REVIEWING THE KILNS AND STONEWARE CERAMICS OF ANGKOR

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ABSTRACT

This study reviews selected literature on Angkorian stoneware ceramics and kilns within the present day borders of Cambodia. Despite the relative youth of Angkorian ceramic and kiln research, this field of study has grown exponentially in the last decade as more kiln and ceramic sites have been found and excavated. As research is conducted at the various sites, new information is produced and interesting avenues of research have been pursued. The purpose of this thesis is to summarize previous research on Angkorian stoneware ceramics, and discuss key debates, issues, and future research paths.

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CHAPTER 1. INTRODUCTION

Research on ceramics provides archaeologists with possible insights into aspects of the past such as the sociocultural or economic development of complex societies. In archaeological studies, research on ceramics and kilns is useful for investigating chronology, technology, inter-site relationships such as trade, and variations in habits such as aesthetic tastes and conscious choice (Orton et al. 1997:23-35). Ceramics are increasingly important to researchers due to the long histories and the occurrences of ceramic sherds in most societies worldwide. Of the multiple ceramic traditions that arose across mainland Southeast Asia, the Angkorian stoneware ceramic industry emerging in the ninth-century is particularly interesting. The field of Angkorian ceramic studies is still relatively young, but is rapidly developing as sites are discovered.

This thesis examines selected previous research in the field of Angkorian ceramics and kiln studies. The cultural influence of Angkor extends beyond the present-day borders of Cambodia. Angkorian ceramic and kiln sites exist outside of present-day Cambodia, primarily in northeast Thailand, and will be discussed briefly. However, the main focus will be on sites situated within Cambodia with most sites located in or surrounding the Angkor Archaeological Park in Siem Reap Province but also in other Cambodian provinces. The main provinces of concern are Siem Reap, Banteay Menchey, Oddar Meanchey, and Kandal provinces in Cambodia and Buriram, Surin, Sisaket, and Nakhon Ratchasima provinces in Thailand (see Figure 1). The literature is reviewed to present an overview of research that has been undertaken, key debates and issues, and possible future directions within Angkorian ceramic studies. A brief summary of the history of research on Angkorian ceramics and kilns is provided before key research areas are discussed. The central research themes and issues of this thesis include technological origin theories, chronology, typology, and the organization of production and distribution networks. Finally, potential research directions are suggested for future investigations.

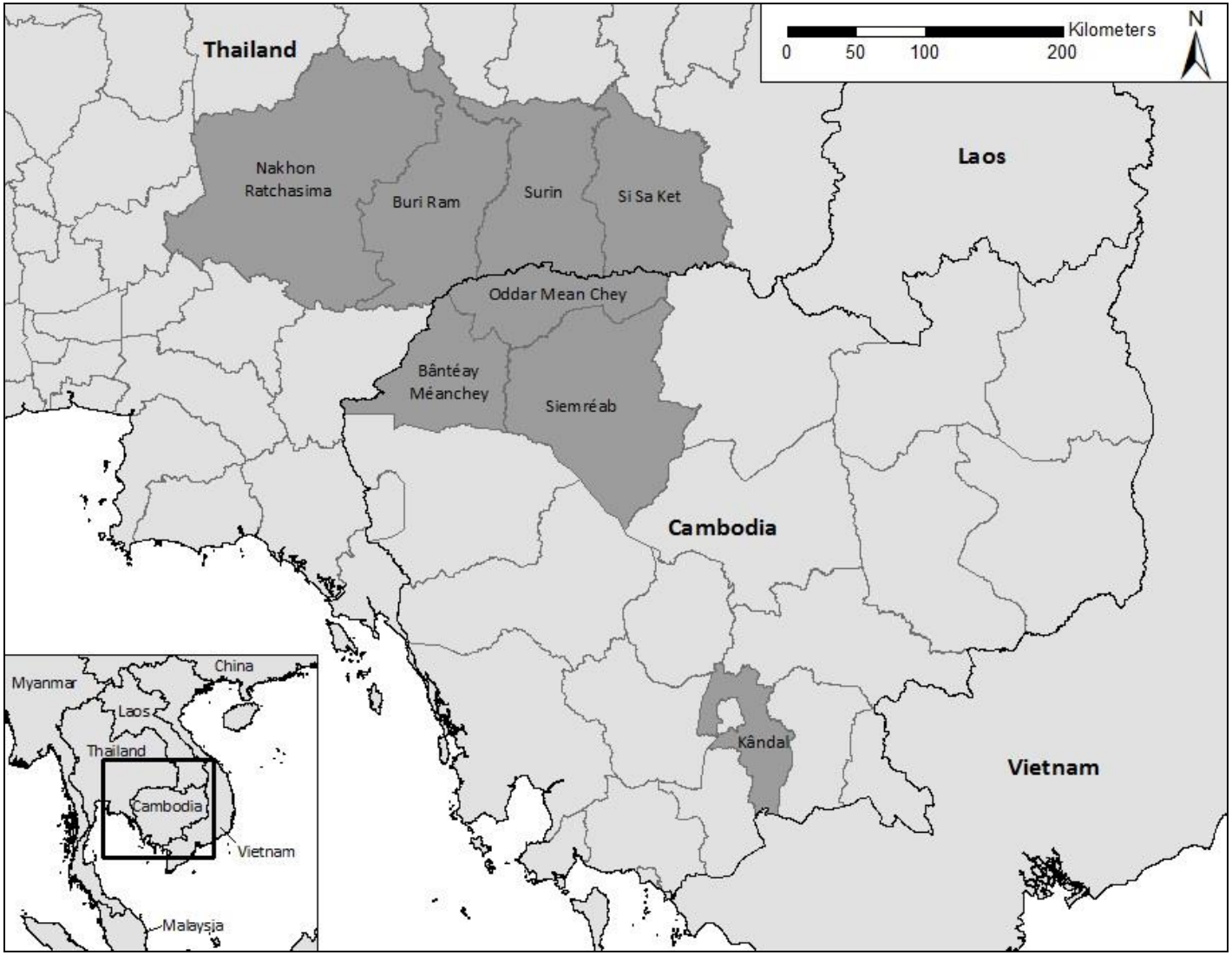


Figure 1. Map of relevant provinces in Cambodia and northeast Thailand.

Research Questions and Orientation

Several research questions have guided the development of this work:

1) What kind of research has been conducted on Angkorian stoneware ceramics and kilns?
2) What are the key debates, themes, and theories in the field of Angkorian stoneware ceramics and kilns?
3) What are the unresolved issues in the field?
4) What are some possible future directions that the field could take?

As this thesis represents a general overview of the field based on selected research, these key research questions are deliberately broad to allow for the synthesis of information from the various research studies in relation to each other. Ideally, a complete overview of Angkorian ceramics would involve both earthenware ceramics and stoneware ceramics. However, such a task is beyond the scope of this project. While earthenware is an important and long-lasting ceramic tradition that is visible in Southeast Asia, the focus of this thesis is on the high-fired stoneware of Angkor. This thesis specifically narrows the topic to discuss Angkorian stoneware ceramics and the associated kilns. In particular, the focus is on glazed Angkorian stoneware ceramic vessels that span the entire Angkorian period, from approximately the ninth to the fifteenth centuries, excluding architectural stoneware ceramics. As such, this work should not be regarded as a comprehensive overview of Angkorian ceramics, or stoneware, but as a glimpse into the development and progress of the field.

Organization of Chapters

The remainder of this chapter provides a brief summary of each section within this thesis and presents some initial background to the project including the preferences in terminology. The key research questions that directed the study and limitations are noted in a general sense.

Chapter 2 provides an introduction to the general history of stoneware ceramics in mainland Southeast Asia. This chapter includes brief discussions of the general time

periods of four mainland Southeast Asian stoneware ceramic traditions – Vietnam, Thailand, Laos, and Myanmar – with the recognition that such borders do not necessarily correspond to the geographic distribution of distinct historical ceramic traditions. The purpose of this chapter is to provide a general context for the information in Chapter 3.

Chapter 3 presents a selective history of research that has been conducted on Angkorian ceramics and kilns. The history of scholarship is divided into two major sections: an overview of Angkorian stoneware ceramics studies and an overview of research conducted on Angkorian kilns. The overview of Angkorian ceramic studies utilizes selected published research conducted on archaeologically provenienced and unprovenienced collections and the central research themes that occur in these works. The overview of Angkorian stoneware kiln sites discusses the history of research projects and the geographic variability that characterizes the central findings of the studies.

Chapter 4 discusses the theories regarding the origins of Angkorian kilns and stoneware ceramic technology. Theories regarding the origins and transmission of technology into Southeast Asia have been and continue to be an issue that is debated among scholars (Brown 1988; Cort 2000; Groslier 1981; Guy 1997; Hein 2008, 2011; Rooney 1984; Tabata 2008; Wong 2010). As more sites are located and excavated in Cambodia and the surrounding region, researchers have been able to refine their original hypotheses by comparing the Angkorian kiln and stoneware ceramic industry with those found in neighboring regions, notably in Thailand, Myanmar, Vietnam, and Laos. Much of the current research suggests a Chinese origin for kiln technology and ceramic techniques (Brown 1988; Cort 2000; Groslier 1981; Guy 1997; Hein 2008, 2011; Rooney 1984; Wong 2010). However, there are scholars who discuss possible Indian origins and others who argue for an indigenous tradition (Groslier 1981; Guy 1997; Selvakumar 2011; Sok 2009; Tabata 2008). The debate continues but many scholars favor the Chinese origin theory.

Chapter 5 explores the key debates and issues in Angkorian ceramic studies. This chapter presents central research themes and issues in Angkorian stoneware research such

as chronology, classification, and organization. Groslier's chronology and changes made by other scholars are discussed. In the section about classification, a system constructed on combining archaeology and linguistics is described. The final theme of organization deals with the organization of production and distribution in Angkor based on new brown ware kiln and ceramic data.

Chapter 6 summarizes and discusses the findings in Chapters 3, 4, and 5. Additionally, this chapter suggests future directions for studies of Angkorian stonewares and kilns. For the most part, excellent research has been and is currently being conducted in the Angkor region and the field is growing rapidly as scholars conduct fieldwork and publish. However, it would be beneficial to the field of Angkorian ceramics and kilns for scholars to address the issues raised in Chapter 5 in the immediate future. This will allow scholars to further refine the Angkorian ceramics chronology and answer questions regarding the social and political organization of craft specialization in Angkor.

Terminology

In the field of Southeast Asian ceramics, many terms are used variably according to the preference of the scholar conducting the research. This inconsistent usage of terminology is seen throughout the publications on Southeast Asian ceramics, including discussions of ceramics from the Angkor region. The various terms are problematic unless first clarified. Below are the basic terms as they are used within this thesis.

In many of the early publications on ceramics within the sphere of Angkorian cultural and political influence, the ceramics are typically discussed as 'Khmer ceramics.' Associating artifacts such as ceramics with a specific race or ethnicity can be difficult. The borders of Southeast Asian polities were fluid until the twentieth century, remaining unresolved in remote areas, and many ethnicities probably inhabited the Angkorian culture area. Research identifies kiln and ceramic sites located in several areas within present day Thailand, Laos, and Vietnam that were once under the influence of the Angkor Empire (Brown 1981, 1988; Brown et al. 1974; Childress and Brown 1978;

Cort 2000; Cort and Lefferts 2000; Cort et al. 2008; Ea 2010; Frasché 1976; Guy 1989; Miksic 2009; Rooney 1984; Wong 2010). Furthermore, the term "Khmer ceramics" is sometimes used to encompass all types of ceramics including earthenware whereas the focus of this thesis is limited to the glazed stoneware vessels produced during the Angkorian period from the ninth to the fifteenth century. Therefore, in this thesis, instead of 'Khmer', the term 'Angkorian' is used to indicate the past peoples and cultures that existed within the fluid borders of the Angkor Empire.

The term 'ceramics' here applies to all fired clay objects regardless of firing temperature or the presence of glaze; this includes earthenware, stoneware, and foreign tradeware. The specific classification of wares, for example earthenware and stoneware, is based on the body material and the firing temperature. 'Earthenware' is unvitrified, usually unglazed, and low-fired at around 900 – 1100 °C (Rice 1987:5). The texture of earthenware is course and porous and is relatively simple to produce. "Stoneware" is considered the next stage in clay and firing technology. Stoneware ceramics can be glazed or unglazed and are fired at high temperatures ranging from 1,200 – 1,350 °C, creating a more durable, harder, and less porous product (Rice 1987:6). In the case of Angkorian stoneware, some scholars also differentiate between low-fired stoneware and high-fired stoneware. The major qualifying characteristics between the two, without scientific testing, are the perceived hardness of the stoneware and the sound it makes when tapped. This distinction is subjective and is not used within this thesis. Additionally, the term "Angkorian ceramics" refers to glazed Angkorian stoneware ceramics unless otherwise stated.

The most common terms used in regards to glazed Angkorian stoneware ceramics are 'green ware' and 'brown ware.' 'Green ware' describes glazed stoneware ceramics upon which the color of the glaze ranges from a pale straw color to a dark green hue. 'Brown ware' refers to glazed stoneware ceramics with a brown glaze ranging from a pale brownish-golden color to a dark, almost black, brown. Both these terms are used in conjunction with the terms "Buriram" and 'Angkor' which indicate the areas associated with the ceramics. For example, 'Buriram brown' ware means that the identifying

morphological features suggest a connection to the Buriram area in present-day Thailand. The characteristics and ranges of the glazes are described in more detail in Chapter 4.

CHAPTER 2. HISTORY OF STONEWARE CERAMICS IN MAINLAND SOUTHEAST ASIA

Southeast Asia's borders are a recent construct and the archaeological cultures of Southeast Asia tend to transcend these nationalistic lines. This chapter briefly mentions relevant sites and related work conducted within other countries in the region. For example, the political and cultural influence of Angkor extended well beyond the borders of present-day Cambodia. Angkorian sites are found within the borders of neighboring countries such as Thailand, Vietnam and Laos (Brown 1981, 1988; Brown et al. 1974; Childress and Brown 1978; Cort 2000; Cort and Lefferts 2000; Cort et al. 2008; Ea 2010; Frasché 1976; Guy 1989; Miksic 2009; Rooney 1984; Wong 2010). The wide distribution of sites means that a brief history of Angkorian stoneware ceramics requires that similar material cultures in neighboring countries are considered when conducting any type of research.

The development of ceramics production varies amongst the different polities of Southeast Asia. The historical polities within present-day Thailand, Vietnam, and Cambodia developed advanced ceramic technology through time. The potters of these areas produced a range of ceramic wares including low-fired, unglazed earthenware and both unglazed and glazed high-fired stoneware. In terms of high-fired ceramic technology, the polities within the borders of present-day Vietnam achieved the highest degree of skill at the earliest date (Rooney 1987:3). Rooney suggests that this achievement derived from direct access to Chinese technology (Rooney 1987:3). Apart from Vietnam, the transmission of kiln technology to other parts of the Southeast Asian region is uncertain and it is currently unclear as to when local production of ceramic wares began in these areas. However, within the archaeological context, local production is often seen alongside imported Chinese tradewares from as early as the ninth or tenth century (Frasché 1997; Guy 1989; Miksic 2009; Rooney 1990).

In general, ceramic production in Southeast Asia began with the manufacture of earthenware in the prehistoric period and continues until the present-day. Earthenware production is visible in the archaeological record in every present-day country within the Southeast Asian region. On the other hand, archaeological evidence of stoneware production is limited to a few countries that comprise mainland Southeast Asia – Myanmar, Laos, Vietnam, Thailand, and Cambodia. The earliest glazed stoneware in the region was produced in Vietnam between the first and third centuries, in Cambodia from the ninth to thirteenth centuries, and in Thailand from the tenth to late sixteenth centuries (Brown 1988; Frasché 1997:23-30, 41-53, 95-99; Miksic 2009:50-65). Glazed stoneware was also made in Myanmar and Laos, but the dates and types of production are not clearly defined (Brown 1988:94; Gutman 2002; Miksic 2009:65-68).

Stoneware research in Laos is sparse since very little research has been conducted. Seven kilns near Vientiane were discovered and excavated in 1970 and a cross-draft kiln was discovered in 1989 during excavations at Sisattanak in Vientiane. In addition to the wares found during the excavation of these kilns, radiocarbon dates and Chinese tradeware sherds suggest that the kilns were operational from the early sixteenth century to the seventeenth century (Brown 1988:94; Hein et al.1992). Besides these sites, stoneware jars and bowls have been excavated from Ban Tao Hai, a kiln site in Laos (Rooney 1987:10).

