Evolution of Aesthetics, Craftsmanship, and Human - Meteorology Relations in Ru Porcelain under Meteorological Perspectives

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Abstract This paper examines the traditional handicraft of Ru porcelain from a unique perspective on the relationship between meteorology and human agency. In this paper, the use of "blue after rain" glaze as a visual symbol of the Song Dynasty's concept of "interaction between heaven and man" and the aesthetics of power is analyzed. Using the theory of anthropological "practical knowledge", this paper reveals how the Ru porcelain firing technique constructs a technical system deeply coupled with local meteorological knowledge through bodily experiences such as "observing the sky, distinguishing the air, and adjusting the kiln". Furthermore, through the evolution axis of energy and kiln technology, the logic of the evolution of the "human - meteorology relationship" in Ru porcelain firing from a natural embedding mode of "conforming to the natural order" to a deterministic production mode of "de meteorologization" is outlined. The paper not only profoundly reveals the ecological wisdom contained in Ru porcelain as a material cultural heritage, but also uses this case to map the inherent tension of "technical efficiency" and "ecological perception" faced by traditional handicrafts in the transformation of modernity, providing interdisciplinary inspiration for re understanding the contemporary value of ancient material culture.

Key words Ru porcelain; Meteorological phenomena; Interaction between heaven and man; Practical knowledge; Human - meteorology relationship; Technology transformation

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The aesthetic characteristics of Ru porcelain, such as "blue as the sky, surface like jade, crab claw pattern, sparse morning star, and the piece was fired with full glaze and supported by small spurs, leaving only faint traces at the base"[1], has always been placed under the dominant interpretation of raw material formula and palace aesthetics. However, a crucial dimension of production logic that has long been obscured: meteorological conditions and their fundamental interaction with process practice require systematic academic exploration. Starting from the *Artificers' Record* that states "heaven has its own time, and the earth has its own energy"[2], traditional Chinese creative thinking regards "heaven timing" (*i.e.* natural rhythms and weather) as the foundation of craftsmanship. The formation of Ru porcelain is not carried out in a vacuum, but is rooted in a "microclimate zone" formed by the specific monsoon climate and hydrogeology of Ruzhou in western Henan. Its production process and kiln operation are deeply embedded in the local phenological rhythm and instantaneous weather. Therefore, it is not only a microscopic examination of craftsmanship by re examining the significance of meteorology in Ru porcelain, but also a material decoding of the ancient Chinese philosophy of coexistence between humans and nature.

By combining the "macro narrative" of cultural analysis with the "micro textual research" of technological history, the cognitive landscape of Ru porcelain research is reconstructed based on meteorology. Firstly, it explores how the color standard of "blue after rain" has evolved from a natural phenomenon to an "aesthetic - political code" that carries cosmology and imperial politics. Secondly, it delves into how craftsmen throughout history have formed a set of technical systems based on their experience and knowledge to cope with, utilize, and even simulate weather, which is a highly localized and embodied "practical knowledge". Thirdly, it is also the core innovative argument of this paper, which analyzes the process of the "human - meteorology relationship" in Ru porcelain craftsmanship, aiming to reveal its technological philosophy transformation from "conforming to the natural order" to "controlling the natural order", and reflect the universal dilemma faced by the modernization of craftsmanship, that is, whether we are losing the dialogic wisdom with the natural environment while pursuing stability and efficiency. This paper aims to provide a vivid interdisciplinary examination sample for the research of ancient material culture, intangible cultural heritage inheritance, and contemporary environmental humanities.

1 "Ritualistic transformation of meteorology": cultural construction and power expropriation of sky blue glaze color in Ru porcelain

Although it is regarded as the inspiration for the color of Ru porcelain, the saying "after the rain stops and the sky clears up, the blue color exposed by the clouds is used to make porcelain"[3] is more significant in that it reveals the power operation

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mechanism of color as a cultural practice. It transforms a fleeting natural landscape into a national aesthetic standard that condenses ideology.

