

Development and Evolution of Papermaking in Ancient China based on the Uses and Forms of Paper

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Abstract: In the past, scholars have divided the history of Chinese papermaking into different stages based on the development of ancient papermaking technology, emphasizing the development and progress of papermaking in different historical periods but paying less attention to the changes in the form of paper. Here, the stages are defined based on changes in use and function rather than technological developments. When this approach is combined with the history of printing, books, calligraphy, and painting, the history of Chinese papermaking can be divided into the writing paper, writing and printing paper, printing paper, and calligraphy and painting paper periods. Different periods of paper have significant differences in texture, form, and performance owing to their different applications. This significant difference provides a reference for the identification of ancient papers and reveals the internal connection between the history of printing, books, calligraphy, painting, and papermaking.

Keywords: papermaking in ancient China; uses and forms; printing history; calligraphy; painting history

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1 Introduction

The papermaking technology originated in China. From ancient times to today, the raw materials, papermaking process, condition, and applications of paper have not remained broadly the same; however, they have been constantly developed. Scholars have divided the history of ancient Chinese papermaking into several periods based on the development of ancient papermaking technology^[1-2].

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(1) The discovery and dissemination period of papermaking technology—Eastern Han dynasty and the Three Kingdoms.

(2) The widespread use of papermaking as a substitute for bamboo slips and silk—the Wei, Jin and Southern and Northern dynasties.

(3) The first prosperous period of papermaking—the Sui and Tang dynasties.

(4) The second prosperous period of papermaking technology—the Song and Yuan dynasties.

(5) The heyday of papermaking—the Ming and Qing dynasties.

(6) The evolution period of ancient Chinese papermaking technology—modern times.

This classification method is based on the historical development of papermaking, including the progress and development of papermaking technology, the application of paper, and the prosperity of the papermaking industry. This method of dividing periods is most commonly used in the field of papermaking history. Dividing the development process using this method displays the development of ancient Chinese papermaking, the development of different dynasties, the contributions and progress of each historical period, the use of paper, varieties of famous paper, and civilian records, evaluations, and praise of paper^[3].

However, this method focuses more on macro-factors and is often not sufficiently specific or clear when viewed from a more microscopic perspective, such as when analyzing the function and morphological changes of a paper. Particularly in the analysis and identification of ancient paper samples, researchers need to be able to identify a chronological time point in the development history of papers through specific features. In addition, when the functional history of paper is combined with that of books and printing, the fit provided by the history of macroscopic development is insufficient. The changes in paper function during different periods of its developmental history especially based on the changes in paper form characteristics caused by functional evolution as well as the

differences in papermaking and processing technology cannot be clearly understood.

2 Division of development stages based on paper usage

In addition to a relatively macroperspective on the development history of papers, it is necessary to examine the process of paper development from a microperspective. Although the development and evolution of this microperspective are similar to that of the macroperspective proposed by scholars in the past, the logic is significantly different. Specifically, the new approach focuses on the specific functions of paper and the changes in paper form caused by the evolution of these functions. This process includes the development of papermaking technology, the evolution of production and processing techniques, and changes in the main raw materials. However, the development of technology is the only cause of morphological evolution, and the changes in paper form caused by it are the main focus of this process. Owing to the close relationship between the specific functions of paper and the development of book and printing history, it is possible to refer to the definition of different eras within the history of books. Furthermore, it is important to consider the influence of printing on paper form and development. For example, the development of calligraphy and painting styles meant that different types of paper with varying forms, performance, and other characteristics were required^[4-7].

The first stage of papermaking history was from the invention of papermaking to the Sui, Tang, and Five dynasties. This era is the papermaking equivalent of the writing era of book history. The main function of the paper during this period was to be written on, and as such, it has been named the writing paper period.

With the invention of printing, the form of paper began to change. For example, in the Song and Yuan dynasties, between approximately the 10th and 14th centuries, paper began to be predominantly used in printing. However, during this period, the function of writing remained, and, therefore, it has been named the

writing and printing paper period.

