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THE YAOZHOU KILNS: A RE-EVALUATION

Volume 1: text

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ABSTRACT OF THESIS

Despite its undeniable beauty, the blue/green ware of Yaozhou was not included among the five famous wares of the Song dynasty, and to this day, despite the evidence of intensive archaeological excavations, its primacy in the history of Chinese ceramics has not been recognised.

Chinese literary sources dating from the eighth to the nineteenth centuries reveal that during the Northern Song (960-1126), the Yaozhou kilns had in fact gained official recognition, but from the Southern Song (1127-1279) onwards this perception had become negative. Ming (1368-1644) and Qing (1644-1912) scholars hardly referred to Yaozhou ware at all, and by the beginning of the twentieth century, Yaozhou ware was not even identified. This may account for the negative view held by ceramic experts up to the first major archaeological excavation in 1958, but why scholars world-wide have continued to under-rate Yaozhou kilns despite the astonishing discoveries of 1973 and of the seasons from 1984 to 1997 is baffling.

This dissertation shows how advanced this kiln centre was by reconstructing the manufacturing process from the preparation of raw materials to firing, on the basis of the archaeological materials. From the analysis of the architectural remains and their contents there emerges a continuous development of techniques and equipment pioneered or adapted by Yaozhou potters from the Tang (618-907) to the Jin dynasty (1115-1234). Finally, the examination of both the macrostructure and microstructure of the body and the glaze of a consistent group of celadon shards dating from the Tang to the Jin dynasty completes the reconstruction of the manufacturing process. Together with the study of the factors influencing the visual appearance of Yaozhou blue/green ware, this dissertation shows how well Yaozhou potters knew local raw materials, how swiftly they adapted to new circumstances, and the full extent of their contribution to the development of Chinese ceramics.

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INTRODUCTION

My interest in the Yaozhou kilns was kindled in Spring 1994 when I had the opportunity to visit the excavation site at Huangbaozhen, Tongchuan, Shaanxi province. As a student of Chinese ceramics, I knew that this kiln centre was famous in the Song dynasty for producing boldly decorated blue/green ware which, albeit beautiful, did not rank among the "five great ceramic families of the Song dynasty". Seeing archaeologists at work in a vast area and handling vessels unearthed a few metres from the Yaozhouyao Museum (at the time still in the process of being fitted out) was a galvanising experience that had an immense impact on me. The specimens were truly astonishing, particularly a group of blue/green wares characterised by a distinct blue tinge of the glaze and no decoration, some bearing the character 官 *guan* incised on the base. I had never seen pieces like these in either publications or salerooms and I would have never associated them with Yaozhou kilns. My surprise did not diminish when it was explained to me that they were from the Five Dynasties, a period regarded in ceramic history, when considered at all, as either an appendix to the Tang or a brief introduction to the Song.

In the following months, I kept thinking of the amazing quality and distinct character of that group of blue/green wares and in December 1994 I had the unique opportunity of meeting Zhuo Zhenxi, the archaeologist in charge of the excavations at Huangbaozhen since the early 1970s. The encounter was inspiring and a few days later I went back to the Yaozhouyao Museum to look at the achievements of this kiln centre in the light of Zhuo's comments. This second visit to Huangbaozhen convinced me of the great importance of the Yaozhou kilns in general and of the special character of their blue/green wares of the Five Dynasties. But I was doubly surprised that nobody in the West had noticed it.

Back at Xibei University in Xi'an, I searched for the archaeological reports and discovered that the first one concerning Five Dynasties blue/green wares had been published as early as 1980 and several others had appeared in 1987, thus showing that some data were available. So why had they been ignored? Had other aspects of the Yaozhou kilns been overlooked? Why were some specimens inscribed with the character *guan*? Had they been made specifically for the emperor? As I continued to read archaeological reports, I realised that a lot of information about Yaozhou kilns was available, but had been largely ignored by western scholars. Why?

To my knowledge, Song Yaozhou blue/green wares were well known in the West and fetched relatively high prices at auction, nevertheless they did not seem to have attracted academic interest.

In my random readings about Yaozhou kilns I found references to ancient literary texts which, except probably for a few, sounded very dismissive of Yaozhou ware. On the other hand, heirlooms and archaeological excavations presented a flattering image of the accomplishments of Yaozhou potters.

A thorough study of the Yaozhou kilns ware to assess their achievements and eventually restore their position in the history of Chinese ceramics was accepted as an appropriate subject for a doctorate.

The starting point of this research was to understand why Yaozhou blue/green wares had not been included among the so-called "five great ceramic wares of the Song dynasty", namely Ding, Ru, Jun, Guan and Ge, despite the undeniable beauty of specimens, such as the box in the Percival David Foundation (fig. 1) or the pillow in the Seikado Bunko Art Museum (fig. 2).

As the concept of the "five great ceramic wares of the Song dynasty" is often presented by modern scholars as a legacy of Ming and Qing *literati*, I consulted some of the most authoritative sources dating back to those periods from which it appeared that Ming and Qing scholars did not praise just Ding, Ru, Jun, Guan and Ge, but a rather more substantial and heterogeneous group of Song wares.

Although it was not entirely accurate that the concept of the "five great ceramic wares of the Song dynasty" was a legacy of Ming and Qing *literati*, it was a fact that the Yaozhou kilns were never included in the selection. This systematic exclusion prompted a research into the perception of Yaozhou wares in the Ming and Qing dynasties which disclosed two very different standpoints: on one side the *literati*, who showed no interest for the Yaozhou wares, except as a remote and lost type of ceramics, and on the other local gazetteers which provided useful information on this kiln centre.

Some of the data mentioned in the local gazetteers echo earlier sources whose analysis demonstrated that in the Northern Song dynasty the Yaozhou kilns were highly praised, while during the Southern Song comments became first contradictory and then negative, and in the Yuan dynasty the reputation of Yaozhou kilns was definitely compromised.

The research into the concept of the "five great ceramic families of the Song dynasty" and the perception of the Yaozhou kilns in imperial China spurred enquiry into a series of issues, such as the meaning of official, imperial, classic, popular and tribute in the Song dynasty, for which a possible interpretation was attempted.

Once the reasons for the exclusion of Yaozhou celadon from the "five great ceramic families of the Song dynasty" were clear, another question arose: why were the Yaozhou kilns not revalued by scholars of the 20th century, particularly in the past twenty-five years?

For experts active in the first half of the last century it was understandably difficult to appraise the Yaozhou kilns, as after centuries of negative publicity, Yaozhou had become the name of an ancient and not particularly famous kiln complex, whose products were no longer identifiable. Beautiful heirlooms coated in a transparent olive-green glaze and decorated with carved or moulded motifs were classified at first under very generic terms, such as "Northern celadon" (used in the West to indicate Yaozhou and Yaozhou-type specimens, while in China it included all blue/green wares made in the north since the sixth century AD), "Lishui ware of the north", "Longquan of the north", and then, after the first field explorations by Japanese scholars in search of the site of the celebrated Ru ware, the more scientific, although erroneous, names "Ru yao" and "Linru yao" were put forward. At this date, in the 1940s, no connection had as yet been made between vessels decorated with carved or impressed motifs under a transparent olive-green glaze and the Yaozhou kilns.

When the newly founded People's Republic of China launched a series of archaeological campaigns all over the country, no excavation of the Yaozhou kiln site was planned. However, both Chen Wanli and Feng Xianming explored the area respectively in 1954 and 1957, and although the site at Huangbaozhen was not recognised for what it really was, that is, the main kiln centre in Yao prefecture, at least it was realised that Yaozhou had been an important Song dynasty kiln whose products were not provincial, indeed were so beautiful that like Ding and Ru wares, the kiln was selected to supply vessels to the imperial court.

Probably because of Chen Wanli and Feng Xianming's finds, in autumn 1958 a full-scale archaeological campaign (that lasted until 1959) was finally organised to investigate and excavate the Yaozhou kilns at Huangbaozhen, Lidipo and Shangdiancun. The finds were astonishing and proved that what Chinese scholars had called Linru ware since Harada's discoveries at Linru county in 1931, was actually Yaozhou ware. The 1958-59 excavations also demonstrated that the first factories commenced production at Huangbaozhen in the Tang dynasty; that the kilns were still active under the Mongols; that they specialised in the production of blue/green wares, but also manufactured other genres; and that technologically the Yaozhou kilns were very advanced.

Despite the publication in 1965 of the archaeological report on the 1958-59 excavations at the Yaozhou kiln site, reconsideration of the position of this kiln centre was slow and fragmented. This pattern was due to be repeated after the brief 1973 campaign which, among others, brought to light the very unusual celadon specimens dated to the Five Dynasties, and after the major excavations carried out between 1984 and 1996. Although three volumes constituting the final report on this full-scale investigation of the Yaozhou kiln site have already been published, with only the last volume still to appear the impressive data they provide do not seem to have made an impact on new research on the subject, particularly in the West.

The western and Chinese studies on the Yaozhou kilns that appeared after the publication of the archaeological report of the first full-scale excavation, highlighted a number of issues such as the dating of the Yaozhou kilns, the influence they received from the Yue kilns, the export of Yaozhou wares and the influence they exerted on other ceramic centres, the question of Yaozhou tribute ware and finally the question of *guan*-marked specimens. A paragraph was dedicated to each of these topics in chapter 2.

Although Chinese and western literature had only marginally accepted the new and updated archaeological data, my conviction that Yaozhou was one of the greatest kiln centres in Song China remained unshaken. But in order to prove this position it was necessary to analyse in detail the technology that lay behind the visual aspect of Yaozhou wares since the Tang dynasty.

Understanding Yaozhou ceramic technology demanded an attempt to reconstruct the manufacturing process that Yaozhou potters implemented and constantly adapted through the ages, from the preparation of the ingredients to the firing of vessels. Although when mentioning ceramic technology one thinks of lab analyses of shards, it seemed that before concentrating on this aspect, valuable information could be obtained from another important source: the frequently underestimated study of the remains of workshops, kilns and their contents, as these can often anticipate or corroborate the results of scientific tests.

The analysis of Yaozhou architectural remains and their furnishings has been undertaken with the intention of establishing a line of development from the Tang to the Jin dynasty and the implications that this development had on the finished product. For example, the adoption in the Song dynasty of chaser mills to pulverise clays demonstrates how sophisticated this process had become by then, while in the same period the changes in quantity and typology of saggars indicate that the latter were much more widely employed than in previous times and this, in turn, demanded modifications to their shape in order to save space in the kiln. Another example is the modification of the kiln structure after the introduction of coal to replace wood as fuel, which had huge repercussions on the visual aspect of the finished product.

The abundance of edifices and furnishings found at Huangbaozhen, which, by itself, should be considered as a proof of the magnitude of this kiln centre, and the copious Chinese literature on the subject has greatly facilitated the task.

In order to understand the remarkable differences that characterise the visual aspect of Yaozhou celadons through the ages and complement the information provided by the study of architectural remains, it was also necessary to analyse the macro- and microstructure of some shards.

In Spring 1996, thanks to a grant from the Irwin Fund assigned by the Academic Trust Funds Committee, and to Zhuo Zhenxi's kind invitation, I was able to spend some time at the archaeological station in Huangbaozhen where I analysed a series of shards dating from the Tang to the Yuan period. Each sample was first analysed by the naked eye and then through a low power binocular microscope (kindly lent to me by SOAS) at three specific magnifications, namely 10x, 20x and 40x, to observe certain phenomena at different levels. Zhuo Zhenxi's generosity extended to granting me permission to photograph a considerable number of the samples examined, thus enabling me to document my examination with photographic evidence.

During that period of fieldwork I also had the opportunity to pick up some shards along the banks of the Qishui, the river that once flowed through the kiln centre, while some others were kindly given to me by Zhou Xiaolu, a ceramic teacher I had had at Xibei Daxue when I was a student in 1994-95.

Back in London, I was very fortunate to meet Nigel Wood, Senior Visiting Research Fellow at the Research Laboratory for Archaeology and the History of Art, University of Oxford, who agreed to arrange for seven of the shards in my possession to be tested at the Oxford Research Laboratory.

The analyses carried out by Dr Christopher Doherty with a scanning electron microscope (with energy dispersive analysis (EDA) and wavelength dispersive analysis (WDA) capabilities) determined the chemical composition and the microstructure of the tested samples. These data were infinitely more significant than those provided by the low power binocular microscope with which I had observed the macrostructure of the samples made available to me.

Although interest in the technology of Yaozhou wares in China was slow to develop, most of the data available at present derives from Chinese laboratories, therefore it seemed opportune to conclude this research by analysing the outcome of the studies carried out in China in the past twenty five years.

The research and compilation of this dissertation were inevitably carried out over a period of several years, during which the interest for the Yaozhou kilns in China grew considerably. A symposium entirely dedicated to the Yaozhou kilns was organised in Tongchuan at the end of 1995 (the proceedings were published in a special issue of *Wenbo* in 1996), and another one was held in June 1999 again at Tongchuan (the proceedings were published in the fourth issue of 文博 *Wenbo* in 1999).

By the time of the publication of the proceedings of the second conference, I had independently noticed that the setting system implemented by the Yaozhou potters in the Five Dynasties to fire fully-glazed specimens on small spurs not only was more advanced than that in use at the Yue kilns, but also anticipated the so-called "sesame seeds" method later employed by Ru potters. However, in her paper at the 1999 conference, Zhou Lili makes this observation and also remarks that by the Five Dynasties Yaozhou blue/green ware was no longer inferior to Yue celadon and in the Northern Song period Yaozhou was the most prosperous celadon-producing centre in China.

The literary material at the base of this research was collected not only at the very well-stocked SOAS library, but also at libraries in China, Taiwan, Hong Kong and Oxford.

For those Song to Qing writings included in the 欽定四庫全書 *Qinding siku quanshu*, or in more modern *collectanea*, such as 美術叢書 *Meishu congshu*, 明清筆記叢書 *Ming Qing biji congshu* or 瓜蒂庵藏明清掌故叢刊 *Guadi'an cang Ming Qing zhanggu congkan*, it was easy to trace facsimile copies of the text; other documents (such as the 陶說 *Taoshuo* and the 歷代名瓷圖譜 *Lidai mingci tupu*) have been reprinted individually and local gazetteers were found in apposite collections (those not available at SOAS were accessed in Oxford or in Taiwan). For the few scholarly works whose facsimile text could not be obtained, I resorted to the volume dedicated to ancient ceramics edited by Sang Xingzhi *et al.* in the series 古玩文化叢書 *Guwan wenhua congshu.*

When only reprints of the first edition of twentieth century writings were available, but the date of their first publication was essential to the argument, the original date appears in brackets next to the date of the publication of the accessible volume.

The final reports on the excavations at the Yaozhou kiln site provided vital information for this research (most of chapter 3 is based on the data they supply), the only problem was the measurements of architectural remains and utensils which sometimes did not correspond to the scale of the drawings. This is the main reason why I have reported the measurements in the relative tables in the appendix, but I did not venture calculations of areas.

Chinese literature on ceramic technology was the most difficult to collect, as it is often published in not very well distributed journals. Some of the papers were strictly for specialists in chemistry, geology and physics, but with some effort it was possible to understand the implications of the discussed tests, although the procedures often remain incomprehensible. A greater detriment was the presence in some papers of inaccuracies and errors which cast doubts on the reliability of the work and the research behind it and called for scrupulous and laborious examination of the information supplied.

The bibliography is divided in two parts: primary and secondary sources. The primary sources section includes all Song to Qing Chinese writings organised in alphabetical order by title. Each entry is also provided with the name of the author and the compilation date, if known. This was done to facilitate tracing literary documents after their first occurrence in the text, as bibliographical information and Chinese characters are specified only at their first mentioning.

The secondary sources section comprises all the studies (books and papers) consulted for this research regardless of their language in order to expedite locating them in the bibliography. Entries are listed in alphabetical order by author followed by the date of publication. In the case of names in Chinese, both surname and name are written in full (to avoid confusion) followed by the corresponding Chinese characters, while in the case of names in Japanese and western languages only the surname appears in the heading. Names in Chinese follow the rule by which the surname always precedes the name, while for names in Japanese and western languages the surname (written in capitals to avoid confusion) follows the name. The names of Chinese journals always occur in full (to avoid searching for abbreviations), but in *pinyin* only: corresponding characters are provided in the glossary.

There are two appendixes: the first one collects Chinese texts from primary sources mentioned in the first chapter and listed in alphabetical order by title as in the bibliography. The second appendix includes a series of tables reporting data to identify workshops and kilns, measurements of portions of architectural remains and of implements, chemical compositions of ceramic samples and their eventual bibliographical reference.

The glossary, organised in alphabetical order, comprises definitions of English and Chinese technical terms, Chinese characters for words that after the first occurrence appear in *pinyin* only and the Chinese characters for the names of Chinese journals.

Although the use of abbreviations was kept to a minimum in order to facilitate reading, in some cases they were unavoidable. A list of abbreviations is supplied for their interpretation.

Illustrations are identified by an Arabic number and the subject of the figure, while the details of the illustrated objects are given in the list of illustrations (together with sources). In the case of specimens such as elements of the potter's wheel, moulds, setters, saggars, etc., many examples were unearthed from the Huangbao kiln site and drawings and photographs of them were published in the final archaeological reports (SPIA 1992, SPIA 1997 and SPIA 1998). However, because of limitations of space, only the most representative ones were selected to be illustrated in this research. In order to show the relation between mould and finished object, in some cases a mould is illustrated together with a finished object which, however, was not necessarily produced with that specific mould. Some of the images are presented upside down on purpose to show how the object in question was used.

The colours of the photographs taken through the low power binocular microscope are not true colours: some of the pictures were taken under very powerful flash lights or in artificial light.

Finally a note on the adoption of the term "blue/green ware(s)". In Chinese, wares coated with iron-coloured glazes fired in reducing atmosphere at high temperature are called *qingci* 青瓷, *qing* meaning both "blue" and "green", and *ci* indicating high-fired bodies. The Chinese term is usually translated in western languages as "green ware(s)" (also spelled "greenware(s)"), or as "celadon". But as it includes wares with both green and blue glazes, to translate *qingci* as "blue/green ware(s)" seems more accurate than "green ware(s)".

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I would like to stress that were it not for some truly remarkable people, this research would have never been completed (and probably not even started) and for this reason my first thanks are for my supervisor, Professor Whitfield, who has been an incomparable model for all these years. I am most grateful to Madame Zhuo Zhenxi without whose active support and benevolence I would have never had the possibility to stay at the Tongchuan station of the Shaanxi Provincial Institute of Archaeology and therefore to study first hand unearthed objects and architectural remains. Many thanks to Prof. Zhou Xiaolu, Xibei University, Xi'an, for his teachings, encouragement and for giving me some of his Yaozhou blue/green shards which have been invaluable to understand the level of technology reached by Yaozhou potters. I am very grateful to Dr. Qin Dashu of the Department of Archaeology, Peking University, for letting me study Linru wares and recently for allowing me to take part in an archaeological excavation led by him in Yuxian, Henan province: although the sites which were being excavated did not belong to the Yaozhou system, the experience was inestimable. I am also deeply indebted to Professor Xie Mingliang of Taiwan National University, Taibei, for teaching me not only about Chinese ceramics, but also to be critical.

I wish to give special thanks to Nigel Wood for proposing to test the shards from the Yaozhou kiln site, for organising the testing at the Research Laboratory of Archaeology and the History of Art, Oxford University and for all the explanations he has very patiently given to me over the years so that I could understand the results of the test and much more. Many thanks to Dr Chris Doherty, the geologist responsible for the tests at the Research Lab in Oxford, who supplied invaluable notes to decipher the microphotographs and kindly checked my elaborations of the same data.

Thanks also to Glenn Ratcliffe, art photographer at SOAS, for teaching me how to take photographs through a microscope and for the photographs he took for me.

I am very appreciative of the grants awarded to me by the Irwin Fund (assigned by the Academic Trust Funds Committee) and by the East Asian History of Science Foundation, Hong Kong, which permitted two periods of fieldwork in China, respectively in Spring 1996 and Winter 1997.

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Finally, many thanks to friends and family who have borne with my many ups and downs over the past seven years.

This dissertation is dedicated to Stefano, who will always be my model of perseverance.

CHAPTER 1

THE "FIVE GREAT WARES OF THE SONG DYNASTY" AND THE PERCEPTION OF YAOZHOU KILNS IN ANCIENT CHINESE DOCUMENTS

1.1 The five great wares of the Song dynasty

One of the points that have stimulated this research is the question that, despite its undeniable beauty, Yaozhou blue/green ware was not included among the so-called "five great wares of the Song dynasty". This concept, which still exerts considerable influence on the classification of Song wares as indeed testified by the fact that any oriental or western student of Chinese ceramics is able to list the five as Ding, Jun, Ru, Guan and Ge, is usually presented as a legacy left by Ming and Qing scholars.[1] But this is only partially true: by consulting Ming and Qing literature on the subject, one realises that Qing commentators followed the pattern set by their Ming predecessors in isolating a group of superior Song wares, but this was rather flexible and usually included at least six ceramic families.[2] The reduction to the five categories mentioned above seems a later interpretation, in the West probably influenced by what scholars could identify, as the exclusion of certain unidentifiable wares such as Dong, Zhang Longquan, Sui, Dashi (Muslim), suggests. But it is better to begin with a brief analysis of some Ming and Qing sources.

Among early Ming records is the 格古要論 *Gegu yaolun*[3] which in the third 卷 *juan* lists ancient wares in the following order: Chai, Ru, Guan, Dong, Gege, Xiang, Gaoli (Koryo), Ding, Jizhou, Cizhou, Jian, Longquan, Raozhou, Huozhou, Dashi and "vessels which did not exist in ancient times".[4] Of these only Chai and Guan are said to have been made by imperial command, the latter under the control of the Department of

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[1] Vainker 1991, p. 93.

[2] See below chapter 1, pp. 17-19.

[3] The 格古要論 ***Gegu yaolun*** was originally written by 曹昭 Cao Zhao in 1387, then it was revised and enlarged by 王佐 Wang Zuo in 1459. The list of ancient wares is in the third *juan*, ff. 1a-4b (see Appendix I, text 6). For a complete study in English see David 1971 (Sir Percival claims to have translated the original edition).

[4] This paragraph of the *Gegu yaolun* concerns shapes rather than a specific ceramic ware.

Internal Affairs (修内司 *xiuneisi*), whilst some Raozhou pieces seem to have been prepared with "imperial clay" (御土 *yu tu*).

The 留留情 *Liuliuqing*[5] describes Ru, Longquan, Ding, Jun, Guan, Xiuneisi, Ge and Xuande wares (Appendix I, text 10), whereas the 博物要覽 *Bowu yaolan*[6] considers Ru, Guan, Ge, Ding, Longquan, Jian, Jun, and Dashi (Appendix I, text 1), and the 清祕藏 *Qingbi zang*[7] groups together Chai, Ru, Guan, Ge and Ding as the most important kilns, but also describes Jun and Longquan (Appendix I, text 11). In the 燕閑清賞箋 *Yanxian qingshangjian*[8] Gao Lian (高濂) discusses Guan, Ge, Chai and Ru wares in one section, Ding in the following one, then dedicates a third section to wares made by imperial command, where he lists Longquan, Jizhou, Jian and Jun and the last section is devoted to new and old Raozhou kilns which are also considered imperial (Appendix I, text 25); the 五雜組 *Wuzazu*[9] discusses in detail Chai ware and then briefly mentions Ding, Ru, Guan and Ge wares, specifying that Ding and Ru served the Song court (Appendix I, text 23). The Song wares illustrated in the 歷代名瓷圖譜 *Lidai mingci tupu*[10] are white, purple and black Ding, Guan, Ru, Longquan, Jun and one Dong specimen, but, judging from the illustrations and their captions, Xiang Yuanbian did not classify ceramic specimens according to the categories accepted today.

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[5] The 留留情 ***Liuliuqing*** is the abridged edition of the *Liuqing rizha*, edited by 徐懋升 Xu Maosheng and published in 1614; ancient wares are listed in *juan* 6, ff. 6b-7b.
The 留情日札 *Liuqing rizha* was written by 田藝蘅 Tian Yiheng (Xu Maosheng's father-in-law) and published in 1572. The form it has survived in includes 39 *juan*, the fortieth is listed in the table of contents, but does not appear in the text (see David 1936-37, p. 34); none of the *juan* refers to ceramics, but the *Taoshuo* reports excerpts from it related to Ding, Ru, Guan, Xiuneisi, Dong, Jun and Jian wares (for details on the *Taoshuo* see below chapter 1, footnote no. 11 and Appendix I, text 18a).

[6] The 博物要覽 ***Bowuyaolan*** was written by 谷泰 Gu Tai between 1621 and 1627. Ancient wares are listed in *juan* 2, ff. 1a-8a. See also David 1936-37, p. 39.

[7] The 清祕藏 ***Qingbi zang was*** written by 張應文 Zhang Yingwen and was published in 1595. Ancient wares are mentioned in the first *juan*, ff. 9a-10b. See also David 1936-37, pp. 38-39.[8] The 燕閑清賞箋 ***Yanxian qingshangjian*** was written by 高濂 Gao Lian at the end of the sixteenth century. Ancient wares are mentioned at ff. 24a-28b.

[9] The 五雜組 ***Wuzazu*** was written by 謝肇淛 Xie Zhaozhe in the 1620s'. Ancient wares are discussed in *juan* 12. See also David 1936-37, pp. 40-41.

[10] The 歷代名瓷圖譜 ***Lidai mingci tupu*** was written by 項元汴 Xiang Yuanbian (1525-1590) at the end of the Ming dynasty. For text and translation see Bushell 1908.

Among Qing dynasty literature, the most famous records are the 陶說 *Taoshuo*[11] and the 景德鎮陶錄 *Jingdezhen taolu*[12], the first listing Ding, Ru, Guan, Xiuneisi, Ge and Longquan specifically as Song kilns, followed by Jizhou, Xiang, Dong, Junzhou, Cizhou, Jian, Shanxi and Gaoli wares (Appendix I, text 18a); the second enumerating Ding, Ru, Guan, Dong, Longquan, Ge, Zhang Longquan, Jun and Sui as Song wares imitated at Jingdezhen (Appendix I, text 8a). The 文房肆考圖說 *Wenfang sikao tushuo* has an extensive list comprising Ding, Ru, Guan, Ge, Longquan, Jizhou, Pengzhou, Xiang, Dong, Junzhou, Cizhou, Jian, Shanxi, Gaoli and Raozhou (Appendix I, text 21).[13] whereas the 窯器說 *Yaoqi shuo* mentions Chai, Ru, Guan, Ge and Ding and discusses Longquan, Xiang, Jian, Raozhou, Jizhou, Shanxi, Shaanxi, Guangdong, Gaoli, Dashi and Cizhou wares (Appendix I, text 26).[14]

From the above it appears that Ming and Qing scholars praised a substantial group of Song wares whose flexible boundaries little resemble the strict range of the five great wares of the Song dynasty as they are known today. However, the exclusion of Yaozhou ware from the circle of superior wares seems constant.

1.2 Yaozhou kilns in Ming and Qing literature

As seen in paragraph 1.1, Yaozhou ware was not included among the best of the Song dynasty by Ming nor Qing scholars, but what was their perception of this kiln centre? Ming literary works ignore Yaozhou ware altogether with two exceptions: the *Liuqing rizha*, as quoted in the second *juan* of the *Taoshuo* in the paragraph dedicated to Ru ware, stating that Yaozhou kilns imitated Ru, but the colour of their wares was not as good (Appendix I, text 18a);[15] and the *Liuliuqing* that reports a very similar statement (appendix I, text 10).[16]

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[11] The 陶說 ***Taoshuo*** was written by 朱琰 Zhu Yan in 1774. Ancient wares are listed in *juan* 2, ff. 2b-11b. For a complete study in English see Bushell 1910.

[12] The 景德鎮陶錄 ***Jingdezhen taolu***, often abbreviated *Taolu*, was compiled by 藍浦 Lan Pu in 1815. Ancient wares are listed in *juan* 6, ff. 1a-5a. For a complete study see Sayer 1951.

[13] The 文房肆考圖說 ***Wenfang sikao tushuo*** was written by 唐秉鈞 Tang Bingjun in 1776 and published in 1778. Ancient wares are discussed in *juan* 3, ff. 28b-36b.

[14] The 窯器說 ***Yaoqi shuo*** was written by 程哲 Cheng Zhe and published in 1913, therefore it formally belongs to the republican period; however, given the fact that the Republic of China had been established only two years earlier, it can still be considered a Qing dynasty literary work. It discusses Song and Ming wares together in the only chapter the text comprises.

[15] For details on the *Liuqing rizha* see above chapter 1, footnote no. 5. Literally the passage from the *Taoshuo*, *juan* 2, f. 5b reads: 留情日札唐鄧耀悉有之而汝為冠色如哥而深微帶黃。"Tang, Deng and

However, a different account emerges from local gazetteers.

The 耀州志 *Yaozhou zhi* compiled in the Jiajing era (1522-1566) provides a detailed chronicle of the name changes the Yaozhou area underwent since the Han dynasty (Appendix I, text 27),[17] while the 同官縣志 *Tongguanxian zhi* compiled in the 46th year of the Wanli reign period (1618) provides precious pieces of information about ceramic activity (Appendix I, text 19). The passage reads:

> 黃堡鎮一名黃堡寨前宋代守禦地也在縣南四十里
>
> 按地理志黃堡在金尤爲重鎮舊有陶場居人建紫極宮祀其土
>
> 神宋熙寧中封其神為德應侯以陶冶著靈應故也祀以晉永和
>
> 時人柏林配享蓋傳居人陶冶術者今其地不陶陶於陳爐鎮其
>
> 鎮復廟祀德應侯如黃堡云。
>
> "Huangbaozhen used to be called Huangbaozhai. In the Northern Song it was a guarded territory. It [Huangbaozhen] is 40 *li* south of the county. According to the Geography Monograph, in the Jin dynasty Huangbao was an especially important town. It used to be a ceramic centre, the inhabitants built the Zijigong to worship their earth spirit. In the Xining reign period [1068-1077] of the Song dynasty the spirit was awarded the title of Marquis Deying. This was on account of the ceramic-making spirit. They worshipped a man of the Yonghe reign period [345-356] of the Jin dynasty, the enshrined Bai Lin, who had taught them the art of making ceramics. Now there are no kilns, they are in Chenlu which has built the temple to worship Marquis Deying just like in Huangbao".[18]

From the account two important data emerge: first, in the early seventeenth century it was known that the spirit of soil was so revered in Huangbaozhen that between 1028 and 1077 it was awarded the official title of Marquis Deying (德應侯

Yaozhou all make it, but Ru is the best; the colour is like that of Ge [ware], only deeper and slightly yellow".

[16] The passage from the *Liuliuqing, juan* 6, ff. 6b-7a reads: 汝窯宋以定州白磁器有芒不堪遂命汝州造青窯器北唐鄧耀州悉有之而汝為冠今河南汝州色如哥而深微帶黃。"Ru ware. In the Song dynasty as Ding white wares had rough [mouth rims], they were not suitable, consequently Ruzhou [kilns] were ordered to make blue/green ware. In the north, Tang, Deng and Yaozhou all make it, but Ru is the best. The colour of Ruzhou [ware] in today's Henan is like that of Ge [ware], only deeper and slightly yellow".
It should be noticed that the just mentioned passages in the *Liuqing rizha* and the *Liuliuqing* echo a very similar passage from another document, the 老學庵筆記 *Laoxuean biji*, analysed below chapter 1, p. 34.

[17] 耀州志 ***Yaozhou zhi***, Jiajing edition, first *juan*, geography 1, ff. 1a-2a.

[18] 同官縣志 ***Tongguanxian zhi***, Ming Wanli edition, *juan* 8, ff. 27a-27b.
The topics of Marquis Deying and Bai Lin are discussed below chapter 1, pp. 26, 28-31.

Deying Hou) and that locals had acquired the art of ceramic manufacture as far back as the fourth century, when a certain 柏 林 Bai Lin arrived in the area. The cult of Marquis Deying and Bai Lin are first mentioned in the stele of Marquis Deying,[19] but odd as it may be, this essential official text is never quoted, not even in Song records. The reason for this probably resides in the fact that the stele went missing soon after it had been erected, possibly during the Jin or, at the latest, the Yuan conquest, but the stories of Marquis Deying and Bai Lin were so extraordinary that they survived in the oral tradition.

The second important item of information is that by 1618 Huangbaozhen ceramic factories had ceased production, but other factories had been established in nearby Chenluzhen which had also continued the cult of Marquis Deying by building a temple just like the one in Huangbaozhen. This is very interesting as it shows that the deities protecting ceramic kilns continued to be respectfully revered, although archaeological finds carried out throughout the twentieth century have demonstrated that ceramic production at Chenluzhen had greatly decreased in quality and quantity in comparison with Huangbaozhen kilns of the Song dynasty.

In the Qing dynasty intellectuals briefly mentioned or totally ignored the Yaozhou kilns in their writings. In the *Taoshuo*[20] Zhu Yan mentions Yaozhou only when quoting previous documents: in *juan* 2, dedicated to ancient wares, he cites the *Liuqing rizha* on Ru ware (Appendix I, text 18a),[21] and in *juan* 5 (Appendix I, text 18b), dedicated to particular items, he adduces the 清異錄 *Qingyi lu*[22] referring to a specific vessel shape called "seagull bowls" (Appendix I, text 13).[23]

The *Jingdezhen taolu* files Yaozhou kilns among old kiln sites listed in *juan* 7 (Appendix I, text 8b):

> 耀州今屬西安府亦宋燒青器色質俱不逮汝窯後燒白器
> 頗勝然陶成皆不堅緻易茅損所謂黃浦鎮窯也。

[19] The stele and its content are discussed in detail below chapter 1, paragraph 1.3, pp. 26-31.
[20] See above chapter 1, footnote no. 11.
[21] *Taoshuo*, *juan* 2, f. 5b; for details on the *Liuqing rizha*, see above chapter 1, footnote no. 5.
[22] The 清異錄 ***Qingyi lu*** was written by 陶穀 Tao Gu (903-970). The passage in question (小海鷗。耀州陶匠創造一等平底深盌狀簡古號小海鷗) can be rendered as: "Yaozhou potters have begun making bowls with flat base and deep sides, their shape is simple and old, they are called seagull bowls".
[23] *Taoshuo*, *juan* 5, f. 12b.

> "Yaozhou belongs to today's Xi'an district. In the Song dynasty it fired blue/green ware, but the colour was inferior to Ru ware. Later it fired white ware which was better. However it was not durable and got damaged very easily. This is the so-called Huangpuzhen ware".[24]

As had happened during the Ming dynasty, Qing editions of local gazetteers provided a different account of the Yaozhou kilns: the Jiaqing (1796-1820) edition of the *Yaozhou zhi* reports an account very similar to that of the Wanli edition of the *Tongguanxian zhi* with detailed information about ceramic activity at Huangbaozhen, the granting of the official title Marquis Deying (德應候) to the local spirits of mountain and soil, the story of Bai Lin (栢林) teaching the locals the art of ceramics, the closure of ceramic factories at Huangbaozhen and their establishment in Chenluzhen which also built the temple to Marquis Deying (Appendix I, text 28).[25]

The *Tongguanxian zhi*, revised in the Qianlong era, supplies some geographical and historical pieces of information and then repeats that at Huangbaozhen there used to be a kiln centre, that the inhabitants built the 紫极宫 Zijigong to worship the spirit of soil on whom was conferred the title of Marquis Deying in the Xining reign period of the Song dynasty, the entire story of Bai Lin and finally that ceramic factories are no longer in Huangbaozhen, but in Chenluzhen where the temple to Marquis Deying had also been built like the one in Huangbaozhen (Appendix I, texts 20a and 20b).[26]

What is interesting to notice is that, albeit the standards of the Chenluzhen factories were very low in the Qing dynasty (as archaeological remains prove), the temple of the kiln divinities was regularly repaired and each time a stone tablet was erected to commemorate the event. This is testified by four stelae, dated 1726, 1816, 1852 and 1882 discovered in 1957 by Feng Xianming in the temple of the kiln divinities in Chenluzhen.[27]

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[24] *Jingdezhen taolu, juan* 7, f. 4a. [25] *Yaozhouzhi*, Jiaqing edition, *juan* 2, Geography, f. 17b.
[26] *Tongguanxian zhi*, Qianlong edition (1765), *juan* 1, f. 16a and *juan* 2, f. 24a.
[27] Feng Xianming 1958, p. 59 reports to have found five stelae and Feng Xianming 1959b, p. 73 gives the dates of four of the five stelae as fourth year of the Yongzheng era (1726), twenty-first year of the Jiaqing era (1816), second year of the Xianfeng era (1852) and seventh year of the Guangxu era (1881); about the fifth stele, he only mentions that it was earlier than the previous four.
The complete texts of the 1726, 1816, 1852 and 1881 stelae are reported by Li Yihua and Yang Jingrong 1987, pp. 49-57.

The text of the stele dated 1726 is particularly important as it chronicles the construction of the temple of the kiln divinities and successive repair works down to the Ming dynasty. The extract reads:

> 同邑東南鄉土少石多大都以陶謀生其先則始於黃堡自彼窯厰廢而陳爐鎮西方始習其口口神之爵實無從考稽而廟之由來閣梁間板記則創自周至五年嗣正觀二年紹興四年社人重修之又越永樂二年正統九年萬曆三年及二十一年天啓三年凡五次重修暨.......
>
> "The village south-east of Tong city is poor in clay and rich in stone, everybody makes a living out of ceramic manufacture, which originally started at Huangbao, but since the kilns there were abandoned, Chenluzhen activated its factories. There is no way to verify the rank of the spirit, but for the origin of the temple, an inscription on one of the beams records that it was started in the 5th year of the Zhouzhi reign period, afterwards in the 2nd year of the Zhengguan reign period and the 4th year of the Shaoxing reign period the people repaired it. It was subsequently repaired five more times in the 2nd year of the Yongle era, the 9th year of Zhengtong era, the 3rd and 21st year of Wanli era, and the 3rd year of Tianqi era ".[28]

Unfortunately, the fifth year of the Zhouzhi reign cannot be identified, as there is no record of it, while 正觀 *zhengguan* is an alternative name for the 貞觀 Zhenguan reign period (627-649), therefore its second year corresponds to 628.[29] The other dates are all easily converted: the fourth year of the Shaoxing reign period corresponds to 1134, the second year of the Yongle era to 1404, the ninth year of the Zhengtong reign period to 1444, the third and twenty-first year of the Wanli era respectively to 1575 and 1593, and the third year of the Tianqi reign period to 1623.

On the basis that dates are given in chronological order, one can assume that the fifth year of the Zhouzhi reign period preceded the Zhenguan reign period, in which case the temple was built before 628, but how much earlier is impossible to determine. However, Li Yihua and Yang Jingrong go further supposing that 周至五年 *zhou zhi wu nian* corresponds to the seventh year of the Kaihuang reign period (581-600) of the Sui

[28] The stele is called ***Chenluzhen xishe zhongxiu yaoshenmiao beiji*** 陳爐鎮西社重修窯神廟碑記; for the whole text in Chinese see Appendix I, text 3).

dynasty (581-618), that is 587,[30] on the grounds that the Northern Zhou dynasty (557-581) and the Zhide reign period (583-586) of the Chen dynasty (557-589) can be combined together and that the seventh year of the Kaihuang reign period of the Sui dynasty was erroneously recorded as the fifth year of Zhouzhi.

The reasoning behind Li Yihua and Yang Jingrong's interpretation is too laborious to be acceptable. In any case, the construction of a temple of kiln divinities implies the existence of a ceramic industry, but presently there is neither archaeological nor literary evidence (except for the text of the 1726 stele) corroborating the presence of this activity at Huangbaozhen in the sixth century.

According to Feng Xianming, the Zhouzhi and Zhengguan reign titles mentioned in the 1726 stele are both miswritten.[31] 至 *zhi* in 周至 *zhouzhi* stands for 主 *zhu*, therefore 周至 *zhouzhi* would become 周主 *zhouzhu*, and for some unexplained reason 周主五年 *zhou zhu wu nian* (fifth year of the Zhou founder) would correspond to the fifth year of the Xiande reign period (954-960) of the Later Zhou (951-960), namely 958.[32]

Likewise, the character 正 *zheng* in 正觀 *zhengguan*, is a mistake for 大 *da*,[33] therefore the Zhengguan reign period would correspond to the Daguan reign (1107-1110) of the Northern Song, and its second year would match with 1108. In this way, the temple would have been built in 958 and repaired in 1108 and 1134. These dates are more consistent with archaeological evidence, but the way they have been worked out is too arbitrary to accept them.

The fact that in the Ming dynasty repair works were carried out five times, namely in 1404, 1444, 1575, 1593 and 1623, thus reveals that the divinities worshipped in the temple were held in high respect not only by the locals, but by government officials as well.

From this analysis it appears that in the Ming and Qing dynasties the Yaozhou kilns were accounted for only in local gazetteers, while intellectuals had no interest for

[29] Li Yihua and Yang Jingrong 1987, p. 46; Li Chongzhi ed., 1985, p. 83.
[30] Li Yihua and Yang Jingrong 1987, pp. 46-47.
[31] Feng Xianming, 1959b, pp. 73-74.
[32] Feng Xianming 1959b, p. 73.
[33] Feng Xianming 1959b, p. 73.

Yaozhou ware, except as a remote and lost type of ceramics. But had Chinese scholars always perceived Yaozhou ware in this way?

1.3 The perception of Yaozhou kilns in pre-Ming literature

The first direct[34] mention of Yaozhou ware is in the already quoted 清異錄 *Qingyi lu*,[35] in which, among the new and fashionable things of the Tang and Five Dynasties, 陶穀 Tao Gu includes so-called "seagull bowls" from Yaozhou.[36] Unfortunately it is not known whether Tao Gu refers to the Tang or Five Dynasties and his description is not detailed enough to identify exactly the type of bowl he alludes to. The fact that it is said that Yaozhou potters have started making this so-called seagull bowl induces one to think that it is a new type, but because one of the attributes of the shape is "old", it is possible that, although new to Yaozhou potters, this shape was not necessarily so to artisans from other kiln centres. However, what matters here is the fact that already before the Song dynasty, Yaozhou was producing wares fashionable enough to be included in a book of this sort.

[34] Some scholars (see SPIA 1992, p. 1; Fu Zhenlun 1994, p. 14) believe that the 鼎州 Dingzhou mentioned in the 茶經 ***Chajing*** (written by 陸羽 Lu Yu and published in 760) was the name of the prefecture that administered the area including the Yaozhou kilns in the Tang dynasty. If this were the case, then the first reference to Yaozhou blue/green ware would be as early as 760 in this renowned book. The often quoted passage reads: 盌。盌越州上鼎州次婺州次岳州次壽州次洪州次..... "Yuezhou bowls are best, followed in order by Dingzhou, Wuzhou, Yuezhou, Shouzhou and Hongzhou....." (Appendix I, text 2).

This passage is very important, as it would show that as early as the middle of the eighth century, Yaozhou kilns produced blue/green ware whose quality was second only to the celebrated Yue ware. Archaeological evidence in the form of coins of the Kaiyuan reign (713-742), supports the establishment of the Yaozhou kilns before the middle of the eighth century (see SPIA 1992, p. 6). However, excavated samples attributed to the Tang dynasty do not seem high enough in quality to stand comparison with Yue ware. Moreover, when Lu Yu compiled the *Chajing*, Ding prefecture in Shaanxi province had been abolished for sixty years (according to the 中國歷史地名詞典 *Zhongguo lishi diming cidian* 1986, p. 861, Ding prefecture was established in 691, abolished in 700, re-instituted in 906 and renamed Yu prefecture under the Later Liang dynasty (907-923)). So why did Lu Yu adopt Dingzhou to indicate the Huangbaozhen ceramic factories? There are three possible answers: the first is that Lu Yu arbitrarily chose to use the old name of the prefecture administering the kiln centre; the second is that despite the official name change, the custom to call it Ding had remained; the third is that the Ding bowls mentioned in the *Chajing* were not made at Yaozhou.

As significant as a reference in the *Chajing* would be, the exclusion is not so crucial and it is actually consistent with archaeological evidence showing a slightly insufficient blue/green ware in the Tang dynasty.

[35] See above chapter 1, footnote no. 22 and Appendix I, text 13.

[36] For a translation of this passage see above chapter 1, footnote no. 22.

The next document in chronological order mentioning Yaozhou is the 太平寰宇記 *Taiping huanyu ji*,[37] which does not refer to ceramic production at Yaozhou, but provides very detailed information about the successive names chosen to designate this area from the Qin (221-207 BC) to the beginning of the Song dynasty (960-1279) and the dates when the names were changed. Thanks to this detailed record, it is known that Yaozhou was instituted at the end of the Tang dynasty and that it retained its name with only a brief interruption between 915 and 923 (Appendix I, text 16).

The *Taiping huanyu ji* only provides geographical data about Yaozhou, leaving our knowledge of the kiln centre very limited. But fortunately another document has survived to provide information about the technology, aesthetics and history of Yaozhou kilns in the Northern Song: the 德應侯碑 *Deying Hou bei* (Stele of Marquis Deying),[38] discovered by Chen Wanli in 1954 at Huangbaozhen in what used to be the temple of the kiln divinities, by then converted into a school.[39]

The stele of Marquis Deying is a dedicatory stele engraved in 1084 at Yaozhou to celebrate the granting of the title "marquis" to the local divinities of mountains and soil (Appendix I, text 4). The custom of awarding deities with titles was very common in the Song dynasty, particularly from the end of the 11th century, when the rigid code controlling this practice was released and deification became applicable to whoever could perform miracles after death.[40]

The bestowing of a title was a memorable event for the community who wanted to celebrate it in the most solemn way, and the engraving of a stone tablet best epitomised this. Stelae in the shape of rectangular stone tablets with round or triangular top supported by a base and bearing an inscription commemorating somebody or something, had been in use since the Western Han dynasty (206 BC - 9 AD);[41] therefore a stele bore an intrinsic cultural significance so deeply rooted in the Chinese mentality as to self-explain its choice. Moreover, being made of a very durable material, the stele reinforced the lasting relationship between the support of the believers and the miracles

[37] The 太平寰宇記 ***Taiping huanyu ji*** was written by 樂史 Yue Shi (930-1007).
[38] The 德應侯碑 ***Deying Hou bei*** is permanently exhibited in the Forest of Stelae (碑林 Beilin) Museum in Xi'an. The inscription is published in SPIA 1965, p. 62; Li Yihua and Yang Jingrong 1987, p. 49; Xue Dongxing 1992, pp. 14-5; Fu Zhenlun 1994, pp. 165-6; here it is reproduced in Appendix I, text 4.
[39] Chen Wanli 1955, pp. 72-4.
[40] Hansen 1989, pp. 29 and 259.
[41] Wong 1996, p. 158; Tsien 1962, p. 64.

of the gods. Stone tablets were placed in central positions, such as a temple or a school, and therefore they could be seen by anybody be they literate or illiterate and every time they happened to pass by the stele would remind them of this reciprocity. Finally, stone slabs were engraved because in the Song dynasty people believed that deities were not gratified by the simple title they were awarded, they also wanted to see the inscription.[42]

The procedure to bestow a title was regulated by the central authority and its complexity shows how seriously the matter was regarded by the government. The worship of a spirit by local people and even the dedication of a temple did not automatically guarantee official recognition. The first step was for the local elite supporting the spirit to force county officials to prepare a petition to the emperor which, according to government regulations, was sent to the Imperial Secretariat who forwarded it to the Board of Rites, who, after checking it, passed it to the Court of Imperial Sacrifices. After providing a provisional title, the Court of Imperial Sacrifices sent it back to the Board of Rites, who, after approving it, returned it to the Imperial Secretariat, which then had to draft an edict bestowing the title and a full report documenting all the local and national investigations.[43]

Once the edict was proclaimed, the carving and erection of the stele was organized. As the inscription itself reveals, the stele of Marquis Deying was erected faithfully observing the official procedures.

When the ceramic industry at Yaozhou became very successful, people believed that the raw materials necessary for the manufacture of highly praised Yaozhou ware were miraculously supplied by the spirits of mountains and soil. As most of the population depended on the kilns for food and clothes (*i.e.* for a living), they revered these spirits in the local temple, albeit they were still afraid that the divinities might feel neglected and stop performing miracles. This would have brought disaster on the entire community and especially on Ma Huacheng, probably a member of the local elite, whose fortune was dependent on the ceramic industry. He donated money for the construction of the memorial hall in the temple and regularly offered cattle and small pigs, but, like everybody else in Yaozhou, he wanted to compliment the spirits fully by awarding them a title.

[42] Hansen, 1989, p. 97.
[43] Hansen, 1989, pp. 121-125

During the Xining reign period (1068-1077), the Secretary of State, the Honourable Yan, decided to write a memorial to the throne either because as part of his duties, he had to signal powerful deities who should be included in the register of sacrifices, or because the local elite were eager to grant a title to their protectors.

After the bureaucratic procedure was completed and the title granted, Ma Huacheng wanted a stele to be carved to commemorate the event and to gratify further the spirits, now enfeoffed as Marquis Deying.

Zhang Long had retreated to the mountains long time before, but he must have been a renowned author and calligrapher, as Wang Congzhen from Taiyuan journeyed to his retreat to discuss the project. Zhang Long agreed to compose both the text and the title and to write the calligraphy for them. A stone carver executed the engraving and a geomancer chose the auspicious date for the erection of the stele: the 18th day of the 9th month of the 7th year of the Yuanfeng reign of the Song dynasty, namely 1084.

The inscription ends with the signatures of the officials who had a part in awarding the title and amongst them was the most prestigious: the Attendant of Three Ranks, a high official who could participate at court audiences,[44] which goes to stress the official character of this stone tablet.

Another part of the inscription concerns a very interesting and debatable story about the origin of ceramic making at Yaozhou, said to be recorded on the beams of the temple in Huangbaozhen. According to the tale, a certain Bai Lin arrived in Huangbaozhen and was so delighted with the landscape and local customs that he decided to teach the local people the secrets of pottery making. As a result, the artisans reached unprecedented levels of refinement. As the people of Huangbaozhen had greatly benefited from this newly-acquired skills, they dedicated a memorial hall in the temple of Marquis Deying to show their gratitude to Bai Lin.

The stele specifies that Bai Lin was already an old man in the Yonghe reign (345-356) of the Eastern Jin dynasty (317-420)[45] and implies that ceramics were made at

[44] Hucker 1985, p. 400, entry no. 4886.

[45] Li Yihua and Yang Jingrong 1987, p. 65.

Ye Zhemin has interpreted the sentence 晉永和中 *jin yonghe zhong* as "in Yonghe county, Shanxi province" on the basis that 晉 *jin* is another name for Shanxi province and 永和 *yonghe* was a county in Song dynasty Shanxi (see Ye Zhemin 1983, p. 178). However, from the structure and content of the sentence in question, it is more reasonable to assume that Bai was already an old man in the Yonghe reign of the Eastern Jin, rather than an old man from Yonghe county, Shanxi province. Moreover, Ye Zhemin's

Yaozhou before Bai Lin settled there himself, thus before the middle of the fourth century. As a consequence of Bai Lin's teachings, the local people became very skilful potters and Yaozhou ceramics became very famous and highly marketable, so the community decided to dedicate an ancestral hall for him in the temple of the marquis, alias the spirits of mountains and soil or the divinities of ceramic kilns. Therefore the temple was built and dedicated to the kiln deities before the ancestral hall for Bai Lin was conceived. Again the text suggests that the ancestral hall was dedicated to Bai Lin not long before the stele was completed: so, why wait for seven centuries to show gratitude to the benefactor of the kiln centre? Personally, I believe that the story of Bai Lin was invented to add lustre to Yaozhou kilns and what induces me to think so is the incredibly long span of time between Bai Lin's arrival in the mid-fourth century and the first archaeological evidence dated to the mid-eighth century.

Because of the way the inscription is composed, it is easy to get confused about the relationship among the divinities of mountains and soil, the marquis and Bai Lin. However, what is important is not to confuse Bai Lin with the marquis, a mistake first made in the Dangyangcun stele (Appendix I, text 7),[46] and perpetrated by later writers.

The opening sentence of the Deying Hou stele affirms that in the Xining reign period (1068-1077), the Honourable Yan presented a memorial to the throne asking to confer the title of Marquis Deying to the spirits of mountains and soil. After telling the story of Bai Lin, the text goes back to the marquis, and that is where confusion arises. However, there are three key sentences which cast aside any doubt. The first two are at the beginning of the text, after the opening statement, before introducing Bai Lin: as a consequence of the memorial presented by the Honourable Yan and the generous decree by the emperor, "the loyal spirits were deified".[47] The second clue comes soon after: "the marquis lives south-east of Huangbaozhen". Therefore, before Bai Lin is mentioned,

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interpretation deflates the intent of the stele to emphasise the outstanding history of Yaozhou kilns by stating that Bai Lin came from nearby Shanxi.

[46] The 懷州修武縣當陽村土山德應侯百靈廟記 ***Huaizhou Xiuwuxian Dangyangcun tushan Deying hou Bai Ling miao ji***, dated 1105, was found by Chen Wanli in 1951 while excavating the kiln site at Dangyangyu (more common name for Dangyangcun) (see Chen Wanli 1954, pp. 44-45).

A double error appears in the title of this stele: 柏 林 Bai Lin has become 百靈 Bai Ling and the temple is dedicated to him, rather than to Marquis Deying. The text emphasises the importance of Bai Ling to the detriment of Marquis Deying to the point that the entire temple rather than just the ancestral hall in the temple at Dangyangcun is dedicated to Bai Ling. For excerpts of this stele see Appendix I, text 7.

we know that the marquis represents the spirits of mountains and soil. The third essential statement is the conclusion to Bai Lin's story: "The people have erected a memorial hall in the marquis's temple...". From this passage it becomes clear that Bai Lin is not the marquis, as his memorial hall was built in the temple to the marquis, and that the marquis temple is independent from Bai Lin.

Thus the marquis mentioned in the next line, "locals depend on the marquis for food and clothes", is the divinities of mountains and soil and must not be confused with Bai Lin, although it is quite natural to make this assumption.

As to the historical existence of Bai Lin, this is a completely different matter. There are no literary records to prove his existence as a man, but, as Li Yihua and Yang Jingrong point out,[48] the stele says that an ancestral hall (祠堂 *citang*) was built for him in the temple of the marquis. Ancestral halls were used to worship deceased people, thus, if Bai Lin was not a person, why dedicate a *citang* to him?

Liang Guandong also believes that the tale of Bai Lin is an invention, but not of Zhang Long's imagination: the author of the inscription would have heard it from local people who had created this myth long before. As China is the cradle of ceramic manufacture, says Liang, many fantastic stories have been invented, and this one about Bai Lin is a perfect example.[49]

It is plausible that at some stage in the history of Yaozhou kilns a particularly skilful potter distinguished himself giving the necessary boost to transform a mediocre ceramic factory into one of the most active kiln centres of the time. But, as said before, what I find unconvincing is the time scale in which this is said to have happened in this particular case. Therefore, I am inclined to regard the story of Bai Lin as unfounded: Zhang Long, the author of the inscription, invented it to give ancient and special origins to the Yaozhou kilns and as further justification of the privilege of the granting of the title "marquis" to the local ceramic divinities. Whether Bai Lin really existed or not is not very relevant here, what really matters is the fact that Huangbaozhen created the cult

[47] When discussing the so-called 柏靈橋 *Bai Ling qiao* stele found while investigating the Haobiji site in 1954, Chen Wanli clearly explains that it is the spirits of mountain and soil that were conferred the degree of marquis (see Chen Wanli 1957, p. 57).
[48] Li Yihua and Yang Jingrong 1987, p. 65.
[49] Liang Guandong 1986, pp. 42-3.

of Marquis Deying and the myth of Bai Lin, thus confirming the leading position of the Yaozhou kilns during the Northern Song.

Above all, the stele of Marquis Deying represents invaluable direct evidence of the appreciation of the Yaozhou kilns at the height of their fame. As far as we know presently, it is the first stele to have been erected to celebrate the granting of an official title to the spirits of mountains and soil strictly connected with ceramic manufacture. Whether the Yaozhou people were the first to worship these spirits is not known, but the fact that they were the first to obtain deification for their protectors demonstrates the status of the Yaozhou kilns in the context of Song ceramics. My belief is that no other kiln centre was as influential as Yaozhou, at least in the second part of the Northern Song. However, most influential does not mean unique: Ding kilns, always included among official wares, were surely highly praised, but the scope of Yaozhou and its industrial organization must have been far larger and more sophisticated than any other kiln complex of the time.

Another crucial document in assessing the position held by the Yaozhou kilns in the Song dynasty is the 元豐九域志 *Yuanfeng jiuyu zhi*,[50] which, after specifying the geographic position and brief history of the names of Yao prefecture, states:

> 戶主一萬九千八百二客六千一百八土貢瓷器五十事。
>
> "There are 19,802 households and 6,108 guests. The local tribute is fifty pieces of ceramics".[51]

This last sentence proves that during the Yuanfeng reign period Yaozhou produced tribute ware for the Song court, just like the much praised Ding kilns. As discussed in detail later in this chapter, "tribute" does not mean "official": the term "tribute" denotes wares accepted, but not ordered by the court, whilst official wares were specifically required by the imperial house. However, the point is that, according to ancient records, Yaozhou ware was accepted as tribute by the Song court and this ought to prove that it was highly appreciated.

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[50] The 元豐九域志 ***Yuanfeng jiuyu zhi*** was presented by 王存 Wang Cun (1023-1101) in 1080 and published in 1085.
[51] *Yuanfeng jiuyu zhi*, *juan* 3, f. 17b, see Appendix I, text 29.

What strikes one as odd is the fact that the *Yuanfeng jiuyu zhi* was completed by 1080, therefore the Yaozhou kilns must have presented tribute ware before this date, but there is no mention of such an important issue in the stele of Marquis Deying, which is dated 1084.

However, any suspicion that the Yaozhou kilns were not allowed to give ceramics as tribute to the Song court is dispelled by a similar record in the 地理志 *Dili zhi* of the 宋史 *Songshi*, although the latter refers to the Chongning reign period (1102-1106), rather than to the Yuanfeng reign period (1078-1085) (Appendix I, text 14). The passage concerning this topic reads:

> 耀州緊華原郡開寳五年為感義軍節度太平興國初改感德軍
> 崇寧戶一十萬二千六百六十七口三十四萬七千五百三十五
> 貢瓷器縣六華原富平三原雲楊同官美原。
>
> "Yao prefecture is close to Huayuan county. In the fifth year of the Kaibao reign period [972] it was under the authority of the governor of the Ganyi garrison. At the beginning of the Taipingxingguo reign period [976-983] [the name] was changed to Gande troop. In the Chongning reign period [1102-1106] there were 102,667 households, 347,535 inhabitants. It offered ceramics as tribute. It included six counties: Huayuan, Fuping, Sanyuan, Yunyang, Tongguan and Meiyuan".[52]

The next document in chronological order referring to Yaozhou is the already mentioned Dangyangcun stele of 1105.[53] Here it is quoted again because by stating that an apprentice was sent all the way to Yaozhou to learn about the temple there erected to worship kiln divinities, it stresses the revered position that Yaozhou kilns enjoyed in the Northern Song.

The first document mentioning Yaozhou kilns after the Song court fled south is the 清波雜志 *Qingbo zazhi* written in 1192,[54] which reports:

The information about the name changes are remarkably similar to the *Taiping huanyu ji*, only the dates of the changes at the beginning of the Song dynasty are more precise, thus suggesting that Wang Cun had access to Yue Shi's work.

[52] Translated from the 宋史 ***Songshi***, *juan* 87, 志 *zhi* (record) 40, 地理 *dili* (geography) 3. Appendix I, text 14.

[53] See above chapter 1, footnote no. 46.

[54] The 清波雜志 ***Qingbo zazhi*** was written by 周煇 Zhou Hui in 1192 and printed in 1198. See also David 1936-37, p. 25.

耀州黃浦鎮燒甆名耀器白者為上河朔用以分茶出窯一有破

碎即棄于河一夕化爲泥。

"The famous Yaozhou ware comes from Huangpuzhen, Yao prefecture. White ware is superior. He Shuo uses it with crushed tea. When unloading the kiln, broken vessels are thrown into the river and immediately turn into mud".[55]

The contradiction in this quotation is evident. 周煇 Zhou Hui, author of this miscellaneous record, recognises that Yaozhou ware is famous, but rates Yaozhou white ware higher than blue/green ware. From archaeological evidence we know that in the Jin dynasty (1127-1279) Yaozhou kilns did not produce white ware, not even of very low quality. So, what does Zhou Hui mean? His words make sense only if he refers to the so-called moon-white ware (月白釉瓷 *yuebaiyou ci*), a type of blue/green ware made after the Jin conquest.[56] As a matter of fact, Yaozhou moon-white specimens are of superior quality compared to the typical blue/green ware usually decorated with carved or moulded motifs for which Yaozhou kilns are famous. If this is the case, Zhou Hui's words should be read: "[moon-]white ware is superior".

The sentence about broken vessels being thrown in the river where they "immediately turn into mud" seems to echo a passage in the stele of Marquis Deying: "When the flames are extinguished and the kiln opened, the objects are examined. They are like swarms of insects on clear flowing water". "The potters' workshops stretch along the river. Every day they throw into the river wasted porcelain that the waves wash away". That potters used to throw damaged pieces into the river is still evident today: it is sufficient to walk along the Qi river (now a stream more than a river) to find shards of all sorts.

Another contradictory account of Yaozhou ware is found in the 老學庵筆記 *Laoxuean biji*,[57] which recounts:

故都時定器不入禁中惟用汝器以定器有芒也

[55] *Qingbo zazhi, juan* 5, f. 9; Appendix I, text 12.
[56] According to SPIA 1998, p. 462, the first specimens of "moon white" ware (月白釉瓷 *yuebaiyouci*) were made at the end of the Northern Song period, but this genre flourished in the Jin dynasty.
[57] The 老學庵筆記 ***Laoxuean biji*** was written by 陸游 Lu You (1125-1210), the exact date of its compilation is unknown. See also David 1936-37, p. 26.

……耀州出青瓷器謂之越器似以其類餘姚縣秘色也然極麁樸不佳惟食肆以其耐久多用之。

"At the time of the old capital Ding ware was not admitted into the Palace. Only Ru ware was used because Ding vessels had rough mouth rims.
……Yaozhou produces blue/green ware which is called Yue ware probably because it resembles *mise* ware from Yuyao county. However [Yaozhou ware] is extremely coarse and bad, only restaurants use it on account of its durability".[58]

How is it possible to resemble *mise* ware and be extremely coarse at the same time? What does Lu You refer to? From archaeological evidence it appears that in the Jin dynasty alongside moon-white and typical blue/green wares, Yaozhou factories also produced blue/green vessels of inferior quality, possibly used in inns. But why did Lu You know and mention inferior quality wares rather than superior ones? Unfortunately, Lu You's remark had negative consequences on the reputation of the Yaozhou kilns, as later scholars seem to have borrowed the information without checking its veracity.

The *Tanzhai biheng*,[59] the *Fuxuan zalu*,[60] the *Chuogeng lu*[61] and the *Shuofu*,[62] written between the end of the Southern Song and the very end of the Yuan dynasty, all repeat two important statements: the first affirms that because of the rough mouth rims, Ding white ware was not suitable for the court who consequently ordered the Ruzhou factories to make blue/green ware; the second maintains that Tang, Deng and Yaozhou imitated it, but Ru kilns remained unsurpassed.[63] The fact that the *Chuogeng lu* quotes the *Tanzhai biheng* and the *Shuofu* quotes the *Fuxuan zalu* well illustrates the tendency of quoting earlier sources without questioning them.

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[58] *Laoxuean biji, juan* 2, f. 11a; Appendix I, text 9.

[59] The 坦齋筆衡 ***Tanzhai biheng*** was written by 葉寘 Ye Zhi in the thirteenth century during the Southern Song; it survives only in the form of excerpts included in the 輟耕錄 *Chuogeng lu* (see below chapter 1, footnote no. 61), *juan* 29, ff. 13a-14a; see also David 1936-37, pp. 27-8.

[60] The 負暄雜錄 ***Fuxuan zalu*** was written by 顧文薦 Gu Wenjian and published between 1260 and 1279; it survives only in the form of extracts included in the 說郛 *Shuofu* (see below chapter 1, footnote no. 62), *juan* 18, f. 10b.

[61] The 輟耕錄 ***Chuogeng lu*** was written by 陶宗儀 Tao Zongyi (1316-?) in 1366; the passage in question is in *juan* 29, ff. 13a-14a. According to Sir Percival, the passage the *Chuogeng lu* claims to have copied from the *Tanzhai biheng* is actually from the *Fuxuan zalu* (see David 1936-37, p. 28).

[62] The 說郛 ***Shuofu*** was written by the same 陶宗儀 Tao Zongyi of the *Chuogeng lu* at the end of the Yuan dynasty (the preface of the *Shuofu* is dated 1370).

[63] See the Tanzhai biheng in the Chuogeng lu, juan 29, ff. 13a-14a (Appendix I, text 17) and the Fuxuan xalu in the Shuofu, juan 18, f. 10b (Appendix I, text 5).

From the analysis of textual sources it appears that until the end of the Northern Song dynasty, Yaozhou ware enjoyed a very high status, while during the Southern Song comments became first contradictory and then negative and dismissive. In the Yuan dynasty the notion that Yaozhou kilns fabricated mediocre ceramics was not questioned, thus sanctioning their unworthiness. Ming and Qing scholars inherited and perpetuated this perception of the Yaozhou kilns despite the information supplied by the *Yoazhou zhi* and the *Tongguanxian zhi*. But why did Ming and Qing scholars not consult contemporary local gazetteers? There are two possible answers, not necessarily unconnected. One is that they did not have access to the gazetteers, the other is that they considered it unnecessary.

But there is still a question to ask: why did scholars of the Southern Song and subsequent dynasties stop appreciating Yaozhou ware?

The answer is not straightforward and probably lies in a combination of reasons which could not really stand by themselves, but which taken together seem to offer a logically acceptable conclusion. When the Song court fled Kaifeng to take refuge in Hangzhou, Yaozhou wares were no longer requested at the Chinese court (for obvious reasons) and its style had already been adopted by Longquan, which, being produced locally in Zhejiang province, was easily obtainable. Besides the purely Chinese taste for ceramics, particularly for blue/green wares, had already started changing radically at the end of the Northern Song[64] and whilst the Longquan kilns could adapt to the new trend, it was too late for Yaozhou. During the Jin dynasty, factories at Huangbaozhen did produce a plain blue/green ware known as "moon-white", but its style, and mainly its colour, was not in the range of Guan or Longquan wares and, one should not forget, it was the product of a foreign, barbarian dynasty. Longquan became one of the most famous kiln centres in China, not long after the Southern Song had established themselves in Hangzhou and consequently Yaozhou ware was soon superseded by Longquan and forgotten, whereas Ru was always recognised as having been the first ware to be ordered by the court.

This theory is valid when applied to Yaozhou ware, but why did Ding ware not suffer the same fate? Like Yaozhou ware, after the Jin invasion Ding ware was no longer

[64] For a discussion on the creation of the imperial ceramic style in the Song dynasty, see Rogers 1992, pp. 64-79.

required at the Song court and several southern kilns, the most important of which are Jingdezhen and Dehua, imitated Ding ware so well that some items are difficult to recognise without a close examination. But whilst the reputation of Yaozhou ware declined rapidly, that of Ding was exalted.

The only explanation one can suggest is that whilst Longquan really replaced Yaozhou and continued to develop, white ware from Jingdezhen did not supersede Ding ware until the Yuan dynasty or even later. By then, both Yaozhou and Ding kilns were manufactures of a distant past, the former largely forgotten, the latter idealised.

It is therefore possible to conclude that Yaozhou was not included among the classic kilns of the Song dynasty because Longquan became a major kiln and because Southern Song connoisseurs did not perceive its significance and as a consequence, whereas Ding and Ru wares were highly praised through the ages, Yaozhou fell into oblivion and by the beginning of the twentieth century, it could not even be recognised.

1.4 The question of official, imperial and classic kilns

From the analysis of the records mentioned in paragraph 1.1, it emerges that Ming and Qing scholars singled out a group of classic Song ceramic families, namely Ding, Ru, Guan, Longquan, Jun, Ge, Chai, Dong, Jian, Jizhou, and Cizhou, the first six usually more appreciated than the others, which they regarded as the best representatives of the ceramic industry of the time.[65] Some of these wares are said to have been used at court, but only one ware is said to have been made by government-owned factories. This is the so-called Guan ware which, according to the records,[66] was first made in the Northern Song capital Bianjing (modern Kaifeng) and when the court moved south, was made by the Xiuneisi (修内司 Department of Internal Affairs) at Fenghuangshan (Phoenix Hill) and later by Jiaotanxia (郊壇下 Suburban Altar) at Wuguishan (Turtle Hill). The vessels produced at these three sites are all called 'official' and whilst most records explain the different provenance, others do not.

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[65] See above chapter 1, pp. 1-3.
[66] *Fuxuan zalu*, in the *Shuofu*, *juan* 18, f. 10b (Appendix I, text 5); *Tanzhai biheng* in the *Chuogeng lu*, *juan* 29, ff. 13b-14a (Appendix I, text 17).

Chai[67] and Ru wares were not made by government-owned factories, but are official in the sense that they are said to have been explicitly ordered by the Later Zhou and Northern Song courts respectively.

Ding ware has always been regarded as official, however that it was used at court is inferred from the passage which first appeared in the *Laoxuean biji* saying that during the Northern Song Ding ware was no longer accepted by the court because of its unglazed rim, and thus Ru ware was used instead.[68] This passage has been repeated in almost all later literary documents, but being a detrimental judgement, it appears in the section dedicated to Ru ware instead of that on Dingyao.

Two earlier records, the 吳越備史 *Wuyue beishi* (Appendix I, text 22) and the 宋會要 *Song huiyao* (Appendix I, text 15), relate early Song Ding ware to the court,[69] but they do not say that the Song court ordered Ding kilns to make vessels for imperial use, thus confirming that Ding ware was of the tribute[70] type rather than of the official one.

From the above it appears that according to Ming and Qing records, the wares related to the Song court are Chai, Ding, Ru and Guan, but western scholars and later Chinese experts usually exclude Chai and include Ge and Jun and sometimes Longquan, presumably because Chai, besides not having been identified, was made in the Five Dynasties. Ge is always associated with Southern Guan because of the striking similarities of their features, Jun is said to have been collected by the court in the Xuande reign period (1426-1435)[71] and, like Longquan, is so beautiful that it seems impossible that it was not appreciated by the court. Moreover, the glazes of plain Jun

[67] Chai ware has not been satisfactorily identified, but this is irrelevant here, as the attention is focused on the information that can be inferred from ancient literature.
[68] *Laoxuean biji, juan* 2, f. 11a (Appendix I, text 9); for details on the *Laoxuean biji* see above chapter 1, p. 34 and footnote no. 57.
[69] The passage in the 吳越備史 *Wuyue beishi* (Complete history of Wuyue), *juan* 4 can be translated as: "On the eleventh day of the ninth month of the fifth year of the Taipingxingguo reign [980 AD] the king [of Wuyue] sent tribute to the court presenting to the Chongde Palace two thousand pieces of Ding ware [with rims] bound with gold, twenty pieces of crystal vessels preciously decorated with agate and one coral tree". 太平興國……五年……九月十一日王進朝謝于崇德殿復上金裝定器二千事，水晶瑪碯寶裝器皿二十事，珊瑚樹一株。The passage in the 宋會要 - 食貨 *Song huiyao - shihuo* (Important documents of the Song dynasty - Monograph on financial administration), *juan* 52, 瓷器庫 *Ciqiku* (porcelains warehouse) can be translated: "The ceramic warehouse in the Jianlong workshop is in charge of the supplies of Ming [Ningbo], Yue, Raozhou, Dingzhou and Qingzhou white wares and of lacquer ware.....". 瓷器庫在建隆坊掌受明越饒州定州青州白瓷器及漆器……
[70] For a discussion on the meaning of tribute see below chapter 1, paragraph 1.6, pp. 43-45.

and of Longquan have been regarded, especially by early western scholars, as intimately connected to the glazes of the celebrated Ru and Southern Guan wares respectively, particularly before Ru and Guan were identified.[72] The desire to include Longquan among official wares was probably strengthened by the fact that the story of the two Zhang brothers, the eldest manufacturing what has become known as Ge ware (*ge* meaning older brother), the younger one managing factories making Longquan ware,[73] was widely accepted, thus tightening the relation Guan-Longquan-Ge. Finally, the fact that many Longquan and Jun specimens were available in the West and fetched high prices might have enhanced the desire to consider them as court wares. An example of the aspiration to promote Jun ware is in this passage by Hobson *et al*: "The Chün wares have never been accorded high rank in Chinese literature. I have followed the order of the T'ao Lu in placing them after the Ting, Ju, Kuan and Ko; and the T'ao Lu, in doing so, has followed the example of the older writers".[74] In the sixth *juan* entitled "Study of ancient wares imitated at Jingdezhen", Lan Pu, the author of the *Taolu*, does place Jun ware after Ding, Ru, Guan and Ge, but Hobson *et al.* seem to ignore conveniently that he also lists Dong, Longquan and Zhang Longquan before Jun kilns and Sui after.

The distinction between official, imperial and classic wares seems to have been very hazy, presumably because other wares were added to the original selection of those said to have been used by the Song court (that is, Ge, Jun and Longquan were annexed to Ding, Ru and Guan), and also because the meaning of the term *guan* (官 official) was distorted.

In ancient literature *guan* is indisputably used to indicate vessels manufactured at government kilns established first in Bianjing and then in Hangzhou. However, in the West its meaning was modified to embrace all those wares that served the court at one point in their history, as this passage by Hobson *et al.* explains: "The Kuan Yao were the Government kilns, properly speaking. They differed from others in being set up at the

[71] Jun kilns are not mentioned in pre-Ming literature; but it is reported to be collected by the Xuande emperor (1426-1435) together with Chai, Ru, Guan, Ge and Ding (see 宣德鼎彝譜 *Xuande dingyi pu*, *juan* 1, f. 1; Appendix I, text 24); see also Gray 1953, p. 31.
[72] Among those who believe that Jun influenced Ru and/or Guan are Honey 1949 (1945), p. 68; Gray 1953, p. 30; Hobson and Hetherington 1923, pp. 7-8; Garner 1959-60, pp. 26-27; National Palace Museum 1961, Jun yao vol. 1, p. 25. Among those hinting that Longquan enjoyed imperial patronage are Gompertz 1958, p. 53; Sullivan 1963, p. 84; Ayers 1964, p. 16; Watson 1973, p. 151.
[73] Jiangxisheng 1963, p. 138 clearly explains that the difference between Ge and Di (younger brother) is that the first is characterised by crackles, whilst the second is plain as typical Longquan ware is.

capital and being more directly under the jurisdiction of the palace authorities. But we must not suppose that they were the only kilns which supplied wares for imperial use, or that their output was necessarily superior to that of other famous kilns, such as Ting and Ju. In fact the T'ao Lu tells us that such was not the case. I have noted in my researches that the term *Sung kuan yao* as used today does not necessarily mean the product of these, strictly speaking, imperial kilns, but is used to indicate all Sung wares whose quality indicates that they were meant for the palace use".[75] Lan Pu does not seem to lay any stress on which kilns supplied the Song court. About Guan ware he writes that between the Daguan (1107-1110) and Zhenghe (1111-1118) reign periods Bianjing (the Song name for Kaifeng) established its own kilns whose wares were called 'official'; when the court moved south, the government established ceramic kilns in the new capital and because they were controlled by the Xiuneisi (Department of Internal Affairs), they were called 'internal kilns' (内窯 *neiyao*) and later, the Jiaotanxia (Suburban Altar) established new kilns whose products were also called 'official'.[76]

As to Ding and Ru, in the paragraph dedicated to Ruyao, Lan Pu records that because of the unglazed mouth, Ding became unfit and the Ru kilns were ordered to make blue/green ware, but in the paragraph about Ding, it is not said that it was used at court.[77] The only occasion where the *Jingdezhen taolu* records that Ru and Ding served the court is in *juan* nine where it reports descriptions from previous commentators.[78]

In the light of this analysis, Hobson's extension of the appellation 'official' to include all "wares whose quality indicates that they were meant for the palace use" must be regarded as misleading, particularly because if the criterion to select imperial wares is their quality, then Yaozhou, Cizhou, Northern Black, Jian, Jizhou and Qingbai wares should all be classified as imperial, whilst he only selected Ding, Ru, Guan, Ge, Jun and Longquan and occasionally considered Dong and Jian.[79]

Nevertheless, Hobson's theory was appealing, as it tried to surmount the bridge between what ancient Chinese literature recorded to have been used at court and what

[74] Hobson 1914, p. 32.
[75] Hobson 1914, p. 23; see also Hobson 1934, p. xix; Lee 1948, p. 171; Gray 1953, p. 20; Sullivan 1963, p. 44; Valenstein 1975, p. 84.
[76] *Jingdezhen taolu, juan* 6, f. 2a (Appendix I, text 8a).
[77] *Jingdezhen taolu, juan* 6, respectively f. 1b and f. 1a (Appendix I, text 8a).
[78] *Jingdezhen taolu, juan* 9, f. 7a (Appendix I, text 8c).
[79] Hobson *et al.* 1914, p. 9; Hobson 1915, p. 48; Hobson 1926, p. xii; Hobson 1934, p. xxvii.

scholars and connoisseurs in the West could identify and collect. Thus it attracted a discreet number of followers among whom was Honey, who specifically selected Chai, Ru, Guan, Ding and Ge as the five wares made for the court, but who also left a door open for Yue, Jun and Longquan.[80] Honey also affirmed that these court wares "came to be regarded as 'classical' by many generations of scholars, commentators and potters",[81] but in the section dedicated to classical Song wares, he included Jun, Longquan and even Northern celadon which he identified with Dong ware.[82]

Gray applied the designation 'classic', which for him was synonymous with 'imperial', to only five Song wares, namely Ding, Ru, Jun, Guan and Ge, surprisingly leaving out the highly praised Longquan.[83] In the catalogue for an exhibition of Chinese ceramics at the Los Angeles County Museum, Trubner, obviously influenced by Honey, wrote: "Chinese scholars, commentators and generations of potters have for long singled out five wares which are said to have been made for the imperial court and were therefore called 'classical', they being the Ch'ai, Ju, Kuan, Ting and perhaps Ko wares. Certain types of Chün yao and the Chekiang celadons (Yueh and Lung-ch'uan ware), though not considered imperial may be included in this group".[84]

In the catalogue of the Baur collection Ayers gave the term 'classic' its proper meaning, that is, of excellence and lasting significance, by including in this category Ding, Northern celadon, Jun, Black, Cizhou, Southern Guan, Longquan and Qingbai wares on the basis that they all made contributions of original and lasting importance to the world of Chinese ceramics.[85] A similar line of classification was introduced by Tregear who, however, presented it from a new and very interesting perspective: that of the social class (or classes) who favoured certain ceramic wares.[86] The novelty is in the fact that wares patronised by the court were not set aside as worthy of more praise than those favoured by the religious or merchant classes, as the boundaries of patronage often overlapped.

To some extent, Medley had also sensed that patronage was not the prerogative of a single social class and that although the palace had its own kilns, this did not imply

[80] Honey 1949 (1945), p. 64.
[81] Honey 1949 (1945), p. 64.
[82] Honey 1949 (1945), pp. 65-81.
[83] Gray 1953; Gray 1980, p. 23.
[84] Los Angeles County Museum 1952, p. 23.
[85] Ayers 1968, vol. 1, p. 30.

that it did not use other wares, but her vision was restricted to the ceramics of southern China,[87] as also was that of Valenstein.[88]

1.5 The question of popular kilns

The classification of Song ceramics in the West was further complicated by the introduction of another appellation put forward by Sullivan who did not single out five or any number of classic/imperial wares, but distinguished Cizhou as 'popular' from classic Ding, Ru and Jun.[89] His statement that "strictly speaking, we are not entitled to call any ware *kuan*, whatever its quality, unless there is evidence that it was made for the palace"[90] sounded like a break with Hobson's theory, but his strong feeling that certain Longquan specimens were of such exquisite quality "that they should surely rank as palace pieces" betrayed it.[91]

The distinction, albeit not clear, between popular and classic/imperial proposed by Sullivan was adopted by others, for example Medley, who classified northern celadon, Jun, Ru and Ding as 'classic' as opposed to popular Cizhou and northern black,[92] and even later by Vainker, who divided the 'classical period', that is the Song dynasty, between 'The five great wares' and 'Popular wares'. According to Vainker, the status of 'five great wares' was accorded to Ding, Ru, Jun, Guan and Ge by Southern Song, Ming and Qing scholars, however, their imperial nature is debatable, as "evidence that they were commissioned by the emperor is scant". In the same section she also described Longquan and Yaozhou wares, thus granting them an imperial connection, whilst Cizhou, Northern Black, Jian, Jizhou and Qingbai were regarded as the popular wares.[93] A more modern and somehow radical approach to the question has been taken by He Li who has classified Song wares as official (Ru from Baofeng, Jun from Yuxian, northern Guan from a yet unidentified site, Yue from Yuyao, Xiuneisi and Jiaotanxia from

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86 Tregear 1982, pp. 11-14.
87 Medley 1989 (1976), pp. 145-146.
88 Valenstein 1989, pp. 96.
89 Sullivan 1963, p. 63.
90 Sullivan 1963, p. 44.
91 Sullivan 1963, p. 82.
92 Medley 1989 (1976), pp. 106-123, 123-138 and 146-168.
93 Vainker (1991) 1995, pp. 93-127.

Hangzhou) and private; the better private kilns, such as Ding and Yaozhou, were occasionally ordered to send tribute to the court.[94]

Although the distinction between classic/imperial and popular wares was introduced comparatively late in the West, its origin can be traced back to the beginning of this century when it was not expressed in direct words, but could be perceived from the layout of certain researches. For example, in *The Early Ceramic Wares of China* Hetherington explained that besides the six classic wares mentioned by Chinese writers, namely Ding, Jun, Longquan, Ru, Guan and Ge, there were other groups, such as Cizhou and Jian, while he defined northern celadon as an experimental grouping.[95] Honey dedicated one chapter of his *The Ceramic Art of China and Other Countries of the Far East* to classical wares (which included Ru, Northern Guan, Jun, Canton wares, Zhejiang celadons, Longquan, Ge, Southern Guan, northern celadon and Ding), and another chapter to "Tz'u Chou, Chien and other stoneware and porcelain".[96] Sherman Lee, who believed that "the word *guan* seems to imply not a specific ceramic type, but rather a definition of the user of the wares produced by a kiln specifically set up to serve the user" divided Song wares (and a few earlier ones) into three categories, namely official, classic and common.[97] Albeit Lee's grouping does not seem to respect his definition of *guan* and appears rather arbitrary and confusing, its merit lies in maintaining that imperial and classic wares were not the same and also in considering wares used by common people for everyday life.

However, the concepts of a distinction between 民窯 *minyao* (popular kiln) and 官窯 *guanyao* (official kiln) was first introduced by Chinese scholars in the 1930s', albeit at the time it was not clearly expressed as a dichotomy.[98] In the 1950s' the concept of *minyao* as opposed to *guanyao* was fully grown and definitions of the two

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[94] He 1996, p. 133.
[95] Hetherington 1922, p. viii.
[96] Honey 1949 (1945), pp. 65 and 81.
[97] According to Lee's grouping, in the Northern Song Ding, Ru, Jun and Kaifeng imperial were the official wares; Chai, white, red and black Ding, green Ru and blue Jun were classic, whilst traditional Tang stoneware and Ding from Yanshancun kiln were common; in the Southern Song the official wares were Yue-*mise*, celadon types, Hangzhou Phoenix Hill and Hangzhou Jiaotanxia, whilst green, white Yue, Zhejiang green, *yingqing*, Jian and Jizhou were classic and Yue, Zhejiang green, Yingqing Jian and Jiangxi brown made for export were common. See Lee 1948, p. 175.
[98] Wu Renjing and Xin Anchao 1936, pp. 36, 39 explain that in the Song dynasty there were official (*guan*) and private (私 *si*) kilns, but while discussing 第 Di kilns, they introduce a third category defining them as *minyao*.

appeared. According to Fu Zhenlun,[99] up to and including the Tang dynasty, all ceramic factories were popular (*min*) and supplied the common people with everyday wares, although they also satisfied requests on a smaller scale from the ruling class. Five Dynasties rulers started establishing imperial (禦 *yu*) kilns and later dynasties followed this example by activating *guanyao*. Popular kilns did not shut down, indeed they continued to produce everyday wares for common people while occasionally supplying the imperial house and the aristocracy who favoured blue/green and white wares. It is interesting to notice that Fu Zhenlun listed Yue, Jingdezhen, Guan, Ru, Xiuneisi and Jiaotanxia as Song official *yao*, whilst considering Ding (both white and black), Jizhou (both white and black), Jun, Dong, Yaozhou, Ge, Di, Lishui, Jingdezhen, Qiong, Jian, Dangyangyu and Cizhou all as popular. In later studies the main difference between popular and officials kilns appears to be that the former are commercial enterprises, whilst the latter are established and controlled by government authorities and their products are exclusively for the court.[100]

1.6 The question of tribute ware

Between *minyao* 民窯 and *guanyao* 官窯 are the so-called 貢 *gong* (tribute) wares, which constitute an important category in the classification of ceramics that is particularly relevant for the understanding of Yaozhou kilns. According to a study by the Jingdezhen Ceramic Research Institute, 貢器 *gongqi* (tribute vessels) is one of the two meanings of the term *guanyao*: tribute vessels were manufactured at popular kilns, but under the supervision of officials sent by the ruling class; because these specimens entered the imperial court, the kilns that made them were called 'official'.[101] More recently Xie Mingliang has traced the tribute system back to the Tang dynasty when central and local officials had to present the emperor with a fixed amount of gifts and the prefectures of the empire also sent their articles; tribute objects were collected in warehouses and delivered to the imperial court when required.[102] A more extensive

[99] Fu Zhenlun 1955, pp. 30-43. For the concept of *minyao* versus *guanyao* see also Chen Wanli (1955) 1990, p. 149; Lin Boshou 1959, pp. 14-16.
[100] Yang Dongchen 1984, p. 82; Li Huibing 1985a, pp. 58-59; Li Huibing 1985b, p. 174; Li Huibing 1987, pp. 20-21; Ge Lingling *et al.* 1988, pp. 130, 136-137;Li Huibing 1989, p. 38; Li Gang 1990, pp. 96-99; Li Huibing 1991, pp. 57-58; Li Huibing 1992, pp. 3-9; Liu Yi, 1994, pp. 90-94.
[101] Jiangxisheng 1963, p. 125.
[102] Xie Mingliang 1987, p. 11.

definition of 貢瓷 *gongci* (tribute wares) and their evolution into official kilns is provided by Li Gang who explains that at the beginning tribute vessels were a selection of the best specimens a kiln (which was privately managed) could make, however, when not only the imperial court, but also officials of all ranks required high quality vessels (thus considerably increasing the demand), production needed to be controlled more closely, and officials were sent to kiln centres to supervise the manufacturing process. This does not mean that the kilns supplying tribute wares became official, they were still run privately, and most of their output was destined for the open market, but they complied with certain shapes and decorations required by the officials.[103] This system, which included Yue, Xing, Ding and Yaozhou wares, remained unaltered until the end of the Northern Song when the court itself began to impose stricter controls on the production of the vessels it ordered. The fact that Ding ware was dismissed because the unglazed mouth was considered unsuitable for the imperial court and instead Ru kilns were ordered to supply the palace can be interpreted as a sign of this new tendency. However, not even the newly-appointed Ru kilns should be regarded as "official" as they were not established and controlled by the government, instead they were commercial kilns chosen by the court to attend temporarily to its particular needs.[104] Geng Baocheng traces a parallel between the *guan* 官 inscription engraved on Song and Jin bronze mirrors to the same character carved on Yue, Ding and Yaozhou specimens and concludes that it was the mark that distinguished tribute objects made by government-controlled kilns.[105]

Recognising that Yaozhou ware was sent as tribute to the courts of the Five Dynasties and the Northern Song[106] is essential to the understanding of this ceramic centre, but, unfortunately, only studies on tribute wares and on the formation of official

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[103] Li Gang 1990, p. 95. For other definitions of *gongci* and/or explanations on the development from tribute to official wares see Yang Dongchen 1984, p. 82; Tang Zhaoliang 1987, p. 147; Ge Lingling *et al.* 1988, pp. 132, 136-137; Li Huibing 1991, pp. 57-58; Li Huibing 1992, pp. 3-9; Liu Yi, 1994, pp. 90-94.
[104] Li Gang 1990, pp. 98-99; Li Huibing 1991, pp. 57-58; Li Huibing 1992, p. 5; Li Minju 1994, pp. 47-48; Liu Lanhua 1996, p. 115; Liu Daoguang 1999, p. 96.
It is interesting to notice that Li Huibing underlines that although Ding is included in the five famous wares of the Song dynasty, it is not an official kiln, but a *minyao* (see Li Huibing 1985a, p.59; Li Huibing 1985b, p. 175; Li Huibing 1987, p. 21.
[105] Geng Baocheng 1999, p. 11.
[106] Yang Dongchen 1984, p. 82; Xie Mingliang 1987, pp. 4-7; Ge Lingling *et al.* 1988, pp. 136-137; Li Gang 1990, p. 97; Li Huibing 1991, p. 57; Li Huibing 1992, p. 4; Liu Yi 1994, p. 91; Liu Lanhua, 1996, pp. 114-115.

kilns seem to acknowledge this, whilst researches on Song ceramics, even those specifically about Yaozhou kilns, seem to ignore it with the result that Yaozhou blue/green ware has often been relegated to a lower rank. In a recent study on ceramic science and technology, Li Jiazhi states that Yaozhou ware was accepted as tribute before Ru ware, but he then introduces Ru ware as one of the five great kilns of the Song dynasty.[107]

1.7 Attempting a new classification

To close the circle it is necessary to go back to the "five famous wares of the Song dynasty" and see how this concept developed among Chinese scholars.

In the 1950s' the choice of Ding, Ru, Guan, Ge and Jun as the celebrated wares of the Song was a *fait accompli*,[108] but earlier researches show that the number and the type of wares was not so strict and that the selected ceramics were simply regarded as famous without implying their actual use by the Song court.[109]

This corroborates the view expressed at the beginning of this chapter that the notion of the 'five celebrated wares' of the Song is not a legacy left by Ming and Qing commentators, but rather an arbitrary selection made by later scholars probably based partly on their interpretation of Ming and Qing literature and partly on the specimens in the imperial collection.

Independently from the reasons why later scholars have singled out these particular five ceramic families, the point made here is that the concept of the five famous wares of the Song has become a deeply rooted notion accepted as an indisputable dogma established centuries ago, which unfortunately has obscured and continues to distort the understanding of Song ceramics in general and of Yaozhou kilns in particular.[110]

On the basis of the literal meaning of the terms classic, imperial, popular etc., and of the information provided by ancient records on the use of various ceramic wares

[107] Li Jiazhi 1998, pp. 258 and 270.
[108] Fu Zhenlun 1955, p. 32; Tong Shuye and Shi Xuetong, 1958, pp. 11-12; Feng Xianming 1959a, p. 67.
[109] Wu Renjing and Xin Anchao 1936, p. 36.
[110] Among the scholars still accepting the notion of the five famous wares of the Song dynasty are Tan Danjiang 1981, p. 69; Liu Liangyou 1985, p. 65; Zhuo Zhenxi 1989, p. 102; Zhongguo taoci shi bianweihui 1991, p. 231; Tianjin Museum 1993, p. 13; Li Jiazhi 1998, p. 270; Liu Fuzhen 1999, p. 96.

in the Song dynasty, it is possible to attempt a new and more comprehensive classification.

Song ceramics should be classified as destined to the court, that is, official wares, or destined to the market, that is, public wares. The first category only includes Guan wares (both northern and southern), while the second comprises all the other Song families, including tribute wares, as these were made by public factories which furnished their best pieces to the court, who accepted them as tribute.

Using this definition, therefore, Yue and Ding, for examples, were market wares, also accepted by the court as tribute; Cizhou and Longquan, for whom there is no literary evidence that they supplied the court, were market wares; Ru was an exception, as it was ordered by the emperor, but was made at public kilns.

The next legitimate question is: to which of these categories did Yaozhou kilns belong? My conviction is that Yaozhou was a market ware which reached the court as tribute like Ding, a conclusion attainable after the first major archaeological campaign in 1958-59[111] and yet ignored for many years and still now not adequately recognised.

For a better understanding of this matter, it is necessary to step backwards to the beginning of this century and examine what western and Chinese scholars thought of celadon production in northern China and, consequently, of Yaozhou wares.

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[111] For the general report of the excavations carried out at Huangbaozhen, Lidipo, Shangdian and Chenluzhen see SPIA 1965.

CHAPTER 2

THE PERCEPTION OF YAOZHOU KILNS IN MODERN RESEARCH

After centuries of negative publicity, it is not surprising that by the beginning of the twentieth century Yaozhou kilns were totally ignored. Were it not for beautiful heirloom specimens, such as the box now in the Percival David Foundation (fig. 1) or the pillow now in the Seikado Bunko Art Museum (fig. 2), Yaozhou ware would have gone into permanent oblivion, as the attention of both Chinese and western scholars was mainly focused on the so-called "five great ceramic families of the Song dynasty", or on later porcelain wares.

2.1 The Western and Japanese perceptions of celadon production in northern China and the first explorations by the Japanese

Although many of the theories by early western scholars of the calibre of Hobson, Hetherington and Honey (just to mention a few) are now superseded, their authors must be credited for clever intuitions and for recognising the beauty of wares that had previously been overlooked, such as Yaozhou and Cizhou. Impressive specimens like those illustrated in figures 1 and 2 obviously constituted a distinctive branch of the vast celadon family the characteristics of which were already clear to Hobson in 1915 who classified them as "Northern Chinese".[112] The geographical indication was inferred from the features that distinguished Northern Chinese wares from Yue, Longquan and Korean celadon, in particular the practice of firing vessels directly on their foot rim, the transparent olive-green glaze and the vivid decoration.[113] That Yaozhou was the home of a kiln centre in the Song dynasty was known from ancient Chinese literature,[114] but nobody had the faintest idea of what type of ceramics it produced, therefore the

[112] Hobson R.L. 1915, p. 85 and pl. 18, fig. 1.
[113] Hobson R.L. 1915, p. 85; Hetherington A.L. 1922, pp. 114-115.
[114] *Yuanfeng jiuyu zhi*, *juan* 3, f. 17b, (Appendix I, text 29); *Songshi*, *juan* 87, record 40, geography 3 (Appendix I, text 14); *Qingbo zazhi*, *juan* 5, f. 9 (Appendix I, text 12); *Laoxuean biji*, *juan* 2, f. 11a, (Appendix I, text 9); *Tanzhai biheng* as reported by the *Chuogeng lu*, *juan* 29, ff. 13a (Appendix I; text 17); *Jingdezhen taolu*, *juan* 7, f. 4a (Appendix I, text 8b).

association between such pieces and the Yaozhou kilns was not made and the term "Northern Chinese" was widely adopted.[115] In 1926, on the basis that according to Chinese records the so-called Dongyao[116] was a superior kind of (northern) celadon made at the Chenliu kilns near the capital Kaifeng, Hobson suggested that northern blue/green wares were also made at Chenliu.[117] In the same catalogue he introduced the term "Northern Celadon" which soon replaced the term "Northern Chinese" used until then.

Despite having its own name, however, northern celadon was not regarded as a fully independent ceramic category, instead it was presented as a poor relation of Longquan ware which continued to be considered the most important and appreciated celadon family of the Song dynasty.[118]

The situation changed, albeit slowly, in the 1930s' when northern celadon started to be associated with Ru and Jun kilns instead of with Longquan ware. This came as a consequence of the intensive explorations of the kiln sites in Linru county, originally Ru prefecture,[119] Henan province. Because of the toponym, these kilns were then believed to be the source of the imperial Ru ware, but instead of Ru specimens, investigations by Harada Gentotsu revealed a considerable amount of northern celadon and Jun shards.[120] This seemed enough evidence for Chinese scholars to conclude that what had been referred to with the generic term of "northern celadon" by western experts was in fact Linru *yao*, the term subsequently adopted in China to indicate Yaozhou-type vessels made in Ruzhou as distinguished from the Ru ware mentioned in ancient records.[121] Western scholars were more cautious and although they acknowledged the importance

[115] Hobson 1926, p. 4; Honey 1949 (1945), p. 80.
[116] For a discussion on Dong kilns see below chapter 2, paragraph 2.2, pp. 49-52.
[117] Hobson 1926, vol. 2, p. 24. Chenliu kilns have not been located so far.
[118] Hetherington 1922, p. 114; Hobson and Hetherington 1923, p. 12; Hobson 1926, p. 23; Hobson 1934, pl. L; Hobson 1936-37, p. 15; Cox 1953 (1944), p. 155; Honey 1949 (1945), p. 77; OCS 1948, p. 7.
[119] For the history of the name of the area see Wang Qingzheng *et al.* 1991, pp. 99-100.
[120] Harada Gentotsu investigated the Linru kiln site in March 1931, the account of his investigations was published in the Japanese newspaper *Tokyo Nichi Nichi* on 13 April 1931 (see Gompertz 1980, p. 85). Harada's finds convinced Nakao Manzo, Provincial Governor in Luoyang, that the main product of the Linru kilns was northern celadon, he visited Linru himself and sent three fragments (two of Jun type and one northern celadon) collected on site to Hobson at the British Museum (see Gompertz 1980, p. 86).
[121] Tan Danjiang 1981, p. 81.

of the discovery, they preferred to remain vague about the exact provenance of northern celadon by maintaining simply that it was produced in Henan, among other places.[122]

The discovery of both Jun and northern celadon specimens at the same kiln site at Linru proved to be not a coincidence, but a recurrent pattern in the Ruzhou area.[123] This pattern persuaded Japanese scholars that "Ru yao" should be used as a geographical term indicating northern celadon which, as Harada's explorations demonstrated, was made in this region.[124] Basically, Japanese scholars regarded northern celadon as either "Ruzhou ware"[125] or an important type of it.[126]

This conviction remained unaltered until the first controlled archaeological excavations carried out at Huangbaozhen, originally in Yao prefecture, Shaanxi province, [127] proved that the superior artefacts illustrated in many Japanese publications[128] as Ruyao were in fact Yaozhou products.

2.2 The question of Dong ware

Japanese scholars were also positive about the identification of the mysterious Dong 董 ware, described in the *Gegu yaolun* as "pale blue/green with many fine crackles, purple mouth and iron foot; in comparison with Guan ware it is not as red, its quality is coarse, it is not refined nor unctuous, it is far inferior to Guan ware; nowadays there are only a few samples",[129] to which the *Taoshuo* added that it "resembles Song Guan ware"[130] and the *Jingdezhen Taolu*, which adopted the character 東 *dong* instead of 董 *dong* (used in the *Gegu yaolun* and the *Taoshuo*) specified that "the Dong kilns were popular kilns in the Eastern Capital (東京 Dongjing) of the Northern Song, in today's Chenliu, Kaifeng prefecture".[131]

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[122] Hobson 1936-37, pp. 11, 16-17; Cox 1953 (1944), p. 161; Honey 1949 (1945), p. 77; Los Angeles County Museum 1952, p. 28; Gray 1953, pp. 32-34.
[123] Gray 1953, p. 34; Gompertz 1980, p. 85.
[124] Koyama F. 1943, pls. 16-23, now recognized as Yaozhou specimens, are labelled "Ru yao".
[125] Nakao Manzo, Otani Kozui and Ozaki Junsei's theories are reported by Gompertz 1980, pp. 86-87.
[126] Koyama's theory is reported by Gompertz 1980, p. 87.
[127] SPIA 1965.
[128] Koyama F. 1943, pls. 16-23; Koyama F. *et al.* 1955, colour pls 3-4, pls. 26-33; Koyama F. 1960, colour pl. 8, pl. 44.
[129] *Gegu yaolun*, third *juan*, ff. 1b-2a (Appendix I, text 6).
[130] *Taoshuo, juan* 2, f. 10a (Appendix I, text 18a).
[131] *Jingdezhen taolu, juan* 6, f. 1b (Appendix I, text 8a).

The specimens regarded by Japanese scholars as Dong ware all share bold decorations carved on multiple levels under a vivid green glaze, as in the case of a ewer in a private Japanese collection (fig. 3). On the basis of the information gathered from ancient Chinese records and of the features of vessels thought to be Dong ware, Koyama Fujio concluded that Dong and Northern Guan kilns were the same, although he admitted that such attributions were just speculative.[132]

Western scholars either avoided the issue of Dong ware, or were very cautious about it, their general view being that Dong ware was a type of northern celadon.[133] However, some of them were more daring like Sir Percival who in the introduction of the catalogue of the OCS exhibition on Ru and Guan wares, partially influenced by an earlier work by Hobson,[134] expressed the view that: "Tung yao, in my opinion, was a ware that had originally been made in certain private factories in Honan during the tenth, eleventh and twelfth centuries. 'Tung-ch'ing' (東青), I would say, refers to the Eastern Capital, or K'ai-feng, as distinguished from the Western Capital, or Hsi-ching, *i.e* Loyang, so that it should be translated 'Tung ching' ('Eastern Capital') (東京), not 'Tung-ch'ing' ('Eastern green') (東青). Tung-ching, the Eastern Capital, was the name by which K'ai-feng itself was known in the Posterior Liang dynasty (907-922) and it is my belief and my present contention that the earliest of the so-called Tung wares was made at that time. Being green in colour, it was later mistakenly referred to as 'eastern green' (東青) and still later as 'winter green'(冬青) ware. By the time the court had been forced to flee from K'ai-feng, it had developed into what we now call Northern celadon ware, which in my opinion might likewise be called Tung ('Eastern') (東) ware".[135] From this passage it appears that Sir Percival preferred the version of the *Jingdezhen taolu*, instead of that of the *Gegu yaolun* and the *Taoshuo*. From a certain point of view, 東 *dong* seems more feasible, however, the fact that earlier documents, such as the *Gegu yaolun* and the *Taoshuo*, employ 董 *dong* induces one to believe that this was the correct character, while 東 *dong* was either a mistake in transcription, or a manipulation to adjust the location of the Dong kilns close to Kaifeng, the Eastern Capital of the

[132] Gompertz 1980, p. 102.
[133] Hobson 1915, p. 82; Hobson 1926, p. 24; Honey 1949 (1945), p. 77; Los Angeles County Museum 1952, p. 28.
[134] Hobson 1915, p. 82.

Northern Song. In any case, Sir Percival's theory that 東青 *dongqing* should be read 東京 *dongjing* seems arbitrary and unnecessary: even if the correct character for Dong ware were 東 *dong*, implying the Eastern Capital, 青 *qing* would be more appropriate than 京 *jing* to indicate the ware there produced.

As to the question of Dong ware being made by private kilns since the Later Liang and then developing into northern celadon, there is no evidence either to prove it or refute it, which is the critique moved to Sir Percival by Gompertz who, however, accepted his theory on the correct version of the name.[136] Following the lead of Japanese scholars, with whom he was closely acquainted, Gompertz identified as Dong ware those vessels with carved decoration,[137] but did not ignore Gray's theory that Dong was rarer than northern celadon and therefore should be identified with more precious vessels like the Alexander bowl in the British Museum.[138] Gompertz acknowledged that some shards collected at Yaozhou during the 1958-59 archaeological campaign,[139] bore a resemblance to the vessels labelled by the Japanese as Dong, but he refused to believe that Dong ware was created by Yaozhou potters and believed instead that Yaozhou was influenced by Dong ware.[140] Successive archaeological excavations at Huangbaozhen, the actual site of the Yaozhou kilns, situated in Tongchuanshi, Shaanxi,[141] have proved him wrong and it is now clear that what Japanese scholars used to call Dong ware was actually made at Yaozhou between the end of the Five Dynasties and the beginning of the Northern Song (figs 4 and 5).

Nevertheless, this does not imply that the Dong kilns mentioned in ancient Chinese literature actually are the Yaozhou kilns, as some Chinese scholars seem to believe.[142] In my view it should be acknowledged that what Japanese scholars had originally identified as Dong ware was made at Huangbaozhen, but whether this identification is correct, or whether Dong ware had a completely different aspect, if it

[135] OCS 1953, Appendix II.
[136] Gompertz 1958, p. 36.
[137] Gompertz 1980, pls. 39, 41, and colour pl. C.
[138] Gray 1953, p. 35 and Gompertz pl. 42.
[139] SPIA 1965.
[140] Gompertz 1980, p. 102.
[141] SPIA 1997.
[142] Feng Xianming 1991, p. 8; Wang Langfang 1993, p. 95; Lin Shuxin 1993, p. 35; Ren Chao 1994, p. 93.

existed in the first place, is bound to remain a mystery until the location of the kiln site has been identified and excavations have been carried out.

2.3 The Chinese perception of celadon production in northern China and the first surface investigations

Up to the early 1950s' Yaozhou ware was virtually unknown in China and what westerners referred to as northern celadon did not engage the interest of the Chinese who firmly believed in the saying "blue/green wares in the south and white wares in the north".[143]

In the early part of the 20th century, heirloom vessels coated in a transparent olive-green glaze and decorated with carved or moulded motifs, whose beauty was undeniable and which therefore could not be ignored, were variously called 'Lishui ware of the north', "Longquan of the north" and "Qin ware",[144] whilst ceramic experts started referring to them as "Linru yao"[145] since Harada's finds at kilns in Linru county in 1931 indicated that northern blue/green ware was made there.

The term northern celadon was adopted by China from the West, but in China it was often used in a broader sense: in the West it was applied only to Yaozhou and Yaozhou-type specimens of the Song period, but in China it included all blue/green wares made in northern China since the sixth century AD, mainly because it was not known at which kilns they were made and therefore a generic term was more suitable.[146]

In 1951 whilst exploring the kiln site at Dangyangyu, Henan province, in the temple to kiln divinities Chen Wanli found the 懷州修武縣當陽村土山德應侯百靈廟記 *Huaizhou Xiuwuxian Dangyangcun Tushan Deying Hou Bai Ling miao ji* stele dated 1105,[147] which clearly states that the temple to kiln divinities in Dangyangyu was built in imitation of the one in Yaozhou. This piece of information should have alerted scholars to the possibility that Yaozhou was the location of a kiln centre earlier and more important than that in Dangyangyu, as the latter erected a temple in imitation of the

143 Chen Wanli 1989 (1956), p. 100.
144 National Palace Museum 1971, pl. 44; Feng Wanli 1975, p. 15; Tan Danjiang 1981, p. 81.
145 Feng Xianming 1959b, p. 72; Tan Danjiang 1981, p. 81; Li Huibing 1987, p. 20.
146 Wu Renjing and Xin Anchao 1936, pls 21 and 22; Chen Wanli 1989 (1956), p. 101; Feng Xianming 1958, pp. 56, 59-60; Lin Boshou 1959, p. 11; Tan Danjiang 1981, p. 81.
147 Chen Wanli 1954, pp. 44-7; the content of this stele have already been discussed above chapter 1, pp. 26-31.

former, but presumably because no ceramic type had at that time been associated with the Yaozhou kilns, Chen Wanli overlooked this important piece of information and on the basis of literary records only concluded that the most prosperous period for Dangyangyu and Yaozhou factories, both of which he regarded as popular ceramic centres, was between the first year of the Xining reign period (1068) and the fourth year of the Xuanhe reign period (1125).[148]

In 1953 a hoard of about three hundred blue/green shards was discovered at Guang'an men in Beijing.[149] Except for three samples published in 1958,[150] the rest of them have never left the store rooms of the Gugong in Beijing, where I had the unique opportunity to examine them in December 1997 thanks to Zhuo Zhenxi, who was also seeing them for the first time.

All the shards share very similar features that show that they belong to the same and very short period. The most striking characteristic is the shape of the ring foot: perfectly square-cut, straight outside, slightly inclined towards the base and much deeper inside thus causing the base to be very thin; the glaze is neatly shaved off the foot at the joint with the body, but in some cases a disc of glaze defined by a ridge is left in the middle of the base. The thinly-applied olive-green glaze has a pronounced yellow tinge and is suffused with millions of tiny bubbles which mar the transparency of the glaze and blur the decoration underneath; on the outside the bubbles are not as numerous, therefore the glaze appears slightly more transparent. All the samples were decorated both inside and outside; the design on the outside is always carved and invariably the same: a stylised floral motif, whilst on the inside it is either carved (in most cases) or impressed and there are two subjects, namely dragons and phoenixes; the carving is always very skilful and precise even in the smallest details. The body of the Guang'an men shards varies in thickness, fineness and colour. The thickness of the base is related to the size of the vessel it supported, but the mouth rims and upper parts are all very thin, in most cases slightly everted, but never thickened. As to fineness, none of them shows the top refinement Yaozhou potters could achieve, some were reasonably fine, but most were disappointing, albeit far from being coarse. The colour of the body varies from pale

[148] Chen Wanli 1954, p. 45.
[149] Feng Xianming 1958, p. 56.
[150] Feng Xianming 1958, p. 56.

to dark grey, the latter usually corresponding to better quality; black impurities are only occasionally present.

Although my high expectations of being shown specimens of the best quality that Yaozhou potters could make were not realised, nevertheless the Guang'an men shards are carefully executed and it is surprising that they did not arouse the interest of Chinese scholars as soon as they were discovered. The reason of this lack of curiosity was probably due to the already mentioned fact that at the time Yaozhou ware had not been recognised and the concept of northern celadon was in its infancy, to put it mildly.

Interest in Yaozhou ware began in 1954 when Chen Wanli visited the Northwest History Museum (now called Shaanxi History Museum) where he observed blue/green shards collected in Shaanxi province that appeared remarkably similar to Linru ware.[151] In the summer of the same year, he investigated Yaozhou kiln site where he collected shards identical to those exhibited in the Northwest History Museum.[152] Albeit superficial, this exploration was crucial as it finally clarified that the type of ceramics manufactured by the Yaozhou kilns was almost exclusively blue/green ware.[153] By comparison with Linru ware, Chen realised not only that many samples previously attributed to Linru factories were actually from Yaozhou, but also that Yaozhou ware was not inferior to Linru.[154] Chen had read in the *Songshi* that Yaozhou factories sent ceramics as tribute to the court during the Chongning reign period (1102-1106),[155] but the shards collected in this first survey did not display imperial standards, therefore he concluded that the Yaozhou kilns produced vessels both for everyday use for the common people and at the same time, superior specimens to send as tribute.[156]

Albeit originally Chen Wanli had not paid much attention to the references to Yaozhou in the Dangyangyu stele, now that he was exploring the Yaozhou kiln site, he searched for the temple to kiln divinities mentioned in the Dangyangyu tablet. The only building vaguely resembling a temple was the elementary school and he was actually told by locals that that used to be the Eastern Mountain temple. Inside he made a sensational discovery: in the area in front of the kitchen Chen saw a flat stone used as a

[151] Shaanxi Bowuguan ed. 1956, p. 1.
[152] *Ibidem*.
[153] *Ibidem*.
[154] Chen Wanli 1955, pp. 72-73.
[155] *Songshi, juan* 87, record 40, geography 3 (Appendix I, text 14).
[156] Chen Wanli 1955, p. 73.

table for the students which turned out to be a stele called *Deying Hou bei* (Stele of Marquis Deying) dated 1084.[157] Luckily it had been placed face down, so the inscription is complete (except for one character) and perfectly legible.

