ISSN: 2688-8653

A Study of Conservation Paradigms for Northern Dynasties Grottoes: A Case Study of the Xiangtangshan Grottoes

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Abstract

Northern Wei cave temples constitute the core repository of China's Buddhist artistic heritage, and their conservation and transmission are of great significance. As a key remnant of the Northern Wei cave temple complex, the Northern Qi Grottoes possess outstanding value and serve as crucial material for the study of Northern Wei culture and sculptural art; however, their conservation currently faces difficulties, and Northern Qi.This paper takes the Xiangtangshan Grottoes as its subject, employing analytical methods such as comparative analysis and SWOT analysis. Drawing on the conservation experiences of the Yungang and Longmen Grottoes, it examines the site's resource endowments and existing challenges, and explores pathways for sustainable development.The research indicates that the Xiangtangshan Grottoes meet the criteria for inclusion in the Tentative List for World Heritage nomination. Based on this, targeted conservation strategies are proposed to establish a suitable conservation paradigm for Northern Wei grottoes, thereby providing a reference for the conservation, development and World Heritage nomination of Northern Wei grotto complexes.

Keywords

Xiangtangshan Grottoes, Northern Wei Grottoes, heritage conservation, sustainable development.

1. Introduction

The Northern Dynasties period marked the zenith of Chinese cave art. These caves embody the political, cultural and religious significance of the era, making their conservation of paramount importance. As a key representative of Northern Dynasties cave art, the Xiangtangshan Grottoes exemplify the artistic style of the Northern Qi Dynasty, blending the cultures of the Central Plains with those of northern ethnic groups, and preserving a wealth of precious relics. However, due to natural erosion and human impact, they suffer from significant deterioration, and conservation efforts are urgently required [1].The state has issued relevant planning documents to provide policy support for the conservation of Northern Wei cave temples[2,3] , whilst the technical guidelines formulated by the Yellow River Cultural Cave Temple Alliance have promoted regional collaborative conservation [4].Authenticity and integrity are core principles of conservation, with research by relevant scholars providing theoretical guidance[5,6], whilst conservation practices at the Yungang and Maijishan Grottoes offer valuable lessons for the Xiangtangshan Grottoes[7-11].

The conservation of the Xiangtangshan Grottoes has made some progress, and relevant research and archaeological discoveries have laid the foundation for the construction of a conservation paradigm ([1,12-15]). Currently, the conservation of Northern Wei grottoes still faces challenges, and existing research lacks systematic approaches. Establishing a conservation paradigm centred on the Xiangtangshan Grottoes is key to implementing national strategies and advancing heritage conservation and transmission.

ISSN: 2688-8653

2. Overview of the Xiangtangshan Grottoes

The Xiangtangshan Grottoes are situated in the Gushan area on the eastern foothills of the Taihang Mountains in Fengfeng Mining District, Handan City, Hebei Province. They constitute a significant grotto site from the Northern Dynasties period and were designated as a National Key Cultural Relic Protection Unit in the first batch by the State Council in 1961.The carving of the grottoes began in the early years of the Wuding era of the Eastern Wei dynasty, with the main body completed during the Northern Qi dynasty. Subsequent carving and restoration work continued through the Sui, Tang, Song, Yuan and Ming dynasties. Centred on the sculptural art of the Northern Qi, they constitute vital physical evidence for the study of Northern Wei politics, culture, religion and sculptural art.The complex comprises three sections: the Northern Hall, the Southern Hall and the Water Bath Temple. It currently comprises 19 major caves, housing nearly 6,000 statues and over 60,000 characters of inscribed sutras. The style of the statues blends the characteristics of northern ethnic groups with those of Central Plains culture, and the site is hailed as a ‘a living fossil of Northern Qi Buddhist aesthetics ’ .Carved into the rock strata of the mountain, the core area of the grottoes has been incorporated into conservation plans, and the findings of the 2024 archaeological excavations have provided tangible evidence to support conservation and research efforts.

The spatial distribution of the Xiangtangshan Grottoes is closely related to geological conditions, with the complex carved along the Gushan mountain range. North Xiangtang is situated on the western slope of Tiangong Peak in Gushan, forming the core of the grotto complex; South Xiangtang is located on the southern foothills, where the remains are concentrated; the Shuiyusi Grottoes are situated to the east, with well-preserved sculptures,a complete system of grotto remains.

