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MINERAL MEMORY AND MATERIAL REVIVAL: THE EVOLUTION OF CHINESE ROCK COLOR PAINTING FROM PAINTED POTTERY TO CONTEMPORARY PIGMENT INNOVATION

MEMÓRIA MINERAL E REVITALIZAÇÃO MATERIAL: A EVOLUÇÃO DA PINTURA EM ROCHAS CHINESAS, DA CERÂMICA PINTADA À INOVAÇÃO CONTEMPORÂNEA EM PIGMENTOS

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Abstract
This study provides a multidisciplinary synthesis of the historical evolution, material composition, and contemporary revival of Chinese rock color painting. We trace the evolution of mineral pigments from Neolithic painted pottery and early cave paintings to the Tang Dynasty, when they gained popularity, and subsequently to the period of literati ink painting, when their usage declined. The research reveals a fundamental connection between the significance of pigments and the broader artistic and cultural changes in China, specifically in the realm of ceramic aesthetics. Ceramics are specifically emphasized in comparative material studies because of their historical role as early substrates for mineral color and their concurrent technical heritage in color saturation, layering, and pigment stability. This study outlines the shared origins of rock color painting and ceramic decoration in mineral-based visual art. The study subsequently examines the resurgence that occurred in the late 20th century. It discusses how Chinese artists educated in Japan introduced novel material advancements. These comprise synthetic rock pigments, superior mixing agents, and enhanced methods for color sorting. The study investigates the interplay between traditional Chinese techniques, Japanese industrial pigment research, and modern scientific developments in binder formulation. This research offers novel insights on the relationship between pigment invention and the connection of ancient art forms, such as pottery, to contemporary fine art practices

Resumo
Este estudo oferece uma síntese multidisciplinar da evolução histórica, composição material e renascimento contemporâneo da pintura rupestre chinesa. Traçamos a evolução dos pigmentos minerais desde a cerâmica pintada do Neolítico e as primeiras pinturas rupestres até a Dinastia Tang, quando ganharam popularidade, e posteriormente até o período da pintura a tinta dos literatos, quando seu uso declinou. A pesquisa revela uma conexão fundamental entre a importância dos pigmentos e as mudanças artísticas e culturais mais amplas na China, especificamente no âmbito da estética cerâmica. A cerâmica é enfatizada em estudos comparativos de materiais devido ao seu papel histórico como substrato inicial para a cor mineral e à sua herança técnica concomitante em saturação de cor, estratificação e estabilidade do pigmento. Este estudo descreve as origens compartilhadas da pintura rupestre e da decoração cerâmica nas artes visuais baseadas em minerais. O estudo examina, posteriormente, o ressurgimento ocorrido no final do século XX. Discute como artistas chineses educados no Japão introduziram avanços materiais inovadores. Estes incluem pigmentos rupestres sintéticos, agentes de mistura superiores e métodos aprimorados para a seleção de cores. O estudo investiga a interação entre técnicas tradicionais chinesas, pesquisas japonesas sobre pigmentos industriais e desenvolvimentos científicos modernos na formulação de aglutinantes. Esta pesquisa oferece novas

through an analysis of rock color painting within a material-cultural framework. It significantly contributes to the ongoing discourse over tradition, sustainability, and the future of mineral-based media.

Keywords: Rock Color Painting. Mineral Pigments. Materiality. Ceramic Aesthetics. Artistic Revival.

perspectivas sobre a relação entre a invenção de pigmentos e a conexão de formas de arte antigas, como a cerâmica, com as práticas contemporâneas de belas artes, por meio de uma análise da pintura rupestre dentro de uma estrutura material-cultural. Ela contribui significativamente para o debate em curso sobre tradição, sustentabilidade e o futuro dos materiais à base de minerais.

Palavras-chave: *Pintura Rupestre. Pigmentos Minerais. Materialidade. Estética Cerâmica. Renascimento Artístico.*

1 INTRODUCTION

1.1 Chinese rock color painting and temporal continuity

Chinese rock color painting, an artistic discipline primarily utilizing mineral-based pigments, occupies a crucial position at the intersection of material science, cultural expression, and temporal continuity (Lin & Zhang, 2024; Xin, 2024). These mineral pigments have significantly influenced the symbolic and aesthetic dimensions of Chinese visual culture, exhibiting remarkable stability and brightness throughout millennia (Orna, 2015; Miller, 2022). The historical timeline extends from the painted ceramics of the Yangshao civilization (Chang, 1987) to the vibrant paintings of the Tang Dynasty's Dunhuang Grottoes (Liu et al., 2025; Whitfield et al., 1990). The material palette, which came from natural ores like lapis lazuli, malachite, and ochre, helped this heritage last a long time (Berke et al., 2009; Yang et al., 2017).

Historically, rock color painting thrived in conjunction with advancements in ceramic and mural art, reflecting the technological sophistication of Chinese civilization and its vital role in transregional trade networks such as the Silk Road, which enabled the importation of essential pigments (Liu et al., 2024; Winter, 2021). In the Song and Yuan dynasties, a significant shift in aesthetic preferences occurred, leading to the widespread popularity of literati ink painting (水墨畫) (Hu, 2023; Wang, 2025). This philosophical perspective prioritized spontaneous expression (spontaneity over materiality) and embraced a monochrome style. This shift diminished the popularity and significance of labor-intensive color-based traditions (Bush & Shih, 2012; Wang, 2014).

The resurgence of interest in rock color painting in the late 20th century signified a crucial new epoch, partially influenced by Chinese artists studying in Japan (Wang, 2014; Yan, 2020). This transnational dialogue has catalyzed the amalgamation of traditional materials with innovative concepts, resulting in novel methods for pigment production, enhancement of blending agents, and standardization of particle grading (Xin, 2024). Yu Junru & K. (2024) parallel this renaissance with developments in other cultural heritage areas, employing contemporary technologies and concepts to reevaluate traditional approaches.

