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To cite this article: Xiaohang Song, Ran Zhang & Derek Kennet (31 Jan 2024): The organization of Chinese ceramic production from the Tang to the Ming periods: archaeological evidence from ceramic workshops, World Archaeology, DOI: [10.1080/00438243.2024.2304327](https://doi.org/10.1080/00438243.2024.2304327)

To link to this article: <https://doi.org/10.1080/00438243.2024.2304327>



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The organization of Chinese ceramic production from the Tang to the Ming periods: archaeological evidence from ceramic workshops

Xiaohang Song^a, Ran Zhang^a and Derek Kennet^{a,b}

^aDepartment of Archaeology, Durham University, Durham, UK; ^bInstitute for the Study of Ancient Cultures, University of Chicago, Chicago, USA

ABSTRACT

This paper analyzes the plans and layouts of Chinese ceramic workshops from the Tang to Ming periods (seventh to seventeenth century AD) to understand how ceramic production was organized and how organization developed over time. Through the comparative examination of 254 workshops from 96 workshop sites, two workshop types have been defined based on the spatial arrangement of their production facilities. This paper argues that each workshop type reflects a different degree of labor specialization, and despite some regional differences, the organization of ceramic production developed in a consistent way across China.

ARTICLE HISTORY

Received 22 October 2023
Accepted 24 November 2023

KEYWORDS


Industrial organization; labor specialization; ceramic manufacture; Chinese ceramics; workshops

Introduction

Chinese glazed stoneware and porcelains were widely consumed in both China and, from the ninth century onwards, around the Indian Ocean (Gutierrez et al. 2021; Zhang 2016, 17–19). Their wide dispersal and relatively accurate dating make them a key archaeological resource for investigating the organization and development of Indian Ocean trade and China's involvement in that trade. The study of these ceramics has predominantly focused on their stylistic or technological development (e.g. Kerr and Wood 2004; Li 1998; Pierson 1996; Xiong 1995), while the use of archaeological evidence, such as the remains of workshops, to study the organization of production has received much less attention. This seems to be partly due to contemporary textual descriptions of production (although such texts inform us only about the highest-quality products) and the relatively small number of workshops that have been carefully excavated and covered in publications.

Ceramic workshops are amongst the archaeological remains with the greatest potential for providing information about the technical aspects of ancient ceramic production, as well as the way in which production processes were managed and labor was organized (Deal 1998, 70; Rye 1981, 7). Some work based on archaeological evidence has been carried out in recent decades on the organization of labor in ceramic industries worldwide, with the majority of the research being focused on the prehistoric Middle East (e.g. Frankel and Webb 2014; Hansen Streily 2000; Stark 1985), ancient Rome (e.g. Murphy 2017; Peacock 1982), and pre-modern Europe (e.g. Crook 2005; Miller 1980; Whipp 2018). Despite the global significance of Chinese ceramics from the Tang period

CONTACT Xiaohang Song  xiaohang.song@durham.ac.uk  Department of Archaeology, Durham University, South Road, Durham DH1 3LE, UK

 Supplemental data for this article can be accessed online at <https://doi.org/10.1080/00438243.2024.2304327>

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onwards, ceramic production practices in China have received only limited attention, the majority of studies being literature-driven. Literature-based studies have mainly focus on government management and tend to use archaeological evidence to reinforce ideas taken from historical texts, suggesting that the production of the highest-quality ceramics was controlled by the imperial court (e.g. Liu 1994; Wang 2004). Studies based on archaeological evidence are discussed in only a few case studies on the Cizhou and Yaozhou sites and suggest that some workshops between the Tang and Song periods (AD 618–1279) showed evidence for a specialized division of labor (Chen 2017; Qin 2010; Wang 2016). However, an overview of the development of the organization of ceramic production from the Tang dynasty onwards in China has not been carried out.

This paper will analyze the plans and layouts of Chinese ceramic workshops with the intention of setting out a new interpretive framework for the organization of ceramic production and labor between the Tang and Ming periods. Through the comparative examination of 254 workshops from 96 sites, two workshop types have been defined based on the spatial arrangement of production facilities. This paper will argue first that each of the two workshop types reflects a specific method of organizing production involving different degrees of labor specialization. Second, by comparing the occurrence of the two workshop types in time and geographical space, it will argue that, despite regional differences, the labor organization of production developed in a consistent way across China. The methods employed are innovative and do have uncertainties; the conclusions drawn are therefore tentative and may be subject to change as further data emerge. Nonetheless, the authors are of the view that there is significant value in presenting the analysis at this stage to introduce a model based primarily on archaeological evidence, to advance our understanding of the issues involved, and to encourage further investigation and debate.

Workshop sites and the spatial arrangement of production facilities

For the purpose of the present study, we need to define two terms on which much of the analysis is based. Some of the thinking behind these definitions is based on the work of Arnold (1991) and Costin (2001).

A *ceramic manufacturing site* is defined as a site where large scatters of wasters, as well as a kiln or kilns and/or other significant evidence of ceramic manufacturing, such as workshop structures and tools, have been found. According to data from the Third National Survey of Immovable Cultural Relics, there were 3913 known ceramic manufacturing sites between the Tang and Ming periods (Chen 2018).

A *workshop site* is defined as a ceramic manufacturing site where evidence of one or more preserved ceramic workshops has come to light. To confirm the presence of a workshop, at least one of the following permanent features is required:

- a workshop building
- a glazing vat with a fixed base
- a throwing wheel
- a clay processing pool

Instances in which only small, movable tools are present are excluded from the analysis due to the possibility that they may have been moved from their original location.

According to the criteria set out above, 96 workshop sites dating from the Tang dynasty to the Ming dynasty (see Part 1 of the online supplementary material [hereafter OSM]) have

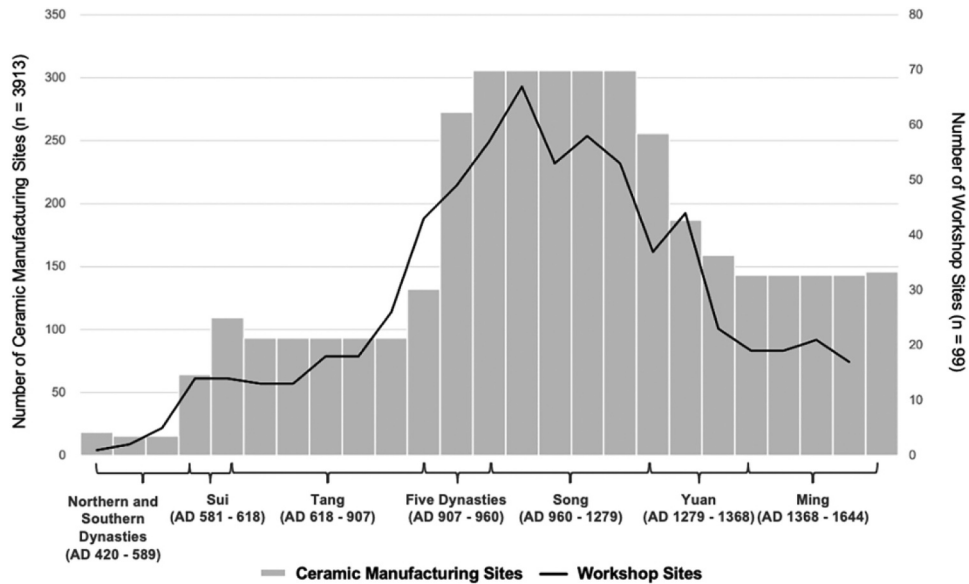


Figure 1. Chronological distribution of ceramic manufacturing sites (grey columns) and workshop sites (black line) in China from the fifth to the seventeenth century AD.