As with Laos, Myanmar is not typically associated with a vigorous stoneware ceramic industry despite textual evidence suggesting an early glazed ceramic tradition (Cœdès 1968:104; Guy 1989:5). This perception is due to the limited amount of research that has been conducted and published although the lack of research is being rectified. According to Guy (1989:5), both archaeological and textual evidence suggest a stoneware tradition existed in Myanmar from at least the ninth century. However, based on historical texts, Gutman (2001:109) suggests that the stoneware ceramic tradition began as early as the seventh century and lasted until the eighteenth century. The notable kiln and stoneware ceramic sites in Myanmar are located in Pagan, Pegu and Martaban. Most of the high-fired ceramics from Burma are large glazed stoneware jars called Martaban

jars associated with the Martaban jar trade, architectural ceramics associated with temple architecture, or celadon wares (Brown 1988:99-108; Gutman 2002; Miksic 2009:66-68). Even with the limited excavations conducted in Myanmar, there is evidence of a considerable degree of shared technology between the various Southeast Asian traditions which point to closer links than were first believed (Brown 2004:87, Guy 1989:2). For example, the kilns in lower Myanmar suggest a common technology with the kilns of Thailand while Burmese celadons have been found to resemble Thai ware (Brown 2004:87; Guy 1989:3-4).

In contrast to the relative lack of ceramic and kiln research conducted in Laos and Myanmar, both Vietnam and Thailand were subject to the earliest and most prolific scholarship in mainland Southeast Asia. The transition from low-fired earthenware to high-fired stoneware originated in China in the first millennium BCE (Rooney 1987:9). At some time between the first and third centuries CE, the technology required for producing stoneware reached Vietnam (Miksic 2009:58). The glazed ceramics of Vietnam represent the most sustained, sophisticated, and varied ceramics industry in Southeast Asia. The transition of Vietnamese ceramics from domestic production to international ceramic trade occurred during the fourteenth century coinciding with the restricted export of Ming Dynasty ceramics, prompting what some call "the Ming Gap" (Brown 2004; Miksic 2009:59). Some of the major ceramic production sites included the kilns at Hai Hung, Chu Dau, Bat Trang, Tho Ha, Binh Dinh, Phuc Yen, Vinh Yen, Bac Ninh, Ha Dong, Quang Binh, and Thanh Hoa (Brown 1977:22-23; Frasché 1976:95-96; Miksic 2009:58-69). Due to the association of the Vietnamese ceramic tradition with the Han Chinese ceramic tradition, the dating of the wares is normally based on Vietnamese dynasties that can be related to the corresponding Chinese dynasty (Brown 1977:8-21; Frasché 1976:96).

The research work conducted in Thailand is extensive and spans more than one tradition. The major traditions are the Angkorian ceramic tradition in the northeast of Thailand and the ceramic traditions located in the north and central parts of Thailand (Brown 1988:41-95; Frasché 1976:41-53; Guy 1997:15-36; Miksic 2009:56-58, 62-65;

Shaw 1989). While glazed and unglazed stoneware was produced in northeast Thailand by the tenth century, the ceramic traditions of both the north and central parts of Thailand began production of glazed stoneware ceramics around the early thirteenth century (Brown 1988:85-86; Miksic 2009:62-64; Rooney 1986, 1987:9; Shaw 1987).

The major central Thai sites were Sisatchanalai (also known as Sawankhalok) and Sukothai. As with Vietnam, both of these ceramic production centers were part of a thriving export market during the fourteenth and fifteenth centuries when the Ming Dynasty placed a restriction on Chinese ceramic exports (Brown 2004; Guy 1989:30; Miksic 2009:62-63). Apart from glazed stonewares, these kilns also produced glazed architectural ceramics. Other kiln and ceramic sites in the area include Phitsanulok, Singburi, and Suphanburi. In the north, there are several kiln sites located between Chiangmai and Chiangrai. The sites in this area are primarily thirteenth to fifteenth century kiln sites such as Kalong, San Kampaeng, and Phan (Brown 1988: 85-86; Miksic 2009:64-65; Rooney 1986, 1987:10; Shaw 1987). The majority of Angkorian kiln research has been conducted in northeast Thailand as compared to Cambodia due to accessibility and a less volatile civil history. Along with the ceramic history of Angkorian kiln and ceramic sites in Cambodia, the Angkorian kiln sites located in northeast Thailand are discussed in more detail in Chapter 3.

CHAPTER 3. HISTORY OF RESEARCH ON KILNS AND CERAMICS IN CAMBODIA

History of Angkorian Ceramic Scholarship

Ceramics represent a robust cultural material that is ubiquitous and practically indestructible (Orton et al. 1997:32). Ceramics are useful for archaeological purposes because the conditions of preservation are better than most cultural materials – ceramics are rarely repurposed once broken and the sherds do not appeal to looters. Additionally, ceramics are present at all levels of society and are both utilitarian and decorative, providing insights into past human behavior (Rice 1987:24-25). Ceramics are suitable as datable material and as evidence of technological and human movement between societies (Orton et al. 1997:23; Rice 1987:25).

The majority of early works conducted on Angkorian ceramics were based on unprovenienced ceramics located in private collections or museums around the world. While these unprovenienced ceramics are able to add to our knowledge of the ceramics themselves in terms of clay composition, glaze types, and typology, the information gleaned is limited to a small and biased sample. There are fundamental questions about chronology and technology that can only be answered by excavating ceramics *in situ*. For example, ceramics *in situ* can be dated based on the associated stratigraphy. The results of both collections-based and field-based research on ceramics are significant as the information produced is complementary and contributes to a more holistic view of the field. Collections-based research should still continue even as field-based work becomes a major focal point of Angkorian ceramics.

A large portion of research at Angkor focused on the tangible and visible material culture aboveground such as the temple monuments, *bas reliefs*, and sculptures rather than on the cultural deposits belowground. Past conflicts and the surplus of those conflicts, such as landmines, rendered both close and remote locations inaccessible, thus restricting the identification and study of sites. Although ceramic sherds have been found at numerous sites, the study of Angkorian ceramics has only gained prominence within

the last three decades as previously inaccessible areas in Cambodia open up and researchers are able to conduct more archaeological excavations at household and kiln sites.

In 1883, Etienne Aymonier suggested the presence of kilns on Phnom Kulen, 40 km northeast of Angkor, based on ceramic sherds observed during surface surveys (Aymonier 1901:414). However, ceramics and kilns were not a main topic of research until almost a century later. In 1981, an exhibition of Angkorian ceramics in Singapore, organized by the Southeast Asian Ceramic Society, encouraged scholars who worked with or were interested in Angkorian ceramics to consolidate their research into one publication entitled *Khmer Ceramics 9th to 14th Century* (Stock 1981). This publication set in motion the study of Angkorian ceramics. At this point, only a few scholars studied Angkorian ceramics. Of these researchers, the most prominent was Bernard Philippe Groslier, who contributed to the 1981 publication with an article that detailed his thoughts and ideas on ceramic wares in Angkor.

Groslier was a French curator of Conservation d'Angkor (Angkor Conservation Office) who had conducted excavations on pre-Angkorian and Angkorian sites within Cambodian borders. In particular, Groslier excavated at the temples of Sambor Prei Kuk, the Royal Palace of Angkor Thom, and Srah Srang, the only cemetery excavation in Angkor. Groslier found many Angkorian ceramic sherds and complete pots at these sites. Groslier compiled a chronology of Angkorian ceramics based on the ceramics from his excavations at Angkor Thom and Srah Srang in what is now known as the Angkor Archaeological Park and at the pre-Angkorian site of Sambor Prei Kuk near Kampong Thom. The chronology, also based on the consecration dates of temples given in associated inscriptions, was divided into time periods based on architectural style and related to the Angkorian rulers of those time periods. Groslier's chronology is accurate and is still referenced today. Researchers continue to refine the chronology based on their findings but the overall categories and time periods do not change significantly. The chronology and changes are discussed in more detail in Chapter 5.

There are several other formative publications that are pivotal to the field of Angkorian ceramics and still referenced to this day. Many of these publications represent early research on unprovenienced collections in museums or private collections around the world. Roxanna Brown published many articles and several about Southeast Asian ceramics. Brown (1981) discusses her findings regarding the Angkorian ceramic and kiln sites on the Korat Plateau in Thailand, including Ban Kruat and Prasat Ban Phluang. This article was largely based on Brown's previous research work in the Korat Plateau, including the co-authored article with Vance Childress (Childress and Brown 1978) on the Angkorian ceramics at Prasat Ban Phluang. The sites that Brown discusses in her articles are in the northeastern provinces of Buriram and Surin in present-day Thailand, about 250 km northwest of the central Angkorian region located in Siem Reap, Cambodia. During the restoration of Prasat Ban Phluang, a late tenth to early eleventh century temple in Surin Province, Thailand, 4,000 pottery fragments representing at least 270 individual vessels were found. The fragments that could not be defined into articulate shapes represent a possible additional 126 individual vessels. These wares are reportedly similar to the wares in Ban Kruat, Buriram province, about 35 km southwest of the provincial capital of Surin. The wares were mainly unglazed earthenware, unglazed stoneware and glazed stoneware. At the time of discovery, Prasat Ban Phluang yielded the most sherds found at one temple. Childress and Brown (1978:73) suggested that the poor quality and limited forms of the ceramic wares at Prasat Ban Phluang meant that the wares were specifically for temple use.

Dawn Rooney, another prominent scholar of Southeast Asian ceramics, produced several works based on unprovenienced collections. As with Groslier and Brown, Rooney contributed to the 1981 publication with an article that discussed the ceramic forms and uses. Subsequently, Rooney (1984) wrote the first comprehensive publication of Angkorian ceramics. This book provides a background to the research area and topic before investigating the different characteristics, shapes, and uses of Angkorian ceramics based on private and public collections in Asia, Australia, Canada, Europe, the United Kingdom and the United States. Rooney (1987) also produced a quick and basic introduction to the development and use of folk pottery in Southeast Asia that links

contemporary utilitarian ceramic wares with the pre-historic and historic ceramic wares of mainland Southeast Asia. Here, Rooney introduces lesser known ceramic types found in Southeast Asia and includes commonly found imported wares from China and Japan. Rooney (1990:1-18) wrote the introduction for the publication by Hiroshi Fujiwara (Fujiwara 1990) that briefly discusses the types of wares, shapes and characteristics of Angkorian stoneware, the issues with dating the wares, and the cultural influences that are deduced from the shapes and forms of the various stoneware. Rooney wrote the introduction to another publication (Honda and Shimazu 1997) based on the private Southeast Asian ceramic collection of Honda and Shimazu which was first published in Japanese by the authors in 1995. Rooney's more recent work (2010) is a book on Angkorian ceramics in a private Thai collection and includes several essays on Angkorian ceramics by Thai scholars. The book is a descriptive catalogue of an extensive collection that spans several time periods and forms.

A key publication from the 1990s is John Guy's 1997 article. This article (Guy 1997) discusses his views on the origins of Angkorian ceramics, reviews the repertoire of Angkorian wares produced, and examines the architectural and social context in which Angkorian ceramic wares were used. Louise Cort (2000) wrote a catalogue of the Hague Collection that serves as a pivotal reference for Angkorian ceramics because Cort not only describes the wares, but also discusses several themes in the field of Angkorian ceramics such as the dating of Angkorian ceramics, technology, the exchange and trade of Angkorian stoneware, and the extent of influence other cultures had on the development of Angkorian stonewares.

Nora Taylor and Jennifer Foley (1999) published an article on the ceramics in the Ruth B. Sharp Collection of Southeast Asian Ceramics at the Herbert F. Johnson Museum of Art at Cornell University, which includes hundreds of Thai Sawankhalok and Sukothai ceramics, Angkorian lime pots, and tradeware from China and Vietnam. Similar to Childress and Brown's 1978 article, Taylor and Foley discuss the ceremonial use of Angkorian wares during the Angkorian period based on the unchanging shapes and forms of the wares and their association with temple sites. David Rehfuss (2008) published a

review of the Freer Study Collection and its Donors which looked at some 3,300 pot sherds from the Study Collection that are not displayed in the museum gallery. In this work, Rehfuss notes that the quantity of Chinese material fragments found mixed in with local wasters and potsherds is relatively limited in the collection.

Thus far, the works discussed have mainly involved collections. While collections-based research has contributed greatly to the study of Angkorian ceramics, ceramic collections tend to be skewed representations of a ceramic assemblage due to the selective nature of the collector. Often only the best pieces are collected. Even in the case of study collections which should be fairly objective, the methodology for collection is questionable and the ceramics do not have provenience. Findings from collections should be confirmed through other complimentary avenues of research such as systematic, archaeological excavations.

Until the mid-1990s, the only field-based research on ceramics involved Groslier's excavations from the 1970s and 1980s. Currently, researchers are conducting more field-based work involving both ceramics and kilns. This work supplements the collection-based scholarship to create a more holistic view of the field of Angkorian ceramics, allowing researchers to validate or disprove various hypotheses. For instance, in contrast to Rehfuss, the field-based work of Aedeen Cremin, through the University of Sydney's Greater Angkor Project, suggests that a great number of Chinese sherds exist in the archaeological context. Cremin's work contributes to the corpus of work on Angkorian earthenware and Chinese tradeware found in Angkor. Cremin (2006) suggests that Groslier's chronology be revised and extended well into the Yuan period (1260 AD - 1368 AD) based on the new information from the various ceramic and kiln sites that have been discovered and excavated. Cremin's article (2009) presents an overview of ceramics at Angkor and discusses the portrayal of ceramics on temple reliefs from the twelfth and thirteenth century in relation to royal propaganda. Sharon Wong is another scholar who focuses on the connection between the Chinese and Angkorian ceramic industries. Wong's doctoral dissertation (2010) discusses the technological and stylistic connections

between Angkorian stoneware ceramics from the Anlong Thom kiln site in Cambodia and Chinese ceramics from the Guangdong area of China.

Other field-based research includes the work of Armand Desbat from the French National Scientific Research Center (CNRS) and Pierre Bâty of the French salvage team from the National Institute for Research in Preventative Archaeology (or INRAP). Working with the École française d'Extrême-Orient (EFEO) in Siem Reap, Desbat's research involves geochemical composition analysis on the clay of Angkorian stoneware ceramics from excavated kiln and ceramic production sites in the Angkor region (Desbat 2008, 2009, 2010, 2011). Bâty and INRAP report on ceramics excavated from habitation sites in preparation for airport construction (Bâty and Bolle 2005). Research by several Japanese teams contribute to both kiln and ceramic studies, especially the National Research Institute for Cultural Properties, Nara (NRICPN), Sophia University Angkor International Mission, and JAPAN-APSARA Safeguarding Angkor (JASA). These teams of scholars have added immensely to the research on ceramics by expanding the known corpus of ceramic artifacts through excavations in many temple and kiln sites in and surrounding the Angkor Archaeological Park area.

Beyond these international teams and scholars, many local Cambodian researchers have begun research on Angkorian ceramics. The Authority for the Protection and Management of Angkor and the Region of Siem Reap (APSARA) has a dedicated ceramics research team and many scholars such as Ea Darith (2006, 2009, 2010, 2012), Tin Tina (2003), Sok Keo Sovanara (2004, 2009), Chhay Visoth (Chhay et al. 2009), Chap Sopheara (Chhay and Chap 2002), and Chhay Rachna (Chhay et al. 2010, 2013) have all published important works on Angkorian ceramics through BA and MA theses, PhD dissertations, and site reports in the last two decades.

The research conducted by the various teams and individuals shows the evolution and advancement of the research work being conducted in the field of Angkorian kilns and ceramics by proposing hypotheses and discussing the issues and theories about Angkorian kilns and ceramics in addition to describing and cataloging the wares.

Overview of Angkorian Stoneware Kiln Sites

In the past few decades, many kiln sites have been identified and excavated within the area of Angkorian cultural influence. Angkorian ceramics seem to span the entire Angkorian period, from the ninth to the fifteenth century. Additionally, current research indicates that the Angkorian kilns are connected to the territorial expansion of the Angkor Empire. This indicates that the kiln sites and Angkorian ceramics are important components for studying Angkor as a whole. As the field of Angkorian kiln studies is just gaining momentum, many researchers are careful in excavating the various kiln sites in order to make the most of current technologies while also preserving the sites for future excavations with more advanced technologies.