In the Ming and Qing dynasties, from the 14th to the 19th centuries, the main application of paper was printing, and this period has been called the printing paper period.

Later, from the late Qing dynasty to the formation of the Republic of China, handmade paper was overtaken by machine-made paper due to its large import amount. Therefore, handmade Chinese paper began to be specifically applied to calligraphy and painting paper. As such, this period can be referred to as the calligraphy and painting paper period.

This classification method emphasizes the main uses of paper rather than the technological advancement of papermaking. Writing paper needs to be tight and smooth, printing paper should be soft and absorb ink; and calligraphy and painting paper requires ink to present an ink charm. As such, different applications have different performance requirements. This difference allows the paper to take different forms during different periods and has necessitated that the form of the paper change throughout history to meet the necessary demand. More importantly, owing to these performance and functional differences, the relationship between the paper texture and historical age can be easily assessed, thereby providing the basis for the age analysis of relevant ancient paper samples ^[8].

3 Writing paper period

This is a relatively long period that spans from the invention of papermaking to the Five dynasties. Before discussing the era of writing paper, it is necessary to briefly explain the origins of papermaking.

The invention of papermaking has been clearly recorded in historical literature. The earliest reference to papermaking was in the biography of Cai Lun in the book *Dong Guan Han Ji*. This book records the specific process of Cai Lun's invention of papermaking in detail. This statement spread for a long time. However, during the 1940s and 1950s, archaeological excavations revealed some paper fragments that were believed to be from the Western Han dynasty and dated

earlier than Cai Lun. With more excavations of paper-like objects in different regions, the origins of papermaking are discussed based on the discovery of these objects. Based on these findings, some researchers tend to believe that paper had already appeared before Cai Lun and that Cai Lun made improvements to papermaking processes. However, some scholars do not agree with this view, and there are different opinions on whether Cai Lun was the original inventor.

The first stage was the writing period. In this period, the main function of the paper was as writing material. However, a few paintings appeared in the later years of the writing period. During the writing period, an important feature was that the papers were specially processed after being made. Before the invention of papermaking, writings were mostly on bamboo and wooden slips, the surfaces of which were relatively dense and smooth. After the invention of papermaking, it was natural to continue writing on these materials. As such, freshly made paper, which was relatively rough and loose, needed to be processed to become dense and smooth so that users could write on it.

Another reason is that the manufacturing process of early paper was still primitive, and thick and long fibers such as those from ramie and paper mulberry were used as raw materials. Therefore, the paper was rough, loose, and thick. Writing directly on the unprocessed paper was significantly different from writing on smooth and dense bamboo slips. Therefore, the paper needed to be processed, which included beating, rubbing, dyeing, sizing, waxing, and coating, to make the paper tight, smooth, and absorption-resistant, which was more suitable for writing.

Some of the most famous papers from this period are recorded in ancient studies. Examples include Zuo Bo, Ning Guang, beaten, and hard yellow papers. For example, a scroll of the "Sutra" from the Beiliang period is shown in Fig. 1. The paper was uniform and smooth, and it was clear that it had been carefully rubbed to achieve the required level of fineness. Moreover, it can be seen that the format of these early sutras is very similar to bamboo slips. The paper has

