified over a wide area were of the Proto-Three Kingdoms period, then kilns were introduced sporadically across broad areas of the western coastal region, but relations among the lines of derivation of these kilns are unclear.

Kilns for Baekje ceramics of the Three Kingdoms period are probably successors of Proto-Three Kingdoms kilns of the same region, and are scattered everywhere in Baekje territory, but no kiln group has been found where large-scale operation can be recognized. Examples where only a few kilns have been identified are common, and their productive capacities are insufficient for distribution over

wide areas. They are climbing kilns with subterranean or semi-subterranean kiln bodies that are elliptical to elongated oval in horizontal plan, and built following the slopes of hills. Many of the kilns on the northern periphery of Baekje in particular follow the form of the Samryongri kilns, and as a characteristic they have fireboxes that are clearly in the shape of vertical pits, as for example at the Maeseongri No. 1 kiln in Cheonan. This feature is called a “vertical firebox” or “vertically fed firebox,” and is regarded as a common form of kilns in the western coastal region (Fig. 14.2). By digging the firebox as a vertical pit, the difference in height with the smoke hole is increased, and this was probably intended to raise the temperature within the kiln. At the same time, kilns having only a gentle incline from the stoke hole to the firebox were seen from an early stage in Baekje, so having a vertical pit was not necessarily an essential characteristic of kilns of the Mahan and Baekje regions.

Baekje kilns changed greatly around the end of the sixth to the start of the seventh century. In addition to the climbing kilns with long elliptical forms in horizontal plan seen up to that time, there are kilns having rather wide, level fireboxes and sloping firing chambers raised one level above. There are also examples in which the firing chamber is stepped in form. These are dual-operation kilns that fired roof tiles and pottery simultaneously, and the Jeongamri kiln group site in Buyeo operated on a large scale in order to supply roof tiles for the temples that were starting to be built in great numbers from this period.

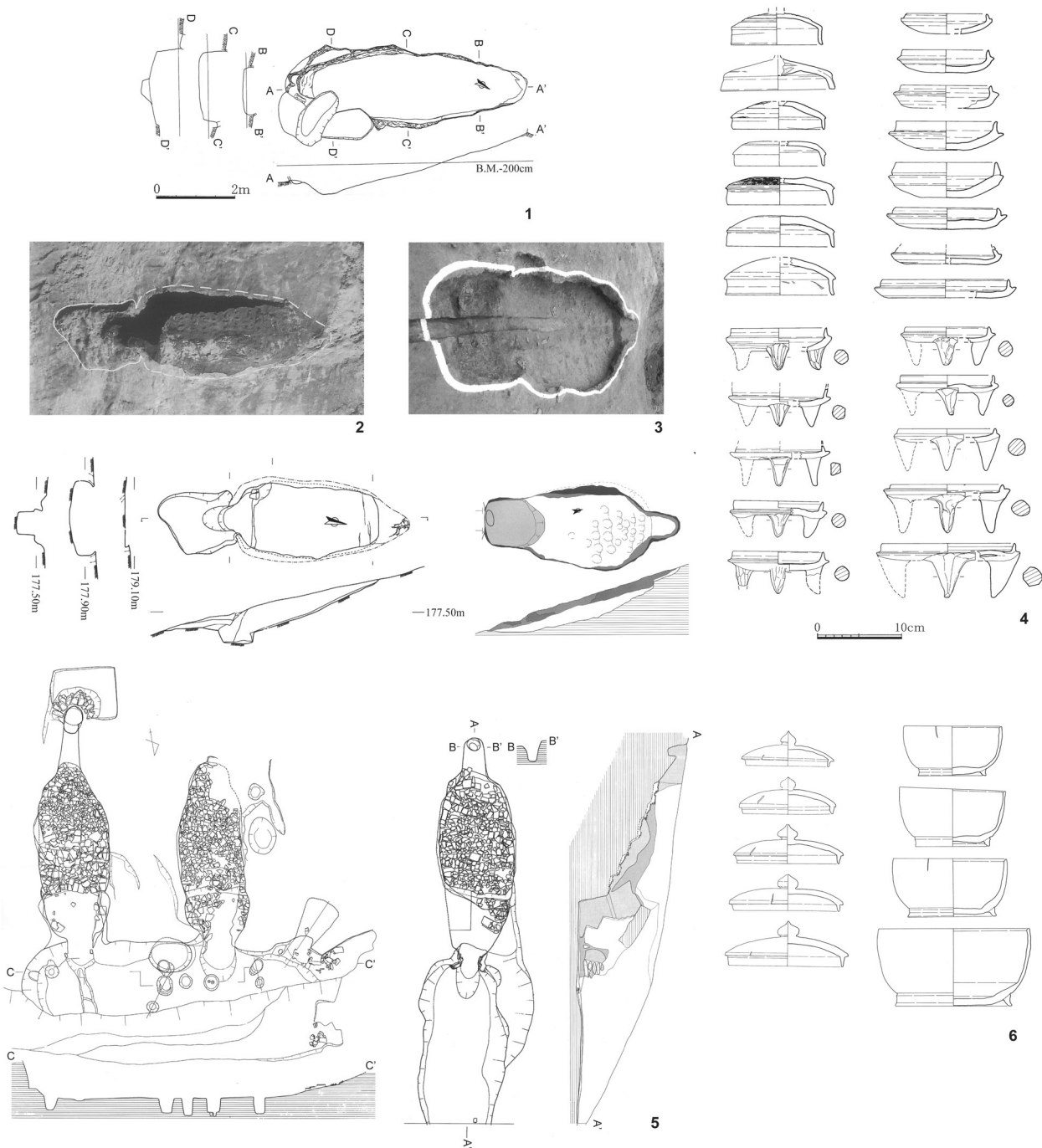
Many pottery kilns have been also been identified in the Three Kingdoms period region of Jeolla Province, which included the Yeongsan River basin, and their characteristics are inherited from those of the Proto-Three Kingdoms period. Many have kiln structures not differing greatly from those of the Baekje region, but in the products and conditions of production there are two major distinctions. First, in connection with the mortuary customs of the area, as it became necessary from around the fifth century to produce in quantity very large jars for use exclusively as coffins, groups of kilns were operated in order to fire these jar coffins (Fig. 14.3). The Oryangdong kiln site in Naju, where the remains of more than 60 kilns and workshops have been identified, is the representative example, and in comparison with kilns that fired general wares for daily use of the same period, many were at least twice as large in terms of firing chamber area, and they were characteristically built with a large forecourt at the kiln’s front. Second, in the Yeongsan River basin of this time a number of huge settlements formed which had between several hundred and more than 1,000 dwelling sites, and kilns were needed to supply pottery for these as well. A pottery kiln belonging to the settlement was built at the Sanjeongdong site in Gwanju, and at the Haengamdong kiln site in Gwanju, where more than 20 kilns have been investigated, from the degree of concentration and placement of the kilns, it can be seen that mass production was carried out in planned fashion and the products were supplied to large



**Figure 14.1. Kilns and potteries of the Proto-Three Kingdoms period (after Kim Jaecheol 2007). 1. Shinchangri site, Gwangju; 2. Bonggyeri site, Sacheon; 3. Gundong site, Yeonggwang; 4. Daeseongdong, Gimhae; 5. Samryongri site, Jincheon.**

settlements in the environs. At the same, from the mid-sixth century on, Baekje pottery came to be made in the Yeongsan River basin as well, and at the Dangga kiln site in Naju, which is representative for this period, the firing chamber floors characteristically have a stepped form. As

this characteristic was also found at the Haengamdong kiln of the previous stage, this change in kiln structure is seen to have occurred within this region, and these local kilns were used to make the newly introduced Baekje pottery.

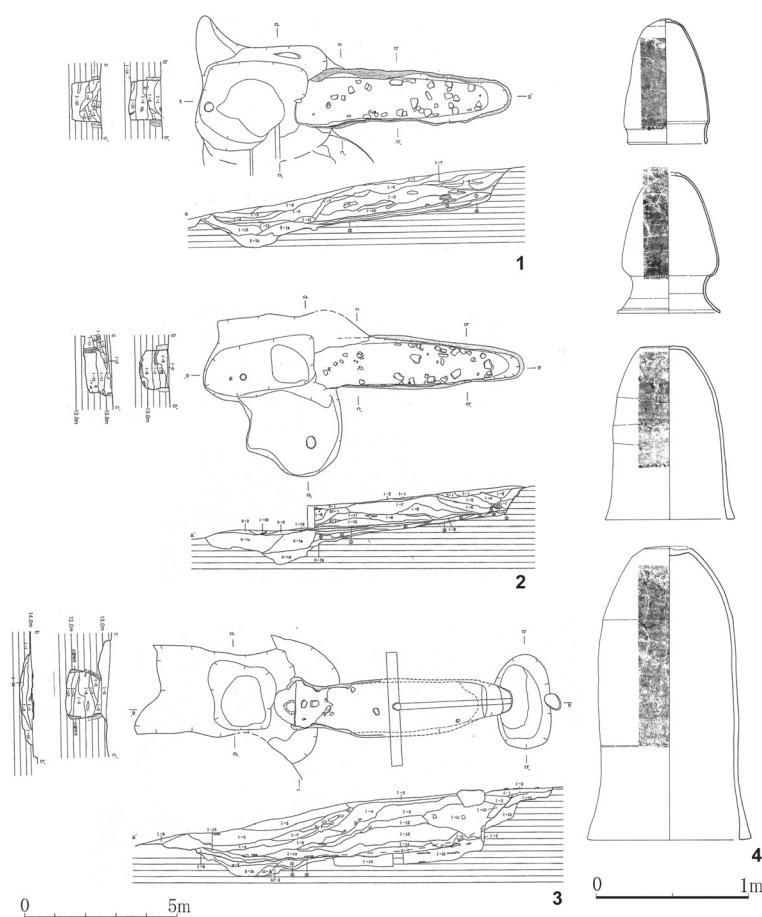


**Figure 14.2. Kilns and potteries of Baekje (Choi Byeonghyeon et al. 2006, CICH 2005, CIHC 2006, BNM1992). 1. Samryongri site, Jincheon; 2. Maeseongri site, Cheonan; 3. Hagamri site, Cheongyang; 4. Various forms of the early type of Baekje pottery; 5. Jeongamri site, Buyeo; 6. Standardized late type of Baekje pottery.**

The initial appearance of kilns in the Gyeongsang Province region is not clear, and while features related to firing from the Proto-Three Kingdoms period at Daeseongdong in Gimhae, Bonggyeri in Sacheon and Hwangseongdong in Gyeongju and others are named as candidates (Kim 2007; Nagatomo 2019), their structures cannot be said to have been standardized, and the lines of derivation are uncertain. At the same time, tile-clay vessels of this period have fixed shapes and styles, and as they are clearly reduction fired there is no doubt that kilns were in existence (Nagatomo 2019). The reason why standardized kiln groups are not

recognized when compared with the western coastal region of the same period is not clear, but it is necessary to consider differences in kiln structure and the relative cultural and geographical distances from China.

Subsequently, at the Hwasanri kiln site in Gyeongju and elsewhere kilns made pottery in the transitional period of the differentiation between Silla and Gaya pottery, while at the Yeochori kiln site in Changnyeong and elsewhere climbing kilns were operated that also manufactured early stoneware, and these had relatively long kiln bodies in



**Figure 14.3.** Kilns and jar coffins of the Yeongsan River basin (Yeon Ong et al 2011, Yamamoto 2016). 1–3. Oryangdong site, Naju; 4. Various forms of jar coffin.

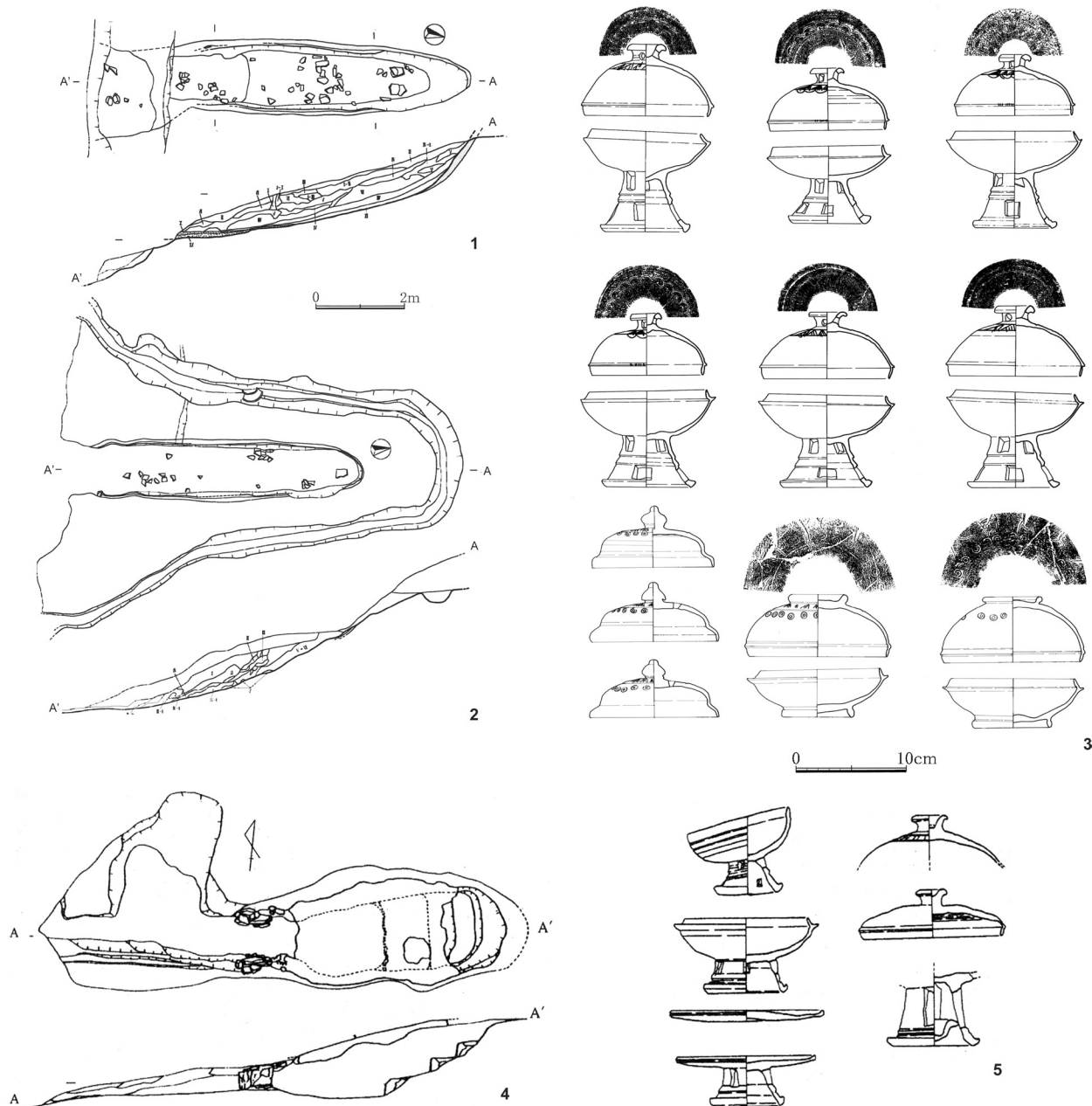
horizontal plan, with the boundary between the firebox and firing chamber being characteristically indistinct.

From the fifth century on, when huge tombs with high mounds came to be made in Silla, large-scale production sites encompassing several tens or more kilns and workshops, as represented by the Songokdong/Mulcheonri kiln site in Gyeongju, came to be operated in Silla (Fig. 14.4). This was a system of production propelled by demands for supply to a permanent capital (one not subject to frequent relocations) and the custom of providing large amounts of pottery as grave goods for the mounded tombs, differing greatly from Baekje, where the capital was repeatedly moved, and the provision of pottery as grave goods to mounded tombs was not very lavish. This type of situation was seen in other regions of Silla as well, and has been confirmed for example at Uksudong in Daegu and Oksandong in Gyeongsan. The kilns of Silla were not greatly different from those of the western coastal region in terms of the size of individual kilns, so they probably managed mass production by the numbers of kilns in simultaneous operation.

In the Gaya region, kilns producing early stoneware have been investigated at Myosari and Ugeori in Haman and elsewhere, and in the same manner as for the western coastal region it can be seen that small-scale kilns became

established at an early stage of the Three Kingdoms period. In structure these were climbing kilns that were oval in horizontal plan, and with consolidated kiln bodies having no difference in height at the boundary between the firebox and firing chamber. Subsequently, separate styles developed in the various subregions of Gaya in the Three Kingdoms period, with each locality using distinctive pottery, but the kilns that made these various Gaya potteries have not yet been investigated. Considering the amounts provided as grave goods for tombs and the standardization of pottery, it is thought highly likely that kiln groups will be found in various locations which made products in bulk numbers.

Historically speaking, from the mid-sixth century on, Silla absorbed the Gaya confederacies, and further advanced into the western coastal region in a manner that split the border between Goguryeo and Baekje. At this time, the style of Silla pottery changed slightly, and the ceramic set comprised of short-legged pedestaled dishes and pedestaled long-necked jars diffused to the regions into which Silla advanced. Kilns that produced pottery of this period have been confirmed in various regions, such as Gimhae and Daegu, so in response to changes in pottery styles of the center and the expansion of state territory, small-scale kilns are seen to have been operated in like manner in each region.



**Figure 14.4. Kilns and potteries of Silla (GNRICH 2004). 1–2. Songokdong site, Gyeongju; 3. Highly standardized Silla pottery; 4. Mulcheonri site, Gyeongju.**

Subsequently, around the start of the seventh century, Silla pottery which had undergone a large-scale transformation (stamped-design pottery) spread across all of the peninsula about the time of unification under Silla. Stamped-design pottery was made in large-scale kiln groups at sites such as Hwagokri and Mangseongri in the environs of Gyeongju, from where it continued to be supplied to the capital and palace, but it is known to have been produced at regional kilns such as Samgyedong in Gimhae as well. As noted previously, looking at the stamped-design pottery recovered from the former Baekje region, there are examples which are notably crude in their firing or decoration, and it is possible that pottery production was being carried out for a time using the previously existing kilns and artisans of local regions. By contrast, regional

differences for kilns are not seen from around the eighth century on.

This situation changes further with the stage of pottery from the end of the Unified Silla to the start of the Goryeo period, as kilns firing massive amounts of products such as the Jinjukri kiln site group in Boryeong are operated in the regions, and take on new roles of supplying and producing pottery. The structure of the kilns does not differ greatly from those of the Three Kingdoms period.

As seen above, from the Three Kingdoms period on, state or monarchy control took effect over the manufacture and distribution of the products of civilization throughout the Korean peninsula. Pottery and roof tiles were no exception,



and as their production has a tendency to change and develop in response to trends in political strength or social currents, investigations into the workshops and kilns which produced them need to keep in mind their connections to political conditions of the time, such as relations between states, when making interpretations of these materials.

Based on this perspective, I wish next to proceed with an examination of the relations between state and social orders and the system of pottery production.

#### 14.5. Systems of production and distribution seen through products and kiln operations

As different styles of pottery were used by each state or region in the Three Kingdoms period, it is difficult to discern whether the lines of craft technology including kiln operations in each region were mutually connected, or whether each developed independently. At the same time, even though the shaping of vessels and the level of manufacture differ, as stoneware began to be manufactured at closely matched periods in the various regions, and as marked differences in the structure of the kilns themselves are lacking, it is observable that on the whole there were no great discrepancies in the technology of firing pottery. What then may have caused the great differences in pottery styles of each region? In checking the numbers and distributions of kilns, and the distributions of the products, it is necessary to take cognizance anew of the underlying differences in the social systems and systems for the supply of materials in each state and region. In order to compare the pottery production systems of each state in the Three Kingdoms period, I would like to take the pottery recovered from the consumption sites (capitals) of Baekje and Silla as objects for examination as manufactured products.

The pottery style typical for Baekje was established during the Hanseong era (to 475) at its capital, which was then located in the vicinity of modern Seoul, and subsequently spread to Gyeonggi Province, Chungcheong Province, Jeolla Province and elsewhere over the western coastal region of the Korean peninsula. Three-legged vessels were the most characteristic type, and kiln-fired items consisted mainly of dishes such as lidded or pedestaled examples, or jars such as those with short or wide mouths. Baekje pottery was also provided among the grave goods of mounds, although the amounts are small, and amounted to the burial of sets of small and medium-sized vessel types that were used in daily life.

As one of the greatest characteristics of Baekje pottery, there are large differences between individual examples even among items of the same vessel type. These are not differences in size, but indicate that various techniques were being employed even while making vessels with a common perception of their type. For example, among three-legged vessels of the same period, the lip rising from the seat for the lid may be made as a single piece with the body or may be a separate attachment, while the legs of those vessels may be shaped and adjusted by manual

kneading or they may be fashioned by cutting away. These differences do not always permit clear distinctions as to the period or region, but may be seen mixed together within items recovered from a single site, and from their commonalities in terms of size and conditions of recovery, they cannot be considered as having been made for different uses either.

Another characteristic of Baekje pottery is that in comparison with other regions the vessel walls are thick, and many of the items are crudely made. This is clear when it is compared with the earthenware or Sue ware of Silla and Gaya of the same period, and even mid- and small-sized vessel types have a heavy feel. Taken together with the aspects of variability in shape noted above, Baekje pottery is relatively poor in standardization, giving the impression that regular styles had not become established.

As background to these unique characteristics of Baekje pottery, although there would naturally have been the individual circumstances of the producers, as there are no great differences with other regions in the structure of individual kilns or in the firing itself, these distinctions may be regarded as differences in the systems of production. To date pottery kilns have been investigated at about 30 locations in the Baekje region, and excluding from these the items of the Proto-Three Kingdoms period the total number of kilns for the Baekje period is not very great. Until about the mid-sixth century, there are no traces of production concentrated at a single location which supplied multiple regions, and from the existence of small-scale groups of kilns in each locale, it can be surmised that there were self-contained production and distribution networks for each local area. In Baekje, which lacked a custom of consuming massive amounts of pottery as grave goods in mounded tombs, there was probably no need for large-scale production. This situation continued from the Hanseong to the Eungjin era (475–538), a period of small-scale capitals at which large populations are not seen to have resided.

This tendency changed starting in the subsequent Sabi era (538–660), when planned moves of the capital were made, and in the first half of the sixth century during this period residential districts were set up at the capital based on a regular checkerboard-like grid of streets, with the surrounding population made to live there in concentrated fashion. At the capital where this populace gathered the volume of pottery consumption greatly increased, but the local system of production and distribution for Baekje pottery prior to that time, which could be termed a “regionally dispersed” or “small-area self-contained” model, could not meet the new demand, so pottery from kilns of the various regions gathered at the capital. In other words, as one reason why examples of the same types of products were mixed together in a variety of shapes, a situation can be supposed in which pottery made in different production sites was assembled at the center. Whether this phenomenon was limited to the capital, or whether similar

situations can be seen for other settlements or tombs etc., will require further examination in the future.

This situation changed in the latter half of the Sabi period (seventh century), when Baekje pottery transformed into a different style, with pedestaled bowls and plates as the main forms. This is called the late Baekje style. The regularization of form proceeded from this period, becoming highly standardized, and production was undertaken at the Jeongamri kiln group in Buyeo adjacent to the capital, where it can be seen that standardized kilns were operated in dense formations. Upon reaching this period, which was the final stage of Baekje, pottery production is seen to have finally come under centralized management of the state or the monarchy.

In contrast to the pottery of Baekje, with its heavy feel and heterogeneity, the thin-walled pottery of Silla and Gaya had the characteristics of being standardized and regular in form, from which the existence of a refined technology of mass production can be surmised. While there is a small amount of stylistic variation from region to region, on the whole a technological homogeneity encompassing multiple regions is visible.

Pedestaled dishes and jar-shaped vessels are the types representative of Silla pottery, and for pedestaled dishes in particular there are several forms, with changes in each vessel form clearly reflecting the age of production. For each vessel type of Silla pottery, products with almost no individual variation were made in great volumes. That the chronology for Silla pottery is detailed and clear-cut in comparison with the pottery of Baekje is due to its regularity of form and universality that were supported by a uniform productive technology. As background for this, the early establishment of a system of mass production in order to satisfy the custom of providing large amounts of grave goods to mounded tombs, and the possibility for continuous management of production and circulation in the outskirts of the political center, since the capital never left Gyeongju, are thought to have been conditions. This form of an organized system for the production of pottery is regarded as lasting from the stage of the fourth and fifth centuries until the seventh century and beyond.

Looking at pottery kilns that have been investigated, it may be seen that large-scale kiln groups were operated in Silla at an early stage in the vicinity of the capital Gyeongju. Kiln site groups at Songokdong/Mulcheonri, Hwagokri, Hwasanri and elsewhere are representative of these, and as more than 80 kilns and related features such as workshops have been confirmed at Songokdong, this is seen to have served as a production site over a long period. Pottery made at these large production sites is thought to have been distributed not only at the capital and large-scale tombs at the center of Silla but throughout the territory, and it is supposed there was also a system by which pottery was produced through imitation in the regions as well. More than 40 kilns have also been identified at the Uksudong/Oksandong kiln site in adjacent parts of Daegu

and Gyeongsan, substantiating the regional existence of such core production sites.

Looking at kiln structure, in comparison with those of Baekje the Silla kilns are standardized in terms of their shapes and scales. There is not much difference with regard to kiln body length between the two regions, and while the slightly narrower kilns of Silla appear inferior in productive capacity per kiln, Silla's mass production is evidenced by the exceedingly greater numbers of kilns in operation.

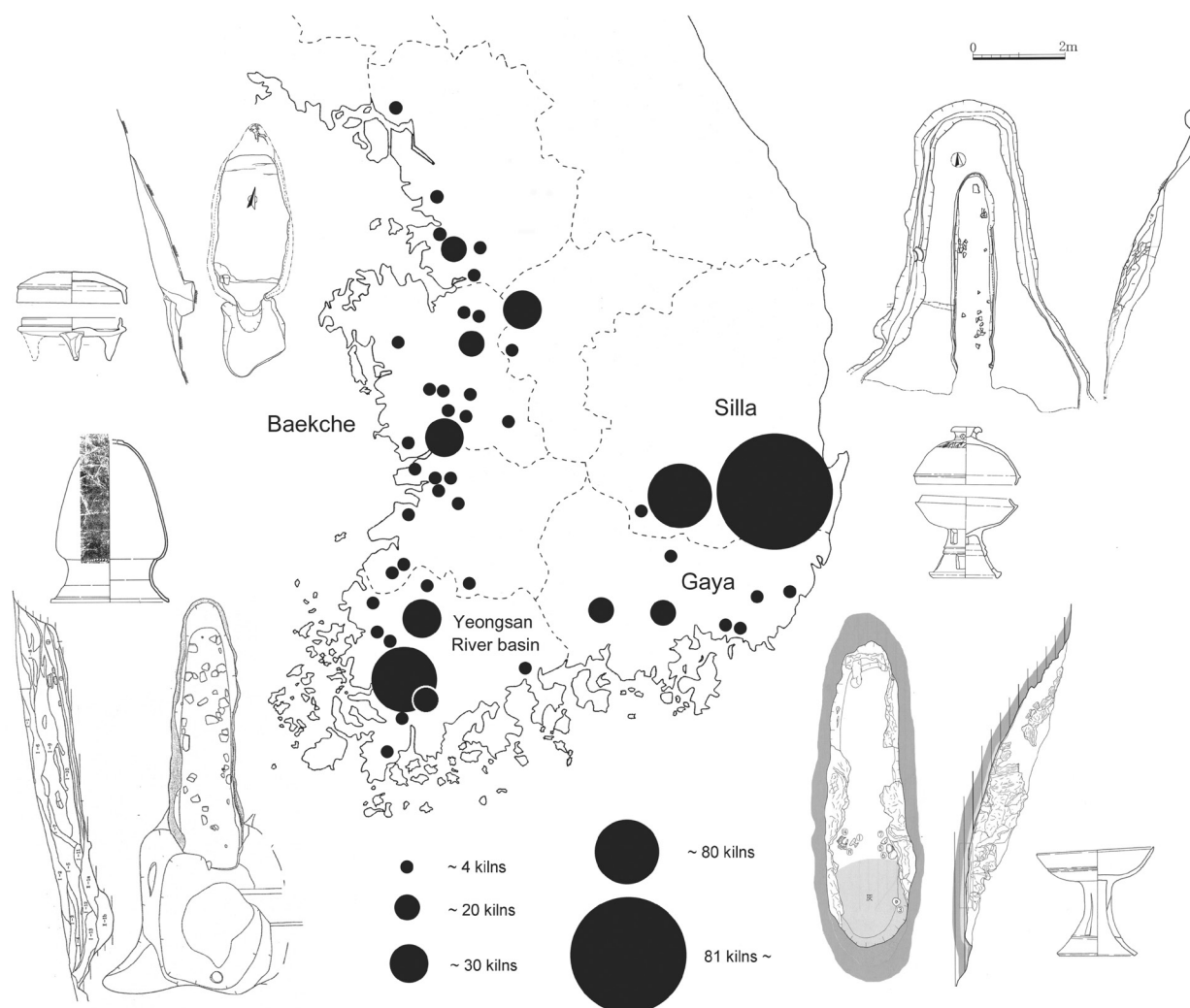
In this manner the pottery production of Silla and Baekje differed not only in the structure of their kilns but in matters such as the system of production as well. The productive system for Gaya pottery supplied spheres that were narrowly focused in individual subregions, but from the element of centralized production seen in the regularity of vessel form it is regarded as approaching that of Silla.

Let me summarize here the content above concerning the technology of pottery manufacture and the system of production of the Three Kingdoms period. In the Silla and Gaya regions, due to demands for large amounts of pottery as grave goods, systems of pottery manufacture intensively producing refined wares at a high degree of standardization with little individual variation became established from early on. Kilns clustered together in the outskirts of capitals or at core regions, and they mass-produced wares that were distributed everywhere. This type of production and distribution can be labeled the "centralized production/regional distribution system."

In contrast, Baekje pottery has great variation among items of the same vessel type, even though the numbers recovered from single sites are small. No kiln sites have been discovered giving evidence that intensive production was undertaken, and a situation can be surmised in which pottery that was fired everywhere in dispersed fashion to supply separate locations of consumption was brought together at sites such as the capital. As a result, the pottery is low in its degree of regularity, and gives the impression of not having been produced with very experienced skill in comparison with the pottery of Silla and elsewhere. The level of management for pottery production appears to have been weak when compared for example to Silla. This can be called a "dispersed production/urban accumulation system" (Fig. 14.5). This situation changed in the mid-sixth century to a centralized production system, with the pottery style completely changing at the same time, which indicates that the making of pottery in Baekje transformed to a system of production under government management. It should be noted that it was carried out simultaneously with the production of roof tiles in kilns that doubled as ones for firing pottery and tiles.

#### **14.6. Pottery kilns and tile kilns**

The use of roof tiles took hold in the Korean peninsula starting from the Three Kingdoms period. While buildings



**Figure 14.5. Distribution and number of kilns in the Three Kingdoms period.**

associated with fortresses and piled-stone mounded tombs are known to have been roofed with tiles from an early period in Goguryeo, there is no information regarding the kilns which produced them. In Baekje as well, tiles are recovered at sites such as Pungnap-toseong, which was a fortress, but the kilns which fired them have not been discovered. These early-period tiles are not associated with temples, and are thought to have probably been used at royal palaces inhabited by the ruling class and similar sites.

The increase in tile production in Baekje came with the full-blown spread of Buddhism, attended by the active construction of temples. Following the introduction of temple construction in the Eungjin era, projects for building temples flourished within and around Sabi Fortress after the move of the capital to Buyeo. Further, with the introduction of a Chinese-style capital, buildings using large numbers of tiles were adopted in palace construction. Starting with state-sponsored temples and those of comparable status (such as the temple sites of Jeongrimsa, Gunsurisa, Wangheungsa, Neungsanrisa, Miruksa and Jaeseoksa), with the adoption of the use of tiles for a variety of buildings, large-scale tile kilns such

as the Jeongamri kiln group were operated in the vicinity of the capital and came to supply various locations, and at those sites not only tiles but pottery was fired as well, and was supplied to core facilities of Baekje centering on the capital from the latter half of the seventh century. At this time a major changeover in pottery style was occurring in Baekje, from the traditional dishes to bowls as the main forms, with the material for firing pottery being close to the clay used for tiles, and regularization in form was progressing. In other words, in Baekje the centralized production of tiles was linked with the stylistic transformation and formal regularization of pottery, and further the system for production of tiles and pottery was changing over from the previous dispersed pattern to a centralized one.

As the kiln structure of this time differed from that of kilns used until then exclusively for pottery, it is necessary to include in examining its line of derivation the influences coming from the outside in tandem with the development of tile production, but there is no doubt that this change was intimately linked with political trends of this period aimed at advancing the centralization of authority. Inkstones that have also been recovered from

the Jeongamri kiln site are impressive artifacts telling of the penetration of document-based administration, and are a vessel type not previously seen (Yamamoto 2017). However, tiles were used not only at the capital and other core establishments but also at regional upland fortresses, and there were probably kilns supplying such individual facilities. Regarding the derivation of Baekje tile kilns, comprehensive investigations including those based on the situation of kilns for bricks are needed in the future.

In Silla as well, kilns where tiles are recovered appear around the time temple construction becomes active, but this does not indicate the creation of a new system of production as in Baekje, as initially tile kilns were built adjacent to the large-scale pottery kiln groups noted above. In other words, tile production in Silla began by building upon the already existing large-scale production of pottery, and no change can be seen therein regarding the systems of production or distribution. At the same time, around the time when regional temples of Unified Silla were being built, the operation of regional kilns for tiles became common, and it is thought that networks for the production and distribution of both pottery and tiles were established to encompass the vast territory that had been acquired.

