Research on the Distribution of Kilns in Jingdezhen, China, from the Tang Dynasty to the Ming Dynasty

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Abstract: The distribution of kilns is a crucial component of ceramic production. This paper applies the ArcGIS software to create figures based on archaeological data and intuitively illustrate the distribution of kilns from the Tang dynasty to the Ming dynasty. The results indicate that ceramic production in Jingdezhen began in the middle Tang dynasty and developed rapidly in the Five and Song dynasties. The kiln distribution was scattered during this period. However, from the Yuan dynasty, the layout of the kilns presented a trend of centralisation towards urban areas, and the number of kilns rapidly decreased. In the Ming dynasty, more kilns were established in urban areas. This phenomenon was connected with government intervention in the Yuan dynasty, the growth of demand for ceramics and the cost of transportation, which were beneficial for the sustained prosperity of ceramic production in Jingdezhen.

1. Introduction

As a commodity, ceramics began to be widely exported during the late Tang dynasty, which promoted exchange and communication between China and various countries worldwide. Jingdezhen became one of the most significant Chinese cities to manufacture ceramics during the Yuan dynasty, and even today, it stands as China's porcelain capital. Therefore, since the early twentieth century, the researches on Jingdezhen and its ceramics have been well researched from the aspects of art history [1–2], archaeological excavations of kiln sites, overseas trade [3] and ceramic technology [4-5]. However, the current understanding of the industrial organisation of ceramic kiln sites in Jingdezhen is minimal. Several scholars have researched the formation and development of Jingdezhen from the Song to the Ming dynasties [6]. Still, few have considered how the geographical distribution of kilns in Jingdezhen changed throughout history. Kiln distribution is significant because it is related to transportation cost, which is one of the most critical aspects of ceramic production. Thus, a systematic analysis of the distribution of kilns in Jingdezhen is necessary. This could not only help reconstruct the changing production mode of the city in ancient times but also provide a further understanding of why Jingdezhen has always been prosperous, from the Yuan dynasty to the present day.

The timeline covered in this paper is from the Tang to the Ming dynasties for ceramic production of Jingdezhen had entered into a significant development stage during this period. As the earliest kilns discovered by archaeologists could be dated to the middle Tang dynasty [7], the discussion and analysis will start from this period. The production mode of ceramics in Jingdezhen in the Qing dynasty continued to develop along the trajectory initiated in the late Ming dynasty [6], during which the prevailing kiln distribution was formed.

The paper will first provide essential information about Jingdezhen to make the subsequent analysis easier to understand. Then, it will fully utilise the collected kiln data to create maps using the

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ArcGIS software and conduct an analysis. Finally, it will summarise the changing trend of the distribution of kilns from the Tang to the Ming dynasties and attempt to determine the causes behind these changes based on the analysis of historical records and archaeological data.

2. The Geographical Environment and Historical Records of the Ceramic Industry in Jingdezhen

Surrounded by mountains, Jingdezhen is located in the northeast of Jingxi Province. To the northeast of the city is part of Huang Mountain, and to the southwest is Huaiyu Mountain. Mountains and hills dominate the Jingdezhen, with the landscape comprised of approximately 69% mountains, 24% plain and 7% bodies of water. As an important river in Jingdezhen, the Chang River, which is 178 km long, begins in Qimen County, Anhui province, flows through Jingdezhen and ends in Poyang Lake provides sufficient water resources for transportation and producing ceramics . The Chang River's basin in Jiangxi Province is 4,160 km² [8], and its tributaries including North River, East River, South River and West River also run through Jingdezhen. Interestingly, the geological conditions of Jingdezhen are complex, and many of the rocks discovered there provide adequate raw materials for ceramics [8].