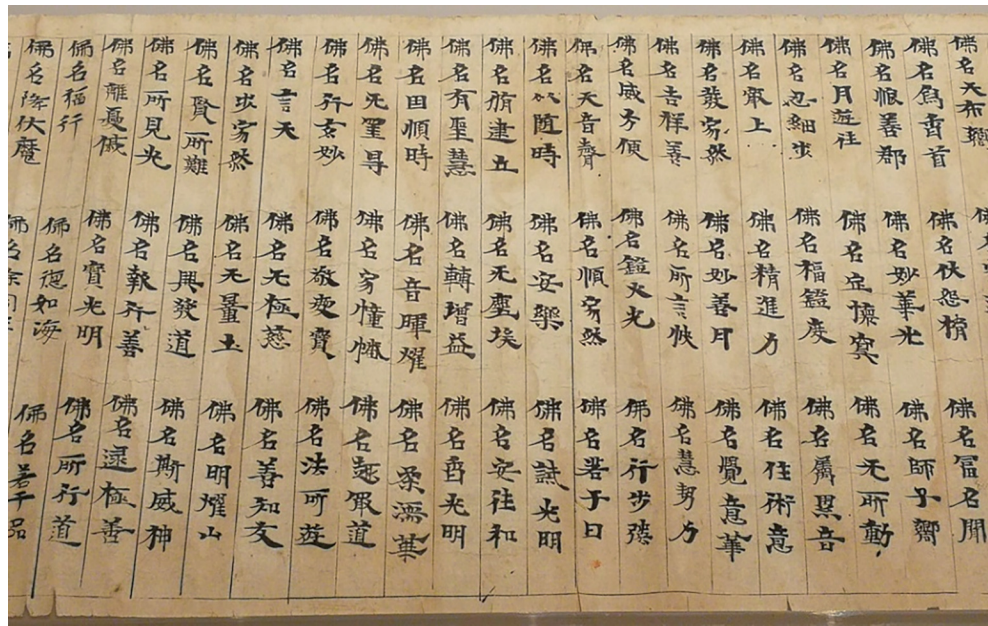


Fig. 1 The Sutra from the Beiliang period (Collection of Anhui Museum)

vertical columns, and the writing style was the same as the one used when writing on bamboo slips. Writing took place from top to bottom and from right to left.

This sutra is relatively well preserved. In contrast, there are many ancient sutras with obvious surface damage, such as traces of peeling marks on the paper surface. This indicated that the surface of the sutra from the Beiliang period was coated. Because paper fibers are relatively rough, it was not easy to write such small characters on them. Therefore, mineral powders were mixed with different types of gums and evenly coated on the surface of the paper so that it became very smooth and suitable for writing.

During the Tang dynasty, papermaking was divided into two steps: raw paper production and paper processing. The first step was generally performed in paper mills, close to where raw materials were easy to obtain. After the raw paper had been produced, it was transported to paper-processing workshops in the city.

In the Five dynasties period, papermaking technology was developed to a very high level, especially for papers made from bast and ramie fibers, which were produced to a high standard. One example is the famous Chengxintang papersheet, which got its name from the name of the emperor's palace during the Nantang dynasty. The paper was of such quality that

many scholars believed it was produced during the Song dynasty. According to the literature, this may have been mulberry paper or paper mulberry paper. The process of making this paper was very elaborate. Additionally, in some ancient poems, it was mentioned that the paper was made in winter because the water quality was better in winter. Furthermore, it took one or two years to make the paper. The real piece of Chengxintang paper was found in the copybook for calligraphy—Chengxintang Tie, written by Cai Xiang during the Song dynasty, and it is currently located at the National Palace Museum in Taipei (China). Its surface condition and texture are clearly different from those of the Wei, Jin, and Tang dynasties. It is white, the fibers are clearer, and it is not as heavily processed.

4 Writing and printing paper period

The Song and Yuan dynasties are the writing and printing paper period. Owing to the increased popularity of block printing, the demand for paper was very high, and the new uses of paper had an impact on the paper properties required. As such, the paper was gradually adapted to meet the requirements of block printing, which requires paper to be light, soft, and absorbent. Papers in this period gradually transitioned

from writing paper to printing paper but still needed to meet the demands of painting and calligraphy. The papermaking techniques became increasingly refined, and, as such, the demand for processing gradually decreased. Therefore, the ubiquitous use of processed paper observed during the Tang dynasty gradually disappeared during the Song dynasty, and many books from the Song dynasty were made of unprocessed paper.

For example, Fig. 2 contains an image of a rare book printed on bast fiber paper during the Song dynasty. Compared with paper from previous dynasties, there is

no trace of processing or dyeing on the surface, and the natural texture of the paper mulberry paper can be seen. This book was composed of processed, refined bast paper.