The importance of this discovery for the understanding of Yaozhou ware has already been underlined in chapter 1,[158] here it is necessary to pause only on the impact that it had at the time, which, unfortunately, was rather limited, probably because the superior quality of specimens described in the stele seemed to have no relation to the shards collected along the Qishui river. The only effect the content of the stele had was on the question of the dating of the beginning of activity at Huangbaozhen. Judging from the dates of the erection of the Dangyangyu and Deying Hou stelae and the style of the shards collected at the kiln site, Chen Wanli concluded that Yaozhou kilns were operating before the Xining reign (1068-1077), but how much earlier was impossible to establish.[159] The stele of Marquis Deying narrates the story of Bai Lin who arrived in the area during the Yonghe reign (345-356) of the Eastern Jin (317-420), but because this information was not corroborated by archaeological evidence, Chen discarded it.[160] Shang Jianqing, a worker at the local ceramic factory, came to the same conclusion, but hinted at the recovery of pre-Song samples.[161]

In the summer of 1954, after Chen Wanli's survey at Huangbaozhen, another important discovery was made. In the nearby Bin county after a ruinous flooding of the local river, a black vat containing complete blue/green specimens came to light. The fact that the vat was in a pit was puzzling and Chen Wanli concluded that it had probably been buried by the monks of the nearby Xianying temple to save the ceramic objects, apparently dating to the Song dynasty, from the disturbances of the Muslim rebellion of 1862-1878.[162] Once again, it is surprising that even these complete specimens, some of which are undeniably beautiful, like the jar and cover with deeply carved decoration (fig. 6) and the cup and saucer (fig. 7) all permanently on display in the Shaanxi History

[157] Chen Wanli 1955, p. 74.
[158] See above chapter 1, pp. 26-31.
[159] Chen Wanli 1955, p. 74
[160] Chen Wanli, 1954, p. 45; Chen Wanli 1955, p. 74; Shaanxi Bowuguan ed. 1956, p. 3. The story of Bai Lin and its implications have already been discussed above chapter 1, pp. 20-22 and 28-31, and Appendix I, text 4.
[161] Shang Jianqing 1955, pp. 76-77.
[162] Shaanxi Bowuguan ed. 1956, p. 4.

Museum, did not manage to stimulate curiosity about this mysterious, but beautiful ceramic ware.

Feng Xianming investigated the Yaozhou kiln site at Huangbaozhen for the first time in 1957 and was the first to see a connection between the shards he collected and those found at Guang'an men in Beijing in 1953.[163] Feng noticed that body and glaze were the same in both groups and the decoration was either carved or impressed, only the subject of the decoration differed being exclusively dragons or phoenixes on the Guang'an men shards and floral on the Huangbaozhen samples. How could it be possible that none of the Guang'an men shards bore a decoration similar to the Huangbaozhen samples and none of the latter was decorated with dragons or phoenixes? Feng Xianming draw the conclusion that the shards collected at Huangbaozhen were destined for every day use by the common people, whilst those found at Guang'an men were specifically made for the Song imperial palace.[164] Like Chen Wanli, Feng Xianming knew that Yaozhou ware had been sent as tribute to the Song court from the passage in the *Songshi*[165] and the dragons and phoenixes on the Guang'an men shards seemed to confirm their imperial destination.

Going back to his comparison of the Guang'an men and Huangbaozhen samples, Feng noticed that it was odd that no shards decorated with dragons or phoenixes had been found at the kiln site, but on the basis of the later practice adopted at Jingdezhen in the Ming and Qing dynasties, he assumed that imperfect pieces were destroyed to prevent their spreading among common people.[166]

The natural objection to this statement is that although the vessels might have been destroyed, they could not have been pulverised, therefore some shards would have survived as they have at Jingdezhen. In more recent archaeological excavations samples decorated with dragons and phoenixes have been discovered,[167] therefore there is no doubt that the Guang'an men pieces had been manufactured at Huangbaozhen; however, as to the practice of smashing imperfect pieces destined for the court, there is no evidence that it was implemented at Yaozhou.

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[163] Feng Xianming 1958, pp. 56-59.
[164] *Ibidem.*
[165] *Songshi, juan* 87, record 40, geography 3 (Appendix I, text 14).
[166] Feng Xianming 1958, p. 59.
[167] SPIA 1998, drawing 60:6, 60:9, p. 107, drawing 202:2, 7-8, p. 409; drawing 205:7, p. 414.

To explain how tribute Yaozhou vessels came to be found at Guang'an men, Feng Xianming suggested that they were objects pillaged from the Song palace by the invading Jin dynasty whose capital Dadu included today's Guang'an men.[168]

On the basis of certain characteristics, such as carved dragons on large 盤 *pan* dishes and the very shape of the dishes that Yaozhou specimens seem to share with Ding ware, Feng Xianming advanced the theory that both kiln centres made tribute wares at the same time, that is around the Chongning (1102-1107)[169] and the Daguan (1107-1110) reign periods;[170] but he did not specify whether tribute vessels were made according to the requirements of the court and which kiln influenced the other.

It is true that Ding and Yaozhou have something in common, mainly the fact that they are decorated and the decorating techniques themselves, and it is also possible that they sent tribute ware to the Song court approximately at the same time, but the reasons for Feng Xianming's specification of the period between 1102 and 1110 need to be scrutinised. The stele of Marquis Deying, which was erected in 1084, does not mention tribute ware, implying that Yaozhou kilns did not send tribute vessels earlier than 1085. This implication seems to contradict the *Yuanfeng jiuyu zhi* (preface dated 1080) which records that Yaozhou kilns were sending tribute ware to the Song court.[171] The other document reporting that Yaozhou ware was accepted as tribute by the Song court is the *Songshi*, according to which this happened in the Chongning reign period (1102-1106).[172] According to the *Gegu yaolun*, Ding kilns were at their best during the Zhenghe (1111-1118) and the Xuanhe (1119-1125) reign periods.[173] When exactly Ru kilns were ordered to manufacture blue/green ware for the palace is not known, but according to the *Chuogeng lu* reporting the *Tanzhai biheng*, government factories were established at Kaifeng in the Zhenghe reign period (1111-1118).[174] Judging from these dates, it appears that Feng Xianming calculated that Yaozhou ware was accepted as tribute by the Song court between the Chongning (1102-1106) and Daguan (1107-1110)

[168] Feng Xianming 1958, p. 59; other scholars sharing Feng Xianming's interpretation are Yang Dongcheng 1984, p. 82; Li Huibing 1987, p. 21; Zhuo Zhenxi 1988b, p. 43; Liu Benqi 1989, p. 143; Liu Fengjun 1990, p. 80; Chen Wenping 1990, p. 71; Zhongguo taoci shi bianweihui 1991, p. 231.
[169] The Chongning reign period started in 1102 and lasted for five years, thus ending in 1106.
[170] Feng Xianming 1958, p. 59.
[171] *Yuanfeng jiuyu zhi, juan* 3, f. 17b (Appendix I, text 29).
[172] *Songshi, juan* 87, record 40, geography 3 (Appendix I, text 14).
[173] *Gegu yaolun*, third *juan*, f. 2b (Appendix I, text 6).
[174] *Tanzhai biheng* in the *Chuogeng lu, juan* 29, f. 13b (Appendix I, text 17).

reign periods because the first is given by the *Songshi* and the second is deduced from the date in which official kilns were established and the court was then supposedly supplied by its own factories.

As to the question of the dating of the activity of Huangbaozhen kilns, Shang Jianqing's suggestion that some shards looked pre-Song was vindicated by Feng Xianming who collected several samples with Tang features, such as the solid foot, the 璧 *bi* foot[175] and the three spur marks on the inside.[176]

On the basis of the passage in the Wanli edition of the *Tongguanxian zhi*, stating that ceramic kilns at Huangbaozhen are no longer active, but they have been moved to Chenluzhen,[177] both Chen Wanli and Feng Xianming inferred that ceramic production ceased in Huangbaozhen and started in Chenluzhen in the Ming dynasty.[178] However, after discovering the 1726 stele in the local temple to kiln divinities in Chenluzhen in 1957,[179] Feng Xianming assumed that the kilns at Huangbaozhen closed at latest by the second year of the Daguan reign period (1108) and, therefore, that the Chenluzhen factories were operating by then.[180] Feng Xianming came to this conclusion on the basis of his interpretation of the dates provided by the 1726 stele, according to which repair works to the temple were carried out in 1108, 1404, 1444, 1575, 1593 and 1623.[181] According to Feng Xianming, this theory was even corroborated by archaeological evidence: during his visit to Chenluzhen he had collected a few shards which, in his opinion, were very similar in style to Northern Song samples from Huangbaozhen.[182] A year later, Feng Xianming pushed further back to the Five Dynasties the time when the Huangbaozhen factories were abandoned, on the basis that the fifth year of the Zhouzhi reign period, given by the 1726 stele as the date of the construction of the temple,

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[175] *Bi* is the name of jade discs with a hole drilled in the centre manufactured since the Neolithic period. By extension, when the foot ring of ceramic vessels is characterised by a wide rim and a small recessed base, it is called *bi* foot.
[176] Feng Xianming 1958, p. 59 and 1959 p. 72.
[177] *Tongguanxian zhi*, Ming Wanli edition, *juan* 8, ff. 27a-27b (Appendix I, text 19); for a translation and discussion of this passage see above chapter 1, pp. 20-21.
[178] Chen Wanli 1955, p. 72 and Feng Xianming 1958, p. 59.
[179] Feng Xianming 1958, p. 59. The discovery of this stele and its contents have already been discussed above chapter 1, pp. 22-24.
[180] Feng Xianming 1958, p. 59.
[181] For a discussion on Feng Xianming's interpretation of the dates provided by the 1726 stele see above chapter 1, p. 24.
[182] Feng Xianming 1958, p. 59.

corresponded to 958.[183] If ceramics production at Chenluzhen began when it ceased at Huangbaozhen and if the construction of the temple to kiln divinities in Chenluzhen started in 958, then Feng Xianming's conclusion that the kiln site at Huangbaozhen was abandoned at the end of the Five Dynasties is correct. But shards collected by Feng Xianming himself at Huangbaozhen and Chenluzhen tell a different story, to conform to which Feng proposed that Huangbaozhen and Chenluzhen were both active in the Song dynasty during which Huangbaozhen ceased production and Chenluzhen developed and improved.[184]

From this it appears that at the end of the 1950s' Huangbaozhen had not yet been recognised for what it really was, that is, the main kiln centre in Yao prefecture, but, at least, Feng Xianming realised that Yaozhou ware was not a provincial product, indeed that it was the product of one of the famous northern kilns of the Song dynasty, unfortunately not acknowledged by many, but so beautiful that like Ding and Ru wares, it was selected to supply vessels to the imperial court.[185]

2.4 The first archaeological excavation

In autumn 1958 a major archaeological campaign was organised to investigate and excavate Yaozhou kilns at Huangbaozhen, Lidipo and Shangdiancun. The first part of the operations was carried out by the Chinese Academy of Sciences, Institute of Archaeology, Xi'an Research Office and from Spring 1959 the Shaanxi Provincial Institute of Archaeology took over. The final report was published as a monograph in 1965,[186] but before then two preliminary reports appeared in 1959 and 1962.[187]

Because of later, more thorough explorations, the 1958-59 campaign is often overlooked, but when put in context, it immediately appears as a major breakthrough in the understanding of Yaozhou ware. If one pauses to think that until a few years earlier the concept of Yaozhou kilns was virtually non-existent and the vessels there produced were at best attributed to another ceramic centre, *i.e.* Linru, it is very significant that a

[183] Feng Xianming 1959b, p. 73. For a discussion on Feng Xianming's interpretation of this date see above chapter 1, p. 24.
[184] Feng Xianming 1959b, p. 74.
[185] Feng Xianming 1959b, pp. 72 and 74.
[186] SPIA 1965.
[187] Shaanxi Institute of Archaeology, Jingshui Team, 1959, pp. 671-673; Wang Jiaguang, 1962, pp. 312-317.

full-scale investigation and excavation of the area was approved and carried out with the best means available at the time.

The finds were astonishing and proved that what Chinese scholars had called Linru ware since Harada's discoveries at Linru county in 1931, was actually Yaozhou ware, that the main kiln centre in Yao prefecture was Huangbaozhen followed by Chenluzhen (still operating at the time of the excavations), Lidipo and Shangdian, that the first factories commenced production at Huangbaozhen in the Tang dynasty and were still active under the Mongols, that this kiln centre was specialised in the production of blue/green ware, but also manufactured other types and that technologically Yaozhou kilns were very advanced.

The excavation was so fruitful because for the first time the site was scientifically excavated, thus allowing to obtain many more pieces of information from each discovered item than uncontrolled and unrecorded excavations could ever produce.

The main feature of this archaeological campaign was the importance attached to the stratigraphic sequence of the excavated trenches which allowed the finds to be placed in relative chronological order. At the end of their stratigraphic studies, the archaeologists concluded that three main cultural levels could be identified: lower, middle (this layer in turn was divisible in three sub-layers) and upper, respectively attributed to the Tang, Song and Jin-Yuan periods on the basis of the stylistic features of the unearthed items, a few dated pieces and coins.[188]

The excavations revealed that in the Tang dynasty Huangbaozhen kilns produced mainly black and white wares followed by green and yellow wares, whilst blue/green ware was a very small part of the whole production.[189] This state of affairs changed in the Song dynasty, when the kilns seem to have specialised in blue/green ware, albeit a small quantity of brown and black wares continued to be made.[190] At the beginning of the Song, the decoration was still very restrained in both subjects and extension and usually appeared in the form of lotus petals carved on the outside, while in a later phase

[188] Shaanxi Provincial Institute of Archaeology Jingshui Team 1959, p. 671; Wang Jiaguang 1962, pp. 312-313; SPIA 1965, pp.3-8.
[189] Wang Jiaguang 1962, p. 312; SPIA 1965, pp. 13.
[190] SPIA 1965, pp. 13, 18, 20, 31.

decorative motifs extended to both the inside and outside of open vessels and the style became more and more flamboyant.[191]

Between body and glaze was noticed a layer of white matter identified as slip and regarded as a sign of refinement, as its absence in Jin-Yuan specimens was noted as confirmation of a decline in quality together with the yellow colour of the glaze and the firing in stacks which required a ring to be wiped clear of glaze on the bottom of open vessels.[192]

Besides vessels, workshop and kiln utensils were unearthed, thus allowing scholars to have at least an idea of manufacturing and firing methods. For example, saggars were already in use during the Tang period, albeit not regularly, judging from their quantity which, on the contrary, increased remarkably in the Song period, thus showing that firing objects singly in saggars became common; in the Jin-Yuan period saggars were predominantly tall cylinders presumably able to accommodate a stack of bowls or plates.[193]

Most of the architectural remains were badly damaged, but the discovery in the Jin-Yuan layer of a group of four workshops opposite three kilns still partially standing and furnished provided a great deal of unexpected information about how Yaozhou kilns were operated.[194] The workshops were identified as such on the basis of the utensils found in them, which demonstrated that clay (and possibly other ingredients) was pulverised with treadle-operated hammers and refined in decanting pools, and that the glaze was prepared in large ceramic vats.[195] The kilns were of the so-called 饅頭 *mantou* type with a horseshoe plan and included door, fire pit, firing chamber and chimneys;[196]

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[191] SPIA 1965, pp. 18, 20, 31.
[192] For the white layer between body and glaze see Wang Jiaguang 1962, p. 312 and 313; Lin Yeqiang 1986, p. 61; for information on Jin-Yuan wares see Shaanxi Provincial Institute of Archaeology Jingshui Team 1959, p. 673; Wang Jiaguang 1962, p. 313; SPIA 1965, p. 37.
[193] SPIA 1965, pp. 17-18, 28-30, 36, 45.
[194] All together four workshops, nine high-temperature kilns, one kiln for firing bricks and tiles and six waste pits were discovered; unfortunately the kilns in the Song layer were too damaged to yield information. See Shaanxi Provincial Institute of Archaeology Jingshui Team 1959, pp. 671-672; SPIA 1965, pp. 1, 8-13.
[195] Wang Jiaguang 1962, p. 313; SPIA 1965, pp. 11-12. For a detail discussion on manufacturing method see below chapter 3.
[196] *Mantou* is the name given to kilns in northern China because their dome-like cover reminds one of the shape of Chinese steamed buns. For full descriptions of the kilns found during the first excavation at Huangbaozhen see SPIA 1965, pp. 8-11; for a discussion on the development of kilns at Huangbaozhen see below chapter 3, pp. 106-120.

those firing at high temperature were also provided with an ash pit to collect ash and cinders.[197]

The samples unearthed at Lidipo and Shangdiancun showed characteristics very similar to those observed on vessels excavated from the upper cultural layer at Huangbaozhen; [198] the same situation applied to Chenluzhen which was only superficially investigated, but the quality and style of the shards there collected suggested that ceramic production at Chenluzhen commenced in the Ming dynasty, thus invalidating Feng Xianming's theory that the Chenluzhen kiln centre was activated in the Five Dynasties.[199]

The explored area extended approximately 5 km from Nichi to Xincungou,[200] thus testifying that Yaozhou was definitely not a secondary kiln site, indeed it was a big ceramic centre.

The information on Yaozhou kilns supplied by the 1958-59 excavations was of so great a relevance that one would have expected an immediate reconsideration of the position of this kiln centre, but recognition was slow and fragmented, except in a few instances.

In China Feng Xianming recognised the superiority of Yaozhou over Linru, especially after comparing with the finds from the latest exploration at Linru kilns.[201] As already mentioned, Feng was a supporter of the theory that Yaozhou kilns provided tribute ware to the Song court,[202] but whilst before this notion was only a reference in literary records not supported by tangible archaeological evidence (the Guang'an men shards had been found in Beijing, not at the Huangbaozhen kiln site), now archaeological evidence was so abundant as to dissipate any doubt.

In Japan scholars realised that what they had so far labelled "Ru *yao*" was actually "Yaozhou *yao*" and promptly amended it,[203] thus demonstrating that the 1958-59 finds were so self-evident as to revolutionise previous interpretations.

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[197] SPIA 1965, p. 8.
[198] Shaanxi Provincial Institute of Archaeology Jingshui Team 1959, p. 671; Wang Jiaguang 1962, p. 313; SPIA 1965, pp. 48, 49, 54, 55.
[199] Wang Jiaguang 1962, p. 313. For Feng Xianming's theory see above chapter 2, pp. 58-59.
[200] Nichi and Xincungou are two small localities respectively north-east and south-west of Huangbaozhen.
[201] Feng Xianming 1964, pp. 15-26.
[202] Se above chapter 2, p. 59.
[203] In the 1965 catalogue of the Tokyo National Museum the objects in figs 203, 204 and 207 (Tokyo National Museum 1965) labelled as "Ru *yao*" in the 1955 series (Koyama *et al.* 1955, vol. 10, figs. 16, 15 and 12) are labelled "Yaozhou yao".

But in the West the impact of the astonishing results obtained at Huangbaozhen and environs were far from immediate. The first full acknowledgement of the importance of those discoveries dates back to as late as 1972 when Gray and Neave-Hill wrote: "One of the major elucidations of Chinese ceramic history in the post-T'ang period during the past fifteen or twenty years, has been the recognition of the long activity and superior quality of the wares of kilns at Yaochou in Shensi".[204] Before this, Sullivan and Ayers had mentioned the discovery of kilns manufacturing blue/green ware in modern Tongchuan, but neither of them challenged the primary position attributed to Linru in the production of northern celadon and both introduced Huangbaozhen kilns as simply another ceramic factory making this type of ware.[205] This approach was maintained by certain scholars, such as Gompertz,[206] as late as 1980, however the majority followed Gray and Neave-Hill's statement and credited Huangbaozhen as the main kiln producing northern celadon, symptomatic of which is the fact that northern celadon has since been called Yaozhou ware. Nonetheless, nobody in the West addressed the question of Yaozhou kilns supplying tribute ware to the Song court and the general feeling that one has when reading western sources is that Yaozhou ware was never considered in the same class as Ding.

2.5 The 1973 excavation

The Shaanxi Provincial Institute of Archaeology resumed excavations at Huangbaozhen in 1973 under the leadership of Zhuo Zhenxi, but no report of the finds appeared until 1980.[207] The new expedition revealed three Song dynasty kilns, several workshops, kiln furniture and shards of all sorts. Among these was a considerable amount of blue/green specimens with characteristics that clearly set them aside from Tang and Song vessels,[208] which, when consulted, Li Huibing and Geng Baochang assigned to the Five Dynasties period.

This discovery was of primary importance, as it demonstrated that from a ceramic point of view, the Five Dynasties was not a mere appendix to the Tang or a brief

[204] The Arts Council of Great Britain and the Oriental Ceramic Society, 1972, p. 33.
[205] Sullivan 1963, p. 71; Ayers 1964, p. 13 and 1968, vol. 1, p. 31 and caption of exhibit A24.
[206] Gompertz 1980, pp. 103-106.
[207] Zhuo Zhenxi and Lu Jianguo 1980, pp. 54-61.

prelude to the Song, instead it was a period with its own characteristics, during which Yaozhou kilns specialised in the production of blue/green ware. Some of the Five Dynasties specimens had a yellowish glaze which betrayed the difficulty of controlling reduction firing, but in comparison with Tang samples, the greyish Five Dynasties glaze was more even in both colour and thickness. The Five Dynasties also appears to be responsible for a major change in the method of firing: during the Tang dynasty, open vessels were fired in stacks separated by three-spurred spacers placed inside which left three marks in the well, but in the Five Dynasties potters started to fully glaze their vessels and, in order to prevent them from sticking to the bottom of the saggar in which they were individually fired, placed them on either three-armed or three sandy setters (in Chinese often called 珠墊 *zhudian*, bead setters). This piece of evidence should have been sufficient for experts to suggest that the technique of fully glazing and firing on small spurs so much praised on Ru ware was not an invention of Ru potters, but was first experimented with by Huangbaozhen craftsmen, and the fact that nobody noticed it confirms the general attitude that Yaozhou cannot be compared with the superior Ru.

Besides Five Dynasties blue/green ware, other ceramic types were unearthed for the first time: white vessels with green or brown decoration, vessels with decoration painted under the glaze and vessels with black decoration painted directly on the plain body, all attributed to the Tang dynasty on the basis of their style, except the white ware with green splashes which probably lasted until the Northern Song; whereas black vessels with rusty speckles and those with *sgraffiato* decoration were added to the Song repertoire.[209]

The new discoveries, especially those concerning ceramic activity at Yaozhou during the Five Dynasties, were of great significance, nevertheless they did not stimulate the publication of researches into the matter and the few articles that appeared on Yaozhou kilns were not affected by the recent explorations.[210]

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[208] These shards were not found at Huangbaozhen, but at Yuhuagong, another kiln centre in Tongchuan municipality, see Zhuo Zhenxi 1988a, p. 152; for a description and drawing of these objects see Zhuo Zhenxi and Lu Jianguo 1980, p. 58.

[209] Zhuo Zhenxi and Lu Jianguo 1980, pp. 54-57; Zhuo Zhenxi 1988, p. 44.

[210] As the articles related to Yaozhou kilns published between 1980 and 1986 do not seem affected by the 1972 finds, their arguments are examined together with those presented in post-1986 publications, see below chapter 2, pp. 68-78.

2.6 The last archaeological campaign: 1984-1997

In summer 1984, after the accidental discovery of a late Song kiln, the Shaanxi Provincial Institute of Archaeology was called in and a full-scale investigation, which lasted over ten years, was organised.[211] Just to give an idea of its scale, it is enough to know that seven areas with a total of 191 trenches were excavated. The results were astonishing in both quantity and quality and produced invaluable new information on ceramic manufacture at Huangbaozhen, confirming evidence provided by previous excavations and sometimes modifying it. The final report in four volumes has started appearing only recently,[212] but preliminary reports were published since 1987.[213] From these it immediately became clear that the Tongchuan station of the Shaanxi Provincial Institute of Archaeology had struck big with the discovery of the first *sancai* (三彩) kiln ever found in China, the first high-temperature kiln of the Tang dynasty at Huangbaozhen, a *sancai* experimental kiln, nine high-temperature Song kilns representing the three phases in which this period is usually subdivided by Chinese archaeologists, seven *sancai* workshops, two Tang, five Song and one Jin stoneware workshops and waste pits full of samples of all sorts, not to mention an enormous quantity of ceramic specimens, kiln implements and workshop furniture.[214]

The new picture of Yaozhou kilns that emerged after this last major archaeological campaign can be briefly recapitulated as follows. For the Tang dynasty, the discovery of the kilns and workshops to fire low-temperature wares proved beyond doubt that in that period Huangbaozhen manufactured *sancai* ware. Before the 1984 excavation, archaeologists had found lead-glaze specimens which made them suspect that Huangbaozhen might have produced this type of ceramics, but because the production of *sancai* ware had always been thought of as exclusively belonging to kilns in Henan, the evidence was regarded as inconclusive and Henan kilns continued to be

[211] Zhuo Zhenxi 1988b, p. 44.
[212] For the final report on the Tang dynasty see SPIA 1992 (2 vols.), for the Five Dynasties see SPIA 1997 and for the Song dynasty see SPIA 1998.
[213] SPIA Tongchuan station 1987a, pp. 15-25; Zhuo Zhenxi 1987, pp. 26-41; Du Baoren 1987b, pp. 32-37; SPIA Tongchuan station 1987b, pp.23-31; Yaozhouyao Museum 1987 pp. 34-45; Wang Lanfang and Yang Minxia 1987, pp. 46-51.
[214] Architectural remains and furniture from workshops and kilns are examined in detail below chapter 3.

considered the sole manufacturers of low-fired wares.[215] Whilst examining low-temperature samples, the archaeologists of the Tongchuan station also realised that what their predecessors had defined as "yellow-glazed" was actually lead-glaze ware, that is, low rather than high-fired ceramic. Besides *sancai* vessels and figurines, Huangbaozhen kilns also made tiles, both flat and cylindrical. According to Zhuo Zhenxi, all low-temperature wares made at Huangbaozhen were fired twice, the first at a higher temperature without the glaze, the second at low temperature to fix the glaze.[216]

White ware had been discovered before at Huangbaozhen, but now it became clear that there was both a coarse type and a better one which, however, could not compare with the fineness of Xing or Ding white wares.[217]

Vessels decorated in black glaze on a plain or white-slipped background (素胎黑花瓷 *sutai heihua ci*) had been found in the 1950s' and 1970s', but at the time the white ground had been mistaken for glaze, whilst it is only slip.

A variation of black ware, characterised by milky bluish splashes over the black glaze, previously thought to have been made exclusively at kiln centres in Henan, was found at Huangbaozhen, thus indicating that this so-called 花釉瓷 *huayouci* (black-glazed ware with milky splashes)[218] was not exclusively made in Henan kilns.[219] Moreover, its quality was not inferior to that of its Henan counterpart, thus demonstrating that although Henan kilns produced better *sancai* wares than Huangbaozhen, the latter could master other types of ceramics.

During the 1958-59 campaign, archaeologists unearthed a few samples covered with an opaque yellowish green glaze which were classified as either yellow or green (°ñ *lü*) wares. The many more samples retrieved in 1984 demonstrated that this was a

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[215] For a discussion on the manufacturing of *sancai* ware at Huangbaozhen, see Zhuo Zhenxi 1988a pp. 147-149; Li Huibing 1987, pp. 24-25; Liu Fengjun 1990, p. 75; Feng Xianming 1991, p. 8; Du Wen 1997, pp. 61-66; Yang Dongchen 1985b, p. 45.

[216] Zhuo Zhenxi 1987, p.32 and 1988a, p. 147.

[217] Zhuo Zhenxi 1987, p.30; Zhuo Zhenxi 1988a, pp. 149-150; Liu Huibing 1987, p. 24; Wang Xiaomeng 1994, p. 84.

[218] Literally "flowered glaze porcelain"; another common name for this type of ceramics is 黑釉彩斑 *hei you cai ban*.

[219] The Duandian kilns in Lushan are now considered the leading producer of black-glazed ware with milky splashes, however the first kiln site yielding samples of this type was Huangdai in Shaan county (see Zhongguo guisuanyan xuehui ed. 1997 (1982), p. 213); shards have also been found at the Xiabaiyu kilns in Yu county, Henan, at kilns in Neixiang county, Henan, and at the Jiaocheng kilns in Shanxi (see Feng Xianming *et al* 1982, p. 213). For reports on the excavations of Lushan kiln site see Li Huibing and

ceramic category in its own right, now known as 茶葉末釉 *chayemo you* or 'tea foam glaze'.[220]

Previous excavations had yielded blue/green specimens, but not in sufficient quantity to understand the nature of Tang blue/green ware. Now it appeared that at the beginning, the transparent blue/green glaze was directly applied on the speckled body, whilst later, in order to hide iron impurities in the body, the latter was first coated with white slip and then with the transparent blue/green glaze.[221] A variation of this category unique to the Huangbaozhen kilns is that with decoration painted in white slip under the blue/green glaze, two specimens of which had been found in 1973.[222] This type of ware shows the versatility of Huangbaozhen potters who turned the glassy nature of their blue/green glaze to their advantage by at least partially covering the impurities in the body with floral designs painted in white slip.

That the Five Dynasties was an important phase in the development of Yaozhou blue/green ware had been perceived in the 1973 campaign, but the new finds were crucial not only because more specimens were unearthed and therefore the nature of the ceramics of the period could be understood, but also because the archaeological stratum related to the Five Dynasties was identified at the Huangbaozhen kiln site.[223] With the 1984 excavation it became clear that the great Song evolution was not accidental, indeed it would have been impossible without the solid foundations laid in the Five Dynasties.[224]

Specimens of the Song dynasty had always been retrieved in abundance, but whilst the development of blue/green ware was rather clear, the production of russet and black wares had not been considered relevant. The new archaeological campaign demonstrated that although blue/green ware was definitely the main product in the Song dynasty, Huangbaozhen kilns also produced high quality russet ware (醬釉瓷

Li Zhiyan, 1980; p. 52; Henan Provincial Institute of Archaeology and Lushan County People's Cultural Bureau, 1988, p. 45.

220 Zhuo Zhenxi 1987, pp. 30-31; SPIA 1992, p. 267.

221 Zhuo Zhenxi 1987, p. 31.

222 For an account of this type of ware see SPIA 1992, pp. 302, 317; for the two pieces unearthed in 1973, see Zhuo Zhenxi and Lu Jianguo 1980, p. 55.

223 As mentioned above chapter 2, paragraph 2.5, the Five Dynasties specimens unearthed during the 1973 campaign were not found at Huangbaozhen, but at Yuhuagong, a nearby kiln centre in Tongchuan municipality. See Zhuo Zhenxi 1988a, p. 152.

224 Zhuo Zhenxi 1987, pp. 32, 41; Yaozhouyao Museum 1987, pp. 37-38, 44-45; Zhuo Zhenxi 1988a, pp. 152-155.

jiangyouci), black wares of the oil-spot (油滴釉 *youdiyou*), hare's fur (兔毫釉 *tuhaoyou*) and feather (黑釉醬斑瓷 *heiyoujiangbanci*) varieties, and even a few white samples.[225]

An even more significant result of the 1984 excavations was that it was finally understood that from the production standpoint the period of foreign rule over China was not a single period, but that the Jin era was distinct from the Yuan and that a decline had only started under the Mongols. The identification of Jin strata as separate from Yuan ones showed that in the Jin dynasty, although blue/green ware was still predominant, the Huangbaozhen kilns continued to manufacture russet, *temmoku* (天目 *tianmu*) and plain black ceramics, and even created a new ware called either 青白玉釉瓷 *qingbaiyuyouci* (bluish-white jade glazed ware)[226] or 月白釉瓷 *yuebaiyouci* (moon-white glazed ware), characterised by a beautiful pale green translucent glaze more similar to Longquan than to traditional Yaozhou blue/green ware. A glance at this new type of ceramics and the theory that Yaozhou kilns started to decline in the Jin dynasty immediately appears incongruous.

This "bluish-white jade" ware was discontinued in the Yuan dynasty when blue/green ware acquired a markedly ginger-yellow tone. However, the decline of the quality of blue/green ware in the Yuan dynasty did not extend to the entire production, as the manufacture of the new (for Yaozhou kilns) black and white ware showed.[227]

2.7 The dating of the Yaozhou kilns

The preliminary reports of the new archaeological campaign at Huangbaozhen spurred the publication of many articles on Yaozhou ware, mainly in China, but also in other countries, often dealing with recurrent topics, of which one of the most regular appears to be the dating of Yaozhou kilns.

The vast majority of scholars agree on the Tang dynasty as the period in which ceramic kilns were established at Huangbaozhen,[228] presumably because the three main

[225] Zhuo Zhenxi 1987, pp. 32-36; Yaozhouyao Museum 1987, pp. 38-43, 45. About Song white ware, I have never seen it either at the Tongchuan archaeological station or at the Yaozhouyao Museum, moreover no white specimens are included in the final report published in 1998 (SPIA 1998).
[226] Zhuo Zhenxi 1987, pp. 36-38, 41.
[227] Zhuo Zhenxi 1987, pp. 38-40, 41.
[228] Zhongguo guisuanyan xuehui, 1997 (1982), p. 251; Lin Yeqiang 1986, p. 58; SPIA Tongchuan Station 1987a, p. 15; Du Baoren 1987b, p. 32; Li Huibing 1987, p. 20; Wang Chongqi 1988, p. 65; Liu Benji 1989, p. 143; Liu Fengjun 1990, p. 74; Chen Wenping 1990, p. 70; Zhuo Zhenxi 1991, p. 40; Zhongguo taoci shi

archaeological excavations pointed to this date. However, Yang Dongchen challenged this widely accepted view by tracing the beginning of ceramic activity there back to the Neolithic era, and by regarding the period from the Western Han (206 BC-8 AD) to the Jin (265-420) as the time during which Yaozhou kilns gradually matured.[229] In this way Yang Dongchen was able to fit in the story of Bai Lin narrated in the Stele of Marquis Deying and was also able to attribute the establishment of Huangbao county recorded in a stele erected in 533, to the fact that by then the ceramic industry at Huangbaozhen was important enough to justify the upgrading to county.[230]

In my opinion, this is one of those cases in which literary records maintain a certain situation, but are not supported by archaeological evidence. This does not imply that the records are necessarily wrong, but until archaeological evidence supporting the argument is found, the argument should be regarded as purely speculative.

The question of when production ceased at Huangbaozhen is a more debated subject, complicated by the fact that while the main kiln centre was at Huangbaozhen, the prefecture included peripheral kilns where production continued after the Huangbaozhen kilns had closed down. The 1944 edition of the *Tongguanxian zhi* records that after the Jin and Yuan armies clashed, the local [Huangbaozhen] kilns were destroyed by fire, but after the Huangbaozhen factories ceased production, kilns were activated at Lidipo, Shangdian and Chenluzhen.[231] Before the 1958-59 archaeological campaign, this passage was universally accepted, but the results of the first systematic excavations revealed that ceramic activity at Huangbaozhen continued throughout the Yuan. The archaeological evidence was irrefutable and scholars shifted the date of closure of Huangbaozhen kilns to the Yuan dynasty,[232] except for Liu Liangyou and Liu Fengjun who insisted that production ceased not long after the Jin invasion.[233]

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bianweihui 1991, p. 227; Wang Lanfang 1993, p. 95; Zhao Ziqiang 1994, p. 236; Chen Huasha 1994, p. 9; Ren Chao 1994, p. 92; Li Keyou 1995, p. 43; Xu Wei 1998, p. 83.

[229] Yang Dongchen 1984, p. 80-81.

[230] Yang Dongchen 1984, p. 81.

[231] 同官縣志 - 工商條 *Tongguanxian zhi - Gongshang tiao*, 1944 edition, *juan* 12, as reported by SPIA 1965, p. 58.

[232] Wang Jiaguang 1962, pp. 312-313; Lu Jianguo 1980, p, 132; Yang Dongchen 1984, p. 81; Lin Yeqing 1986, pp. 61-61; SPIA Tongchuan Station 1987, p. 15; Li Huibing 1987, p. 22 (although he sets the end of Yaozhou kilns in the Yuan dynasty, he is utterly dismissive about Yuan production); Zhuo Zhenxi 1988a, p. 147; Liu Benji 1989, p. 143.

[233] Liu Liangyou 1985, p. 65; Liu Fengjun 1990, pp. 74, 80.

Although it was recognised that the extinction of Yaozhou kilns did not occur before the Yuan dynasty, the view that decline started after the Jurchen invasion was widely accepted and continued to be so even after the 1984 excavations clearly revealed that from the standpoint of production, the Jin and Yuan dynasties were two distinct periods and that the former was far from being a period of decline.[234]

This lack of agreement on the date in which Yaozhou kilns ceased production can probably be imputed to the fact that it is often unclear whether the subject is Yaozhou in general or Huangbaozhen kilns in particular and whether it is Yaozhou ceramics, meaning any type, or just blue/green ware.

Supposedly because archaeological evidence has proved that Huangbaozhen was the main kiln centre in the prefecture and its flagship was blue/green ware, the fates of Huangbaozhen kilns and Yaozhou blue/green ware have become inextricable and Yaozhou and Huangbaozhen kilns have become synonyms like Yaozhou blue/green ware and Yaozhou ware. But according to the *Yaozhou zhi* and to archaeological evidence, after Huangbaozhen kilns closed down, ceramic production continued at Chenluzhen, Lidipo, Shangdian, Yuhua and Xunyi (the latter in Yao county instead of Tongchuan municipality),[235] therefore, although it is licit to affirm that the quality of Yaozhou blue/green ware started to decline in the Yuan dynasty, factories continued to be operational to this day.[236] Therefore, when strictly speaking of Huangbaozhen kilns, one can assert that they faded with the Yuan dynasty, whereas other kilns in Yao prefecture were still operational throughout the Ming dynasty[237] and possibly into the Qing,[238] with Chenluzhen still active in the 20th century. Similarly, when referring to Yaozhou blue/green ware, it is correct to affirm that its quality declined considerably in the Yuan dynasty and, while it was produced at peripheral kilns after the Mongols had been expelled, its appearance could hardly be compared with the beautiful specimens of

[234] Zhuo Zhenxi 1987, p. 41. Among the scholars holding on the theory that the Jin and Yuan dynasties can be considered as one phase in the ceramic activity of Yaozhou kilns are Yaozhou Wares Museum 1987, pp. 43-44, 45; Wang Changqi 1988, pp. 62-65. Among the scholars convinced that the Jin and Yuan periods correspond to two different phases are Chen Wenping 1990, p. 71; Feng Xianming 1991, p. 8; Zhuo Zhenxi 1991, p. 40; Wang Langfang 1993, p. 96; Chen Huasha 1994 (1979), p. 12; Fu Zhenlun, 1994, p. 15, Ren Chao 1994, p. 94; Li Keyou 1995, p. 43.

[235] *Tongguanxian zhi - Gongshang tiao*, 1944 edition, *juan* 12, as reported by SPIA 1965, p. 58; SPIA 1965, pp. 47-56.

[236] This theory is hinted at by Wang Changqi 1988, p. 65.

[237] Zhongguo guisuanyan xuehui, 1997 (1982), p. 251; Wang Changqi 1988, p. 63.

[238] Yang Dongchen 1985b, p. 45.

the Song period. At the same time it is also correct to maintain that blue/green ware was manufactured at kilns in Yao prefecture well after the Ming conquest.

The issue that, strictly speaking, Yaozhou kilns were not confined to Huangbaozhen was taken to the extreme by Yang Dongchen who did not recognise the supremacy of Huangbaozhen and pointed out that kilns at Xijunyucun (Tongchuan), Anrencun (Xunyi county), Chenluzhen and Tapo (You county) were equally important and this is the reason why the blue/green ceramics made in this area during the Song are called Yaozhou ware, rather than Huangbaozhen ware.[239]

However, archaeological evidence has proved beyond doubt that Huangbaozhen was the main and first factory in the area, and it is very probable that the other kilns were activated simply to continue the Huangbaozhen tradition.[240] As to the name Yaozhou rather than Huangbaozhen ware, it followed the custom of taking after the name of the prefecture where the ware was made: Ding ware, for example, was made at Jiancicun,[241] but it was called Ding ware after the name of the prefecture in which Jiancicun village was located.

2.8 The influence of Yue ware on Yaozhou ware

According to archaeological evidence, the Yaozhou kilns were established in the Tang dynasty in an area with no ceramic tradition. In comparison with the Yue kilns in Zhejiang province, whose tradition in the manufacture of blue/green ware goes back to the Bronze Age, the Yaozhou centre seems to have no earlier foundations and this is probably the reason why many scholars believe that the development of blue/green ware at Yaozhou kilns was influenced by the celebrated Yue ware.[242]

Close similarities in the overall effect of the glaze and the technique of decorating vessels by incising motifs under the glaze, as well as certain patterns and shapes , are undeniable and because the Yue kilns were much more advanced than the

[239] Yang Dongchen 1984, pp. 80, 82; Yang Dongchen 1985b, pp. 44-45.
[240] Several scholars seem to believe that Yaozhou *yao* is a collective name including Chenluzhen, Lidipo, Shangdian, Yuhuagong and Xunyi, but they also recognise the supremacy of Huangbaozhen over the other factories. See Liu Liangyou 1985, p. 68; Lin Yeqiang 1986, p. 57; Wang Changqi 1988, p. 62; Zhuo Zhenxi 1991a, p. 40; Zhuo Zhenxi 1991b, p. 22; Zhongguo taoci shi bianweihui 1991, p. 228.
[241] Zhongguo guisuanyan xuehui, 1997 (1982), p. 232.
[242] Jiangxisheng 1963, p. 128; Zhongguo guisuanyan xuehui, 1997 (1982), p. 254; Liu Liangyou 1985, p. 67; Lin Yeqiang 1986, p. 58; Li Huibing 1987, p. 21; Zhuo Zhenxi 1989, p. 91; Liu Fengjun 1990, p. 75; Chen Wenping 1990, p. 70; Feng Xianming 1991, p. 8; Zhongguo taoci shi bianweihui 1991, p. 227; Zhao Ziqiang 1994, p. 236; Chen Huasha 1994, p. 9.

Yaozhou kilns were in the Tang dynasty, it is logical to assume that the influence travelled from south to north.

The establishment of Yaozhou kilns in the Tang dynasty was part of the general proliferation of ceramic centres all over China at that time, a phenomenon probably linked to the fact that upper social classes, including the Tang court, began to use ceramic vessels for household and religious purposes.[243] This development was probably triggered by a combination of factors, such as the consistent development of ceramic technology, which now allowed the production of very refined vessels. The elegant forms of beaten gold and silver vessels in typically Persian style,[244]must have captured the imagination of Tang potters who started to imitate them in order to find new and more sophisticated markets for their products, especially when there was official prohibition to use gold and silver wares,[245] and in view of the scarcity of copper and, consequently, of bronze, normally employed to make ceremonial vessels.[246]

Generally speaking, northern kilns specialised in the production of white wares and southern factories in blue/green ceramics, but the appreciation of both types did not know a geographical divide. As archaeological evidence indicates, in the Tang dynasty Yaozhou kilns tried to make white ware,[247] but local raw materials were much more suitable for blue/green ware and as the best vessels of this genre were from Yue kilns, these were logically regarded as the example to imitate. It is also possible that although the production of blue/green ware seemed to have been the prerogative of southern kilns, seen its popularity, the north also tried to make it so that it was more readily and widely available. The link between the shapes of early Yaozhou blue/green ware (Tang and Five Dynasties) and those of Tang metal ware is quite evident,[248] but whether Yaozhou potters were following metal shapes as imitated by their Yue colleagues, or metal shapes directly cannot be established.

2.9 The influence exercised by Yaozhou kilns and the export of their wares

[243] Eichhorn 1969, pp. 214-215.
[244] Schafer 1963, pp. 251-256.
[245] Xie Mingliang 1987, pp. 12-13; Li Huibing 1985a, p. 58.
[246] Eichhorn 1969, pp. 214-215.
[247] The main produce of Yaozhou kilns during the Tang dynasty was black ware followed by white ware, whilst blue/green ware was a marginal product.
[248] Zhuo Zhenxi 1991a, p. 42; Zhuo Zhenxi 1991b, p, 24; Ren Chao 1994, p. 93.

Although the vast majority of experts believes that the relation Yue-Yaozhou was a one-way system from south to north, nevertheless the influence exerted by Yaozhou ware on other kilns is widely acknowledged, particularly on ceramic centres in Henan (Linru, Yuxian, Baofeng, Yiyang, Xin'an, Neixiang, etc.), but also those in Guangdong (Xicun), Guangxi (Yongfu), Jiangxi (Jizhou) and Gansu (Tianshui).[249]

This recognition of Yaozhou's legacy is very significant as it finally acknowledges not only that Yaozhou was superior to Linru,[250] but also that Yaozhou was the main producer of northern blue/green ware in the Song dynasty and that its style was so influential as to be imitated all over China, thus creating a 'Yaozhou system'. However, this recognition was slow to arrive: an article by Li Huibing, published as late as 1987, maintains that Linru kilns started imitating the style of Yaozhou blue/green ware only because after the establishment of 官 *guan* (official) factories in Yuxian, 民 *min* (public) kilns were strictly forbidden to make vessels similar to the official ones, and so they started imitating other styles.[251]

Because Yaozhou ware was so influential as to create a 'Yaozhou system', one would expect that it was exported in large quantities like Yue and Longquan wares, but so far, archaeological finds have suggested the opposite. Yang Dongchen has claimed that *sancai* samples from the Yaozhou kilns have been found in Egypt, Iran, Korea and Japan, but this is not confirmed by other researches.[252] More consistent proof is available on the export of Yaozhou blue/green ware: According to Yang Dongchen, examples of this ware have been unearthed in Korea, Oman, Japan and many countries in South-East Asia;[253] according to Zhuo Zhenxi, it was exported to Japan, Korea, the Persian Gulf, Egypt and even Tanzania,[254] whilst Li Huibing only mentions Egypt and Oman.[255] At a

[249] Zhongguo guisuanyan xuehui, 1997 (1982), pp. 255-259; Yang Dongchen 1984, p. 83; Liu Liangyou 1985, pp. 69-72; Lin Yeqiang 1986, p. 62; Li Huibing 1987, p. 22; Du Baoren 1987b, p. 37; Liu Benji 1989, p. 143; Liu Fengjun 1990, p. 74; Chen Wenping 1990, p, 72; Zhuo Zhenxi 1991a, p. 40; Zhuo Zhenxi 1991b, p. 22; Zhongguo taoci shi bianweihui 1991, p. 227; Chen Huasha 1994, p. 10; Li Keyou 1995, p. 43.
[250] Liu Liangyou 1988b, p. 57; Zhuo Zhenxi 1989, pp. 94-95; Chen Wenping 1990, p. 72; Zhuo Zhenxi 1991b, pp. 31-32; Zhongguo taoci shi bianweihui, 1991, p. 231; Chen Huasha 1994, pp. 10-11.
[251] Li Huibing 1987, p. 22.
[252] Yang Dongchen 1984, p. 83.
[253] Yang Dongchen 1984, p. 83; Yang Dongchen 1985b, p. 46.
[254] Zhuo Xhenxi 1991b, p. 25.
[255] Li Huibing 1987, p. 23.

recent conference in Paris, Dr Auxelle Rougeulle showed shards of Yaozhou ware collected in the Yemen.[256]

That Yaozhou ware was not exported in the Tang dynasty is conceivable: neither its white nor its blue/green wares could compete with the highly accomplished Xing and Yue wares, but why it was not widely exported in the Song dynasty when it had developed its unique style, is difficult to understand. The geographical position of Yaozhou kilns, so far away from sea ports, might have been a reason, but then the same should apply to Xing and later to Ding wares, although one has to keep in mind that no other centre could challenge Ding kilns in the manufacture of white ware, whereas Yue first and Longquan later, albeit different from Yaozhou celadon, could meet the overseas demand for blue/green ware. Moreover, when Yaozhou blue/green style was specifically required, southern kilns imitating Yaozhou blue/green ware could supply it more readily (and cheaply), and this seems to be the reason why southern factories imitated Yaozhou blue/green ware in the first place.[257]

2.10 Yaozhou tribute ware

Although the Yaozhou kilns supplied the Song court with tribute specimens just like Ding, and many scholars acknowledge the passages in the *Songshi* and the *Yuanfeng jiuyu zhi* recording that Huangbaozhen kilns made tribute ware,[258] the opinion that Yaozhou kilns were essentially popular, that is, they supplied the demand for utilitarian vessels for common people, persists. This is misleading when studies on Yaozhou kilns fail to mention that at least some of their products were accepted as tribute by the Song court, less so when the researchers accept the passages in the two documents referred to above. However, even in the latter case, some scholars are very open about their position on the popular character of Yaozhou kilns: for example, the Chinese Silicate Institute and Li Huibing state that Yaozhou kilns made vessels which were then sent to the

[256] The conference was the first organised by the Musée Cernuschi and the Société Française d'Etude de la Céramique Orientale, 22-23 October 1999.
[257] Zhongguo taoci shi bianweihui 1991, p. 228; Li Huibing 1987, pp. 22-23.
[258] Zhongguo guisuanyan xuehui, 1997 (1982), p. 254; Yang Dongchen 1984, p. 82; Liu Liangyou 1985, p. 65; Liu Huibing 1987, pp. 20-21; Liu Benqi 1989, p. 143; Chen Wenping 1990, p. 71; Liu Fengjun 1990, p. 76; Zhongguo taoci shi bianweihui 1991, p. 230; Zhuo Zhenzi 1991a, p. 44; Zhuo Zhenxi 1991b, pp. 25, 35; Zhao Ziqiang 1994, p. 236; Ren Chao 1994, pp. 92, 94; Xu Wei 1998, p. 84.

imperial palace, but remained essentially popular kilns.[259] This is not incorrect, as it is true that only a minor portion of the entire output was sent as tribute, whilst the vast majority of the vessels was destined to the market, but then the same should be said of Ding kilns. If a ceramic ware needs to be made at government-controlled factories in order to be considered official, then Ding ware cannot be so considered, and the kiln centre should be listed as tribute, just like Yaozhou. But, on the contrary, we are infallibly reminded of the official or imperial nature of Ding ware. Only Liu Benqi lays some emphasis on the imperial acceptance of Yaozhou ware by saying that it was so good that the Zhao, that is the Song ruling family, used it.[260]

2.11 官 *Guan*-marked Yaozhou specimens

The general reluctance to recognise the high status that Yaozhou kilns enjoyed in the Northern Song period and even earlier is reflected in the different relevance given to the marks on white wares and on Yaozhou specimens.

The mark 官 *guan* has been found on several ceramic wares, but mainly on white wares, most of which appear to be from Ding kilns;[261] the only blue/green wares bearing this mark are a vase of Yue ware[262] and several bowls unearthed at Huangbaozhen in 1984.[263] The white specimens and the Yue vase were found in tombs and pagodas dated from the end of the Tang dynasty to the beginning of the Northern Song,[264] while the Yaozhou samples were found in the Five Dynasties strata,[265] thus their date is consistent with that of the other pieces, and in a certain way they corroborate the conclusion that the tenth century is the most likely period to their manufacture. From this one can infer that the practice of marking certain vessels with the character *guan* was adopted at the end of the Tang dynasty and died out at the beginning of the Northern Song.

[259] Zhongguo guisuanyan xuehui, 1997 (1982), p. 254; Li Huibing 1987, pp. 20-21; Chen Wenping 1990, p. 71; Liu Fengjun 1990, p. 76; Zhongguo taoci shi bianweihui 1991, p. 230; Zhao Ziqiang 1994, p. 236; Xu Wei 1998, p. 84.
[260] Liu Benqi 1989, p. 143.
[261] Feng Xianming 1979, pp. 27-28; Feng Yongqian 1984, pp. 393-403; Li Huibing 1984, pp. 58-63; Xie Mingliang 1987, pp. 1-5.
[262] Zhejiangsheng wenwu guanli weiyuanhui, 1975, p. 67; Xie Mingliang 1987, p. 6.
[263] Xie Mingliang 1987, pp. 6-7; Yaozhouyao Museum 1989, p. 44-46.
[264] Chen Wanli 1956, p. 15; Dingxian bowuguan 1972:8, pp. 39-51; Zhejiangsheng bowuguan and Hangzhoushi wenguanhui 1979, pp. 18-23; Mingtangshan kaogudui 1981, pp. 94-104; Zhejiangsheng wenwu guanli weiyuanhui, 1975, pp. 66-72.
[265] SPIA 1997, pp. 97, 113, 116-118.

Independently from the meaning attributed to this mark, the very fact that some wares bear it is indicative that these ceramic families have something in common, that is, only these kilns were selected to produce *guan*-marked specimens. Because Yue and Ding kilns have always been highly ranked, this is not surprising and it has been regarded as further proof that Ding ware in particular was used by the Song court. But that Yaozhou was also chosen to manufacture *guan*-marked vessels puzzled the scholars who, therefore, preferred to ignore the subject.

This is reflected in the articles written on this topic: more research has been done on white *guan*-marked wares because they were the first discovered in the 1950s' and because objectively they are the most numerous.[266] When the Yaozhou samples were unearthed one would have expected researchers to have tackled the problem again, but except for the articles by Zhuo Zhenxi and the Yaozhouyao Museum,[267] only three studies on Yaozhou wares mention Yaozhou blue/green specimens inscribed with the character *guan*, and of these only two try to link them to the imperial house.[268]

It is very difficult to establish the meaning of the character *guan* and all its implications (why was it inscribed and what was the use of the objects bearing it?), but it cannot be denied that by the use of this very character, the marked specimens were related to official authority and therefore to the court. Whether for 'court' one intends the imperial family, or the government is a matter of speculation. In the late Northern Song period *guan* came to indicate wares made by government-run kilns destined for use at court only, but the specimens with the *guan* inscription are datable to the late Tang and Five Dynasties and the latest to the very early Northern Song, when the mark *guan* had not yet acquired that specific meaning. Therefore, one can assume that Yue, Ding and Yaozhou kilns of the Tang and Five Dynasties were connected to the government, but were not official kilns in the late Northern Song sense.

It is worth noticing that marked pieces do not show any particular feature (except for the mark): no special care was taken to shape and decorate these specimens and their

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[266] Feng Xianming 1979, p. 27; Feng Yongqian 1984, p. 393.

[267] Zhuo Zhenxi 1988a, pp. 155, 161; Zhuo Zhenxi 1989, p. 92; Yaozhouyao Museum 1989, pp. 44-46.

[268] Li Huibing 1987, p. 20; Feng Xianming 1991, p. 8; Xu Wei 1998, p. 83. In addition to these three papers, some studies specifically concentrating on the mark *guan* take *guan*-marked Yaozhou ware into consideration, see Xie Mingliang 1987, pp. 11-13; Li Huibing 1991, p. 57.

quality is not superior to that of unmarked ones, thus suggesting that the mark was probably applied in order to distinguish them from the rest of the output.[269]

So far, *guan* (and 新官 *xin guan*) specimens have been unearthed either from kiln sites or from tombs and pagodas, thus indicating that they had a religious connection. Were they ordered by the government to be bestowed to temples where the marked pieces could be recognised as those given by the Palace? And were they given to important officials as presents or recognition from the palace for special services? Or were they part of the gifts that central and local officials had to present to the throne?

The last option seems the one most widely shared among scholars.[270] Under the Tang dynasty a tribute system was organised whereby officials had to present regular gifts to the throne and prefectures had to send their products to the court. When in the Tang dynasty ceramic technology improved to meet the quality worthy of the imperial palace, ceramics were included in the tribute system together with precious metals, jade, lacquer, etc. At first officials simply selected the best specimens produced by the kiln of their choice, but when the demand became more sophisticated, officials were sent to the factories to supervise the manufacturing process.[271] It is probably at this time that the marks *guan* and *xin guan* appeared.

The last issue is symptomatic of the hesitation with which significant archaeological evidence concerning the period in which the Yaozhou kilns specialised in the manufacture of blue/green ware is absorbed by researchers. According to the results of the 1958-59 campaign, it appeared that in the Tang dynasty Yaozhou kilns did not concentrate on the production of one ceramic type, indeed they produced many different ones, but in the Song dynasty they specialised in the production of blue/green ware. Anticipated by the 1973 excavation, the 1984 major exploration demonstrated that this specialisation actually took place during the Five Dynasties, however, some scholars persist in ignoring the significance of the Five Dynasties period and maintain that Yaozhou kilns only specialised in blue/green ware under the Northern Song.[272]

[269] Xie Mingliang 1987, p. 1; Ge Lingling *et al.* 1988, p. 137; Li Gang 1990, p. 95.
[270] Xie Mingliang 1987, p. 11; Ge Lingling *et al.*, 1988, pp. 132, 136-137; Li Gang 1990, pp. 95.
[271] For lengthy discussions on the tribute system from the Tang dynasty and how ceramics related to it see Tong Zhaoliang 1987, pp. 147-151; Ge Lingling *et al.*, 1988, pp. 130-138; Li Gang 1990, pp. 91-105; Li Huibing 1991, pp. 57-58; Liu Xi 1994, pp. 90-94.
[272] Zhongguo guisuanyan xuehui, 1997 (1982), p. 255; Li Huibing 1987, p. 21; Liu Fengjun 1990, p. 76; Zhongguo taoci shi bianweihui 1991, p. 230. Among those who recognise that Yaozhou kilns specialised

This analysis of studies on Yaozhou kilns shows that despite highly revealing archaeological finds, the leading position held by Yaozhou kilns in the technology and style of Chinese ceramics particularly from the tenth to the twelfth century has at best only partially been recognised. Hopefully this tendency will be finally reversed in the next two chapters.

in the manufacture of blue/green ware in the Five Dynasties are Liu Benqi 1989, p. 144; Chen Wenping 1990, p. 70; Feng Xianming 1991, p. 8; Chen Huasha 1994, p. 9; Xu Wei 1998, p. 83.

CHAPTER 3

THE TECHNOLOGY OF YAOZHOU KILNS THROUGH ARCHITECTURAL REMAINS

If the beauty of the many heirloom and excavated specimens of Yaozhou blue/green ware has not been enough to attract the attention of modern scholars and convince them of the importance of this kiln centre, a study of the technology implemented there through the ages ought to reverse this tendency. In fact, the reconstruction of the manufacturing process at every stage from the preparation of the various ingredients to firing adopted and adapted by Yaozhou potters from the Tang to the Jin dynasty will prove how advanced this kiln centre was.

In order to reconstruct the manufacturing process of a ceramic ware, one needs to carry out scientific tests of shards of certain provenance,[273] but another important source of information, frequently underestimated, is the study of workshops, kilns and their contents, as these can often anticipate or corroborate the results of scientific tests.

This chapter is dedicated to the analysis of the architectural remains and their contents discovered at Yaozhou kiln site with the intention of establishing a line of development from the Tang to the Jin dynasty and the implication that this had on the finished product.

In this task one is greatly facilitated by the abundance of building remains and furnishings found at Huangbaozhen, which, by itself, should be considered as a proof of the magnitude of this kiln centre.

During the 1958-59 archaeological campaign, four areas were delineated and excavated at Huangbaozhen (fig. 8),[274] whilst those explored since 1984 by the Tongchuan station of the Shaanxi Provincial Institute of Archaeology total seven (fig. 9).[275] The areas excavated during the first campaign were not re-explored in 1984, except for area 58-59 III which approximately corresponds to areas 84-97 I and 84-97 II.

[273] See below chapter 4.
[274] For sake of clarity the areas excavated in 1958-59 will be indicated as 58-59 I, 58-59 II, etc.
[275] For sake of clarity, the areas excavated between 1984 and 1997 (excavations at Huangbaozhen formally ceased in 1997 and in April 1998 the Tongchuan archaeological station was closed) will be indicated as 84-97 I, 84-97 II, etc.

From 1958 to 1997 a total of 63 workshops, 61 kilns and 39 waste pits were found.

3.1 Workshops[276]

3.1.1 Distribution and orientation

Remains of workshops (and kilns) were found scattered on the terraces shaping both sides of the *loess* plateau traversed by the Qi river (a tributary of the Wei river which in turn flows into the Yellow River). A close analysis of the distribution of the workshops reveals that most of them have a north-south orientation with the entrance facing south.[277] However, what they are actually facing is not the cardinal point but the river, since workshops on the opposite bank tend to have north-facing doors.[278] This rather consistent river-facing orientation was imposed by the physical features of the terrain.

3.1.2 Type of construction

The workshops discovered at Yaozhou kiln site can be grouped on the basis of their architectural type: they can be open-air,[279] shed-like,[280] or *yaodong* 窯洞,[281] that is, dwelling caves dug into the cliffs of *loess* that characterise so much of Shaanxi province. Cave structures can be divided into proper caves dug inside a cliff and in subterranean structures, partially dug and partially built, and according to the building material(s) they can be further subdivided in earth, stone, brick (sometimes re-used) or combined

[276] The term "workshop" is here used in a very broad sense to include all the structures different from kilns and ash pits. However, the function of each fabric will be specified when its content is analysed. Single workshops are here indicated with the letter "Z" (from 作坊 *zuofang*, workshop), followed by a number (given by Chinese archaeologists at the time of the excavation) and the initial "t" for Tang, "f" for Five Dynasties, "s" for Song, "j" for Jin, "y" for Yuan and "jy" for Jin-Yuan. For descriptions of workshops unearthed at Huangbaozhen see SPIA 1965, pp. 11-12; SPIA 1992, pp. 10-19, 24-34; SPIA 1997, pp. 10-12; SPIA 1998, pp. 15-60. For full data on workshops, see below Appendix II, table 1.

[277] Z2:1-7t, Z4t (fig. 18), Z7t (fig. 19), Z8t (fig. 20), Z12t (fig. 21), Z18t (fig. 22), Z25t (fig. 24), Z70f (fig. 25), Z66f (fig. 44), Z1:1-2s (figs. 26a-b), Z5s (fig. 28), Z21s (fig. 45), Z37s (fig. 34), Z45s (fig. 36), Z60s, Z69s (fig. 41), Z71s (fig. 42).

[278] Of the eight workshops excavated south of the river, five faced north, one south, one south-east and one west.

[279] Examples of open-air workshops are Z20t (fig. 10), Z76s (fig. 11), Z77s (fig. 12), Z78s (fig. 13).

[280] Z29s (fig. 14), Z34s (fig. 15), Z19s (fig. 16), 58-59Z4 .

[281] Z2:1-7t (figs. 17a-g), Z4t (fig. 18), Z7t (fig. 19), Z8t (fig. 20), Z12t (fig. 21), Z18t (fig. 22), Z24t (fig. 23), Z25t (fig. 24), Z70f (fig. 25), Z1:1-2s (figs. 26a-b), Z3:1-2s (figs. 27a-b), Z5s (fig. 28), Z11s (fig. 29), Z14s , Z15s (fig. 30), Z16s , Z22s (fig. 31), Z23s , Z30s , Z32s (fig. 32), Z33s (fig. 33), Z37s (fig. 34),

edifices;[282] occasionally wasted saggars are used in combination with other materials for portions of walls, but because they are rarely employed and usually with other materials, no edifice can be defined as "saggar-built" workshop.

As the word itself suggests, open-air workshops are simply areas with no cover and no walls used for activities which did not need to be carried out indoors, or, as Chinese archaeologists have suggested, because the equipment was too big to be housed indoors.[283] This consideration might apply to Z76s (fig. 11), which is a circular stone mill[284] 7.2 m in diameter, but it is not applicable to the so-called "washing tank" and "decanting tank"[285] in workshop Z20t (fig. 10) because their measurements are comparable with the 炕 *kang* (heatable brick bed) in Z1:1s (fig. 26a) or the kneading enclosure in Z1:2s (fig. 26b). Moreover, the fact that no "washing" or "decanting tanks" are included in *yaodong* structures confirms that activities such as washing the clay and settling larger particles took place outdoors.[286]

A group of three "washing tanks" characterises workshop Z77s (fig. 12) which not being surrounded by traces of walls seems to corroborate that "washing tanks" were built outside. Workshop Z78s (fig. 13) also has no walls and includes a "washing tank" directly connected to a "decanting" tank plus another set of "washing" and "decanting tanks" whose connexion is unfortunately lost. Finally, workshop Z17f (fig. 46) includes a "washing tank" and an earthen vat, the latter containing some very refined clay paste, but its structure is not clear.

According to Chinese archaeologists, the walls of workshops Z19:1-3s (figs. 16a-c), Z29s (fig. 14) and Z34s (fig. 15), all attributed to the Song dynasty, were either roofed or were simple sheds.[287] Without any further explanation, it is very difficult to assess what type of structure these workshops were. Z19s (fig. 16) is composed of three

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Z38s, Z39 s, Z42s (fig. 35), Z45s (fig. 36), Z46s (fig. 37), Z47s (fig. 38), Z49s (fig. 39), Z60s, Z63s, Z65s (fig. 40), Z69s (fig. 41), Z71s (fig. 42), Z74s, Z84s (fig. 43).

[282] The Chinese terminology related to the subject is rather confusing.

[283] SPIA 1998, p. 57.

[284] For a description of this piece of equipment see below chapter 3, p. 85.

[285] As discussed in the section dedicated to the processing of raw materials (see below chapter 3, pp. 84-88), what Chinese archaeologists call "washing tanks" should be interpreted as settling tanks and what they call "decanting tanks" ought to be considered de-watering tanks. Before the subject is debated, the terms used by Chinese archaeologists will occur within inverted commas.

[286] Workshop Z66f (fig. 44), which has traces of the eastern and southern walls, includes a "washing" tank, but its structure is not clearly defined by Chinese archaeologists, thus making it impossible to attribute it to a specific type of building.

[287] SPIA 1998, p. 57.

adjacent rooms with the middle one sharing most of its long sides respectively with the first and the third. The fact that the three rooms are adjacent is not unusual, what is unusual is the fact that they are not independent. The front portions of Z19:2s (fig. 16b) and Z19:3s (fig. 16c) were lost, therefore it is impossible to reconstruct their aspect, but if they were similar to that of Z19:1s (fig. 16a), then they were as wide and as high as the structure itself. This is probably what qualifies them as "sheds" together with the fact that they were all built on ground level. The furniture is not very helpful as it only includes a potter's wheel in Z19:2s (fig. 16b) and a stove in Z19:3s (fig. 16c).

On the basis that the floor of the three rooms was covered with a layer of trampled body paste and on account of the presence of a potter's wheel, Chinese archaeologists have concluded that Z19:2s (fig. 16b) was used for throwing, whilst Z19:1s (fig. 16a) and Z19:3s (fig. 16c) were used for decorating and glazing.[288] Whereas the conclusions about Z19:2s (fig. 16b) are plausible, those about the other two rooms seem baseless.

The layout of Z29s (fig. 14) is puzzling, but comparable to that of Z34s (fig. 15) in that it seems divided into sub-spaces. Proceeding from east to west along the south perimeter wall, Z29s (fig. 14) presents a room sharing its eastern wall with the perimeter wall, another room sharing its southern wall with the perimeter wall and with no clear aperture, as the five bricks along the northern side identified as the threshold seem to lie behind a stone wall; next is a water tank divided in two parts by a partition stonewall, probably included in the adjacent long room whose south side coincides with the southern perimeter wall and whose northern wall runs parallel to the south wall of two more rooms. The long room along the south perimeter wall is equipped with a stone mortar and some unidentified elements. The presence of stones behind the south wall has led the archaeologists to conclude that the stones were steps leading to the rooms which are separated by an incomplete wall. One of these rooms is empty, the other is equipped with a stove. Next to this room is a space, furnished with a potter's wheel and some earthen vats, which trespass into the long room on the south side adjacent to the water tank. All the walls of this workshop are made of stone and rise from ground level. The furniture indicates that this workshop was involved in the preparation of the clay and in shaping by throwing on the potter's wheel.

[288] SPIA 1998, p. 28.

Z34s (fig. 15) has an equally puzzling layout with its incomplete stone walls rising from ground level; its furniture, consisting of only two stoves, makes its purpose even more uncertain.

The legitimate question is: what were the shed-like buildings used for? From the scanty material provided by Z19:2s (fig. 16b) and Z29s (fig. 14) it seems that sheds were built to carry out activities connected to refining and shaping, but because Z19:1s (fig. 16a), Z19:2s (fig. 16b) and Z34s (fig. 15) do not supply any clue, this assumption cannot be conclusive.

Z21s (fig. 45) is the only example of a house-type structure:[289] it was built on ground level without foundations, it includes a corridor connecting the (missing) door to the actual room and its walls are made of square, refractory bricks. The corridor is typical of cave-type workshops too, but the absence of steps descending to the working area and the fact that it was built at ground level qualify it as a house-type rather than a cave-type. The use of regularly-shaped refractory bricks is a sign of the particular attention reserved to an edifice built on the ground rather than dug into it.

The only piece of furniture it is equipped with is a partially buried earthen jar (36 cm high and 44 cm in diameter) which Chinese archaeologists have related to potting, rather than glazing, probably because of the layer of trampled clay paste found on the floor. However, the possibility that this pottery jar contained glaze suspension should not be ruled out, although this leaves the purpose of the house-type building undefined.

The vast majority of the edifices discovered at Huangbaozhen are cave-shaped (窯洞 *yaodong*, or 窯洞式 *yaodongshi*).

From the drawings and photographs published in recent archaeological reports by the Shaanxi Provincial Institute of Archaeology it is impossible to distinguish caves from semi-subterranean structures, therefore one can only rely on the descriptions supplied by Chinese archaeologists. Supposedly, the workshops described as having a brick- and stone-built vault are subterranean structures with the lower part dug into the ground and the upper one built. This implies the use of building skills not required for the realization of caves and a different use of the space: whereas *yaodong* structures are dug horizontally into the cliff thus leaving the terrace above them free, semi-

[289] SPIA 1998, p. 29.

subterranean ones are partially dug vertically in the level terrace which is then occupied by the edifice.

From archaeological evidence, semi-subterranean structures appeared in the Song dynasty, when, however, the majority of the workshops were still set up in *yaodong*. One wonders why partially built edifices were introduced at Yaozhou kiln site: they do not seem bigger or more stable than dug ones, but they probably benefited from natural light through the provision of windows.

3.2 Workshops appliances and utensils

Workshops, either indoor or outdoor, were equipped with appliances and tools which helped the potter to manufacture vessels up to the stage when they were loaded into the kiln for firing. On the basis of their use, these instruments can be divided in four broad categories: utensils for processing raw materials, for shaping, for finishing and for decorating.

3.2.1 Processing

Deposits of "perfect" clay, that is, of clay ready to be used by the potter, exist, but they are rare and in many cases they do not exactly match the potter's needs, therefore clays usually undergo preparation. The preparation, or processing, of clay includes several stages at the end of which the paste that the potter will shape into vessels, is achieved. On the basis of the equipment found at the Yaozhou kiln site, an attempt to reconstruct the manufacturing process from collection of clay to vessel ready to enter the kiln is made below.

After **collecting** their clays at local deposits,[290] Yaozhou potters probably removed large foreign inclusions, such as stones, leaves, roots, etc., by hand and then spread the clays to undergo **weathering**, that is, exposed them to rain, sun, frost and wind in order to disintegrate the grains and make them more plastic.[291] Open-air areas

[290] Around Huangbaozhen there are deposits whose clays have been used in a recent experiment to duplicate ancient Yaozhou ceramics (Li Guozhen and Guang Peiying 1982, pp. 191-200). Although the composition of the new samples did not match that of the original ones, it is evident that these clays could be used for manufacturing high-fired ceramics. Moreover, it is logical to assume that local clays were employed, as it would have been most inconvenient to set up a ceramic industry in an area which lacked the essential ingredient.
[291] For a detailed account of clay preparation, see Hamer and Hamer 1997, pp. 261-266; Leach 1976, pp. 47-53; Rhodes 1996, pp. 64-71; Fieldhouse 1956, pp. 23-24.

and portions of open-air workshops, such as Z20t (fig. 10), Z77s (fig. 12), Z78s (fig. 13), etc., were probably reserved for this purpose. After weathering, clays need to be **crushed**, that is, they are reduced to fine powder. There is no evidence of how this was accomplished in the Tang and Five Dynasties,[292] but a chaser mill (Z76s (fig. 11)) discovered in a Song dynasty layer reveals how sophisticated the technology implemented at the Yaozhou kilns was by then.[293] This chaser mill was made of 21 curved stone segments placed to form a circular path whose sides had stone edging to avoid spillage (see drawing of the section in fig. 11). The hole at the centre of the chaser mill contained the pivotal post which sustained the superstructure holding the crushing wheel. The power was probably supplied by animals: a drawing from the Ming dynasty *Tiangong kaiwu* 天工開物 shows a mill equipped with a large roller stone revolving around a central turnstile in a circular trough pulled by a buffalo and controlled by a man,[294] the materials to be crushed were placed in the trough where the stone wheel milled them.

Mortars and pestles, which were used for grinding, have been recovered in abundance, but given their size, they were probably used to crush glaze ingredients, or materials needed in small quantities. Mortars were all made of stone, some were as small as those used in the kitchen, others were bigger and probably placed on the floor whilst a worker pounded from a standing position.[295] The different size of the mortars was reflected in the different length of pestles, all made of stone, except one reported to be of iron.[296] Some pestles showed a cavity in one of the extremities where a wooden handle was probably attached (fig. 52).

After weathering and crushing, the clay still contained foreign inclusions, such as carbonaceous matter, large and heavy material, sand and shale, which were removed by

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[292] Chinese archaeologists have assumed that clays were crushed because of the fineness of the clays found around levigation tanks (SPIA 1992, p. 524, for levigation see below chapter 3, pp. 85-86).
[293] SPIA 1998, pp. 51-2, 57, 497; Zhuo Zhenxi and Lu Jianguo 1980, p. 59. Hommel 1969, p. 98 defines a chaser mill "as a rotating edge-wheel revolving at the end of a radial arm in a trough".
[294] The 天工開物 *Tiangong kaiwu* (The exploitation of the works of nature) was written by Song Yingxing 宋應星 in 1637. Different editions alternatively show a chaser mill equipped with two symmetrically arranged wheels pulled by two donkeys (fig. 49), or a single-wheeled chaser mill powered by a buffalo (fig. 50). Hommel maintains that all the Chinese mills he has seen have one wheel or a set of wheels on one side of the central post (Hommel 1969, p. 98).
[295] For descriptions of mortars and pestles, see SPIA 1965, pp. 36-37, 45-46; SPIA 1992, p. 466-8, SPIA 1998, p. 497. A representative set of mortar and pestle is illustrated in fig. 51.
[296] The iron pestle is reported in SPIA 1965, p. 46.

levigation: basically, a batch of weathered clay was churned with water so that coarse fragments sank, while the fine ones formed a thin slurry that could be decanted.[297] If more than one clay was required for the body recipe, it was at this stage that they were mixed together. After levigation, the fine slurry was subjected to **sedimentation**, that is, it was left to settle for a few days,[298] so that the clear water on the surface could be decanted and the heavy slurry thus obtained could undergo **de-watering**, that is, water was allowed to evaporate until the slurry turned into mud of the desired consistency.[299] According to Chinese archaeologists, the clay was levigated in "clay-washing tanks" (淘洗池 *taoxichi*),[300] usually lined with stones or bricks, then sedimented in "settling tanks" (沉澱池 *chendianchi*), simply dug into the ground,[301] and finally placed in earthen vats for de-watering.[302] Without contemporary written records, it is very difficult to establish the exact clay-processing routine implemented by the Yaozhou potters. For example, Leach used to churn a small batch of clay and water in a barrel, then he decanted the slurry through a sieve into a second barrel; when the slurry had sedimented, the clear water at the top was siphoned out and the sediment was let out into a trough were it was allowed to dry.[303] But at Jingdezhen stone-lined pits were used to levigate the clay which was then decanted in another tank for settling and finally the heavy slurry was placed in large moulds for drying.[304] The only certainty one can apprehend from these accounts is that it is unlikely that earthen vats were used for de-watering: the water could evaporate from the porous pottery, but it would have taken much longer than in a large and shallow container, possibly placed outside where the sun and the wind promoted evaporation. Another consideration to take into account is that the washing tanks discovered at the Yaozhou kiln site seem too shallow (although it is understood that the measurements are for the remaining walls and not necessarily the full original height) to allow vigorous

[297] Leach 1976, pp. 47, 49-50; Tichane 1983b, pp. 20 and 64-65; Hamer & Hamer 1997, pp. 299 and 265.
[298] Leach 1976, pp. 47, 49-50; Tichane 1983b, pp. 20 and 64-65; Hamer & Hamer 1997, pp. 200-201 and 265.
[299] Leach 1976, pp. 47-50; Tichane 1983b, p. 65; Hamer & Hamer 1997, p. 103.
[300] Washing tanks were found in workshops Z20t (fig. 10), Z17f (fig. 46), Z66f (fig. 44), Z67s (fig. 47), Z77s (fig. 12) and Z78.
[301] Settling tanks were found in workshops Z20t (fig. 10) and Z78s (fig. 13).
[302] Pottery vats were found in the vicinity of "washing" tanks in workshops Z20t (fig. 10), Z17f (fig. 46), Z66f (fig. 44), Z77s (fig. 12), Z78s (fig. 13), Z29s (fig. 14) (in this case close to a potter's wheel). The clay-processing sequence is described in SPIA 1992, p. 524; SPIA 1997, p. 12 and SPIA 1998, pp. 57-58.
[303] Leach 1976, pp. 47-50.
[304] Tichane 1983b, pp. 20, 64-65, 137.

stirring of water and clay, especially in contrast with the 170 cm depth of settling tank A in Z78s (fig. 13).[305]

Given the above considerations and the position of washing and settling tanks and earthen vats in relation to each other in the workshops discovered at the Yaozhou kiln site, it is possible to advance several feasible suggestions: a) clay and water were churned in earthen vats, then the thin slurry was decanted in settling tanks (corresponding to the washing tanks in workshops Z20t (fig. 10) and Z77s (fig. 12) A), and once it had sedimented, it was decanted into a de-watering tank (settling tank in Z20t (fig. 10)); b) levigation took place in deep vats, such as the 沉澱池 *chendianchi* in Z20t (fig. 10) (which is 60 cm deep) and 淘洗池 *taoxichi* A in Z78s (fig. 13) (95 cm deep), while both sedimentation and de-watering took place in shallow tanks, such as the *taoxichi* in Z20t (fig. 10) (10-15 cm deep); c) clay and water were churned in earthen vats, then the slurry was decanted in deep tanks for sedimentation and finally decanted in shallow tanks for de-watering.

When the washing and settling tanks occur together, they are either close to each other (Z20t (fig. 10), Z78s (fig. 13)), or even connected (Z78s (fig. 13)). It is possible that the washing and settling tanks in Z78s (fig. 13) which look close, but not connected were originally joined, but the link has not survived. It is also possible that in Z20t (fig. 10) they are not connected because at the time the system was not as developed as it was in the Song dynasty. Nevertheless one cannot ignore the fact that the settling tank in Z20t (fig. 10) is completely different from those in Z78s (fig. 13) and, actually, they are so dissimilar to wonder whether they served the same purpose. Especially the one in Z78s (fig. 13) directly connected to a washing tank is hardly a tub, being surrounded and diagonally divided by a sort of channel whose function is not at all clear. It would be more logical to think that what was identified as the washing tank was instead the settling tub, whereas the 沉澱池 *chendianchi* (settling tank) was used for de-watering.

The body paste resulting from the evaporation of water from the clay slurry in the de-watering tank was not homogeneous (especially if it was made of more than one clay): the clay paste at the edge was dryer and harder than that in the middle, but

[305] For the dimensions of washing and settling tanks unearthed at the Yaozhou kiln site see Appendix II, tables 3 and 4. Henderson 2000, p. 168 that the washing tank in Z20t (fig. 10) "might be regarded as rather small for this purpose".

homogeneity is an essential requirement, therefore the newly formed paste had to be wedged. **Wedging** implies cutting, compressing and mixing the paste to equalise the distribution of water throughout the clay, to remove air pockets and to make the clay most cohesive.[306] In order to improve the plasticity of the clay paste, the latter is then left to **age**, that is, it is left to mature in damp conditions, so that water can slowly penetrate between clay particles, the weight of the paste itself compresses the clay particles, and attraction among particles is promoted by the action of bacteria.[307] Immediately before forming, the clay paste needs to be **kneaded**, that is stretched and rolled in order to expel all the air bubbles and mix it thoroughly.[308]

Chinese archaeologists have identified special enclosures paved and lined with neatly arranged bricks found inside several workshops as 練泥池 *liannichi*.[309] The exact meaning of the word 練 *lian* is not straightforward, it could indicate both wedging and kneading, but according to the *Zhongguo gu taoci tudian* (Illustrated dictionary of ancient Chinese ceramics), 練泥 *lianni* implies taking some already washed clay paste and repeatedly turning it over and beating it, or cutting the clay paste in small lumps and repeatedly piling them up, beating and treading them.[310] Therefore, it seems that *liannichi* are wedging enclosures where

Chinese archaeologists have also suggested that the large stone or brick platforms at the back of some workshops, such as Z1:2s (fig. 26b), Z33s (fig. 33), Z37s (fig. 34) and Z42s (fig. 35), were used to pile up clay paste and in some cases to wedge it (Z33s and Z42s) and even to age it (Z37s).

Wedging is a relative short process that occurs in the order of hours, while ageing takes place in the order of weeks (and even months), therefore it is convenient to

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[306] Leach 1976, pp. 50-51; Hamer and Hamer 1997, p. 357; Fieldhouse 1956, pp. 27-28. This process is described by traditional western potters (Leach 1976, pp. 50-51; Hamer and Hamer, p. 357; Fieldhouse, p. 28) as taking place on a strong and slightly absorbent table where a large lump of clay is dropped, half of it is then cut, turned over, lifted and thrown down on the remaining half about fifty times..

[307] Rhodes 1996, pp. 70-71; Hamer and Hamer 1997, pp. 2-3.

[308] Leach 1976, pp. 51-52; Hamer and Hamer 1997, p. 194; Rhodes 1996, p. 71.

[309] Such enclosures were found in workshops Z66f (fig. 44), Z68f (fig. 48), , Z1:2s (fig. 26b), Z37s (fig. 34), Z49s (fig. 39) and Z45s (fig. 36). Z25t (fig. 24) has no such enclosure, but the rear part of the workshop, where there were four piles of clay paste, was defined as *liannichi*. A stone paved enclosure in workshop Z77s (fig. 12) was also identified as *liannichi*, but given its location in an open-air workshop next to a washing tank, it seems improbable that it was a *liannichi*.
For data on these enclosures see Appendix II, table 5.

move the wedged clay paste on one side, such as the rear part of the workshop on a platform or simply on the floor. When ageing, it is of paramount importance that the paste is kept damp at all times and for this reason ceramic vats seem more appropriate, but considering the amount of clay paste used up daily at the Yaozhou kiln site, it is not surprising that ageing occurred in larger areas, where the paste was kept damp under wet cloths. As explained above, immediately before shaping, the clay paste needs to be kneaded. Kneading is done by traditional potters by hand on a small amount of body paste usually on a wooden bench.[311] No wedging table was found in Yaozhou workshops, but the potters might have kneaded their clay paste directly on the platform at the rear of the workshop where it was kept during ageing or, again considering the amount of clay paste used up daily at a kiln site as big as Yaozhou, they might have moved it to the wedging enclosure where it was kneaded by foot (presumably by an assistant). The latter supposition is inferred by the fact that all the *liannichi* found in complete workshop (namely, Z1:2s (fig. 26b), Z37s (fig. 34), Z45s (fig. 36) and Z49s (fig. 39)) were close to remains of potter's wheels: wedging does not need to take place close to the potter's wheel, while it would be convenient to knead the clay paste for a few minutes and pass it directly to the potter working at the wheel.

3.2.2 Shaping

Soon after kneading, the Yaozhou potter shaped the body paste by either throwing it on the potter's wheel, or by pressing it into a mould. Vast numbers of moulds have been retrieved during the excavations at the Yaozhou kiln site, therefore it is possible to understand what types of moulds were used through the historic periods, whereas the reconstruction of the potter's wheel is more complex, as the function of the single components is not always clear, some were made of perishable material and the terminology used by Chinese archaeologists is not consistent.

The remains of one or more potter's wheels were discovered in 19 workshops out of 62.[312] In most cases what was visible was a circular pit in the centre of which there

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[310] Zhongguo gu taoci tudian 1998, p. 367.
[311] Leach 1976, pp. 51-52; Fieldhouse 1956, p. 28; Hamer and Hamer 1997, p. 194.
[312] Traces of potter's wheel were found in workshops Z2:3t (fig. 17c), Z2:5t (fig. 17e) (2), Z2:6t (fig. 17f), Z2:7t (fig. 17g), Z4t (fig. 18), Z25t (fig. 24), Z70f (fig. 25), Z1:2s (fig. 26b), Z19:2s (fig. 16b), Z29s (fig. 14), Z32s (fig. 32), Z33s (fig. 33), Z37s (fig. 34) (2), Z42s (fig. 35), Z45s (fig. 36) (2), Z46s (fig. 37),

was a narrower and deeper hole, which presumably contained the shaft or spindle that supported the wheel. The diameter of the circular pit was approximately half a metre, ranging between 85cm and 30cm; the depth varied between 25 and 50 cm with extremes at 20 and 80 cm. The diameter of the shaft hole became regular in the Song dynasty when it measured between 8 and 10 cm, but on one occasion it was only 6 cm and in the Tang dynasty it reached 15 cm; its depth was very inconsistent with cases as shallow as 27 cm and an average of 81. The reason for dwelling on measurements is to understand the structure of the Yaozhou wheel: different cultures have developed different types of wheels and even within the same country different types were used at the same time.[313] Broadly speaking, potter's wheels can be single or double wheels, each with many variants. A deep shaft hole is a sure sign that the potter's wheel was of the pit type which usually belongs to the double wheel category.[314] Basically the double wheel is composed of a top wheel, also known as wheel-head, on whose surface the objects are thrown, and a lower wheel, or flywheel, which maintains the speed of the wheel-head constant; the two are connected by a long central spindle passing through the flywheel and fixed in the centre of the underside of the wheel-head;[315] "in some cases the shaft revolves in a socket at the bottom of its pit, in others the spindle is fixed in the ground. The latter type is common in the East and the former in the West".[316]

Judging from the narrow and deep holes found in some of the workshops discovered at the Yaozhou kiln site, the Yaozhou potter's wheel was of the pit type, but with a single wheel.

From archaeological remains, it appears that in the Tang dynasty the Yaozhou potter's wheel consisted of a wooden shaft, deeply set in the earth, whose conical top fitted in a cavity carved in the centre of the underside of the single turning wheel (轉盤

Z49s (fig. 39), Z60s and Z71s (fig. 42); for data on excavated pits of potter's wheels see Appendix II, table 6.

[313] Laufer 1917, pp. 148-177; Foster 1959, pp. 104-110; Hommel 1969, pp. 140, 270-272, 352-353; Leach 1976, pp. 66-70; Orton *et al.*, 1997, pp. 120-125.

[314] Orton *et al.*, 1997, p. 120 maintain that "pit wheel", "double wheel" and "kick wheel" are the one and the same type, however not all double wheels are set in motion by kicking and not all pit wheels are necessarily double, as it transpires from the reconstruction of the Yaozhou potter's wheel attempted in this dissertation.

[315] Orton *et al.*, 1997, pp. 121-124.

[316] Leach 1976, pp. 67-68; the drawing of a Japanese wheel on p. 69, however, shows a pit wheel, but with a single wheel.

zhuanpan) made of wood.[317] Hollow ceramic attachments circular inside and pentagonal outside, usually glazed on the vertical sides which were often waisted outside and convex inside (figs. 53 and 54),[318] were retrieved from Tang contexts and Chinese archaeologists believe that they were mounted on the shaft right under the wheel-head.[319] The exact function of this element is not specified, but similar attachments were retrieved from Five Dynasties and Song contexts and classified as "rotating hoops/rings" (蕩箍 *danggu*).[320] However, there are some significant differences concerning shape and dimensions: Tang specimens are all pentagonal, Five Dynasties ones are either pentagonal or circular (figs. 55 and 56), Song rotating hoops are all circular (fig. 57). The diameter of the circular hole of Tang and Five Dynasties examples is about 8 cm (with the Tang iron sample measuring an unusual 12.6 cm), while that of Song rotating hoops is about 13 cm. As no Tang wheel-head has survived, it is difficult to reconstruct the type of potter's wheel in use at the Yaozhou kilns in the Tang dynasty. However, from the two stone wheel-heads retrieved from Song workshops Z29s (fig. 64) and Z71s (fig. 67) and from a traditional potter's wheel I had the opportunity to see in Shenhouzhen, Yuxian, Henan, it appears that the Song wheel-head was stabilised by means of two wooden slats (or bars) fitted at the top end in the two square holes flanking the shaft hole in the wheel-head, and at the other end fastened to a rotating ring with a rope (fig. 59).[321] Assuming that the Song method of stabilising the stone wheel-head by means of wooden bars attached to a ceramic rotating ring was likely inherited from a previous wooden model, one can suggest that the Tang wooden wheel-head was stabilised in the same way, only the wooden slats were five, one for each side or corner of the pentagonal rotating hoop in use at the time (fig. 58). In fact, of the four pentagonal hoops retrieved from Tang contexts, two show a through hole at each of the five corners of the hoop (fig. 53), while two are plain (fig. 54). Given the fact that the only Five Dynasties pentagonal rotating ring shows no holes, it appears that to start with

[317] As the archaeological report maintains, no Tang wheels were unearthed thus suggesting that they were made of perishable wood (see SPIA 1992, p. 468, 524.)
[318] One of the four excavated attachment is made of iron and is unusually large in comparison with the ceramic ones. For a description of these Tang dynasty attachments see SPIA 1992, p. 468 and fig. 263:1-4.
[319] SPIA 1992, p. 468.
[320] 蕩 *dang* literally means "to move backwards and forwards as in rowing", therefore 蕩箍 *danggu* can be translated as "rotating hoop/ring".
For Five Dynasties rotating hoops see SPIA 1997, p. 220 and fig. 119:2, 6; for Song ones see SPIA 1998, pp. 499-501, fig. 243:6-9.

pentagonal hoops were equipped with holes which probably hosted the wooden bars, then the holes were eliminated and the wooden slats were tied to each of the five sides of the hoop, and finally the entire shape of the hoop was modified to a circular ring. As noted above, the internal diameter of Song ring-shaped rotating hoops is wider (about 13 cm) than that of earlier samples (about 8 cm), which means that the two wooden bars tied to the hoop were further apart from each other in relation to the shaft, thus making the stabilising device more efficient (although only two wooden slats were now employed). Another method to improve the stability of the wheel-head was to place the rotating hoop lower down the shaft, but the reported depth of wheel pits (Appendix II, table 6) is too inconsistent to corroborate this hypothesis.

The suggestion that the Tang pentagonal rotating hoop was placed on the shaft right under the wheel-head might have been induced by the smaller diameter of Tang and Five Dynasties hoops which tightly fitted around the spindle, and by the holes at the corners of the pentagonal shape which might have served the purpose of attaching the hoop to the wheel-head. However, the fact that other contemporary hoops do not have holes invalidates this method of employment, and in any case, the rotating hoop placed right under the wheel-head could hardly have prevented the *zhuanpan* from swaying.

Tang dynasty strata also yielded another element made of black-glazed ceramic, varying in shape, but always characterised by a notch with a vertical side and a slanting one, surrounded by two, three or four small holes (fig. 60).[322] They have been identified as wheel turners (轉盤撥動 *zhuanpan bodong*) fitted on the wooden wheel-head to impart movement to the wheel by inserting a rod in the nest and turning.[323] The fact that several ceramic wheel turners were found in Tang contexts, but not in later ones is probably linked to the material used for making the wheel-head: if the wheel-head was made of wood, a movement-imparting notch carved in it would have worn out quickly, whilst a ceramic one, nailed down to the wood and thus firmly fixed in place, would have lasted much longer. When the turning wheel was made of stone, the ceramic notch was no longer needed and ceased to be made.

[321] The Song potter's wheel is described in detail below, chapter 3, pp. 93-94.
[322] Wheel turners are described in SPIA 1992, pp. 473-474; one example has no fixing holes (SPIA 1992, pp. 473-4, fig. 267:1).
[323] SPIA 1992, p. 473.

According to Chinese archaeologists, in the Tang and Five Dynasties the Yaozhou potter's wheel was also equipped with a 盤頭 *pantou*, centred on the 轉盤 *zhuanpan* (turning wheel) for shaping and finishing objects.[324] Excavated *pantou* are made of ceramic and resemble upside-down basins (except for one, which is solid) with an everted foot and concentric grooves running on the top surface (figs. 61 and 62).[325] Hommel describes a potter's wheel seen close to Dean, Zhejiang, with the wooden disk (wheel-head) equipped with an air-dried clay frustum (a truncated cone) on which objects were shaped, and Li Wenjie illustrates one from Hubei characterised by a cylindrical wooden segment 木盤 *mupan*, 20 cm in diameter and 6 cm high) attached to the wheel-head with some clay paste (泥料 *niliao*).[326] However, in my opinion, Hommel's air-dried clay truncated cone and Li Wenjie's cylindrical wooden segment do not correspond to the *pantou* unearthed at Huangbaozhen, as the latter are made of ceramic, their top surface is dented and, except for one, they are not solid; moreover the very concentric grooves on their top surface made *pantou* particularly useful to locate and hold in place the piece being finished, rather than the clay paste being thrown, while the everted foot offered a wider support to secure the *pantou* on the turning wheel (possibly by fitting it in the groove running around the the hole(s) on the wheel-head).

Judging from the potter's wheel fittings found in Five Dynasties contexts at the Yaozhou kiln site, some changes in the design of the potter's wheel began at the time. Besides the already mentioned rotating hoops, ceramic "upside down bowls" (頂碗 *dingwan*) were introduced.[327] These were placed upside down in the cavity carved in the centre of the underside of the wheel-head that hosted the shaft to reduce the wearing off of the unprotected cavity.[328]

No Five Dynasties wheel-heads were unearthed at the Yaozhou kiln site, suggesting that they were probably still made of wood, while Song strata yielded two

[324] SPIA 1992 pp. 468-73, 524; SPIA 1997 p. 220. No *pantou* were unearthed in Song contexts.
[325] *Pantou* are described in SPIA 1992 pp. 468-473 and SPIA 1997 p. 220.
[326] Hommel 1969, p. 353 and fig. 520; Li Wenjie 1996, pp. 163-165.
[327] Four ceramic "upside down bowls" have been unearthed from strata attributed to the Five Dynasties; one is circular covered in blue/green glaze over white slip, the other three are multi-faceted (with nine, eight and six sides) and coated with tea-dust or blue/green glaze (fig. 63). *Dingwan* are described in SPIA 1997, pp. 218-220.
[328] Sanders 1967, p. 60; Lu Jiaxi and Li Jiazhi eds. 1998, p. 261.

stone wheels, thus proving that by then stone wheels were in use.[329] The first of the two wheels (fig. 64) is characterised by a central circular through-hole flanked by two square mortices (also through) all carved within a circular double frame, while a notch is chiselled out by the edge of the wheel in line with the holes. The notch by the edge was where the potter inserted the stick to impart movement to the wheel,[330] thus substituting the ceramic notches (轉盤撥動 *zhuanpan bodong*) of the Tang dynasty; the side square holes hosted the two wooden slats held in position at the other end by a rotating ring (蕩箍 *danggu*),[331] while the central hole received an iron or ceramic spindle cap (輪軸帽 *lunzhoumao*) (fig. 65)[332] that replaced the upside down bowl used in the Five Dynasties.[333] However, the spindle did not fit directly in its cap: a star-shaped spindle bearing (軸承 *zhoucheng*) (fig. 66) with six pointed spikes was inserted on the wooden shaft with one of its spikes accommodated in the spindle cap.[334] The fact that examples of spindle caps and spindle bearing have been unearthed only from Song strata might be indicative that these elements were developed at that time to make the potter's wheel more efficient and durable.

The second stone wheel displays only a circular central through-hole within a circular double frame (fig. 67). The lack of a notch for turning it may raise the doubt that it was the second of a double wheel. However, several considerations should be taken into account. The first is the dimension of this stone wheel: its 68 cm diameter would have only fitted into one of the wheel pits discovered at the Yaozhou kiln site.[335] Second, both drawings by Zhuo Zhenxi show only one wheel just like the "traditional wheel" still used by some potter craftsmen in northern China today.[336] It is, therefore, possible

[329] The two stone wheel-heads are described in SPIA 1998, p. 499. SPIA 1998, p. 551 maintains that the 轉輪 *zhuanlun*, not the 轉盤 *zhuanpan* began to be made of stone from the Song dynasty, while before it used to be made of wood. Supposedly, 轉輪 *zhuanlun* is synonymous with 轉盤 *zhuanpan*.

[330] Zhuo Zhenxi, private communication and traditional potter's wheel seen in use at Shenhouzhen, Yuxian, Henan.

[331] See above chapter 3, pp. 91-92.

[332] Spindle caps have been retrieved only from layers attributed to the Song dynasty (see SPIA 1998, p. 499), thus showing that they were introduced at that time, or simply that examples from previous periods have not survived.

[333] No upside down bowls have been found in Song contexts at the Yaozhou kiln site.

[334] Only one shaft bearer made of iron with six spikes has been unearthed from a Song dynasty layer (see SPIA 1998, p. 499).

[335] For wheel pit dimensions see Appendix II, table 6.

[336] While in Shenhouzhen, Yuxian, Henan, I had the possibility to see a potter working in the traditional way and to inspect the structure of its manually powered wheel: it included a thick stone wheel-head

that this wheel was part of a slow turning wheel used for finishing and trimming, or it was simply an unfinished wheel-head.

Once thrown, objects needed to be finished. The only trimming tool recovered from the excavation of the Yaozhou kiln site is the scraper (刮泥板 *guaniban*), made of ceramic or stone, thus indicating that most finishing implements were made of perishable material, such as bamboo. Four out of the seven unearthed examples look like foot-less, fan-shaped bowls with the inner surface made rough by lines incised in the leather-hard paste, whereas the other three look like solid discs with smooth surfaces (fig. 68).[337] According to Chinese archaeologists, these scrapers were employed to help shaping objects at the time of throwing.[338] Scrapers were retrieved only from Tang dynasty strata.

Shapes which were too small, or angular, component parts of figurines and vessels, such as handles, spouts, feet, lids, etc., were formed by employing moulds.[339] The mould from which items are shaped is made from a master mould, also called matrix or model.[340]

To be successful a mould must have the right chemical composition, the right porosity and must be fired at the right temperature. A team of researchers led by Guo Yanyi has looked at the first two conditions and has discovered that of the moulds tested in their study, the Tang, Five Dynasties and some of the Northern Song ones are high in alumina and relatively low in silica in proportions similar to the local *nichi* clay,[341] whereas the rest of the Northern Song and Jin moulds are very high in silica and lower in alumina, thus making the researchers conclude that the former were probably made with *nichi* clay alone, whilst the latter resulted from a mixture of the local clay plus extra

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balanced on a wooden spindle positioned in the centre of its underside and on two short wooden slats also fitted in the underside of the wheel-head and kept in place by a circular oscillation hoop.

[337] SPIA 1992, p. 473.

[338] SPIA 1992, pp. 490 and 524.

[339] Because the generic word "mould" can land itself to misinterpretation, for sake of clarity, in the present research the term "mould" is used to indicate the mould employed to make objects or their decoration, whilst the term "matrix" is used to indicate the master mould from which the mould is made.

[340] SPIA 1998, p. 471; Wood 1999, p. 115; Wang Lanfang and Yang Minxia 1987, pp. 46-51.

[341] Nichi is the name of a village close to Huangbaozhen rich in refractory clay which has been named after its place of origin. *Nichi* clay has been analysed in several studies attempting to re-create ancient Yaozhou ware. See Guo Yanyi 1987, pp. 16-18; Yap and Hua ISAC '95, p. 160; Lu Jiaxi and Li Jiazhi eds. 1998, pp. 262-263; Wood 1999, pp. 112 and 114.

quartz.[342] When the team analysed the porosity of their samples, they calculated that decorated moulds of the Song period were highly porous at 27-35%, whereas the Tang and Five Dynasties samples only registered 14-17% porosity.[343] Porous moulds are better than ones with low porosity because they allow a more rapid extraction of water from the clay, so that the piece can be removed and the mould re-used without waiting for a long time for it to come away easily. This means that Song moulds are easier to use than earlier ones, which does not surprise considering that moulding was much more widely used in the Northern Song than in the Five Dynasties or Tang periods. The improvement of the quality of moulds is a typical example of technological advancement at Huangbaozhen.

From the porosity values this group of scientists estimated that the moulds were fired between 1050° and 1250°C,[344] calculations generally in agreement with but not as precise as Wang Fen and Wang Lanfang's experiments according to which the best firing temperature for moulds is between 1100° and 1200°C for clay pastes with 20-24% water content.[345]

Firing moulds is a very delicate procedure, as their success as long lasting and good quality moulds depends on it. First of all, Wang Fen and Wang Lanfang note, they must dry slowly to avoid uneven and incomplete drying which will make the moulds crack in the kiln; second the best firing temperature should not exceed 1200°C, but should be at least 1100°C. In fact, Wang Fen and Wang Lanfang discovered that moulds fired at 1250°C proved to be unsuitable because the body paste stuck to the mould when duplicating vessels, whereas moulds fired below 1100°C proved to be not very strong with an easily damaged surface and required the clay to be applied with considerable strength to impress the design clearly.[346]

Moulds can be employed for shaping or decorating objects and sometimes they perform both functions at the same time. On the basis of the type of objects they produce, moulds can be divided in moulds for shaping vessels, figurines, or component parts.

[342] Guo Yanyi *et al.* ISAC '95, p. 322.
[343] Guo Yanyi *et al.* ISAC '95, p. 322 also quoted by Lu Jiaxi and Li Jiazhi eds. 1998, p. 264.
[344] Guo Yanyi *et al.* ISAC '95, p. 323.
[345] Wang Fen and Wang Lanfang ISAC '95, pp. 316-317. It is not clear what is meant for water content of the paste, but one can assume it is the sum of plastic, pore and bound water; see Hamer and Hamer 1997, pp. 354-355.
[346] Wang Fen and Wang Lanfang ISAC '95, pp. 316-317.

Those for shaping vessels can be one-piece or two-piece press moulds.[347] The one-piece type (fig. 69) were used to produce small items, such as 盅 *zhong* wine/tea cups,[348] or 杯 *bei* cups.[349] In order to speed up the process, moulds were made from decorated matrices,[350] therefore these moulds belong to the shaping-and-decorating category. Most of these moulds are outer moulds, that is, the clay paste is pressed against their interior to shape and decorate the exterior of the vessel, but some of them show decorative motifs on the outside instead (fig. 70), thus indicating that they were inner moulds employed to shape and decorate the interior of the vessel.

One-piece press moulds were also employed to shape open forms with lobed or fluted profiles, such as that illustrated in fig. 71.[351]. All the moulds with lobed or fluted profiles are plain, thus suggesting that, when required, the decoration was carved and/or incised in a second phase.

One plain kidney-shaped mould for pillows and a portion of a decorated one possibly rectangular in shape, have been reported (figs. 72 and 73),[352] from which one can infer that plain pillows were made with plain moulds, whilst decorated ones could be shaped either with pre-decorated moulds or with plain ones and then decorated at a later stage. The same applies to saucers: the one illustrated in fig. 74 is complete with decoration, whilst that in fig. 75 is plain. The usage of the latter is not clear:[353] as their outer surface is precisely shaped, they must be inner moulds, but their form does not correspond to the section of any of the reported finished items.

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[347] By two-piece mould is meant a mould made of two matching halves that generate the front and back, or left and right or top and bottom portions of an object. These two-piece or two-halves moulds must not be confused with twin moulds used since the Yuan dynasty to shape the inside and outside of certain vessels, particularly large dishes with barbed rim (Medley 1974, p. 43).

[348] Moulds for *zhong* cups are described in SPIA 1992, p. 478; SPIA 1997, pp. 211-4.

[349] Moulds for *bei* cups are described in SPIA 1997, p. 214.

[350] An article by Wang Lanfang dedicated to Yaozhou moulds of the Five Dynasties explains that hemispherical moulds, which were typical of this period, were made by pressing clay paste around the exterior of the matrix and then by smoothing the *mantou*-shaped exterior of the new mould (Wang Lanfang 1995, p. 54).

[351] This type of mould is described in SPIA 1998, p. 478, figs 231:5, 231:7, 232:1, 232:3.
Wang Fen and Wang Lanfang ISAC '95, p. 319 (of the Chinese version or p. 313 of the English version) also identify a type of mould for modifying the shape of already thrown vessels, that they call 整形模 *zhengxing mo* and translate as "dressing mould" (the common term is actually "profile mould"). However, without other details nor illustrations of so-called "dressing moulds", it is difficult to determine whether Yaozhou potters used them or simply employed one-piece press moulds for shaping vessels.

[352] These two fragments are described respectively in SPIA 1992, p. 480, fig. 269:5 and SPIA 1998, p. 496, fig. 241:5.

[353] A similar mould was unearthed in a Five Dynasties context; see SPIA 1997, p. 218 and fig. 117:6.

A one-piece mould to produce stands decorated with a paw-like motif was excavated from a layer attributed to the Tang dynasty (fig. 76);[354] it is not possible to define whether this would have generated a whole stand, or just part of it.

Angular forms such as tiered boxes, or square 盤 *pan* dishes, were supposedly shaped using moulds, but no moulds of this type have been retrieved during the excavations.

From a layer classified as Tang, a mould for making three-armed spacers was found (fig. 77), thus indicating that setters were standardised to meet the standardised size of the vessels they separated.[355]

Moulds made by cutting the crust of clay paste applied around the matrix from one side to the other, in order to obtain two halves later luted together, were employed to form vessels with complex profiles. Strictly speaking, bilaterally symmetrical vessels, such as the "double fish" vase (that is, a vase in the shape of two fish arranged vertically) illustrated in fig. 78, did not need to be made with a two-piece mould: they simply required two identical one-piece moulds, as the two halves of the vase needed to be made at the same time to be luted together when they reached the leather-hard state. However, as each double fish vase matrix yielded two identical moulds and the vase required two moulds to be shaped, bilaterally symmetrical vessels fall into the category of objects made with two-piece moulds. Unfortunately, only one mould for a double fish vase has been reported.[356]

Judging from a Tang dynasty sample, some stands (or portions of them) were also made with two-piece press moulds, or with two identical one-piece moulds cut in pairs from one matrix (fig. 79).[357]

Albeit strictly speaking 鈴 *ling* rattles and 塤 *xun* whistles are not utilitarian vessels, the two-piece press moulds employed to shape them are treated in this section, as the two types cannot be included among figurines. Rattles seem to have been popular particularly in the Tang dynasty, whilst whistles continued to be made throughout the

[354] SPIA 1992, p. 479.
[355] SPIA 1992, pp. 474-8.
[356] SPIA 1992, p. 478.
[357] SPIA 1992, p. 479, fig. 269:4.

history of the Yaozhou kilns.[358] Rattle moulds were made by cutting longitudinally the crust of clay paste applied all around the decorated model in order to get two hemispherical parts; the top and bottom portions yielded by a two-piece press mould were then luted together to form a rattle (fig. 80).

Some rattle moulds show register marks carved on their outer surface, to ensure a correct fit.[359]

Whistles had a roughly spherical shape and their moulds were made in the same way as those for rattles, except that the cut was executed vertically, because one side of the whistle usually corresponded to a mask (the other was left plain) and in order not to have a join running through it, the two halves of the mould were prepared as front and back (fig. 81).

Figurines seem to have been popular not only during the Tang dynasty, when large quantities were made specifically for funerary purposes, but throughout the history of Yaozhou kilns.[360] They represented all sorts of people and animals, sometime in a very humorous fashion. Figurines in the round can be shaped by modelling or sculpting them, but this method is very time-consuming, whilst the great demand for figurines from the Tang dynasty onwards required a rapid mass-production process. This is what probably prompted the introduction of two-piece press moulds either front and back, or side and side.[361] As noted about two-piece press moulds for rattles, the two halves of figurine moulds were often marked with a register mark (fig. 82).[362] Another method to ensure a correct match between mould halves was to cut the crust around the model at an odd angle (fig. 83).

Some pillows have the headrest supported by one or two human or animal figures which were produced with the two-piece press mould method employed to shape

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[358] Rattle moulds are described in SPIA 1992, pp. 480-2 and SPIA 1998, p. 473. Whistle moulds are described in SPIA 1992, pp. 482-4.
[359] SPIA 1992, fig. 270:4.
[360] Figurines are described in SPIA 1992, pp. 60-66, 69-71, 116-119, 147-192, 212-217, 261-264, 299-300, 341-3422, 454-457, 458-460; SPIA 1997, pp. 176-177, 188-189; SPIA 1998, pp. 376-404, 433-435, 469-471.
[361] Figurine moulds are described in SPIA 1992, pp. 482-489; SPIA 1997, p. 218; SPIA 1998, pp. 480-2.[362] In this case the register mark is a cross inscribed across the join. This two-piece mould also has a three-character inscription (possibly the potter's name) separately inscribed on both halves.

individual sculptures; the headrest was shaped separately and then applied on the support (fig. 84).

Vessel components were moulded presumably to obtain well-defined items rapidly. Strap handles (like those for the ewers in figs. 3 and 4) were made in one-piece moulds,[363] the one illustrated in fig. 85 is particularly ingenious as it could produce strap handles of four different patterns: the clay strip was pressed on the chosen pattern, removed when still pliable and bent into the required curve as it was being applied to the vessel.

Spouts[364] required two-piece press moulds: the phoenix head-shaped mould in fig. 86 can be compared with the spout of the ewer in fig. 5, although they were found in contexts attributed respectively to the Tang and Five Dynasties.

Feet were shaped from one-piece moulds (fig. 87),[365] as the back of the foot was plain and usually straight.

Lids were also shaped using one-piece press moulds. Unfortunately only a few lid moulds have been retrieved and all of them are from Five Dynasties contexts.[366] Judging from the shape of the mould and that of related lids (figs. 88 and 89), it appears that the crown of the lid was made with a mould, while the eventual flange was modelled with the tips of the fingers from the clay placed inside the mould. Lids with complex profiles, such as that illustrated in fig. 90, were shaped in a one-piece press mould with a contour that allowed easy removal of the lid from the mould; then the lid was placed on a slow-turning wheel and its profile was trimmed with a cutting tool or the potter's fingers.

3.2.3 Decorating

From the many samples of Yaozhou ceramics it is known that decorative motifs could be incised, carved, combed, hollowed out, applied in relief and moulded. However, except for moulds, which were retrieved in abundance, only a few bone awls (fig. 91)

[363] Handle moulds are described in SPIA 1992, p. 478; SPIA 1997, p. 218.
[364] Spout moulds are described in SPIA 1992, p. 478; SPIA 1997, p. 218; SPIA 1998, pp. 478-80.
[365] Foot moulds are described in SPIA 1992, pp. 478-479; SPIA 1998, p. 480.
[366] Lid moulds are described in SPIA 1997, pp. 214-216. For descriptions of lids, see SPIA 1992, pp. 109-115, 146, 199-201, 257SPIA 1997, pp. 146-171, 180-182, 188; SPIA 1998, pp. 356-374, 432-433, 452, 460.

and bone combs (fig. 92) were unearthed, thus suggesting that the majority of the tools employed in decorating were made of perishable materials, such as wood or bamboo.[367]

Moulds employed to reproduce decorative patterns can be classified as follows on the basis of the type of decoration they produce:

a) moulds to generate relief elements to be applied as decoration on the surface of vessels, hereafter called appliqué or sprig moulds;[368]
b) moulds to imprint a single pattern, hereafter called decorative stamps;[369]
c) moulds to impress a complex design covering the inner surface of a vessel, hereafter called hump moulds.[370]

Sprig moulds were presumably made by pressing successive layers of clay paste onto a model (either solid or hollow) that looked very much like the finished object without glaze; the resulting mould had the desired pattern impressed inside, whilst the outside was either domed (fig. 93) or flat (fig. 94) and its surface could be smooth or dented. No sprig moulds are reported from the Tang layers at Huangbaozhen. In the Five Dynasties sprig decoration in the form of small, individual animals, such as bird (fig. 93), fish and turtle, applied on the bottom of *bei* and 盞 *zhan* cups became very fashionable,[371] but this vogue died out in the Song dynasty when sprig elements were occasionally applied to embellish the surface of vases and their handles, lamps, lamp stands, incense burners, boxes and lids.[372] Unfortunately none of the finished pieces can be matched with the excavated moulds.