Influenced by the Hongzhou kiln and Yue kiln which were noteworthy kilns firing celadon, Jingdezhen entered into the production of celadon in the middle and late Tang dynasty. In 907, Zhu Wen started a war against the Tang government [9], resulting in many people and kilns moved to the south against the background of the war in the north [10]. Then, Jingdezhen began to produce whiteware under the influence of Ding kiln situated in the northern China, promoting the technologies used to create bluish-whiteware matured in Jingdezhen in the Song dynasty, and the city began to gain prestige. The government dispatched officers to supervise ceramic production in Hutian kiln, the most famous kiln in Jingdezhen in the Song dynasty [8]. In 1278, during the Yuan dynasty, Fuliang Ceramic Bureau was established in Fuliang County, Jingdezhen, to manage ceramic production [11]. According to previous research, the functions of Fuliang Ceramic Bureau can be summarised as collecting ceramic tax and producing ceramics for the royal court and trade [12]. Art Bureau was also built in the Yuan dynasty. Many ceramic patterns, especially those for the royal court, were designed by Art Bureau and delivered to Fuliang for production, resulting in the elegant ceramic patterns Jingdezhen is known for [13]. In the Ming dynasty, the imperial kiln was established, which promoted a ceramic production monopoly in Jingdezhen.

3. The Kiln Distribution in Jingdezhen

The location of kilns is a significant topic of research on different models of kiln organisation. By analysing the kiln distribution, the sources of the materials and the labour and the kiln administration will be clearer, facilitating the study of the development of the ceramic industry in Jingdezhen. Thus, this paper will briefly discuss the kiln distribution in different periods and attempt to trace out causes behind changes and clarify its influence on the development of kilns.

3.1 The Kiln Distribution in Jingdezhen During the Tang, Five and Song Dynasties

Table 1 Detailed information on kilns in the Tang dynasty and Five Dynasties

No.	Kiln Name	Dynasty	No.	Kiln Name	Dynasty	No.	Kiln Name	Dynasty
1	Taocixueyuan Xice	Five	8	Yingtian	Five	15	Wanggangkeng Cun	Five
2	Yangmei Ting	Five	9	Liangshan Shuxia	Five	16	Nanmen Wu	Five
3	Hutian	Five	10	Xianghu	Five	17	Jiaokeng Wu	Five
4	Wai Xiaoli	Five	11	Lingzhu	Five	18	Nanyao	Tang
5	Huangni Tou	Five	12	Liujia Wan	Five	19	Sanbu Yuan	Tang
6	Tangxia	Five	13	Nanshi Jie	Five	20	Dajin Wu	Tang
7	Baihu Wan	Five	14	Banlu Gang	Five	21	Wanyao Wu	Tang

As kiln materials from the Tang dynasty are limited and the Five Dynasties was a brief period

between the Tang and Song dynasties, the data of these two periods will be amalgamated in this research. As shown in Table 1, 9 excavated kilns with detailed reports and 12 kilns investigated by archaeologists were selected in this thesis since these kilns' precise locations could be traced.

As Figure 1 illustrates, the kiln distribution in the middle and late Tang dynasty was dispersed. As such, it is clear that the development of ceramic production in Jingdezhen was still in its infancy in this dynasty. However, the ceramic industry developed rapidly during the Five Dynasties, and 17 kilns have been discovered from this period. All were built near rivers, concentrated close to the South River and Little South River (Fig. 2). And it must be stressed that to interpret the changing kiln distribution in the urban and rural areas of Jingdezhen, the extent of the city and distribution areas of kilns in different periods was determined. However, as there are few kilns from the Tang dynasty, the distribution area and density of kilns in this period were not calculated here.

Regarding the Five Dynasties period, the distribution area of the kilns was 648 km^2, measuring 18 km from the east to the west and 36 km from the south to the north. To measure the scope, a line was drawn between the farthest kilns to the south (Nanshijie Kiln), north (Wanggangkengcun Kiln), east (Wanggangkengcun Kiln) and west (Tangxia kiln), and the area was measured (Fig. 2). Regrettably, the historical records of the extent of the city in the Tang dynasty and Five Dynasties are absent. Therefore, the density of kilns in the urban areas of Jingdezhen during these periods could not be calculated.