1.1 Aesthetic symbol transformation of natural phenomena "Blue after rain" is not an objective description of a constant blue color spectrum, but a capture of the saturated, clear, and vibrant blue color that appears in the sky at a specific time: after the rain, at a specific weather turning point: when clouds break and the sky opens. It is between green and blue, with both the calmness of blue and the gentleness of green, forming a moderate, elegant and harmonious color tone[4]. In the cultural context of the interweaving of strong Taoism and Neo Confucianism in the Northern Song Dynasty, this imagery perfectly blends the Taoist concept of "purity and non action" with the Confucian concept of "moderation and warmth", becoming a visual theme that connects the harmony of the universe, political clarity, and personal self-cultivation. Emperor Huizong of Song designated this meteorological image as the highest standard for imperial kilns, which was a precise symbolic political act, aimed at directly linking the legitimacy of imperial power with the indescribable "natural law" by monopolizing a visual link with specific natural images.

1.2 Logic of "simulating heaven" in technical practice From the perspective of material generation, the formation of sky blue glaze in Ru porcelain is highly dependent on the complex color reaction of iron ions in the glaze layer under reducing flame atmosphere, and its success or failure is subtly related to the atmosphere and temperature curve of the cooling process in the kiln. Although ancient craftsmen lacked modern chemical knowledge, they established a perception system through long-term practice that linked the weather conditions outside the kiln (such as wind direction, air pressure, humidity) with the control of the atmosphere inside the kiln. For example, changes in air pressure and humidity can affect the combustion rate and ventilation of fuel, thereby altering the oxygen content inside the kiln, ultimately resulting in subtle color differences such as sky blue, powder blue, and egg blue on the glaze surface. Therefore, the successful production of the color "blue after rain" is not only a result of glaze science, but also a practice of "timing" that captures, caters to, and even "simulates" specific external meteorological conditions within a limited human control framework. In this sense, glaze color is an "artificial celestial phenomenon" that is sealed on objects and solidified through human intervention.

2 "Technicalization of meteorology": phenological rhythms and localized knowledge in burning practice

Ru porcelain firing is a highly environmentally sensitive systematic technique, which is essentially an "ecological adaptability technology" that highly relies on and finely adapts to local meteorological conditions. This technology cannot be simplified into operational processes, but rather a form of "practical knowledge" rooted in specific geographical ecosystems and cultural traditions. This knowledge is more manifested in bodily perception, situational judgment, and synchronized production rhythms with phenological cycles, rather than textual theoretical summaries.

2.1 Synchronization of raw material processing and phenology The practice of Ru porcelain firing technology has shown that the starting point of Ru porcelain production chain is closely tied to meteorological cycles. For example, the mining of local clay needs to be carried out in the dry autumn season. After months or even years of open-air "aging", it is weathered and domesticated in the four-season cycle to achieve ideal physical properties. The collection and crushing of mineral raw materials for glazes such as agate and calcite also need to consider seasonal and weather factors to avoid excessive humidity or dust. This series of processes arranged around phenology is a collective habitual knowledge of craftsmen adapting to specific phenological environments in the local area, in order to achieve optimal raw material performance guarantee.

2.2 "Observing the sky, distinguishing qi, and adjusting the kiln" in physical experience The firing process is the core of the success or failure of Ru porcelain, and it is also the ultimate test of the craftsman's physical experience and weather perception ability. This is particularly evident in the era of using firewood and coal as fuel. Ancient craftsmen did not have instruments to measure oxygen concentration or flame temperature. They relied on their sense of smell (judging combustion status through smoke smell), vision (judging kiln temperature and atmosphere through changes in the color and luster of "fire"), hearing (judging ventilation through the sound of flame combustion), and physical sensation (judging aerodynamic conditions through wind direction and perceived humidity outside the kiln).

For example, experienced craftsmen must adjust the size of the kiln door inlet, the direction of the outlet, and even the height of the chimney baffle in real time according to the wind direction and wind force at that time, in order to form and maintain the weak reducing flame necessary for producing a "sky blue" color. This operation of "adjusting the wind according to the wind" is a continuous, fine tuned, and dynamic manual intervention of meteorological conditions, requiring craftsmen to have a comprehensive intuitive grasp of the local wind field rules, kiln structure, and complex chemical reactions between kiln changes. The basis for its judgment is not precise data, but the "sense of practice" internalized through countless successes and failures. This knowledge is integrated with the local climate environment, specific kiln structures, and even the physical and mental state of individual craftsmen, presenting distinct place-based and embodied characteristics that are difficult to replicate in writing without context.