1.2 The multidisciplinary discourse on rock color painting

The current literature on Chinese rock color painting is extensive but fragmented, including historical, technical, cultural, and material dimensions (Liu et al., 2025; Wang, 2025).

1.2.1 Historical and cultural foundations

Researchers consistently associate the origins of rock color painting with early Neolithic pottery and cliff murals, emphasizing its concurrent development with ceramic design and ancient ritual significance (Chang, 1987; Xu et al., 2025). Scholars concur that rock color painting had its zenith of competence and artistry during the Tang Dynasty. The Silk Road brought mineral colors like lead (Schafer, 1956) and lapis lazuli to China for use in the Dunhuang paintings (Wei et al., 2023; Whitfield et al., 1990). The eventual decline of the practice is intricately associated with the rise of literati ink painting (Hu, 2023; Wang, 2025). This alteration, coupled with elevated costs and challenges in pigment preparation, resulted in the marginalization of mineral color aesthetics for centuries (Golas, 2014; Wang, 2014).

1.2.2 Transnational revival and technical innovation

A substantial corpus of research elucidates the resurgence of rock color painting in the 20th century (Wang, 2014). Researchers highlight the significant role of Japanese artists, who inherited and refined the Tang-era material tradition, improving techniques

through the refinement of commercial pigments and imbuing them with modern artistic significance (Graham & Chance, 2021; Lizun et al., 2022). Chinese artists educated in Japan throughout the 1980s revived these methodologies, acting as a crucial catalyst for technological and artistic advancement in China (Wang, 2014).

Recent technical analyses corroborate this trend by investigating improvements in pigment composition, blending agents, and visual effects (Gärtner, 2021; Yan, 2020). Current studies highlight the technological advancement of mineral particles (Liu et al., 2024) and the application of non-invasive analytical techniques, including HH-XRF (Zhang et al., 2023), THz spectroscopy (Yang et al., 2017), and machine learning (Markowski et al., 2025), to precisely identify and classify ancient pigments (Shen et al., 2024; Zhang et al., 2021).

1.2.3 Research gap

Although prior research has emphasized the historical significance and contemporary revival of Chinese rock color painting, gaps remain in understanding its material relationship between ceramic and pictorial art forms. A comprehensive analysis of the influence of ancient mineral pigment techniques—originally utilized in pottery and mural painting—on the aesthetics, texture, and materiality of modern rock color painting is lacking. Traditional Chinese practices and Japanese industrial pigment innovation remain underexplored as a transnational material heritage phenomenon. This study seeks to rectify these shortcomings by presenting a material-focused art historical narrative and an experimental analysis of pigment properties and their evolving applications.

The principal shortcoming in the literature on Chinese rock color painting is the lack of a thorough, interdisciplinary examination that covers the complete history of the medium. Contemporary research is bifurcated: Historical and cultural studies accurately outline the chronology from the Neolithic period to the zenith of the Tang Dynasty; yet they often lack thorough material and technological study across many eras. Conversely, contemporary and transnational studies examine Japan's impact on other nations and the transformative effects of new technologies on the world, albeit within a limited temporal scope. Scientific and conservation studies employ advanced non-invasive techniques (such as HH-XRF) to analyze individual, static artifacts; nonetheless, they are limited to discrete case studies rather than extensive comparative analyses of material changes

throughout time. The primary deficiency is the absence of a comprehensive study that integrates the historical context and cultural changes with the evolution of material preparation, technical application methods, and binding agents from ancient ceramics to modern mineral-based painting techniques.

Scarce research offers a thorough synthesis of the progression of materials from ancient pigment applications (e.g., on ceramic substrates) to contemporary mineral-based painting techniques, particularly through a comparative and multidisciplinary framework that integrates historical context, technical material science, and empirical artistic practice. The deficiency is in the absence of comprehensive research that examines the "what" (identification of pigments), the "how" (technical application methods and binders), and the "when/why" (historical and cultural transformations) across the medium's complete history.

2 RESEARCH OBJECTIVES

1. To examine the historical and cultural importance of Chinese rock color painting, spanning from prehistoric painted pottery to contemporary mural and scroll art.
2. To examine the historical and contemporary methods, pigments, and blending agents employed in rock color painting, and their evolution throughout time.
3. To explore how Japanese innovations in materials and superior industrial pigments have revitalized Chinese rock color painting in contemporary society.
4. To investigate the visual and textural effects of rock color pigments through studio experiments and comparisons with other media.

3 RESEARCH METHODOLOGY

This study utilizes a mixed qualitative methodology that carefully integrates historical analysis, material assessment, and studio-based artistic creation. The research design posits that to fully comprehend the evolution of traditional art forms and their potential future, one must engage with them actively rather than merely contemplating them. This comprehensive approach enables the triangulation of historical knowledge, technical procedures, and creative outcomes, offering a detailed and cohesive perspective on the continuity and contemporary relevance of Chinese rock color painting.

3.1 Research design components

The study is systematically organized into four interconnected components, each addressing specific research objectives:

3.1.1 Historical research

To achieve Objective 1, this component necessitates a thorough examination of archives and literature. It traces the trajectory of Chinese rock color painting from ancient painted ceramics and Han-Tang Dynasty murals, such as those in Dunhuang, to its decline during the Song Dynasty and its contemporary resurgence. Primary and secondary sources (art historical texts, pigment manuals, exhibition catalogues, artist interviews) and visual analysis of significant historical examples (e.g., Tibetan thangkas) will be utilized to understand the formal characteristics, cultural contexts, and historical evolution of techniques and iconography.