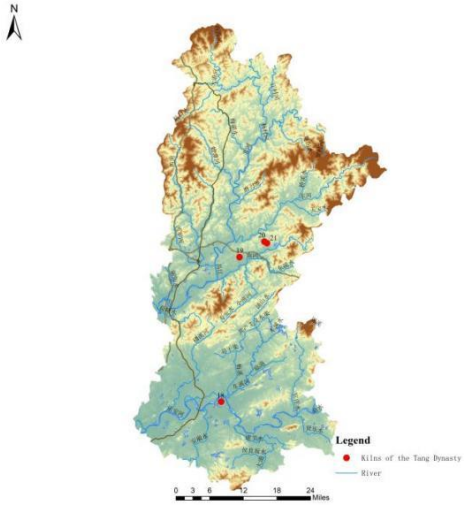
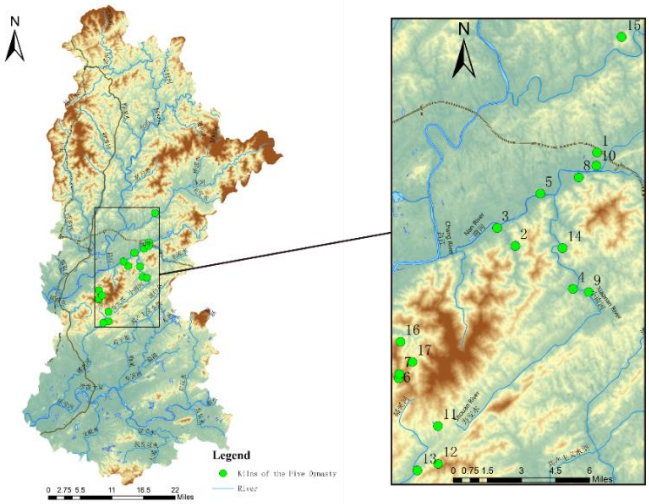


Fig. 1 The distribution of kilns in the Tang dynasty



(Note : The black square represents the distribution area, and the following figures are the same)

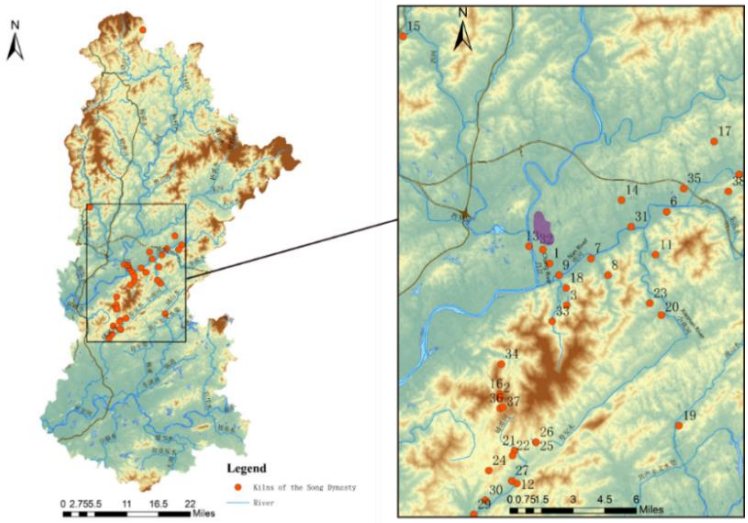
Fig. 2 The distribution of kilns in the Five Dynasties

Table 2 The details of the kilns from the Song dynasty

NO.	Kiln Name	NO.	Kiln Name	NO.	Kiln Name	NO.	Kiln Name
1	Luoma Qiao	11	Jinkeng	20	Wai Xiaoli	30	Ning Cun
2	Tangxia	12	Nanshi Jie	21	Yueshan Xia	31	Huangni Tou
3	Yinkeng Wu	13	Fenghuang Shan	22	Liangshan Shuxia	32	Zhushan Zhonglu
4	Lantian	14	Sanbu Yuan	23	Fukeng	33	Hongjiaao
5	Xianghu	15	Jiaokeng Wu	24	Dawu Xia	34	Nanmen Wu
6	Yingtian	16	Baihu Wan	25	Lingzhu	35	Taocixueyuan Xice
7	Hutian	17	Dajin Wu	26	Lingan	36	Huaertan
8	Yangmei Ting	18	Tongluo Shan	27	Zhuxi	37	Shanjiaoxia
9	Daotang Li	19	Mingkou	28	Xixi	38	Raonan
10	Liujia Wan			29	Feng Wang		