During the Song dynasty, some high-grade papers were produced, such as those used in the imperial palace. The book in Fig. 3 is a genealogical book of the Song dynasty imperial family; it is found in the National Library of China. It can be seen here, that although there are some losses and water stains, the paper in the middle part of the book is still in good condition. The raw material is likely to have been

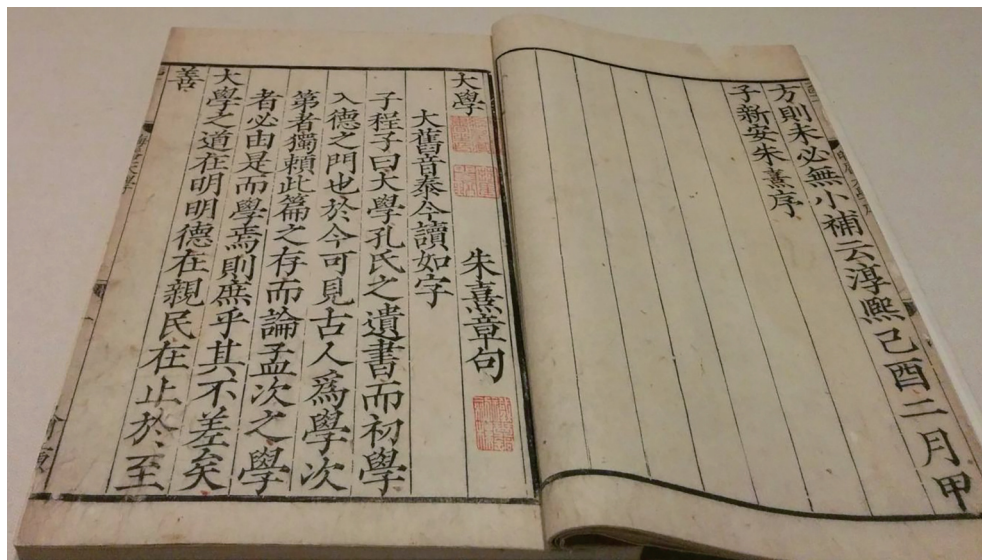


Fig. 2 A block-printed book produced during the Song dynasty (Collection of National Library of China)

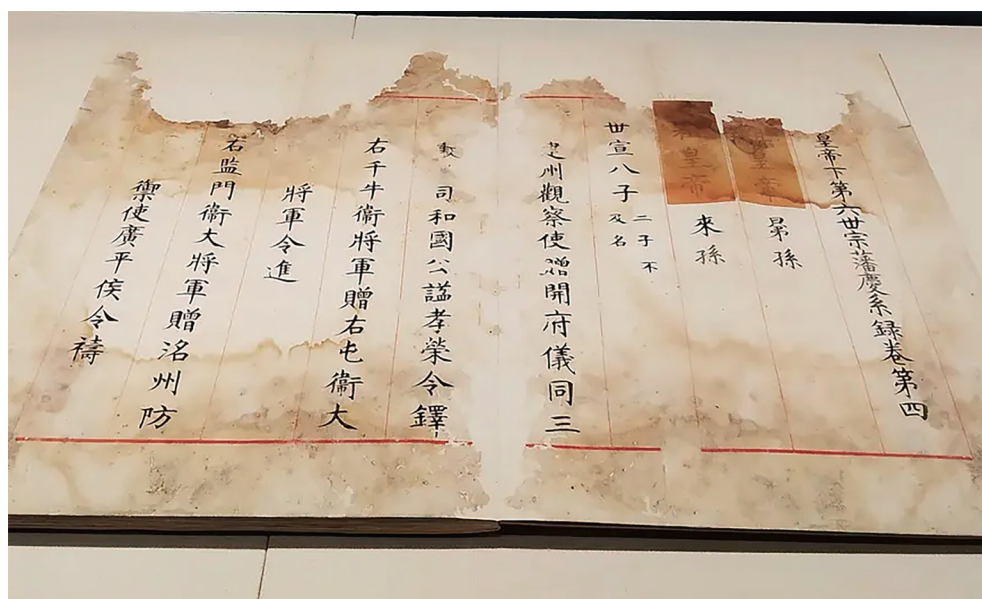


Fig. 3 The genealogical book of the Song dynasty imperial family (Collection of National Library of China)

mulberry or paper mulberry bast, which has long fibers; however, the texture of the paper is similar to that of short fiber paper, which indicates that the technology for making bast fiber paper was well established at the time of production.