3.1.2 Technical and material study

This section compares pigment components, binders, and substrates, considering Objective 2. We will examine the particle composition and color characteristics of many natural pigments, including malachite, azurite, and cinnabar, as well as their contemporary synthetic counterparts. We will evaluate binders, including traditional animal glue, gelatin, and modern resins, to assess their adhesion and impact on saturation. This study employs scientific analytical techniques, such as microscopy and spectroscopy, with technical reports and material samples, to assess material behavior throughout different historical periods and practices.

3.1.3 Empirical/practice-based artistic research

This research, grounded on studio practice, explores the visual and textural potential of rock color painting, central to Objective 4. A series of controlled painting experiments will be conducted, modifying pigment granularity, binder concentration, and layering techniques. These studies will yield direct observational data concerning

aesthetic consequences, encompassing color brightness, opacity, granulation, surface texture, and expressive effects. Documentation will include process photography, reflective journaling, and pigment samples to assess practical feasibility and artistic adaptation.

3.1.4 Cross-cultural and transnational analysis

This section of Objective 3 examines Japanese inventions through a comparative analysis of various literary works and case studies, including post-Meiji Nihonga practices and contemporary industrial pigment classification. We will examine significant advancements, such as enhanced particle grading systems and synthetic rock pigments, to understand how Japanese material expertise was transmitted and adapted and its impact on the technological resurgence of contemporary Chinese rock color painting.

3.1.5 Trustworthiness measures

To ensure the rigor of this integrated qualitative and practice-based study, the following metrics were implemented to enhance its credibility (internal validity), transferability (external validity), dependability (reliability), and confirmability (objectivity):

- **Credibility:** This was accomplished by methodological triangulation, integrating historical, technical, and practice-based data, and collaborating with external experts, including art historians and specialists.
- **Transferability:** They are preserved by meticulously documenting the pigments, binders, and supports utilized in experiments, enabling later researchers or artists to replicate or modify them with ease.
- **Dependability:** A systematic documentation system in the studio (material logs, notes, photographs) was employed, and historical facts were verified against various scholarly and archival sources.
- **Confirmability:** To mitigate interpretation bias in the technical evaluation, researchers maintained reflective memoranda to acknowledge their biases and compared the material results to observable criteria such as colorfastness and stacking behavior.

4 RESULTS

4.1 The historical and cultural importance of chinese rock color painting

The historical development of Chinese rock color painting illustrates its enduring importance in cultural expression and artistic identity from antiquity to the present day. This mineral-based artistic form has evolved due to alterations in cosmology, ritual practices, and interregional trade. It illustrates the evolution of aesthetic values and material innovation across time.

4.1.1 Historical Trajectory and Material Foundations

- **Antiquity (Neolithic to Han Dynasty):**
  - Early Use: The tradition commenced with the painted pottery of the Yangshao culture (about 5000–3000 BCE), which employed natural mineral pigments such as red and black ochres for ceremonial and symbolic embellishment.
  - Early Monumental Works: This endeavor established the foundation for significant creations such as the Luoyang and Mawangdui tomb murals during the Han Dynasty (206 BCE–220 CE).
- **The Zenith (Tang Dynasty, 618–907 CE):**
  - Chromatic Sophistication: The pinnacle of rock color painting was achieved through the Silk Road, which introduced exotic pigments such as lapis lazuli from Afghanistan.
  - Cultural Zenith: The extensive Buddhist murals in the Mogao Caves of Dunhuang were created between the 4th and 10th centuries CE. Malachite (green), cinnabar (red), and azurite (blue) were among the pigments used to make bright, layered images that were connected to Buddhist cosmology and imperial patronage.

4.1.2 Decline and marginalization (song–qing dynasties)

- Aesthetic Shift: The emergence of literati painting, endorsed by scholars such as Su Shi, established monochromatic ink and individualized brushwork as the predominant artistic style.
- Marginalization: Individuals began to favor ink-based abstraction over mineral pigments, which were regarded as ornamental and aristocratic. Rock color painting predominantly persisted within traditional frameworks, including Buddhist temple art and folk ceremonial contexts.

4.1.3 Contemporary revival and cultural significance

- Contemporary Reawakening: The resurgence of rock color painting in contemporary times indicates a cultural shift towards historical preservation, identity formation, and a reevaluation of traditional visual language.
- Dynamic Practice: Currently, it functions as a vibrant platform for artists to merge traditional craftsmanship with contemporary material science and global artistic discourse, sometimes including cross-cultural influences (see Objective 3). The medium serves as a significant connection to China's extensive artistic and material heritage.

The complete trajectory, from the initial application of minerals to contemporary materials research is illustrated in Figure 1. The illustration demonstrates the convergence of historical context, artistic emphasis, and material innovation.

Figure 1

Visual timeline of historical development

(a)

(b)