In addition to the collections-based research work on Angkorian ceramics, the improved accessibility due to development and land mine clearing in the 1990s brought about the discovery of many kilns in Cambodia. Unfortunately, the improved accessibility also contributed to looting and destruction at these newly identified sites, and the need to conduct research became even more pressing. While many Angkorian kiln sites have been found and excavated in northeast Thailand since the 1970s , the first Angkorian kiln site in Cambodia to be systematically excavated was the Tani kiln complex (1996 - 2001). The Tani kiln excavation was part of a joint rescue archaeological project conducted by APSARA Authority, the National Research Institute for Cultural Properties, Nara (NRICPN), and Sophia University Angkor International Mission (Aoyagi et al. 1998). With the discovery of multiple kiln sites in the past decade and a half, the excavation of several kiln sites has contributed greatly to the field of Angkorian ceramics. The excavation of the Tani kilns was followed by the excavations of kilns at Khnar Po (2006), Sar Sei (2007), Anlong Thom (2007, 2009), and Bang Kong (2008, 2011) in the first decade of the twenty-first century (Ea 2009:210). The most recent excavations of kiln sites were conducted at Cheung Ek (2012), Torp Chey (2012), Bos Domlong (2013), and Chong Samrong (2013). Through the excavation of these kiln sites and the ceramics contained within and in the vicinity of the kilns, researchers are slowly unraveling the mysteries of Angkorian kiln and ceramic technology. With an

article on the ceramic kiln lineages of mainland Southeast Asia), Don Hein (2008) has made great progress on the subject of kilns in Southeast Asia, particularly on a regional scale. Nevertheless, as a majority of kiln sites were only recently discovered or excavated, the provenienced and unprovenienced collections were and still are an important source of information on Angkorian ceramics.

Previous Research on Contemporary Kilns in Thailand

While research on Angkorian kilns in Cambodia has only gained momentum in the last decade or so, research on Angkorian kilns in the northeast of Thailand has been ongoing since the 1970s. In particular, the provinces of Buriram, Surin, Sisaket, and Nakhon Ratchasima have produced hundreds of individual kilns (Natthapatra 1990:230; Fine Arts Department 1989; Tin 2004:19). Buriram, Surin and Sisaket provinces are approximately 250 km northwest of the Angkor Archaeological Park in Siem Reap Province and are located along the present-day Thai-Cambodian border; Nakhon Ratchasima is a province located to the west of Buriram province. These provinces were once part of the ancient Angkor Empire and most are connected to Angkor by ancient roads.

The kilns at Buriram, predominantly brown glaze kilns, were some of the first Angkorian kilns to be excavated and studied by the Fine Arts Department of Thailand (hereafter FAD) (1989); many of the sites were surveyed but not excavated. The few initial sites that were excavated were the Nai Jian and Sawai kilns in Ban Kruat district in 1975 and the Khok Lin Fa kilns in Lahan Sai district in 1984 (Brown 1981:43; Natthapatra 1990; FAD 1989; Rooney 1984:17). While the total number of kiln sites is as yet unknown, there were approximately 164 kilns distributed among 38 kiln sites in eight districts of Buriram province (Natthapatra 1990:230). By the early 1980s the number rose to 200 kiln mounds identified by Thai FAD in Lahan Sai district and in 1986, another official survey by FAD documented 40 kiln mounds in Tanon Noi village, Ban Kruat District (Brown 1988:45).

From the excavations in Ban Kruat, we know that the kilns are located on a large mound and seem to consist of kilns sharing side walls. The kilns typically consist of three parts: the combustion chamber, the firing chamber and a vent system or chimney (Figure 2). The majority of ceramics produced in this area are similar in form to wares from the Angkor region and include pumpkin shaped vessels, small boxes, bird-shaped boxes, animal figurines, *kendi* (spouted bottles), dishes, bowls, oil lamps, elongated water vessels, and jars with decoration along the shoulder. The two kilns excavated in Ban Kruat district were preserved, covered with roofs, and opened for public inspection (Ea 2009:212; Ea et al. 2008:283).

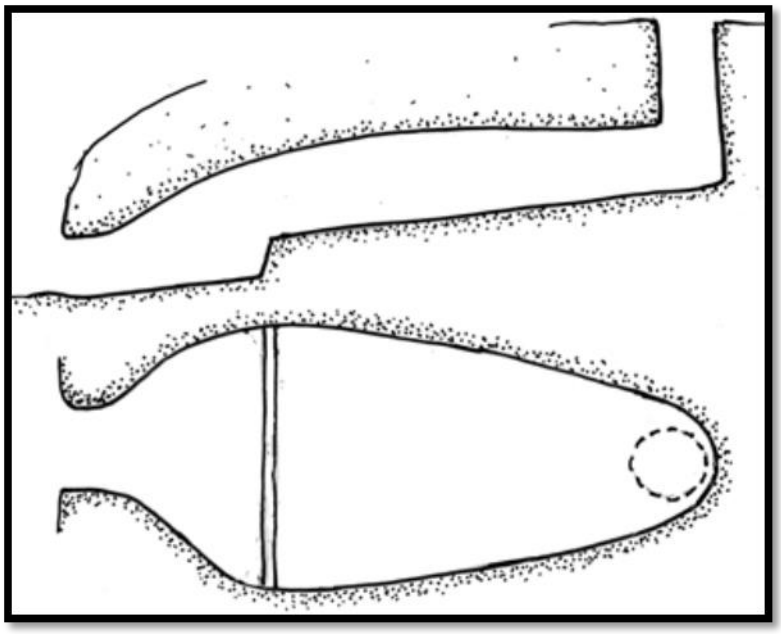


Figure 2. Inground kiln with a straight firewall and a small chimney dug upwards through the ceiling of the firing chamber (Hein 2008:4, Figure 3).

Many of the kilns in the region are superimposed which indicates that use of the site and the production of ceramics extended over a period of time. Since no kilns had been found in Cambodia at the time and these kilns were located in close proximity to the Angkorian road, scholars initially hypothesized that the area was a production and distributional center for brown wares which were transported to Angkor via the Phimai road (Brown 1988:46). However, more recent evidence from Cambodia, discussed below, disproves this hypothesis.

History of Scholarship on Angkorian Kilns

Unlike the history of kiln research in Thailand, the history of kiln investigations in Cambodia is very recent, with research being conducted intensively in the last fifteen years. While Aymonier first identified a kiln site on Phnom Kulen in 1883, work conducted on Angkorian kilns in Cambodia only began in 1995 with the discovery of kiln sites at Tani, located to the east of the Angkor Archaeological Park, in conjunction with a road construction project (Aoyagi et al. 1998). By 2000, at least five other kiln sites had been discovered to the east of Siem Reap. Currently, most kiln sites have been identified within close proximity to the Angkorian center in Siem Reap as well as along the royal road network. The discovery of four ancient roads leading out of Angkor to the provinces initiated the Living Angkor Road Project (LARP), which in turn uncovered many kiln sites along these roads. Most kiln sites have been discovered to the east of the Angkor Archaeological Park in Siem Reap Province, as well as to the west of Angkor, along the two ancient roads leading west into the Cambodian provinces of Oddar Meanchey and Banteay Meanchey, and northwest towards Phimai in northeast Thailand. (Ea 2009:211-213, 2010:93, 96, 102; Tin 2004:17) (Figure 3). Completely separate from these kiln sites, a site called Cheung Ek in Kandal province in the south, close to the capital of Phnom Penh, was discovered in 2001. It is thought that the sites in the Angkor region and northeast Thailand were active during, and can be dated to, the Angkor period. Interestingly, the Cheung Ek kiln site in Kandal province spans the pre-Angkorian to post-Angkorian periods (Phon et al. 2013).

Of the many Angkorian kiln sites that have been discovered in Cambodia, ten kiln groups have been extensively studied. The ten groups that have been extensively studied are Tani, Anlong Thom, Sar Sei, Khnar Po, Bang Kong, Torp Chey, Chong Samrong, Teuk Lech, Kantout, and Cheung Ek (Aoyagi et al. 1998; Chhay et al. 2009; Cort 2000; Ea et al. 2005, 2008; Ea 2006, 2009, 2010, 2012; Hein et al. 2013; Miksic et al. 2009; Phon et al. 2013; Sok 2009) (see Table 1; Figure 4). Of the ten groups, only eight have been excavated. Recent ongoing kiln excavations by Cambodian scholars include Bos Domlong (Chhay Rachna, personal communication, 2013).

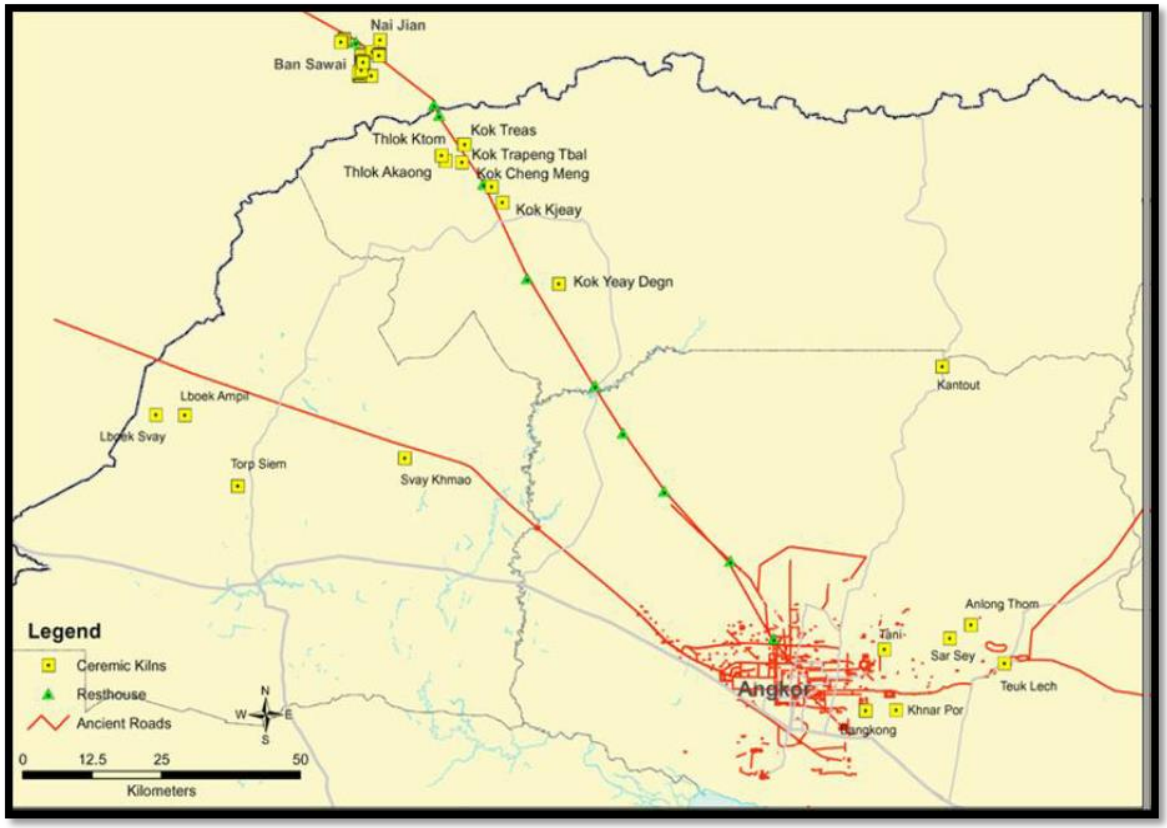


Figure 3. Distribution of Angkorian kiln sites in Cambodia (Ea 2010:250, Figure 2).

Table 1. Excavated kilns in Cambodia.

Kiln Name	Designation	Area	Commune	District	Province	Team	Excavation dates	Radiometric dates (CE)	Publications
Tani	N/A	Tani	Run Ta Ek	Banteay Srei	Siem Reap	APSARA, NARA, Sophia U	1996-2001	11th - 12th C	NARA 2005; Aoyagi and Sasaki 2007
Thnal Mrech	ALK or TMK	Anlong Thom, Phnom Kulen	Khnang Phnom	Svay Leu	Siem Reap	APSARA, Sophia U, NUS	2007	9th - 13th C	Tabata 2007; Chhay et al. 2009; Miksic et al. 2009
Sar Sei	N/A	Sar Sei	Tbeng	Banteay Srei	Siem Reap	APSARA, NARA	2007	11th-13th C	Sok 2004, 2009
Khnar Po	N/A	Bos	Khnar Po	Sotr Nikum	Siem Reap	APSARA, Otani U	2007	11th - 13th C	Ea et al. 2008
Bang Kong	BK	Bang Kong	Ampil	Prasat Bakong	Siem Reap	APSARA, Sophia U, Otani U	2008, 2010	9th - 10th C	Ea et al. 2008; APSARA 2010
Torp Chey	N/A	Torp Chey	Beng Mealea	Svay Leu	Siem Reap	APSARA, Nalanda Sriwijaya Center	2012	12th - 13th C	Ea 2012
Chong Samrong	N/A	Kambor Or	Beng Mealea	Svay Leu	Siem Reap	APSARA, Smithsonian	2013	N/A	Hein et al. 2013
Cheung Ek	N/A	Cheung Ek	Cheung Ek	Dankoar	Kandal	APSARA, RUFA	2012/2013	4th – 16th C	Phon et al. 2013

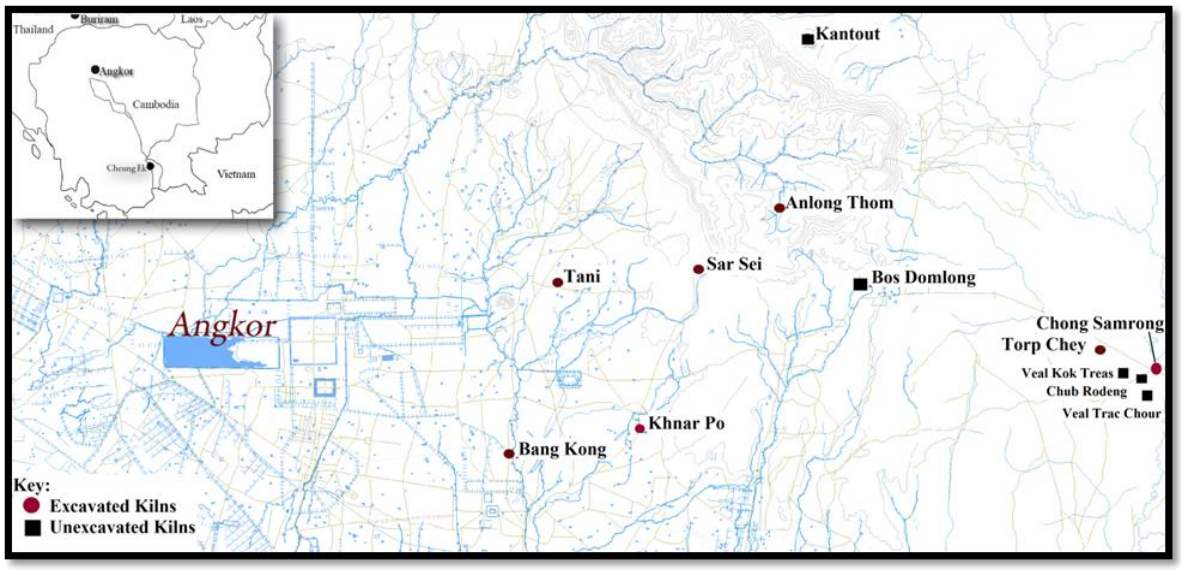


Figure 4. Excavated and unexcavated kiln sites in Siem Reap province (adapted from Chhay et al., SAA poster 2013).

Excavated Kilns

A variety of Angkorian kiln sites have been excavated in the Angkor region (see Table 1). The Tani kiln site was the first kiln site to be excavated not only at Angkor, but in all of Cambodia. The site is located at Tani village, Run Ta Ek commune, Banteay Srei district, Siem Reap province, approximately 20 km northeast of the town of Siem Reap. The site is located near a river and is only 7 km east of the East Baray. The Tani site consists of 26 kilns divided into five groups (Tin 2004:39). Three kilns were excavated from 1996 to 2001 in a joint research project between APSARA Authority, the National Research Institute for Cultural Properties, Nara (NRICPN), and Sophia University Angkor International Mission (Aoyagi et al. 1998). Unfortunately, less than half the kiln structures remained due to looting and development of the area. The kilns are cross-draft kilns and the structures are oval in shape and made of clay. Several ceramic types were found, including small ash-glazed wares, large unglazed wares, and roof tiles (Ea et al. 2008:279). The green glazed wares are small covered boxes, bowls, bottles and jars. The unglazed stoneware are large basins, large jars with ears, *kendi*, water jars with small necks and wide rims, and roof tiles, including round tiles, flat tiles, eave tiles and ridge ornament tiles. There were no brown-glazed wares found at the site (Ea 2009:208).