After the end of the Qing dynasty, the production of a large variety of handmade paper stopped, papermaking technology regressed, and paper quality declined. Therefore, many researchers, especially foreign researchers, believe that the quality of handmade Chinese paper in the past is lower than that of Japanese paper.

Another important development during the Song dynasty was the invention of bamboo paper. Bamboo paper rapidly became cultural paper during the Song dynasty. However, making paper out of bamboo is considerably more difficult because of the natural strength of bamboo and the difficulty of preparing bamboo pulp. With improvements in technology, bamboo paper could be made to meet the requirements for printing in the Song dynasty, and it was soon popularized ^[9-10]. In the Song and Yuan dynasties, the main raw materials for paper were mulberry and paper mulberry bast fibers, Thymelaeaceae bast fibers, and bamboo. At the same time, the use of ramie fibers was gradually reduced because of their poor availability ^[11].

The production of bamboo paper was an important technological advancement that could be called the Second Revolution in papermaking. The invention of bamboo paper helped address the problem of sourcing raw materials for papermaking. Shortly after its invention, papermaking was still a relatively simple process wherein rags or bast fibers were used as raw materials. However, sourcing bast fibers was difficult. For example, ramie was used to make clothing and textiles, which were more important than paper. Subsequently, the paper was made from bast fibers; however, the bast tree usually needed to grow for two to three years. When the demand for paper increased dramatically due to the invention of printing, the production of bast paper alone could not meet this demand. However, after bamboo paper was invented,

the supply issues were reduced because bamboo grew very fast and was produced on a large scale. Moso bamboo, in particular, was ideal for commercial growth because it was a fast-growing plant. After the commercialization of bamboo, the issue of raw materials shortage for papermaking was alleviated.

Since Gutenberg invented the technology of lead movable type printing in 1455, the consumption of paper throughout Europe has rapidly increased, and by the 17th to the 18th centuries, many countries began to experience shortages of paper raw materials. In the 18th century, the British government issued a decree prohibiting the burial of deceased people wrapped in shrouds, in order to save fabric for papermaking. During the same period, a large number of rag smuggling activities occurred in the areas bordering France, Germany, and Switzerland, where local people collected rags and sold them at high prices. However, these problems were not encountered in China, and the price of books in China throughout history has remained quite stable. The price of a book is about the equivalent of 5 kg rice, which is very economical for book readers. Even for civilians, buying a book was not a significant problem. Cheap papers and books gave people more opportunities to read, which promoted the development of culture. Therefore, from this perspective, the invention of bamboo paper was an important technological revolution.

In the Song dynasty, some paper was produced after a complex production process. Such as the famous Jinsushan Zang Jing paper, which was made to imitate the hard yellow paper of the Tang dynasty and could be considered a continuation of the hard yellow paper. Meanwhile, there were some more high-quality examples of processed paper, such as the paper used for the Song Huizong calligraphy “Qian Zi Wen”. The surface of the paper had a pattern of gold-painted clouds and dragons. Furthermore, some beautifully decorated Hua Jian paper with beautiful patterns was printed during the Song dynasty. Compared to the same paper from the Tang dynasty, its style was more elegant.

5 Printing paper period

The third period of papermaking history can be considered the printing paper period and refers to the Ming and Qing dynasties. During this period, the development of paper technology peaked, and the production of paper was very high. The main use of paper was in printing books. The main characteristic of paper from this period was that the manufacturing process was fine and that the paper was not normally processed. The paper was soft, light, and had moderate ink absorption. During this period, bamboo paper was the primary type of paper used and accounted for more than 80% of the ancient books. Some of the paper produced during this period was prepared from mixed materials, such as Xuan and Bai. Alongside bamboo, other papermaking materials such as mulberry bast, paper mulberry bast, ramie, Thymelaeaceae bast, blue sandalwood bast, and rice straw were abundant at the time.

