

Digital Protection and Research of Cangyuan Rock Paintings

Liu Qianyu^{1,a}, Muhammad Fadhil Wong Bin Abdullah^{1,b,*}

¹Faculty of Art, Sustainability and Creative Industries, Universiti Pendidikan Sultan Idris, 35900, Tanjung Malim, Perak, Malaysia

^a172237387@qq.com, ^bfadhil.wong@fskik.upsi.edu.my

*Corresponding author

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Abstract: As a significant legacy of rock art in southern China, the Cangyuan Rock Paintings document the activities, daily life, and primitive religious beliefs of ancient Wa ethnic ancestors, possessing immense historical, scientific, artistic, and economic value. Since Professor Wang Ningsheng's first systematic documentation in 1965, research on these paintings has evolved from traditional archaeological and art historical methods to modern digital technologies. Although digital applications have significantly enhanced conservation and research capabilities, as demonstrated by digital documentation and protective measures, the fragile and non-renewable nature of these paintings remains vulnerable to both natural and human destruction. Taking the current state of Cangyuan cliff paintings as an example, severe damage caused by natural and human factors has raised conservation concerns. Economically, protecting these rock paintings is crucial for sustainable cultural tourism, as their deterioration directly leads to revenue loss. Therefore, exploring a virtuous cycle development model that allows cultural heritage protection to drive economic growth, with economic support in turn feeding back into preservation, has become key to ensuring the long-term sustainable development and local prosperity of Cangyuan Rock Paintings. Developing reasonable utilization models to achieve a virtuous cycle between cultural heritage protection and utilization has emerged as the critical direction for contemporary rock art conservation efforts.

1. The Origin of rock painting research

The study of the Cangyuan rock paintings began in 1965, when Professor Wang Ningsheng, during an ethnic investigation in the Cangyuan area, first systematically documented this significant cultural heritage. As an important relic of rock paintings in southern China, The Cangyuan rock paintings vividly depict the production methods, living styles of the ancestors of the ancient Wa people, as well as their primitive religious beliefs, all imbued with unique artistic charm and profound cultural connotations. Professor Wang Gai Shanlin's pioneering work, earning him the title 'Father of Chinese Rock Painting Studies', has filled the gap in rock painting research in China and marked the formal academic attention to this cultural heritage^[1].

2. Early-stage research methods

In the early research stage, the scholars mainly used the traditional archaeology and art history methods to investigate the Cangyuan rock paintings. The archaeological method primarily examines the distribution patterns, ages of production, and creative techniques employed in the rock paintings^[2]. Utilizing field investigations, typological analyses, and dating techniques, researchers have established a preliminary framework outlining the spatial and temporal distribution of Cangyuan rock paintings^[3]. The art history method focuses on the analysis of the artistic characteristics of rock paintings, including the composition mode, modeling characteristics, expression techniques, etc., and deeply discusses the artistic value and cultural connotation of rock paintings^[4]. These traditional research methods have laid an important foundation for the study of Cangyuan rock paintings and accumulated valuable first-hand information^[5].

3. Technical limitations

Limited by the technical conditions at that time, the early research rarely used digital technology and other modern scientific and technological means to protect and research the rock paintings^[6]. This limitation is mainly reflected in the following aspects: firstly, in recording means, traditional reliance on manual drawing and film photography has made it difficult to comprehensively and accurately record the detail information of rock paintings. Secondly, there is an absence of scientific examination and analysis of pigments, ent composition and weathering mechanism; again, in protection measures, digital technology is unable to establish permanent archives of rock paintings, making it challenging to implement precise preventive measures for their protection. These technical limitations not only limit the depth and breadth of the research, but also have a negative impact on the protection and inheritance of rock paintings^[7].

4. Introduction and application of digital technology



Figure 1 Traditional archaeological methods at Northwestern University, a pioneer in archaeological research and education, particularly noted for its contributions to the study of the Silk Road and the development of innovative archaeological methodologies.