Phnom Kulen is a hill-plateau that is about 600 m above ground level, approximately 35 km northeast of Siem Reap. There are many kilns on Phnom Kulen but the exact number is unknown due to looting and the heavily forested location. However, the site is thought to be among the largest kiln industries in Southeast Asia (Chhay et al. 2009:216). The site of interest at Phnom Kulen is the Anlong Thom kiln site which is located near Anlong Thom village, Khnang Phnom commune, Svay Leu district, Siem Reap province. The Anlong Thom site consists of many kilns spread along both sides of the ancient Thnal Mrech (Pepper Road) dike. Two kilns sites at Anlong Thom were excavated in early 2007 by a joint research project involving APSARA Authority, the National University of Singapore (NUS), and Tabata Yukitsugu, supported by a grant-in-aid from the Japan Society for the Promotion of Science. The site is unique in that it is the first excavation to be directed by Cambodian archaeologists and extra care was taken to ensure that long-term research would be viable such as excavating half of the kiln mound and creating a flexible, open ended catalogue system.

The ceramics from these kilns are mainly green glazed wares with a small number of unglazed wares. The green glazed wares include cylindrical covered boxes, round covered boxes, bottles, bowls, flower vases, and roof tiles; the unglazed wares are basins and water jars. From the large number of sherds scattered across the surface, the Anlong Thom site appears to be a major ceramic production center in the Angkor area. The high quality of these ceramics, as compared to those from other kilns in the region, led scholars to suggest the Anlong Thon kilns were royal kilns. This group of kilns is also suggested to be the oldest in the region, due to the association of Phnom Kulen with Angkor's first monarch Jayavarman II who ruled from 802 CE (Ea et al. 2008:279). However, this hypothesis seems to be mostly based on circumstantial factors as recent radiocarbon dating places the use of this particular site in the eleventh to thirteenth century (Miksic et al. 2009:8-9).

The Sar Sei kilns are located in Sar Sei Village, Tbeng Commune, Banteay Srei District, Siem Reap Province, about 25km northeast of Angkor Thom. Sar Sei was identified in 2002 and mapped in 2003. In 2007, Sar Sei was excavated as part of a joint

research project between APSARA Authority, NRICPN, and Otani University (Ea 2009:210). The Sar Sei site consists of approximately 28 or 29 kilns divided into three groups (Tin 2004:42). The first group, Trapeang Neang Snay, has twelve kilns; the second group along the stream Or Neang Snay has nine; Thma Chul has seven or eight but this could not be confirmed due to land mines and undergrowth. The ceramics are mostly the same as those from the Anlong Thom site but contain more unglazed wares. The kiln is similar in structure to the kilns in Tani.

Khnar Po is located in Bos Village, Khnar Por Commune, Sotr Nikum District, about 20 km to the east of Siem Reap town. Khnar Po was surveyed in 2002 and excavation began in 2006 as a joint project between APSARA Authority and Otani University with the support of NRICPN. Khnar Po consists of 19 kilns divided into four groups (Ea 2009:210). Group A on the western dike of water reservoir Tonle Bet has ten kilns, group B has three kilns about 100m west of first group, group C has thirteen kilns located on the southern dike, and group D is located south of the Tonle Bet. The right lengthwise half of one kiln in Group B, designated B1, was excavated. The structure looks similar to Tani and yielded only unglazed water jars, basins, jars with four ears and roof tiles.

Bang Kong is in Bang Kong Village, Ampil Commune, Prasat Bakong District, approximately 13 km to the east of Angkor Wat. Bang Kong kiln sites were first reported in 1998 during road construction and again in 2005 and 2006. However, it was only in 2008 that APSARA Authority was able to conduct rescue excavation at two kilns, BK15 and BK16, out of the 37 kilns inventoried at Bang Kong. In 2009, a joint project with APSARA Authority and Otani University with the support of NRICPN began and in 2010 the study of BK6 was conducted. Unfortunately, at this point, only fifteen kilns were in good condition while the other fourteen had been completely destroyed. The ceramics are similar to that of Khnar Po.

The Torp Chey kilns are located in Torp Chey Village, Beng Mealea Commune, Svay Leu District, Siem Reap Province. The site is located past Phnom Kulen, along the

East road leading from Beng Mealea temple to Preah Khan of Kompong Svay. Recent survey along this road has identified the first evidence of brown ware kilns east of Angkor near Prasat Teap Chei. Torp Chey was initially discovered in early 2007 through the Living Angkor Road Project and the ceramics from the surface collection were initially assessed by Mitch Hendrickson (2008) under the site name Teap Chei. The Torp Chey kiln complex consists of twelve kiln mounds with three more mounds located in the eastern part of Torp Chey Village. The kiln that was excavated by the joint APSARA and Nalanda Sriwijaya Center team was kiln number 2, a well-preserved mound located approximately 60 m south of Torp Chey Toch. The kiln is 4 m in height, 25 m in length running on an east-west axis, and is 15 m wide following a north-south orientation. The structure is comprised of three kilns constructed on top of each other and is unique from other Angkorian period kilns due to its size and kiln modifications that are not seen elsewhere in Angkor, such as the presence of secondary firing trenches located on the uppermost kiln. The artifacts consist of cylindrical jars, large jars, baluster-shaped bottles, roof tiles, and animal-shaped figurines. The initial, tentative dating of the site places it in the late twelfth to early thirteenth century based on the association of the site with brown-glazed ceramics. However, radiocarbon dating will further clarify the chronological placement of the site (Ea 2012).

Chong Samrong is a kiln site located near the village of Kambo Or on the ancient road leading from Angkor and Beng Mealea to Bakan (Hein et al. 2013:4). The site is located within close proximity to Torp Chey and contains two known kiln mounds. Excavation on the kiln was conducted as part of a training program and the kiln was excavated lengthwise on a north-south axis. Only half of the kiln, the east portion, was excavated. Few ceramic sherds were found and is probably a consequence of both looting and a kiln specific focus. The range of forms at Chong Samrong was limited and of poor quality. Despite the proximity of Torp Chey, the Chong Samrong kiln appears to retain elements of earlier Angkorian kiln forms. It is possible that Chong Samrong represents an intermediary kiln between the common Angkorian kiln and Torp Chey.

The Cheung Ek kiln site is a massive complex of hundreds of small kiln mounds. Some of the mounds have been destroyed due to urbanization of the area but many more kilns are still intact. Recent excavations conducted in 2012 and 2013 have produced a large number of Angkorian ceramics. The excavations have also uncovered pre-Angkorian ceramics as well, indicating that there is a long tradition of continuity among the potters at the site; researchers suggest that the site dates back to the fourth or fifth century (Phon et al. 2013:3). A site such as Cheung Ek has many important and interesting implications for the field of Angkorian ceramics and could contribute much to the discussions of chronology, the origins of the tradition, and the evolution of techniques and technology. However, since the excavation of the site is still ongoing and the information is based on a small number of excavated sites, more information, especially radiocarbon dates, is needed before researchers can truly claim to have found a site that spans several periods of ceramic production.

Unexcavated Kilns

Kiln sites have been found in the central Angkor region of Siem Reap province and also in the neighboring provinces of Banteay Meanchey and Oddar Meanchey. There are two sites in the Angkor region of Siem Reap province that have been surveyed with published reports on the ceramics found through surface collection: Teuk Lech and Kantout. The Teuk Lech kiln group is in Teuk Lech Village, Beng Mealea Commune, Svay Leu District, about 40 km northeast of Angkor Thom. The ceramics are all unglazed roof tile with a few brown wares. Kantout kiln site is in Kantout Village, Kantout Commune, Svay Leu District, north of Phnom Kulen. There are two kiln sites. The first is Ta Tuot located in Ta Tuot Village, Kantuot Commune, Svay Leu District, Siem Reap Province, about 5km northeast of Kulen that contains two identified groups. The second site is located in Beng Mealea Commune, Banteay Srei District and consists of three kiln sites: Chub Rodeng kiln in village No. 103, Veal Kok Treas located in village No. 104 and Veal Trac Chour (Sok 2009). The ceramic sherds are almost all brown wares that are similar to those found in northeast Thailand.

The Banteay Meanchey kilns are located along the ancient road that leads from Angkor to the Sdok Kak Thom temple. The site is composed of four sites that were surveyed in 2003 but not excavated: Lboek Svay in Svay Chek Commune, Svay Chek District; Lboek Ampil in Svay Chek Commune, Svay Chek District; Torp Siem in Slor Kram Commune, Svay Chek District; and Svay Khmau in Ponlay Commune, Phnom Srok District. The number of kilns is not given for the Svay Khmau kiln site due to the land mines still prevalent in the area but Lboeuk Svay and Lboeuk Ampil consist of two groups of kilns each while Torp Siem is composed of two to four groups of kilns (Ea 2009:212). The survey of these sites comprised of recording surface ceramic sherds found at the sites as many sites were destroyed or inaccessible. The sherds were mainly brown wares with a smaller quantity of ash-glazed and unglazed wares; the forms included bowls, water jars, large storage jars with ears, basins, baluster jars, and zoomorphic jars (Ea et al. 2008:280).

The Oddar Meanchey kilns are found along the road to Phimai and were discovered during the 2006 survey for the LARP. Researchers speculate that there are a minimum of seven sites in the area with two identified kilns; unfortunately, the sites are badly looted or destroyed (Ea 2009:211).

CHAPTER 4. ORIGIN THEORIES OF ANGKORIAN KILNS AND CERAMICS

Archaeologists consider the advent of technology, especially craft specialization, as a social phenomenon that heralds the development of complexity in a particular society. A ceramic industry utilizing kilns not only involves social organization but also an awareness of raw materials and their interactions with controlled temperatures as well as developing techniques and technology that allow for mass production such as a throwing wheel or the construction of kilns that utilize the surrounding environment (Orton et al. 1997:133; Rice 1987:11, 109, 161). Currently, Angkorian ceramic and kiln research is comprised of more questions than answers. Even as new information adds to the overall knowledge of the subject and provides some answers, the new data generates new lines of inquiry and expands upon unsolved as well as previously answered questions. There are several key research themes that are continuously debated in the field of Angkorian stoneware studies. One of the biggest debates is centered on the theme of origin. Origin theories are usually based on the transfer of knowledge that relies on the relationship between polities and the interaction among networks of specialists.

The origin and history of kiln technology in Southeast Asia is important as it directly relates to the origin and history of stoneware technology and production in the region. As with the transmission of other influences in the Southeast Asian region, such as certain cultural practices and aspects of religion, ceramic and kiln technology are thought to have originated from either India or China. The dominant origin theory suggests that the kiln technology originated from China (Brown 1988; Groslier 1981; Guy 1997:42; Hein 2008; Wong 2010). However, the possibility of an Indian origin or an indigenous Southeast Asian origin should not be dismissed.

While the focus of this thesis is on glazed stonewares, it should be noted that the people of mainland Southeast Asia, including Cambodia, have continuously produced unglazed, low-fired earthenware throughout the ages into the present day. However,

earthenware firing is different from kiln firing and does not necessarily mean that earthenware was the origin of stoneware. Earthenware production may have influenced stoneware shapes, forms, and techniques, however, earthenware continued to be produced alongside glazed stoneware (Cort 2000; Groslier 1981).

The Origin of Kilns in Southeast Asia and Angkor

Origin theories address the dissemination of kilns to the region. The dominant theory is that kiln technology originated from China (Brown 1988; Groslier 1981; Guy 1997:42; Hein 2008; Wong 2010). The basic kiln types present in mainland Southeast Asia are the updraft kiln and the crossdraft kiln (Hein 2008:3). Hein (2008:2, 9-10) suggests that due to the complexities of such kilns, it is unlikely for kiln technology to have developed independently in Southeast Asia. Instead, the knowledge of kiln technology was introduced to Southeast Asia from China in a fairly primitive state. Local innovation or a series of technological influences would account for the subsequent development of kiln technology and the variation visible in the widely distributed Angkorian kilns. Hein's hypothesis assumes that the transference of kiln technology occurred either through long apprenticeships resulting in knowledge being brought back to Angkor or through the movement of foreign or experienced potters to new areas (Hein 2008:30-31). Either way, the kiln technology introduced to new areas would reproduce kiln technology at the originating site. Thus, the origin of the technology would be traceable through a lineage of similar kiln attributes in other polities.

Based on his research, Hein states that updraft kilns are prevalent in Thailand, Myanmar and Laos while crossdraft kilns are found in Vietnam and Cambodia (Hein 2008:17). The close resemblance between Angkorian kilns and Vietnamese kilns suggests one tradition while the kilns in the rest of mainland Southeast Asia seem to belong to a distinctly different tradition. Therefore, Hein proposes two zones of influence: the Coastal Zone and the Inland Zone (see Figure 5). These two zones followed different timelines, with about a thousand year difference, different production

technology, different ceramic products, and even different distribution strategies and markets (Hein 2008). These two zones are described below.

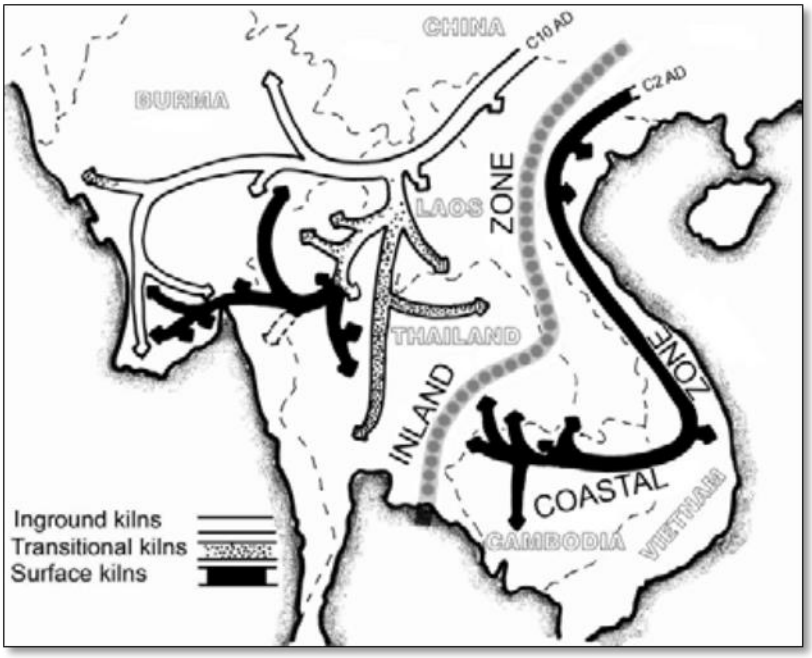


Figure 5. Hein's two zones of influence (Hein 2008:1, Figure 1).

Based on Hein's model, the first stage saw crossdraft kiln technology introduced to Vietnam from China, either through informal migration or Chinese colonial efforts, before spreading to Cambodia around two thousand years ago; Hein calls this the Coastal Zone. The second stage, called the Inland Zone, saw the separate introduction of updraft kiln technology from China into Burma, Laos and Thailand about one thousand years later (Hein 2008:13-30). According to Hein, Coastal Zone crossdraft kilns originated from southeastern China while the Inland Zone updraft kilns might have originated from either China or the Middle East via India (Hein 2008:18). The kilns are useful for tracing influence and could potentially link kiln sites and generations of potters in Southeast Asia with the parent sites in China through the longevity of the original characteristics the kiln types exhibit (Hein 2008:31; Wong 2010).

Compared to Chinese kilns, Southeast Asian kilns were relatively small and the shape of the firing chamber depended on the point of entry into the region. The kilns

dispersed through the Coastal Zone (Vietnam and Cambodia) were usually fairly rectangular in shape and often had more than one firehole at one end with a wide vent-like chimney at the other. On the other hand, the kilns that were established in the Inland Zone (Thailand, Burma and Laos) were more oval in shape with a round chimney (Hein 2008, 2011:17). Apart from the variation in kiln forms between the Coastal Zone and the Inland Zone, there are slight variations in kiln forms amongst the Angkorian kilns. It is possible that the technology in the Coastal Zone was transferred internally and modified over time. Changes were not necessarily due to the occasional injection of techniques and technology from China. These modifications suggest local innovation and ingenuity in adapting the kilns to the surrounding landscape and local production needs (Hein 2008:33). Tabata agrees with Hein that the basic kiln technology may have been Chinese. However, Tabata argues that the development of kiln technology in Vietnam, after arrival from China, should be considered an indigenous origin of technology upon arrival in Angkor (Tabata 2010:103-104). This is purely semantics. The majority of scholarship on the origins of Southeast Asian kiln technology is focused on and supports a Chinese origin. However, due to the relative youth of Southeast Asian kiln studies, the possibility of an Indian origin or an indigenous origin of kiln technology should not be entirely disregarded as new evidence might be uncovered.