As the nature and targets for supply of the products differ for pottery and tiles, when considering the lines of derivation for each regarding kiln operation technology and kiln structure, it is necessary to make examinations after assessing relations between the aims of production and state policy, the manner of social role carried out by the products, and so forth.

#### 14.7. Conclusion

Following the Proto-Three Kingdoms period, when pottery production based on kiln firing took root, pottery differing with each regional polity or state came to be used at the stage when ancient states were established throughout the Korean peninsula. It must be considered that if aspects of state policies are reflected in this situation, political conditions are reflected in the operations of kilns that fired the pottery as well, and that the mode of management varied from state to state. Baekje and Silla, which have been predominantly investigated in this contribution, make a good contrast, and their systems have herein been labeled as a “dispersed production/urban accumulation system” and a “centralized production/regional distribution system.” Differences between the two states in their social characteristics and political systems, and in their ritual customs including burial practices and so forth, serve as the background to this contrast, and differences are thought to have appeared as well in the bases of their handicraft production. While preserving the kiln industry that had developed regionally, Baekje sought to maintain uniformity in vessel form by making specifications as to product shape. As background, there was no stable capital or grave goods custom that consumed large amounts of pottery. In Silla on the other hand, it may be said that mass

production of pottery at a high standard was achieved by having state management of pottery production from the start. As background for this there was a high volume of consumption at the capital, which did not relocate, and the custom of providing large amounts of pottery as grave goods in mounded tombs. This situation continued for a while during the Unified Silla period as well, but as the “cultural rivalry” synthesized by the division into separate states vanished, state involvement in the production of articles of daily use such as pottery faded. The need for distinctions in material culture on a country-by-country basis disappeared, and a unified culture came to spread across the entire Korean peninsula. This situation should also be discernible in the kilns that produced pottery and tiles.

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## Part IV

### **Developments on the islands of the eastern periphery**



## The Beginning of Stoneware in the Japanese Archipelago

*Tomoko Nagatomo*

**Abstract:** The appearance of kilns in the Japanese archipelago dates from the end of the fourth century to the beginning of the fifth century. The author analyzes early Korean Sue ware and soft earthenware from the Uji City site during this period. The Uji City site is a regional site, and the Suemura kilns are a group of kilns controlled by the central government. The early Sue ware from Uji City site is compared with Suemura Sue ware and Gaya stoneware. As a result, it is found that the early Sue ware from the Uji City site was produced by Korean people using the soil around the site. It was also found that earthenware was produced. If we assume that kiln-fired stoneware was produced by men and field-fired pottery by women, we can understand that a small group of men and women came from the Gaya region of the Korean Peninsula. This is very different from the Suemura kiln, where a group of male artisans came from the Korean peninsula and produced Sue ware.

**Keywords:** Uji City site, early Sue ware, Korean low-fired earthenware, Gaya stoneware, Suemura kilns

### 15.1. Introduction

Stoneware kilns were introduced to the Japanese archipelago from the Korean peninsula at the end of the fourth century. In contrast to the kilns managed and operated by the central administration, the local kilns were run by a regional chief. Sakai suggest that the spread of kilns from the Korean peninsula to the Japanese archipelago took place multiple times, not only from the Gaya region of the Korean peninsula, but also from the Yeongsan River basin in Baekje and Mahan. The specific circumstances of the introduction of kilns have gradually become clearer. However, while these studies focus on kilns and kiln-fired stoneware and examine immigrants who brought kiln techniques to new lands, they do not take into account their relationship to potters who made the Korean Yeonjil (soft fired) earthenware during the same period. Another problem was the fact that the influence of technique by immigrants has been discussed without clarifying the form of pottery production on the Korean peninsula. In this chapter, therefore, I will discuss the migratory forms in the introduction of the kiln, considering the potters who made Korean Yeonjil earthenware. To this end, I will first point out that some of the Korean Yeonjil earthenware was fired openly, and then show that there are multiple forms of pottery production on the Korean peninsula. In addition, I will examine Suemura kilns as the primal kiln and Uji City site as a case study of the local pottery production. Not only early stoneware but also Korean Yeonjil earthenware excavated from the Uji City site was analyzed and archeologically examined, and it was shown that these wares were produced by potters who

migrated from the Korean peninsula to the area around the site. I will show the background of two different forms of pottery production by primal kilns and local kilns during the introduction of kiln technique.

### 15.2. Historical background and past research on the introduction of kilns

#### 15.2.1. The historical background of the introduction of kilns in the Japanese archipelago

On the Japanese archipelago, rice farming began in earnest around the Yayoi period (ninth century BC), and as it became established, large settlements where people gathered together developed. The regional differences in graves, such as the use of jarred coffin tombs in northern Kyushu, protruding four-cornered tombs in the Sea of Japan region and square-shaped circumscribed tombs in the Kinki region, prove that different funeral rituals were carried out in each region. In the first century, settlements were reorganized and large settlements were dismantled, but around the second century, much larger settlements appeared. The largest tombs, about 80 m in length, were built for the chiefs in each area. However, the shapes of the large tombs in different parts of the country during this period were diverse and still regional in nature. In the middle of the third century, a huge keyhole-shaped tumulus over 200 m in length called the Hashihaka Tumulus was constructed in the Nara Basin. After this time, tumulus of the same shape began to be built in other areas, and regional differences in the shape of the mounds disappeared. The funeral rituals were unified as well. The construction of a



large-scale mound required the labor of many people, and since many valuable objects such as Chinese mirrors were buried in the mounds, it is thought that the Great King and the wealthy families connected to him were buried in the large keyhole-shaped tumuli. The largest of these tumuli was being constructed continuously in the Nara Basin in the Kinki region throughout the fourth century. The gradual spread of keyhole-shaped tumuli to the Setouchi, Kyushu, Tokai and Hokuriku regions suggests that the relationship between the central and local regions was formed over a wide area. The period in which these huge keyhole-shaped tumuli were constructed is called the Kofun period.

According to *Sangokushi* (The Chronicles of the Three Kingdoms), in 239, Queen Himiko sent a messenger to Wei with slaves and various tributes, and was given the seal of the King of Wei. There is no mention of Wa (ancient Japan) in Chinese history until the fifth century, when the five kings of Wa sent messengers and supplied tribute to China in an effort to obtain titles. Archeological evidence shows that Wa not only sent emissaries to China, but also interacted with the Korean peninsula and imported various goods and the following advanced techniques. The king and chiefs introduced horse-breeding and armor-making techniques to strengthen their military power, and gilding techniques to show off their authority with magnificent prestige goods. The kiln for Sue-ware ceramics was one of the continental techniques introduced at this time. Kiln-fired, leak-proof stoneware containers allowed for the long-term storage of liquids, and the hard, gray stoneware tableware became indispensable for feasting in the continental style during negotiations and trade.

### 15.2.2. Past research on kilns and stoneware

It is known that the Suemura kilns, the largest group of kilns in the Japanese archipelago, have been in continuous operation for more than 300 years, with more than 800 kilns in operation. Since it was initially believed that the kiln TK (Takakura area) 73 of the Suemura kilns was one of the oldest kilns in the Japanese archipelago, it was understood that the techniques for firing Sue ware spread to the other parts of the Japanese archipelago from the Suemura kilns, which themselves were developed with techniques from the Korean peninsula (Tanabe 1966). However, since then, even older kilns such as Yamakuma No. 1 in Fukuoka, Mitani-Saburodani Seigan kiln in Kagawa and Okugatani kiln in Okayama, have been discovered. In addition, kilns TG (Toga) 232 and 231, which are older than TK73, were discovered among the Suemura kilns (Okado 1995, 1996). The Deai kiln in Hyogo Prefecture, which predates TG232 and other kilns, was found in 1981 (Ueno 1998, Kameda 2008).

The discovery of these earlier kilns (Fig. 15.1), mainly along the Seto Inland Sea coast, has led to the mainstream understanding that kiln technique was introduced to the Japanese archipelago in a pluralistic manner (Hashiguchi 1982, Fujiwara 1992, Takesue 1993). Excavations revealed

that the early local kilns were isolated and abandoned after a short time, while the Suemura kilns were continuously operated for a long time, and there was large number of them. In addition, the transmission of techniques from the Suemura group to early local kilns has been pointed out, because some of the early Sue ware in each region bears the characteristics of that made in the Suemura kilns. Therefore, the importance of the Suemura kilns has been re-evaluated (Ueno 2002). It has also been pointed out that the kilns previously recognized as early local kilns did not appear at the same time, but rather were constructed during three separate periods (Nakatsuji 2013). In recent years, a study of the distribution of early Sue ware supplied by the Suemura and Ichisuka No. 2 kiln as well as the Suita kiln has been examined using fluorescent X-ray analysis of clay (Shiraishi and Tanaka 2016).

In the Korean peninsula, not only kiln-fired white and gray hard stoneware but also red earthenware is used as cookware. This is called Korean Yeonjil earthenware. A pioneering study that analyzed the distribution and types of Korean Yeonjil earthenware excavated from the Japanese archipelago noted the presence of immigrants (Imazu 1987, 1994), followed by a comprehensive collection of Korean Yeonjil earthenware found in the Kinki region (Nakano 2007, Society of Ancient Studies 2012). It has been shown that the changes in the shape of the Japanese Haji ware (low-fired stoneware) were caused by the influence of Korean Yeonjil earthenware (Kyoshima 1994). This influence has been observed at the Kyuhouji-Nagahara site, as well as in the northern part of Kawachi and the western part of Settsu, prior to the other sites (Kyoshima 1994), even within the confines of the Kinai region, which has strong royal control (Nakakubo 2009, Nakano 2017). It was noted that there were varying degrees of impact on the local pottery manufacture depending on the site and region. Furthermore, steamers, which were introduced to the Japanese archipelago from the Korean peninsula along with a new cooking method, have been studied to determine their place of origin on the Korean peninsula, because there are clear localities (Sugii 1994, Sakai 1998, et al.).

A series of kilns have been discovered on the Korean peninsula, and a collection of kiln data is being compiled (Kang 2005, Ueno 2009, 2013, 2015). Researchers from the Honam (Lee 2008, Park 2001, Jeong 2008), Hoso (Choi 2010) and Yongnam regions (Kim 2004, Kim 2007, Park 2001) have examined the kilns in their respective localities. In the Honam region, two distinct types were found: regular kilns used for production of everyday ceramics, and a more specialized type used for firing large jar-shaped coffins (Choi et al. 2004, Jeong 2012). An analysis of ceramic-making techniques has been carried out to study the production system (Lee 2005, 2011), and the distribution area of ceramic has been examined based on the analysis of ceramic samples (Cho 2008). In order to better understand production techniques, archeologists examined stoneware and



- |                           |                              |                                 |                                  |
|---------------------------|------------------------------|---------------------------------|----------------------------------|
| [Gyeonggi region: Beakje] | [Honam region: Mahan/Baekje] | [Yeongnam region: Kaya, Shilla] | [Kysuyu region]                  |
| 1 Neungsanri              | 12 Bugokri                   | 21 Ugeori                       | 29 Yamaguma                      |
| 2 Cheonggyeri             | 13 Seongnamri                | 22 Myosari                      | 30 Iyashiki                      |
| 3 Gajaeri                 | 14 Wonheungri                | 23 Yeochori                     | [Setouchi region]                |
| 4 Nongseori               | 15 Songcheonri               | 24 Jisadong                     | 31 Ichibaminamigumi              |
| [Hoseo region]            | 16 Nodongri                  | 25 Songokdong                   | 32 Mitanisaburodani Seigan       |
| 5 Yongwonri               | 17 Oryangdong                | 26 Hwangseongdong               | 33 Miyayama                      |
| 6 Maeseongri              | 18 Gungokri                  | 27 Wolseong Haeja               | 35 Okugatani                     |
| 7 Samryongri / Sansuri    | 19 Daegokri                  | 28 Songgokdong                  | [Kinki region]                   |
| 8 Gagyedong               | 20 Mipyedong                 |                                 | 35 Deai                          |
| 9 Eungamri                |                              |                                 | 36 Suita                         |
| 10 Naseongri              |                              |                                 | 37 Uemachidani                   |
| 11 Gwisani                |                              |                                 | 38 Ichisuka                      |
|                           |                              |                                 | 39 Suemura                       |
|                           |                              |                                 | 40 Uji city site (not kiln site) |

Figure 15.1. Korean kilns in fourth and fifth centuries and early Japanese kilns.

kilns without Yeonjil earthenware that was fired openly (Kim 1988, Park 2003, Tsuchida 2016, Cho 2016). So far, while the provenance of early Sue ware with a distinctive regional color in the Korean peninsula has been investigated, the Yeonjil earthenware with a general regional color has been studied as evidence for the process of establishment of the Korean people who came to the Japanese archipelago with their tools of daily use. Thus, although both early Sue ware and Yeonjil earthenware originated from the Korean peninsula, they have been discussed for different purposes, separately, which is a problem. A comprehensive examination of early Sue ware and Yeonjil earthenware would provide clues to the patterns of visiting groups of people with pottery-making techniques. For this purpose, it is necessary to examine the pottery production system of the Korean peninsula by way of analyzing how the productions of ceramics and Yeonjil earthenware were combined.

### 15.3. Pottery production in the Korean peninsula

It was during the first century BC that kilns were introduced to the Korean peninsula. The first low-temperature flat kilns were introduced to the Korean peninsula from northern China, and later, under the influence of the long-bodied kilns in southern China, long, sloped kilns were constructed, which were used to fire pieces at high temperatures (Chapter 1, Section 1). High-temperature kilns were being operated in the southern part of the Korean peninsula when kilns spread from the Korean peninsula to the Japanese archipelago during the fourth and fifth centuries. Focusing on the fourth and fifth centuries, we will examine the production pattern of stoneware and earthenware in the Korean peninsula in view of the location of the kilns and the number of kilns that formed a group.

There are four types of groups of kilns in Baekje. The first is a large group of kilns consisting of more than seven, such as the Samryongri/Sansuri sites in Jincheon and Naseongri site in Yeongi. The second is a small group of kilns. Both of these types are located far away from the settlement they serve. The third consists of a few kilns in the settlement itself. Last are special kilns for large jar coffins, like the one at the Oryangdong site in Naju.

In Silla, there are large groups of more than 40 kilns, such as the Seongokdong site in Gyeongju and the Uksudong site in Duegu. The other pattern is a relatively smaller group with up to six kilns. There is no settlement around these kilns. In some cases, there are kilns at the iron-making site.

In contrast to Baekje and Silla, in Gaya there are only small groups with one to four kilns. However, because of the large number of stoneware buried in the tumuli at Silla and Gaya, it is expected that large group of kilns will be found in Gaya in the future.

Failed stoneware was unearthed in a discarded kiln. Along with this, a small number of Yeonjil earthenware pieces were also discovered within the same kiln. It was assumed that both the stoneware and the Yeonjil earthenware were fired in the same kiln<sup>1</sup> (Lee 2005, Tsuchida 2016). However, the number of Yeonjil earthenware pieces is very small compared to the amount of stoneware excavated from the kiln. Since rice was cooked in each house in the settlement, cooking utensils were required in large quantities. It is difficult to imagine that all of the rice-cooking utensils, which are oxidation-fired potteries, could be supplied based on the amount detected in the kiln remains. Observations of long pots excavated from settlements (Singyeom sites in Gwangju and Taemokri sites in Gwangju) showed distinctive black spots (see Fig. 15.6). These are traces of carbon from the fuel that was placed under and covered the earthenware to seal it, when it was fired openly. This cannot occur in kiln firing, where the fuel does not come in contact with the stoneware. However, some steamers were burned in the kiln; most cooking utensils are burned openly. Since open-fired earthenware has strong fire resistance, it is plausible that these cooking utensils were fired openly.<sup>2</sup> In the Korean peninsula, there are differences in polity and society between Baekje, Silla and Gaya (Yamamoto 2017). Therefore, it is necessary to distinguish these differences when we discuss pottery production, namely which are controlled by king and loyal people. On the other hand, the coexistence of kiln firing and open firing is common in the pottery production systems of Baekje, Silla and Gaya.

How can we recognize the remains of open-fired pottery production? Because of the use of anvils for forming earthenware into a mushroom shape, we can identify the places where these are found as pottery-making sites. Therefore, it is assumed that only open-fired earthenware was produced in settlements where anvils were found but no kilns have been located in the surrounding area.

An analysis of the kilns and the settlements where the anvils were found reveals the following types of pottery production in the Korean peninsula: Type 1 production was only concerned with producing stoneware. No pottery was produced here. A group of kilns was built far from the settlement, including a large group of kilns (Type 1A) and a small group of kilns (Type 1B). Another type of stoneware production is concerned with pottery production. A small number of kilns operated in a settlement in which anvils were found has been categorized as Type 2. Type 3 is the

<sup>1</sup> In the Baekje region, there is an example of a stoneware kiln and an iron-making site located in the same water system. Windpipes, which are essential for the operation of the iron-making kiln at the Seokjangri site in Jincheon, were made at the stoneware kiln of the Samryongri/Sansuri sites in Jincheon (Nagatomo 2008).

<sup>2</sup> Lee Seongju understands that in Gaya and Silla, after the fifth century, the field-firing technique disappeared and all stoneware and Yeonjil earthenware was fired in kilns (Lee 2006). Tsuchida Junko also assumes that Yeonjil earthenware from Baekje is kiln-fired, but the possibility of open-fired earthenware is also considered, based on the case of a long-bodied boiler from Namsan site No. 4 pit with burnt earth in Jeongeup, which was excavated with charcoal (Tsuchida 2016).

**Table 15.1. Pottery production in Korean Peninsula**

Production system	Archaeological site	stoneware production	earthenware production
Specialising in stone wares	Large group of kilns away from the settlement	●	×
	Small group of kilns away from the settlement	●	×
Production of both stone wares and earthenware	One or two kilns in the settlement	●	●
Production of earthenware only	Settlement without kilns but with tools for pottery making	×	●

case of a settlement in which anvils were found, but no kilns were discovered in the area. According to the author's previous analysis of the distribution of kiln clusters and anvil sites in the Hosō area (Nagatomo 2008, fig. 4-26), at least six sites are classified as open-fired pottery production settlements. Since anvils were not found in all settlements, it is understood that some settlements did not produce stoneware. Thus, three types of production existed (Table 15.1): stoneware production, which includes both a large and a small kiln group; stoneware and Yeonjil earthenware (cooking utensils) production; and only Yeonjil earthenware (cooking utensils) production. Large groups of kilns with only stoneware would have been directly controlled by the central government in some cases.

#### 15.4. The introduction of kilns in the Japanese archipelago

The following is an examination of the group of people who transmitted kiln technique to the Japanese archipelago, with the patterns of stoneware production in the Korean peninsula in mind.

##### 15.4.1. Primal kiln: Suemura Obadera kiln TG232 in Osaka

The Suemura kilns, located in the southern part of Osaka, are the largest groups of kilns from the Kofun period. The Izumi Mountains stretch from north to south on the east of the Osaka Plain, and gently sloping terraces rise up from the plain to the hills, derived from the mountains, and then to Osaka Bay in the west. A number of rivers flow from the mountain range, forming valleys on the hills and terraces. The Suemura group of kilns lies on a terrace spreading out from the bottom of the hill, while the TG232 kiln, the earliest kiln in this group, is located close to the plain. In the vicinity of the Obadera site, where the TG232 kiln is located, is the Fushio site, which is a settlement inhabited by the manager of the kiln complex, with an

accompanying large, special house in which managers lived and a warehouse. It is also worth noting that the Daisen Tumulus of the Great King, the largest of the Mozu Tumuli Group, is located about 6 km north of the Obadera site.

More than 800 kilns have been detected in the Suemura group, and it is estimated that there were more than 1000 kilns in the area at the time. The kilns were continuously operated for more than 300 years, from the end of the fourth century, when they were first introduced to the Japanese archipelago, to the end of the 7th century. The Suemura kilns are located next to the tumulus of the Great King, and the number of kilns in operation is far greater than that seen in other groups of kilns in the Japanese archipelago, so it is understood that the Suemura group of kilns was directly operated by the Great King.

**Early Sue ware.** The amount of Sue ware unearthed from the TG232 kiln dump is very large, approximately 1400 containers (Okado 2005). A count of vessel types by the number of pieces at the mouth rim show that it includes 51 percent large jars, 16.5 percent pots, 10 percent vessel stands, 10 percent tall cups, 8 percent small and short-necked jars, 2 percent lids, 2 percent bowls with handle and small jars with covered legs, and 0.5 percent cups and bowls. We know that storage tools and tableware were burned in kiln TG232. In addition, kiln furniture was also excavated. Most of the Sue-ware pieces are very similar in design and form to Korean stoneware and were most likely made by craftsmen who came from the Korean peninsula. It is believed to be one of the earliest kilns in the Japanese archipelago because its form and design resemble Korean stoneware of the late fourth or early fifth century, and it has no original characteristics of Sue ware made in the Japanese archipelago. The vessel stand has characteristics of the Nakdong River area in the southeastern part of the Korean peninsula, and the bowl with handles has characteristics of the areas west of the Nakdong River, such as Haman and Masan (Okado 2005). There are numerous types of tall cups. Small wide-mouth pots and small jars with hole were produced in Honam in the southwestern part of the Korean peninsula. It is thought that craftsmen from several regions were invited to make the Sue ware, which has the characteristics of several areas: the border area between Gaya and Silla (Nakdong River area), Gaya (Haman and Masan) and Mahan (Honam).

A small amount of Korean Yeonjil earthenware and Haji pottery was found at the kiln dump. The reporter believes that the Korean Yeonjil earthenware was burned in the kiln and the Haji pottery was not, but instead were brought in (Okado 2005: 113). This will be discussed below.

##### 15.4.2. Local pottery production: a case study of pottery from the Uji City site in Kyoto

The amount of failed stoneware unearthed from the central Suemura kiln TG232 is enormous, indicating that the potter

produced large quantities of Sue ware from the time of kiln introduction onward. On the other hand, it is assumed that the production volume by local kilns was lower, because the number of failed potteries discarded in the local kilns was less than that of the central Suemura kiln. A small-scale kiln is difficult to find. Therefore, if there are no kilns around where early Sue ware was excavated, it is not easy to determine where it was made. Another problem is that the relationship between the craftsmen of stoneware and potters of Yeonjil earthenware cannot be determined by analyzing only artifacts from the kiln, because Yeonjil earthenware was rarely found at kiln sites. Therefore, we analyzed early Sue ware and Korean Yeonjil earthenware from the Uji City site in Kyoto that was found in a ditch. Alongside the Sue ware, pieces of wooden tools were excavated, and later dated by dendrochronology to AD 389.

The Uji City site is located in the eastern part of the Kinki region, which was a central area in the Kofun period, and is about 60 km away from the Suemura kilns. The Uji River from the east, the Kizu River from the south and the Kamo River from the north flowed into Ogura Pond, and the Yodo River flowed from this pond into Osaka Bay. The Uji City site is situated near the confluence of the Uji River and Ogura Pond, which is a key point of interchange on the route to the east. Early Sue ware, Yeonjil earthenware and Haji ware were excavated from the ditch of the Uji City site.

**Early Sue ware.** In terms of the composition of the pottery excavated from the Uji City site, early Sue ware was estimated to account for 12 percent, Yeonjil earthenware for 30 percent, and Haji ware for 58 percent, so the ratio of early Sue ware and Yeonjil earthenware to the total was extremely high at 42 percent (Hamanaka and Tanaka 2006). Early Sue ware consisted of tableware such as tall cups and bowls, and storage tools such as jars, while Yeonjil earthenware consisted of cooking tools such as flat-bottomed pots, steamers and boilers. Since early Sue ware has been described in detail by Ha Seungcheol (Ha 2005), I will simply summarize the results here. Yeonjil earthenware was reported by Hamanaka Kunihiro and Tanaka Motohiro (Hamanaka and Tanaka 2006, 2008), and the results of the author's observations are also presented.

The covered tall cup (Fig. 15.2: 4–6) is similar to stoneware from the Gime region, which is considered to be the Gimhae Gaya. The uncovered tall cup (Fig. 15.2: 8) and the cup (Fig. 15.2: 2) are similar to ones from the Sacheon, Jinju and Goseong, which are considered to be Small Gaya. The cylindrical vessel stand (Fig. 15.2: 3) and the cup-shaped vessel stand (Fig. 15.2: 9–11) are also similar to Gaya ware. While the small jar with hole was a common shape in Mahan, the round-bottomed one, as shown in Fig. 15.2: 1, is similar to the type in the Kaya region.<sup>3</sup> Sue ware from the Uji City site has a

strong affinity with Gaya stonewares. Among them, the tall cup shown in Fig. 15.2: 8 is similar to one found in Gaya from the late fourth century, when the stoneware regionalism became apparent<sup>4</sup>. It is consistent with the fact that the felling date is coterminous with the wood tools of AD 389.

**Yeonjil earthenware.** Steamers and flat-bottomed pots accounted for 96 percent of the total of Yeonjil earthenware (Hamanaka and Tanaka 2006), and many of them were found to be cooking utensils. The outer surface of the flat-bottomed pots (Fig. 15.2: 12) were beaten and have variety patterns on the surface, such as lattice-grained, rope, parallel-grained and ungrained. Most Yeonjil earthenware has a weak lateral stroking technique on the inside, where traces of the anvil are visible, but other pieces have a strong lateral stroking technique. The area around the bottom of the inner surface is adjusted with a finger nudge. A characteristic feature is a trace cut by the lateral spatula on the lower part of the body (Fig. 5.2: 12). This is a production technique that spread from the Lelang commandery in the northern part of the Korean peninsula to the southern part of the peninsula. It is assumed that the pots were made by people who came from the Korean peninsula. With the exception of one, the flat-bottomed pots are covered with soot and scorch marks, indicating that they were used and discarded. Fragments of the bottom and the rim of a long-bodied boiler were found. The bottom piece was adjusted by beating with a rope-pattern paddle. There are multiple mouth-rim fragments, with both lattice and rope strikes identified. Several steamers were identified, and the bottom of the steamer, reconstructed to perfect form (Fig. 15.2: 13), consists of a large central hole and a number of smaller holes around it. This bottom is the same as that of the steamers in western Kaya (Small Kaya) and westward (Cho 2016). However, its mouth rim is bent outward, which is a characteristic of the steamers from the eastern part of Gaya to the Silla region. Therefore, the origin of the steamer from Uji City site is the middle of eastern and western part of Gaya (Anra Kya). It can thus be stated with confidence that both early Sue ware and Yeonjil earthenware are strongly related to the Gaya region.

#### 15.4.3. Results of scientific analysis

If the stoneware and earthenware excavated in the Japanese archipelago were made by Korean potters, the form and design of the pottery would be the same as Korean stoneware and earthenware. As a result, the form and pattern of the stoneware and earthenware can help estimate the place of origin of the potter, but

<sup>3</sup> However, the Gaya small jars with hole are supposed to be from the fifth century onwards (Ha 2008). There is also a view that the

Japanese archipelago is the place of origin (Nakakubo 2017). The double mouthparts are gently bent, short and thick from the neck to the mouthparts without steps, which makes it one of the earliest examples of the small jar with hole in the Japanese archipelago.

<sup>4</sup> Suggestions were made by Mr. Ha Seungcheol.

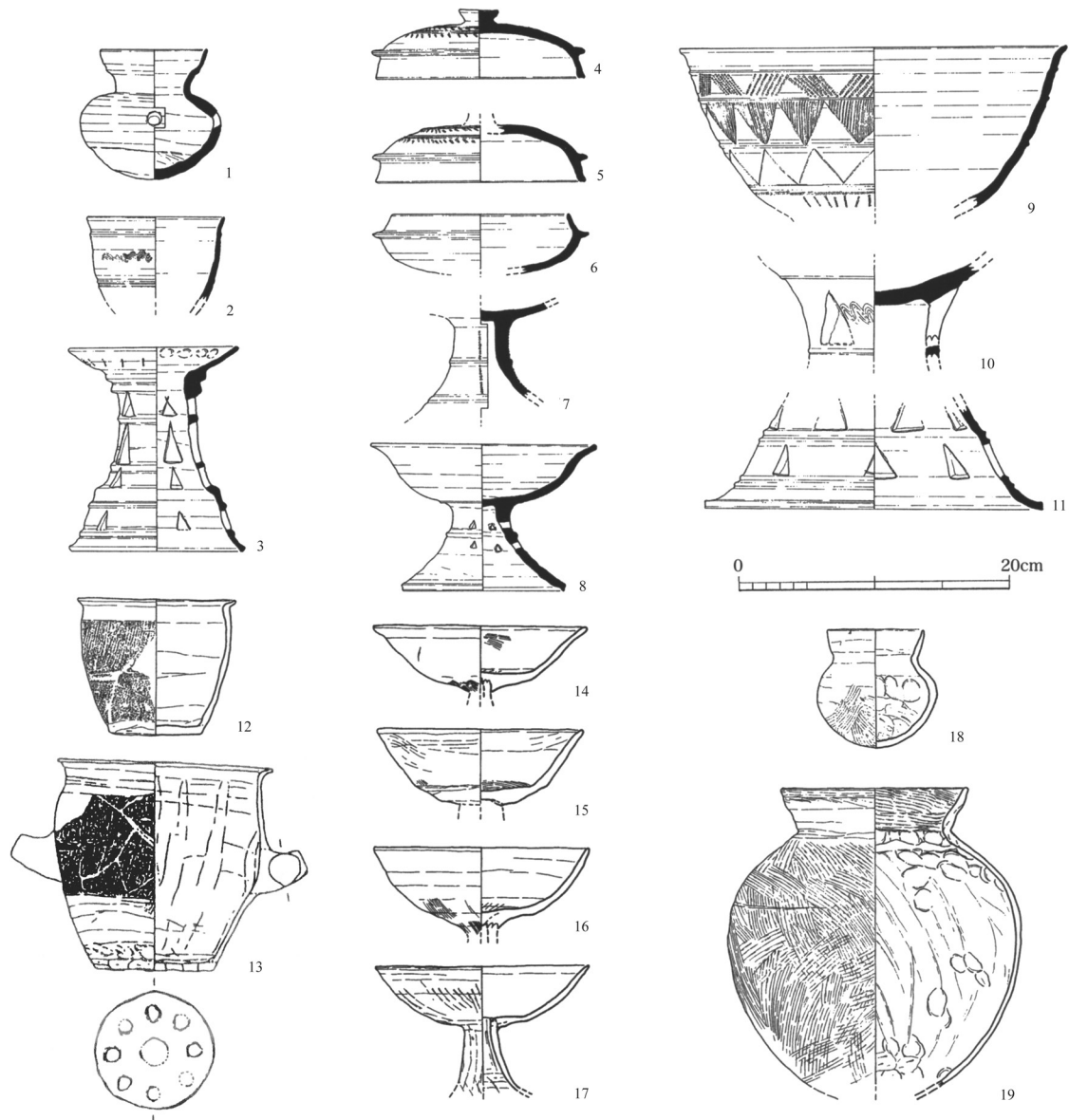


Figure 15.2. Early Sue ware (1–11), oxidation-fired pottery (12, 13) and Haji ware (14–19) from Uji City site (Hamanaka and Tanaka, 2006, Ha 2008).

it is not possible to determine where the pottery was made. Therefore, we analyzed the clay of the pottery and estimated its area of production. First, Kim Gyuho conducted X-ray fluorescence analysis of early Sue ware of the Uji City site (Nagatomo, Nakamura and Kim 2016). Then, Mitsuji Toshikazu conducted X-ray fluorescence analysis and X-ray diffraction, focusing on six elements, to compare Yeonjil earthenware and Haji ware (Arakawa, Mitsuji, and Nagatomo 2016).

**Early Sue ware.** An analysis of the early Sue ware from the Uji City site is shown in Fig. 15.3. Fig. 15.3: 1 shows a graph comparing clay used in stoneware from the following sites: kiln TG 232, the Uji City site and Hayagari kiln (kiln No. 1 and No. 2), which is located near the Uji City site and dates to the seventh century. So, we can recognize the local stoneware data

as stoneware from these kilns. The principal analysis revealed that the early Sue ware of the Uji City site showed no overlap of the principal component distribution with that of kiln TG-232, and is closer in this regard to that of Hayagari kiln No. 2. Fig. 15.3: 2 is a graph comparing stoneware excavated from Korean peninsula, such as from Daseongdong tumulus and Mangdeok site in Gimhae and Dandeokri tumulus in Jinju, with early Sue ware excavated from Japanese archipelago, such as from the Uji City site, kiln TG232 and the Hayagari kiln. The early Sue ware excavated from the Uji City site differs greatly from the Gaya stoneware from the Korean peninsula, so it is difficult to believe that this Sue ware was brought from Gaya. Therefore, it is most likely that the early Sue ware from the Uji City site was produced in the vicinity of the site.