been identified by this study. Some of these sites trace their origins in the Eastern Han dynasty (AD 25–220), with some remaining in use until the Qing dynasty (AD 1636–1912). For the purposes of the present analysis, the dating of the workshop sites has been taken from the respective publications without further evaluation or critique. The published dates normally derive from the ceramic products, which are themselves dated based on comparative finds from dated tombs or kilns, as well as coins, and inscriptions on tools and bricks used in construction. Of the 96 workshop sites 45 are dated by more than one type of evidence, including eight that have a clear historical record of their date (see Part 1 of the OSM). As Figure 1 shows, the chronological distribution of the 96 workshop sites is roughly in accord with the 3913 ceramic manufacturing sites, suggesting that the workshop sites reflect the overall chronological pattern.

Among the 96 workshop sites, 254 individual workshops have been identified, with many of the sites containing two, three, or sometimes more workshops. Each workshop was allocated a workshop number (W001–W254; see Part 2 of the OSM), along with descriptions, locations, dates (where present), and references.

The workshops typically feature the three primary processes involved in ceramic production: 1) clay preparation, 2) forming, and 3) glazing. These processes are identified in this paper using the following archaeological features: 1) washing and sedimentation pools/vats, 2) throwing wheels, and 3) glazing vats. Other features exist that are more generally indicative of ceramic production but can play more than one role. Examples are drying facilities – such as drying platforms and ovens – which could be associated with wheels as part of the last step of forming or with glazing vats as the first step of glazing.

Workshop types

A key premise of the present analysis is that the spatial arrangement of the production facilities in a workshop or series of workshops reflects the spatial relationship of production activities. In the majority of cases, a workshop with a more specialized organization of labor would be more effectively housed in a series of separate spaces, in each of which specific tasks could be carried out at higher productivity (e.g. Arnold 1991, 87–91; Peacock 1982, 12–52; Van der Leeuw 1977). In this paper, we use two different workshop types to describe and associate the differing spatial arrangements of workshops: Type 1, which we call specialized workshops, and Type 2, which we call non-specialized workshops. This distinction is based on whether the three primary stages of ceramic production were spatially separated.

In our dataset of 254 workshops, 105 examples could be allocated to one of the two above types (Part 2 of the OSM). The 149 workshops that could not be allocated to a type are generally poorly preserved and/or had no published study or their study was published with inadequate or missing plans and without a detailed description of the associated finds and other information.

Type 1: specialized workshops

A specialized workshop is defined as a workshop that is specialized in a specific part of the production process or which has defined and separate areas for each production process it houses. The facilities relating to the different parts of the production process can be located in different workshop buildings or in different units within the same building. Altogether, 79 specialized workshops were identified among the 105 classified examples.

A typical example is a workshop at Huangbao (W183) in Shaanxi Province, which has a body-forming workshop (throwing wheels and a clay pugging pool) and a glazing workshop (including glaze vats and a drying platform) located in separate spaces (Figure 2). The workshop at the Huangye site (W128) in Henan Province is a courtyard-structured workshop with forming and glazing facilities in different but connected rooms (Figure 2). Similar workshops are also found at the Caoliaoshan site, Fujian Province, where body forming and glazing facilities are separated into different rooms in the same workshop structure (W101), while clay processing facilities are placed together in another area (W100; see Figure 2). There are also a few sites, such as the Linjiang site in Fujian Province (Figure 2), at which all the production facilities are placed in the same space, without a very clear physical separation, but the facilities used in the same process are clustered together as a specialized functional area. Such workshops are therefore also classified here as specialized. Although the precise forms of specialized workshops can vary greatly, the facilities are clearly specialized and separated into different spaces or functional areas.

Type 2: non-specialized workshops

Of the 105 classified workshops, 26 show no clear division of function and are classified as non-specialized. In these, the facilities related to the different production processes are placed in the same space, without clear separation. Typical examples are from the sites of Jingfeng (W108) in Sichuan, Huangbao (W203) in Shaanxi, and Yuankou (W048, W049, W050, W053) in Zhejiang (Figure 3). In workshops W108 and W201, forming facilities (with wheel bases) and glazing facilities (with glaze vats) are placed in the same space

