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An Analysis of Scientific Research on Chinese Porcelain at the Sèvres Manufactory in the Mid-19th Century—Centering on the Series of Papers by Ébelmen and Salvétat

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Abstract: *In the early 18th century, two letters written by Père Francois Xavier d'Entrecolles provided the West with valuable insights into Chinese porcelain-making techniques. For more than a century thereafter, scholarly research on Chinese porcelain remained stagnant, with no significant advancements. It was not until the mid-19th century that this situation underwent a substantive transformation. During this period French scholars Jacques-Joseph Ébelmen (1814–1852) and Louis-Alphonse Salvétat (1820–1882) at the Sèvres Manufactory conducted a series of scientific research on Chinese porcelain and published three academic papers. Their work represented a significant contribution by the French academic community to the scientific and objective understanding of Chinese porcelain. Building upon previous research, this study analyzes the historical background of this series of studies, summarizes the main content and research methods, and further explores its significance and limitations. By doing so, it aims to offer the academic community a more comprehensive and in-depth understanding of this subject.*

Keywords: *Mid-19th century, Sèvres Manufactory, Chinese porcelain, scientific research*

1. Introduction

Since the transmission of Chinese ceramics to the West, European countries have continuously endeavored to uncover the secrets of porcelain manufacturing. Although France was not the first European country to produce hard-paste porcelain, it has played a significant role in the study of Chinese ceramic technology, with the Sèvres Manufactory serving as a representative institution. In the mid-19th century, Sèvres conducted a series of studies on Chinese ceramics and successively published three academic papers focusing on Chinese ceramic bodies and glazes, low-temperature overglaze enamels, and medium to high temperature colored glazes. More than 170 years have passed since the publication of these papers, which collectively reflect the achievements of Sèvres' research on Chinese ceramic technology during that period.

Although these papers were later reproduced, collected, and translated, academic research on this topic has only increased in recent years. Notably, the exhibition *The Secrets of Colors: Chinese and European Ceramics from the 18th Century to the Present*, held at the Baur Foundation, Museum of Far Eastern Art in Geneva from September 14, 2022, to February 12, 2023, showcased physical artifacts and images related to Sèvres' research on Chinese ceramic colors during this period. French scholar Pauline d'Abrigeon conducted a specialized study on collectors and their activities in gathering research materials on Chinese ceramics in China.[1] Japanese scholar Imai Yūko explored the influence of Sèvres' research on Chinese ceramic technology on the development of Sèvres' new hard-paste porcelain and certain colored porcelain wares.[2] Chinese scholar Hu Hanhan, based on archival materials from the Sèvres Manufactory, introduced Joseph Father as a key supplier of samples during this period and, for the first time, translated French correspondence related to Chinese ceramic technology from this stage.[3]

Although the sources of research samples and some of the influences of these studies have been relatively well established, this paper builds upon previous research to analyze the historical context, systematically summarize the main content and research methods of Sèvres' studies on Chinese ceramic technology, and further explore their significance and limitations. The aim is to provide the

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academic community with a more comprehensive and in-depth understanding of this subject.

2. The Historical Background

The Sèvres Manufactory is France's renowned royal porcelain manufacturer, not only representing French porcelain production but also serving as a significant global center for ceramic research. Its predecessor, the Vincennes Manufactory, was established in 1738 by Orry de Fulvy, a French advisor and Controller-General of Finances. Shortly thereafter, the manufactory received royal financial support and was relocated to Sèvres in 1756. With the patronage of King Louis XV and Madame de Pompadour, Sèvres quickly became one of Europe's leading porcelain manufacturers, producing high-quality and artistically refined ceramics. Its products were highly esteemed by European royal courts and gained widespread admiration among the aristocracy.

During the French Revolution, the production of Sèvres Manufactory was severely affected. In 1800, Alexandre Brongniart (1770–1847) was appointed director of the Sèvres Manufactory. Under his leadership, the manufactory was revitalized and experienced rapid development. His primary objective was to maintain Sèvres' dominance by leveraging its superior design and decorative excellence, thereby surpassing the competition and disputes among private manufacturers.[4] To achieve this goal, Brongniart implemented a series of measures to improve product quality, reduce costs, and enhance market competitiveness during his tenure. In 1804, he discontinued the production of soft-paste porcelain, shifting the manufactory's focus exclusively to the production and research of hard-paste porcelain.