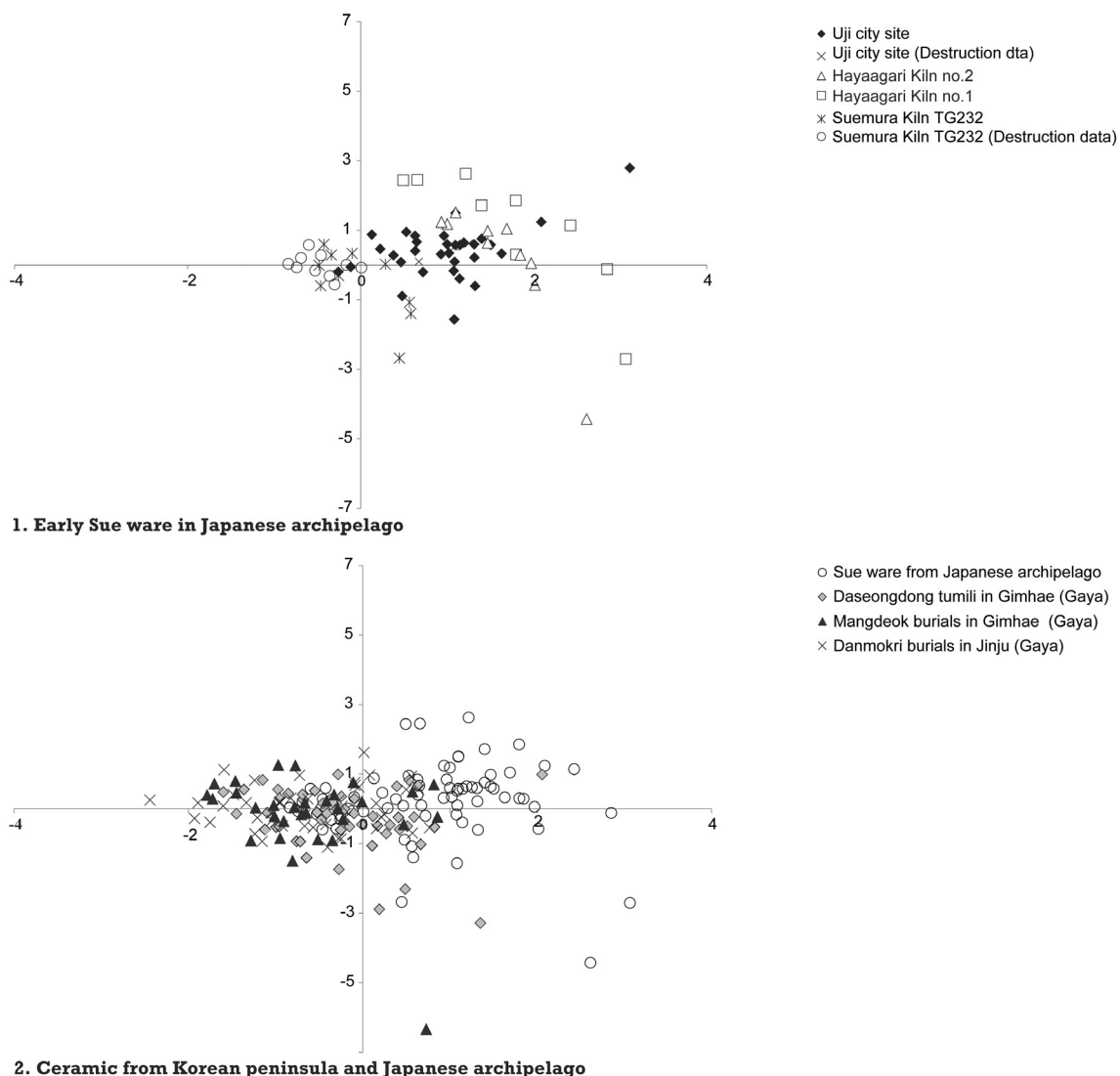


Figure 15.3. Principal component analysis (Nagatomo, Nakamura and Kim 2016).

**Yeonjil earthenware.** The results of the analysis of Yeonjil earthenware and Haji ware are shown in graphs in Fig. 15.4. Fig. 15.4: 1, 2, 5 and 6 are graphs of Haji ware, and Fig. 15.5: 3, 4, 7 and 8 are graphs of Yeonjil earthenware. Each graph shows the relationship between the two elements in Haji ware and Yeonjil earthenware. Fig. 15.4: 1 (correlation between potassium and calcium) and 2 (correlation between rubidium and strontium) show that the Haji ware shows a certain degree of unity with the exception of references 15 and 20. Therefore, the concentration of these dots shows us where Haji ware made locally, and the results were compared with Yeonjil earthenware (Fig. 15.4: 3 and 4). The Yeonjil earthenware was confined to the area of local ware with the exception of Samples 4 and 12, indicating that the Yeonjil earthenware was similar to the clay of the Haji ware. Furthermore, the correlations between potassium and rubidium (Fig. 15.4: 5 and 7), and calcium and strontium (Fig. 15.4: 6 and 8), were examined. In these results, the values of Yeonjil earthenware and Haji ware show close correlation. However, since the distribution area is somewhat displaced, it is presumed that the clay was not collected at the exact same site, but rather at locations close to each other.

The results of the scientific analysis of the early Sue ware and Yeonjil earthenware excavated from the Uji City site can be summarized as follows: (1) Although the kilns still have not been detected, the early Sue ware from the Uji City site was produced in the vicinity of the site. (2) Archeological investigations have shown that the Yeonjil earthenware was produced by people from the Korean peninsula, as it has not been integrated with the techniques of the Haji ware. Therefore, it can be concluded that both the early Sue ware and the Yeonjil earthenware were made in the vicinity of the Uji City site by people from the Korean peninsula.<sup>5,6,7</sup>

<sup>5</sup> In the kiln with separate combustion and firing sections, black spots do not form due to carbon deposits from fuel. However, in the case of large jar coffins excavated from the Oryangdong site in the Korean peninsula, there were cases of black spots on the coffins fired in the kiln. This is thought to be due to the fact that the bottoms of the coffins were covered with fuel to stabilize them.

<sup>6</sup> Short-necked pots appearing in the Proto-Three Kingdoms period may be either open-fired or kiln-fired in the period of their appearance.

<sup>7</sup> Another aspect of the parallels between Yeonjil earthenware and early Sue ware excavated from sedimentary layers and houses in the valley



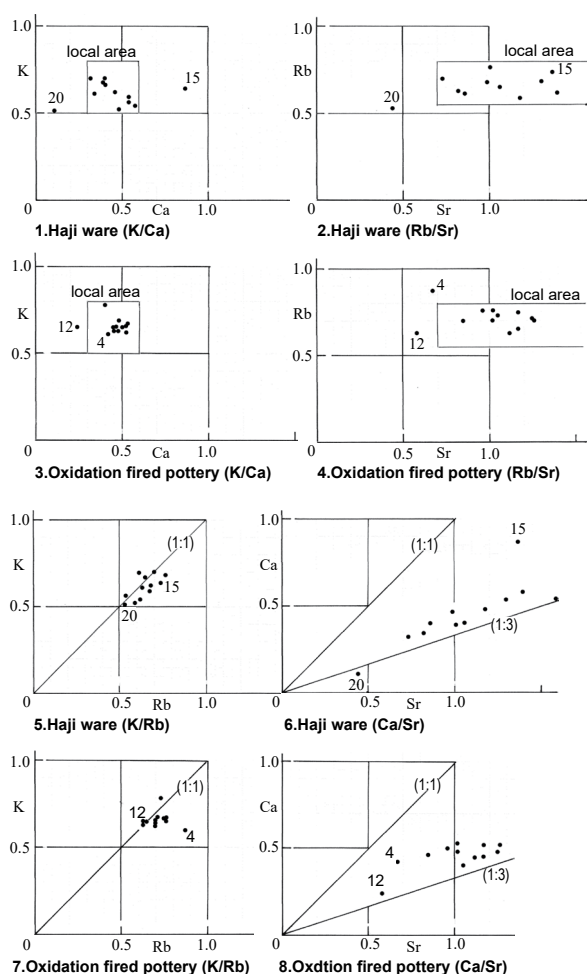


Figure 15.4. Analysis of Haji ware and oxidation-fired pottery from Uji City site (Arakawa, Mitsuji and Nagatomo 2016).

## 15.5. Conclusion

The extent of stoneware production can be assumed based on the size and continuity of the kiln and the number of discarded failed pieces. As mentioned above, looking at the number of failed pieces discarded in the kilns, a large amount of Sue ware was found in the central Suemura kiln, and a small amount in the local kilns, indicating a difference in production volume between the central and local kilns. From the differences in the amount of stoneware production by each kiln, it may be possible to infer differences in the scale of the number of potters who came to the Japanese archipelago. On the other hand, what about the oxidation potters who came to the Japanese archipelago? Long-bodied boilers of Korean descent, along with early Sue ware, have been excavated from the valley around the TG232 kiln in Obadera site (Fig. 15.5: 2). These long-bodied boilers are covered with black spots, indicating that they were burned openly. Very interestingly, they show numerous lines that are not usually found on boilers. Several boilers with these characteristics have been excavated. Since the

multi-stranded line design is usually found on short-necked pots fired in kilns (Fig. 15.6: 1), it is possible that the kiln-firing craftsmen may have made these cooking utensils as well. The other boilers were burned by the kilns, as evidenced by their hard, gray texture. After arriving in the Japanese archipelago, it was the stoneware specialists who made the cooking utensils for boiling rice. Therefore, it is understood that the people who transmitted their skills to the Suemura kilns were mainly stoneware specialists, not including the Yeonjil earthenware makers.

On the other hand, there is no evidence for the stoneware technique in the Yeonjil earthenware from the Uji City site, but rather for a Korean technique for Yeonjil earthenware. This is also the case in other regions. Since most of the early Sue wares and oxidation fired potteries at the Uji City site have been found in Gaya, it is assumed that the group of immigrants included oxidation potters and stoneware specialists from Gaya.

In other words, the craftsmen who were invited to the Suemura kilns were a specialized group engaged in the production of stoneware in the Korean peninsula, while the group that came to the Uji City site was a composite group of stoneware potters with kiln technique and oxidation-fire potters who burned cooking utensils openly. Some sites in the Kinki region are known to have contained almost no early Sue ware, just Yeonjil earthenware. Interestingly, some of these sites include migrant groups with horse-herding techniques or ironware specialists. In that case, it is likely that the Yeonjil earthenware makers accompanied a group of people with skills other than pottery to the Japanese archipelago. As mentioned above, there are three types of pottery production on the Korean peninsula: Type I, in which only stoneware is produced; Type II, in which both stoneware and Yeonjil earthenware are produced together; and Type III, in which only Yeonjil earthenware is produced (Fig. 15.7). If we understand the above, we can see that the pattern of migratory groups to the Japanese archipelago is strongly influenced by the diversity of production systems on the Korean peninsula. Concretely, it is suggested that a Type I group migrated to the Suemura kiln, a Type II group to the Uji City site, and a Type III group of oxidation-fire potters who migrated with non-pottery technique.

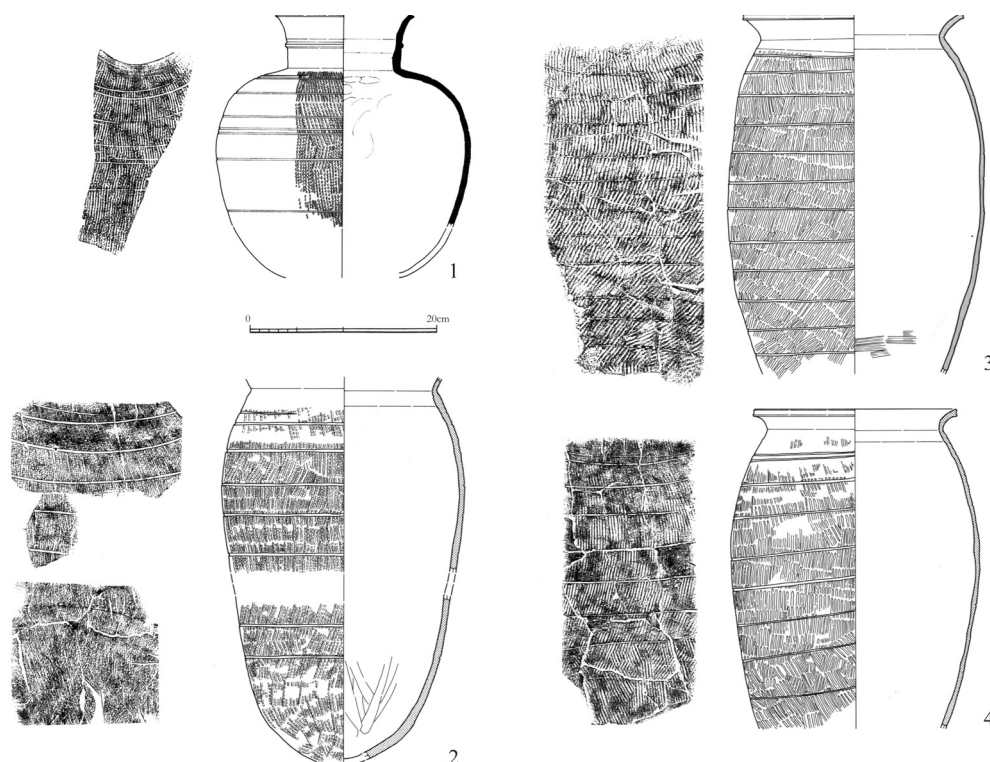
In considering the gender of the potters, Tsude Hiroshi has an interesting suggestion. He presented a graph of the gender of people engaged in different types of occupations, based on the ethnographic statistics examined by Murdoch (Tsude 1989). The results showed that a high percentage of women were engaged in pottery production for the main purpose of self-consumption. Specifically, 13 of the 106 cases had a male main role, 2 cases where the male was in the main role and the female was in a supporting role, 6 cases where both men and women were involved, 8 cases where the female was in the main role, and 77 cases where only women were in the main role. The total number of

topography adjacent to the kiln TG232 kiln suggests that the Sue ware craftsmen made the Yeonjil earthenware (Ōtsubo 2010).





**Figure 15.5. Long-bodied boiler with black spots.**



**Figure 15.6. Short-necked pot from kiln TG232 (1) and long-bodied boilers from the valley around kiln TG232 (2–4) (Okado eds. 1995, 1996).**

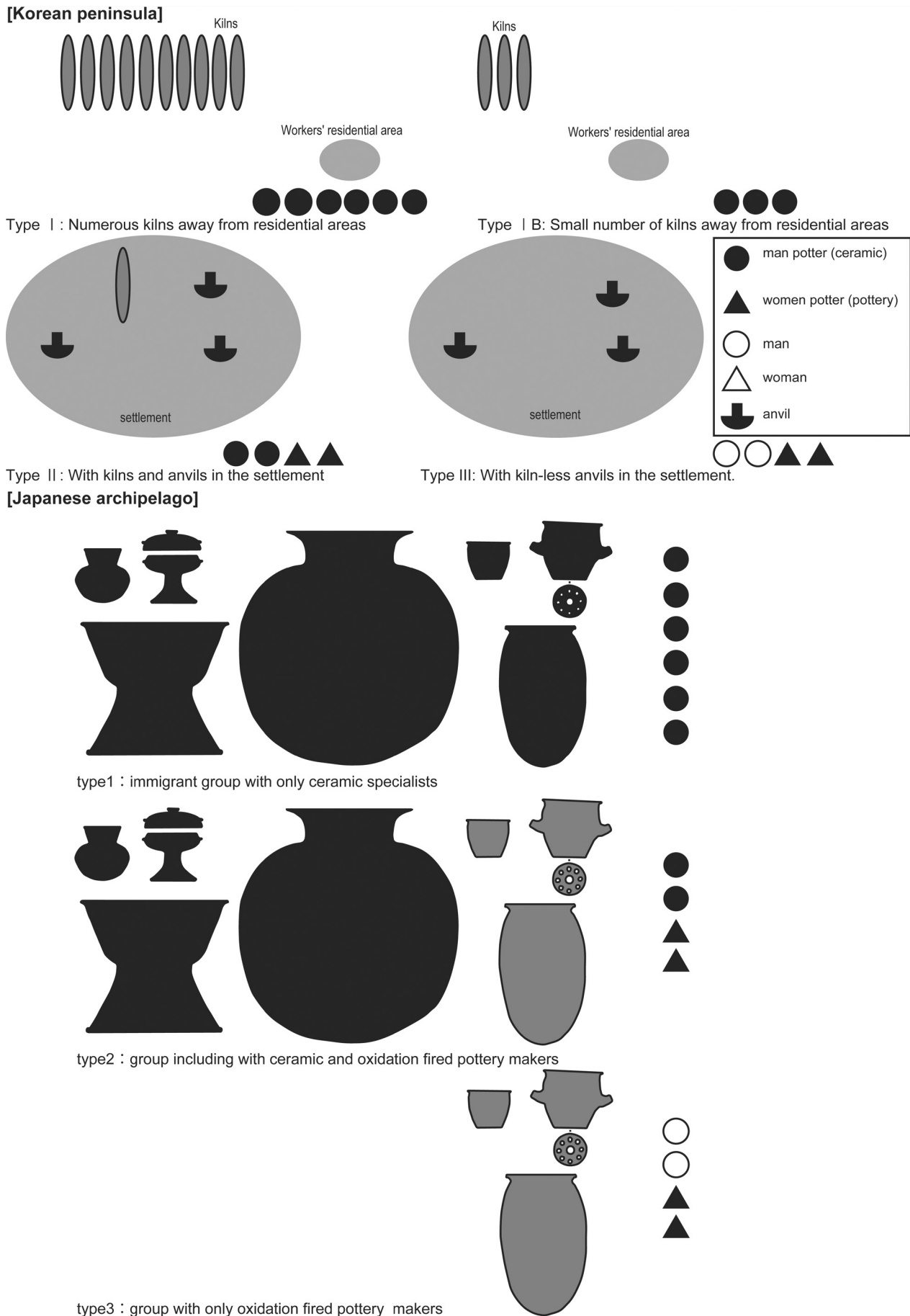


Figure 15.7. Model of pottery production system.

cases of predominantly female and female-only cases are 85, indicating an 80 percent female majority. He also pointed out that according to ancient Japanese literature, women were the makers of Haji ware, and men were charged with heavy labor, such as digging, carrying and pounding earth, fetching firewood, preparing and carrying straw. Women shared the responsibility for making Haji ware, which was used at the shrines, and men made Sue ware.

Early Sue ware excavated from Suemura kiln TG 232 includes some tall cups that have elements in common with Haji ware (Okado 1995: 276, 277). Therefore, in the beginning of stoneware production, women skilled in making Haji ware assisted in forming Sue ware. Basically, however, the techniques of Haji ware and Sue ware did not merge. Haji ware was rather strongly influenced by Korean Yeonjil earthenware. Haji-ware pots were influenced by long-bodied Korean boilers, in turn becoming longer themselves, and eventually people used them as boilers as well. Therefore, it is assumed that Sue ware fired by kilns was produced by men and Haji ware by women, and even on the Korean peninsula, stoneware was produced by men and Yeonjil earthenware by women. The three production patterns are very interesting to consider, including the division of roles between men and women. We can assume a division of roles and production patterns: Type 1 is a group of women-only specialists. Type 2 is a group of both stoneware-making men and open-fired-earthenware-making women, and Type 3 is a group of men with no pottery skills and women with pottery-making skills. The king and wealthy families of the Japanese archipelago invited and hired a group of stoneware specialists and formed the Suemura primal kilns. On the other hand, it is thought that some families migrated to the Japanese archipelago from a community of men who made stoneware and women who made open-field earthenware, and this was an example of an immigrant group of local kilns. The local chiefs of the Japanese archipelago invited them to produce Sue ware, and at the same time, they adopted a new cooking style that require Yeonjil earthenware.

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## Structure of Sue-Ware Tunnel Kilns on the Japanese Archipelago

Masaaki Kidachi

**Abstract:** The author examines the structure of *anagama* kilns (long-chamber kilns) introduced to the Japanese archipelago, as follows. During the early period in the Japanese archipelago, *anagama* kilns could be divided into the sunken kiln and the semi-sunken kiln. The choice of sunken or semi-sunken kiln depended on the topography and geology in which the kiln was constructed. Sunken kilns are not easy to heat up, but have the characteristic of being difficult to cool. On the other hand, semi-sunken and surface kilns are more efficient at raising temperatures, but have the feature that the temperature in the firing chamber rises and falls remarkably due to the small heat-storage capacity of the kiln itself. In the second half

**Keywords:** Sue-ware tunnel kilns, sunken kilns, semi-sunken kilns, surface kilns, S-F angle

### 16.1. Introduction

Bernard Leach recognizes that tunnel kilns were a technological development unique to the East, while bottle oven kilns developed in the West (Leach 2020 [1939]: 285). However, Hirotsugu Sekiguchi states that “unroofed kilns,” an archetype of bottle oven kilns, have had a longer history in China than in West Asia and Europe (Sekiguchi 1983). Yoshiki Fukasawa concludes that unroofed kilns originated in northern China in prehistoric times (Fukasawa 2011) and then spread to southern China. This suggests that tunnel kilns originated in southern China later than unroofed kilns and developed in parallel with the latter. The two different kiln traditions originated in different areas but coexisted in East Asia for a long time. It should also be remembered that, as Leach points out, while unroofed kilns developed into bottle oven kilns in the West, the former continued to exist in the East while maintaining their archetypal characteristics.

On the Japanese archipelago, these two types of kilns have become known as examples of folklore (Fig. 16.1a). From prehistoric times until the present day, pottery on the Japanese archipelago has developed under the strong influence of pottery in mainland China and the Korean peninsula. However, since the tradition of kilns deriving from unroofed kilns has not been thoroughly examined in the historical context of East Asia, it has not been clearly positioned in the history of pottery on the Japanese archipelago. In China, many remains of unroofed kilns built on the ground have been found in Beijing’s Longquanwu kiln site, which dates back to the tenth to twelfth centuries (Beijing Municipal Institute of Cultural Relics 2002: 54–80), and an increasing number of unroofed kilns have thus been surveyed. Meanwhile, unroofed kilns after the

development of tunnel kilns have not been fully examined. The relationship between the historical development of unroofed kilns and that of tunnel kilns in mainland China is a crucial subject for academic exploration. Furthermore, that relationship in mainland China is thought to have had a major impact on the development of kilns in the Korean peninsula and the Japanese archipelago.

This article introduces the results of examinations from the perspectives of folkloric archeology and experimental archeology of the structure of tunnel kilns on the Japanese archipelago, with the main focus placed on Sue-ware kilns dating back to the fifth to eleventh centuries (Fig. 16.1b).

### 16.2. Structure of Sue-ware tunnel kilns on the Japanese archipelago

The Japanese archipelago saw the development of Sue ware after the introduction of ceramics from the Korean peninsula in the fourth and fifth centuries. Sue ware is a kind of stoneware that is thought to have been spread in a political manner in parallel with the formation of the ancient Japanese state. It was produced within the ancient state based politically in present-day Nara Prefecture roughly between the fifth and eleventh centuries. Since the firing process of Sue ware involved reduction cooling, Sue ware ceramics are generally in gray or bluish gray. The firing temperature is thought to have peaked at 1150°C. While the way of finishing the firing process varied over time, recent findings in experimental archeology suggest that Sue ware was in fact often fired at lower temperatures than 1150°C. Due to the structure of tunnel kilns, temperature differences between various spots in them cannot be avoided. Therefore, a certain fluctuation in firing temperatures was inevitable (see Chapter 1, Section 1.3.3).





**Figure 16.1. Unroofed kiln. a: Kiln fired for Fushimi dolls in 1923; b: Experiment tunnel kiln in 2005.**

Since tunnel kilns are generally built using mountain or hill slopes, their firing chambers have sloped floors. There are rare examples of tunnel kilns built on flat land. However, even this kind of kiln has a pit dug in the ground and a sloped firing chamber dug from the bottom of the pit.

There are also very few tunnel kilns with almost flat firing-chamber floors, which are sometimes called “flat kilns.” However, as explained below, flat kilns have a large height difference between the stokehole and the flue hole, and rely on that difference to draw the fire deep inside. This means that flat kilns have a similar mechanism to sloped tunnel kilns.

#### **16.2.1. Kiln types by construction method: sunken kilns and artificially roofed kilns**

In the Japanese archipelago, Sue-ware kilns used to be categorized in terms of structure into sunken kilns and semi-sunken kilns (e.g. Tanabe 1966: 30). However, recent studies have revealed the realities of surface kilns, resulting in growing awareness of three types of kilns categorized by construction method: sunken kilns (Fig. 16.2a), semi-sunken kilns (Fig. 16.2b) and surface kilns (Fig. 16.2c) (Moriuchi 2010).

The key point in kiln construction methods is whether a kiln is dug out to be roofed with the natural ground surface or has an artificial ceiling. From this point of view, there is a radical difference between sunken kilns roofed with the natural ground surface and semi-sunken kilns, which have artificial frames for their ceilings upon the ground. Meanwhile, semi-sunken kilns and surface kilns share the same structure of artificial ceilings. Since the difference between semi-sunken kilns and surface kilns is relatively small, excavators often face difficulty categorizing the kilns they are excavating into semi-sunken kilns or surface kilns. For this reason, this article categorizes Sue-ware kilns into the two types of sunken kilns and artificially roofed kilns (including both semi-sunken kilns and surface kilns), instead of using the two terms semi-sunken kilns and surface kilns as different categories. Although it is sometimes difficult to distinguish between sunken kilns

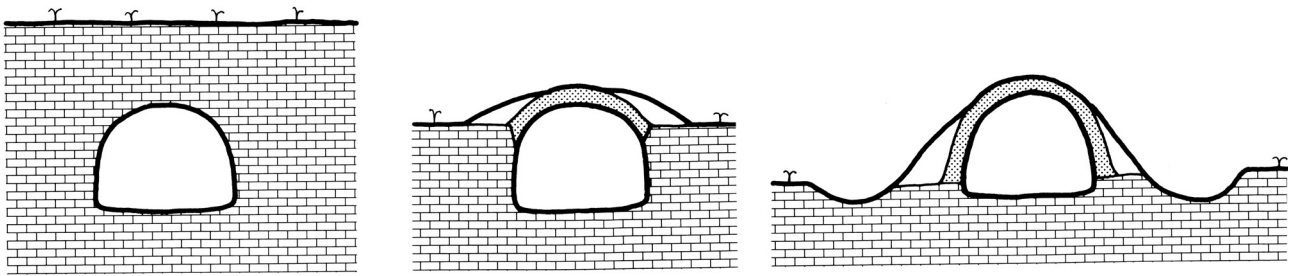
and artificially roofed kilns at excavation sites, a layer of earth outside the side walls and a trace of earth applied for protective purposes to the exterior of the kiln are clues to judging that a kiln was used as an artificially roofed kiln. Basically, no protective layer of earth can or needs to be applied to the exterior of sunken kilns.

Even if the roofs of sunken kilns collapse, a trace of the collapse can often be found without the need for excavation, in the form of trenches in the ground. Meanwhile, artificially roofed kilns generally do not leave any trench-like trace, even if their roofs collapse. In the case of a kiln built by digging the surrounding area to create a seemingly elevated area and constructing a roof/ceiling above the elevated area, the elevated area sometimes remains even if the roof/ceiling collapses. Therefore, a pre-excavation observation of micro-landforms sometimes helps judgment on whether a kiln is a sunken kiln or an artificially roofed kiln.

On the Japanese archipelago, sunken kilns and artificially roofed kilns have coexisted since the origination of Sue ware. Meanwhile, it has been confirmed that both sunken kilns and artificially roofed kilns already existed on the Korean peninsula in the third or fourth century, prior to their introduction to the Japanese archipelago (Han 2005: 90). It can be inferred that these two different types of kilns were used for different purposes according to the need. Exploring the relationship between product types and firing finishes is a challenge to be tackled henceforth.

#### **16.2.2. Selection of kiln location: relationship between geographic and geological features and kiln structure**

The selection of a kiln location depends on the kiln construction method. The construction of a sunken kiln requires easy-to-dig but collapse-resistant soil as a crucial condition. In hard bedrock that cannot be easily hollowed, or overly weak ground, sunken kilns cannot be built, but artificially roofed kilns can be constructed. Weathered granitic soil, which is easy to dig and heat-resistant despite entailing the risk of collapse, is a favorable ground condition for constructing sunken kilns. In areas without



**Figure 16.2. Pattern diagram of kiln section. a: Sunken kiln roofed with natural ground; b: Semi-sunken kiln with artificial frame for ceiling; c: Surface kiln with artificial frame for ceiling.**

favorable geological conditions and with hard-to-dig bedrock, such as the Harima area and the Tanba area, kilns cannot be dug in the ground, so artificially roofed kilns are the main type of kilns found.

The question of whether a kiln is dug out with the natural ground surface preserved as the kiln roof or has an artificial ceiling frame is related to the question of what geographical features are used to build the kiln. The kiln location affects the angle of the sloped floor and the length of the flue, as well as whether or not the kiln has a flue. Artificially roofed kilns are often built using a natural slope for their floor, because kilns of this type need a sloped floor in place of a long flue, which they cannot have for structural reasons. While steep cliffs on the skirts of mountains can be used as they are to build kilns, the construction of sunken kilns on gentle mountain slopes must be begun by digging the slopes to create vertical surfaces. In such a case, the earth removed to dig out a kiln is disposed of in front of the kiln, and sometimes accumulated to create a flat area beneath the kiln. The flat area, called the “forecourt,” is thought to have been used as a workspace during kiln construction. However, if a kiln is dug out on the boundary between a mild slope and a steep cliff, the removed earth falls under the cliff, leaving no trace. In some areas, such geological conditions were preferred for kiln construction.

A thorough analysis is necessary to determine whether kilns that matched local geological or geographic conditions were constructed or particular geological or geographic conditions were selected to construct kilns of particular structural types.

### **16.2.3. Functional differences between sunken kilns and artificially roofed kilns**

#### **Features of sunken kilns**

A sunken kiln has a firebox and a firing chamber deep underground, so raising the kiln temperature requires heating the overall surface of the ground. Since the overall ground surface and the whole kiln must be heated for a long time, instead of being heated rapidly, the sunken kiln needs a much longer time for firing and cooling and consequently a larger amount of firewood than the artificially roofed kiln.

One Japanese potter said that a tip for kilning is “firing the kiln before firing stonewares” (Furutani 1994: 48). Stonewares alone cannot be fired without firing the kiln. A raised temperature over the whole kiln helps to successfully fire works in the kiln. Compared with modern tunnel kilns, most of which are artificially roofed, ancient sunken kilns probably required a longer time to heat the whole kiln.

Despite needing a large amount of fuel and being difficult to heat rapidly, sunken kilns can retain heat very well and hardly cause temperature differences between various points in the kilns or sudden temperature changes. Even putting firewood into a sunken kiln at a slow speed does not cause a rapid temperature decline in the kiln. The temperature of this type of kiln drops slowly, causing little damage to fired stonewares. When fired in kilns other than sunken kilns, thick or large stoneware vessels are very likely to break when rapidly cooled down, due to the large temperature difference between their inner and outer surfaces or between their upper and lower parts. Meanwhile, small or thin vessels seldom break because they are characterized by only a small temperature difference between the two surfaces. By contrast, the temperature in sunken kilns changes slowly both during and after firing, so kilns of this type are very favorable for firing thick or large stoneware works.

Potters today say that it takes as many days as needed for firing works to cool the fired works before they can take them out of their kiln. If the firing process needs 3 to 7 days, it takes 6 to 14 days for the potters to complete the entire process, beginning from starting firing and ending with the removal of the fired works from the kilns. However, given that most modern tunnel kilns are artificially roofed, it can be inferred that ancient sunken kilns needed a longer time for the entire process than modern kilns. This would have meant a long cycle of firing, leaving sunken kilns at a disadvantage in terms of meeting the need to fire stonewares quickly and take them out in a short time.

#### **Features of artificially roofed kilns: semi-sunken and surface kilns**

The above-quoted Japanese potter also said, “With low thermal conductivity, air per se is an excellent thermal



insulator” (Furutani 1994: 34). Compared with sunken kilns, artificially roofed kilns, elevated on the ground, have a smaller proportion underground and have a larger surface exposed to the air. One can stand next to an artificially roofed kiln even when its internal temperature exceeds 1200°C, because the air insulates the heat.

It can be inferred that, unlike in a sunken kiln, the heat generated by burning firewood in an artificially roofed kiln is little absorbed into the ground, and is able to rapidly increase the internal temperature of the kiln. A thinner roof/ceiling would have further enhanced the thermal efficiency of the kiln, despite its weaker structure. Meanwhile, a thicker roof/ceiling would have required greater calorific power to heat the thicker walls of the kiln, despite its stronger structure.

Since the thermal storage capacity of an artificially roofed kiln is small, the internal temperature drops immediately when firewood is not supplied. This type of kiln thus features drastic sudden temperature changes. It is inferred that thick or large stoneware works fired in artificially roofed kilns were very likely to cool down rapidly and get cracked.

It is also inferred that, when the internal temperature of this type of kiln was raised rapidly, the temperature difference increased between the kiln’s upper part near the ceiling and its lower part near the ground. It is thought that preventing such a temperature difference required using certain special techniques, including the technique of firing stonewares while maintaining the same temperature, known as *nerashi shosei*, and *tomedaki* technique. *Tomedaki* is the technique of closing a kiln after its temperature reaches a certain level and firing the kiln again the next day. While in the general kilning process the kiln temperature is gradually raised, preventing a sudden temperature rise, the *tomedaki*

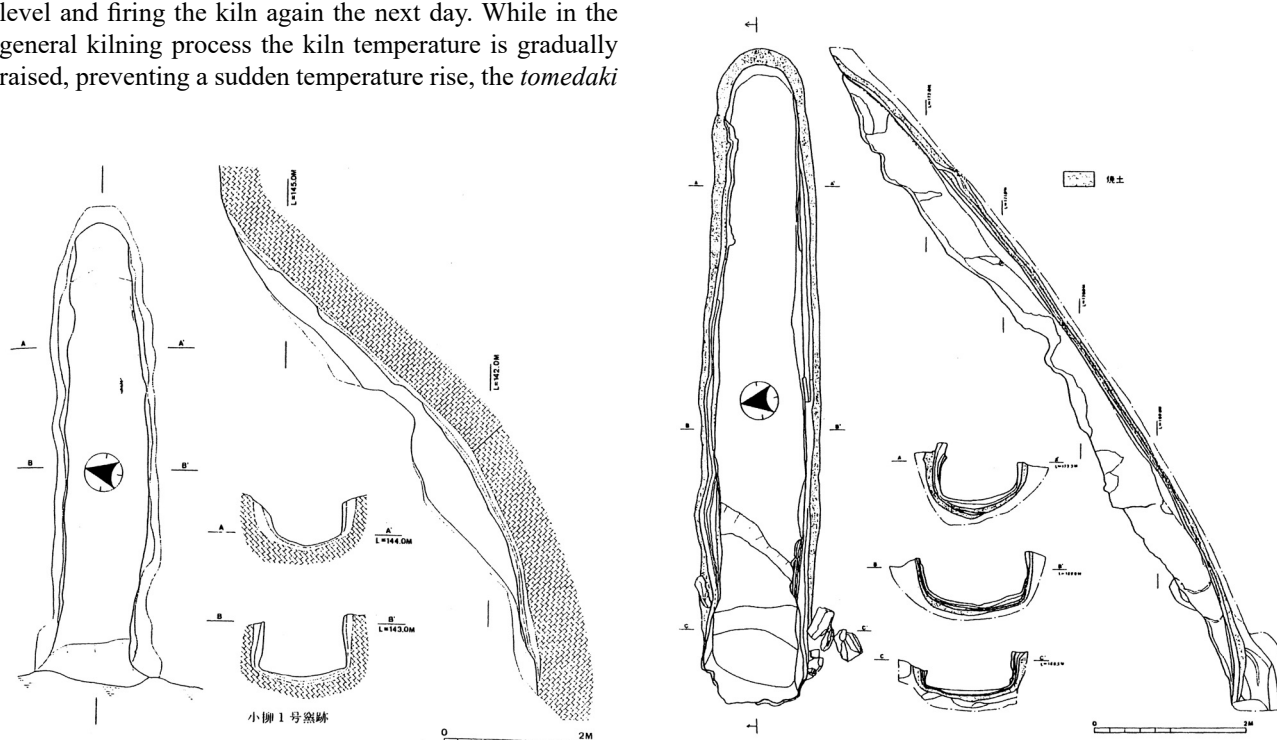
technique helps increase the kiln temperature in one go to the same level as the previous day. This technique is effective in reducing the temperature difference in the entire kiln by increasing the volume of heat stored on the floor and reducing the temperature difference between the ceiling and the floor. As described above, it is inferred that the structural disadvantages of artificially roofed kilns could be offset to some extent by using special firing techniques.