Decorative stamps are flat and most probably did not need a model, as the pattern could be incised directly on the previously shaped surface; a knob on the opposite side served as the handle to grasp the stamp (fig. 95).

Hump moulds (figs. 96, 98 and 99) were apparently introduced in the Song dynasty; they were made from hollow matrices which had been thrown on the potter's

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[367] For bone awls see SPIA 1992, p. 474; for bone combs see SPIA 1992, p. 474 and SPIA 1998, p. 497.
[368] Sprig moulds are described in SPIA 1997, p. 216 and SPIA 1998, pp. 496-7; Wang Fen ISAC '95, p. 488.
[369] Decorative stamps are described in SPIA 1992, p. 489; SPIA 1997, pp. 216-8; SPIA 1998, p. 496.
[370] Decorative moulds are described in SPIA 1965, pp. 25-28, 36, 45; SPIA 1998, pp. 482-96.
[371] For finished examples see SPIA 1997, pp. 37-9, 48, 53-9, figs. 23:3-4,6, 24:2, 30:7-11, 31, 32:7,10, 33:1-6142, 143, tables 12:2,6, 23, 24:1-4, 25:5-6, 26:1, 103:6, 104:1-5.
[372] See SPIA 1998 p. 295, fig. 150:4, p. 297, fig. 151:1-3, table 79:1, p. 305, fig. 155:1-2, table 82:2-3, p. 311, figs. 157:4-5, 158:1, table 84:1, pp. 3268, fig. 165:1-5,8-9, colour table 10:1, pp. 331-3, fig. 167 1,5-6,11-12, pp. 402-4, figs. 198:6, 199, table 121:3-4. Another example is offered by SPIA 1998 fig. 147:11, but in this instance it is difficult to establish whether the dragon was made in a mould or was hand-made.

wheel in the shape of the object that wanted to be accomplished, only with comparatively thick walls in order to facilitate carving the desired decoration on the interior of the matrix (fig. 97);[373] patterns were carved in relief or intaglio, depending on how they were expected to appear on the finished vessel: if they were carved in intaglio, they would appear in relief on the mould and therefore in intaglio on the vessel, if they were carved in relief, the mould would have showed them in intaglio and the finished vessel in relief.[374] Wang Fen and Wang Lanfang have advanced the theory that the decoration could have been carved directly on the mould, rather than on its matrix, in order to generate more sharply defined patterns and that a plain matrix could have been used simply to shape the mould.[375] This hypothesis is plausible, albeit no plain matrices have been retrieved during the excavations at Yaozhou kiln site.

Except for the mould in fig. 99, which is solid with three deep holes to accommodate the potter's fingers during handling, all the others are hollow (fig. 98), usually with the rim shaped in a way to facilitate their handling. Completely solid moulds are difficult to dry fully and fire successfully, whilst hollow ones have higher rate of success, are easier to store and handle, their porosity can be increased to speed up the drying of vessels and ultimately to increase production.

Open forms, such as bowls and plates, were shaped on hump moulds firmly placed on the potter's wheel by applying a thick slab of clay paste over a perfectly dry and clay dusted mould to prevent sticking. The clay paste was then pressed against the mould by patting and smoothing carefully to avoid splitting or folding until the desired wall thickness of the vessel was achieved; the excess clay was removed from the edges with a knife. A coil of clay paste was attached on the top and thrown to form the foot.[376] When it reached the leather-hard state, the vessel was removed from the mould, but as the clay paste naturally shrank, the potter had to apply pressure little by little around the vessel in order to release it. This explains the radiating lines visible on the exterior of

[373] Matrices for moulds employed to impress complex designs on the inner surface of open vessels are described in SPIA 1998, pp. 473-475.
[374] According to Wang Fen the decoration was carved in intaglio on the mould, but there are many finished examples with decoration in negative betraying carving in relief on the mould (Wang Fen ISAC '95, p. 489).
[375] Wang Fen and Wang Lanfang, ISAC'95, p. 316. The two scholars also specify that the matrix was made by throwing it roughly on the wheel, trimming it, carving the decoration and finally firing it. The mould was made by applying and pressing successive layers of clay paste inside the model and when it had dried it would have automatically detached itself from the matrix.
[376] Leach 1976, pp. 93-96; Sanders 1967, pp. 71-73; Fieldhouse 1956, pp. 33-34.

Yaozhou moulded vessels (fig. 100). As a matter of fact, many moulded Yaozhou samples are so well executed, that it would very difficult to distinguish them from carved ones were it not for these very radiating lines.

Judging from the many finished objects and the amount of models and moulds excavated from Yaozhou kiln site, hump moulds to impress a complex design covering the inner surface of vessels became widely used in the Song dynasty, thus suggesting that production methods were revolutionised at the time probably as a result of a dramatically increased demand for Yaozhou ware.

3.2.4 Glazing

Glazing is the process by which the glaze is applied to the body. The ingredients, which derive from rocks and minerals, must be collected and suitably prepared, that is, must be extracted, ground, mixed and transformed into a suspension Proper grinding is fundamental because the larger the grain size the longer is the time required to fuse them during firing. Supposedly, Yaozhou potters milled glaze ingredients in the mortars found in some workshops or, for larger batches, in the stone mill.

Once the raw materials have been suitably ground, they can be mixed. Thorough mixing is essential to attain a successful glaze, because certain elements melt before others and promote melting; if rapidly melting materials are not evenly spread, the glaze will melt disparately with disastrous results. From the high percentage of successful glazes at Yaozhou kilns, one can infer that Yaozhou potters had mastered the technique of mixing, but unfortunately it is impossible to reconstruct the process.

Once mixed and turned into a suspension the glaze can be applied by dipping, pouring, brushing, spraying, dripping, splashing and trailing.[377] It is difficult to establish with certainty which method of glaze application was most often employed by Yaozhou potters, but today the artisans reproducing ancient wares in the little workshop in the grounds of the Museum of Yaozhou kilns in Huangbaozhen opt for dipping.

Besides helping to reconstruct the manufacturing system from the processing of raw materials to the finished item, the furniture found in the workshops can shed light on the function (or functions) of the workshops and, therefore, their degree of specialisation.

[377] For an explanation of these various techniques see Leach 1976, pp. 144-7; Rhodes 1996, pp. 224-6.

For example, the presence of a stone mill indicates that Z76s (fig. 11) was the area where raw materials were processed, whilst the washing vats and de-watering tank in Z78s (fig. 13) show that this workshop was for preparing the clay paste. Potter's wheels are a clear indication that in Z2:3t (fig. 17c) and Z33s (fig. 33), just to mention two examples, shaping took place, but whether glazing was carried out in the same edifices is hard to establish. The discovery of workshops with no shaping equipment or traces of shaping activities, such as Z12t (fig. 21), Z1:1s (fig. 26a), Z65s (fig. 40), suggests that the two functions were carried out in separate buildings, although it would have been more logical a sequence to shape and glaze vessels in the same edifice in order to avoid moving (and thus possibly damaging) them unnecessarily and to speed up the process.

The key to solve this question lies in the function of the many vats found in various workshops, but without a description and analysis of the content of the vats, this is impossible. One has to bear in mind that the glaze slip was prepared and stored in large containers and the ceramic vats found in some of the workshops are perfectly suitable, but water was an essential element in shaping, particularly during throwing, therefore some vats were water containers.[378] Vats appearing in workshops with no shaping equipment are more likely to be glaze containers; those found together with potter's wheels, wedging/ageing enclosures and piles of clay paste were probably water containers, although their use as glaze vats cannot be completely ruled out. The position of the vat and the eventual presence of shaped items might offer a clue. When the vat is placed close to the entrance of the workshop, it is more likely to be a water container because the position would have been rather inconvenient for glazing: after glazing, objects are vulnerable and need some time to dry. For this reason, it would have been more convenient to place the glaze vat in a part of the workshops, like the rear, where glazed items could have been arranged in great quantities on a platform, out of the way. Workshop Z25t (fig. 24) well exemplifies this theory: a large vat was placed in a corner by the entrance not far from a potter's wheel so that the craftsman could easily fill in the small container of water he kept by the wheel for throwing; another vat, smaller than the previous one, was found in the extension of the workshop together with a large quantity of ewers, thus indicating that it was used for the glaze slip. ' If the red powder contained in this vat was indeed a glaze ingredient, it is possible to conclude that workshop Z25t (fig. 24) was for both shaping and glazing, although the two functions took place in separate areas. Workshop Z1:2s (fig. 26b) was equipped with two potter's wheels, a wedging/ageing enclosure, a mortar and a vat placed right by the entrance. From this layout one can assume that this was a workshop for shaping. The adjacent workshop Z1:1s (fig. 26a) did not yield any shaping equipment, it only contained three large vats (95 cm, 85 cm and 80 cm in diameter respectively), which have led Chinese archaeologists to conclude that this workshop was for glazing. This is very possible, but without other corroborating elements it is difficult to confirm. The exact function of workshop Z2:5t (fig. 17e) is even less straightforward. Chinese archaeologists have classified the vat found in this workshop as a water container.[379] The layout and equipment are more likely to be those of workshop for shaping vessels, but it is impossible to exclude categorically that glazing also took place here. The vat in question is roughly in the middle of the right wall preceded by neatly stacked lamps and a potter's wheel, opposite another wheel, more stacked lamps and piles of clay paste. It seems more logical to deduce that it was a water container supplying water to the craftsmen throwing objects on the wheels, but one cannot exclude that it was the vat where thrown vessels were glazed, especially when comparing this vat and workshop with the vats found in workshop Z33s (fig. 33) classified by Chinese archaeologists as glaze containers.[380] The layout of workshop Z33s includes a potter's wheel on the left, two vats on the right and a brick platform covered with very fine clay paste at the back, which, according to Chinese archaeologists was used either for storing or wedging/ageing clay paste.[381] If indeed the brick platform was for storing or kneading clay paste, the furniture in this workshop suggests that it specialised in shaping vessels, rather than shaping and glazing. The same reasoning can be applied to workshop Z37s (fig. 34). A puzzling case is offered by workshop Z2:3t (fig. 17c), where a pottery vat unusually connected to a groove was placed by the right wall in the rear part of the workshop close to a small stove, with numerous thrown bowls, moulded lions and

[378] Ceramic vats were also used for washing clay, or, as Chinese archaeologists maintain, for de-watering, but are more easily recognizable because they usually appear in workshops equipped for preparing the clay paste, such as Z20t (fig. 10), or Z78s (fig. 13).
[379] SPIA 1992, p. 17.
[380] SPIA 1998, p, 36.
[381] SPIA 1998, p. 36.

accumulations of clay paste nearby, whilst the front section of the workshop was equipped with a stone platform and a potter's wheel. According to the archaeological report,[382] both the groove and the vat contained clay paste, but no explanation is provided about the opposite end of the groove and how it might have been used. As mentioned before, Chinese archaeologists believe that de-watering of the clay slurry took place in vats whilst in my opinion they were employed for clay washing, nevertheless neither of the two uses justifies its location: if it was for de-watering, the wet clay left after water evaporation still needed to be wedged, aged and kneaded, therefore it could not be used immediately for moulding or throwing objects; if the purpose of the vat was clay washing, its presence in this workshop is even more incongruous. It would be more compatible if the vat were a glaze container where the objects thrown on the wheel at the front of the workshop and those moulded possibly at the back were glazed. The groove connected to the mouth of the vat could have served to pour out excess water and the residue found in both the groove and the vat might have been from glaze materials. If this hypothesis is correct, workshop Z2:3t (fig. 17c) should be classified as one for shaping and glazing, but, unfortunately, it is impossible to ascertain it beyond doubt.

In the light of the observations made about the few workshops examined above, one can conclude that Yaozhou workshops often specialised in one function, such as processing raw materials, preparing clay paste, shaping and glazing; however, because the last two activities could be, and sometimes indeed were carried out in the same building, it is not always straightforward to establish whether a workshop was only for shaping, or for both shaping and glazing.

3.3 Kilns[383]

During the excavation of the Yaozhou ceramic centre, the architectural remains of tens of kilns were discovered ranging in age from the Tang to the Yuan. Some of them were damaged to the point that only small portions could be recovered, but many

[382] SPIA 1992, pp. 13-15.

[383] Excavated kilns are here indicated with the letter "Y" (from 窯 *yao*, kiln), followed by a number (given by Chinese archaeologists at the time of the excavation) and the initial "t" for Tang, "f" for Five Dynasties, "s" for Song, "j" for Jin, "y" for Yuan; kilns excavated outside Huangbaozhen and/or before the 1984-97 campaign are preceded by the date of the excavation or the name of the locality. For full data on excavated kilns see Appendix II, table 7.

were in good condition and had preserved important features of their equipment, thus yielding valuable information on the firing process.

All the excavated kilns except one, namely Y12t (fig. 101), have a horseshoe ground plan, a domical cover (饅頭 *mantou* in Chinese) and are of the 半倒焰窯 *bandaoyanyao* semi-down-draught type. Western terminology does not include this definition, kilns are up-, cross- or down-draught,[384] but as it will be explained below in paragraph 3.3.4, these Chinese kilns are a combination of cross- and down-draught, therefore the term "semi-down-draught" is maintained.

Most kilns were built on the ground with refractory bricks sometimes mixed with stones and/or saggars, with the fire pit slightly lower than the firing chamber and the ash pit, when present, dug under the fire pit.[385] The perimeter brick walls were presumably surrounded by a reinforcement wall made of soil and finished with bricks. Traces of the reinforcement wall are scarcely identifiable at Yaozhou because the outer brick wall (that contained the soil between itself and the perimeter brick wall) has very seldom survived and always in very small portions only (fig. 119). However, the perimeter brick wall alone would have collapsed under the weight of the dome that overhung the kiln and it would have not insulated the kiln properly with a consequent enormous waste of energy. The area of red-burnt ground that often surrounds the perimeter wall of excavated kilns is likely to correspond to the thickness of the soil pressed against the perimeter wall;[386] the bricks that held the soil in place have rarely survived presumably because they could be re-used as building material.[387] The theory that Yaozhou *mantou* kilns were surrounded by reinforcement walls is substantiated by the discovery of well-preserved walls around some of the furnaces at the Guantai kiln site, Cixian, Hebei (fig. 135), and by some modern *mantou* kilns.[388]

384 Hamer and Hamer 1997, p. 191.
385 One kiln, namely Y46s, is reported to be dug into a cliff, see SPIA 1998, pp. 77, 84.
386 This area is visible around kilns Y14t (fig. 106), Y28t (fig. 107), Y15f (fig. 108), Y29f (fig. 109), Y31f (fig. 110), Y32f (fig. 111), Y43f (fig. 112), Y58f (fig. 113), Y7s (fig. 114), Y3s (fig. 115), Y62s (fig. 116), Y1s (fig. 117), Y4s (fig. 118), Y36s (fig. 119), 73Y2s (fig. 120) Y2s (fig. 121), Y5s (fig. 122), Y19s (fig. 123), Y20s (fig. 124), Y21s (fig. 125), Y47s (fig. 127), Y56s (fig. 128), Y63s (fig. 129), Y67s (fig. 130), and 58-59Y2jy (fig. 131).
387 Portions of a brick wall that might have been the exterior of the reinforcement wall were found by kilns Y29f (fig. 109), Y1s (fig. 117), Y4s (fig. 118), 73Y2s (fig. 120), Y2s (fig. 121), Y5s (fig. 122), Y44s (fig. 126), Y63s (fig. 129) and Y67s (fig. 130).
388 For ancient Guantai kilns see Beijing daxue kaogu xuexi *et al.* 1997, pp. 22-23, 32-35; Beijing daxue kaoguxi and Hebeisheng wenwu yanjiusuo 1990, pp. 18, 19 and fig. 38; Qin Dashu 2000, pp. 269, 271, 272, 273, 277 and figs. 1-6; for an example of modern *mantou* kilns see Wood 1999, p. 134.

To the fundamental structure of the kiln, consisting of entrance, firebox, firing chamber and chimneys, two new elements, namely ventilation duct and ash pit, were added when wood was replaced by coal as fuel which led to substantial changes in the appearance of the fired vessels.

3.3.1 Distribution and orientation

From the incomplete maps of the areas and trenches,[389] neither the distribution nor the orientation of the kilns seem to follow a regular pattern, therefore it is possible to conclude that most kilns were positioned according to the features of the terrain regardless of the direction of the sun or the course of the nearby Qishui river.

Chinese archaeologists claim that each workshop or group of workshops was served by a kiln on account of their vicinity.[390] No doubt that the kilns were built close to and among the workshops presumably to make the production system more efficient, but in the distribution of kilns and workshops there is no definite indication that one kiln fired the vessels manufactured in certain workshops.

According to Du Baoren,[391] kilns at Huangbaozhen were grouped in clusters of two or three, but from the maps supplied in archaeological reports this seems to happen very seldom.

3.3.2 Size

As it is possible to see from Appendix II, table 8, the size of the various kiln elements fluctuated considerably: fireboxes varied from about 0.50 m^2 to 4.50 m^2, chambers could be as small as 2 m^2 or as large as about 11 m^2 and chimney stacks varied not only in size, but also in number. Even when considering measurements relative to each historic period, no strong pattern seems to emerge.[392] The same can be applied to the study of the proportions of firebox to firing chamber: in the Tang dynasty it varied from just over 1:1 to almost 1:2.5; in the Five Dynasties it was relatively regular between 1:2.25 and 1:3.25; but during the Northern Song it changed from as little as 1:1.75 to a staggering 1:8. However, one can affirm that in the Tang and Five Dynasties

[389] SPIA 1992, pp. 8-9; SPIA 1997, p. 6; SPIA 1998, pp. 9-11.
[390] SPIA 1998, p. 61.
[391] Du Baoren 1987b, p. 37.

the total area of the kilns and of their single elements changed considerably, while in the Song dynasty variations were less divergent. Generally speaking, Song kilns tended to be bigger than their predecessors and the firing chamber in particular seems to follow this trend. The change of fuel may be involved in this evolution: up to and including the Five Dynasties, Yaozhou kilns were stoked with wood, whilst in the Northern Song they switched to coal.[393] Wood, which has a long flame and burns quicker, needs large fireboxes, whilst coal, which has a short flame and burns slowly, is a more concentrated fuel better suited to smaller fireboxes.[394] In a study on northern kilns, Qin Dashu has noticed that starting from the Tang dynasty the firing chamber began to be shorter and wider (thus making the entire furnace more compressed), and that when coal replaced wood the area of the firing chamber was also enlarged, as coal allowed to maintain high temperatures stable, therefore the capacity of the kiln could be increased.[395]

From the final archaeological bulletins it appears that all the furnaces discovered at the Yaozhou kiln site in Song (and later) contexts were equipped with an ash pit in the firebox and were stoked with coal, while all the previous ones did not include an ash pit and were wood-fuelled. As with all changes, the switch to coal and the related modifications that the new fuel imposed on the kiln structure were not sudden and did not occur at the enthronement of the new dynasty. Judging from the appearance of Yaozhou greenwares, it seems that the colour and texture of the glaze of early Song specimens is more similar to the bluish and translucent glaze of the Five Dynasties than to the yellowish and transparent one applied on beautifully carved vessels from the middle Northern Song. Therefore it seems that coal was more likely adopted in the eleventh rather than the tenth century and the fact that all the unearthed Song kilns were coal-fuelled may be due either to the possibility that wood ones were not found or that early Song wood furnaces were modified to burn coal.

[392] The extreme caution in drawing conclusions is due to the fact that the available measurements are not very reliable, as they are not very accurate and seldom match the drawings.
[393] Chinese scholars agree that coal replaced wood as kiln fuel in northern China sometime during the Northern Song dynasty (Lu Jiaxi and Li Jiazhi eds. 1998, p. 266), but when exactly this happened within that period is a matter of debate. Recently, Qin Dashu has suggested that coal was adopted by main northern kiln centres, such as Yaozhou, Guantai, etc., at the end of the Song dynasty and its use became widespread in the Jin dynasty (Qin Dashu 2000, p. 286).
[394] Wood 1999, pp. 102-103.
[395] Qin Dashu 2000, pp. 283-288.

It is very probable that coal was introduced because of a shortage of wood, whilst coal was abundant and easily accessible in the region. At first coal simply replaced wood in the traditional *mantou* kiln, but because of its burning characteristics, the structure of the kiln had to be modified with the addition of the ventilation duct outside and the ash pit in the firebox.[396]

3.3.3 Building method

Most kilns, regardless of the historic period they belong to, are built on the ground with their perimeter walls made of refractory bricks laid in staggered formation;[397] occasionally, together with bricks there are discarded saggars, which are of course able to withstand high temperatures, besides improving the insulation of the structure.[398] However, some kilns were partially dug into the ground and partially built with bricks, and in one case the entire kiln was dug into the cliff.[399] The perimeter of kiln Y56s (fig. 128) seems entirely made of or dug into the soil, the reason for this being obscure. Finally, the brick structure can be reinforced by stones as in the case of kiln Y47s (fig. 127).

3.3.4 Kiln elements

Ventilation duct

The ventilation duct is one of the two major alterations made to *mantou* kilns stoked with coal to improve the combustion of this slow-burning fuel.[400] When complete,

[396] For a detailed description of these two features see below chapter 3, pp. 110-113 nd 116-117.
[397] Y12t (fig. 101), Y6t (fig. 102), Y9t (fig. 103), Y10t (fig. 104), Y11t (fig. 105), Y28t (fig. 107), Y29f (fig. 109), Y31f (fig. 110), Y32f (fig. 111), Y58f (fig. 113), Y7s (fig. 114), Y62s (fig. 116), Y4s (fig. 118), Y2s (fig. 121), Y5s (fig. 122), Y19s (fig. 123), Y20s (fig. 124), Y44s (fig. 126) and Y63s (fig. 129).
[398] Kilns Y1s (fig. 117) and Y21s (fig. 125).
[399] For partially dug and partially built kilns see kilns Y14t (fig. 106), Y15f (fig. 108), Y43f (fig. 112), Y3s (fig. 115),Y36s (fig. 119), and 58-59 Y2jy (fig. 131); Y46s is the only example of a kiln dug into the cliff.
According to Qin Dashu, partially dug kilns were common in northern China from the end of the Tang to the beginning of the Song dynasty (Qin Dashu 2000, pp. 283-284). However, given the fact that 58-59 Y2jy is a Jin-Yuan kiln, it seems that this particular building method was still employed at Yaozhou in later times.
[400] According to Qin Dashu, the ventilation duct was developed before switching to coal: wood-stoked kilns, such as Y5s (fig. 122) at Yaozhou and Y3 at Yanhedian, Linru, Henan province, had difficulties in burning the fuel because the fire boxes were small and shallow, so long and narrow ventilation ducts were developed to remedy this defect (Qin Dashu 2000, pp. 288, 294). The report on the excavation of the Yanhedian site has not been published yet, but as far as kiln Y5s (fig. 122) is concerned, Du Baoren (Du Baoren 1987b, p. 33) states that coal detritus was found in its ash pit, while the description of this particular kiln in the final archaeological report does not specify whether wood or coal fuelled it, but in the

it includes a shallow, square or rectangular pit,[401] the duct itself and air inlets connecting the duct directly to the ash pit in the firebox.

Chinese archaeologists report that the shallow pit preceding the duct was an operational station during firing, helping to control the atmosphere in the kiln.[402] Presumably, this was done by covering or uncovering at the right moment the shallow pit which thus provided unrestricted means for air to be drawn into the kiln and when it was time to reduce the supply of oxygen it was covered.[403]

The tunnel was dug into the ground and usually lined with bricks on both sides and covered with either stone slabs or large, square bricks; sometimes the side walls were lined with stones and in one occasion they were left bare.[404] Both extremities of the ventilation duct were trumpet-shaped.

As already mentioned, the channel may branch out in smaller holes (usually four, sometime six) before joining the upper part of the ash pit. This was to make the burning of coal more effective: by dividing the trumpet-shaped termination of the channel into smaller inlets, the air they conveyed was more evenly distributed under the grating on which the coal was placed, thus promoting a more even burning of the fuel. Whereas, if the ventilation channel were directly connected to the ash pit, the air it conveyed would have caused the coal placed above it to burn quicker, leaving the coal on the edges to burn slowly, and thus causing uneven burning and uneven atmosphere in the kiln.

The level of sophistication reached by Yaozhou workers in building ventilation systems is showed by Y21s (fig. 125), one of the two excavated kilns endowed with a ventilation duct branching in six air inlets. The lateral two inlets are wider than the central ones in order to draw equal amounts of air to the sides as well as to the middle.

Kiln Y36s (fig. 119) is unique being endowed with three ventilation ducts, one central with the usual characteristics described above, and two additional and separate lateral ducts leading into the ash pit from the perimeter walls of the firebox; there is no

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conclusions it is stated that all the three types of kilns in which the furnaces discovered at the Yaozhou kiln site are classified were coal-burning (SPIA 1998, pp. 87-88).

[401] This pit has not always survived, but kilns Y2s (fig. 121), Y5s (fig. 122), Y19s (fig. 123), Y44s (fig. 126), Y47s (fig. 127) and Y67s (fig. 130) all have one.

[402] SPIA 1998, pp. 65, 87.

[403] Lu Jiaxi and Li Jiazhi eds. 1998, p. 270.The shallow pit of kiln Y44s (fig. 126) is even divided into two by a 20 cm high brick slab to facilitate covering; about kiln Y5s (fig. 122) Du Baoren has noted that the two stones found just outside the ventilation duct were part of a damper which helped to control the firing atmosphere (see Du Baoren 1987b, p. 34; Qin Dashu 2000, pp. 288, 294).

[404] Kilns Y1s (fig. 117), Y4s (fig. 118) and Y56s (fig. 128).

trace of their structure outside the kiln.[405] According to Chinese archaeologists who excavated this kiln, the side ducts only had the function of ventilating the firebox, whereas the central one had the double function of conveying air and enabling the removal of ash.[406]

Chinese archaeologists have suggested that when the ventilation duct was not too narrow and long, people could crawl inside during the firing process to retrieve dust and cinder.[407] Besides the fact that only in three cases excavated ventilation ducts are large enough to allow people to crawl inside,[408] it seems physically impossible to remove hot detritus during firing, while it is possible that hot ash and cinder could be retrieved by a worker standing in the ventilation pit using an iron rod.[409] As coal produces a great amount of ash, it was vital for the success of the firing that clinker could be removed. According to Nigel Wood,[410] this was actually the main function of the ventilation duct: air could have been introduced from an opening by the door of the kiln, it did not need to be forced through a tunnel, whereas removing clinker through the ventilation duct had the great advanatge of warming up the air entering the kiln through the ventilation channel laid with hot ash and cinder; this method considerably improved the kiln efficiency.

Although Chinese archaeologists who excavated at Yaozhou believe that all the furnaces discovered in Song contexts were equipped with a ventilation duct,[411] kilns Y3s (fig. 115) and Y62s (fig. 116) do not seem to have one. As mentioned above, most ventilation ducts branched out into air inlets, but others were directly connected to the ash pit.[412] These circumstances suggest a possible evolution of the coal-burning *mantou* kiln. When coal replaced wood, kilns were equipped with an ash pit to collect coal ash and thus promote the combustion of coal, however, this device was not enough and the ventilation duct was added to improve combustion and retrieve clinker during firing. As the draught improves with the length of the channel, shorter and wider ventilation ducts

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405 SPIA 1998, pp. 74-76.
406 SPIA 1998, p. 87.
407 SPIA 1998, p. 87.
408 See kilns Y1s (fig. 117), Y4s (fig. 118), and 73Y2s (fig. 120).
409 Unfortunately, none of these rods has been published, but a couple of them from Y19s are on show at the Yaozhouyao Museum and are mentioned in SPIA 1998, p. 70, where they are described as an "iron rod" (鉄制通條 *tiezhi tongtiao*) and an [iron] "fire-hook" (火鈎 *huogou*).
410 Nigel Wood, private communication.
411 SPIA 1998, p. 84.

were replaced by narrower and longer ones fed by a shallow pit well away from the kiln structure. To begin with, the ventilation duct joined the ash pit as a single channel, but because this caused irregular burning of the coal depending on whether it was over the channel or at the edges, this end of the duct was modified into smaller air inlets. The reason for considering kilns with the ventilation channel joining the ash pit directly earlier than those provided with air inlets is that the structure with air inlets is more complex and it is more natural to begin with a duct directly connecting the ash pit to the outside, than the opposite.

If the development of the ventilation system of Yaozhou kilns described above is correct, then Y3s (fig. 115) and Y62s (fig. 116) are earlier than Y1s (fig. 117), Y4s (fig. 118), Y25s, Y36s (fig. 119) and 73Y2s (fig. 120), which are earlier than Y2s (fig. 121), Y5s (fig. 122), Y19s (fig. 123), Y20s (fig. 124), Y21s (fig. 125), Y44s (fig. 126), Y47s (fig. 1273), Y56s (fig. 128), Y63s (fig. 129) and Y67s (fig. 130).

Entrance

The entrance is the opening through which the kiln was stoked, loaded, unloaded and cleaned. None of the excavated Tang kilns had a door or traces of it that would help in understanding its structure, presumably it was bricked up after loading the kiln leaving small holes for stoking during firing, and demolished at the end of each firing cycle.

That the entrance was simply an opening on the perimeter wall at the front of the edifice is proved by the remains of a Five Dynasties kiln, Y15f (fig. 108): the entrance to the kiln was demolished, but not totally, leaving the first layer of bricks complete, and those above complete enough to understand the structure. The entrance of two other Five Dynasties kilns, namely Y29f (fig. 109) and Y58f (fig. 113), confirms that kiln doors were openings on the perimeter wall, bricked up and demolished at the beginning and at the end of each firing cycle.

The remains of kiln Y31f (fig. 110) show an alteration to the basic structure described above: a passage seems to have been added to the entrance. Its function is unclear, but it might be related to the stability of the entire building, which must have suffered the repeated demolition of part of its perimeter. From the architectural remains

[412] See kilns Y1s (fig. 117), Y4s (fig. 118), Y25s, Y36s (fig. 119) and 73Y2s (fig. 120).

discovered at Yaozhou kiln site, it is difficult to establish whether this modification of a wood-burning kiln of the Five Dynasties was one-off, or whether a passage was also added to other kilns.

The ventilation duct, running under the door and covered with stones or bricks, in case of the occurrence of a passage, would have had the double function of covering the duct and paving the passage. Kiln Y2s (fig. 121) seems to have traces of a passage in stones placed so as to cover the ventilation duct, and kilns Y4s (fig. 118) and Y63s (fig. 129), besides a stone or brick-lined ventilation duct, also have a portion of a stone wall which could have been a side of the passage. However, kilns Y19s (fig. 123), Y44s (fig. 126) and 73Y2s (fig. 120) show more extended portions of stone walls which could not belong to a passage because of their length and shape, thus undermining the theory that shorter stone walls might have been part of a passage. But what was the purpose of these external walls? Judging from those around kiln Y44s (fig. 126), they might have served to divide areas with specific functions. In fact, Chinese archaeologists have identified an area for drying vessels, one for stacking coal and one for stacking ash and clinker. Nevertheless, the fact that in each case the external walls seem to follow the same pattern, extending from the entrance and then bending so that they run parallel to the contour of the kiln suggests that their purpose was not to delimit stacking or drying areas. The clue is provided by a cluster of kilns discovered at Guantaizhen in Hebei province, which demonstrates that these external walls were exactly that: an outer perimeter shared when two or more kilns were grouped together (figs. 136 and 137).[413] According to the archaeologists who have excavated the Guantaizhen kiln site, the main purpose of this perimeter wall was that of improving the insulation of the kiln for a more efficient firing and that of protecting the kiln structure.[414]

Firebox

The firebox is the portion of the kiln where the fuel was burnt; it usually had a fan shape and was lower than the kiln chamber with which it shared its back wall.[415] The floor was left bare, except in the case of Y11t (fig. 105), a Tang dynasty kiln for firing

[413] Beijing daxue kaogu xuexi *et al.*, 1997, pp. 19-35, figs. 7, 9, 11-13.
[414] Beijing daxue kaogu xuexi *et al.*, 1997, p. 23.
[415] The only exception is Y43f (fig. 112), a Five Dynasties kiln, where the firebox is higher than the kiln chamber. For a detailed description of the kiln chamber see below chapter 3, p. 117-119.

sancai ware, where it was paved with large, slab-like refractory bricks. In some cases the portion of the firebox of some coal-burning kilns preceding the ash pit (Y2s (fig. 121), Y5s (fig. 122), Y19s (fig. 123) and Y47s (fig. 127)) was paved with bricks, but as they were found over the ventilation duct, they were laid to cover the ventilation duct, rather than to pave the firebox. When the back wall of the ash pit[416] does not coincide with the back wall of the firebox, the area between the ash pit and the kiln chamber may be paved with refractory bricks,[417] but most of the time it was not.

The back wall of the firebox was usually lined with bricks all the way up to the kiln chamber where it appeared as a single line of bricks crossing the chamber from left to right.[418]

According to a reconstruction by Margaret Medley,[419] *mantou* kilns at Yaozhou were provided with a bag wall standing between the firebox and the kiln chamber, supposedly as an extension of the back wall of the firebox. Down-draught kilns are supposed to have bag walls to direct hot air and flames upwards before the dome ceiling bends them back downwards.[420] Although the single line of bricks running along the firebox-kiln chamber divide could be the basis of a bag wall, the fact that traces of it have not been identified in any of the excavated kilns and that Chinese archaeologists never mention the possibility of its existence seem strong enough evidence to show that these *mantou* kilns were not equipped with a bag wall.[421] Moreover, the fact that Chinese scholars refer to Yaozhou kilns as semi-down-draught (半倒焰窯 *bandaoyanyao*), rather then either down-draught or cross-draught, is also indicative: because of its physical properties, hot air rises, but because there is no bag wall it also propagates horizontally; because the kiln is small, the hot air reaches the ceiling which,

[416] See below chapter 3, p. 116-117.
[417] See kilns Y5s (fig. 122), Y19s (fig. 123) and Y63s (fig. 129).
[418] The only two exceptions are two Five Dynasties kilns, Y15f (fig. 108) and Y43f (fig. 112), in which the back wall is left bare.
[419] Medley 1989, 115-118.
[420] Hamer and Hamer 1997, p. 107
[421] When describing furnaces unearthed at the Guantai kiln site, Hebei, Qin Dashu calls the wall shared by both fire box and firing chamber *danghuoqiang* which can be translated as "fire-shielding wall" (see Qin Dashu 2000, pp. 269, 271-272, 274-276). However, besides the fact that the wall in question does not seem built to protect from fire as it was the back (solid) side of the fire box, at Yaozhou it is always too short to have a similar function. As shallow fire boxes are characteristic at Yanhedian, Linru, another kiln centre that specialised in the production of blue/green ware, Qin Dashu has concluded that this feature is related to the production of this specific ware: blue/green ware required to be fired in a reducing atmosphere which is more easily attainable if the firebox is shallow (see Qin Dashu 2000, pp. 284, 288).

being dome-shaped, bends it back downwards. Supposedly because the hot air in a *mantou* kiln moves both horizontally and downwards, thus the draught is neither totally horizontal nor downwards, but a combination of the two, Chinese scholars refer to this type of kiln as semi-down-draught. According to Xiong Haitang,[422] the position of the vents that draw hot air also qualify the type of kiln: in semi-down-draught kilns vents are arranged at the bottom of the wall separating the kiln chamber from the chimney, while in full down-draught kilns they are placed on the floor of the kiln chamber.

Coal-burning kilns are endowed with the second major modification brought to these kilns to facilitate the combustion of coal: an ash pit. The ash pit is a deep opening in the ground of the firebox, covered with a grating to let the coal ash fall through and thus not hamper the combustion of the remainder.[423] When paired with a ventilation duct, the grating-covered ash pit maximised the ventilation system: the grating, on which coal was stoked, allowed the air introduced by the ventilation duct to be released under the fuel, thus promoting its combustion.[424] The configuration of the grating is rather ingenious: when the width of the ash pit was less than 40 cm, rectangular or triangular refractory bricks were respectively placed flat and point down at equal distances across the narrow width of the pit; these elements are called 爐柵 *luzha* or rails regardless of their shape.[425] When the ash pit was too wide, one or two crosspieces (爐橋 *luqiao*) were arranged lengthwise, so that the width is reduced and the rails can be arranged as before in two or more rows.[426] The crosspieces were made of different materials, such as refractory bricks, disused saggars or stones.[427]

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422 Xiong Haitang 1994, pp. 60, 80.

423 According to Qin Dashu, the ash pit was first developed in wood-stoked kilns at several ceramic centres in northern China to improve ventilation (Qin Dashu 2000, p. 288). However, about the Yaozhou furnace he takes as example, namely Y5s (fig. 118), Du Baoren affirms that the ash pit was full of coal debris (Du Baoren 1987b, p. 33) and the final archaeological report states that all Yaozhou Song furnaces were coal-fuelled (SPIA 1998, pp. 87-88, 556).

424 Qin Dashu has noted that in comparison with other kiln centres in northern China, the Yaozhou and Linru Yanhedian kilns were characterised by deep, but small ash pits which obstructed the fire. As a consequence, fuel burned slowly and incompletely, which is probably the reason why these kilns developed long and narrow ventilation ducts with air-blasting devices (Qin Dashu 2000, p. 288).

425 See kilns Y62s (fig. 116), Y36s (fig. 119) and Y5s (fig. 122); in the cases of Y19s (fig. 123), Y21s (fig. 125), Y44s (fig. 126), Y47s (fig. 127) and Y63s (fig. 129), the *luzha* (rails) have not survived, but it was possible to understand how they were arranged.

426 See kilns Y4s (fig. 118) and Y67s (fig. 130).

427 See kilns Y4s (fig. 118) and Y67s (fig. 130).

The front and back walls of the ash pit were lined with bricks, whilst the left and right ones were either lined with bricks or saggars, or left bare.[428]

The ash pit was located approximately in the middle of the firebox, or at the back in which case it usually shared its back wall with that of the firebox itself; some ash pits were long and narrow, others were more regular. There is no apparent relation between shape and position of the ash pit and the only advantage in having the firebox and the ash pit sharing the same back wall is the simplification of the construction.

The space between the floor of the firebox and its ceiling was left empty, but in the case of a kiln excavated at nearby Anren, Xunyi county in 1978, the firebox was equipped with a sort of shelves constituted by six layers of bricks jutting from the side walls.[429]

An attempt to establish the relative dating of the kilns on the basis of the shape and position of the ash pit does not seem feasible. The only published Jin-Yuan kiln seems to have the ash pit in the middle of the firebox, but because the drawing of the cross section and that of the ground plan are not consistent, it would be hazardous to draw any conclusion.

As already mentioned, the firebox is usually lower than the kiln chamber, and, generally speaking, the difference is more pronounced in wood-burning than in coal-burning kilns,[430] probably due to the long flame of wood in contrast with the short one typical of coal.[431]

Kiln chamber

The kiln or firing chamber was the area of the kiln where vessels were placed to be fired; it was comprised between the firebox and the chimney, it was usually higher

[428] See for example kilns Y36s (fig. 119), Y2s (fig. 121), Y5s (fig. 122),Y21s (fig. 125), Y63s (fig. 129), Y67s (fig. 130) and 58-59Y2jy (fig. 131).
[429] Du Baoren 1987b, p. 35; Xiong Haitang 1994, p. 69.
[430] The difference in levels between firebox and kiln chamber in wood-burning kilns Y6t (fig. 102), Y28t (fig. 107), Y29f (fig. 109), Y31f (fig. 110), Y32f (fig. 111) and Y58f (fig. 113) is respectively 54, 64, 80, 60, 80 and 46 cm (the last being only the remaining height); the difference in coal-burning kilns Y3s (fig. 115), Y4s (fig. 118), Y5s (fig. 122), Y20s (fig. 124), Y36s (fig. 119), Y44s (fig. 124), Y47s (fig. 127), Y56s (fig. 128), Y63s (fig. 129), Y67s (fig. 130) and 73Y2s (fig. 120) is respectively 40, 28, 14, 10, 12, 10, 40, 14, 12, 30 and 12 cm.
[431] According to Qin Dashu, the very limited difference in height between firebox and firing chamber in Yaozhou furnaces is linked to green ware production at this kiln centre: green wares are fired in reduction which is better achieved when the firebox is only slightly lower than the firing chamber (Qin Dashu 2000, p. 284).

than the former and was the largest part of the kiln. Generally speaking, it seems that from the Tang dynasty onwards the capacity of firing chamber tended to be increased by expanding its width and shortening its length. According to Qin Dashu's study on the development of northern kilns, this phenomenon, consistent with the general evolution of kilns in northern China, was intensified in coal-burning furnaces: wider and shorter firing chambers apparently improved the semi-down-draught system, the heating up process and the heat efficiency.[432] This is presumably due to the short flame typical of coal: if the firing chamber is too long, the short-flamed coal will not be able to heat it up consistently thus generating uneven temperature in the kiln and requiring more fuel, whereas if the firing chamber is wider, but shorter it can be heated up evenly, thus improving the kiln efficiency.

The floor of the kiln chambers unearthed at the Yaozhou kiln site, which was very often slightly slanting down towards the chimney, was left bare, that is, it was simply made of soil which subjected to numerous firing cycles burnt hard, compact and red in colour.

The small circular traces imprinted on the ground of some of the firing chambers have been attributed to small pillars (or supports) in Tang dynasty contexts and the somewhat larger circles to saggars in later periods.[433] Chinese archaeologists who excavated the Yaozhou kiln site seem to have distinguished circular traces belonging to small pillars on the basis of their diameter, which does not exceed 6 cm, and of the presence of supports in kilns Y10t (fig. 104) and Y28t (fig. 107), the latter also including kiln slabs.[434]

The left and right sides of the kiln chamber coincided with the perimeter wall and were built with firebricks, unless this part was partially dug into the ground. The back wall was made of firebricks and communicated with the chimney behind it through vents opened at the bottom of the wall. To begin with, the number of vents was four (two per chimney stack), but sometime during the Five Dynasties it was increased to five, as kiln Y43f (fig. 112) demonstrates. Six must have been the ideal number as the vast

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[432] Qin Dashu 2000, pp. 283, 288.

[433] Circular traces found in kilns Y10t (fig. 104) and Y28t (fig. 107) were attributed to supports, while those found in later kilns were attributed to saggars. For a discussion on supports see below chapter 3, paragraph 3.4.3, pp. 132-135; for a discussion on saggars see below chapter 3, paragraph 3.4.1, pp. 124-129.

majority of Song kilns had three vents per chimney stack, but it is possible that towards the end of this period and during the next one, the number of vents was increased to four per chimney, as two Song kilns (Y19s (fig. 123) and 73Y2s (fig. 120)) and the only Jin-Yuan one, namely 58-59Y2jy (fig. 131), show.[435] The latter is equipped with an extra vent cut in the portion of thick wall separating the two chimneys and directly connected to the outside.

From the Five Dynasties onwards, the internal walls of the kiln chamber were sometime smeared with refractory plaster, supposedly to improve the insulation of the brickwork.[436]

Chimney

The chimney, which was the part through which fumes escaped, was usually divided in two separate quadrangular stacks built with firebricks and placed at the back of the kiln.[437] The lower part of the front wall of the chimney corresponded to the back wall of the kiln chamber where vents let the fumes of combustion pass from the kiln chamber to the chimney.

Although most of the kilns present two chimney stacks, kilns Y31f (fig. 110),[438] Y43f (fig. 112), Y36s (fig. 119) and Y67s (fig. 130) have only one stack and kiln Y47s (fig. 127) has three stacks. The kiln illustrated in fig. 130 and defined as a tile kiln on the basis that it yielded pieces of bricks and tiles (although mixed with fragments of saggars, blue/green and moon-white wares) also has three chimneys, but in this case the side ones curve to join the central one and thus form one stack.[439] Each of the three chimneys is connected to the kiln chamber through a vent opened in their lower part. Although

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[434] For a discussion on kiln slabs and their possible employment see below chapter 3, paragraph 3.4.4, pp. 136.

[435] Only one coal-burning kiln, namely Y56s (fig. 128), is equipped with only two vents per chimney. Kiln Y44s (fig. 126) might have had only two vents per chimney, but its remains are not very clear in this area.

[436] See kilns Y15f (fig. 108), Y29f (fig. 109), Y31f (fig. 110), Y32f (fig. 111), Y1s (fig. 117), Y4s (fig. 118), 73Y2s (fig. 120) Y5s (fig. 122), Y44s (fig. 126), Y67s (fig. 130), and 58-59Y2jy (fig. 131).

[437] Generally there is a space at the back of the kiln between the two chimneys-stalks, but in the case of kiln Y14t (fig. 106) they share a thick common wall, with no gab between them.

[438] According to Chinese archaeologists, kiln Y31f (fig. 110) had two chimney stacks (SPIA 1997, p. 17), but the fact that the back wall is straight and continuous invalidates this assumption and suggests, instead, that the chimney was not divided.

[439] SPIA 1965, pp. 10-11.

unusual, this chimney design occurred at other kiln centres in northern China during the Northern Song.[440]

Kilns Y31f (fig. 110) and Y43f (fig. 112) are of the wood-firing type, thus showing that the fuel did not influence the number of chimney stacks.

The arrangements of vents in single-chimney kilns cannot be generalised, as in the case of kilns Y31f (fig. 110) and Y67s (fig. 130) no traces of the vents had survived, kiln Y36s (fig. 119) had one row of seven and Y43f (fig. 112) had three rows with five large vents at the bottom, seven small ones in the middle row and at least five at the top. The distribution of vents in more than one row occurs only in one other instance, namely, kiln Y47s (fig. 127), where, however, the chimney comprised three stacks. Basically, it is as if the gap between the two usual chimney stacks had been closed with a wall curving outwards. Each of the two lateral chimneys has two large vents at the bottom and a small one at the top for a total of three vents each; the middle chimney has two large vents at the bottom, above which the wall did not survive, therefore it is impossible to ascertain the final number of vents.

Besides the vents, each of the chimneys of kiln Y5s sports a window (not visible in fig. 122) on the back wall. This has been interpreted by Chinese archaeologists as a device with the double purpose of removing soot from the chimneys and of controlling the atmosphere in the kiln.[441] Unfortunately this is the only case of a chimney with a window, but it seems logical to think that by opening it the draught increased and smoke escaped more quickly, while closing it the draught decreased and smoke took longer to escape. According to Shui Jisheng, on the domical roof of *mantou* kilns there were five openings (four around and one on the very top) which functioned as an exhaust system.[442] By opening or closing these openings, the potters could control the atmosphere in the kiln.

3.4 Odd kilns

Besides the kilns described above which, despite certain peculiarities and variations, fall in the standard horseshoe-shaped and dome-covered kilns of northern China, one

[440] According to Xiong Haitang, similar chimneys were rather popular in the area delimited by Xi'an, Luoyang and Kaifeng and in particular at Ru kilns and at Jun kilns in Yuxian (Xiong Haitang 1994, p. 72 and fig. 3-3-17, p. 73).
[441] SPIA 1998, p. 67; Lu Jiaxi and Li Jiazhi eds. 1998, p. 270.

unusual furnace was discovered. Kiln Y12t (fig. 101) comprises two communicating circular rooms, the front one slightly bigger, the back one connected through a passage to a roughly circular chimney. The two rooms, both identified as kiln chambers, are lined with firebricks, the chimney is dug into the soil and plastered. According to Chinese archaeologists, this was a cross-draught kiln to fire small batches or for test firing.[443] Given the dimension (the diameter of the first kiln chamber is 90 cm and that of the second 84 cm) and overall shape, it seems that this was a test kiln for temperature.[444] The reason for not simply scaling down a common *mantou* kiln is that the firebox would be too small to generate enough heat to fire the kiln to stoneware temperatures.[445] The size of total firebox volume to total kiln-setting-space volume decreases markedly as the kiln chambers increases in size, but the converse of this is that very small kiln chambers may need fireboxes of almost equal volume to fire to high temperatures – hence the odd proportions of the Yaozhou (and Cardew) test kiln.

3.5 Calcination kilns[446]

Y16s (fig. 138) and Y27s (fig. 139) are kilns for calcining limestone found in Xincungoukou, at the south-west end of Huangbaozhen. They include one circular room built with firebricks, preceded by a ventilation tunnel also lined with firebricks. The circular room has the double function of firebox and kiln chamber and includes an ash pit covered with a grating made of radiating stone rods leaning on a stone pillar placed in the middle of the pit and on the edge of the ash pit. The fact that both kilns contained either not fully calcined limestone or white lime indicated that their purpose was that of calcining limestone.

Limestone is a sedimentary rock used as a source of calcium oxide in glaze recipes, however, because it comes in the carbonate form, it cannot be simply ground (which is very difficult due to its hardness) and added to the glaze, but it has to be transformed into calcium oxide.[447] The process to transform limestone, or calcium carbonate, into lime, or calcium oxide, is called calcination. It consists of heating

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[442] Shui Jisheng ISAC '89, p. 449.
[443] SPIA 1992, p. 38.
[444] For a comparison see Cardew 1969, p. 202.
[445] Wood, private communication.
[446] See SPIA 1998, pp. 88-89, figs. 52 and 53 and Appendix II, table 10.
[447] Hamer and Hamer 1997, p. 203.

limestone to a temperature of 825°C at which calcium carbonate decomposes to calcium oxide liberating carbon dioxide.[448]

The discovery of these two calcination kilns is very important from a technological point of view: Yaozhou potters increased the quantity of calcium oxide in the glaze by adding calcined limestone. This means that they knew that extra flux was needed and that it could be obtained by heating up limestone which they found in cliffs and mountains.

3.6 Waste pits[449]

As the name itself suggests, these pits were used to dispose of imperfect objects, including saggars and spacers. Some of them were dug with this intent, but others had originally been created for another purpose and when they could no longer serve it, they were used as waste pits.[450]

Waste pits can be circular, quadrangular, or irregular in shape with flat or concave bottom, deep or shallow, with straight or slightly curving sides, but whatever their form, they are always dug into the ground. An unusual shape may indicate that the original function was not that of waste pit, but this is not a general rule. Pits 91H8f (fig. 140:11) and H14s (fig. 141:4), for example, are characterised by uncommon shape and to begin with they were respectively used as a sand container and as a subterranean room, whereas H6f (fig. 141:3), H19f (fig. 141:4) and 90H11s (fig. 142:1) have a common shape, although originally they were water tanks.[451]

The presence of fine white sand inside 91H8f (fig. 141:11) has led Chinese archaeologists to deduce that it was a pit for storing fine white sand employed for 墊燒

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[448] Hamer and Hamer 1997, p. 42.

[449] In Chinese they are called 灰坑 *huikeng* or "ash pits", but because they do not collect only ash, but also other refuse, here the term "waste pits" has been adopted instead.
Waste pits are here indicated with the letter "H" (灰坑 *huikeng*, ash pit) followed by a number (given by Chinese archaeologists when excavating) and the initial "t" for Tang, "f" for Five Dynasties, "s" for Song, "jy" for Jin-Yuan; to distinguish waste pits of the same period sharing the same excavation number the year of the excavation is inserted before the letter "H"; waste pits excavated during the 1958-59 campaign are marked with the date 58-59. For complete references on excavated waste pits see Appendix II, table 11.

[450] See H6f (fig. 141:3), H19f (fig. 141:10), 91H8f (fig. 141:11), 90H11s (fig. 142:1), H14s (fig. 142:4), 58-59H3jy and 58-59H4jy.

[451] H6f (fig. 141:3), H19f (fig. 141:10) and 90H11s (fig. 142:1) are identified as pits to store water (SPIA 1997,pp. 22, 25 and SPIA 1998, p. 89).

dian shao,[452] that is, the white grit or sand placed under the fully glazed foot rim in order to prevent it from sticking to the saggar in which it was placed for firing.[453]

Water marks and silt have been interpreted as signs that these waste pits originally functioned as water tanks. H19f (fig. 141:4)was situated within the area of workshop Z66f (fig. 44) very close to a wedging/ageing area and not far from a settling tank which clearly suggest that this was a workshop for preparing raw materials. This process requires a large amount of water which was stored in H19f which when it could no longer serve this purpose was used as a waste pit.

From the map of area VI,[454] H6f (fig. 141:3) appears to occupy about half of a waste pit (H4f),[455] which, in turn, seems to be a portion of a rectangular area, possibly a workshop, probably destroyed by later constructions. Z29s (fig. 14) is in the same part of the same trench). If this is the case, H6f might have originally been the tank from which potters drew the water necessary for their activities.

Unfortunately there is no map of the trench where 90H11s (fig. 142:1) was located, therefore it is impossible to establish whether it was within or close to a workshop.

H14s (fig. 142:4) was clearly a room with its four (or more) steps leading down and is roughly rectangular. When it was excavated, the floor was 205cm from ground level which, supposedly, made the archaeologists conclude that it used to be a subterranean pit subsequently used as a waste pit.[456]

But why has this been defined as a subterranean pit, when its dimensions and the steps leading down remind of workshops, and what was its purpose? If the depth of the original room was the same as that of the waste pit (205 cm), then it was obviously underground and could not have had a window. A reason to dig a cellar is to store clay paste waiting to be worked into vessels, as finished objects do not need to be stored underground. But this does not explain the uniqueness of the cellar, nor its large dimensions.

452 SPIA 1997, p. 25.
453 For more details on this setting system see below chapter 3, pp. 131-132.
454 SPIA 1997, p. 6, fig. 4.
455 No details of H4f are given.
456 SPIA 1998, p. 92.

The archaeologists who excavated 58-59H3jy and 58-59H4jy believe that their original purpose was storage, but without a drawing of the plans and their exact location in the trenches, it is impossible either to accept or refute this position.

3.7 Kiln furniture

By kiln furniture is meant all the tools used inside the kiln to improve the firing of the vessels.

3.7.1 Saggars[457]

Saggars are employed to protect vessels from direct contact with flames and ash which, otherwise, would damage the objects, and also to buffer sudden changes in temperature during the firing cycle.[458]

The saggars in use at Yaozhou kiln centre had rather thick walls and were usually coarse in texture, as they included grit or sand in their body paste. These granular and highly refractory materials were added to make the body of the saggar fire resistant, as they had to endure many high temperature firing cycles, and yet to remain porous, as vapour and gases had to be able to escape from the saggar without causing it to explode.

The body of saggars was generally grey (in various hues) in section, although grey white was another common colour in the Tang dynasty, orange and red occasionally appeared in the Five Dynasties and several shades of brown were an alternative to grey in the Song; sometimes the body appeared interspersed with reddish brown or black speckles.

Saggars were not glazed, as this would have prevented the passage of vapour and gases through their walls. The surface acquired a reddish colour, either purple- or brown-suffused, occasionally dotted with black or brown speckles. The phenomena of flying ash and glassy slag ("kiln sweat") being deposited on the surface of the saggars were very common: ash produced by the burning of fuel was carried into the kiln chamber by flames and it either fell on the saggars or adhered to the walls and ceiling of

[457] Saggars are described in SPIA 1965, pp. 17-18, 28-30, 36, 45, 52, 55; SPIA 1992, pp.491-493; SPIA 1997, pp. 226-234; SPIA 1998, pp. 501-515.
[458] SPIA 1992, p. 500; Xiong Haitang 1994, pp. 169, 179. For a survey on Chinese saggars see Xiong Haitang 1994, pp. 179-195.

the kiln. The ash that fell on the saggars was eventually melted by the high temperature; the ash that adhered to the walls and ceiling inside the kiln also melted because of the high temperature, but here it looked like droplets of sweat coming out of the brickwork, hence the definition; these drops often fell from the ceiling and deposited themselves on the saggars, which prevented the vessel inside from being damaged.[459]

Most saggars were shaped by throwing on the potter's wheel.[460] Many samples are characterised by a more or less gently corrugated outer surface, probably to permit a more rapid absorption and transmission of heat.

From the shape of the saggars, it is possible to understand a lot about their development.

In the Tang dynasty, both quantity and variety were very limited, the bucket shape was the most common, all saggars had flat base and walls often over 1 cm thick (fig. 143); some of them had a circular perforation close to the base (fig. 144).[461] Such perforations appear in later periods also, and were probably intended to allow for the even circulation of hot gases during firing.

When tall vessels were fired, instead of making tall saggars, two smaller ones were placed mouth to mouth with some paste in between to secure them.[462] Another Tang practice was to place small items inside big ones, thus saving the use of extra saggars and space in the kiln.[463] From the presence of strips of clay (or traces of them) on the mouth and foot of some containers, Chinese experts have concluded that these strips were arranged between one saggar and the next to secure them together,[464] and according to the archaeologists who excavated the Yaozhou kiln site in 1958-59, wedge-shaped props were placed under the saggar to balance them (fig. 147),[465] but this theory has not been confirmed by later finds.

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[459] Wood defines "kiln sweat" as "glassy slag from the kiln walls and ceiling" (Wood 1999, p. 226).
[460] SPIA 1965, p. 28 affirms that saggars of the Song dynasty were thrown on the wheel, but most of the saggars handled at Yaozhou kiln site appeared to be made on the wheel regardless of their period of manufacture.
[461] The perforation can also appear in the base or close to the mouth, as figs 145 and 146 show.
[462] SPIA 1992, p. 491.
[463] SPIA 1992, p. 525. Xiong Haitang has suggested that the invention of saggars probably derived from the observation by potters that the glaze of small vessels fired inside bigger ones to save space in the kiln was better in quality and was not contaminated by ash and dirt in the kiln (Xiong Haitang 1994, p. 180).
[464] SPIA 1992, pp. 499-500.
[465] SPIA 1965, p. 31. In the paragraph dedicated to props shaped like the Chinese character "工", Xiong Haitang mentions wedge-shaped props arranged under saggars to correct for the slope of the floor of the kiln chamber (Xiong Haitang 1994, pp. 176-177).

In the Five Dynasties, both quantity and variety increased dramatically. There were 盤 *pan* plate-, 鉢 *bo* bowl-, cylindrical and bucket-shaped saggars, all with flat base and with or without perforations (figs. 148-151).[466] It is interesting to note that in this period, the number of perforations was no longer limited to one and in some cases even the base was scattered with small holes (fig. 150), probably to promote the free circulation of hot gases through the saggars stacked into columns and to ensure the even firing of all the pieces. As in the Tang dynasty, there is no apparent difference in either the thickness or the compactness of the body to justify the presence (or absence) of the perforations.

In the Five Dynasties, besides the shapes mentioned above, a new type of saggar appeared: the so-called "M-shaped" saggar (figs. 152-158) used to fire bowls and plates.[467] This model was constituted of a bowl- or plate-shaped body where the vessel was placed, with the rim bent down to form a surrounding wall which can be called the "skirting foot". "M-shaped" saggars were stacked up with the skirting foot of the one above sitting on the mouth rim of the one below. The skirting foot could be straight or slightly swelling, taller than the base of the saggar, thus acting as the resting foot (figs. 152-153), on the same level, so that the saggar stood on both its base and the skirting foot (figs. 154-155), or shorter, in which case each successive saggar dipped into the empty space of the one below it (figs. 156-158). Only open forms, such as bowls and plates, could be fired in this model of saggars, but these were the most popular forms produced at the Yaozhou kilns and the creation of the "M-shaped" saggar was very ingenious, as it solved the problem of stacking vessels with the mouth larger than the base. If bowls and plates were placed in saggars with a profile similar to that of the vessel they protected, the stack would have had the smallest object at the bottom of the pile and the largest at the top with considerable loss of space and great instability. The problem could have been solved by making cylindrical saggars, but this system would have reduced the loading capacity of the firing chamber, as each item would have

[466] A general introduction to Five Dynasties saggars is provided by Wang Fen ISAC '95, pp. 489-490.
[467] This type of saggar is often referred to as "funnel-shaped", but SPIA 1998, p. 501 has refined the name by adding "M-shaped". In the present work, the term "M-shaped " on its own is preferred, as it adequately describes the profile of this type of saggar.
According to Xiong Haitang, "M-shaped" saggars were first employed by Yue potters in the late Tang dynasty and Yaozhou artisans borrowed them only from the middle Northern Song period (Xiong Haitang 1994, pp. 66, 105, 180, 192, 195).

occupied its full height plus the difference of the height of the saggar. This probably explains why "M-shaped" saggars with short skirting foot were developed and, judging from the amount retrieved from the excavations, why they were more widely employed. Moreover, "M-shaped" saggars were easily stackable, as the diameter of the mouth matched that of the foot.

The practice of perforating the body (and the base) of the saggars was extended to many "M-shaped" ones (figs. 152, 154, 156), which showed two or three relatively large holes rather than a large number of small perforations.

Another detail added to some "M-shaped" saggars was the cutting of one or two crescents on the rim of the skirting foot (figs. 152, 153, 155),[468] which left gaps between the stacked saggars probably to handle them better or to promote circulation of hot gases as in the case of the circular perforations on the main body.

In the Song dynasty "M-shaped" saggars were even more popular, probably because Yaozhou wares became very fashionable and production increased. Except for three items (figs. 159-161), none of the illustrated saggars attributed to the Song dynasty shows perforations (figs 162-169)). Song "M-shaped" saggars are slightly thicker than their Five Dynasties counterparts and a few samples have a comparatively thick base (figs. 163 and 166). If the purpose of the holes was to help the even circulation of hot gases,[469] it is possible that Song saggars did not need them because the body recipe included grit and/or sand which made them more penetrable. As a matter of fact, a study carried out on kiln furniture by Zhang Zhigang *et al.* shows that the amount of alumina in the body saggars increased progressively from the Tang to Yuan dynasty, while the amount of silica decreased.[470] Alumina makes the body of the saggar more refractory, which has a two-fold result: being more refractory, if fired at the same temperature, the saggar with more alumina will be more porous and will also withstand high temperature, a fundamental requirement for a good quality, durable saggar.

The variations in the profile of the body of Song "M-shaped" saggars reflect the many shapes made at the time.

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[468] Only in one case three have been reported (fig. 158), see SPIA 1997, p. 232.
[469] Lu Jiaxi and Li Jiazhi eds. 1998, p. 270.
[470] Zhang Zhigang *et al.*, ISAC '99, table 2, p. 493; however, the same study (p. 494) states that saggars of the Tang and Five Dynasties are high in alumina and low in silica, while some Song and Jin saggars are high in silica and low in alumina.

A variation to the "M-shaped" saggar is represented by fig. 160 which has a solid skirting foot, that is, there is no space between the skirting foot and the body. This type of saggar has the same stacking facilities of the "M-shaped" one, and its shaping was probably more straightforward, but its thick wall must have been a drawback: gases circulated with difficulty, and despite the perforation, the rate of success was lower in comparison with "M-shaped" saggars and this variation did not become popular.

Although "M-shaped" saggars were by far the most widely used in the Song dynasty, cylindrical ones to protect tall shapes were also employed (fig. 170).

According to the archaeologists who excavated in 1958-59, three types of saggars were in use during the Jin-Yuan period,[471] but from the illustrations only the first and the third are containers (respectively cylindrical -fig. 171- and bucket-shaped -fig. 172), whilst the second is a small cylinder apparently placed on top of a pile of bowls to prevent them from shaking (fig. 173). No "M-shaped" saggars are mentioned, but during fieldwork at the Yaozhou kiln site I examined a few. Their characteristics were very similar to those examined on Song saggars, only the quantity was not that high.

The stack of saggars was crowned with a lid, which could be a simple flat disc (figs. 174-175), a shallow, round cap (fig. 176), a cover in the shape of a bowl or a plate placed upside down (figs. 177-179), or of a ceramic box lid (figs. 180-181).[472] Sometimes discarded saggars, including the "M-shaped" ones (figs. 182-183), were recycled as lids.[473] The discovery of tools shaped like a brimmed hat with no top (fig. 184) has suggested that a setter was placed between the top saggar and the lid to secure the lid,[474] or, more probably, to encase vessels projecting above the side walls of the saggar.

The quantity of saggars found for each historic period is proportional to their use: in the Tang dynasty, saggars were used, but not constantly, whilst in the Five Dynasties and Northern Song they were an integral part of the firing process. The decrease in number of "M-shaped" saggars coincides with the restoration of the old practice of firing low quality open forms in stacks, which occurred at the end of the Jin dynasty and

[471] SPIA 1965, p. 45. The dimensions of the first type of saggar are d. (mouth) 10, (body) 10.8, h. 26; the dimensions of the second and third types are reported to be d. (mouth) 5-5.8, (body) 4.5-5.5, h. 2.9-4.7.
[472] SPIA 1992, p. 493; SPIA 1997, p. 235; SPIA 1998, pp. 515-518.
[473] SPIA 1998, p. 515.
[474] SPIA 1997, p. 235.

spread during the Yuan. Cylindrical saggars in which to fire tall vessels were used throughout the period of activity of the Yaozhou kilns.

The considerable increase in the use of saggars in the Song dynasty is not only linked to the increase in production, but also to the adoption of coal as fuel: "fly ash from coal burning is gritty and could easily damage fine glazes, while the action of wood ash on ceramics is generally benevolent".[475]

3.7.2 Setters[476]

Setters, or spacers, are implements employed to set a vessel and to separate it from either the bottom of the saggars in which it is fired or from another vessel.[477] When used inside the saggar, they are a sign of refinement of the firing system, as they are not absolutely indispensable, but considerably improve the chances of successful firing. Specimens can be fired standing directly on the bottom of a saggar which has been previously dusted with fine sand,[478] but in this way they can shift easily from their position when loading and unloading the kiln. Setters reduce the possibility of displacement of the vessel inside the saggar and, in case of sticking, the object would more likely stick to the spacer (which can be easily removed after firing) than to the saggar, thus saving both object and saggar. At the Yaozhou kiln centre (as at many other ceramic centres), setters were made of the same material as that used for the vessels, so that the contraction and expansion rates of both the ceramic specimens and their spacers was the same and the risk of failure reduced.[479]

The setters excavated at Yaozhou kiln site can have a flat surface (figs. 185-203), or can be spurred (204-211). Flat spacers can be cake- (figs. 185-192), ring-, (figs. 193-201) or bowl-shaped (figs. 202-203); spurred ones can be circular (both solid and hollow)

[475] Wood 1999, pp. 102-103. According to Li Jiazhi, the wide spread employment of saggars in the Song was influenced by the use of coal as fuel (Lu Jiaxi and Li Jiazhi eds. 1998, p. 270).
[476] Excavated setters are described in SPIA1965, pp. 18, 31, 36, 52, 56; SPIA 1992, pp. 496-499; SPIA 1997, 222-226; SPIA 1998, pp. 523-525.
[477] Xiong Haitang defines setters as auxiliary tools placed between glazed objects to prevent them from sticking together during firing and to optimise the vertical space in the kiln (Xiong Haitang 1994, p. 152). However, this definition seems reductive, as setters also have the function of securing an object.
For a complete history and classification of setter used in China see Xiong Haitang 1994, pp. 152-168.
[478] Xiong Haitang 1994, pp. 153, 166-167.
[479] SPIA 1992, p. 500. On the basis of a study carried out by Zhang Zhigang *et al.*, the chemical composition of Yaozhou setters is very similar to that of the body of celadon specimens of Tang, Five Dynasties, Song and Yuan periods and to moulds of the Tang and Five Dynasties, that is, they are high in alumina and low in silica (Zhang Zhigang *et al.* ISAC '99, pp. 493-494).

(figs. 209-212), triangular (figs. 206-208), or with arms (usually three) (figs. 204-205) branching out;[480] the number of spurs is most commonly three (figs. 204-209), but it can also be four, five and even nine (figs. 210-212). Flat setters are used when the foot of the vessel is not glazed, because, in this case, there is no risk that the foot is going to get stuck to the saggar.[481] Spurred setters are necessary when the surface of the vessel is glazed: if the foot of an item is fully glazed, a flat spacer would get stuck to it and would be impossible to remove,[482] but by diminishing the area of contact to the indispensable minimum, the fully glazed vessel can be detached from its setter with a firm and decisive stroke, leaving only small scars corresponding to the spurs.

In the Tang dynasty all the above mentioned types of setters were already in use, but as no fully glazed item has been attributed to this period, how were spurred setters employed? Although the custom of the Tang dynasty was to leave the foot (and often the lower part of the vessel) unglazed, open specimens were fired in stacks and therefore needed to be separated.[483] Flat spacers would have remained stuck to the glazed interior, therefore Yaozhou potters adopted spurred ones: circular, triangular or three-armed spacers were placed spurs down on the interior of a bowl or plate and platform up to hold the foot of the vessel above.[484] At the end of the firing, the spacer was removed leaving the typical three scars on the interior of the vessel. Although this system was widely used by Yaozhou potters, they cannot be credited with its invention: spurred setters to fire specimens in stacks had been in use since the Sui dynasty at several kiln centres in Henan province.[485]

According to the illustrations published in archaeological reports, in the Five Dynasties spacers were very widely used by Yaozhou potters, who even introduced

[480] According to Xiong Haitang, spurred setters with three arms were first employed in the Tang dynasty by potters of the Xing-Ding system and are generally associated with horseshoe-shaped kilns producing white or *sancai* wares (Xiong Haitang 1994, pp. 66-67).
[481] Unless the glaze runs down and causes the vessel to adhere to the saggar.
[482] Unless, as Xiong Haitang remarks, the solid flat setter is smaller in diameter than the foot ring and it is placed inside the foot under the base (Xiong Haitang 1994, p. 158). However, this implies that the base of the vessel is glaze-free.
[483] Lu Jiaxi and Li Jiazhi eds. 1998, pp. 269-270. Li also specifies that in the Tang dynasty Yaozhou specimens were fired in stacks mouth upwards as well as upside down (fig. 213).
[484] For a brief mention of spurred spacers used at Yaozhou kiln site during the Tang dynasty see You Enpu et al. 1982/1987, p. 312, or You Enpu 1982/1986, pp. 283-284.
[485] Chinese Silicate Institute, 1997, pp.184-185. According to Xiong Haitang, in the Sui dynasty this type of setter was also employed by the Xing kilns in Hebei and in the Tang it was also adopted by Ding kilns, Zibo kilns, Shouzhou kilns and Huaian kilns (Fuzhou, Fujian) (Xiong Haitang 1994, p. 166).

bowl-shaped ones.[486] Spurred spacers were found in large quantity (213 have been reported), but no vessel attributed to the Five Dynasties shows spur marks on the interior. This is because they were no longer used to separate vessels arranged in stacks like in the Tang dynasty, but were placed with the spurs upwards to support the fully-glazed foot rim or base of the specimen.[487] This practice is revealed by the small scars left on the foot rim (fig. 215) or on the base (fig. 216) of certain vessels and is extremely important as it marks a brand new technique of firing fully-glazed vessels.

Until the discovery of the Five Dynasties layer at Yaozhou kiln site, Ru potters had been credited with the invention of firing fully glazed items on small spurs.[488] Although Ru specimens show extremely refined and small spur marks on the base, it now appears that the first potters to use this method were those from Yaozhou. Firing on spurs was not a novelty, as it had been in use at the Yue kilns in Zhejiang since the third century AD, but to begin with, southern vessels were not fully glazed and the spurs were individual lumps of clay which later develop into long and narrow bars arranged to form a circle.[489] However, the scars left by bar-shaped setters on the base of Five Dynasties Yue ware are not even remotely as neat as those visible on contemporary Yaozhou blue/green ceramics (figs. 217-218), mainly because Yaozhou potters were already employing a more sophisticated method: instead of individual lump spurs, they adopted setters equipped with several pointed spurs, the most frequent being the three-armed one.[490] As we have seen, even in the Tang dynasty, such three-armed setters could quickly be turned out using a mould (see fig. 77 and p. 98, footnote 355 above).

However, before employing the spurred setters method, Yaozhou potters prevented their fully-glazed specimens from sticking to the saggar in which they were placed for firing by arranging three piles of sand grains (usually quartz) on the bottom of

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[486] SPIA 1997, p. 224, figs. 120:9-13. One square cake setter was also found.
[487] Wang Fen ISAC '95, p. 489; Lu Jiaxi and Li Jiazhi eds. 1998, p. 270.
[488] Xiong Haitang attributes the first application of this method to the Yue kilns in the Western Jin dyansty then to Duandian kilns in the Tang dynasty and then jumps to the Northern Song with the Qingliangsi kilns ignoring the Yaozhou kilns completely (Xiong Haitang 1994, p. 157). The author has never come across pre-Five Dynasties fully glazed items fired on so-called "sesame seed" spurs.
[489] About setters used at the Yue kilns see Medley 1989, p. 62; Watson 1984, pp. 63-64; Gompertz 1980, p. 48; Tregear 1976, p. 21. According to Xiong Haitang, individual lump setters, called 托珠 *tuozhu* (setting beads), were first employed by kilns in the Lake Tai-Hangzhou Bay region between the end of the Western Zhou and the Spring and Autumn period (Xiong Haitang 1994, p. 155).
[490] Xiong Haitang distinguishes between individual spurs and spurred setters (Xiong Haitang 1994, pp. 153-158, 165-166).

the saggar corresponding exactly to the ring foot of the vessel.[491] After firing, objects were easily removed from their containers, but gritty adhesions marked the foot rim (fig. 214) and made it rough to the touch. Probably for this reason, Yaozhou potters tried to refine this somehow unsatisfactory technique and soon took the lead in ceramic technology by creating a new method of firing fully-glazed specimens later adopted by the celebrated Ru kilns.

In the Song dynasty, only cake and ring setters (figs. 190-192, 198-201) were used, thus indicating that all the specimens had at least the foot rim clean of glaze, and that they were fired singly.

Under the Jin rule, Yaozhou potters continued to use flat setters, but they also re-introduced firing in stacks. However, contrary to their Tang predecessors, instead of separating one item from the next with a spurred spacer placed with the spurs downwards, they wiped a ring of glaze from the bottom of one vessel and placed the foot of the next one on the unglazed ring. This explains the absence of spurred setters in the Jin and Yuan periods, although stack firing became common again. According to Li Jiazhi,[492] in the Jin and Yuan dynasties bowl-shaped setters were the most widely employed: they were placed in saggars to prop up stacked articles.

3.7.3 Supports[493]

During the excavation of the Yaozhou kiln site, archaeologists found variously shaped implements that they classified first as 窯柱 *yaozhu* (kiln post or pillar)[494] and then, more broadly, as 支燒具 *zhishaoju* (supporting firing implement or prop).[495] *Yaozhu* can be defined as vertical elements of various shapes placed on the floor of the kiln chamber under a stack of saggars or of vessels to scatter the flames from the firebox

[491] Wang Fen ISAC '95, p. 489; Lu Jiaxi and Li Jiazhi eds. 1998, p. 270. Xiong Haitang describes the sand piles (沙堆 *shadui*) technique as a method to stack vessels on top of each other invented in the Southern Song period by the Cifeng kilns in Peng county, Sichuan (Xiong Haitang 1994, p. 158). Quantities of sand suitable for this purpose were excavated from pit 91H8f (see above chapter 3, pp. 122-123).
[492] Lu Jiaxi and Li Jiazhi eds. 1998, p. 270.
[493] For descriptions of supports see SPIA 1965, pp. 31, 45, 56; SPIA 1992, pp. 493-496; SPIA 1997, pp. 235-237, SPIA 1998, pp. 518-523; the size of the supports unearthed at the Yaozhou kiln site are reported in Appendix II, table 9.
[494] SPIA 1992, pp. 20, 23, 40; SPIA 1997, p. 235.
[495] SPIA 1998, p. 518.

and to drive their flow.[496] Thanks to these small pillars the heat circulated not only around, but also under the vessels, thus ensuring a good firing of all the specimens regardless of their position in the stack.[497] *Zhishaoju* is more generic a term to indicate all those implements used in the kiln to support stacks of vessels or saggars.

Probably because of the wide variety of shapes in which these supporting tools come, there is a proliferation of names which can be rather confusing: *yaozhu* 窯柱,[498] *zhishaoju* 支燒具,[499] *zhizhu* 支柱,[500] *zhidianju* 支墊具,[501] *zhidian* 支墊,[502] *zhipian* 支片,[503] *dianhuan* 墊環,[504] *zhijuan* 支圈,[505] *diantuo* 墊托,[506] *dianzhu* 墊柱,[507] *qituo* 器托,[508] *zhidingbo* 支頂鉢,[509] *tuobo* 托鉢 and *tuobei* 托杯.[510] The variety of shapes (and names) may be due to the different use of the implements in question: they all supported stacks of vessels (or saggars), but while some raised them from the ground to scatter flames and hot air, others simply served to place the bottom vessel securely and without touching the floor of the kiln.

Yaozhou potters seem to have limited their range of props which can be divided into two broad categories (each with several variants): a) pillar-shaped with straight or waisted sides or splayed foot (figs. 219-233); b) bowl- or cup-shaped (figs. 234-237). Regardless of their form, most supports are characterised by a sealed extremity (figs. 219-225, 227, 230, 232-233, 235-237, 239), but some have both sides opened (figs. 226, 228, 229, 231, 234, 238, 240).[511]

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[496] SPIA 1992, p. 494; SPIA 1997, p. 235; Lu Jiaxi and Li Jiazhi eds. 1998, p. 270; Xiong Haitang 1994, p. 169.
[497] You Enpu et al. 1982/1987, pp. 315-316, or You Enpu 1982/1986, p. 286; Xiong Haitang 1994, p. 169.
[498] SPIA 1992, pp. 20, 23, 40; SPIA 1997, p. 235; Shui Jisheng 1982/1987, pp. 334, 335; Beijing daxue kaoguxi and Hebeisheng wenwu yanjiusuo 1990, p. 4.
[499] SPIA 1992, p. 493; SPIA 1998, p. 518; Henansheng bowuguan and Anyang diqu wenhuaju 1977, p. 50; Xiong Haitang 1994, pp. 169-179.
[500] Liu Fengjun 1988, p. 54.
[501] Beijing daxue kaogu xuexi *et al.* 1997, pp. 431-433.
[502] *Ibid*, p. 438.
[503] *Ibid*, pp. 438-441.
[504] *Ibid*, pp. 441-443.
[505] *Ibid*, pp. 443-445.
[506] Chongqingshi bowuguan 1986, p. 902; Chongqingshi bowuguan and Chongqingshi Nan'anqu wenguansuo 1991, p. 228
[507] Shaoxingshi wenwu guanli weiyuanhui 1981, pp. 46-47.
[508] Zhou Shirong 1978, p. 71.
[509] Beijing daxue kaogu xuexi *et al.* 1997, pp. 433-434.
[510] Hu Yueqian 1961, p. 64.
[511] Xiong Haitang, who analyses all sorts of supports, considers those with a solid, rather than open extremity as a sub-group of the "short posts" class (Xiong Haitang 1994, pp. 171, 175-176). Because

Although in the final report on the excavations at the Yaozhou kiln site props are mainly illustrated open side up, they were actually used the other way round, the closed extremity serving as the base for the stack of vessels or saggars above, and the open end, usually larger, offering a wider, hence more stable foundation.[512] This is confirmed by the fact that when traces of spacers were found stuck to the supports, they were on the sealed side (figs. 223, 225, 229, 235, 238).[513]

Yaozhou pillar-shaped props can have the sealed side completely solid (fig. 233) or perforated in the middle (fig. 229), but in both cases they offer a surface on which to place the bottom vessel (or saggar). Hollow pillars were presumably fitted with a setter on which the stack of vessels or saggars was then carefully placed.

The smaller extremity of Yaozhou bowl-shaped supports is always sealed, but while in some cases it is flat, in others it recessed, just like the base of a ring-footed bowl. The raised ring probably served to secure the foot of the bottom vessel (or saggar) or a setter.

While vessels stacked upside up could be placed directly on the support, when they were loaded upside down they needed a spacer (usually a three-spurred one) in order to prevent the bottom object from sticking to the support and from collapsing under the weight of the stack.

The borderline between supports on one side and saggars and setters on the other may seem blurred at times. However, a closer look to the dimensions reveals that even when the shapes are comparable, props are always considerably shorter and narrower and could have hardly been used as saggars.[514] For example, the support illustrated in fig. 219 and the saggar illustrated in fig. 241 are comparable by shape, but their

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many posts excavated at Yaozhou kiln site have a solid extremity, regardless of height and shape, this has not been considered as a distinctive feature identifying a type.

[512] Hu Yueqian 1961, p. 64; Henansheng bowuguan and Anyang diqu wenhuaju 1977, p. 49; Shui Jisheng 1982/1987, pp. 334-335; Chongqingshi bowuguan 1986, pp. 901-902; Chongqingshi bowuguan; Liu Fengjun 1988, p. 54; Hebeisheng wenwu yanjiusuo 1990, p. 7; Chongqingshi Nan'anqu wenguansuo 1991, p. 228.

[513] The only exception to this pattern is fig. 230 in which the stuck paste is on the open side.

[514] For dimensions of supports see Appendix II, table 9.

According to Xiong Haitang there is a relation between posts and saggars: the former were used to raise objects over what he calls the low temperature zone just above the kiln floor in order to fire them successfully; supports were invented before saggars, but when the latter were introduced, posts were no longer indispensable (Xiong Haitang 1994, pp. 169-172). Nevertheless, the fact that Yaozhou potters continued to use them throughout the history of these kilns is indicative that saggars did not entirely replace supports.

measurements are substantially different (the support is 12 cm high and 6.6 cm in diameter, whilst the saggar is 20 cm high and 14 cm in diameter) and the walls of the setter (1-1.4 cm) are considerably thicker than those of the saggar (0.8 cm). Another parallel can be traced between the bowl-shaped support in fig. 237 (h. 8.6, mouth d. 12.2, foot d. 6.4, thickness. 0.8) and the saggar in fig. 243 (h. 14.4, mouth d.18.3, foot d. 12.4, thickness. 1.8), but as in the previous case, dimensions reveal that the support is smaller than the saggar, although in this instance the wall of the setter is much thinner than that of the saggar. Moreover, saggars have the inner base as flat as possible to provide a stable support for the vessel being fired, whereas some posts have a protuberance which would make the placement of a vessel awkward and unsafe.

Less straightforward is the distinction between ring- and disc-shaped props and setters (for example, compare the prop in fig. 240 and the setter in fig. 202): although there are no specific definitions, props are placed on the floor of the kiln chamber, while setters are used to separate stacked objects or an object from its saggar. However, because of their very shape, some props can perform both functions.[515]

Circular traces imprinted on the ground were found on the floor of firing chambers belonging to every historic period of activity of the Yaozhou kilns, however, only those found on the floor of Tang kilns Y10t (fig. 104) and Y28t (fig. 107) were attributed by Chinese archaeologists to supports, while those found in later furnaces were interpreted as prints left by saggars,[516] presumably on the basis that in some cases the saggars were still in place and when only traces were visible, their diameter was bigger than that of the biggest recorded supports and their arrangement was too close.[517]

However, supports continued to be made after the Tang dynasty, therefore they continued to be used.

3.7.4 Refractory slabs

The only case in which an item might have been wrongly listed is that of the post in fig. 234 which could be a saggar lid like the one illustrated in fig. 237.

[515] Beijing daxue kaogu xuexi 1997, pp. 438-443.

[516] See above chapter 3, p. 118.

[517] Kiln Y31f (fig. 110) had 12 funnel-shaped saggars measuring 24 cm in diameter stuck to the floor of its chamber; kiln Y1s (fig. 117) showed circular impressions and one "M-shaped" saggar of the diameter of 25 cm; kiln Y4s (fig. 118) revealed both saggars (4) and marks; kiln Y19s (fig. 123) had impressed circles very close together, 5cm deep and 18cm across; kiln 73Y2s (fig. 120) showed 117 marks measuring 23cm in diameter and 2-3 in depth; and kiln 58-59Y2jy (fig. 131) revealed 70 marks 28 cm across.

These are the large, thin (50x36x4.5 cm), brick-textured implements found nearby kiln Y10t (fig. 104) and in kiln Y28t (fig. 107).[518] The Shaanxi Provincial Institute of Archaeology has suggested that these slabs were placed on supports to build a double floor,[519] while Liu Fengjun and Xiong Haitang describe a method involving the construction of multi-layered shelves with slab-like firebricks supported by small pillars on which objects were placed for firing.[520]

The double floor method sounds very sophisticated and precarious at the same time: small pillars supporting large slab-like firebricks and stacks of vessels, and its very fragility probably caused it to be abandoned by the Five Dynasties.

The shelf system had the advantage of firing vessels without piling them on top of each other, thus avoiding to separate them with setters that inevitably left scars on the glazed surface. But as the vast majority of ceramic specimens unearthed from Tang dynasty strata at the Yaozhou kiln site show spur marks on the interior, it seems that Yaozhou potters used to fire their vessels in stacks, rather than on shelves, thus suggesting that the slabs were more likely employed to build a double floor.

3.7.5 Pyroscopes (test pieces)[521]

A considerable number of fragments, usually from bowls, with a hole drilled in the middle was found in the layers attributed to the Five Dynasties, Song and Jin-Yuan periods. They are not shards, but tools used by Yaozhou craftsmen to measure the heat-work, that is, the effect of temperature and time, on the vessels in the kiln and, therefore, can be called "pyroscopes".[522] Because all the pyroscopes unearthed at the Yaozhou kiln site are made of the same material as the body paste of contemporary Yaozhou wares and as they are all coated with blue/green glaze, one can conclude that they were employed to check the effects of the heat-work on the glaze, rather than the body, and

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518 Slabs were found in the Tang dynasty stratum near kiln Y10t and in the soil filling kiln Y28t at the time of excavation (SPIA 1992, pp. 23, 40).

519 SPIA 1992, pp. 23, 40.

520 Liu Fengjun 1988, p. 54; Xiong Haitang 1994, p. 177.

521 Excavated pyroscopes are described in SPIA 1965, pp. 45, 56; SPIA 1997, pp. 237-238; SPIA 1998, pp. 525-529.

522 Hamer and Hamer 1997, p. 270. For a lengthy discussion on pyroscopes see Chen Wenxue 1997, pp. 183-188; Xiong Haitang 1994, pp. 196-199.

particularly the level of reduction in the kiln.[523] This means that Yaozhou craftsmen did not need to check upon the body of their vessels because they knew its properties and the heat-work it needed and could stand. But the time to start reducing the atmosphere in the kiln could not be planned in advance, and because its timing was essential to the success of the entire firing, it had to be detected each time. The pyroscopes were created exactly to serve this purpose: by observing the changes in the glaze of the pyroscope, the kiln stoker knew when to reduce or block the supply of oxygen. Because the pyroscopes had to mirror what was happening to the vessels inside the saggars, they were made of the same paste and coated with the same glaze as the specimens in the kiln. In order to observe what was happening to the pyroscopes (and therefore to the vessels), there must have been one or more spyholes in the wall of the kiln chamber through which the pyroscopes could be retrieved with a rod.[524]

As mentioned above, the pyroscopes found at Yaozhou kiln site were all from bowls and included either the foot area with a small portion of the sides (figs. 244-245), or a part of the side and rim (figs. 246-247). In the case of the former, the hooking hole was drilled in the base, with the latter, the hole was bored approximately in the middle of the side.

[523] According to Wang Fen, some Five Dynasties pyroscopes were not glazed (Wang Fen ISAC '95, p. 490).
[524] Lu Jiaxi and Li Jiazhi eds. 1998, pp. 270-271; Xiong Haitang 1994, p. 196.

CHAPTER 4

MACRO- AND MICROSTRUCTURE OF YAOZHOU BLUE/GREEN WARE FROM TANG TO SONG

The study of architectural remains and of their contents has revealed many pieces of very valuable information on the manufacturing process of Yaozhou ware, however, if one wants to know about the composition of the raw materials, how they were prepared into a clay mix by the potter, or about the firing atmosphere and the temperature, why the products look the way they do, visual, petrological, physical and compositional analyses of ceramic fragments are necessary.

The reason why one wants to gather these pieces of information is that by combining the answers it is possible to reconstruct the process of manufacture from the selection of the clay(s) to the firing, and therefore to understand the knowledge, skills and intent of the potters. For example, generally speaking, the glaze of Yaozhou blue/green ware of the Five Dynasties is more bluish and cloudy than that of Northern Song pieces. Is this because Five Dynasties' potters did not possess the skills to make transparent glazes or was it their intention? Why do the two glazes look different?

The appearance of the glaze is particularly important and intriguing as it is possibly the first feature that strikes the observer even without handling a piece. Longquan, Yue and Yaozhou wares all belong to the large family of celadon or blue/green wares, but they do not look the same. As a matter of fact, when presented with a specimen, one is able to establish its provenance[525] not only from its shape and decoration, but also, and often primarily, from the type of glaze with which it is coated. Nevertheless, Longquan, Yue and Yaozhou glazes are fundamentally the same, being high temperature glazes coloured with a small percentage of iron oxide fired in a reducing atmosphere. What does make the difference then? The appearance of a celadon glaze is after all an optical effect, that is, the difference between one blue/green ware and another and indeed within specimens of the same ceramic genre depends on how the

[525] In this specific instance, provenance does not mean the exact kiln the piece was made at, but the ceramic family it belongs to.

light is reflected and refracted. This in turn is ultimately determined partly by the microstructure of the glaze and partly by the colour and texture of the body (or slip) underneath. But what factors determine the difference in microstructure?

As Yaozhou ware was made at the kiln centre in Huangbaozhen, one would expect that the glaze suspension was prepared following precise rules on the choice of the raw materials, their processing (including milling and refining), and their percentages; the firing process must have also been well established by the Five Dynasties, thanks to the experience accumulated since the middle of the eighth century when the kiln centre was activated. There is no doubt that recipes and manufacturing principles were transmitted from one generation of potters to the next, however one must not forget that no matter how skilful and professional Yaozhou artisans were, all the operations that led to the production of a ceramic vessel were manual and, therefore, subject to variations, albeit minimal. But what can appear negligible in numerical terms, for example 0.5% increase in iron oxide, 2% decrease in calcium or a 50°C rise in temperature, is often crucial for the final appearance of a ceramic piece. To control a firing cycle is difficult, as a slightly higher temperature or a longer period of cooling can produce remarkably different results. If one thinks that the texture of bread changes according to whether it is baked on a dry or a wet day, it is easy to imagine how much more temperamental the firing of ceramics in a *mantou* kiln (or in a dragon kiln in South China) must have been a thousand years ago.

Nevertheless, given an error margin present in any manual activity, one can usually understand what the aim of the potter was within a ceramic ware. Taste and styles changed with time, as the final effect sought by Yaozhou potters in the Five Dynasties is different from that pursued in the Northern Song or the Jin dynasties, but by observing the output of each period, one can comprehend what the ceramicist intended to achieve. However, in order to establish whether that was the desired result or the only result achievable using the technology of the time, scientific tests are necessary. The variations due to human error which are visible, for example, in Yaozhou specimens of the Five Dynasties are worth studying as it is those variations that allow one to understand and reconstruct the manufacturing process and its eventual flaws. By comparison with later samples it is then possible to understand how these flaws were overcome, if they were at all, and why new problems emerged.

By reconstructing the manufacturing process of specimens made at the same centre in different periods, it is possible to observe how the level of technological complexity of a kiln centre evolved in time and, by comparison with other factories, whether it influenced or imitated other kilns. And by knowing the composition and therefore the properties of the raw materials, it is possible to assess whether certain effects were inevitable or intentional and to what extent technology imposed the style of a ceramic ware and, vice-versa, how fashion changed the technology.[526] All this helps to establish the actual position a kiln centre holds in the history of Chinese ceramics, as opposed to the appreciation of later connoisseurs, often biased by inaccurate literature.

In the past twenty-five years, many Chinese experts[527] have carried out tests on samples of Yaozhou ware either for the purpose of studying this type of ware in particular, or in a broader context, where comparisons were made among different wares. In both instances, charts of the composition of Yaozhou bodies and glazes have been repeatedly published,[528] nevertheless, this study additionally avails itself of the results of the tests undertaken on a group of Yaozhou shards in my possession by no less an institute than the Research Laboratory for Archaeology and the History of Art, University of Oxford.[529]

Recently Chinese scientists have also published the results of their scientific researches,[530] which will be discussed in the section dealing with Chinese studies.

The aim of this chapter is to answer the questions posed at the beginning of it on the basis of the analysis of the shards I have examined with a binocular microscope, of the results of the tests carried out at the Oxford Research Laboratory, and of the outcome of the researches carried out in China in the past twenty-five years.

4.1 Macrostructure, microstructure and chemical composition of six shards of Yaozhou ware and one shard of Yue ware.

[526] The importance of technical analysis in the understanding of Chinese ceramics has already been stressed by Pamela Vandiver in Vandiver 1992.

[527] Li Jiazhi 1985; Guo Yanyi 1987; Li Guozhen and Gao Lingxiang 1986; Vandiver and Kingery 1986; Li Guozhen *et al.* 1989; Zhang Zhigang *et al.* 1995; Li Guozhen and Guan Peiying (1979) 1982; Chen Xianqiu *et al.* 1989; Yang Zhongtang *et al.* 1995; Yang Zhongtang 1992; Guo Yanyi and Li Guozhen 1986; Yap C.T. and Hua Younan 1995; Wang Fen *et al.*, ISAC '99; Yang Zhongtang *et al.*, ISAC '99; Wang Fen ISAC '99; Zhang Zhigang *et al.* ISAC '99;

[528] See previous footnote.

[529] From now on abbreviated as Oxford Research Laboratory.

The seven specimens (six of Yaozhou ware and one of Yue ware for comparison) analysed in this study were selected from the small collection in my possession. All of them are of secure provenance as they were either donated by Zhou Xiaolu, assistant Professor at Xibei Daxue Wenbo Xueyuan, Xi'an, or personally collected during a survey along the banks of the Qishui river. Each specimen was dated by comparison with excavated pieces and they cover the period from the Tang to the Northern Song dynasty.

All the samples were first examined by the naked eye and then through a low power binocular microscope at three specific magnifications, namely 10x, 20x and 40x, to observe certain phenomena at different levels. The low power binocular microscope put at my disposal by SOAS is a Nikon stereoscopic microscope model SMZ-2.

Finally the seven selected specimens were tested at the Oxford Research Laboratory. Dr Chris Doherty examined the shards using a Cameca SU30 scanning electron microscope (SEM)[531] with energy dispersive analysis (EDA) and wavelength dispersive analysis (WDA) capabilities to determine their chemical composition and the micromorphology of the minerals. In particular, the energy dispersive analysis[532] was applied for the chemical composition of the samples, whilst the textural relationships of the mineral and glassy phases were analysed with backscattered electron microanalysis.[533] Representative offcuts of the shards were set in epoxy resin blocks under vacuum and polished with diamond paste to give a flat, mirror surface. Body and slip analysis was by quantitative EDA using a de-focussed beam, typical operating

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[530] See note n. 3 above.

[531] In SEM the sample is bombarded with a beam of primary electrons producing a variety of electron and X-ray signals which are intercepted by suitable detectors; the most useful signals for morphological and chemical analysis are secondary electrons, backscattered electrons and X-rays. For a more detailed description of SEM, see Leute 1987, p. 122-124; Kingery and Vandiver 1986, pp. 300-302; V&A 1989, p. 4.

[532] Very simply, in EDA the sample is irradiated by a beam of X-rays which makes the electrons in the inner shells jump to the next higher level, but the electrons move back immediately emitting an amount of energy specific for each element. By measuring the amount and intensity of the emitted energy it is possible to identify the element that produced it and its percentage in the overall composition. For a more detailed description of EDA see ; Kingery and Vandiver 1986, p. 304; V&A 1989, p. 11.

[533] Backscattered electron microanalysis is based on the detection of backscattered electrons (one of the many signals produced when the beam of electrons bombards the sample) which have the property of emitting signals whose intensity is proportional to the mean atomic number of the elements. As a result, in images and microphotographs heavier elements are represented in light hues, whereas light elements appear dark. For a more detailed explanation of the behaviour of backscattered electrons see V&A 1989, p. 6.

conditions being 5-10 micron spot size, and operating conditions of 15 KV, 10 nA, 10 second count time. All reported values are means of five analyses.

The following descriptions of the microstructure of samples A-G borrow heavily from the notes that Dr Doherty provided together with the results of the tests he carried out on the above mentioned specimens.

Sample A

Yaozhou ware

Tang dynasty

Macrostructure

This shard, which comprises the complete foot and part of the sides up to the mouth rim of a bowl, belongs to the Tang dynasty (fig. 248). The foot is of the so-called *bi* type,[534] that is, large in diameter, short, splayed and chamfered and with a wide rim (fig. 249). The open sides are very slightly curved on the exterior and contract slightly before the weakly everted mouth rim (fig. 250).

The grey body, re-oxidised buff where exposed, is covered with a layer of white slip and a very thin layer of blue/green glaze, both stopping three quarters down the exterior. The glaze, applied in a very thin layer, does not seem very successful, as it looks yellowish green with distinctively yellow patches and greener ones where it run thicker; despite the presence of white slip, the glaze appears dotted with dark spots. Several pinholes are also present.[535] As it was the custom in the Tang dynasty, bowls were fired in stacks separated by three-armed spacers equipped with a spur at the end of each arm (figs. 204, 206-207) placed with the spurs down on the bottom, hence the three rather large scars inside the piece.

A crack runs inside and out over the mouth rim; at its widest (over the mouth rim) it involves the glaze, while at its narrowest the glaze has resisted the fracturing tension.

Body A closer look at the body reveals the presence of many impurities which become more evident under the microscope (fig. 251). The black spots vary in size, but

[534] *Bi* is the name of jade discs with a small hole drilled in the centre manufactured since the Neolithic period. By extension, when the foot ring of ceramic vessels is characterised by wide rim and small recessed base, it is called *bi* foot.

[535] A pinhole is a hole, as small as a pinprick, left on the glaze surface by a burst bubble. The crater provoked by the eruption would eventually be healed by the viscous glaze, given sufficient time (see Hamer and Hamer 1997, p. 250).

are homogeneously distributed: occasionally white patches appear too, indicating that the body paste was probably made by mixing at least two types of clay, one of which was much purer than the other(s). Even at low magnification the body shows many small pores alongside a few very large ones, usually perfectly round; tears occur in small quantity denoting that the body paste was well kneaded. At 40x (fig. 252) this situation is much clearer and the large pores also appear very deep; the body shows a well-matured fabric, particularly around and inside the large pores indicating that the firing of the body was rather successful and that the iron-rich impurities promoted firing maturity. The presence of pores and tears is reflected in the performance of the body when a drop of water was dropped on its section: the drop expanded rapidly and was partially absorbed, indicating that the body of sample A is relatively permeable. The permeability, or capacity of absorbing water, of a body depends not only on the number of pores, but mainly on their distribution and also on their size: at equal porosity (e.g. same ratio of volume of pores to volume of samples), if the pores are poorly connected, the body will be less permeable than one characterised by good connectivity of the pores.[536]

White layer In this case there is no doubt that the white layer is slip, because, albeit the intent was to apply the glaze over the slip, in some areas they do not match, and one can see either the slip without the glaze, or the glaze coating the body directly (fig. 249). This is interesting because it shows to what extent the slip affected the glaze, and therefore the appearance of the vessel. It seems plausible to conclude that the slip was employed to conceal the impurities in the body which, without the slip, would show through the glaze spoiling the final effect.

Glaze The glaze is suffused with large clusters of tiny bubbles (more numerous where the glaze is thick) surrounded by thin, white haloes that make it semitransparent (fig. 253) and give the surface an orange-peel effect[537] visible when observing at an angle; the density of the bubbles increases with the thickness of the glaze, but in the rare spaces between clusters of bubbles, the glaze appears transparent (fig. 254). The fine network of crazing, barely visible by the naked eye, becomes clearer when magnified (fig. 253).

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[536] Doherty, private communication.

[537] The orange-peel effect is the network of tiny pinpricks provoked by bubbles which have exploded on the surface of the glaze or by their shrinking during cooling. See Hamer and Hamer 1997, p. 230; Kingery and Vandiver 1986, p. 266.

Of the three observed pinholes, only the one at the centre of a yellow patch on the right of the crack has a perfectly circular crater, while the other two (one at the centre of a green patch on the bottom of the bowl and the other in a yellow patch on the lower right of the crack) show irregular shapes. This shows that the first pinhole occurred earlier than the others and the glaze had time to begin the healing, while the other two occurred later and the time was not sufficient for the glaze to heal the irregular craters.

Microscopic examination has confirmed that the crack running over the mouth rim developed under the glaze where it is narrow, but over the mouth rim, where it is at its widest, the glaze cracked too because it could not withstand the tension. The soft edges of the crack suggest that it occurred in making or early firing, rather than in cooling.

Microstructure[538]

Body Figures 255 and 256 show body, slip and glaze in section. The body is clearly composed of at least two clays mechanically mixed, that is, mixed without being refined and in the dry or plastic state, which is why they do not blend and the iron-rich clay(s) takes over the purer one(s).

The very bright white grains are rutile, a natural titanium oxide containing a small amount of iron, which, as shown in figure 257, undergoes selective dissolution. In the same figure, on the top left side, there is a hexagonal bright grain identified as zircon or zirconium silicate, a mineral associated with acid igneous rocks (e.g. granites). The main use of zirconium is as a glaze opacifier, but here it appears in the body where it probably occurred as a resistant ("heavy") mineral in the clay.

The main phase in the body is quartz recognizable as dark grey angular shapes in light areas In figure 257. The light areas, clearly visible In figures 255 and 256, are vitrified zones virtually free from residual quartz, but rich in calcium and iron, which, being fluxes, stimulated melting. The maturity level of the body appears to be rather advanced, but there are still small pores adjacent to larger ones. Around the central pores it is possible to notice a slight development of secondary phases, probably calcium

538 The description of the microstructure of samples A-G borrows heavily from the notes (and verbal suggestions) that Dr Doherty kindly provided with the microphotographs of the tested specimens.

plagioclase (anorthite)[539] and/or aluminium spinel,[540] which denote breakdown of original clays.

White layer From figs 255 and 256 it immediately appears that the slip is very similar to the body, only finer in texture either because the clay chosen for the slip was cleaner than that employed for the body, or because it was refined through levigation and/or sieving, perhaps through silk.[541] The fact that the slip is paler is due to the iron content (1.21%) which is less than half in comparison with the body (2.78%); however it has a distinct yellowish tinge due to the relatively high titanium dioxide content (1.35%) which in combination with iron yields a yellow colour. This is reflected in the presence of small bright white dots in the slip, again identified as rutile, mineral titanium dioxide containing a small quantity of iron. The slip was applied to prevent the iron in the body from showing as black specks in the glaze,[542] and the fact that it is yellowish does not compromise this function, but it does compromise the colour of the glaze. This is a celadon glaze, but because it was applied so thinly, the titanium-rich slip makes it look yellowish, rather than green. This is particularly obvious around splits and pinholes where the slip could re-oxidise under the glaze causing accentuated yellow areas.[543]

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[539] Plagioclase is a feldspar mineral belonging to the sodic-calcic feldspar series. The composition of a given plagioclase is intermediate between two end members, albite ($NaAlSi_3O_8$) and anorthite ($CaAl_2Si_2O_8$). As complete solid solution exists between these two end members, all intermediate values are permitted. Plagioclase feldspar is predominant in igneous rocks where it varies systematically from calcium plagioclase in basatic rocks to sodic plagioclase in granites. In ceramic systems plagioclase is typically calcic (anorthite). A second feldspar series also exists. This shows incomplete solid solution between a sodic end member (albite plagioclase) and a potassic end member (for example, orthoclase). This series is known as the alkali feldspar group, and is most common in granite rocks (private communication from Dr Doherty).
Feldspar constitutes 60% of granite and it is very important from a ceramic point of view as clay forms from its decomposition: when feldspar is attacked by chemical weathering , the alkaline oxides are removed by water and part of the silica engages in chemical combinations; the remaining silica and alumina become clay after a very long exposure to water which combines chemically. For more details see Kearey 1996 pp. 111 and 238; Green 1963, pp. 31-37; Fournier 1973, pp. 11 and 81; Hamer and Hamer 1997, pp. 126-127; Rhodes 1996, pp. 3-4.

[540] In ceramic systems, spinels form as a secondary phase following the complete breakdown of the parent clay minerals. The reaction is not straightforward, involving an intermediate step or steps. Such secondary spinels appear in backscattered images as very fine ($< 2\mu m$) bright grains centred on specific areas, usually representing the former site of a less refractory clay domain on a feldspar. Because of the very small size ($< 2\mu m$), it is not possible to analyse directly these by EDA as the beam samples a large area - e.g. if the analysis showed EDA equal to Al_2O_3 + CaO + SiO_2 + others, the first possibility is that it is aluminium spinel plus some contamination by fused body clay, the second possibility is that it is anorthite plus minor contribution from body clay. However, both aluminium spinel and anorthite signify breakdown of original clays (Doherty, private communication).

[541] Comment on the Oxford report by Nigel Wood.

[542] This effect is very clear in the portion of the shard in which the glaze does not stop together with the slip, but covers an area of exposed body.

[543] Comment on the Oxford report by Nigel Wood.

At the slip-glaze boundary there is a diffuse zone of anorthite[544] crystals which means that slip and glaze reacted.

Glaze The glaze (figs. 255, 256 and 258) shows some angular quartz similar to that observed in the body, which did not enter into solution, thus indicating incomplete firing of the glaze.[545] In figure 258 it appears that quartz largely converted to tridymite,[546] owing to the presence of calcium and magnesium oxides (amongst others) which are high in this glaze (respectively 16.31% and 2.38%). The fact that quartz converted to tridymite is important because it indicates that the firing took place over a long time and/or at high temperature. Given that in the Tang dynasty furnaces were fuelled with wood, which allows to reach high temperature in a relatively short time, it is possible to attribute the conversion to tridymite in this instance to the high temperature in the kiln.[547] In the glaze around the quartz grains converted to tridymite, it is possible to detect a weakly developed zone of skeletal anorthite/wollastonite[548] crystals. Anorthite crystals seed when the amount of both calcium and alumina is high, while wollastonite crystals need an environment rich in calcium and free silica, both types of crystals precipitate if the kiln temperature is high, the soaking long and the cooling slow. Wollastonite crystals in particular need a kiln temperature not inferior to 1200°C.[549]

Some large bubbles are visible in the glaze among smaller ones, and they all seem characterised by irregular contours. According to a study of the microstructure of sacrificial red glazes by Moriyoshi Yusuke, "the surface of bubbles provides a very good site for the precipitation of cristobalite and other crystals, and perhaps for the

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[544] Anorthite is a calcium aluminium-silicate that grows where the amount of both calcium and aluminium is high if two of the following conditions are satisfied: high kiln temperature, long soaking and slow cooling.

[545] Quartz is silica which melts and becomes glaze. Once melted, quartz does not re-crystallise during cooling, therefore the presence of undissolved quartz in the glaze can only be interpreted as incomplete firing or underfiring. Hamer and Hamer 1997, p. 272.

[546] Tridymite, like quartz, is a polymorph, therefore they share the same chemical formula, but have different crystallographic structure. Quartz converts to tridymite between 870°C and 1470°C if catalysts such as calcium, magnesium, potassium, sodium, aluminium or iron oxides are present; above 1470°C tridymite converts to pure cristobalite. Hamer and Hamer 1997, pp. 306-7.

[547] For a comment on the influence of fuel on the structure and functioning of kilns at the Yaozhou site see above chapter 3, paragraphs 3.3.2 and 3.3.4.

[548] Wollastonite is a calcium silicate ($CaSiO_3$) which forms where calcium and free silica are high and alumina low, that is, in fluid glazes if the kiln temperature reaches at least 1200°C and the cooling rate is slow; wollastonite crystals are easily recognizable thanks to their characteristic spherical shape. For more details see Hamer and Hamer 1997, p. 360; Kingery and Vandiver 1986, pp. 81-89.

[549] Hamer and Hamer 1997, p. 360.

segregation of impurities",[550] which means that the irregular contour of the bubbles is caused by crystals finding the different density around the bubbles favourable to their development.[551] The fact that in the microphotographs the bubbles appear of different colours is due to the different extent to which backscattered electrons are being returned from the bubble cavity to the detector; depth of bubble and smoothness or irregularity of its surface will produce different grey scales in the image.[552]

The chemical composition of the glaze of sample A shows that the amount of titanium in the glaze is negligible (0.13% TiO_2) compared to that in the slip (1.35% TiO_2) and in the body (1.26% TiO_2), thus demonstrating that the glaze ingredients were different from those of the body. This is a very important point as it reveals that glaze technology in northern China was very different from that in the south, as southern potters prepared their glazes by adding fluxes to the clay used for the body, whilst in the north body materials tended not to be used as major glaze ingredients.[553]

The overall chemical composition of sample A is very similar to that of the Yue sample G indicating that Yaozhou potters had the ingredients and the technology for preparing good glazes as early as the Tang dynasty, however their glazes where not as successful as Yue or later Yaozhou ones because, as Nigel Wood has suggested,[554] the potters had not yet grasped the formula of efficient reduction firing, employed poorly-refined stoneware clays and titanium-rich slips which affected the colour of the thinly-applied celadon glaze. The glaze of sample A has a very high content of CaO which significantly lowers the high temperature viscosity of the glaze, therefore, in order to prevent the glaze from running during firing, the glaze suspension had to be applied very thinly. On this, as on most Tang samples, the glaze is thin and the reduction firing defective, thus the titanium- and iron-rich slip assumes a yellow tinge that compromises the green colour of the glaze. Nevertheless, it is important to stress that Yaozhou potters of the Tang dynasty were already able to implement good glaze formulations.

[550] Moriyoshi 1992, p. 66. For cristobalite sees below footnote 557.
[551] Moriyoshi 1992, p. 66.
[552] Private communication from Dr Doherty.
"Bright" bubbles can be produced by a build-up of electrons at the bubbles margin due to defects in the carbon-coat (a carbon coat is always applied to the sample to conduct away incident electrons) (private communication from Dr Doherty).
[553] Wood 1978, pp. 30-31; Wood 1999, pp. 117-118.
[554] Wood, private communication.

Sample A	SiO_2	Al_2O_3	CaO	MgO	K_2O	Na_2O	Fe_2O_3	TiO_2	MnO_2	P_2O_5
Body	63.65	28.38	0.93	0.77	1.79	0.15	2.78	1.26	0.03	0.25
Slip	63.06	30.87	0.73	0.66	1.82	0.15	1.21	1.35	0.01	0.14
Glaze	63.52	12.73	16.31	2.38	1.72	0.36	1.67	0.13	0.11	1.10

Table A Chemical composition of sample A

Sample B

Yaozhou ware

Five Dynasties

Macrostructure

This shard comprises the complete foot, a portion of the sides up to the mouth rim and another small portion of the sides; the large bowl it comes from was characterised by straight ring foot and lobed sides marked by ridges on the interior and dents on the exterior, ending in an everted mouth; the bottom sinks irregularly, while the base sags more evenly (figs. 259-261). A thick (in comparison with samples A and C), translucent, greyish blue/green glaze covers the entire sample including the foot rim on which there are two gritty areas (one larger than the other, the grit is white) and a third one without grit.[555] Between the latter and the larger gritty section the glaze shows an opaque area scattered with holes of varying size: supposedly this area came in contact with the saggar in which the bowl was fired spoiling the final effect. A dense orange-peel effect is evident all over the glaze surface.

There are three pinholes (two large and one slit-shaped) relatively close to each other around the foot ring.

A few fingernail marks are visible around the foot ring suggesting that the vessel was held by the foot at some stage of its manufacturing, perhaps after the foot had been pared to remove the bowl from the turn table, or at the time of slipping or glazing which may have occurred by dipping or pouring.

The section reveals a very dark body with black spots and some large pores. A thin, white layer is visible between body and glaze.

Unfortunately, the surface of the shard is contaminated with brown matter probably from burial.

[555] The grit or sand is white and was placed under the fully glazed foot rim in order to prevent it from sticking to the saggar in which it was placed for firing (quantities of sand suitable for this purpose were excavated from waste pit 91H8f – see above chapter 3 pp. 122-123). For more details on this setting system see above chapter 3, pp. 51-52.