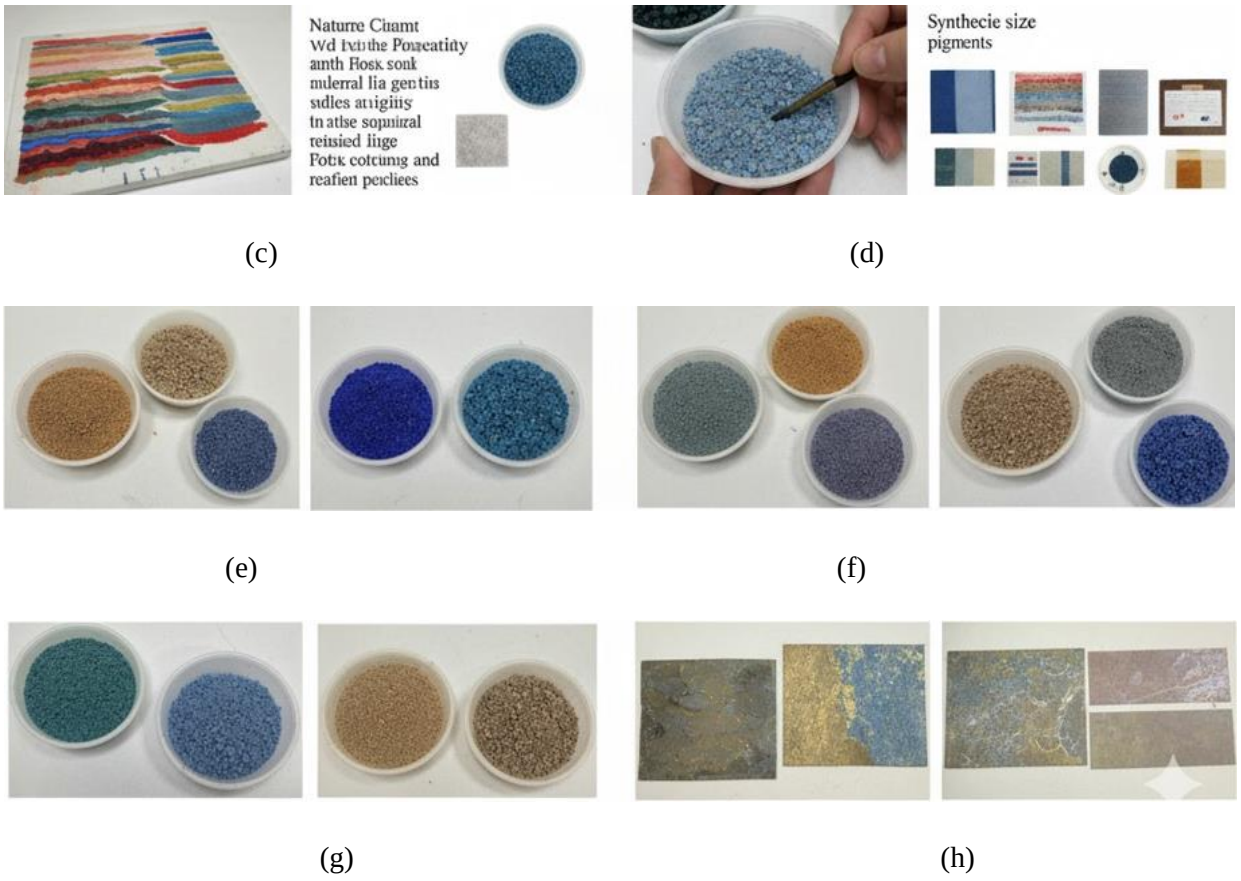


Figure 1 illustrates a timeline detailing the evolution of Chinese rock color painting across four historical phases. It highlights how the art form's central theme and technical materials changed over time. The graphic (a-h) is structured around four primary chronological rows, each depicting a distinct phase in the medium's development:

(a) Neolithic to Tang Dynasty: Flourishing of Natural Mineral Color: This part pertains to the inception of the era, encompassing Neolithic painted pottery and the Dunhuang murals. The artwork primarily encompasses painted pottery, murals, and pigments derived from the Silk Road. It consists of natural minerals such as malachite and lapis lazuli.

(b) Song–Qing Dynasties: Marginalization and Decline: This row discusses the evolution of the art form, highlighting the increasing use of literati ink and the diminishing significance of mineral aesthetics. The novel material demonstrates that botanical dyes and mineral pigments may serve as alternatives.

(c) Post-1980s Revival (Japan–China): Introduction of Synthetics: This section discusses the contemporary resurgence occurring due to global impact. The primary objective is to reintroduce mineral aesthetics into contemporary art. The

primary emphasis of material innovation is on synthetic rock hues and improved particle gradation, such as some Japanese industrial grades.

(d) Contemporary Practices: Hybridity and Material R&D: The final row addresses current events. The primary emphasis is on the amalgamation of many art forms and researching and development (R&D) on innovative materials. Material innovation encompasses sophisticated mixing agents, foil substances, and digital application techniques.

The four main historical periods (Neolithic to Tang, Song–Qing, Post-1980s Revival, and Contemporary Practices) are employed to establish study objectives that delineate four additional example categories (e, f, g, and h) that support the assertions made in the timeline.

(e) Cultural Apex: Visual evidence that the medium is optimized. This image or diagram of the Dunhuang Mogao Grotto murals illustrates the significance of the Tang Dynasty's extensive color palette in relation to cosmology and the empire.

(f) Technical Evolution: The diagram illustrates the production process of pigments. One panel depicted hand grinding natural ores using a historical technique including animal glue, while another panel exhibited a microscopic view of synthetic mineral pigments and a contemporary binder, highlighting the evolution of processes and blending agents.

(g) Transnational Catalyst: The map serves as a visual representation of the mutual influence between Japan and China. A graphic illustrating the evolution of technical knowledge: from the enhancement of Japanese Nihonga materials (synthetic pigment charts) to the establishment of Chinese rock color research facilities (such as Tianya) during the 1980s study period, symbolizing a resurrection.

(h) Textural Effects: Experimental studio showcasing particle differentiation. A compilation of sample swatches illustrating the same color (e.g., azurite) utilized in different gradations: Coarse particles produce a substantial, sculptural surface texture, while fine particles yield a pristine optical blend and elevated reflectivity.

Having examined the extensive historical and cultural trajectory of Chinese rock color painting—from its prehistoric origins to its contemporary resurgence—we now turn our attention from the *why* and *where* to the technical substance of the medium. The following section will detail the specific methods, pigments, and blending agents that

have defined this tradition, tracing their evolution from ancient, hand-ground minerals to modern, industrially refined materials.

4.2 Traditional and modern techniques, pigments, and blending agents

This section examines the technical fundamentals of Chinese rock color painting, tracing the evolution of its primary materials and techniques from traditional craftsmanship to contemporary hybrid approaches.

4.2.1 Traditional foundations

The technical distinctiveness of Chinese rock color painting lies in its meticulous utilization of natural mineral pigments and specific application techniques.