However, a remaining problem for us to address is that excavations alone cannot easily reveal what special firing techniques were used. This problem needs to be addressed through repeated archeological experiments and in-depth examination based on excavations.

### 16.3. Inclination of Sue-ware tunnel kilns

#### 16.3.1. Two types of sloped floors

Shozo Tanabe (Tanabe 1966) points out that there are two types of floors of Sue ware kilns: a curved floor, whose angle of inclination varies across the kiln in such a manner that the floor steeply rises toward the depth of the kiln (Fig. 16.3a); and a sloped flat floor, whose angle of inclination is uniform from the stokehole to the other end of the kiln (Fig. 16.3b). Tanabe calls the angle of inclination of the line between the floor surface at the stokehole and the top of the flue hole the “S-F angle” (see Chapter 1, Section 1.3.4, Fig. 1.2). Although previous studies on the structure of Sue-ware kilns have placed importance on the angles of the sloped kiln floors, the key to greater power



**Figure 16.3. Two floor types. a: Bow-shaped floor type, Koyanagi No. 1 kiln in Kyōto Prefecture; b: Straight climbing floor type, Ishihirabata No. 2 kiln in Kyōto Prefecture (Kiln Research Society 2004).**

to draw the fire deep into the kilns is S-F angle. Both types of Sue-ware kiln floors are thought to have been designed based on calculation of the S-F angle.

A careful observation of floor inclination and the overall shapes of kilns reveals that many kilns with curved floors narrow toward their maximum depths. The overall shape of a kiln of this type resembles a candle flame. The above-quoted modern Japanese potter explains that kilns of this shape can easily allow fire to spread across their internal space (Furutani 1981: 102). This well-designed type of kiln features high fuel efficiency. By contrast, many kilns with sloped flat floors are almost rectangular in overall shape. Although it seems that these kilns were designed to use the S-F angle to increase the power to draw the fire deep into the depths of the kiln, their rectangular shapes hardly facilitated the smooth flow of fire, resulting in the need for large amounts of fuel. Detailed consideration of the flame shapes and the flow of fire suggests the high likelihood of an insufficient spread of fire at the maximum depths of kilns with sloped flat floors. It is supposed that this type of kiln needed accurate calculation of a good balance between the S-F angle and the sizes of the stokehole and the flue hole.

Kilns with curved floors are thought to have accommodated few works other than small ones near their maximum depths due to their steeply sloped, narrow floors. Meanwhile, kilns with sloped flat floors are thought to have accommodated stoneware works of any size even at their maximum depths. However, it seems unlikely that the latter type of kiln, with an insufficient spread of fire, was designed with high importance placed on the quality of products.

As seen above, it can be concluded that selection between the two types of sloped kiln floors was made considering the types of stoneware products to be fired in the kilns and the firing efficiency.

### 16.3.2. Changes in S-F angle

It has been pointed out that, while Sue-ware kilns dating back to the early seventh century generally have steeply sloped floors, kilns constructed after the origination of kilns with upright flues in the late seventh century have more gently sloped floors (Mochizuki 1993). This is also the case with tile kilns. Both Sue-ware kilns and tile kilns dating back to the early seventh century mostly feature curved floors that rise up toward their depths, and boundaries between floors with the different angles of inclination. It is thought that kilns in the early seventh century had a flue hole cut directly in the ceiling above their maximum depth, instead of having a long flue. Many of those kilns had a large, flat firebox. As a natural consequence, their S-F angle was smaller than the angle of the sloped floor. Therefore, compared with early seventh-century kilns, kilns with upright flues constructed in the late seventh century have a larger ratio of the height gap between the stokehole and the flue hole to the entire length

of the kiln body, resulting in greater power to draw the fire deep into the kiln despite the slight angle of their sloped floor. Gently sloped floors require less effort to put works in the kiln. In addition, it is supposed that this newer type of kiln had much greater power to draw the fire toward its depth than older types, leading to a shorter time needed to increase the temperature of the kiln. However, it is thought that these kilns in turn were more susceptible to leaking heat and were less fuel-efficient. These disadvantages may have been overcome to some extent by adjusting the sizes of the stokehole and flue hole. Nevertheless, the early seventh-century type of kiln structure was used even in the late seventh century in some areas and for some kilns. Comparison between areas where the new type of kiln was introduced and those where it was not will require further analysis from a wide range of perspectives, including the quality of the stoneware works fired in those kilns and the production systems.

## 16.4. Conclusion

Surveys of the remains of Sue-ware kiln clusters have revealed that, while some clusters continued to use sunken kilns over time, others shifted from sunken kilns to artificially roofed kilns (Mochizuki and Kashima 2010: 639). It is inferred that the way of selecting kiln types differed according to the cluster due to the natural environment and the conditions of the local community. Some remains of kiln clusters suggest that both sunken kilns and artificially roofed kilns coexisted and were used for different purposes in the same cluster. The complex structure of tunnel kilns on the Japanese archipelago differed according to the area, and changed over time in a diverse, complex manner. Nevertheless, the two types of kiln structures continued to coexist and were handed down to medieval Japanese society.

When tunnel kilns were introduced from the Korean peninsula, the Japanese archipelago did not have kilns of any kind. Instead, people fired pottery covered with fuel on the ground. It is thought that the Japanese method of firing ceramics under a cover on the ground lasted until long after the introduction of tunnel kilns, and was gradually replaced by unroofed kilns from the tenth century on (see Kiln Research Society 1997). On the Japanese archipelago, the introduction of tunnel kilns was followed by that of unroofed kilns, probably in reverse order to that in mainland China. While regional differences in unroofed kilns need further examination, regional differences and historical changes in tunnel kilns have been examined in detail from the perspectives of both ware and kiln structure (Kiln Research Society 2010). Kiln structure will be an important research topic not only as evidence of the genealogy of ancient kiln engineers but also as an indicator of changes in demand.

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## Nakadake Sanroku: The Southernmost Sue-Ware Kiln Site Center in Ancient Japan

*Naoko Nakamura*

**Abstract:** The Nakadake Sanroku Kiln Site Center was installed by the ancient Japanese state at the beginning of the ninth century AD in its southern border region. Unlike other Sue kiln site centers, Nakadake Sanroku is geographically separated from sites related to the ancient province administration, and the area around the site had been the center of a local group of indigenous people until a few decades earlier and a hub for trade with the southern islands over the centuries. After subjugation by the Japanese state, state administration was weak and the need for Sue ware for state administration as well as Buddhist temples was low, but Sue ware from Nakadake is found on the southern islands, outside the realm of the state. The chapter introduces the background of the kiln site center and recent research in a large international and interdisciplinary project.

**Keywords:** Nakadake Sanroku Kiln Site Center, Sue-ware production center, periphery of the Ancient Japanese state, South Kyūshū, Ryūkyū archipelago, long-distance trade, economic strategy

### 17.1. Introduction

The Nakadake Sanroku kiln site center – which will be called “Nakadake Sanroku” for convenience in this chapter – was installed around or shortly after 800 AD by the ancient Japanese state as one of the last Sue production centers and is the southernmost kiln site center of its kind.

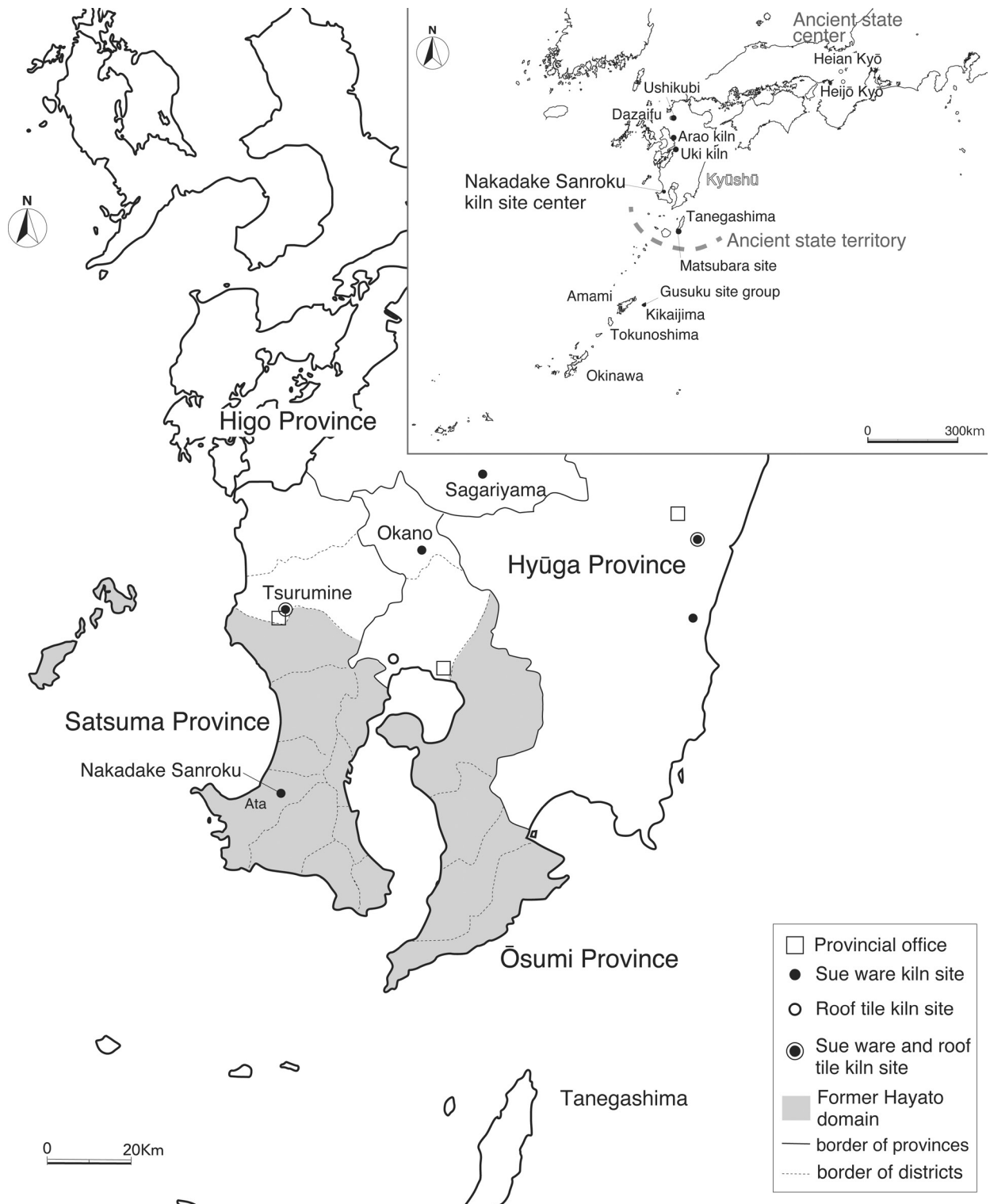
Nakadake Sanroku is located at the foot of Mt. Nakadake (hence its name), on the western coast of the Satsuma peninsula in Kagoshima prefecture (Fig. 17.1). The site extends from the mountain towards the estuary of the Manose River (Fig. 17.2). This area was a hub of trade with the Ryūkyū islands from prehistoric times, and later its trade routes extended as far as Song Dynasty China and South East Asia, and this southern trade route paved the way for the Western world’s contact with Japan from the sixteenth century onwards.

Nakadake Sanroku is unique and fascinating in the Japanese context for several reasons:

- It was set up in a region that is related to the Hayato, the indigenous people who inhabited southern Kyūshū and who had been subjugated by the Japanese state only a few decades earlier. The kilns that should have served the provincial government in the north of the province were instead set up further south, in the former center of that powerful local group.

- Its geographical location and the archeological evidence suggest that the region had been a hub of exchange between the north and south of the Japanese archipelago from prehistoric times down to the Middle Ages. Thus, the location of the production center – which should have been a purely administrative site in the context of the ancient Japanese state – adds another aspect to its interpretation.
- Distribution of Sue ware from this site can be traced to as far south as Tokunoshima, which later became home to the Kamuiyaki kiln site center that will be introduced in the next chapter. Although there is no evidence of a direct relation between the two, Nakadake Sanroku and the distribution of its pottery illustrate the beginnings of resurgent exchange with the south that led to vibrant trade in the Middle Ages.
- From the discovery of the first kiln sites in 1984, and as a result of recent prospections, the overall size has been estimated to exceed the norm expected from Satsuma Province – a poor, small province in the periphery of the ancient state.
- International and interdisciplinary research on this site was funded in two large research projects by the JSPS KAKENHI Grant Number 25580170 and 15H01902 starting in 2013, adding new methods and ideas to the well-established toolbox for research on Sue kiln site centers.

This chapter gives an overview of this background and introduces the interdisciplinary research of recent years;



**Figure 17.1.** Location of the Nakadake Sanroku Kiln Site Center in South Kyūshū and related kiln sites. District borders are based on a map of ancient districts and villages in Haraguchi et al. (2011: 86).

a comprehensive report is being prepared, and as of 2022, updates on new developments can be found on our website at <https://nakadake-kilns.netlify.app>.

The site is of particular interest because of its geographical and historical setting between “Japan” and the “Ryūkyū islands,” between state administration and trade activities, and between the central state and indigenous local powers.

## 17.2. Historical and geographical background

### 17.2.1. Kyūshū: between the Korean peninsula and Honshū

Mt. Nakadake is located near the southwestern coast of Kyūshū, one of the largest islands in the Japanese archipelago (Fig. 17.1). The northwestern part of this

island is close to the Korean peninsula, and therefore was the main contact point for exchange with the continent and China from prehistoric times. Wet-field rice agriculture entered the archipelago via northwestern Kyūshū from the ninth century BC (Miyamoto 2019: 206), bronze and iron tools from China and the Korean peninsula can be found in elite burials from the third century BC (Fukuoka City Museum 2015: 17), and from the Yayoi period to the sixth century, most of the iron resources in Japan came from the Korean peninsula (e.g. Murakami 2017: 9).

From the third century on, the Yamato administration, which was a coalition of chiefs based in the Kinki region of Honshū, began to spread its influence over the Japanese archipelago. By the seventh century, it had become the core of the ancient Japanese state. The Yamato administration was actively engaged in diplomacy with the Korean peninsula in order to acquire the newest technologies, such as those used in the production of metal crafts and the hard fired ceramics that later came to be called Sue ware in Japan (Tsude 2010: 109), which were later produced in Nakadake Sanroku.

Developing from the Yamato administration, a centralized state was formed in the seventh century, and subsequently provinces were established in each region of the Japanese islands. There were three tiers of local administration: provincial, district and township. A provincial governor was deployed from the capital to each province, a local magistrate appointed in each district and a township head set up in each village. In the latter half of the seventh century, Dazaifu was established in Chikuzen Province in northwest Kyūshū as an administrative and judiciary organ of the government in Kyūshū, as well as for diplomacy with and defense against the Korean peninsula (Satō 2019: 198). Like other administrative centers of that time, kilns for production of hard fired Sue ware were located close to Dazaifu, which formed the largest kiln cluster on the island of Kyūshū and one of the largest Sue kiln site clusters in Japan. The area around Nakadake was not part of these developments for centuries, and to understand the case of Nakadake Sanroku, it is essential to know that the production of Sue ware was closely related to the ancient state and that the South of Kyūshū was late in being incorporated into the ancient state.

### 17.2.2. Southern Kyūshū and the Ryūkyū islands

There are two peninsulas in southern Kyūshū, separated to the north of Kyūshū and the territory of the ancient state by a central mountain ridge: Satsuma in the west and Ōsumi in the east. The Ryūkyū archipelago stretches to the south.

The small-scale plains and volcanic soils of southern Kyūshū are not suitable for paddy-field rice cultivation, the main occupation in Japan from the Yayoi period onward and subject to taxation in the ancient state. According to the tax records of Satsuma Province written in the early eighth century just shortly after its installation, this

province had significantly lower storage of rice than other provinces (Nakamura A. 2006: 545–46).

Despite that, southern Kyūshū was an active hub of trade, which included shell trade with the Ryūkyū islands. Large shells, gathered in the central part of the Ryūkyū islands, were processed as bracelets and horse accessories during the preceding Yayoi and Kofun periods (e.g. Kinoshita 1996) and traded as prestige goods to the elite in other areas of Kyūshū and to Honshū.

During the Yayoi period, a trade route existed along the western coast of Kyūshū (Kinoshita 1996: 188). Not far from where Nakadake Sanroku was to be built, along the lower reaches of the Manose River, several sites show the importance of this region as a trading hub. The Takahashi site revealed large shells and Nakabaru-type potteries from the Ryūkyū islands, as well as Itazuke-type potteries from the northwestern part of Kyūshū (Kawaguchi 1963). At the Shimoshōji site, a jar-coffin was unearthed, which is a type of burial commonly found in northwestern Kyūshū (Kawaguchi et al. 1976). The corpse also wore shell bracelets that were typical of the style found in northwestern Kyūshū, and so it is suggested that the buried person was a local chief who had been active in trading (e.g. Nakazono 2004: 308). Sherds of pottery produced in southern Kyūshū have been found in sites in the central Ryūkyū islands, suggesting active trade during the middle Yayoi period (Shinzato T. 1999: 101, Nakazono 2004: 533). A new route along the east coast of Kyūshū was added during the Kofun period. There are several large tumuli from the fourth and fifth centuries along the eastern coast of the Ōsumi peninsula, and the elite buried in these tumuli may have obtained power through trade activities with the Ryūkyū islands (Hashimoto 2012: 23).

As the discussion of the kiln site center in Nakadake Sanroku will show, trade along the West coast of Satsuma to the southern islands started to flourish again in the eighth century, and later in medieval times the lower reaches of the Manose River evolved into a flourishing center for domestic trade and a hub between China and all of Japan (Yanagihara 2007: 71, Miyashita 1998, Shinzato A. in this volume).

### 17.2.3. Process of incorporation into the ancient Japanese state

#### 17.2.3.1. State administration and the Hayato

The incorporation of southern Kyūshū into the ancient Japanese state started with the establishment of Hyūga Province in southeast Kyūshū in the middle of the seventh century. Satsuma Province was separated from Hyūga Province in 702. Ancient records show that the districts of Satsuma Province were smaller than those in other provinces (Nakamura A. 2006: 541), one of the many peculiarities in this small and poor province. The former capital of the province was located in what is now Satsuma Sendai City in the north (Kagoshima Prefecture

Board of Education 1975). The site of the accompanying provincial temple complex revealed that the buildings were constructed in the latter half of the eighth century and that they were relatively small compared to those in other provinces (Sendai City Board of Education 1981, Obara 2005: 277).

Ōsumi Province on the Ōsumi peninsula was established in 713. The site of the capital and the provincial temple is thought to have been located in what is now Kirishima City, but details such as the size of the buildings are not known (Fukano 2019: 204).

The indigenous people of southern Kyūshū were known as the “Hayato” before they were incorporated into the ancient Japanese state. They were described in the first historical documents, written in the seventh century, as barbarians with a different ethnic identity who paid tribute to the Yamato imperial court. Often mentioned in a similar context is a population from northern Honshū called the “Emishi.” Like the Hayato, they were under the control of the Yamato imperial court as a separate ethnic group. For the Yamato court, the existence of distant, tribute-paying barbarians had political effect and indicated the extent of Imperial power (e.g. Nakamura A. 2006, Nagayama 2009).

The Hayato rose up against the Yamato imperial court in 701 and 713, and in 720 they carried out the largest uprising, which lasted several years until it was ruthlessly crushed. The efforts of the central state to control the south are exemplified by the relocation of people from other regions of Kyūshū to the Hayato domain, as told in the written sources (Nakamura A. 2006: 540, Nagayama 2009: 78) and the archeological record (e.g. Miyata & Hirakoba 2005). Participation in a large uprising in North Kyūshū in 740 on both the government’s side and on the rebellious side (Nagayama 2009: 80–95) shows that the insecure situation in South Kyūshū continued long after the establishment of the provinces.

Archeological remains in southern Kyūshū from the latter half of the eighth century indicate that the use of the local type of pottery had declined rapidly. At that time, the lifestyle of the locals had begun to conform to that of the general Japanese population. Archeological findings from the ninth century show an increase in the number of industrial remains such as Sue kilns and those from iron production, suggesting that new and intensive technologies had been introduced (Ikehata & Kawaguchi 2006: 611).

In AD 800, later than in other provinces, the *handen shūju* law of periodic reallocation of rice land was implemented in southern Kyūshū, and the tribute paid by the Hayato was halted. “Hayato” as the name of the people of southern Kyūshū disappeared (Nagayama 2009: 145). It is during these years, at the beginning of the ninth century, that Sue production in Nakadake Sanroku was established.

### 17.2.3.2. *Ata in Satsuma*

Mt. Nakadake is located in the Ata District of Satsuma Province. Because the Hayato population on the Satsuma peninsula were called “Ata Hayato,” it is thought that Ata had been the seat of local power in Satsuma until the eighth century (Yanagihara 2007: 151). According to the *Wamyō Ruijūsho* from the tenth century, there were four townships in Ata District, which is estimated to have been the most populous district in Satsuma Province.

At the Konakabaru site, 1.5 km from Nakadake Sanroku, a piece of Haji ware engraved with the Chinese characters for Ata (阿多) was found (Ushinohama ed. 1991: 177). The Ata district dates back to before the establishment of Satsuma Province, and the Konakabaru site is probably the location of the former district office.

### 17.2.3.3. *The Ryūkyūs: part of state territory and beyond*

The islands of Tanegashima and Yakushima south of the Ōsumi peninsula form the main part of the northern region of the Ryūkyū archipelago. Tane Province was established in 702, but by 824, it was incorporated into Ōsumi Province. Historical and archeological data show that these islands were home to an agrarian society (Torao 2006: 4). The central and southern Ryūkyū islands were home to hunter-gatherer societies, each with their own distinctive culture, and were outside the territory of the ancient Japanese state. The border of the territory of Japan was between the northern and central parts of the Ryūkyū islands.

However, from the ninth to the twelfth century, the relationship of the Ryūkyū islands with the ancient Japanese nation became closer, as seen in the trade of the great green turban shell, the raw material for mother-of-pearl inlay work. The Gusuku site cluster on Kikai Island in the central Ryūkyū region, which dates from the ninth to the fifteenth century, has revealed evidence of widespread trade. Artifacts found in the site cluster include ceramics made at the Yuezhou kilns in southeastern China, celadon and unglazed ceramics produced on the Korean peninsula, and Haji and Sue ware. Some large buildings with eaves found in the site group show a style of architecture that was used in the ancient Japanese state (Matsubara et al. 2015: 77–78). Kikai Island thus differs significantly from other islands of the central and southern Ryūkyū islands, where local potteries were dominant. Part of the Gusuku site cluster is presumed to have been the residence of a local leader’s family that was connected with southern Kyūshū society (Kōmoto 2015: 58). As we will see below, Sue ware from Nakadake can be found in this site cluster as well, and it is distributed further to the south.

From the eleventh century on, under the influence of the Song Dynasty and a policy that encouraged trade and interaction, commerce at sea flourished for many centuries (Shinzato A. 2018: 159). During the medieval period, the central and southern Ryūkyū islands became important

hubs along the trade routes to and from South China and South East Asia. The first Westerners also came to Japan via this very route in 1543, then again in the middle of the nineteenth century, when Japan opened to the West after centuries of self-isolation.

#### **17.2.4. Sue production in the ancient Japanese state and Kyūshū**

##### *17.2.4.1. The transition of Sue ware in Japan*

The technology of Sue production was introduced to Japan from several regions on the Korean peninsula by the end of the fourth century. Sue ware was first produced for use as ceremonial vessels for the elite, but came into daily use by the sixth century. Under the *Ritsuryō* system of the emerging centralized state during the seventh century, Sue kilns were established in most provinces. Sue ware was supplied to government offices and temples in the form of storage containers for water or alcoholic drinks and as tableware for officials and Buddhist monks. It is thought that the production and distribution of Sue ware were controlled by the provincial or district offices. By the eighth century, Sue ware was being produced in Kyūshū, Shikoku and Honshū, an area that encompassed the entirety of the ancient Japanese state, but in the last half of the century, the popularity of Sue ware declined in and around the capital due to the nobles' demand for Chinese ceramics, green-glazed ware and Haji ware, a type of tableware fired in an oxidizing atmosphere with firing temperatures significantly below that of Sue ware. As a result, traditionally gray Sue ware diversified and kilns that produced green-glazed ware appeared (Kitano 2007: 267).

##### *17.2.4.2 Main Sue kiln site centers in Kyūshū*

Dazaifu was established in the late seventh century in Northwest Kyūshū, and the Ushikubi Sue kilns supplied the necessary Sue ware (Funayama & Ishikawa eds. 2006: 30, Ishiki 2010: 300). They were located about 3 km from Dazaifu and were used for 300 years, from the middle of the sixth to the middle of ninth century. During the latter half of the seventh century, production of Sue ware at other kilns in Chikuzen Province was discontinued and moved to Ushikubi (Ishiki 2010: 51). The kiln cluster consisted of a large number of sub-clusters and is estimated to have contained more than 500 kilns (Funamaya & Ishikawa eds. 2006: 5), thus being by far the largest kiln site center in Kyūshū.

From the latter half of the eighth century, the Ushikubi kilns shifted to producing small-sized products, and production was suspended by the middle of the ninth century. During the same time, Sue-ware kiln centers in Higo Province became large-scale. Thus, during the latter half of the eighth century, the center of Sue-ware production in Kyūshū moved from Ushikubi to Higo Province, and at the same time the main Sue ware produced in Kyūshū shifted to storage containers (Ishiki 2007: 309, Kitano

2007: 263). The most important were the Arao kiln center, with an estimated 120 kilns (Amita 2012: 131), and the Uki kiln center, with an estimated 23 kilns (e.g. Yamamoto 2018: 125).

The Arao kiln center produced Sue ware from the sixth century to the ninth century, with its peak of prosperity from the late eighth century to the early ninth century (Amita 2003: 361). The Kita-Urayama-A kiln site in the Arao center was an underground-type kiln and probably in use during the late ninth century (Ishiki 2004: 128). Because the kiln collapsed during the firing process, 20 pots and 30 pieces of tableware remained in the kiln. On the floor of the kiln, there were seven steps for holding Sue ware made from rocks that were held in place by a mixture of clay and straw (Matsumoto ed. 1980: 51–66), similar to the kiln excavated in Nakadake Sanroku.

##### *17.2.4.3. The role of Sue ware at the southern border of the ancient state*

During the eighth century, Sue-ware production began in southern Kyūshū. It may have served three different purposes.

The first was the standard supply of Sue ware to local government facilities, such as the provincial offices and the provincial temples. Given the small quantities of Sue ware in southern Kyūshū earlier, it is clear that there was a need for Sue-ware products at local government facilities. Objects used for ceremonies and other necessities were made of Sue ware. This included the essential writing tool of inkstones, which, during the Heian period, were generally made of Sue ware (Nakatani 2020).

The second was to supply settlements. Narikawa pottery had been used in southern Kyūshū from the Kofun period. This style of pottery reflected the unique lifestyle of the residents of southern Kyūshū. After the Hayato people were subjugated by the Japanese state, Narikawa pottery disappeared and was replaced by Haji ware and Sue ware (Nakamura 2015: 29). The demand for Sue ware increased with the Hayato people's change in lifestyle.

The third was to supply containers for trade. Since prehistoric times, southern Kyūshū had been a hub of active trade with the Ryūkyū islands. The Ryūkyū islands did not produce hard, durable ceramics, such as Sue ware, until the eleventh century, and Sue-ware items were both traded and used as containers for shipping.

##### *17.2.4.4. Sue-ware kiln sites in southern Kyūshū*

Besides Nakadake Sanroku, three other Sue-ware kiln site clusters have been identified in the southern half of Kyūshū. All of these started production at the time of the establishment of Satsuma and Ōsumi Provinces or thereafter. Two sites are in Satsuma Province and one site is in Ōsumi Province. Furthermore, the Sagariyama kiln sites in Higo Province north of Satsuma Province are close



to the kiln sites from Ōsumi Province and are estimated to have been used from the late eighth to the ninth centuries.

The Okano kilns in Ōsumi Province were located in Isa City, in the former Hishikari District, bordering Higo Province. Five kiln remains have been found at this site, all of which were used for the production of Sue ware from the late eighth to the early ninth century. Four kilns and an ash heap have been excavated. The kilns were the underground type. The best-preserved kiln, OK-III, shows similarities to a kiln in the Sagariyama kiln site cluster, had an upright flue at the rear of the kiln and a *bunen chū* a pillar located in the center of the kiln (Aosaki et al. 1983: 10). It is assumed that the pillar was for spreading the heat of the fire evenly throughout the kiln (Ishiki 2004) or for supporting the ceiling of the kiln (Aosaki et al. 1983: 10).

The Tsurumine kiln site cluster is located near the former Satsuma provincial capital, and about 1 km from the site of the former provincial temples. During the early eighth century, one kiln produced Sue ware, and two kilns produced roof tiles (Oda & Kawaguchi 1975). The remains show that this kiln cluster was built with the purpose of supplying roof tiles and Sue ware to the Satsuma provincial offices and the provincial temple. The kiln site for Sue ware was the semi-underground type and had two pillars, one located in the center and the other against the wall of the kiln.

Nakadake Sanroku was in operation from the ninth century through the early tenth century (Kamimura 2005: 246). It was located 50 km away from the Satsuma provincial capital (Fig. 17.2), far from where kilns would be situated if their purpose was to provide Sue ware to the provincial offices and the provincial temple. The site is located in Ata, the seat of local power in Satsuma prior to the establishment of the province, near the Manose River estuary, an important area for trade from prehistoric times until the fifteenth century. The location raises some interesting research questions about the power of the local elite, the kilns' proximity to the Manose River port, and the environmental conditions for pottery production.

### 17.3. The Nakadake Sanroku Sue Kiln Site center

#### 17.3.1. Research history

Nakadake Sanroku is located along the lower southwest side of Mt. Nakadake, a 287 m sandstone hill. The hillsides are etched with gullies, a topography which is well suited for Sue-ware kilns (Fig. 17.2). It was discovered in 1984 (Kamimura 1984: 191) when erosion due to intensive rainfall began to reveal ash heaps and kiln sites. However, no excavation had taken place in the 30 years since its discovery, and the last field-walking prospection for more than 30 years was in 1985. Therefore, the entire size of the kiln site center, the period that it was in operation and the construction style of the kilns, as well as the kinds of pottery produced there, were not understood until recently.

When field-walking prospections were carried out in 1984 and 1985, five kiln site sub-clusters were confirmed. At one of these, sub-cluster Arahira 1, remains of five kilns were identified on a slope, artifact finds were reported, and a topographical map of the sub-cluster area was created (Kamimura 1984, Kamimura & Tsubone 1985).

In 2012, tentative prospections showed that erosion had increased significantly and had almost completely destroyed some of the reported kiln sites in the Arahira 1 sub-cluster, but some potential kiln site areas reported in 1985 were confirmed again, and additional sites were discovered (Nakamura 2014: 283–85). Concentration of sherds, kiln furniture and wall fragments in a wider region on Mt. Nakadake hinted at a larger number of kilns in the cluster and an even wider extension of the whole production center than originally estimated.

Since 2013, the JSPS has supported a new approach of systematic research on an international and interdisciplinary level that was new to Sue-ware research and to kiln research in Japan. Excavations were carried out five times from 2013 to 2019, during which the structure of one of the kilns and artifacts found in a nearby ash pile were fully investigated (Nakamura 2020). Systematic analyses of samples from the excavation and prospections, as well as geographical investigations, are still being carried out, and a preliminary report is available (Nakamura & Shinoto eds. 2015), and a comprehensive report in English is in preparation.

#### 17.3.2. Historical context and research hypotheses

Considering the historical context of southern Kyūshū as explained in the previous sections, the following questions are of particular interest: (1) From where did the technique and craftsmen come? (2) Why was the kiln site center set up at the foot of Mt. Nakadake?