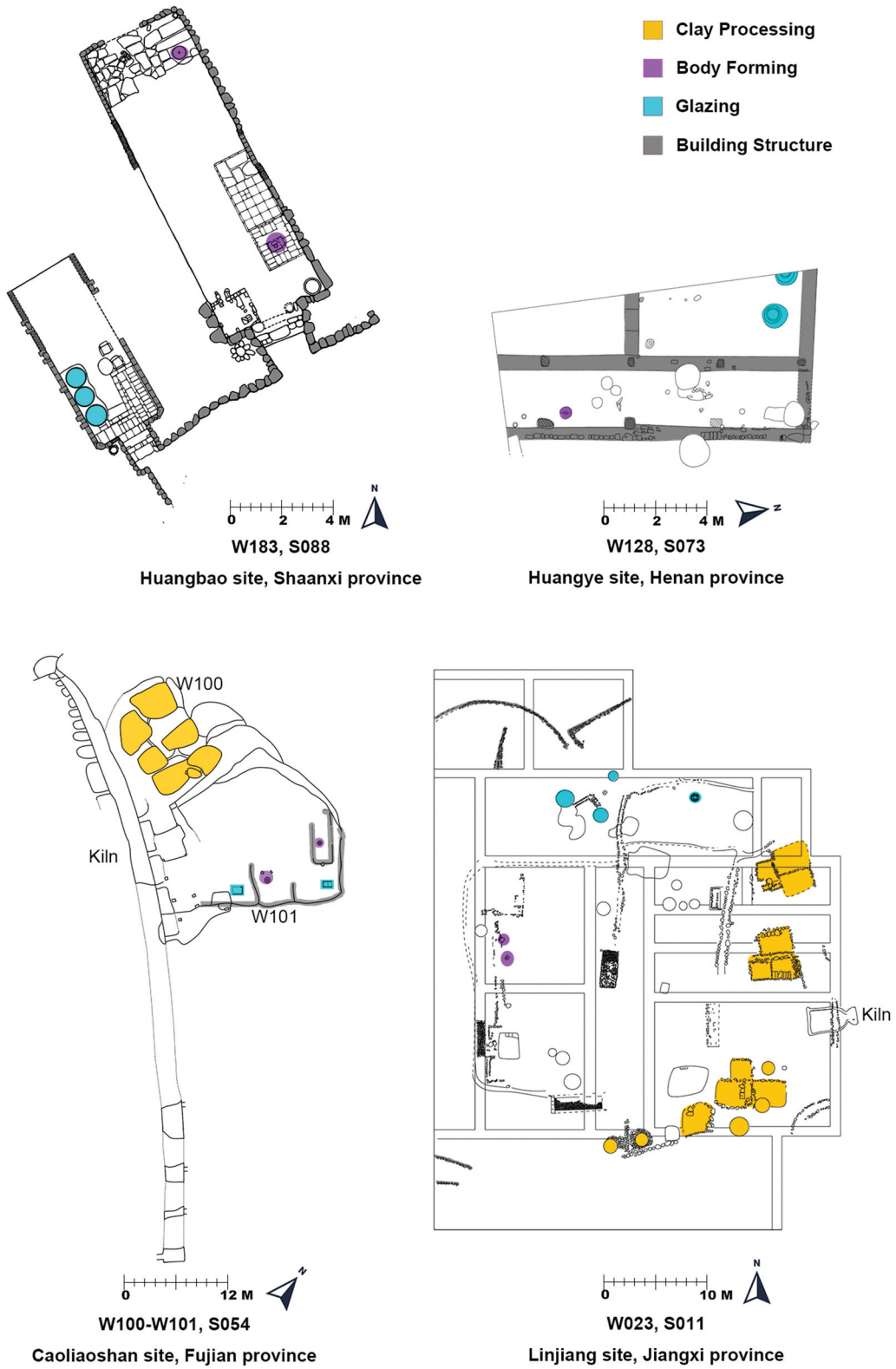


Figure 2. Examples of specialized workshops.

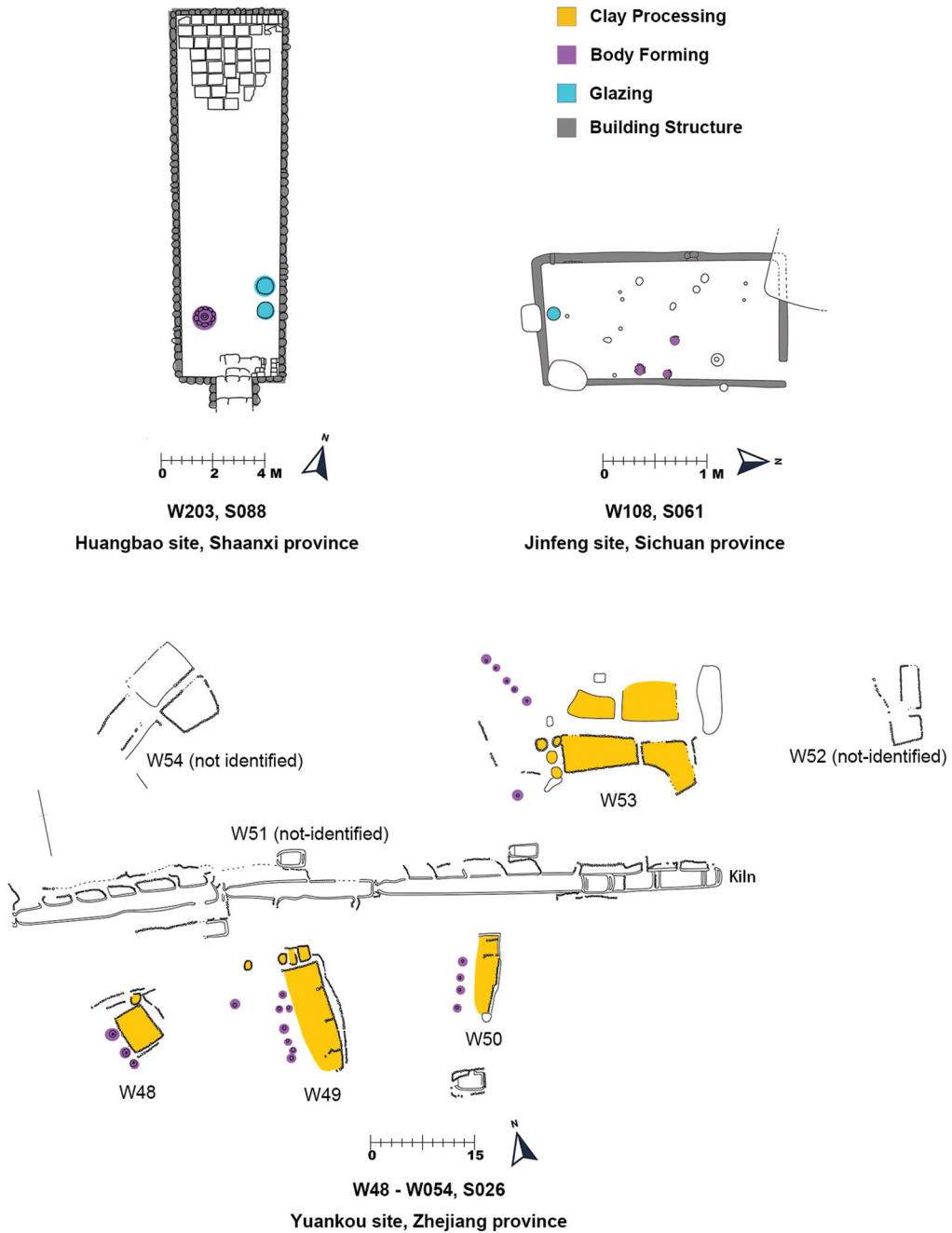


Figure 3. Examples of non-specialized workshops.

Chronological development and geographical distribution of workshops

From the beginning of this research, analysis of the chronological and geographical distributions of the two types of workshops was expected to provide insight into the broader development of the

Table 1. Summary of workshop site categorization.

Workshop site category	Workshop type(s) identified from the site	Number
Specialized	Specialized only	27
Mixed	Specialized & Non-specialized	6
Non-Specialized	Non-specialized only	6
Unidentified	Unidentified	57
Total number of workshop sites		96

organization of Chinese ceramic production. Indeed, the analysis shows there does seem to have been consistent development across time and locations.

Workshop types and sites

When analyzing the 105 classified workshops, we noted that the number of individual workshops at workshop sites could vary from one to as many as 54. Large numbers of a single workshop type located at one workshop site would obviously unbalance the percentage of that type in the respective period and location and thereby produce a misleading result. Therefore, to prevent such bias, we allocated a category to each site based on the workshop types present. There are four categories of workshop sites: 1) specialized sites are sites with only specialized workshops (27 sites), 2) mixed sites have both specialized and non-specialized workshops (6 sites), 3) non-specialized site have only non-specialized workshops (6 sites), and 4) unidentified sites are those that do not have any identifiable workshop types (57 sites). We were thus able to allocate categories to 39 workshop sites (Table 1; Part 1 of the OSM).