The Origin of Ceramics in Angkor

In contrast to the currently uncontested Chinese origin theory for kilns in Southeast Asia, including Angkorian kilns, the origin of ceramic technology deals with several different points of origin. Many researchers have suggested a Chinese origin (Aymonier 1901:414; Groslier 1981:20; Rooney 1984:24). However, it has also been suggested that early knowledge of ceramic technology came from South India or was developed indigenously (Guy 1997:42-49; Willetts 1971:7-9).

Much of the supporting evidence of Chinese influence in Angkor is derived from the written account of Zhou Daguan, an emissary from China in the thirteenth century, and the presence of Chinese ceramics found alongside Angkorian ceramics at various

sites in Cambodia. Early excavations at Angkor Thom and Sras Srang yielded a rich variety of glazed wares and Chinese tradewares while subsequent excavation around the Angkor region have yielded small amounts of Chinese tradeware mixed with Angkorian ceramics (Cremin 2006; Groslier 1981:17; Guy 1989:15; Wong 2010:207-214, 226). Chinese influences are mainly apparent in the shape and decoration of some ceramic vessels resembling those from south China (Brown 1977:31; Groslier 1981:21; Guy 1997:55; Wong 2010).

Although Indian influences were important in Angkorian culture before and during the Angkor Empire, the argument for Indian origins of Angkorian kiln and ceramic technology is not very strong, nor is it well-researched at the moment. In fact, a popular suggestion is that the transmission or origin of earthenware and earthenware forms is Indian while glaze ware ceramic technologies, particularly the kiln technology, are Chinese (Groslier 1981:21; Guy 1997:43-49). The argument for Indian influence on Angkorian ceramics is based on the shapes of the ritual vessels that mimic Indian prototypes, particularly specific cultural or ceremonial objects such as a conch or *kendi* (Brown 1977:31; Groslier 1981:35; Guy 1997:42-49). A combination of linguistic and archaeological research also links several descriptive Sanskrit words to specific ceramic forms unique to Angkorian glazed ware (Sok 2009). The pairing of Sanskrit ceramic terms with ceramic forms only found in Angkor suggests that the ceramic shapes are known in India or comparable forms were brought from India and incorporated into Angkorian ceramic forms.

Willetts (1971:7-9) suggested an indigenous origin for Angkorian ceramics while Miksic and his collaborators propose that Angkorian ceramics evolved differently and separately from imported Chinese ceramics; Angkorian potters may have selectively included certain Chinese ceramic elements but the general aesthetic of the ceramics were entirely Angkorian (Miksic et al. 2008). Wong (2009:214) agrees with the assessment that Angkorian potters made specific technological choices in creating the various stoneware ceramics.

Discussion

Based on the information above, it is apparent that the origin theory for kiln technology revolves around a Chinese origin while the origin of ceramic technology is less certain in that influences from China and India as well as local indigenous development have been noted. Brown (1988:41-42) suggests that the technology might have been brought to Angkor directly by Chinese potters migrating to Angkor by the late ninth century, but Hein (2011:13-17) and Tabata (2010:103-104) argue that there is no basis for direct transference; the technology was filtered through other Southeast Asian polities before arriving at Angkor. Both arguments have also been suggested by Rooney who goes one step further to say that the indigenous development of ceramic technology might have paralleled influences from China and possibly Vietnam (Rooney 1984:24). Wong (2009:279) states that based on the slab kiln structures and kiln furniture which are distinct in shape from Chinese kiln furniture, the Angkorian potters did have their own indigenous techniques.

Despite the evidence supporting a Chinese origin (historical texts of known contact, archaeological artifacts, etc.) it is possible that China had little to do with the origin of the Angkorian kilns and stoneware industry beyond the initial introduction of crossdraft kilns. It seems that the research on kiln technology does not take into account other factors such as the firing techniques and glazing techniques in addition to the kilns themselves. Due to local technological modifications, the relationship between the kilns in different areas should be considered in terms of the ruling polity, time period, and wares produced. The depth of the relationships between the different technological cultures is also not well defined. Very little research has been conducted to strengthen connections between Indian ceramic technology and Angkorian ceramic technology and, apart from the early kilns found in China, there is not a close relationship between Angkorian and Chinese kilns or technology.

Hein's proposed timing for the introduction of separate kiln traditions in Southeast Asia should be viewed with caution as much more research needs to be

conducted. The suggestion that there were two very different kiln traditions being introduced at vastly different times could account for the dissimilarities in the production technology and the ceramic wares. Based on Hein's two-zone theory, this explanation is logical. However, Hein is not able to adequately explain the time of foundation of Thai kiln sites due to a lack of information from archaeologically excavated kiln sites (Hein 2008: 26). While the possibility of multiple transfers of technology from China into Cambodia via Vietnam among the Coastal Zone kiln sites cannot be discounted, more research needs to be conducted. For example, the kiln sites located within modern-day Thai borders, where updraft kilns are found in association with crossdraft kilns, represent a unique research opportunity that could potentially produce important information on the origins and development of kilns in Southeast Asia.

While there has been research conducted on crossdraft kilns throughout the region, there has been little research done on the updraft kilns in mainland Southeast Asia, so the hypotheses put forth by Hein cannot be considered complete until further research is conducted. This is due to the fact that many kilns have not been found or excavated. For example, recent excavations at the extensive Cheung Ek kiln site produced two sets of Accelerator Mass Spectrometry (AMS) radiocarbon dates that place the operation of Cheung Ek kilns in the fourth to sixth century (Phon et al. 2013:3). This result not only contributes to the discussion of chronology and technology but has implications for re-evaluating the timing of the theories on origins and sociopolitical interactions. There is a growing body of information based on new discoveries and excavations at kiln sites that are beginning to divert from emphasis on outside influences to a more indigenous explanation for origin or development.

Even as researchers agree that the crossdraft kiln and the ceramics created by Angkorian potters were introduced from China, they are still uncertain as to when and how kiln technology was introduced to Angkor; they are currently trying to identify the original source of innovation and technology beyond the general Chinese point of origin (Brown 1988; Groslier 1981; Guy 1997; Hein 2008, 2011; Rooney 1984; Taylor and Foley 1999; Wong 2010). The developmental or experimental stages of kiln and ceramic

technologies are not clearly defined without substantial archaeological evidence. Kiln sites or sites with evidence of ceramic industries that are able to showcase experimentation at all levels of production – refining and combining raw materials such as clay and glazes, firing arrangements, and modification of kilns to adapt to local environments or to affect temperatures – would contribute to the indigenous origin theory. The development and decline of the Angkorian stoneware ceramic production from the pre- and post- Angkorian eras are not clear as these periods have not been extensively studied in regards to the ceramic industry. The lack of archaeological evidence of a pre-Angkor and post-Angkor ceramics industry needs to be addressed with more research. The Cheung Ek kiln site is the first step in providing evidence of a sustained ceramic industry that spans both the pre-Angkorian and post-Angkorian periods.

If the Angkorian kilns did develop locally, then the general consensus is that the technology first appeared at Phnom Kulen. This includes the initial site of development or transference of Chinese ceramic technology. Phnom Kulen is seen as the site of technological transference based on circumstantial evidence in the form of corroborating legends as well as the presence of ninth century kilns, the beginning of the Angkorian stoneware industry (Brown 1988:41; Lefferts and Cort 2008:286-289). However, the recent discovery and excavation of the Cheung Ek kiln complex and the resulting radiocarbon dates complicate the Phnom Kulen hypothesis and challenges the validity of Phnom Kulen as the initial site of Angkorian kiln and ceramic technology is challenged. Depending on the interaction between the polities in the two regions, it is possible that Angkorian kiln and ceramic technology originated from pre-Angkorian kiln sites such as Cheung Ek. This is consistent with Hein's coastal influence theory where the technological knowledge was transmitted down the coast of Vietnam before going to Cambodia. However, Angkorian kilns could also be a separate development based on direct Chinese influence. For this hypothesis to be true, earlier sites need to be found on Phnom Kulen or within the Angkor region or solid proof of direct Chinese technological transmission needs to be unearthed.

The cultural influence of both India and China on Angkor are prevalent in the archaeological record, the architecture, the *bas reliefs*, ceramic forms, and the religious, political and spiritual beliefs. For instance, some scholars note that with the advent of glazed ceramics, the shape of the roof tiles used in Angkorian architecture changed from the flat Indian roof tile to the curved Chinese roof tile (Brown 1988:42; Groslier 1981). This shift not only involves both Indian and Chinese influences but also displays the cultural selectivity of the Angkorian people during that period. As with all other cultural and technological influences evident in the Angkorian landscape, the people of Angkor only acquired facets of other cultures that appealed to them and integrated or adapted these influences into the local culture.

It is generally accepted that Indian and Chinese influences were incorporated into the Angkorian ceramics industry to produce ceramics that are unique (Brown 1977, 2000; Rooney 1984; Wong 2010). However, not much is known about the transference of technology or ideas, or how deeply the Angkorian potters were influenced by either culture, although scholars such as Wong are beginning to address the topic through comparative studies. Brown notes that further influence from China was not vital or significant to the industry after the initial transference of knowledge (Brown 1988:42). It should also be noted, however, that the transference of technology is not usually a one way transmission. Wong (2010:242, 246-253, 258-261, 278) discusses the fact that the exchange between Angkor and China was a two way exchange. While the Angkorian ceramics and kilns display Chinese influences, the Chinese ceramics that were made for Angkor were influenced by the needs and demands of the Angkorian market and therefore incorporated Angkorian shapes, designs and decorations (Wong 2010:278). In this sense, it is possible for there to be a Chinese influence apparent in Angkorian ceramics without there actually having to be a direct transference of technology from China. However, Wong suggests that the technological innovation within the Angkorian ceramic industry was stimulated by the introduction of techniques from south China (Wong 2010:280). Logically, Wong proposes that the indigenous techniques should first be identified before searching for an explanation of why specific aspects of Chinese technology were adopted (Wong 2010:281). Chinese adaptation in terms of techniques

and ceramic products to cater to the local Angkorian market could have negatively impacted the production and development of similar wares within the Angkorian ceramic industry (Guy 1997:43).

CHAPTER 5. KEY DEBATES AND ISSUES IN ANGKORIAN CERAMICS

In Chapter 4, the origin theories of both Angkorian kilns and ceramics were discussed. Technology is an important theme that links the various research topics. Scholars not only look at the origin of technology, but also the timing, transmission, and the evolution of technology. The different but interrelated aspects of technology allow scholars to form hypotheses regarding the ways Angkorian potters acquired and utilized ceramic techniques. Furthermore, since Angkorian ceramics were produced during the entire Angkorian period, from the ninth to the thirteenth century, scholars could potentially track the stylistic, technological, and organizational changes through time. The roughly six century time period allows scholars to create a framework of chronology based on different methods of dating Angkorian kilns and ceramics. Related to the origin debates are several key research subjects including chronology, classification, and organization.

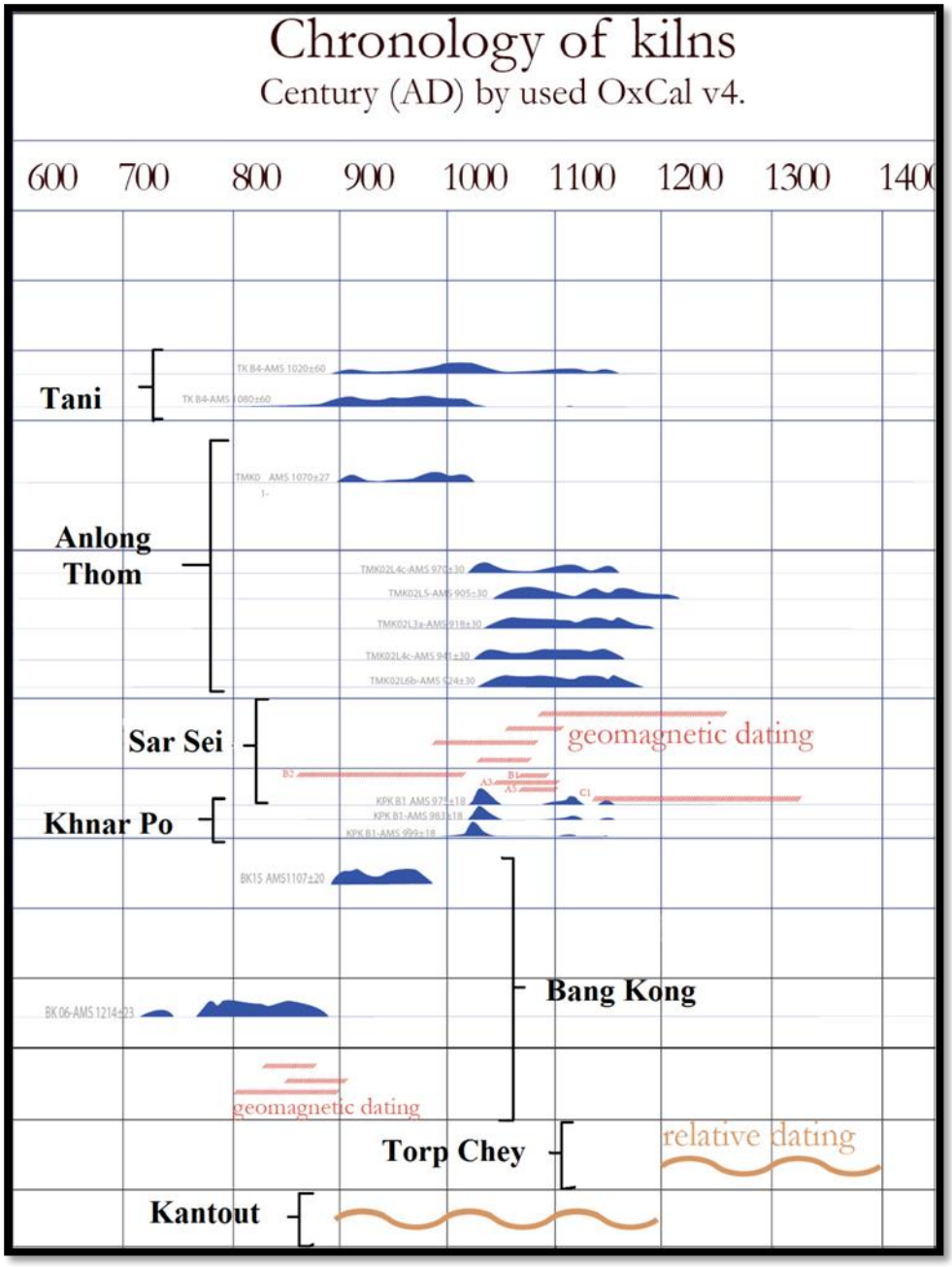
Chronology

Ceramics and dating are inextricably linked in archaeology. Ceramics present an ideal medium for carrying chronological information – abundance, multiplicity of form, function, and decoration – and can be used across sites if suitably dated (Orton et al. 1997:182; Rice 1987:435). Research on Angkorian ceramic and kiln technology has advanced considerably over the past few years. There are several ways to construct a chronology using different dating methods. The two main dating methods are relative dating and chronometric dating. Relative dating involves cross-dating and sequence dating where typologies and classifications are created for artifacts based on seriation or associating artifacts and sites with known, dated materials such as inscriptions (Rice 1987:436). Chronometric dating utilizes scientific testing that is often destructive but yields dates in absolute time – calendar years or calibrated years. Some examples of chronometric dating are radiocarbon dating and geomagnetic dating.

With the discovery of new kilns and the use of advanced technology, more precise dating can be used to confirm or create a chronology. For instance, for the EurAESAA 2012 Conference in Dublin, Chhay Rachna put together a chart detailing an assortment of dates from various sites that were derived from different dating methods: relative dating, Accelerator Mass Spectrometry (AMS) radiocarbon dating, and geomagnetic dating (see Figure 6). Each dating method allows scholars to place sites or artifacts within a specific range of dates utilizing different materials. Relative dating is based on seriation, radiocarbon dating is used to date charcoal and other organic materials, and geomagnetic dating measures the magnetic fields of fired clay samples. These dates correspond to the time periods during which the specific kilns were in use and do not necessarily represent the entire time span of a certain glaze ware tradition. The only issue with employing several different methods in a comparative study is that each of these dating methods possess different rates of precision.

Ceramic chronologies are typically based on the evolution of vessel forms, shapes, and decoration that develop from simple to complex. However, the chronology of Angkorian ceramics is not so straightforward. The study of Angkorian ceramics chronology and classification began with Bernard Groslier, who wrote an essay on the comparative dating of the ceramics at Phnom Kulen and referred to the wares as 'Kulen Ware' (Groslier 1981).