Table 1. Analysis of the Core Background Information of the Xiangtangshan Grottoes

Dimension	Information Description
Geological Background	Located on the eastern foothills of the Taihang Mountains, the grottoes were carved from rock strata suitable for sculpting. Due to natural weathering, rainwater erosion and geological movements, the grotto structures themselves exhibit defects such as weathering and fissures.
Historical Background	As a core remnant of Northern Dynasties cave temples, the site features carvings predominantly from the Northern Qi period, whilst also incorporating elements from the Northern Wei to the Sui dynasties, making it a vital component of the Northern Dynasties cave temple system.
Cultural Background	A key vehicle for the propagation of Buddhism during the Northern Dynasties, these caves blend Han Chinese Buddhism from the Central Plains with the religious cultures of northern ethnic groups. They feature a distinctive style of sculpture and have exerted a profound influence on carving techniques.
Policy Background	The core remains have been incorporated into the ‘Hebei Grottoes Conservation and Utilisation Plan (2022–2030)’, and conservation work is being carried out in accordance with the ‘Technical Guidelines for the Collaborative Conservation of Northern Dynasties Grotto Complexes’.

3. Comparative Analysis of the Xiangtangshan Grottoes and Representative World Heritage Grotto Sites

Comparative analysis is an important approach for evaluating the conservation performance of cultural heritage. Rather than examining the Xiangtangshan Grottoes in isolation, this study

ISSN: 2688-8653

compares the site with representative Chinese World Heritage grottoes, including the Yungang Grottoes and the Longmen Grottoes. These sites were selected because they share similar historical backgrounds, artistic traditions and conservation objectives, while representing more advanced stages of heritage management[9,12,17].

The comparison focuses on five dimensions: heritage resources, conservation management, preventive conservation, digital preservation and sustainable utilisation. By introducing quantitative indicators where available, the analysis provides a more objective assessment of the current strengths and limitations of the Xiangtangshan Grottoes[2-4].

Although Xiangtangshan possesses outstanding artistic and historical value within the Northern Dynasties grotto system, considerable differences remain between Xiangtangshan and the established World Heritage sites. These differences are reflected not only in the scale of heritage resources but also in conservation investment, monitoring systems, digital documentation and visitor management[13-14,16-17].

Table 2. Comparative Evaluation of Major Chinese Grotto Heritage Sites

Indicator	Xiangtangshan Grottoes	Yungang Grottoes	Longmen Grottoes
Historical Period	Eastern Wei–Northern Qi	Northern Wei	Northern Wei–Tang
UNESCO Status	Potential Candidate	World Heritage	World Heritage
Major Caves	(Insert data)	(Insert data)	(Insert data)
Sculptures	(Insert data)	(Insert data)	(Insert data)
Annual Visitors	(Insert official data)	(Insert official data)	(Insert official data)
Digital Documentation	Partial	Nearly Complete	Extensive
Environmental Monitoring	Basic	Intelligent Monitoring	Intelligent Monitoring
Preventive Conservation	Developing	Mature	Mature
Annual Conservation Funding	(Insert official data)	(Insert official data)	(Insert official data)
World Heritage Management Experience	Limited	Mature	Mature

Source: Compiled by the author based on References [1–4,7–18] and official statistics published by the relevant heritage management authorities.

The comparison presented in Table 2 demonstrates that the Xiangtangshan Grottoes possess cultural significance comparable to that of other nationally important grotto complexes; however, clear differences remain in conservation capacity and management performance. In particular, the application of preventive conservation, digital documentation and environmental monitoring is considerably less developed than at the Yungang and Longmen Grottoes[7-11,15,17,18].

Digital conservation has become one of the principal indicators of modern heritage management. The Yungang Grottoes have established an integrated digital conservation system combining three-dimensional laser scanning, high-resolution image acquisition, artificial intelligence-assisted restoration and long-term environmental monitoring[7,9,10]. Similarly, the Longmen Grottoes have developed comprehensive digital archives that support condition

ISSN: 2688-8653

assessment, virtual exhibition and scientific research[10,11]. By comparison, digital documentation at the Xiangtangshan Grottoes remains under development, and the coverage of three-dimensional recording and intelligent monitoring is comparatively limited[15,18].

Visitor management also illustrates the different stages of heritage development. World Heritage grottoes have established relatively mature visitor capacity management systems supported by environmental monitoring, reservation mechanisms and risk assessment[2-4,7-11]. In contrast, Xiangtangshan still requires a more systematic strategy integrating visitor control, environmental monitoring and preventive conservation to minimise the cumulative impacts of tourism on fragile limestone sculptures[1-4,17].

Another important difference concerns conservation investment and interdisciplinary collaboration. Long-established World Heritage grottoes benefit from stable governmental funding, specialised conservation institutions and continuous scientific research programmes[2-4,7-11]. Although conservation investment at Xiangtangshan has increased in recent years, additional financial support, technical personnel and interdisciplinary cooperation remain necessary to strengthen long-term conservation capacity[1,2,3,15,17].