3 From "adapting to the natural order" to "controlling the natural order": transformation of the "human – meteorology" relationship in the evolution of fuel and kiln technology

The deep thread of the millennium long firing history of Ru

porcelain is humanity's attempt to understand, cope with, and ultimately surpass meteorological uncertainty to replicate ideal glaze colors. Through the evolution of energy and kiln technology, this process clearly demonstrates the fundamental transformation of the "human – meteorology – technology" interaction mode. Taking the fuel as the core, it is divided into three historical stages for analysis.

3.1 Ancient "phenological dependence model": deep coupling between wood and coal burning and natural rhythms The ancient Ru porcelain firing represents the perfect technical interpretation of the traditional concept of "people following the laws of the earth, the earth following the laws of the sky, and the sky following the laws of the Tao". Its core technological features have two aspects. The first is ecological embeddedness of fuel. Specific wood as the main fuel, and its harvesting and drying must strictly follow phenological rhythms. It is not advisable to cut down trees in spring (due to high water content), and in summer, it is necessary to store them in direct sunlight. Fuel storage itself is a labor that is synchronized with the natural cycle. The type, year, and moisture content of wood directly determine the length, calorific value, and smoke composition of the flame, forming the basis for obtaining stable kiln temperature and ideal atmosphere. It is also a "phenological fuel production".

The second is the nature of "passive adaptation" of technology. Craftsmen face open or semi open dragon kilns and dome kilns. The aerodynamic system of the kiln itself is constrained by the atmospheric environment—wind force, wind direction, air pressure, and humidity together form an inseparable set of variables. At this point, the role of the craftsman is more like that of a "natural keen reader and limited regulator". They formulate firing strategies in advance by observing the weather, such as planning the layout of the kiln according to the seasonal wind direction, and making temporary and subtle adjustments during firing by observing the color of the kiln smoke, fire test pieces, *etc.* After the Yuan Dynasty, coal became the main fuel for firing porcelain, and the combustion of coal relied more on sufficient and stable ventilation to control the atmosphere inside the kiln. However, ventilation was directly affected by external wind, and craftsmen had to make stronger and more frequent manual interventions, namely finely adjusting the opening angle of the air outlet based on real-time wind direction and speed, and even temporarily blocking some air outlets with mud and ash to maintain a stable atmosphere inside the kiln, creating a "semi artificial microclimate" conducive to generating a reducing atmosphere.

3.2 Contemporary "de meteorologization model": realization of electric kiln, gas kiln and technological certainty Since the late 20th century, liquefied gas kilns and electric kilns have gradually become the mainstream equipment for Ru porcelain production, marking a fundamental philosophical shift in the firing mode—"de meteorologization". This is directly affected by two factors. The first is the purity and controllability of the fuel. Liquefied gas and electricity are highly pure, stable, and controllable energy sources. Electric kilns directly convert thermal energy through heating elements, while gas kilns transport gas through controllable flow valves, both of which are completely cut off from the external atmospheric environment (such as humidity and oxygen content) and the fluctuation of the fuel itself. The second is to construct a closed artificial thermodynamic system. Electric and gas kilns use completely sealed metal or composite insulation structures. The temperature is regulated by precision thermocouples and digital temperature controllers, while the atmosphere is monitored by air valve flow rate and sensors. The entire process can be programmed with parameters (temperature curve, atmosphere ratio) and recorded and automatically calibrated through computer programs.

These two factors have enabled modern Ru porcelain artists to realize their ideal of "controlling the heaven timing". The firing process has transformed from an uncertain and highly dependent skill on the dialogue between craftsmen and "divine will" to a precise, repeatable, and standardized laboratory production process. The "black box" of Ru porcelain firing has been largely opened up, leading to the replacement of the accidental factors behind mysterious beauty such as "blue after the rain" by scientific principles. Its chromaticity, glossiness, and opening effect have achieved unprecedented stability and high success rate.

3.3 Victory of technological rationality and loss of "practical knowledge" With the advancement of technology, a profound cultural rupture has also emerged: the highly personalized and embodied "practical knowledge" that was once honed in "listening to the wind and distinguishing the image" is rapidly declining. The new generation of craftsmen have mastered the control panel and programming software, but they can no longer predict and correct the firing results by sensing temperature changes, listening to the whistling wind in the kiln, or observing the clouds passing by in the sky. "Heaven timing" has transformed from a lively conversational partner to a disruptive variable that needs to be eliminated. Although technology has reproduced the "form" and "color" of Ru porcelain, we have to ask: has the spiritual state and process experience of waiting in uncertainty, capturing and achieving the beauty of Ru porcelain through coordination, and engaging in dialogue with nature also disappeared? When the firing process completely eliminates its dependence on weather, as the poetic core of "heavenly craftsmanship" and "human ingenuity" crystallization, can Ru porcelain be fully preserved in pure standardization and automation? This is not only a question about the inheritance of Ru porcelain, but also a long-standing paradox in modern technological philosophy: we have gained stronger control over nature, but at the same time, we may be losing our profound and intuitive connection with the natural world.