Groslier first created the chronology of Angkorian ceramics based on the chronology of rulers and on consecration dates of temples as recorded in stone inscriptions, which he associated with the wares excavated or found in their vicinity. In this chronology, the stoneware ceramics were classified based on the basic glaze colors – green and brown – apparent in the wares as well as the forms of some of the most commonly occurring wares – green celadon-colored 'Kulen' wares, '*lie-de-vin*,' glossy brown, dark green, matte brown and black, two-colored, baluster jars, and zoomorphic pots. Groslier's system is considered problematic because it relies solely on relative dating and requires fine-tuning based on other methods of dating. However, Groslier's chronology and classification are still used to this day by many scholars. In fact, most



Key	
	Relative Dating
	AMS Radiocarbon Dating
	Geomagnetic Dating

Figure 6. Angkorian stoneware kiln chronology (adapted from Chhay 2012, unpublished).

scholars agree with Groslier that the Angkorian glazed stoneware ceramic period began in the ninth century and lasted until about the thirteenth century (Brown 1981; Ea 2010; Groslier 1981; Guy 1997; Rooney 1984).

At the time when Groslier's chronology was conceived, the only known kiln site was on Phnom Kulen, where Aymonier had reported the probable kiln site based on the amount of ceramic debris that was found there; this was followed by subsequent observations by Groslier and Parmentier (Brown 1988). Based on the limited information from surface survey, the ceramics on Phnom Kulen were classified by Groslier as a celadon-colored 'Kulen' glaze and the moniker 'Kulen Ware' was applied to all ash-glazed green ware in Angkor, from the yellowish straw-colored green glazes to the truer green glazes. The use of 'Kulen' as a general term is convenient, as it encompasses the many different shades of ash-glazed green ware. However, it is also problematic, because the term 'Kulen' refers to both a geographical area and a time period, and does not take into account the probable date and place of manufacture of the green glazed wares which are not entirely unique to Phnom Kulen (Brown 1988:43; Cort 2000:120). Groslier suggested that Kulen Wares or Khmer green glazed stoneware production began in the ninth century, which placed the appearance of glazed stoneware in conjunction with the reign of Indravarman at Hariharalaya (present-day Roluos) (Groslier 1981:18). In this chronology, the green glazed ware does not quite end in the twelfth century, but seems to transition into dark green glazes that were produced until the fifteenth century.

Groslier suggests that brown ware appeared around the mid- to late-tenth century or the beginning of the eleventh century and developed to become widespread among Angkorian ceramics (Brown 1988:46; Groslier 1981:23-25). Brown ware vessels were most prolific during the mid-eleventh century, possibly due to potters from Phnom Kulen migrating out to establish kilns in the Angkor provinces; it was during this period, from about the middle of the eleventh century to the twelfth century, when two-toned glaze ware of exceptional quality began appearing in small numbers (Brown 1981:44; Groslier 1981:29). The eleventh century also saw the introduction of new shapes and forms such as zoomorphic lime pots. Matte brown and black glaze ware came about sometime in the

twelfth or thirteenth centuries and, by the fourteenth century, the Angkorian glaze ware had been replaced by the increasing importation of Chinese, Thai and Vietnamese ware (Groslier 1981:30).

Groslier related the classic age of Angkorian ceramics with the peak of Angkor in the twelfth century (Groslier 1981:30). While the development of Angkorian ceramics correlated with the rise and establishment of kilns, including the provincial kilns in modern-day northeast Thailand, following the expansion of the empire, the decline of the Angkorian ceramic industry is not so clear (Cort 2000:125; Groslier 1981:31-32; Guy 1997:51-52). Only one other scholar also uses the term "classic" in relation to Angkorian ceramics. However, unlike Groslier, who related the classic period of Angkorian ceramics to the peak of the Angkor Empire, Ea divided the production of classic Angkorian ceramics into three stages. Stage one extends from the beginning of the ninth century to the end of the tenth century, stage two begins in the eleventh century and does not have a clear concluding date before the thirteenth century, and stage three is related to the decline of Angkor starting in the thirteenth century (Ea 2010:223-229). This division of the classic period of Angkorian ceramics seems to be based on the development of green glaze and brown ware and does not necessarily represent the peak of Angkorian ceramics.

Groslier's chronology, despite being based on the limited information available at the time, has provided a firm foundation for other scholars to build a more informed chronology. Several scholars have challenged and revised Groslier's chronology at various levels in the last few years (Brown 1988:50-54; Cort 2000:108-111; Cremin 2006, 2009; Desbat 2011; Groslier 1981). The most recent revision of Groslier's chronology comes from Armand Desbat (2011) of EFEO using dated deposits (see Table 2). Desbat's revision only affects Groslier's dates for '*lie-de-vin'* glaze, baluster jars, glossy brown glazes, and zoomorphic pots. For these categories, Desbat's research places the beginning of these categories in the mid-eleventh century and extends these time periods to the early-fifteenth century. While Desbat did not revise Groslier's dates for green ware, recent ^{14}C dating of Anlong Thom kiln TMK02 on Phnom Kulen places the

Table 2. Bernard Philippe Groslier's chronology for Angkorian ceramics with Armand Desbat's revisions (Brown 1977:34-53; Cremin 2006:123; Desbat 2011:13 and 27; Groslier 1981)

	Indravarman Yasovarman	Rajendravarman Jayavarman V	Suryavarman I	Udayadityarman Jayavarman VI	Suryavarman II	Jayavarman VII	Post Jayavar. VII
	880-950s	950s-1000	1000-1050	1050-1100	1100-1177	1177-1250	1250-1430
Celadon-colored 'Kulen' glaze						?	
'*lie-de-vin'* glaze							
Baluster jars							
Glossy brown glaze							
Zoomorphic pots							
Two-color glazes							
Applied ornament							?
							?
Matte brown and black glazes							

Table 2. (Continued) Bernard Philippe Groslier's chronology for Angkorian ceramics with Armand Desbat's revisions (Brown 1977:34-53; Cremin 2006:123; Desbat 2011:13 and 27; Groslier 1981)

Dark green glazes			
Low-fired, unglazed wares			
Bowls with inner foot			?
Buriram glaze			?
Anthromorphic pots			

Key:	
Groslier's original chronology	
Desbat's revised chronology	

TMK kilns from the early to mid-eleventh century to the thirteenth century. Although this result does not confirm nor disprove the ninth century green ware dates suggested, no revision in Groslier's date has been made, as TMK02 may be a later kiln group and other Anlong Thom kilns might predate it (Chhay et al. 2013; Miksic et al. 2009; Tabata 2008).

Groslier created a category called '*lie-de-vin*' and suggested that it may or may not have been intentional. According to Groslier, '*lie-de-vin*' is said to have developed around the middle of the tenth century and continued to be produced into the eleventh. As previously stated, Desbat (2011) revised Groslier's '*lie-de-vin*' category. Using ceramic samples recovered from dated excavation contexts, Desbat extends the '*lie-de-vin*' production to span almost the entire Angkorian glaze ware period. While it is possible that '*lie-de-vin*' represents a transitional or experimental phase between unglazed and brown ware, some researchers suggest that '*lie-de-vin*' is not an appropriate glaze category and was probably accidently formed due to the impurities in the vessel interacting during firing to form a slip (Cort 2000:120; Groslier 1981:22). Based on Desbat's research, the '*lie-de-vin*' wares span a rather long time period to be considered "accidental." If Angkorian potters were indeed specialists, then an accidental '*lie-de-vin*' phase would not have lasted for very long. The presence of '*lie-de-vin*' throughout the Angkorian period implies that the '*lie-de-vin*' category was not simply an accident or an experimental phase on the path to producing brown ware. Contrary to the original chronology of brown ware appearance, Desbat's revised chronology places the beginning of the brown glaze industry in the mid-eleventh century, along with the emergence of two-toned wares, with both types of glazed ware production extending into the post-Angkorian period. Desbat also introduces a new category of Buriram glaze that is contemporary with the beginning of the brown and two-toned glaze wares at Angkor. Buriram glaze is a thick dark brown, almost black, glaze. Desbat's revision is based on radiocarbon dates obtained from excavated kiln sites with ceramics *in situ*.

While the chronology based on ceramic wares is still being refined, a chronology for kiln sites has not yet been created. The lack of a kiln chronology is due to the relative youth of the field. Many more kilns, especially experimental or transitional kilns, need to

be excavated before researchers can piece together a chronology of kiln evolution and its possible connection to the expansion of Angkorian cultural influence and political authority.

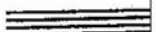
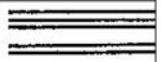
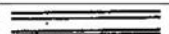
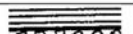
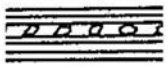
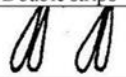
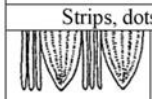
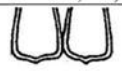
Classification

Typology or classification can be derived using various identifiers, but ceramics are most commonly classified based on the variability and similarity of material, style, and vessel forms (Orton et al. 1997:153). Angkorian stoneware ceramics range from utilitarian wares to decorative wares and also include architectural wares. Variations in glazes and shapes differ based on the purpose of the ceramic product, the size of the vessel, a combination of both glazes and shapes, and changing cultural aesthetics through time. The classification of ceramics can also contribute to discussions regarding chronology through relative dating and seriation.

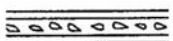
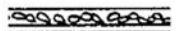
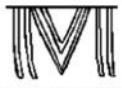
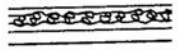
In terms of ceramic technology, Angkorian potters utilized various techniques, such as wheel-throwing, coiling, molding, and hand-modeling (Cort 2000:111-114). The potters used a potter's wheel to shape the clay into the stoneware vessels, either from a lump of clay or beginning with a coiled base shape for larger vessels before throwing it on a wheel (Cort 2000:112). Angkorian potters also utilized hand-molding to create zoomorphic and anthropomorphic shapes and to add human- or animal-like features to ceramics. Instead of paint, Angkorian potters used several different techniques to decorate the ceramics. For the most part, Angkorian potters decorated their wares while the vessels were still on the wheel. The potters cut profiles into the vessels using combinations of lines, molding, combing, and motifs incised or impressed into the vessel just after shaping to produce a repertoire of bands and lines that are typically horizontal but can also include vertical or diagonal lines (Cort 2000:115) (see Table 3). Such decorations indicate that the Angkorian potters used simple tools to create their ceramics.

Likewise, the Angkorian clay and glazes were fairly simple. Two different types of clay were used to create Angkorian stoneware ceramics – a fine white-to grey-colored

Table 3. Examples of decorations used on Angkorian ceramics (reproduced from Wong 2010, Table 4.3)

dots	lines			Lines, circles and dots			
	Horizontal straight line						
	Double lines	Four lines	Five lines				
							
(Chhay and Chap 2002:96,453)	(Chhay and Chap 2002:95,433)	(Chhay and Chap 2002:95,436)	(Chhay and Chap 2002:95,435)	(Chhay and Chap 2002:97,466)	(Chhay and Chap 2002:97,464)	(Chhay and Chap 2002:97,459)	(Chhay and Chap 2002:97,461)
Dots and lines	With inclined line						
							
(Chhay and Chap 2002:96,450)	(Chhay and Chap 2002:95,434)	(Chhay and Chap 2002:95,435)		(Chhay and Chap 2002:97,457)	(Chhay and Chap 2002:97,465)		
Strips and dots	Lotus petal			Strips			
	Double lines	Four lines	Five lines	Single strip	Double strips	Triple strips	Forth strips
							
(Chhay and Chap 2002:97,454)	(Chhay and Chap 2002:96,447)	(Chhay and Chap 2002:96,448)	(Chhay and Chap 2002:96,449)	(Chhay and Chap 2002:96,445)	(Chhay and Chap 2002:96,446)	(Chhay and Chap 2002:96,441)	(Chhay and Chap 2002:96,442)
Strips, dots and lines						Multiple strips	
							
(Chhay and Chap 2002:97,455)	(Chhay and Chap 2002:97,456)	(Chhay and Chap 2002:96,451)	(Chhay and Chap 2002:96,452)	(Chhay and Chap 2002:96,439)	(Chhay and Chap 2002:95,437)	(Chhay and Chap 2002:95,438)	(Chhay and Chap 2002:96,443)	(Chhay and Chap 2002:96,444)

2. Decorative patterns from Sarsey and Khnar Por kilns

lines		Lines and dots			Lines, strips and dots		
							
Sarsey (Tin 2003:145)	Sarsey (Tin 2003:145)	Khnar Po (Em 2004:122)	Khnar Po (Em 2004:121)	Khnar Po (Em 2004:123)	Sarsey (Tin 2003:145)		
							
Sarsey (Tin 2003:145)	Khnar Po (Em 2004:124)	Khnar Po (Em 2004:120)	Khnar Po (Em 2004:133)	Khnar Po (Em 2004:125)	Sarsey (Sok 2003:279,276,278)		

clay was used for green glazed wares while a coarser mixed clay was used for the brown wares (Brown 1977; Cort 2000; Ea 2010; Groslier 1981; Guy 1989, 1997; Rooney 1981, 1984, 1987; Wong 2010). Similarly, two basic glazes, green and brown, were used. Green glaze is thought to have been produced earlier, around the beginning of the ninth century, while brown glaze was introduced later, towards the end of the tenth century. The wide variation in glaze color and hues depended on the composition of clay used as well as the composition of the glaze. The color and quality of both glaze types seem to evolve through time, which suggests experimentation. However, the approximate timing of glaze evolution is unknown. The first type of glaze, the ash or lime glaze, turns into a green glaze that was initially a thin, translucent, almost colorless glaze. This evolved into a light straw-colored yellowish green that is thicker than the previous glaze and crazed (has fine cracks) before advancing to a light straw-colored greenish yellow or a light green that is thicker, crazed, translucent, and mottled (Rooney 1990:10). The characteristic defects of the earlier green glaze are crazing or flaking of the glaze during firing, while crawling (separation of the glaze from the body during firing) is typical of the later green wares (Rooney 1990:10). The second and later type of glaze, emerging around the tenth century, is an iron oxide glaze that produces a brown glaze that ranges from a light caramel to a golden brown to an olive brown, or a brownish black glaze. The color of the glaze darkens based on the proportion of the iron in the glaze (Rooney 1990:10).

Groslier's '*lie-de-vin*' glaze is generally thought to be accidental and caused by the impurities in the clay bodies of the vessels but it is possible that the color was deliberate. The potters also produced a two-toned glaze ware that was usually green on the upper portion, around the neck of the vessel, and brown on the bottom part of the body. Depending on the size of the vessel, the potters would laminate white clay onto a red clay body to create these distinctive vessels (Cort 2000:120).

With the discovery of kilns and ceramic wares within the Angkor region as well as other provinces, the issue of feature identification arises. In attempting to classify form and decoration, the underlying issue is that data regarding form types may be missing or

incomplete (Orton et al. 1997:76). Before Angkorian brown ware kilns were found in several provinces in Cambodia, most, if not all, brown wares were thought to be from Buriram, especially when these wares were archaeologically unprovenienced. Although some scholars might be able to tell the difference between Buriram brown or green ware and Angkor brown or green ware (Chhay Rachna, personal communication 2012), little has been published to disseminate the identifying features or differences of these two wares. Closely connected to the issue of identification of wares from individual areas of production is the issue of identifying the form and function of many Angkorian stoneware ceramic pieces. As some wares are not used or produced today and there is no written record of what specific vessels were used for, scholars are left to guess the function of a vessel based on the shape and morphological features of it.

The classification of Angkorian ceramics is usually based on morphological characteristics, such as rim, body, jar, and pot. A standardized typology of Angkorian stoneware ceramics was only recently developed. Groslier was one of the only scholars who attempted to use the Khmer names when describing ceramics, quite possibly due to possessing the unique perspective of someone living amongst the Khmers (Guy 1997). He tried to relate the use of the Angkorian ceramics with elements of everyday life while he lived in Cambodia. It is interesting that Groslier organized the contemporary production into three main groups using the Khmer names – *kaam* for containing liquids, *thlang* or cooking pot, and *khvang* for food storage which is linked to the *peang* sub-group of jars (Groslier 1981:10). However, he described the Angkorian stoneware using western terms and lengthy descriptions – covered boxes, bowls, baluster vases, jars, jugs, and bottles (Groslier 1981:18, 23, 28). In the same vein, many other researchers used English descriptions that could not account for the variety of ceramic shapes and forms. Rooney discussed bottles, bowls, covered boxes, jars, urns, and pots among the shapes apparent in the ceramic assemblage of the Kamratan Collection (Rooney 1990:11-16). Brown described the wares as jars, urns, bowls, bottles, and covered boxes (Brown 1977:37). While this initial typology may seem to be generalized and standardized, the subtle differences in the vessels themselves were not articulated in the type, and

morphological differences such as whether the neck was short or long had to be conveyed in text.