As Figures 4 and 5 present, the chronological and geographical distribution of these 39 categorized workshop sites broadly reflect those of all 96 workshop sites, indicating that this sample group can reasonably be considered to reflect regional and chronological patterns.

Methodology

Each of the workshop sites can be dated with a reasonable degree of precision based on the material presented in the excavation reports. Some sites were in use for only a short period, such as the Wuguishan site, dated to the Southern Song dynasty (about 150 years), while others remained in use for much longer periods, such as the Cizao site, dated from the Northern Song to the Yuan dynasty (about 950 years). The chronological analysis was conducted using 50-year periods. Each workshop site was given a value of one for each of the 50-year periods during which it can be shown to have been in use. We thus determine the number of workshop site categories in use in any of the 50-year periods, shown in Figures 5 and 6.

Chronological changes in the geographical distributions of sites with different workshop types

The overall trend in the number of workshop sites, as indicated by the grey line in Figure 5, shows low, stable numbers from the early seventh to the late eighth century. This is followed by a long period during which the numbers increased, peaking in the twelfth century. Afterwards, the numbers began to decline slowly and irregularly, until the late fourteenth century, after which time a steep decline occurred, bringing the numbers down quite markedly, almost to their pre –

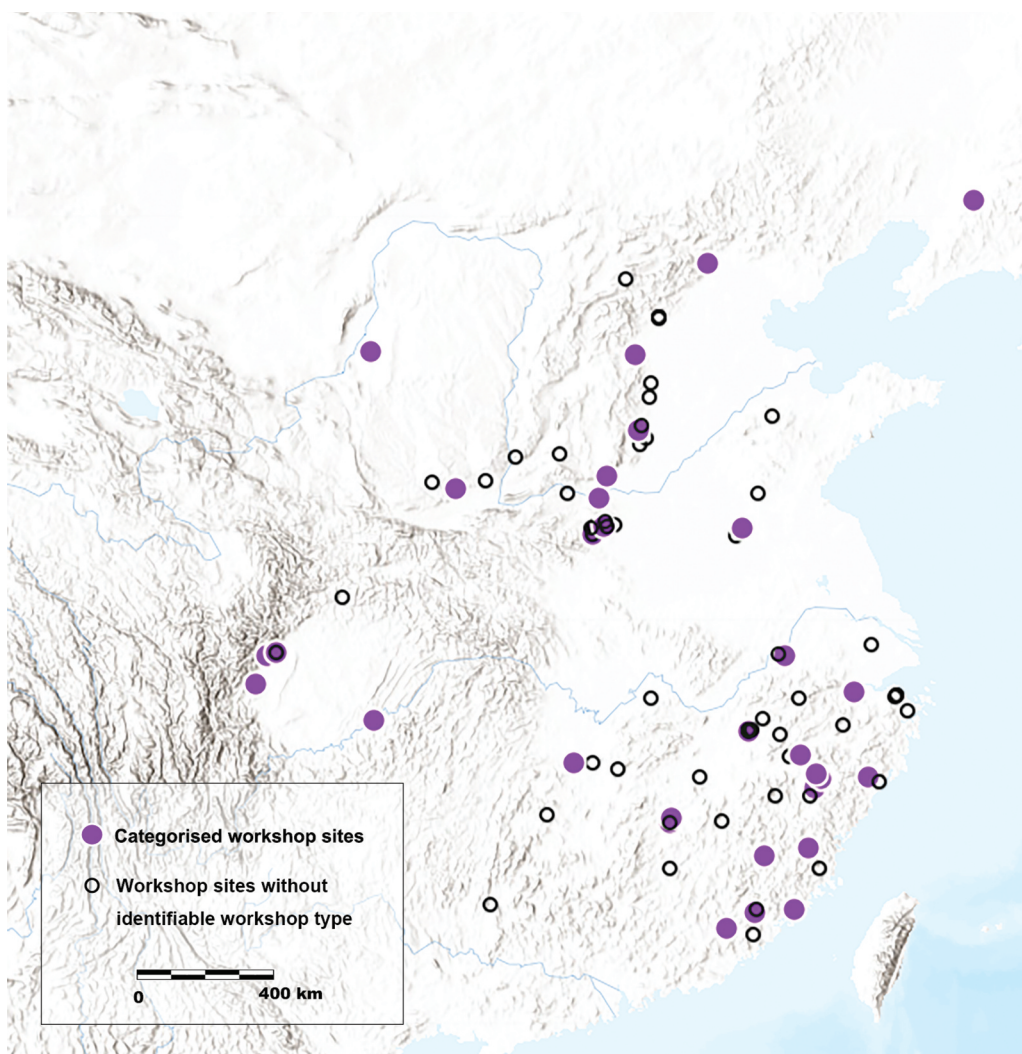


Figure 4. Geographical distribution of workshop sites in China.

ninth-century levels. The categorized workshop sites (columns) display a pattern that is generally consistent with the total number of sites.

Figure 5 also presents the trend of proportions of the workshop sites with different workshop types, which is shown more clearly in Figure 6. Both figures clearly show that, until the late tenth century, there was a roughly equal balance between specialized and non-specialized workshop sites. From that time onwards, the proportion of specialized workshop sites increased steadily until, following a marked jump in the early fifteenth century, they made up the vast majority (ca. 89%) of the workshop sites across China, with only a small number of non-specialized sites remaining. The proportion of sites with mixed workshop types remained relatively stable from the tenth to the fourteenth century, but these then disappeared in the fifteenth century. These trends are very marked and quite consistent, suggesting that, despite

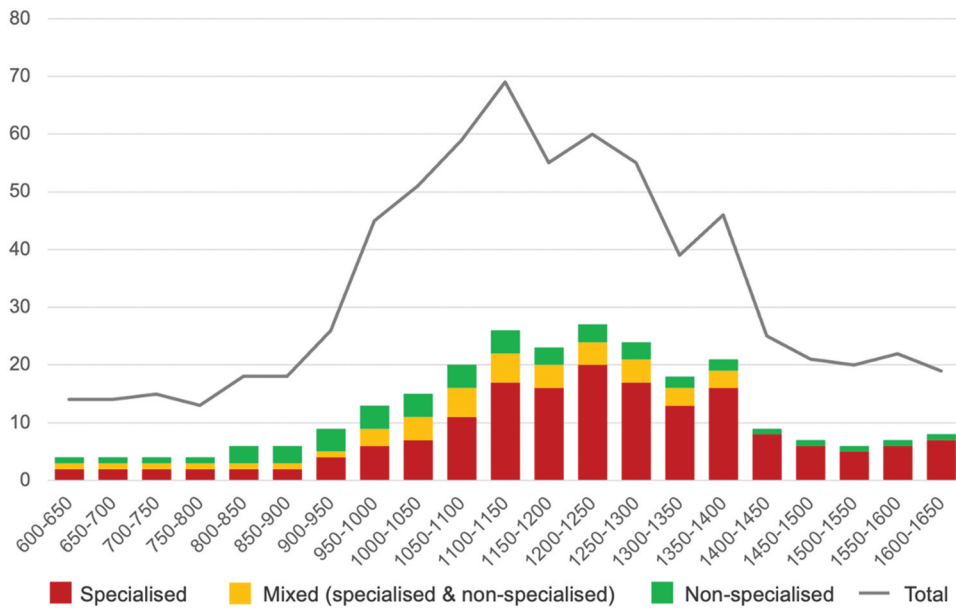


Figure 5. Chronological distribution of sites with different workshop types by number.