Body At low magnification (fig. 262) the body along the section appears rather even in colour, although speckled with black spots, but at 20x (fig. 263) and 40x (fig. 264) it shows a mixture of very pale and very dark grey grains which have not blended into a uniform grey. The black spots vary in size like the many pores, which are often elongated; some of the pores are surrounded by a black circle denoting that they are the result of overfired impurities. Tears are not infrequent. The glassy phase in the body becomes progressively evident as the magnification increases, indicating that the firing must have been long enough and/or at high enough temperature to allow the partial melting of some elements. The water drop tests has revealed that the body of sample B is rather impermeable (especially in comparison with sample A).

White layer The layer between body and glaze runs all along the sections, it is greyish white in colour and has a glassy phase. The only clue that might help to identify the nature of the white layer is provided by two long horizontal fractures in the layer itself where the outer wall of the bowl meets the foot.

Glaze At 10x (fig. 265) the bubbles that obstruct the passage of light through the glaze to the body are barely discernible, but even at 40x (fig. 266), although many smaller ones become visible, they still seem surrounded by a white halo and submerged in a murky substance. The presence of millions of tiny bubbles may be interpreted as a sign of underfiring: the bubbles did not have the time to reach the surface and escape.

The murky super-cooled liquid surrounding the bubbles can also be interpreted as an indication of underfiring: it may contain smaller bubbles imperceptible to a low power microscope, or unmelted matter, but it can also be a sign of slow cooling, during which the glaze devitrified, that is, crystals re-formed. Underfiring occurs when the ingredients are not given enough time or a high enough temperature to melt. The reason why the glaze of sample B looks underfired in comparison with that of sample A can be that the two glazes are compositionally the same, but B was fired for a shorter period than A, or that B contains less fluxes (or more alumina) than A, therefore it required a longer firing than A. As the chemical composition of sample B will show,[556] it is the second possibility: the glaze of sample B contains much more alumina and much less calciumthan the glaze of sample A, thus making it more refractory than sample A.

[556] See below chapter 4, table B, p. 152.

The questions of underfiring and the consequent translucent aspect of the glaze of sample B have been discussed as if they were a fault, but the effect that the Yaozhou potters sought in the Five Dynasties was probably that of a translucent and unctuous glaze, rather than a transparent one, therefore the cloudy aspect of this glaze should be appreciated.

The three pinholes observed by the naked eye show the following features: by looking at the shard as standing on its foot, the first pinhole on the left, which is also the largest, displays a round crater (a sign of healing by the glaze) developing sideways; the slit-shaped pinhole actually appears to be elliptical (fig. 267) and the third pinhole shows an irregular crater, suggesting that the glaze did not have time to begin healing it.

Along the foot rim the glaze is often opaque and scattered with craters of varying size.

Microstructure

Body In figure 268 the body appears more refined than that of sample A, but figure 269 reveals that the improvement does not depend on a better paste (in fact, as noticed above, observation under a simple microscope suggests that the body was made of the mixture of two not entirely blended clays), but mainly on the firing, which must have been longer and/or at a higher temperature to allow residual quartz to convert extensively to cristobalite[557] and/or tridymite.

[557] Cristobalite is another phase of silica like quartz and tridymite and in fact they all share the same chemical formula SiO_2, but have different crystallographic structures. From the potter's standpoint, the presence of cristobalite in the body is opportune, as it prevents the glaze from crazing during cooling, but a large amount of it is not desirable because it can cause shattering. Cristobalite is extremely rare in nature, therefore it cannot be introduced in the body paste as an ingredient, but has to be "produced" by converting from quartz phase to cristobalite phase. The conversion takes place if temperature and time are high and long enough respectively and if catalysts, such as calcium and magnesium oxides are present. The process theoretically starts at 870°C, but in ceramics it does not begin before the temperature in the kiln reaches 1100°C, when quartz starts converting to tridymite and disordered cristobalite. The transformation, during which some tridymite further converts to disordered cristobalite, continues up to 1470°C, above which tridymite and disordered cristobalite convert to pure cristobalite. On cooling, cristobalite inverts at 226°C and tridymite inverts between 200°C and 75°C and because the inversion causes a sudden contraction of the body, if this is not strong enough to contain the stress, it will crack causing a dunt (for a detailed explanation of this term see Hamer and Hamer 1997, pp. 110-114). Besides the stress within the body, the sudden inversion of cristobalite and tridymite causes stress between body and glaze: at 226°C the glaze has already solidified, therefore it cannot adapt to the contraction of the body. This provokes a compression of the glaze, which is the opposite of crazing and that is why cristobalite and tridymite are useful in preventing crazing, but if too abundant, their presence can be negative. See Hamer and Hamer 1997, pp. 90-93,110-114, 303-310, 345; Fournier 1973, p. 62.

Rutile and zircon are still present, as the bright white dots show, but are less conspicuous than in sample A. Several rutile grains are observed undergoing partial dissolution along cleavage traces and exsolution lamellae, which is consistent with the suggested longer and/or higher firing (fig. 269).

White layer In figure 268 the slip looks like a denser body, and in figure 270 it appears that it is made of fine quartz with the only other phases being rutile and zircon, also present in the body, therefore indicating that the rutile and zircon bearing clay employed for the body was also included in the slip recipe. To give an idea of the fineness of the quartz, it is sufficient to report that the largest quartz grains in the body measure 50 μm, whilst those in the slip are only 15 μm. As to the residual quartz in the body, that in the slip shows the presence of cristobalite and tridymite which would not have developed unless the firing were long and/or at high temperature. The layer of slip, which is 100-200 μm thick, has a planar boundary against the glaze-layer because there was no reaction between slip and glaze; figure 270 does show some anorthite crystals at the slip-glaze interface, but their development is so weak that they are insignificant. But how to reconcile the presence of cristobalite and the absence of anorthite precipitates? The conversion to cristobalite/tridymite, albeit demanding long and high firing, is rather common, as the many catalysts in the batch aptly assist and swiftly promote it, whilst the formation of anorthite requires even longer soaking and/or cooling.[558]

Glaze The glaze shows large (up to 100 μm) grains of converted quartz which did not enter into solution (figs. 268 and 270), like in sample A. There is some incipient precipitation of anorthite within the glaze which confirms the suggestion that cooling was too rapid to allow re-crystallisation. Moreover, the amount of calcium oxide (a fundamental promoter in the precipitation of anorthite) in this glaze is low, being only 8.13%. It is possible that the incipient precipitation of anorthite within the glaze was encouraged by the presence of residual quartz.

The bubbles can be divided in two main categories on the grounds of their dimensions: a few large ones close to the slip and very small ones distributed all over the glaze layer. According to a study on Jun ware glazes by David Kingery and Pamela

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[558] Cristobalite can form from quartz or from other free silica, e.g. clay. In the first case it forms rather easily and it is visible as rims around residual cores; in the second it derives from the dissociation of kaolinite ($3Al_2.2SiO_2.2H_2O$) in mullite ($3Al_2O_3$. $2SiO_2$), cristobalite ($4SiO_2$) and water ($6H_2O$) (Doherty, private communication).

Vandiver,[559] the formation of bubbles of different sizes is related to the presence of phosphorous, "perhaps through the breakdown of the pentoxide (P_2O_5) to the trioxide (P_2O_3)":[560] "a sample melted without phosphorous additions shows a uniform size bubble population, whereas samples melted with a 1% addition of bone ash show a range of bubble sizes".[561] The chemical analysis of the glazes of samples A-G reveals that they all include an amount of phosphorous which is correlated to the content of calcium, thus suggesting that both elements originate from the same source.[562]

What is interesting to notice is that pores (black) outnumber bubbles.[563]

From the chemical standpoint, the glaze of sample B is relatively low in calcium and high in potassium oxide, making it a good quality lime-alkali glaze, which is a glaze fluxed not only by lime (calcium carbonate), as sample A, but also by alkali (sodium and potassium oxides in this case). The advantage of lime-alkali over lime glazes is their higher maturing temperature which makes lime-alkali glazes more viscous than their lime counterparts at the same temperature. This allowed a thicker application of the glaze with no fear of running which in turn produced a more intense, unctuous and smoother glaze.[564] The colour and quality of the glaze of sample B are certainly a great improvement over those of sample A.

Sample B	**SiO_2**	**Al_2O_3**	**CaO**	**MgO**	**K_2O**	**Na_2O**	**Fe_2O_3**	**TiO_2**	**MnO_2**	**P_2O_5**
Body	64.59	28.90	0.72	0.41	1.65	0.05	2.09	1.46	0	0.12
Slip	63.44	30.69	0.77	0.47	1.52	0.14	1.04	1.67	0.01	0.24
Glaze	69.89	15.43	8.13	1.42	2.93	0.34	1.46	0.14	0.10	0.50

Table B Chemical composition of sample B

Sample C

Yaozhou ware

Five Dynasties

559 Kingery and Vandiver 1983, pp. 1269-79.
560 Wood 1999, p. 121.
561 Kingery and Vandivery, 1983, p.1271. Bone ash contains phosphorous, therefore the addition of bone ash to the glaze formulation provides phosphorous.
562 Wood, private communication.
563 By the term "bubbles" is meant spherical features indicative of the expansion of a gaseous phase; while by "pores" is meant irregular cavities, probably deriving from original defects or discontinuities within the glaze which have to some extent been "opened up" by gaseous products. Strictly speaking, bubbles are a sub-set of pores. In fact, some pores may be large bubbles (or agglomerations of bubbles) which have been streaked out due to glaze run (Doherty, private communication).
564 For more detailed explanations on lime and lime-alkali glazes see Wood 1999, pp. 30-31, 50, 114-115.

Macrostructure

This sample corresponds to the lower part of a fully glazed tea bowl decorated with a small animal applied in relief on the bottom and fired on placing sand set at three roughly equidistant places on the foot rim (figs. 271-273). The body is dark grey, almost black, dotted with a few black spots. Between body and glaze runs a very thin, white layer, but to the naked eye it is impossible to establish its nature. The glaze is translucent, grey-green in colour with a yellowish tinge (especially in comparison with that of sample B) which changes to bluish where it runs thick around the sprig-moulded motif on the bottom and more conspicuously yellow on the base and some patches around the foot ring. On the foot rim, especially along the edges, the glaze displays a brown colour, probably due to re-oxidation of the body here protected by a flimsy layer of white matter, and reveals some dark spots due to impurities in the body.

The orange-peel effect on the surface is evident even without a microscope.

Along the exterior of the foot ring there are numerous indentations under the glaze presumably caused by fingernails holding the cup from the foot to dip it into the slip and/or the glaze. On the external side there is also a long, winding dent probably occasioned by a fingernail or a tool.

Body At low magnification (fig. 274) the body looks well blended, pores begin to appear, but even at 40x (fig. 275) the body maintains a compact aspect. Signs of maturity are evident in the glassy phases of the body. The water absorbance[565] of the body of sample C is higher than that of sample B, but lower in comparison with sample A.

White layer Under the microscope the white layer becomes more distinct and in general it is slightly thicker on the inside than the outside of the cup. The sharp contour both against the body and the glaze that it shows at 10x (fig. 274) remains unaltered at higher magnifications.

Glaze At 10x (fig. 276) it is already possible to notice the myriad bubbles that cloud the glaze, at 20x (fig. 277) their many different sizes become manifest too and at 40x (fig. 278) rare clear patches begin to appear; this is particularly evident when

[565] Water absorbance is the capacity of a fired body to absorb water; it depends not only on the number and size, but also on the distribution of the pores: connected pores make a body more water absorbant than separated ones.

observing the section. Around the sprig-moulded motif on the bottom of the cup, the glaze is scattered with larger bubbles (fig. 276) (discernible even by the naked eye), but because these are much less frequent, the glaze results clearer (fig. 279).

When viewed through the optical microscope, the glaze over the fingernail marks (fig. 280) appears much darker because here the body shows through the removed or much thinned layer of white matter.

Microstructure

Body In figure 281 the body shows an outstanding contrast of black elements against a paler background. This is partially due to the fact that the photograph was taken in high contrast, but it also depends on the relatively high content of iron oxide (2.44%) in the body. This phenomenon becomes clearer in figure 282 where lighter patches scattered on the background are better visible. The black dots with closely jagged edge in the same figure are residual quartz whose conversion to tridymite is very well accomplished, as shown by their closely indented rims; this means that the soaking was much longer and the temperature higher than in samples A and B. Besides tridymite phase, figure 283 also shows mullite crystals and rutile (the very bright patch in the centre-left), the latter undergoing dissolution along paired cleavage traces and including oxidation lamellae of hematite (rutile is TiO_2, but it usually contains a small amount of FeO, which becomes oxidised to hematite during firing). Mullite crystals are dark grey needle-shaped formations which make the body stronger owing to their typical reticulated arrangement.[566]

[566] Mullite crystals are aluminium silicates ($3Al_2O_3.2SiO_2$) with a characteristic needle shape. As they extend themselves into the glassy matrices within the body, thus lacing them together, they greatly contribute to the strength of the body (Rhodes 1996, p. 18). Mullite crystals result from the dissociation of kaolinite at high temperature in stoneware and porcelain bodies. Basically, by the time the temperature in the kiln reaches 600°C, the chemically combined water has evaporated from the clay crystals which are no longer hydrated aluminium-silicates (Al_2O_3 . $2SiO_2$. $2H_2O$), but metakaolin (Al_2O_3 . $2SiO_2$). Body maturing begins at approximately 800°C when some of the components of the body start melting and fill in the spaces among clay particles, the molten fluxes attack the metakaolin which releases some silica and thus becomes mullite, an alumino-silicate with high alumina content. Mullite starts forming at 1000°C, but its presence is not guaranteed unless the temperature reaches 1150°C and the cooling is slow (see Hamer and Hamer 1997, pp. 220, 224; Fournier 1973, p. 156). This implies that all stoneware bodies grow mullite crystals, but SEM analysis revealed the presence of mulite only in the body of sample C. This does not mean that the other samples do not include mullite crystals, but that their cooling was too fast for the crystals to grow thick enough to be identified by SEM (Doherty, private communication).

White layer While neither the naked eye nor the low power microscope could establish beyond doubt the nature of the white layer between body and glaze, SEM has revealed that it is slip. Its prominent feature is its thickness on the interior of the vessel as opposed to its thinness on the exterior and a close observation of figure 281 seems to show two layers of slip on the left (corresponding to the interior of the bowl). There is no difference in the chemical composition of the slip applied inside or outside the vessel, and, once again, it is very similar to that of the body with rutile and zircon grains (fig. 283), the former undergoing dissolution (fig. 284). The glaze-slip boundary (figs. 284 and 285) is sharp and planar with some penetration of glass into the slip which appears as a medium dark grey strip of fine quartz with a few pores (black with a white halo) and rutile grains between the glaze and the slip proper. At the glaze-slip contact it is possible to distinguish a limited development of anorthite crystals.

Glaze The glaze is characterised by abundant large pores (fig. 281) and sporadic bubbles (figs. 281, 283 and 284),[567] some of which are large and probably caused by the decomposition of phosphates,[568] but most are very small, albeit unequal. All the relict quartz, which is much coarser than that monitored in the slip, has converted to tridymite, confirming the long soaking already noticed about the body. The irregular fringe of anorthite crystals at the glaze-slip contact has already been mentioned, and it is also worth noticing the localised development of anorthite along the margins of the larger pores. In order to form from a melt, crystals (e.g. anorthite) need a nucleation surface and bubbles present an ideal surface (they may present a slightly cooler surface, probably due to gas expansion).[569]

Chemically, the glaze of this specimen is of the lime-alkaline type with an even lower percentage of calcium as regards sample B, which has increased the viscosity of the glaze at high temperature and might explain the presence of the many small bubbles scattered throughout.

Sample C	**SiO_2**	**Al_2O_3**	**CaO**	**MgO**	**K_2O**	**Na_2O**	**Fe_2O_3**	**TiO_2**	**MnO_2**	**P_2O_5**
Body	64.64	28.08	0.90	0.45	1.92	0.06	2.44	1.44	0	0.05

567 For the difference between bubbles and pores see above chapter 4, footnote 563.
568 For the explanation of the relation between phosphate breakdown and large, clear bubbles see above chapter 4, pp. 151.152.
569 Doherty, private communication.
The tendency of crystals to form on the surface of bubbles has been related by Moriyoshi to the improved stability of the bubbles owing to the different density around them (see Moriyoshi 1992, p. 66).

Slip	64.75	30.17	0.76	0.31	1.44	0.05	0.94	1.48	0.01	0.10
Glaze	72.07	15.13	6.38	1.18	3.04	0.27	1.48	0.11	0.08	0.31

Table C Chemical composition of sample C

Sample D

Yaozhou ware

Five Dynasties

<u>Macrostructure</u>

Sample D only comprises a very small fragment of a mouth rim (figs. 286-287). Its body is dark grey, almost black with a long, irregular tear on the section parallel to the mouth rim. It is coated with a beautiful blue green, translucent glaze, turning brownish where it runs thin along the rim; a dense, although not very deep orange-peel effect is visible on both sides of the shard when the light strikes it an angle and crazing has developed on the interior (only one crack is visible on the exterior). The body is separated from the glaze by a layer of white matter.

<u>Body</u> Under the microscope (figs. 288-289) the body seems to have been made by mixing at least two clays which did not blend into one uniform mixture, but remained separated, thus resulting in two different hues of grey (one light, one dark); another prominent feature is the heavy presence of elongated pores running in parallel; black dots also appear. At higher magnification the maturing process of some of the elements in the body becomes visible (fig. 290). The water drop test has revealed that the permeability of the body of sample D is very low.

<u>White layer</u> At 10x (fig. 288) the white layer, which is thicker on the inside than the outside, displays sharp contours both against the body and the glaze, but as the magnification increases it seems that the boundary between the white layer and the glaze is sharp, but that between the white layer and the body is much less distinct (fig. 289). If the different thickness of the white layer inside and outside the shard is to be interpreted as a symptom that the white layr is actually slip, then its blurred contour at the body interface suggests that when the slip was applied, the body had already begun drying, therefore the liquid slip penetrated the pores left empty by the evaporated water of plasticity. However, without the aid of highly sophisticated methods of examination, it is impossible to establish positively the nature of the white layer in this small fragment.

Glaze The many bubbles obstructing the passage of light through the glaze to the body are clearly visible in all their different sizes even at low magnification (fig. 291). They are all surrounded by thick, nebulous halo, but they are not the only cause of haze, in fact, the solidified liquid in which they are submerged is blurred. While in the case of sample B this cloudy effect might have been caused by smaller bubbles indistinguishable even at 40x, here it is evident that the "blurring agent" is not minute bubbles (fig. 292). Primary undissolved quartz occasioned by underfiring, or re-crystallisation induced by long cooling, can be the cause of cloudy glaze, but without the help of SEM it is not possible to establish which of the two is the culprit.

Along the mouth rim the bubble population is less dense because the glaze is thinner, therefore there are less layers of bubbles and more could escape through the surface; their general smaller size might also be due to the thinness of the glaze: large bubbles are more buoyant, thus reach the surface quicker than small ones.

Microstructure

Body Figures 293 and 294 show not only the heavy presence of elongated pores already evident under the low power microscope, but also their pronouncedly parallel alignment and in some cases their curving and pairing to enclose clear areas. The elongated pores parallel to the shard walls are due to air-pockets introduced during clay preparation and "stretched" by forces in throwing, whilst the paired curved pores are voids which have opened up as a result of the clay bead shrinking away from the body during the drying stage.[570] The clear areas enclosed by curved pores have approximately the same size and shape of quartz but do not contain inclusions, either primary or secondary, and except for the marginally higher content of potassium oxide, their composition is nearly the same as that of the body, which suggests that they are fragments of the body clay not homogenised or incorporated during firing, implying coarse grounding and/or insufficient firing temperature.

Quartz relicts, which have converted to tridymite, but only peripherally (fig. 295), also follow the parallel alignment of the pores and the margins of the shard (fig. 294).

Another distinguishing feature of this sample is the higher concentration of rutile and zircon: figure 295 shows a rutile grain undergoing partial dissolution (middle of

[570] Doherty, private communication.

bottom). Both the conversion of quartz to tridymite and the dissolution of rutile are signs of soaking at high temperature, but as the conversion is only peripheral and dissolution partial, one can assume that the soaking did not last for a long time.

White layer The high concentration of zircon and rutile is maintained in the slip (fig. 296). As already mentioned,[571] zircon is a mineral associated with acid igneous rocks introduced in the body paste as part of a clay and rutile is a natural titanium oxide contaminated by iron. It is almost impossible (and definitely impossible for potters of the Five Dynasties) to remove rutile from the clay it comes with. It is therefore possible that one of the clays used for the body was pure enough, albeit contaminated by zircon and rutile, to be used for the slip as well.

There is no great disparity in the slip thickness from one side of the shard to the other, nevertheless it is slightly thicker on the interior than on the exterior. The relict quartz grains, scattered among the very fine pores, which clearly distinguish the slip from the body, are much smaller than those in the body, as their maximum dimension is 15 μm against 50 μm in the latter.

The slip-glaze boundary is planar with a fibronormal fringe of anorthite crystals which implies long soaking and/or slow cooling.

Glaze The glaze shows fewer pores (fig. 296) than sample C, but in comparison with all the previous samples, this manifests a much greater degree of anorthite development throughout the glaze (fig. 297), thus suggesting that both soaking and cooling were longer than for the specimens examined so far. The development of anorthite crystals is promoted by the high content of both alumina and calcium and, as one can see from the composition diagram, the glaze of sample D is very rich in calcium oxide (14.69%) and relatively high in alumina (15.19%, superseded only by the 15.43% of sample B), thus providing a very favourable environment for the growth of these crystals. The fact that no residual quartz is visible in the glaze is a sign of complete firing of the glaze, which, nevertheless appears translucent because of the light-diffusing effects of the anorthite crystals.

Sample D	**SiO_2**	**Al_2O_3**	**CaO**	**MgO**	**K_2O**	**Na_2O**	**Fe_2O_3**	**TiO_2**	**MnO_2**	**P_2O_5**
Body	64.25	28.55	0.50	0.66	1.82	0.07	2.47	1.51	0	0.16
Slip	59.38	33.54	0.45	0.71	2.14	0.11	1.95	1.56	0	0.17

[571] See above chapter 4, p. 144.

Glaze	63.71	15.19	14.69	1.64	2.26	0.31	1.75	0.15	0.14	0.53

Table D Chemical composition of sample D

Sample E

Yaozhou ware

Northern Song

Macrostructure

This sample includes part of the foot ring with a small portion of base and sides of an object decorated on the inside with carved and combed motifs carrying on regardless of the marked boundary between bottom and sides (figs. 298 and 300). The foot is straight cut, but it slants in an outward direction and its rim tilts up towards the base (figs. 299-300). A transparent, olive-green glaze covers the shard except for the foot rim which was wiped clean; where it runs particularly thin, as on the edge of the foot rim and on a small patch on the external sides, the glaze fired to a rusty colour. The orange-peel effect is recognisable in a few sparse pin pricks on the surface of the glaze. The grey body appears uniform and compact without black spots. Between body and glaze there is a distinct white layer. There are several fingernail marks on the exterior of the foot ring and one on the wall; they are all covered by glaze.

Body Under the microscope the body maintains its compactness, but shows pores and a few tears (figs. 301-302). In comparison with the previous samples the quality of the body has greatly improved, probably due to better grinding and mixing techniques developed in the Northern Song. This situation is also reflected by the extremely low permeability of the body of this sample, as a matter of fact the lowest registered among the analysed samples.

White layer The layer between body and glaze (fig. 300) is of a purer white colour than that observed on previous samples and at low magnification it seems to maintain a sharp edge at the glaze boundary (fig. 301), while at higher magnification it seems to have reacted slightly with the body; however, at 40x the edge at the glaze contact loses its sharpness and the reaction with the body appears more evident. Neither the naked eye nor an optical microscope can help to establish the nature of this white layer.

Glaze The transparent glaze is scattered with bubbles, some rather large in size (fig. 303). Regardless of their size, the bubbles appear surrounded by a dark green halo and at 40x (fig. 304) it is possible to see that along the halo of larger bubbles there are smaller ones; this is because in their journey to the surface large bubbles drag smaller ones. Where the glaze has run thin and has fired brown, the bubble population is less dense and in general the size is smaller.

Microstructure

Body From figure 305 it appears that the body is very uniform in contrast with the body of the previous samples, which, albeit in different degrees, all manifest a rough amalgamation of the clays employed for the paste. The homogeneity of sample E is a very important point indicating a development in ceramic technology: it seems that in the early Northern Song period, Yaozhou potters abandoned the old system of mechanical mixing and adopted the more sophisticated method of reducing the clays to slip consistency and mixing them when still wet.[572] For this reason it is impossible to distinguish different types of clay in Song bodies and therefore it is even possible that Yaozhou bodies of the Northern Song were made with a single clay, but this supposition cannot be substantiated because of the high refinement of the paste. Figure 306 shows a remarkably mature body (pale grey) scattered with residual quartz marginally converted to tridymite (dark grey areas with fringed rim), irregular pores (black spots with bright halo) opaques, namely rutile (bright white spot on the right) and zircon (bright white spot on the left), and some unconverted quartz (grey spots with no fringed margin). The well developed glassy phase in the body and the conversion of quartz to tridymite testify that the firing was long and at high temperature; whilst the presence of rutile and zircon suggests that the clay bearing these impurities in the bodies of the Tang and Five Dynasties periods was also used in the Northern Song, which in turn suggests that the Song bodies were still made of a combination of clays, albeit much more refined.

As to the chemical composition, one should notice that in comparison with the Five Dynasties samples tested in Oxford by Dr Doherty, the amount of silica and potassium oxide increases, whilst aluminium, calcium, titanium and iron decrease, the last two considerably. Potassium and iron are both strong body fluxes, therefore the increase of one is counteracted by the decrease of the other. However, in this specific case, the increase of silica and decrease of alumina and calcium might have encouraged

[572] Wood, private communication.

vitrification of the body, whilst the considerable decrease of titanium and iron is responsible for the paler grey hue of the body.

White layer The most evident characteristic of sample E is the absence of slip between body and glaze, as figures 305, 307 and 308 illustrate. When examined first by the naked eye and then with the aid of the low-power binocular microscope, the shard revealed a layer of white matter between body and glaze which looked very much like slip, but the electron probe microanalysis unequivocally shows that there is no slip at the body-glaze boundary, only a fringe of anorthite crystals growing between the two.

For secondary anorthite crystals to precipitate, it is necessary to provide an environment that is particularly rich in alumina and calcium and a long enough soaking.

Glaze The glaze visible in figures 305, 307 and 308, shows bubbles distributed throughout its thickness. The fact that there is no residual quartz in the glaze means that the firing was long and at high temperature to allow the glaze to reach maturity, whilst the absence of anorthite crystals is a sign of fast cooling. The presence of anorthite crystals at the body-glaze boundary and its absence in the glaze are not incongruous: anorthite crystals at the body-glaze contact are secondary crystals fostered by material in the interlayer that is rich in both calcium(from the glaze) and alumina (from the body), whereas the glaze was so well prepared and fired that no seeding occurred. Moreover, as the composition chart below demonstrates, the glaze of sample E is not of the lime type and its alumina content is relatively low, thus providing an unfavourable environment for the development of anorthite crystals.

Sample E	**SiO_2**	**Al_2O_3**	**CaO**	**MgO**	**K_2O**	**Na_2O**	**Fe_2O_3**	**TiO_2**	**MnO_2**	**P_2O_5**
Body	66.03	27.58	0.55	0.42	2.51	0.17	1.73	0.89	0	0.11
Glaze	70.43	13.64	7.74	1.52	3.28	0.44	2.01	0.15	0.12	0.71

Table E Chemical composition of sample E

Sample F

Yaozhou ware

Northern Song

Macrostructure

This sample probably comes from a closed-shaped object, such as a ewer or a vase, as the interior which is covered with a very thin film of glaze that has fired to a rusty colour suggests (fig. 310): this portion would have been hidden to the view, therefore it was not necessary to apply a thick coat. However thin, the glaze on the interior presents three stages: where it is thinner, it appears opaque and reveals the texture of the body; in the middle it becomes translucent with a veil of opacity on the surface and hides the irregularities of the body; where it runs slightly thicker it becomes darker with impurities; a tear of greenish thicker glaze separates the latter area from the middle one.

The exterior is decorated with carved and combed motifs under a thick, transparent, although scattered with large bubbles, olive-green glaze with a pronounced orange-peel effect (fig. 309). The body is grey, apparently similar to that of sample E, that is, uniform and compact without black spots. A thin layer of white matter runs between body and glaze on both sides of the section.

Body At 10x (fig. 311) small pores begin to appear and, as the magnification increases, it is possible to detect that, besides the pore, there are dark spots scattered all over the body. At 40x the fabric appears well matured (fig. 313). The water drop test has revealed that the body of sample F is slightly less impermeable than that of sample E.

White layer The microscope confirms the presence of a white layer between body and glaze, thicker on the decorated side (fig. 311). The contour of the white layer presents a clean-cut edge against the glaze (fig. 312) and a blunt one against the body. As to the nature of the white matter, it is impossible to establish it at this stage of the analysis.

Glaze A horizontal view of the glaze over the decorated surface shows that the orange-peel effect is characterised by large, although sparse, craters caused by the expulsion of the large bubbles that distinguish the glaze at first glance (fig. 311). However, even at low magnification, the bubble population appears much more numerous and varied in size than expected (figs. 314-315): large bubbles seem to float amidst tiny ones, the latter responsible for a decrease of transparency in comparison with sample E. The different size of the bubbles and their distribution, with larger ones generally closer to the body, appears very clear when viewing the shard in section (fig. 311).

The glaze coating the interior surface of the shard appears matt where it runs at its thinnest (fig. 316), while in the middle it acquires a more "glassy" nature (fig. 317) and where it is thicker, it reveals impurities in the form of tiny brown spots (probably because it is less opaque) (fig. 318). A section view at 40x reveals the presence of bubbles where the glaze runs thicker.

Microstructure

Body It appears less refined and less well mixed (figs. 319-320) than the body of sample E, but much more uniform than that of samples A or B. This means that the clays were not as accurately refined as those employed for sample E and therefore the paste, although homogeneously blended, is not as smooth. Nevertheless, the fabric is uniformly mature (as fig. 320 illustrates), as there are no lighter patches as in samples A and B; there are sporadic grains of opaques, namely rutile and zircon (figs. 321 and 320), relict quartz extensively converted to tridymite and a substantial growth of mullite crystals in the melt phase (fig. 321). As observed about sample C, mullite crystals grow in the body if the temperature in the kiln reaches at least 1150°C and the cooling is slow.

White layer Figure 319 clearly shows that the glaze was directly applied on the body without any slip and figure 322 highlights a fringe of anorthite crystals at the body-glaze interface.

Glaze The glaze is of the lime-alkali type, similar to that of sample E in that bubbles are sporadic, pores are of variable dimensions and there is no development of anorthite, but the glaze of this sample includes undigested quartz mantled by tridymite (fig. 322). The presence of residual quartz in the glaze means that it was not fired to completion, whilst the absence of anorthite is a sign of fast cooling.

Sample F	**SiO_2**	**Al_2O_3**	**CaO**	**MgO**	**K_2O**	**Na_2O**	**Fe_2O_3**	**TiO_2**	**MnO_2**	**P_2O_5**
Body	67.75	23.98	1.37	0.66	2.49	0.22	2.66	0.90	0	0.16
Glaze	71.09	13.25	8.14	1.53	2.94	0.42	1.80	0.13	0.10	0.63

Table F Chemical composition of sample F

Sample G

Yue ware

Tang dynasty ,

Macrostructure

This shard comprises a segment of the foot, including the base, and a small part of the sides of a plain Tang dynasty Yue bowl (figs. 323-325). The reason for including a Yue specimen in this study is that of comparison: Yaozhou blue/green ware is often compared to Yue ware, indeed many scholars believe that Yaozhou potters were inspired by Yue style in the making of blue/green ware.[573] However, if from an aesthetical standpoint Yaozhou and Yue wares can be similar, from the mineralogical one they are completely different.[574]

This bowl was characterised by a very small recessed base encircled by a very wide *bi* foot irregularly glazed and exhibiting traces of the single setters on which the vessel was fired (fig. 324). Where the glaze runs extremely thin, it has burnt to a rusty colour and the position of the setters is recognisable by the fine clay adhering to the foot rim (fig. 324). On the rest of the object the thinly applied glaze appears green and transparent, although scattered with small bubbles responsible for the dense, but shallow orange-peel effect on the surface. Inside the bottom of the bowl develops uninterrupted into the sides; the body is grey, uniform and compact (fig. 325); the thinly applied glaze is olive-green and transparent, but scattered with a few bubbles. No white layer is visible by the naked eye.

<u>Body</u> Under the microscope, pores and black inclusions become visible, but they are remarkably smaller and sparser than in the previously examined Yaozhou samples, thus making the Yue body finer and denser (figs. 326-327), nonetheless it does not seem as mature as the Yaozhou specimens. The water drop test has revealed that the water absorbance is low, although higher than that of samples E and F; it can approximately be compared to that of sample D.

<u>White layer</u> No white layer is detectable under the optical microscope, although sometimes one has the impression of perceiving a very thin grey line between body and glaze (fig. 326).

<u>Glaze</u> Observation under the optical microscope reveals that the bubble population is much more numerous than expected: besides larger bubbles, there are myriad smaller ones that become increasingly manifest as the magnification intensifies (figs. 328-329).

[573] See above chapter 2, pp. 71-72.
[574] Wood 1994, pp. 41-42.

The dense orange-peel effect concerning both the interior and exterior surfaces presents an unusual behaviour on the inside: here it appears that the bubbles have reached the surface, but have not been expelled yet, thus appearing like tiny swellings rather than pricks. The bubbles on both sides are defined by neat green halos.

Microstructure

Body The prominent feature of the body (figs. 330-331) is the relict quartz lacking any significant development of tridymite, thus suggesting that the soaking at high temperature was short.

On the right hand side of figure 330 there is a concentration of microporosity identified as relict feldspar, whose morphology is similar to residual quartz in size and to a triangle in shape (detail in fig. 332). The presence of feldspar is not anomalous, as southern clays always include some.[575]

The body has a relatively high content of opaque grains (fig. 331), but this is probably due to lower firing rather than to an actual increase of titanium and iron. As a matter of fact, the higher the firing the fewer the opaque grains, as they dissolve at high temperature; moreover from the EDA it is possible to see that there is no significant increase in the amounts of titanium and iron, therefore the higher concentration of opaques must be related to lower firing temperature instead.

White layer Figure 333 reveals that the flimsy grey layer between body and glaze detectable by the optical microscope is not slip, but a fringe of anorthite crystals. The limited development of anorthite crystals at the body-glaze interface denotes that although a high kiln temperature was reached, it was not maintained and the cooling must have been rapid. This is not surprising if one considers that Yue ware was fired in so-called dragon kilns: because of their elongated shape and because they were stoked with wood, high temperatures could easily be reached, but could not be maintained and cooling was very fast, thus hindering the formation of secondary crystals.

Glaze The glaze is free from both residual quartz and other impurities, only a few large bubbles appear occasionally (fig. 333). This indicates that the raw materials were finely ground and carefully mixed and that the firing temperature was high enough to

[575] Wood 1994, p. 42.

allow a successful maturing of the glaze, while the absence of crystals confirms the rapid cooling observed for both the interlayer and the body.

From a chemical point of view, the Yue shard is considerably different from the Yaozhou specimens examined in this study. The amount of silica (76.65%) and potassium (2.63%) is substantially higher, while that of alumina (17.01%) is lower, therefore the Yue body is less refractory than the Yaozhou one which implies that it matures at lower temperature than that required for the maturing of the Yaozhou bodies.

As to the glaze, it is much less viscous than its Yaozhou counterparts with remarkably lower alumina (12.29%) and silica (62.47%) and significantly higher calcium oxide (16.45%), the latter responsible for the high shrinkage level and of the fine crazing typical of Yue ware. As in the case of Yaozhou ware, the glaze colour of the Yue sample depends on the amount of iron (similar to Yaozhou) and titanium (higher than Yaozhou) which is responsible for the yellowish green tinge. But the element relevant to the understanding of Yue glaze technology is phosphorous pentoxide, which is virtually absent in the body composition and present in quantity in the glaze. As Nigel Wood has remarked,[576] as southern body clays do not contain phosphorous, the latter must be supplied by wood ash, which also provides the large amount of calcium oxide.

From the above considerations it is possible to infer that Yue ware matured at a temperature lower than that needed for Yaozhou ware and the fast cooling to which it was subjected in the wood-fuelled dragon kilns is the reason why, generally speaking, Yue glazes are more transparent than Yaozhou ones.

Sample G Yue	**SiO_2**	**Al_2O_3**	**CaO**	**MgO**	**K_2O**	**Na_2O**	**Fe_2O_3**	**TiO_2**	**MnO_2**	**P_2O_5**
Body	76.65	17.01	0.20	0.23	2.63	0.68	1.85	0.59	0.03	0.12
Glaze	62.47	12.29	16.45	2.48	1.82	0.74	1.81	0.23	0.26	1.44

Table G Chemical composition of sample G

4.2. The technology of Yaozhou blue/green ware

4.2.1. Body

The body of the Yaozhou blue/green samples described above shows a high alumina content consistent with northern wares and contrasting with the low amount of alumina in southern wares (with the exception of Southern Guan and black-bodied

Longquan specimens).[577] This significant difference has already been attributed to the divergent quality of Chinese raw materials: in the north stoneware clays tend to be aluminous, rich in true-clay minerals and low in natural fluxes, while in the south they are often primary, frequently volcanic, and rich in fine-grained quartz and secondary potassium micas.[578]

The chemical compositions of the tested samples show very little fluctuation of the various elements in the stoneware bodies between the Tang and Five Dynasties periods. In the Song dynasty the amount of silica and potassium oxide increased, whilst oxides of aluminium, titanium and iron decreased, suggesting a change in clay recipe. Potassium and iron oxides are both strong body fluxes, therefore the increase of one is counteracted by the decrease of the other. However, in this specific case, the increase of silica and decrease of alumina made the body less refractory (although slightly) in comparison with the Tang and Five Dynasties samples, and thus more easily matured (at equal temperature). The considerable decrease of titanium and iron was responsible for the paler grey hue of the body, easily detectable to the naked eye.

Although chemical changes in the body suggest possible modifications to the clay recipe in the Song dynasty, the differences between the Tang and the Five Dynasties bodies are negligible, and those occurring in the Song period are not radical enough to justify the significantly different appearance of the body from one historic period to the next.

The body of sample A (Tang) appears even to the naked eye like a mixture of light- and dark-burning clays and SEM clearly shows that it was composed of two types of clays, one purer than the other, which, being poorly ground and mechanically mixed, that is, mixed without being refined in the dry or plastic state, did not blend.

Five Dynasties samples seem to have better bodies, but SEM suggests that the improvement was due to better firing conditions (higher temperature and/or longer soaking), which produced a more mature fabric. This is clear when comparing the body

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[576] Wood 1994, p. 47.
[577] Guo Yanyi and Li Guozhen 1982/1987, p. 171; Zhang Zhigang *et al.* ISAC '95, p. 60.
[578] Wood 1999, pp. 28, 108.
Besides observing the high content of alumina in Yaozhou and northern bodies, Zhang Zhigang, Li Jiazhi and Zhuo Zhenxi, consider the titania content as considerably higher in northern than in southern bodies and they conclude that northern raw materials (which are sedimentary) are richer in impurities than their southern counterparts (Zhang Zhigang *et al.* ISAC '95, p. 60). However, it does not seem a rule that northern stoneware materials are richer in titania than southern ones (Wood 1999, pp. 112).

of samples A (Tang) and B (Five Dynasties): A has the lowest amount of silica, a medium content of alumina and the highest concentration of fluxes, while B has a medium content of silica, the highest concentration of alumina and the lowest in fluxes, nevertheless B is more extensively mature than A.

A real breakthrough occurred in the Northern Song when bodies with a uniform colour and compact texture were produced. The homogeneity of sample E is evident even to the naked eye and SEM shows that its texture is as fine as that of the slip coating Tang and Five Dynasties specimens. This uniformity implies a remarkable development in ceramic technology, more specifically in the preparation of the body paste. In fact, the homogeneity of the body of sample E suggests that in the Northern Song period, Yaozhou potters replaced the old method of mixing plastic clays mechanically with a much more sophisticated one that included better refining and mixing the clays by reducing them to slip consistency, and screening them through a small-mesh sieves (probably made from textiles). Better refinement of raw materials has direct positive consequences on firing efficiency: at equal temperature (and refractoriness), a more refined body matures more easily than a coarse one.

On the basis of the above considerations, it is possible to conclude that the bodies of Yaozhou blue/green wares were made from a combination of two types of clays, one containing at least 2% iron oxides, the other only about 1%, and both including titanium and zircon, which are visible in the microstructure of the body and the slip of all the tested samples.

Although the Yaozhou kilns are famous for their celadons, in the Tang dynasty the bulk of the production consisted of black and *sancai* wares, followed by white and finally by blue/green wares.

The body of black wares varies considerably both in colour and texture[579] as they were made of either high or low iron clays, but as it was covered with black glaze, it did not matter. The body of Yaozhou *sancai* specimens appears much purer,[580] but this is due to the fact that the same clay fired at about 1000° C results whiter than when fired at 1250-1300° C. Yaozhou *sancai* bodies were made from either high or low iron clays, the first (but sometimes the second too) subsequently coated with white slip to provide the

[579] Tang dynasty excavated black wares are described in SPIA 1992, pp. 150-227.
[580] Tang dynasty excavated *sancai* wares are described in SPIA 1992, pp. 47-71.

light background necessary to enhance the colourful, brilliant and highly transparent lead glazes.

As to Yaozhou white ware, it is necessary to distinguish between what can be called "true white ware", that is a type of ceramic characterised by pale, slightly yellowish body made of light-firing (low iron) clays, and what can be defined as "imitation white ware", that is a stoneware made of relatively iron-rich clays and coated with white slip under a transparent, yellowish glaze. These latter wares were designed to imitate the true white wares. Nonetheless, in either case, Yaozhou white wares could not compete with those of contemporary Gongxian or Xing kilns, which produced truly white-bodied ceramics.

From the chemical compositions available at present (Appendix II, tables 19 and 20), it seems that the bodies of Yaozhou black, some *sancai*, "imitation white" and blue/green wares were very similar, thus suggesting that their original recipes were much the same. Green specimens show grey, speckled bodies because they were fired in reducing atmosphere: had they been fired in oxidation, like black, *sancai* and white wares, the iron impurities in the clays would have remained in their higher states of oxidation, and would have not reacted with, and diffused into the bodies, due to the fluxing nature of FeO.

On the basis of these considerations, it appears that the bodies of Yaozhou celadons were often virtually the same as those used for black, some *sancai* and white wares, but were fired in reducing atmospheres. This means that the technology of Yaozhou blue/green ware developed directly from local oxidised ceramics, particularly from "imitation white wares". This view is also consistent with the fact that Tang celadon samples are less numerous than Yaozhou black and white wares, and apparently not very successful.

4.2.2. Slip

In the Tang and Five Dynasties Yaozhou blue/green wares were usually coated with a layer of white slip under the glaze in order to prevent the particulate iron in the body from showing as black specks in the glaze.[581]. However, a layer of white slip was

[581] This undesirable effect is very clear in a portion of sample A where the glaze has overrun the slip covering an area of exposed body.

also applied on oxidised stonewares which, being fired in oxidation, do not develop black specks.

From a chemical standpoint, the slip coating samples A-D is not dissimilar from that of the body: the slip is more refractory with its high alumina and low fluxes content, and it is paler due to the considerable decrease of iron oxide (roughly by half), but the presence of titania (more or less in the same amount) is responsible for its yellowish colouration. The high titanium oxide content of the slip does not compromise its concealing function, but it can compromise the colour of the glaze: the glaze of sample A is a celadon glaze, but because it was applied so thinly, the titanium-rich slip makes it look yellowish, rather than green. This is particularly obvious around splits and pinholes where the slip could re-oxidise under the glaze causing accentuated yellow areas.

The microstructure shows that the slip is very similar to the body, only finer in texture, and, therefore much more compact. The slip is finer, either because the clay was naturally finer and cleaner, and/or because it was refined more carefully by levigation and screening (possibly through a small-mesh sieve).

4.2.3. Interlayer

Like the Tang and Five Dynasties specimens, samples E and F, that date to the Northern Song, also show a white layer between body and glaze, but SEM unequivocally revealed that this was a layer of anorthite crystals at the outermost part of the reaction zone. The reaction zone can be defined as that part of the body (or the slip) and that part of the glaze which show chemical and/or microstructural modification due to mutual interaction.[582] By closely observing fig. 307, it is possible to notice that the outer part of the body has been penetrated by the glaze, resulting in a decrease in porosity, while the basal zone of the glaze has developed anorthite crystals as a result of alumina diffusing from the body. Heat plays an important role in promoting interaction between body and glaze, but it is not the only factor in firing, as time is also important. Stoneware and porcelain bodies are fired at high temperature by definition, therefore their reaction with the glaze should be expected, but anorthite crystals are not always present. Yue ware (sample G) is fired at high temperature, and its glaze is particularly rich in calcium. Nevertheless the white interlayer is extremely limited (and in other Yue

[582] Doherty, private communication.

specimens it does not exist at all), probably due to speed of firing. By contrast Song dynasty Yaozhou celadon glazes (samples E and F) include comparatively less calcium oxide, but the interaction with the body is always intense and clearly manifests itself as a thick and extremely white interlayer. The glaze of Tang and Five Dynasties blue/green wares from Yaozhou usually include more calcium than their Song counterparts. Nevertheless SEM revealed that both the reaction with the slip, which is a sort of super refined body with an even higher alumina content, and the growth of secondary anorthite crystals are rather limited. It seems therefore possible to conclude that in order to form at the body-glaze boundary, secondary anorthite crystals require not only a calcia- and alumina-rich environment, but also a long firing.

The length of firing seems connected not as much to the type of kiln, as to the type of fuel employed. Sample G, which is from the Yue manufactures and was fired in a dragon kiln, shows a very limited development of anorthite crystals at the body-glaze interface. Samples A, B, C and D are Yaozhou specimens fired in *mantou* kilns and they also show an extremely limited fringe of anorthite crystals, if any at all. However, samples E and F, which are also from the Yaozhou ceramic centre and fired in *mantou* kilns, are characterised by a remarkable development of anorthite crystals at the basal glaze zone. A limited development of anorthite crystals at the body-glaze interface denotes that although a high kiln temperature was reached, it was not maintained and the cooling must have been rapid. Wood, characterised by long flames, allows the kiln to reach high temperatures in a relatively short period of time, thus giving more even and shorter firings. On the contrary, coal has a short flame taking much longer to even out the temperature at the height of firing. As a result, a coal-stoked kiln requires a very long final soak at full temperature,[583] during which time body and glaze interact (if calcia and alumina are high) and secondary anorthite crystals grow at the body-glaze boundary (among other reactions).

By providing a "natural" white background, the layer of anorthite crystals growing at the body-glaze interface enhanced the glaze colour, its transparency and the impact of the carved (or moulded) decoration typical of Song and Jin dynasty Yaozhou wares, making the use of slip no longer necessary or practical.

[583] Shui Jisheng ISAC '89, p. 473.

4.2.4. Glaze

Analysis shows that the six Yaozhou glazes examined had typical Chinese celadon compositions in the lime to lime-alkali range.

The glaze of sample A is of the lime type and its overall chemical composition can be compared with that of contemporary Yue celadon,[584] except for its titanium dioxide content which is extremely low at 0.13%. As the body contains 1.26% TiO_2 and the slip contains 1.35% TiO_2, one can infer that neither the body clay nor the white slip clay were included in the glaze recipe (at least not significantly). This circumstance is extremely significant as it evidences a fundamental difference from the celadon glaze technology implemented at the Yue kilns. Here (and in southern China in general) the main ingredient of celadon glazes was the same clay used for the body fluxed with wood-ash and possibly a small amount of limestone.[585]

Titanium dioxide cannot be removed from the stoneware clay and its presence in celadon glazes affects the colour (besides the level of reduction reached in the kiln) which assumes a grey tinge. By contrast, celadon glazes containing low levels of TiO_2 can produce high quality blue-green glazes.[586] For example, the exceptionally fine bluish hue of the glaze of sample B could have not been achieved if the titania content were not so low (0.14%). However, one must not forget that despite low titania levels, if the glaze is not well reduced in the kiln, it results yellowish green as glaze C shows.

The intense, unctuous and smooth effect of glazes B and C is due to their lime-alkali nature. Lime-alkali glazes have higher maturing temperatures which means that they can be applied more thickly and yet they will not run.[587]

Glaze E is also of the lime-alkali type, but its appearance is completely different from that of glazes B and C. The transparency of glaze E is due to the longer firing glaze E was subjected to: although lime-alkali glazes are more refractory than their lime counterparts, if the temperature is high enough or the soaking is long enough, all the elements in the glaze matrix will melt. The firing of glaze E was longer because it took place in a coal-fuelled kiln, which in order to even out the temperature, needed a long

[584] Guo Yanyi *et al.*, 1980, p. 237, table 3; Wood 1999, p. 38, table 8a, p. 40 table 8b.
[585] Wood 1999, p. 38.
[586] Wood *et al.*, forthcoming.
[587] For more detailed explanations on lime and lime-alkali glazes see Wood 1999, pp. 30-31, 50, 114-115.

final soak at full temperature.[588] Deliberate fast cooling, perhaps encouraged by allowing air into the white-hot kiln chamber at the end of the firing, prevented devitrification and guaranteed a transparent glaze.

The other major difference of the aspect of glaze E (and F) is its distinctive olive-green colour. The amount of titania and iron oxide in glaze E is slightly higher than in glazes B and C, but not as significantly as to justify the marked alteration. A study on ancient glasses shows that their blue colour is influenced by the levels of ferric-sulphide complex.[589] Basically, the stronger the reduction firing, the higher the ferri-sulphide complex, the more olive-green the glass colour.[590]As coal-burning emits sulphur that can combine with the iron in the glaze making it yellowish, the olive-green hue of Song Yaozhou celadon can be correlated to the introduction of coal as fuel.[591]

Glazes A, B and C show phosphorus pentoxide (P_2O_5) contents correlated to their calcia levels, thus suggesting that wood-ash was the main glaze-flux in the Yaozhou celadon recipe.[592]

4.3. The technology of Yaozhou blue/green ware through Chinese studies

In China the interest in ceramic technology dates back to the 1950s when, although the attention was essentially concentrated on Jingdezhen kilns, it slowly extended to include other wares, mainly from the south.[593] Yaozhou shards were included in the pioneering work undertaken by Zhou Ren and Li Jiazhi,[594] but a comprehensive study of Yaozhou ware did not appear until the end of 1979,[595] probably stimulated by the encouraging results from the new archaeological campaign at Huangbaozhen kiln site directed by Zhuo Zhenxi.

Since then a considerable number of articles on the technology of Yaozhou wares have appeared in specialized publications so that a picture, albeit still incomplete, of the technology of Yaozhou ware has started to emerge. Some articles are too

[588] The different firing cycles of wood-burning versus coal-burning kilns were discussed above chapter 3, paragraphs 3.3.2 and 3.3.4 "Kiln chamber". See also Shui Jisheng ISAC'89, p. 449.
[589] Schreurs and Brill 1984, p. 199.
[590] Schreurs and Brill 1984, p. 200.
[591] Henderson 2000, p. 166.
[592] Wood, private communication; Rastelli *et al.*, forthcoming in ISAC 2002.
[593] For an excursus of early Chinese studies on ceramic technology see Wood 1992, pp. 142-143.
[594] Zhou Ren and Li Jiazhi 1960, pp. 89-107.
[595] Li Guozhen and Guan Peiying (1979) 1982, pp. 191-200.

scientific for those who are not specialised in chemistry, geology and physics, but with an effort it is possible to understand the implications of the tests, although the procedures often remain incomprehensible.

A greater detriment is the presence in some articles of inaccuracies and errors which cast doubts on the reliability of the article and the research behind it and have imposed a very scrupulous and laborious examination of the available information.

The main concern when observing celadon wares is the appearance of the glaze, therefore it is not a surprise that many studies focus on related subjects, such as air bubbles, degree of reduction, identification of the interlayer, etc. Hence, the best method to explore Chinese technological insights on Yaozhou ware and to produce a picture of the technology of the kiln centre, is to deal with each subject from the standpoint of the Chinese studies.

4.3.1 Glaze colour

Because the tinge of blue/green wares varies considerably from kiln centre to kiln centre and within a single tradition to the point that it is almost possible to state that each specimen has a unique hue, many studies are at least partially dedicated to the understanding of this fascinating phenomenon.

It is well known that the colour of celadon wares depends on the quantity of iron (and titanium) contained in the glaze and on the level of reduction achieved in the kiln, but the chemical reasons behind this phenomenon are less well known. As two Chinese studies[596] explain, the glaze colour is subject to iron ions which can be present in the Fe^{3+} and Fe^{2+} forms, the first responsible for the yellow tinge, the second for blue.[597] The subtle variations of the glaze colour of Yaozhou blue/green wares (as of any celadon) are caused by the fact that both forms of iron ions are present in a glaze, but in different percentages according to the level of reduction in which the vessel was fired. Basically, when the supply of oxygen in the kiln is curtailed, Fe_2O_3 is gradually reduced to Fe_3O_4, that is, Fe^{3+} ions acquire one electron becoming Fe^{2+}.[598] As the reducing atmosphere

[596] Li Zhiyan and Guan Peiying (1979) 1982 pp. 191-200; Li Guozhen *et al.* ISAC'89, pp. 255-265. The study carried out by Zhang Zhigang *et al.* ISAC '95 p. 63 also attributes the colour of Yaozhou blue/green ware to the balance of iron ions.

[597] Fe^{2+} is actually colourless, but when combined with Fe^{3+}, it produces blue hues.

[598] Every substance has oxidisation numbers showing its tendency to cede (oxidisation numbers: -1, -2, etc.)or acquire electrons (oxidisation numbers: +1, +2, etc.) when it reacts with other substances. Iron has

becomes stronger, Fe^{3+} decreases, Fe^{2+} increases and the blue tone turns deeper. If the atmosphere is weakly reduced, that is, Fe^{2+} is less than double the amount of Fe^{3+}, the glaze acquires a yellowish tinge, whilst if the quantity of Fe^{2+} is at least twice that of Fe^{3+}, the glaze results progressively bluer.

From the tests carried out by Li Zhiyan and Guan Peiying,[599] it emerged that Yaozhou ware of the Song dynasty was weakly reduced, as the ratio of reduced iron to oxidised iron was 1.3/1. On the basis of the shards examined by them, Li Guozhen's team[600] concluded that the strongest reduction was achieved in the Tang dynasty and the weakest in the Five Dynasties. These results are contradicted by the Oxford research, by Yang Zhongtang's study[601] and by the general appearance of Yaozhou blue/green wares of successive dynasties. The misjudgement is probably owed to the fact that neither the Tang or the Five Dynasties specimens selected by Li Guozhen's team for analysis were representative of their period, the Tang sample being above average and the Five Dynasties one far below. It is worth noticing that all the studies mentioned above agree on Yaozhou Song vessels being weakly reduced. From this it is possible to infer that whilst in the Tang and Five Dynasties periods control over firing was not always achieved, in the Song it was usually successful.

In a more recent study, Yang Zhongtang, Li Yueqin, Wang Zhihai and Xu Peicang take the explanation of the colour of Yaozhou wares a step forward by analysing the molecular network structure of silica phases in the glaze.[602] According to their research, silica tetrahedra[603] can join in six different ways, thus forming six silica polymers or compounds, namely Pure Network (Np), Network (Ne), Sheet (Sh), Ring and Chair (Ch), Dimer (Di) and Monomer (Mo). These six polymers are made of the same molecules (silica tetrahedra), but are different because the arrangement of the molecules is different. The way silica tetrahedra join is determined temperature. The

two main oxidisation numbers, namely +2 and +3. In reducing atmosphere, Fe_2O_3 (in which the iron oxidisation number is +3) acquires one electron, thus becoming Fe_3O_4 (in which the iron oxidisation number is +2).

599 Li Zhiyan and Guan Peiying (1979) 1982 p. 198.

600 Li Guozhen *et al.* ISAC '89, p. 261.

601 Yang Zhongtang 1992, p. 164.

602 Yang Zhongtang *et al.* ISAC '95, pp. 72-77.

603 Silica is silicon dioxide expressed by the chemical formula SiO2, however a molecule of silica is composed of one atom of silicon and four of oxygen arranged as a triangular pyramid with the oxygen atoms at the vertexes and the silicon one in the middle. Silica molecules join together by a common oxygen atom. See Hamer and Hamer 1997, p. 304.

molecular network structure of a glaze is determined by the presence and distribution of clusters of atoms of silica. As X-ray diffraction analysis shows, a glaze can contain all of them and its appearance depends on the amount in which each cluster of atoms of silica is present, therefore on the firing temperature. By observing the type of cluster of atoms of silica in their selected samples with a Raman laser microprobe, Yang Zhongtang and his colleagues realised that the main cluster of atoms of silica in Yaozhou blue/green samples are Np and Ne followed by Ch and Sh, while Di only appeared in the glaze of Tang specimens where it was higher than Ch and Sh, but was the main cluster of atoms of silica in black wares followed by Ch, Ne and Sh. The team also noticed that in contrast with blue/green wares, black-glazed specimens are very high in carbon molecular network structure.

The fuel employed to stoke the kiln is considered to influence the colour of the glaze. It is generally accepted that wood was used at Huangbaozhen until the Northern Song, when potters switched to coal. According to Li Guozhen and his colleagues,[604] when firing with wood, besides CO, H_2 also forms in the kiln and because H_2 has a strong reducing power, the colour of Tang and Five Dynasties vessels is rather successful. The excellent olive-green colour typical of the Song dynasty is attributed by Li's team to the effects of burning coal, which allows the kiln to reach higher temperatures, thus promoting a series of reactions which in turn intensify the density of CO, control the Fe^{3+}/Fe^{2+} ratio and form the Fe^{3+}-O-Fe^{2+} chromophore.[605]

Yang Zhongtang is convinced that nitrogen affects the colour of the glaze through the bubbles nitrogen forms when fresh air is introduced in the kiln before the reducing phase is completed.[606] However, only three of the eight ancient samples he has examined contain nitrogen in greatly varying amounts[607] which do not seem related to the intensity of the yellow tinge of the glaze.

Li Guozhen and Guan Peiying[608] affirm that both zinc and potassium oxides function as secondary colouring agents deepening the blue tone of a glaze. This theory has not been confirmed by anybody else and zinc does not appear among the

[604] Li Guozhen *et al.* ISAC '89, p. 263
[605] A chromophore is a group of atoms in a chemical compound that are responsible of the colour of the compound.
[606] Yang Zhongtang, ISAC '92, p. 165.
[607] Yang Zhongtang, ISAC '92, table n. 2, p. 164.
[608] Li Guozhen and Guan Peiying 1979, p. X and 1982, p. 198.

components of Yaozhou glazes in either the Oxford tests or the other Chinese studies consulted for this research.

Three studies have calculated the reflectance index, that is, the ability of a glaze to reflect light, of the tested specimens, but there is considerable discrepancy between the reported values. In fact, according to Guo Yanyi and Li Guozhen the reflectance index of Song Yaozhou ware is between 700 and 1000 μm,[609] whilst according to the team led by Li Guozhen the reflectance index of Yaozhou blue/green wares varies from 400 to 800 μm from Tang to Song,[610] and according to Zhang Zhigang and his colleagues it fluctuates arbitrarily between the Tang and the Yuan dynasties from 540 to 680 μm.[611]

Inconsistent results aside, it is worth noticing Zhang Zhigang's team's attempt to relate the reflectance of a sample to its FeO/Fe_2O_3 ratio to see if there is correspondence between reflectance and glaze colour. Unfortunately, the team's results and colour classification are not very clear and the lack of reasonable colour photographs of the tested specimens makes it impossible to infer the colours. However, in broad terms, one can deduce that specimens with a strong yellow tinge have a higher reflectance in the region of 660-680 μm, whilst those tending to green and blue are less reflectant at 540-560 μm.

The measurement of reflectance is very subjective, therefore its calculation for each dynastic period cannot be absolute and should be based on the average of many samples, rather than on only one or two as in the case of the above mentioned studies.

4.3.2 Bubbles

As it was noticed in the examination of the samples selected for this study, bubbles play a determining role in the visual appearance of the glaze and therefore their formation is a main concern for the ceramic technologist.

Generally speaking, bubbles are gases generated by the body at the body-glaze interface and within the glaze; once formed, they migrate by natural buoyancy and convection to the surface of the glaze where they are expelled; large bubbles are more

[609] Guo Yanyi and Li Guozhen 1986, p. 164.
[610] Li Guozhen *et al.* ISAC '89, p. 260.
[611] Zhang Zhigang *et al.* ISAC '95, p. 63.

buoyant, therefore they move more rapidly to the surface of the glaze, but surface tension hampers their floatability keeping them at the body-glaze interface.[612]

In 1989 at the International Conference on the Science and Technology of Ancient Chinese Ceramics a group of researchers led by Li Guozhen presented a thorough study on the formation of bubbles.[613] Unfortunately the part of the paper concerning the formation of bubbles in the glaze and at the body-glaze boundary is strictly for experts and this is aggravated by the confusion on measurement unit,[614] nevertheless the conclusions are accessible. Li Guozhen's team affirms that the micro-pores at the body-glaze boundary are the means for the formation of CO_2 bubbles, as the pressure of the gas in the pores pushes until the gas is released in the glaze in the shape of a bubble. Bubbles grow stimulated by heat and pressure and when they reach 0.082mm they dissipate and the CO_2 is liberated in the atmosphere.

Yang Zhongtang[615] takes the study of bubbles a step forward first of all by specifying that the gas matter in the glaze has various sources: 1) gas released by the decomposition and breakdown of raw materials; 2) gas produced when the air in the kiln comes in contact with, spreads into and reacts with the ceramic material during firing; 3) gas trapped in the body paste and between mineral particles during shaping. He then explains that bubbles are made of gas whose type and amount are subject to the firing which is affected by the kind of fuel used, but mainly depends on the kiln atmosphere. Basically, the air in the kiln reacts with the ceramic material forming gas; as the body is sealed by the glaze, it is difficult for the gas to escape and if the pressure is insufficient it remains entrapped in the glass and forms bubbles. If the firing occurs in presence of abundant oxygen, oxidised gases such as CO_2, SO_2 and O_2 are present in the bubbles; but if the oxygen in the kiln is scarce, then reduced gases such as CO, CH_4 and H_2S form.[616]

Yang Zhongtang has also noticed that the gas composition of bubbles varies from slipped to unslipped specimens, thus leading to the conclusion that the slip affects

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[612] Private communication from Dr Doherty.
[613] Li Guozhen *et al* ISAC '89, pp. 263-265.
[614] At page 261 it is said that the glaze thickness is 0.1mm in the Tang, 0.2mm in the Five Dynasties and 0.4mm in the Song, at p. 263 it is said that bubbles smaller than 5mm are round, at p. 264 it is said that when bubbles reach 0.082mm diameter, they are released from the glaze into the atmosphere, but at pp. 264 and 265 bubbles trapped in Yaozhou glaze are reported to be inferior to 1mm. This is not wrong, it is just odd to jump suddenly to such big measurement.
[615] Yang Zhongtang ISAC '92, pp. 161-166.
[616] Yang Zhongtang ISAC '92, p. 164.

the formation of bubbles in the glaze. Apparently, in unslipped samples bubbles of different sizes are irregularly distributed because besides the many micro-pores which form at the body-glaze boundary, there are also cavities and excrescencies, the first produced by gas breaking through the pore, the second caused by gas pressing against, but not breaking the pore. These cavities and protuberances are responsible for the rough appearance of the body at the body-glaze boundary which, on the contrary, appears smooth in slipped specimens. Moreover, the gas composition in unslipped samples appears to be complex in comparison with that of slipped pieces. This, affirms Yang Zhongtang, is due to the fact that the slip acts like a screen preventing gases in the body from diffusing into the glaze, which, therefore, only contains gases yielded by the burning of its own elements. Another effect of the screening action of the slip is that the body gases, being unable to pass into the glaze, gather in the slip and at the body-slip boundary.[617] This theory is logical, but unfortunately it is not corroborated by the microphotographs produced by the Oxford Research Laboratory. Another statement by Yang Zhongtang refuted by direct observation is that in many Five Dynasties specimens the glaze peels off because its binding power is dramatically reduced by the many pores that form in the slip and at the body-slip contact.[618] None of the excavated Five Dynasties specimens exhibits this tendency.

In the same study, Yang Zhongtang also notices that bubbles in Yaozhou blue/green wares are usually single, but sometimes they also appear in clusters, in which case the bubbles have a rather larger diameter. As to their distribution, he remarks that bubbles are arranged from small and many to large and few from the bottom to the surface of the glaze, a logical progression not always respected in reality. He also claims that Tang and Five Dynasties bubbles are characterized by clear edges, whilst in the Northern Song they display fuzzy outlines, another observation confuted by experience. However it is true that the average diameter starts to increase in the Five Dynasties and becomes at least double in the Northern Song, whilst the density decreases irregularly in the Five Dynasties and dramatically in the Northern Song.

[617] Yang Zhongtang ISAC '92, p. 165.
[618] Yang Zhongtang ISAC '92, p. 165.

Although the study by Li Wenchao, Wang Jian and Li Guozhen[619] focuses on the formation of the transitional layer in Jun, Ru and Yaozhou wares, it also provides important information about bubbles. The three scientists point out that the higher the viscosity of a glaze, the more the bubbles are entrapped in it as the viscous glaze prevents the bubbles from growing and escaping. Viscosity is determined by the network structure of the glaze: the more compact the network, the more viscous the glaze, and the compactness of the network is proportional to the amount of bridging oxygen.[620] This is confirmed by another very complex study by Yang Zhongtang, Li Yueqin, Wang Zhihai and Xu Peicang[621] who state that glazes with a low degree of broken bonds and non-bridging oxygen are characterized by small and densely distributed bubbles, whilst those with a high degree of broken bonds and non-bridging oxygen tend to have large and scattered bubbles. The degree of broken bonds and the amount of bridging and non-bridging oxygen are determined by the firing temperature: the higher the temperature, the higher the level of broken bonds and non-bridging oxygen, therefore the more liquid the melt and the smaller the number of trapped bubbles. This is consistent with reality which generally speaking shows Northern Song pieces fired at higher temperature characterized by clear glazes scattered with large bubbles in contrast with Five Dynasties specimen fired at lower temperature characterized by translucent to opaque glazes suffused with tiny bubbles.

4.3.3 Chemical composition of the glaze

One of the main agents in the visual appearance of a glaze is its chemical composition which therefore deserves careful consideration.

The <u>silica /alumina ratio</u> in a glaze is important because it determines its maturing temperature: the bigger the ratio, the higher the maturing temperature.[622] From the Oxford tests (Appendix II, table 16), it appears that this proportion approximately varies between 4:1 and 6:1, values confirmed by Chinese literature.[623] On the same

[619] Li Wenchao *et al.* ISAC '92, pp. 222-226.
[620] Bridging oxygen is the atom of oxygen shared by two molecules of the same type.
[621] Yang Zhongtang *et al.* ISAC '95, p. 75.
[622] For more details on the amount of silica and alumina in glazes see Rhodes 1996, pp. 164-167.
[623] Li Guoxhen and Guan Peiying (1979) 1982, pp. 199 and 195 (chart); Li Guozhen *et al.* ISAC '89, pp. 255 and 258, Li Wenchao *et al.* ISAC '92, p. 223, do not discuss the question of the silica/alumina ratio, but report the chemical composition of the samples they have examined and a chart of the silica/alumina ratio, both confirming the values provided by the Oxford Research Laboratory; Zhang Zhigang *et al.*

subject, Zhang Zhigang's team points out that the silica/alumina proportion increased from the Tang to the Jin dynasty to decrease sharply in the Yuan period, that the silica and alumina contents in the Tang and Five Dynasties are similar to that of Southern Song Longquan and Yue wares, whilst the silica content of Yuan Yaozhou glazes is lower than that of Southern Song Longquan and Yue wares.[624]

According to a study by Wang Fen *et al.* dedicated to blue/green wares of the Five Dynasties, the percentage of silica and alumina in the glaze increased in time within limited values,[625] although judging from the chemical composition of Five Dynasties samples it appears that the difference was rather remarkable: the silica content went from a minimum 56.11% to a maximum 75.5% and the alumina percentage varied from as little as 12.78% to 20.06%.[626]

As to the amount of calcium oxide, the just mentioned study reports that it progressively decreased from the Tang to the Jin dynasty, but then increased again in the Yuan period and specifies that unlike southern celadon, Yaozhou blue/green glazes did not undergo the change from "calcium" to "calcium-alkali" to "alkali-calcium" type.[627] This conclusion might be correct for the samples analysed by Zhang Zhigang and his colleagues, but the results of the Oxford tests (Appendix II, table 16) clearly show that the amount of calcia in Yaozhou blue/green glazes varied at random from one dynastic period to another. On the contrary, Li Jiazhi's conclusion is that the amount of calcium in Yaozhou blue/green glazes varied greatly (5.58-16%), but in general it progressively decreased from the Tang dynasty.[628] Li has also noticed that to a decrease of calcium corresponded an increase in potassium:[629] this is true, but the increment of potassium is not proportional to the reduction of calcium.

ISAC '95, p. 62 report a chart of the silica/alumina ratio expressed in molecular rather than real weight; Chen Xianqiu *et al.* ISAC '89, p. 331, Yang Zhongtang *et al.* ISAC '95, p. 76, Yap and Hua ISAC '95, p. 157, do not directly speak of the silica/alumina ratio in Yaozhou glazes, but from the chemical composition of the samples they have examined it is possible to calculate it and the results show that it is usually comprised between 4:1 and 6:1. Only one article (Guo Yanyi and Li Guozhen 1986, pp. 168 and chart p. 165) maintains that the silica/alumina ratio in Yaozhou glazes is 7.9, albeit the result of the reported test are consistent with the values supplied by the Oxford Research Laboratory. Although it is not specified in the article, I believe that the reported ratio of 7.9 is in molecular rather than real weight.

[624] Zhang Zhigang *et al.* ISAC '95, p. 62.

[625] Wang Fen *et al.* ISAC '99, p. 57.

[626] See Wang Fen *et al.* ISAC '99, table 2, p. 57.

[627] Zhang Zhigang *et al.* ISAC '95, p. 63.

[628] Li Jiazhi ed. 1998, p. 264.

[629] Li Jiazhi ed. 1998, p. 264.

Li Guozhen and Guan Peiying limit their contribution to the statement that the calcium content in Yaozhou samples of the Northern Song is similar to that of Southern Song Longquan wares,[630] whilst C.T. Yap and Younan Hua not only notice that the amount of calcium varies considerably from as high as 16% in the Tang to as low as 5.58 in the Northern Song, but also that the local Fuping glaze stone and Chenlu limestone were not the only ingredients of Yaozhou blue/green glazes as their mixture would have been too low in alumina, and that within northern wares of the Song dynasty, Yaozhou stands aside for its special glaze.[631]

According to Chen Xianqiu and his colleagues, Yaozhou blue/green glazes are particularly rich in calcia in the Tang dynasty, a tendency confirmed by both Chinese and Oxford tests.

Li Guozhen and Guan Peiying affirm that potassium is higher in Longquan than Yaozhou wares.[632] Because potassium is a fluxing agent and has a high coefficient of expansion, its higher concentration makes a glaze more fluid and more prone to crazing.[633]

The effects of titanium oxide in the glaze have already been discussed in the paragraph dedicated to the glaze colour, nevertheless it is not superfluous to report Li Guozhen and Guan Peiying's observation that this metal is more abundant in Yaozhou than Longquan specimens.

Finally, an interesting approach to the significance of chemical composition is introduced by Yang Zhongtang *et al.* who see it as functional to the determination of the melting temperature.[634] Unfortunately these scholars do not explain the process followed to calculate the exact melting temperature of a sample from its chemical composition. In order to find a method, I have separately summed the refractory (silica and alumina) and flux (calcium, magnesium, potassium, sodium, iron and titanium) elements of the specimens examined by Yang Zhongtang *et al.* and then I have calculated their ratio.
The results are schematised in the diagram below, but no fixed pattern seems to emerge.

Sample	Refractory	Fluxes	Ratio	Temperature

[630] Li Guoxhen and Guan Peiying (1979) 1982, pp. 199.
[631] Yap and Hua ISAC '95, pp. 159-161.
[632] Li Guozhen and Guan Peiying (1979) 1982, p. 199.
[633] Rhodes 1996, p. 89.
[634] Yang Zhongtang *et al.* ISAC '95, pp. 75 and 76 (chart).

	elements			
89Y-01	84.81 (2)	15.05 (2)	5.63 (2)	1309°C (2)
89Y-02	78.94 (5)	20.63 (3)	3.82 (4)	1258°C (5)
89Y-03	74.41 (6)	26.56 (6)	2.80 (6)	1223°C (6)
89Y-05	79.14 (4)	20.75 (4)	3.81 (5)	1267°C (3)
89Y-06	87.00 (1)	14.78 (1)	5.88 (1)	1322°C (1)
89Y-07	80.47 (3)	20.89 (5)	3.85 (3)	1267°C (3)

Table H Calculations of the refractory element, fluxes, their ratio and the firing temperature of the samples analysed by Yang Zhongtang *et al.* The number in parentheses indicates the classification of the sample under each heading.

The two specimens that according to Yang Zhongtang and his colleagues were fired at exactly the same temperature should reveal identical patterns in the refractory or flux content or in their ratio, but all that emerges is the already known tendency that the higher the refractory content the higher the temperature. Therefore one has to conclude either that this is not the method adopted by Yang Zhongtang *et al*, or that it is not a reliable analytical process.

4.3.4 Crazing

Crazing on Yaozhou wares is not intentional, it decrease the strength of the fired object and does not possess the decorative function it has on Ru or Guan wares, hence it should be regarded as a fault, however, it rarely disturb the visual appearance of the finished object, therefore it is not regarded as a defect.

Li Guozhen and Guan Peying explain that crazing on Yaozhou wares is caused by the fact that the body is very rich in clay, ignoring the other important factor, namely a high flux content.[635] Generally speaking, crazing is caused by the lower coefficient of expansion of the body in comparison with that of the glaze: during cooling, the body contracts less than the glaze which therefore cracks under the tension. A clay-rich body is characterized by its content of ultra-fine silica which fuses when fired at high temperature for a prolonged period of time and fused silica contracts less than its crystalline form, thus promoting the development of fine cracks in the glaze.[636] A flux-rich (and therefore silica-poor) glaze tends to craze because the oxides of potassium, sodium and calcium have a high rate of contraction which makes the glaze brittle and prone to contract intensely.[637]

[635] Li Guozhen and Guan Peiying (1979) 1982, p. 199.
[636] Hamer and Hamer 1997, p. 89.
[637] Hamer and Hamer 1997, p. 89.

Wang Fen has noticed that the glaze on Five Dynasties celadon specimens with white body displays a dense network of fine cracks.[638] A body results white when its clay(s) is low in impurities and particularly in iron, but kaolin, which is virtually impurity-free and therefore white, is characterised by high alumina and an average silica content. Nevertheless, its firing shrinkage is limited because the temperature is not hot enough to approach its vitrification point. Although the point raised by Wang Fen is worth noticing, it should be remembered that glaze crazing is not influenced by the colour of the body, which depends on the impurity content, but on the silica content of the body and the flux amount in the glaze.

Zhang Zhigang's team affirms that Yaozhou wares have no crazing.[639]

4.3.5 White layer

After the glaze appearance, the second most intriguing aspect of Yaozhou ware is the identification and significance of the white layer that often appears between body and glaze. Almost all Yaozhou blue/green wares display this evident white seam at the body-glaze boundary which neither the naked eye nor a low power binocular microscope can identify, hence the proliferation of names, such as interlayer, interface, reaction zone, 白衣 *bai yi* (white coat), 漂白層 *piao bai ceng* (white-bleached layer), 陶衣 *tao yi* (ceramic coat) and 底釉 *di you* (under coat).[640]

Supposedly, the fascination with the "white coat" is due to the fact that on some early specimens (Tang and Five Dynasties) it is clearly white slip applied over the body before glazing and this must be how it was labelled until sophisticated tests proved that sometimes it was the result of a series of chemical reactions occurring during firing, often identified with the layer of precipitated anorthite. My interpretation of this phenomenon based on western studies was given in the paragraph dedicated to the

[638] Wang Fen ISAC '99, p. 486.
[639] Zhang Zhigang *et al.* ISAC '95, p. 65.
[640] Liang Guandeng 1985, pp. 42-43. This article is a perfect example of confusion about the interpretation of the white layer between body and glaze in Yaozhou specimens. Briefly, Liang writes that the white layer that some Yaozhou samples have can either be slip or the layer produced by the body-glaze contact. This is correct, albeit very general, but the idea that the relief decoration carved on certain pieces appears pale because the raised motifs are slipped is entirely groundless. It is well known that the reason why the raised decoration appears paler than its recesses is due to the different thickness of the glaze on the two portions.

interlayer,[641] but there are also several Chinese contributions to the subject worth noticing.

Guo Yanyi and Li Guozhen[642] explain that at high temperature the molten glaze progressively penetrates the body and by reacting with it forms the interlayer. Simultaneously, part of the carbon produced by the firing and now diffused into the glaze combines with oxygen expelled by the body, the remaining oxygen combines with iron and titanium ions which upgrade to their Fe^{3+} and Ti^{4+} forms and finally, through a series of reactions, the clean, white and compact area, that is, the body-glaze interlayer, is formed. In the cooling phase a 0.02-0.03μm thick layer of anorthite crystals develops.

In another study, Li Wenchao and Li Guozhen[643] conclude that the interface consists of anorthite crystals and bubbles, plus nucleated glass. Figures 307 and 308 clearly reveal a development of anorthite crystals and occasional pores (irregularly shaped black areas surrounded by a white halo); as to the nucleated glass, I suppose it is the reaction zone itself.

Other Chinese scholars,[644] however, are of the opinion that the white layer corresponds to anorthite crystals, which are white because of the so-called "bleaching" or "purifying" effect. According to Liang Guandeng's explanation[645] anorthite crystals are able to eliminate iron ions and other impurities whose frequency in that area diminishes, thus making it appear white. However, the natural colour of anorthite is white even when it contains small amounts of iron, and in natural iron-rich lavas, (e.g. basalt) anorthite does not tend to eliminate iron, therefore, this theory is not supported by geological analogies and cannot be accepted.[646]

More simply, Li Jiazhi states that between body and glaze there is a layer of anorthite crystals which form the reaction layer.[647]

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[641] See above chapter 4, paragraph 4.2.3, pp. 170-171.
[642] Guo Yanyi and Li Guozhen 1986 p. 170.
[643] Li Wenchao *et al.* 1992, A-30, pp. 222-226; for the English translation see volume in English, A-30, pp. 280-285.
[644] Chen Xianqiu *et al.* ISAC '89, p. 330; Zhang Zhigang *et al.*, ISAC '95 p. 65; Liang Guandeng 1985, p. 43 after Chen Xianqiu *et al.* 1981, pp. 250.
[645] Liang Guandeng 1985, p. 43.
[646] Private communication from Dr Doherty. Another explanation for the whiteness of the interlayer that sometimes develop between body and glaze has been provided by Rhodes (Rhodes 1996, p. 88), according to whom "the fluid glaze ...... tends to eat down into the clay a bit, taking some of it into solution and perhaps dissolving iron and other impurities from the clay surface".
[647] Li Jiazhi ed. 1998, p. 264.

A less controversial subject is the chemical composition of the reaction zone, usually described as being midway between that of the body and that of the glaze. Li Wenchao, Wang Jian and Li Guozhen[648] go to great length to explain the chemical and physical phenomena behind it, but only the results of their calculations are intelligible to non-scientists. Basically, the three scholars maintain that because of their different coefficients of expansion, the amounts of calcium and potassium in the transition layer decrease in comparison with the glaze, whereas the alumina content increases. During cooling, anorthite and silica separate out, but because the viscosity of the melt is rather high, silica does not crystallise. This is understandable, but the statement that the amount of bridging oxygen in the transition layer is much smaller than in the glaze, therefore the viscosity of the interlayer is lower than that of the glaze, hence air bubbles in the glaze move *towards* the transition layer is inadmissible.[649] Bubbles mostly form at the body-glaze interface and migrate to the surface propelled by their natural buoyancy and convection;[650] moreover, the interlayer cannot possibly be less viscous, that is, more fluid than the glaze, even if it is more fluid than the body. Li Wenchao *et al.*'s conclusion that the interlayer is composed of anorthite crystals and bubbles[651] is plausible as long as the bubbles are not believed to have migrated backwards from the glaze.

Another explanation for the reaction zone in Yaozhou blue/green wares of the Northern Song is proposed by Li Guozhen *et al.* who conclude that when the cooling is slow, wollastonite and anorthite crystals develop in the lower portion of the glaze layer because, as the equilibrium phase diagram shows, the Yaozhou glaze is located in the quartz-wollastonite-anorthite area.[652] This means that according to this group of scholars, the reaction zone is the product of the composition and therefore of the microstructure of the glaze, which is true, but their explanation ignores the fundamental role played by the firing cycle.

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[648] Li Wenchao *et al.* ISAC '92, pp. 224-225.
[649] Li Wenchao *et al.* ISAC '92, p. 225.
[650] See above chapter 4, p. 61.
[651] At p. 225 Li Wenchao *et al.* affirm that the transition layer is made of anorthite crystals and bubbles, but at p. 226 they add nucleated glass to the previous two components. See Li Wenchao *et al.* ISAC '92, pp. 225-226.
[652] Li Guozhen *et al.* ISAC '89, p. 259.

The slip is also considered a sort of crossbreed between body and glaze, being a super refined body made of kaolinitic clay containing free quartz and flux,[653] but, if from the chemical standpoint slip and reaction zone are similar, their appearance under the scanning electron microprobe is completely different, therefore, while a low power binocular microscope cannot distinguish them, its more sophisticated relative never fails.[654] However, the distinction between body and slip in microphotographs is not straightforward, as the only difference is the smaller size of quartz and pores in the slip in rapport to the body.[655]

The research led by Chen Xianqiu, which concentrates on Yaozhou wares of the Tang dynasty, raises two important questions: the formation of a reaction layer between slip and glaze and between body and glaze in Tang dynasty samples.[656] Chen Xianqiu and his colleagues have noticed a more or less continuous layer of anorthite crystals at the slip-glaze contact of blue/green samples and at the body-glaze boundary of an unslipped, black-glazed specimen which also displays a reaction zone between the glaze and the slip decoration applied over the glaze.

Probably because most Tang dynasty Yaozhou blue/green wares are slipped, the issue of the formation of a layer of secondary crystals at the slip-glaze boundary has been overlooked, but as observed on the microscopic examination of sample A, this is perfectly plausible, as the slip is a sort of super refined body which, therefore, can react with the glaze, provided that the firing conditions are met.

As to the black sample with overglaze slip decoration, it should not surprise that the glaze reacted with both the body underneath and the slip above, albeit it is a Tang dynasty specimen. According to a research by Yang Zhongtang *et al*, Yaozhou black wares were fired at higher temperature than their blue/green counterparts, as the higher degree of melting of the quartz and the higher amount of broken bonds in the molecular network structure prove.[657]

If their theory is correct, the Tang black glaze reacted with the body because the temperature in the kiln was high enough and maintained long enough to allow it.

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[653] Chen Xianqiu *et al.* ISAC '89, p. 332.
[654] See microphotographs and descriptions of samples A-F.
[655] Chen Xianqiu *et al.* ISAC '89, p. 333.
[656] Chen Xianqiu *et al.* ISAC '89, p.

4.3.6 Body

The body of Yaozhou wares varies in colour from very dark grey to grey, pale grey and buff, depending on its chemical composition and firing atmosphere.[658]

From the chemical composition standpoint, Chinese studies agree that alumina content is higher in Yaozhou and northern wares than in Longquan and southern wares in general with the exception of Southern Guan and black-bodied Longquan specimens.[659] A higher amount of aluminium oxide implies a more refractory nature of northern bodies in comparison with their southern counterparts.[660] As regards Yaozhou clay bodies, Li Jiazhi points out that the alumina content varied greatly (between 20 and 30%), suggesting that the clays were not washed according to a standardised method,[661] but the amount of alumina in a clay cannot be modified by the washing method. On the basis of the analysis of twenty-four Five Dynasties samples, Wang Fen *et al.* conclude that Five Dynasties clay bodies were characterised by low silica and high alumina content which compositionally qualifies them between the Tang and the Song period.[662]

Zhang Zhigang, Li Jiazhi and Zhuo Zhenxi notice not only the high content of alumina in Yaozhou and northern bodies, but also the elevated amount of titania and attribute the differences in the chemical composition of northern and southern bodies to the raw materials which, being of the sedimentary type, are richer in impurities in the north than in the south.[663]

According to Chinese studies, mullite is a constant in the body of Yaozhou wares. Li Guozhen and Guan Peiying believe that the growth of mullite in the body can be determined by the kneading of the paste,[664] whilst a more complex research[665] affirms that from the chemical composition it is possible to see that the main phases in the body are silica, potassium and alumina and from the thermodynamic equilibrium phase diagram

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[657] Yang Zhongtang *et al.* ISAC '95, pp. 74-76.
[658] For a good description of the colour and quality of Yaozhou bodies of the Five Dynasties, se Wang Fen ISAC '99, pp. 485-486.
[659] Guo Yanyi and Li guozhen 1986, p. 171; Zhang Zhigang *et al.* ISAC '95, p. 60.
[660] Li Guozhen and Guan Peiying (1979) 1982, p. 199.
[661] Li Jiazhi ed. 1998, p. 264.
[662] Wang Fen *et al.* ISAC '99, pp. 55-56.
[663] Zhang Zhigang *et al.* ISAC '95, pp. 60-61
[664] Li Guozhen and Guan Peiying (1979) 1982, p. 199.
[665] Li Guozhen *et al.* ISAC '89, p. 259.

(fig. 334)[666] it is possible to see that the body of Song dynasty Yaozhou wares falls in the quartz-mica-mullite area which means that in pseudo-equilibrium circumstances mullite, α-quartz and glass develop in the body.

Porosity, which is given by the ratio volume of pores to volume of sample, is a physical property that helps establishing the quality of a ceramic body: in general terms, the more porous the worse the quality, however, in practice complete vitrification is not advisable as this leaves no room for movement except by fracture. A body with a porosity of 1-2% is actually much stronger than a completely vitrified one.[667] A few Chinese studies refer to porosity, but unfortunately their calculations are not consistent: according to Guo Yanyi and Li Guozhen, the porosity of Yaozhou bodies is very irregular varying between 1 and 2.6%,[668] whilst according to the team led by Li Guozhen it is considerably lower in the Five Dynasties and Northern Song (respectively 0.57 and 0.51%) after a very high 6.6% in the Tang dynasty.[669] The discrepancy can be attributed to the subjectivity of this physical property and to the fact that tests have been carried out on too few samples to reach conclusive results. Zhang Zhigang and his colleagues simply say that Yaozhou bodies are highly porous[670] without specifying the percentage, thus making it difficult to interpret the information. Li Jiazhi, who associates porosity and water absorbance to the firing temperature, states that in the Tang dynasty, when the firing temperature was low, clay bodies resulted highly porous and water absorbant. While in the Song dynasty, when the firing temperature raised to 1320°C, porosity and water absorbance were low.[671]

4.3.7 Temperature

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666 Thermodynamic phase diagrams show how changes in composition and temperature affect the resulting microstructure. From the overall composition and firing temperature it is possible to determine the relative amount of each phase present in the microstructure by applying Gibbs' thermodynamic rules. The thermodynamic phase diagram is represented by a triangle at whose vertices are silica, potassia and alumina (in this case); the vertix represents 100% of that element, the opposite side represents 0%; in this way each point in the diagram corresponds to a particolar mixture of the three elements. Lines indicating the temperature isolate areas where particular compositions include certain phases. For more details see Kingery and Vandiver 1986, pp. 27-36.

667 Hamer and Hamer 1997, pp. 259-260.

668 Guo Yanyi and Li Guozhen 1986, p. 165.

669 Li Guozhen *et al.* ISAC '89, p. 260.

670 Zhang Zhigang *et al.* ISAC '95, p. 65.

671 Li Jiazhi ed. 1998, p. 264.

The firing temperature of Yaozhou wares in successive dynasties is not agreed on. This is partially due to the fact that it varied from firing to firing and scientists' conclusions are heavily biased by the characteristics of the specific samples they have tested. Furthermore, the chemical changes that occur during firing in the body and the glaze depend not only on the temperature, but also on the soaking. Nigel Wood has calculated that the same results are obtained if the temperature is increased by 15°C per hour in the last two hours of firing reaching 1251°C, or by increasing the temperature by 60°C per hour to 1285°C, or by 150°C per hour to 1305°C.[672] This means that a longer soaking at lower temperature produces the same effect that a shorter soaking at high temperature.[673]

According to Li Guozhen and Guan Peiying's tests, Yaozhou blue/green ware of the Song dynasty was fired at c. 1310°C, a temperature confirmed by Yang Zhongtang and his colleagues,[674] but considered too high by Guo Yanyi and Li Guozhen who establish it at 1300°C maximum and to low by Li Jiazhi who estimates it at 1320°C.[675] Another group of researchers lead by Li Guozhen,[676] proposes 1280°C for their Song specimen, 1290°C for the Five Dynasties and 1250°C for the Tang. As their tests were carried out on only one or two samples for each period, it is possible that they were not representative of the period and that the higher temperature results for the Five Dynasties rather than for the Northern Song are in fact anomalous.

The value of 1250°C for the Tang dynasty is refuted by another paper presented at the same conference which proposes 1200°C maximum on the basis of the lack of tridymite.[677] An even lower temperature has been calculated for the Tang dynasty by Zhang Zhigang, Li Jiazhi and Zhuo Zhenxi who suggest a temperature range between 1180°C in the Tang dynasty and 1320°C in the Yuan.[678]

From the data reported above, it is clear that there is no agreement on the firing temperature of Yaozhou blue/green wares of successive dynasties, however, it is

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672 Private communication from Mr Wood. See also Kingery and Vandiver 1986, pp. 224-226.
673 Shui Jisheng 1989, p. 450.
674 Yang Zhongtang *et al.*, ISAC '95, p. 75.
675 Guo Yanyi and Li Guozhen 1986, p. 171; Li Jiazhi ed. 1998, p. 264.
676 Li Guozhen *et al.* ISAC '89, p. 260.
677 Chen Xianqiu *et al.* ISAC '92, p. 333.
678 Zhang Zhigang *et al.* ISAC '95, p. 64; at p. 65 the same article states that Yaozhou ware was fired between 1190°C and 1320°C.

possible to notice a general progressive increase from the Tang to the Yuan dynasties which is consistent with the appearance of the vessels.

From a research on the molecular network structure of blue/green and black Yaozhou wares,[679] it appears that black wares tend to have a higher degree of broken bonds and a higher ratio of non-bridging oxygen/silicon. Bonds are broken by temperature, therefore the higher the degree of broken bonds the higher the firing temperature; the same applies to non-bridging oxygen. On this basis, one can assume that the firing temperature of black wares was higher than that of blue/green wares, however, Yang Zhongtang's team concludes that the melting, not the firing temperature was higher. I presume that the firing temperature is the temperature reached in the kiln for a specific batch and by definition, the melting temperature is the temperature at which the glaze becomes liquid, that is, all the bonds between oxides are broken.[680] Therefore, the melting point is determined by the chemical composition of the glaze, the firing temperature by the kiln structure and the ability of the workers who attended to the firing.

[679] Yang Zhongtang *et al.* ISAC '95, p. 74.
[680] Hamer and Hamer 1997, pp.219-220.

CONCLUSION

As archaeological excavations have proved, the Yaozhou kilns were set up at Huangbaozhen in the eighth century AD. Although they are famous essentially for their blue/green wares, at the beginning the bulk of the production consisted of *sancai* and black wares, followed by white and finally by blue/green wares whose quality was not excellent. *Sancai* wares (previously believed to have been made only at the Gongxian kilns in Henan) were made to satisfy the huge demand for funerary objects imposed by lavish **Tang** burial practices. Considering that this area had had no significant ceramic tradition prior to the establishment of the Yaozhou kilns, and the Tang capital, Chang'an, was only 100 km south of the kiln centre, it seems very probable that the Yaozhou kilns were set up in order to meet the increasing demand of the huge population of the capital for burial items. The body of Yaozhou *sancai* specimens appears very light, but this is due to the fact that the same iron-contaminated clay fired at about 1000°C results whiter than when fired at 1250-1300°C. Yaozhou *sancai* bodies were made from either high or low iron clays, the first (but sometimes the second too) subsequently coated with white slip to provide the light background necessary to enhance the colourful, brilliant and highly transparent lead glazes. *Sancai* wares were fired in oxidation, as lead glazes cannot be fired in reduction.

Besides burial objects, the population of the capital (and beyond) also needed vessels for everyday use. Black wares were relatively easy to make: the colour and texture of the body varied greatly at Huangbao depending on whether high or low iron clays were employed for it, but this did not matter, as the body was covered with black glaze. Generally speaking, in the Tang dynasty black wares were not particularly appreciated, they were mainly destined for everyday use, which is probably the reason why they were produced in great quantities. However, the Yaozhou potters soon began to experiment with new effects: black glaze designs over white slip or plain body, motifs carved through the black glaze, milky blue splashes over black glaze and underfired iron-rich glaze resulting in a brown-speckled, opaque coating evocatively called "tea-dust". Black wares were also fired in oxidation.

The most celebrated wares of the Tang dynasty were the white ware of the Xing kilns in Hebei and the blue/green ware of the Yue kilns in Zhejiang. The Yaozhou potters did attempt to make white ware and they actually produced two: one that can be called "true white ware", characterised by pale, slightly yellowish body made of low iron clays, and one that can be defined "imitation white ware", a stoneware made of relatively iron-rich clays and coated with white slip under a transparent, yellowish glaze. However, neither of the two types of Yaozhou white wares, which were fired in oxidation, could compete with those of contemporary Xing or Gongxian, which produced truly white-bodied ceramics.

Unsuccessful white wares and a drop in the demand for *sancai* after major changes in late Tang burial practices may be what prompted Yaozhou potters to experiment with blue/green wares: celadon glazes do not need to be applied on pure bodies, although they do require to be fired in a reducing atmosphere, a method previously unknown to Yaozhou potters and much more difficult to control than oxidation. Because of reduction firing, the body of Tang Yaozhou blue/green wares resulted unevenly grey, similar to a mixture of light- and dark-burning clays (the first purer than the second) poorly ground and mechanically mixed, scattered with black spots caused by particulate iron: had it been fired in oxidation like *sancai*, black and white wares, the iron impurities in the clays would have remained in their higher state of oxidation and would have not reacted with and diffused into the bodies. The impurities in the body were concealed by coating the vessels with a layer of white slip already used on some *sancai*, "imitation white" and even some black wares, which also enhanced the glazes' colours. From the chemical compositions available at present, it seems that the bodies of Yaozhou black, some *sancai*, "imitation white" and blue/green wares were very similar, thus suggesting that their original recipes were very much the same; the slip recipe was also relatively constant. Tang Yaozhou blue/green glazes are of the lime type, chemically very similar to those of Yue ware, except for the content of titanium dioxide which is extremely low in the Yaozhou recipe. This implies that the Yaozhou glaze technology remarkably differed from Yue: Yaozhou potters did not include any significant portion of body or white slip clays in the glaze recipe, thus opening the way for making northern high-quality blue/green glazes, such as Ru. A comparison of the chemical compositions of Yaozhou "imitation white" and blue/green wares shows very close similarities, which confirms that the technology of Yaozhou blue/green ware developed directly from local oxidised ceramics, particularly from "imitation white ware". This view is also consistent with the fact that Tang celadon samples are less numerous than Yaozhou black and white wares, and apparently not very successful. The phosphorous pentoxide content in the glaze suggests that wood-ash may have been included as flux.

Although the first Yaozhou celadon samples were not very effective, presumably because workers were not familiar with reduction firing, they eventually mastered the technique, which in turn led to the production of beautiful bluish-green, translucent glazes in the **Five Dynasties** period and to the Yaozhou kilns specialising in celadon at this time. The specialisation in blue/green ware may have also been influenced by political circumstances: during the Five Dynasties, communication between north and south China became difficult, thus the demand for celadons from the north could no longer be met by the Yue kilns. This, in conjunction with the fact that *sancai* ware was no longer required, and that Yaozhou white ware was really a white-slipped stoneware that could not compare with the great traditions of Gongxian, Xing and Ding, while its black ware was not as appreciated as white or blue/green wares, contributed with their success at controlling reduction firing to direct the efforts of the Yaozhou potters towards the production of celadon.

The body of Five Dynasties Yaozhou blue/green wares appears very dark, almost black, and more uniform in comparison with its Tang counterpart, but microscopic analysis shows that the improvement was not due to a better paste, but to better firing conditions (higher temperature and/or longer soaking) which produced a more mature fabric. From a chemical standpoint, there are some differences between Tang and Five Dynasties bodies, but they are negligible. Like in the Tang dynasty, Five Dynasties bodies were coated with a layer of white slip in order to prevent particulate iron in the body from showing through, but the titania-rich slip often caused the glaze to assume an undesirable yellowish tinge. To avoid this defect, Yaozhou potters started to fully-glaze their celadon pieces, but this method presented them with other problems, such as handling and firing the objects without having them stick to the saggars in which they were placed for firing. The first "anti-adhering" method developed at Yaozhou consisted of providing the bottom of the saggar with three piles of granular quartz which supported the foot rim of the specimen to be fired. This technique had the drawback that the grit adhering to the foot rim made it rough in places. Attempts to minimise the extent of the adhesions were made until the Yaozhou craftsmen re-adapted the three-armed spacers used in the Tang dynasty to fire vessels in stacks, only this time, they were placed upside down, that is, with the spurs turned up under the foot of the objects. In this way, only three small scars were left on the foot. The technique was further refined by placing the setter under the base, so that a fully glazed and perfectly smooth foot was accomplished, and by sharpening the spurs, so that only tiny scars were visible. In this way, the Yaozhou potters anticipated their Qingliangsi colleagues, who have always been acknowledged with the invention of this technique, by at least 150 years.

If Five Dynasties potters continued to prepare the body paste virtually in the same way as their Tang predecessors, they did experiment with their celadon glaze. This is visible from the chemical composition of the glazes of Five Dynasties blue/green samples: they are all low in titanium dioxide, but while some are lime glazes (like Tang ones), other are lime-alkali. The low titania content guaranteed a fine, bluish-green colour - when reduction firing was managed correctly – and the lime-alkali nature allowed thicker application of the glaze which thus resulted more unctuous and smooth, just like jade. Although the amount of calcium oxide varies greatly in the chemical composition of Five Dynasties blue/green samples, the phosphorous pentoxide content is always proportional to that of CaO, thus corroborating the argument that wood-ash may have been a significant ingredient in the glaze recipe.

Despite the short history of the Yaozhou kilns and even shorter blue/green ware tradition, in the Five Dynasties Yaozhou potters accomplished a product high enough in quality to attract the attention of the government: Yaozhou blue/green ware was one of the very few ceramics selected to enter the tribute system. Objects destined for this purpose were distinguished by engraving the mark *guan* (official) on their base.

Although fully glazed vessels are aesthetically very pleasing, the technology behind them is very complex and their failure rate was high (with considerable economic loss). A more refined body paste would have permitted the elimination of slip-coating and allowed full-glazing. From archaeological evidence, it appears that at the beginning of the **Northern Song** period Yaozhou potters finally achieved better body pastes by crushing the clays to fine powder, reducing them to slip consistency and screening them through a small-mesh sieve. This yielded very homogeneous, pale grey and well matured bodies which no longer required the application of a layer of white slip, therefore vessels could be fired standing on their glaze-free foot rim. Better refinement of raw materials had direct positive consequences on firing efficiency: at equal temperature (and refractoriness), a more refined body matured more easily than a coarse one. But another change was about to transform the visual appearance of Yaozhou blue/green ware: the introduction of coal as fuel.

Since the establishment of factories at Huangbaozhen in the eighth century, furnaces had been fuelled with wood, which sometime in the eleventh century was replaced by coal, presumably because of a shortage of wood balanced by huge local deposits of coal. Coal is characterised by a short flame and burns slowly, which required alterations to the kiln structure. An ash pit was dug in the ground of the firebox and covered with a grating to let the coal ash fall down and thus not hamper the combustion of the remainder. A ventilation duct running underground from a (optional) shallow pit outside the kiln to the ash pit was added to maximise the ventilation system, to remove clinker from the ash pit during firing and contemporarily warm up the air entering the kiln through the ventilation channel lined with hot ash and cinder. In order to even out the temperature in the kiln at the height of the firing, coal-burning *mantou* furnaces required very long high-temperature soaks during which the glaze came to full maturity. Deliberate fast cooling, perhaps encouraged by allowing air into the white-hot kiln-chamber at the end of the firing, prevented devitrification, thus creating transparent glazes.

Moreover, coal burning emitted sulphur which combined with the iron in the glaze and made the latter assume an olive-green hue.

During the long high-temperature soaks secondary anorthite crystals precipitated at the body-glaze boundary thus guaranteeing an overall white background that enhanced the transparency and colour of the glaze, just like a layer of white slip.

These new circumstances, particularly the transparent nature of the glaze, may be at the basis of the introduction of carved (and later impressed) decorating motifs on the body: now that the jade-like effect was no longer achieved and the transparent glaze produced a rather dull effect on a plain background, Yaozhou potters re-invented their main product by embellishing it with bold carved patterns. Besides celadon, in the Northern Song period Yaozhou craftsmen also produced remarkable black wares including the so-called "hare's fur" and "oil spot" types, and russet (also called persimmon) wares of such high quality to stand the comparison with the same ceramics from the celebrated Ding kilns.

However, Huangbaozhen became synonymous with boldly decorated vessels coated with transparent olive-green glaze. These were so successful that production grew enormously, and Yaozhou was the first kiln centre whose ceramic divinities were granted the official title of "marquis". The beauty of this new genre of Yaozhou blue/green ware was also recognised by the Song court who accepted as tribute.

Between the Tang and the Song dynasty, the visual aspect of Yaozhou blue/green wares changed so remarkably that without archaeological evidence, one would doubt that Five Dynasties and Song specimens came from the very same kiln centre. The development of Yaozhou ceramics, in particular that of blue/green ware, seems to have been linked closely to changes in the firing methods adopted at the Yaozhou kilns.

Judging from archaeological evidence, the Yaozhou kilns were not deeply affected by the fall of northern China into the hands of the Jurchen in 1126. Not only production was resumed soon after the establishment of the **Jin** dynasty, but the kilns maintained the high standards of the Song period, and the so-called "moon white" glaze (experimented with at the very end of the Northern Song period) was perfected. Yaozhou "moon white" ware is characterised by shiny and soft glazes with a jade-like appearance that echo Five Dynasties Yaozhou blue/green ware or contemporary Longquan celadon. However, towards the end of the Jin dynasty, the Yaozhou kilns began to produce lower quality wares for a less demanding market: vessels were thickly potted, decorated with stiff and repetitive moulded patterns, and coated with dull, brownish-green glazes.

This trend was further accentuated in the **Yuan** dynasty, when the Yaozhou kilns produced little, low quality celadon and concentrated instead on black-and-white and black wares. In the **Ming** dynasty, the Huangbaozhen kilns were shut down. Factories and the temple to kiln divinities were set up in nearby Chenluzhen, but the essence of the Yaozhou ceramics was irreparably lost.

The reputation of the Yaozhou kilns, that Southern Song literary sources had already damaged by reporting first contradictory and then negative comments, was irremediably compromised by Yuan intellectuals who labelled Yaozhou ceramics as second rate imitations of Ru ware. When Ming and Qing scholars did not ignore the

Yaozhou kilns altogether, they perpetuated the negative perception inherited from their predecessors, despite the different account supplied by local gazetteers.

Although the decline of the Yaozhou kilns has often been associated to the Jin conquest, it is possible that their fate was already doomed by then. Emperor Song Huizong had directed ceramic taste towards intense, unctuous, smooth, bluish-green glazes first selecting Ru ware and then establishing his own factories within the imperial palace. By the time the Song court fled Kaifeng to take refuge in Hangzhou, the jade-like style had emerged, Yaozhou wares were no longer requested at court and their style had already been adopted by the Longquan kilns. The latter quickly adapted to the taste promoted by the court, while since the introduction of coal as fuel the Yaozhou kilns no longer had the right environment to produce jade-like glazes. An attempt was made with "moon white" ware, but its unctuousness and colour could not compare with Southern Guan and Longquan wares. Superseded by Longquan, the Yaozhou kilns were ignored and forgotten to the point that by the twentieth century, the connection between specimens with vivid motifs carved (or impressed) under a transparent, olive-green glaze and Huangbaozhen was lost.

It has taken an impressive, full-scale archaeological campaign lasted the best part of two decades and Zhuo Zhenxi's team's painstaking collection and generous publication of data to attract the attention of contemporary scholars on the importance of the Yaozhou kilns.

Nonetheless, the unique position that Huangbaozhen held as a true ancestor to magnificent Ru and consequently Guan and Ge wares has not yet been recognised.

Sabrina RASTELLI

THE YAOZHOU KILNS: A RE-EVALUATION

Volume 2

A thesis submitted to the University of London
in partial fulfilment of the requirements for the
degree of Doctor of Philosophy

School of Oriental and African Studies,
University of London

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APPENDIX I

CHINESE TEXTS

Text 1. 博物要覽 *Bowu yaolan, juan* 2, ff. 1a-8a.

The text could not be photocopied; the list of mentioned is as follows:

汝，官，哥窯 (ff. 1a-5a); 定窯 (ff. 5a-6b); 龍泉窯 (ff. 6b-7a); Jian 建窯 (ff. 7a-7b); 鈞窯 (ff. 7b-8a); 大食窯 (f. 8a); 玻璃 (f. 8a); 饒州窯 (ff. 8a-10a).

After 中國近代小説史料續編 *Zhongguo jindai xiaoshuo shiliao xubian* 1986.

Text 2. 茶經 *Cha jing*, middle *juan*, f. 6b.

盌. 盌越州上鼎州次婺州次岳州次壽州次洪州次.....

After 欽定四庫全書 *Qinding siku quanshu*, 子 *zi* section no. 150, 譜錄 *pulu* category, general vol. 844, p. 617.

Text 3 *Chenluzhen xishe zhongxiu yaoshenmiao beiji* 陳爐鎮西社重修窯神廟碑記, engraved in 1726,

清雍正四年重修窑神庙碑记（陕西耀州窑） 1726

皇清重修窑神庙碑记

陈炉镇西社重修窑神庙碑记

同邑东南乡土少石多大都以陶谋生其先则始于黄堡自汔窑厂废而陈炉镇西方始习其□□

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得告竣雍正三年阖社等以旧所输银年久猝不能索仍输资捐工而仪像庄严矣栋宇辉□□□

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弁首事者之功以笔之于书 癸卯科举人候铨知县崔锺琰撰文 庠生孙琦书丹 庠生孟继讨篆额

以下为总理事会首捐钱人姓名及捐钱数目

（以下姓氏名录略）

After Li Yihua 李毅華 and Yang Jingrong 楊靜榮 1987. "Yaoshen beiji zongkao" 窯神碑記綜考, in: *Zhongguo gu taoci yanjiu* vol. 1, 1987, p. 51.

Text 4. 德應侯碑 *Deying hou bei.*

宋元丰七年德应侯碑（陕西耀州窑）

宋耀州太守　阎公奏封　德应侯之碑

三秦张　隆　撰并书及题额

熙宁中尚书郎　阎公作守华原郡寻明年时和政通奏

土山神封

德应侯

贤侯上章

天子下诏　黄书布渥

明神受封庙食终古不其盛哉

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之中其灵又不可穷也殿之梁间板记且古哉

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侯之勤碑为文刻诸石将使万古之下传之无穷又皆知

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三公之下矣斯诚可纪闲无请荒芜之言直笔以书之

大宋元丰七年九月十八日立石

镇将刘德安　张化成

三班奉职监耀州黄堡镇酒税兼烟火吕　闰

茂陵马化成施石立碑男马安　马信　马明

太原王吉掌　敕．　看庙清河张显　州人刘元刊

After Li Yihua and Yang Jingrong 1987, p. 49.

Text 5. 負暄雜錄 *Fuxuan zalu*.

本朝以定州白磁器有芒不堪用遂命汝州造青窯器故河北唐鄧耀州悉有之汝窯為魁.

After the 說郛 *Shuofu*, by Tao Zongyi 陶宗儀, *juan* 18, f. 10b.

說郛 *Shuofu*, *juan* 18, f. 10b. After 陶宗儀 Tao Zongyi, 說郛 *Shuofu*, 陶珽 (纂) Tao Ting (compiled by), 說郛續 *Shuofu xu*, 李際期宛委山堂 Li Jiqi Wanweishan tang, 1646.

Text 6. 格古要論 *Gegu yaolun*, third *juan*, ff. 1a-4b.

欽定四庫全書
格古要論卷下
明　曹昭　撰
古窯器論
柴窯
出北地世傳柴世宗時燒者故謂之柴窯天青色滋潤細媚有細紋多足麄黄土近世少見
汝窯
出北地宋時燒者淡青色有蟹爪紋者真無紋者尤好土脉滋媚薄甚亦難得
官窯
宋修内司燒者土脉細潤色青帶粉紅濃淡不一有蟹爪紋紫口鐵足色好者與汝窯相類有黒土者謂之烏泥窯僞者皆龍泉燒者無紋路
董窯
淡青色細紋多亦有紫口鐵足比官窯無紅色質麄而不細潤不逮官窯多矣今亦少
哥窯
舊哥窯色青濃淡不一亦有鐵足紫口色好者類董窯今亦少有成羣隊者元末新燒者土脉麄燥色亦不好
象窯
有蟹爪紋色白而滋潤者高色黄而質麄者低俱不甚直錢
高麗窯
古高麗窯器皿色粉青與龍泉窯相類上有白花朶兒者不甚直錢
古定器
古定器土脉細色白而滋潤者貴質麄而色黄者價低外有淚痕者是真劃花者最佳素者亦好繡花者次之宣和政和間窯最好但難得成羣隊者有紫定色紫有墨定色黑如漆土俱白其價高如白定俱出定州東坡詩云定州花瓷琢紅玉凡窯器茅篾骨出者價輕

曰茂無油水曰骨出此青骨黄中話也

吉州窯

其色與紫定相類體厚而質麁係吉州燒者不甚直錢

古磁器

好者與定相類但無淚痕亦有劃花繡花素者價低於

定器新者不足論

古建器

建碗盞多是𥫗口色黑而滋潤有黄兎毫斑滴珠大者

欽定四庫全書　格古要論 卷下　三

真但體極厚俗甚少見薄者

古龍泉窯

古青器土脉細且薄翠青色者貴粉青色者低有一等

盌底雙魚盌口有銅掇環體厚者不甚佳

古饒器

御土窰者體薄而潤最好有素折腰樣毛口者體雖厚

色白且潤尤佳其價低於定元朝燒小足印花者内有

樞府字者高新燒者足大素者欠潤有青花及五色花

者且俗甚矣

霍器

出霍州元朝劍金匠彭君寶效古定制折腰樣者甚整

齊故曰彭窰土脉細白者與定相似皆滑口欠滋潤極

脆不甚直錢賣骨董者稱為新定器好事者以重價收

之尤為可笑

大食窰

以銅作身用藥燒成五色花者與拂郎嵌相似嘗見香

欽定四庫全書　格古要論 卷下　四

爐花瓶合兒盞子之類但可婦人閨閣中用非士夫文

房清玩也又謂之鬼國窰

古無器皿

古人喫茶湯俱用甆取其易乾不留滓飲酒用盞未嘗

把盞故無勸盤今所見定勸盤乃古之洗古人用湯瓶

酒注不用胡瓶及有嘴折盂茶鍾臺盤此皆外國所用

者中國始於元朝汝定官窰俱無此器

古漆器論

After 欽定四庫全書 *Qinding siku quanshu*, 子 *zi* section no. 177, 雜家 *zajia* category, general vol. 871, pp. 106-108.