Table 2 shows 38 kilns to map the kiln distribution in the Song dynasty, 24 of which were newly established. As illustrated in Figure 3, most newly established kilns were built in the South River

Basin, the Little South River Basin and Shouan County. According to records, in the Song dynasty, the urban areas of Jingdezhen stretched from Shibaqiao in the east to the banks of the Chang River in the west and from Daijia Nong in the south to Guanyin Ge in the north, covering 0.75 km^2 [14]. As Figure 3 displays, no kilns were located in the city centre. All kilns were established in the surrounding countryside. The density of kilns in the urban areas of Jingdezhen was zero. In addition, the kilns' distribution area was 1,260 km^2, measuring 30 km from the east to the west and 42 km from the south to the north (Fig. 3).



(Note : The purple area represents the extent of the urban areas of Jingdezhen in different dynasties, and the following figures are the same.)

Fig. 3 The distribution of kilns in the Song dynasty

3.2 The Kiln Distribution in Jingdezhen during the Yuan and Ming Dynasty

Thus far, 19 kilns from the Yuan dynasty have been discovered (Table 3), 9 of which were newly established during that period. Compared to the Song dynasty, most kilns built in Shouan County fell into disuse in the Yuan dynasty, and more new kilns were established closer to the urban centre (Fig. 4). With the development of the economy, the urban expansion of Jingdezhen developed rapidly and southward in the Yuan dynasty [15], with the urban areas covering 9 km^2. 6 kilns were found in the urban areas, accounting for approximately 33% of all Yuan kilns; the urban density was 0.66 kilns per km^2. The distribution area, however, decreased from the 1,260 km^2 of the Song dynasty to 540 km^2, measuring 27 km from the west to the east and 20 km from the south to the north (Fig. 4). Therefore, it seems that the kilns began to centralise towards the urban areas while becoming more dispersed in the rural areas.

Table 3 The details of the kilns from the Yuan dynasty

NO.	Kiln Name	NO.	Kiln Name	NO.	Kiln Name	NO.	Kiln Name
1	Xiaogang Zui	6	Zhongdu Kou	11	Zhijiu Shan	16	Rao Nan
2	Luoma Qiao	7	Tangxia	12	Liujia Wan	17	Yuyao
3	Liujia Nong	8	Yinkeng Wu	13	Jinkeng	18	Zaisheng Nong
4	Dai Jianong	9	Yueshan Wu	14	Nanshi Jie	19	Hongjiaao
5	Shiba Qiao	10	Hutian	15	Wang Jiawu		

The data of 21 kilns from the Ming dynasty, was collected in this study (Table 4). As Figure 5 illustrates, 4 new kilns were established in rural areas including Yaoli County and Leping County. Leping, however, was not under the jurisdiction of Jingdezhen in the Ming dynasty. Therefore, the Leping kilns were not included in the analysis in this period. The distribution area of the kilns in the Ming dynasty was 558 km^2, measuring 31 km from the east to the west and 18 km from the south to the north. The city borders of Jingdezhen increased rapidly to 18 km^2 in this period, stretching from Lishi Du in the north to the Xiaogang Ju in the south and from Maan Shan in the east to Sanlv Miao

in the west [15]. At this time, 8 kilns were established in the urban areas of Jingdezhen, accounting for 47% of 17 kilns considered in this analysis (not including those from Leping) (Fig. 5). The density of kilns in the urban areas was 0.44 kilns per km^2.