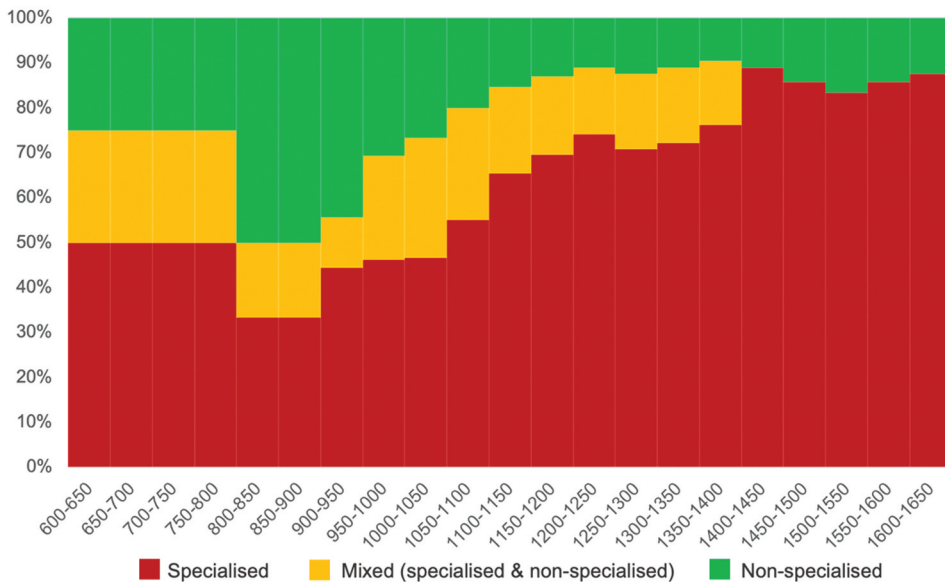


Figure 6. Chronological distribution of sites with different workshop types by percentage.

the relatively small sample on which they are based, they are likely to reflect actual trends in Chinese ceramic production.

As can be seen in [Figure 6](#), in the ninth century, there appears to have been a slight decline in the proportion of workshop sites categorized as specialised. Because the number of workshop sites known from this early period is very low (four) ([Figure 5](#)), it is not clear how representative this trend

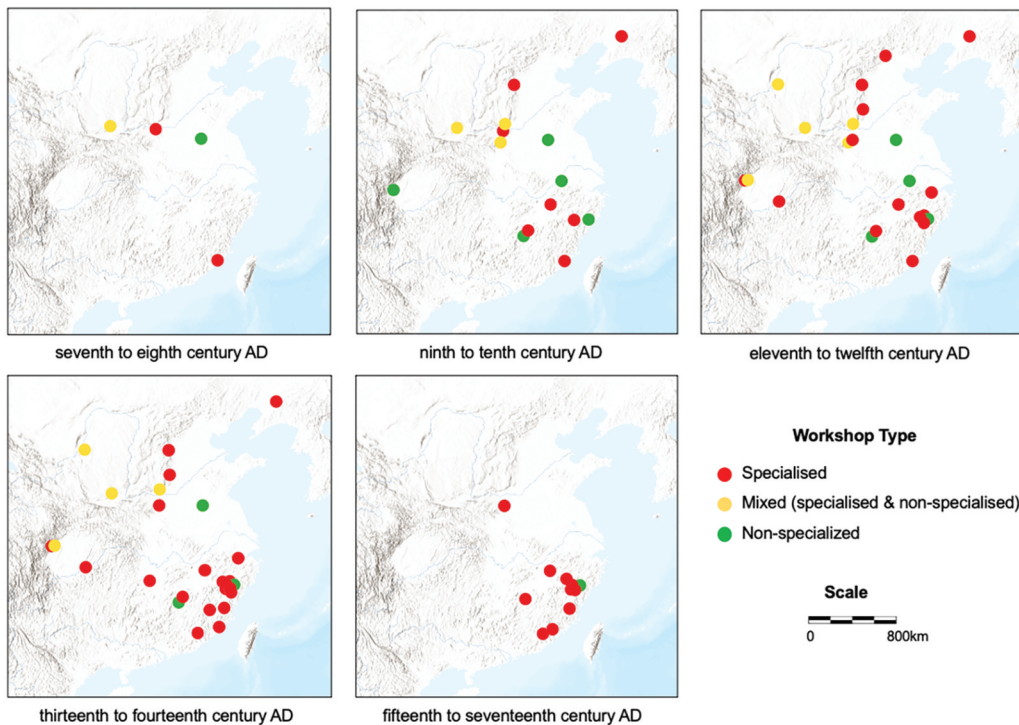


Figure 7. Distribution of the different categories of workshop sites across China by period.

actually is. It should also be noted that the number of workshop sites categorized as specialized did not actually decrease; rather, the change in proportions is due to the number of non-specialized workshop sites newly built in the ninth century.

Figure 7 shows that, in both south and north China, the number of specialized workshop sites increased significantly between the seventh and fourteenth centuries and their distribution expanded greatly especially in south. The number of workshop sites then decreased from the fifteenth century, with the majority of those which continued in use concentrated in south China, but specialized workshop sites still dominated. By contrast, the distribution of non-specialized workshop sites experienced only a slight growth in the ninth to tenth century and then decreased in the following periods.¹ Sites with mixed workshop types are distributed only in north and west China, and their distribution expanded from the seventh to the twelfth centuries and then decreased and disappeared between the thirteenth and seventeenth centuries. Generally, the expansion of sites with specialized workshops is a nationwide trend, but it developed at different rates in different areas, since some sites in north and west included both specialized and non-specialized workshops.

Discussion

This analysis of workshop types and their chronological and geographical distributions in China provides useful insights and potential models for the development and labor organization of ceramic production. The primary difference between specialized and non-specialized workshop

types is likely related to the division of labor. It suggests that the growing prevalence of specialized workshops indicates a trend towards more specialized labor organizations.