Text 7. 懷州修武縣當陽村土山德應侯百靈廟記 *Huaizhou Xiuwuxian Dangyangcun tushan Deying hou Bai Ling miao ji.*

Excerpts after Chen Wanli 1954, pp. 44-45:

……元符三年七月十五日蓋廟畢……

……大宋崇寧四年歲次乙酉閏二月十五日建……

……造範砦器乃其糴郡立祠……

……遂斸日發徒遠邁耀地觀其位貌繪其神儀而立廟像於玆焉……

……世利玆器埏埴者百餘家資養者萬餘口……

After Ye Zhemin 1983, p. 177:

"大哉百靈之智也，造範磁器乃其始".

"斸日發徒遠邁耀地觀其位貌繪其神儀".

After Fu Zhenlun 1994, p. 15:

"百靈之智，耀郡之祠，當陽之巧 世利玆器，埏埴者百餘家，資食者萬餘戶，都戶溫良昆仲一吾徒，世事此業，……遠邁耀地，觀其位（廟？）貌，繪其神儀，乃立廟像於玆焉。程筠號葆光作歌，當陽陳立子荃子徒，……造範玆器，砦得百靈（柏林）之妙意卞國、河朔江南事一同，故鄉遠在鄐君（郡）國，鄐郡之民善陶冶。熙寧四年乙酉（1071）閏二月十五日建。元符三年（1080）七月十五日蓋廟畢，扈虞、雷順、楊貴立石".

Text 8a. 景德鎮陶錄 *Jingdezhen taolu, juan* 6, ff. 1a-5a.

景德鎮陶錄卷六

昌南藍　浦濱南氏原著

門人鄭廷桂問谷補輯

鎮仿古窯攷

定窯

宋時所燒出直隸定州有南定器北定器土脈細膩質薄有光素凸花劃花印花繡花諸種多牡丹萱草飛鳳花式以白色而滋潤爲正白骨而加以泑水有如淚痕者佳俗呼粉定又稱白定其質粗而微黃者低俗呼土定東坡試院煎茶詩云定州花瓷琢紅玉蔣記云景德鎮陶器有饒玉之稱視眞定紅瓷足相競則定器又有紅者間造紫定黑定然

f. 1a

惟紅白二種當時尙之唐氏肆攷云古定器以政和宣和間窯爲最好色有竹絲刷紋其出南渡後者爲南定北貴於南劃花最佳光素亦好昌南窯倣定器用青田石粉爲骨質粗理鬆亦曰粉定其紫定色紫黑定色若漆無足重也

汝窯

汝亦汴京所轄宋以定州白器有芒不堪用遂命汝州建青器窯土細潤如銅體有厚薄色近雨過天青汁水瑩厚若堆脂有銅骨無紋銅骨魚子紋二種格古要論云汴中棱眼隱若蟹爪者尤佳輟耕錄云河北唐鄧耀州悉效之而汝窯爲魁底有芝麻花細小掙釘當時珍尙

唐氏肆攷云汝器土脉質製較官窯尤滋潤薄者爲貴屑瑪瑙爲油如

f. 1b

哥而深微似卵白眞所謂淡青色也然無紋者尤好

官窯

宋大觀政和間汴京自置窯燒造命曰官窯土脈細潤體薄色青帶粉
紅濃淡不一有蟹爪紋紫口鐵足大觀中釉尙月白粉青大綠三種政
和以後惟青分濃淡耳

案南渡時有邵成章提舉後苑襲舊京遺製置窯於修內司燒造曰內
窯亦名官窯澄泥爲範極其精製釉色亦瑩澈爲當時所珍　後郊壇
丁別立新窯亦曰官窯式製不殊比之舊窯內窯大不侔矣
唐氏肆攷云古官器其妙處當在體質油色色帶白而薄如紙者頗亞
於汝僞者皆龍泉所造無紋路南宋餘姚秘色甆今人率以官窯目之

f. 2a

不能別白間見亂眞

東窯

北宋東京民窯也卽今開封府陳留等處土脈黎細質頗粗厚淡青色
亦有淺深多紫口鐵足無紋比官窯器少紅潤唐氏肆攷誤以爲董窯
又云核之董窯似官其不同者質粗欠滋潤蓋東董聲相近唐氏半採
格古要論乃傳聞之訛也

案古東器雖有紫口鐵足無蟹爪紋不逮官窯多矣唐氏何得云似陶
成記事亦稱東窯載東青有淺深二種唐氏於東青色則書冬青何不
自知東之訛董也且今所倣東青器倂無紫口鐵足或更加彩矣

龍泉窯

f. 2b

宋初處州府龍泉縣琉田市所燒土細埴質頗粗厚色甚葱翠亦分淺深無紋片有一等盆底有雙魚盆外有銅掇環器質厚實者耐摩弄不易茅蔑第工匠稍拙製法不甚古雅耳景德鎭唐窰有做龍泉寶燒一種尤佳格古要論以爲亦有薄式

唐氏肆攷云古龍泉器色甚葱翠妙者可與官哥爭豔但少紋片紫骨鐵足耳

哥窰

宋代所燒本龍泉琉田窯處州人章姓兄弟分造兄名生一當時別其所陶曰哥窯土脈細紫質頗薄色青濃淡不一有紫口鐵足多斷紋隱裂如魚子釉惟米色粉靑二種汁純粹者貴

f. 3a

唐氏肆攷云古哥窰器質之隱紋如魚子古官窰器質之隱紋如蟹爪碎器紋則大小塊碎古哥器色好者類官亦號百圾碎今但辨隱紋耳又云汁油突不如官窰案哥窰在元末新燒土脉粗燥色亦不好見格古要論舊呼哥哥窰亦取土於杭

章龍泉窰

卽生一之弟章生二所陶者仍龍泉之舊又號章窰或曰處器青器土脉細膩質薄亦有粉青色翠青色深淺不一足亦鐵色但少紋片較古龍泉製度更覺細巧精緻至今溫處人猶稱爲章窰

唐氏肆攷云兄弟二窰其色皆青有濃淡皆鐵足舊聞有紫足少見惟哥窰有紋弟章窰無紋爲別春風堂隨筆云章窰所陶青器純粹如美

f. 3b

玉爲世所貴即官窯之類案白壤所造外塗洳水翠淺露白痕者眞明
初窯移處州青器土堅火候漸不及前矣
均窯
亦宋初所燒出鈞臺鈞臺宋亦稱鈞州即今河南之禹州也土脉細釉
具五色有兔絲紋紅者若臙脂硃砂爲最青若葱翠紫若墨者次之三
者色純無少變雜者爲上底有一二數目字號爲記者佳若青黑錯襍
如垂涎皆三色之燒不足者非別有此樣俗取梅子青茄皮紫海棠紅
猪肝騾肺鼻涕天藍等名蔣記云近年新燒皆砂土爲骨釉水微似製
有佳者俱不耐久
唐氏肆攷云均窯始禹州禹州昔號鈞臺均合葢鈞今通作均沿寫已

f. 4a

久此窯惟種菖蒲盆底佳甚他如坐墩罏合方缾罐子多黃沙泥坯則
器質不佳案唐說特就古均器言之耳若今鎮陶所倣均器土質既佳
缾罏尤多美者
碎器窯
南宋時所燒造者本吉安之廬邑永和鎮另一種窯土粗堅體厚質重
亦具米色粉青樣用滑石配釉走紋如塊碎以低墨土赭搽薰既成之
器然後揩淨遂隱含紅黑紋痕冰碎可觀亦有碎紋素地加青花者
唐氏肆攷云吉州宋末有碎器亦佳今世俗訛呼哥窯其實假哥窯雖
有碎紋不同魚子且不能得鐵足若鐵足則不能有聲惟仍呼碎器爲
稱案所謂紫口鐵足今鎮陶多可僞設即魚子紋亦不必定屬汝哥類

f. 4b

凡圓琢小件皆有精倣者矣

f. 5a

After Huang Binhong 黃賓虹 and Deng Shi 鄧實 (eds.), *Meishu congshu* 美術叢書, Shanghai: Shenzhou guoguang shi, 1947, 集 2, 輯 8.

Text 8b. 景德鎮陶錄 *Jingdezhen taolu, juan* 7, f. 4a.

耀州窯. 耀州今屬西安府亦宋燒青器色質俱不逮汝窯後燒白器頗勝然陶成皆不堅緻易茅損所謂黃浦鎮窯也.

After Huang Binhong 黃賓虹 and Deng Shi 鄧實 (eds.), *Meishu congshu* 美術叢書, Shanghai: Shenzhou guoguang shi, 1947, 集 2, 輯 8.

Text 8c. 景德鎮陶錄 *Jingdezhen taolu, juan* 9, f. 7a

宋時官中所有定汝器率銅鈐其口以是損價而今之求定汝者卽以銅鈐口爲真骨董家論古往往如此.

After Huang Binhong 黃賓虹 and Deng Shi 鄧實 (eds.), *Meishu congshu* 美術叢書, Shanghai: Shenzhou guoguang shi, 1947, 集 2, 輯 8.

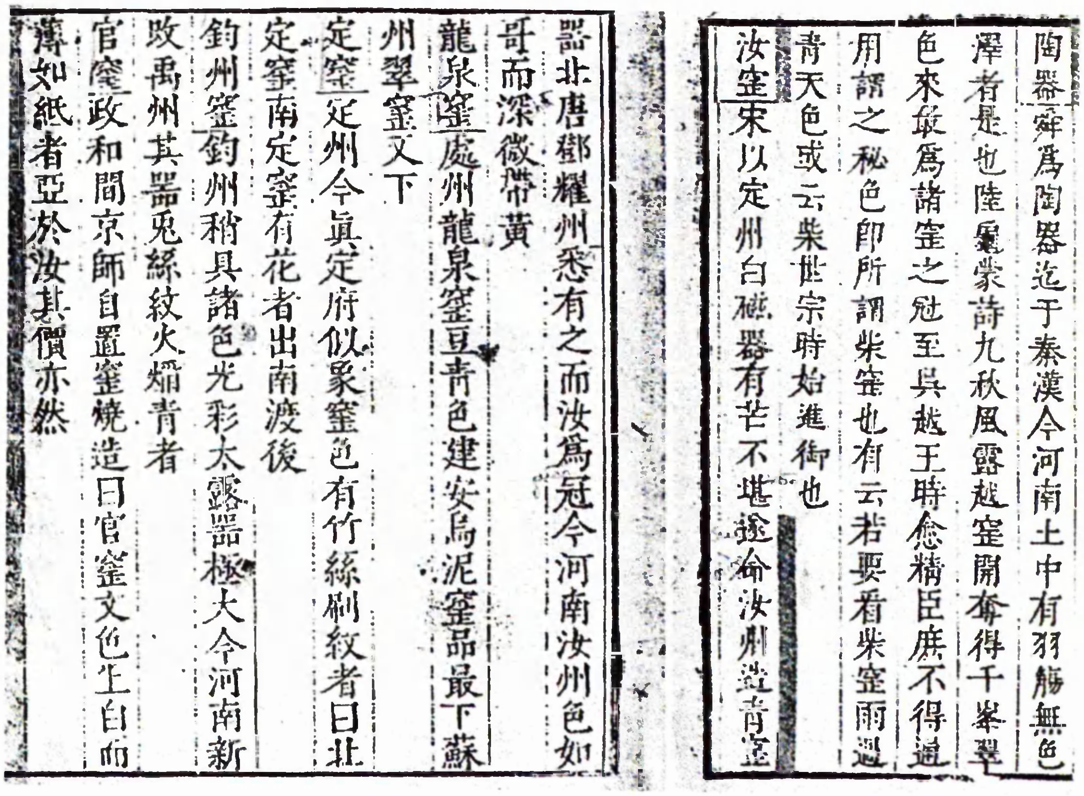
Text 9. 老學庵筆記 *Laoxue an biji, juan* 2, f. 11a.

故都時定器不入禁中惟用汝器以定器有芒也.

……耀州出青瓷器謂之越器似以其類餘姚縣秘色也然極麁樸不佳惟食肆以其耐久多用之.

After 欽定四庫全書 *Qinding siku quanshu*, 子 *zi* section no. 171, 雜家 *zajia* category, general vol. 865, p. 17.

Text 10. 留留情 *Liuliuqing*, *juan* 6, ff. 6b-7b.



陶器 舜爲陶器迄于秦漢今河南土中有羽觴無色
澤者是也陸龜蒙詩九秋風露越窯開奪得千峯翠
色來最爲諸窯之冠至吳越王時愈精臣庶不得進
用謂之秘色即所謂柴窯也有云若要看柴窯雨過
青天色或云柴世宗時始進御也
汝窯 宋以定州白磁器有芒不堪遂命汝州造青窯

器北唐鄧耀州悉有之而汝爲冠今河南汝州色如
哥而深微帶黃
龍泉窯 處州龍泉窯豆青色建安烏泥窯品最下蘇
州翠窯又下
定窯 定州今眞定府似象窯色有竹絲刷紋者曰北
定窯南定窯有花者出南渡後
鈞州窯 鈞州稍具諸色光彩太露器極大今河南新
敗禹州其器兎絲紋火焰青者
官窯 政和間京師自置窯燒造曰官窯文色上白而
薄如紙者亞於汝其價亦然

f. 7a　　　　f. 6b

After David 1936-37, pl. 14 reproduced from the 1614 edition of the *Liuliuqing*, (one copy available in the Percival David Foundation of Chinese Art, University of London).

Text 11. 清祕藏 *Qingbi zang*, first *juan*, ff. 9a-10b.

論窑器

論窑器必曰柴汝官哥定。柴不可得矣聞其製云青如天明如鏡薄如紙聲如磬此必親見故論之如是其真

余向見殘器一片製為絛環者色光則同但差厚耳又曹明仲云柴窑足多黃土未知然否汝窑余嘗見之其色卵白汁水瑩厚如堆脂然汁中棕眼隱起若蟹爪底有芝蔴花細小掙釘者乃真也。較官窑質製尤滋潤官窑品格與哥窑大約相同其色俱以粉青色為上淡白色次之油灰色最下紋取冰裂鱔血為上梅花片墨紋次之細碎紋最下必鐵足為貴紫口為良第不同者官窑質之隱紋亦如蟹爪哥窑質之隱紋如魚子其汁料

f. 9b f. 9a

稍不如官窑之尤佳耳定窑有光素凸花二種以白色為正白骨而加以泑水有如淚痕者佳間有紫色者黑色者不甚珍也

均州窑紅若臙脂者為最青若葱翠色紫若墨色者次之色純而底有一二數目字號者佳其雜色者無足取均州窑之下有龍泉窑古宋龍泉窑器土細質厚色甚葱翠妙者與官窑爭艷但少紋片紫骨鐵足耳且極耐磨弄不易茅篾第工匠稍拙製法不甚古雅有等用白

土造器外塗泑水翠淺影露白痕乃宋人章生所燒號曰章窑較龍泉製度更覺細巧精緻我朝宣廟窑器質料細厚隱隱橘皮紋起冰裂鱔血紋者幾與官汝窑敵即暗花者（內燒絕細龍鳳暗花底有大明宣德年製暗款六字）紅花者（以西紅寶石為末圖畫花鳥魚蟲等形骨內燒出凸起寶光鮮紅奪目）青花者（用蘇浡泥青圖畫龍鳳花鳥蟲魚等形深厚堆垛可愛）皆發古未有為一代絕品迥出龍泉均州之上又有元燒樞府字號器永樂細款青花杯成化五彩蒲萄杯各有可取然亦尚在龍泉章窑之下

f. 10b f. 10a

After 欽定四庫全書 *Qinding siku quanshu*, 子 *zi* section no. 178; 雜家 *zajia* category, general vol. 872, pp. 7-8.

Text 12. 清波雜志 *Qingbo zazhi, juan* 5, f. 9.

耀州黃浦鎮燒甆名耀器白者為上河朔用以分茶出窯一有破碎即棄于河一夕化爲泥.
After 欽定四庫全書 *Qinding siku quanshu*, 子 *zi* section no. 345, 小説家 *xiaoshuojia* category, general vol. 1039, p. 36.

Text 13. 清異錄 *Qingyi lu*, second *juan*, f. 25b.

小海鷗. 耀州陶匠創造一等平底深盌狀簡古號小海鷗.
After 欽定四庫全書 *Qinding siku quanshu* 子 *zi* section no. 353, 小説家 *xiaoshuojia* category, general vol. 1047, p. 900.

Text 14. 宋史 *Songshi, juan* 87, 志 record 40, 地理 geography 3.

耀州緊華原郡開寶五年為感義軍節度太平興國初改感德軍崇寧戶一十萬二千六百六十七口三十四萬七千五百三十五貢瓷器縣六華原富平三原雲楊同官美原.
After 脫脫 Tuo Tuo, 宋史 *Songshi*, Beijing: Zhonghua shuju, 1977, vol. 7, p. 2146.

Text 15. 宋會要- 食貨 *Song huiyao- shihuo, juan* 52, 瓷器庫 *Ciqiku*, f. 37a.

瓷器庫在建隆坊掌受明越饒州定州青州白瓷器及漆器……
After *Song huiyao jigao*, Taibei: Xinwenfeng, 1976, vol. 146, p. 5703.

Text 16. 太平寰宇記 *Taiping huanyu ji, juan* 31, f. 1.

欽定四庫全書

太平寰宇記卷三十一

宋 樂史 撰

關西道七

耀州

耀州華原郡今理華原縣本雍州之地在秦為北地郡
泥陽富平隸焉後為華原縣漢魏至唐皆為畿甸唐末
李茂貞據鳳翔僭行墨制建剬耀州仍為義勝軍節度
使剬同州美原為鼎州以為屬郡温韜為節度使梁貞

欽定四庫全書　太平寰宇記 卷三十一　一

明元年韜降於梁乃改耀州為崇州義勝軍為靜勝軍
又改鼎州為裕州依舊以温韜為節度使後唐同光元
年改為耀州順義軍并割雍州之富平三原雲陽同官
美原以屬焉三年降為團練州周顯德中降為刺史皇
朝升為感德軍節度

After 欽定四庫全書 *Qinding siku quanshu*, 史 *shi* section no. 227, 地理 *dili* category, general vol. 469, p. 267.

Text 17. 坦齋筆衡 *Tanzhai biheng*.

f. 13a

窑器

宋葉寘坦齋筆衡云陶器自舜時便有三代迄于秦漢所謂甓器是也今土中得者其質渾厚不務色澤末

欽定四庫全書　輟耕錄 卷二十九

俗尚靡不貴金玉而貴銅磁遂有秘色窑器世言錢氏有國日越州燒進不得臣庶用故云秘色陸龜蒙詩九秋風露越窑開奪得千峯翠色來如向中宵盛沆瀣共嵇中散鬬遺杯乃知唐世已有非始於錢氏本朝以定州白磁器有芒不堪用遂命汝州造青窑器故河北唐鄧耀州悉有之汝窑為魁江南則處州龍泉縣窑質頗麤厚政和間京師自置窑燒造名曰官窑中興渡江有邵成章提舉後苑號邵局襲故京

f. 13b

遺製置窑于修内司造青器名内窑澄泥為範極其精製油色瑩徹為世所珍後郊壇下别立新窑比舊窑大不侔矣餘如烏泥窑餘杭窑續窑皆非官窑比若謂舊越窑不復見矣

f. 14a

After the 輟耕錄 *Chuogeng lu* by Tao Zongyi 陶宗儀, *juan* 29, ff. 13a-14a.

輟耕錄 *Chuogeng lu*, *juan* 29, ff. 13a-14a. After 欽定四庫全書 *Qinding siku quanshu*, 子 *zi* section no. 346, 小說家 *xiaoshuojia* category, general vol. 1040, pp. 735-736.

Text 18a. 陶說 *Taoshuo*, *juan* 2, ff. 2b-11b.

古窯考

唐越州窯　夏少康封少子無餘於會稽號曰於越秦於此立會稽郡隋改
爲越州唐復爲會稽郡後又爲越州今浙江紹興府
陸羽茶經盌越州上鼎州次婺州次岳州次壽州次洪州次或以邢州處
越州上殊爲不然邢甆類銀越甆類玉邢不如越一也邢甆類雪越甆類
氷邢不如越二也邢甆白而茶色丹越甆青而茶色綠邢不如越三也
樂府雜錄唐大中初有調音律官大興縣丞郭道源善擊甌用越甌邢甌
一十有二以筯擊之
陸龜蒙詩九秋風露越窯開奪得千峰翠色來如向中宵承沆瀣共嵇中
散鬬遺杯
按唐越窯實爲錢氏祕色窯之所自始後人因祕色爲當時燒進之

f. 3a　f. 2b

名窯所由來負暄雜錄據陸龜蒙詩謂越陶唐中已有[illegible]
柳宗元代人進甆器狀謂欲補負暄雜錄之遺然亦存其說而已未
得越窯明據晉杜毓荈賦云器擇陶揀出自東甌甌亦越也今茶經
曰越州已有其地證之當時顧況茶賦云越泥似玉之甌孟郊詩云
越甌荷葉空鄭谷詩云茶新挽越甌韓偓詩云越甌犀液發茶香言
越甆者不一而足遂特表而出之曰唐越州窯爲之一快又唐國史
補云内邱白甆甌端溪紫石硯天下無貴賤通之考唐地理志邢州
鉅鹿郡縣内邱是邢甆亦爲時所重故郭道源擊甌邢越並用杜工
部集有於韋處乞大邑甆盌詩云大邑燒甆輕且堅扣如哀玉錦城
傳大邑在唐屬邛州又出茶經所數諸州之外陶至唐而盛矣瓶花

f. 3b

譜亦云古無瓷瓶皆以銅爲之至唐始尙窯器
吳越祕色窯　錢氏有國時越州燒進
高齋漫錄越州燒進爲供奉之物臣庶不得用故云祕色
按王蜀報朱梁信物有金稜椀致語云金稜含寶椀之光祕色抱青
瓷之響則祕色是當時瓷器之名不然吳越專以此燒進而王蜀亦
取以報梁耶
後周柴窯　柴世宗時燒者故曰柴窯相傳當日請瓷器式世宗批其狀曰
雨過天青雲破處者般顏色作將來作讀做
夷門廣牘柴窯出北地天青色滋潤細媚有細紋足多麤黃土近世少見
博物要覽昔人論柴窯曰青如天明如鏡薄如紙聲如磬

f. 4a

事物紺珠柴窯製精色異爲諸窯之冠
淸祕藏論窯器必曰柴汝官哥定柴不可得矣余向見殘器一片製爲絛
環者色光則同但差厚耳
按後周都汴唐屬河南道考唐書地理志河南道貢瓷石之器是其
地本宜於陶也宋政和官窯亦起於汴汝亦唐河南道所轄之州柴
窯當卽在其都內高澹人宋均窯瓶歌注云近人得柴窯碎片皆以
裝飾玩具蓋雖得而可貴也王漁洋香祖筆記謂貴人得盌一枚其
色正碧流光四照何其幸與
宋定窯　出定州今直隸眞定府
格古要論古定器土脈細色白而滋潤者貴質麤而色黃者價低外有淚

f. 4b

痕者是眞劃花者最佳素者亦好繡花者次之宋宣和政和間窯最好但
難得成隊者有紫定色紫有黑定色黑如漆
留青日札似象窯色有竹絲刷紋者曰北定窯南定窯有花者出南渡後
博物要覽定器有劃花繡花印花三種多因牡丹萱草飛鳳三種時造式
多工巧
清祕藏定窯有光素凸花二種以白色爲正白骨而加以泑水有如淚痕
者佳間有紫色黑色者不甚珍也
按定器以北定爲貴北定以政和宣和間窯爲最好然如東坡試院
煎茶詩所云定州花瓷琢紅玉不在宣和政和前與且云花瓷亦非
必有花者出南渡後也又有元朝戧金匠彭均寶者效定器作折腰

f. 5a

樣甚整齊曰彭窯時稱之爲新定格古要論云土脈細白者與定器
相似比青口欠滋潤極脆又博物要覽謂新做定器如文王鼎爐獸
面戟耳彝鑪不減定人製法可以亂眞若周丹泉初燒爲佳愛古者
能分別南北定而又不爲後來仿效者所惑庶幾不媿鑒賞家矣
宋汝窯　時以定州白瓷器有芒命汝州建青器窯屑瑪瑙爲油
留青日札唐鄧耀悉有之而汝爲冠色如哥而深微帶黃
格古要論宋時燒者淡青色有蟹爪紋者眞無紋者尤好土脈滋潤薄亦
甚難得
博物要覽汝窯色卵白汁水瑩厚如堆脂然汁中棕眼隱若蟹爪底有芝
蔴花細小掙釘

f. 5b

清祕藏汝窯較官窯質製尤滋潤
按汝本青器窯留青日札云色微帶黃博物要覽云色卵白似立異
論然合之可得淡青色也掙蟹爪紋如端溪石子辨鷓鴣眼眼本石
病得此可驗眞水坑故曰無紋者尤好
宋官窯　宋政和間京師自置窯燒造曰官窯
留青日札文色上白而薄如紙者亞於汝其價亦然博物要覽官窯品格
大率與哥窯相同色取粉青爲上淡白次之油灰色色之下也紋取冰裂
鱔血爲上梅花片墨紋次之細碎紋紋之下也
宋修內司官窯　宋南渡有邵成章提舉號邵局襲舊京遺製置窯於修內
司造青器曰內窯亦曰官窯

f. 6a

留青日札模範極精油色瑩澈爲世所珍
格古要論官窯器宋修內司燒者土脈細潤色青帶粉紅濃淡不一有蟹
爪紋紫口鐵足好者與汝窯相類
博物要覽官窯在杭鳳凰山下其土紫故足色若鐵時云紫口鐵足紫
口乃器口上仰釉水流下比周身較淺故口露紫痕此何足貴惟尙鐵足
以他處之土咸不及此也
稗史類編後郊壇下別立新窯亦曰官窯比之舊窯大不侔矣
按古窯柴汝最重次及官定柴汝之器傳世絕少而官定猶有存者
非官定易得也定有北定南定而彭窯亦曰新定官有舊京修內司
之別而郊壇下新窯亦曰官窯新定不如南定南定不如北定京舊

f. 6b

官窯爲時未久當以修內司所造爲最新窯爲下其時已有差等而
博物要覽謂新仿定器有不減定人製法者有製作極工不入清賞
者格古要論謂官窯器有黑色謂之烏泥窯僞者皆龍泉所燒無紋
路六研齋筆記謂兩宋餘姚祕色甆今人率以官窯目之不能別白
間見疊出以亂其眞又如此好事者指某器曰定某器曰官安知不
爲贋鼎所惑也
又按內窯器葉寘筆衡云沉泥爲範極其精緻其妙處當在體質而
世之論者曰紫口鐵足皮毛之見也博物要覽辨之是矣五雜俎云
定汝難於完璧宋時宮中所有率銅鈐其口以是損價而今之求定
汝者即以銅鈐口爲眞骨董家之論古往往如此

f. 7a

宋哥窯　本龍泉琉田窯處州人章生一生二兄弟於龍泉之窯各主其一
生一以兄故其所陶者曰哥窯
格古要論舊哥窯色青濃淡不一亦有鐵足紫口色好者類董窯今亦少
有
稗史類編土脈細薄油水純粹者最貴哥窯則多斷紋號百圾碎
春風堂隨筆哥窯淺白斷紋
博物要覽官窯質之隱紋如蟹爪哥窯質之隱紋如魚子但汁釉不如官
窯
五雜俎柴窯之外定汝官哥皆宋器也流傳至今惟哥窯稍易得蓋質重
耐藏定汝難於完璧

f. 7b

宋龍泉窯　卽章生二所陶者時以哥名兄窯弟仍龍泉之舊曰龍泉窯
稗史類編龍泉窯至今温處人稱爲章窯
格古要論古龍泉窯今日處器青器古青器土脈細且薄翠青色者貴有
粉青色者有一等盆底有雙魚盆外有銅掇環體厚者不甚佳
博物要覽龍泉窯妙者與官哥爭豔但少紋片紫骨耳器質厚實極耐摩
弄不易茅篾
清祕藏古宋龍泉窯器土細質厚色甚葱翠妙者與官窯爭豔但少紋片
紫骨鐵足耳且極耐摩弄不易茅篾第工匠稍拙製法不甚古雅有等用
白土造器外塗泑水翠淺影露白痕乃宋人章生所燒號曰章窯較龍泉
製度更覺細巧精緻

f. 8a

春風堂隨筆弟所陶青器純粹如美玉爲世所貴卽官窯之類兄所陶色
淡
按稗史類編論章生一生二窯云其色皆青濃淡不一其足皆鐵色
亦濃淡不一舊聞紫足今少見而格古要論亦云舊哥窯色青濃淡
不一亦有鐵足紫口古龍泉青器土脈細且薄翠色者貴曰舊曰古
蓋指生一生二之所製原不甚殊也惟有紋無紋爲兄弟之別必曰
兄所陶色淡弟所陶質厚皆非章氏之初也哥窯在元末新燒土脈
麤燥色亦不好龍泉窯在明初移處州府青色土惡火候漸不及前
矣方密之通雅云假哥窯碎紋不能鐵足鐵足則不能聲龍泉不能
得其淡色淡則無聲此亦鑑古之精者也

f. 8b

又按博物要覽云官哥二窯出器時有窯變狀類蝴蝶禽魚麟豹於本色釉外變色或黃或紅紫肖形可愛火之幻化理不可解然窯變時有尙不足異蘇東坡集載瓶笙詩有引云庚辰八月二十八日劉幾仲餞飲中觴聞笙簫聲杳杳若在雲霄間抑揚往返麤中音節徐而察之則出於雙瓶食頃乃已春渚紀聞載萬延之瓦缶畫冰云赴銓都下銅禁嚴甚以十錢市之代沃盥之用時當凝寒注湯頮面既覆有餘水留缶成冰視之桃花一枝也明日成雙頭牡丹一枝次日又成寒林滿缶水村竹屋斷鴻翹鷺宛如圖畫後以白金爲襯什襲而藏遇寒則約客張宴以賞之未嘗一同此二事幻之又幻矣

吉州窯　在今吉安府廬陵縣永和鎭

f. 9a

格古要論色與柴定器相類體厚而質麤不甚直錢宋時有五窯書公燒者最佳有白色有紫色花瓶大直數金小者有花又有碎器最佳相傳宋文丞相過此窯變爲玉遂不燒

矩齋雜記宋時江西窯器出廬陵之永和市有舒翁工爲玩具翁之女尤善號曰舒嬌其爐甕諸色幾與哥窯等價余嘗得一盤一盎質著白而光燦然以注水經月不變望之知爲古物相傳陶工作器入窯變成玉工懼事聞於上封穴逃之饒今景德鎭陶工故多永和人見吉安太守吳炳遊記

象窯　在今寧波府象山縣

格古要論有蟹爪紋色白而滋潤者高色黃而質麤者低俱不甚直錢

f. 9b

董窯

格古要論淡青色細紋多有紫口鐵足比官窯無紅色質麤而不細潤

按吉窯象窯似定董窯似官其不同者質麤欠滋潤耳留青日札云

象窯又次彭窯

均州窯　今河南禹州

留青日札稍具諸色光彩太露有兎絲紋火燄青

博物要覽有硃砂紅葱翠青俗名鸚哥綠茄皮紫者紅如燕支青若葱翠紫若墨黑三者色純無少變露者爲上品底有一二數目字號爲記豬肝色火裏紅青綠錯雜若垂涎皆上三色之燒不足者非别有此樣俗取鼻涕豬肝等名是可笑耳此窯惟種菖蒲盆底佳甚他如坐墩鑪合方缾罐

f. 10a

子俱黃沙泥坯故器質不佳近年新燒皆宜興砂土爲骨釉水微似製有佳者但不耐用

清祕藏均州窯紅若臙脂者爲最青若葱翠紫若墨色者次之色純而底有一二數目字號者佳雜色者無足取

通雅均州有五色窯變則時有之報國寺觀音窯變也

磁州窯　在河南彰德府磁州

格古要論好者與定器相似但無淚痕亦有劃花繡花素者價高於定新者不足論

建窯　在福建泉州府德化縣

格古要論盌琖多是擎口色黑而滋潤有黃兎斑滴珠大者眞但體極厚

f. 10b

少見薄者舊建瓷有薄者絕類宋器佛像最佳

按宋時茶尚𩞁盌以建安兎毫琖爲上品價亦甚高留青日札云建安烏泥窯品最下豈今昔不同耶然𥓙花譜以烏泥與龍泉均州章生諸窯並重博物要覽謂烏泥質麤不潤而釉水燥暴溷入官哥今亦傳世則當差肩象蕫留青日札最下之品目未可傳信也因論建窯及此

山西窯　在太原府榆次縣平定州平陽府霍州霍州所出曰霍器

高麗窯　在高麗國

格古要論色粉青似龍泉上有白花朶兒者不甚值錢

按高麗窯器與饒相似有細花彷彿北定者故附雜窯之後島夷之

f. 11a

玻璨窯大食國之佛郎嵌皆非瓷石所成不概錄

f. 11b

After Huang Binhong 黃賓虹 and Deng Shi 鄧實 (eds.), *Meishu congshu* 美術叢書, Shanghai: Shenzhou guoguang shi, 1947, 集 2, 輯 7.

Excerpts from the 留情日札 *Liuqing rizha* not included in the form the *Liuqing rizha* has survived.

Text 18b. 陶說 *Taoshuo, juan* 5, f. 12b.

小海鷗. 清異錄耀州陶匠創造一等平底深盌號小海鷗.

After Huang Binhong 黃賓虹 and Deng Shi 鄧實 (eds.), *Meishu congshu* 美術叢書, Shanghai: Shenzhou guoguang shi, 1947, 集 2, 輯 7.

Text 19. 同官縣志 *Tongguanxian zhi*, Ming Wanli 46th year (1618), *juan* 8, ff. 27a-27b.

After Shao Guoli 邵國李 (ed.), *Zhongguo xibei xijian fangzhi xuji* 中國西北稀見方志續集, *shibu* 史部, Beijing: Zhonghua quanguo tushuguan suowei fuzhi zhongxin, Zhongguo gonggong tushuguan guji wenxian zhenben huikan, 1997, pp. 425-6.

黃堡鎮一名黃堡寨前宋代守禦地也在縣南四十里.

按地理志黃堡在金尤爲重鎮舊有陶場居人建紫極宮祀其土神宋熙寧中封其神為德應侯以陶冶著靈應故也祀以晉永和時人柏林配享蓋傳居人陶冶術者金其地不陶陶於陳爐鎮其鎮復廟祀德應侯如黃堡云.

Text 20a. 同官縣志 *Tongguanxian zhi*, Qing Qianlong 30th year (1765), *juan* 1, f. 16a.

黃堡鎮一名黃堡寨

在縣南四十里前時居民守禦地也在金尤為重鎮地理志載焉晉升平初姚襄自杏城進據黃洛堡秦苻生遣苻黃眉擊敗之明嘉靖三十五年復築堡城舊有陶場居人建紫極宮祀其土神宋熙寧中知州封其神為德應侯以陶冶靈故也祀以晉人栢林配享林蓋傳居人陶術者今其地不陶陶於陳爐鎮復廟祀德應侯如黃堡云

After *Xinxiu fangzhi congkan* 新修方志叢刊, *Xibei fangzhi* 西北方志 no. 26, Taibei: Taiwan xuesheng shuju, 1968, p. 53.

Text 20b. 同官縣志 *Tongguanxian zhi*, Qing Qianlong 30th year (1765), *juan* 2, f. 24a.

德應侯廟. 宋熙寧中建舊址在黃堡後徙陳爐鎮清康熙五十七年重修.

After *Xinxiu fangzhi congkan* 新修方志叢刊, *Xibei fangzhi* 西北方志 no. 26, Taibei: Taiwan xuesheng shuju, 1968, p. 115.

Text 21. 文房肆考圖說 *Wenfang sikao tushuo, juan* 3, ff. 28b-36b.

古窯器攷

陶窯上古已作非虞帝始

宋葉寘坦齋筆衡云。窯器自舜時便有。三代迄於秦漢。所謂甓器是也。此必葉公僅依周禮考工記有虞氏上陶。禮記明堂位泰。有虞氏之尊也。韓非子虞舜作食器。史記五帝本紀舜陶河濱。作什器於壽邱。河

f. 27b

濱器皆不苦窳。諸經史之句而云然耳。鈞嘗閱汲古周書。有云。神農作瓦器。路史有云。燧人爲釜。物原有云。神農作甕。及軒轅作盌楪。紺珠有云。瓶缾同神農制。呂氏春秋有云。黃帝有陶正。昆吾作陶。説文亦云。昆吾作陶。春秋正義。少皞有五工正。摶埴之工曰鶽雉之數。則陶窯上古已有。不自舜始也。[illegible]考工禮記韓非史記皆稱有虞氏者。蓋以上古太樸。陶器祇始今黃沙之質。至舜而制度略備。精粗有別。故有泰尊犧[illegible]之作爾。其稱[illegible]陶者。上與[illegible]通。謂舜[illegible][illegible]陶

f. 28a

器也。當訓好尚之尚。不作上下之上解。然稽唐虞三代。以迄秦漢魏晉六朝。著於經史子集者。如曰缶、曰土塯、曰土刑、曰泰尊、曰甒、大瓦棺、曰甑、盆、曰瓦旗之類。名凡數十。而窯無所攷。至唐而始著窯名。竊念先王禮器法物。金玉犀象寶貝。艸野編氓。不特家未嘗藏。且更目未嘗覩。若窯陶瓷器。迺生民飲食日用之不可缺。寧可不辨精麤。不知高下乎。故并攷而詳之。

古今諸窯

越州窯　越州窯。唐代所燒。越州即今浙江紹興府

f. 28b

也。夏后氏會諸侯。計功於此。命曰會稽。少康封少子無餘。奉禹祀其地。號曰於越。春秋爲越國。秦置會稽郡屬吳。隋唐曰越州。宋曰紹興。陶至唐而盛。始尚窯器。按唐越陶實爲錢氏秘色窯之所自始。陸羽茶經。推爲最上。謂邢瓷類銀。越窯類玉。邢瓷類雪。越瓷類冰。邢瓷白而茶色丹。越瓷青而茶色綠。陸龜蒙詩云、九秋風露越窯開。奪得千峰翠色來。韓偓詩云、越甌犀液發茶香。孟郊詩云、越甌（甌小盆也盌深者爲甌）荷葉空。鄭谷詩云、茶新換越甌。柳柳州河東集代人進瓷器狀

f. 29a

云、藝精埏埴。制合規模。晉杜毓荈賦云、器擇陶揀。出
自東甌。東甌閩中地 甌亦越地。顧況茶賦云、越泥似玉之
甌。稱美越瓷者。不一而足。越窯之爲重於時如此。杜
少陵集、韋處乞大邑瓷盌詩云、大邑燒瓷輕且堅。扣
如哀玉錦城傳。君家白盌勝霜雪。急送茅齋也可憐。
首句美其質。次句想其聲。三句美其色。說得珍重可
愛。然後冀其急送茅齋。可知越州瓷器。爲唐時韻物
矣。
秘色窯　吳越秘色窯。錢氏有國時。於越州燒進。爲

f. 29b

供奉之物。臣庶不得用。故云秘色。然蜀王建報朱梁
信物。有金稜椀。致語云、金稜含寶椀之光。秘色抱青
瓷之響。則秘色乃是當時瓷器之名。不然。吳越專以
此燒進。何王蜀反取之以報梁耶。
柴窯　柴窯後周柴世宗所燒。以其姓柴。故名。後周
都汴出北地河南鄭州。其地本宜於陶也。宋政和官
窯。亦起於汴。汝亦唐河南道所轄之州。柴窯青如天。
明如鏡。薄如紙。聲如磬。滋潤細媚。有細紋。相傳當日
請瓷器式。世宗批其狀曰、雨過天青雲破處。者般顏

f. 30a

色作將來。足多麤黃土。製精色異。爲諸窯之冠。論窯
器者。必曰柴汝官哥定。而柴不可得矣。得殘器碎片。
製爲縧環玩具。蓋難得而貴重之也。
定窯　古定器。宋時所燒。出定州。今直隸真定府也。
似象窯。色有竹絲刷紋者曰北定。以政和宣和間窯
爲最好。然難得成隊者。有花者乃南定窯。出南渡後。
然按東坡試院煎茶詩云、定州花瓷琢紅玉。則有花
者。非至南渡後而出也。北貴於南。定窯土脉細。有光
素凸花劃花印花繡花等種。多因牡丹萱艸飛鳳。式

f. 30b

多工巧。劃花最佳。素者亦好。以白色而滋潤爲正。白
骨而加以泑水有如淚痕者佳。質麤而色黃者低。土
俱白者。其價高於白定。閒有紫定色紫。黑定若漆。不
甚珍也。
汝窯　宋時以定州白瓷器。有芒不堪用。遂命汝州
建青器窯。屑瑪瑙爲油。如哥而深。微帶黃。有似卵白。
真所謂淡青色也。汁水瑩厚如堆脂。格古要論云、汁
中椶眼。隱若蟹爪者真。又云無紋者尤好。說似互異。
此如端溪石子。辨鸜鵒眼。眼本石病。得此可驗真水

f. 31a

坑也。故曰無紋者尤好。底有芝麻花細小掙釘。土脉
質製較官窯尤滋潤。薄者難得。時唐鄧耀諸州悉有
窯。而以汝爲冠。
官窯　宋政和間。徽宗於京師。置窯燒造曰官窯。土
脉細潤。色青帶粉紅。濃淡不一。有蟹爪紋。紫口鐵足。
文色上白而薄如紙者。頗亞於汝。其價亦然。有黑土
者謂之烏泥窯。僞者皆龍泉所造。無紋路。中興渡江。
有邵成章提舉後苑。襲舊京遺製。置窯於修內火造
青器。號曰邵局。又曰內窯。亦曰官窯。澄泥爲範。極其

f. 31b

精緻。其妙處。當在體質。油色又瑩徹。爲世所珍。後郊
壇別立新窯。亦曰官窯。比之舊窯。大不侔矣。南宋餘
姚秘色瓷。今人率以官窯目之。不能別白。間見亂眞
按餅花譜、以烏泥與龍泉均州章生諸窯並重。博
物要覽。謂烏泥質麤不潤。而釉水燥暴。溷入官窯。
今亦傳世。則當差肩象董矣。畱青日札云、建安烏
泥窯品最下。未可傳信。抑今昔之不同耶。
哥窯　亦宋時所燒。本龍泉琉田窯。處州人章生一、
生二兄弟。於龍泉之窯。各主其一。生一以兄故其所

f. 32a

陶者曰哥窯。色青。濃淡不一。土脉細薄。亦有鐵足紫
口。多斷紋。號百圾碎。油水純粹者。最貴。色好者類董
窯。今亦少有。官窯質之隱。紋如蟹爪。哥窯質之隱。紋
如魚子。但汁釉不如官窯。
龍泉窯　古龍泉窯。土細質厚。色甚葱翠。妙者與官
哥爭艷。但少紋片紫骨鐵足耳。有一等盆底有雙魚。
盆外有銅掇環。器質厚實。極耐摩弄。不易茅蔑。第工
匠稍拙。製法不甚古雅。若用白土造器。外塗泑水翠
淺。影露白痕。即章生二所陶者。時以哥名兄窯。第仍

f. 32b

龍泉之舊。亦曰龍泉窯。又號章窯。土脉細且薄。翠青
色者貴。又有粉青色者。較龍泉製度。更覺細巧精緻。
至今温處人。猶稱爲章窯。或曰處器青器。春風堂
隨筆云。弟所陶青器。純粹如美玉。爲世所貴。即官窯
之類。
按兄弟二窯。其色皆青。濃淡不一。足皆鐵色。亦濃
淡不一。舊聞紫足。今少見。惟兄窯有紋。弟窯無紋
爲別。哥窯在元末新燒。土脉麤燥。色亦不好。龍泉
窯在明初。移處州。青器土垩。火候漸不及前矣。假

f. 33a

哥窯碎紋。不能得鐵足。鐵足則不能聲。龍泉不能
得其淡色。淡則無聲。此通雅鑑古之精者也。
吉州窯　出今吉安州永和鎮。宋時江西窯器出吉
安屬廬陵縣永和市。有白色。有紫色者。與紫定相類。
宋時有五窯。舒翁工爲玩具。燒者最佳。翁之女號舒
嬌。尤善。其爐瓮諸色。幾與哥窯等價。花瓶大者直數
金。小者有花。又有碎器更佳。今世俗訛稱哥窯。體原
質麤者。不甚直錢。相傳陶工作器入窯。宋文丞相過。
變成玉。工懼事聞於上。遂封穴不燒。逃之饒。故景德

f. 33b

鎮陶工多永和人。
彭窯　元朝戧金匠彭均寶效古定器。製折腰樣者
甚整齊。故以彭窯得稱。土脉細白者。與定相似。比青
口欠滋潤。極脆。難以傳世。不甚直錢。市肆賣骨董者。
竟稱爲定器。非真賞家。嘗以重價收之。
象窯　或云出今寧波府象山縣。有蠏爪紋。色白而
滋潤者高。貴而質麤者低。俱不甚直錢。
董窯　淡青色。細紋。多有紫口鐵足。比官窯無紅色。
質麤而不細潤。不逮官窯多矣。今亦罕見真者。

f. 34a

按象董二窯。不詳出處朝代。核之象窯吉窯似定。董窯似官。其不同者。質麤欠滋潤耳。象窯又次。彭窯。

均州窯　均即今河南禹州。均窯具五色。光彩太露。有兔絲紋。紅若臙脂硃砂爲最。青若葱翠。紫若墨黑者次之。三者色純。無少變露者爲上品。底有一二數目字號爲記者佳。青綠錯襍若垂涎。皆上三色之燒不足者。非別有此樣。俗取茄皮紫。猪肝紅。鼻涕等名。是可笑耳。皆無足取。此窯惟種菖蒲盆底佳。甚他如

f. 34b

坐墩鑪合方餅罐子俱黃沙泥坯。故器質不佳。近年新燒。皆宜興砂土爲骨。釉水微似。製有佳者。俱不耐用。

磁州窯　磁器。出古邯鄲地磁州。故名磁器。昔屬河南彰德府。今屬北直隸廣平府。好者與定器相似。但無淚痕。亦有劃花繡花。素者價高於定。新者不足論。磁乃石名。此磁器以所出地而名也。今人訛以陶窯瓷瓦器。概書爲磁器。真可笑耳

建窯　出福建泉州府德化縣。盌琖多是撃口。色黑

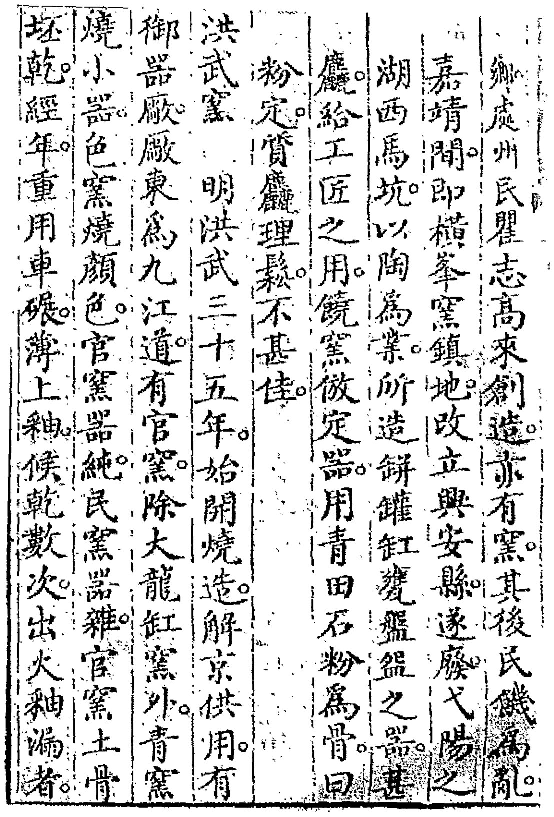
f. 35a

而滋潤。有黃兎斑滴珠大者真。但體極厚。舊建瓷有
薄者。絕類宋器。而今罕矣。佛像最佳。按宋時茶尚撆
盌。以建安兎毫琖爲上品。價亦甚高。
山西窯　出太原府榆次縣平定州。平陽府霍州。霍
州者曰霍器。
高麗窯　出高麗國。與饒相似。色粉青者似龍泉。有
細花者。髣髴北定。上有白花朶兒者。不甚直錢。
饒州窯　出江西饒州府浮梁縣。西興鄉景德鎮。水
土宜陶。宋景德中。設鎮置監鎮。奉御董造饒窯。因名

f. 35b

其鎮曰景德鎮。袤延僅十餘里。山環水繞。僻處一隅。
民窯二三百區。工匠人夫。不下數十萬。藉此飲食。候
火如候晴雨。望陶如望黍稷。元更監鎮爲提領本路
總管監陶。宋元皆有命則供。否則止。宋時燒鄉土窯。
體薄而潤。色白花青。較定器少次。元朝燒小足印花。
內有樞府字號者最高。新燒大足。素者欠潤。色白而
瑩者亦好。有青花及五色花者俗。明初燒者。有青黑
色戧金者。多是酒壺酒琖。甚可愛。
按江西窯。唐在洪州。今南昌。見茶經。弋陽縣太平

f. 36a



鄉。處州民瞿志高來創造。亦有窯。其後民饑爲亂。
嘉靖間。即橫峯窯鎮地。改立興安縣。遂廢。弋陽之
湖西馬坑。以陶爲業。所造餅罐缸甕盤盌之器。甚
麤。給工匠之用。饒窯做定器。用青田石粉爲骨。曰
粉定。質麤理鬆。不甚佳。
洪武窯　明洪武三十五年。始開燒造。解京供用。有
御器廠。廠東爲九江道。有官窯。除大龍缸窯外。青窯
燒小器。色窯燒顏色。官窯器純。民窯器雜。官窯土骨
坯乾。經年。重用車碾。薄上釉。俟乾。數次出火。釉漏者。

f. 36b

After the 1778 library edition available in the Percival David Foundation of Chinese Art, University of London.

Text 22. 吳越備史 *Wuyue beishi, juan* 4, f. 33b.

太平興國……五年……九月十一日王進朝謝于崇德殿復上金裝定器二千事，水晶瑪磁寶裝器皿二十事，珊瑚樹一株.

After *Sibu congkan xubian* 四部叢刊續編, *shibu* 史部, Shanghai: Shangwu yinxuguan, 1926-36, vol. 3043.

Text 23. 五雜組 *Wuzazu*, 卷 *juan* 12, 物部 *wubu*.

漢文帝時。嗇少年挂金杖。武帝有玉箱杖。嘉平中袁逵作二公賜玉杖。晉
佛圖澄金杖銀鉢。劉向別傳。有麒麟角杖。曹操賜楊彪銀角桃杖。今人但用竹
杖耳。漢昌邑王至滎陽。買積竹刺杖。龔遂諫曰。積竹刺杖。少年驕蹇杖也。今武
陵有方竹爲杖。甚佳。及蜀卭州杖。巨節如雞骨然。夫杖扶老登山。取其輕便爲
貴。金玉徒爲觀美。未必當於用也。

皮日休有天台杖。色黯而力遒。謂之華頂杖。有龜頭山疊石硯高不二寸。
其仞數百。謂之太湖硯。有桐廬養和一具。怪形拳跼。坐若變去。謂之烏龍養和。
養和者。隱囊之屬也。按李泌以松膠枝隱背。謂之養和。後得如龍形者獻帝。四
方爭効之。今吳中以枯木根作禪椅。蓋本於此。

陶器柴窰最古。今人得其碎片。亦與金翠同價矣。蓋色既鮮碧。而質復瑩
薄。可以妝飾玩具。而成器者杳不可復見矣。世傳柴世宗時燒造。所司請其色。
御批云。雨過青天雲破處。這般顏色做將來。然唐時已有秘色。陸龜蒙詩。九天
風露越窰開。奪得千峰秘色來。惜今人無見之耳。余謂洛中人。有掘得漢唐時
墓者。其中多有陶器。色但淨白而形質甚粗。蓋至宋而後。其製始精也。

柴窰之外。有定汝官哥四種。皆宋器也。流傳至今者。惟哥窰稍易得。蓋其
質厚。頗耐藏耳。定汝白如玉。難於完璧。而宋時宮中所用。率銅鈐其口。其是損
價。

今龍泉窰世不復重。惟饒州景德鎮所造。徧行天下。每歲內府。頒一式。度
紀年號於下。然惟宣德款製最精。距迄百五十年。其價幾與宋器埒矣。嘉靖次
之。成化又次之。世宗末年所造金籙。大醮壇用者。又其次也。

宣窰不獨款式端正。色澤細潤。卽其字畫。亦皆精絕。余見御用一茶盞。乃
畫輕羅小扇撲流螢者。其人物毫髮具備。儼然一幅李思訓畫也。外一皮函。亦
作盞樣盛之。小銅屈戌。小鎖尤精。蓋人間所藏宣窰。又不及也。

蔡君謨云。茶色白。故宜於黑盞。以建安所造者爲上。此說余殊不解。茶色
自宜帶綠。豈有純白者。卽以白茶注之黑盞。亦渾然一色耳。何由辨其濃淡。今
景德鎮所造小壇盞。做大醮壇爲之者。白而堅厚。最宜注茶。建安黑窰間有藏
者。時作紅碧色。但免俗爾。未當於用也。

今俗語窰器。謂之磁器者。蓋河南磁州窰最多。故相沿名之。如銀稱朱提。
墨稱隃糜之類也。

景德鎮所造。常有窰變云。不依造式。忽爲變成。或現魚形。或浮果影。傳聞
初開窰時。必用童男女各一人。活取其血祭之。故精氣所結。凝爲怪耳。近來禁
不用人祭。故無復窰變。一云恐禁中得知。不時宣索。人多碎之。

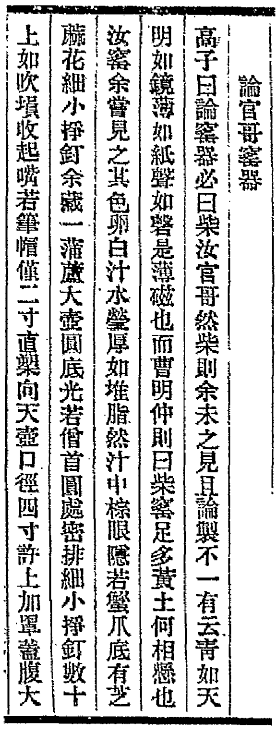
After Zhang Yiping 章衣萍 ed., *Guoxue zhenben wenku* 國學珍本文庫, 1st series, no. 13, vol. 2, Shanghai: Zhongyang shudian zongdian, 1935, pp. 168-170.

Text 24. 宣德鼎彝譜 *Xuande dingyi pu, juan* 1, f. 1.

內庫所藏柴汝官哥鈞定各窯器皿.

After *Qinding siku quanshu* 欽定四庫全書, *zi* 子 section no. 146, *pulu* 譜錄 category, general vol. 840, p. 1021.

Text 25. 燕閑清賞箋 *Yanxian qingshangjian*, ff. 24a-28b.


論官哥窯器
高子曰論窯器必曰柴汝官哥然柴則余未之見且論製不一有云青如天
明如鏡薄如紙聲如磬是薄磁也而曹明仲則曰柴窯足多黃土何相懸也
汝窯余嘗見之其色卵白汁水瑩厚如堆脂然汁中棕眼隱若蟹爪底有芝
蔴花細小掙釘余藏一蒲蘆大壺圓底光若僧首圓處密排細小掙釘數十
上如吹塤收起嘴若筆帽僅二寸直槊向天壺口徑四寸許上加罩蓋腹大

f. 24a

徑尺製亦奇矣又見碟子大小數枚圓淺瓮腹磬口泑足底有細釘以官窯
較之質製滋潤官窯品格大率與哥窯相同色取粉青爲上淡白次之油灰
色色之下也紋取冰裂鱔血爲上梅花片墨紋次之細碎紋紋之下也論製
如商庚鼎純素鼎葱管空足沖耳乳爐商貫耳弓壺大獸面花紋周貫耳壺
漢耳環壺文已尊祖丁尊皆法古圖式進呈物也俗人凡見兩耳壺式不論
式之美惡咸指曰茄袋瓶也孰知有等短矮肥腹無矩度者似亦俗惡若上
五製與敵姬壺樣深得古人銅鑄體式當爲官窯第一妙品豈可概以茄袋
言之又如葱管脚鼎爐環耳汝爐小竹節雲板脚爐沖耳牛奶足小爐戟耳
彝爐盤口束腰桶肚大瓶子一觚立戈觚周之小圓觚素觚紙槌瓶膽瓶雙
耳匙筋瓶筆筒筆格元葵筆洗桶樣火洗蛋肚盂鉢二種水中丞二色雙桃

f. 24b

水注立瓜臥瓜臥茄水注扁淺磬目棊盤方印色池四八角委角印色池有
文圖書戟耳彝爐小蓍草瓶小製漢壺竹節段壁瓶凡此皆官哥之上乘品
也桶爐六棱瓶盤口紙槌瓶大蓍艸瓶鼓爐菱花壁瓶多嘴花罐肥腹漢壺
大椀中椀茶盞茶托茶洗提包茶壺六棱酒壺瓜壺蓮子壺方圓八角酒甕
酒杯各製勸杯大小圓碟河西碟荷葉盤淺碟桶子箍碟絲環小池中大酒
海方圓花瓮菖蒲盆底龜背絲環六角長盆觀音彌勒洞賓神像鷄頭罐楂
斗圓硯筋搠二色文篆隸書象棋子齊筋小碟螭虎鎮紙凡此皆二窯之中
乘品也又若大雙耳高瓶徑尺大盤夾底骰盆大撞梅花瓣春勝合棋子罐
大匾獸耳彝敦鳥食罐編籠小花瓶大小平口藥罈眼藥各製小罐肥皂罐
中菓盒子蟋蟀盆內中事件佛前供水碗束腰六脚小架各色酒案盤碟凡

f. 25a

此皆二窯之下乘品也要知古人用意無所不到者余概論如是其二窯燒造種種未易悉舉例者可見所謂官者燒於宋修內司中爲官家造也窯在杭之鳳凰山下其土紫故定色若鐵時云紫口鐵足紫口乃器口上仰泑水流下比周身較淺故口微露紫痕此何足貴惟尙鐵足以他處之土咸不及此哥窯燒於私家取土俱在此地官窯質之隱紋如蟹爪哥窯質之隱紋如魚子但汁料不如官料佳耳一窯燒出器皿時有窯變狀類蝴蝶魚麟豹等象布於本色泑外變色或黃黑或紅紫形肖可愛是皆火之文明幻化否則理不可曉似更難得後有董窯烏泥窯俱法官窯質粗不潤而泑水燥暴溷入哥窯今亦傳世後若元末新燒宛不及此近年諸窯美者亦有可取惟紫骨與粉青色不相似耳若今新燒去諸窯遠甚亦有粉青色者乾燥無華卽

f. 25b

光潤者變爲綠色且索大價愚人更有一種復燒取舊官哥磁器如爐欠足耳瓶損口稜者以舊補舊加以泑藥裹以泥合入窯一火燒成如舊製無異但補處色渾而本質乾燥不甚精采得此更勝新燒奈何二窯如葱脚鼎爐在海內僅存一二乳爐花觚存計十數彝爐或以百計四品爲鑒家至寶無怪價之忘値日就增重後此又不知凋謝如何故余每德一德心目爽朗神魂爲之飛動頓令腹飽豈果躭玩痼僻使然更傷後人聞有是名而不得見是物也慨夫

論定窯

高子曰定窯者乃宋北定州造也其色白間有紫有黑然俱白骨加以泑水有如淚痕者爲最故蘇長公詩云定州花磁琢如玉其紋有畫花有繡花有

f. 26a

印花紋三種多用牡丹萱草飛鳳時製其所造器皿式多工巧至佳者如獸
面彝爐子父鼎爐獸頭雲板脚桶爐䑓瓶花尊花觚皆略似古製多用己意
此爲定之上品餘如盒子有內子口者有內替盤者自三四寸以至寸許式
亦多甚枕有長三尺者製甚可頭余得一枕用哇哇手持荷葉覆身葉形前
偃後仰枕首適可巧莫與並瓶式之巧百出而碟製萬狀余有數碟長樣兩
角如錠皺起傍作四摺又如方式四角彎若蓮瓣而傍若蓮捲或中作水池
傍作闌邊可作筆洗筆覘此皆上古所無亦燒人物仙人哇子居多而兜頭
觀音羅漢彌勒像貌形體眉目衣摺之美克肖生動其小物如水中丞各色
瓶礶自五寸至以三二寸高者余見何止百十而製無雷同更有燈檠大小
椀盤酒壺茶注式有多種巧者俱心思不及其水注用蟾蜍用瓜茄用鳥獸

f. 26b

種種入神若巨觥承盤巵匜盂罇柳斗柳升柳巴其編條穿線模塑毫絲不
斷又如菖蒲盆底大小水底儘有可觀更有坐墩式雅花甕元腹口坦如槖
盤中孔徑二寸許用插多花酒甕圓腹倣口如一小碟光淺中穿一孔用以
勸酒式類數多莫可名狀諸窰無與比勝雖然但製出一時工巧殊無古人
遺意以巧惑今則可以製勝古則末也如宣和政和年者時爲官造色白質
薄土色如玉物價甚高其紫黑者亦少余見僅一二種色黃質厚者下品也
又若骨色青溷如油灰者彼地俗名後土窰又其下也他如高麗窰亦能織
花蓋甌式有可觀但質薄而脆色如月白甚不佳也近如新燒文王鼎爐獸
面戟耳彝爐不減定人製法可用亂眞若周丹泉初燒爲佳亦須磨去滿面
火色可玩若玉蘭花杯雖巧似入惡道且輪廻甚速又若繼周而燒者合爐

f. 27a

桶爐以鎖子甲毬門錦龜紋穿挽爲花地者製作極工不入清賞且質較丹
泉之造遠甚元時彭君寶燒於霍州者名曰霍窰又曰彭窰效古定折腰製
者甚工土骨細白凡口皆滑惟欠潤澤且質極脆不堪眞賞往往爲牙行指
作定器得索高貲可發一哂

論諸品窰器 龍泉窰 吉州窰 章窰 建窰 古磁 均州窰 大食窰 玻璃

定窰之下而龍泉次之古宋龍泉窰器土細質薄色甚葱翠妙者與官窰爭
豔但少紋片紫骨鐵足耳其製若瓶若觚若蓍草方瓶若鬲爐桶爐有耳束
腰小爐菖蒲盆底有圓者八角者葵花菱花者各樣酒豐斝盆其水盤之式
有百稜者大圓徑二尺者外此與菖蒲盆式相同有深腹單邊盥盆有大乳
鉢有葫蘆瓶有酒海有大小藥瓶上有凸起花紋甚精有坐鼓高墩有大獸

f. 27b

蓋香爐燭臺花瓶幷立地插梅大瓶諸窰所無但製不甚雅僅可適用種種
器具製不法古而工匠亦拙然而器質厚實極耐磨弄不易茅蔑（行語以開路曰蔑損失些少曰茅）但在昔色已不同有粉青有深青有淡青之別今則上品僅有葱色
餘盡油青色矣製亦愈下有等用白土造器外塗泑水翠淺影露白痕此較
龍泉製覺細巧精緻謂之章窰因姓得名者也有吉州窰色紫與定相似質
粗不佳建窰器多甓口碗盞色黑而滋潤有黃兔毫斑滴珠大者爲眞但體
極厚薄者少見有大食窰銅身用藥料燒成五色有香爐花瓶盒子之類窰
之至下者也又若玻璃窰出自島夷惟粵中有之其製不一奈無雅品惟瓶
之小者有佳趣他如酒鍾高礶盤盂高脚勸杯等物無一可取色有白纏絲
鴨綠天青黃鎖口三種俱可觀但不耐用耳非鑒賞佳器若均州窰有硃砂

f. 28a

紅葱翠青俗謂鶯哥綠茄皮紫紅若臙脂青若葱翠紫若墨黑三者色純無
少變露者爲上品底有一二數目字號爲記猪肝色火裏紅青綠錯雜若垂
涎色皆上三色之燒不足者非別有此色樣俗卽取作鼻涕涎猪乾等名是
可笑耳此窰惟種蒲盆底佳甚其他如坐墩爐盒方瓶礶子俱以黃沙泥爲
坯故氣質粗厚不佳雜物人多不尙近年新燒此窰皆以宜興沙土爲骨泑
水微似製有佳者但不耐用俱無足取

論饒器新窰古窰

古之饒器進御用者體薄而潤色白花青較定少次元燒小足印花內有樞
府字號者價重且不易得若我明永樂年造壓手杯坦口折腰沙足滑底中
心畫有雙獅滾毬毬內篆書永樂年製四字細若粒米爲上品鴛鴦心者次

f. 28b

After Huang Binhong 黃賓虹 and Deng Shi 鄧實 (eds.), *Meishu congshu* 美術叢書, Shanghai: Shenzhou guoguang shi, 1947, 集 3, 輯 10.

Text 26. 窯器說 *Yaoqi shuo*, ff. 1a-6a

窰器說

歙縣程　哲聖跂著

窰器所傳柴禹官哥鈞定可勿論矣在勝朝則有永宣成宏正嘉隆萬官窰其品之高下首成窰次宣次永次嘉其宏正隆萬間亦有佳者其土骨紫白料法也墨藥水法也底足火法也花青彩畫法也所忌者三釉澤不具曰骨鯙折曰蕨邊毀剝曰茅　成窰之草蟲可口子母雞勸盃人物蓮子酒盞草蟲小琖青花小琖其質細薄如紙葡萄靶盃五色做口匾肚齊箸小碟香合小罐皆五采者成盃茶貴于酒采貴于青其最者鬭雞可口謂之雞缸（神宗時尚食御前成盃一雙已值錢十萬）成宣靶盃皆非所貴　宣窰之祭紅盃盤有通體紅者有紅魚者百果者有西紅寶石墨塗燒者其寶光凸起紫黑者火候失也青花

f. 1a

f. 1a

有茶靶盃（松梅 溫北 皮）有酒靶盃（海棠 海獸 人物）硃砂紫紅少大器壺物有色紅鮮白鎖
口者有竹節滷壺小壺匾罐皆有蓋者罏缾盃碟敞口花尊蜜漬桶罐多五
采者白壇讌心有壇字暗花白茶盞瓮肚釜底線足裏有龍鳳暗花底有大
明宣德年製暗款坐墩有漏花填采皆深青地有藍地填采有白地青花有
氷裂紋其形以拱面爲上凹面次之爲其積水故也又以花款青堊光素品
者次之水注有五采桃注石榴注采色雙瓜注雙鴛注筆洗有魚藻洗葵洗
磬口洗螭洗兩蓋鐙檠幡幢雀食罐蟋蟀盆徐應秋曰宣窰不獨款式端正
色澤細潤卽其字畫亦精絕嘗見一茶盞乃畫輕羅小扇撲流螢其人物毫
髮具備儼然一幅李思訓畫 永窰之壓手杯傳用可久擊口折腰沙足滑
底外深青花內雙獅毬毬內篆書永樂年製細如粟米鴛鴦心次之近彷鑑

f. 1b

厚約略形似耳 嘉窰泡盃其極低小磬口者有花三友者稱最水藻者次
之芝草者又次之壇琖大中小三號內茶字者爲最橄欖字酒字棗湯字次
之薑湯字又次之（薑湯不恒有）琖色以正白如玉斯美堊嫩則近青堊不淨則近
黃其青花五色二窰器製悉備有三色魚匾殘磬口饅心圓足紅鉛小花合
子等有大如錢有青花有紅花蓋永尙厚成尙薄宣青尙淡嘉青尙濃成青
爲蘇渤泥青宣青名麻葉青宣采未若成采淺深入畫也嘉萬之回青特爲
幽菁鮮紅土綠色止礬紅而回青爲作 隆窰之祕戲不入鑒賞他物汁水
瑩厚如堆脂汁故名雞皮橘皮質料厚實不易茅蔑也官窰土骨坯乾隆年
方用車碾薄上堊水候乾數次故入骨最堅而厚出火口足堊不滿者則碾
去土堊更燒之故有雞橘紋起用久口不茅身不蔑其發棱眼蟹爪紋者堊

f. 2a

中心小疵反以驗火候之到亦如宣鑪冷熱充補他鑄無及者至于別見他
產者畧疏于後　彭窰元時戧金匠彭君寶效古定器制折腰樣者甚佳土
脈細白者與足器相似青口欠滋潤極鬆脆稱爲新定近景德倣者用青田
石粉爲骨燒造名爲粉定璺粗骨鬆更不佳　龍泉窰出浙江處州龍泉縣
與哥窰共一地道宋時名曰青瓷明窰移處州府處州青色土璺火候較舊
龍泉質劣古器質薄一種盤底有雙魚外有銅掇環體厚者不佳　象窰出
浙江寧波府象山縣似定而粗色帶黃有蟹爪紋色白滋潤者高俱不貴
歐窰出江南常州府宜興縣明歐姓者燒造有倣哥窰紋片者有倣官鈞窰
色者采色甚多皆花盤奩架諸器不一舊者頗佳　建窰出福建泉州府德
化縣其色有甜白青色深淺不同古建瓷薄者絕類宋瓷盌盞多是撆口色

f.2b

f. 2b

黑滋潤有黃兎斑滴珠大者眞體厚者多少見薄者唯佛像最佳　饒器出
江西饒州府浮梁縣景德鎮及廣信府弋陽縣宋時器色樣甚繁其淋璺甚
肥鬆透與定相近而稍有異明官窰皆出于此其官造窰小而器不多甚至
一窰止燒一器者蓋取火候和勻周密而無欹斜走烟破璺之失祭紅以西
紅寶石爲璺又有硃砂點翠青花點色不同璺肥俱有橘皮紋甜白一種色
如羊脂者尤可愛重璺不到磨去復上入窰再燒故棱紋甚厚久用而不茅
蔑御土窰體薄而潤最好素折腰樣茅口者體薄色潤瑩白尤佳其値低于
定器元時燒小定印花者內有樞府字者高新燒大足素者欠潤有青色及
五色花者今燒此器佳者色白而瑩最高青黑色戧金者多是酒壺酒盞之
屬　吉窰出江西吉州府廬陵縣永和鎮色與紫定相類體厚而質粗不足

f.3a

f. 3a

貴宋時有五窯書公燒者佳有白紫二色花餅大者直數金小者有花又有
碎器亦佳相傳文丞相過此窯器盡變成玉遂止不燒 山西窯出太原府
榆次縣平定州平陽府霍州又出霍器 陝窯出平涼府平涼華亭兩縣
廣東窯出潮州府其器與饒器類 高麗窯器類饒磁有甜白色而壁乾燥
微近黃皮粗骨輕花素不等細花竟似北定印花青色者似龍泉上有白花
朵者不甚佳 大食國器以銅骨爲身起線填五采藥料燒成俗謂法瑯是
也宋官窯色鮮菁可愛明官窯亦佳又謂之鬼國窯 古瓷器出河南彰德
府磁州與定器相似但無淚痕亦有劃花繡花素者值昂于定新者不足論
也
附明沈德符敝帚齋餘譚本朝窯器用白地青花間裝五色爲古今之冠

f.3b

f. 3b

如宣窯品最貴近日又重成窯出宣窯之上蓋兩朝天縱留意曲藝宜其
精工如此然花樣皆作八吉祥五供養一串金西番蓮以至鬬雞百鳥人
物故事而已至嘉靖窯則又做宣成二種而稍勝之惟崔公窯加貴其值
亦第宣成之什一耳幼時曾于二三中貴家見隆慶窯酒杯茗椀俱繪男
女私褻之狀蓋穆宗好內以故傳命造此種然漢時發冢鑿甎畫壁俱有
之且有及男色者書册所紀甚具則杯盤正不足怪也以後此窯漸少今
絕不復覯矣
國朝張宗柟帶經堂詩話附識曝書亭集詞注後周時請瓷器式世宗批
其狀曰雨過天青雲破處者般顏色做將來又南宋雜事詩註五雜組柴
窯之外有定汝官哥四種皆宋器也傳流至今者惟哥窯稍易得蓋其質

f.4a

f. 4a

厚類汝窯其法汝白如玉難于定窯宋時宮中所用率銅釦其口以是損
價稗編渡江後修內司造青器名內窯澄泥為範極其精緻油色瑩徹為
世所珍後郊壇下別立新窯餘如烏泥窯餘杭窯續窯皆非官窯比所謂
舊越窯不復見矣四部稾南宋時處州章生兄弟皆作窯兄所作者視弟
色稍白而斷紋多號白芨碎又考古括遺芳稱兄所作為哥窯六研齋筆
記南宋時餘姚有祕色磁麤樸而耐久今人率以官窯目之不能別白也
又見寒坪曰高江村宋均窯瓶歌註世傳柴窯色如天聲如磬今人得其
碎片皆以裝飾玩具又宋以白定有芒不堪用命汝州造青窯器以瑪瑙
末為油又南渡後邵成章提舉後苑時號邵局法政和間京師舊製名官
窯進奉之物臣庶不敢用又南宋時處州章生兄陶者為哥窯弟陶者為

f.4b

f. 4b

龍泉足皆鐵色哥窯多斷紋名百圾破更見重于世又雞缸實燒碗硃砂
盤最為精緻價在宋磁上　成窯雞缸歌註成窯酒杯種類甚多有名高
燒銀燭照紅妝者一美人持燭照海棠也錦灰堆者折枝花果堆四面也
鞦韆盃者士女戲鞦韆也龍舟杯者鬬龍舟也高士杯者一面畫周茂叔
愛蓮一面畫陶淵明對菊也娃娃杯者五嬰兒相戲也滿架葡萄者畫葡
萄也其餘香草魚藻瓜茄八吉祥優鉢羅花西番蓮梵書名式不一皆描
畫精工點色深淺磁色瑩潔而質堅又雞缸上畫牡丹下有子母雞躍躍
欲動又梅村作宣宗戧金蟋蟀盆詩以雞缸為宣窯又云楊致軒先生曾
語余祭紅亦作霽紅或作際紅惜不及問其出處
劉廷璣在園雜志磁器起于柴世宗迄今將近千年徒傳柴窯片之名所

f.5a

f. 5a

謂雨過天青者已不可問矣嗣後惟官哥汝定其價甚昂間亦有之然而
不易多得若成窯五彩暗花而體薄者雖缸一對價値百金亦難輕購本
無多也再則宣窯最佳一時稱盛而眞者甚少以嘉萬之間本朝便倣本
朝極易混淆至　國朝　御窯一出超越前代其款式規模造作精巧多
出於秋官主政伴阮兄之監製焉近復郎窯爲貴紫垣中丞公開府西江
時所造也倣古暗合與眞無二其摹成宣釉水顏色橘皮椶眼款字酷肖
極難辨別予初得描金五爪雙龍酒杯一隻欣以爲舊後饒州司馬許玠
以十杯見貽與前杯同詢之乃郎窯也又于董妹倩齋頭見靑花白地盤
一面以爲眞宣也次日妹倩復惠其八曹織部子淸始買得脫胎極薄白
碗三隻甚爲賞鑒費價百二十金後有人送四隻云是郎窯與眞成毫髮

f5b

f. 5b

不爽誠可謂巧奪天工矣磁器之在　國朝洵足淩駕成宣可與官哥汝
定媲美更有熊窯亦不多讓至于磁床磁燈又近日之新興也
阮葵生茶餘客話　御窯磁器超越前代規模款識多出刑部主事劉伴
阮監製伴阮名源又有郎窯巡撫廷極所造仿古酷肖今之所謂成宣者
皆郎窯也又熊窯亦不多讓近則年窯唐窯皆入賞鑑

f. 6a

f. 6a

After Huang Binhong 黃賓虹 and Deng Shi 鄧實 (eds.), *Meishu congshu* 美術叢書, Shanghai: Shenzhou guoguang shi, 1947, 集 1, 輯 3.

Text 27. 耀州志 *Yaozhou zhi*, Ming Jiajing (1522-1566), first *juan*, Geography 1, ff. 1a-1b.

耀州志
卷之上
地理志第一
耀州禹貢雍州之域在漢祋祤縣景帝二年置隸
左馮翊魏改宜州隋置華原縣隸京兆郡唐武德元
年復宜州領華原同官二縣貞觀十七年州廢二縣
隸京兆垂拱元年置永安縣天授元年復雲陽涇
陽醴泉三原富平美原等縣置宜州大定元年州復

f. 1a

廢為華原縣天祐三年李茂貞據鳳翔始改華原為
耀州名順義軍以富平三原雲陽同官美原五縣隸
之尋降為團練州周顯德中又為刺史州開寶五年
陞感義軍節度使太平興國二年改感德軍增領華
原淳化二縣金改感德軍太守元仍為耀州隸奉元
路領華原富平三原同官美原五縣後併美原入富
平又廢華原入州就領之奉元即京兆也

f. 1b

After *Tianyige zang Mingdai fangzhi xuankan xubian* 天一閣明代方志選刊續編, Shanghai: Shanghai shudian, 1990, vol. 72, pp. 11-13.

Text 28. 耀州志 *Yaozhou zhi*, Qing Jiaqing (1796-1820), *juan* 2, Geography, f. 17b.

黃堡鎮一名黃堡寨三堡寨皆前時居民守禦地也
黃堡在金時尤爲重鎮地理志載焉鎮故有陶場居
人建紫極宮祀其土神宋熙寧中知州閻作奏以鎮
土山神封德應侯以陶冶著靈應故也祀以晉人栢
林配享林蓋傳居人陶術者今其地不陶附於陳爐
陳爐復廟祀德應侯如黃堡云縣東北一里有

After *Zhongguo fangzhi congshu* 中國方志叢書, *Huabei difang* 華北地方, no. 527, Taibei: Chengwen chubanshe, 1976, p. 76.

Text 29. 元豐九域志 **Yuanfeng jiuyu zhi,** ***juan*** **3, f. 17b.**

緊耀州華原郡感德軍節度（唐義勝軍節度周降刺史皇朝開寶五年為感義軍節度太平興國元年改感德軍治華原縣）

地里東京一千二百里東至本州界七十八里自界首至同州一百二十里西至本州界一百三十里自界首至邠州一百里南至本州界六十里自界首至京兆府一百里北至本州界九十五里自界首至坊州七十五里東南至本州界八十五里自界首至華州九十五里西

欽定四庫全書　元豐九域志　卷三　十七

南至本州界八十五里自界首至華州九十五里西南至本州界一百里自界首至坊州八十里西北至本州界八十里自界首至邠州一百里

戶主一萬九千八百二客六千一百八

土貢瓷器五十事

After *Qinding siku quanshu*, 史 *shi* section no. 229, 地理 *dili* category, general vol. 471, p. 67.

APPENDIX II:

TABLES

Table 1

Excavated workshops

The symbol "×" indicates that there is no published illustration for the workshop in question.

Code used in this research	Period	Figure no. in this research	Code used in Chinese archaeological reports	Bibliographical reference
Z1:1s	Song	26a	84 I T2 ③Z1-1	SPIA 1998, pp. 15-17, fig. 9B, p. 18; SPIA Tongchuan Station 1987a, pp. 19-21, fig. 4, p. 20
Z1:2s	Song	26b	84 I T2 ③ Z1-2	SPIA 1998, pp. 17-19, fig. 9C, p. 20; SPIA Tongchuan Station 1987a, pp. 19-21, fig. 4, p. 20
Z2:1t	Tang	17a	II Z2-1	SPIA 1992, p. 12, fig. 8, p. 12 SPIA Tongchuan Station 1987a, p16, fig. 1, p. 16
Z2:2t	Tang	17b	II Z2-2	SPIA 1992, pp. 12-13, fig. 9, p. 13
Z2:3t	Tang	17c	II Z2-3	SPIA 1992, pp. 13-15, fig. 10, p. 16; SPIA Tongchuan Station 1987a, pp. 17-18, fig. 2, p. 17
Z2:4t	Tang	17d	II Z2-4	SPIA 1992, pp. 15, fig. 11, p. 16
Z2:5t	Tang	17e	II Z2-5	SPIA 1992, pp. 15-17, fig. 12, p. 18
Z2:6t	Tang	17f	II Z2-6	SPIA 1992, p. 17, fig. 13, p. 18
Z2:7t	Tang	17g	II Z2-7	SPIA 1992, p. 19, fig. 14, p. 19
Z3:1s	Song	27a	85 I T22 ③ Z3-1	SPIA 1998, p. 19, fig. 10, p. 21
Z3:2s	Song	27b	85 I T22 ③ Z3-2	SPIA 1998, pp. 19-21, fig. 10, p. 21

Z4t	Tang	18	I Z4	SPIA 1992, p. 25, fig. 18, p. 26; SPIA Tongchuan Station 1987a, pp. 18-19, fig. 3, p. 18
Z5s	Song	28	85 II T4 ④ Z5	SPIA 1998, pp. 21-22, fig. 11, p. 22
Z7t	Tang	19	II Z7	SPIA 1992, pp. 25-27, fig. 19, p. 27
Z8t	Tang	20	II Z8	SPIA 1992, pp. 27-28, fig. 20, p. 28
Z11s	Song	29	86 I T14 ③ Z11	SPIA 1998, p. 23, fig. 12, p. 24
Z12t	Tang	21	I Z12	SPIA 1992, p. 29, fig. 21, p. 30
Z14s	Song	×	86 III T4 ② Z14	SPIA 1998, p. 23
Z15s	Song	30	86 III T4 ② Z15	SPIA 1998, pp. 23-25, fig. 13, p. 25
Z16s	Song	×	86 IV T8 ③ Z16	SPIA 1998, p. 25
Z17f	Five Dynasties	46	86 IV Z17	SPIA 1997, p. 12, fig. 9, p. 13
Z18t	Tang	22	I Z18	SPIA 1992, pp. 29-31, fig. 22, p. 31
Z19s	Song	16	87 I T13 ③ Z19	SPIA 1998, pp. 25-28, fig. 14A, p. 26
Z19:1s	Song	16a	87 I T13 ③ Z19-1	SPIA 1998, p. 26, fig. 14B, p. 27
Z19:2s	Song	16b	87 I T13 ③ Z19-2	SPIA 1998, pp. 26-27, fig. 14C, p. 28
Z19:3s	Song	16c	87 I T13 ③ Z19-3	SPIA 1998, pp. 27-28, fig. 14D, p. 29
Z20t	Tang	10	I Z20	SPIA 1992, p. 31, fig. 23, p. 32
Z21s	Song	45	87 I T18 ② Z21	SPIA 1998, pp. 28-29, fig. 15, p. 30
Z22s	Song	31	87 I T19 ② Z22	SPIA 1998, pp. 29-31, fig. 16, p. 32
Z23s	Song	×	87 I T20 ② Z23	SPIA 1998, p. 31
Z24t	Tang	23	II Z24	SPIA 1992, pp. 31-32, fig. 24, p. 33
Z25t	Tang	24	II Z25	SPIA 1992, pp. 32-34, fig 25, p. 35
Z29s	Song	14	90 VI T8 ③ Z29	SPIA 1998, pp. 31-33, fig. 17, p. 34
Z30s	Song	×	90 VI T20 ③ Z30	SPIA 1998, p. 33
Z32s	Song	32	90 VI T23 ③ Z32	SPIA 1998, p. 33, fig. 18, p. 35
Z33s	Song	33	90 VI T24 ③ Z33	SPIA 1998, pp. 33-36, fig. 19, p. 37
Z34s	Song	15	90 VI T25 ③ Z34	SPIA 1998, p. 36, fig. 20, p. 38
Z37s	Song	34	90 VI T29 ② Z37	SPIA 1998, pp. 36-39, fig. 21, p. 40
Z38s	Song	×	90 VI T36 ④ Z38	SPIA 1998, p. 39
Z39s	Song	×	90 VI T38 ④ Z39	SPIA 1998, pp. 39-40

Z42s	Song	35	90 VI T53 ② Z42	SPIA 1998, pp. 40-41, fig. 22, p. 42
Z45s	Song	36	90 V T26 ③ Z45	SPIA 1998, pp. 41-42, fig. 23, p. 43
Z46s	Song	37	90 VI T53 ③ Z46	SPIA 1998, pp. 42-43, fig. 24, p.44
Z47	Song	38	90 VI T22 ③ Z47	SPIA 1998, pp. 43-44, fig. 25, p. 44
Z49s	Song	39	90 VI T55 ④ Z49	SPIA 1998, pp. 44-45, fig. 26, p. 45
Z60s	Song	×	90 V T33 ③ Z60	SPIA 1998, pp. 45-46
Z63s	Song	×	91 II T9 ③ Z63	SPIA 1998, p. 46
Z65	Song	40	91 VI T63 ③ Z65	SPIA 1998, p. 46, fig. 27, p. 47
Z66f	Five Dynasties	44	86 IV Z66	SPIA 1997, pp. 10-12, fig. 8, p. 11
Z67s	Song	47	91 IV T15 ③ Z67	SPIA 1998, p. 46, fig. 28, p. 48
Z68f	Five Dynasties	48	88 VI Z68	SPIA 1997, p. 12, fig. 10, p. 13
Z69s	Song	41	91 IV T23 ③ Z69	SPIA 1998, p. 48, fig. 29, p. 49
Z70f	Five Dynasties	25	91 IV Z70	SPIA 1997, p. 10, fig. 7, p. 11
Z71s	Song	42	91 IV T25 ③ Z71	SPIA 1998, pp. 48-51, fig. 30, p. 50
Z74s	Song	×	92 VII T10 ③ Z74	SPIA 1998, p. 51
Z76s	Song	11	85 IV T4 ② Z76	SPIA 1998, pp. 51-52, fig. 31, p. 52
Z77s	Song	12	91 IV T25 ③ Z77	SPIA 1998, pp. 52-53, fig. 32, p. 54
Z78s	Song	13	86 III T6 ② Z78	SPIA 1998, p. 53, fig. 33, p. 55
Z84s	Song	43	97 IV T36 ② Z84	SPIA 1998, pp. 53-54, fig. 34, p. 56
58-59Z1jy	Jin-Yuan	×	58-59 II T5-6 ③ Z1	SPIA 1965, p. 10, table V:5
58-59Z2jy	Jin-Yuan	×	58-59 II T5-6 ③ Z2	SPIA 1965, p. 10
58-59Z3jy	Jin-Yuan	×	58-59 II T5-6 ③ Z3	SPIA 1965, p. 10, table V:1-4
58-59Z4jy	Jin-Yuan	×	58-59 II T5-6 ③ Z4	SPIA 1965, p. 10

Table 2

Earthen vats (*taogang* 陶缸)

Dimensions are given in cm and correspond in order to length, width and height. When two or more vats occur simultaneously, they are indicated with capital letters A, B, C, etc.

Abbreviations: md.: mouth diameter; bod: body diameter; bd.: base diameter; h: height; rh.: remaining height.

Location	Quantity	Dimensions	Position	Notes
Z20t	9 *taogang* 陶缸	Not reported	Close to settling and de-watering tanks	1/3 driven into ground
Z66f	1 *taogang* 陶缸	bd. 25	Close to settling tank	
Z17f	1 *taogang* 陶缸	md. 54, bd. 32, rh. 60	Close to settling tank	20 cm of very fine clay paste (*gan ni*)
Z77s	1 *taogang* 陶缸	d. 55	Close to settling tank	
Z78s	28 *taogang* 陶缸	d. 80-100, rh. 30-60	Close to settling and de-watering tanks	Partially driven into ground
Z29s	2 *taogang* 陶缸	A: bd. 20, rh. 7 B: bd. 30, rh. 8	Close to potter's wheel	5 cm very fine clay paste (*gan zi ni*)
Z2:6t	3 *taogang* 陶缸	Not reported	Close to potter's wheel	
Z4t	2 *taoweng* 陶瓮	A: md. 35, bd. 25, h. 18 B: md. 40, bd. 30, h. 16	Close to potter's wheel and paste	Partially driven into ground
Z49s	1 *taogang* 陶缸	d. 50, rh. 25	Close to potter's wheel, wedging/ ageing enclosure	
Z32s	3 holes for *taogang* 陶缸	A: d. 50, h. 5; B: d. 45, h. 10; C: d. 70, h. 10	Opposite potter's wheel	
Z33s	2 holes for *taogang* 陶缸	d. 60, h. 15-16	Opposite potter's wheel	
Z2:5t	1 *taogang/weng* 陶缸/瓮	d. 120		Overlaps the perimeter wall
Z2:3t	1 *taogang* 陶缸	d. 75, h. 35		Equipped with a channel suspended between the vat's mouth and the wall
Z25t	1 black-glazed *ci/taogang* 瓷/陶缸 1 *taoguan* 陶罐	*Ci/tao gang* 瓷/陶缸: bod 48, bd. 22, rh. 20-35; *taoguan* 陶罐: not reported	*Ci/tao gang* 瓷/陶缸 by corner inside entrance; *taoguan* 陶罐 in extension	Red powder inside *taoguan* 陶罐
Z37s	1 *taogang* 陶缸	md. 100	By corner inside entrance, close to potter's wheel and	Partially buried in the ground

			wedging/ageing enclosure	
Z1:2s	1 *shuigang* 水缸	md. 34, bd. 28, h. 51	By corner inside entrance, close to mortar, potter's wheel and wedging/ageing enclosure	
Z70f	1 *taogang* 陶缸	Not reported		No shaping equipment in this part of workshop, but 2 potter's wheels in separate part
Z2:4t	1 *tao/wapen* 陶/瓦盆	Not reported	Back of the workshop, moulds nearby	
Z12t	1 *taoweng/gang* 陶瓮/缸 1 *taoguan* 陶罐 2 *taogang* 陶缸 1 tea-dust glazed *taoguan* 瓷罐	*Taoweng/gang* 陶瓮/缸: md. 37, bd. 26, h. 60; *taoguan* 陶罐: md. 9, bd. 15, h. 40; 2 *taogang* 陶缸: md. 40, bod. 50, h. 68; tea-dust glazed *taoguan* 瓷罐: rh. 20		No shaping equipment. Small tea-dust glazed cup inside first *taoguan* 陶罐
Z1:1s	3 *tao/you gang* 陶/釉缸	A: md. 95; B: md. 85; C: md. 90		
Z3:1s	1 *heici gang* 黑瓷缸 2 *tao/you gang* 陶/釉缸 group broken *taogang* 陶缸	Not reported	Along both side walls	No shaping equipment
Z65s	4 holes for *taogang* 陶缸	d. 10-40		No shaping equipment
Z21s	1 *taogang* 陶缸	d. 44, h. 36		1/3 buried in the ground
Z47s	1 *taogang* 陶缸	Not reported		30 cm driven into ground; 2 cm clay paste (*ganni* 坩泥) on ground

Table 3

Washing tanks (*taoxichi* 淘洗池)

Dimensions are given in cm and correspond in order to length, width and height.

Location	Dimensions	Lining material	Notes
Z20t	155x70x10-15	Refractory bricks	
Z17f	160x65-81x20-25	Stone	Clay (*gantu* 坩土) residue on the bottom
Z66f	165x45x40	Paved with refractory bricks, lined with stones	
Z67s	210x180x18-34	Stone	Clay (*gantu* 坩土) residue on the bottom
Z77s tank A	205x150x20	Stone	Clay (*gantu* 坩土) residue on the bottom
Z77s tank B	165x135x40	Stone	
Z77s tank C	100x60x22	Stone	
Z78s tank A (east)	195x120-130x95 (max.)	Stone	Concave floor, connected to adjacent tank
Z78s tank B (west)	Not reported	Not reported	

Table 4

Settling tanks (*chendianchi* 沉澱池)

Dimensions are given in cm and correspond in order to length, width and height.

Location	Dimensions	Lining material	Notes
Z20t	150x65x60	Refractory bricks on one long side, natural soil for the rest	Clay (*ganni* 坩泥) on floor
Z78s A	top: 440x335 } x170 bottom: 315x240}	Natural soil	Connected to adjacent settling tank
Z78s B	Not reported	Not reported	

Table 5

Wedging/ageing enclosures (*liannichi* 練泥池)

Dimensions are given in cm and correspond in order to length, width and height.

Location	Dimensions	Lining material	Notes
Z25t	480x240-260x10-12	Paved with stones	Lower than the workshop floor; 4 piles of well wedged clay paste (*ganni* 坩泥)
Z68f	232x38-64x34 (incomplete)	Paved with large bricks placed over a layer of broken saggars	Reported measures and scale of drawing do not match. Layer of clay paste (*ganni* 坩泥)
Z66f	Not reported	Not reported	Overlaps perimeter wall
Z77s	65x50x24	Stone	

Z1:2s	300x135x14	Bricks	Clay paste on floor; indoor workshop
Z37s	197x160	Bricks	Indoor workshop
Z45s	200x80 (incomplete)	Paved with bricks, lined with stone	Indoor workshop
Z49s	60x40x20	Lined with bricks	Clay paste on floor; indoor workshop

Table 6

Potter's wheel pits

Dimensions are given in cm and correspond in order to length, width and height. When two or more wheel pits and spindle pits occur, they are indicated with capital letters A and B.

Abbreviations: md.: mouth diameter; bod.: body diameter; bd.: base diameter; h: height; rh.: remaining height.

Location	Wheel pit dimensions	Shaft pit dimensions	Notes
Z2:3t	Not reported	Not reported	
Z2:5t	Not reported	Not reported	2 wheel and shaft pits
Z2:6t	d. 45, h. 45	15x15, h. 70	
Z2:7t	d. 46, h. 33	d. 15, h. 27	
Z4t	md. 50, bd. 14, h. 69	Not reported	
Z25t	d. 54, h. 24	d. 12, h. 90	
Z70f	A: d. 45, h. 25; B: d. 50, h. 26	Not reported	
Z1:2s	43x40	Not reported	
Z19:2s	46x38, h. 60	d. 6, h. 80	Oblong, funnel-shaped wheel pit divided in 2 levels: lower level 8 cm narrower
Z29s	d. 65, h. 50	d. 10, h. 74	
Z32s	d. 60, h. 20	Not reported	
Z33s	d. 50, h. 40	d. 10, h. 60	
Z37s	A: d. 45 B: d. 51, h. 37	A: d. 9, h. 125 B: d. 9, h. 110	
Z42s	d. 85, h. 45	d. 10, h. 90	
Z45s	A: d. 50	A: d. 10, h. 122 B: d. 8, h. 70	At the top of shaft pit B there was a shaft cap
Z46s	d. 50, h. 25	d. 10, h. 80	
Z49s	Not reported	d. 8, h. 90	
Z60s	d. 30, h. 80	Not reported	
Z71s	A: d. 36, h. 40 B: not reported	A: d. 10, h. 35 B: not reported	

Table 7

Excavated kilns

The symbol "×" indicates that there is no published figure for the kiln in question.

Abbreviation used in this research	Period	Figure no. in this research	Abbreviation used in Chinese archaeological reports	Bibliographical reference
Y1s	Song	117	84 I T1 ③ Y1	SPIA 1998, pp. 60-61; fig. 36; p. 62
Y2s	Song	121	84 VII T3 ③ Y2	SPIA 1998, p.61; fig. 37; p. 63
Y3s	Song	115	85 II Y3	SPIA 1998, pp. 61-63, fig. 38, p. 64
Y4s	Song	118	85 II Y4	SPIA 1998, pp. 63-65, fig. 39, p. 66; SPIA Tongchuan Station 1987a, pp. 22-24, fig. 7, p. 24; Du Baoren 1987b, pp. 33-35, fig. 3, p. 33; Xiong Haitang 1994, p. 70, fig. 3-3-12
Y5s	Song	122	85 I T13 ③ Y5	SPIA 1998, pp.65-67, fig. 40, p. 68; Du Baoren 1987b, pp. 33-35, fig. 4, p. 34
Y6t	Tang	102	I Y6	SPIA 1992, pp. 34-36, fig. 27, p. 37; SPIA Tongchuan Station 1987a, pp. 21-22, fig. 6, p. 23; Du Baoren 1987b, pp. 32-33, fig. 1, p. 32; Xiong Haitang 1994, p. 67, fig. 3-3-10
Y7s	Song	114	85 I T13 ③ Y7	SPIA 1998, p. 67, fig. 41, p. 69
Y9t	Tang	103	I Y9	SPIA 1992, p. 38, fig. 28, p. 39
Y10t	Tang	104	II Y10	SPIA 1992, pp. 10-11, fig. 15, p. 20; SPIA Tongchuan Station 1987a, p. 21, fig. 5, p. 22; SPIA Tongchuan Station 1987b, p. 26, fig. 5, p. 26
Y11t	Tang	105	II Y11	SPIA 1992, p. 21, fig. 16, p. 21
Y12t	Tang	101	II Y12	SPIA 1992, p. 38, fig. 29, p. 40
Y14t	Tang	106	II Y14	SPIA 1992, pp. 21-23, fig. 17, p. 22
Y15f	Five Dynasties	108	86 IV Y15	SPIA 1997, pp. 12-14, fig. 11, p. 15
Y19s	Song	123	86 IV T9 ② Y19	SPIA 1998, pp. 67-70, fig. 42, p. 71
Y20s	Song	124	86 IV T9 ② Y20	SPIA 1998, p. 70, fig. 43, p. 72
Y21s	Song	125	86 I T8 ③ Y21	SPIA 1998, pp. 70-72, fig. 44, p. 73
Y23t	Tang	×	I Y23	SPIA 1992, pp. 38-39

Y24s	Song	×	87 I T13 ③ Y24	SPIA 1998, pp. 72-74
Y25s	Song	×	87 I T13 ③ Y25	SPIA 1998, p. 74
Y26s	Song	×	87 VII Y26	SPIA 1998, p. 74
Y28t	Tang	107	VI Y28	SPIA 1992, pp. 39-40, fig. 30, p. 41; Li Jiazhi (ed.) 1998, p. 266, fig. 8-6
Y29f	Five Dynasties	109	88 VI Y29	SPIA 1997, p. 14, fig. 12, p. 16
Y31f	Five Dynasties	110	90 VI Y31	SPIA 1997, pp. 14-17, fig. 14, p. 19
Y32f	Five Dynasties	111	90 VI Y32	SPIA 1997, p. 17, fig. 13, p. 18
Y36s	Song	119	90 VI T37 ④ Y36	SPIA 1998, pp. 74-75, fig. 45, p. 76
Y43f	Five Dynasties	112	90 VI Y43	SPIA 1997, p. 20, fig. 15, p. 21
Y44s	Song	126	90 VI T56 ③ Y44	SPIA 1998, pp. 75-77, fig. 46, p. 78
Y45s	Song	×	90 VI T54 ③ Y45	SPIA 1998, p. 77
Y46s	Song	×	90 VI T55 ④ Y46	SPIA 1998, pp. 77-79
Y47s	Song	127	90 VI T59 ③ Y47	SPIA 1998, pp. 79-81, fig. 47, p. 80
Y56s	Song	128	90 VI T63 ③ Y56	SPIA 1998, p. 81, fig. 48, p. 82
Y58f	Five Dynasties	113	91 IV Y58	SPIA 1997, p. 20, fig. 16, p. 21
Y60f	Five Dynasties	×	91 IV Y60	SPIA 1997, p. 20
Y61s	Song	×	91 VII T5 ② Y61	SPIA 1998, p. 81
Y62s	Song	116	94 V T40 ③ Y62	SPIA 1998, pp. 81-82, fig. 49, p. 83
Y63s	Song	129	94 V Y63	SPIA 1998, pp. 83-84, fig. 50, p. 85
Y67s	Song	130	94 V T39 ③ Y67	SPIA 1998, p. 84, fig. 51, p. 86
73Y2s	Song	120		Zhuo Zhenxi and Lu Guojian 1980, pp. 58-59, fig. 7, p. 58
58-59Ys tile	Song	134		SPIA 1965, pp. 10-11, fig. 8, p. 10
58-59Y2jy	Jin-Yuan	131		SPIA 1965, pp. 8-10, fig. 7, p. 9; Du Baoren 1987b, pp. 35-36, fig. 5, p. 35; Li Jiazhi (ed.) 1998, p. 267, fig. 8-7[681]
Anren, Xunyi Y1	Jin-Yuan	132		Du Baoren 1987b, p. 36, fig. 6, p. 35; Xiong Haitang 1994, p. 70, fig. 3-3-13
Anren, Xunyi Y2	Jin-Yuan	133		Du Baoren 1987b, p. 36, fig. 7, p. 35
Lidipo Y2y	Yuan?	134		SPIA 1965, pp. 48-49, fig. 31, p. 49

[681] Li Jiazhi attributes this kiln to the Song dynasty.

Table 8

Dimensions of the various portions of the kilns

Dimensions are given in cm and correspond in order to length, width and height; not reported dimensions are indicated with a question mark; the symbol "×" indicates that that element was not included in the structure; the abbreviation "r." after dimensions indicates the remaining length, width or height; when there are two or more chimneys, they are indicated with the capital letters A, B and C.

Kiln	Ventilation pit	Ventilation channel	Entrance	Firebox	Ash pit	Kiln chamber	Chimney
Y10t (*sancai*)	×	×	Not reported	80-140x140	×	140-170 x 205	Not survived
Y11t (*sancai*)	×	×	74	74-130x178	×	130-164 x 145r.	Not survived
Y14t (*sancai*)	×	×	Not survived	32-74r. x98	×	72r.-146 x 161	A: 35x54 B: 37x54
Y6t	×	×	Not survived	130-296 x 210	×	308-480 x 278	A: 100-118 x 116 B: 116-118 x 118
Y9t	×	×	Not survived	Not survived	×	158-198 x 205r.	A: 60-84 x 54-60 B: 60-84 x 54-60
Y12t	×	×	Not survived	Not survived	×	A: d. 90 B: d. 84	36x24 (oblong)
Y23t	×	×	Not survived	70-190x150	×	Seriously damaged	Not survived
Y28t	×	×	Not survived	315x36r.	×	300x225	A: 92-85 x 124 B: 75-83 x 101
Y15f	×	×	120	120-210 x 117	×	210-275 x 245	A: 100x62 B: not survived
Y29f	×	×	60	60-159x90	×	159-180 x 152	A: 42x58 B: 43-46 x 60
Y31f	×	×	40	40-286x?	×	256x305	Not reported
Y32f	×	×	Not reported	70-220 x 116	×	230-274 x 210	A: 54-70 x 46 B: not reported
Y43f	×	×	Not survived	Not survived	×	230-260 x 275	275 x 135
Y58f	×	×	40	90-206 x 150	×	Not survived	Not survived
Y1s	×	120 x 85 x 200-220r.	85	85-240 x 95	? x ? x 200	240-280 x 200	A: 135-14- x 170 B: 135-140 x 185
Y2s	110-120 x 160-65x?	550 x 30 x 20-30	60	Not reported	95x60x75	Not survived	Not survived
Y3s	×	× [or not survived?]	90	90-225x65	80x150r. x 195	225-265 x 190	A: 90x100 B: 95x105

Y4s	×	120r. x 50-60 x 130-160	50	50-310x75	100 x 60 x 130-160	310-328-300x246	A: 100-105 x 80 B: 100x80
Y5s	98x106 x 34	440x 26x18	68	68-230x135	106x25 x 88-100	230-240 x 160	A: 70x70 B: 65-70 x 65-70
Y7s	×	× [or not survived?]	90	90-160x36	138x36x40-74r	160-260x?	Not survived
Y19s	44-64r. x 46 x 20	332x 29x18	100	100-228x70	112x24 x 98-110	228-335- 325 x 298	A: 90-102 x 98 B: not survived
Y20s	×	148x40-75 x 20	100	100-210x98	122x26 x 100	210-320 x 300	Not survived
Y21s	24-42x30 x 20	220x23-26x 20	85	85-254x100	238x30 x 54-60	254-300 x 210	Not survived
Y24s	Not survived	Not survived	Not survived	Not survived	Not survived	270x86r.	A: 74x100 B: 86x110
Y25s	×	115-126 x 50-60 x 106-112	56	56-242x68	Not survived	Not survived	Not survived
Y26s	Not survived	Not survived	Not survived	130-310 x 130	105-110x26 x 121	310r. x 110r.	Not survived
Y36s	×	Left: 50x 24x20 Right: 50x 22x24	2	62-182x86	154x30 x 40	182-212 x 202	214-218 x 50-65
Y44s	135x130 x 20	195x 20x15	80	80-190x?	170x30 x 80	190-230 x 165	Not survived
Y45s	Not survived?	Not survived?	90	Not reported	220x60 x 75	220-370r. x 185r.	Not reported
Y46s	× [or not survived?]	× [or not survived?]	Not survived	Not survived	180r x 40x60	180r-250 x 150	A: d. 30 B: d. 30
Y47s	110x100 x 20	?x 20-40x 20 -30	120	120-235 x 124	40x220 x 100	258x324	A: 60x85 B: 110 x 100-124 C: 60x85
Y61s	Not survived?	Not survived?	Not survived	Not survived	Not survived	390r x 300r.	Left: 110-130r x 110 Right: 150-110
Y62s	Not survived?	Not survived?	70	54-210x185	160x36x60	210-265 x 100-150r	Not survived
Y63s	Not survived	340 x 50-28-85 x 24	94	90-294x90	190-200x28	298-340 x 286	A: 90x100-110 B: 90x96-110
Y67s	150x120x 37-52	250 x 56-26 x 20	50r.	80-160x 50x?	80x60x70	230x230 [?]	140x110
73Y2s	Not survived	240x20-80x 100	89r.	340x128	110-120 x 36x130	394x268	A: 145x83-90 B: 145x83-90
58-59Y2jy	Not survived	Not survived	68	268x94	Top: 95x33-36 Bottom: 36x37-42	336x216	A: 116x118 B: 116x118
58-59Ytile	Not survived?	Not survived?	60	215-74	×	215x170	Not reported

Anren, Xunyi Y1	Not survived	Not survived	90	432x258	Not reported	420x220	A: 124x102 B: 124x102 Semicircular
Anren, Xunyi Y7	Not survived	228 x 105-119 x 128	66	260x120	?x?x247	358x520	Not reported
Lidipo Y2y	Not survived?	Not survived?	68	295x90	×	315x205	A: 95x115 B: 95x115

Table 9

Kiln support dimensions

The kiln supports are indicated by the publication they are illustrated in, the number of the corresponding figure, the number of the corresponding item and the letters "t" for Tang, "f" for Five Dynasties, "s" for Song and "jy" for Jin-Yuan.

Measurements are in cm.

Support	Top	Base	Height	Support	Top	Base	Height
SPIA 1992, fig. 277:1t	5.7	5.7	7.2	**SPIA 1998, fig. 249:5s**	2.4	3.5	5.9
SPIA 1992, fig. 277:2t	5.5	4.8	9.2	**SPIA 1998, fig. 249:6s**	1.8	3.5	4.6
SPIA 1992, fig. 277:3t	6.6	6.6	12	**SPIA 1998, fig. 249:7s**	4.5	4.7	9.4
SPIA 1992, fig. 277:4t	2.9	3.3	4.3	**SPIA 1998, fig. 249:8s**	6	8	11.2
SPIA 1992, fig. 277:5t	12.6	8	14	**SPIA 1998, fig. 249:9s**		9	11.6
SPIA 1992, fig. 277:6t	5.2	4.9	4.9	**SPIA 1998, fig. 249:10s**	3	6.6	5
SPIA 1992, fig. 277:7t	10.4	11.2	13.6	**SPIA 1998, fig. 249:11s**	4.1	6.1	7.1
SPIA 1992, fig. 277:8t	7.8	7.4	11.4	**SPIA 1998, fig. 249:12s**	7.2	7.2	13
SPIA 1992, fig. 277:9t	11	11.6	13.4	**SPIA 1998, fig. 249:13s**	7.2	6.4	7.4
SPIA 1992, fig. 277:10t	8.9	13.4	13.2	**SPIA 1998, fig. 249:14s**	8.4	8.4	8.2
SPIA 1992, fig. 277:11t	8.9	6.4	10.2	**SPIA 1998, fig. 249:15s**	8.4	8	9.2
SPIA 1992, fig. 277:12t	4.8	4.5	9.7	**SPIA 1998, fig. 250:1s**	7.5		6.8
SPIA 1992, fig. 277:13t		7	8	**SPIA 1998, fig. 250:2s**	12.2	6.1	8.6
SPIA 1992, fig. 278:1t	14.4	7	8	**SPIA 1998, fig. 250:3s**	8	5	4.3
SPIA 1992, fig. 278:2t	11.8	7.8	5.7	**SPIA 1998, fig. 250:4s**	9.1	5.9	6.7
SPIA 1992, fig. 278:3t	7.2	5.3	4.3	**SPIA 1998, fig. 250:5s**	8.5	6.7	8.5
SPIA 1992, fig. 278:4t	6.2	5.6	3.1	**SPIA 1998, fig. 250:6s**	6.4	7.8	13.6
SPIA 1992, fig. 278:5t	6	5.7	3.3	**SPIA 1998, fig. 250:7s**	4.8	5.8	8.8
SPIA 1997, fig. 126:7f	10.7	11.7	13	**SPIA 1998, fig. 250:8s**	7	8.2	13.3

SPIA 1997, fig. 126:8f	5.4		8.4	**SPIA 1998, fig. 250:9s**	6.8		5.2
SPIA 1992, fig. 126:9f	7	7	7.5	**SPIA 1998, fig. 250:10s**	9.2	16	10
SPIA 1997, fig. 126:10f	6.1	7.1	12.6	**SPIA 1998, fig. 250:11s**	10.8	6	8
SPIA 1998, fig. 249:1s	3	5.7	7.1	**SPIA 1998, fig. 250:12s**	3.2	8	2.3
SPIA 1998, fig. 249:2s	4	6.3	7.2	**SPIA 1998, fig. 250:13s**	3.2	4.3	2.1
SPIA 1998, fig. 249:3s	3.2	4.5	6.1	**SPIA 1965, p. 31 s**	8	8	6.7-9
SPIA 1998, fig. 249:4s	3.9	4.9	4.8	**SPIA 1965, p. 45 jy**	6.4-7.4		14

Table 10

Excavated calcination kilns

Measures are given in cm; the abbreviations "w." and "d" stand respectively for "width" and "diameter".

Abbreviation used in this research	**Period**	**Figure no. in this research**	**Dimensions**	**Abbreviation in Chinese archaeological reports**	**Bibliographical references**
Y16s	Song	133	Entrance: w. 28-32 Chamber: d. 150	86 I T14 ③ Y16	SPIA 1998, pp. 88-89, fig. 52, p. 90
Y27s	Song	134	Entrance: w. 28-32 Chamber: 84x118	87 I T18 ② Y27	SPIA 1998, p. 89, fig. 53, p. 91

Table 11

Waste pits (*huikeng* 灰坑)

The symbol "×" indicates that there is no published figure for the waste pit in question.

Dimensions are given in cm and correspond in order to length, width and height.

Abbreviations: md.: mouth diameter; bod.: body diameter; bd.: base diameter; h: height; rh.: remaining height.