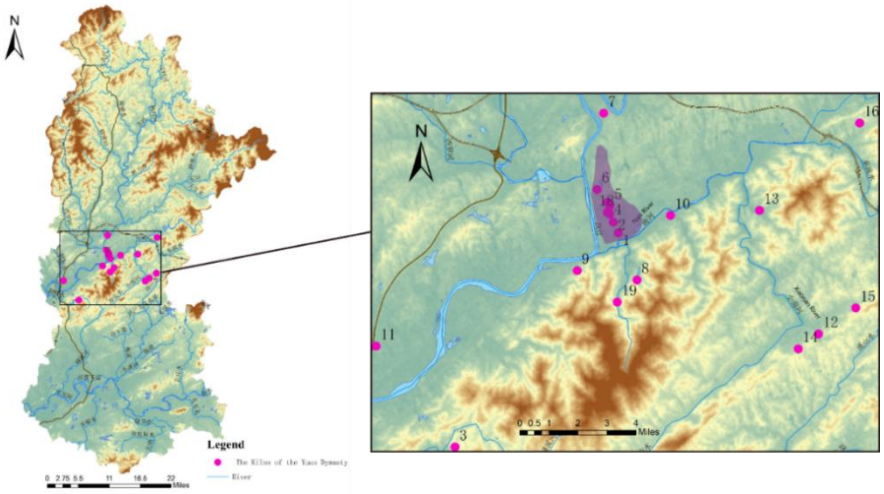


Fig. 4 The distribution of kilns in the Yuan dynasty (based on the data from Table 3)

Table 4 The details of the kilns from the Ming dynasty

No.	Kiln Name	No.	Kiln Name	No.	Kiln Name
1	Dai Jianong	8	Xia Chang	15	Yao Shang
2	Shiba Qiao	9	Zhangjia Qiao	16	Nan Bo
3	Guanyin Ge	10	Wang Jiawu	17	Yuyao
4	Hutian	11	Dongjia Wu	18	Saipao Tan
5	Longzhu Ge	12	Nei Rao	19	Liujia Nong
6	Ciqi Shan	13	Rao Nan	20	Huanglao Da
7	Huajia	14	Chang Ming	21	Hongjiaao

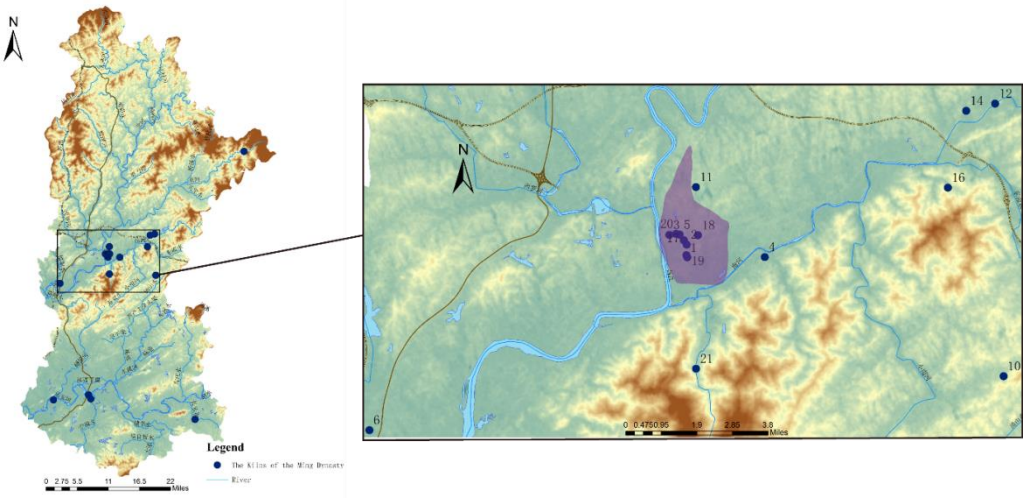


Fig. 5 The distribution of kilns in the Ming dynasty (based on the data from Table 4)