- Pigments: In the past, artists used minerals that they ground by hand, such as malachite (green), azurite (blue), and cinnabar (red). People liked these because they were strong, didn't fade in the light, and were naturally bright.
- Blending Agents: Animal glue or gelatin served as the primary traditional adhesive. The binder required meticulous preparation and application, as it significantly influenced the adhesion of the pigment and its resultant hue.
- Classical Techniques: Conventional methods focused on achieving depth and saturation through successive layers of application:
  - *Color Accumulation* (堆色法): Creating thick, impenetrable layers of color
  - *Sequential Layering* (重彩法): Applying many translucent layers to enhance color depth
  - *Line-Reserved Application* (留白技法): Employing techniques commonly utilized in murals and thangka scrolls to maintain clarity in linework and color saturation across extensive surfaces

4.2.2 Evolution and contemporary hybridity

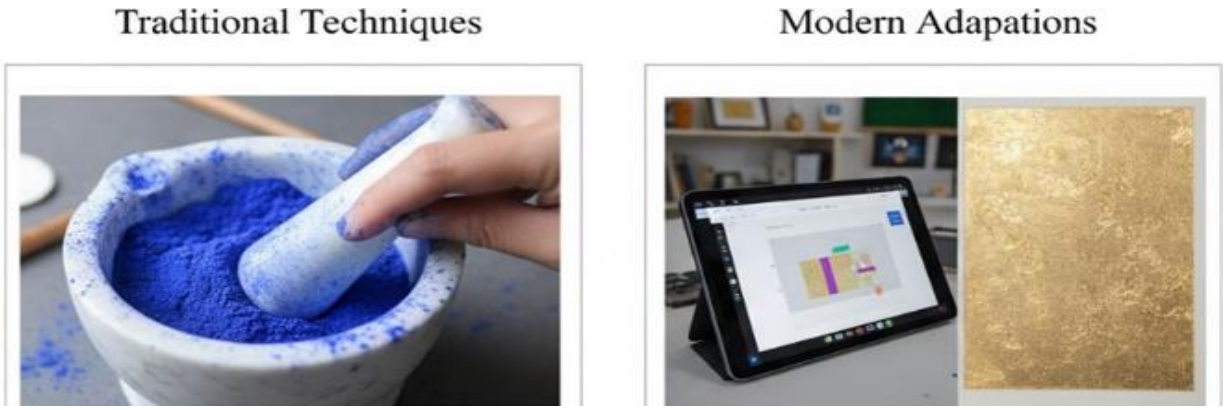
The revival of the late 20th century introduced new technical terminology to the medium through the integration of advancements in materials science.

- Pigment Evolution: Contemporary artists employ both synthetic and natural mineral pigments in their creations. These synthetic materials provide artists with enhanced color constancy, particle regulation, and lightfastness.
- Blending Agents: Individuals currently utilize advanced synthetic resins in binders. These resins exhibit greater flexibility and water resistance compared to animal glue, which was previously utilized.
- Technological Fusion: Modern artists frequently integrate traditional methods with contemporary technologies:
  - Modern Techniques: The application of methods like hot stamping, foil overlay (utilizing mica or metallic foils), and computerized compositional layout indicates an evolution towards a more innovative and eclectic style.
  - Material Interplay: This combination highlights chromatic depth and material texture, making rock color painting a versatile and dynamic approach.

Figure 3 below illustrates the comparative evolution of various techniques, from hand-ground pigments to synthetic materials and foil ornamentation.

Figure 3

Traditional and Modern Techniques in Rock Color Painting



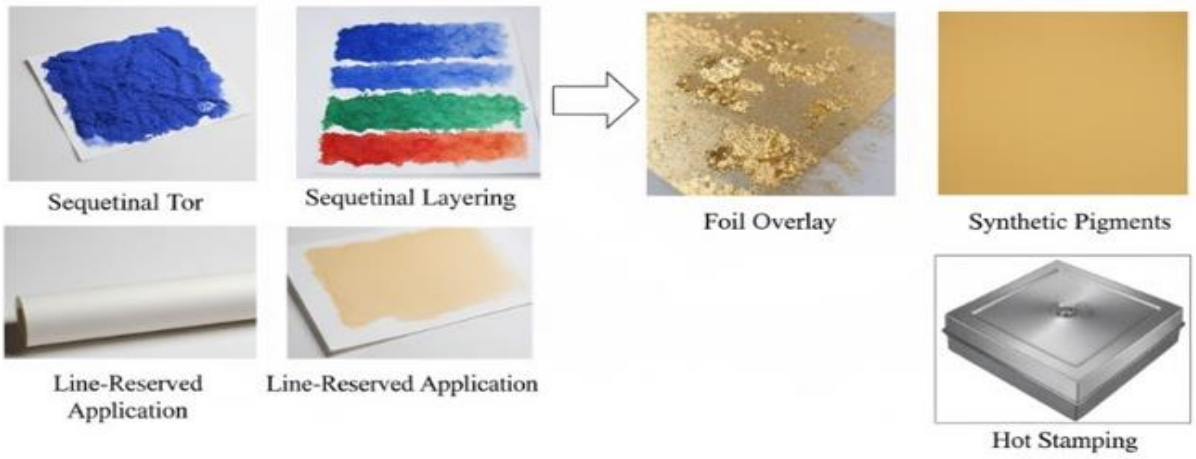


Figure 3 illustrates numerous significant materials and their applications in this artistic medium. It displays eight distinct images, likely to illustrate both traditional and contemporary methods. Colorants and Substances The image depicts several items suitable for painting:

- Sequential Tor: A heap of vivid blue powdered pigment resembling its natural source, potentially a mineral or rock hue.
- Foil Overlay: A method that displays gold leaf or foil fragments applied to a surface, indicating the employment of metallic materials for ornamental purposes.
- Synthetic Pigments: A solid block of an ochre or gold hue representing contemporary, artificial pigments that can substitute mineral-derived colors.
- Hot Stamping: An image of a metallic die or plate. This is a contemporary method for applying metallic foils or specific pigments to a surface with the application of heat and pressure.