Abbreviation used in this research	**Period**	**Fig. no. in this research**	**Dimensions**	**Abbreviation in Chinese archaeological reports**	**Bibliographical reference**
H19t	Tang	140:1	md. 150, bd. 125 x 170	IV H 19	SPIA 1992, p. 43, fig. 32:1, p. 44
H34t	Tang	140:2	d. 180-190 x 160	III H34	SPIA 1992, p. 43, fig. 32:2, p. 44
H32t	Tang	140:3	220-240 x 190-200 x 60-70	I H32	SPIA 1992, p. 43, fig. 32:3, p. 44
H20t	Tang	140:4	230x100x175	IV H20	SPIA 1992, p. 43, fig. 32:4, p. 44

H12t	Tang	140:5	166x118x85	II H12	SPIA 1992, p. 43, fig. 32:5, p. 44
H7t	Tang	140:6	230x215x140	I H7	SPIA 1992, p. 43, fig. 32:6, p. 44
H16t	Tang	140:7	134x96x60	I H16	SPIA 1992, pp. 43-45, fig. 32:7, p. 44
H5f	Five Dynasties	141:1	md. 150, bd. 50 x 70	90 VI H5	SPIA 1997, p. 22, fig. 17:1, p. 23
H1f	Five Dynasties	141:2	md. 200, bd. 260 x 140	90 VI H1	SPIA 1997, p. 22, fig. 17:2, p. 23
H19f	Five Dynasties	141:4	md. 150, bd. 125 x	86 IV H19	SPIA 1997, p. 22, fig. 17:4, p. 23
H6f	Five Dynasties	141:3	md. 200, bod. 205, bd. 100 x 170	90 VI H6	SPIA 1997, p. 22, fig. 17:3, p. 23
91 H12f	Five Dynasties	141:5	md. 200, bd. 200 x 65	91 IV H12	SPIA 1997, p. 22, fig. 18:1, p. 24
91 H8f	Five Dynasties	141:11	md. 105, bod. 255, bd. 100 x 480	91 IV H8	SPIA 1997, p. 25, fig. 18:7, p. 24
90 H12f	Five Dynasties	141:6	80x120x80	90 VI H12	SPIA 1997, p. 25, fig. 18:2, p. 24
90 H8f	Five Dynasties	141:7	130x200x60	90 VI H8	SPIA 1997, p. 25, fig. 18:3, p. 24
H15f	Five Dynasties	141:9	125x330x150	91 IV H15	SPIA 1997, p. 25, fig. 18:5, p. 24
H17f	Five Dynasties	141:8	mouth: 82x94, base: 115-118 x 120	91 IV H17	SPIA 1997, p. 25, fig. 18:4, p. 24
H9f	Five Dynasties	141:10	155x155x175	91 IV H9	SPIA 1997, p. 25, fig. 18:6, p. 24
90 H11s	Song	142:1	md. 198, bd. 175-190 x 240	90 VI T13 ④ H11	SPIA 1998, p. 89, fig. 54:1, p. 92
91 H11s	Song	142:2	mouth: 185-245, base: 190-245 x 120	91 IV T21 ③ H11	SPIA 1998, p. 89, fig. 54:2, p. 92
H9s	Song	142:3	mouth: 190x 60-140 x 20-50	85 II H9	SPIA 1998, pp. 89-90, fig. 54:3, p. 92
H14s	Song	142:4	530x190 x 205	86 II T6 ④ H14	SPIA 1998, pp. 92-93, fig. 54:4, p. 92
58-59 H5t	Tang	×	300x150x110	III H5	SPIA 1965, p. 12
58-59 H1s	Song	×	md. 600, bd. 420 x 50-120	I H1	SPIA 1965, p. 12
58-59 H2s	Song	×	Seriously damaged	II H2	SPIA 1965, p. 12, plate III:5
58-59 H2Ajy	Jin-Yuan	×	Not reported	II H2A	SPIA 1965, p. 12, plate III:6
58-59 H3jy	Jin-Yuan	×	md. 110, bd. 150 x 130	II H3	SPIA 1965, pp. 12-13
58-59 H4jy	Jin-Yuan	×	md. 100, base: 50x75x130	II H4	SPIA 1965, pp. 12-13

Table 12

Chemical composition of saggars published in Chinese literature.

For a question of simplicity in the compilation of the following table, the samples have been re-numbered according to their date; bibliographical references relative to each sample are listed below in table 3.13.

The abbreviation "Sag" stands for "saggar", "Por." stands for porosity and "Wa." for water absorbance.

The letters "t", "f", "s", "j" and "y" indicate the dynasty the sample in question dates back to: Tang, Five Dynasties, Song, Jin and Yuan.

The symbol "×" indicates that the value for the element in question was not reported.

Sag	SiO_2	Al_2O_3	CaO	MgO	K_2O	Na_2O	Fe_2O_3	TiO_2	MnO_2	P_2O_5	Por.	Wa.
1t	65.53	26.13	0.73	0.90	1.60	0.13	2.14	1.62	×	0.07		
2t	63.63	28.50	0.55	1.00	1.91	0.19	1.95	1.03	0.006	0.09		
3f	58.91	32.71	0.47	0.80	1.71	0.14	2.86	1.43	0.006	0.09		
4s	63.50	28.45	0.90	0.77	1.71	0.16	2.54	1.54	×	0.10		
5s	59.33	32.52	0.44	0.79	2.10	0.10	2.60	1.94	×	0,05		
6s	71.62	20.95	0.69	0.74	2.31	0.51	1.98	1.11	0.006	0.08		
7s	62.54	27.94	0.95	0.82	2.45	0.29	2.16	1.09	0.014	0.17		
8s	62.65	29.28	0.48	0.63	2.10	0.37	1.79	1.05	0.024	0.085		
9s	70.69	21.92	0.27	0.63	1.95	0.26	2.25	0.88	0.004	0.024		
10s	71.56	20.70	0.38	0.72	2.27	0.07	1.63	0.86	0.004	0.09		
11s	68.82	21.68	1.13	0.83	2.52	0.27	1.89	0.73	0.015	0.18		
12s	65.81	27.79	0.37	0.64	2.14	0.14	1.26	1.03	0.004	0.09		
13s	65.22	27.28	0.60	0.76	2.32	0.21	2.17	0.95	0.01	0.10		
14s	66.10	27.07	0.44	0.52	2.16	0.13	1.67	0.91	0.005	0.06		
15s	62.53	36.31	0.53	0.73	1.33	0.20	2.92	1.64	×	×	×	×
16s	53.97	38.37	0.55	0.92	1.38	0.26	2.65	1.57	×	×	×	×
17j	72.93	19.41	0.34	0.07	2.52	0.27	1.56	0.90	0.005	0.11		
18y	52.99	32.99	0.93	0.97	1.52	0.20	7.45	1.78	×	0.07		

Table 13

Bibliographical references related to the saggars listed in Table 3.12

Saggar	Bibliographical references
1t	Zhang Zhigang *et al.*, ISAC '99, p. 493, table 2, item 1
2t	Li Jiazhi (ed.) 1998, p. 262, table 8-2, item 7
3f	Li Jiazhi (ed.) 1998, p. 262, table 8-2, item 12
4s	Zhang Zhigang *et al.*, ISAC '99, p. 493, table 2, item 6
5s	Zhang Zhigang *et al.*, ISAC '99, p. 493, table 2, item 7
6s	Li Jiazhi (ed.) 1998, p. 262, table 8-2, item 1
7s	Li Jiazhi (ed.) 1998, p. 262, table 8-2, item 2
8s	Li Jiazhi (ed.) 1998, p. 262, table 8-2, item 4
9s	Li Jiazhi (ed.) 1998, p. 262, table 8-2, item 6
10s	Li Jiazhi (ed.) 1998, p. 262, table 8-2, item 8
11s	Li Jiazhi (ed.) 1998, p. 262, table 8-2, item 9

12s	Li Jiazhi (ed.) 1998, p. 262, table 8-2, item 10
13s	Li Jiazhi (ed.) 1998, p. 262, table 8-2, item 11
14s	Li Jiazhi (ed.) 1998, p. 262, table 8-2, item 13
15s	You Enpu *et al.* 1982/1987, p. 311, table 1, item Yaozhou 1
16s	You Enpu *et al.* 1982/1987, p. 311, table 1, item Yaozhou 2
17j	Li Jiazhi (ed.) 1998, p. 262, table 8-2, item 3
18y	Zhang Zhigang *et al.*, ISAC '99, p. 493, table 2, item 9

Table 14

Chemical composition of the body of samples A-G

Body	SiO_2	Al_2O_3	CaO	MgO	K_2O	Na_2O	Fe_2O_3	TiO_2	MnO_2	P_2O_5
A	63.65	28.38	0.93	0.77	1.79	0.15	2.78	1.26	0.03	0.25
B	64.59	28.90	0.72	0.41	1.65	0.05	2.09	1.46	0	0.12
C	64.64	28.08	0.90	0.45	1.92	0.06	2.44	1.44	0	0.05
D	64.25	28.55	0.50	0.66	1.82	0.07	2.47	1.51	0	0.16
E	66.03	27.58	0.55	0.42	2.51	0.17	1.73	0.89	0	0.11
F	67.75	23.98	1.37	0.66	2.49	0.22	2.66	0.90	0	0.16
G (Yue)	76.65	17.01	0.20	0.23	2.63	0.68	1.85	0.59	0.03	0.12

Table 15

Chemical composition of the slip of samples A-D

Slip	SiO_2	Al_2O_3	CaO	MgO	K_2O	Na_2O	Fe_2O_3	TiO_2	MnO_2	P_2O_5
A	63.06	30.87	0.73	0.66	1.82	0.15	1.21	1.35	0.01	0.14
B	63.44	30.69	0.77	0.47	1.52	0.14	1.04	1.67	0.01	0.24
C	64.75	30.17	0.76	0.31	1.44	0.05	0.94	1.48	0.01	0.10
D	59.38	33.54	0.45	0.71	2.14	0.11	1.95	1.56	0	0.17

Table 16

Chemical composition of the glaze of samples A-G

Glaze	SiO_2	Al_2O_3	CaO	MgO	K_2O	Na_2O	Fe_2O_3	TiO_2	MnO_2	P_2O_5
A	63.52	12.73	16.31	2.38	1.72	0.36	1.67	0.13	0.11	1.10
B	69.89	15.43	8.13	1.42	2.93	0.34	1.46	0.14	0.10	0.50
C	72.07	15.13	6.38	1.18	3.04	0.27	1.48	0.11	0.08	0.31
D	63.71	15.19	14.69	1.64	2.26	0.31	1.75	0.15	0.14	0.53
E	70.43	13.64	7.74	1.52	3.28	0.44	2.01	0.15	0.12	0.71
F	71.09	13.25	8.14	1.53	2.94	0.42	1.80	0.13	0.10	0.63
G (Yue)	62.47	12.29	16.45	2.48	1.82	0.74	1.81	0.23	0.26	1.44

Table 17

Chemical composition of the body of samples tested in the West

For a question of simplicity in the compilation of the following table, the samples whose chemical composition was analysed in the West, have been renamed as "W1", "W2", etc., followed by a letter indicating their date: "f" for Five Dynasties and "s" for Song; bibliographical references relative to each sample are listed below in table 24.

"White" means that the sample in question is white ware.

The symbol "-" means that the valuse for that element was not determined.

Body	SiO_2	Al_2O_3	CaO	MgO	K_2O	Na_2O	Fe_2O_3	TiO_2	MnO_2	P_2O_5
W1f white	63.6	29.8	0.7	0.5	1.5	0.6	0.6	1	-	-
W2s white	54.8	34.7	1.9	0.8	1.2	0.7	×	0.14	-	-

Table 18

Chemical composition of the glaze of samples tested in the West

For a question of simplicity in the compilation of the following table, the samples whose chemical composition was analysed in the West, have been renamed as "W1", "W2" etc., followed by a letter indicating their date: "f" for Five Dynasties and "s" for Song; bibliographical references relative to each sample are listed below in table 4.8.

"White" means that the sample in question is white ware.

The symbol "-" means that the valuse for that element was not determined.

Glaze	SiO_2	Al_2O_3	CaO	MgO	K_2O	Na_2O	Fe_2O_3	TiO_2	MnO_2	P_2O_5
W1f white	61.6	18.5	10.2	1.7	3.2	1.3	0.7	0.4	-	-
W2s white	65	19	8.4	2.2	1.2	0.4	0.4	0.02	-	-
W3s	71.4	14.5	4.7	1.3	3.8	0.5	1.8	0.2		
W4s	68.53-69.28	11.74-14.56	7.74-11.68	0.6-1.43	2.51-4.28	0.75-1.24	1.53-1.73	0.22-0.35		

Table 19

Chemical composition of the body of samples tested in China

For a question of simplicity in the compilation of the following table, the samples whose chemical composition was analysed in China, have been renamed as "C1", "C2", etc., followed by a letter indicating their date: "t" for Tang, "f" for Five Dynasties, "s" for Song and "j" for Jin; bibliographical references relative to each sample are listed below in table 24.

"Xunyi" means that the sample in question is from the Anren kiln site in Xunyi county, Shaanxi.

"Linru" means that the sample in question is from the Linru kilns.

Body	SiO_2	Al_2O_3	CaO	MgO	K_2O	Na_2O	Fe_2O_3	TiO_2	MnO_2	P_2O_5	CuO
C1t	66.49	26.22	0.48	0.77	1.60	0.12	2.20	1.55	0.01		
C2t	65.92	19.77	0.89	0.72	1.51	0.12	1.93	1.72	0.02	0.13	0.0019
C3t	63.65	25.59	0.47	0.70	2.69	0.43	4.12	2.33	×	×	×
C4t											
C5f	61.67	23.88	0.58	0.77	1.90	0.17	2.84	1.82	0.037	0.16	0.0018
C6f	63.97	27.90	0.06	0.89	2.07	0.14	3.18	1.77	0.01	0.15	
C7f	63.47	28.34	1.80	o.83	1.98	0.20	2.37	1.70	0.01	0.19	
C8f	59.77	30.60	1.10	0.92	2.06	0.22	2.50	1.89	0.01	0.06	
C9f	6170	30.78	0.46	0.76	1.88	0.17	2.54	1.92	0.01	0.06	
C10f	63.41	29.15	0.28	0.88	2.25	0.16	2.64	1.72	0.03	0.09	
C11f	62.61	28.97	0.52	0.84	1.97	0.14	2.80	1.91	0.01	0.8	
C12f	62.14	28.34	0.28	0.61	5.58	0.15	1.60	0.93	0.01	0.09	
C13f	68.09	22.77	1.07	0.43	5.77	0.14	1.45	0.33	0.01	0.11	
C14f	65.71	26.83	0.81	0.73	1.40	0.16	2.23	1.82	0.11	0.7	
C15f	44.39	34.90	0.85	3.69	3.41	0.72	8.44	3.51	0.9	×	
C16f	53.00	36.37	0.41	1.92	2.61	0.38	2.91	2.33	0.00	×	
C17f	59.32	30.29	0.43	1.21	1.78	0.22	4.38	2.22	0.15	×	
C18f	65.36	26.43	0.39	0.84	1.70	0.23	2.93	1.94	0.20	×	
C19f	68.75	26.39	0.09	0.42	1.38	0.22	1.51	1.26	0.00	×	
C20f	68.24	25.94	0.06	0.65	1.86	0.18	1.65	1.43	0.00	×	
C21f	65.38	26.43	0.39	0.82	1.70	0.23	2.93	1.94	0.20	×	
C22f	64.02	27.65	0.73	0.81	1.84	0.21	2.96	1.79	0.00	×	
C23f	66.04	26.18	0.41	0.82	1.71	0.25	2.87	1.58	0.13	×	
C24f	63.06	28.95	0.72	1.08	1.84	0.18	2.97	1.56	0.01	×	
C25f	65.48	26.77	0.52	0.79	1.49	0.27	2.69	1.86	0.13	×	
C26f	64.69	27.54	0.61	1.05	1.89	0.22	2.69	1.70	0.00	×	
C27f	64.64	27.42	1.65	0.66	1.66	0.22	2.21	1.54	0.03	×	
C28f	57.58	35.06	2.44	0.56	2.75	0.26	0.68	1.07	×	0.07	
C29f	61.06	30.65	1.12	0.43	3.43	0.24	1.05	1.24	1.01	0.05	
C30s	72.60	21.92	0.21	0.62	0.24	1.55	1.18			0.06	
C31s	64.53	29.79	0.53	0.68	0.26	1.76	1.36			0.06	
C32s	65.44	28.05	0.93	0.22	2.48	0.30	1.54	1.27	traces	×	
C33s	70.18	24.59	0.20	0.61	2.37	0.26	1.43	1.20		0.04	
C34s	72.16	20.28	0.38	0.78	2.59	0.35	1.71 +FeO 1.30	1,16		0.14	
C35s	66.41	22.77	0.56	0.58	2.37	0.15	1.29	1.49	0.02	0.13	0.0015
C36s	71.50	22.43	1.25	0.79	2.07	0.27	1.34	1.17			
C37s	69.32	23.77	0.59	0.61	2.48	0.16	1.35	1.56	0.02	0.14	
C38s	71.50	22.43	0.93	0.22	2.48	0.30	1.34	1.17	×	×	
C39s	74.49	19.43	0.54	0.64	2.12	0.17	1.56	1.18	0.005	×	×

C40s	68.96	22.39	1.95	0.62	2.06	0.51	2.26	1.17	0.02	×	
C41j Xunyi	73.91	19.01	0.46	0.81	2.33	0.20	2.54 FeO 0.24	1.15	0.01	×	
C45 Linru	64.89	27.61	1.46	0.81	1.19	0.43	2.06	1.14	0.06	×	×
C46 Linru	63.95	28.38	0.93	0.66	1.55	0.50	2.53	1.18	0.02	×	×
C48 Linru	64.11	29.44	0.54	0.41	1.64	0.29	1.97 FeO 0.20	1.14		0.10	
C49 Linru	64.31	29.64	0.37	0.45	1.97	0.35	2.12	1.02	0.08	0.08	
C50 Linru	63.15	30.17	0.28	0.42	2	0.37	1.90 FeO 1.57	1.19		0.09	
C51 Linru	69.46	23.82	0.43	0.64	2.26	1.23	1.75 FeO 1.23	1.16		0.16	
C52 Linru	65.47	27.88	0.76	0.36	1.50	0.37	1.80	1.32	×	×	×

Table 20

Chemical composition of the body of some black, white and *sancai* ceramics from Yaozhou

For a question of simplicity in the compilation of the following table, the samples whose chemical composition was analysed in China, have been renamed as "C1", "C2", etc., followed by a letter indicating their date: "t" for Tang, "f" for Five Dynasties, "s" for Song and "j" for Jin; bibliographical references relative to each sample are listed below in table 24.

"Black" means that the sample in question is black ware.

"White" means that the sample in question is white ware.

"Sancai" means that the sample in question is *sancai* ware.

The symbol "×" indicates that the value for the element in question was not reported.

Body	**SiO_2**	**Al_2O_3**	**CaO**	**MgO**	**K_2O**	**Na_2O**	**Fe_2O_3**	**TiO_2**	**MnO_2**	**P_2O_5**
C55t black	69.12	25.42	0.67	0.36	1.48	0.16	1.53	1.36	0.07	×
C56t white	65.21	26.1	0.84	1.14	2.23	0.23	2.26	1.99	×	×
C57t white[682]	66.37	26.64	0.9	0.94	1.61	0.31	1.84	1.39	×	×
C58t white	64.32	26.70	0.87	1.16	1.61	0.36	2.29	1.53	×	×
C59t	63.65	29.78	0.69	0.52	1.48	0.58	1.06	1.02	×	×

[682] Sample TYZ 1 comes from a shard of Tang dynasty white ware coated with butter yellow glaze with green splashes.

C60t white	67.38	27.04	0.44	0.47	1.61	0.44	0.56	1.02	×	×
C61s white	58.64	34.71	1.96	0.78	1.20	0.68	0.56	0.14	×	×
C62t sancai	67.52	26.56	0.22	0.40	2.01	0.34	0.61	1.39	×	×
C63t sancai	65.90	27.85	1.48	0.55	1.32	0.51	1.15	1.21	×	×
Sample A	63.65	28.38	0.93	0.77	1.79	0.15	2.78	1.26	0.03	0.25
Sample B	64.59	28.90	0.72	0.41	1.65	0.05	2.09	1.46	0	0.12
Sample C	64.64	28.08	0.90	0.45	1.92	0.06	2.44	1.44	0	0.05
Sample D	64.25	28.55	0.50	0.66	1.82	0.07	2.47	1.51	0	0.16
Sample E	66.03	27.58	0.55	0.42	2.51	0.17	1.73	0.89	0	0.11

Table 21

Chemical composition of the white slip coating some Yaozhou ceramics

For a question of simplicity in the compilation of the following table, the samples whose chemical composition was analysed in China, have been renamed as "C1", "C2", etc., followed by a letter indicating their date: "t" for Tang, "f" for Five Dynasties, "s" for Song and "j" for Jin; bibliographical references relative to each sample are listed below in table 24.

"Black" means that the sample in question is black ware.

"White" means that the sample in question is white ware.

Slip	**SiO_2**	**Al_2O_3**	**CaO**	**MgO**	**K_2O**	**Na_2O**	**Fe_2O_3**	**TiO_2**	**MnO_2**	**P_2O_5**
Sample A	63.06	30.87	0.73	0.66	1.82	0.15	1.21	1.35	0.01	0.14
Sample B	63.44	30.69	0.77	0.47	1.52	0.14	1.04	1.67	0.01	0.24
Sample C	64.75	30.17	0.76	0.31	1.44	0.05	0.94	1.48	0.01	0.10
Sample D	59.38	3354	0.45	0.71	2.14	0.11	1.95	1.56	0	0.17
C4t[683]	57.12	33.29	3.34	0.30	2.87	0.17	1.03	1.78		
C55t black	55.70	35.49	2.31	0.37	3.49	0.26	1.17	1.24		
C56 white	64.96	26.85	0.26	1.09	2.46	0.32	1.63	2.41		

[683] This sample is coated with a celadon glaze over white slip decoration.

Table 22

Chemical composition of the glaze of Yaozhou blue/green samples tested in China

For a question of simplicity in the compilation of the following table, the samples whose chemical composition was analysed in China, have been renamed as "C1", "C2", etc., followed by a letter indicating their date: "t" for Tang, "f" for Five Dynasties, "s" for Song and "j" for Jin; bibliographical references relative to each sample are listed below in table 24.

"Xunyi" means that the sample in question is from the Anren kiln site in Xunyi county, Shaanxi.

"Moon white" means that the glaze of the sample in question is pale green in colour and translucent.

"Linru" means that the sample in question is from the Linru kilns.

"New" means that the sample in question is a modern imitation of ancient Yaozhou celadon ware.

The symbol "-" means that the value was not determined.

Glaze	SiO_2	Al_2O_3	CaO	MgO	K_2O	Na_2O	Fe_2O_3	TiO_2	MnO	P_2O_5	CuO
C1t	61.41	16.30	16	1.51	1.75	0.21	1.92	0.41	0.07	0.77	
C2t	63.86	15.92	10.43	1.30	1.35	0.24	1.81	0.90	0.05	0.37	0.0045
C3t	63.50	12.71	17.49	2.75	1.57	0.09	1.56	0.33	-		-
C4t[684]	68.25	11.94	13.86	2.47	1.95	0.10	1.13	0.26	0.03		-
C5f	66.26	15.58	9.28	1.36	1.73	0.29	1.69	0.39	0.057	0.32	0.0025
C6f	61.71	14.57	17.41	1.88	1.58	0.21	1.52	0.17	0.06	0.68	
C7f	71.17	14.69	8.02	1.45	2.58	0.28	1.74	0.15	0.05	0.37	
C8f	70.36	13.65	8.21	1.67	2.62	0.40	1.90	0.16	0.08	0.45	
C9f	64.49	12.93	16.12	1.48	2.25	0.28	1.26	0.14	0.06	0.71	
C10f	66.07	15.56	11.45	1.70	2.47	026	1.92	0.15	0.05	0.50	
C11f	66.84	12.89	13.60	1.52	2.23	0.26	1.50	0.16	0.06	0.63	
C12f	64.35	14.05	13.92	1.58	3.03	0.18	1.38	0.15	0.07	0.57	
C13f	67.01	13.41	11.22	1.22	4.04	0.25	1.54	0.17	0.14	0.49	
C14f	70.11	14.02	9.48	1.57	2.21	0.23	1.80	0.15	0.06	0.42	
C15f	63.55	17.72	9.26	2.03	3.26	0.48	2.95	0.30	0.45		
C16f	59.79	20.06	10.75	2.76	3.49	0.59	2.42	0.11	0.05		
C17f	73.45	14.60	4.78	1.35	2.97	0.32	2.09	0.32	0.14		
C18f	64.21	14.90	14.16	1.46	2.37	0.34	2.17	0.21	0.18		
C19f	72.79	15.97	6.62	1.12	1.99	0.34	0.97	0.03	0.00		
C20f	65.57	13.91	13.79	1.88	2.45	0.35	1.81	0.19	0.06		
C21f	64.21	14.90	14.16	1.46	2.37	0.34	2.17	0.21	0.15		
C22f	60.28	14.10	20.09	1.57	1.84	0.40	1.43	0.18	0.09		
C23f	69.70	14.30	9.86	1.39	2.32	0.35	1.81	0.17	0.13		
C24f	59.58	14.91	19.63	1.48	1.83	0.32	1.42	0.19	0.09		
C25f	75.50	12.78	6.40	0.86	2.26	0.29	1.53	0.19	0.20		
C26f	60.27	15.90	18.35	1.82	1.74	0.35	1.42	0.06	0.01		
C27f	69.78	14.86	9.81	1.19	2.33	0.46	1.45	0.18	0.05		
C28f	65.12	18.83	8.97	1.32	2.30	0.32	1.42	0.29	0.05	0.49	
C29f	56.11	18.25	18.66	1.94	1.33	0.29	1.40	0.47	0.03	0.96	

684 This sample is coated with a celadon glaze over white slip decoration.

C30s	65.67	14.28	12.62	2.17	1.92	0.37	1.51	0.29	0.06	0.47	
C31s	67.03	15.27	9.63	1.38	2.57	0.38	1.82	0.34	0.07	0.72	
C32s	68.25	14.72	10.27	1.87	2.40	0.37	1.90	0.19	0.06		
C33s	71.58	14.42	5.58	1.55	3.05	0.56	1.94 +FeO 1.87	0.37	0.05	0.47	
C34s	70.00	13.59	9.48	1.32	2.71	0.31	1.43 +FeO 0.58	0.11	0.05	0.61	
C35s	62.19	14.40	12.10	1.82	2.06	0.37	1.97	0.58	0.08	0.59	0.0044
C36s	67.90	14.37	9.39	2.10	2.81	0.68	2.24	0.17			
C37s	64.67	14.98	12.58	1.89	2.14	0.39	2.05	0.60	0.08	0.62	
C38s	67.90	14.37	9.39	2.10	2.81	0.68	2.24	0.17			
C39s	69.07	13.95	8.62	1.14	3.09	0.36	2.08	0.29	0.08	0.67	
C40s	73.07	15.65	3.92	1.33	2.75	0.43	2.43	0.17	0.03		
C41j Xunyi	59.83	14.27	13.47	3.24	1.76	0.33	3.95	1.13	0.07	1.88	
C42j moon white	70.24	15.28	6.82	1.39	3.38	0.45	1.23	0.12	0.03		
C43j moon white	71.98	16.47	4.85	1.17	3.48	0.31	1.46	0.21	0.03		
C44j moon white	74.23	14.33	3.57	1.30	3.35	0.37	1.38	0.17	0.00		
C45 Linru	68.32	13.04	9.92	0.85	3.51	1.29	1.60	1.24	0.15	0.52	
C46 Linru	66.30	13.35	11.10	0.86	3.20	1.49	2.74	0.25	0.09	×	×
C47 Linru[685]	58.80	17.02	15.16	1.71	3.24	0.60	2.31	0.21	0.12	0.58	×
C48 Linru	67.01	14.70	9.19	0.77	3.58	1.52	1.48 +FeO 0.14	0.33	0.09	0.37	
C49 Linru	66.70	15.33	8.62	0.73	3.77	1.72	1.76 +FeO 0.79	0.29	0.05	0.38	
C50 Linru	67.52	15.31	7.57	1.07	3.7	1.36	1.91 +FeO 1.55	0.31	0.05	0.66	
C51 Linru	67.66	14.52	8.55	0.76	4.17	1.62	1.62 +FeO 0.82	0.21	0.06	0.45	
C52 Linru	68.09	14.56	7.74	0.60	4.28	2.51	1.53	0.26		0.50	
C53 new	68.03	12.59	9.67	4.21	1.97	1.06	1.93	0.20			
C54 new	68.77	14.31	8.03	1.43	5.16	1.27	1.70	0.07			

685 The same composition is reported for a Ru shard analysed by Li Guozhen and Gao Lingxiang 1986, p. 141, table 3, item 14. It is possible that, when taking data from Li Guozhen and Gao Lingxiang 1986, Li Guozhen *et al.* ISAC '89 copied the wrong column, therefore their item L4-SR actually corresponds to Li Guozhen and Gao Lingxiang 1986 item 15.

Table 23

Chemical composition of Yaozhou white and black glazes tested in China

For a question of simplicity in the compilation of the following table, the samples whose chemical composition was analysed in China, have been renamed as "C1", "C2", etc., followed by a letter indicating their date: "t" for Tang, "f" for Five Dynasties, "s" for Song and "j" for Jin; bibliographical references relative to each sample are listed below in table 24.

"Black" means that the sample in question is black ware.

"White" means that the sample in question is white ware.

The symbol "-" means that the value was not detrmined.

Glaze	SiO_2	Al_2O_3	CaO	MgO	K_2O	Na_2O	Fe_2O_3	TiO_2	MnO	P_2O_5	CuO
C55t[686] black	65.92	12.80	8.70	3.41	2.83	0.26	5.24	0.83	-		-
C56t white	70.82	12.12	9.39	3.16	2.78	0.02	1.41	0.30	-		-
C57t[687] white	64.34	12.18	16.02	2.30	2.42	0.21	1.90	-	-		0.63
C58t white	63.06	14.02	15.90	1.58	2.36	0.48	1.24	0.07			
C59t white	62.08	20.19	9.73	0.92	2.30	0.58	0.82	0.46			
C60t white	61.61	18.53	10.18	1.68	3.26	1.26	0.74	0.39			
C61s white	65.03	19.05	8.40	2.24	1.25	0.38	0.46	0.02			

Table 24

Bibliographical references for samples tested in the West and in China

The letters "t", "f" and "s" indicate respectively that the sample in question is Tang, Five Dynasties, or Song.

"White" means that the sample in question is white ware.

"Xunyi" means that the sample in question is from the Anren kiln site in Xunyi county, Shaanxi.

"Moon white" means that the glaze of the sample in question is pale green in colour and translucent.

"Linru" means that the sample in question is from Linru kilns.

[686] This is a black ware sample with decoration carved through the glaze.
[687] This is a sample of white ware with green splashes.

"New" means that the sample in question is a modern imitation of ancient Yaozhou celadon ware.

"Black" means that the sample in question is black ware

"Sancai" means that the sample in question is *sancai*.

Sample	Bibliographical references
W1f white	Wood 1992 , p.154, item Yaozhou 5 Dyn.
W2s white	Wood 1992 , p.154, item Yaozhou N. Song
W3s	Vandiver 1992 , p. 138, table 2, item British Museum no. 1928 10-22 46; Vandiver and Kingery 1985, p. 203, table 6, item Northern Celadon (No. 24); Vandiver 1986 , p. 222, table 1, item d
W4s	Vandiver 1992 , p. 138, table 2, item Norther Celadon 11-12th C., Collected, Various [items]
C1t	Guo Yanyi *et al.* 1980, p. 236, table 2, p. 237, table 3, item 89; Li Guozhen and Gao Lingxiang 1986, p.138, table 2, p. 140, table 3, item 11; Li Jiazhi 1985, table 1-3 (p. 15), item 89; Li Guozhen *et al.* ISAC '89, p. 255, table 1, p. 257, table 2, item L4-TY; Yap C. T. and Hua Younan ISAC '95, p. 157, table 1, item 58; Li Jiazhi (ed.) 1998, p. 265, table 8-3, item 89; Wood 1999, p. 116, table 42, item Yaozhou
C2t	Li Guozhen *et al.* ISAC '89, p 255, table 1, p. 257, table 2, item TY1
C3t	Chen Xianqiu *et al.*, ISAC '89, p. 331, table 1, item TYZ5
C4t	Chen Xianqiu *et al.*, ISAC '89, p. 331, table 1, item TYZ6
C5f	Li Guozhen *et al.* ISAC '89, p. 255, table 1, item WDY, p. 257, table 2, item W-1
C6f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ1
C7f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ2
C8f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ3
C9f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ4
C10f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ5
C11f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ6
C12f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ7
C13f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ8
C14f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ9
C15f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ10
C16f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ11
C17f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ12
C18f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ13
C19f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ114
C20f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ15
C21f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ16
C22f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ17
C23f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ18
C24f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ19
C25f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ20
C26f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ21
C27f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ22
C28f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ23
C29f	Wang Fen *et al.* ISAC '99, p. 56, table 1 and p. 57, table 2 item FQ24
C30s	Guo Yanyi 1987, pp. 16-17, table 6, item Yaozhou; Guo Yanyi and Li Guozhen 1987, p. 165, table 1, item Y-2; Li Guozhen *et al.* ISAC '89 p. 255, table 1, item L4-SY;[688] Yap C. T. and Hua Younan ISAC '95, p. 157, table 1, item 61; Li Jiazhi (ed.) 1998, p. 265, table 8-3, item Y-

[688] The chemical composition of the glaze of item L4-SR in Li Guozhen *et al.* ISAC '89, p. 255, table 1 matches with that of item Y-2 in Guo Yanyi and Li Guozhen ISAC '89, p. 165, table 1, while the chemical composition of the body matches with that of item S7-2 in Zhou Ren and Li Jiazhi 1960, table 1.

	2; Wood 1999, p. 116, table 42, item Yaozhou
C31s	Guo Yanyi 1987, pp. 16-17, table 6, item Yaozhou; Guo Yanyi and Li Guozhen 1987, p. 165, table 1, item Y-3; Yap C. T. and Hua Younan ISAC '95, p. 157, table 1, item 62; Li Jiazhi (ed.) 1998, p. 265, table 8-3, item Y-3; Wood 1999, p. 116, table 42, item Yaozhou
C32s	Zhou Ren and Li Jiazhi 1960, table 1, item S7-1; SPIA 1965, tables 2 and 3, p. 59, item S7-1; Li Guozhen and Guan Peiying 1982, p. 194, table 2, p. 195, table 3, item *Song ci*-2; Li Jiazhi 1985, table 1-3 (p. 15), item S7-1; Guo Yanyi 1987, pp. 16-17, table 6, item Yaozhou; Yap C. T. and Hua Younan ISAC '95, p. 157, table 1, item 57; Li Jiazhi (ed.) 1998, p. 265, table 8-3, item S7-1
C33s	Guo Yanyi and Li Guozhen 1987, p. 165, table 1, item Y-1; Li Guozhen and Gao Lingxiang 1986 Y-1[689]; Yap C. T. and Hua Younan ISAC '95, p. 157, table 1, item 60; Li Jiazhi (ed.) 1998, p. 265, table 8-3, item Y-1; Wood 1999, p. 116, table 42, item Yaozhou
C34s	Guo Yanyi and Li Guozhen 1987, p. 165, table 1, item Y-4; Yap C. T. and Hua Younan ISAC '95, p. 157, table 1, item 63; Li Jiazhi (ed.) 1998, p. 265, table 8-3, item Y-4; Wood 1999, p. 116, table 42, item Yaozhou
C35s	Li Guozhen *et al.* ISAC '89, p. 255, table 1, item SY, p. 257, table 2, item B-1
C36s	Li Guozhen and Guan Peiying 1982, p. 194, table 2, p. 195, table 3, item *Song ci*-1
C37s	Li Wenchao *et al.* ISAC '92, p. 222, table 1, item *yaozhou*
C38s	Li Jiazhi 1985, table 1-3 (p. 15), item SP-1; Yap C. T. and Hua Younan ISAC '95, p. 157, table 1, item 64; Li Jiazhi (ed.) 1998, p. 265, table 8-3, item 247; Wood 1999, p. 116, table 42, item Yaozhou
C39s	Guo Yanyi *et al.* 1980, p. 236, table 2 and p. 237, table 3, item 247;[690] Yap C. T. and Hua Younan ISAC '95, p. 157, table 1, item 59; Li Jiazhi (ed.) 1998, p. 265, table 8-3, item *Song ci* 1
C40s	Zhou Ren and Li Jiazhi 1960, tables 1 and 2, item S7-2; Li Guozhen *et al.* ISAC '89, p. 257, table 2, item L4-SY[691]
C41j	Guo Yanyi *et al.* 1980, p. 236, table 2 and p. 237, table 3, item 243
C42 moon white	Yang Zhongtang *et al.* ISAC '1999, p. 64, table 1, item YJ-34
C43 moon white	Yang Zhongtang *et al.* ISAC '1999, p. 64, table 1, item YJ-38
C44 moon white	Yang Zhongtang *et al.* ISAC '1999, p. 64, table 1, item YJ-40
C45 Linru	Zhou Ren and Li Jiazhi 1960, tables 1 and 2, item S1-2
C46 Linru	Zhou Ren and Li Jiazhi 1960, tables 1 and 2, item S1-3
C47 Linru [692]	Li Guozhen *et al.* ISAC '89, p. 255, table 1, item L4-SR

[689] Guo Yanyi and Li Guozhen 1984 (Silicate Study Journal), 1986 (ISAC' 86) and 1987 (Zhongguo taoci yanjiu) first reported the chemical composition of this shard. Li Guozhen and Gao Lingxiang 1986, (Ceramics and Civilizaion 3, 1986) report the same data specifying that they are after Guo Yanyi and Li Guozhen 1984 (Silicate Study Journal), 1986 (ISAC' 86) and 1987 (Zhongguo taoci yanjiu). However, the body composition of the Yaozhou sample reported by Li Guozhen and Gao Lingxiang 1986 corresponds to Guo Yanyi and Li Guozhen 1984 (Silicate Study Journal)item Y-1, whilst the glaze to item Y-2.

[690] The chemical composition of the body reported by Guo Yanyi *et al.* 1980, p. 236, table 2, item 247 is not matched by that reported by Li Jiazhi ed. 1998, p. 265, table 8-3, item *Song ci* 1. The body composition reported by Li Jiazhi corresponds to that of Guo Yanyi *et al.* 1980 item 243, instead of 247.

[691] The body composition of item L4-SY in Li Guozhen *et al.* ISAC '89, p. 257, table 2 matches with that of item S7-2 in Zhou Ren and Li Jiazhi 1960, table 1, while the glaze composition matches with that of item Y-2 in Guo Yanyi and Li Guozhen 1987, p. 165, table 1.

C48 Linru	Guo Yanyi 1987, pp. 16-17, table 6, item Linru Song Linru, Guo Yanyi and Li Guozhen 1987, p. 165, table 1, item LR-1; Yap C. T. and Hua Younan ISAC '95, p. 157, table 1, item 48; Wood 1999, p. 116, table 42, item Linru
C49 Linru	Guo Yanyi and Li Guozhen 1987, p. 165, table 1, item LR-2; Li Guozhen and Gao Lingxiang 1986, p. 138, table 2, p. 140, table 3, item 15; Li Guozhen *et al.* ISAC '89, p. 257, table 2, item L4-SR; Yap C. T. and Hua Younan ISAC '95, p. 157, table 1, item 49; Wood 1999, p. 116, table 42, item Linru
C50 Linru	Guo Yanyi and Li Guozhen 1987, p. 165, table 1, item LR-3; Yap C. T. and Hua Younan ISAC '95, p. 157, table 1, item 50; Wood 1999, p. 116, table 42, item Linru
C51 Linru	Guo Yanyi and Li Guozhen 1987, p. 165, table 1, item LR-4; Yap C. T. and Hua Younan ISAC '95, p. 157, table 1, item 51; Wood 1999, p. 116, table 42, item Linru
C52 Linru	Guo Yanyi *et al.* 1980, p. 236, table 2, p. 237, table 3, item 72; Yap C. T. and Hua Younan ISAC '95, p. 157, table 1, item 52; Wood 1999, p. 116, table 42, item Linru
C53 new	Li Jiazhi 1985, table 1-3 (p. 15), item E1
C54 new	Li Jiazhi 1985, table 1-3 (p. 15), item E2
C55t black	Chen Xianqiu *et al.* ISAC '89, p. 331, sample TYZ9
C56t white	Chen Xianqiu *et al.* ISAC '89, p. 331, sample TYZ17
C57t white	Chen Xianqiu *et al.* ISAC '89, p. 331, sample TYZ1
C58t white	Zhang Zizheng *et al.* 1985, pp. 23-24, item TBS1
C59t white	Zhang Zizheng *et al.* 1985, pp. 23-24, item TBS2
C60t white	Zhang Zizheng *et al.* 1985, pp. 23-24, item TBS3
C61s white	Zhang Zizheng *et al.* 1985, pp. 23-24, item SBS
C62t sancai	Lizhiyan and Zhang Fukang 1982/1987, p. 70, table 1, item TT3
C63t sancai	Li Guozhen *et al.* 1982/1987, p. 79, table 1, item B_2

[692] The chemical composition of the body of item L4-SR in Li Guozhen *et al.* ISAC '89, p. 257, table 2 matches that of item 15 in Li Guozhen and Guo Lingxiang 1986, p. 138 table 2, while the glaze composition matches that of item 14 in Li Guozhen and Guo Lingxiang 1986, p. 140, table 3 described as a shard of Ru ware, and that of item Linru Guanru in Guo Yanyi 1987, pp. 16-17, table 6. Therefore it is possible to assume that in the case of the glaze composition of item L4-SR, Li Guozhen *et al.* ISAC '89, p. 257, table 2 have made a mistake and that the glaze composition of this item is the same as that reported by Li Guozhen and Guo Lingxiang 1986, p. 138 table 2, item 15.

CHRONOLOGY OF CHINESE DYNASTIES AND PERIODS

Xia 夏: ca. 21st-16th c. BC

Shang 商: ca. 1600-1045

Zhou 周:1045-256

Western Zhou 西周: 1045-771

Eastern Zhou 東周: 770-256

Chunqiu/Spring and Atumn 春秋: 770-476

Zhanguo/Warring States 戰國: 475-221

Qin 秦: 221-206

Han 漢: 202 BC–AD 220

Former/Western Han 前/西漢: 202 BC-AD 23

Xin: AD 9-23

Later/Eastern Han 後/東漢: 25-220

Wei 魏, Jin 晉, Northern and Southern Dynasties/Nan-Bei Chao 南北朝: 220-589

Sanguo/Three Kingdoms 三國: 220-280

Wei 魏: 220-265

Han 漢: 221-263

Wu 吳: 222-280

Jin 晉: 265-420

Western Jin 西晉: 265-316

Eastern Jin 東晉: 317-420

Six Dynasties 六朝: 222-589

Sixteen Kingdoms 十六國: 304-439

Nan-Bei Chao/Northern and Southern Dynasties 南北朝: 420-589

Southern Dynasties 南朝: 420-579

Northern Dynasties 北朝: 386-581

Sui 隨: 581-618

Tang 唐: 618-907

Wudai Shiguo/Five Dynasties and Ten Kingdoms 五代十國: 902-979

Five Dynasties 五代: 907-960

Later Liang 後梁: 907-923

Later Tang 後唐: 923-936

Later Jin 後晉: 936-947

Later Han 後漢: 947-950

Later Zhou 後周: 951-960

Ten Kingdoms 十國: 902-979

Song 宋: 960-1279

Northern Song 北宋: 960-1127

Jianlong 建隆: 960-963

Qiande 乾德: 963-968

Kaibao 開寶: 968-976

Taipingxingguo 太平興國: 976-984

Yongxi 雍熙: 984-987

Duangong 端拱: 988-989

Chunhua 淳化: 990-994

Zhidao 至道: 995-997

Xianping 咸平: 998-1003

Jingde 景德: 1004-1007

Dazhongxiangfu 大中祥符: 1008-1016

Tianxi 天禧: 1017-1021

Qianxing 乾興: 1022-

Tiansheng 天聖: 1023-1032

Mingdao 明道: 1032-1033

Jingyou 景祐: 1034-1038

Baoyuan 寶元: 1038-1040

Kangding 康定: 1040-1041

Qingli 慶曆: 1041-1048

Huangyou 皇祐: 1049-1054

Zhihe 至和: 1054- 1056

Jiayou 嘉祐: 1056-1063

Zhiping 治平: 1064- 1067

Xining 熙寧: 1068-1077

Yuanfeng 元豐: 1078-1085

Yuanyou 元祐: 1086-1094

Shaosheng 紹聖: 1094-1098

Yuanfu 元符: 1098-1100

Jianzhongjingguo 建中靖國: 1101-

Chongning 崇寧: 1102-1106

Daguan 大觀: 1107-1110

Zhenghe 政和: 1111-1118

Zhonghe 重和: 1118-1119

Xuanhe 宣和: 1119-1125

Jingkang 靖康: 1126-1127

Southern Song 南宋: 1127-1279

Jin 金: 1115-1234

Yuan 元: 1279-1368

Ming 明: 1368-1644

Hongwu 洪武: 1368-1398

Jianwen 建文: 1399-1402

Yongle 永樂: 1403-1424

Hongxi 洪熙: 1425

Xuande 宣德: 1426-1435

Zhengtong 正統: 1436-1449

Jingtai 景泰: 1450-1457

Tianshun 天順: 1457-1464

Chenghua 成化: 1465-1487

Hongzhi 弘治: 1488-1505

Zhengde 正德: 1506-1521

Jiajing 嘉靖: 15222-1566

Longqing 隆慶: 1567-1572

Wanli 萬曆: 1573-1620

Taichang 泰昌: 1620

Tianqi 天啓: 1621-1627

Chongzhen 崇禎: 1628-1644

Qing: 1644-1912

Tianming 天命: 1616-1626

Tiancong 天聰: 1627-1636

Chongde 崇德: 1636-1643

Shunzhi 順治: 1644-1661

Kangxi 康熙: 1662-1722

Yongzheng 雍正: 1723-1735

Qianlong 乾隆: 1736-1795

Jiaqing 嘉慶: 1796-1820

Daoguang 道光: 1821-1850

Xianfeng 咸豐: 1851-1861

Tongzhi 同治: 1862-1874

Guangxu 光緒: 1875-1908

Xuantong 宣統: 1909-1912

Republic of China 中華民國: 1912-

People's Republic of China 中華人民共和國: 1949-

GLOSSARY

ageing: souring, the process by which the clay paste is left to mature in damp conditions.

air inlets: the passage ways connecting the ventilation duct to the ash pit in the firebox of the kiln.

albite: the most sodium-rich feldspar ($NaAlSi_3O_8$).

alumina: dialuminium trioxide (Al_2O_3).

anorthite: the most calcium-rich feldspar ($CaAl_2Si_2O_8$).

anorthite crystals: a calcium aluminium-silicate that grows where the amount of both calcium and aluminium is high if two of the following conditions are satisfied: high kiln temperature, long soaking and slow cooling; anorthite crystals have a characteristic needle-shape.

Anren(cun): 安人(村).

applied decoration or **appliqué**: relief elements (usually made from appliqué or sprig moulds) applied as decoration on the surface of vessels.

appliqué or **applied decoration**: relief elements (usually made from appliqué or sprig moulds) applied as decoration on the surface of vessels.

appliqué or **sprig mould**: mould generating relief elements to be applied as decoration on the surface of vessels.

ash pit: the deep opening in the ground of the firebox, covered with a grating to let the coal ash fall through.

backscattered electron microanalysis: it is based on the detection of backscattered electrons (one of the many signals produced when the beam of electrons bombards the sample) which have the property of emitting signals whose intensity is proportional to the mean atomic number of the elements. As a result, in images and microphotographs heavier elements are represented in light hues, whereas light elements appear dark.

bag wall: a firebrick structure standing between the firebox and the kiln chamber, which serves the double purpose of preventing the flames from the firebox from striking directly on to the wares and of directing hot air and flames upwards before the dome ceiling bends them back downwards.

Bai Lin 柏 林, sometimes (wrongly) written 百靈 Bai Ling: name of the person who taught the Yaozhou people the secrets of pottery making and to whom a memorial hall in the temple of Marquis Deying was dedicated.

bandaoyanyao 半倒焰窯: semi-down-draught kiln.

Baofeng: 寶丰.

base: in the anatomy of a vessel, the portion included within the foot.

bi 璧 name of jade discs with a small hole drilled in the centre manufactured since the Neolithic period. By extension, when the foot ring of ceramic vessels is characterised by wide rim and small recessed base, it is called *bi* foot.

bei 杯: small cup.

Bianjing: 汴京.

biscuit: unglazed fired ware.

bo 鉢: a type of large bowl, also called alms bowl.

bottom: in the anatomy of a vessel, the portion of the interior corresponding to the base and the underside (when present).

bridging oxygen: the atom of oxygen shared by two molecules of the same type.

bubble: spherical feature indicative of the expansion of a gaseous phase in the glaze, a sub-set of pores.

cake setter/spacer: setter or spacer shaped like a disc with or without spurs.

calcia: calcium oxide (CaO).

calcination: the process that transforms limestone, or calcium carbonate, into lime, or calcium oxide; it consists of heating limestone to a temperature of 825°C at which calcium carbonate decomposes to calcium oxide liberating carbon dioxide.

chayemo you 茶葉末釉: tea foam glaze.

Chai: 柴.

chendianchi 沉澱池: settling tanks used for sedimentation of the clay.

Chenliu: 陳留.

Chenluzhen: 陳爐鎮.

chimney: the part of the kiln through which fumes escaped; it was usually divided in two separate quadrangular stacks built with firebricks and placed at the back of the kiln.

Cifeng: 磁峯.

citang 祠堂: ancestral hall.

Cizhou: 磁州.

crackle: deliberately induced crazing in the glaze.

crazing: a very fine network of cracks in the glaze.

cristobalite: a polymorph of silica sharing the same chemical formula (SiO_2) as other polymorphs of silica, such as quartz and tridymite, but having different crystallographic structure.

cross-draught kiln: a kiln in which the arrangement of the firebox, vents and chimney causes the flame to travel horizontally among the wares.

Dadu: 大度.

Dashiyao 大食窯: Muslim ware.

danggu 蕩箍: stabilising hoop. Pentagonal or circular hoops with a circular hole in the middle which hold the wooden slats fixed in holes in the wheel-head to prevent the latter from swaying.

danghuoqiang 擋火牆: "fire-shielding wall" or bag wall.

Dangyangcun: 當陽村.

Dangyangyu: 當陽峪.

Dehua: 德化.

decorative stamp: mould to imprint a single pattern.

devitrification: development of crystals in the glaze during slow cooling.

de-watering: the process by which water is allowed to evaporate until the slurry turns into mud of the desired consistency.

Deying Hou: 德應侯: Marquis Deying.

Deng[zhou]: 鄧[州].

Di: 第

dianshao 墊燒: setting method by which fine sand is piled under the fully-glazed foot rim to prevent it from sticking to the bottom if the saggar in which the vessel is placed for firing.

Ding: 定.

dingwan 頂碗: ceramic "upside down bowls" placed in the cavity carved in the centre of the underside of the wheel-head that hosted the shaft to reduce the wearing off of the unprotected cavity.

Dongyao: 董窯 (in the 格古要論 *Gegu yaolun* and the 陶說 *Taoshuo*); 東窯 (in the 景德鎮陶錄 *Jingdezhen taolu*); **Dongqing** 冬青 (in other documents).

down-draught kiln: a kiln in which the arrangement of vents and chimney causes the flames to travel downward over or between the wares.

dragon kiln: name given to kilns in southern China because their elongated and sinuous shape stretching up hillsides poetically reminds of dragons.

"dressing mould": presumably "profile mould", 整形模 *zhengxing mo* in Chinese.

Duandian: 段店.

EDA: energy dispersive analysis. The sample is irradiated by a beam of X-rays which makes the electrons in the inner shells jump to the next higher level, but the electrons move back immediately emitting an amount of energy specific for each element. By measuring the amount and intensity of the emitted energy it is possible to identify the element that produced it and its percentage in the overall composition.

entrance: opening through which the kiln was stoked, loaded, unloaded and cleaned.

feldspar: the most abundant mineral in the crust (feldspar crystals constitute 60% of granite), cooled and crystallized from a molten magma. Feldspars are aluminium-silicates of calcium, sodium or potassium, that is, they contain alumina and silica combined with one or more alkalis, the main one giving the name to that particular feldspar. The most calcium-rich feldspar is called anorthite ($CaAl_2Si_2O_8$), the most sodium-rich is called albite ($NaAlSi_3O_8$)

and the most potassium-rich is called orthoclase ($KAlSi_3O_8$). Common feldspars are solid solutions of the three end-member components anorthite, albite and orthoclase. Clay forms from the decomposition of feldspar: when feldspar is attacked by chemical weathering , the alkaline oxides are removed by water and part of the silica engages in chemical combinations; the remaining silica and alumina become clay after a very long exposure to water which combines chemically.

firebox: the portion of the kiln where the fuel was burnt; it usually had a fan shape and was lower than the kiln chamber with which it shared its back wall.

firing/kiln chamber: the area of the kiln where vessels were placed to be fired.

flux: an oxide that promotes ceramic fusion by intreraction with other oxides.

Fujian wenbo 福建文博: name of a journal.

free silica: silica existing in a clay or body in a separate crystalline or cryptocrystalline state, that is, neither attached to nor involved in a compound.

ganni 坩泥: clay paste.

Gansu: 甘肅.

Gaoliyao 高麗窯: Koryo [918-1392] ceramics.

Ge: 哥.

gong: 貢 tribute.

gongci: 貢瓷 tribute ceramic wares.

gongqi: 貢器 tribute objects.

grating: the grate placed over the ash pit in the firebox, on which coal was stoked.

guaniban 刮泥板: scraper; a finishing tool.

guan 官: it literally means "official". It is the name given to the blue/green ware made at the official kilns in Hangzhou during the Southern Song and it appears as a mark carved on some Tang to Song specimens.

Guang'an men: 廣安門.

Guantai: 觀台.

Guanyao: 官窯 official kiln/ware.

Guangdong: 廣東.

Guangxi: 廣西.

Gugong bowuyuan yuankan 故宮博物院院刊: name of a journal.

Gugong wenwu yuekan 故宮文物月刊: name of a journal.

Gugong xueshu jikan 故宮學術集刊: name of a journal.

Haijiao shi yanjiu 海交史研究: name of a journal.

Hangzhou: 杭州.

Hebei: 河北.

Henan: 河南.

Hebei taoci 河北陶瓷: name of a journal.

heiyoujiangbanci 黑釉醬斑瓷: black ware with feather effect.

huayouci: 花釉瓷, a type of ware characterised by milky bluish splashes over the black glaze.

Huaian: 懷安.

Huangbao:黃堡.

Huangbaozhen:黃堡鎮.

Huangpuzhen:黃浦鎮.

huikeng 灰坑: waste pit.

hump mould: convex mould with carved decoration employed to impress a complex design covering the inner surface of a vessel (and at least partially shape the vessel).

Huozhou: 霍州.

inner mould: a mould on which the clay paste is pressed against the exterior to shape and decorate the interior of a vessel.

interface: boundary between body and glaze.

interlayer: reaction zone between body and glaze including the layer of anorthite crystals that precipitates on the edge of the reaction zone; the composition of the interlayer is different from both that of the glaze and that of the body.

Jizhou: 吉州.

Jian: 建.

Jiangxi: 江西.

jiangyouci 醬釉瓷: russet ware.

Jiaotanxia 郊壇下: Suburban Altar.

Jingdezhen: 景德鎮.

Jingdezhen taoci 景德鎮陶瓷: name of a journal.

juan 卷: typical division of ancient Chinese literary documents, loosely equivalent to "book" or "volume".

Jun: 鈞.

Junzhou: 鈞州.

Kaifeng: 開封

kang: heatable brick bed typical of northern China

Kaogu 考古: name of a journal.

Kaoguxuebao 考古學報: name of a journal.

Kaogu yu wenwu 考古与文物: name of a journal.

kaolinite: name for the idealised clay mineral in which an aluminium: silicon: oxygen structure is laced together by hydroxyl bonds: $Al_2O_3Si_2O_5(OH)_4$.

kiln/firing chamber: the area of the kiln where vessels were placed to be fired.

kiln furniture: all those tools used inside the kiln to improve the firing of the vessels.

kiln sweat: droplets of melted ash appearing on the brickwork inside the kiln.

kneading: the stage of clay paste preparation before shaping involving stretching and rolling a small quantity of paste.

leather-hard: the stage in the drying process where the modelled clay body is stiff enough to be handled without distortion, yet soft enough to permit turning, luting, carving and incising.

levigation: the process by which coarse and fine clay fragments are separated; it consist of churning a batch of weathered clay with water so that coarse fragments sink, while the fine ones form a thin slurry that can be decanted

Lidipo: 立地坡.

liannichi 練泥池: wedging and/or kneading tank in the form of a special enclosure paved and lined with neatly arranged stones or bricks.

lime glaze: glaze fluxed by calcium carbonate.

lime-alkali glaze: glazes fluxed by calcium carbonate (below 15%) and the alkalis sodium and potassium (about 3%).

limestone: a sedimentary rock used as a source of calcium oxide in glaze recipes; limestone is calcium carbonate, but it can be transformed into calcium oxide by calcination.

Lishui: 麗水.

Linru: 臨汝.

Linruxian: 臨汝縣.

Longquan: 龍泉.

ling 鈴: rattle.

luzha 爐柵: rails forming the grating on the ash pit; they were rectangular or triangular refractory bricks respectively placed flat and point down across the narrow width of the ash pit.

luqiao 爐橋: the crosspieces of the grating on the ash pit arranged lengthwise, so that the width was reduced and the rails could be arranged in two or more rows.

lunzhoumao 輪軸帽: iron or ceramic spindle cap placed in the cavity carved under the wheel-head, and hosting the star-shaped spindle-bearing (軸承 *zhoucheng*) in the Song dynasty potter's wheel.

lute: to join two unfired clay bodies using slip.

"M-shaped" saggar: a type of saggar characterised by a bowl- or plate-shaped body (where the vessel was placed), with the rim bent down to form a skirting foot.

mantou 饅頭: name given to kilns in northern China because their domical cover reminds of the shape of Chinese steamed buns.

Marquis Deying: 德應侯 Deying Hou.

master mould: matrix or model from which moulds are made.

matrix: see master mould.

maturing: the part of firing between two temperatures where the body reaches its correct strength and compactness through vitrification.

metakaolin: the crystal resulting from the dissociation of kaolinite during firing: as the temperature rises, the chemically combined water in the clay crystals evaporates and, as a result, the clay crystals are no longer hydrated aluminium-silicates ($Al_2O_3Si_2O_5(OH)_4$), but aluminium-silicates or metakaolin ($Al_2O_3 . 2SiO_2$).

mica: a group of minerals composed of hydrated aluminium-silicates (kaolinite) and alkali (potassium and sodium) silicates. Mica is one of the products of the decomposition of igneous and metamorphic (and some sedimentary) rocks together with clay, feldspar and quartz. Porcelain stone from southern China mainly consists of quartz and mica (plus minor amounts of primary clay and feldspar)

miseci 秘色瓷: "secret colour" ware; the most refined product of the Yue kilns.

minyao 民窯: usually translated as "popular kiln/ware", but better translated as "private kiln/ware".

molecular network structure: the three-dimensional placing of fixed points on which molecules of a solid are positioned.

mullite crystals: aluminium silicates ($3Al_2O_3.2SiO_2$) with a characteristic needle shape, resulting from the dissociation of kaolinite at high temperature in stoneware and porcelain bodies. Mullite starts forming at 1000°C, but its presence is not guaranteed unless the temperature reaches 1150°C and the cooling is slow, thus implying that all stoneware bodies grow mullite crystals, but if the cooling was too fast for the crystals to grow thick, SEM analysis does not identify them. Mullite crystals make the body stronger owing to their typical reticulated arrangement.

Neixiang: 内鄉.

Neiyao 内窯: shorter name for the wares made under the 修内司 Xiuneisi, or Department of Internal Affairs.

nichi clay: clay from the small village of 泥池 Nichi located north-east of Huangbaozhen.

outer mould: a mould in which the clay paste is pressed against the interior to shape and decorate the exterior of a vessel.

orange peel effect: the texture of the surface of a glaze characterised by many small craters similar to pin pricks.

orthoclase: the most potassium-rich feldspar ($KAlSi_3O_8$).

pan 盤: a type of shallow, usually round, dish.

pantou 盤頭: ceramic attachment for the potter's wheel shaped like an upside down basin with an everted foot and concentric grooves running on the top surface, placed over the wheel-head.

particulate iron: iron consisting of separate particles.

Pengxian: 彭縣.

permeability or **water absorbance**: the capacity of a fired body to absorb water; it depends not only on the number and size of pores, but also on their distribution: connected pores make a body more water absorbant than separated ones.

pillar or **support** or **prop**: variously shaped implement used in the kiln to support or to raise stacks of vessels or saggars.

pinhole: a small hole in the glaze surface resembling a miniature volcano crater.

plagioclase: a feldspar mineral belonging to the sodic-calcic feldspar series. The composition of a given plagioclase is intermediate between two end members, albite ($NaAlSi_3O_8$) and anorthite ($CaAl_2Si_2O_8$). As complete solid solution exists between these two end members, all intermediate values are permitted. Plagioclase feldspar is predominant in igneous rocks where it varies systematically from calcium plagioclase in basatic rocks to sodic plagioclase in granites. In ceramic systems plagioclase is typically calcic (anorthite). A second feldspar series also exists. This shows incomplete solid solution between a sodic end member (albite plagioclase) and a potassic end member (for example, orthoclase). This series is known as the alkali feldspar group, and is most common in granite rocks.

polymer: a compound characterised by large molecules consisting of many relative simple repeated units.

pores in the body: interstitial spaces not occupied by molten components of the clay during firing.

pores in the glaze: irregular cavities, probably caused by original defects and discontinuities within the glaze; not to be confused with bubbles.

porosity: the ratio of the volume of pores to the volume of sample.

potassia: potassium oxide (K_2O).

precipitation: combination of essential oxides (which become solid) in the surrounding fluid glaze which no longer holds them in solution, therefore they are said to be precipitated; given enough time, these isolated combinations of oxides arrange themselves in regular patterns, that is, they become crystals.

profile mould: a mould used to modify the shape of already thrown pieces, 整形模 *zhengxing mo* in Chinese.

prop or **support** or **pillar**: variously shaped implement used in the kiln to support or to raise stacks of vessels or saggars.

pyroscope: glazed ceramic test piece placed in the kiln during firing to measure the effect of temperature and time on the vessels in the kiln.

quartz: a polymorph of silica sharing the same chemical formula (SiO_2) as other polymorphs of silica, such as tridymite and cristobalite, but having different crystallographic structure.

quartz relicts or **residual quartz** or **relict quartz**: undissolved quartz.

Qishui: 漆水.

Qin [ware]: 秦.

qingbai: 青白.

qingbaiyuyouci 青白玉釉瓷: literally "bluish-white jade glazed ware", indicates a type of Yaozhou celadon coated with a pale green glaze; also called 月白釉瓷 *yuebaiyouci*, literally "moon-white glazed ware".

Qingliangsi: 清涼寺.

Qiong[ware]: 邛[窯]

Raozhou: 饒州.

reaction zone: that part of the body (or slip) and that part of the glaze which show chemical and/or microstructural modification due to mutual interaction.

refractory slab: large, thin (50x36x4.5 cm), brick-textured implements found nearby kiln Y10t (fig. 104) and in kiln Y28t (fig. 107).

relict quartz or **residual quartz** or **quartz relicts**: undissolved quartz.

residual quartz or **relict quartz** or **quartz relicts**: undissolved quartz.

ring setter/spacer: a setter or spacer shaped like a ring with or without spurs.

rotating hoop: pentagonal or circular hoops with a circular hole in the middle which hold the wooden slats fixed in holes in the wheel-head to prevent the latter from swaying. 蕩箍 *danggu* in Chinese.

Ru: 汝.

rutile: a natural titanium dioxide (TiO_2) containing a small amount of iron.

saggar: ceramic container employed to protect vessels from direct contact with flames and ash and to buffer sudden changes in temperature during the firing cycle.

sancai: 三彩, literally "three-colour glaze", generally low-firing glazes, that is, lead glazes.

scraper: a finishing tool. 刮泥板 *guaniban* in Chinese.

secondary crystals: crystals whose formation is fostered by other elements offering a surface upon which secondary crystals can grow.

secondary potassium mica: also called hydromica or sericite, a product of the alteration and weathering of feldspars (known as sericitisation). Thanks to the minute, flat, platy crystals they contain, hydromicas supply plasticity to southern

Chinese materials which are naturally low in true clay. Moreover, the potassium supplied by secondary potassium mica promotes the melting of silica in the clay body which results very tough.

sedimentation or **settling**: the process by which the levigated clay slurry is left to settle for a few days, so that the clear water on the surface can be decanted.

SEM: scanning electron microscope. The sample is bombarded with a beam of primary electrons producing a variety of electron and X-ray signals which are intercepted by suitable detectors; the most useful signals for morphological and chemical analysis are secondary electrons, backscattered electrons and X-rays.

semi-down-draught kiln (半倒焰窯 *bandaoyanyao* in Chinese): a definition applied to *mantou* kilns in which the hot air and flames from the firebox travel both horizontally and vertically.

setter or spacer: implements employed to set a vessel and to separate it from either the bottom of the saggars in which it is fired or from another vessel.

sgraffiato: decoration technique consisting of removing a top layer of slip to reveal another layer of slip or the body underneath.

Shanxi: 山西.

Shaanxi: 陝西.

Shaanxi shifan daxue bao 陝西師範大學報: name of a journal.

shaft or spindle: the wooden axle that supports the turning wheel-head of the potter's wheel.

Shangdiancun: 上店村.

Shenhouzhen: 神垕鎮.

Shoucangjia 收藏家: name of a journal.

Shouzhou: 壽州.

Sichuan: 四川

silica: silicon dioxide (SiO_2).

silica tetrahedron: the three-dimensional representation of a silica molecule (SiO_4) with the four atoms of oxygen at the four corners of the triangular pyramid and the single atom of silicon in the middle of the tetrahedron.

***siyao* 私窯**: private kiln/ware.

soaking: a stage of the firing process during which the temperature is maintained at the same level for a given period.

spacer or setter: implements employed to set a vessel and to separate it from either the bottom of the saggars in which it is fired or from another vessel.

spindle or shaft: the wooden axle that supports the turning wheel-head of the potter's wheel.

spindle bearing: iron star-shaped element placed over the wooden shaft and under the spindle cap (輪軸帽 *lunzhoumao*) in the Song dynasty potter's wheel. 軸承 *zhoucheng* in Chinese.

spindle cap: iron or ceramic cap-shaped element placed in the cavity carved under the wheel-head, and hosting the star-shaped spindle-bearing (軸承 *zhoucheng*) in the Song dynasty potter's wheel. 輪軸帽 *lunzhoumao* in Chinese.

spinel: in ceramic systems, a secondary phase produced by the complete breakdown of the parent clay minerals.

sprig or **appliqué mould**: mould generating relief elements to be applied as decoration on the surface of vessels.

support or **prop** or **pillar**: variously shaped implement used in the kiln to support or to raise stacks of vessels or saggars to scatter the flames from the firebox and to drive their flow.

***sutai heihuaci* 素胎黑花瓷**: a type of ware characterised by black glaze on a plain or white-slipped background.

Sui (ware): 碎（窯）.

surface tension: a property of liquids caused by intermolecular forces which act in a direction parallel to the boundary surface and tend to reduce that surface to a minimum; work has to be done to increase the area of the surface against this force.

Tapo: 塔坡.

Tang[yi]: 唐[邑].

***taoxichi* 淘洗池**: washing tank used for levigation of the clay.

tear: when referred to the body of a ceramic vessel, it indicates lacerations of the body fabric caused by smearing of the material when it is prepared and by the alignment of the particles during throwing.

temmoku: Japanese for 天目 *tianmu*, indicating black wares with hare's fur or oil-spot effects.

thermodynamic phase diagram: a diagram showing how changes in composition and temperature affect the resulting microstructure.

three-armed spacer/setter: setter or spacer with three arms.

throwing: the shaping of vessels on the potter's wheel.

Tianshui: 天水.

titania: titanium dioxide (TiO_2).

Tongchuan: 銅川.

Tongguan: 銅官.

Tongguanxian: 銅官縣.

tridymite: a polymorph of silica sharing the same chemical formula (SiO_2) as other polymorphs of silica, such as quartz and cristobalite, but having different crystallographic structure.

tuhaoyou 兔毫釉: [black ware] with hare's fur effect.

tuozhu 托珠: setting beads.

turning: shaving and paring leather-hard clay from the walls or feet of pots on the potter's wheel.

underside: in the anatomy of a vessel, it is the portion of the exterior from the foot to side with which it usually forms an angle.

vent: the openings at the bottom of the wall separating the firing chamber from the chimney through which flames escaped.

ventilation duct: portion of the kiln preceding the entrance; it improved the combustion of coal.

vitrification: glassification of the body, involving the progressive fusion of the elements constituting the body.

vitrification point: the point in the firing where the body is in malleable state, the furthest stage to which a body can be taken without deformation.

water absorbance or **permeability**: the capacity of a fired body to absorb water; it depends not only on the number and size of pores, but also on their distribution: connected pores make a body more water absorbant than separated ones.

wollastonite: a calcium silicate ($CaSiO_3$) which forms where calcium and free silica are high and alumina low, if the kiln temperature reaches at least 1200°C and the cooling rate is slow. Wollastonite crystals have a characteristic spherical shape.

waste pit: pit employed to dispose of imperfect or no longer useful objects and tools.

weathering: the exposure of unrefined clay to the action of the elements to disintegrate the grains and make them more plastic.

Wenbo 文博: name of a journal.

wedging: the process by which the stiffened slurry resulting from de-watering is made homogeneous by compressing, beating and mixing it.

Wenwu 文物: name of a journal.

Wenwu tiandi 文物天地: name of a journal.

Wenwu cankao ziliao 文物參考資料: name of a journal.

Wheel-turner: a black-glazed ceramic attachment of varying shape, but always characterised by a notch with a vertical side and a slanting one, surrounded by two, three or four small holes; 轉盤撥動 *zhuanpan bodong* in Chinese.

Xibei daxue xuebao 西北大學學報: name of a journal.

Xi'an: 西安.

Xicun: 西村.

Xiang: 象.

Xin'an: 新安.

Xincungou: 新村溝.

xinguan 新官: mark engraved on the base of some white specimens.

Xiuneisi: 修內司, Department of Internal Affairs.

xun 塤: whistle.

Xunyi(xian): 旬邑(縣).

Yanhedian: 嚴和店.

yao: 窯, kiln/ware.

yaodong: dwelling cave typical of northern China dug in the characteristic *loess* landscape, still existing in many northern provinces.

Yaozhou: 耀州.

yaozhu 窯柱: kiln post, see **support** or **prop** or **pillar**.

Yijunyucun: 宜君玉村.

Yishujia 藝術家: name of a journal.

Yiyang: 宜陽.

Yongfu: 永福.

youdiyou 油滴釉: [black ware] with oil-spot effect.

Yuhuagong: 玉華宮.

Yuxian: 寓縣.

Yuyao: 餘姚.

Yue: 越.

Yueyao: 越窯.

Yuezhou: 越州.

yuebaiyouci 月白釉瓷, literally "moon-white glazed ware", in this research it refers to a type of Yaozhou celadon coated with a pale green glaze; also called *qingbaiyuyouci* 青白玉釉瓷, literally "bluish-white jade glazed ware".

zhan 盞: small bowl.

Zhejiang: 浙江.

zhengxing mo 整形模: profile mould, a mould used to modify the shape of already thrown pieces.

zhishaoju 支燒具: "supporting firing implement", see **support** or **prop** or **pillar**.

zhong 盅: very small cup for drinking wine or tea.

Zhongguo gu taoci yanjiu 中國古陶瓷研究: name of a journal.

Zhongguo guisuanyan xuebao 中國硅酸鹽學報: name of a journal.

Zhongguo wenwu shijie - Antiquary 中國文物世界: name of a journal.

Zhongyuan wenwu 中原文物: name of a journal.

zhoucheng 軸承: star-shaped spindle bearing placed over the wooden shaft and under the spindle cap (輪軸帽 *lunzhoumao*) in the Song dynasty potter's wheel.

zhudian: 珠墊: bead setters.

zhuanpan 轉盤: wheel-head.

zhuanpan bodong 轉盤撥動: wheel turners, a black-glazed ceramic part varying in shape, but always characterised by a notch with a vertical side and a slanting one, surrounded by two, three or four small holes.

zhuanpan fujian 轉盤附件: literally "wheel attachment", in reality a rotating hoop.

Zibo: 淄博.

Zijigong: 紫极宫.

zircon: zirconium silicate, a mineral associated with acid igneous rocks (e.g. granites).

zuofang 作坊: workshop.

ABBREVIATIONS

EDA: energy dispersive analysis

O.C.S. Oriental Ceramic Society

Oxford Research Laboratory: Research Laboratory for Archaeology and the History of Art, University of Oxford

SEM: scanning electron microscope

SPIA Shaanxi Provincial Institute of Archaeology

V & A: Victoria and Albert Museum, London

WDA: wavelength dispersive analysis

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49. Double-wheeled chaser mill pulled by two donkeys
After Guoxue jiben congshu jianbian 國學基本叢書簡編, *Tiangong kaiwu* 天工開物, Shanghai: Shangwu yinshuguan, 1936, p. 97.

50. Single-wheeled chaser mill pulled by a buffalo
After Qinghua daxue jixiechang gongren lilunzu 清華大學機械廠工人理論組 (annotated by), "*Tiangong kaiwu*" *zhushi* 《天工開物》注釋, Beijing: Kexue chubanshe, 1976, p. 124.

51. Mortar and pestle and photograph of a similar mortar and pestle
Song dynasty
Mortar: total h. 11.2; hole d. 11; hole depth 8.4
Pestle: h. 13.4; maximum d. 6.8
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Photopraph personally taken at the Yaozhou kiln site at Huangbaozhen

52. Pestle
Song dynasty
h. 11.2; maximum d. 7.4

Excavated at Huangbaozhen kiln site
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53. Pentagonal hollow ceramic attachment for the potter's wheel (轉盤附件)
Tang dynasty
h. 2.8; d. 8; side l. 7.6
Excavated at Huangbaozhen kiln site
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54. Pentagonal hollow ceramic attachment for the potter's wheel (轉盤附件)
Tang dynasty
h. 2.5; d. 8.4; side l. 8.8
Excavated at Huangbaozhen kiln site
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55. Pentagonal rotating hoop (蕩箍 *danggu*)
Five Dynasties
h. 2.5; d. 8.7; side l. 12
Excavated at Huangbaozhen kiln site
After SPIA 1997, plate XCV:4

56. Circular rotating hoop (蕩箍 *danggu*)
Five Dynasties
h. 3.2; outer d. 14.5; inner d. 7.6
Excavated at Huangbaozhen kiln site
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57. Circular rotating hoop (蕩箍 *danggu*)
Song dynasty
h. 2.4; d. 12.8
Excavated at Huangbaozhen kiln site
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58. Drawing of a possible reconstruction of the potter's wheel in use at the Yaozhou kilns in the Tang dynasty
Personal drawing

59. Drawing of a possible reconstruction of the potter's wheel in use at the Yaozhou kilns in the Song
Personal drawing

60. Wheel turner (轉盤撥動 *zhuanpan bodong*)
Tang dynasty
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Excavated at Huangbaozhen kiln site
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61. *Pantou* (盤頭)
Tang dynasty
h. 4.2; head d. 14; inner d. 9.2; base d. 16.6
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62. *Pantou* (盤頭)
Five Dynasties
h. 6.6; head d. 9.6; base d. 12
Excavated at Huangbaozhen kiln site
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63. *Dingwan* (頂碗)
Five Dynasties
h. 4.5; mouth d. 18.2; foot d. 16.8
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 119:3

64. Stone wheel
Song dynasty
h. 8; d. 68
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 243:1 and Museum of Oriental Ceramics, Osaka 1997, p. 167, fig. 10 Picture taken

65. Spindle cap (輪軸帽 *lunzhoumao*)
Song dynasty
h. 2.7; hole d.1.6; depth 1.8
Excavated at Huangbaozhen kiln site
After SPIA 1998, plate CXLVI:4

66. Spindle bearing (軸承 *zhoucheng*)
Song dynasty
h. 7
Excavated at Huangbaozhen kiln site
After SPIA 1998, plate CXLVI:3

67. Stone wheel
Song dynasty
h. 6; d. 68
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 243:2

68. Scraper (刮泥板 *guaniban*)
Tang dynasty
h. 4.9; l. 8.6; w. 3.4-9.6
Excavated at Huangbaozhen kiln site

After SPIA 1992, fig. 266:6 and plate CXXXI:2

69. One-piece outer mould with inside decoration for *bei* cups and cup made from similar mould
Five Dynasties
Mould: h. 3.5; d. 7.1
Cup: h. 4.8; mouth d. 9.5
Excavated at Huangbaozhen kiln site
Mould after Museum of Oriental Ceramics, Osaka 1997, no. 171 (left)
Cup: after SPIA 1997, colour plate I:1

70. One-piece inner mould with outside decoration for *bei* cups
Five Dynasties
h. 4.5; mouth d. 8; base d. 3.8
Excavated at Huangbaozhen kiln site
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71. One-piece inner mould for lobed *xi* basins
Song dynasty
H. 4.3; top d. 8.3; base d. 11.5
Excavated at Huangbaozhen kiln site
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72. One-piece outer mould for kidney-shaped pillows and pillow made from a similar mould
Tang dynasty
h. 9.3-10.6; l. 24; w. 18
Excavated at Huangbaozhen kiln site
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73. One-piece decorated outer mould for pillows
Song dynasty
Remaining l. 8
Excavated at Huangbaozhen kiln site
SPIA 1998, fig. 241:5

74. One-piece decorated outer mould for saucers
Five Dynasties
h. 3.3; d. 7.8
Excavated at Huangbaozhen kiln site
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Song dynasty
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Tang dynasty
h. 6.4; mouth d. 18.2; top d. 11.3
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77. One-piece outer mould for three-armed spacers
Tang dynasty
h. 2.3; l. 8
Excavated at Huangbaozhen kiln site
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78. Half of a two -piece mould for fish-shaped vases and fish-shaped vase
Mould: Tang dynasty
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Vase: Tang dynasty
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79. Half of a two -piece mould for stands
Tang dynasty
h. 4; d. 8.2
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 269:4 and plate CXXXIII:5

80. Top half of a two-piece mould for rattles
Tang dynasty
h. 4; d. 6.6
Excavated at Huangbaozhen kiln site
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81. Front half of a two-piece mould for whistles and whistle
Tang dynasty
Mould: h. 3.5; w. 6.5
Whistle: h. 4.3; w. 4.3
Excavated at Huangbaozhen kiln site
Mould after SPIA 1992, fig. 271:11
Whistle after SPIA 1992, plate XLIV:3

82. Two-piece mould with register mark
Tang dynasty
h. 17.4; w. 12.9
Excavated at Huangbaozhen kiln site
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83. Two-piece mould cut at an odd angle
Tang dynasty
h. 21.6; l. 20.4; w. 16.4
Excavated at Huangbaozhen kiln site
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84.Half of a two-piece mould for the base of a headrest and a headrest made from a similar mould
Mould: Tang dynasty
h. 8.6; remaining l. 8.5; w. 5
Excavated at Huangbaozhen kiln site
After SPIA 1992 fig. 269:7 and plate CXXXIV:4
Headrest: Tang dynasty
h. 11; l. 15; w. 11.2
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85. Mould for handles of ewers, giving a choice of four different patterns and blue/green ewer with similarly patterned handle
Mould: Five Dynasties
remaining l. 8; w. 3
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 118:2
Ewer: Five Dynasties
h. 17.7
Excavated at Huangbaozhen kiln site
After personally taken photograph

86. Half of a two-piece mould for spouts in the shape of a phoenix-head
Tang dynasty
h. 4.8-6.6; l. 10
Excavated at Huangbaozhen kiln site
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Mould:Song dynasty
h. 5.9
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 233:3 and plate CXLII:4
Incense burner: Song dynasty
h. 7.2; d. 6.7
Excavated at Huangbaozhen kiln site
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88. Mould for lids and lid made from the same mould
Mould: Five Dynasties
h. 1.9 d. 5.6
Excavated at Huangbaozhen kiln site

After SPIA 1997, fig. 116:4 and plate XCII:4
Lid: Five Dynasties
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89 Mould for lids and lid made from the same mould
Mould: Five Dynasties
h. 3.2; d. 7.6
Excavated at Huangbaozhen kiln site
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Lid: Five Dynasties
h. 1.7; d. 5.2
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90. Lid
Five Dynasties
h. 5.6; d. 5.2
Excavated at Huangbaozhen kiln site
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91. Bone awl
Tang dynasty
l. 13.4
Excavated at Huangbaozhen kiln site
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92. Bone comb
Song dynasty
h. 4; w. 8.5
Excavated at Huangbaozhen kiln site
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93. Sprig mould and *bei* cup with appliqué decoration
Five Dynasties
Sprig mould:d. 3.1, thickness 0.5-0.8
Cup: h. 6; mouth d. 9.7, foot d. 4.3
Excavated at Huangbaozhen kiln site
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94. Sprig mould
Five Dynasties
d. 4.1, thickness 1.2
Excavated at Huangbaozhen kiln site
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95. Decorative stamp

Five Dynasties
h. 4.4; d. 6.4
Excavated at Huangbaozhen kiln site
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96. Hump mould for impressing a complex design on the inner surface of a bowl and bowl decorated with the same pattern
Song dynasty
Mould: h. 9.3; d. 15
Bowl: h. 6; d. 13
Excavated at Huangbaozhen kiln site
Yaozhouyao Museum
After Museum of Oriental Ceramics, Osaka 1997, no. 159

97. Matrix for hump moulds for impressing a complex design on the inner surface of a bowl
Song dynasty
h. 6.3; mouth d. 23.2; foot d. 7
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98. Hump mould for impressing a complex design on the inner surface of a bowl
Song dynasty
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Excavated at Huangbaozhen kiln site
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99. Mould for impressing a complex design on the inner surface of a bowl
Song dynasty
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Excavated at Huangbaozhen kiln site
After SPIA 1998 234:5

100. Moulded *pan* dish showing radiating lines on the outside
Song dynasty
d. 19.3
Private collection
After: The Museum of Oriental Ceramics, Osaka 1997, no. 65

101. Kiln Y12t
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 29

102. Kiln Y6t
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 27

103. Kiln Y9t

Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 28

104. Kiln Y10t
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 15

105. Kiln Y11t
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 16

106. Kiln Y14t
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 17

107. Kiln Y28t
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 30

108. Kiln Y15f
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 11

109. Kiln Y29f
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 12

110. Kiln Y31f
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 14

111. Kiln Y32f
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 13

112. Kiln Y43f
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 15

113. Kiln Y58f
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 16

114. Kiln Y7s
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 41

115. Kiln Y3s

Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 38

116. Kiln Y62s
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 49

117. Kiln Y1s
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 36

118. Kiln Y4s
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig.39

119. Kiln Y36s
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 45

120. Kiln 73Y2s
Excavated at Huangbaozhen kiln site
After Zhuo Zhenxi and Lu Guojian 1980, fig. 7

121. Kiln Y2s
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 37

122. Kiln Y5s
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 40

123. Kiln Y19s
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 42

124. Kiln Y20s
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 43

125. Kiln Y21s
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 44

126. Kiln Y44s
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 46

127. Kiln Y47s

Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 47

128. Kiln Y56s
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 48

129. Kiln Y63s
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 50

130. Kiln Y67s
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 51

131. Kiln 58-59Y2jy
Excavated at Huangbaozhen kiln site
After SPIA 1965, fig. 7

132. Kiln Anren, Xunyi Y1jy
Excavated at the Anren kiln site at Xunyi county, Shaanxi
After Du Baoren 1987b, fig. 6

133. Kiln Anren, Xunyi Y2jy
Excavated at the Anren kiln site at Xunyi county, Shaanxi
After Du Baoren 1987b, fig. 7

134. Kiln Lidipo Y2y
Excavated at Lidipo kiln site
After SPIA 1965, fig. 31

135 Kiln 58-59Ys tile
Excavated at Huangbaozhen kiln site
After SPIA 1965, fig. 8

136. Kiln Y3 at Guantai kiln site, Cixian, Hebei
Excavated at Guantai kiln site, Cixian, Hebei
After Beijing daxue kaoguxuexi *et al.* 1997, fig. 9

137. Group of kilns surrounded by an outer perimeter wall at Guantai kiln site, Cixian, Hebei
Excavated at Guantai kiln site, Cixian, Hebei
After Beijing daxue kaoguxuexi *et al.* 1997, fig. 7

138. Calcination kiln, Y16s
Song dynasty
Huangbaozhen kiln site
After SPIA 1998, fig. 52

139. Calcination kiln, Y27s
Song dynasty
Huangbaozhen kiln site
After SPIA 1998, fig. 53

140. Tang dynasty waste pits
Huangbaozhen kiln site
After SPIA 1992, fig. 32

141. Five Dynasties waste pits
Huangbaozhen kiln site
After SPIA 1997, figs. 17-18

142. Song dynasty waste pits
Huangbaozhen kiln site
After SPIA 1998, fig. 54

143. Saggar
Tang dynasty
h. 13; mouth d. 19; base d. 15.3
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 276:2

144. Saggar
Tang dynasty
h. 7.6; mouth d. 20.5; base d. 21; thickness 1-1.2
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 276:9

145. Saggar
Tang dynasty
h. 11.6; mouth d. 16.6; base d. 11.2
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 276:6

146. Saggar
Tang dynasty
h. 10; mouth d. 20.8; base d. 7.2, thickness 0.8
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 276:12

147. Prop for balancing saggars
Song dynasty
l. 4-7.4; thickness 0.5
Excavated at Huangbaozhen kiln site
After SPIA 1965, plate XIII:9

148. Saggar
Five Dynasties
h. 5.4; mouth d. 19.5; foot d. 20.5; thickness 0.7
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 122:4 and plate XCVII:2

149. Saggar
Five Dynasties
h. 6; mouth d. 19.2; foot d. 12.2; thickness 0.8-1.1
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 122:5

150. Saggar
Five Dynasties
h. 12; mouth d. 17.7; foot d. 18; thickness 0.6-1.6
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 122:11 and plate XCVII:3

151. Saggar
Five Dynasties
h. 10.8; mouth d. 14.6; foot d. 11.4; thickness 0.7
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 122:15

152. Saggar
Five Dynasties
h. 4.8; mouth d. 18; foot d. 8; thickness 0.4-0.6
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 123:5

153. Saggar
Five Dynasties
h. 5.4; mouth d. 21; foot d. 8
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 123:4 and plate XCVII:6

154. Saggar
Five Dynasties
h. 3.8; mouth d. 15; foot d. 5.2; thickness 0.5
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 124:2

155. Saggar
Five Dynasties
h. 4.8; mouth d 18.1; foot d. 4.9
Excavated at Huangbaozhen kiln site
After SPIA 1997, plate XCVIII:1
156. Saggar

Five Dynasties
h. 3.7; mouth d 14.6; foot d 6
Excavated at Huangbaozhen kiln site
After SPIA 1997, plate XCVIII:2

157. Saggar
Five Dynasties
h. 5; d. 18.5
Excavated at Huangbaozhen kiln site
Yaozhouyao Museum
After Museum of Oriental Ceramics, Osaka 1997, no. 172

158. Saggar
Five Dynasties
h. 4.8; mouth d. 15.6; foot d. 5.4; thickness 0.4
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 124:6

159. Saggar
Song dynasty
h. 5; mouth d. 15.2; foot d. 4; thickness 0.4-0.8
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 247:13

160. Saggar
Song dynasty
h. 9.2; mouth d. 15.6; foot d. 5.8; thickness 0.8-1.2
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 247:21 and plate CXLIX:1

161. Saggar
Song dynasty
h. 4; mouth d. 16; foot d. 6; thickness 0.8
Excavated at Huangbaozhen kiln site
After SPIA 1965, fig. 15:10

162. Saggar
Song dynasty
h. 4.6; mouth d. 18.8; thickness 0.3-1
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 244:11

163. Saggar
Song dynasty
h. 3.7; mouth d. 13.4; thickness 0.6-0.9
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 244:10

164. Saggar
Song dynasty
h. 4; mouth d. 11.8; foot d. 2; thickness 0.6-0.8
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 245:14 and plate CXLVII:5

165. Saggar
Song dynasty
h. 5.6; mouth d. 14.4; foot d. 2.6; thickness 0.6
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 246:13 and plate CXLVIII:1

166. Saggar
Song dynasty
h. 6.5; mouth d. 15.8; foot d. 4; thickness 0.4-0.8
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 246:11

167. Saggar
Song dynasty
h. 8.8; mouth d. 19.4; foot d. 5; thickness 0.8-1.2
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 247:8 and plate CXLVIII:3

168. Saggar
Song dynasty
h. 8.2; mouth d. 23.4; foot d. 9; thickness 0.8-1.2
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 247:19 and plate CXLVIII:5

169. Saggar
Song dynasty
h. 9: mouth d. 14.8; foot d. 7.6; thickness 0.6-0.9
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 247:12 and plate CXLVIII:4

170. Saggar
Song dynasty
h. 18.4; mouth d. 13; foot d. 11.2; thickness 0.9-1.2
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 244:7 and plate CXLVII:3

171. Saggar
Jin-Yuan dynasty
h. 26; mouth d. 10; foot d. 10.8; thickness 1.1
Excavated at Huangbaozhen kiln site
After SPIA 1965, fig. 25:8

172. Saggar
Jin-Yuan dynasty
Measurements not clearly reported: h. 2.9-4.7; mouth d. 5-5.8; foot d. 4.5-5.5
Excavated at Huangbaozhen kiln site
After SPIA 1965, plate XXII:8

173. Saggar
Jin-Yuan dynasty
Measurements not clearly reported: h. 2.9-4.7; mouth d. 5-5.8; foot d. 4.5-5.5
Excavated at Huangbaozhen kiln site
After SPIA 1965, plate XXII:10

174. Saggar lid in the shape of a flat disc
Tang dynasty
h. 1.7; d. 24
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 276:13

175. Saggar lid in the shape of a flat disc
Five Dynasties
h. 1.8; thickness 0.6
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 126:4

176. Saggar lid in the shape of a round cap
Five Dynasties
h. 5.6; mouth d. 16; thickness o.5
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 126:1

177. Saggar lid in the shape of an upside down bowl
Five Dynasties
h. 4.2; mouth d. 13; top d. 6; thickness 0.3-0.5
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 126:2 and plate XCIX:2

178. Saggar lid in the shape of an upside down bowl
Song dynasty
h. 4.6; mouth d. 13.2; top d. 6; thickness 0.2-1
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 248:7 and plate CXLIX:3

179. Saggar lid in the shape of an upside down bowl
Song dynasty
h. 4.4; mouth d. 12.8; top d. 4.4; thickness 0.4-0.6
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 248:19 and plate CL:3

180. Saggar lid in the shape of a box lid
Tang dynasty
h. 6; d. 24.3; thickness 0.6-0.8
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 276:15

181. Saggar lid in the shape of a box lid
Song dynasty
h. 3.4; d. 17; thickness 0.4
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 248:14 and plate CXLIX:6

182. Saggar recycled as saggar lid
Song dynasty
h. 8; d. 15.5
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 248:1

183. Saggar recycled as saggar lid
Song dynasty
h. 5.4; d. 14.4
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 248:2

184. Saggar lid fastner
Five Dynasties
h. 2.4; mouth d. 25.5; top d. 15; w. 3.8
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 126:5 and plate XCIX:3

185. Flat cake-shaped spacer
Tang dynasty
h. 0.8; d. 13
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 278:7 and plate CXLIII:5

186. Flat cake-shaped spacer
Tang dynasty
h. 0.8; d. 3.8
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 278:6

187. Flat cake-shaped spacer
Five Dynasties
h. 0.6; d. 6.8
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 120:2

188. Flat cake-shaped spacer
Five Dynasties
h. 1.3; d. 5.8
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 120:3

189. Flat cake-shaped spacer
Five Dynasties
h. 1-3.7; d. 5.2
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 120:4

190. Flat cake-shaped spacer
Song dynasty
h. 1.2; d. 11.4
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 251:10

191. Flat cake-shaped spacer
Song dynasty
h. 0.4-0.5; d. 6
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 251:7 and plate CLII:4

192. Flat cake-shaped spacer
Song dynasty
h. 0.4; d. 8
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 251:8

193. Flat ring-shaped spacer
Tang dynasty
h. 1-1.2; d. 6.4
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 278:10 and plate CXLIII:6

194. Flat ring-shaped spacer
Tang dynasty
h. 4.8; d. 9.2; thickness 0.9-1
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 278:11

195. Flat ring-shaped spacer
Five Dynasties
h. 0.4; d. 19.5; inner d. 13.8
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 120:5

196. Flat ring-shaped spacer
Five Dynasties
h. 1.2; d. 6.2: inner d. 3
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 120:7

197. Flat ring-shaped spacer
Five Dynasties
h. 2.1; d. 5.5; inner d. 3
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 120:8

198. Flat ring-shaped spacer
Song dynasty
h. 0.5; d. 3
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 251: 2

199. Flat ring-shaped spacer
Song dynasty
h. 0.8; d. 3.9; inner d. 1.6
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 251: 3 and plate CLII:2

200. Flat ring-shaped spacer
Song dynasty
h. 1.2; d. 4.9
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 251: 4

201. Flat ring-shaped spacer
Song dynasty
h. 1.2; d. 10; inner d. 5.2; thickness 0.5
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 251: 5 and plate CLII:3

202. Flat *bo*-bowl-shaped spacer
Five Dynasties
h. 2; mouth d. 3.2; belly d. 6; foot d. 3.4
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 120:10

203. Flat *bo*-bowl-shaped spacer
Five Dynasties
h. 1.6; mouth d. 4.4; belly d. 6.6; foot d. 5.8
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 120:13

204. Spurred spacer
Tang dynasty
h. 1.5; l. 8.2
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 279:2

205. Spurred spacer
Five Dynasties
h. 1.4; l. 7
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 121:1

206. Spurred spacer
Tang dynasty
h. 1.2; l. 7
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 279:5

207. Spurred spacer
Tang dynasty
h. 3.3; l. 7
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 279:9 and plate CXLIV:3

208. Spurred spacer
Five Dynasties
h. 1.1; l. 5.5
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 121:3

209. Spurred spacer
Tang dynasty
h. 1.3; d. 6.2
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 280:1 and plate CXLIV:4

210. Spurred spacer
Tang dynasty
h. 3.6; d. 24.3
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 280:3 and plate CXLIV:6

211. Spurred spacer
Five Dynasties
h. 1.8; d. 9.7
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 121:6

212. Spurred spacer
Five Dynasties
h. 2.4; d. 7
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 121:5

213. Stack firing
After Lu Jiaxi and Li Jiazhi (eds.) 1998, fig. 8-9, p. 269.

214. Gritty spur marks on the foot rim of a Yaozhou bowl
Yaozhou kilns
Five Dynasties
h. 5.5; d. 12.7
After Museum of Oriental ceramics, Osaka 1997 no. 15

215. Spur marks on the foot rim of a Yaozhou basin
Yaozhou kilns
Five Dynasties
Excavated at Huangbaozhen kiln site
Photograph taken at Huangbaozhen kiln site during the 1996 fieldwork.

216. Spur marks on the base of a Yaozhou bowl
Yaozhou kilns
Five Dynasties
Exhibited at *The Masterpieces of Yaozhou Ware* exhibition (Museum of Oriental ceramics, Osaka 1997, no. 131)
Personally taken photograph

217. Spur marks on a Yaozhou dish
Yaozhou kilns
Five Dynasties to early Northern Song
h. 2; d. 13.5
Tokyo National Museum
After Museum of Oriental ceramics, Osaka 1997 no. 17

218. Spur marks on a Yue bowl
Yue kilns
Five Dynasties to early Northern Song
h. 5.3; mouth d. 14.2, foot d. 7.4
Shanghai Museum
After Wang Qingzheng (ed.) 1996, no. 33.

219. Pillar-shaped prop
Tang dynasty
h. 12; d. 6.6; thickness 1-1.4
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 277:3

220. Pillar-shaped prop
Five Dynasties
h. 7.5; d. 7; thickness 0.8-1.1
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 126:9 and plate XCIX:5

221. Pillar-shaped prop
Song dynasty
h. 13; d. 7.2; thickness 0.6-1
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 249:12

222. Pillar-shaped prop
Song dynasty
h. 8.4; d. 8.4; thickness 0.8-1.2
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 249:15 and plate CL:6

223. Pillar-shaped prop
Song dynasty
remaining h. 6.8; belly d. 7.5; foot d. 6; thickness 0.5-1
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 250:1

224. Pillar-shaped prop
Tang dynasty
h. 9.2; mouth d. 5.5; foot d. 4.8; thickness 0.7-0.9
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 277:2

225. Pillar-shaped prop
Song dynasty
h. 13.6; d. 6.4-7.8; thickness 1.2-1.6
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 250:6

226. Pillar-shaped prop
Song dynasty
h. 8.8; mouth d. 4.8; foot d. 5.8; thickness 0.7-1.8
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 250:7 and plate CLI:3

227. Pillar-shaped prop
Tang dynasty
h. 13.6; mouth d. 10.4; belly d. 7; foot d. 11.2; thickness 1.4
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 277:7

228. Pillar-shaped prop
Tang dynasty
h. 14; mouth d. 12.6; foot d. 8; thickness 0.8-1
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 277:5

229. Pillar-shaped prop
Five Dynasties
h. 13; top d. 10.7; foot d. 11.7; thickness 1.4
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 126:7 and plate XCIX:6

230. Pillar-shaped prop
Song dynasty
h. 9.4; mouth d. 4.5; foot d. 4.7; thickness 0.6
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 249:7

231. Pillar-shaped prop
Song dynasty
h. 7.1; mouth d. 3; foot d. 57; thickness 0.6
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 249:1

232. Pillar-shaped prop
Song dynasty
h. 5; mouth d. 6.6; top d. 3; thickness 0.4
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 249:10 and plate CL:4

233. Pillar-shaped prop
Song dynasty
h. 7.1; mouth d. 6.1; top d. 4.1; thickness 0.3-0.8
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 249:11 and plate CL:5

234. Bowl-shaped prop
Tang dynasty
h. 4.3; mouth d. 7.2; belly d. 8.2; foot d. 5.3
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 278:3 and plate CXLIII:4

235. Bowl-shaped prop
Tang dynasty
h. 8; mouth d. 14.4; foot d. 7
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 278:1

236. Bowl-shaped prop
Tang dynasty
h. 3.3; mouth d. 6; foot d. 5.7
Excavated at Huangbaozhen kiln site
After SPIA 1992, fig. 278:5

237. Bowl-shaped prop
Song dynasty
h. 8.6; mouth d. 12.2; foot 6.4; thickness 0.8
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 250:2

238. Prop
Song dynasty
h. 10; mouth d. 9.2; foot d. 16; thickness 1.2-1.9
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 250:10 and plate CLI:5

239. Prop
Song dynasty
h. 2.3; d. 8; top d. 3.2; thickness 0.2-0.5
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 250:12 and plate CLII:1

240. Prop
Song dynasty
h. 2.1; d. 4.3; thickness 0.4-0.6
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 250:13

241. Saggar
Song dynasty
h. 20; mouth d. 14; base d. 13, thickness 0.8
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig.244:6

242. Saggar lid
Song dynasty
h. 2.3; mouth d. 9, thickness 0.5-0.6
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig.248:20

243. Saggar
Song dynasty
h. 14; mouth d. 18.3; base d. 12.4, thickness 1.8
Excavated at Huangbaozhen kiln site
After SPIA 1965, fig. 15:5

244. Pyroscope
Five Dynasties
h. 2.1; foot d. 4.7
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 127:4 and plate C:3

245. Pyroscope
Song dynasty
h. 1.9; foot d. 3.4
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 252:7 and plate CLII:5

246. Pyroscope
Five Dynasties
h. 4.5-4.7; l. 6.5-6.7
Excavated at Huangbaozhen kiln site
After SPIA 1997, fig. 127:1

247. Pyroscope
Song dynasty
h. 0.3; l. 5.3; w. 4.6-6.5
Excavated at Huangbaozhen kiln site
After SPIA 1998, fig. 253:5 and plate CLII:6

248. Sample A
Bowl
Yaozhou blue/green ware
Tang dynasty
h. 3.9; foot d. 5.2
Excavated at Huangbaozhen kiln site
Author's collection
Author's photograph

249. Sample A: foot
Author's photograph

250. Sample A: side and cross section
Author's photograph

251: Sample A: magnified cross section (10x)
Author's photograph

252. Sample A: magnified body (40x)
Author's photograph

253. Sample A: magnified glaze (10x)
Author's photograph

254. Sample A: magnified glaze (40x)
Author's photograph

255. Sample A: microphotograph showing body, slip and glaze
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

256. Sample A: microphotograph showing body, slip and glaze
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

257. Sample A: microphotograph of the body showing rutile (very bright white grains) undergoing selective dissolution, and zircon (hexagonal bright grain on the top left side)
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

258. Sample A: microphotograph showing the glaze
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

259. Sample B
Bowl
Yaozhou blue/green ware
Five Dynasties
h. 7.1; foot d. 7.8
Excavated at Huangbaozhen kiln site
Author's collection
Author's photograph

260. Sample B: side and cross section
Author's photograph

261. Sample B: foot with gritty adhesions
Author's photograph

262. Sample B: magnified cross section (10x)
Author's photograph

263. Sample B: magnified glaze, slip and body (20x)
Author's photograph

264. Sample B: magnified body (40x)
Author's photograph

265. Sample B: magnified glaze (10x)
Author's photograph

266. Sample B: magnified glaze (40x)
Author's photograph

267. Sample B: magnified pinhole (10x)
Author's photograph

268. Sample B: microphotograph showing body, slip and glaze
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

269. Sample B: microphotograph showing the body
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

270. Sample B: microphotograph showing the slip-glaze boundary
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

271. Sample C
Bowl
Yaozhou blue/green ware
Five Dynasties
remaining h. 2.7; foot d. 4.6
Excavated at Huangbaozhen kiln site
Author's collection
Author's photograph

272. Sample C: side and cross section
Author's photograph

273. Sample C: foot with gritty adhesions
Author's photograph

274. Sample C: magnified cross section (10x)
Author's photograph

275. Sample C: magnified body (40x)
Author's photograph

276. Sample C: magnified glaze on the bottom of the shard close to the appliqué motif(10x)
Author's photograph

277. Sample C: magnified glaze on the bottom of the shard close to the appliqué motif (20x)
Author's photograph

278.Sample C: magnified glaze (40x)

Author's photograph

279. Sample C: magnified glaze on the appliqué motif (10x)
Author's photograph

280. Sample C: magnified fingernail (10x)
Author's photograph

281. Sample C: microphotograph of the cross section
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

282. Sample C: microphotograph showing the body
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

283. Sample C: microphotograph showing glaze, slip and body
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

284. Sample C: microphotograph showing glaze and slip
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

285. Sample C: microphotograph showing the glaze-slip boundary
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

286. Sample D
Yaozhou blue/green ware
Five Dynasties
1.5 x 1.7
Excavated at Huangbaozhen kiln site
Author's collection
Author's photograph

287. Sample D: cross section
Author's photograph

288. Sample D: magnified cross section (10x)
Author's photograph

289. Sample D: magnified cross section (20x)
Author's photograph

290. Sample D: magnified body, slip and glaze (40x)
Author's photograph

291. Sample D: magnified glaze (10x)
Author's photograph

292. Sample D: magnified glaze (40x)
Author's photograph

293. Sample D: microphotograph showing the cross section
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

294. Sample D: microphotograph of the body showing the parallel alignment of both quartz relicts and pores
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

295. Sample D: microphotograph of the body showing quartz relicts peripherally converted to tridymite, rutile grain undergoing partial dissolution (middle of the bottom) and zircon
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

296. Sample D: microphotograph showing body, slip and glaze
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

297. Sample D: microphotograph showing glaze and slip boundary
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

298. Sample E
Yaozhou blue/green ware
Northern Song
remaining h. 1.8
Excavated at Huangbaozhen kiln site
Author's collection
Author's photograph

299. Sample E: foot
Author's photograph

300. Sample E: side and cross section
Author's photograph

301. Sample E: magnified cross section (10x)
Author's photograph

302. Sample E: magnified body (40x)
Author's photograph

303. Sample E: magnified glaze (10x)
Author's photograph

304. Sample E: magnified glaze (40x)
Author's photograph

305. Sample E: microphotograph showing glaze and body
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

306. Sample E: microphotograph of the body showing a remarkably vitrified body (pale grey) scattered with residual quartz marginally converted to tridymite (dark grey areas with fringed rim), irregular pores (black spots with bright halo), opaques, namely rutile (bright white spot on the right) and zircon (bright white spot on the left), and some unconverted quartz (grey spots with no fringed margin).
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

307. Sample E: microphotograph showing body, glaze and body-glaze interface
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

308. Sample E: microphotograph of the body-glaze interface with anorthite development
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

309. Sample F
Yaozhou blue/green ware
Northern Song
5.7 x 5
Excavated at Huangbaozhen kiln site
Author's collection
Author's photograph

310. Sample F: reverse
Author's photograph

311. Sample F: magnified cross section (10x)
Author's photograph

312. Sample F: magnified body, white layer and glaze (20x)
Author's photograph

313. Sample F: magnified body, white layer and glaze (40x)
Author's photograph

314. Sample F: magnified glaze (10x)
Author's photograph

315. Sample F: magnified glaze (40x)
Author's photograph

316. Sample F: magnified thin glaze on the reverse (10x)
Author's photograph

317. Sample F: magnified medium glaze on the reverse (10x)
Author's photograph

318. Sample F: magnified thick glaze on the reverse (40x)
Author's photograph

319. Sample F: microphotograph showing body and glaze
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

320. Sample F: microphotograph showing the body
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

321. Sample F: microphotograph of the body showing quartz partially converted to trydimite and mullite needles
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

322. Sample F: microphotograph showing the body-glaze interface with anorthite development
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

323. Sample G
Yue blue/green ware
Tang
6 x 4
Author's collection
Author's photograph

324. Sample G: foot with marks left by spacers
Author's photograph

325. Sample G: side and cross section
Author's photograph

326. Sample G: magnified cross section (10X)
Author's photograph

327. Sample G: magnified body (40x)
Author's photograph

328. Sample G: magnified glaze (10x)
Author's photograph

329. Sample G: magnified glaze (40x)
Author's photograph

330. Sample G: microphotograph of the body showing a concentration of microporosity identified as relict feldspar
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

331. Sample G: microphotograph of the body showing minor opaques and lack of trydimite
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

332. Sample G: microphotograph of the body showing the morphology of relict feldspar similar to residual quartz in size and to a triangle in shape
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

333. Sample G: microphotograph showing the body and glaze with anorthite development
Dr Doherty, Research Laboratory for Archaeology and the History of Art, University of Oxford

334. Thermodynamic phase diagram of the body of some Yaozhou specimens
After Li Guozhen *et al.* ISAC '89, p. 259, fig. 4.