Table 3. Evidence-based SWOT Analysis of the Xiangtangshan Grottoes

Dimension	Analysis
Strengths (S)	Outstanding Northern Qi artistic heritage; high authenticity and integrity; important archaeological discoveries; inclusion within national conservation planning.
Weaknesses (W)	Progressive weathering and structural deterioration; incomplete digital documentation; limited preventive monitoring; comparatively lower conservation investment than World Heritage grottoes.
Opportunities (O)	National conservation policies; rapid development of digital heritage technologies; increasing interdisciplinary cooperation; growing cultural tourism demand; potential World Heritage nomination.
Threats (T)	Continuing environmental weathering; increasing visitor pressure; climate change; shortage of specialised conservation professionals; long-term funding uncertainty.

The SWOT analysis indicates that the Xiangtangshan Grottoes possess significant advantages in historical authenticity, artistic value and archaeological importance. These characteristics establish a solid foundation for future conservation and possible World Heritage nomination[5,6,13,14,16].

However, the analysis also reveals several critical weaknesses. Compared with representative World Heritage grottoes, Xiangtangshan still lacks a comprehensive preventive conservation system supported by quantitative monitoring. Digital documentation has not yet achieved complete coverage of the site, and long-term environmental monitoring remains limited. These shortcomings reduce the efficiency of conservation decision-making and increase the vulnerability of the grottoes to environmental deterioration[1,15,17,18].

The external environment nevertheless presents substantial opportunities. National policies on grotto conservation, advances in digital heritage technologies and increasing interdisciplinary collaboration provide favourable conditions for improving conservation quality[2-4,7,10,11]. By integrating geological monitoring, digital documentation, preventive conservation and public participation into a unified management framework, Xiangtangshan can substantially strengthen its long-term conservation capacity[4,10,11,15,17].

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At the same time, persistent natural weathering, increasing tourism and climate-related environmental change continue to threaten the physical stability of the grottoes. Sustainable conservation therefore requires a balanced approach that integrates scientific monitoring, visitor management and ecological protection while maintaining the authenticity and integrity of the heritage[1-6,15,17].

4. Analysis of the Conservation and Sustainable Development of the Xiangtangshan Grottoes

As a significant remnant within the Northern Dynasties cave temple system, the conservation of the Xiangtangshan Grottoes concerns not only the physical safety and continued existence of the cultural relics themselves, but also the transmission of heritage value, the development of regional culture and the stability of the ecological environment.Against the backdrop of the gradual standardisation and systematisation of cave temple conservation and utilisation, promoting the sustainable development of the Xiangtangshan Grottoes requires concerted efforts across multiple dimensions, including planning guidance, resource utilisation, ecological conservation, publicity and promotion, the integration of recreation, and environmental education. Building upon the principles of authenticity and integrity, a long-term, stable development model must be established in which conservation and utilisation mutually reinforce one another [5][6].This chapter analyses the sustainable development pathways for the Xiangtangshan Grottoes from six perspectives, drawing upon relevant national and local planning requirements, established domestic experience in grotto conservation, and the specific conditions of the Xiangtangshan Grottoes themselves.

4.1. Planning-led Approach to Promote Sustainable Development

A scientifically sound and comprehensive conservation plan is a prerequisite for the long-term protection and orderly development of cave heritage. The ‘Special Plan for the Conservation and Utilisation of Cave Temples (2021–2035)’, issued at the national level, clarifies the overall direction, key tasks and implementation strategies for cave temple conservation from a macro perspective, providing an institutional basis for cave temple conservation work across the country [2].In line with the characteristics of heritage distribution in the region, Hebei Province has formulated the ‘Hebei Grottoes Conservation and Utilisation Plan (2022–2030)’, which further specifies the conservation objectives, management requirements and utilisation pathways for important grottoes within the province, including the Xiangtangshan Grottoes [3].During the implementation of the plan, the approach of holistic conservation and systematic management has been adhered to, coordinating the protection of the grottoes themselves, the improvement of the surrounding environment, exhibition and utilisation, and archaeological research. This avoids fragmented management and blind development, enabling the Xiangtangshan Grottoes to achieve sustainable conservation and development within a stable institutional framework [5,6].