During the past decade, with many local Cambodian scholars involved in Angkorian ceramic studies, efforts have been made to use Khmer words and names to describe wares. Scholars at APSARA, in conjunction with other local and foreign researchers, have begun creating a typology of the morphological traits of Angkorian stoneware based on ceramics from two sites, Bang Kong and Anlong Thom. This tentative classification is based on the morphologies of the recovered artifacts that are still known to the locals in the surrounding areas and the Khmer terms that are still found in the Khmer dictionary. The product is a flexible paradigmatic classification system based on shapes and morphological features such as rims, bases, decorations, and incisions (Miksic et al. 2009:9). Separated by hyphens, each shape is coded alpha-numerically with the first capital letter indicating the main family, the small letters following this indicating subgroups or sub-subgroups that allow for the definition of shape varieties within the subgroup category, and a final numeric code defining the specific morphology and style variations; for example, A-a-a1 (Miksic et al. 2009:9).

This system allows for easy and endless additions to specific categories and classes. The Khmer terms are much more specific than English terms, encompassing both the shape and function of a vessel. The categories are *kpoeurng, danlap, kotth, khuoch, krala, phoeng* and/or *peang, ak kambor, ka-am, chhnang,* and *chan* (see Table 4). The system is also conducive to describing and accounting for the variety in ceramic form visible in the Angkorian stoneware ceramic assemblage (see Figures 7 and 8). However, no typological code for firing supports due to their distinctive characteristics. Firing supports can be divided roughly into three main types. A sausage-like shape (B, BC, C), semi-cylindrical brick-shaped support used to stand on the inclining floor, and a piece of clay applied to the interiors of A, B and C to stack smaller ceramics inside bigger ones. In addition, recent work by Sok (2009), using ceramic vocabulary in Old Khmer or Sanskrit inscriptions to verify the Angkorian ceramic typology and create a chronology of wares, has interesting implications for understanding Angkorian ceramics.

Table 4. Classification system for Angkorian ceramics (Miksic et al. 2009).

Khmer name		Code	English
Main	Sub		
Kpoeurng (roof tile)	*Kpoeurng phkap*	A-a	Round tile or cover tile
	Kpoeurng phnga	A-b	Flat tile or canal tile
	Rong sbov	A-c-	Carved wooden plank used at the distal end of roof 'eave tiles'
	Prum dambol	A-d-	Finial tile
Danlap (covered container)		B	Small or large globular covered box used to store bees' wax or perfume
Kotth		C	Urn used to store cremated ash
Kumrop		BC	Lid
		BCE	Lid
Khuoch		D	Bottle
Krala (and/or *peang*)		E	Jar
Phoeng (and/or *peang*)*		F	Cylindrical vessel; flowerpot
Ak kambor		G	Zoomorphic pottery in bird form
Ka-am		H	Water vessel
Chhnang		I	Cooking pot
Chan		J	Bowl or plate
Unidentified		U	Unidentifiable pieces

*Additional terms for *krala* and *phoeng* are used depending on function. Due to confusion of the term *peang*, its identification will fall into both categories E and F.

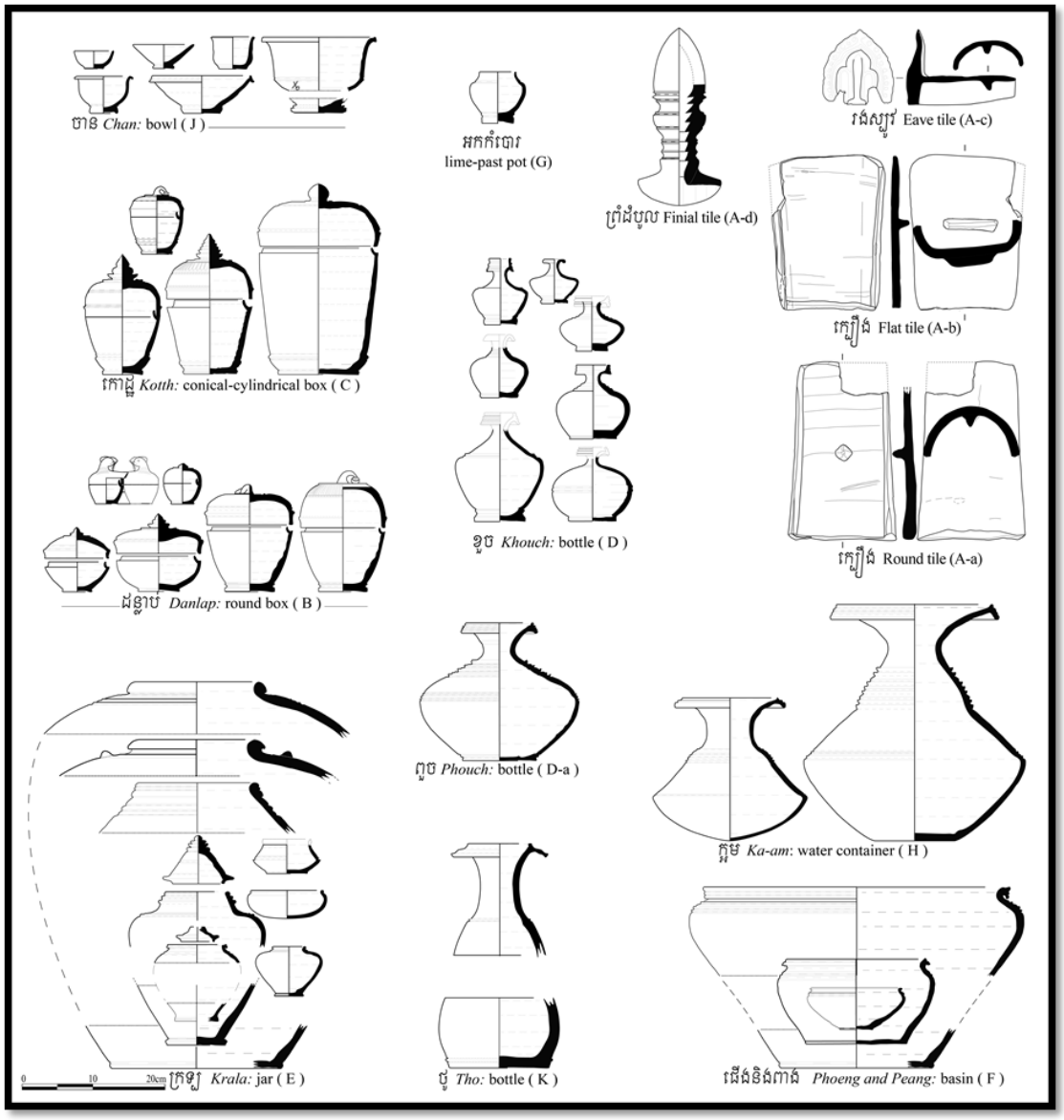


Figure 7. Examples of the various types of Angkorian stoneware ceramic forms (adapted from Chhay et al. 2013).

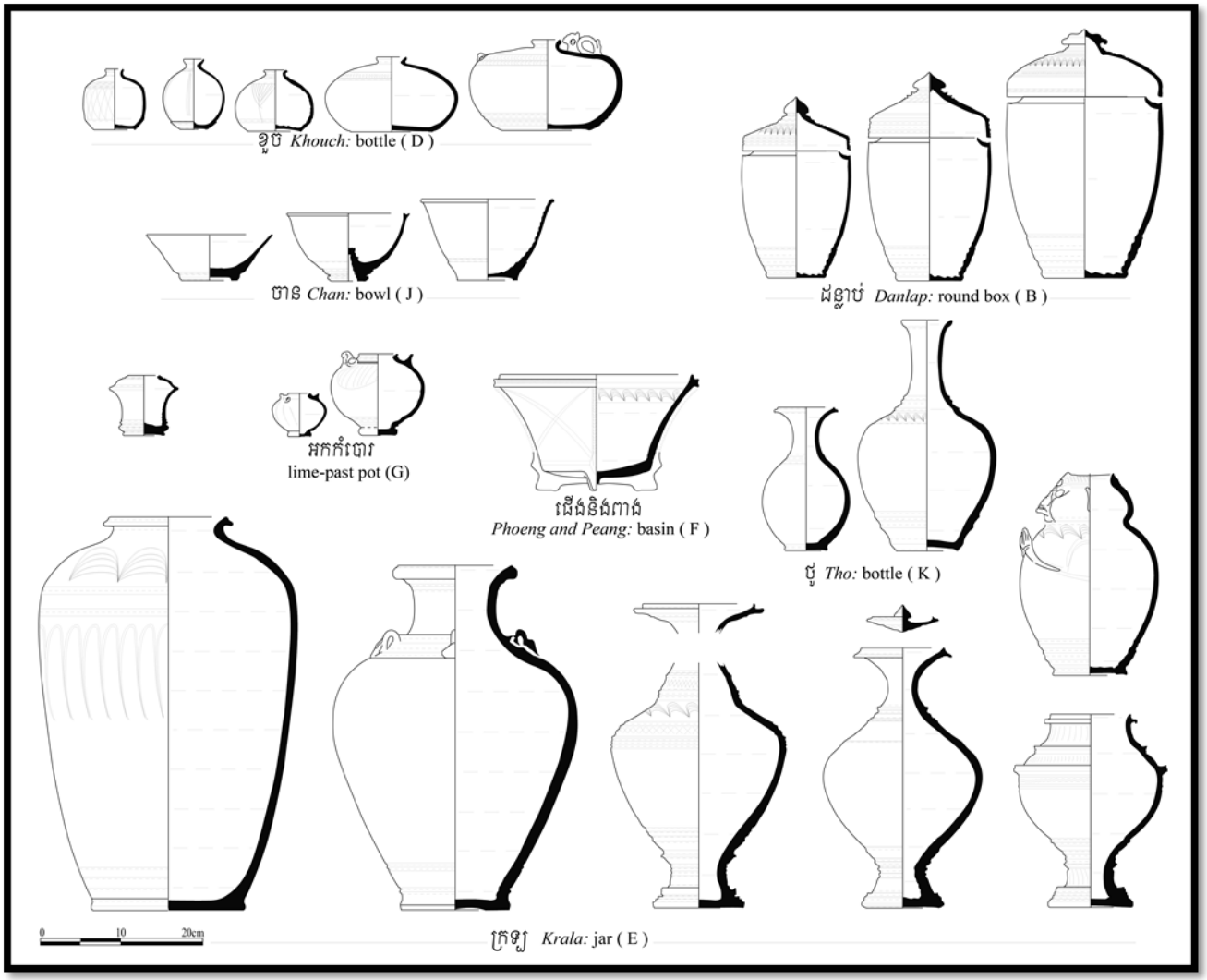


Figure 8. Examples of the various types of Angkorian stoneware ceramic forms (adapted from Chhay et al. 2013).

What affects the research on Angkorian ceramics identification and classification is the language usage as well as the typologies themselves. With many international teams working on ceramics at different sites, many words to describe the different types of Angkorian wares are based on English or French words instead of Khmer words, and each site has its own typology of wares (Brown 1977; Desbat 2011; Ea 2010; Groslier 1981; Miksic 2009; Rooney 1984; Wong 2010). Many researchers are forced to rely on lengthy descriptions of wares, while certain wares have more than one name or description. The methods of research and the interpretations are as different as the languages in which the scholarship is conducted. This complicates the identification of wares at sites, as well as the sharing of data across projects to create a collective or comprehensive database.

Organization

Another theme in the early stages of investigation is the theme of organization. The organization of production and distribution is important for any industry. Typically, the organization of ceramic production can be seen by locating the source of clay and the location of the pottery-making industry (Rice 1987:180). The scale, mode, and variability of production are factors that should be considered when discussing the organization of production (Rice 1987:170). The scale of production involves the level of labor, resources used, and market demand. Stoneware ceramics technology involves a high level of specialization and organization that requires in-depth knowledge of clays, glazes, temperature control, and even architecture in order to take advantage of the natural resources and surroundings when building and using kilns. The mode of production is connected to the manufacturing technology utilized, the role of producers and consumers, and the relation between production and investments.

With new information, the scope of production and distribution of Angkorian stoneware ceramics has been revealed to be far larger than previously thought. While it is unknown to what extent the Angkorian potters were connected to or independent from the central administrative core of Angkor, the use of wheel-throwing techniques, kiln

production of stoneware, and the standardization of forms suggest that the Angkorian stoneware industry involved production of ceramics at both the small-scale cottage industry and large-scale mass production level. This, in turn, implies that the stoneware industry was an organized, specialized industry. As more kilns and workshop sites are discovered, researchers can work towards investigating the nature of Angkorian stoneware production to address questions regarding the scale and mode of production, the level of specialization among Angkorian potters, and the extent of involvement that the central governing authority had over the production of stoneware ceramics in Angkor.

Based on the various research conducted on ceramic sherds and forms from Angkorian sites, as well as the bas-reliefs depicting vessels that are assumed to be ceramic, Angkorian stoneware ceramics were likely used for domestic, religious, ceremonial, and architectural purposes (Brown 1988:42-43; Cort 2000:127; Groslier 1981:12-13). Arguments for the vastly different uses are based on the shape and form of the ceramic wares as well as their association with the sites where the ceramics and kilns are found. Kiln sites are typically found within proximity of – and associated with – temple sites, which suggests a relationship between Angkorian ceramics and their use in religious and ceremonial activities. The forms of ceramics are similar to what are commonly identified as metal or wooden vessels that are depicted on the bas-reliefs or are known to be religious or ceremonial implements. That the forms of these religious or ceremonial ceramics do not appear to have changed very much over the lifespan of the Angkorian ceramics industry, nearly five centuries in duration, suggests a specific purpose for the ceramics that is linked to symbolic and ceremonial importance (Cort 2000:127; Taylor and Foley 1999). The idea that the kilns on Phnom Kulen were royal kilns has been considered, but no concrete research has been conducted to prove this hypothesis. Instead, scholars are more likely to suggest that Angkorian ceramics were intended for the elite to use in their daily and ceremonial activities (Wong 2010:277).

The possibility that Angkorian ceramics were more suited to ceremonial or religious use meant that the unique developments of the Angkorian religion was a deterrent for export or distribution beyond the borders of Angkor because none of the

polities trading with Angkor had the same need or value for these ceramic implements (Guy 1997:42-49). The uniqueness of Angkorian ceramics is further compounded by the fact that these ceramics do not seem to have been traded beyond the boundaries of the Angkor Empire. This limited distribution suggests that Angkorian ceramics were made for domestic consumption, that they did not appeal to a wider audience in terms of function or style, and/or that the ceramic distribution networks of Angkor focused on distribution within a certain area based on resources or other factors. Whatever the reason, the restricted distribution of Angkorian ceramic wares is used as the basis for an argument for provincial production centers instead of centralized distribution being controlled by a centralized authority (Lefferts and Cort 2008:293). This argument is supported by Hendrickson's research (2008) on Teap Chei (Torp Chey), where brown ware kilns have been found along a road leading out of Angkor. These kilns imply that brown ware was produced within Angkor and not imported from kilns in Buriram. Since a majority of these brown wares were not widely distributed within the central core of Angkor, the distribution of brown wares and brown ware kilns suggests that provincial kilns were established to meet the ceramic needs of the local population. Lefferts and Cort (2008) also suggest that ceramic production on Phnom Kulen was made for distribution to the populace on Phnom Kulen, and that distribution to the wider Angkorian region was limited by the remote and harsh terrain of Phnom Kulen. The argument is that wares were produced and distributed within the provincial area. However, the proximity of the kilns to the roads could possibly mean that some of the wares produced were being sent to Angkor. Indeed, Brown and Groslier have noted the presence of Buriram brown ware in the Angkor region, so the distribution of wares was not just restricted to provincial centers.

Another factor said to have affected the trade of Angkorian ceramics is market demand. China obviously dominated the market for ceramics in that they were able to produce a variety of high-quality ceramics in large quantities that specifically catered to the Angkorian aesthetic values at a low or reasonable price (Brown 1988:53-54; Groslier 1981:30-31; Wong 2010). The distribution of Chinese wares at various archaeological sites within Angkor suggests that there was a demand for these wares, and that a growing

percentage of Chinese ceramics at later levels of excavation is paralleled by a diminishing indigenous presence (Groslier 1981; Guy 1997:42; Wong 2010). However, more research needs to be conducted to prove that the decline in Angkorian stoneware ceramics is directly correlated to a rise in Chinese ceramic imports. The quantity of wares distributed throughout Angkor from certain kiln sites is unknown, as is the extent of the distribution network and how the wares were transported. Until more research is done on tracing the compositional materials of ceramics to certain areas, researchers can only speculate as to the scope of the network based on the characteristics and physical appearance of the wares that resemble wares from different kiln regions, such as Buriram brown ware in comparison to Angkor brown ware.