Application Procedure The image additionally illustrates several applications of these materials:

- Sequential Layering: This photography illustrates three horizontal bands of color—blue, green, and red—applied on paper. It demonstrates the sequential application of pigment layers.
- Line-Reserved Application: This approach appears to consist of two components. The initial image depicts a blank sheet of white paper or a roll thereof. The second image depicts a surface that is pale yellow in hue. This photography illustrates a technique wherein certain areas remain unpainted or "reserved" to create lines or

patterns. The arrow illustrates the entire process, indicating that the initial colors and layers culminate in the incorporation of decorative features such as the foil overlay.

This study will now analyze a crucial external element after reviewing the development of traditional processes, pigments, and binders in China. The subsequent section examines how Japan's advancements in materials science and enhanced industrial pigment production have fundamentally transformed and revitalized Chinese rock color painting in the modern era.

4.3 Influence of japanese material innovation on contemporary revival

This section analyzes the significant impact of Japanese innovation in materials and industrial technology on the late 20th-century resurgence of Chinese rock color painting, thereby defining the cross-cultural dynamic that has shaped the contemporary medium.

4.3.1 The catalyst: japanese preservation and innovation

The practice of rock color painting in China declined due to changing aesthetic standards and increased material costs, but Japan preserved and refined similar mineral pigment techniques, particularly via the development of the *Nihonga* style.

- Advanced Pigment Systems: Japanese industrial manufacturers developed superior industrial pigments that were more effective than their competitors' products:
  - Refined Particle Gradation: Advanced categorization techniques produced pigments with uniform particle sizes (grades 14–18), enabling painters precise control over the texture and appearance of their creations.
  - Synthetic Development: The development of synthetic rock pigments enabled the attainment of more uniform and durable hues compared to several natural sources.

4.3.2 Transnational exchange and reappropriation

The primary catalyst for the renaissance in China was the flow of ideas and cultures that commenced in the 1980s.

- Knowledge Transfer: Wang Xiongfei and other Chinese artists studied in Japan, acquiring knowledge of advanced pigment systems and material philosophies. They returned to China equipped with not only advanced technology skills but also a strategy for integrating traditional handicraft with contemporary design.
- Institutional Revival: This symposium ignited renewed interest in mineral pigments in China, resulting in the establishment of research facilities such as the Tianya Rock Color Research Center, which focused on innovative methods for producing pigments and binders.
- Dynamic Reinterpretation: The exchange was an active reappropriation rather than a passive transfer. Chinese painters modified these foreign techniques to align with their cultures, ensuring that the art form retained its distinctive themes, narratives, and symbols.

This global transformation highlights the imperative of intercultural dialogue for the technical and aesthetic revitalization of a traditional art form. Figure 4 below illustrates the effect of Japanese material preparation and industrial standards on the Chinese response.

Figure 4

The Impact of Japanese Material Innovation on Contemporary Revival

Figure 4 illustrates a diagrammatic representation that depicts the influence of Japanese art materials and techniques (Nihonga) on the contemporary resurgence of Chinese rock color painting (Yancaihua). The infusion of ideas and resources from Japan revitalized a neglected tradition in China that emphasizes innovative applications for specific materials. The drawing depicts a three-step process that may feature images of things, individuals, and/or historical eras.

1. The Historical Chinese Genesis and Decline

• It depicts ancient Chinese cave paintings, notably those in Dunhuang and the Kizil Grottoes, where rock color painting (utilizing pigments derived from broken rocks and earth) was prevalent during the Tang Dynasty (618–907 CE).

• This tradition ultimately ceased in China, giving way to ink wash painting.

2. Preservation and Innovation in Japan (Nihonga)

• This illustrates the continuity of the rock color technique in Japan as Nihonga (Japanese-style painting).

• It emphasizes Japanese material innovation, such as:

o Iwa-enogu (natural mineral pigments), which exhibit a vast array of regulated, graded textures.

o Gofun (white powdered oyster shell).

o Nikawa (animal skin glue) as the specialist adhesive.

o The development of synthetic "new rock" pigments (artificial mineral hues) to enhance color variety and reduce costs.

3. Contemporary Chinese Revival:

• This section will depict the resurgence of the technique in China, particularly during the late 20th century (e.g., the 1980s or 1990s) by artists who studied Nihonga in

Japan.

• The outcome is the inception of a contemporary Chinese rock color painting trend that merges the elegance of old murals with sophisticated Japanese material technology. This has resulted in the establishment of research centers and a modern art scene in China.

The Japanese influence (4.3) provided the essential technological and conceptual basis for the contemporary resurgence of rock color painting; however, a direct interaction with the medium is necessary for a comprehensive understanding. The final phase transcends the examination of archives and diverse cultures, focusing instead on physical engagement. The subsequent section delineates the insights gained from the studio-based investigations, which examined the impact of both traditional and contemporary materials on the aesthetic and tactile qualities of objects in practical applications.

4.4 Visual and textural possibilities through studio-based experimentation

This section presents the findings of empirical, studio-based research that investigated the visual, tactile, and expressive properties of rock color pigments employed using various techniques on different substrates.

4.4.1 Key findings on material behavior

Studio investigations have demonstrated that material variables significantly influence the aesthetic outcome of rock color painting.

1. Particle Size and Texture:
   - Experiments with coarse and small particle classifications of minerals such as malachite, azurite, and mica demonstrated that particle size directly influences chromatic saturation, surface accumulation, and light reflectance.
   - Coarser particles created a texture resembling a sculpture or relief, while some observers noted that it appeared ceramic.
   - Smaller particles enabled finer color gradations, smoother blending, and optical mixing.
2. Binder Performance:

- A comparative analysis of blending agents—gelatin, animal glue, and synthetic resin—demonstrated differences in drying time, adhesive strength, and colorfastness.
- Synthetic resin binders exhibited enhanced flexibility and water resistance.
- Gelatin typically preserved the intrinsic tonal integrity and matte quality of mineral pigments.