With the end of the "secret recipe" era, European porcelain manufactories began to recognize the importance of experimentation. Brongniart's leadership during his long tenure at Sèvres—ending only with his death in 1848—was instrumental in the placing of chemistry and mineralogy at the center of procelain makers' concerns and in destroying the culture of Old Regime secrecy.[5] He specifically recruited chemists and mineralogists to join his research team and conducted experiments on the chemical composition of raw materials, the principles of glaze coloration, and the control of temperature and atmosphere during firing, thereby advancing ceramic craftsmanship from an empirical practice to a scientific discipline. Additionally, he established a museum to collect and study ceramics from around the world, further enriching the knowledge base of the field. Brongniart's initiatives laid a solid scientific and artistic foundation for the Sèvres Manufactory, further solidifying its leadership in the global ceramics industry. Given that Chinese porcelain had long been renowned for its distinctive glazes and exceptional craftsmanship, Brongniart designated it as a key research focus—both as part of an academic pursuit and as a strategic move in commercial competition.

The first step in studying Chinese porcelain is acquiring raw materials. Brongniart turned to merchants and consuls of all nationalities who planned to travel to China. Through his efforts, the Sèvres Manufactory successfully acquired a substantial collection of raw material samples during the 1840s and 1850s. These samples were primarily obtained through the contributions of three individuals: Joseph Ly (Chinese name Li Yuese 1803–1854), Jules Itier (1802–1877), and Rutherford Alcock (1809–1897). The collected samples encompassed the entire production process of Chinese ceramics, from unprepared raw materials to the finished product. They were not only diverse in type but also well-documented and of reliable provenance. Notably, Joseph Ly provided a detailed letter specifically describing the porcelain-making techniques of Jingdezhen.[3]18 The acquisition of these raw material samples made the systematic study of Chinese ceramic technology possible.

3. The Main Content and Methods of Ébelmen and Salvetat's Series of Scientific Research on Chinese Porcelain

In the mid-19th century, the Sèvres Manufactory conducted scientific research on Chinese ceramics under the leadership of Jacques-Joseph Ébelmen and Louis-Alphonse Salvetat. Both were experts with systematic training in chemistry, and their experience working at Sèvres, along with their immersion in the manufactory's production environment, facilitated their familiarity with specialized knowledge related to ceramics. The samples utilized in this research included those provided by the three main suppliers mentioned above, as well as additional materials donated by Joseph Ly to the École des Mines in France and select finished pieces from the Sèvres Manufactory's museum collection.

The first paper focused on analyzing the raw materials used in ceramic bodies and white glazes, including kaolin, porcelain stone, talc, glaze frit, glaze ash, gypsum, and pre-processed ceramic

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pastes.[6] Since no prepared transparent glaze materials were available, finished porcelain glaze samples were also examined. The second paper analyzed various overglaze enamel materials, such as powdered glass, Qian Fen(lead oxide), cobalt pigment, white, black, blue, green, yellow, and red enamels, as well as gold foil, diluents, and brushes.[7] The final paper investigated some medium and high temperature colored glazes found on Chinese porcelain pieces from the Sèvres collection, such as copper reds, celadon, etc.[8] In the first two papers, researchers conducted quantitative analyses of the chemical compositions of these materials. However, due to the lack of raw materials, the third study was limited to qualitative analysis.

In order to gain a deeper understanding of the materials used by the Chinese in the production and decoration of porcelain, the researchers employed a series of scientific and technological methods, with mineralogical identification and high-temperature testing as primary approaches. Given the large number of unprocessed mineral raw materials involved in the study, the researchers first conducted detailed observations of their external characteristics, such as color, texture, and mineral structures (e.g., quartz, feldspar, mica), and measured the density of the samples to gain an initial understanding of the raw materials. Then by subjecting the samples to high temperatures, the researchers determined mass loss upon heating, which allowed them to assess the materials' loss on ignition. Additionally, raw materials were fired in the kilns of the Sèvres Manufactory to observe their fusibility and color changes, such as the whiteness of kaolin at high temperatures and the fluidity of glazes, etc.