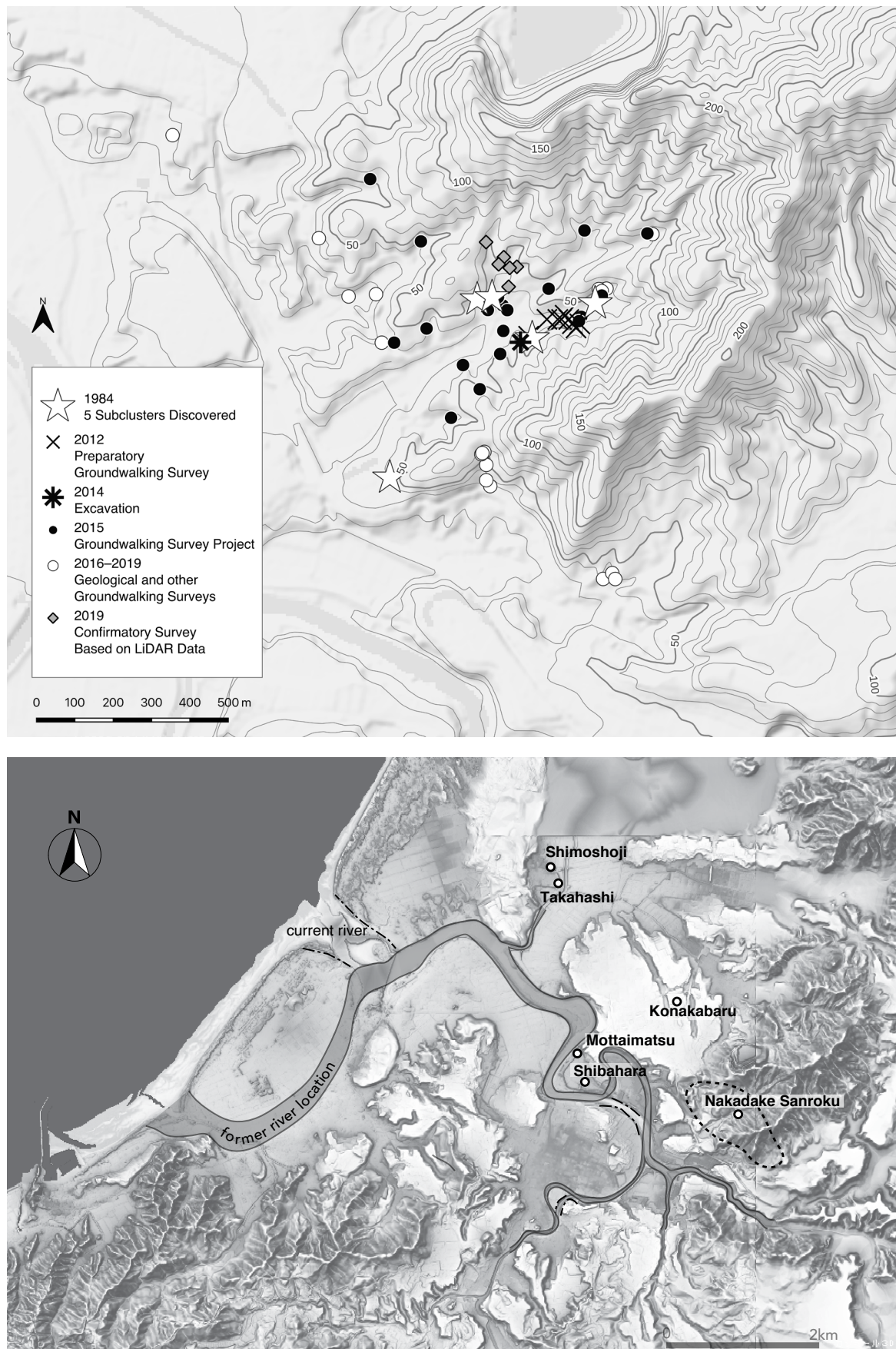
To answer these questions, attention must be given to the following interrelated issues:

- The subjugation of the Hayato and the role of Ata.
- The role of the central administration in provincial governments.
- Immigration from other regions.
- The process of incorporating the southern regions into the Japanese state.
- The development and intensification of trade and exchange with the Ryūkyū islands.

The next two sections cover earlier research which played an integral part in the formation of our hypotheses.

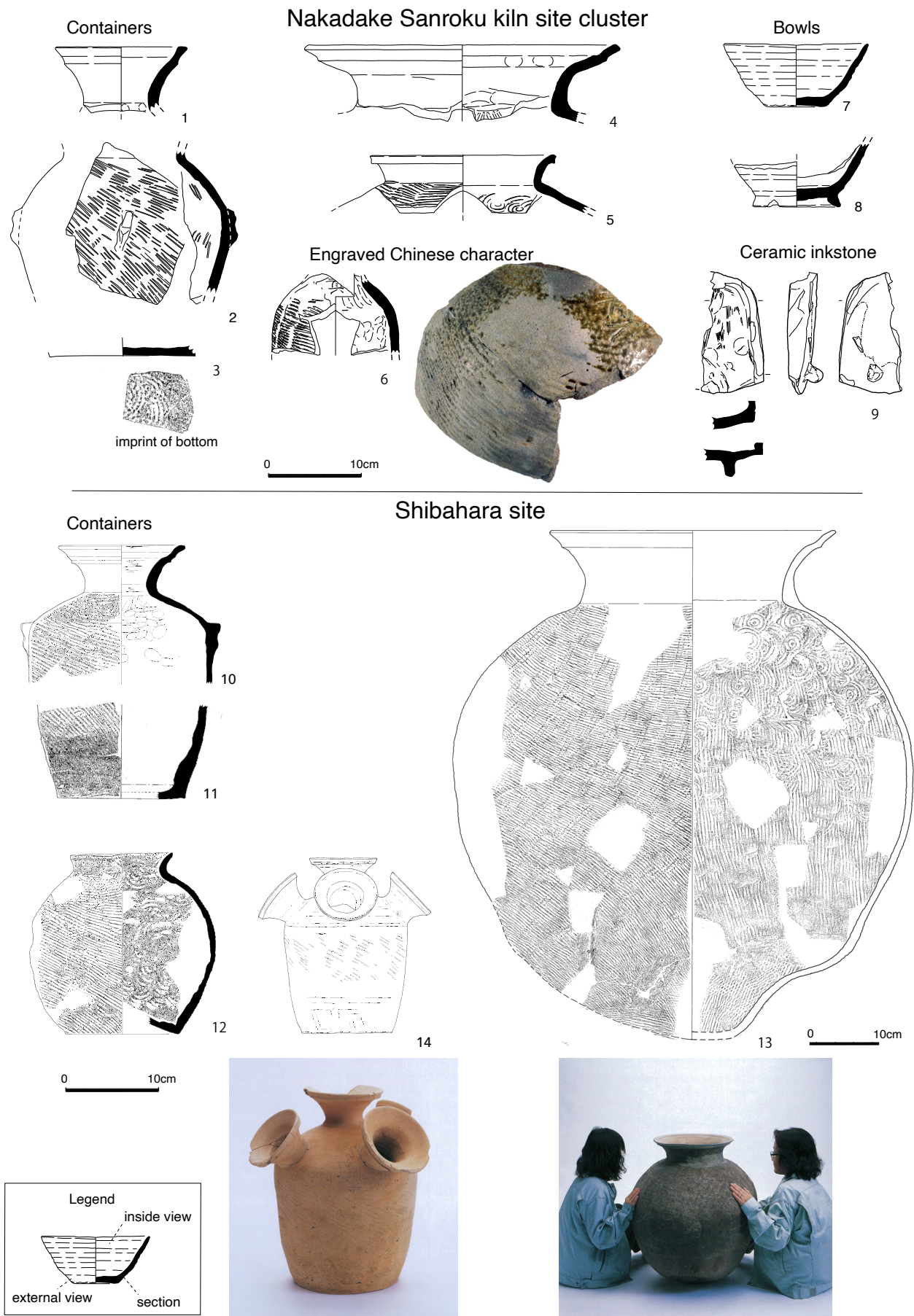
##### 17.3.2.1. Craftsmen and technology

From the time the kiln sites were discovered until 2013, numerous artifacts were collected at the site and surrounding areas which hinted at the specific techniques that had been used at Nakadake Sanroku (Fig. 17.3).



**Figure 17.2.** Structure and size of the Nakadake Kiln Site Center as revealed by ground-walking surveys in 1985, 2012, 2014 and 2015 to 2019 (top). Estuary of the Manose River, related harbor sites and the ancient access to the sea (bottom). Created from DEM Nr. 4730-12 (2016-10-01) (<https://fgd.gsi.go.jp>, downloaded 2020-02-23) by M. Shinoto (top) and (bottom) by the author with KASHMIR 3D from the same data source. Information about the former river location was taken from Yanagihara (2017: fig. 1).





**Figure 17.3.** Sue vessels from Nakadake Sanroku (collected in surveys in Nakadake Sanroku in 1985, 2012, and excavated at Shibahara site (Seki et al. 2012)) (1–6, 8 from Nakamura & Shinoto eds. 2015: fig. 6, 8, 12, 16; 10–14 from Seki et al. 2012: fig. 54, 58, 68, 69; 13, 14 (photos) from Seki et al. 2012: beginning of the book).

These artifacts had four similarities with those found at the Arao kiln site center in Higo Province, which led to the hypothesis that potters immigrated from Arao and introduced their techniques.

First, the main vessels produced at both sites were storage containers, like jars and pots. At the Arao kilns, by the ninth century, more storage containers were being produced than tableware. Likewise, the sherds of Sue ware collected at Nakadake Sanroku were only from storage containers. In examining the typology, the shapes of Sue ware found at both sites were similar, namely pots (*kame*) and jars (*tsubo*). Furthermore, Nakadake Sanroku is estimated to have been in operation from the second half of the ninth century (Amita 2003: 366).

Second, the flat bottoms of the pots that have been found in both kiln site centers show traces of anvil markings (Kamimura & Tsubone 1985: 170). The high ratio of anvil marking on flat-bottomed pots is characteristic of artifacts found at the Arao kiln site center (Amita 2003: 366).

Third, the shapes of the pots and the designs of the anvil marks are similar. To make it easier to remove the paddle and anvil from the surface of the Sue ware, the surfaces of the paddle and anvil were carved with patterns, such as parallel lines, concentric circles, and in one rare case, a wheel design. This wheel design was found both at Nakadake and at the Arao kilns (Amita 2003: 366).

Fourth, clay that contained straw was used for the kiln walls and stands (Fig. 17.5). Many lumps of clay that had been mixed with straw have been found at the Nakadake and Arao kiln sites (Kamimura & Tsubone 1985: 162; Becker et al. 2015). While this is also seen at other kiln site clusters, it is a common method both in Arao and Nakadake Sanroku.

To sum up the observations, the similarities both in kiln materials and in the process of molding the Sue ware suggest an exchange of technical knowledge and even a dispatch of craftsmen from Arao to Nakadake. Since the Arao kiln site center predates the Nakadake kilns, Kamimura (2005) concluded that Arao potters immigrated to Ata and started Sue-ware production in Nakadake Sanroku under the management of the Ata district offices.

This leads to the second set of hypotheses regarding Nakadake-Sanroku's relation to the provincial government in northern Satsuma Province and to the nearby district administration.

#### 17.3.2.2. Location and size of the Nakadake Sanroku kiln site center

Since its discovery, the number of potential sub-clusters has led to a relatively high estimated number of kilns that were in operation at the site, about 30 according to Kamimura at an early stage of research (Kamimura & Tsubone 1985; see fig. 2). Such a number is too high for

district-level administration, so a relation to the provincial capital could not be ruled out, despite its distant location and the number of kilns, which far outnumber what would have been expected in a poor and small province like Satsuma. These factors have led to three alternative hypotheses as to why Nakadake Sanroku was chosen:

- Good conditions for pottery production: clay, water, firewood.
- Political power of the Ata region in contrast to the provincial administration.
- Convenience for trade to the south, being near the active port of Shibahara site and its trading experts.

In southern Kyūshū, fuel and water are relatively easy to procure because the land is covered by mountains and forests, so these should not have been of concern when searching for a location for a pottery production center. The availability of raw materials could have been the main consideration. A geological map of Kagoshima Prefecture (Committee for the Edition of the Geological Map of Kagoshima Prefecture 1991) shows that the soil found in the area within 10 km of the Satsuma provincial capital is the same type of sandstone of which Nakadake is made. The project was set up to investigate the soil at Nakadake Sanroku in more detail.

As for the second hypothesis, it must be remembered that Ata was the seat of local power in Satsuma prior to the establishment of the province. When deciding where to establish Sue-ware production in Satsuma Province, the political and economic power of the various districts may have been taken into consideration, but this is difficult to investigate with the current archeological record.

Various archeological studies prior to the beginning of the recent Nakadake Sanroku project back up the third hypothesis: One of the most notable features of Mt. Nakadake is its location near the Manose River estuary, with its important role in trade. Earlier XRF analyses of a number of main and minor elements showed chemical overlaps with sherds from Nakadake Sanroku in sherds unearthed as far away as Tokunoshima and other Ryūkyū islands (Mitsuji 1985, Ikehata et al. 2008). This is interpreted as evidence for a distribution of products from Nakadake Sanroku far to the south and outside the borders of the ancient Japanese state.

Ports related to Mt. Nakadake have also been identified. The Shibahara site is located on the bank of the Manose River, 2 km from Nakadake Sanroku (Seki et al. 2012). Many kinds of storage containers produced at Nakadake Sanroku have been unearthed at the Shibahara site. Since Nakadake Sanroku is a production center from which complete vessels were exported while only fragments of rejects were left on site, we do not find fully preserved products in the kiln site center itself. However, many larger pieces of Sue ware with the same typological characteristics as those produced at Nakadake Sanroku have been excavated from the Shibahara site.

In addition, the remains of buildings considered to be warehouses have been found, as well as a *sekitai* – a decorative stone belt worn by low-level officials. These findings indicate that Shibahara was an administratively managed port facility (Seki et al. 2012: 484).

In the Mottaimatsu site adjacent to the Shibahara site, a large quantity of ceramics from China and South East Asia which were produced from the eleventh to fourteenth century have been excavated (Miyashita 1998, Nukumizu et al. 2007). It has been pointed out that the port administrative facilities from the ninth and tenth centuries found in the Shibahara site might have developed as a base for foreign trade in the medieval period (Seki et al. 2012: 486).

Although it is currently difficult to prove the second hypothesis with archeological methods alone, provenance studies and other scientific methods seem promising in solving the first and third hypotheses accompanying excavations, prospections and other archeological studies.

#### 17.4. Recent international research at Nakadake Sanroku

##### 17.4.1. Overview of the progress since 2012

Since 2012, the Nakadake Sanroku kiln site center and its surroundings have been subject to intensive and thorough research. While trying to find answers to the hypotheses described above, the investigations will also confirm the extent of the site. Excavations were conducted at the sub-cluster in Arahira 2, which was discovered in 1984. The excavations were an international joint research project involving researchers and students mainly from Japan and Germany.

In the 2012 field survey (Fig. 17.2), many Sue sherds were found in sub-clusters Arahira 1 and 2, where Arahira 2 was relatively well preserved in comparison to the sub-cluster Arahira 1. Since 2013, our research team has received JSPS KAKENHI Grants for seven years and has been able to conduct five excavations in Arahira 2.

In 2014, since most finds had thus far been concentrated on the western slope of the valley, trenches were mainly dug in the western area, and in one such trench part of a kiln was unearthed (Nakamura and Shinoto eds. 2015: 10, Becker et al. 2015, Shinoto et al. 2015). This kiln was named “kiln site No. 1.” Sherds of Sue ware and burned lumps of earth and clay were found in another trench below kiln site No. 1. They were debris from an ash heap (*haibara*).

From 2016 to 2019, excavations focused on a thorough investigation of kiln site No. 1 as well as locating and then excavating kiln ruins on the eastern slope.

Since Kamimura & Tsubone (1985) had identified kiln ruins on the eastern slope, magnetic surveys were

conducted to search for kilns at the second Arahira kiln site cluster in 2017 (Hatakeyama et al. 2019). Anomalies in the earth’s magnetic field were detected on the eastern slope, so seven trenches were opened on that side. Burned bedrock and burned rocks were found in four of the trenches that were dug across the line of magnetic anomalies. Since the burned area was spread in a continuous belt, it is presumed that there had been a kiln and that its ruins had been scattered.

In order to determine the scale of the kiln center, along with the excavations, several field surveys were conducted throughout Mt. Nakadake (Nakamura & Shinoto eds. 2015: 7, Matsusaki 2018). The remains were hard to detect in the densely forested, mountainous area. Therefore, LiDAR data analysis was considered the method of choice for effectively identifying additional kiln sites. In 2018, with the cooperation of Nakanihon Air Service Co., Ltd., a LiDAR survey covering an area of 0.5 km<sup>2</sup> at the southwest foot of Mt. Nakadake was conducted (Shinoto et al. 2019), and in 2016 and 2017, geological and mineralogical surveys were also conducted in order to find suitable places for kilns and to research clay used for Sue ware (Steup 2017).

##### 17.4.2. Surface investigation and LiDAR

As a result of surface investigation, artifacts have been found at 23 points covering an area of 4 km<sup>2</sup> on Mt. Nakadake. These points are concentrated in the southwest section of Mt. Nakadake, but new finds from 2019 hint at kilns in a separate valley in the south east (Fig. 17.2). There are pieces of kiln walls at 15 of these points, which are therefore considered part of the kiln site cluster. Five kiln sites have been discovered at the first Arahira kiln site cluster (Kamimura & Tsubone 1985), and if the other site groups have the same number of kilns, it is estimated that there are over 70 kilns at Nakadake Sanroku.

In 2018, LiDAR data analysis on a 0.5 km<sup>2</sup> test area in the center of the area covered by ground-walking surveys earlier succeeded in identifying some characteristic landforms that determine buried kiln sites in the first stages of interpretation of various visualizations. Tentatively, 65 elongated depressed topographies found on several slopes were deemed potential kiln sites, but a significant number may be natural depressions. Verification of the sites by ground-walking surveys could only be performed in one smaller valley, but at least two kiln sites, ash heaps and pieces of Sue ware could be verified as a result of the LiDAR findings (Shinoto et al. 2019, Doneus et al. 2019, Herzog et al. 2021).

Taking into consideration the results of surface investigation and the LiDAR data analysis, the number of kilns is large considering other sites that are typically found in rural provinces. It is estimated that this site operated on a larger scale than most other local Sue-ware production areas.

### 17.4.3. New discovery of artifacts

Many of the artifacts collected after 2012 were similar to those found in the past, such as pots and jars of Sue ware, fragments of kiln walls and clay stands, but there were some new discoveries. One is a piece of the shoulder of a jar on which a character is engraved (Nakamura & Shinoto eds. 2015: fig. 8-21), and the other is a piece of an inkstone made of Sue ware (Nakamura & Sträter 2017: fig. 4). Both were collected from the first Arahira kiln group.

About two-thirds of a Chinese character was engraved on the surface of the jar, which can be interpreted as “真 (shin)” or “貢 (kō).” However, the reason why the character was engraved is unknown. The “真” character was found to be written in black on three pieces of Haji ware found at the Hashimuregawa site in the southern part of the Satsuma peninsula. If the character was “貢,” it could be related to taxation.

From the eighth to the tenth century, many pieces of Haji and Sue ware were found to have characters written on them, but some of them were not accurate characters. Although a part of the character mentioned above is missing, it is an accurate character and was inscribed before the Sue ware was fired. This shows that some potters were able to write characters, and it is a sign of the social position of the potters and their leaders.

Inkstones are tools used by government officials and priests. The discovery of an inkstone in Nakadake indicates that Sue ware produced there was supplied to government offices and temples.

### 17.4.4. Excavation of a kiln and related structures

#### 17.4.4.1. Kiln 1

Kiln site No. 1 (Fig. 17.4, 17.5) was found on the western slope of the second Arahira kiln site cluster, with a gradient of the firing chamber of 45 degrees. Kiln site No. 1 is the only kiln that has been excavated and analyzed at Nakadake Sanroku, and it is from this that we have learned the details of the kiln structure.

Fortunately, the kiln was well preserved. The whole form except the ceiling was uncovered, revealing the ruins of an underground kiln. The inside of the kiln was filled with earth and sand, and the ceiling of the kiln had collapsed; the floor and some of the walls remained intact. The lower half of the kiln had a sandstone base, as the kiln had been made by hollowing out a bed of sandstone.

The surface shape of the kiln is long and narrow, with a length of 6 m and a maximum width of 1.8 m. The height difference between the floor of the entrance and the flue was 4.5 m. The width of the furnace opening was 1 m. It is the largest kiln among Sue-ware kilns discovered in southern Kyūshū.

The floor of the 2 m long firebox was inclined slightly so as to rise toward the firing chamber. The floor of the firing chamber had a length of 5 m with an inclination of 40–45 degrees.

Clay stands, used to hold the pottery in place during firing, remained in place at the rear of the kiln, but in the center, the stands had become displaced and tumbled to the bottom of the incline. The clay stands at the rear of the kiln were small, with a width of 0.2 m and a length of 0.15 m. They were used for small-sized Sue ware. There were large stands among the tumbled stands which were for large Sue ware, and they were presumed to have been placed in the front half of the firing chamber. It is presumed that large Sue ware and small Sue ware was placed in the front and the back respectively, and that they were fired in the same way as at the Kita-Urayama A kiln in the Arao kiln site center in Higo region.

There was an upright flue at the rear of the kiln. It was about 0.8 m long and its inner diameter was 0.5 m. The flue opening and the brittle rock surface surrounding it were flat. The surrounding rock seems to have been smoothed to provide a workspace. Holes for roof supports were not found around the flue opening.

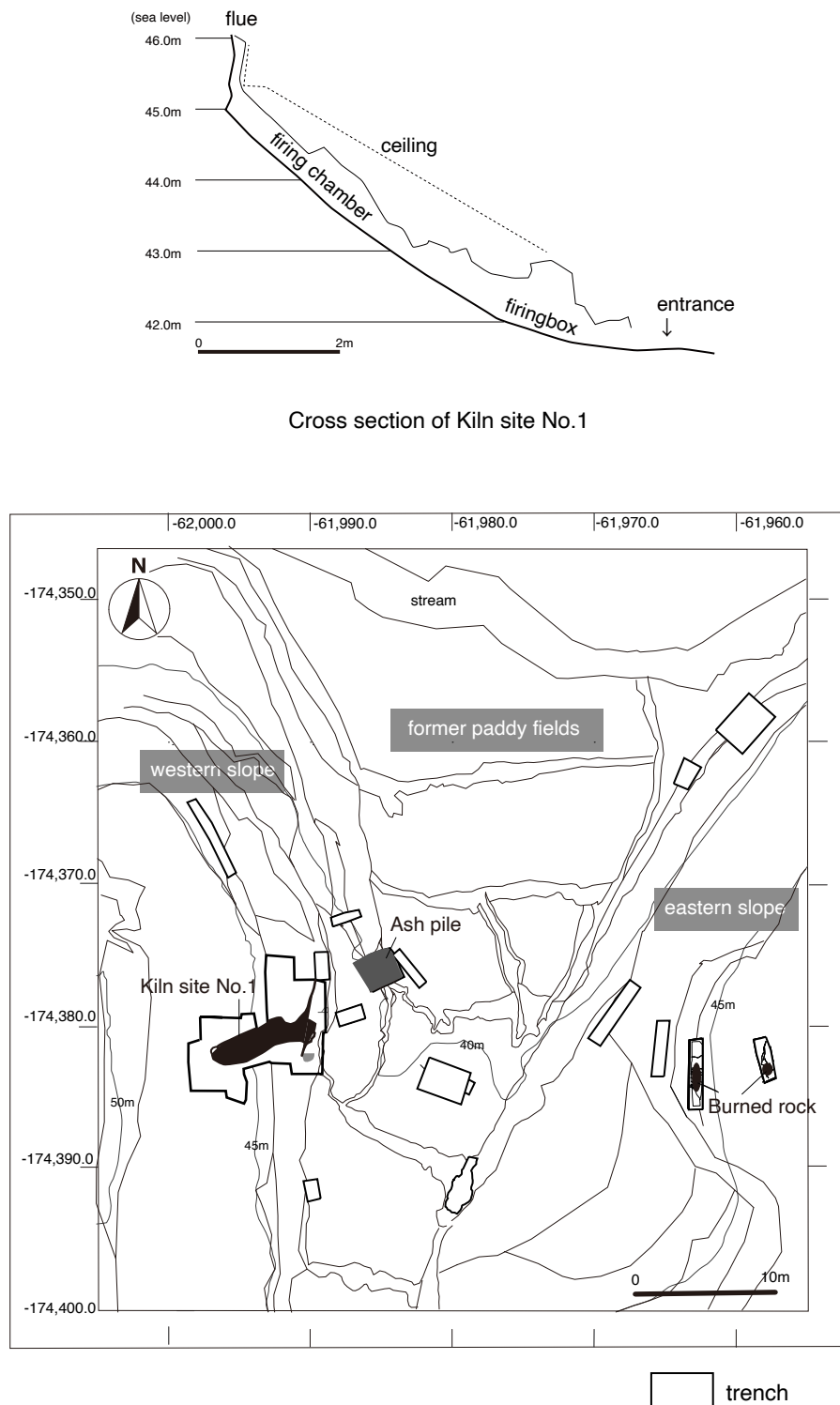
Two layers of walls have been identified on either side of the entrance. The two wall layers of this kiln show that the kiln entrance was walled off at least two different times. This indicates that kiln No. 1 was not a single-use kiln. The entrance was filled with stands. It seems that when the kiln was abandoned, the potter closed the entrance with stands from nearby abandoned kilns.

A hole was found under the floor from the entrance to the firing section. The hole was not completely excavated, but a sub-trench 0.3 m in width was placed along the center axis of the kiln. From the section confirmed in the sub-trench, the length of the hole was 2.3 m, and the depth was estimated to be over 0.5 m, though the bottom could not be confirmed.

This type of hole is called a boat-bottom pit due to its shape. The hole was filled with soil and covered with charcoal, and so it is thought to have been dug shortly before the kiln was fired. It is assumed to have been made so that the potters would have more room in which to maneuver to place the Sue ware in the kiln. Systematic analyses of the kiln construction, materials used and firing technology are still ongoing.

#### 17.4.4.2. Artifacts found in the kiln and its ash heap

There were few sherds of Sue ware inside the kiln. The artifacts found in the kiln were clay stands and fragments of the kiln. Some of the fragments contained large amounts of organic temper. X-ray investigation of a fragment with a thickness of 0.2 m showed the layers of soil bending like an arch from side wall to ceiling (Becker et al. 2015). Since the lower side wall remained intact and was not covered



**Figure 17.4.** Excavation at kiln No. 1 in Arahira 2, Nakadake Sanroku. Longitudinal section of the kiln (top) and location of trenches (bottom).

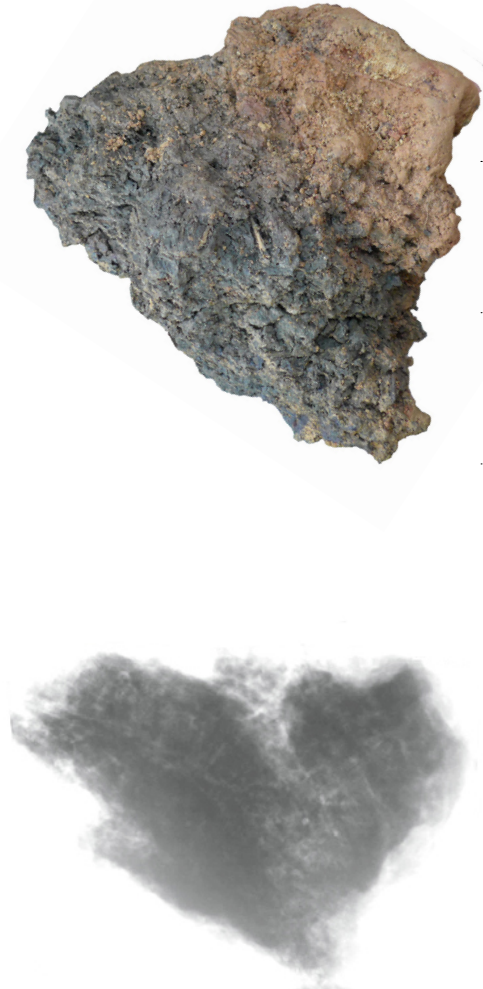
with a thick layer of clay, the fragment may have been part of the ceiling of the kiln.

An ash heap was found in a trench located 5 m to the northeast of kiln site No. 1. The upper side of the ash heap was destroyed by cultivation during the late modern period. However, a 0.3 m thick portion of the ash heap remained, and many sherds of Sue ware, stands and kiln walls were found. Because of the relative positions of kiln

site No. 1 and the ash heap, the ash heap was presumed to have held the waste from kiln site No. 1.

Radiocarbon dating of charcoal collected from the ash heap showed Cal AD 775–890 (1 $\sigma$ ) (Kokankyō Kenkyūjo 2015). Thermoluminescence dating of the kiln wall determined that it had been used in the ninth century (Shitaoka et al. 2018), which is consistent with the results of radiocarbon dating.





**Figure 17.5.** The kiln almost fully excavated in 2019 (left), and fragment of the kiln wall excavated in 2014. Plaster with organic material, top right; X-ray photo showing the arc of the tunnel (Photos and X-Ray by LVR-Landesmuseum Bonn, 2014; Becker et al. 2015).

The sherds of Sue ware excavated in the kiln and the ash heap are considered to have been fired in kiln No. 1. Most of them were containers such as jars and pots, and less than one-tenth of them were bowls.

#### **17.4.5. Geology and analyses of raw materials and products**

Mineralogical studies using the typical set of methods, XRF (X-ray fluorescence analysis) and XRD (X-ray diffraction) for sherds, soil samples and parts of kilns, and SEM and several other methods of analysis for thin sections of the sherds, have been carried out, and a detailed geological map was created. The soil surrounding the kilns is a ubiquitous yellow layer of sandstone containing clusters of rock, soil and good quality clay at various stages of weathering (Steup 2017). Among the various types of soil found in Nakadake, weathered sandstone is the most suitable material for Sue ware. As a result of analysis, it was determined that the clay has features similar to Sue ware

but is not exactly the same. The raw material was probably processed in several ways (Raith & Hoffbauer 2015, 88) to increase its plasticity, which led to the different properties of the sherds. In addition, mineralogical analysis revealed traces of high temperatures (1050–1150°C) in all sherds.

An experiment in Sue-ware firing was conducted with the cooperation of a potter who produces ceramics with clay from the southern Satsuma region. For the experiment, clay dug from the second Arahira kiln site cluster was used. The results showed that the freshly dug clay has a low heat-shrinkage percentage and was suitable for use in high-temperature kilns, yet it was not suitable for Sue ware, due to its lack of plasticity making it difficult to shape. However, after one year of storage, the clay viscosity increased enough for it to be used in Sue ware. This experiment also tested weathered clay, and showed that it was not the best material for Sue ware but that it could be used if it was improved through storage and/or the addition of other material.



#### 17.4.6. Provenancing

From 2014, the application of Neutron Activation Analysis (NAA) has been carried out on sherds, kiln fragments and soil (Sterba 2015, see Sterba in this volume). NAA of sherds from the Nakadake Sanroku kiln site center unveiled “chemical fingerprints” of the pottery, and analysis of sherds found on the Ryūkyū islands was conducted to find matches with these fingerprints.

The analysis of sherds from the Nakadake Sanroku kiln site cluster produced several groups, which may hint to the existence of several workshops in the kiln cluster, or perhaps to other reasons, such as differentiation in raw material selection or preparation or simply change in raw material over time.

Sherds of Sue ware which fit into the NAA groups found at the Nakadake Sanroku kiln site cluster have been found southwards down to the central part of the Ryūkyū islands, particularly on Kikai Island, and matching sherds were found at the Matsubara site on Tanegashima (Sterba 2015), which was part of Ōsumi Province in the ninth century. As mentioned above, the distribution of Sue ware from Nakadake Sanroku to the Ryūkyū islands had been suggested by XRF analysis earlier, and the rigid NAA analyses reinforced this.

NAA can minimize the destruction of artifacts because only a small amount of sample (50–150 mg) is used for analysis. Because many of the sherds found at Nakadake and on the southern islands are small, it is difficult to estimate their provenances typologically. Through NAA, we expect to obtain results on the provenance of many of these small sherds of Sue ware, and NAA studies on a larger scale are ongoing. Recent research suggests the fine-grained chemical groups based on NAA analyses may be used for chronological classification of sherds that are so fragmented that chronological identification based on archeological typology is impossible (Sterba et al. 2020).

#### 17.4.7. Intermediate results from recent research

Because Sue ware from Nakadake Sanroku was distributed widely to the south beyond the ancient Japanese state and has been found in locations known to be trading centers, I am led to conclude that the purpose of establishing the Nakadake Sanroku kiln center was mainly for trade.

### 17.5. Conclusion

This chapter started with a description of the geographical and historical background of the Nakadake Sanroku kiln site center and then covered research that relates to the unique role and location of the site.

The Nakadake Sanroku kiln center was built in the Ata district, 50 km away from the provincial capital and Kokubunji temples, which were considered to be the main places to which Sue ware was supplied after the

establishment of the provinces in the eighth century. Ata was the center of the indigenous Hayato on the Satsuma peninsula and the only site producing Sue-ware kilns in Hayato territory. The Hayato were considered a separate ethnic group until the end of the eighth century. The Nakadake Sanroku kiln center started producing Sue ware in the ninth century. This means that soon after the Hayato became incorporated into the Japanese state, the Nakadake kilns were purposely built far from the provincial capital, the stronghold of the local Japanese government. It is assumed that the Nakadake Sanroku kiln center was not only set up in order to supply the state administration, as is generally seen in local Sue-ware production areas, but also with exchange with the southern islands in mind.