4 Conclusions

This paper systematically reinterprets the cultural significance, technological system, and historical evolution of Ru porce-

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2.3.1 Light olefin yield. The yields of ethylene plus propylene and ethylene plus propylene plus butylene from F-T gasoline cracking were substantially higher than those from aromatic raffinate. At 630 ℃ and 1.5 h^{-1}, the ethylene plus propylene yield of F-T gasoline (41.10 wt%) was 1.52 times that of aromatic raffinate (27.06 wt%), which is ascribed to the high α-olefin content of F-T gasoline, facilitating β-scission to form light olefins.

2.3.2 Liquid aromatic content. At the same temperature, the aromatic content of liquid products from F-T gasoline cracking was much higher than that from aromatic raffinate, reaching 79.20 wt% at 670 ℃ versus only 34.10 wt% for the latter. Olefins exhibited higher aromatization activity than saturated hydrocarbons.

2.3.3 Reaction condition adaptability. The optimal temperature for F-T gasoline cracking was 630 – 650 ℃, balancing olefin yield and selectivity. In contrast, aromatic raffinate required a higher temperature (645 ℃) to enhance cracking and aromatization.

3 Conclusions

(1) The F-T gasoline fraction, containing 60.57 wt% α-olefins and ultra-low heteroatom contents, is an excellent feedstock for catalytic cracking to light olefins. Under optimized conditions (630 ℃, 1.5 h^{-1}, and 0.05 MPa), the yield of ethylene plus propylene reached 41.10 wt%. At 670 ℃, the yield of ethylene plus propylene increased to 43.37 wt%, with a liquid aromatic content of 79.20 wt%.

(2) The reforming aromatic raffinate can be upgraded via catalytic cracking for high-value utilization. At 645 ℃, a yield of ethylene plus propylene of 27.53 wt% and a liquid aromatic content of 34.10 wt% were achieved. Higher temperatures favored both light olefin production and aromatic formation.

(3) Space velocity significantly influenced the cracking performance of F-T gasoline. A space velocity of 1.5 h^{-1} was optimal; lower space velocity promoted over-cracking, while higher space velocity resulted in insufficient conversion.

(4) Marked differences in cracking behavior existed between the two feedstocks. The F-T gasoline fraction was highly suitable for high-yield production of light olefins and aromatics, whereas the aromatic raffinate required more severe conditions for efficient conversion. The results provide a technical basis for the industrial application of these light hydrocarbon streams.

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lain from a meteorological perspective. Firstly, it clarifies the symbolic political attributes of "blue after rain" beyond aesthetic imagery, which is a visual extension of the imperial cosmology. Secondly, relying on the theory of "practical knowledge", it reveals that the essence of traditional Ru porcelain firing techniques is an "ecological adaptive technology" that integrates meteorological perception, physical skills, and phenological rhythms, demonstrating how ancient people internalized "heaven timing and earth qi" into exquisite craftsmanship practices. Finally, this paper focuses on the evolution of Ru porcelain technology from wood burning to modern electric and gas kilns, and constructs a "human – meteorology relationship" from a "phenological dependence model" that "conforms to the natural order" to a "de meteorologization model" that "shields the weather". This is not only a history of improving process efficiency, but also an evolution of the way humans deal with the relationship between the natural world, reflecting the rational pursuit of certainty and control in modern technology, while also gradually distancing itself from the symbiotic wisdom and process poetry contained in traditional craftsmanship. Therefore, the core value of Ru porcelain as an intangible cultural heritage should not only lie in its glaze color and form itself, but also in the ecological wisdom and life philosophy of "entering the Dao through technique and crafting art according to the heavens" contained in it. The understanding of this wisdom undoubtedly has profound enlightening significance for us to explore a more harmonious and sustainable form of civilization in today's increasingly tense relationship between technology and nature.

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