ILLUSTRATIONS

Fig. 1 Covered box with carved floral decoration

Fig. 2 Pillow with carved decoration

Fig. 3 Ewer with deeply carved decoration

Fig. 4 Ewer with deeply carved decoration and lion-shaped spout

Fig. 5 Ewer with deeply carved decoration and phoenix-head-shaped spout

Fig. 6 Jar and cover with deeply carved decoration

Fig. 7 Cup and saucer

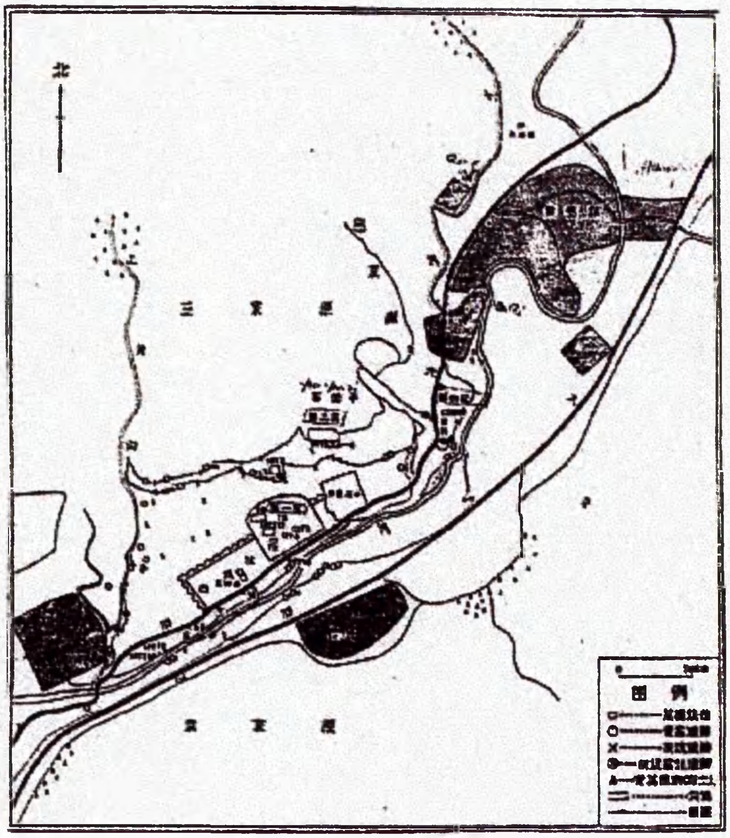


Fig. 8 Map of the distribution of areas excavated in 1958-59 at Huangbaozhen kiln site

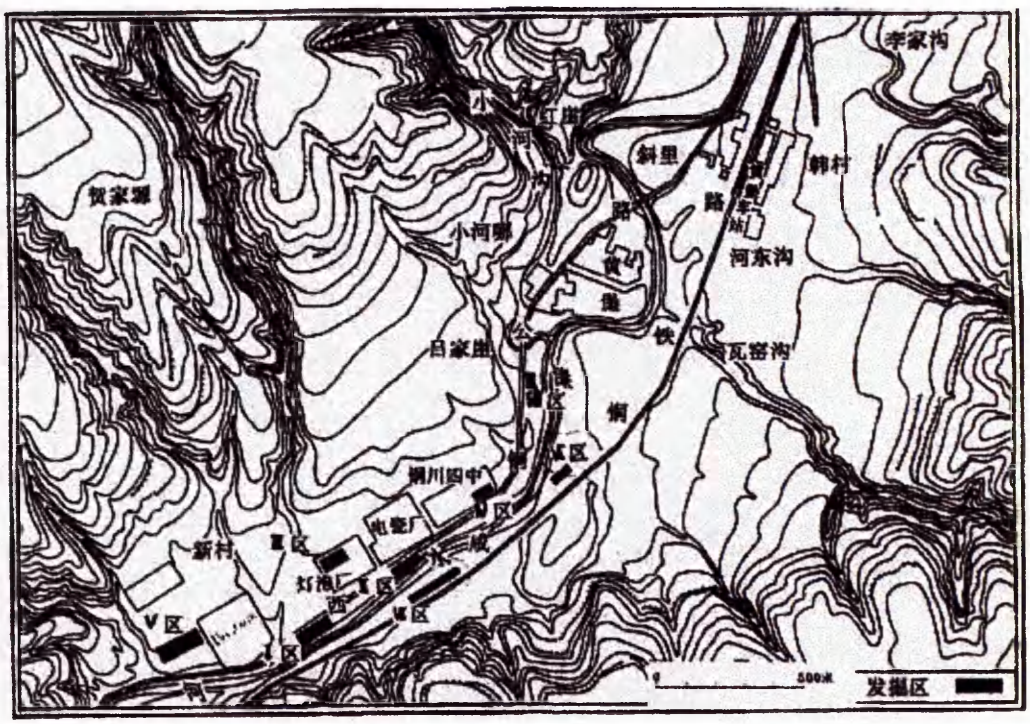


Fig. 9 Map of the distribution of areas ex-cavated in 1984-97 at Huangbaozhen kiln site

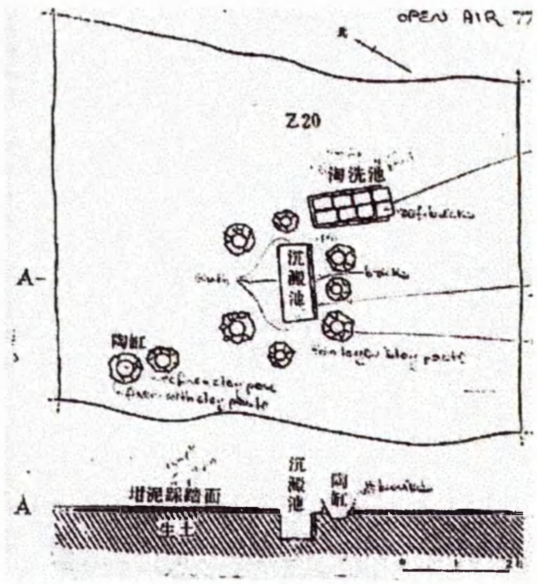


Fig. 10
Workshop Z20t

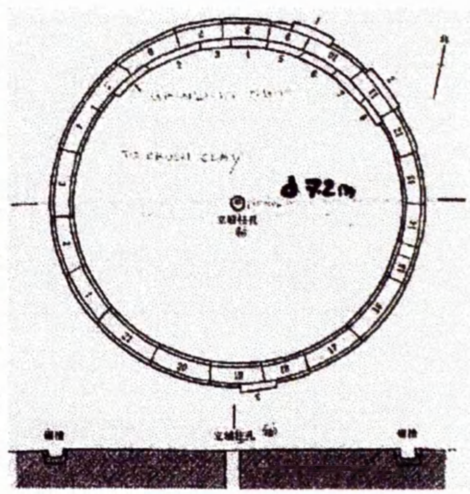


Fig. 11
Workshop Z76s

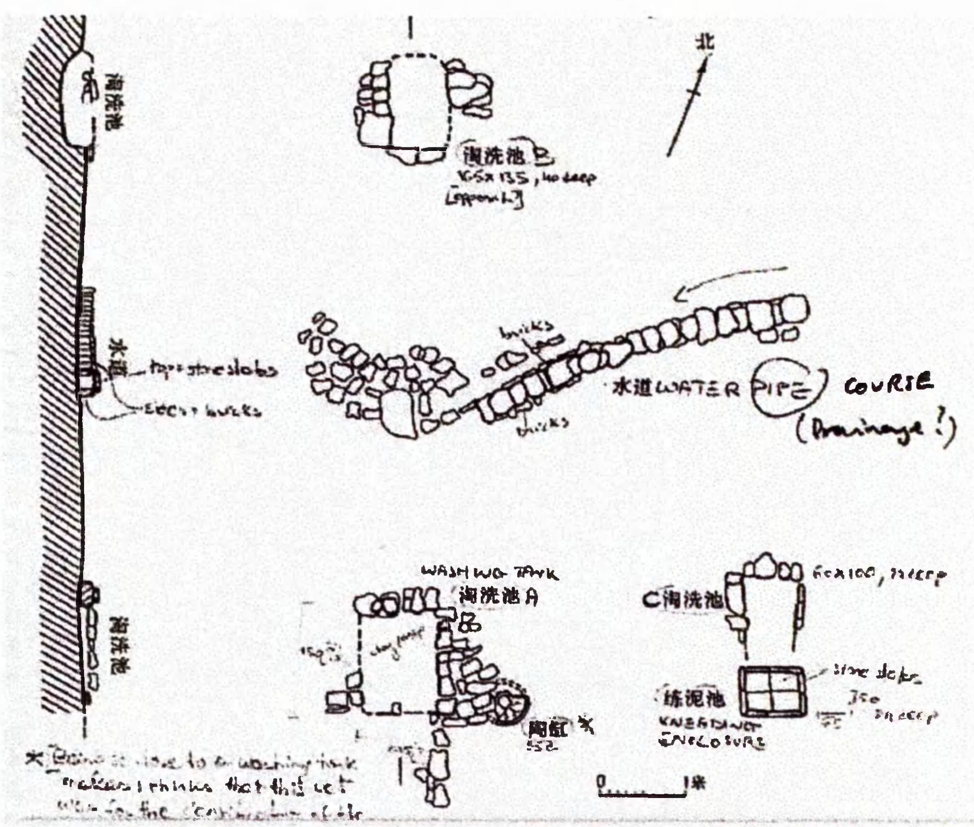


Fig. 12
Workshop Z77s

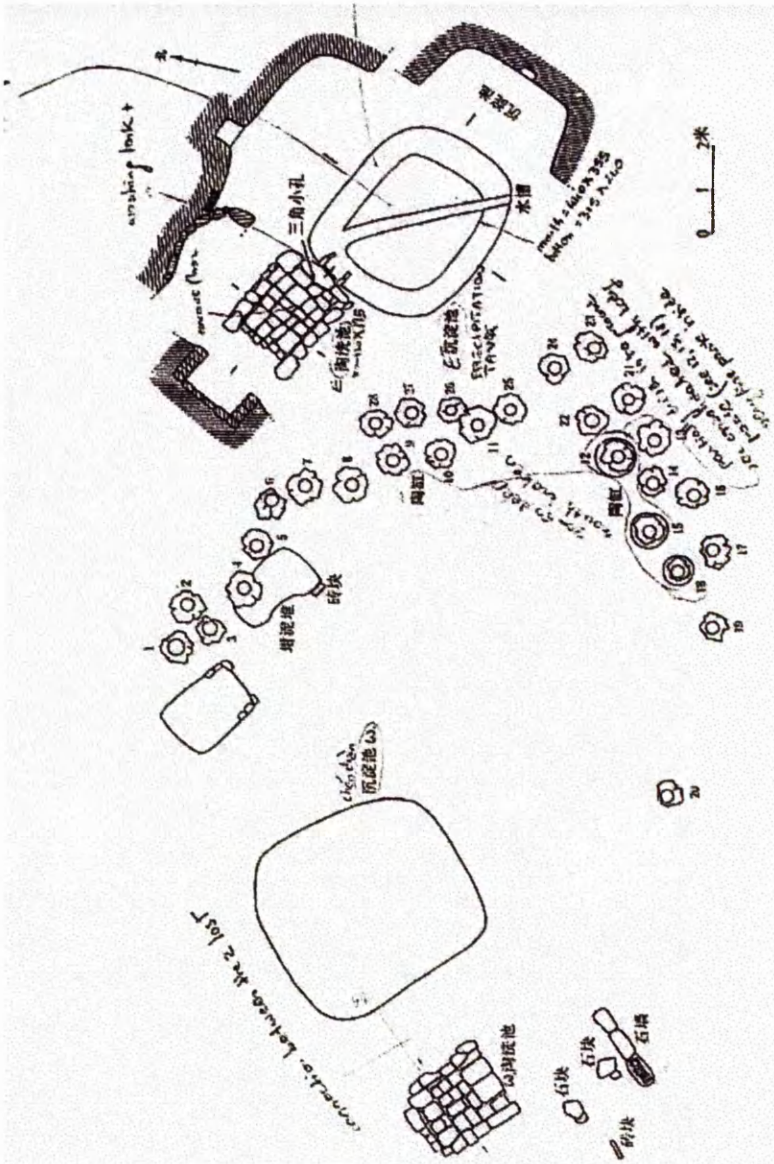


Fig. 13
Workshop
Z78s

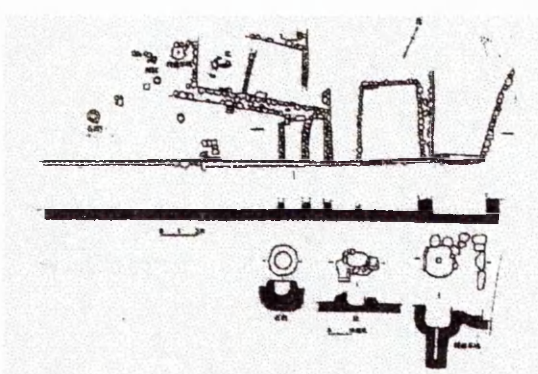


Fig. 14
Workshop Z29s

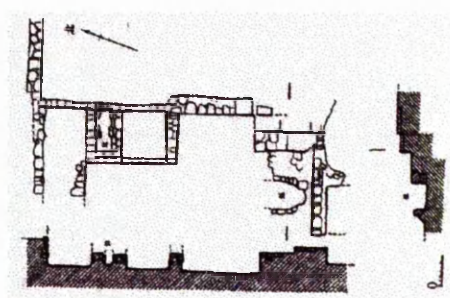


Fig. 15
Workshop Z34s

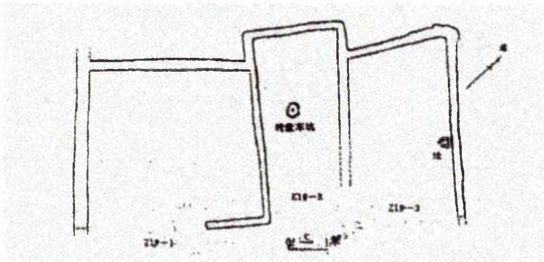


Fig. 16 Workshop Z19s

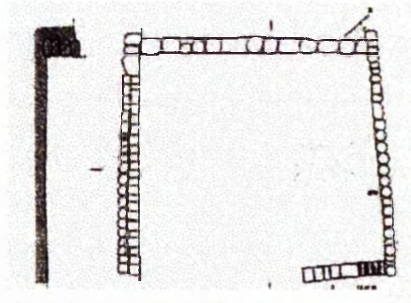


Fig. 16a Workshop Z19:1s

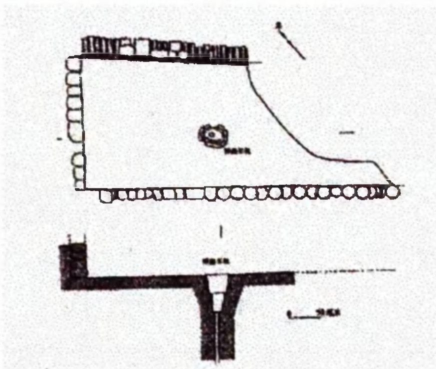


Fig. 16b Workshop Z19:2s

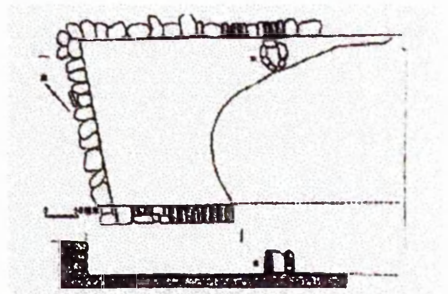


Fig. 16c Workshop Z19:3s

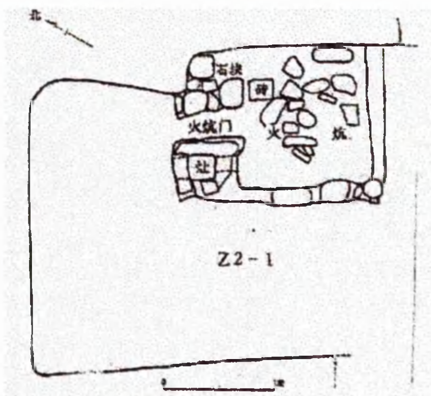


Fig. 17a Workshop Z2:1t

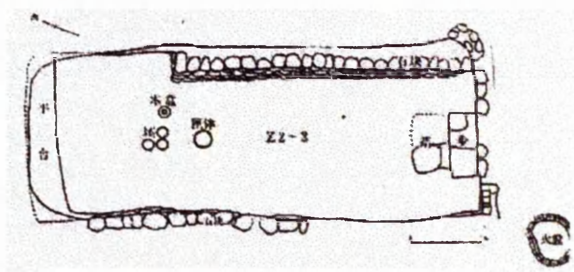


Fig. 17b Workshop Z2:2t

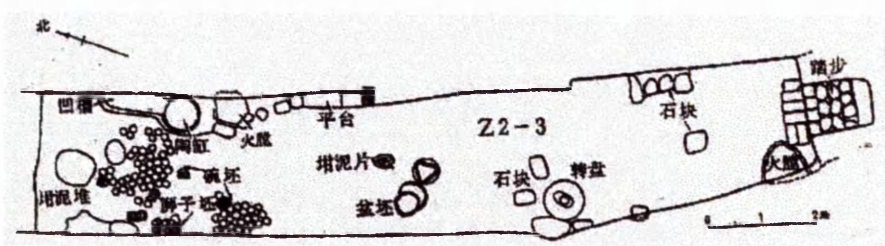


Fig. 17c Workshop Z2:3t

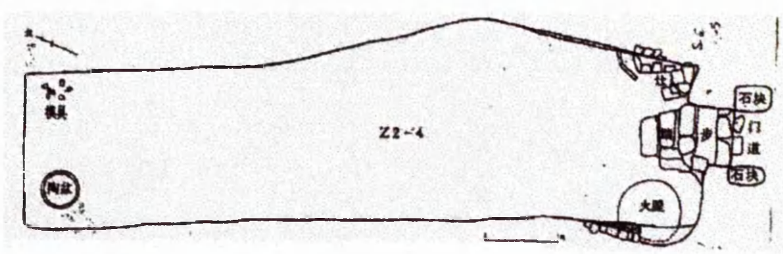


Fig. 17d Workshop Z2.4t

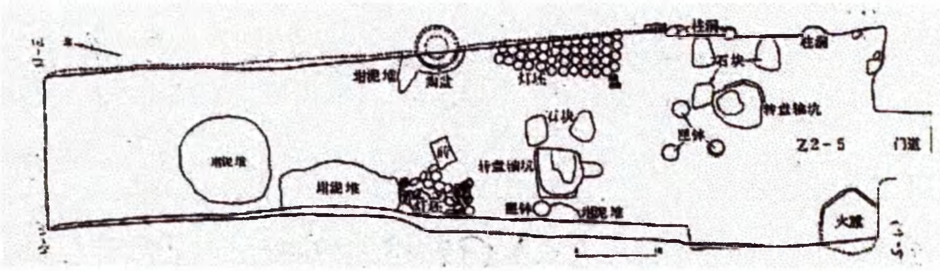


Fig. 17e Workshop Z2:5t

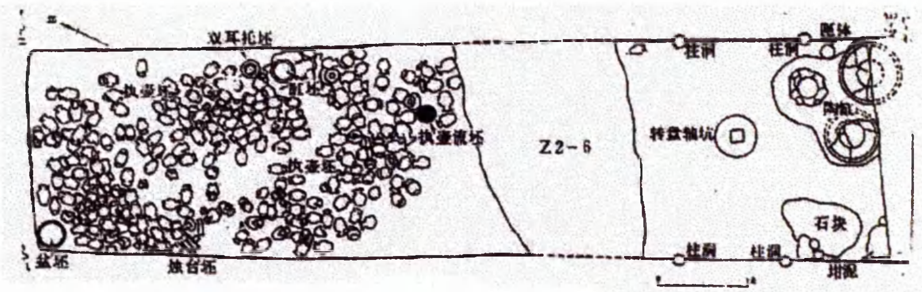


Fig. 17f Workshop 2:6t

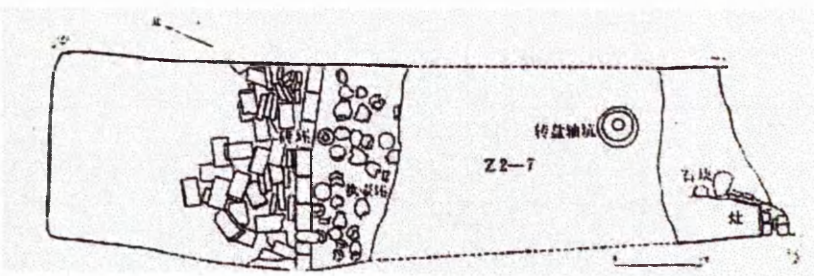


Fig. 17g 2:7t

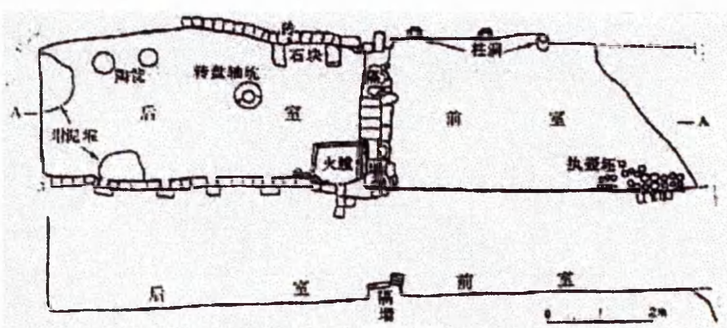
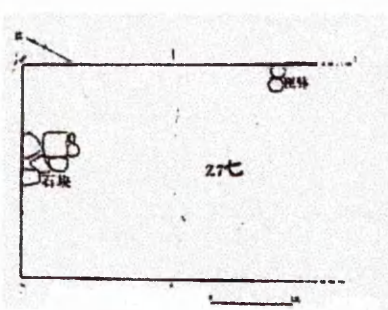


Fig. 18 Workshop Z4t



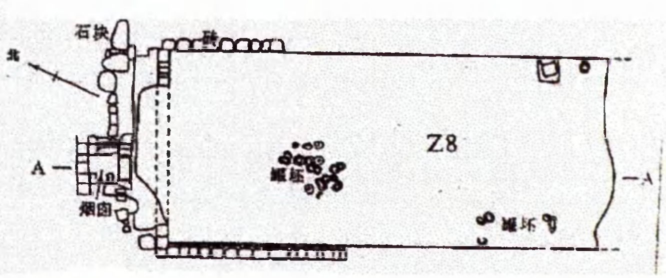


Fig. 19 Workshop Z7t Fig. 20 Workshop Z8t

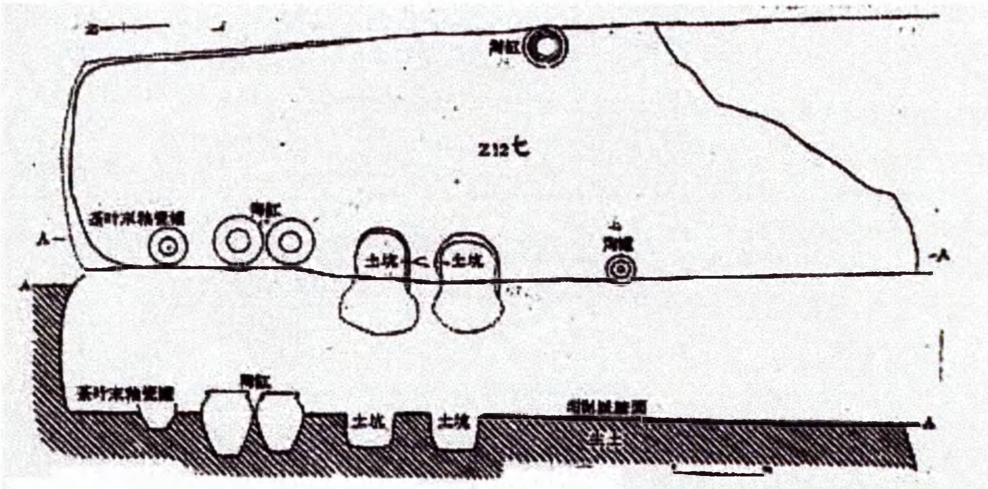


Fig. 21 Workshop Z12t

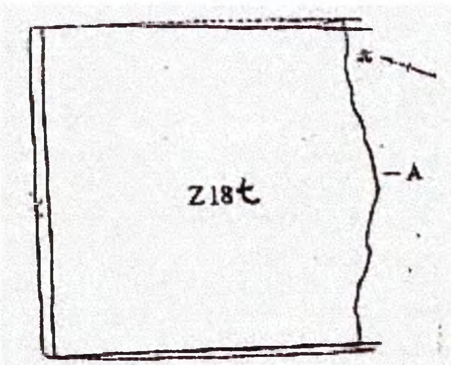


Fig. 22 Workshop Z18t

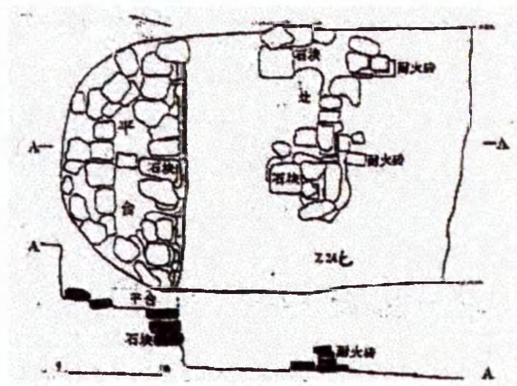


Fig. 23 Workshop Z24t

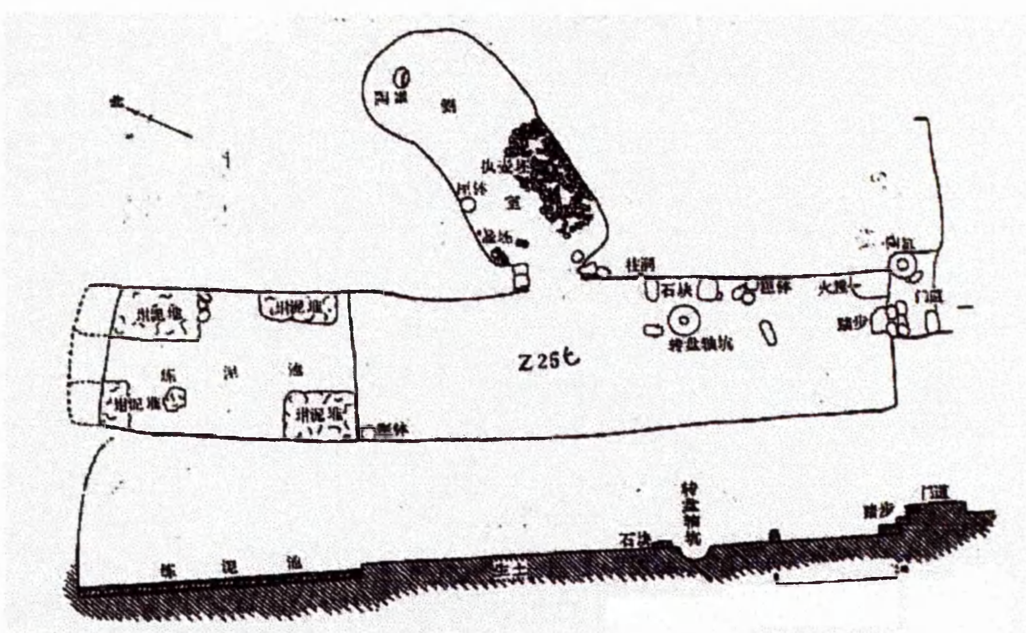


Fig. 24 Workshop Z25t

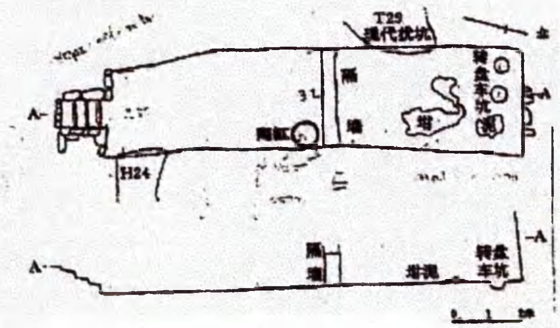


Fig. 25
Workshop 70f

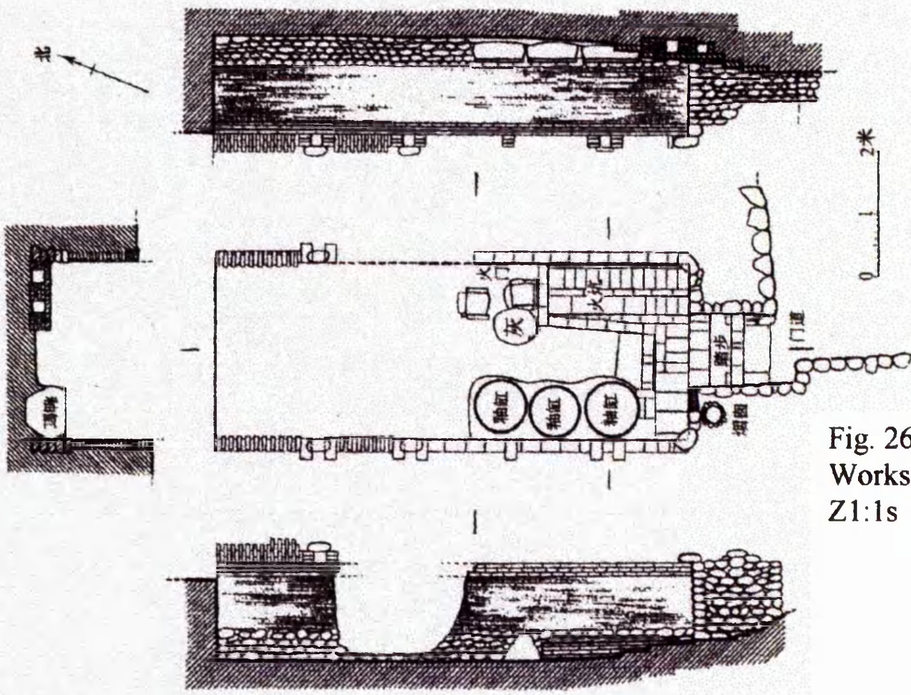


Fig. 26a
Workshop
Z1:1s

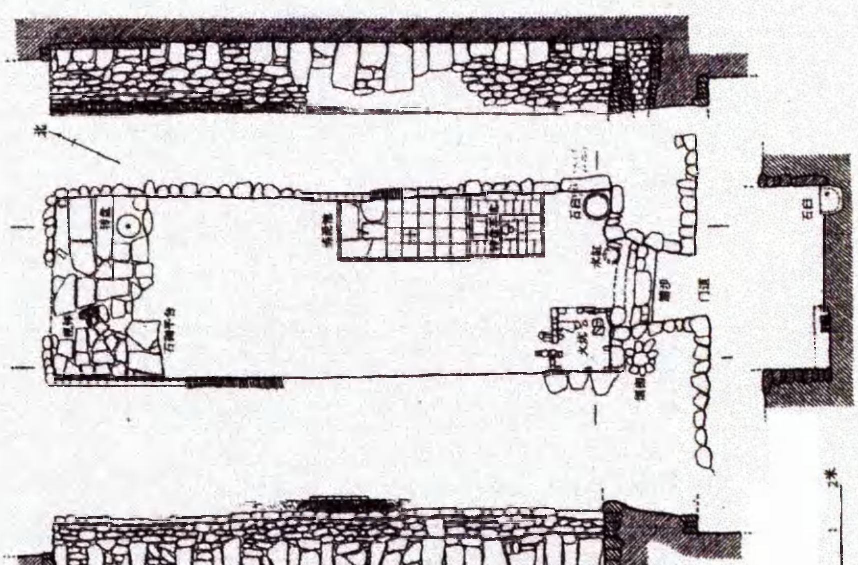


Fig.26b
Workshop
Z1:2s

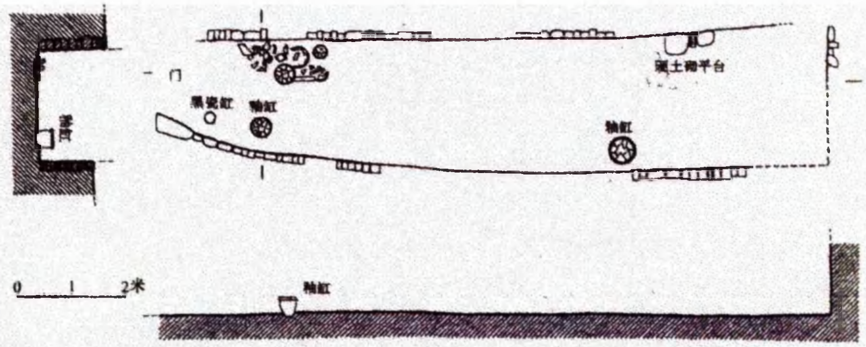


Fig. 27a Workshop Z3:1s

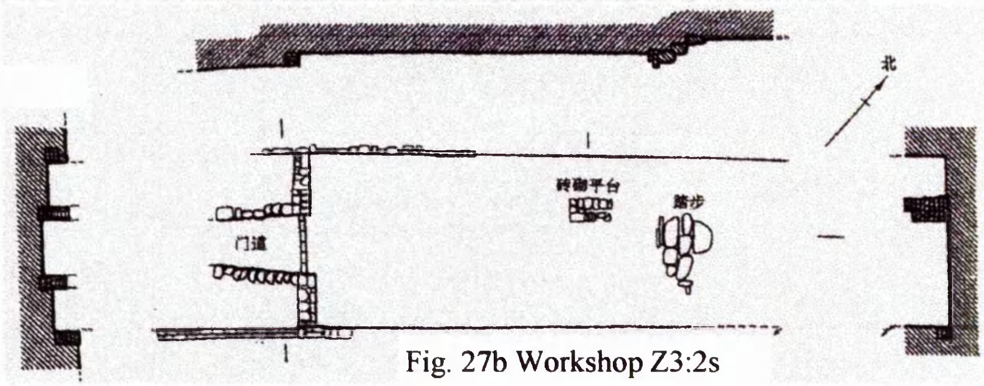


Fig. 27b Workshop Z3:2s

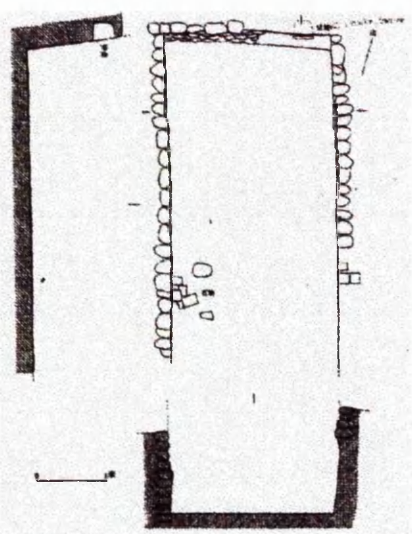


Fig. 28 Workshop Z5s

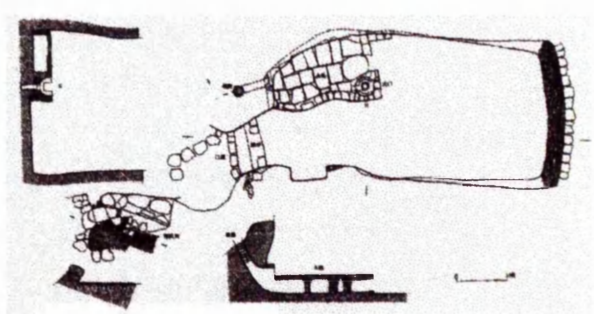


Fig. 29 Workshop Z11s

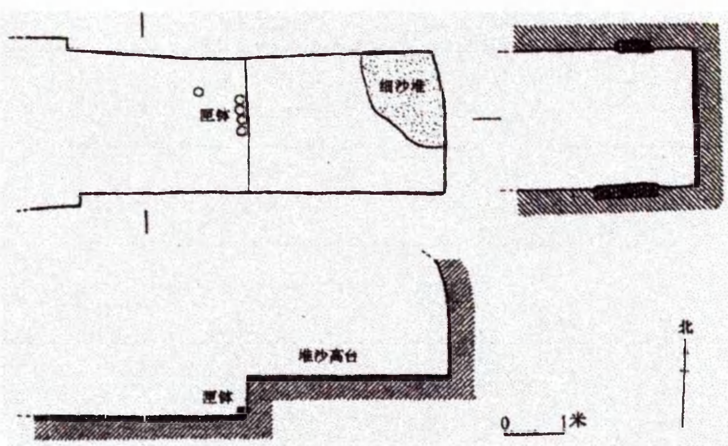


Fig. 30 Workshop Z15s

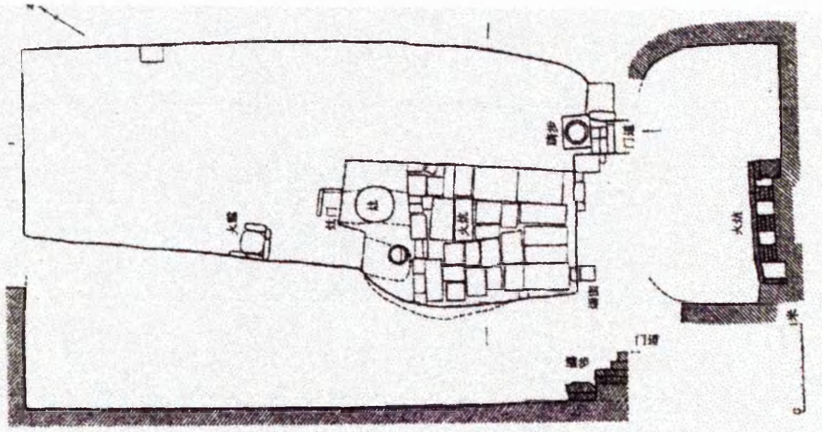


Fig. 31
Workshop
Z22s

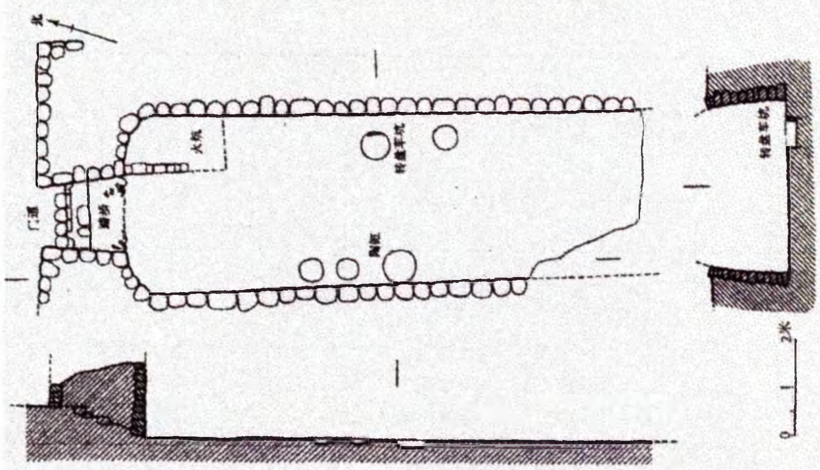


Fig. 32
Workshop
Z32s

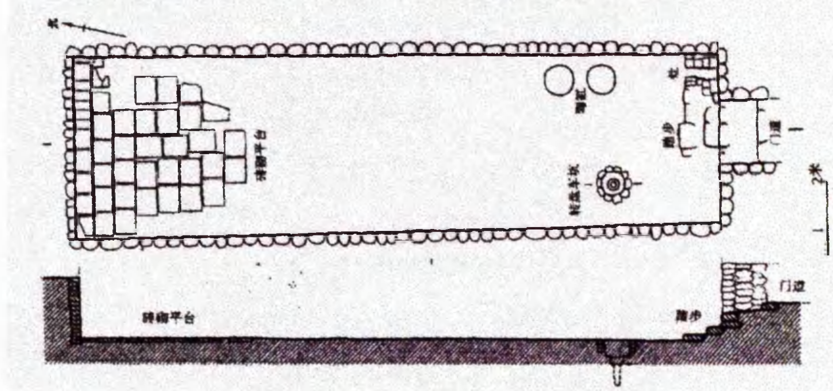


Fig. 33
Workshop
Z33s

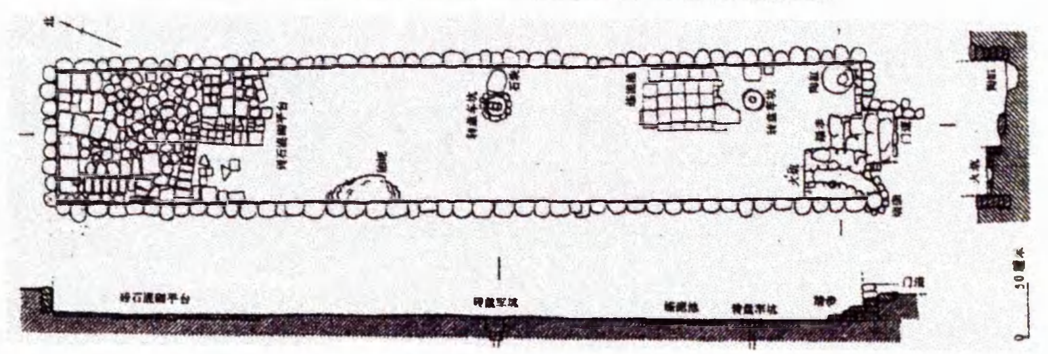


Fig. 34 Workshop Z37s

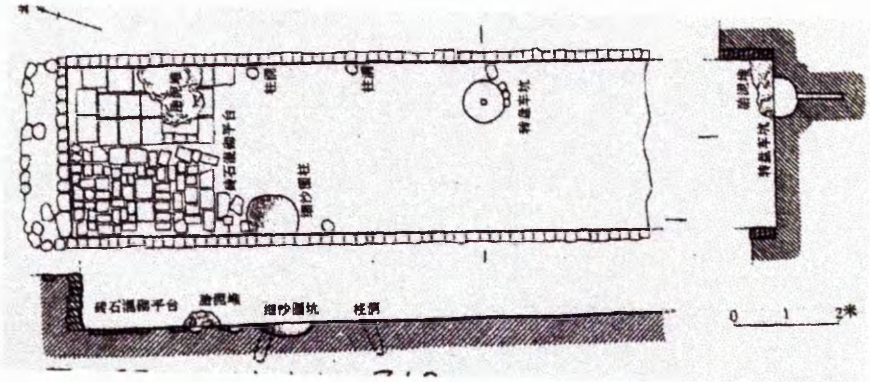


Fig. 35 Workshop Z42s

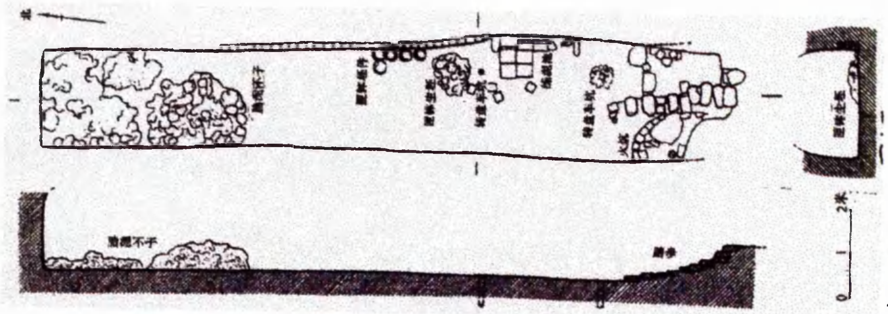


Fig. 36 Workshop Z45s

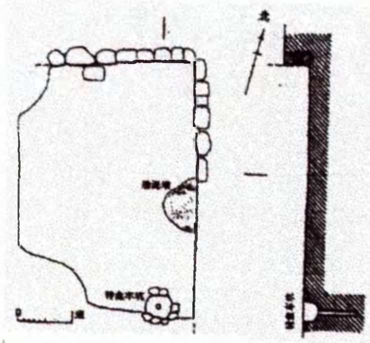


Fig. 37 Workshop Z46s

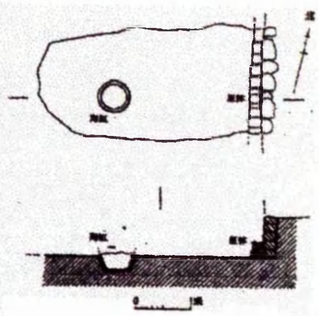


Fig. 38 Workshop Z47s

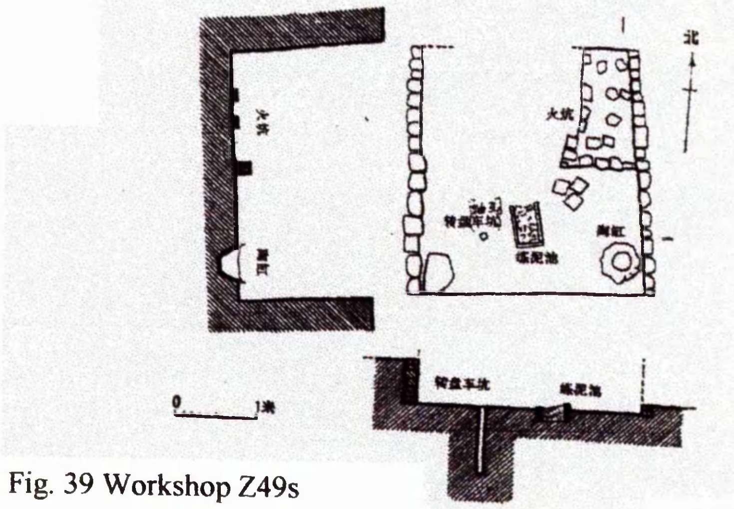


Fig. 39 Workshop Z49s

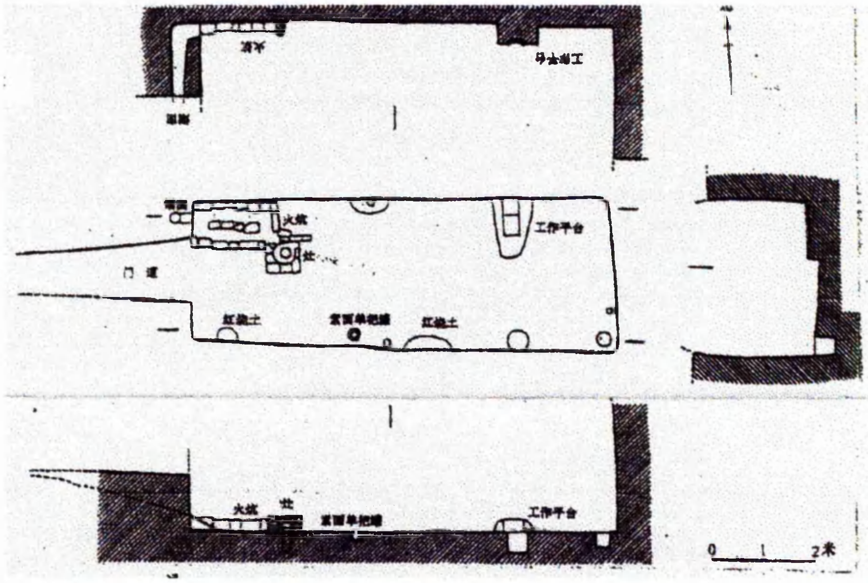


Fig. 40
Workshop
Z65s

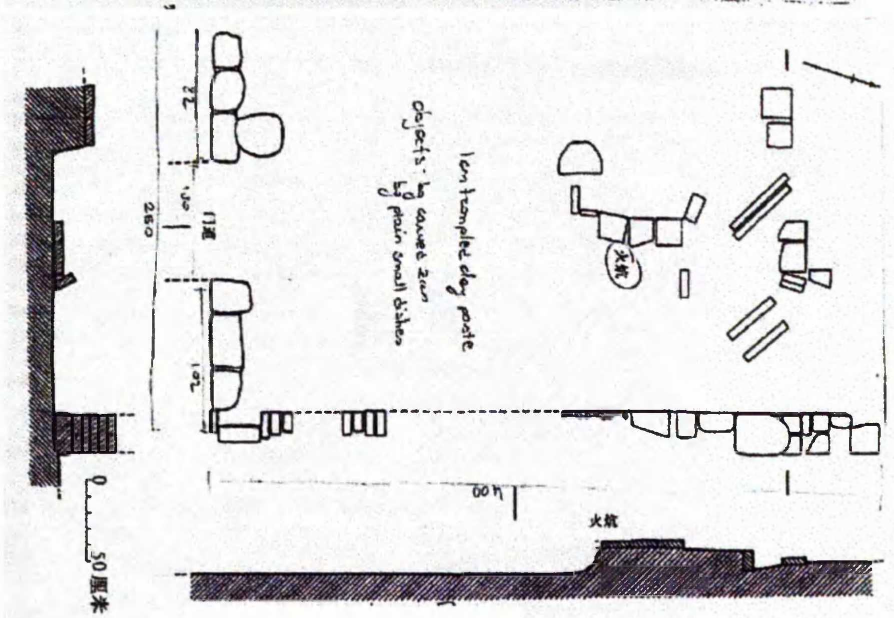


Fig. 41
Work-
shop
Z69s

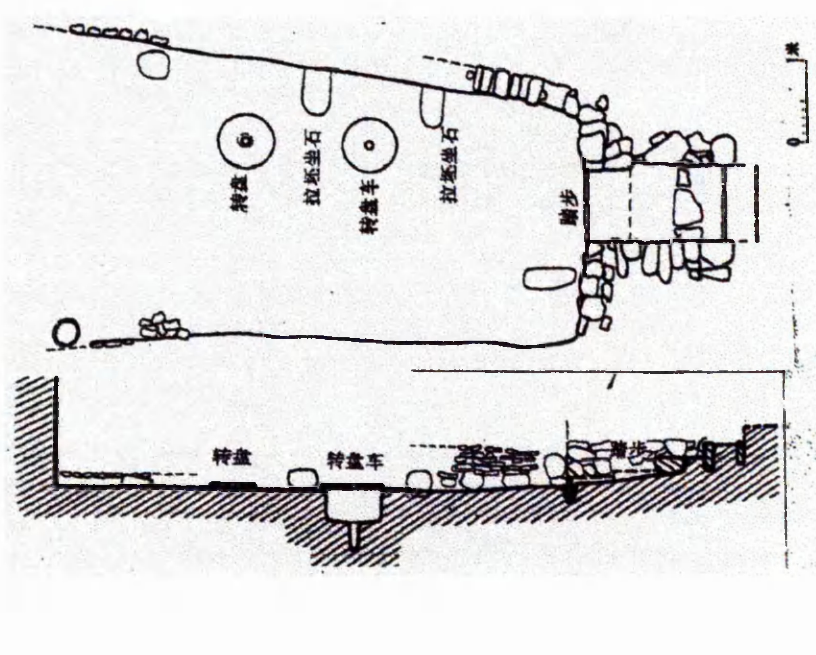


Fig. 42
Workshop
Z71s

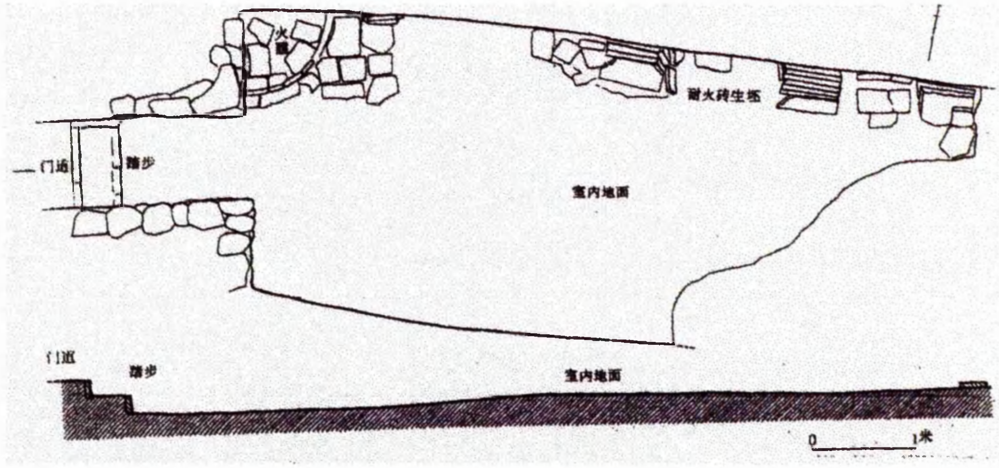


Fig.43 Workshop Z84s

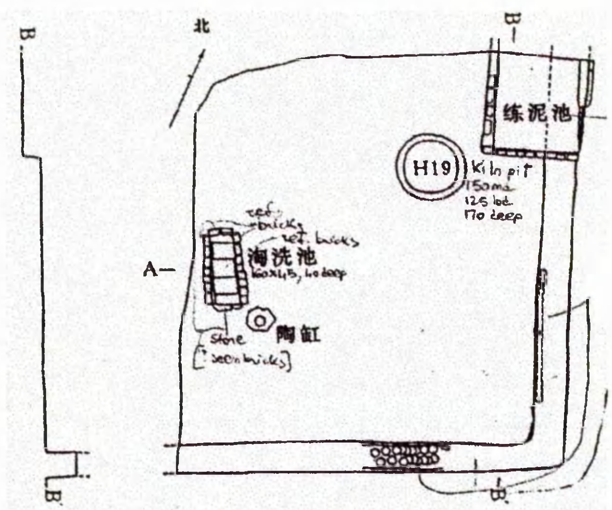
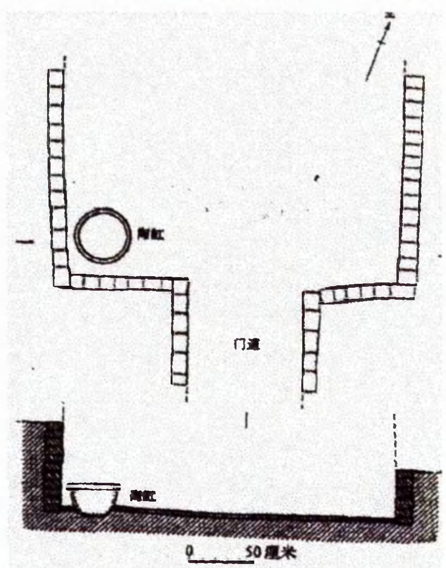


Fig. 44 Workshop Zssf



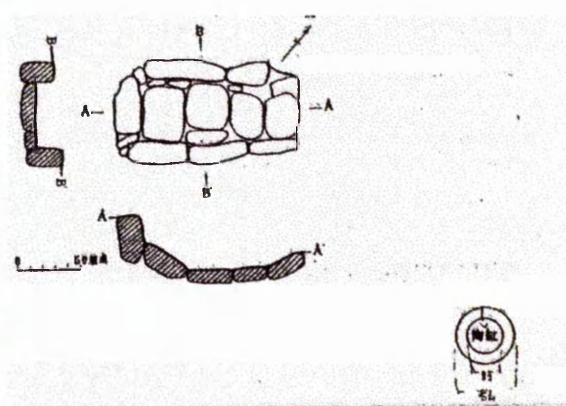
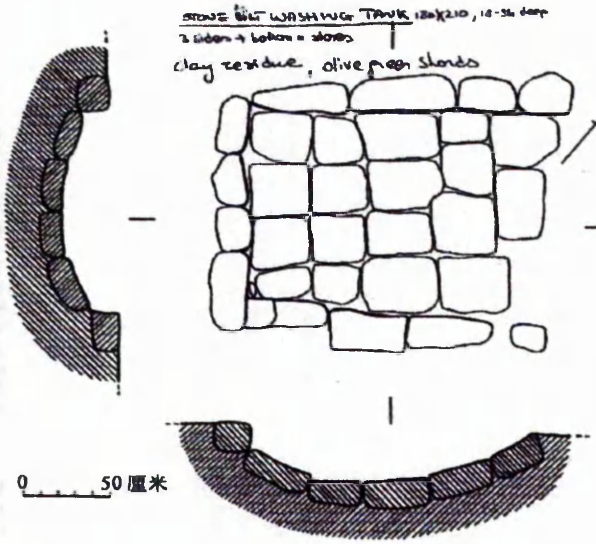


Fig. 45 Workshop Z21s

Fig. 46 Workshop Z17f



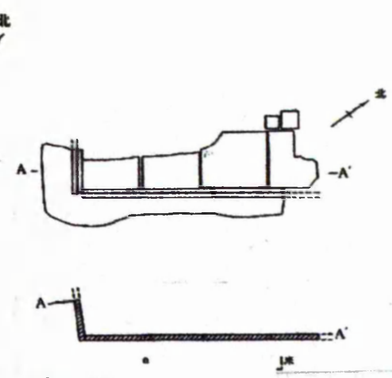


Fig. 48
Workshop Z68f

Fig. 47 Workshop Z67f

Fig. 49 Double-wheeled chaser mill pulled by two donkeys

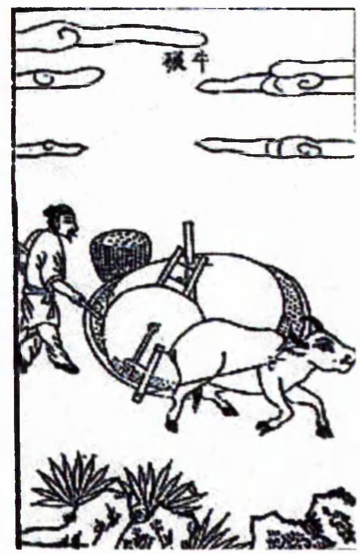


Fig. 50 Single-wheeled chaser mill pulled by a buffalo

Fig.51 Mortar and pestle and photograph of a similar mortar and pestle

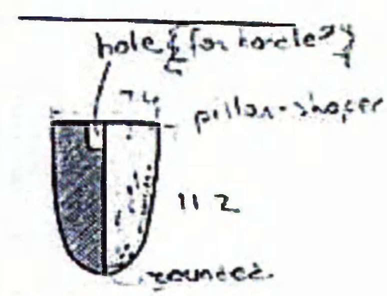


Fig. 52 Pestle

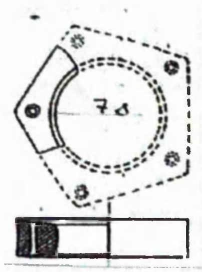


Fig. 53 Pentagonal hollow ceramic attachment for the potter's wheel

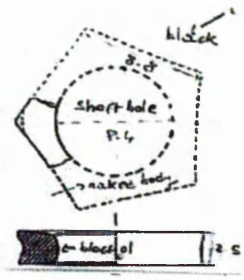


Fig. 54 Pentagonal hollow ceramic attachment for the potter's wheel

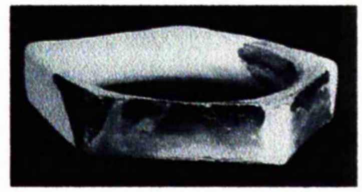


Fig. 55 Pentagonal rotating hoop

Fig. 56 Circular rotating hoop

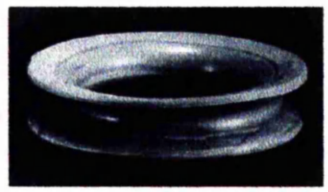


Fig. 57 Circular rotating hoop

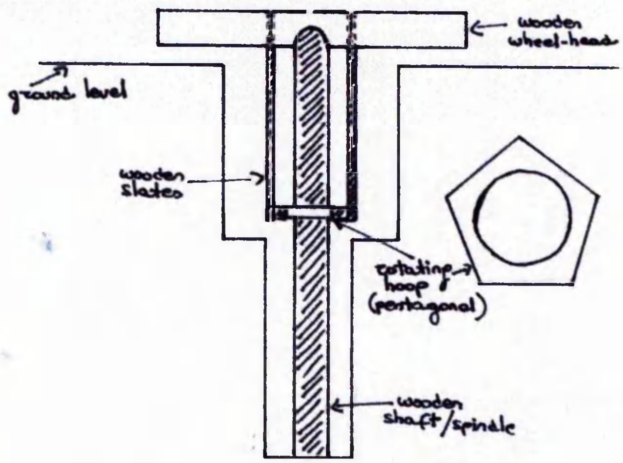


Fig 58 Drawing of a possible reconstruction of the potter's wheel in use at the Yaozhou kilns in the Tang dynasty

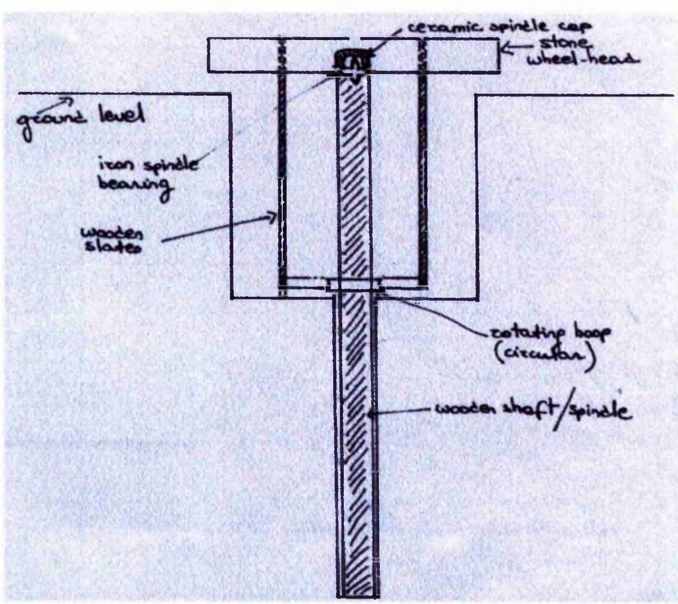


Fig 59 Drawing of a possible reconstruction of the potter's wheel in use at the Yaozhou kilns in the Song dynasty

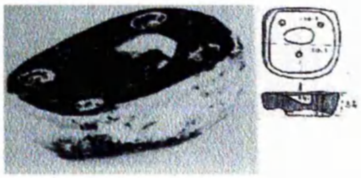


Fig. 60 Wheel turner

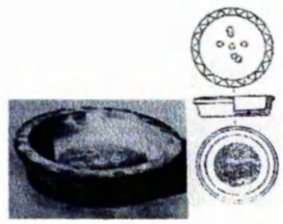


Fig. 61 *Pantou*

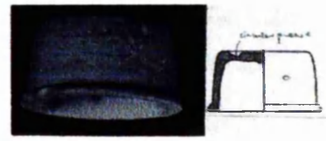


Fig. 62 *Pantou*

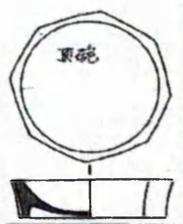


Fig. 63 *Dingwan*

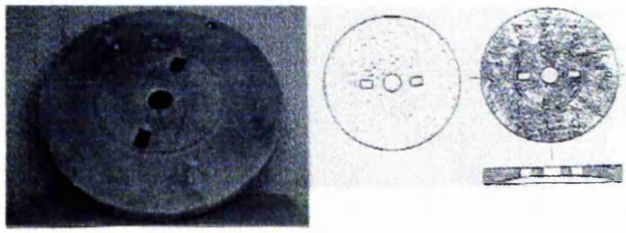


Fig. 64 Stone wheel

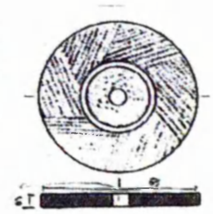


Fig. 67 Stone wheel

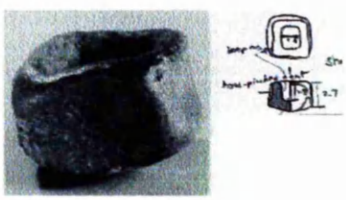


Fig. 65 Spindle cap

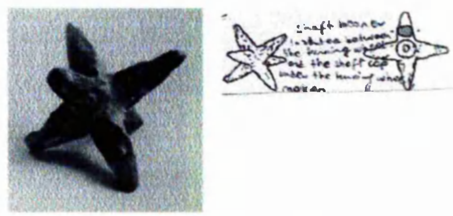


Fig. 66 Spindle bearing

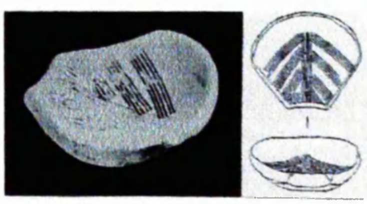


Fig. 68 Scraper

Fig. 69 One-piece outer mould with inside decoration for *bei* cups and cup made from similar mould

Fig. 70 One-piece inner mould with outside decoration for *bei* cups

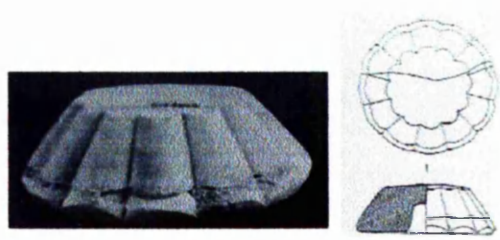


Fig. 71 One-piece inner mould for lobed *xi* basins

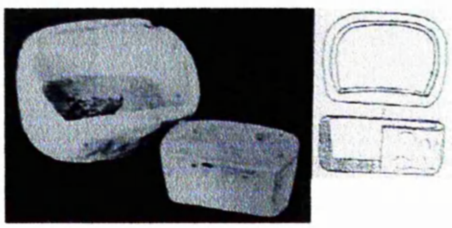


Fig. 72 One-piece outer mould for kidney-shaped pillow and pillow made from a similar

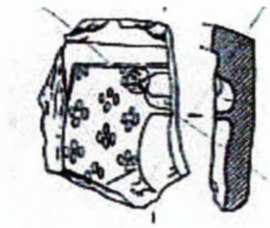


Fig. 73 One-piece decorated outer mould for pillows

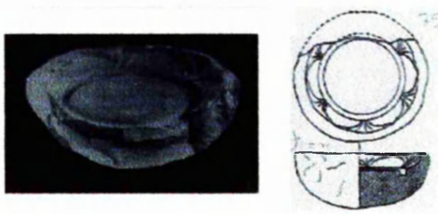


Fig. 74 One-piece decorated outer mould for saucers

Fig. 75 One-piece plain outer mould for saucers

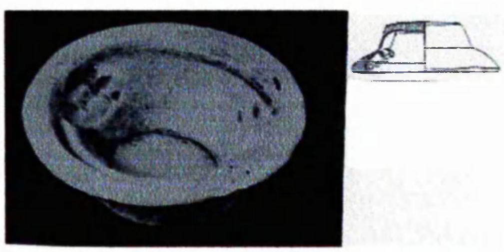


Fig. 76 One-piece outer mould for stands

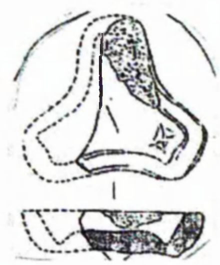


Fig. 77 One-piece outer mould for three-armed spacers

Fig. 78 Half of a two-piece mould for fish-shaped vases and fish-shaped vase made from a similar mould

Fig. 79 Half of a two-piece mould for stands

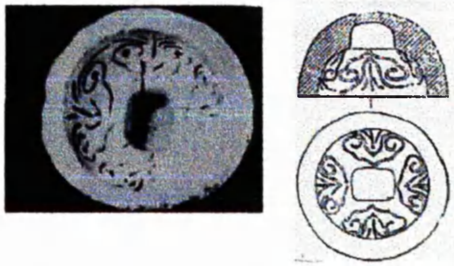


Fig. 80 Top half of a two-piece mould for rattles

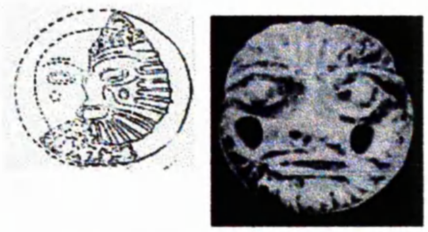


Fig. 81 Front half of a two-piece mould for whistles and whistle

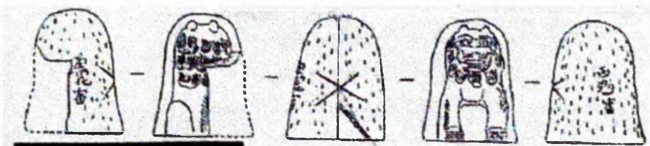


Fig. 82 Two-piece mould with register mark

Fig. 83 Two-piece mould cut at an odd angle

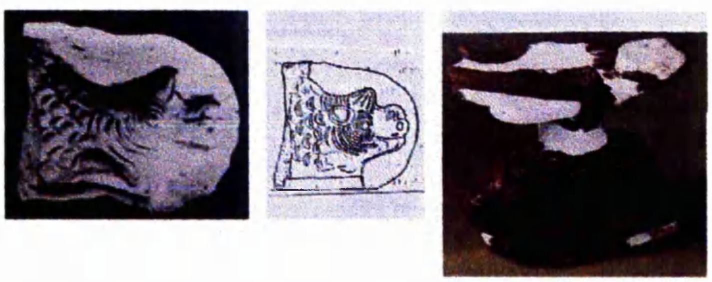


Fig. 84 Half of a two-piece mould for the base of a headrest and a headrest made from a similar

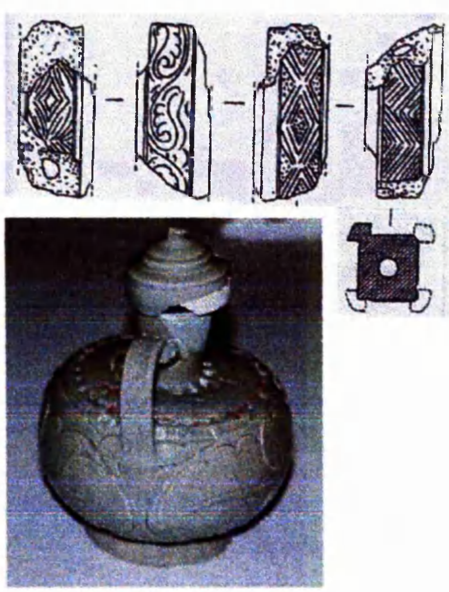


Fig. 85 Mould for handles of ewers, giving a choice of four different patterns and a ewer with similarly patterned handle

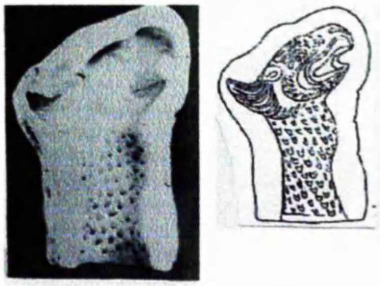


Fig. 86 Half of a two-piece mould for spouts in the shape of a phoenix-head

Fig. 87 Mould for feet and an incense burner with similar feet

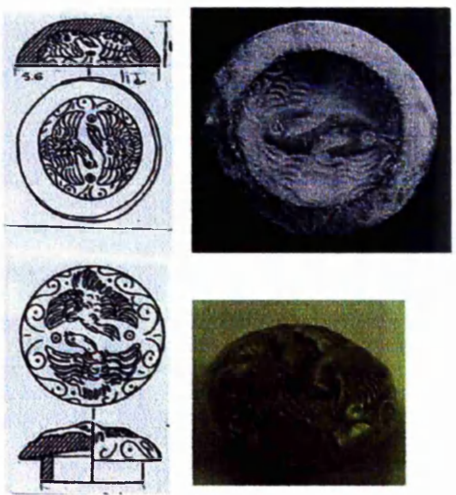


Fig. 88 Mould for lids and lid made from the same mould

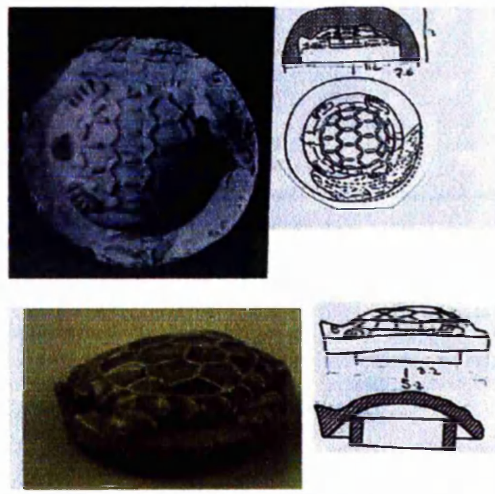


Fig. 89 Mould for lids and lid made from the same mould

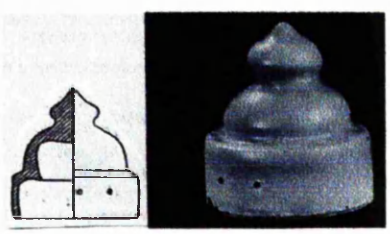


Fig. 90 Lid

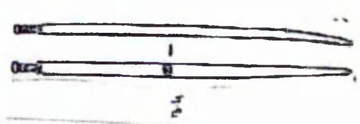


Fig. 91 Bone awl

Fig. 92 Bone comb

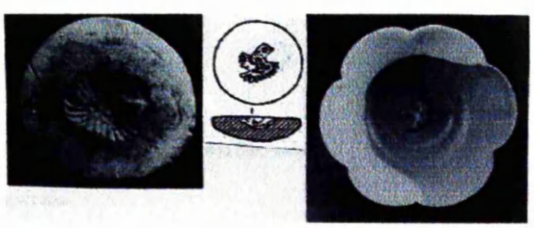


Fig. 93 Sprig mould and *bei* cup with appliqué decoration made from the same sprig mould

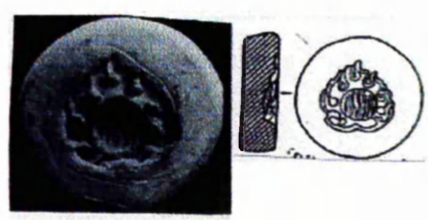


Fig. 94 Sprig mould

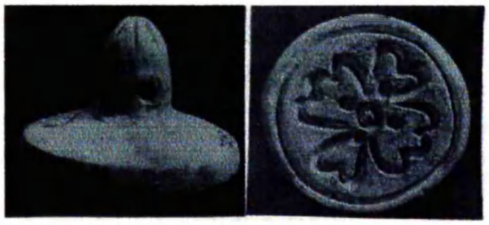


Fig. 95 Decorative stamp

Fig. 96 Hump muold for impressing a complex design on the inner surface of a bowl and bowl decorated with the same pattern

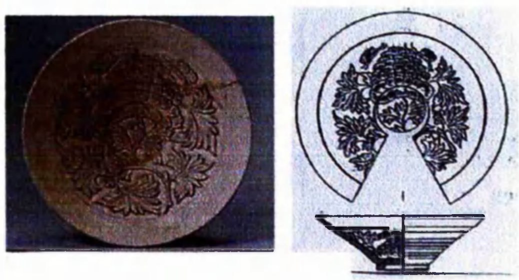


Fig. 97 Matrix for hump moulds for impressing a complex design on the inner surface of a bowl

Fig. 98 Hump muold for impressing a complex design on the inner surface of a bowl

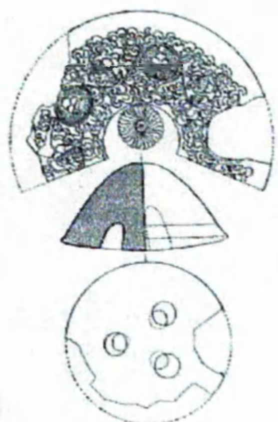


Fig. 99 Hump muold for impressing a complex design on the inner surface of a bowl

Fig. 100 Moulded *pan* dish showing radiating lines on the outside

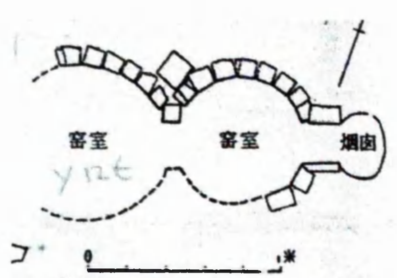


Fig. 101 Kiln Y12t

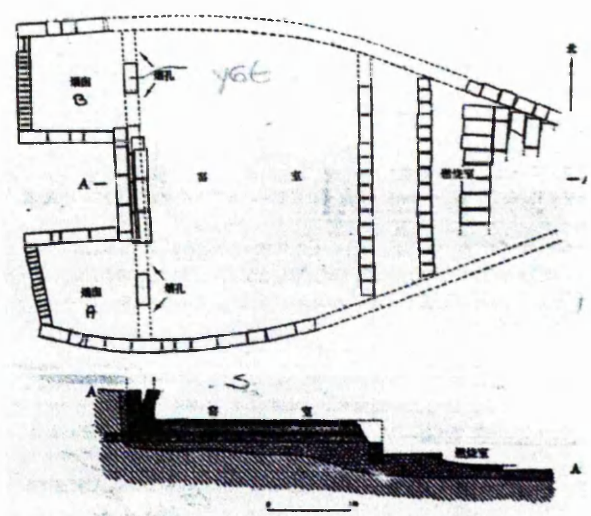


Fig. 102 Kiln Y6t

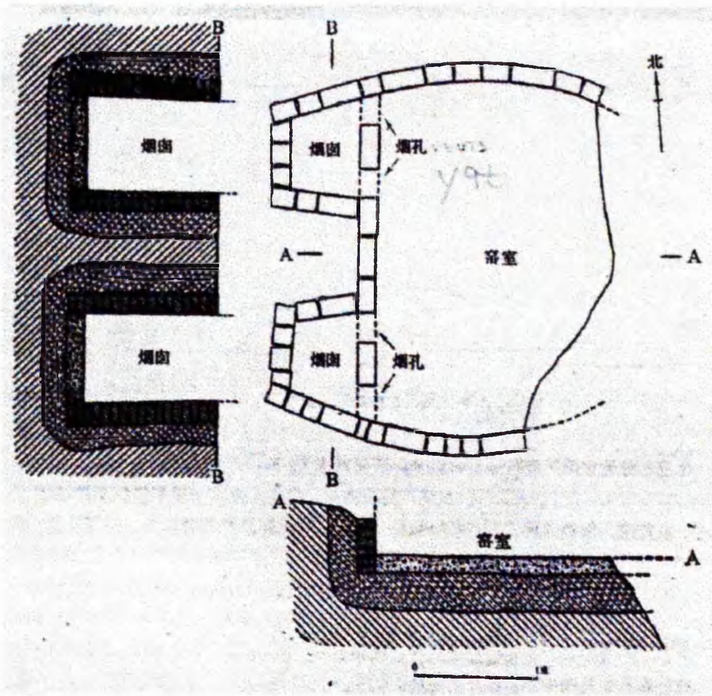


Fig. 103 Kiln Y9t

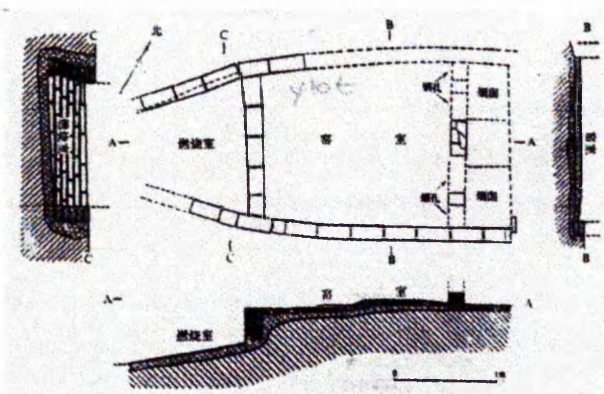


Fig. 104 Kiln Y10t

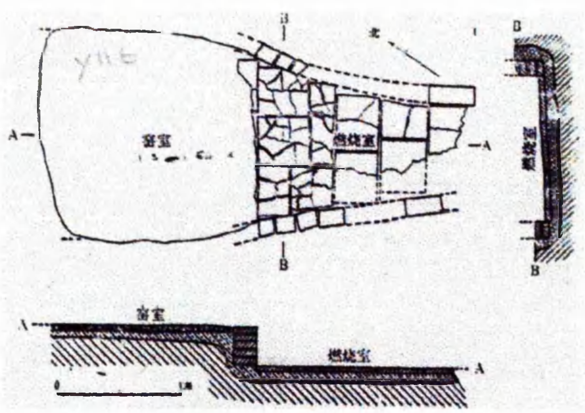


Fig. 105 Kiln Y11t

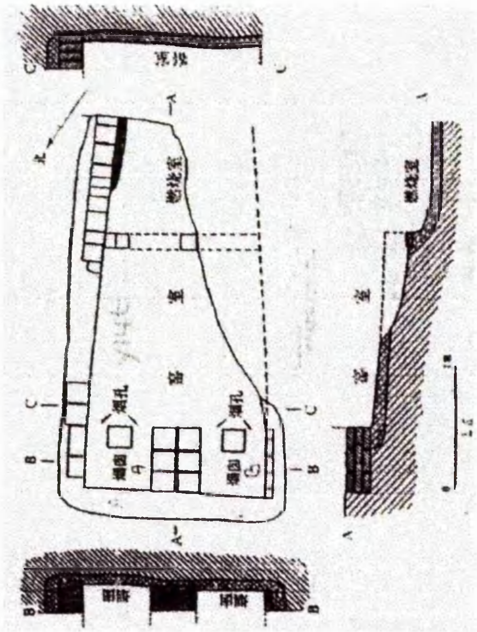


Fig. 106 Kiln Y14t

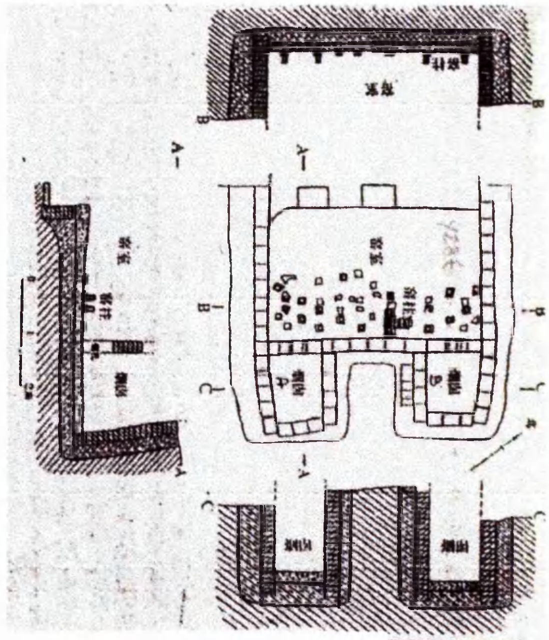


Fig. 107 Kiln Y28t

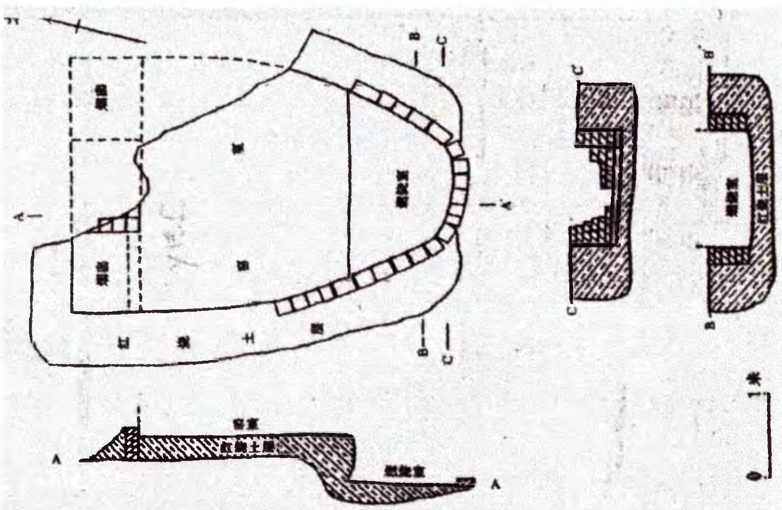


Fig. 108
Kiln Y15f

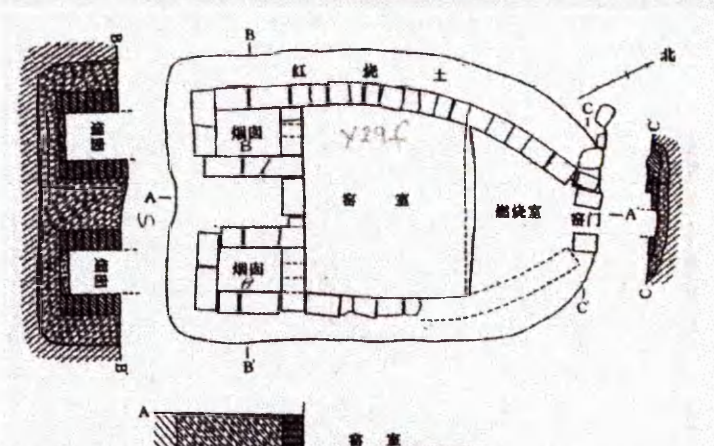


Fig. 109
Kiln Y29f

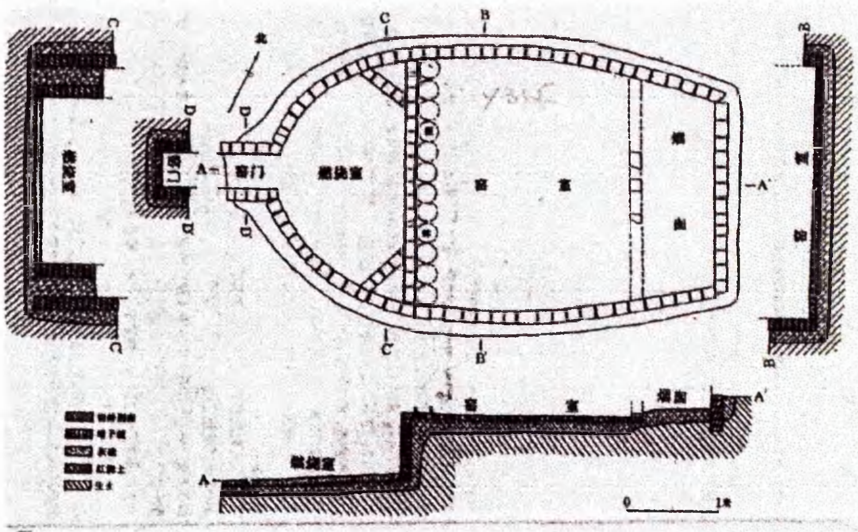


Fig. 110
Kiln Y31f

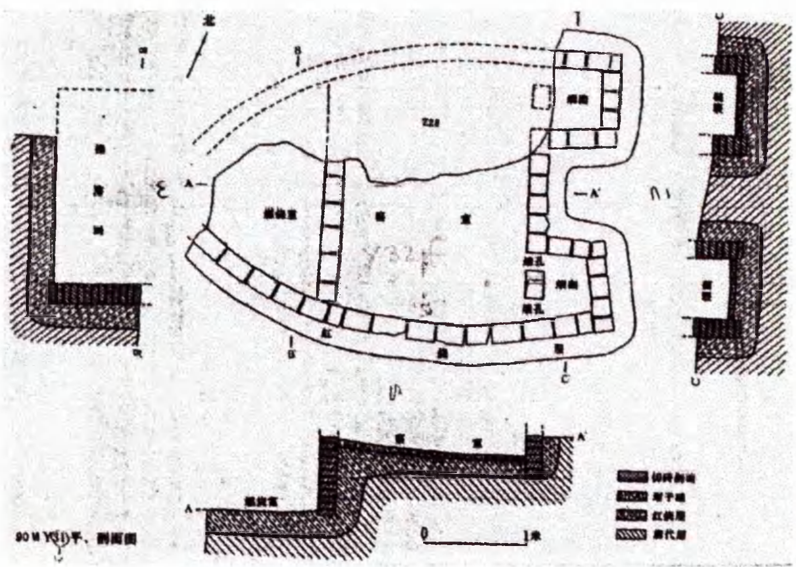


Fig. 111
Kiln Y32f

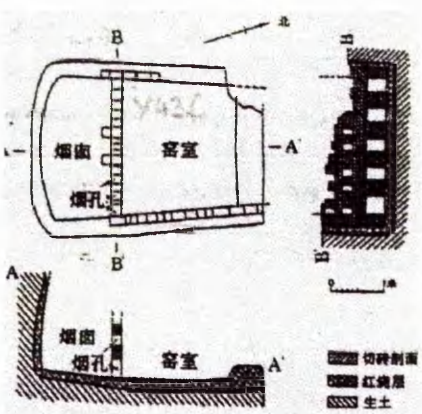


Fig. 112 Kiln Y43f

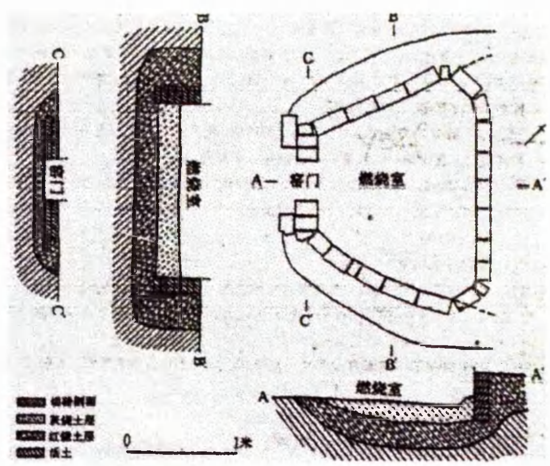


Fig. 113 Kiln Y58f

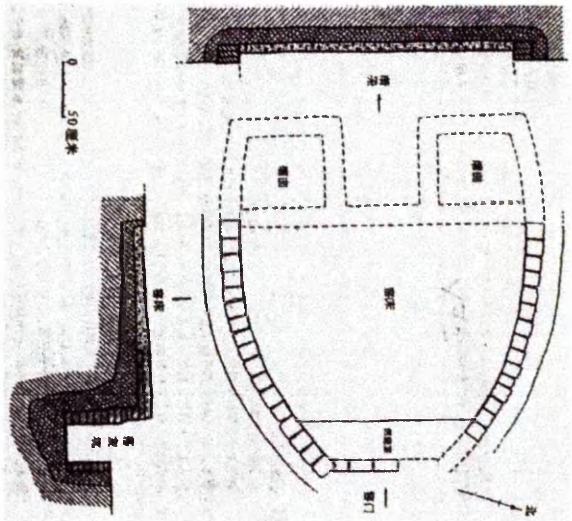


Fig. 114 Kiln Y7s

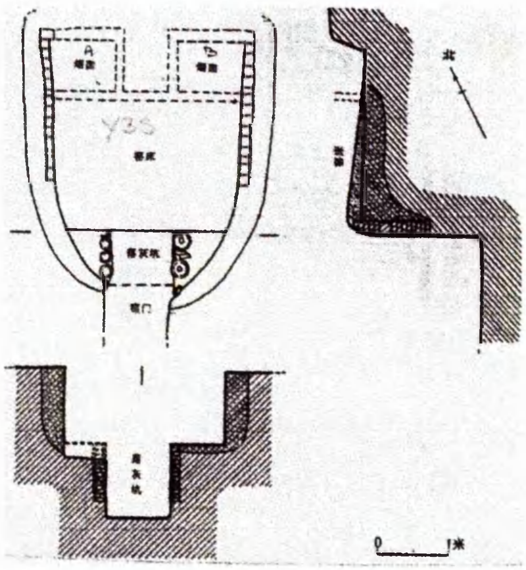


Fig. 115 Kiln Y3s

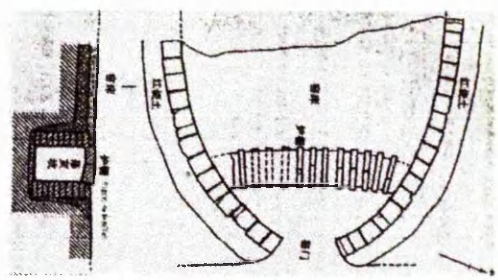


Fig. 116 Kiln Y62s

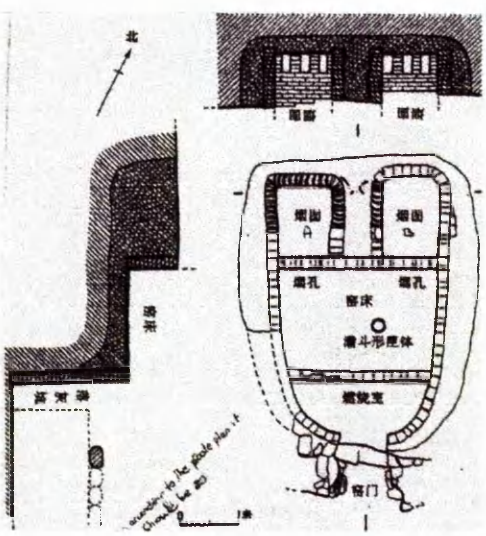


Fig. 117 Kiln Y1s

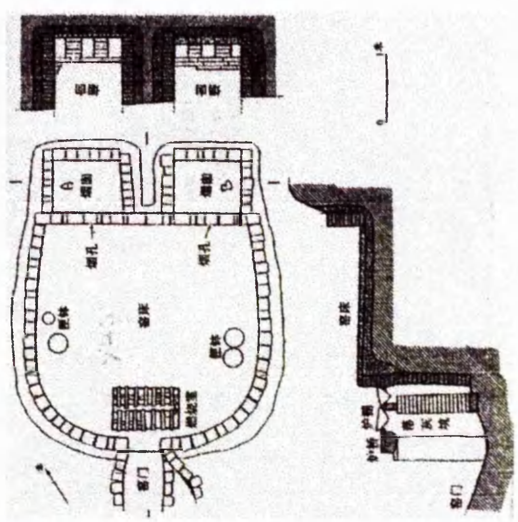


Fig. 118 Kiln Y4s

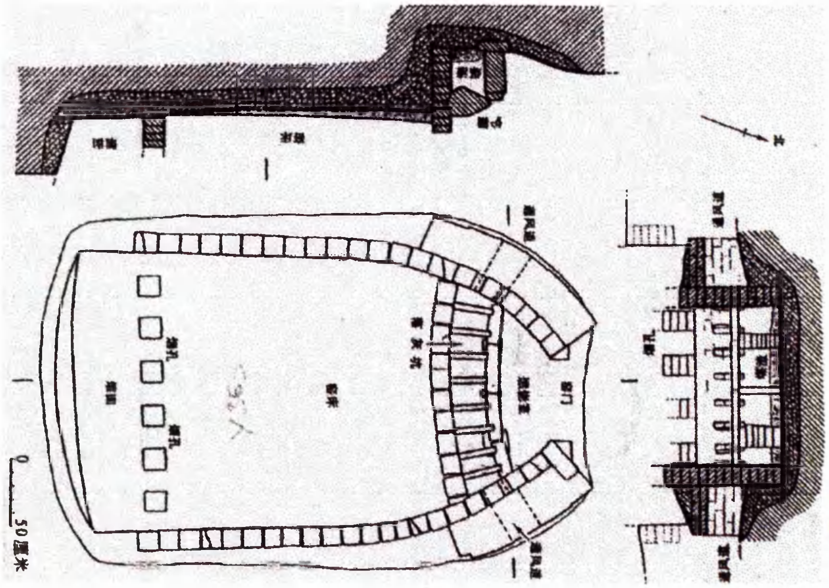


Fig. 119
Kiln Y36s

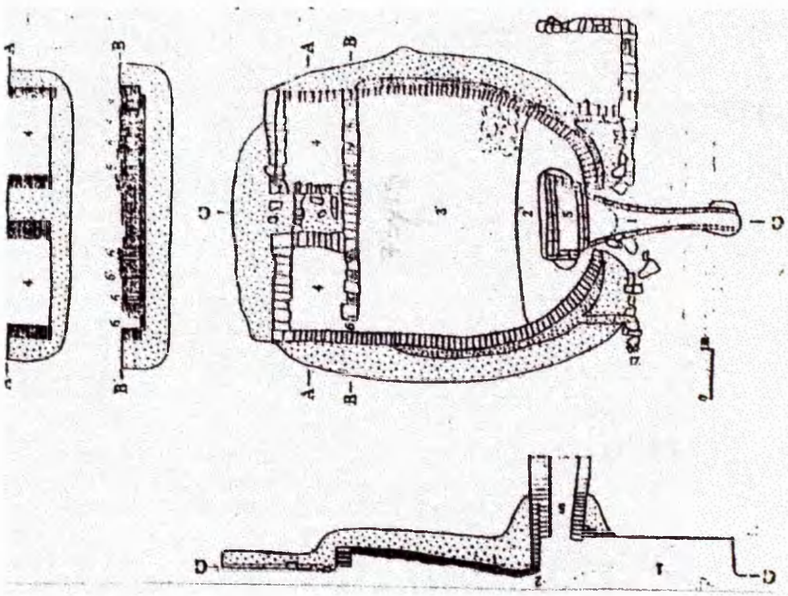


Fig. 120
Kiln 73Y2s

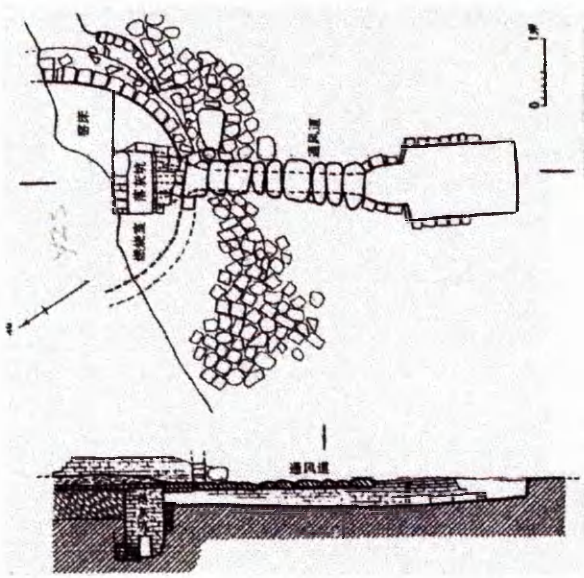


Fig. 121 Kiln Y2s

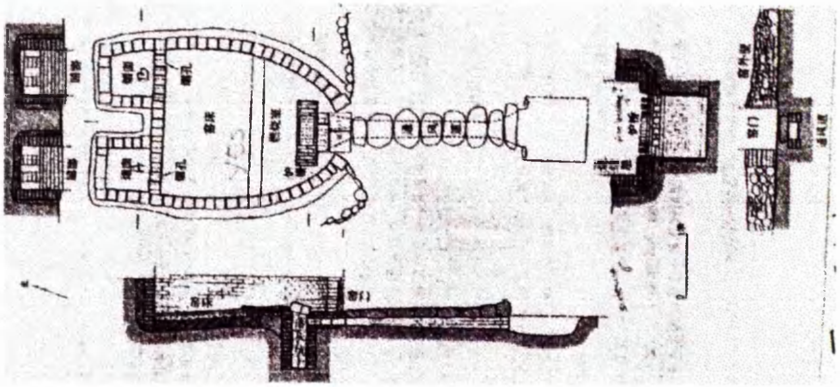


Fig. 122 Kiln Y5s

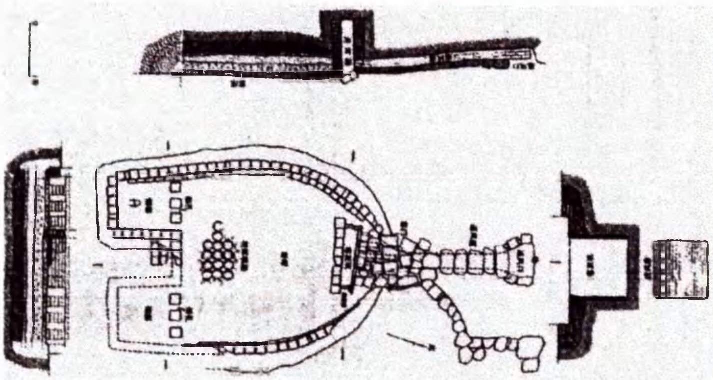


Fig. 123 Kiln Y19s

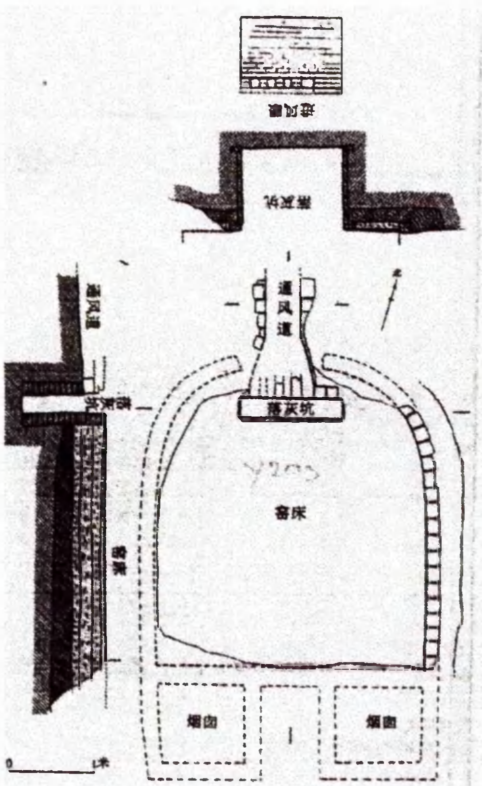


Fig. 124 Kiln Y20s

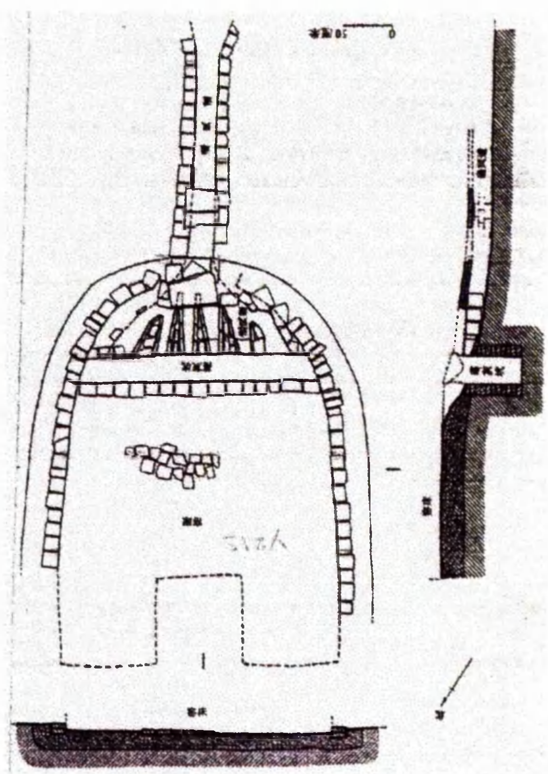


Fig. 125 Kiln Y21s

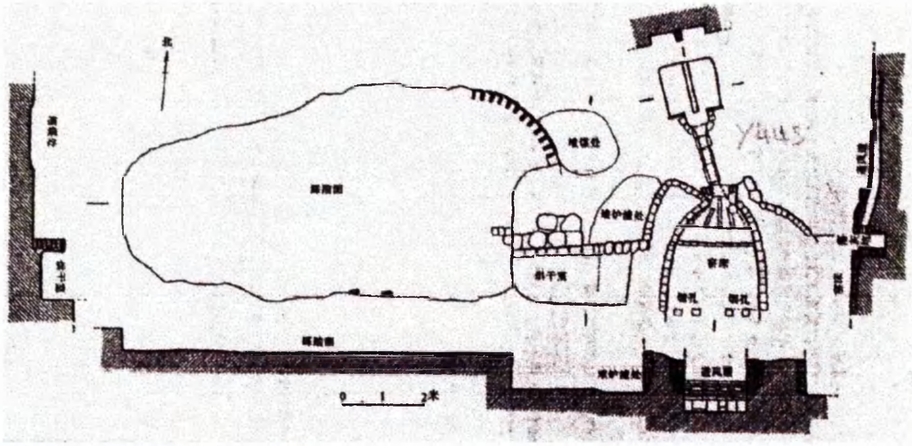


Fig. 126
Kiln
Y44s

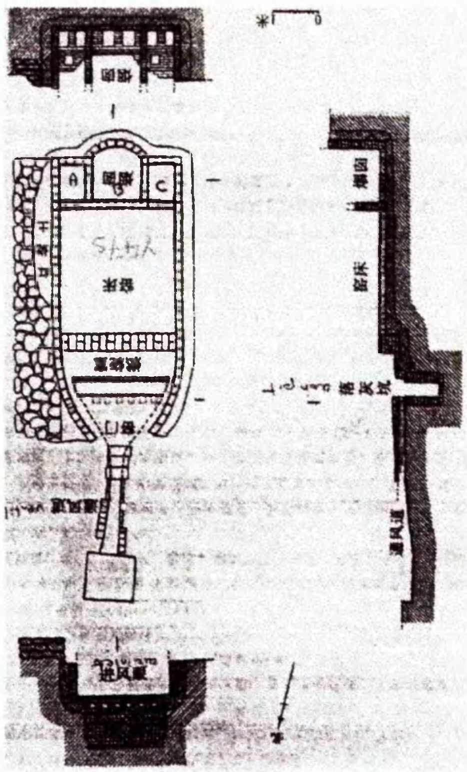


Fig. 127 Kiln Y47s

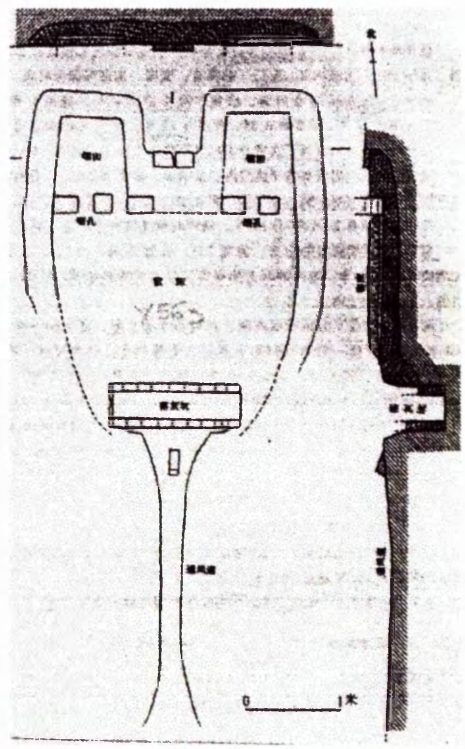


Fig. 128 Kiln Y56s

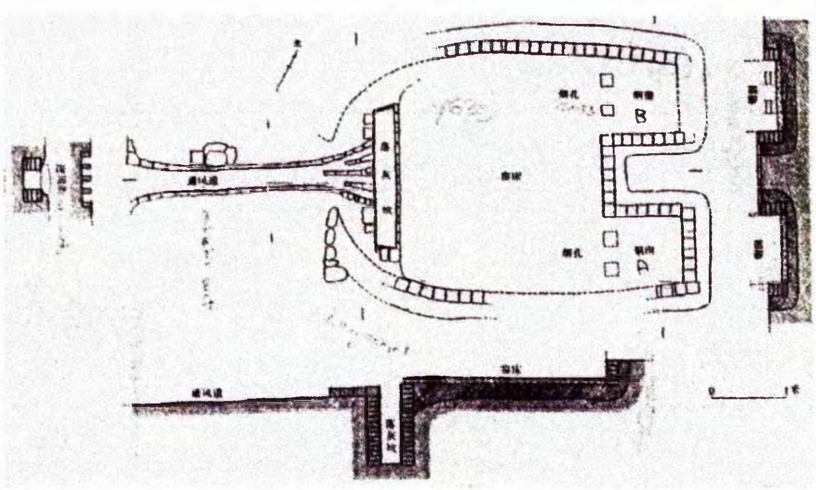


Fig. 129
Kiln Y63s

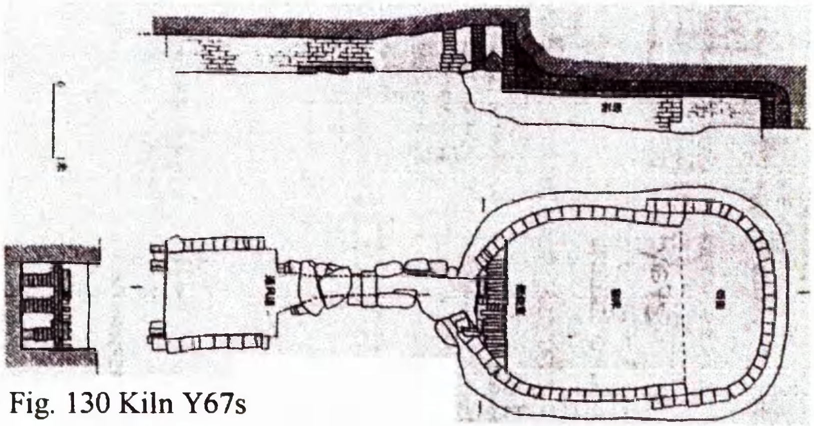


Fig. 130 Kiln Y67s

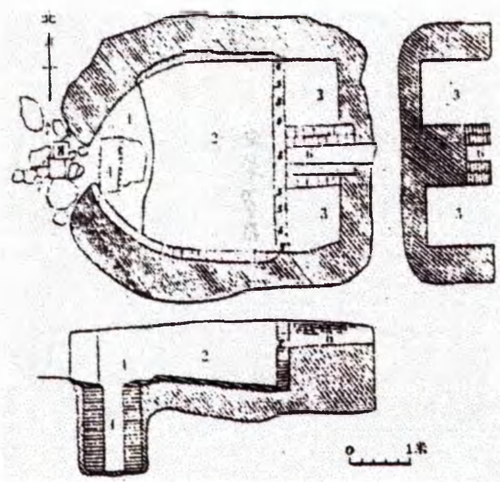


Fig. 131 Kiln 58-59Y2jy

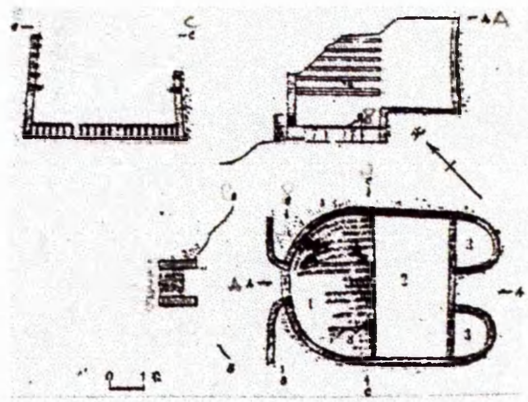


Fig. 132 Kiln Anren, Xunyi Y1jy

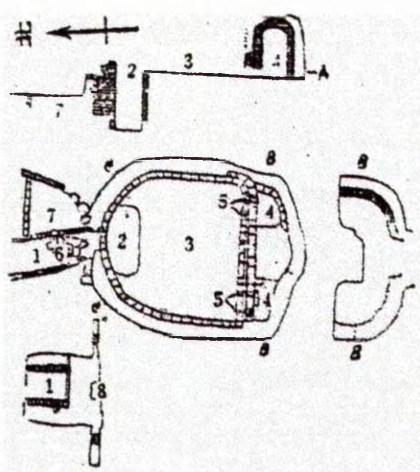


Fig. 133
Kiln Anren, Xunyi Y2jy

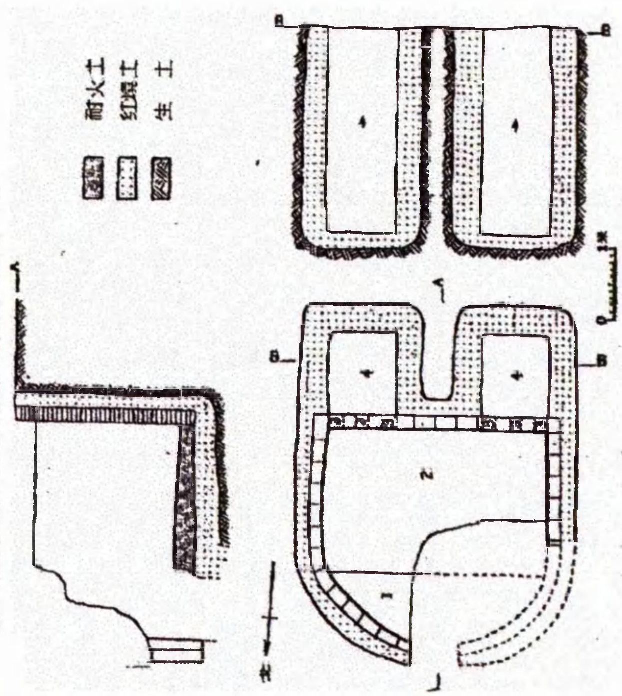


Fig. 134 Kiln Lidipo Y2y

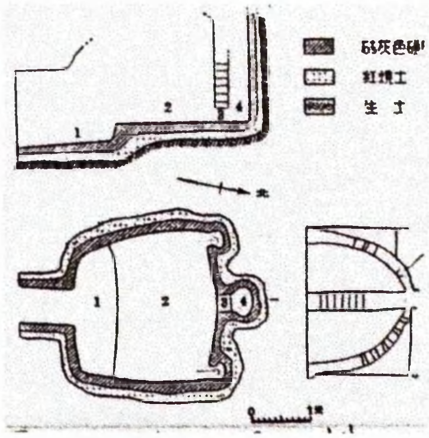


Fig. 135 Kiln 58-59Ys tile

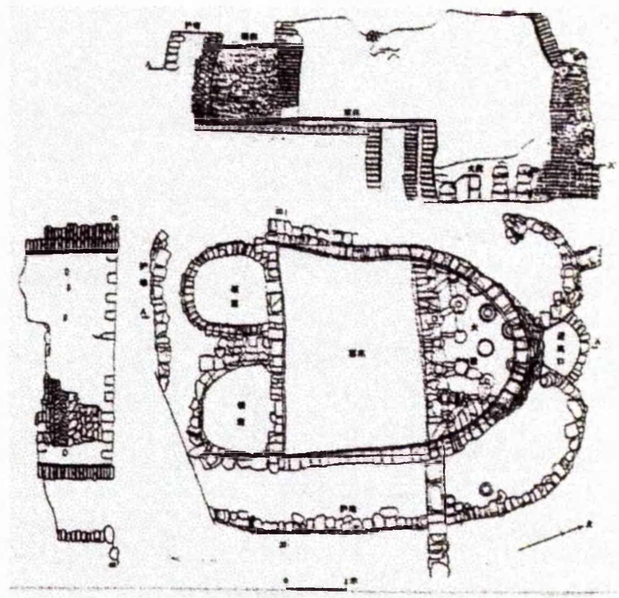


Fig. 136 Kiln Y3 at Guantai kiln site, Cixian

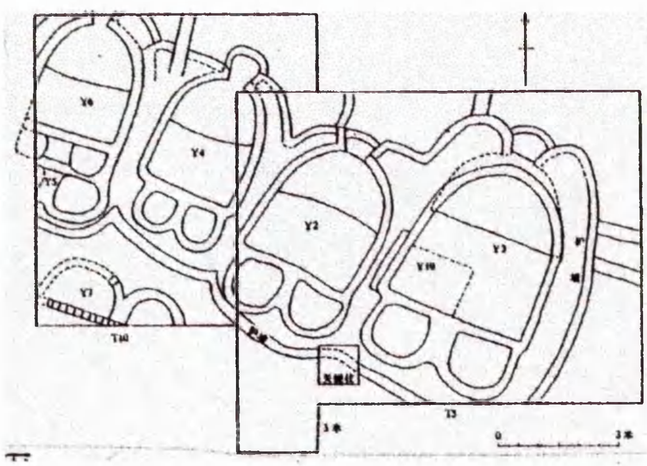


Fig. 137 Cluster of kilns surrounded by an outer perimeter wall at Guantai kiln site, Cixian