The next series of methods employed was chemical analysis. Depending on the research requirements, the raw materials were subjected to sequential processes, including crushing, levigation, air drying, and high-temperature calcination. They were then treated with hydrochloric acid, sulfuric acid, and nitric acid etc, followed by roasting and immersion in boiling potassium carbonate or ammonia solution, among other procedures. Through these classical chemical analysis techniques, the samples underwent mineral decomposition, facilitating the separation and identification of metal oxides. The primary chemical components, such as the percentages of silicon, aluminum, iron, potassium, sodium, cobalt, manganese, and copper oxides, were quantitatively determined. These analytical methods were not merely adopted from previous researchers; the distinguished chemist Ébelmen himself introduced several significant methodological improvements.

The third method employed was technical firing experiments in kilns. Under experimental conditions in the manufactory, experiments were conducted that Chinese raw materials were tried on French porcelain bodies. For instance, Qimen porcelain stone were crushed, washed, and processed, then uniformly applied to a Sèvres porcelain body piece using a dipping technique. After firing at high temperatures, a beautiful glaze layer formed on the surface.[6]266

In addition to the aforementioned scientific methods, the researchers also integrated the results of their scientific analysis with historical documentation, and compared these findings with the raw materials and techniques of French porcelain manufacturing, further deepening the understanding of Chinese porcelain.

4. The Significance and Limitations of the Sevres Manufactory's Scientific Research on Chinese Porcelain in the Mid-19th Century

During this period, by way of the systematic study of the rich and reliable Chinese porcelain samples using a variety of scientific analytical techniques and methods, the Sèvres Manufactory has obtained substantial and valuable research findings. The following points outline the significance of the scientific research on Chinese porcelain:

First, it was the first systematic effort to reveal the chemical and mineralogical characteristics of various Chinese ceramic raw materials, a groundbreaking discovery that forms the core value of this research.

In the 19th century, the French scholar Otto du Satel (1832-1891), while commenting on the letters of Father Entrecolles, pointed out that Chinese kiln workers and painters had transmitted certain terms related to ceramic production, such as names of elements, firing techniques, and common kiln vocabulary to Europe, but these elements were difficult to understand, and some were even incomprehensible.[9] The Sèvres Manufactory's research on Chinese ceramic technology during this period precisely articulated its findings using scientific data and professional terminology.

This achievement not only filled the gaps in the historical accounts provided by earlier researchers, but also laid a solid theoretical foundation for the scientific understanding of Chinese ceramic raw

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materials and techniques. Rose kerr comments that these pioneering scientific studies paved the way for further research into Chinese ceramics, by both both Chinese and Western scholars, in the +20th and +12th centuries.[10] what's more, they later were applied to production practices. These extensive analyses of Father Ly's samples presumably fed directly into the formulation of the body pastes at Sèvres from the mid-nineteenth century onwards.[11] The Sèvres Manufactory developed a new hard-paste porcelain production technique by the end of 19th century.

Secondly, the research delved into the decorative art characteristics of Chinese porcelain.

Prior to this, Father Entrecolles had criticized the painting techniques on Chinese porcelain, describing them as "roughly executed, comparable to the work of apprentices in Europe who had only studied for a few months. Although these craftsmen possessed some painting skills, they were entirely ignorant of the principles of artistic composition".[12]149 Similar viewpoints are frequently found in Western literature.

However, this study, through the scientific analysis of enamels, demonstrated that the metal oxide colorants used in Chinese porcelain had relatively low concentrations. Based on this finding, the researchers further recognized that only when the pigments reach a certain thickness can the colors of Chinese porcelain fully display their intended color effects, so the harmonious aesthetic of porcelain painting is, in fact, the result of the interaction between the glaze properties and its chemical composition.[7]360 This conclusion provided a scientific basis for the aesthetic qualities of Chinese porcelain decoration and further promoted an objective evaluation of its painting techniques. The perspective on materials and its influence on the understanding of Chinese porcelain decorative art was widely accepted by later French scholars such as Otto du Sartel, Ernest Grandidier (1833-1912) and others. Subsequently, there was an increasing number of works focused on the study of Chinese ceramic art around the world.