With advancements in science and technology and the evolution of research paradigms, Cangyuan rock painting research has recently embarked on utilizing 3D scanning, multispectral imaging, digital modeling, and other cutting-edge technological tools^[8]. The application of new technologies, such as high-precision uranium-series dating and 3D scanning, has significantly improved the accuracy and integrity of rock painting records, as evidenced by the Cangyuan cliff paintings in Yunnan province, which have been dated to between 3800 and 2700 years ago^[9]. These advancements not only enhance the scientific basis for the protection and restoration of rock paintings but also provide valuable insights into the cultural and historical significance of these

ancient artworks., and effectively promoted the research of Delving deeper into Cangyuan rock paintings, the application of digital technology has carved out a novel path for the perpetual preservation and extensive dissemination of rock painting information, thereby playing a pivotal role in heightening public awareness and fostering the inheritance of cultural heritage.As show in figure 1

Cangyuan Rock Art, situated in the subtropical monsoon climate zone south of the Tropic of Cancer in Cangyuan Wa Autonomous County, Lincang City, Yunnan Province, is a vital component of China's southwestern rock art system. It is recognized as one of the oldest rock art clusters in China, with its origins dating back to the late Neolithic period, around 3,000 to 4,000 years ago^[10]. This ancient art form, created using natural pigments such as ochre mixed with animal blood, depicts a range of subjects including houses, tools, animals, and mythological figures^[11]. The rock art's colors are said to change with the time of day and weather conditions, a phenomenon that has been observed and described by the local Wa and Dai peoples^[12]. This invaluable cultural treasure not only embodies the quintessential spirit of the southern Chinese rock art but also serves as crucial physical evidence for studying the development of ancient human civilization^[13].

The themes and content of the Cangyuan rock paintings are extremely rich and diverse, vividly depicting the colorful social life scenes of ancient Wa people. From hunting and gathering, transitioning to farming and animal husbandry; from solemn sacrificial rituals to fierce war scenes; and from intricate astronomical calendars to profound totem worship, these rock paintings meticulously capture the creators' diverse production methods, intricate living customs, and deep-rooted religious beliefs^[14]. Among the rock paintings discovered in China so far, the Cangyuan rock paintings stand out with their unique content, form, and artistic style: In terms of content, they include a large number of scenes reflecting primitive religious ceremonies; in terms of form, they adopt a unique silhouette technique; in terms of style, they exhibit both rugged boldness and delicate realism^[15]. The Cangyuan rock paintings, with their unique features, are endowed with exceptional historical significance, scientific value, and aesthetic appeal. They serve as tangible evidence for the study of ancient societies, much like the rock paintings in Xiangcheng County and the Daxinganling region, which are crucial for understanding prehistoric social structures, spiritual life, and material culture.ial organization, religious beliefs, and artistic evolution of ancient humans^[16].

5. Protection and future outlook of rock paintings

The Protection and Future Prospects of Rock Art In recent years, with the increasing emphasis on cultural heritage protection by the state, significant progress has been made in the conservation of Cangyuan rock art. On the policy front, the national and local governments have successively issued laws and regulations such as the "Cultural Relics Protection Law of the People's Republic of China" and the "Yunnan Province Cultural Relics Protection Regulations," providing institutional guarantees for rock art protection^[17]. In terms of financial investment, a special fund for protection has been established to support the daily maintenance, scientific research, and technical preservation of rock art. In terms of talent development, through professional training and international exchanges, a group of professionals who are proficient in both traditional cultural relics protection and modern technology have been cultivated. In terms of technological application, we have introduced advanced techniques and methodologies. Technologies such as 3D laser scanning, multispectral imaging, and aerial surveys conducted by drones have substantially bolstered the technological support and efficacy in protecting rock art^[18]. The implementation of these measures has led to a qualitative leap in the environment and level of rock art protection compared to the past.

6. Challenges faced by

As an immovable cultural relic, the rock paintings are non-renewable and fragile. Rock paintings are subject to dual threats from natural weathering and human destruction. Natural factors such as sunlight, rain, temperature fluctuations, and biological erosion persistently degrade their condition, while human activities, including tourism development and infrastructure projects, further exacerbate the risk of damage to these ancient artworks. Theoretically, rock paintings will inevitably be destined to fade away as time passes. Therefore, it is particularly important to explore the reasonable mode of development and utilization while strengthening the protection^[19]. By establishing the way of digital archives, developing virtual display system and carrying out popular science education, it can not only effectively expand the social influence of rock paintings, but also minimize the intervention in physical objects, so as to realize a virtuous cycle of cultural heritage protection and utilization. This concept of protective development is becoming a reasonable way for the value to preserve, expand and improve the influence of rock paintings^[20].

7. Conclusion

As a precious cultural heritage, Cangyuan rock paintings possess not only immense value in the realms of art and historical research, but also serve as a paradigm for cultural heritage protection. While digital technology presents novel avenues for the preservation and exploration of rock paintings, it must concurrently grapple with the delicate nature and irreplaceability of these ancient artworks. Looking ahead, scientific conservation efforts will be pivotal in ensuring the enduring preservation of and extensive dissemination of Cangyuan rock paintings can be realized, providing a deeper cultural experience for the public, and promoting the inheritance and development of cultural heritage.

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