3. Substrate Interaction:

- Cross-media experiments on materials like ceramic tiles, gesso boards, and handmade paper revealed that substrate porosity significantly affects color absorption and texture formation.
- For example, utilizing coarse pigment on a non-porous substrate such as porcelain resulted in a robust sculptural finish, whereas its application on handmade paper facilitated a seamless blend and enhanced light reflection.

4.4.2 Conclusion of practice-based inquiry

These results indicate that painting rocks is a dynamic and adaptive material technique, rather than merely a means of reviving traditional skills. Studio experimentation serves as a crucial method to bridge our understanding of historical materials with innovative artistic perspectives. It enables artists to transcend the boundaries of this heritage by engaging with it tactilely and integrating it into other domains. Figure 5 illustrates the methodology and outcomes of these studio experiments, encompassing the examination of pigment particles, the comparison of binders, and the investigation of the effects of paint application on various surfaces.

Figures 5

Methodology and Outcomes of Studio Experiments

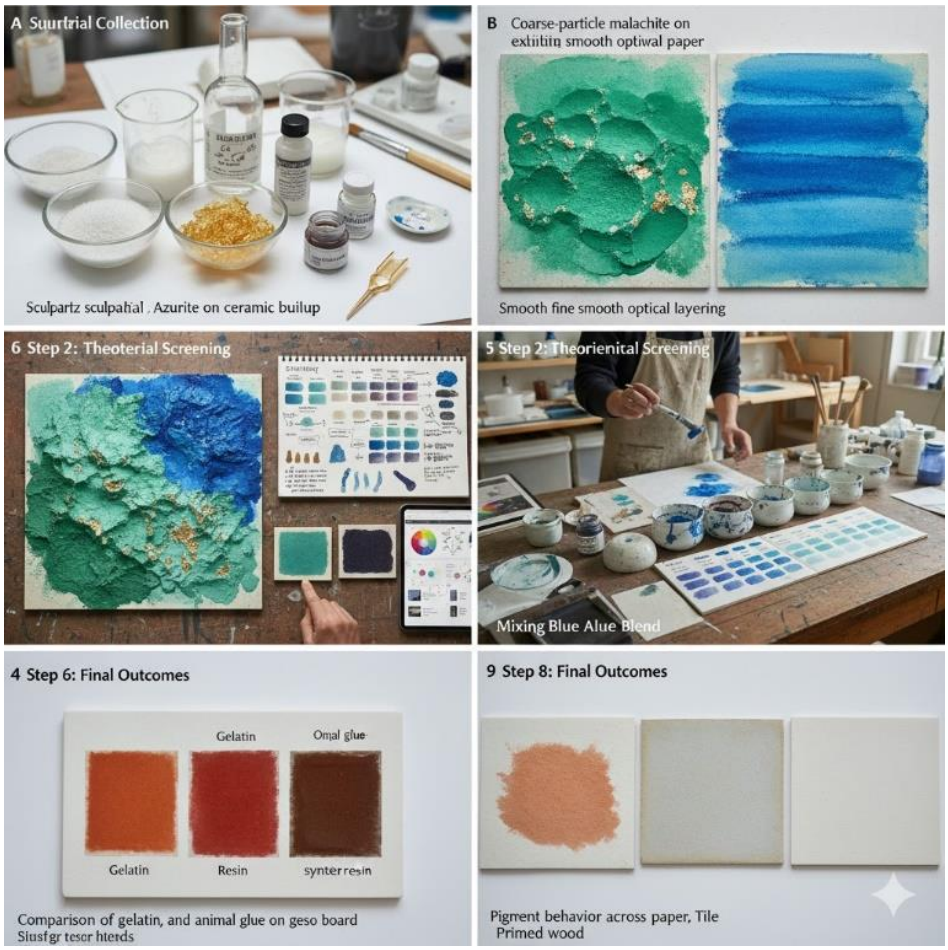


Figure 5 illustrates the technical procedures required to evaluate materials for rock color painting. These procedures involve examining pigment particles, comparing binders, and investigating the interaction of paint with various surfaces.

This debate incorporates empirical findings from studio experiments, historical data derived from archival analysis, and cross-cultural perspectives obtained from literature review. The effects of pigment particle size and binder performance (Objective 4) are assessed in relation to the recorded technological transitions from ancient Tang Dynasty methods to contemporary Japanese-influenced practices (Objectives 2 & 3). This section fills the primary research gap by offering a thorough, multidisciplinary overview of the development of Chinese rock color painting and its modern uses. It accomplishes its goal by juxtaposing these findings with the existing historical narrative of mineral aesthetics (Objective 1).

5 DISCUSSION

The literature assessment delineates a distinctive historical trajectory for Chinese rock color painting, characterized by phases of flourishing, deterioration, and contemporary revival, while also highlighting significant aspects of variation within the discourse. This discourse will consolidate the most pertinent findings from the literature, elucidate their significance, and demonstrate their alignment with the necessity for a more cohesive approach to research.

5.1 Synthesis of historical trajectory and material influence

The study robustly confirms the significant historical continuity of rock color painting, tracing its origins to ceremonial art and ceramic design in the Neolithic period (Chang, 1987; Xu et al., 2025). The enduring character demonstrates the stability and significance of mineral pigments as a primary medium for cultural expression. The zenith of the Tang Dynasty, illustrated by the Dunhuang murals, shows China's technological sophistication and involvement in transregional material exchange along the Silk Road (Schafer, 1956; Wei et al., 2023).