The development of the specialization of labor division

The analysis presented here suggests that the Song period is the time when the organization of labor in ceramic manufacturing underwent a remarkable development. The number of specialized workshops sites peaked during the twelfth to thirteenth centuries (Figure 5), while the percentage of specialized workshops sites exceeded 50% of the total from as early as the late eleventh century (Figure 6). Specialized division of labor is usually considered a strategy intended to improve the quantity and quality of products, namely, productivity (Rice 2015, 357). Historical evidence has shown that China witnessed tremendous population and industrial production growth during the northern Song dynasty (AD 960–1127) (Broadberry, Guan, and Li 2018), implying an increasing demand for ceramic products and a flourishing ceramic industry. The number of ceramic manufacturing sites also peaked during the Song period, with nearly 2,000 newly built sites, clearly indicating that the ceramic industry witnessed considerable growth in this period (Chen 2018). Most kilns, except those with official status, were intended to make a profit (GSYXH 1997, 227–229; Liu 1994). Growing market demand and competition are therefore likely to have required higher productivity, which could have influenced the organization of production. As the earliest ceramic monograph *Taoji* (dated to the thirteenth to fourteenth centuries AD) records, prestigious kilns such as the Ding kilns and the Longquan kilns competed with each other during the Song period (Xiong and Xiong 2000, 28–34). Such kilns are thought to have employed relatively mature technology, produced on a large scale, and organized labor into the most effective structure possible to be competitive. These kilns may have employed many specialist craftsmen who supported themselves through ceramic production (Xiong and Xiong 2000, 28–34).

As Figure 5 shows, there was a clear reduction in the number of workshop sites after the Northern Song Dynasty (early twelfth century AD). Similarly, the Third National Survey of Immovable Cultural Relics indicates that the total number of ceramic manufacturing sites decreased sharply after the Song period (Chen 2018). The destruction of the ceramic industry in northern China caused by the Jin – Song wars is believed to be an important reason (GSYXH 1997). However, this decline does not represent the entirety of the Chinese ceramic industry. Instead, to some extent, it may be attributable to changes in the organizational strategies of ceramic production. Figure 6 presents the upward trend of the percentage of specialized workshop sites, which did not decline in the Song and the following periods. Simultaneously, archaeological evidence shows that the center of Chinese ceramic manufacturing shifted to the Jingdezhen and Longquan areas after the Song period, and Fujian and Guangdong provinces had robust ceramic industries, particularly as exporters (Zhang 2016, 38). This suggests that, with the increased specialization of labor division and centralization of ceramic production in some areas, Chinese ceramic production maintained a certain level of productivity through changes in organizational strategies after the Song period when the number of ceramic manufacturing sites declined.

Government involvement is also a factor that cannot be ignored in Chinese ceramic production, influencing the organization of production through various means, such as the establishment of official kilns, the production of official products in private kilns, and the collection of taxes (Wang 2004). While some kilns may produce products ordered by the government or pay taxes in the form of ceramic products to the government, their fundamental nature remains that of private kilns. Their production is still significantly influenced by ceramic consumption in domestic and overseas

markets, as exemplified by the Longquan kiln, for example (Zhang et al. 2023). By contrast, the establishment of official kilns was a manifestation of government authority that went beyond economic interest, as the government provided funding and controlled the consumption of the products, and monitored the quality of the products; thus, the productive nature of official kilns was different from private kilns (Liu 1994; Wang 2005). There are three confirmed official kilns among the 27 specialized workshop sites, and the reason for their use of specialized labor may be the quality of products instead of the quantity, which is not the case with private production. Nevertheless, the establishment of official production may have also been based on the increasing specialization of labor organization. The earliest confirmed official kilns are the Wuguishan and Laohudong kilns of the Southern Song dynasty in south China (Du 2002; IACASS and HMAPCR 1996). As shown in Figure 7, specialized workshop sites experienced remarkable growth in south China between the twelfth and thirteenth centuries, which coincides with the construction of the earliest official kilns. The historical literature records how the Song government hired specialist craftsmen from private kilns, based on their place of residence (Wang 2002), whilst analysis of kiln technology also suggests that the official kiln technology was adopted from local private kilns in south China (Xiong 1995). This may indicate these craftsmen brought their working methods from local private kilns in south China to official kilns. Therefore, it is possible that the production organization of official kilns was derived from those of certain local private kilns in southern China.

Regional patterns

Although the increase and spread of specialized workshops appears to have been the trend from the tenth century, this expansion exhibits regional variation. Mixed workshop sites were found only in north and west China, and these persisted until the fifteenth century, indicating the slower expansion of specialized workshops in these regions compared to south China. The uneven development of the ceramic industry in north and south China could be an important reason for the disparity in labor organization. Historical records indicate that, during the Song period, when China's economic center shifted from north to south, south China comprised more than half the country's population, with abundant labor and a broad market for some fast-growing industries, such as textiles and ceramics (Ge 2010; Zhang 1957; Zheng 1996). Archaeological evidence also suggests that most ceramic manufacturing sites were located in south China from the Song period, which suggests that the south had a more developed ceramic industry (GSYXH 1997, 227–231).

From the perspective of workshop sites, the uneven development of the ceramic industry in north and south China may be attributable to kiln structure. There are two primary types of kiln structures in China: 1) mantou kilns and 2) dragon kilns. Mantou kilns are distributed throughout north China and a few regions in the south in the same areas where sites with mixed workshop types have been found. By contrast dragon kilns are found exclusively in southern China (Figure 8). Dragon kilns, with an average length of 30 metres, had a loading capacity that was 10 times higher than that of mantou kilns, which typically vary from several to a dozen square meters (Kerr and Wood 2004; Li 1998) (Figure 9). Since the division of tasks is a response to large-scale and high-intensity ceramic production (Arnold 1991, 107), the workshop type is likely to be related to kiln type/capacity. In south China, the enormous capacity of dragon kilns requires a much larger output of vessels and may have been linked to created a tendency towards a more specialized organization of labor that would allow for more efficient collaboration between workers in different workshops and spaces. In contrast, the lower-capacity mantou kilns in north China seem to be linked to more