Including the intermediate results of recent Nakadake Sanroku kiln site center research projects, the following four points can be summarized regarding the purpose of installation and the characteristics of this kiln center:

1. The topography and geology of Mt. Nakadake are suitable for Sue-ware production, although the clay is not ideal. In addition, the same geology and geography existed near the Satsuma provincial capital, so it cannot be said that geography and geology were the primary reasons for its establishment.
2. The structure of the kilns, the types and forms of the Sue ware produced, and the molding techniques are all highly similar to those of kiln sites in the Higo region, and so it is assumed that Higo craftsmen settled in the Nakadake area.
3. The number of Sue kilns verified in the Nakadake Sanroku amounts to 30 based on the surveys in the 1980s, but an estimate may well go beyond 70 kilns. This is large scale for local production of Sue ware in the ninth and tenth centuries. On the other hand, the governmental offices and temples in Satsuma Province, which are considered to be the main places supplied with Sue ware, are small in scale and therefore could not have factored in such a large production of Sue ware.
4. The distribution of Sue ware from the Nakadake Sanroku kiln site center covers a wide area that has been confirmed up to the central part of the Ryūkyū islands. The remains of a harbor were also found in the vicinity of Mt. Nakadake. This harbor later became a base for foreign trade in the medieval period.

From the above, it can be concluded that the main purpose of establishing a Sue-ware production area in Mt. Nakadake was to produce Sue ware for trade. The reason why the kiln was purposely built in Ata, which had been the center of local government, was not only because it was geographically and geologically suitable, but also because it was a base for trade with the Ryūkyū islands from prehistoric times and the people there already had the necessary experience with trade and seafaring.

The most interesting part is the role that Nakadake Sanroku played in the growth of trade centered in the Japanese

south. The trade route for Sue ware from the Nakadake Sanroku kiln center developed into a foreign trade route that became active after the eleventh century and eventually led to the connection with Western societies in the sixteenth century.

In understanding eras for which written sources are virtually nonexistent, the Sue ware from Nakadake distributed to the islands can provide an important source of information. The distribution of Nakadake Sue ware sheds light on ancient sea trade routes to the south, as well as the development of trade in southern Kyūshū and the Ryūkyū islands from the eighth century through the flourishing Middle Ages.

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## Production at the Kamuiyaki Kiln Site Cluster and the Connection of the Ryūkyū Archipelago to Surrounding Societies During the Eleventh Through Fourteenth Centuries

Akito Shinzato

**Abstract:** Kamuiyaki is a stoneware that was produced in Kamuiyaki on the Ryūkyū island Tokunoshima in the southwest of Japan between the eleventh and fourteenth centuries. In this chapter, the technological roots, production, distribution, consumption and typology of Kamuiyaki are introduced and the background of its formation, development and decline are discussed. While the technology was transferred from overseas, the production trend is related not only to the economic development in medieval East Asia but also the upgrading hierarchical organization on the Ryūkyūs. Besides kiln technology, Kamuiyaki offers important information about the state formation of Ryūkyū in a time for which written documents are scarce on the islands.

**Keywords:** Ryūkyū archipelago, Kamuiyaki, Gusuku period, Japanese Middle Ages, Goryeo stoneware, status-symbol culture

### 18.1. Introduction

The Kamuiyaki kiln site cluster in Tokunoshima is the oldest stoneware industry site in the Ryūkyū Islands. It was not based on the techniques for production of the local earthenware or the ancient Sue ware of southern Kyūshū, but was established on the basis of the stoneware technology of the Korean peninsula during the Goryeo period (918–1392). The emergence of Kamuiyaki signals that the Ryūkyū Islands had entered into the commercial area of East Asia, and this was the first step of the Ryūkyū archipelago in becoming connected with international societies. The Kamuiyaki kiln site cluster was designated as a National Historic Site of Japan in February 2007 because of its importance for understanding the Ryūkyū society and economy in an era when no texts were recorded.

### 18.2. The geographical environment of the Ryūkyū Islands and Tokunoshima

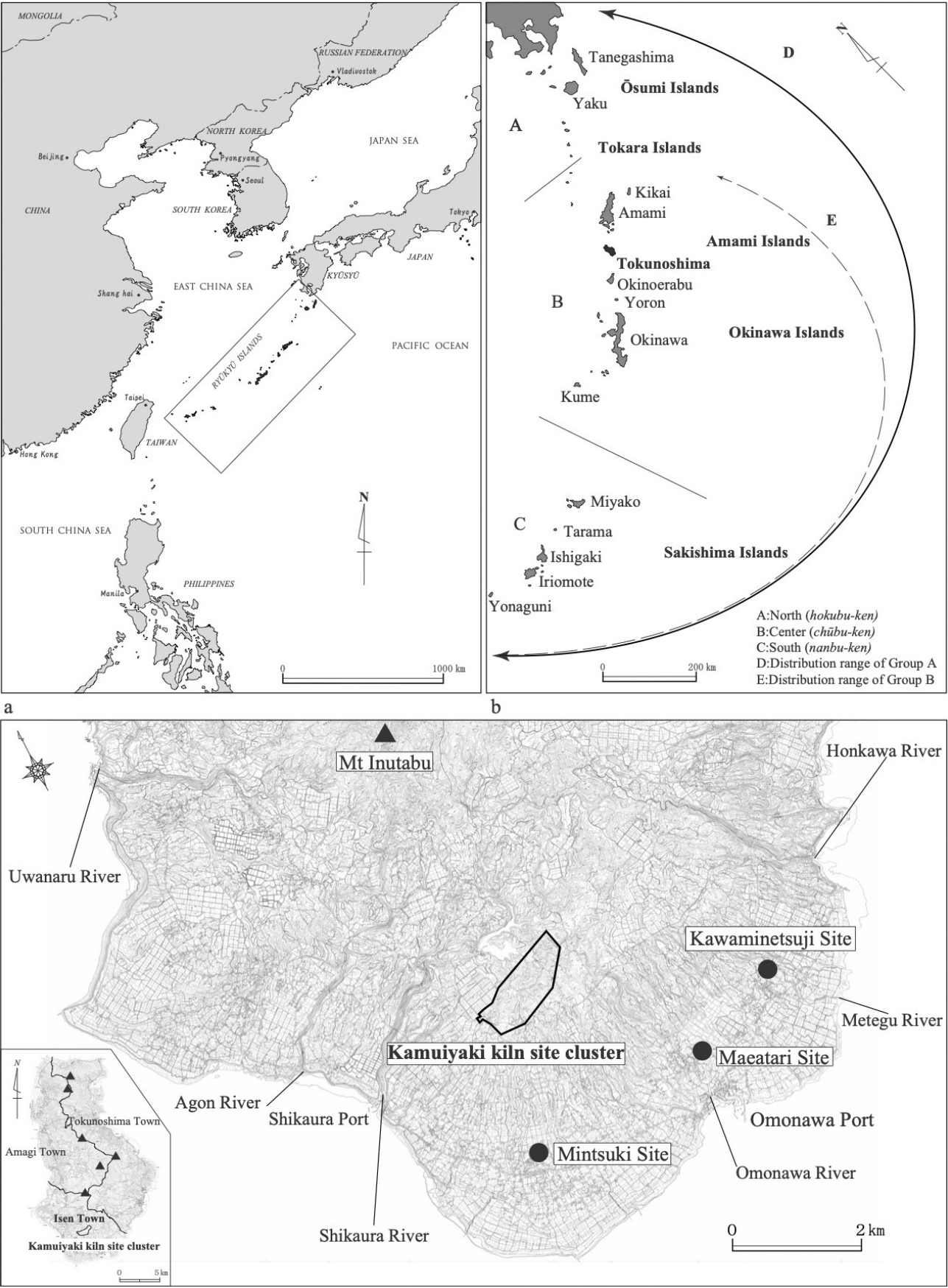
The Ryūkyū archipelago is the southernmost part of Japan, and consists of about 200 islands scattered between Kyūshū and Taiwan (Fig. 18.1a). It is characterized mostly by coral reefs in this subtropical climate area. The Ryūkyū Islands are divided into the Ōsumi Islands, the Tokara Islands, the Amami Islands, the Okinawa Islands and the Sakishima Islands, the proximate location of which is on the map (Fig. 18.1b). These islands are composed of volcanic islands (*kōtō* high islands) and of coral reef islands (*teitō* low islands). The former roughly corresponds to the area from the Ōsumi Islands to the Tokara Islands, and many of the latter are to the south of the Tokara Islands.

Volcanic islands are characterized by rich water and wood resources (Mesaki 1985: 12–21, Takanashi 2001: 221–30). Tokunoshima, included in the Amami Islands, is classified as a *kōtō* type island. On the central axis of Tokunoshima, there are six mountains with an altitude of over 400 m, and they are surrounded by terraces and dunes of Ryūkyū limestone (Fig. 18.1c). Isen Town, where the Kamuiyaki kiln sites were discovered, is located in the southern part of Tokunoshima, and its main industry is agriculture. The west coast of Isen Town has a wide, raised plateau of Ryūkyū limestone, and cliffs have been formed due to sea erosion. Coastal terraces and dunes have been formed from the south to the southeast. Contrasting topography can be seen in the east and west area of Isen Town. There are six rivers in Isen Town, which start from a high terrace close to the kiln site and flow radially into the sea through underground caves and valleys (Fig. 18.1c). Its highest mountainous area is composed of slate, tuff and diabase, and the surrounding plateau corresponds to the granite, Ryūkyū limestone and gravel zone. This means that topographical features are closely associated with its geology. According to a survey of natural vegetation (Terada 2015), the flora of the mountainous areas was similar to that of the Ryūkyū Aoki (*Psychotria rubra* (Lour.) Poir.)–Sudajii (*castanopsis Sieboldii* Subsp.) community. These results show that the plant distribution corresponds to the particularities of topography and geology.

### 18.3. The historical background of the emergence of the Kamuiyaki kilns

The Ryūkyū archipelago has a different history from its Japanese counterparts. First, the age of hunter-gatherers





**Figure 18.1. Geographical context and distribution of sites and cultural areas mentioned in this chapter. a: Location of the Ryūkyū Islands. b: Major islands, prehistoric cultural areas from north to south, distribution of Kamuiyaki pottery. c: Location of the Kamuiyaki kiln site cluster and related sites in Tokunoshima (Maps are redrawn by the author from Shinzato 2018: 2(a), Shinzato 2018: 2(b), Shinzato & Tsune eds. 2018: 5(c)).**

(parallel to the Jōmon to Heian period, about 7,000 to 1,000 years ago) continued for at least 6,000 years. Second, the beginning of agriculture around the tenth century AD was much more recent than in the Japanese archipelago. These two historical distinctions mean that the prehistoric era of the Ryūkyū archipelago continued for a long time. However, the study of settlements and tombs, based on the highly accurate chronological studies of the local earthenware, suggests that social organization (settlement, labor investment and social division of labor) gradually progressed during the prehistoric period (Takamiya & Shinzato 2013: 106). In the prehistoric age, the resources available in subtropical forests and coral reefs were particularly important, and it is a well-known historical fact that shellfish inhabiting coral reef areas were transported to the Japanese archipelago and the Korean peninsula for trade after the Yayoi period in Japan (Kinoshita 1996). Although they did not belong to the national territory of the ancient state of Japan that started in the seventh century AD, imported goods from Kyūshū, including Sue ware from Nakadake, were brought to the Ryūkyū archipelago through trade and cultural exchange with remote areas.

In the prehistoric age of the Ryūkyū Islands, there were three cultural areas (Fig. 18.1b); the first is the northern area (Hokubu-ken), closely related to the pottery culture of Kyūshū (Ōsumi Islands–Akuseki Island in the Tokara Islands); the second is the central area (Chūbu-ken), with its own pottery culture (Takara Island and Kodakara Island in the Tokara Islands, Amami Islands and Okinawa Islands); and the last is the southern area (Nanbu-ken), which also shows some contacts with Taiwan and the Philippines (Miyako Islands and Yaeyama Islands) (Kokubu 1966: 34–40). Since the north side is close to Kyūshū and the south side is adjacent to Taiwan, these cultural characteristics had a tendency correspond to their location on the map. We can see such a diversity of material culture despite the common subtropical environment.

The proto-history period that followed is called the Gusuku period, during which the entire Ryūkyū archipelago reached the stage of a production economy supported by agriculture and livestock farming (parallel to the late Heian to Nanbokuchō period, about eleventh to fourteenth century) (Asato 1990: 110–11). Rice, barley, wheat, foxtail millet, millet (Takamiya & Chida 2014: 132–37) and the bones of cows and horses used as livestock (Toizumi 2011: 123–26) have been excavated from many of sites in the Ryūkyū Islands. These provide archeological evidence of the beginning of the Gusuku period. In addition, we can see a decrease in tortoises (*Ryūkyū-yamagame* (*Geoemyda japonica*)) compared to the previous era (Toizumi 2011: 124) due to the land development aimed at the maintenance of the *gusuku* (castles), villages and cultivated land. This shows that these social changes also had an impact on the surrounding environment. Widespread distribution of commodities had also begun. Kyūshū's talc pots for boiling were circulated throughout the Ryūkyū Islands, and local

earthenware with the shape of these was produced in the Amami, Okinawa and Sakishima regions. The stoneware manufactured in Tokunoshima (Kamuiyaki) was used as a set of tableware with these kinds of pots and Chinese ceramics. This means that the prehistoric Chūbu-ken and Nanbu-ken above were integrated into a common pottery cultural area.

In the first half of the Gusuku period (mid-eleventh century to mid-thirteenth century), pottery production, iron production and goods distribution started in earnest, and in the latter half (late thirteenth century to fourteenth century), the fortresses (*gusuku*) were constructed prosperously. Then, at the end of the fourteenth century, the three chiefdoms (Hokuzan, Chūzan and Nanzan) on the main island of Okinawa entered into tribute trade with the Ming Dynasty of China. The Gusuku period was an epoch-making era in which a more organized society (social division of labor, stratification etc.) was formed than before, and was also the premise of the Maritime City Nation Ryūkyū kingdom. In the Ryūkyū islands, a long-term, constant hunter-gatherer era continued, and there was the establishment of the Ryūkyū kingdom shortly after the spread of agriculture. Imbalance between the two is among the major characteristics of its history.

The Song Dynasty succeeded in turning high-quality goods such as ceramics into inexpensive mass products by promoting its own industry, and its development of marine transport led to these becoming widespread in the surrounding areas (Kamei 1986: 30, Yoshioka 1994: 38, Tsuchihashi 1997: 61). Japan's medieval era and Ryūkyū's Gusuku period correspond to this age. Hakata in northern Kyūshū was the international port city at which there were Chinese merchants called *Hakata Gōshu*. They set up their houses in Hakata and engaged in large amounts of goods trade from their homeland (Kamei 1986: 30). This trading system is called *Jūban Bōeki* (Kamei 1986: 24–35). On the other hand, great green turban shells (*Turbo marmoratus*) and trumpet shells (*Charonia tritonis*) from the coral reef areas of the Ryūkyū Islands (Kinoshita ed. 2002: 129–34, Takanashi 2005: 251–56) and sulfur from the Ōsumi Islands (Yamauchi 2009: 56–58) were shipped to Hakata. In this way, the Ryūkyū Islands became incorporated in the East Asian commercial zone through Hakata. This is the historical background of the various kinds of tableware that were transported from distant regions such as China, the Korean peninsula and Japan to the Ryūkyū Islands. From the perspective of the Ryūkyū's state formation, Pearson paid attention to the establishment of Kamuiyaki in such a historical context. He noted that the emergence of its production, distribution and consumption promoted population increase, technological diffusion, economic development, distribution patterns and social complexity, and they involved the creation of new identity. He also asserted that this process in the Ryūkyū Islands was part of medieval history in the Japanese archipelago (Pearson 2007: 145–46). Thus, Kamuiyaki is not only an archeological material symbolic of a time when the society

of the Ryūkyū Islands had begun to change significantly, but is also an important cultural heritage that is helpful in the reconstruction of East Asian history. Furthermore, this history is not limited to the Japanese archipelago. Due to its importance, the Kamuiyaki kiln site cluster was designated as a historic site in Japan in February 2007.

#### 18.4. The discovery of the kiln

The earliest archeological record of Kamuiyaki pottery can be found in the manuscript “Local History Research ‘Tokunoshima’ in 1932,” by Yūryō Hirose, a local researcher who lived in Tokunoshima (Hirose 2019 [1933]: 43). Hirose discovered a small jar that had been stored in a private house in Kametsu Village, Tokunoshima. He introduced this jar as a pottery of Japan’s medieval period, with his own sketch of it. However, Hirose died at a young age, and the report was not officially published. Therefore, it was not until after World War II that Kamuiyaki pottery came to the attention of Japanese archeologists. After the 1950s, during which time there was a full-scale archeological survey of the Ryūkyū Islands, it became known that hard burned gray stoneware had been discovered along with Chinese ceramics in several sites of Amami and Okinawa (Tawada 1956). Kamuiyaki was excavated together with talc pots from Kyūshū, so archeologists thought that its origin was the Japanese archipelago at the beginning of the research (Kokubu et al. 1959: 248). Subsequently, some theories were announced that its production area was the main island of Okinawa (Tomoyose 1964: 19) or the Korean peninsula (Mishima 1966: 51). Then materials showing the overall shape were found in the Tokara Islands and the Amami Islands; from a comparative study of manufacturing skills, the opinion that Kamuiyaki’s technique was related to the ceramics technology of the Korean peninsula was proposed. Focusing on the wavy pattern and the firing technique, Kazumi Shirakihara pointed out the relationship between the ceramic pottery of the Korean peninsula and Kamuiyaki (Shirakihara 1971: 264). Based on the similar patterns of Kamuiyaki pottery and Koryo roof tiles, Tadashi Nishitani thought that the production skills of Kamuiyaki came from the Korean peninsula during the Goryeo era (Nishitani 1981: 83–84).

Till the kilns were found, the production site of Kamuiyaki remained a mystery for a long time. However, the discovery of the kilns on Tokunoshima Island in 1983 led to the question of the industry being solved immediately. Nobuhiro Yotsumoto, who was working at the Isen Town History and Folklore Museum, found that many pieces of pottery, charcoal and burned kiln wall clay were scattered at the pond’s renovation work area in Asan, Isen Town. After confirmation by Norikazu Gi, a local researcher who lived in Isen, and several archeologists from the Kagoshima prefecture and Amami-Ōshima Island, they concluded that Tokunoshima Island was indeed the production area of Kamuiyaki pottery (Gi & Yotsumoto 1984). Before

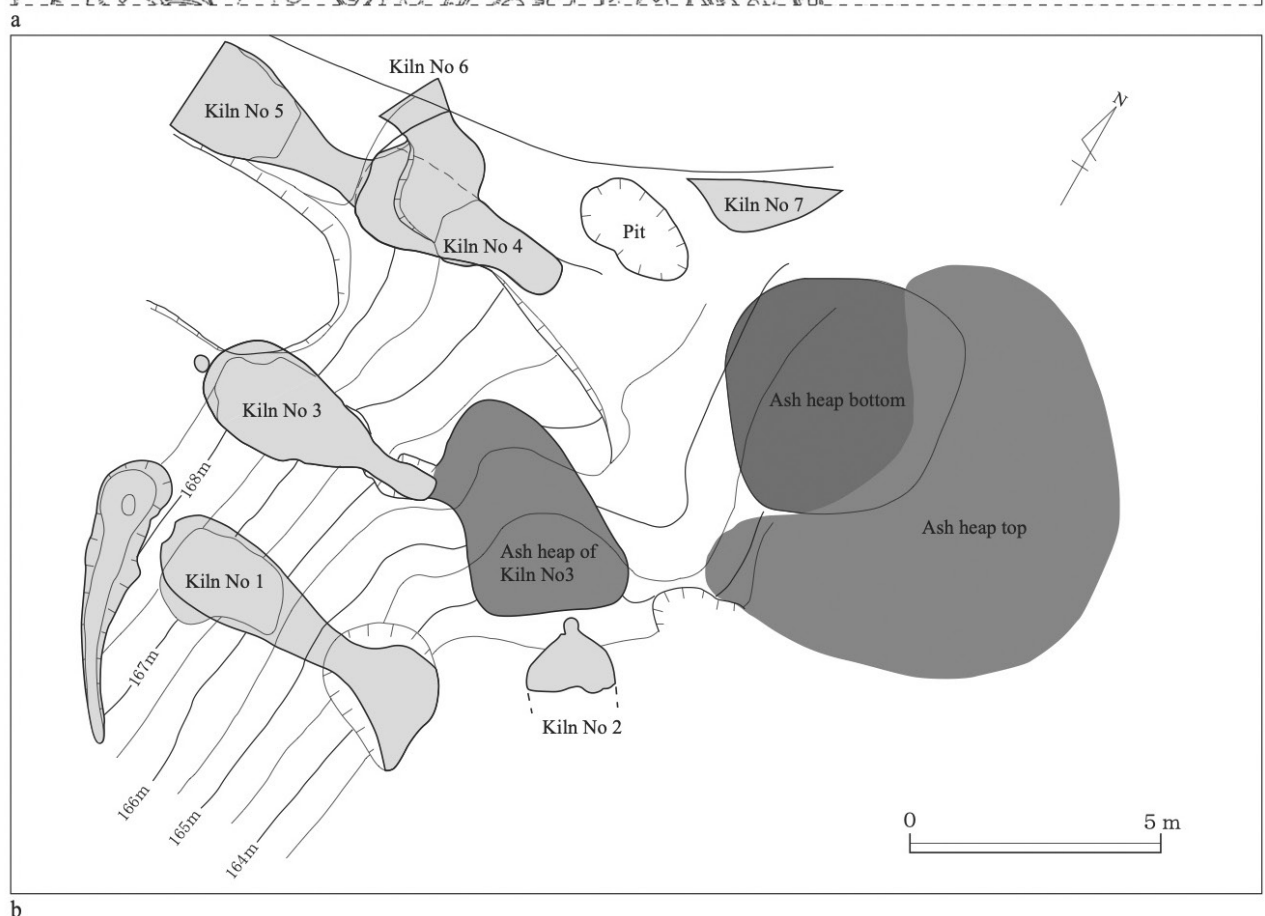
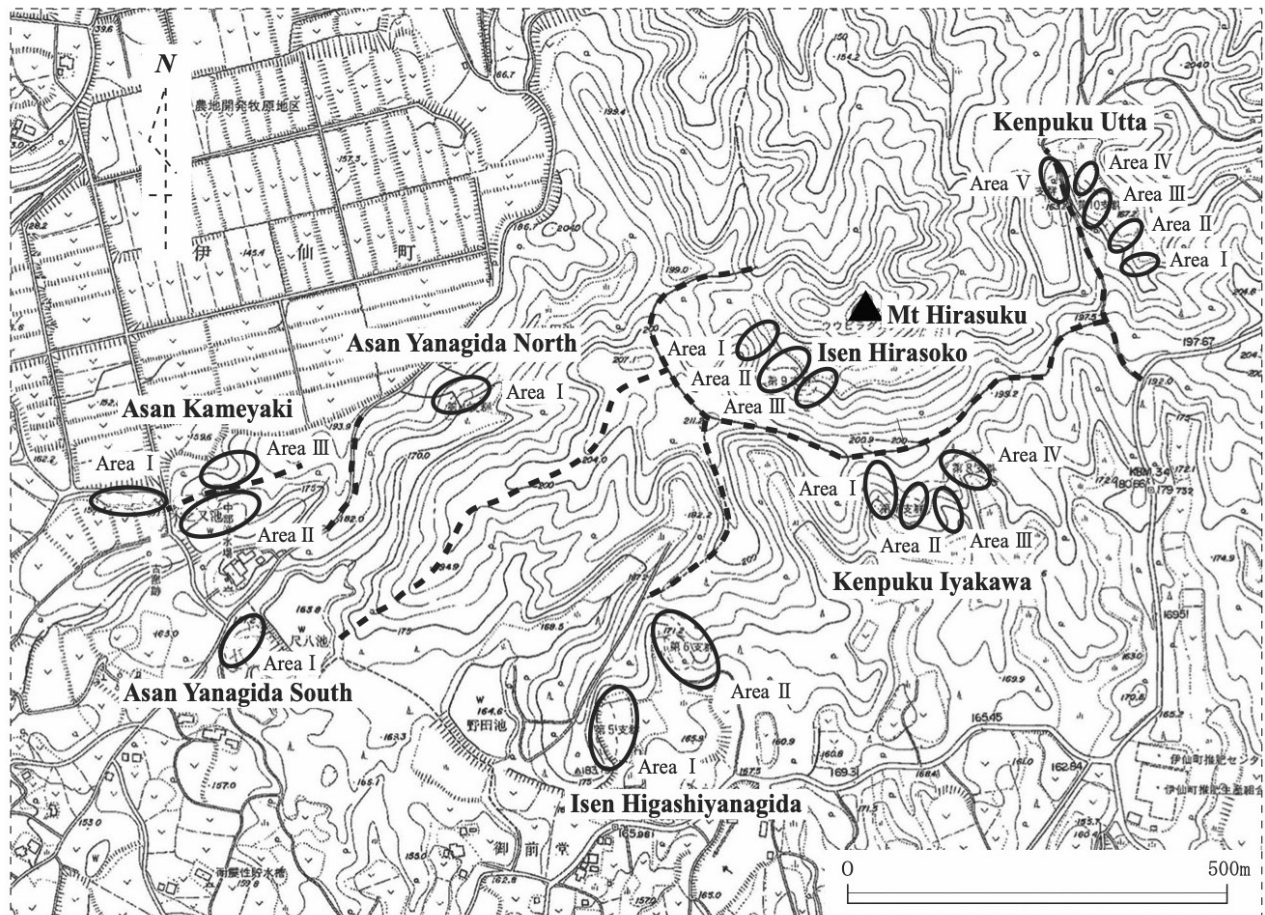
its homeland was revealed, this pottery was called *ruisueki* (Shirakihara 1973:11, 1975: 112), but then they named Kamuiyaki officially after the local name of the discovery area.

#### 18.5. The history of kiln investigation

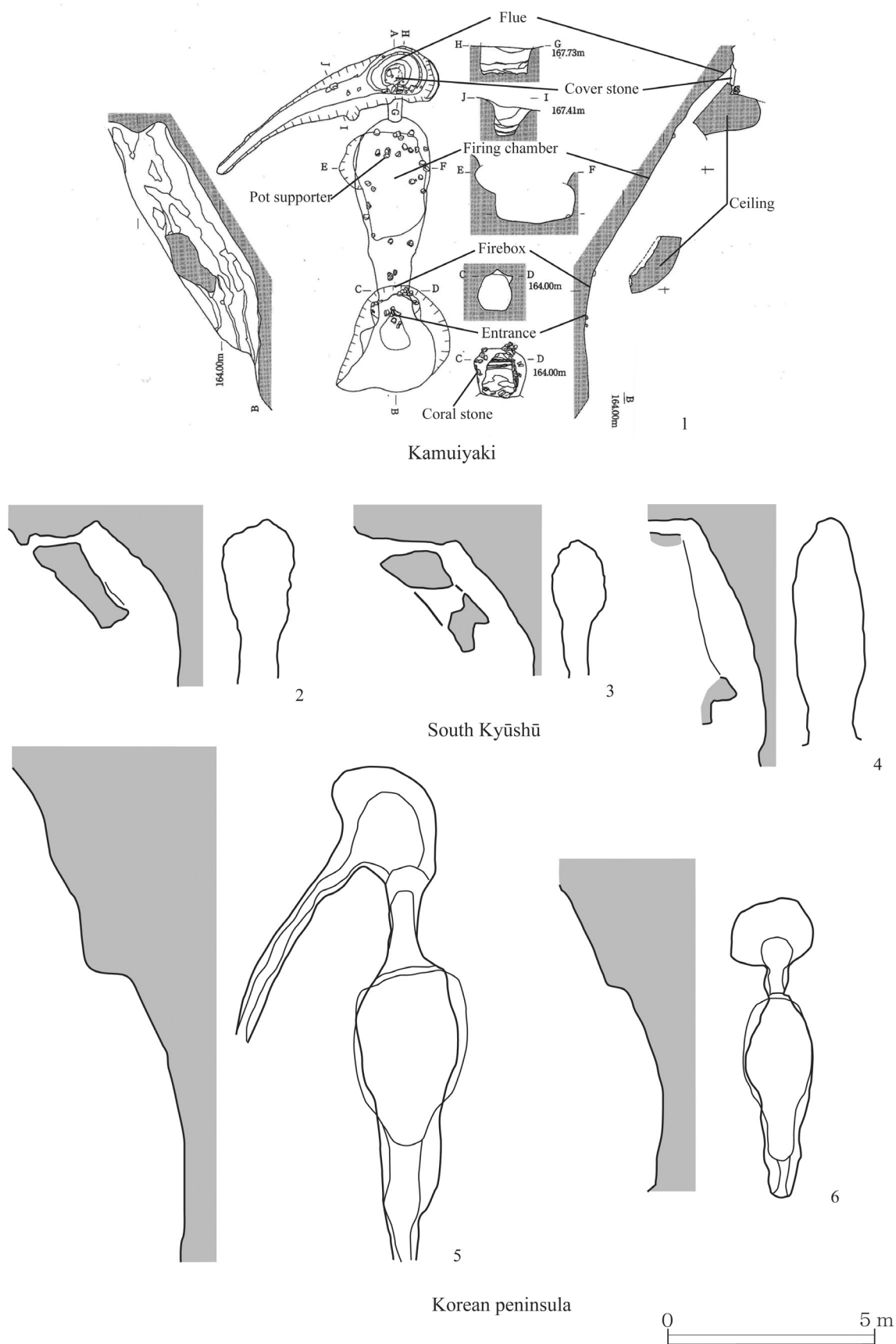
From October to November 1984, the year following the discovery of the kiln, the first confirmation survey was carried out with the aim of conservation, and three kilns and six ash heaps were excavated (Asan Kameyaki Group Area II, Fig. 18.2a). In addition, seven new kilns were found on the slope of a farm road located 50 m southwest of this area (Asan Kameyaki Group Area I). Since the former group would sink underwater in the pond after maintenance, an urgent full-scale survey of all the kilns in the construction area was carried out (Shintō & Aozaki eds. 1985a), and finally seven kilns, one pottery disposal pit and several ash heaps were excavated, and many relics were recovered (Shintō & Aozaki eds. 1985b, Fig. 18.2: b). The investigation of the production site revealed the kiln structure and size, the inclination angle and the height of the firing chamber, the shape of the firing entrance and the flue, and new knowledge about the vessel composition was gained (Fig. 18.3: 1).

Based on the shape of the kiln, and the existence of a bowl that imitated Song Dynasty Chinese ceramics, a technical and contemporary relationship with the Sagariyama kiln in southern Kyūshū was revealed (this is discussed below). Results from radiocarbon and geomagnetic dating concluded that the date of the kilns was between the eleventh and the thirteenth century (Shintō & Aozaki eds. 1985b: 97). In 1985, the range of the production area expanded to the east side due to the discovery of other kilns on the hill slopes southwest of the groups investigated in 1984 (Ushinohama & Inoue eds. 1986: 13–14). Then, in the third investigation, carried out from 1996 to 1999, due to the general survey at the entire area of Mt. Hirasuku, new kiln groups were discovered, and the range of the production area expanded further to the east (Aozaki & Itō eds. 2001, Fig. 18.2: a). From 2001 to 2005, high-precision topographic maps around kiln sites were created, and good residual status of kilns was confirmed by magnetic and electrical surveys (Nishiguchi 2005). A natural science analysis was also conducted involving the radiocarbon dating of carbons excavated from ash heaps (Paleoenvironment Research Institute Co., Ltd 2005a), the identification of tree species (Paleoenvironment Research Institute Co., Ltd 2005b) and an XRF analysis of excavated sherds (Mitusuji 1985, 2001, 2005). Archeologists from the Ryūkyū University in Okinawa also participated in these surveys, and a typological study of surface-collected potteries from each group was carried out at the same time (Ikeda ed. 2005: 45–110).

The number of areas where kilns were found increased to 13 through the progressive investigations. As a result of re-examining the distribution, location, scale and range



**Figure 18.2.** Distribution of kiln groups and kilns in Kamuiyaki. a: Location of kiln groups (Shinzato ed. 2005, 7); b: Distribution of kilns at Asan Kameyaki Group Area II (Shintō & Aozaki eds. 1985b: 11).



**Figure 18.3.** Construction of kilns from the Kamuiyaki kiln site cluster compared with kilns from South Kyūshū and the Korean peninsula. 1: Asan Kameyaki Group Area II, kiln No. 1 (Shintō & Aozaki eds. 1985b: 13–14); 2: Sagariyama kiln site cluster, kiln No. 1 (Matsumoto ed. 1980: 130); 3: Sagariyama kiln site cluster, kiln No. 3 (Matsumoto ed. 1980: 139); 4: Sagariyama kiln site cluster, kiln No. 8 (Matsumoto ed. 1980: 149); 5: Mujangri kiln site cluster, kiln No. 3 (Lee H., Lee S., O Gyujin, Na Geonju eds. 2000: 39); 6: Mujangri kiln site, kiln No. 2 (Lee H., Lee S., O Gyujin, Na Geonju eds. 2000: 35). – Modified from the excavation reports by the author.

of the kilns, the group composition, 19 production points already confirmed were reorganized into seven groups (Shinzato ed. 2005, Fig. 18.2: a).

### 18.6. The actual conditions of production

As a result of the excavation of kilns, the general survey of the forest and the natural scientific analysis (achievements of vegetation and geography investigations are discussed in detail below), the actual conditions of the pottery production gradually became clear (Shintō & Aozaki eds. 1985a, b, Aozaki & Itō eds. 2001, Shinzato ed. 2005). In previous surveys, an excavation of 10 kilns, 20 ash heaps and one pit, which was a pottery disposal, was carried out. The other kilns were limited to investigation by confirmation of ash heaps and electrical/magnetic exploration for proper preservation as part of the national heritage. But the pottery workshops, related villages and the harbor for shipping have not yet been revealed.