The subsequent decline in the Song Dynasty is a notable finding, indicating that artistic advancement is shaped not just by technological factors but also by prevailing philosophical aesthetics (Hu, 2023; Wang, 2025). For centuries, the aesthetics of mineral colors were marginalized due to the prominence of literati ink painting. This style valued spontaneous expression more than the physicality of color (Golas, 2014; Wang, 2014). Cultural factors dictate the significance of a medium, which often has little correlation with its longevity.

5.2 Interpretation of transnational revival and technical disaggregation

The research identifies the Japanese contribution as the primary catalyst for the medium's revival in the 20th century (Wang, 2014; Graham & Chance, 2021). Through the adoption and enhancement of Tang heritage, Japanese artists successfully modernized materials by incorporating innovative concepts from industry and commerce (Lizun et al., 2022). This underscores that the revival of rock color painting in contemporary

Chinese art was mostly a transnational technical reappropriation, facilitated by Chinese artists who studied overseas in the 1980s.

The current technical research, while significant, often functions independently of the historical narrative. Research focuses on modern analytical precision, employing tools like HH-XRF and machine learning to identify and classify pigments (Markowski et al., 2025; Zhang et al., 2023). These studies are crucial for conservation and material verification; however, they mainly offer static representations of material composition rather than a dynamic, comparative analysis of the material's evolution and application—particularly regarding pigment composition, particle size, and blending agents—across diverse historical or contemporary contexts (Gärtner, 2021; Liu et al., 2024).

The literature offers a solid basis for understanding the historical continuity, cultural disturbance, and technological progress associated with Chinese rock color painting. However, the ongoing discourse lacks a thorough material synthesis. Historical analyses clarify the "when" and "why" of the tradition's changes, whereas technical investigations focus on the specific "what" and "how" of pigment identification. A clear demand exists for research that integrates both aspects. A comparative, multidisciplinary study is required to bridge the gap between the ancient use of ceramics and contemporary mineral-based painting employing advanced hybrid techniques.

6 CONCLUSION

This study has analyzed the historical, technical, and material evolution of Chinese rock color painting, illustrating its enduring cultural significance and possibility for contemporary reinterpretation. Rock color painting is a distinctive amalgamation of pigment science, aesthetic philosophy, and cultural memory. It has been around since ancient pottery and Dunhuang paintings, and it is still used on experimental canvases today. This practice, once marginalized by the dominance of literati ink traditions, is now being revitalized through legacy reclamation and innovative applications of materials from diverse cultures.

The research shows that modern rock color painting techniques go beyond nostalgia by using synthetic pigments, new binders, and cross-media applications to reinterpret old methods. Japanese industrial pigment technology has influenced Chinese painters, enabling them to reclaim and modernize their visual heritage. Consequently,

contemporary rock color painting has evolved into a dynamic domain that bridges tradition and innovation.

Studio-based experimentation demonstrates that this medium offers a diverse array of aesthetic and tactile possibilities that resonate with contemporary artists and viewers. Rock pigments, when employed with contemporary processes, exhibit substantial material strength, color depth, and a stratified texture. This method is both historically grounded and forward-looking.

This work contributes to material-based art research by demonstrating the transformation of a historically significant and culturally emblematic medium into a creative space. Rock color painting is an ancient art tradition that serves as a fertile ground for exploring innovative concepts in ceramic arts, pigment technology, and contemporary cultural expression.

7 IMPLICATIONS

This research presents numerous theoretical, practical, and cultural consequences. Initially, it recontextualizes Chinese rock color painting as an essential medium for cultural continuity and material innovation, contesting the preeminence of ink-centric narratives in the history of Chinese art. Secondly, by amalgamating studio-based practice with historical and cross-cultural analysis, it offers an interdisciplinary framework that can enhance pigment research, heritage conservation, and contemporary visual arts teaching.

The study emphasizes the expressive potential and technical diversity of rock pigments when utilized on various supports and binders, benefiting working artists and material scientists. The material exploration illustrates the possibilities of mineral pigments in painting, ceramic glazes, mixed-media installations, and digital applications, thereby broadening the function of conventional pigments in contemporary media contexts.

The findings highlight the importance of endorsing pigment research centers, cross-cultural material studies, and interdisciplinary collaborations that preserve traditional practices while promoting innovation in the art and design sectors.

8 LIMITATIONS

The research improves the understanding of Chinese rock color painting; yet numerous limitations must be acknowledged. The historical analysis is comprehensive yet predominantly reliant on secondary sources and selected instances. It may not encompass all regional or undocumented customs. The technological explorations were constrained to a limited palette of colors and binders due to resource restrictions and the studio's inaccessibility.

The influence of Japanese material innovation was mostly analyzed through literature and key artist case studies. Extensive fieldwork utilizing institutional archives or pigment manufacturers in both nations would provide greater empirical depth. This work links art history and studio experimentation but omits audience reception research and ethnographic observations regarding contemporary viewers' engagement with rock color painting.

9 SUGGESTIONS FOR FUTURE RESEARCH

- Expanded Material Testing: Future research should explore a wider range of natural and synthetic pigments across various climatic conditions, substrates (including ceramic, wood, and textile), and conservation scenarios to assess long-term effectiveness and sustainability.
- Cross-Cultural Comparative Studies: Examining analogous processes in Japanese Nihonga, Korean minhwa, and Southeast Asian murals may enhance our understanding of the dynamics of mineral pigments and their transformations across transnational art histories.
- Audience Reception and Pedagogy: Future studies may explore the interpretations and reactions of contemporary audiences—students, curators, and spectators—to rock color painting. Educational research may also evaluate the integration of pigment-based methodologies into fine arts curricula.
- Digital and Hybrid Media Applications: As digital technologies advance, a study may assess the adaptation or imitation of rock pigments in AR/VR environments, digital displays, or interactive museum experiences, while maintaining their textural and chromatic characteristics.

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Authors' Contribution

Both authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

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