The integration of papermaking technology occurred in the Ming and Qing dynasties. A very important symbol was the publication of *Tian Gong Kai Wu*, which comprehensively summarized papermaking technology from a technical perspective. The technologies of bamboo and bast papermaking are mentioned in the book, and their production processes are described in

detail. The book mentions that paper made from paper mulberry bast is called white cotton paper, which is an interesting name because, during the Song dynasty, paper made from paper mulberry bast was often called white ramie paper. The naming method was not based on the material but on the texture of the paper. The change in name from ramie to cotton not only shows the changes in paper texture but also reflects the improvement of papermaking techniques. Paper produced during the Ming dynasty was much more delicate than paper made during the Song dynasty.

Bamboo paper was mostly produced in the Ming and Qing dynasties. Currently, bamboo papermaking techniques have been developed at a high level, and the product types vary. Some scholars have classified the bamboo papermaking techniques in the Ming and Qing dynasties into the following five types (Fig. 4).

The first type is bleached bamboo paper. This paper is white and fine and is generally known as Lianshi bamboo paper. The second type was boiled carefully several times but was not bleached. The paper color remained light yellow, which is suitable for writing; this paper is generally known as Gongchuan bamboo paper. The third type, which has no boiling process, is called Maobian paper and is usually used to print books because of its low cost. The fourth type is Yuanshu paper, which was boiled once. The paper is thick and

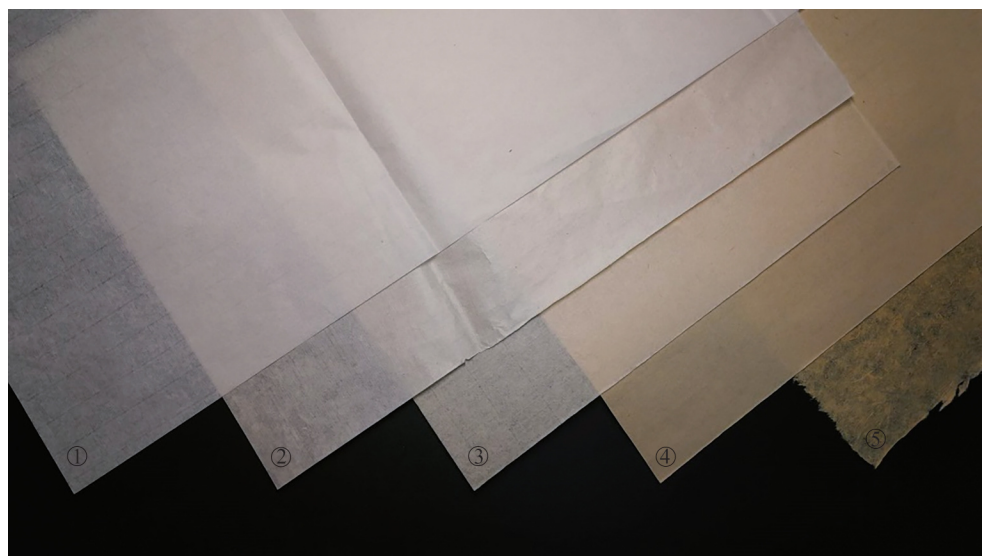


Fig. 4 The five representative samples of bamboo paper

yellow, making it suitable for daily writing. The last type was the burning paper used by civilians.

The five pieces of paper shown in Fig. 4 are representative samples of bamboo paper. The first one on the left is the Yanshan Lianshi paper, which is bleached bamboo paper. The second type is bamboo paper from Liuyang, Hu'nan Province. The third type is an example of Fujian's Maobian paper, which has not yet been boiled. Instead, by mixing bamboo and quick lime and soaking them for a long time, the bamboo was softened and suitable for making Fujian's Maobian paper. The fourth is Yuanshu paper, which was boiled only once and had a slightly yellow color. Yuanshu's paper is relatively soft and suitable for publication purposes. The fifth is Xiangyang Zhang paper, which is a commonly used burning paper.