The features common to several kilns that survived well are summarized below (Fig. 18.3: 1):

1. The kiln is of a completely underground type constructed by excavating weathered granite soil, which is the bedrock soil of the hill, and shows a climbing kiln structure. It is speculated that this soil was suitable for tunnel excavation because it was clayey and well tightened. Although the ceiling is largely collapsed, the height of the firing chamber can be estimated to be around 80 cm from the remaining cases. Since the width of the firing entrance is narrower than that of the firing chamber, the plane shape reveals a deflated balloon shape.

2. The firing entrance has a width of 1 m and a height of 1 m and expanded in a fan-like shape toward the direction of the ash heap. Its floor kept a constant elevation level, but it had bumpy surface.

3. The firing place was slightly inclined upward compared to the entrance, and had a flat floor surface. The side wall of the firing place was constructed by embedding cuboid-shaped Ryūkyū limestones in the wall clay. The method of closing the kiln entrance was to stack the pot supporters and seal it with clay.

4. At the center of the kiln, where the floor surface has a steep slope of 31–42 degrees, is the firing chamber, and there are severe cracks and flaking due to the high temperature. The structure was a slope type without steps. Its cross-section shows two types, a barrel-vault type in which both sides rose vertically and an oval type in which both sides were stretched. In the firing chamber, it was confirmed that hoof-shaped clay pot supporters were arranged in an arc following the outer shape of the kiln.

5. The flue was dug diagonally from the ground surface toward the innermost part of the kiln, and the angle was steeper than that of the firing chamber. There was an

example of a drainage ditch dug near the vent, and the chimney was blocked with flat stone.

6. At Asan Kameyaki Group Area 2, it was confirmed that after the ceiling of the No. 4 kiln collapsed, the No. 5 kiln was constructed by digging out the innermost part of No. 4. It is probable that some kilns were repeatedly built in suitable areas for construction.

7. Taking the example of the ash heap from kiln No. 3 of Asan Kamuiyaki Group Area II, it had a length of 3 m, a width of 2 m, and a layer of 50 cm thickness. On the east side of the survey area in Asan Kameyaki Group Area II, four ash heaps were found with clay, which is a by-product of constructing the kiln, sandwiched between them. It can be seen that the top of the ash heap was developed when the new kiln was built.

The amount of excavated pottery from the kiln itself was small, and most of the excavated materials were from ash heaps. It is not clear how the potteries were placed in the kiln, because no kiln has been found that was abandoned during the firing process. Looking at the sherds of Kamuiyaki, the front and back surfaces are gray and the core is red, so it seems that oxygen was supplied by opening the entrance or flue during firing, rather than complete reduction firing. A flat stone near the chimney of kiln No. 1 at Asan Kameyaki Group Area II may be related to the opening and closing of the vent (Fig. 18.3: 1).

### 18.7. The natural scientific research

The geomagnetic (Tokieda & Itō 1985: 48, Tokieda 2001: 76) and radiocarbon (Yamada 1985: 55, Paleoenvironment Research Institute 2005a: 82) analyses showed dates between the eleventh and thirteenth centuries AD. These results are consistent with the ages of the distribution sites in the Ryūkyū Islands.

According to X-ray fluorescence analysis of the pottery itself, Kamuiyaki had higher Fe and Ca compared to the pottery from the Japanese archipelago in the same period (Mitsui 1985: 54, 2001: 76, 2005: 65). It is possible to distinguish it from South Kyūshū and Korean peninsula pottery by analyzing the values of K, Fe, Rb and Sr (Mitsui et al. 2006: 16, Shinzato & Mitsui 2008). Most of the charcoal tree species found in the ash heaps were identified by analysis as *Sudajii* (*Castanopsis sieboldii*) (Paleoenvironment Research Institute 2005b: 84), and it was concluded that this was frequently used as fuel (Shinzato ed, 2015: 15).

Based on the results of the natural science analyses, the natural environmental factors of the pottery production were also considered. Fe and Ca are abundant in the pottery; it is said that the former was derived from weathered granite soil that forms the bed-soil of the forest where many kilns are located, and the latter originated from the Ryūkyū limestone that is distributed around there. It was assumed that the pottery material came

from the soil and minerals obtained around the kiln site (Naruo 2015). *Sudajii* (*Castanopsis sieboldii*), which still proliferates around the kiln site today, is said to be outstanding as a sustainable fuel because it has a strong fire power when burned and a high vitality of germination after logging (Terada 2015). Near the kiln site, there are some underground caverns and sinkholes made by water eroding the Ryūkyū limestone. In such an environment, a groundwater vein develops, so it is easy to gain abundant water (Naruo 2015). Clay, wood and water, the essential resources for pottery production, still remain around the kiln site.

### 18.8. Problems related to the shipping port and the potters' settlement

A natural environment similar to that around the kiln site can be seen in Mt. Amagi and Mt. Inokawa in the central part of Tokunoshima Island, but no kiln site has been found so far, because their high altitudes would have made it difficult to transport many products. This shows that not only materials but also a location with easy access to the coast suitable for its transportation were important for pottery production and widespread distribution.

Supposing that there was a base of transportation near the kilns, Omonawa, which is 2 km south of the Kamuiyaki kiln site cluster, is a promising candidate port, since sherds of Kamuiyaki and Chinese ceramic have been found on the sea bed (Nansei Islands Underwater Cultural Heritage Study Group, Laboratory of Material Culture Faculty of Low, Economics and Humanities Kagoshima University eds. 2013: 26–31). However, no relics related to medieval shipping have been found, so further underwater archeological investigations are needed.

Although the potters' residences have not yet been determined, as mentioned above, the settlements during the operation of the Kamuiyaki kiln site cluster were mostly distributed in the middle and high terraces of Ryūkyū limestone, the elevation of which is 100 m, lower than the location of the Kamuiyaki kiln site (Fig. 18.1c). Close to the kiln site, there are also the Mintsuki site (Shirakihara & Gi 1976: 67), the Kawaminetsuji site (Shinzato ed. 2010) and the Maeatari site (Shinzato & Tsune eds. 2018), and they have the common characteristic that most of the excavated remains were Kamuiyaki. In particular, the excavation survey of Maeatari sites found pillar holes of houses and warehouses, rice fields, iron furnaces, some tombs where iron swords, iron spindles, glass beads and Kamuiyaki pottery were buried (Shinzato & Tsune eds. 2018). But no tools related to the production of pottery were found in these sites, so it is assumed that the potters' work area was located in the forest close to the production area.

### 18.9. Typological study

Shinji Satō, the pioneer of typological studies on Kamuiyaki pottery, clarified that the rim morphology of the

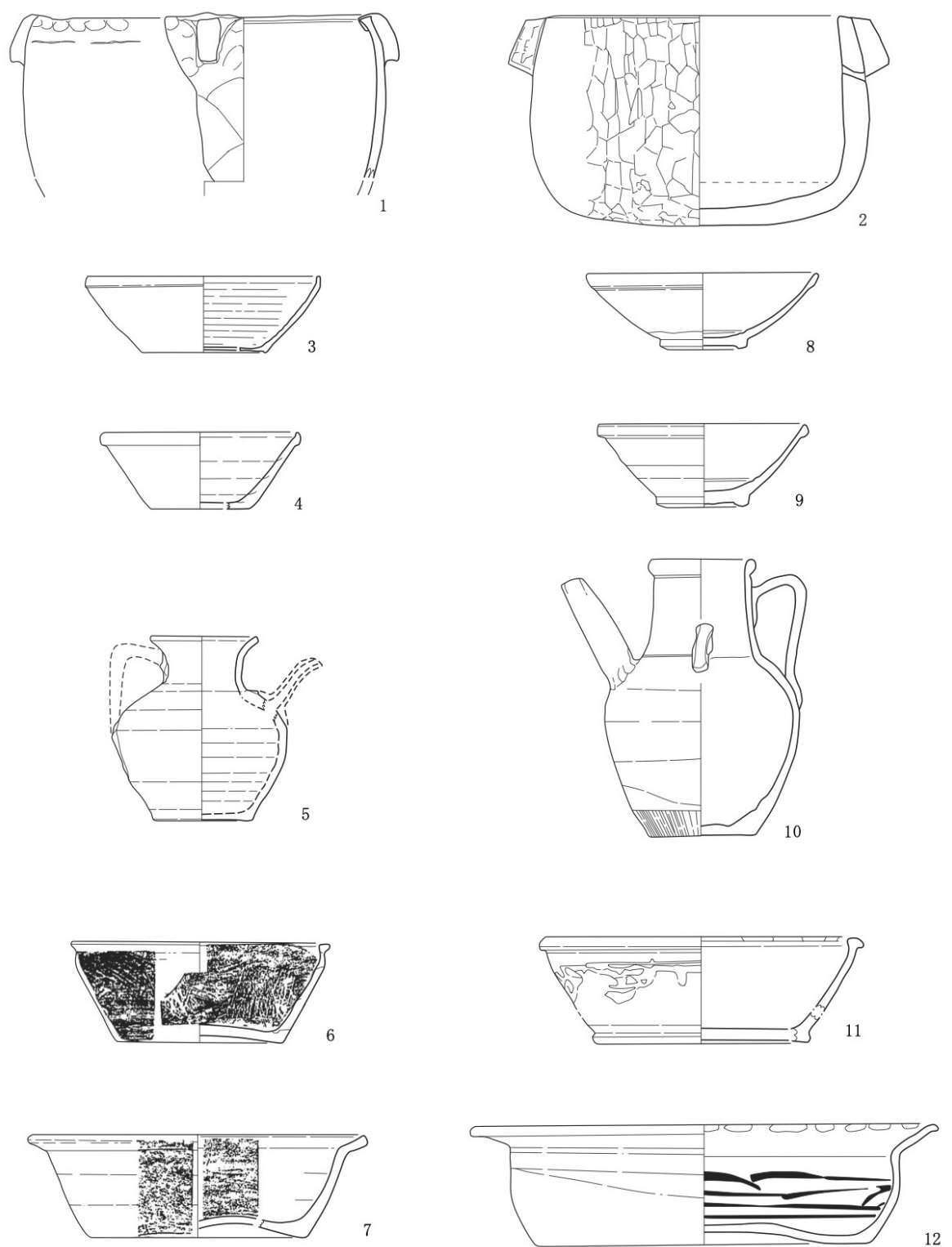
jar became plain in shape along with the simplification of the drawing pattern technique; for example, the transition from an individual drawing style to a spiral drawing style (Satō 1970:178–82). This typological change was later confirmed by an examination of articles unearthed from cave sites in Okinawa too (Asato 1975: 45–46).

Shortly after the discovery of the kiln site in 1983, the characteristics of the excavated Kamuiyaki pottery in the Okinawa area were summarized (Kin 1986); for understanding the correspondence between the production site and the distribution sites, much archeological information was gathered (Ikeda 1987). The results of Satō's research were inherited developmentally, and several scholars proposed a chronology of the jar that focused on its lip shape (Asato 1987: 76–77, 1991: 589–91, Ōnishi 1996: 26). As the number of related archeological materials increased due to a survey of kilns in Tokunoshima and of distribution sites in various parts of the Ryūkyū archipelago, the research achievements were published one after another to clarify the vessel composition (Yoshioka 2002: 414–23, Ikeda eds. 2005: 45–110, Asato 2006: 135–36). Through these examinations, the production of a bowl, a kneading bowl and a water ewer imitating the shape of Chinese porcelain gradually became apparent too, and Kamuiyaki pottery has attracted much attention, as an international stoneware incorporating the East Asian tableware culture of the medieval period (Fig. 18.4).

By comprehensive checking of materials excavated from the kiln sites, I have constructed their chronology. The resulting conclusions are that Kamuiyaki pottery was manufactured from the latter half of the eleventh century to the end of the fourteenth century and its production techniques changed significantly in the middle of the thirteenth century (Shinzato 2003a: 88). Beyond that, some characteristics of Kamuiyaki production, including the new findings obtained by the additional studies, are summarized below (Shinzato 2018: 93–117):

1. Jars, kneading bowls and pots have a common feature that their rim changed in a series from a three-dimensional shape to a flat and simple shape. They can be divided into six types (Shinzato 2018: 94).
2. Focusing on the change in the morphology of the jar's rim, the examination of its external form, the thickness of body, the presence or absence of wavy line patterns, the patterns of tapping and the treatments on their surface showed that Kamuiyaki can be classified into two groups. Group A have a thin body and there are dense grid marks or wide parallel lines on their inner surface. Group B has a thickened body type, their outer surface was smoothed by stroking, and narrow parallel lines are left on their inner surface sparsely. Group A corresponds to rim types 1 to 4; Group B correlates with types 5 and 6 (Shinzato 2018: 103–05). Similar classifications have been proposed by Okinawan researchers and will not change significantly in the future (Kin 1986, Ikeda ed. 2005: 108–09).



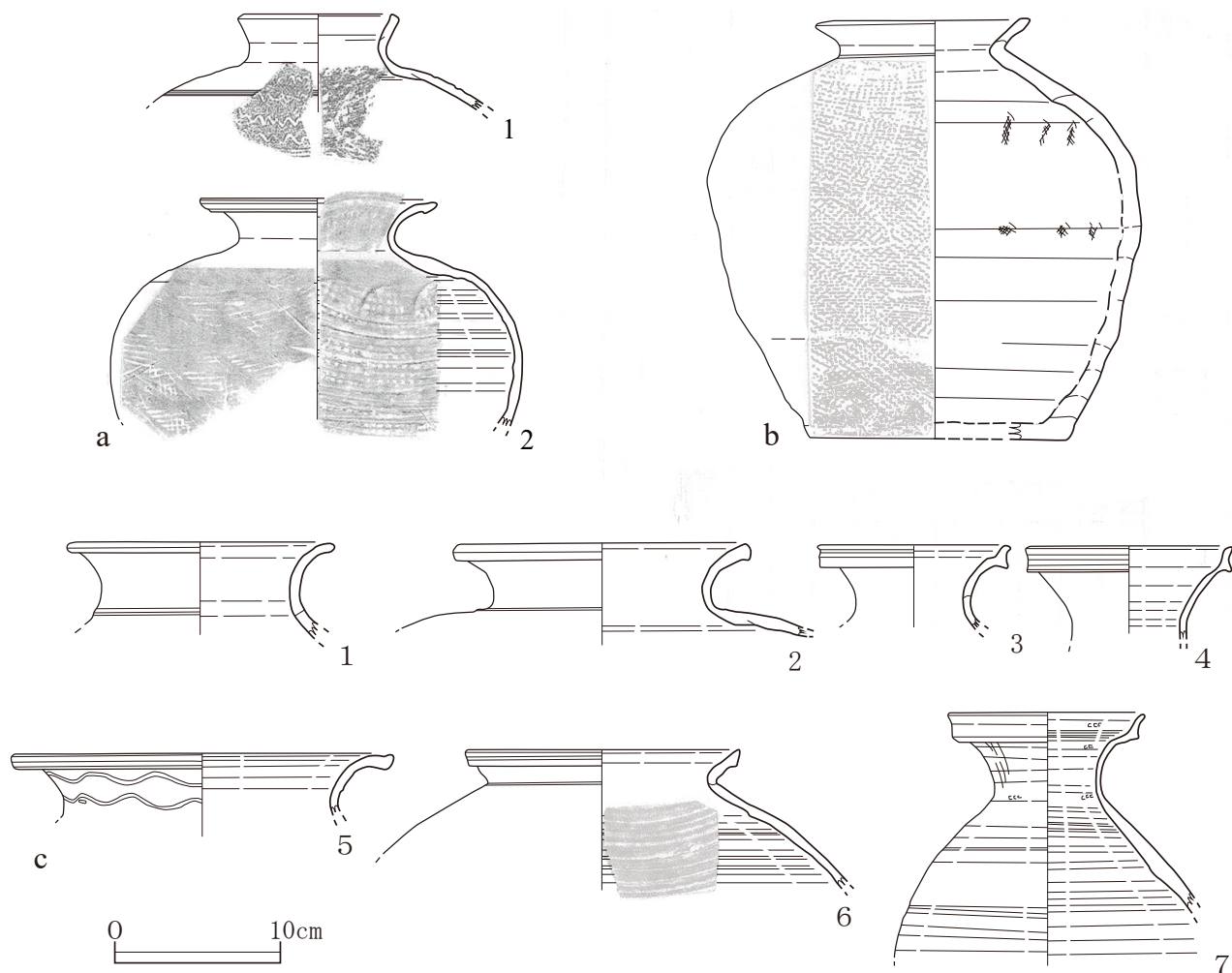


- 1: Local earthenware (pot shape) from Atta shell-mound site, produced in Okinawa.  
 2: Talc pot from Uminonakamichi site, produced in Kyūshū.  
 3-7: Kamuiyaki from Kamuiyaki kiln site cluster and Kanna Yūagimō site.  
 8-12: Chinese ceramics from Dazaifu site.

0 20cm

**Figure 18.4. Imitation phenomenon of imported tableware seen in local earthenware and Kamuiyaki in the Ryūkyū Islands (1: Kin & Higa eds. 1979: 32; 2: Yamasaki ed. 1982: 80; 3: Aozaki & Itō eds. 2001: 23; 4: Shintō & Aozaki eds. 1985b: 78; 5: Shinzato ed. 2005: 16; 6: Shintō & Aozaki eds. 1985b: 77; 7: Shintō & Aozaki eds. 1985b: 76; 8: Miyazaki ed. 2000: 16; 9: Miyazaki ed. 2000: 13; 10: Miyazaki ed. 2000: 58; 11: Miyazaki ed. 2000: 54; 12: Miyazaki ed. 2000: 54). 1: Local earthenware (pot shape) from Atta shellmound, produced in Okinawa. 2: Talc pot from Uminonakamichi site, produced in Kyūshū. 3–7: Kamuiyaki from Kamuiyaki kiln site cluster and Kanna Yūagimō site. 8–12: Chinese ceramics from Dazaifu site.**





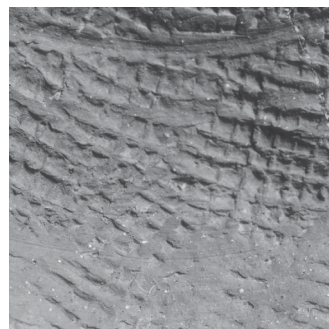
Outer surface of a-2



Outer surface of b



Inner surface of c-3



Inner surface of a-2



Inner surface of b



Inner surface of c-6

**Figure 18.5. Vessel formation techniques of Kamuiyaki, Goryeo and Sagariyama pottery. a (Kamuiyaki): 1: Isamēbaru No. 1 site (Tōme ed. 2001: 72); 2: Kamuiyaki kiln site cluster, Asan Yanagida South group (Aozaki & Itō eds. 2001: 15); b (Sagariyama): Sagariyama kiln site (Matsumoto ed. 1980: 135); c: 1–4: Mungri kiln site cluster (Lee H., Lee S., O Gyu-jin, Na G. eds. 2000: 48; 58), 5–6: Dazaifu site (Kyūshū Historical Museum ed. 1990: 106; 101); 7: Hakata site (Shimomura ed. 1996: 30). – Photographs without scale. – Drawings modified by the author, photographs by the author.**

3. The latest chronological chart created after typological examination is shown in Fig. 18.6 (Shinzato 2018: 111). Kamuiyaki production is largely divided into two stages, and there are six small epochs subdividing it.

4. The products of Group A were jars, kneading bowls and pots. In Group B, there were large vessels such as very large-sized kneading bowls and pots (Shinzato 2018: 112–13). However, in both groups, jars account for more than 60 percent of the total number of vessels (Shinzato 2018: 112).

5. The boundary between Group A and Group B is in the middle of the thirteenth century (Shinzato 2018: 113–15). At this time, the production in Kamuiyaki changed significantly.

The Isen Town Board of Education, which manages the kiln site, is currently repairing excavated potteries with the aim of publishing a comprehensive research report on the Kamuiyaki kiln site cluster. Recently, results have been published in which two scientific groups extracted by neutron activation analysis of 20 samples picked up from these restorations correspond to the Group A and Group B described in this paper (Sterba et al. 2020: 511). Archeologists and scientists have already begun collaborative investigations into the actual conditions of pottery production, and the continuation of such researches will reveal chemical characteristics of clay paste not only caused by differences in their age but also those from vessel types. Furthermore, by analyzing potteries excavated from the consumption sites, it is expected that the distribution conditions which cannot be visually confirmed will be elucidated – for example, the circulation process from a certain production group to a specific island.

#### **18.10. Technical genealogy and distribution**

As mentioned above, Kamuiyaki is similar to Goryeo pottery, and it has been thought that the kiln structure and vessel composition are closely related to Southern Kyūshū. In the 1990s, it became clear that Goryeo pottery tends to be excavated from the international port city Hakata and the national institution Dazaifu (Akashi 1991), and the similarity in production technology between Kamuiyaki and Goryeo pottery was refocused (Akashi 1999: 56, 2007: 127–30). Yoshifumi Ikeda, who paid attention to this situation, argued that further research with a broader perspective on East Asia was needed (Ikeda 2000). Nevertheless, from the standpoint of emphasizing the commonality of kiln structure and vessel composition, mainly the jar, the relationship between Kamuiyaki and Sagariyama continued to be supported (Ōnishi 1996: 64–65). However, an excavation survey of Mujangri kiln site (Lee et al. eds 2000) in South Korea from 1997 to 1998 made it possible to compare Kamuiyaki with Goryeo pottery and Sue ware from Sagariyama kiln site archeologically. With this opportunity, I re-examined these potteries and confirmed the similarities between Kamuiyaki and Goryeo pottery in the rim-shaping technique with beating, as well

as the tapping pattern (Shinzato 2004: 330–38, Fig. 18.6). Regarding the kiln structure, although there are differences in the angle of their flue, kilns from Kamuiyaki, Mujangri, and Sagariyama shared their basic plane shape: the deflated balloon type (Shinzato 2004: 330–38, Fig. 18.3).

Studies of Sue ware (Yoshioka 2002: 432–34) and roof tiles (M. Uehara 1980: 6) have confirmed that the ceramic production in medieval Japan was technically influenced by Goryeo, and old Okinawan roof tiles were too (S. Uehara 2000: 39). These facts indicate that the exchange of ceramic technique among these three regions was common in their history. Considering this historical background, it can be accepted that the Ryūkyū islands, which had lacked the tradition of pottery production until then, were directly influenced by the technology from the Korean peninsula, and then Kamuiyaki, which is similar to Goryeo pottery, was established. How was the transfer of ceramic techniques to Tokunoshima Island realized? To understand this, it is effective to examine the relics brought from the Korean peninsula to the Ryūkyū archipelago.

In recent years, archeological survey of the Amami Islands has reported the discovery of Goryeo's pottery and celadon, which dated to the eleventh century (Shinzato ed. 2010: 108, Matsubara et al. eds. 2015: 43, Shinzato & Tsune eds. 2018: 53). These were not excavated in as great a quantity as Kamuiyaki and Chinese ceramics, and tend to be found on specific islands, such as Kikai Island, where the distribution base was located, and Tokunoshima Islands, which was the stronghold of Kamuiyaki production. The small amount of excavated material and limited find cases of these are the same in Kyūshū (Yamamoto 2003: 79). This shows that they were not imported as commodities, but as the daily necessities or transport containers of visitors from the Korean peninsula (potters and merchants). Focusing on this archeological condition, it is highly probable that the emergence of Kamuiyaki kiln site cluster was achieved by the migration of a certain number of potters from the Korean peninsula rather than just the transfer of ceramic technology (Shinzato 2020: 34–36).

In order to understand the economic background of its introduction to Tokunoshima Island, it is important to confirm the distribution of the older type of Kamuiyaki's Group A. These were circulated mainly in Amami and Okinawa Islands, but were spread to Kyūshū in the north and Sakishima Islands in the south (Fig. 18.1b, Shinzato 2018 [2003b]: 120). This situation indicates that the Ryūkyū Islands had a strong economic relationship with Kyūshū when the Kamuiyaki production started. It is in harmony with the fact that Kyūshū's talc pots have been excavated throughout the Ryūkyū archipelago. Considering the economic circumstances at that time, it is assumed that the transference of ceramic skills from the Korean peninsula reached the Tokunoshima Island via Kyūshū.

On the other hand, the newer Group B are very few in the north of Tokara Islands and Sakishima Islands, which

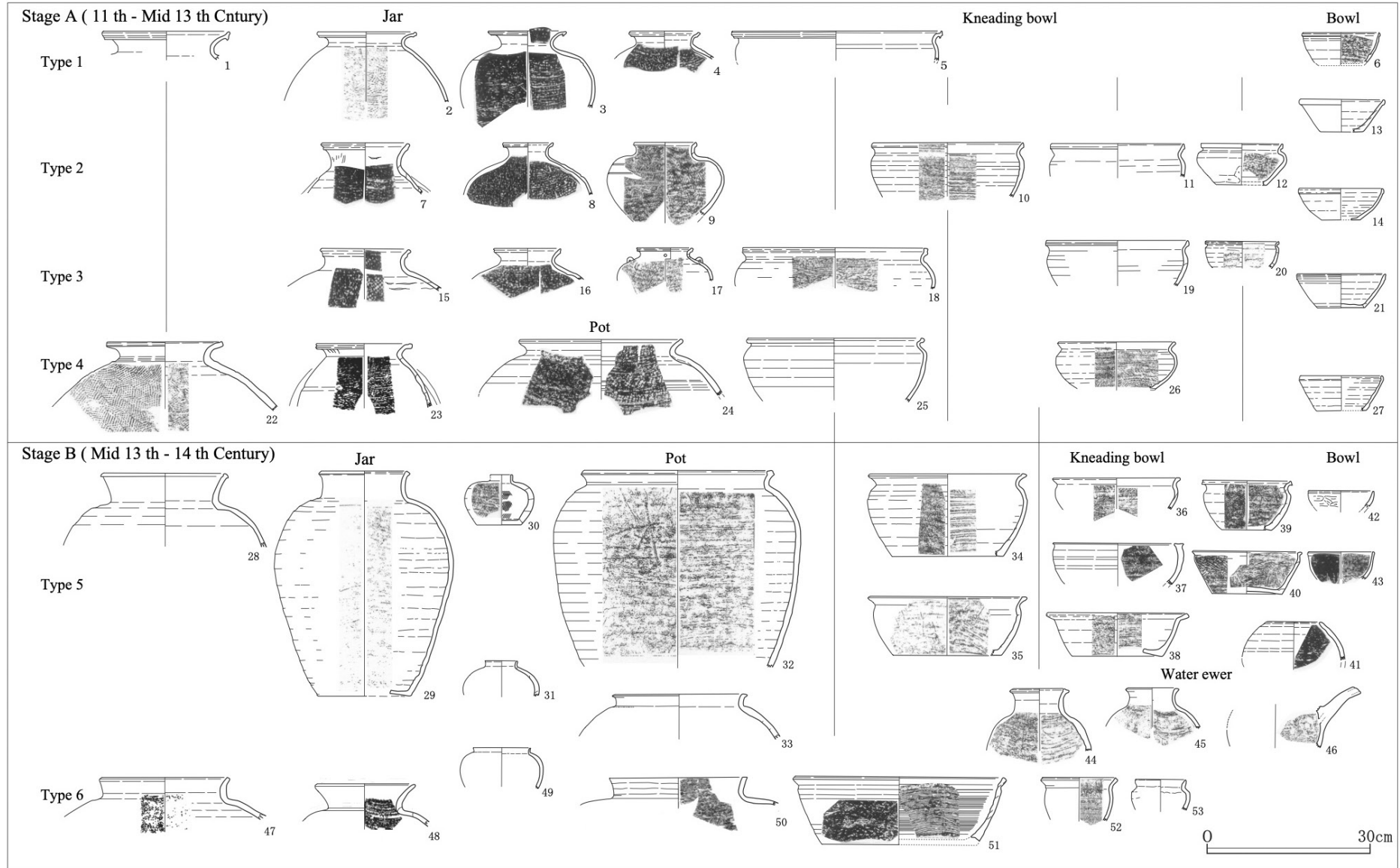


Figure 18.6. Chronology of Kamuiyaki pottery (Shinzato 2018: 111, modified by the author).

shows their different distribution status. As Asato (2006: 37) points out, the number of excavations in Amami Island and Kikai Island decreased, and Tokunoshima Island and Okinawa Island came to be the center of consumption (Shinzato 2018 [2003b]: 120–23). This means that the change of distribution area corresponded to the innovations of the production technique in kiln sites shown above. From their technological origin and distribution, it can be assumed that the series of historical processes, Kamuiyaki's establishment, development and demise, correlated with the negotiation relationships in medieval East Asia. To verify this, the next section will examine how Chinese ceramics were brought into the Ryūkyū Islands, and consider the causality between Kamuiyaki production, the trade network and the society of the Ryūkyū archipelago.

### **18.11. The Ryūkyū Islands society from the viewpoint of Kamuiyaki production**

Chinese ceramics from the Tang Dynasty to the northern Song Dynasty (late eighth century to early eleventh century) were excavated in the Amami Islands, but it was after the middle eleventh century that these ceramics were used throughout the Ryūkyū archipelago. In the eleventh to twelfth century, bowls and plates were mainly consumed, and these tend to be excavated together with Kyūshū's talc bowls. Therefore, it is believed that these porcelains were brought to the Ryūkyū Islands via Kyūshū (Kin 1998). This is also supported by the fact that the types of Chinese ceramics before the first half of the thirteenth century are not much different from the general archeological sites in Japan around the same time (Morimoto & Tanaka 2004: 366). From the historical situation that international trade was exclusively developed in the port city Hakata at that time (Ōba 1999: 89), it can be read that Japan's international trade with Song and Goryeo Dynasty, which lay behind the transfer of ceramic technology from the Korean peninsula, reached Tokunoshima Island.

Among the islands of the Ryūkyū archipelago, the Amami Islands tend to produce many Chinese ceramics excavated from the eleventh and twelfth centuries. They are located on the northern edge of the Ryūkyū Islands, so it can be judged that they played a leading role in trade with Kyūshū (Shinzato 2018 [2015]: 79). The reason why Tokunoshima was selected as the production center of Kamuiyaki may be due to the trade advantage of the Amami Islands in addition to the natural environment suitable for pottery production.

From the latter half of the thirteenth century, Chinese ceramics were consumed more than before in the Ryūkyū Islands (Shinzato 2018 [2015]: 80). Because the composition of Chinese ceramics in the Amami Islands around this time is similar to that in Kyūshū, it is considered that the economic relationship between the Amami Islands and Kyūshū continued (Shinzato 2018 [2015]: 83). However, on the other hand, a new situation has been confirmed in the Sakishima Islands.

A certain amount of Fujian porcelain called Nakijin type and Birōsuku type was consumed, while there was little Chinese ceramic (White porcelain type IX in the F period of Dazaifu) of the type that was common in Kyūshū at the same era (Shinzato 2018 [2015]: 82). Both of these Fujian porcelains, which date from between the middle of the thirteenth century and the middle of the fourteenth century, proved to be the products of the Min River basin by the survey of their production area (Kinoshita ed. 2009: 253). These were rarely excavated in Hakata (Tanaka 2009: 97), and are thought to have been brought to the Ryūkyū Islands from South China via the Sakishima Islands (Kinoshita ed. 2009, Ikeda 2019: 34–35). Nakijin type and Birōsuku type are the archeological evidence that symbolize the new economic relationship between the Ryūkyū Islands and South China. In addition to this, the Sakishima Islands have the regional features that there are very few examples of Kamuiyaki Group B, and they are instead rich in possession of Chinese brown-glaze potteries, the vessel types of which are jars, pots, kneading bowls and water ewers (Shinzato 2018: 156).

From the distribution patterns of Chinese ceramics, we can read the process that the Ryūkyū Islands were connected to Kyūshū through the Amami Islands from the eleventh century on, and the economic network was diversified due to the linkage between the Sakishima Islands and South China after the mid-thirteenth century. This was not unrelated to the emergence of Kamuiyaki in the eleventh century, and in particular the major shift in its production in the latter half of the thirteenth century must be strongly related to the latter situation. This is because the rise of the Sakishima Islands must have led to competition between Kamuiyaki and Chinese ceramics. From this point, it can be accepted that the flat and simple appearance of Kamuiyaki Group B was due to the efficiency improvement of manufacture aiming at mass production (Shinzato 2018: 156). As mentioned above, it is clear that the production trend of Kamuiyaki was closely related to the economic situation in medieval East Asia. There is no doubt that the Kamuiyaki kiln site cluster is an important cultural heritage for understanding the history of the Gusuku period, for which there is no direct textual material. Finally, I would like to focus on the symbolic aspects of Kamuiyaki and conclude this chapter by giving my opinion on the process of increasing social complexity in the Ryūkyū archipelago.

It is highly likely that the Amami Islands had already reached a stratified social stage when the Kamuiyaki production started, because castles that require large-scale civil engineering work, and huge settlements which played the role of trading hub centers appeared on Amami Island and Kikai Island (Nakayama ed. 2003, Matsubara et al. eds 2015). This is the reason why plenty of Chinese porcelains were brought to the Amami Islands due to their strong economic relationship with Kyūshū. What we should pay attention to here is the existence of the Kamuiyaki bowl. These bowls, which imitated Chinese porcelain, were actively consumed in the Amami

Islands, where aggressive trading was developed and social stratification was relatively advanced (Shinzato 2018: 132). This fact indicates that these were not daily utensils that made up for the shortage of Chinese ceramics, but the symbolic tableware used effectively in a layered society. That is, it can be hypothesized that Kamuiyaki bowls had a cultural function that expressed the social hierarchical position of those who used them. If we confirm the consumption pattern of Kamuiyaki bowls according to this hypothesis, this expression culture begun to flourish in the Amami Islands, which had the advantage of trade, and after a while gradually spread to the entire Ryūkyū archipelago. Ultimately, it came to be a cultural phenomenon predominantly recognized in Okinawa Island in the middle of the thirteenth century (Shinzato 2018: 155). On Okinawa Island from the mid-thirteenth century to the fourteenth century, the construction of a large-scale castle began, and three kings started tribute trade with the Ming Dynasty of China. These historical facts are evidence that a more highly stratified society was established on the main island of Okinawa.