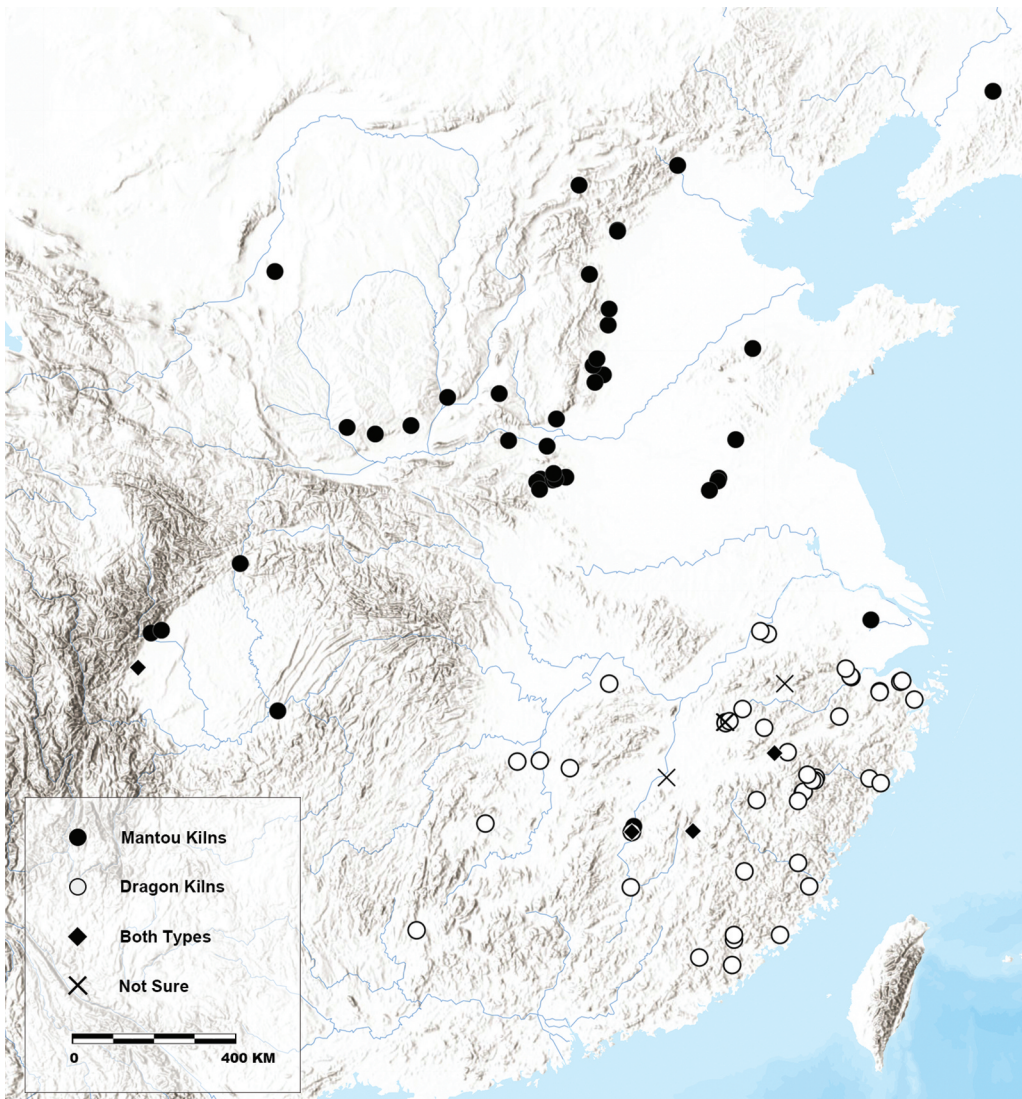


Figure 8. Distribution of kiln types at the 96 workshop sites.

modest scale production and did not require the same degree of specialized labor division, and this may have slowed the expansion of specialized workshops.

Although mantou kiln technology has a long-standing tradition in north China, the construction of specialized workshops increased significantly between the seventh and 14th centuries. This may have been related to the increased centralization of the firing area, which occurred with the adoption of coal. By the tenth century, coal was adopted as a fuel source due to firewood shortages in north China, leading to improvements in the structure of mantou kilns at some advanced ceramic manufacturing sites (Kerr and Wood 2004, 317–322; Qin 2010). The Guantai and Jinfeng sites show that coal kilns have larger capacities than firewood kilns and that the coal kilns were clustered closer together as a centralized kiln area to improve thermal efficiency and ensure continuous production



A Mantou Kiln Structure in Cizhou Kiln, Hebei



A Dragon Kiln Structure in Longquan Kiln, Zhejiang

Figure 9. Mantou kilns (left) and dragon kilns (right).

(Huang, Qing, and Tuoyu 2002; Qin 2010), which may have led to the adoption of more specialized labor organization in northern China.

Conclusion

The analysis presented here suggests that the labor organization of the production of Chinese ceramics became increasingly specialized after the tenth century. This is reflected in the increasing number of ceramic manufacturing sites with workshops laid out to accommodate a more specialized production process and labor organization, and this trend showed faster progress in south China than in the north. The specialized division of labor might be attributable to the marked development of the ceramic industry from the time of the Song Dynasty, which increased market competition and production scale. The construction of official kilns during the Southern Song Dynasty may have been influenced by the increasingly specialized organization of labor in south China. The regional differences seem to have been associated with the more developed ceramic industry and the higher loading capacities of dragon kilns in south China. Despite the effect on ceramic production in north China of the shift of the economic center to the south, the specialization of labor nonetheless appears to have slowly increased, possibly due to the more clustered mantou kiln areas associated with the change to coal.

It is hoped that the analysis presented here has demonstrated the value of analyzing numbers of ceramic workshop sites in China at a broad geographical and temporal scale in order to gain insight into the developing organization of production and labor in the ceramic industry. It is also hoped that the approach will raise awareness of the potential value of archaeological evidence in a subject area that has previously been dominated by textual evidence.

Note

1. In the discussion of workshop sites from the 10th century onwards, this paper focuses only on the Song period (AD 960–1279) because it is often difficult to date workshop sites to the short Five Dynasties and Ten Kingdoms Period (AD 907–960) using archaeological methods.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by the China Scholarship Council.

Notes on contributors

Xiaohang Song is a PhD candidate at the Department of Archaeology, Durham University. Her study is about the labour organisations of ancient Chinese ceramic industries from the 7th to the 17th centuries AD.

Ran Zhang is Assistant Professor at the Department of Archaeology, Durham University. His research is concerned with how ancient Chinese trade affected the maritime economy in the Indian Ocean and Europe from the eighth to the nineteenth centuries. He also has expertise in the identification and dating of Chinese ceramics.

Derek Kennet is the Howard E. Hallengren Professor in Arabian Peninsula and Gulf States Archaeology at the Institute for the Study of Ancient Cultures, University of Chicago. His research interests cover Indian Ocean trade.