3.3. Discussion

Table 5 lists the distribution data of the kilns for an intuitive understanding of the distribution changed from the Tang to the Ming dynasties. Note that the urban area data of the Tang dynasty and Five Dynasties is absent, and the density of the kilns in the urban areas was difficult to calculate. Nevertheless, as mentioned above, urban expansion in Jingdezhen was based on the area of previous dynasties. The urban area of the Yuan dynasty, for example, was developed on the basis of that of the Song dynasty, and so did the urban areas of other dynasties. Consequently, it could be inferred that the urban areas in Jingdezhen of the Song dynasty were extended based on those of the Tang dynasty

and Five Dynasties; the urban areas of the Song dynasty were larger than those of the aforementioned periods. If the data of the urban areas of the Song dynasty were used to calculate the density of urban kilns in the Tang and the Five Dynasties periods, the results would indicate that there were no kiln sites in the urban areas at this time. Thus, it is highly likely that the density of kilns in the Tang dynasty and Five Dynasties within the urban areas was zero, as the urban areas of Jingdezhen during the Five Dynasties were likely roughly the same or smaller than those of the Song dynasty. Moreover, as stated previously, since only four kilns from the Tang dynasty were discovered, the density of kilns during that period was not calculated here.

Table 5 The percentage of kilns within the urban areas in different dynasties

Dynasty	The percentage of kilns within the urban areas	The density of kilns in the urban areas (km^{-2})	The distribution area of the kilns in the urban areas (km^2)
Tang	0%	0	-
Wudai	0%	0	648
Song	0%	0	1260
Yuan	33%	0.66	540
Ming	47%	0.44	558

As shown in Table 5, the increase of the percentage of kilns within the urban areas rose from 0% to 33% during the Song to the Yuan periods and from 33% to 47% during the Yuan to the Ming periods. This illustrates that more kilns were established in urban areas while fewer kilns were built in the rural areas of Jingdezhen from the Song to the Ming dynasties. Moreover, the density of kilns in the urban areas started at zero, rapidly increased to 0.66 from the Song dynasty to the Yuan dynasty and declined slightly to 0.44 in the Ming dynasty. That is, many kilns were distributed in the urban areas during the Yuan dynasty, at a high density. This density reduced to 0.44 in the Ming dynasty, although this does not mean fewer kilns were established in comparison with the Yuan dynasty. That is, with economic development, the urban areas expanded quickly from the Yuan to the Ming periods while the number of kilns remained nearly unchanged. The distribution area of the kilns increased rapidly in the Song dynasty, as illustrated in Table 5, but the kilns were relatively dispersed. Both the number of kilns and the distribution area fell in the Yuan and Ming dynasties because the layout of kilns became more centralised.

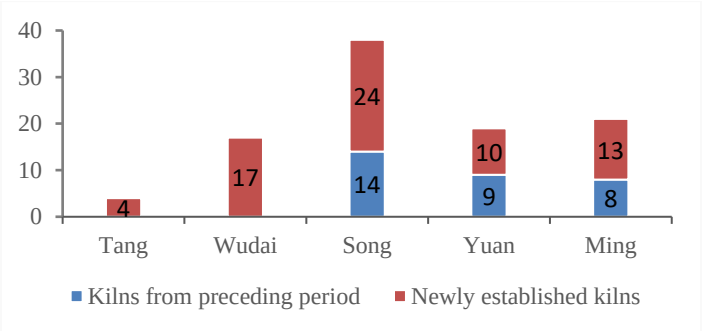


Fig. 6 The kilns from different dynasties in Jingdezhen

In additions, as shown in Figure 6, the Song dynasty had the largest number of kilns, and most kilns from the Five Dynasties were inherited. There were 10 kilns in the Yuan dynasty and 13 kilns in the Ming dynasty were established newly in Jingdezhen, and newly established kilns were much more than kilns from the preceding period from the Song to the Ming dynasties. This illustrates that the ceramic industry in Jingdezhen was still prosperous. Moreover, 6 of the 10 (60%) newly established kilns in the Yuan dynasty were built in urban areas. Of all the thirteen newly established kilns in the Ming dynasty, four kilns built in Leping are not discussed here. Of those remaining, six kilns established in the city or surrounding areas, accounting for 66.6% of the nine newly established kilns are considered here. Obviously, most newly established kilns were concentrated in the urban areas. In conclusion, the kilns gradually became more centralised in the urban areas from the Tang to the Ming periods.