It can be read that the remarkable development of the hierarchical expression culture using tableware on Okinawa Island at this period was deeply related to these historical circumstances.

The reason for the end of production of Kamuiyaki is probably that many Chinese ceramics were brought to the Ryūkyū Islands by direct negotiations with the Ming Dynasty after the fourteenth century, and that it lost the economic competition with them (Ōnishi 1996: 33, Shinzato 2018 [2003a]: 117). The subsequent movement of the potters group has not been clarified. They may have been converted to roof-tile makers of Okinawa Island. This is a subject for future research.

## 18.12. Conclusion

The discovery of the Kamuiyaki kiln site cluster on Tokunoshima Island far from Okinawa Island, the base of the Ryūkyū Kingdom, is evidence of the social division of labor across the sea during the Gusuku period, and it reformed Ryūkyū's historical image. The introduction of ceramic technology to Tokunoshima Island was due to the economic activities of the Amami Islands and Kyūshū. This can be positioned as an extension of the international trade between Japan and the Song Dynasty, Japan and the Goryeo Dynasty developed in Hakata. The centralized production of Kamuiyaki on Tokunoshima Island and its widespread distribution were inseparably achieved with the spread of agriculture in the Ryūkyū archipelago, and played a major role in the integration of tableware culture in the Amami, Okinawa and Sakishima Islands.

According to typological examination of Kamuiyaki, its production surely started in the middle of the eleventh century, and its appearance and production techniques changed significantly in the middle of the thirteenth

century. During this period, because of the highly motivated trade activities of the Sakishima Islands with South China, it can be concluded that Kamuiyaki's production conversion was the result of mass production in preparation for competition with Chinese ceramics brought from the south margin. In addition, the Kamuiyaki bowl had a cultural function that expressed the social class of its users, so it is very useful for understanding the evolution of the Ryūkyū Islands society, where hierarchization was progressing. In other words, this symbolic significance of Kamuiyaki has the potential to contribute to the elucidation of the state formation process in the Ryūkyū archipelago.

In this way, the production and distribution of Kamuiyaki corresponded to the economic situation in medieval East Asia and the development of the Ryūkyū Islands' society. Kamuiyaki kiln site cluster provides us with the important historical information mentioned above, and so has remarkable value as cultural heritage. Some surveys of the industry areas revealed that the kilns were well preserved and various types of vessels produced, but the amount of products in a single firing has not yet been clarified. In addition, the potters' settlements and the shipping port of the potteries have not been discovered. Also, the whereabouts of the craftworker group after the abolition of the kilns is left to future investigations. In order to clarify these problems, further research is necessary and depends on active cooperation among archeologists, historians and natural scientists.

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## Glossary

The glossary lists names and terminology mentioned in this book that are characteristic to kiln research in East Asia. Several research traditions and languages use different names or writings for identical or mostly identical sites or concepts and methods. For each name or term that may not be well known to the Western reader, and which occur in one of the chapters, an entry is given exactly the way the name or term occurs in that chapter, i.e. in a writing that may be considered standard or a variant.

If a term or writing is considered a variant, the entry only links to an entry that is considered standard.

An entry is considered standard either if (a) it is a translation into English which conveys the meaning well and is not tightly bound to one of the various cultures or traditions, or (b) if it is a transliteration that follows a standard transliteration of the language as defined in the introduction. In some cases, the editors suggest an English translation that is not established but at least is not bound to one tradition one-sidedly. In most cases these are suggestions for Western terminology from the introductory chapter and therefore have no East Asian writing counterparts; these suggestions may be object to future discussion for a consistent and culture-independent terminology in this field of archaeological studies.

The standard entry also lists variants in translation or transliteration as well as in other languages that are used in this book or are otherwise common. Some of these variants may deviate slightly from the concept of the entry or are outdated; they are mentioned nevertheless since they can be found in literature that is still valuable. As for variants in East Asian scripts, the language is not indicated but may be inferred from the concrete form. However, the Chinese, Korean, and Japanese writing may look identical in many cases.

The aim of the glossary is to help the reader making connections between concepts and regions which may be difficult to understand otherwise; the editors are thankful for any critique that improves the suggestions for a consistent terminology. This glossary is the result of collaboration of authors and editors, however, responsibility for errors and other shortcomings is with the editors.

**Abaoji** (hist. name), also *Yelü Abaoji*. 阿保机, Амбагян.  
**anagama** (kiln term.), see *long-body kiln without oven floor*. 龙窑、平焰龙窑, 登窯, 登窯、窖窯、穴窯.  
**Anan'evka walled settlement** (site), also *Anan'evka walled town*. Ананьевское городище.  
**Anshan** (kiln site), see *Xiaoshan Anshan*. 安山.  
**Arahira** (kiln site), also (*Nakadake Sanroku Arahira subcluster*). 荒平、(中岳山麓荒平支群).  
**Arao** (kiln site). 荒尾(窯跡群).  
**Arimata** (kiln site). 荻又遺跡.  
**Asakura** (kiln site). 朝倉(窯).  
**Asan Yanagida** (kiln site). 阿三柳田.  
**ash deposit** (kiln term.), see *ash heap*. 灰坑, 灰原, 灰原.  
**ash glazed pottery** (ware). 灰釉陶器.  
**ash glazed pottery kilns** (kiln term.). 灰釉陶器窯.  
**ash heap** (kiln term.), also *ash pile*, *ash deposit*; not: *ash pit*. 灰坑, 灰原, 灰原.  
**ash pile** (kiln term.), see *ash heap*. 灰坑, 灰原, 灰原.  
**ash pit** (kiln term.), not: *ash heap*.  
**Ata district** (hist. name). 阿多郡.

**Atta shellmound** (site). 熱田貝塚.  
**Babai cemetery** (site). 八拜墓地.  
**Baekche** (hist. name), see *Baekje*. 百濟.  
**Baekje** (hist. name), also *Paekche*, *Baekche*. 百濟.  
**Baideng (battle of)** (hist. name). 白登之围, Пинчений тулаан.  
**Balhae** (hist. name), also *Bohai*, *Bokkai*, *Bokhai*, *Palhae*, *Parhae*. 渤海, 渤海, Бохай.  
**barrel-vault type** (kiln term.). イチジク型.  
**Birōsuku type** (ware). ビロースクタイプ.  
**Bizishan** (site). 鼻子山遺址.  
**bo bell** (form/item). 搏钟.  
**boat bottom pit** (kiln term.). 舟底状ピット.  
**Bohai** (hist. name), see *Balhae*. 渤海, 渤海.  
**Bonggyeri** (kiln site). 鳳溪里.  
**bottle oven kiln** (kiln term.), see *kiln with oven floor*. 德利窯.  
**bowl** (form/item). 括鉢, 鉢, 碗, 鉢, 碗.  
**broad-short kiln with oven floor** (kiln term.), also *semi-downdraft kiln*, *flat kiln*, *flatland kiln*, *flatdraft kiln* / type.

*flatdraft-dragon kiln, mantou kiln.* 半倒焰窯、饅頭窯, 平窯, 平窯、広短式窯.

**broken line patterns** (ornament). 折綫紋.

**broneware-imitated pottery for ritual** (form/item). 仿青铜礼器.

**bu** (form/item). 甗.

**bunen chū** (kiln term.), see *pillar for dividing flame*. 分焰柱.

**Buxia Wangjia** (kiln site). 埠下王家.

**Buyeo** (hist. name), also *Fuyu, (Puyo)*. 扶余, 扶餘, 扶余.

**Byeonhan** (hist. name). 弁韓.

**ceiling-structured type** (kiln term.), see *semi-sunken type & surface type*. 天井架構式、半地下式・地上式.

**celadon** (ware). 青磁.

**Central Ryūkyū (Islands)** (other), also *Chūbu-ken*. 琉球列島中部.

**Changshan** (kiln site). 长山窑遗址.

**checkered filing line pattern** (ornament). 方格填綫紋.

**checkered pattern** (ornament). 方格紋.

**Cherepakha-7** (site), also *Cherepakha-7*. Черепакха-7.

**Chernyatino-2** (site). Чернятино-2.

**Chikuzen Province** (hist. name). 筑前国.

**chimney** (kiln term.), also *chimney tube*; not: *flue*. 煙突.

**chimney tube** (kiln term.), see *chimney*. 煙突.

**Chinese brown-glaze pottery** (ware). 褐釉陶, 褐釉陶器, 褐釉陶器.

**Chintolgoi Castle** (site). Чинтолгой балгас.

**Chūbu-ken** (other), see *Central Ryūkyū (Islands)*. 中部圈.

**chunyu** (form/item). 罇于.

**Chūzan (chiefdom)** (hist. name). 中山.

**circular kiln** (kiln term.), also *circular plan of broad-short kiln without oven floor*. 圓形半倒焰、窯饅頭窯, 平窯, 平窯、広短式窯.

**clapper** (term). 拍.

**clay stand** (kiln term.), see *stand*, also *pottery supports*. 窑具、托珠, 도지미, 焼き台、トチン.

**climbing kiln** (kiln term.), see *long-body kiln without oven floor*. 龙窑、平焰龙窑, 登窯, 登窯、窖窯.

**cloudscapes** (ornament). 云雷紋.

**combustion chamber** (kiln term.), see *firebox*.

**connected cloud patterns** (ornament). 勾连云紋.

**continuous chambered climbing kiln** (kiln term.), also *noborigama*. 半倒焰連房窯, 登窯, 連房式登窯.

**Daegokri** (kiln site). 大谷里.

**Daeseongdong** (site). 土城洞.

**Daeseongdong Tumuli** (site). 大成洞古墳群.

**Daisen Tomb** (site). 大仙古墳.

**Dajinsitun** (kiln site). 大金丝屯.

**Daming Palace** (hist. name). 大明宮.

**Dandeokri burial mound** (site). 丹德里古墳.

**Dangga** (kiln site). 唐加.

**dangling (bell)** (form/item). 悬鈴.

**daruma kiln** (kiln term.), see *broad-short kiln without oven floor (type of)*. 達磨窯.

**Dazaifu** (hist. name). 太宰府.

**Dazaifu site** (site). 太宰府遺跡.

**Deai** (kiln site). 出合窯.

**diamond filling line pattern** (ornament). 菱形填綫紋.

**diamond patterns** (ornament). 菱形紋.

**ding** (form/item), also *tripod vessel*. 鼎.

**Dojil ware** (ware). 陶質土器, 陶質土器.

**Dong Xia** (hist. name), also *Eastern Xia*. 东夏.

**Donghu** (hist. name). 东胡, Дорнод ху.

**Dongpolin** (site). 东坡岭.

**dou vessel** (form/item). 豆高坏.

**double hook line “S” shape** (ornament). 双勾綫“S”形.

**Doufu** (kiln site), also *Doufu (Qin Yongcheng)*. 豆腐村.

**downdraft kiln** (kiln term.), also *downdraught kiln*. 倒焰窯.

**downdraught kiln** (kiln term.), see *downdraft kiln*.

**dragon kiln** (kiln term.), see *long-body kiln without oven floor*. 龙窑、平焰龙窑, 登窯, 登窯、窖窯.

**drainage ditch** (kiln term.). 排水溝.

**dugout type** (kiln term.), see *sunken kiln*. 地下式, 地下式, 地下式.

**earthenware** (ware). 土器, 土器, 土器.

**ember** (term). 燠.

**Emishi** (hist. name). 蝦夷、夷.

**fang vessel** (form/item). 觚.

**Fangshan Nangzheng** (kiln site). 房山南正.

**Fangwanggang burial** (site). 放王岗.

**Fangzhou** (hist. name). 防州.

**fine disordered cloud patterns** (ornament). 双勾綫.

**firebox** (kiln term.), also *combustion chamber, fuel section, furnace chamber, furnace section, firing box*. 火膛, 燃燒室, 燃燒室.

**fire chamber** (kiln term.), also *firing chamber, firing section*. 燒成室、窖室, 燒成室, 燒成室.

**fire roads** (kiln term.), see *fire-ways*. 烟道, 火道, 火道.

**fire-ways** (kiln term.), also *fire roads*. 烟道, 火道, 火道.

**firing entrance** (kiln term.). 投柴口, 焚口, 焚口.

**firing section** (kiln term.), see *fire chamber*. 燒成室、窖室, 燒成室, 燒成室.

**First Emperor’s Jieshi Palace** (site). 碣石宮.

**flame hole** (kiln term.), see *flue hole*. 排煙口.

**flame paths** (kiln term.), see *flue channels*.

**flask with openwork pattern on its body** (form/item). 鏤孔长颈瓶.

**flat kiln** (kiln term.), see *broad-short kiln without oven floor*. 半倒焰窯、饅頭窯, 平窯, 平窯、広短式窯.

**flatdraft kiln / type** (kiln term.), see *long-body kiln without oven floor*. 龙窑、平焰龙窑, 登窯, 登窯、窖窯.

**flatdraft-dragon kiln** (kiln term.), see *long-body kiln without oven floor*. 龙窑、平焰龙窑, 登窯, 登窯、窖窯.

**flatland kiln** (kiln term.), see *broad-short kiln without oven floor*. 饅頭窯、半倒焰窯, 平窯, 平窯、広短式窯.

**flue** (kiln term.), also *smoke-extraction chamber*. 烟道, 煙道, 煙道.

**flue channels** (kiln term.), also *flame paths*. 煙突.

**flue hole** (kiln term.), also *flame hole, smoke outlet, stokehole, vent*. 排煙口.

**fuel section** (kiln term.), see *firebox*. 火膛, 燃燒室, 燃燒室.

**fuel-loading hole** (kiln term.).

**Fujian porcelain** (ware). 福建白磁.

**furnace chamber** (kiln term.), see *firebox*.

**furnace opening** (kiln term.). 窑斗, 焚口, 焚口.

- furnace pit** (kiln term.).
- furnace section** (kiln term.), see *firebox*. 火膛, 燃烧室, 燃烧室.
- Fusheng** (kiln site). 富盛窑址.
- Fushio** (site). 伏尾.
- futatsuki** (form/item). 盞杯.
- Fuyu** (hist. name), see *Buyeo*.
- Gajaeri** (kiln site). 佳才里.
- Gaya** (hist. name), also *Kaya*. 伽耶.
- geometric stamped stoneware** (ware). 印纹硬陶.
- Gimhae** (hist. name), also *Kimhae*. 金海.
- Goguryeo** (hist. name), also *Kokuryo*. 高句丽, 高句麗.
- Göktürks** (hist. name), also *Old Turk*, *Ancient Turk*. 突厥, Гоктүрк.
- Goryeo pottery** (ware), see *Goryeo stoneware*. 高麗土器.
- Goryeo roof tiles** (ware), also *Koryo roof tiles*. 高麗瓦.
- Goryeo stoneware** (ware), also *Goryeo pottery*, *Koryo stoneware / pottery*. 高麗陶器.
- goudiao** (form/item). 句鐃.
- green glazed ware** (ware). 綠釉陶器.
- grid marks** (ornament). 格子目文.
- gui** (form/item). 簋.
- Gundong** (kiln site). 郡洞.
- Gungokri** (kiln site). 郡谷里.
- gusuku** (castle) (term). 城、グスク.
- Gusuku period** (hist. name), also *not*: *Gusuku (site cluster)*. グスク時代.
- Gusuku site cluster** (site), also *not* “*Gusuku period*”. 城久遺跡群.
- Gwisanri** (kiln site). 貴山里.
- Haengamdong** (kiln site). 杏岩洞.
- Haihunhou Liuhe tomb** (site). 海昏侯刘贺墓.
- Haji ware** (ware), also *hajiki*.
- hajiki** (ware), see *Haji ware*. 土師器.
- Hakata Gōshu** (other). 博多綱首.
- Hakata site** (site). 博多遺跡.
- hanging drum seat** (form/item). 悬鼓座.
- Haojing** (site). 锅京.
- hard pottery** (ware). 硬質土器.
- Hashihaka Tomb Mound** (site). 箸墓古墳.
- Hashimuregawa** (site). 橋牟礼川遺跡.
- Hayaagari** (kiln site). 隼上り窯.
- Hayato** (hist. name). 隼人.
- he** (form/item). 盞.
- herringbone patterns** (ornament). 人字纹.
- Higo Province** (hist. name). 肥後国.
- Hishikari district** (hist. name). 菱刈郡.
- Hokubu-ken** (other), see *North Ryūkyū (Islands)*. 北部圈.
- Hokuzan (Chieftdom)** (hist. name). 北山.
- Honam region** (other). 湖南地域.
- Hongshan burial complex** (site), also *Hongshan burials*. 鸿山墓.
- Hoso region** (other). 湖西地域.
- Huangheshan burial complex** (site), also *Huangheshan burials*. 黄鹤山遗址.
- Hui (Ye)** (hist. name). 濊, 葦, 濊, 葦.
- Hui character crisscross pattern** (ornament). 回字交叉纹.
- Hui character pattern** (ornament). 回纹.
- Hui tao** (ware). 灰陶.
- Huoshashan** (kiln site). 火烧山(原始瓷窑址).
- Hwagokri** (kiln site). 花谷里.
- Hwanseongdong** (site). 隍城洞.
- Hwasanri** (site). 花山里.
- Hyūga Province** (hist. name). 日向国.
- Ichisuka No 2 kiln** (kiln site). 一須賀2号窯.
- inclined kiln** (kiln term.), see *long-body kiln without oven floor*. 龙窑、平焰龙窑, 登窯, 登窯、窖窯.
- inkstone (made of various materials)** (form/item), also *suzuri*. 硯.
- Isamēbaru No. 1** (site). 伊佐前原第一遺跡.
- Itazuke type pottery** (ware). 板付式土器.
- Ivolga fortress** (site). Иволгинское городище.
- Iyashiki** (kiln site). 居屋敷窯.
- Izumi Mountains** (other). 和泉丘陵.
- jar** (form/item), also *tsubo*. 壺.
- jar coffin** (term). 甕棺.
- jar with a folding rim** (form/item). 折沿罐.
- Jeongamri** (site). 亭岩里.
- jian** (form/item). 鉴.
- jiguan jar** (form/item). 鸡冠壺.
- Jingdezhen** (kiln site).
- Jinhan** (hist. name), also *Chinhan*. 辰韩, 辰韓.
- Jinjukri** (kiln site). 眞竹里.
- Jinshan** (kiln site). 禁山.
- jitui bottle** (form/item). 鸡腿瓶.
- jūban bōeki** (term). 住蕃貿易.
- jugou bell** (form/item), also *Pinyin “judiao”*. 句鐃.
- Jurchen** (hist. name). 女真, Зүрчид.
- kame** (form/item), see *pot*.
- Kamuiyaki** (kiln site). カムイヤキ遺跡.
- Kamuiyaki** (site, ware), see *Kamuiyaki kiln site cluster*, *Kamuiyaki stoneware*. カムイヤキ.
- Kamuiyaki kiln site cluster** (kiln site), also *Kamuiyaki*. カムイヤキ窯跡群、カムイヤキ陶器窯跡.
- Kamuiyaki stoneware** (ware), also *Kamuiyaki*, *Kamuiyaki ware*, *deprecated*: *rui-sueki* Quasi Sueki. カムイヤキ、カムイヤキ陶器.
- Kanna Yūagimō** (kiln site). 漢名ユアギモー遺跡.
- Kawachi** (hist. name). 河内.
- Kawaminetsuji** (site). 川嶺辻.
- Kenpuku Iyakawa** (site). 検福イヤ川.
- Kenpuku Utta** (site). 検福ウッタ.
- Khar bukh Castle** (site). Хар бухын балгас.
- Khitans** (hist. name). 契丹, Кидан.
- Khustyn Bulag** (site). Хустын Булаг.
- kiln complex** (kiln term.).
- kiln furniture** (kiln term.). 窑具, 窑道具, 窑道具.
- kiln site** (kiln term.), also (*kiln site center*). 窑址, 窑址, 窑跡.
- kiln site center** (kiln term.), also *kiln site cluster*, *kiln site group*. 窑址群, 窑址群, 窑跡群.
- kiln site cluster** (kiln term.), see *kiln site center*. 窑跡群.
- kiln site group** (kiln term.), see *kiln site center*. 窑跡群.
- kiln wall** (kiln term.), also *not*: *kiln ceiling*. 窑壁.
- kiln waste products** (kiln term.), also *spoilage*.
- kiln with oven floor** (kiln term.), also *updraft kiln*, *bottle oven floor*, *oven-floor kiln*.

**kiln without oven floor** (kiln term.), see *broad-short kiln and long-body kiln without oven floor*. 饅頭窯、半倒焰窯, 平窯, 平窯、広短式窯.

**kiln's rear (section)** (kiln term.). 窯尻.

**Kita Urayama A kiln** (kiln site). 北浦山A窯.

**Kizu River** (other). 木津川.

**Kofun period** (term). 古墳時代.

**Kokubunji** (hist. name), see *Provincial temple*.

**Konakabaru** (site). 小中原遺跡.

**Korean Three Kingdom period (KTKP)** (term). 三國時代.

**Korsakovskoe-2** (site). Корсаковское-2.

**Koryo roof tiles** (ware), see *Goryeo roof tiles*.

**kōtō** (term). 高島.

**Kraskino walled settlement** (site), also *Kraskino walled town*. 克拉斯基諾城址, Краскинское городище.

**Krasnyi Yar walled settlement** (site), also *Krasny Yar walled settlement, Krasny Yar walled town*. 克拉斯諾雅羅夫斯科耶城址, Краснояровское городище.

**Krounovskaya (culture)** (other). кроуновская.

**Kuaiji** (hist. name). 会稽.

**Kumejima** (other). 久米島.

**Kyūhōji-Nagahara** (site). 久宝寺・長原遺跡.

**Langya** (hist. name). 琅邪.

**Langye** (hist. name), see *Langya*.

**Laofendun tomb** (site). 老墳墩墓.

**Laohudun DI tomb** (site). 老虎敦.

**Lazovskoe walled settlement** (site), also *Lazovskoe walled town*. 拉佐夫ское городище.

**lei vessel** (form/item). 罍.

**Lelang commandery** (hist. name), also *Lolang*. 乐浪郡, 樂浪郡, 樂浪郡.

**Lianshan tomb** (site). 梁山墓.

**Lijiayao** (kiln site). 李家窑.

**Liu Bang** (hist. name). 刘邦.

**Liulongzui village** (kiln site). 流龙咀村.

**long chamber kiln** (kiln term.), see *long-body kiln without oven floor*. 龙窑、平焰龙窑, 登窯, 登窯、窖窯.

**long kiln** (kiln term.), see *long-body kiln without oven floor*. 龙窑、平焰龙窑, 登窯, 登窯、窖窯.

**long-body kiln without oven floor** (kiln term.), also *flatdraft kiln, flatdraft dragon kiln, long chamber kiln, barrel-vault type, oval type, dragon kiln, climbing kiln, anagama, sloping tunneled kiln, flatdraft kiln, inclined kiln, narrow-long kiln, semi-downdraft kiln, tunneled kiln, sloping kiln,...* 龙窑、平焰龙窑, 登窯, 登窯、窖窯.

**Longquanwu** (kiln site). 龙泉务窑.

**Lushanmao** (site). 蘆山峯.

**Maeatari** (site). 前当り遺跡.

**Maeseongri** (kiln site). 梅城里.

**Mahan** (hist. name). 马韩, 馬韓, 馬韓.

**Mahan-Baekje** (hist. name). 馬韓(百濟時代).

**Malaya Podushechka** (site). 小ала Подушечка.

**Mangdeok tumulus** (site). 望德古墳.

**Mangseongri** (kiln site). 望星里.

**mantou kiln** (kiln term.), see *broad-short kiln with oven floor*; also *steamed bun type, (horseshoe shaped kiln)*. 饅頭窯、半倒焰窯, 平窯, 平窯、広短式窯.

**Maowanli** (kiln site). 茅湾里窑址.

**mat pattern** (ornament). 席纹.

**Matsubara** (site). 松原遺跡.

**Meihuadun** (kiln site). 梅花墩窑.

**mi character pattern** (ornament). 米字纹.

**mingqi** (other). 明器.

**Mintsuki** (site). ミンツイキ遺跡.

**Mitani-Saburoike** (kiln site). 三谷三郎池窯.

**Modu Chanyu** (hist. name). 冒頓單于, Модун шаньюй.

**Mokhe** (hist. name). 摩訶.

**Mongchon fortress** (site). 夢村土城.

**Mottaimatsu** (site). 持躰松遺跡.

**Mozu tombs group** (site). 百舌鳥古墳群.

**Mujang-ni** (kiln site), see *Mujangri*.

**Mujangri** (kiln site), also *Mujang-ni*. 舞将里窯址.

**multi-chambered climbing kilns** (kiln term.), see *semi-downdraft continuous chamber kiln*. 連房式登窯.

**Muromachi Period** (term). 室町時代.

**Muyangcheng** (site). 牧羊城.

**Myosari** (site). 苗沙里.

**Nakabaru type pottery** (ware). 仲原式土器.

**Nakadake** (kiln site), see *Nakadake Sanroku*.

**Nakadake Sanroku** (kiln site), also *Nakadake*. 中岳山麓窯跡群.

**Nakijin type** (ware). 今帰仁タイプ.

**Nanbu-ken** (other), see *South Ryūkyū (Islands)*. 南部圈.

**Nanshan** (kiln site). 南山窑址.

**Nanzan (chiefdom)** (hist. name). 南山.

**Narikawa pottery** (ware). 成川式土器.

**narrow-long kiln** (kiln term.), see *long-body kiln without oven floor*. 龙窑、平焰龙窑, 登窯, 登窯、窖窯.

**Naseongri** (site). 羅城里.

**Neungsanri-saji** (site), also *Nynsanri-sachzhi*. 陵山里寺址, Нынсанри-сачжи.

**niaoshu** (ornament). 鸟书.

**Nigushan** (kiln site). 尼姑山窑址.

**Nikolaevka walled settlement** (site), also *Nikolaevka walled town*. 尼古拉耶夫ское городище.

**noborigama** (kiln term.), see *continuous chamber climbing kiln*. 登窯.

**North Ryūkyū (Islands)** (other), also *Hokubu-ken*. 琉球列島北部.

**Novyi Mir** (site), also *Novy Mir*. Новый Мир.

**Nuekdo** (site). 勒島.

**Nynsanri-sachzhi** (site), see *Neungsanri-saji*.

**Obadera site** (site). 大庭遺跡.

**Ogura pond** (other). 巨椋池.

**Okano** (kiln site). 岡野窯跡群.

**Oksandong** (site). 玉山洞.

**Okugatani** (kiln site). 奥ヶ谷窯.

**Omonawa** (other). 面縄.

**Oryangdong** (site). 五良洞.

**Ōsumi Province** (hist. name). 大隅国.

**oval type** (kiln term.), see *kiln without oven floor*.

**oven floor** (kiln term.), also (*Partition between firing and combustion sections*).

**oven-floor kiln** (kiln term.), see *kiln with oven floor*.

**Paleometal period** (other). период палеометалла.

**Piaoshan** (kiln site). 瓢山窑遗址.

**piled-stone mounded tombs** (term). 积石塚, 積石塚, 積石塚.

- pillar for dividing flame** (kiln term.), also *bunen chū*. 分焰柱.
- pit kiln** (kiln term.), see *pit-type kiln*.
- pit-type kiln** (kiln term.), also *primitive kiln*, *pit kiln*.
- porcelain** (ware). 瓷器, 磁器, 磁器.
- porcelain clay** (other). 瓷土, 磁土, 磁土.
- pot** (form/item), also *kame*. 甕.
- pot supporter** (kiln term.), also *conical support bead*, *stand*; not: *spacer*. 窑具、托珠, 도지미, 焼き台、トチン.
- potter's wheel** (term).
- pottery** (ware). 土器(龍山土器), 土器(無文土器、粘土帶土器、軟質土器、硬質土器、瓦質土器), 土器(縄文土器、弥生土器、土師器).
- pottery supports** (kiln term.), see *stand*. 窑具、托珠, 도지미, 焼き台、トチン.
- Pre-State period** (other). предгосударственный период (among others).
- primitive kiln** (kiln term.), see *pit-type kiln*.
- Primor'e** (other), also *Primorye*, *Southern/Maritime Region of the Russian Far East*. Приморье, Приморский край.
- Primorye** (hist. name), see *Primor'e*.
- proto porcelain** (ware), see *Proto-porcelain*.
- Proto Three Kingdom period (P-TKP)** (term). 原三國時代.
- proto-celadon** (ware). 原始青瓷.
- proto-porcelain** (ware), also *Proto porcelain*. 原始瓷器.
- Provincial temple** (hist. name), also *Kokubunji*. 国分寺.
- Pungnap fortress** (site). 風納土城.
- Qianshan** (kiln site), see *Xiaoshan Qianshan*. 前山窯址.
- Qiaozhen** (site). 桥镇.
- Qiu Chuji** (hist. name). 丘处机丘長春.
- Qiuchengdun tomb** (site). 邱承墩墓.
- Qizhen** (site). 齐镇村.
- Raozhou castle** (site). 饶州城.
- rhombic cloudscapes** (ornament). 菱形状云雷纹.
- rice sieve pattern** (ornament). 米筛纹.
- Ritsuryō system** (term). 律令制.
- rui-sueki** (ware), see *Kamuiyaki stoneware*, deprecated: *Sueki-like ware*, *Quasi Sueki*. 類須惠器.
- Russian Far East (Southern)** (other), see *Primor'e*.
- Sagariyama** (kiln site), also *Sagariyama kiln*. 下り山窯跡群.
- Samgyedong** (kiln site). 三溪洞.
- Samryongri / Sansuri** (kiln site). 三龍里・山水里.
- Sanjeongdong** (kiln site). 山亭洞.
- Sansuri** (kiln site). 山水里.
- Satsuma Kokubunji** (hist. name, site), see *Satsuma Provincial Temple*.
- Satsuma Province** (hist. name). 薩摩国.
- Satsuma Provincial Temple** (hist. name, site), also *Satsuma Kokubunji*. 薩摩国分寺.
- semi underground** (kiln term.), see *semi-sunken type*.
- semi underground type** (kiln term.), also *semi-sunken type*.
- semi-downdraft continuous chamber kiln** (kiln term.), also *multi-chambered climbing kilns*.
- semi-downdraft kiln / type** (kiln term.), see *broad-short kiln without oven floor*. 饅頭窯、半倒焰窯, 平窯, 平窯、広短式窯.
- semi-sunken type** (kiln term.), also *semi underground type*, *ceiling-structured type*. 半地下式.
- semi-underground type** (kiln term.), see *semi-sunken type*. 半地下式.
- Seokchondong** (site). 石村洞.
- Seokjangri iron-making site** (site). 石帳里製鐵遺蹟.
- Seongokdong** (site). 孫谷洞.
- Sergeevka** (kiln site). Сергеевка.
- Settsu** (other).
- Shaiga walled settlement** (site), also *Shaiga walled town*. 赛加城址, Шайгинское городище.
- Shangjiao village** (kiln site). 上焦村.
- Shangjing** (hist. name). 上京.
- Shangjing Longquanfu** (hist. name). 上京龙泉府.
- Shangyu** (kiln site). 上虞.
- shell bracelet** (form/item). 貝輪.
- Shibahara** (site). 芝原遺跡.
- Shimoshoji** (site). 下小路遺跡.
- Shitomiyakita** (site). 部屋北遺跡.
- side-hole kiln** (kiln term.).
- Silla** (hist. name), also *Shilla*. 新罗, 新羅.
- Singyeom** (site). 新今.
- sinker-shaped pottery** (form/item). 网坠形器.
- slope type without steps** (kiln term.), see *long-body kiln without oven floor*. 無段式登窯.
- sloping kiln** (kiln term.), see *long-body kiln without oven floor*; also *climbing kiln*.
- Small Gaya** (hist. name). 小伽耶.
- smoke extraction chamber** (kiln term.), see *flue*.
- smoke outlet** (kiln term.), see *flue hole*.
- soft pottery** (ware). 软陶.
- Solnechnyi Bereg** (site), also *Solnechny Bereg*. Солнечный Берег.
- Songokdong-Mulcheonri** (kiln site). 孫谷洞・勿川里.
- South Ryūkyū (Islands)** (other), also *Nanbu-ken*. 琉球列島南部.
- spacers** (kiln term.), see *pot supports*. 間隔具.
- spoilage** (kiln term.), see *kiln waste products*.
- stamped hard pottery** (ware). 印纹硬陶.
- steamed bun type kiln** (kiln term.), see *mantou kiln*.
- stokehole** (kiln term.), see *flue hole*. 焚口.
- stoneware** (ware). 硬陶, 陶質土器, 炆器, 須惠器、緑釉陶器、灰釉陶器.
- sudajii** (other). すだ椎.
- Sue ware** (ware), also *sueki*. 須惠器.
- sueki** (ware), see *Sue ware*.
- Suemura kilns** (kiln site). 陶邑窯.
- suichū** (form/item), see *water ewer*.
- Suita** (kiln site). 吹田窯.
- sunken type** (kiln term.), also *underground type*, *dugout type*.
- surface type** (kiln term.), also *wall-ceiling structured type*, *ceiling-structured type*.
- suzuri** (form/item), see *inkstone*.
- symmetrical arc patterns** (ornament). 对称弧形纹.
- Takahashi shellmound** (site), see *Takahashi site*. 高橋貝塚.



**Takahashi site** (site), also *Takahashi shellmound*. 高橋遺跡.  
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The start of ceramic industry is an important stage in mass production and is closely related to social complexity and social exchanges including the immigration of specialists. The introduction of high-temperature operations and varying firing regimes is a technological breakthrough in ceramic production. This book discusses the introduction and the background of kilns and advanced technology in the wider area of East Asia, covering the early appearances of the typical East Asian kiln technology in China, and its distribution to the Russian Far East, the Korean peninsula, and the central Japanese archipelago. Using both scientific and archaeological analysis, this book tries to help better understand the introduction factors of kilns, management of kilns by each regime, and the development of technology. An extensive glossary at the end of the book orientates readers not familiar with research in East Asia or languages referenced in this book.

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