References

- Arnold, Philip. 1991. *Domestic Ceramic Production and Spatial Organization: A Mexican Case Study in Ethnoarchaeology*. Cambridge: Cambridge University Press.
- Broadberry, Stephen, Hanhui Guan, and David Daokui Li. 2018. "China, Europe, and the Great Divergence: A Study in Historical National Accounting, 980–1850." *The Journal of Economic History* 78 (4): 955–1000. <https://doi.org/10.1017/S0022050718000529>.
- Chen, Chaoyun. 2017. "Songdai Ciqi Zhizao Jishu De Kaoguxue Guancha." *Kaoguxuebao* (4): 495–514. (in Chinese).
- Chen, Yun. 2018. "Zhongguo Gudai Taoci Yaozhi Ziyuan Tongji Yu Fenxi." *Nanfangwenwu* (2): 208–216. (in Chinese).
- Costin, Cathy Lynne. 2001. "Craft Production Systems." In *Archaeology at the Millennium: A Sourcebook*, edited by Gary M. Feinman and Theron Douglas Price, 273–327. Boston, MA: Springer US.
- Crook, Penny. 2005. "Quality, Cost and Value: Key Concepts for an Interpretive Assemblage Analysis." *Australasian Historical Archaeology* 23:15–24. <http://www.jstor.org/stable/29544530>.
- Deal, Michael. 1998. *Pottery Ethnoarchaeology in the Central Maya Highlands*. Salt Lake City: University of Utah Press.
- Du, Zhengsheng. 2002. "Hangzhou Laohudong Nansong Guanyaozhi." *Wenwu* (10): 4–31. (in Chinese).
- Frankel, David, and Jennifer M. Webb. 2014. A Potter's Workshop from Middle Bronze Age Cyprus: New Light on Production Context, Scale and Variability. *Antiquity* 88 (340): 425–440. <https://doi.org/10.1017/S0003598X00101097>.
- Ge, Jinfang. 2010. *Liang Song Shehui Jingji Yanjiu*. Tianjin: Tanjinguji Chubanshe (in Chinese).
- GSYXH. 1997. *Zhongguo Taocishi*. Beijing: Wenwu Chubanshe (in Chinese).
- Gutierrez, Alejandra, Chris Gerarrd, Ran Zhang, and Wang Guangyao. 2021. "The Earliest Chinese Pottery in Europe?" *Antiquity* 95 (383): 1213–1230. <https://doi.org/10.15184/aqy.2021.95>.
- Hansen Streily, Andrea. 2000. "Early Pottery Kilns in the Middle East." *Paléorient* 26:69–81. <https://doi.org/10.3406/paleo.2000.4711>.
- Huang, Xiaofeng, Zhang Qing, and Fan Tuoyu 2002. Dujiangyanshi Jinfengyao Fajue Baogao [The Report of the Excavation at Jinfeng Kiln Site in Dujiangyan City]. In *Chengdu Kaogu Faxian 2000*, edited by CDSWWKGYJS. 222–287. Beijing: Kexue Chubanshe (in Chinese).

- IACASS, ZPICRA, and HMAPCR. 1996. *Nansong Guanyao*. Beijing: Zhongguo Dabaike Quanshu Chubanshe (in Chinese).
- Kerr, Rose, and Nigel Wood. 2004. *Science and Civilisation in China, Volume 5: Chemistry and Chemical Technology. Part 12: Ceramic Technology*. Cambridge: Cambridge University Press.
- Li, Jiazhi. 1998. *Zhongguo Kexue Jishu Shi, Taoci Juan*. Beijing: Kexue Chubanshe (in Chinese).
- Liu, Yi. 1994. "Guanyao Zhidu De Xingcheng Jiqi Shizhi." *Zhongyuanwenwu* (3): 90–94. (in Chinese).
- Miller, George L. 1980. Classification and Economic Scaling of 19th Century Ceramics. *Historical Archaeology* 14 (1): 1–40. <https://doi.org/10.1007/BF03373454>.
- Murphy, Elizabeth A. 2017. "Roman Workers and Their Workplaces: Some Archaeological Thoughts on the Organization of Workshop Labor in Ceramic Production." In *Work, Labor, and Professions in the Roman World*, edited by Christian Laes and Koenraad Verboven, 133–146. Leiden & Boston: Brill.
- Peacock, David PS. 1982. *Pottery in the Roman World: An Ethnoarchaeological Approach*. London: Longmans.
- Pierson, Stacey. 1996. *Earth, Fire and Waters: Chinese Ceramic Technology, a Handbook for Non-Specialists*. London: Percival David Foundation of Chinese Art.
- Qin, Dashu. 2010. "Cizhouyao De Shengchan Fangshi Chutan—Faxian Yaoye Yiji Suo Tixian De Shengchan Moshi." In *Zhongguo Gutaoci Yanjiu*, 117–136. Vol. 16. Beijing: Zijincheng Chubanshe (in Chinese).
- Rice, Prudence M. 2015. *Pottery Analysis: A Sourcebook*. Chicago: University of Chicago Press.
- Rye, Owen S. 1981. *Pottery Technology: Principles and Reconstruction*. Washington DC: Taraxacum.
- Stark, Barbara L. 1985. "Archaeological Identification of Pottery Production Locations: Ethnoarchaeological and Archaeological Data in Mesoamerica." In *Decoding Prehistoric Ceramics*, edited by Ben A. Nelson, 158–194. Carbondale and Edwardsville: Southern Illinois University Press.
- Van der Leeuw, Sander E. 1977. "Towards a Study of the Economics of Pottery Making." *Ex Horreo* (4): 68–76.
- Wang, Guangyao. 2002. "Cong Guan Shougongye Zhidu Kan Ruyao: Jianlun Songdai De Guanfu Yaoye Zhidu." *Gugongbuwuyuan Yuankan* (1): 50–58. (in Chinese).
- Wang, Guangyao. 2004. *Zhongguo Gudai Guanyao Zhidu*. Beijing: Zijincheng Chubanshe (in Chinese).
- Wang, Guangyao. 2005. "Songdai Guanyao Zhidu Chutan." *Wenwu* (5): 74–79. (in Chinese).
- Wang, Xing. 2016. "Yaozhouyao Shengchan Fangshi De Kaoguxue Yanjiu." Master's thesis, Beijing University. (in Chinese).
- Whipp, Richard. 2018. *Patterns of Labor: Work and Social Change in the Pottery Industry*. London: Routledge.
- Xiong, Haitang. 1995. *Dongya Yaoye Jishu Fazhan Yu Jiaoliushi Yanjiu*. Nanjing: Nanjingdaxue Chubanshe (in Chinese).
- Xiong, Liao, and Wei Xiong. 2000. *Zhongguo Taoci Guji Jicheng*. Shanghai: Shanghai Wenhua Chubanshe (in Chinese).
- Zhang, Jiaju. 1957. *Liangsong Jingji Zhongxin De Nanyi*. Wuhan: Hubeirenmin Chubanshe (in Chinese).
- Zhang, Ran. 2016. "An Exploratory Quantitative Archaeological Analysis and a Classification System of Chinese Ceramics Trade in the Western Indian Ocean, Ad C. 800–1500." PhD diss., Archaeology Department, University of Durham.
- Zhang, Ran, Derek Kennet, Peter J. Brown, Xiaohang Song, Wang Guangyao, Yi Zhai, and Wu Mingjun. 2023. "Longquan Celadon: A Quantitative Archaeological Analysis of a Pan-Indian Ocean Industry of the 12th to 15th Centuries." *World Archaeology* 1–23. <https://doi.org/10.1080/00438243.2023.2216183>.
- Zheng, Xuemeng. 1996. *Zhongguo Gudai Jingji Zhongxin Nanyi He Tang Song Jiangnan Jingji Yanjiu*. Changsha: Yuelushushe (in Chinese).