The hypothesis that the Angkorian stoneware ceramic tradition flourished and declined due to supply and demand, or even with the rise and fall of the Angkor Empire, is interesting. This hypothesis regarding the distribution and development of Angkorian ceramics as closely connected with the territorial expansion of the Angkor Empire as well as growing trade networks, requires research work that transcends the fluid borders of the Angkor Empire.

The ever-increasing collective knowledge of Angkorian kiln sites has made an impact on the field of Angkorian ceramic and kiln studies. Through the discovery of kilns along the ancient roads leading out of Angkor, including the kilns in the northeastern provinces of Thailand, it is possible to link the distribution of Angkor period kiln sites, monuments, and water features with the expansion of the Angkor Empire (Ea 2006). The discovery of kilns in the Angkor region provides concrete evidence of ceramic production industries closer to the center of the Angkor Empire (Aoyagi et al. 1998; Hendrickson 2008; Tin 2004).

With the discovery of the brown glaze stoneware kiln sites in Banteay Meanchey, Oddar Meanchey and the Angkor region, Brown's earlier hypothesis of brown ware production being restricted to the northeast provinces of Thailand and being imported along the road from Phimai to Angkor has been disproved (Brown 1988:46). These Angkor brown ware kiln sites confirm that brown-glazed ceramics were made and

distributed locally (Hendrickson 2008:55). Furthermore, these new kiln sites provide researchers with more information on the sources, development, and expansion of brown ware production and distribution, especially since many of these brown ware kilns are located along the ancient roads. The popularity and prevalence of brown ware over green ware could have been caused by the development of the roads in the tenth and eleventh centuries, where the accessibility of materials, such as clay availability, initiated a change in wares (Ea 2009:213-214).

The appearance of light brown-glazed ware at the TMK kiln group of Anlong Thom on Phnom Kulen supports the hypothesis that brown ware appeared during the late tenth to early eleventh century (Miksic et al. 2009:52-54). The light brown ware represents a possible experimental stage in the transition from green glaze to brown glaze. Due to the occurrence of brown glaze kilns along the roads, it appears as though the brown wares were introduced to the population at large as the potters moved out of Angkor to the provincial centers where the fine white clay of Phnom Kulen was not so readily available (Ea 2009:213-214). Whether the same potters were involved in this transition out to the provinces is a question that needs more time and research before it can be answered satisfactorily. The change in the raw material would account for the change in clay composition as well as for glaze type, but would not be totally responsible for the change in forms or shapes. Additionally, craft production is typically based on apprenticeships that span several years. It may therefore be possible to trace the lineage of potters based on the ceramic wares produced due to the similarities in the wares as well as the kiln structures.

Some scholars argue that distribution from the Phnom Kulen kilns was restricted to the surrounding Phnom Kulen area due to the distance between the central temples of Angkor and Phnom Kulen (Lefferts and Cort 2008:293). This hypothesis is interesting, but does not take into account the fact that many of the temple building materials were quarried from Phnom Kulen; the transportation of ceramics, along with the quarried stone, would not have posed a problem. The availability of the raw materials for making green ware, the symbolic significance of Phnom Kulen to the Angkorian people, and the

quality of the wares produced on Phnom Kulen would also contribute to the demand for wares from Phnom Kulen in the capital.

It is uncertain if the consumption patterns of Angkorian ceramics spanned both elite and non-elite use of certain ceramic wares for daily or occasional use. There has been little excavation conducted on residential elite and non-elite sites in the Angkor region. Therefore, the nature of common versus elite consumption of stoneware is an issue that requires extensive archaeology. It is possible that the nature of consumption changed over time, but unless more research is conducted to see if consumption patterns are visible through a holistic study of all ceramic shapes and the quantity of those ceramic forms in both the elite and non-elite context, it is difficult to pinpoint an exact ratio of consumption in Angkorian society. The discovery of more kilns in the Angkor region, combined with the study of differences in the quality of wares found in the kilns themselves, as well as at habitation sites might indicate a distinction, if any, between elite and common wares and kilns.

Comparison of the excavations in northeast Thailand and in the Angkor kilns reveals that, although similarities exist between the brown wares of the two areas, there are differences in the kiln structures as well as the ceramics. Groslier (1981) considered the brown wares from Angkor to be superior in quality to the provincial wares from Buriram kilns. It could be that these differences are due to local preference or innovation, but more research needs to be conducted before this hypothesis can be confirmed. In this sense, there is ample future work that can be done in terms of differentiating between the different types of brown ware from the various brown ware-producing areas. Some scholars make distinctions between Buriram brown ware and Angkor brown ware, but as yet, there have been no publications on the differences, if any, between the two. The most recent research conducted in relation to questions of sourcing involves Desbat's geochemical compositional analysis of stoneware fabrics from several excavated kiln sites including Tani, Sar Sei, Anlong Thom, and Torp Chey, among others. Desbat's program seeks to define the known characteristics of production, such as cataloguing a directory of forms and technical aspects for each site (Desbat 2008, 2009, 2010).

Desbat's work would enable researchers to analyze the consumption and distribution of sites based on the clay composition of the ceramics. This research has interesting implications on a regional level if more testing results in a bigger database that includes data from Angkorian sites in Thailand, Laos and Vietnam.

CHAPTER 6. CONCLUSIONS

Summary of Findings

This thesis began with an introduction to the research questions and scope of this project, and included an explanation of terminology within the thesis. Chapter 2 provided a brief overview of other stoneware traditions within the region in present day Myanmar, Laos, Vietnam, and Thailand. This general history is useful for placing the Angkorian stoneware ceramics study in perspective in relation to the other stoneware ceramic traditions.

Chapter 3 presented the history of Angkorian stoneware ceramic and kiln scholarship from the infancy of the field to current research work. A brief overview of Angkorian ceramic studies and a summary of the geopolitical variability was given at the beginning of the chapter. The history of scholarship begins with an introduction to Groslier's pioneering research on stoneware ceramics chronology, which is discussed along with other significant works by Rooney and Brown that were published in the seminal book *Khmer Ceramics, 9th – 14th century* (Stock 1981). A number of collections-based projects and some field-based projects are mentioned. This chapter briefly discussed previous research on kilns in Thailand as well as the history of scholarship on Angkorian kilns, including excavated and unexcavated kilns in Cambodia. As outlined in this chapter, research on collections with and without archaeological provenience continues and more excavation work on kilns is being conducted at a rapid pace. Together, these avenues of research will allow for a better understanding of the Angkorian ceramics industry and the relationship between the different kiln traditions in the region.

Chapter 4 discussed origin theories of Angkorian kiln and ceramic technologies. While an Indian or indigenous Southeast Asian origin is possible, the dominant kiln origin theory involves Hein's (2008) suggestion of technological transmission from China in two zonal phases. On the other hand, ceramic technology not only displays

influences from both China and India, but also indigenous development. Examining the relationships between Angkorian kiln traditions both internally in the Angkorian region and externally with neighboring countries in Southeast Asia, as well as in India and China, will assist researchers in determining the origin and routes of transference for kiln and ceramic technologies.

Chapter 5 presented the central research themes and issues of Angkorian ceramic and kiln studies related to this research. The three main research themes are chronology, classification, and organization. Major strides have been made in the last decade as researchers revise the chronology of the wares and traditions through the use of current technological methods. Many of the inherent issues stem from the fact that ceramic and kiln studies in Cambodia are still in the early stages of development and will be resolved as more work is conducted in the near future.

Conclusion and Future Directions

The purpose of this work was to review selected previous research in the field of Angkorian ceramics and kiln studies, primarily within present-day Cambodia. The literature on Angkorian ceramics was presented to form an overview of the research undertaken, key debates, issues, and possible future directions within Angkorian stoneware ceramic studies. A brief summary of the history of research on Angkorian ceramics and kilns was provided before key research areas are discussed. The reoccurring central research themes in this thesis include origin theories, chronology, classification, and organization.

Although an attempt was made to summarize much of the work conducted in the field of Angkorian ceramics, a complete overview of the field is not possible due to linguistic limitations. The biggest obstacle to a comprehensive review is the sheer scope of international effort that has been made at Angkor in terms of archaeology. As research in the Angkor region has become an international effort in recent years, many of the publications and reports are in several different languages. Most of the published works

in English are fairly accessible, but many of the unpublished English works as well as the works that are written in foreign languages are not as easily available, particularly theses and internal reports. Few French and Japanese-language reports and publications and no Khmer-language reports, theses, and publications were included in this review. Unfortunately, most of the accessible publications on ceramics are based on ceramics from various existing collections rather than excavated ceramics. The field-based publications and internal reports remain in different languages as different teams conduct research. This fact has been noted by scholars, who suggest that every researcher conducting research in Cambodia and Angkor should try to publish in English and Khmer on top of their native language so that the information is accessible to all (Wong 2010:289).

A related issue deals with the fact that the various international teams have used different methods of excavation and artifact assessment that do not allow for the data of different research projects to be directly compared or contrasted easily by other researchers. Standardization of techniques would be ideal, but because archaeologists tend to come from different theoretical backgrounds and practical training, an attempt at uniformity in terms of excavation and laboratory methods would not work.

Despite the language barriers and differences in methods, every researcher in the field of Angkorian ceramic and kiln studies has much to contribute to the archaeological scholarship of Angkor and Cambodia. The technological and stylistic changes of ceramics can be traced through time and they provide a chronology of traditions. Additionally, the study of ceramics can present clues to trade and alliance relationships, and inform on the nature of consumption and distribution patterns vital to the sociopolitical organization of polities. While such information is valuable in piecing together Cambodia's prehistoric and early historic periods, the field of Angkorian ceramic studies has not yet been able to explore these exciting avenues of research in detail. The initial effort to provide a chronology and investigate the implications of the ceramic industry within the sociopolitical context has been made and continues to be refined.

Many new kiln sites have been identified within the past few years; it is expected that there are many more undiscovered kilns throughout the immediate Angkor region and beyond. These recent discoveries and research have already contributed immensely to the study of Angkorian ceramics. Hopefully the scope of research will continue to expand and the many questions that current research is generating can be answered. The excavation in other areas of Cambodia and even portions of neighboring countries that were once part of Angkorian territory will address questions of chronology and distribution, as researchers will be able to refine the dating of sites and wares and produce a reliable and proven chronology. However, a regional study of kilns and ceramics would also be beneficial.

As Angkorian kiln and ceramic studies are just emerging from research focused on Angkorian monuments, there is much work that can and will be conducted in the future. There are several interesting avenues that researchers could pursue; for example, utilizing kiln lineages to trace the origin of kilns, looking at the nature of consumption and production patterns of the various glaze wares, and further refining both the kiln and ceramic typology.

While most researchers agree that the crossdraft kiln technology and certain ceramic forms created by Angkorian potters were introduced or influenced by Chinese potters, the origin of the Angkorian ceramics industry is still not precise (Brown 1988; Groslier 1981; Guy 1997; Hein 2008, 2011; Rooney 1984; Taylor and Foley 1999). Researchers are currently trying to identify the original source of innovation and technology beyond the general Chinese point of origin. This issue can be potentially addressed with more archaeological research on the pre-Angkorian ceramics industry. While it is generally accepted that Indian and Chinese influences were incorporated into the Angkorian ceramics industry to produce ceramic wares that are uniquely Angkorian, little is known about the transference of technology or ideas and how deeply the Angkorian potters were influenced by either culture. Additionally, not much has been said about the introduction and production of unglazed stonewares, which surely

preceded the glazed stonewares that were probably introduced around the beginning of the ninth century. The various phases of development and decline of the Angkorian stoneware industry are not clearly defined and are quite difficult to substantiate using archaeological research at this current stage. Just as research into the pre-Angkorian ceramics industry is important, so too is work on the post-Angkorian ceramics industry. This avenue of research has already been started with the discovery and very recent excavation of the Cheung Ek kiln, which is located near the present-day capital of Phnom Penh. The discovery and excavation of experimental kiln or ceramic production sites would be beneficial. Such sites would provide insights into the development of the Angkorian ceramic industry and might possibly connect both the pre-Angkorian and post-Angkorian ceramic industries with the development and production of Angkorian ceramics. This type of work needs to be conducted on kilns on both a local and regional scale.

Additionally, obtaining at least one date from each kiln site in Southeast Asia and applying the data, as well as other data such as kiln shape, kiln type, and kiln furniture to Hein's model of kiln lineages would allow researchers to contribute to a more holistic view of the various kilns and their relationships to each other.

In comparing and contrasting the various kilns that have been excavated in Cambodia and northeast Thailand, the similarities and differences in the kiln technologies and in the ceramic wares provide researchers with future directions in typology. It could be that these differences are due to local preference, materials, or innovation, but more research needs to be conducted before this hypothesis can be confirmed. Some scholars make distinctions between Buriram brown ware and Angkor brown ware, but as yet, there have been no publications on the differences, if any, between the two. For instance, Groslier and Brown both considered the differences between Buriram brown ware and Angkor brown ware to be noticeable enough that one type of ware was considered to be of higher quality than the other (Brown 1988; Groslier 1981). In this sense, there is ample future work to be done based on the compositional analysis of the wares that can be performed to differentiate between the various types of brown ware from the many brown

ware producing areas. If enough compositional work was collected on both kilns and ceramics, as Desbat has begun, it is possible that sites could be dated through the ceramics. The issues of typology and chronology are ongoing and continual revision based on contemporary research will allow for more precise chronologies and typologies of the Angkorian ceramic wares and kilns. The chronology of ceramics has already been established and is continually being improved, but a chronology or typology of kilns still needs to be created once more kilns are discovered and excavated.

While studies on the composition of clay fabric and inclusions can inform researchers on the source of raw materials, it is difficult to compare the compositions of different assemblages in terms of classification, as it is impossible to assign all sherds a type. Additionally, quantification of sherds and whole ceramics does not seem to be addressed. This could be difficult because quantification depends on what is found, which is finite compared to the infinite number of ceramics that have not been found.

Another avenue of future research would be to determine the nature of consumption and distribution patterns relating to the Angkorian ceramics. Of particular interest would be the differences, if any, between the ceramic consumption of the elite and the commoners and if there was a change in the nature of consumption that is visible in the archaeological record. This direction of research would have to take typology into account as well as the use, quality, and quantity of ceramic wares at various sites. The quantity of wares and the variety of sites would tie the nature of consumption together with the nature of the distribution network of the kilns and ceramics. Current research has linked the production and distribution of most wares with the surrounding area, where distribution would be more likely to be provincial rather than through a central authority. However, production is a certain area does not necessarily mean that distribution will happen locally. As with typology, more work on tracing the compositional materials of the wares to certain production areas would be beneficial to this line of research. Being able to trace the fabric of the ceramic pieces back to the area of origin would provide researchers with information that could address trade networks, gift economies, and ceramic aesthetic values. The geographical distribution of ceramics is related to

identifying the source of ceramics through studying the fabric and inclusions in the clay. This distribution is associated with ceramics as evidence of trade. Different modes of distribution may affect the proportions of ceramics from different sources at sites.

More research into the kiln sites and ceramics will no doubt provide more information on the origins and development of ceramic styles, production, distribution, and the movement of potters or their technologies and techniques throughout the Angkor Empire. As more data is collected, it will be possible to make more comparisons between kilns and wares. For instance, comparisons of the Angkorian stoneware found at different sites such as at the royal palace versus at a temple versus at a village or burial site, will provide information about the importance and use of certain wares over others depending on context. It will allow us to see if there are certain distinctive wares from each site and if there is a range of output. A shared database detailing percentage of sherd types, forms, decorations, and so on would be useful for researchers who intend to conduct comprehensive or comparative studies. If a database is not practical, then a public archive would be essential for future research. APSARA has taken the first step towards such a repository by forming the Angkor International Research and Documentation Center. It might be helpful for APSARA to require a one-page summary or archive report for each report or publication that is submitted, and to make the submission of reports a mandatory requirement for working at Angkor. Researchers are taking precautions at current kiln sites to ensure that comparative studies between kiln sites will be possible in the future (Miksic et al. 2009). This foresight will be incredibly beneficial to the field of Angkorian ceramics as more work is conducted. Much more research is needed and will contribute greatly to the overall understanding of the Angkorian people and the Angkor Empire.

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