4. Analysis of the Causes Behind the Kiln Layout Changes

Based on the above discussion, kilns were centralised in the urban areas of Jingdezhen from the Yuan dynasty. This change may have been related to transportation and the Yuan government's management of raw materials.

4.1. Governmental Management of Ceramic Production

In the Song dynasty, there were no official institutions to manage ceramic production. However, in the Yuan dynasty, the government created new institutions, such as Fuliang Ceramic Bureau, to manage ceramic production, facilitating the centralisation of the kilns [8]. As exemplified by Fuliang Ceramic Bureau, which was established in Jingdezhen in 1278, the government concentrated the artisans together and created new positions, such as Dashi (commissioner) and Fushi (vice commissioner) of Fuliang Ceramic Bureau and Dutao official (the commissioner for ceramic industry), to supervise their activities, according to *Tongzhi Tiaoge* [12]. The principal sources of artisans at Fuliang Ceramic Bureau are Jianghu (craftsman), a community that members must be engaged in handicrafts for the government for generations. Most Jianghu immigrated from the Western Region or were captured by the army of the Yuan government [16]. Moreover, some Fork Craftsmen were also selected for Fuliang Ceramic Bureau for their tremendous firing skills. The craftsmen of the Cizhou and Jizhou kilns, for example, immigrated to Jingdezhen and continued working on producing ceramics, which had a significant impact on the ceramic decorations and technologies, such as underglaze painting, in Jingdezhen during the Yuan dynasty [17]. To a certain degree, the diverse sources of craftsmen of the kilns in this dynasty stimulated the development of ceramic production and technological innovation in the city.

In the Ming dynasty, the officer who supervised production of ceramic factory was chosen among local officials [12]. Regarding the management of artisans, the early Ming dynasty inherited the Jianghu system (Craftsman Management System) from the Yuan period. The Jianghu were allowed to be privately engaged in the production of ceramics during the break, which promoted the growth of professional ceramic craftsmen and the communication of technology between fork kilns and official kilns. Moreover, the demand for ceramics gradually increased during this period. Weng estimated that the exports of ceramics in Jingdezhen leapt from 6,476,000 pieces in the sixteenth century to 100,880,000 pieces in the seventeenth century [18].

However, the imperial kilns had insufficient capacity to produce so much ceramics (Table 6) and started facing supply problems. Therefore, order forms were allocated to other fork kilns [19], which resulted in more kilns being established in the urban area. The technology to produce ceramics and the pattern designs of the imperial kilns were much better compared with those of the fork kilns. Thus, an increasing number of fork kilns began to be constructed in urban areas to learn more advanced technology from the imperial kilns and share advancements with the fork kilns in other areas, which promoted technical exchange in Jingdezhen.

Table 6 The output of the imperial kilns during the period from Emperor Jiajing to Emperor Longqing [19]

Period(AD)	1529	1531	1544	1555	1571
Pieces	2570	12300	50000	79750	105770

In sum, government management during the Yuan and Ming dynasties promoted the emergence of professional artisans and the development of ceramic production in Jingdezhen. First, the emergence of professional artisans made it possible for them to survive with work aside from agricultural activities, which provided a prerequisite for artisans to leave the rural areas and move to the urban areas for ceramic production. Second, the technological development and innovation of ceramic production led to a more complex production process and raised the requirements for labour and production collaboration. Thereupon, it became difficult for the ceramic workshops relying on the small-scale farmer economy to continue to survive. These workshops gradually detached from agricultural activities, prompting the kilns to be built ever closer to the urban areas to obtain more labour. Finally, the mismatch between the growth in demand for ceramics and the limited production

capacity of the imperial kilns led to supply problems. As such, production orders were assigned to fork kilns, which attracted the establishment of more fork kilns near the imperial kilns.

4.2. Raw Materials and Transportation

The transportation of raw materials and ceramics is a critical factor in the process of ceramic production because it is related to the production costs. Jingdezhen has abundant forest and vegetation resources, such as evergreen broad-leaved forests, coniferous forests and deciduous broad-leaved forests, providing sufficient fuel for ceramic production. However, with the development of ceramic production in the city, nearby forest resources became scarce and had to be harvested from more distant places, such as Le Ping and Poyang. In such cases, transportation played an increasingly important role in site selection.