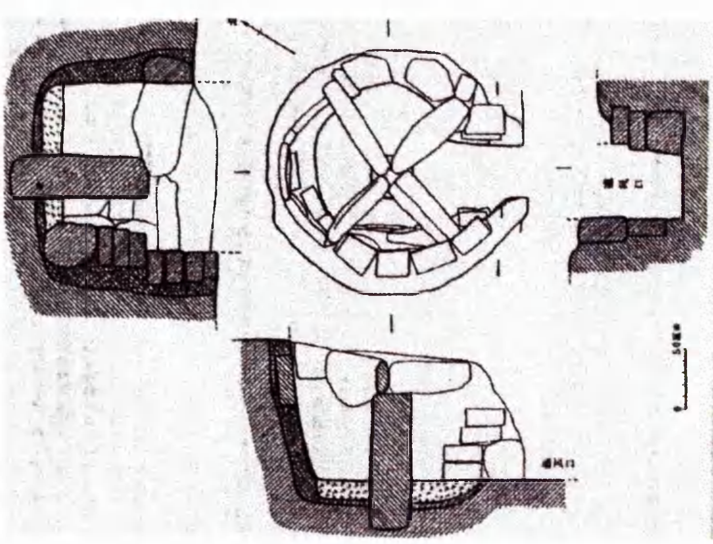


Fig. 138 Calcination kiln Y16s

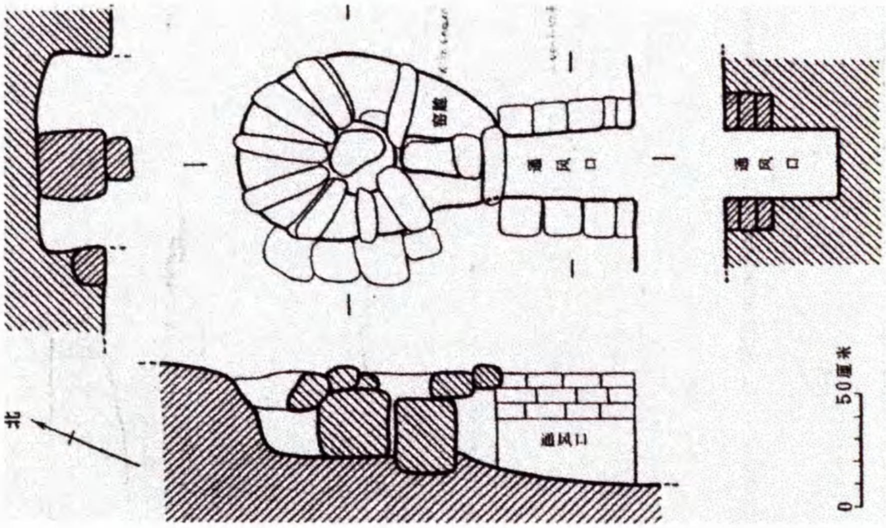


Fig. 139 Calcination kiln Y27s

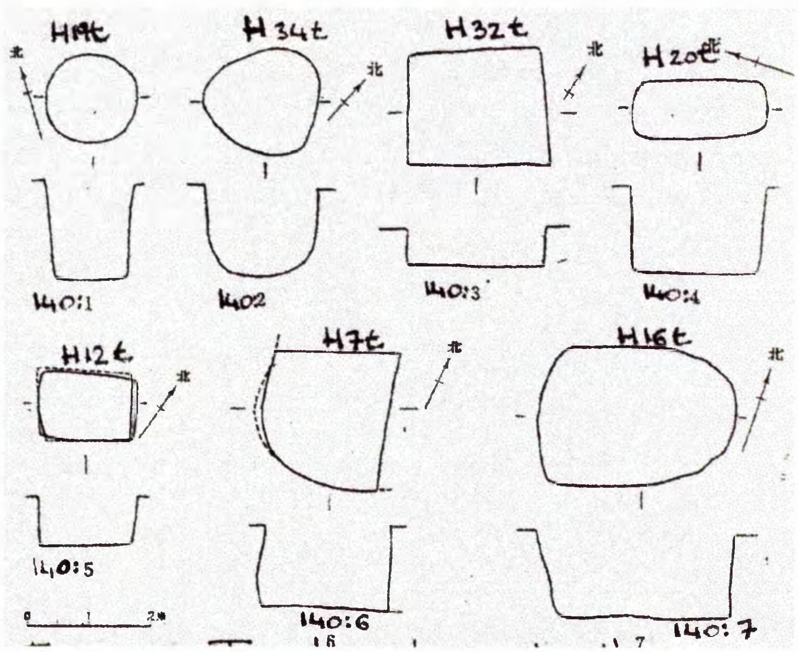


Fig. 140 Tang dynasty waste pits

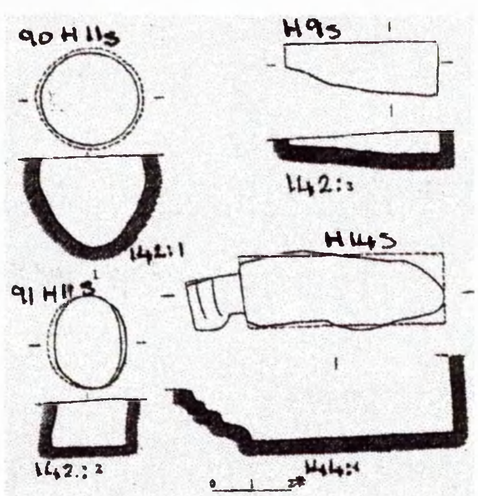


Fig. 142 Song dynasty waste pits

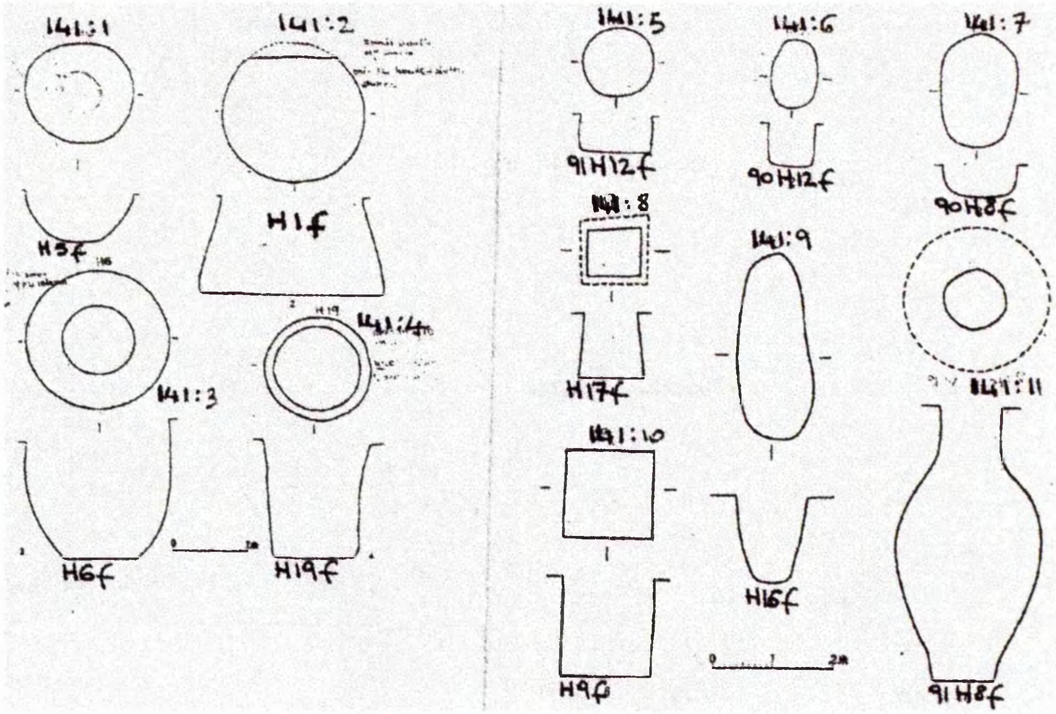


Fig. 141 Five Dynasties waste pits

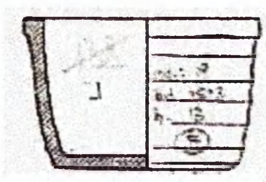


Fig. 143 Saggar

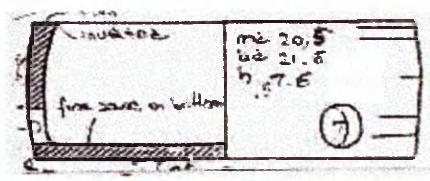


Fig. 144 Saggar

Fig. 145 Saggar

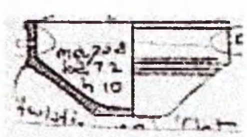


Fig. 146 Saggar

Fig. 147 Prop for balancing saggars

Fig. 148 Saggar

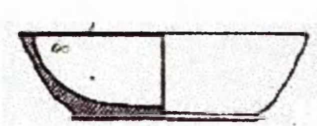


Fig. 149 Saggar

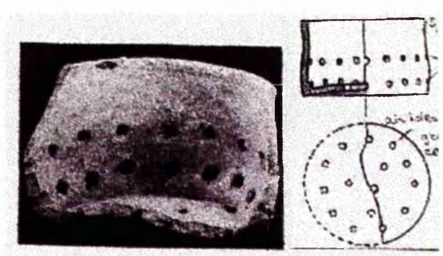


Fig. 150 Saggar

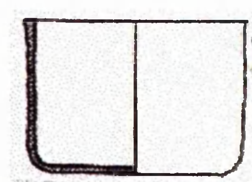
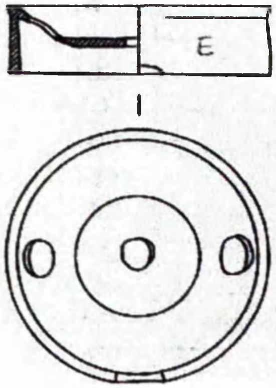
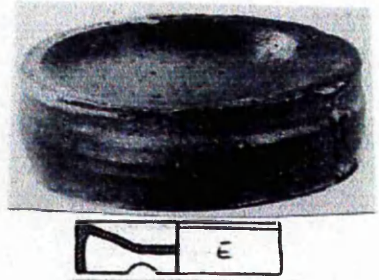


Fig. 151 Saggar





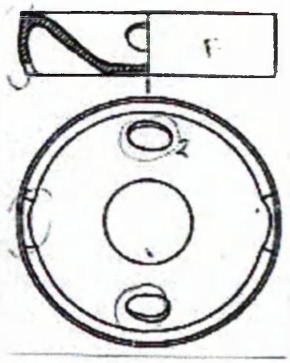


Fig. 152 Saggar

Fig. 153 Saggar

Fig. 154 Saggar

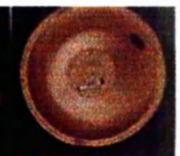
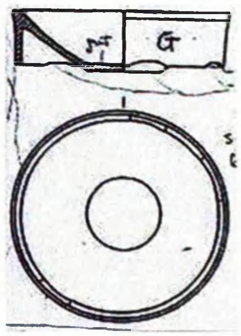


Fig. 157 Saggar

Fig. 155 Saggar



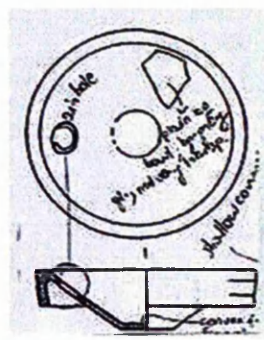
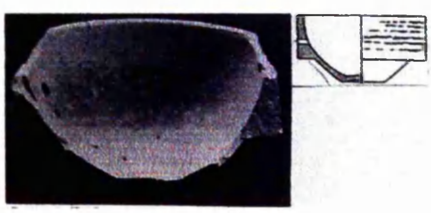
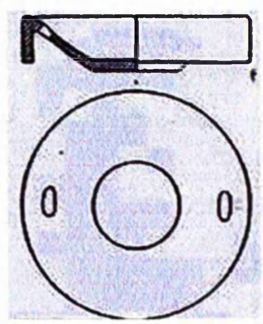


Fig. 156 Saggar

Fig. 158 Saggar

Fig. 159 Saggar





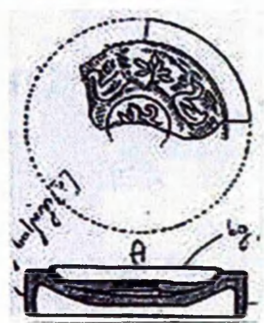


Fig. 160 Saggar

Fig. 161 Saggar

Fig. 162 Saggar

Fig. 163 Saggar

Fig. 164 Saggar

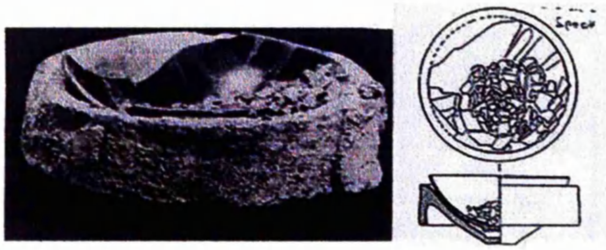


Fig. 165 Saggar

Fig. 166 Saggar

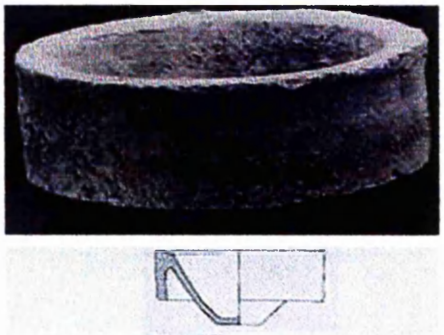
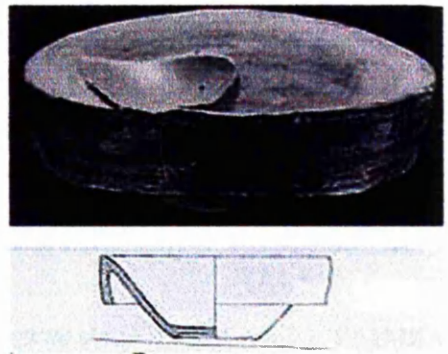


Fig. 167 Saggar



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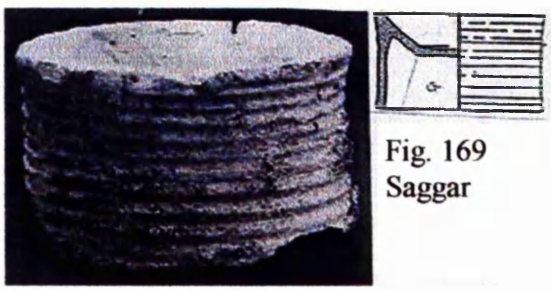

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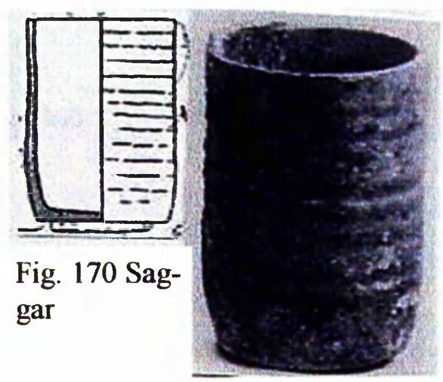

Fig. 170 Saggar

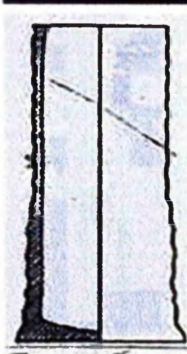

Fig. 171 Saggar

Fig. 172 Saggar

Fig. 173 Saggar

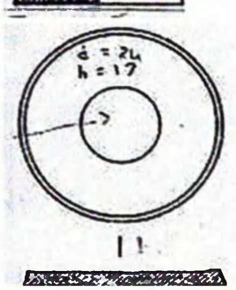

Fig. 174 Saggar lid in the shape of a flat disc

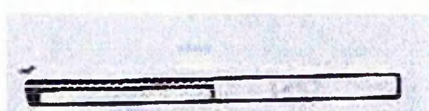

Fig. 175 Saggar lid in the shape of a flat disc

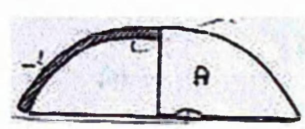

Fig. 176 Saggar lid in the shape of a round cap


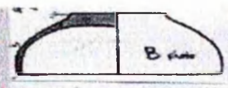

Fig. 177
Saggar lid in the shape of an up-side down bowl


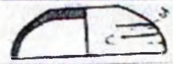

Fig. 178
Saggar lid n the shape of an up-side down bowl

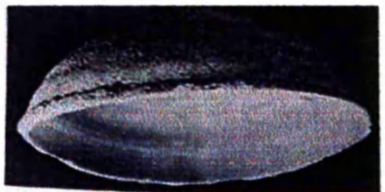
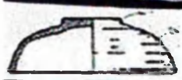

Fig. 179 Saggar lid in the shape of an upside down bowl

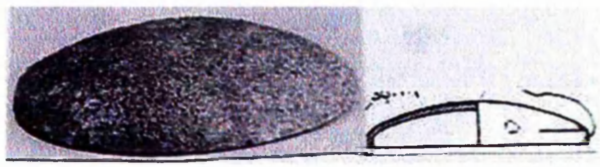

Fig. 181 Saggar lid in the shape of a box lid

Fig. 180 Saggar lid in the shape of a box lid

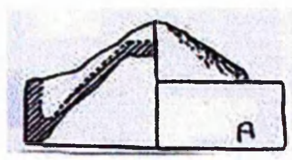

Fig. 182 Saggar recycled as saggar lid

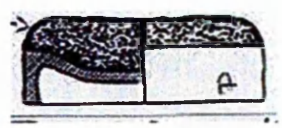

Fig. 183 Saggar recycled as saggar lid

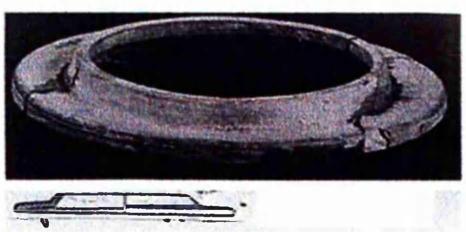

Fig. 184 Saggar lid fastner

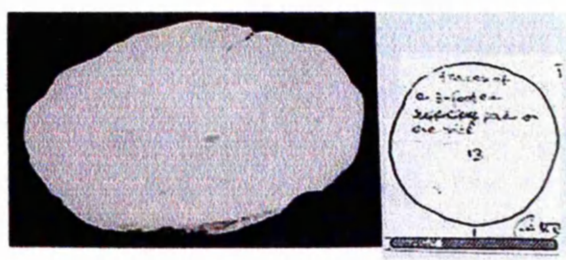

Fig. 185 Flat cake-shaped spacer

Fig. 186 Flat cake-shaped spacer

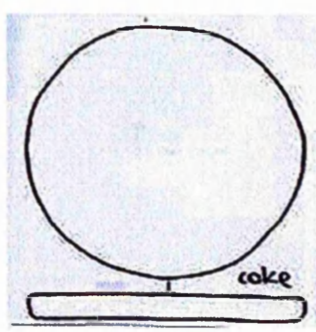

Fig. 187 Flat cake-shaped spacer

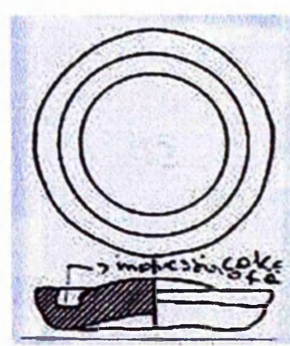

Fig. 188 Flat cake-shaped spacer

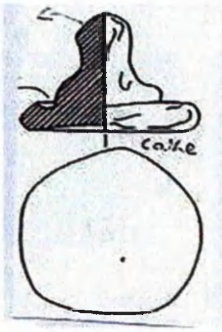

Fig. 189 Flat cake-shaped spacer

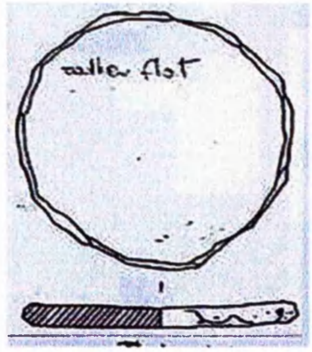

Fig. 190 Flat cake-shaped spacer

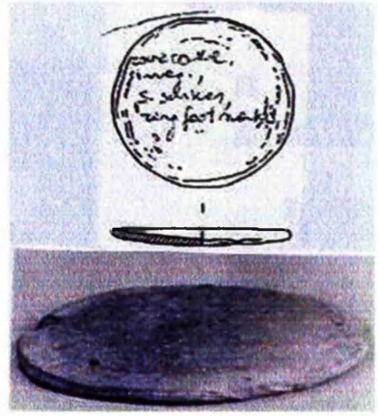

Fig. 191 Flat cake-shaped spacer

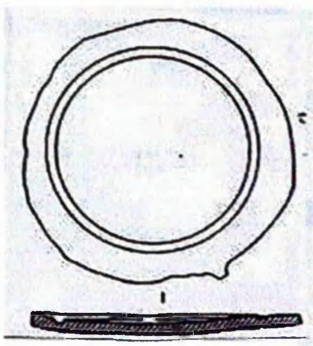

Fig. 192 Flat cake-shaped spacer

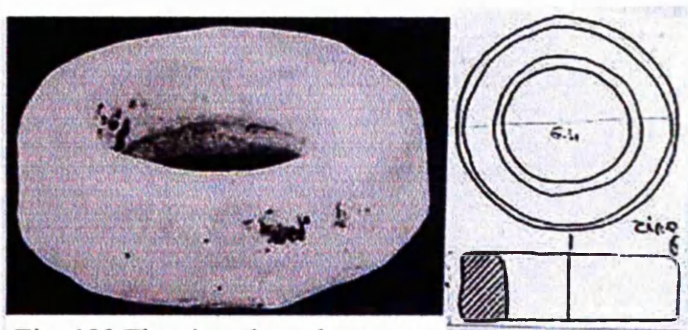

Fig. 193 Flat ring-shaped spacer

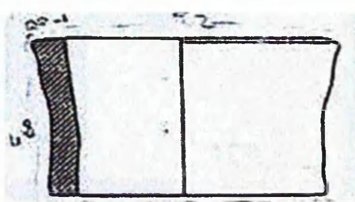

Fig. 194 Flat ring-shaped spacer

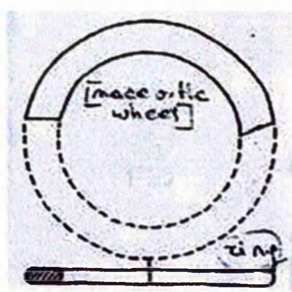

Fig. 195 Flat ring-shaped spacer

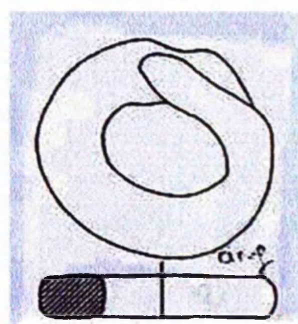

Fig. 196 Flat ring-shaped spacer

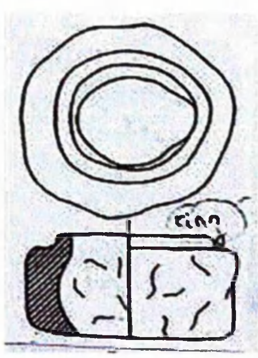

Fig. 197 Flat ring-shaped spacer

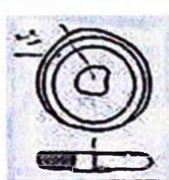

Fig. 198 Flat ring-shaped spacer

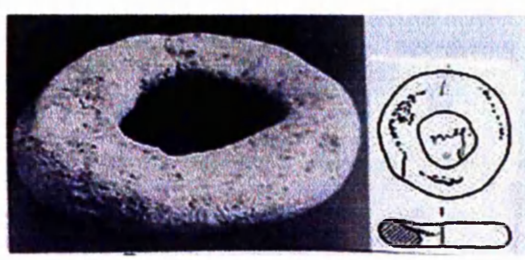

Fig. 199 Flat ring-shaped spacer

Fig. 200 Flat ring-shaped spacer

Fig. 201 Flat ring-shaped spacer

Fig. 202 Flat *bo* bowl-shaped spacer

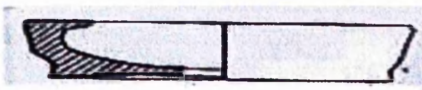

Fig. 203 Flat *bo* bowl-shaped spacer

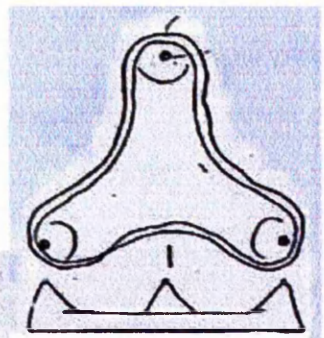

Fig. 204 Spurred spacer

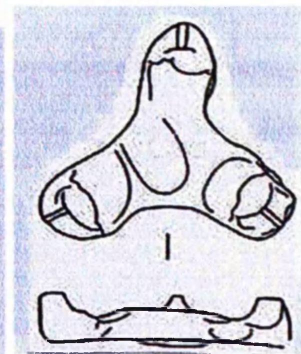

Fig. 205 Spurred spacer

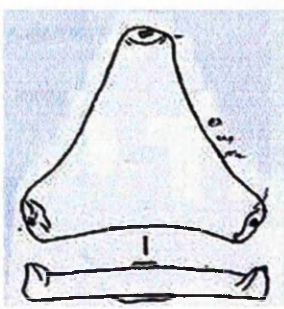

Fig. 206 Spurred spacer

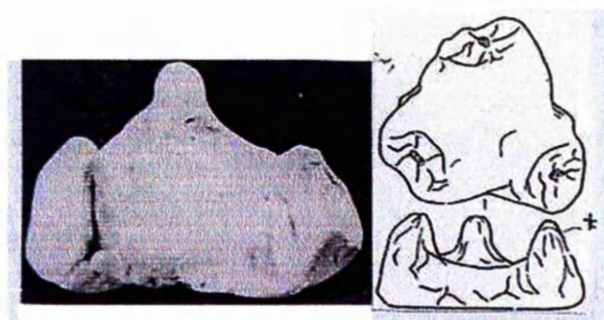

Fig. 207 Spurred spacer

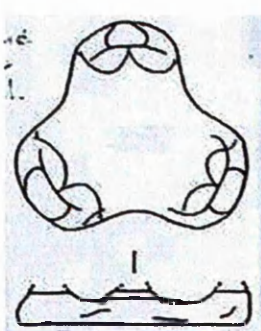

Fig. 208 Spurred spacer

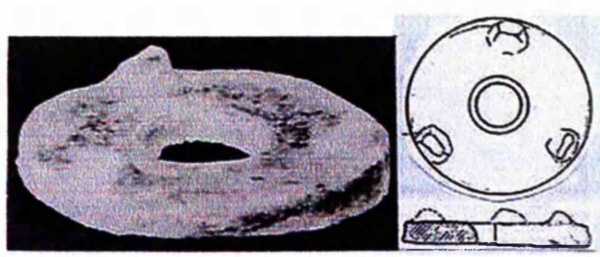

Fig. 209 Spurred spacer

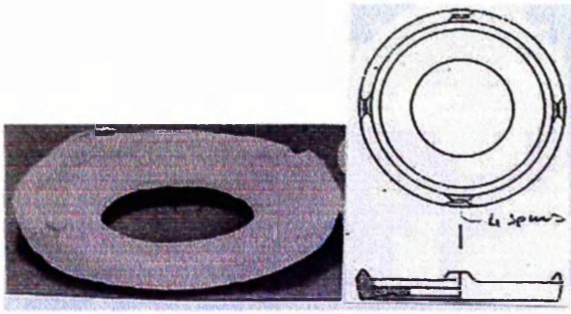

Fig. 210 Spurred spacer

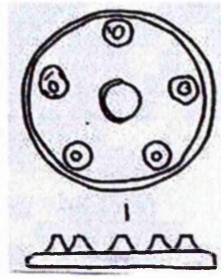

Fig. 211
Spurred spacer

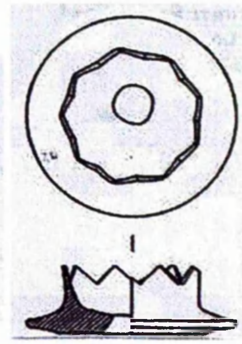

Fig. 212
Spurred spacer

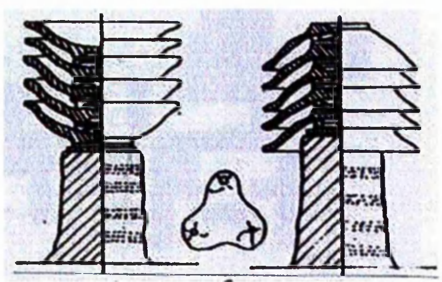

Fig. 213 Stack firing

Fig. 214 Gritty spur marks on the foot rim of a Yaozhou bowl

Fig. 215 Spur marks on the foot rim of a Yaozhou basin

Fig. 216 Spur marks on the base of a Yaozhou bowl

Fig. 217
Spur marks on a Yaozhou dish

Fig. 218 Spur marks on a Yue bowl

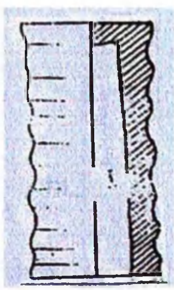

Fig. 219 Pillar-shaped prop

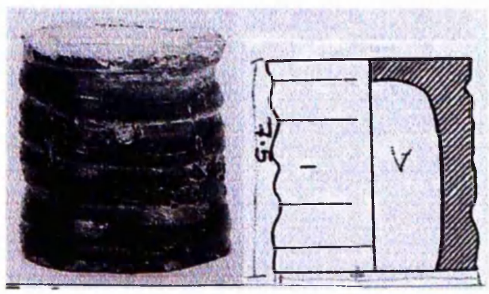

Fig. 220 Pillar-shaped prop

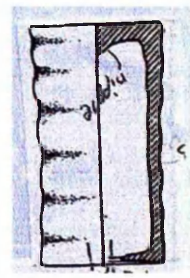

Fig. 221 Pillar-shaped prop

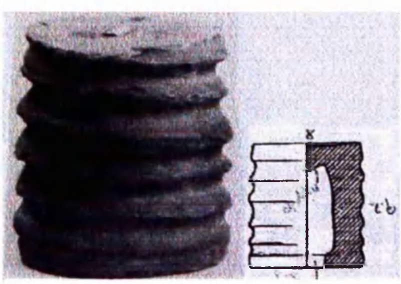

Fig. 222 Pillar-shaped prop

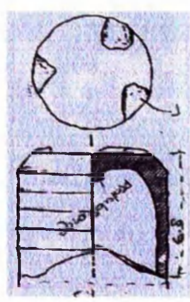

Fig. 223 Pillar-shaped prop

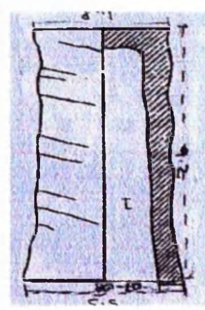

Fig. 224 Pillar-shaped prop

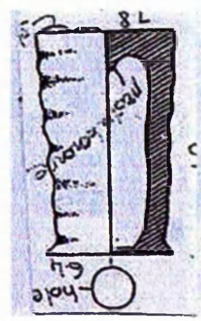

Fig. 225 Pillar-shaped prop

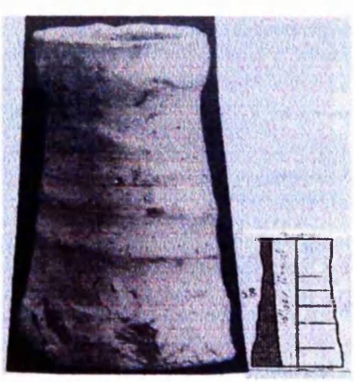

Fig. 226 Pillar-shaped prop

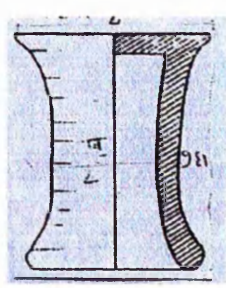

Fig. 227 Pillar-shaped prop

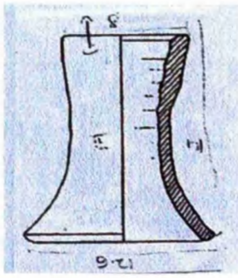

Fig. 228 Pillar-shaped prop

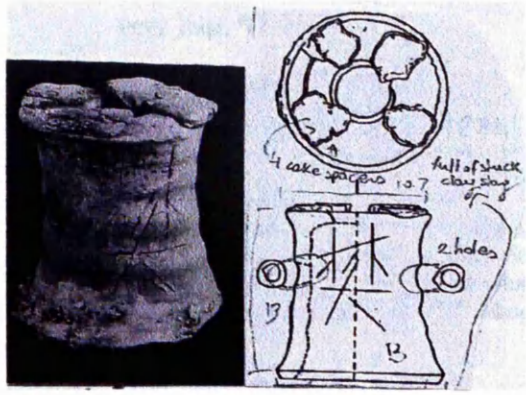

Fig. 229 Pillar-shaped prop

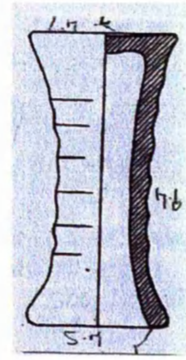

Fig. 230 Pillar-shaped prop

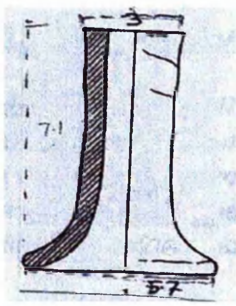

Fig. 231 Pillar-shaped prop

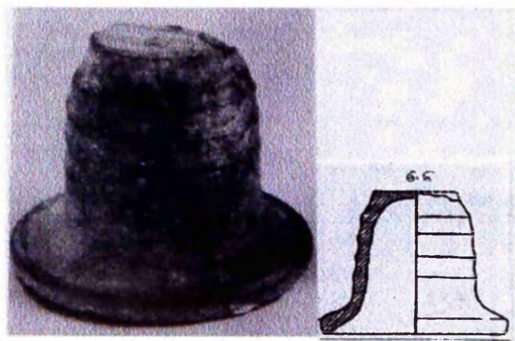

Fig. 232 Pillar-shaped prop

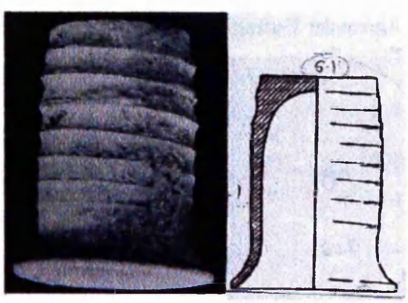

Fig. 233 Pillar-shaped prop

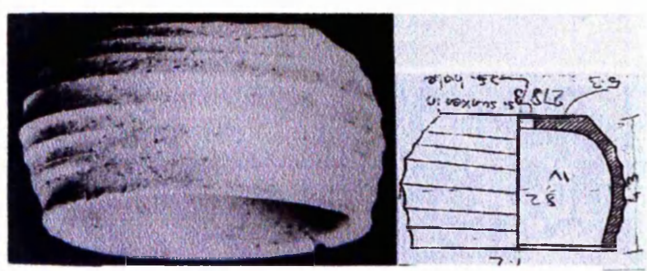

Fig. 234 Bowl-shaped prop

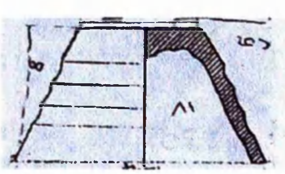

Fig. 235 Bowl-shaped prop

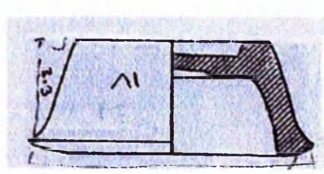

Fig. 236 Bowl-shaped prop

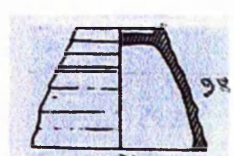

Fig. 237 Bowl-shaped prop

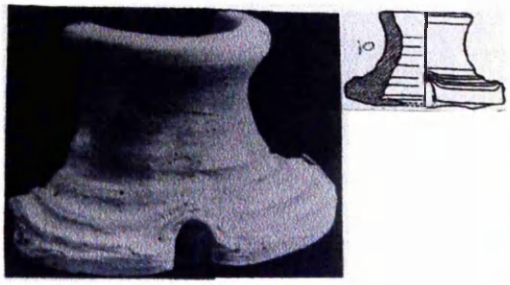

Fig. 238 Prop

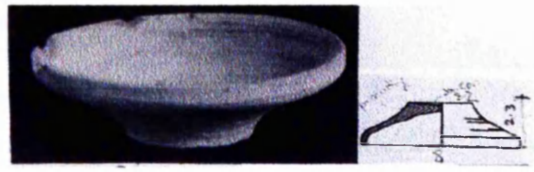

Fig. 239 Prop

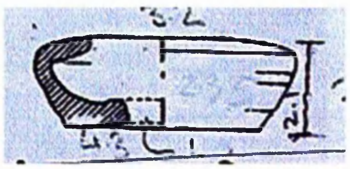

Fig. 240 Prop

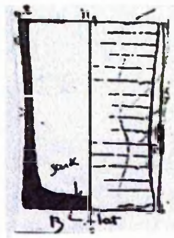

Fig. 241 Saggar

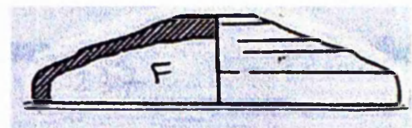

Fig. 242 Saggar lid

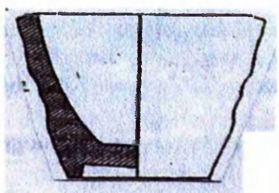

Fig. 243 Saggar

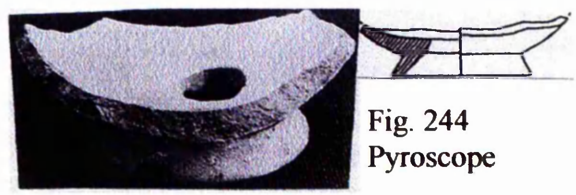

Fig. 244 Pyroscope

Fig. 245 Pyroscope

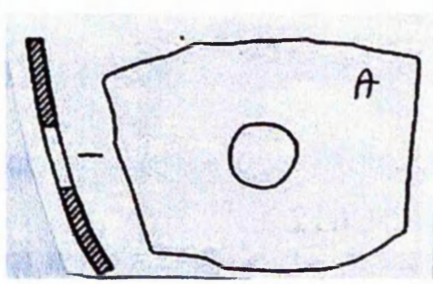

Fig. 246 Pyroscope

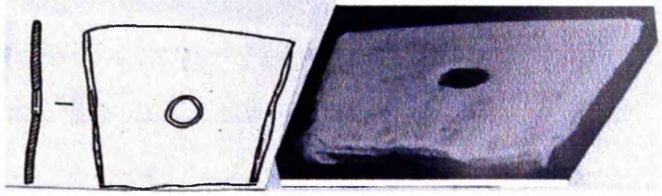

Fig. 247 Pyroscope


Fig. 248
Sample A


Fig. 249
Sample A: foot


Fig. 250
Sample A:
side and cross
section

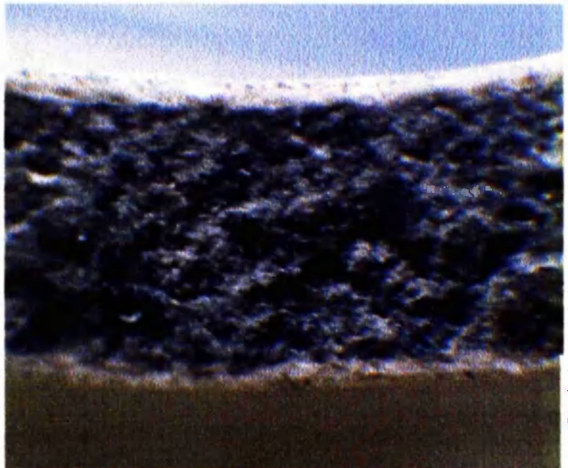
Fig. 251 Sample A: magnified cross section (10x)

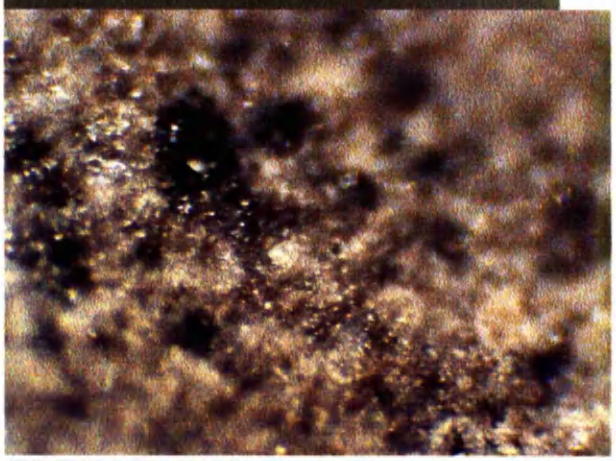
Fig. 252 Sample A: magnified body (40x)

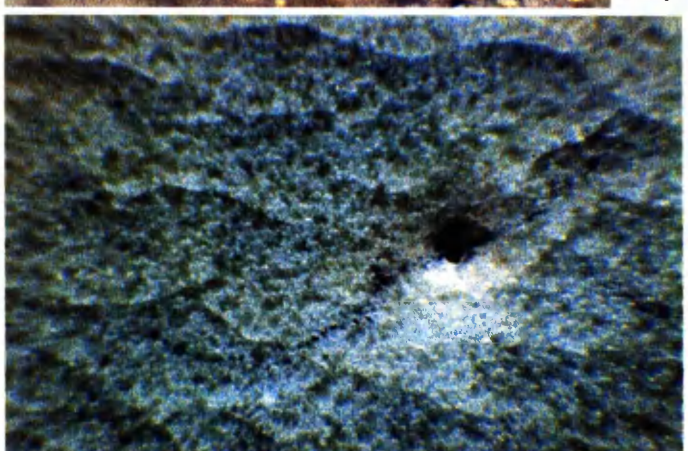
Fig. 253 Sample A: magnified glaze (10x)

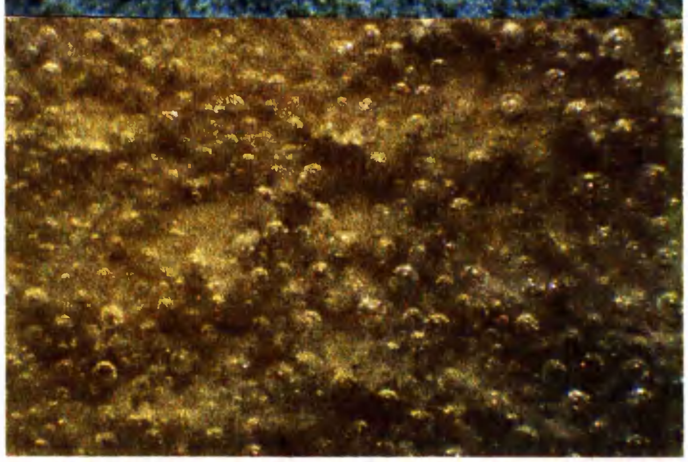
Fig. 254 Sample A: magnified glaze (40x)

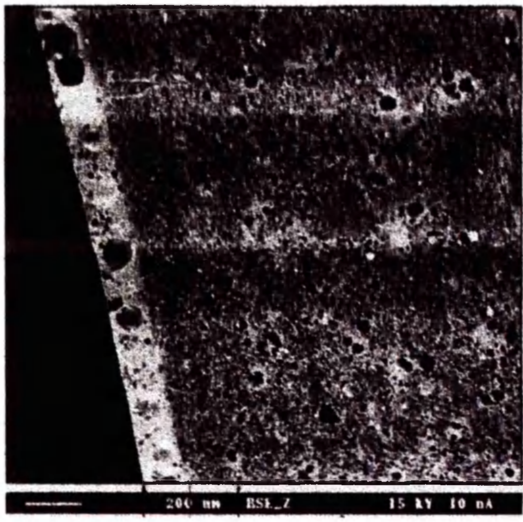

Fig. 255 Sample A: microphotograph showing body, slip and glaze

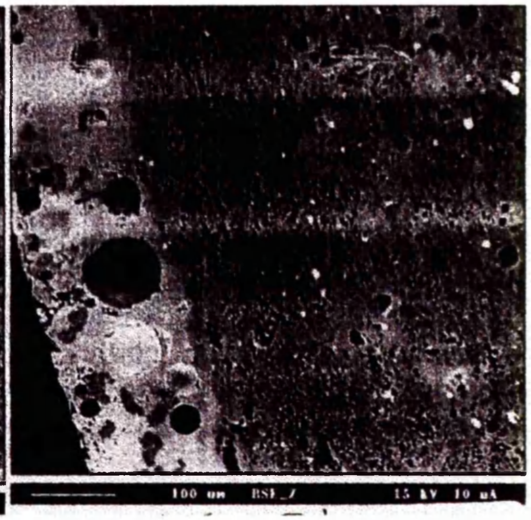

Fig. 256 Sample A: microphotograph showing body, slip and glaze

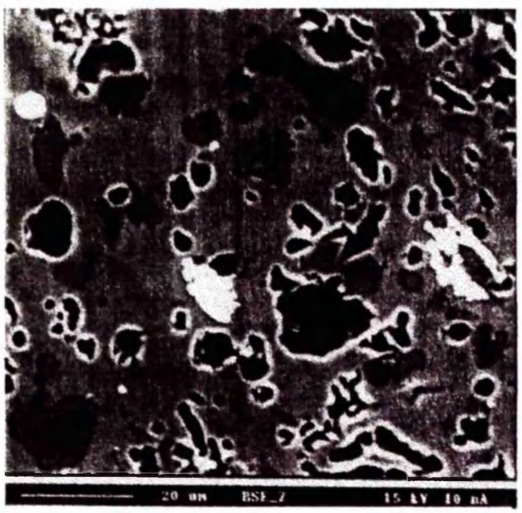

Fig. 257 Sample A: microphotograph of the body showing rutile (very bright white grains) undergoing selective dis-solution, and zircon (hexagonal bright grsin on the top left site)

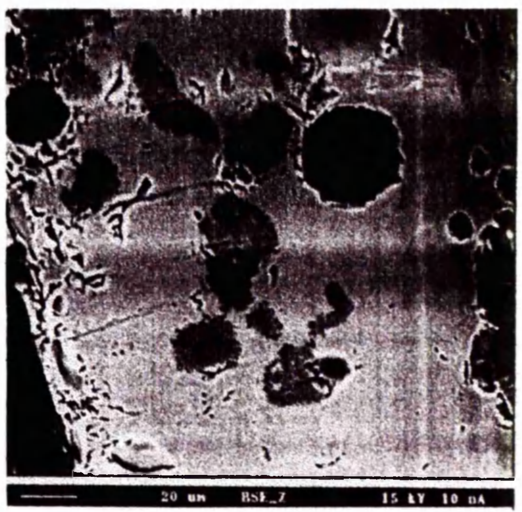

Fig. 258 Sample A: microphotograph showing the glaze

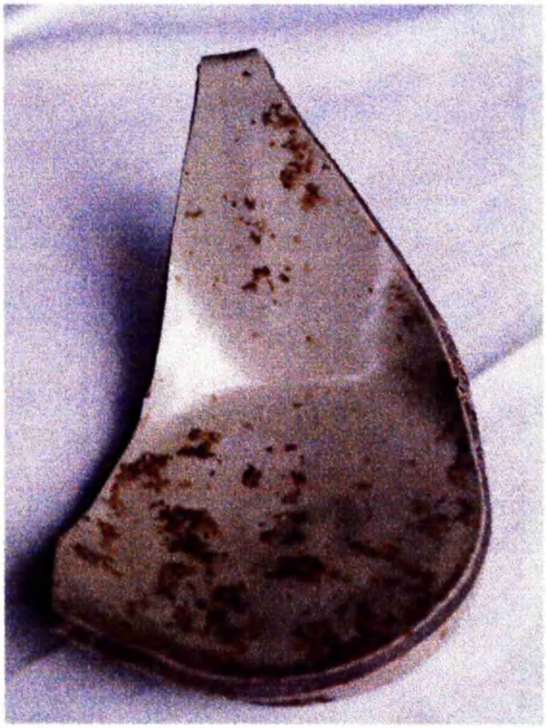

Fig. 259 Sample B

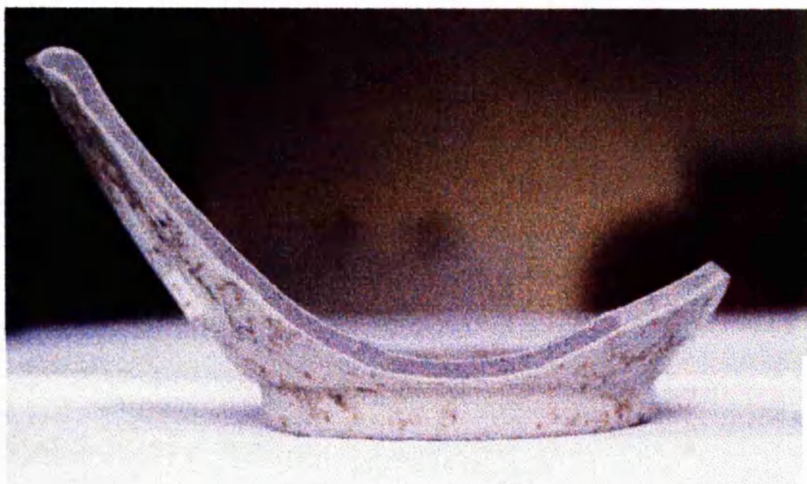

Fig. 260 Sample B: side and cross section

Fig. 261 Sample B: foot with gritty adhesions

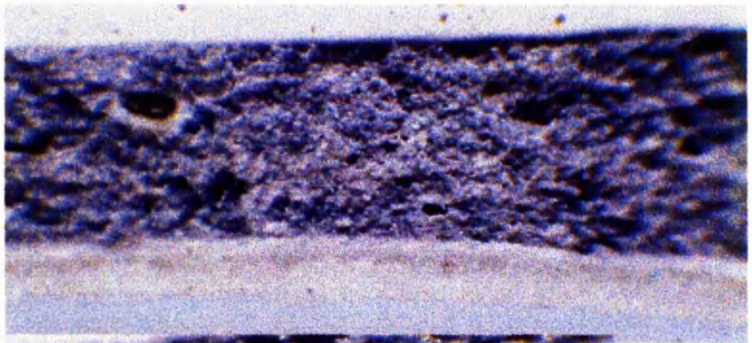

Fig. 262 Sample B: magnified cross section (10x)

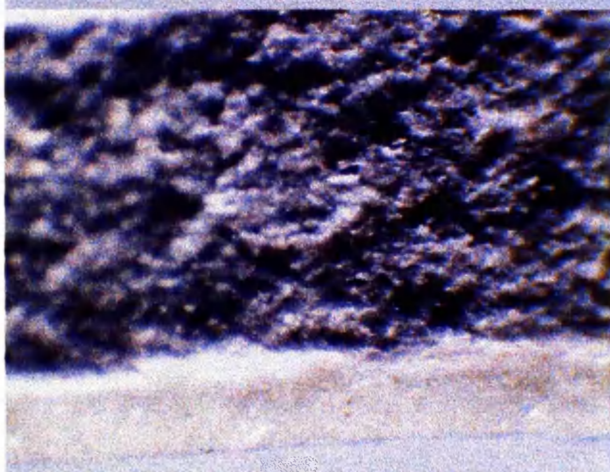

Fig. 263 Sample B: magnified body, slip and glaze (20x)

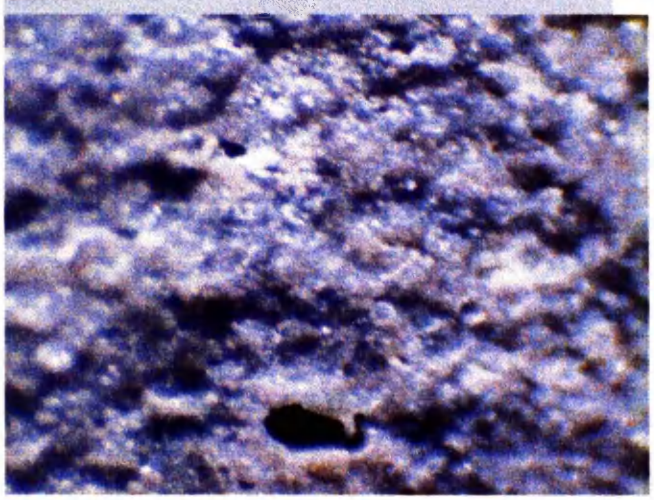

Fig. 264 Sample B: magnified body (40x)

Fig. 265 Sample B: magnified glaze (10x)

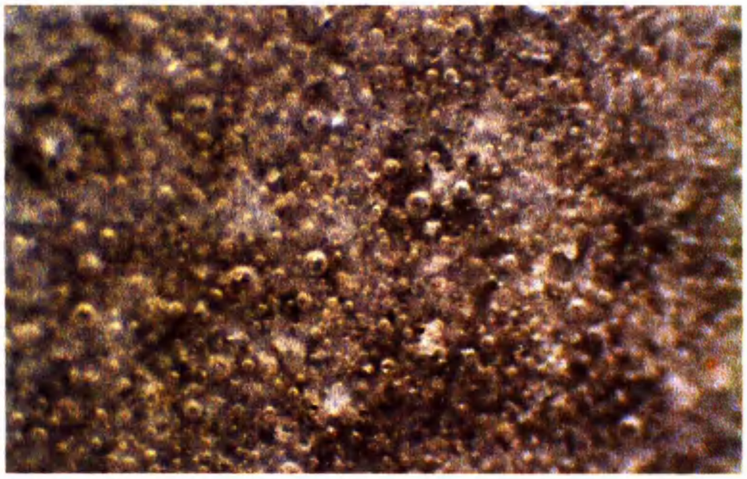

Fig. 266 Sample B: magnified glaze (40x)

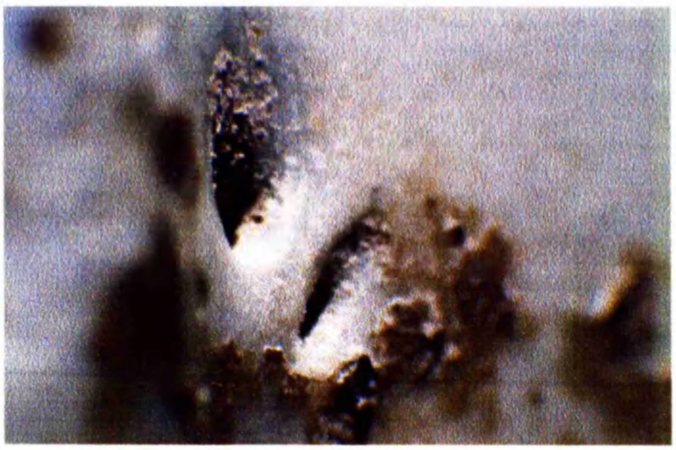

Fig. 267 Sample B: magnified pinhole (10x)

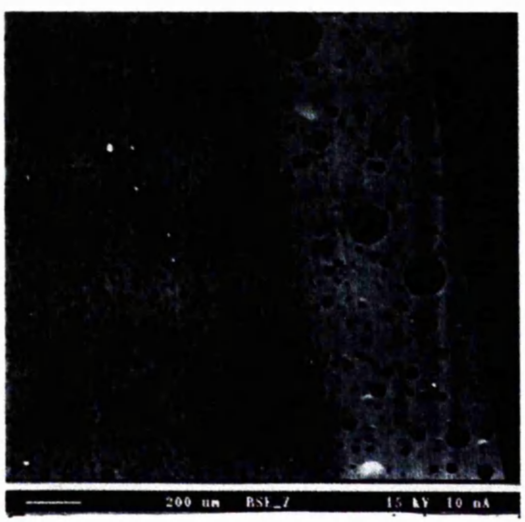

Fig. 268 Sample B: microphotograph showing body, slip and glaze

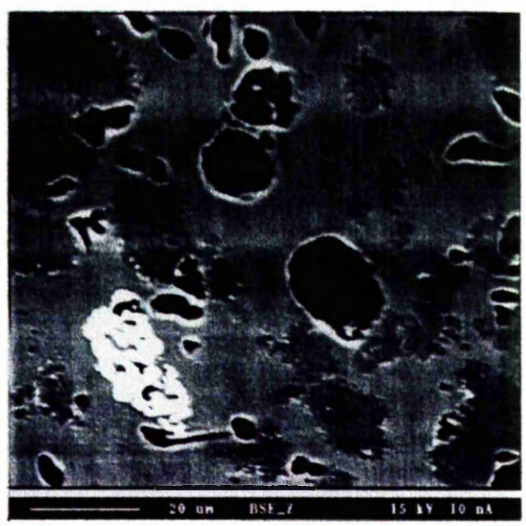

Fig. 269 Sample B: microphotograph showing the body

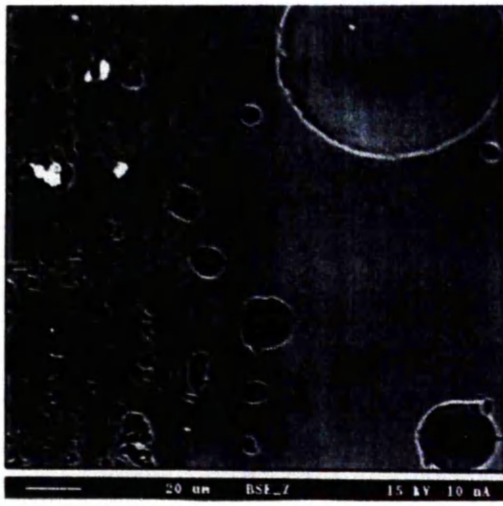

Fig. 270 Sample B: microphotograph showing the slip-glaze boundary

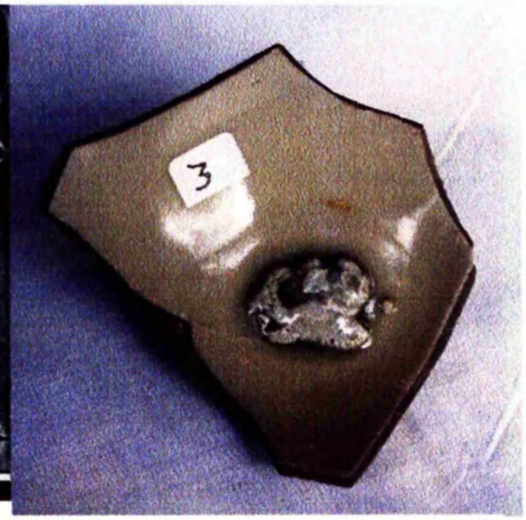

Fig. 271 Sample C

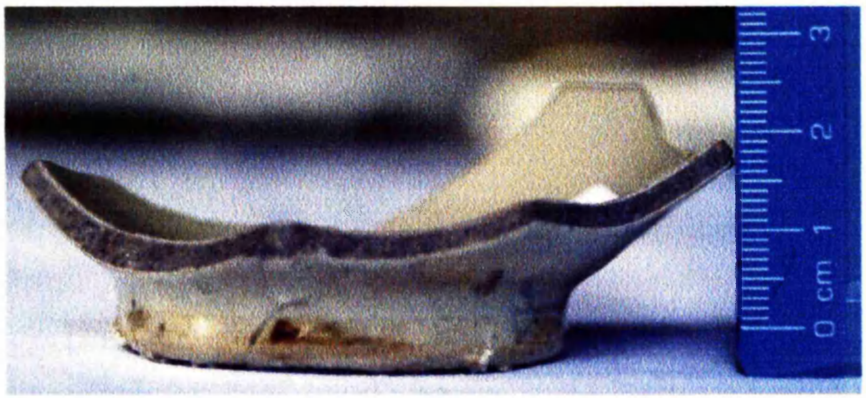

Fig. 272 Sample C: side and cross section

Fig. 273 Sample C: foot with gritty adhesions

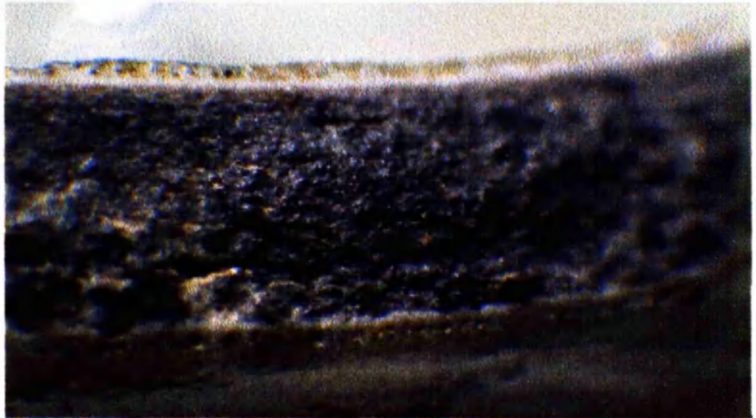
Fig. 274 Sample C: magnified cross section (10x)

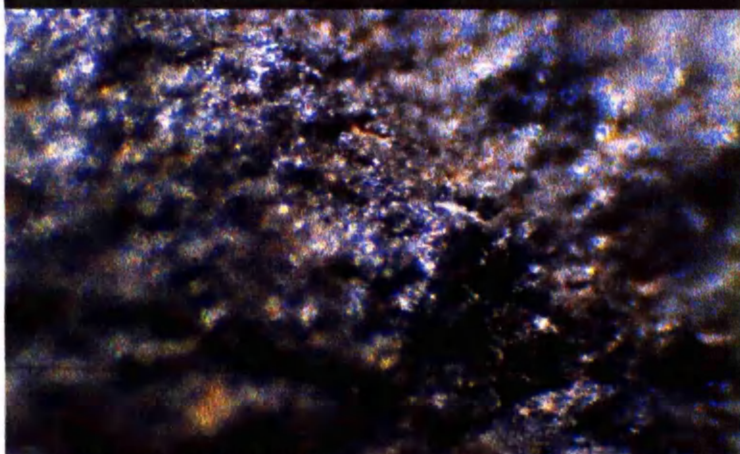
Fig. 275 Sample C: magnified body (40x)


Fig. 276 Sample C: magnified glaze on the bottom of the shard close to the appliqué motif (10x)

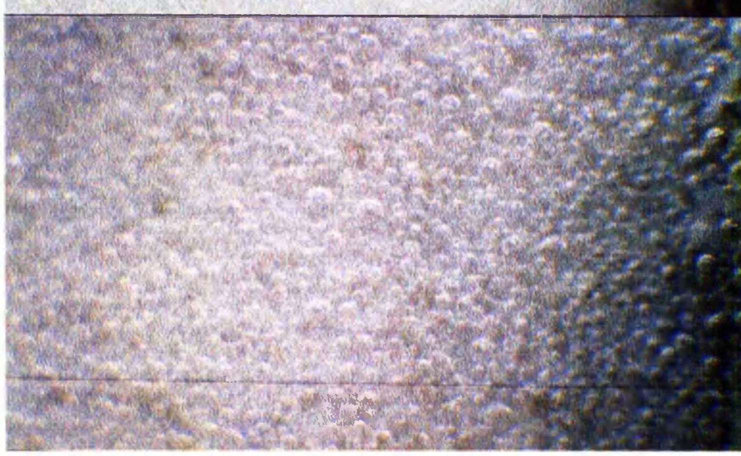
Fig. 277 Sample C: magnified glaze on the bottom of the shard close to the appliqué motif (20x)

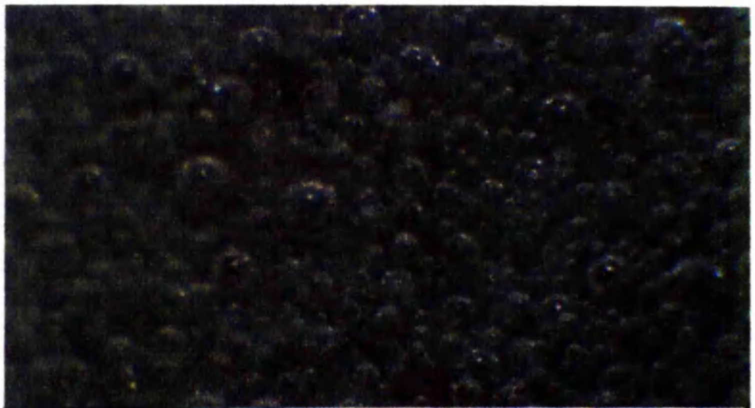

Fig. 278 Sample C: magnified glaze (40x)

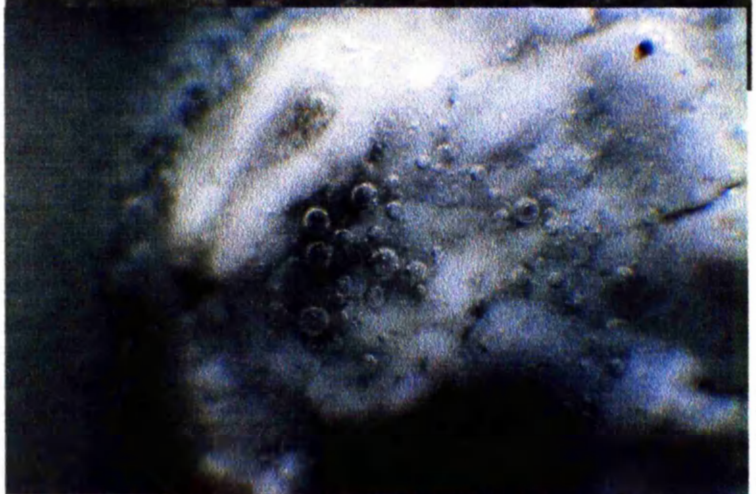

Fig. 279 Sample C: magnified glaze on the appliqué motif (10x)

Fig. 280 Sample C: magnified fingernail (10x)

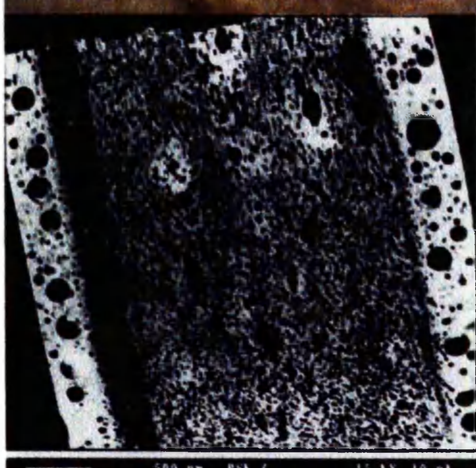

Fig. 281 Sample C: microphotograph showing the cross section

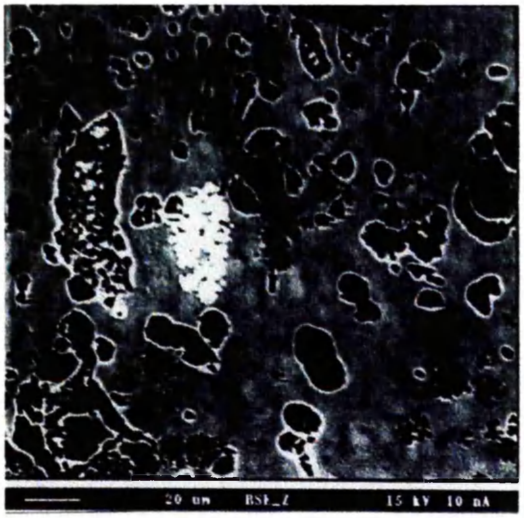

Fig. 282 Sample C: microphotograph showing the body

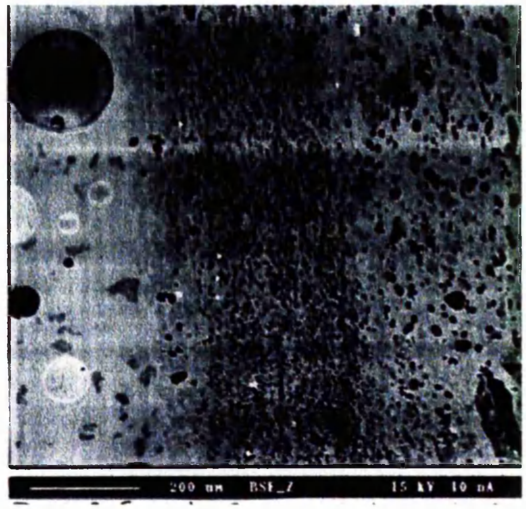

Fig. 283 Sample C: microphotograph showing glaze, slip and body

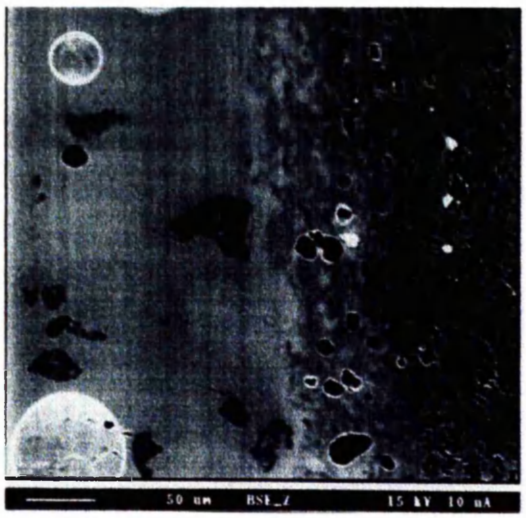

Fig. 284 Sample C: microphotograph showing glaze and slip

Fig. 285 Sample C: microphotograph showing the glaze-slip boundary

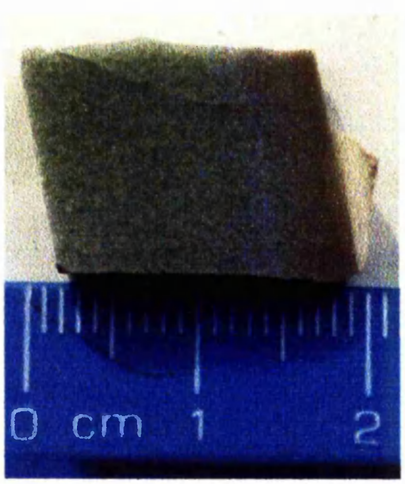

Fig. 286 Sample D

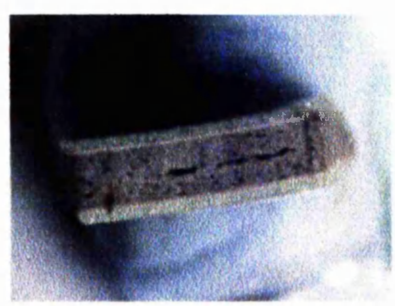

Fig. 287 Sample D: cross section

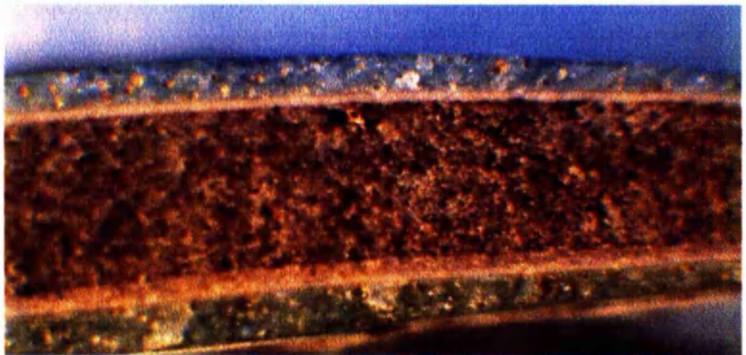

Fig. 288 Sample D: magnified cross section (10x)

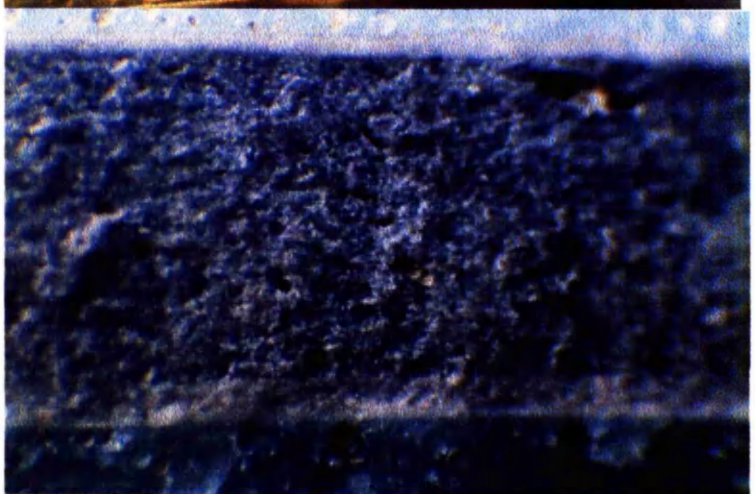

Fig. 289 Sample D: magnified cross section (20x)

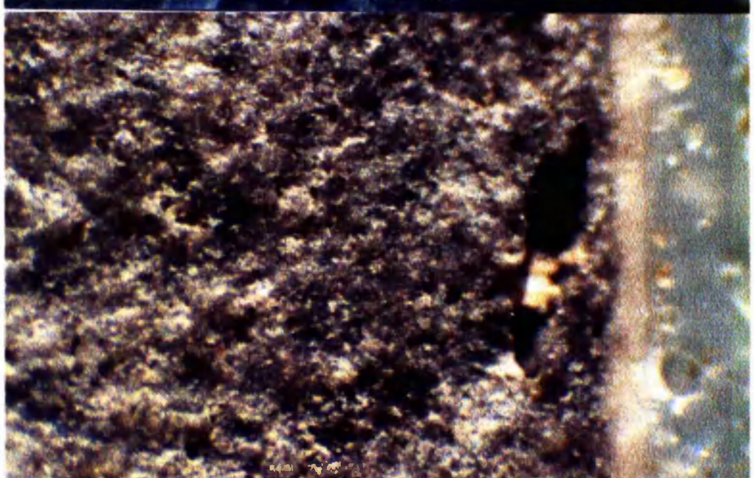

Fig. 290 Sample D: magnified body, slip and glaze (40x)

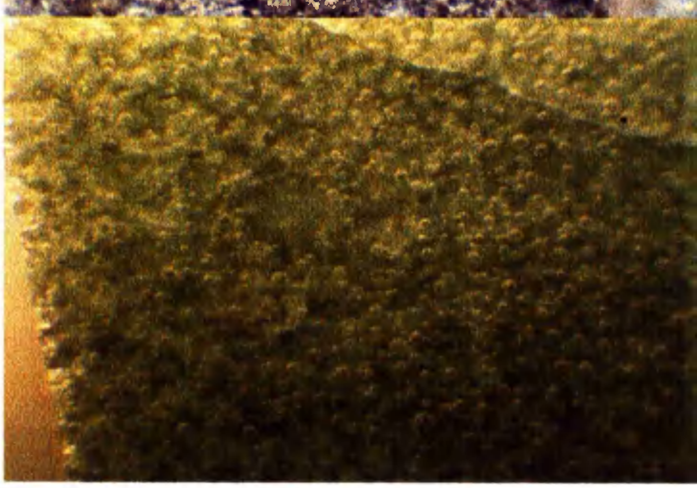

Fig. 291 Sample D: magnified glaze (10x)

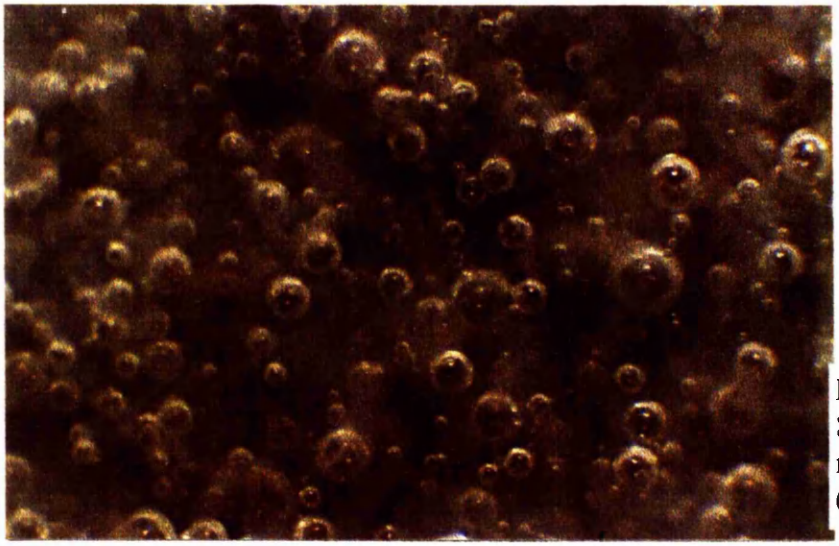

Fig. 292
Sample D:
magnified glaze
(40x)

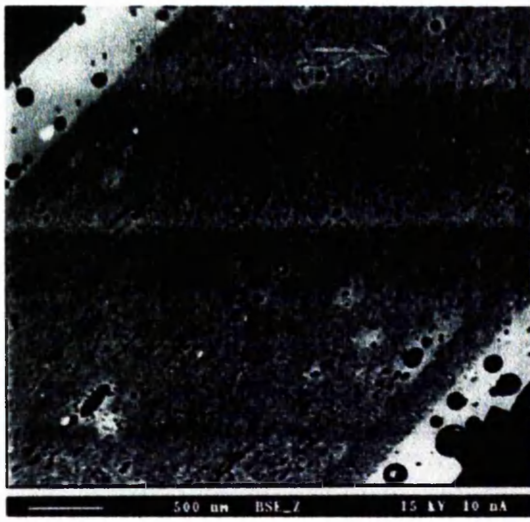

Fig. 293 Sample D: microphotograph showing the cross section

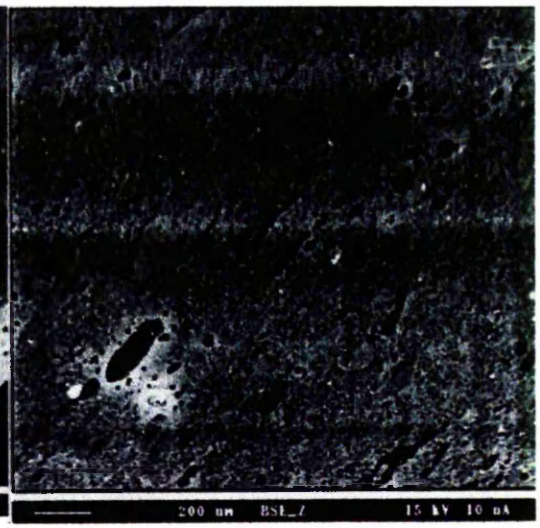

Fig. 294 Sample D: microphotograph of the body showing the parallel alignement of both quartz relicts and pores

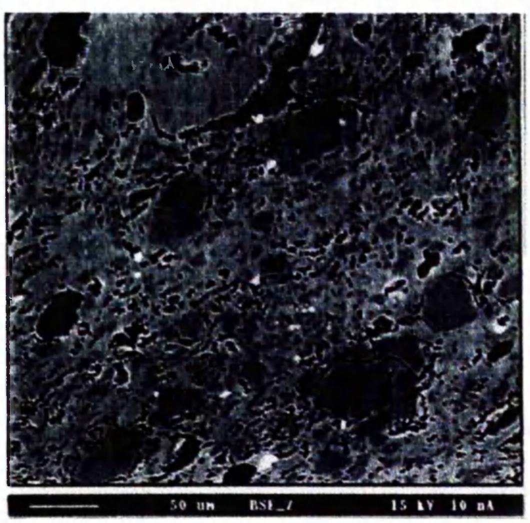

Fig. 295 Sample D: microphotograph of the body showing quartz relicts peripherally converted to tridymite, rutile grains undergoing partial dis-solution (middle of the lower part) and zircon

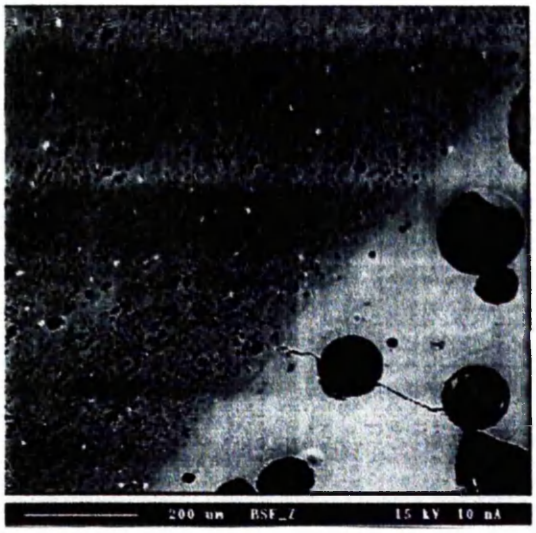

Fig. 296 Sample D: microphotograph showing body, slip and glaze

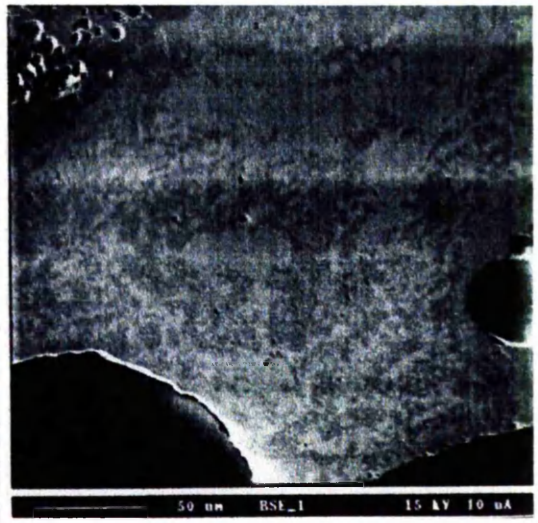

Fig. 297 Sample D: microphotograph showing the glaze-slip boundary

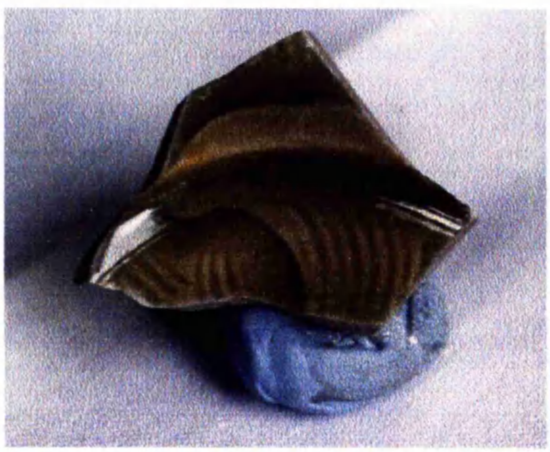

Fig. 298
Sample E

Fig. 299
Sample E: foot

Fig. 300
Sample E: side and cross

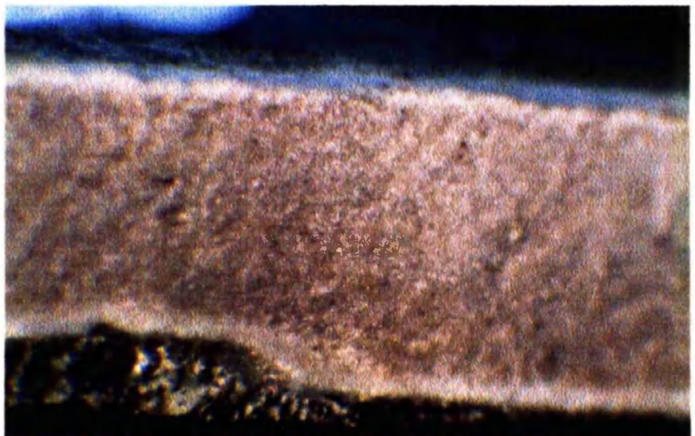

Fig. 301
Sample E:
magnified cross section 10x)

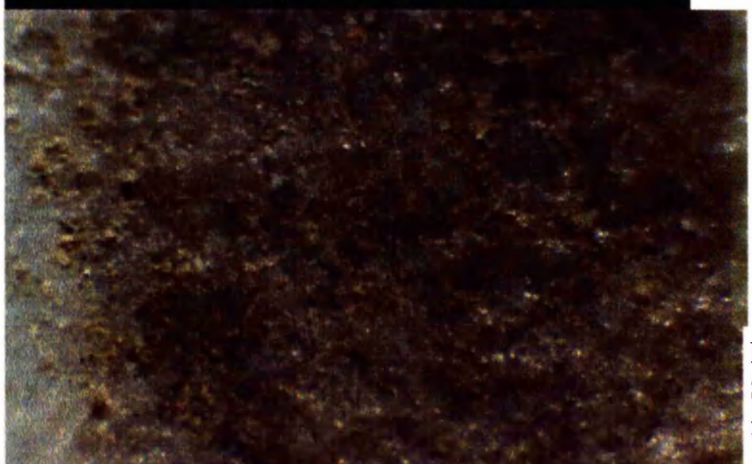

Fig. 302
Sample E:
magnified body (40x)

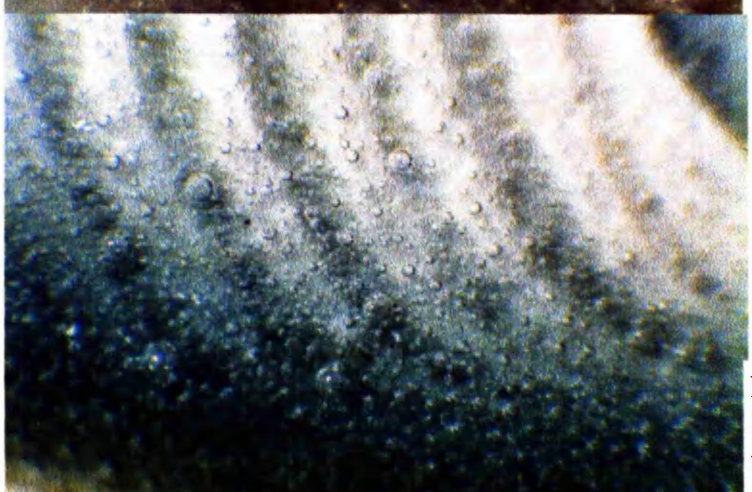

Fig. 303
Sample E:
magnified glaze (10x)

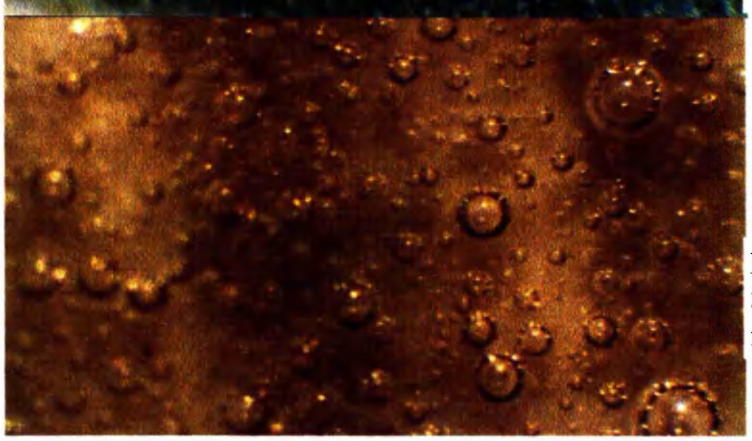

Fig. 304
Sample E:
magnified glaze (40x)

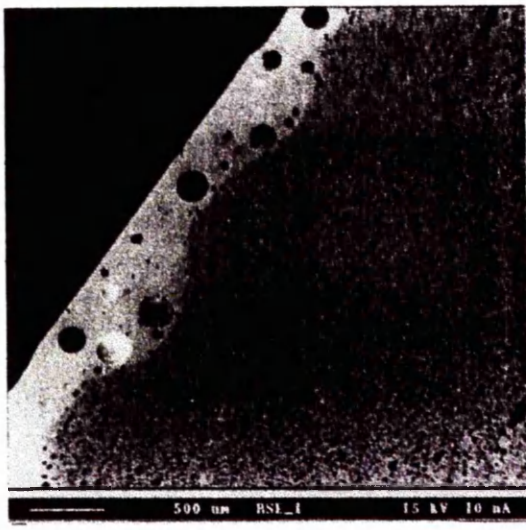

Fig. 305 Sample E: microphotograph showing glaze and body

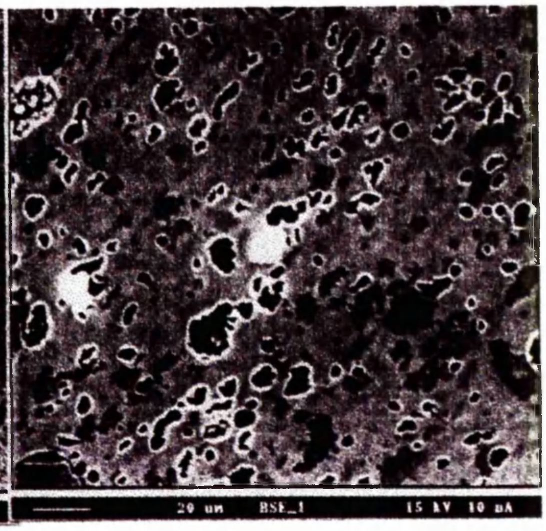

Fig. 306 Sample E: microphotograph of the body showing a remarkably vitrified body (pale grey) scattered with residual quartz marginally converted to tridymite (dark grey areas with fringed rim), irregular pores (black spots with bright halo), opaques, namely rutile (bright white spot on the right hand side) and zircon (bright white spot on the left hand side), and some unconverted quartz (grey spots with no fringed margin)

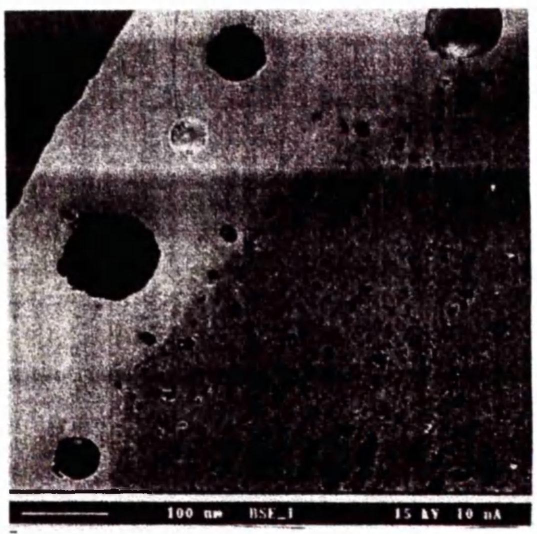

Fig. 307 Sample E: microphotograph showing body, glaze and body-glaze boundary

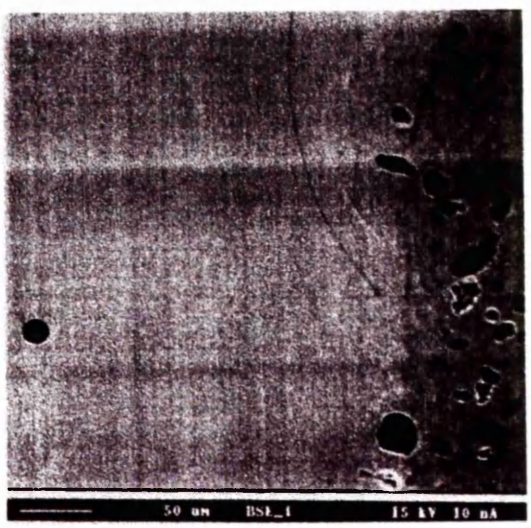

Fig. 308 Sample E: microphotograph showing the body-glaze interface with anorthite development

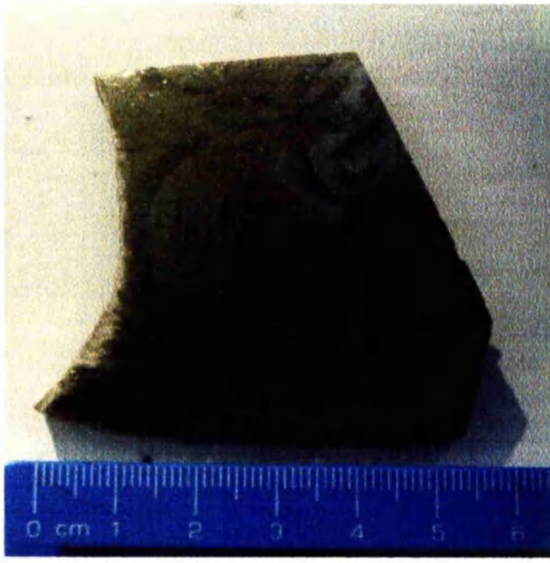

Fig. 309 Sample F

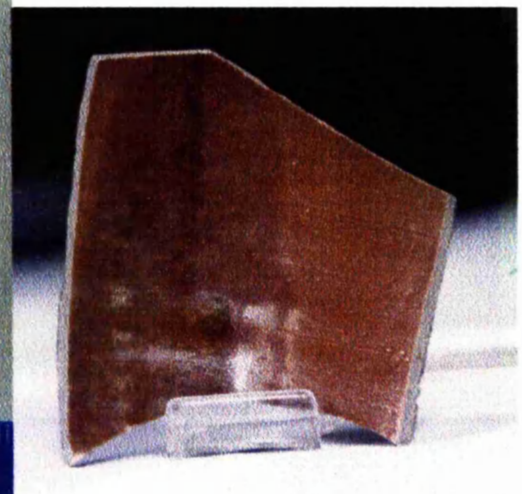

Fig. 310 Sample F: reverse

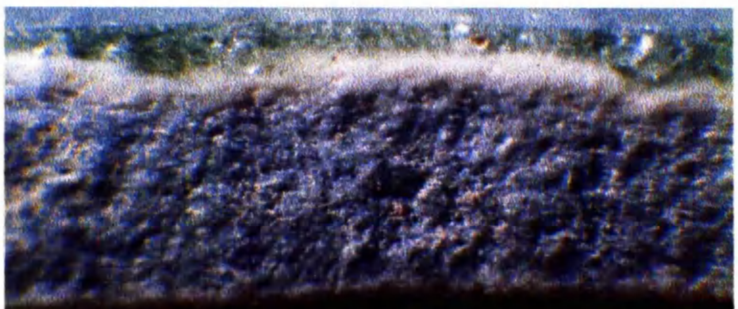

Fig. 311 Sample F: magnified cross section (10x)

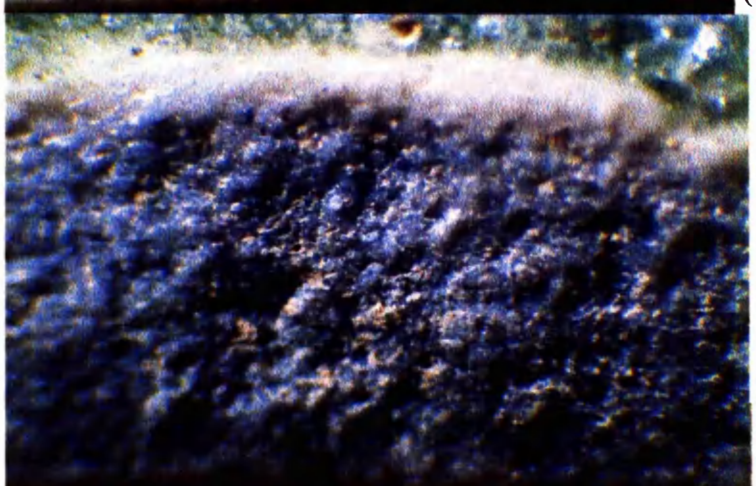

Fig. 312 Sample F: magnified body, white layer and glaze (20x)

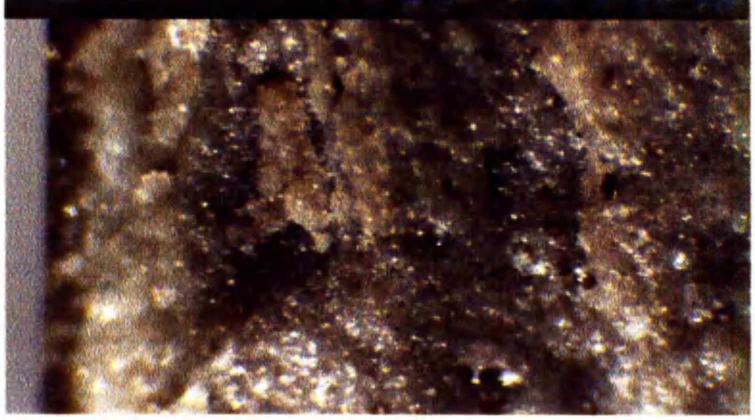

Fig. 313 Sample F: magnified body, white layer and glaze (40x)

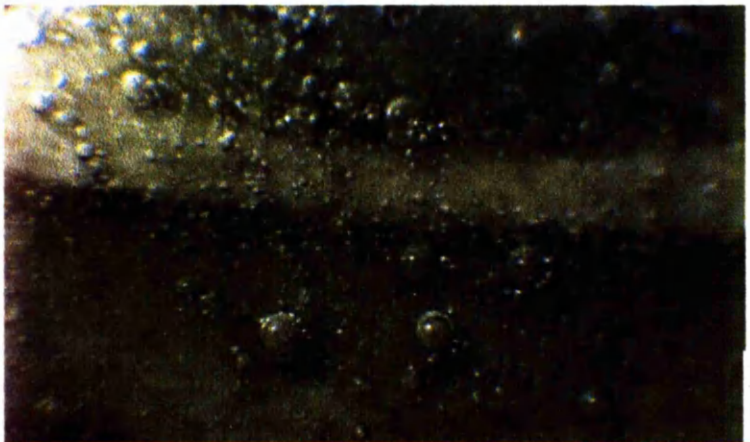

Fig. 314 Sample F: magnified glaze (10x)

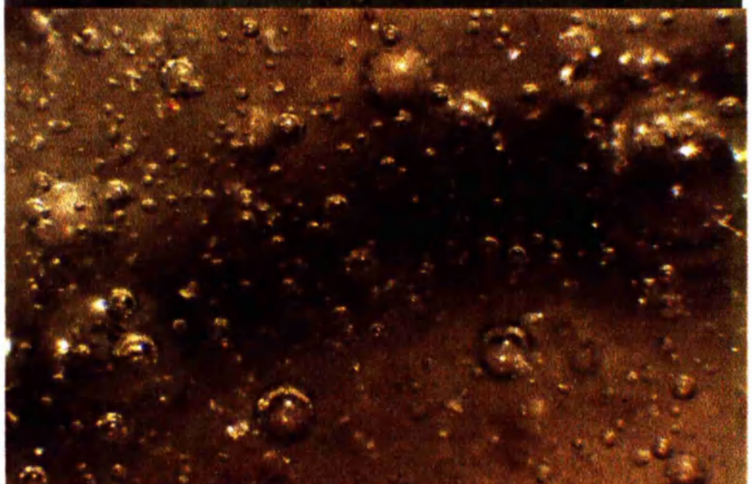

Fig. 315 Sample F: magnified glaze (40x)

Fig. 316 Sample F: magnified thin glaze on the reverse (10x)

Fig. 317 Sample F: magnified medium glaze on the reverse (10x)

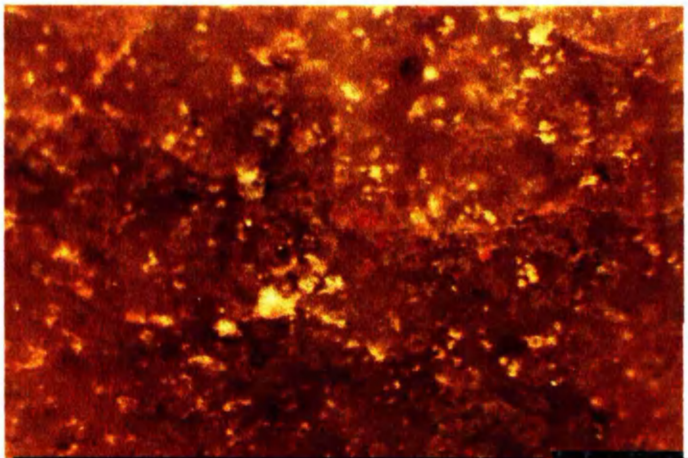

Fig. 318 Sample F: magnified thick glaze on the reverse (40x)

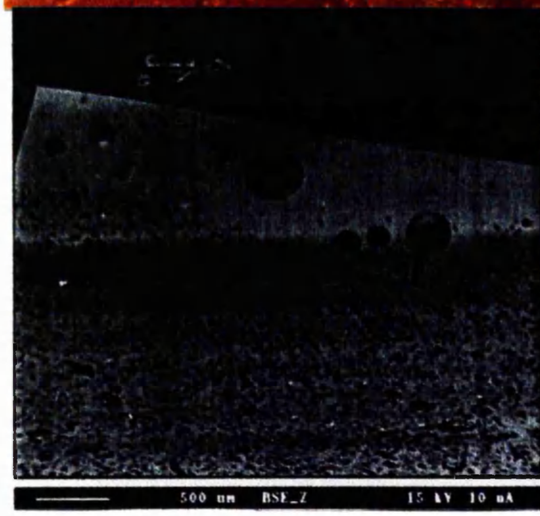

Fig. 319 Sample F: microphotograph showing body and glaze

Fig. 320 Sample F: microphotograph showing the body

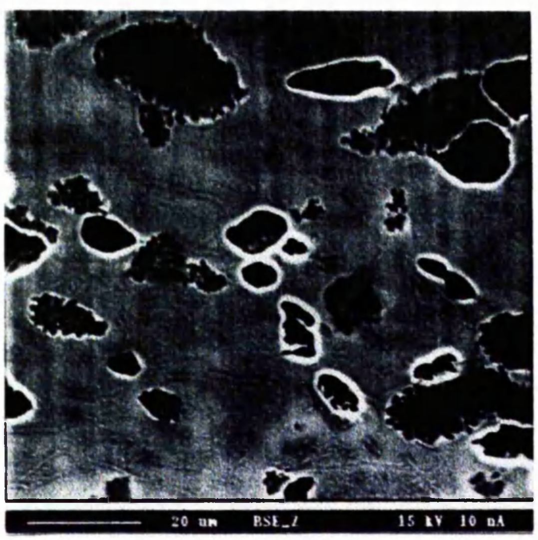

Fig. 321 Sample F: microphotograph of the body showing quartz partially converted to tridymite and mullite needles

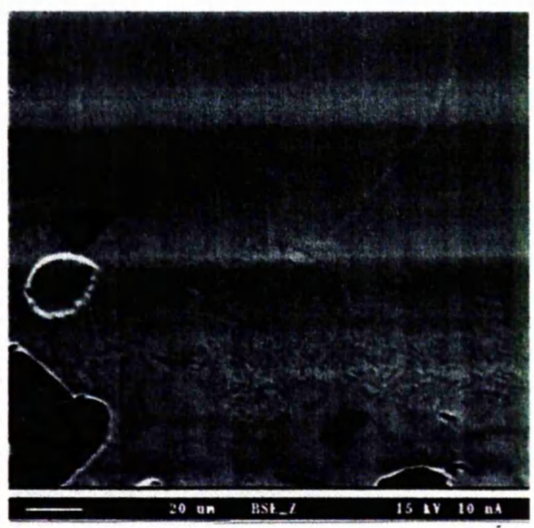

Fig. 322 Sample F: microphotograph showing the body-glaze interface with anorthite development

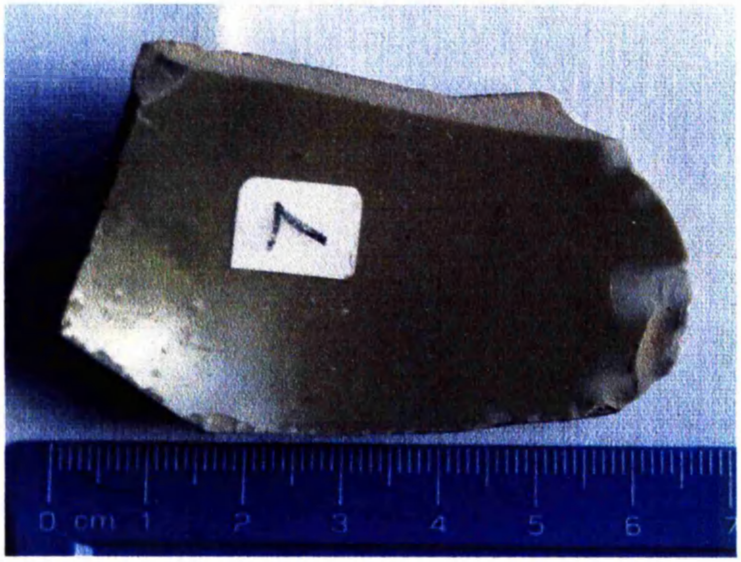

Fig. 323 Sample G

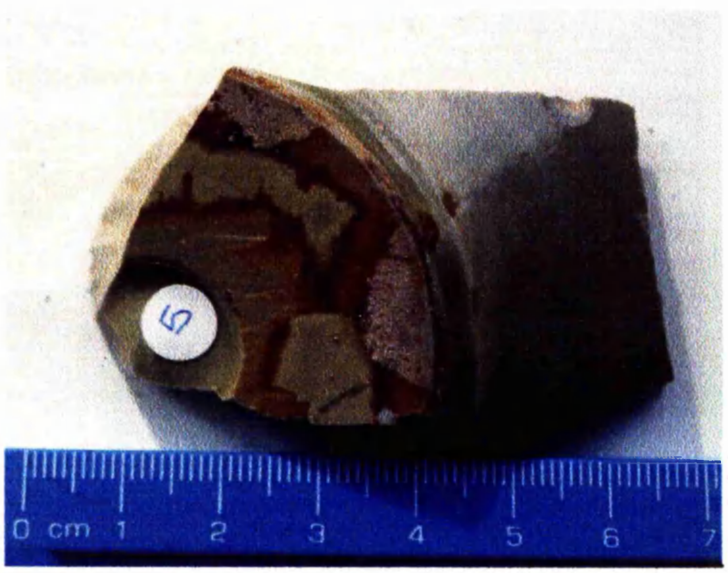

Fig. 324 Sample G: foot with marks left by spacers


Fig. 325 Sample G: side and cross section

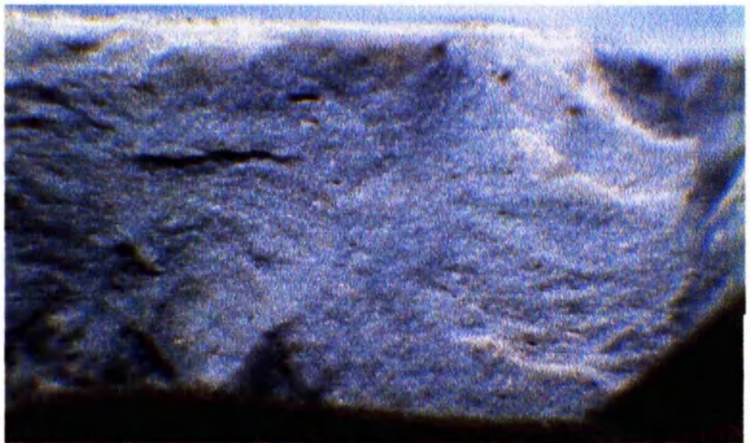

Fig. 326 Sample G: magnified cross section (10x)

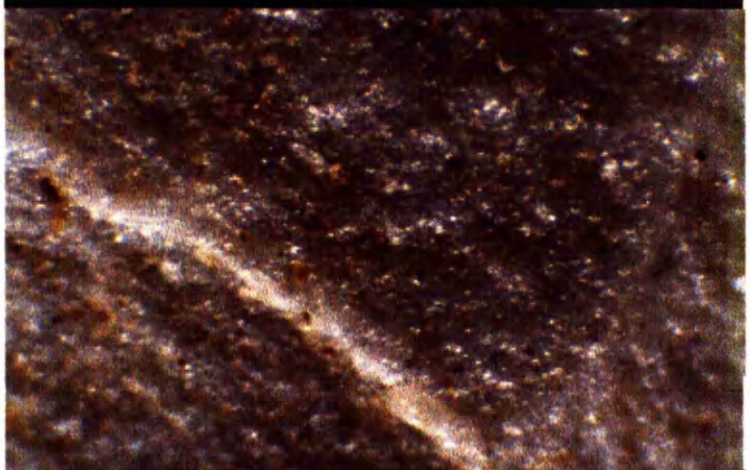

Fig. 327 Sample G: magnified body (40x)

Fig. 328 Sample G: magnified glaze (10x)

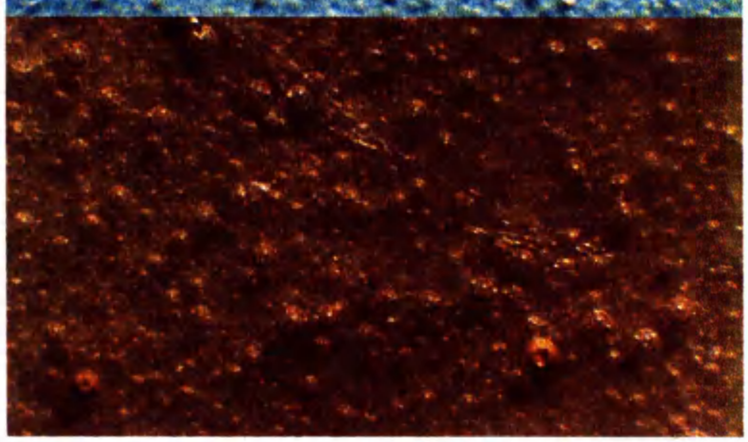

Fig. 329 Sample G: magnified glaze (40x)

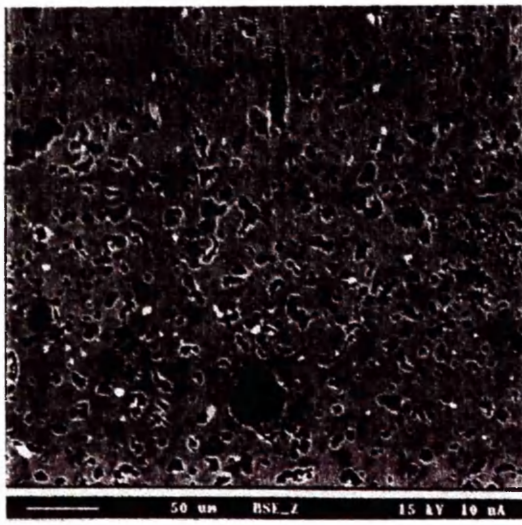

Fig. 330 Sample G: microphotograph of the body showing concentration of microporosity identified as relict feldspar

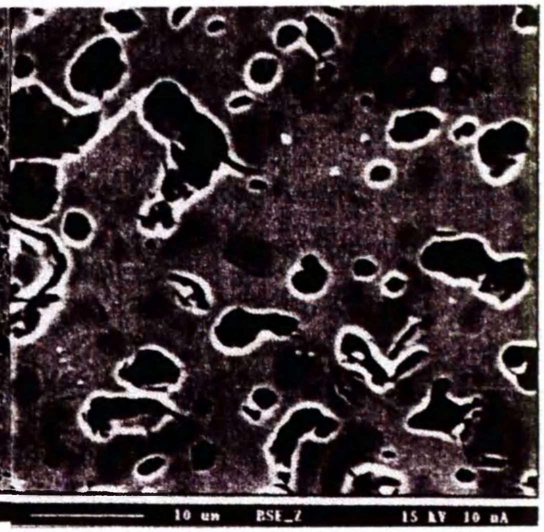

Fig. 331 Sample G: microphotograph of the body showing minor opaques and lack of tridymite

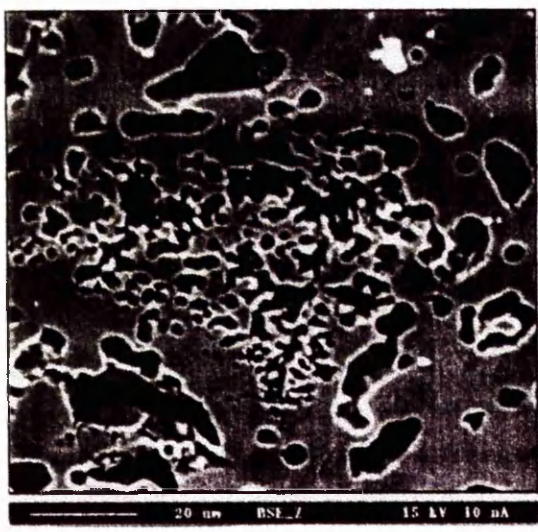

Fig. 332
Sample G: microphotograph of the body showing the morphology of relict feldspar similar to residual quartz in size and to a triangle in shape

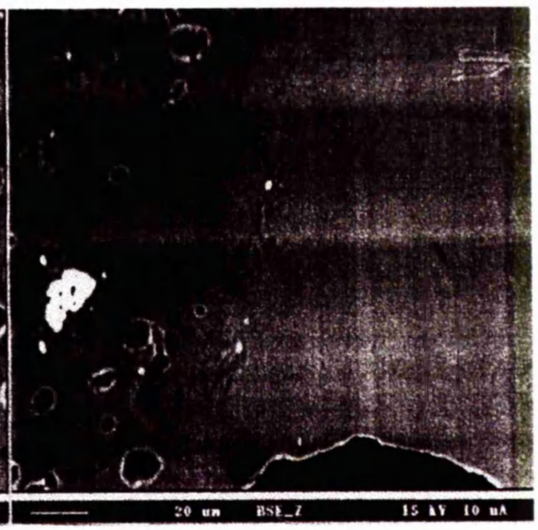

Fig. 333
Sample G: microphotograph showing body and glaze with anortite development

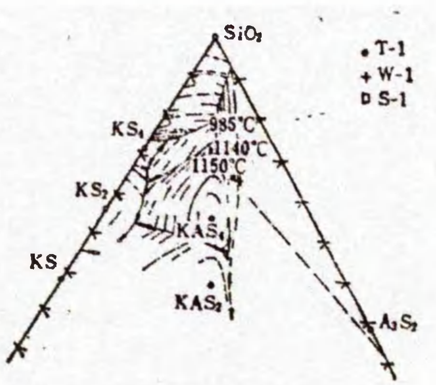

Fig. 334
Thermodynamic phase diagram of the body of some Yaozhou specimens