In addition to bamboo paper, another important type of paper that appeared in the Ming and Qing dynasties was Xuan paper, or Jingxian paper. It was produced in Jingxian County, Anhui Province, China. From the end of the Yuan to the beginning of the Ming dynasty, the paper was made with blue sandalwood bast as the main raw material and rice straw as a secondary material. In the late Ming and early Qing dynasties, paper made of pure blue sandalwood bast was considered the top printing paper because of its delicate white texture and smooth, uniform, and comfortable luster. Pure blue sandalwood bast paper was often used to print imperial books. Paper with rice straw as a secondary material is referred to as Xuan paper. It has a unique effect on painting and calligraphy, which is suitable for the style of Chinese ink painting; therefore, it later became one of the most well-known types of handmade Chinese paper^[12].

Xuan paper was used for the ink painting by Zhu Da, shown in Fig. 5. There are obvious changes in the painting style compared to previous dynasties, and ink blots are easily identifiable; which makes the Xuan paper very unique.

Fig. 6 shows the examples of quickly drawn brushstrokes on Xuan paper. The numbers in Fig. 6 are the order of the strokes, these strokes make the wash



Fig. 5 Part of an ink painting by Zhu Da using Xuan paper

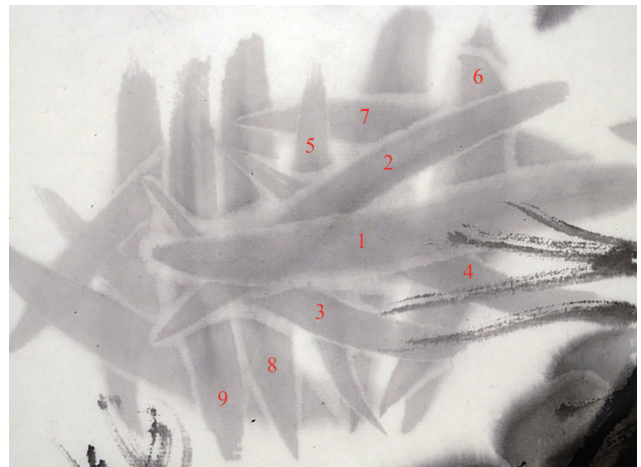


Fig. 6 Examples of quickly drawn brushstrokes on Xuan paper

painting three-dimensional.

Furthermore, there are some well-known processed papers from the Ming and Qing dynasties. For example, Xuande tribute paper was used during the Ming dynasty and was a batch of processed paper made by the court during the Xuande period. Among them, there was a famous indigo paper, Yangnao paper. The Qing dynasty court produced some famous processed papers, such as imitations of the Jinsu Shan Zang Jing paper and the Mei Hua Yu Ban paper.

6 Calligraphy and painting paper period

In the late Qing dynasty, foreign machine papermaking technology was imported to China. Machine-made paper quickly occupied the market, especially the printing paper market. Therefore, handmade printing and writing papers have largely been replaced with machine-made papers. As such, the most important market for traditional handmade paper was almost entirely lost. Many types of handmade paper have disappeared, and their main applications are now painting and calligraphy.

7 Conclusion

In summary, this review explores the development and evolution of traditional Chinese handmade paper over time, and discusses the various characteristics and main types of paper during each historical period.

Unlike the previous methods used to distinguish between different periods of papermaking history, the method proposed here is based on the main uses and functions of paper. The wide variety of uses and functions determine the performance needs and tendencies of paper, resulting in significant differences in the appearance, texture, production process, and raw material selection of paper across different periods. When these differences are understood, the changes in the types of ancient papers and the characteristics of papers in different periods can be easily comprehended. Making use of this approach, it should be possible to estimate the age of some unknown samples. Therefore, the new methodology

provides a new approach for the age identification of ancient books, calligraphy, and paintings. This method of dividing periods can also be combined with the histories of printing, books, calligraphy, and painting, further revealing the connections between their simultaneous development.

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