Thirdly, the study explored the similarities and differences between Chinese and French porcelain manufacturing techniques. The research showed that the processing methods for Chinese porcelain body materials were largely similar to those used in Europe, but there were significant differences in firing techniques and glaze characteristics. Compared to European porcelain, Chinese porcelain was fired at lower temperatures, and its glaze exhibited more fusible properties. This phenomenon was primarily attributed to the higher proportion of lime content in the glaze.[6]285 These differences also serve as opportunities for mutual learning and inspiration.

Although this series of studies holds the aforementioned significance, there are also some limitations. First, due to the researchers' oversight, they concluded that Chinese porcelain stones, like European porcelain, are compact feldspar. In fact, Ébelmen and Salvetat did note that the Chinese petrosilex contains a considerable amount of water that does not leave even when the material is exposed to temperatures of 100°C for an extended period and must be heated to a red-hot state to be completely removed,[6]268 but unfortunately, they didn't attach importance to it. Through the efforts of later scholars, a deeper understanding of the subject was achieved. Wood summarized that the feldspar tends to operate as a secondary flux to the potassium mica, mainly taking the form of sodium feldspar (albite) in Jingdezhen porcelains, and the feldspars were present in the local porcelain-stones, mixed naturally with large amounts of quartz and mica and, in many cases, primary kaolinite (true clay).[13] Secondly, due to the researchers' limited knowledge of Chinese ceramic ancient texts, the paper repeatedly misidentifies the supervisor of the kiln, Tang Ying, as the author of *Tian Gong Kai Wu* (*The Exploitation of the Works of Nature)*. At that time, the French sinologist Stanislas Julien (1797-1843) began compiling the book *Histoire et Fabrication de la Porcelaine Chinoise* (*The History and Manufacturing of Chinese Porcelain*), which was primarily based on sections from the Chinese ceramic classic *Jing Dezhen Tao Lu (Description of the Porcelain of Ching-te-chen)*, while also referencing other important works such as *Fu Liang Xian Zhi* (Gazetteer of *Fuliang County)*, Song Yingxing's *Tian Gong Kai Wu* (*The Exploitation of the Works of Nature)*, and Tang Ying's *Taoye Tushuo(Illustrated Explanation of Ceramic Production)*.[14] Perhaps the researchers were confused by so many texts and their authors.

5. Conclusion

In summary, during the mid-19th century, the French Sèvres Manufactory, as a representative of national porcelain art, focus on ceramic scientific research, which included the study of Chinese porcelain. With the help of missionaries, merchants, diplomats, and others, the manufactory obtained a large amount of raw materials from Jingdezhen porcelain production and the over-glaze enamels used

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in Canton porcelain painting. Through a series of mineralogical, chemical analyses, and firing experiments, the manufactory's chemists studied these materials and for the first time gathered analytical data on various aspects of Chinese porcelain, including raw materials, formulations, processes, and coloring principles. This study provided the academic world with a scientific and objective understanding of Chinese porcelain, laid the scientific foundation for the aesthetic characteristics of Chinese porcelain decoration, further promoted an objective evaluation of its painting techniques, and revealed the similarities and differences between Chinese and French porcelain materials and techniques.

However, due to the researchers' own oversight and limited understanding of Chinese ceramic literature and knowledge, there were some issues in the study. The mistaken belief that Chinese porcelain was similar to European "feldspathic" porcelain stemmed from this misunderstanding. Nevertheless, the scientific nature of this study and its pioneering contributions to the history of research on Chinese porcelain technology are undeniable. Moreover, it was another significant contribution by the French academic community to the scientific understanding of Chinese ceramic techniques, following the letters of Father Entrecolles. The publication and reprints of this series of papers, along with the citation of related knowledge, facilitated the spread of Chinese ceramic culture in Europe and even around the world.

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