In addition to wood, the essential raw materials for firing ceramic are clay and glaze. In the Song dynasty, china stones were frequently used as raw materials in making ceramics. China stones are primarily distributed in the fault zone between Yifeng and Jingdezhen [20]. For example, Liujiawan in the South River Basin was the principal mining area. Thus, the South River Basin, rich in firewood and china stone resources, naturally became the main distribution area of kilns in the Song dynasty. However, during the Yuan dynasty, craftsmen found that kaolin and china stone mixed at a certain proportion to make ceramic could significantly reduce the deformation of ceramic pieces while firing.The kaolin resources were produced at Dongxiang, Mingsha, Yinkengwu and Xingzi, located several tens or hundreds of kilometres from Jingdezhen.

China stone was not the only unique raw material used to make ceramics. Therefore, it was unnecessary to select areas rich in china stone or kaolin; on the contrary, establishing kilns in places with convenient transportation amenities was more economical. Additionally, several areas in which raw materials were harvested were over-exploited. More raw materials could only be transported by river from further locations, such as Mingsha, Yinkengwu, Xingzi and Qimen [20]. As such, to ensure the continuous supply of high-quality raw materials, choosing a position with convenient transportation was necessary because diverse materials and fuel could be transported from various places simultaneously.

Table 7 Basic information on the transportation routes of Jingdezhen (data based on Liu's [20] research).

Transportation routes	Producing areas the route passed through	Length (Kilometres)	Range
Upstream of Chang River	Qimen: firewood and kaolin; Fuliang Beixiang: firewood	135	From Qimen to Jingdezhen
East River	Yaoli, Ehu: Youguo (Enamel Stone), firewood, etc.	60	East River Basin
South River	Xianghu, Liujiawan, etc: china stones	45	South River Basin
Lower reaches of Chang River	Yugan, Leping: kaolin	90	From Jingdezhen to Poyang

Owing to the Chang River flowing through the city, Jingdezhen enjoys convenient transportation. The Chang River has always been the main transportation route for the commodities and raw materials required for ceramic production. As shown in Table 7, there are four primary water transportation routes in the Chang River Basin, including the upstream portion of the Chang River, the East River, the South River and the lower reaches of the Chang River. All four routes pass through important raw material production areas in Jingdezhen and transport various raw materials required for ceramic production to the urban areas of the city. Furthermore, the ceramics fired in Jingdezhen was primarily transported outward by waterway in the Ming dynasty, and the main transit point was the lower reaches of the Chang River region [20]. This means that obtaining a balance between the transportation of raw materials and ceramics for trade would be possible if the kilns were built in the urban areas of Jingdezhen. As diverse raw materials could be transported to urban areas of Jingdezhen from different regions. Meanwhile, quantity of ceramics was carries directly by Chang River crossing

the city of Jingdezhen to other cities all over the country, resulting in lower transportation costs.

In summary, the lower reaches of the Chang River provided convenient transportation and were an essential channel for both transporting raw materials to the urban areas and exporting goods. After the Yuan and Ming dynasties, the construction of kiln factories in the urban or suburban areas of Jingdezhen became inevitable to save costs on raw material and ceramics transport.

5. Conclusion

In sum, from the Tang dynasty to the and Song dynasty, the kilns distribution were scattered. Nevertheless, the spatial distribution pattern of the kilns in Jingdezhen changed after the Yuan Dynasty, where they began to centralise towards the urban area. The trend of the kilns concentrating towards the urban areas became more pronounced in the Ming dynasty, and the urban areas became a new distribution region. The concentrated kiln distribution pattern of Jingdezhen was influenced by political and economic factors that significantly impacted ceramic production. When policy and economic circumstances changed, the kiln distribution was adjusted to adapt. The resulting distribution pattern was beneficial in saving transportation costs and promoting the exchange and innovation of technology in Jingdezhen, which stimulated the city to become the ‘Chinese Ceramics Capital’ and remain prosperous to this day.

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