4.2. Promoting Sustainable Development through the Rational Use of Resources

The Xiangtangshan Grottoes integrate Northern Wei-era sculptures, inscribed sutras, cave architecture and geological landforms, possessing outstanding historical, artistic and scientific value, and serving as vital physical evidence for the study of Northern Wei grottoes in China [1,14]. Achieving sustainable development hinges on the rational, moderate and orderly utilisation of various resources, subject to strict conservation measures.Drawing on the resource characteristics of the three major areas—North Xiangtang, South Xiangtang and Shuiyu Temple—work can be carried out in a categorised manner, including archaeological documentation, condition monitoring, digital recording and value interpretation, thereby

ISSN: 2688-8653

avoiding irreversible damage to the grottoes themselves caused by excessive tourism development [13,15].At the same time, by drawing on the proven experience of sites such as the Yungang Grottoes and the Maijishan Grottoes in resource utilisation, we can enhance the efficiency of resource use whilst prioritising conservation, thereby promoting the synergistic enhancement of heritage value and social value [7,9,11].

4.3. Ecological and Environmental Protection to Promote Sustainable Development

The long-term preservation of cave heritage relies on a stable geological and ecological environment. The Xiangtangshan Grottoes are situated in the Gushan area on the eastern foothills of the Taihang Mountains. Long-term exposure to weathering, water erosion, and fluctuations in temperature and humidity has led to prominent deterioration issues, such as efflorescence and the development of fissures in the sculptures [1].Efforts should be made to strengthen mountain monitoring, water environment management and vegetation protection, reduce natural erosion, establish an ecological security framework, and minimise human disturbance, thereby providing stable conditions for the long-term preservation of the grottoes [2,3]. Only through the coordinated advancement of ecological conservation and cultural heritage protection can the sustainable development of the geological environment, cultural heritage and natural ecology be achieved.

4.4. Empowering Sustainable Development through Public Awareness

Strengthening publicity, promotion and the interpretation of value is a key means of raising public awareness of conservation and promoting the sustainable transmission of heritage. Centred on Northern Wei sculptural art, regional archaeological findings and conservation practices, the Xiangtangshan Grottoes possess rich promotional material and significant communicative value [14,15]. Through various forms such as academic exchanges, thematic exhibitions, digital displays and public awareness campaigns, public understanding of the historical significance and conservation importance of the Xiangtangshan Grottoes can be enhanced.Drawing on the experience of the Yungang Grottoes in cultural dissemination and brand building, we should employ digital displays, virtual reconstructions and the presentation of AI monitoring results to enrich communication formats, enabling more people to understand the preciousness of the grotto heritage and the urgency of its conservation [7,10]. Broad social recognition and public participation can foster a favourable atmosphere for heritage conservation and provide sustained momentum for sustainable development.

4.5. Integration of Recreation to Promote Sustainable Development

A well-designed recreational system is a key vehicle for achieving a positive interaction between conservation and utilisation. The Xiangtangshan Grottoes can establish a low-impact recreational model centred on cultural experiences and educational visits, whilst strictly controlling visitor numbers, standardising tour routes and demarcating conservation zones, thereby avoiding excessive commercialisation and unregulated development [3].By establishing appropriate exhibition areas, walking trails and public service facilities in accordance with the distribution characteristics of the grottoes, spatial separation and functional complementarity between recreational activities and cultural heritage conservation can be achieved. Through a moderate, orderly and scientific model of cultural and tourism integration, the vitality and appeal of the heritage site can be enhanced, whilst ensuring the safety of the grottoes themselves and promoting a long-term balance between conservation and development [4].

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4.6. Environmental Education Promotes Sustainable Development

Environmental education is a crucial step in shifting cave conservation from a professional endeavour to a matter of social consensus. The Xiangtangshan Grottoes, which integrate historical culture, Buddhist art and geological landscapes, possess natural conditions for conducting historical education, science popularisation and heritage conservation education [1,8].By utilising resources such as the cave remains, geological cross-sections and conservation project sites, regular educational programmes can be established for schools, communities and the general public to disseminate knowledge of cave conservation and cultural heritage concepts. Through the establishment of educational mechanisms and the encouragement of public participation in monitoring and conservation practices, heritage conservation awareness across society can be continuously enhanced.Only by promoting voluntary conservation through environmental education and consolidating conservation achievements through public participation can the long-term and sustainable development of the Xiangtangshan Grottoes be truly realised [2,4].

5. Conclusion

Through a comparative analysis of world-renowned cave heritage sites such as the Yungang Grottoes and the Longmen Grottoes, this article establishes that the Xiangtangshan Grottoes date back to the Northern Dynasties and deserve inclusion on the World Heritage List. As a National Key Cultural Relic Protection Unit of the first batch, the Xiangtangshan Grottoes are well-preserved and possess distinctive characteristics; we therefore recommend that they be included in the Tentative List for World Cultural Heritage nomination, thereby laying the groundwork for the nomination of Northern Wei cave sites in China. The site possesses a wealth of Northern Wei cave and sculptural relics, and combines ecological, educational, economic and social value, making it highly versatile.

Vigorously promoting heritage tourism, cave study tours and other scientific and educational activities will not only drive the steady growth of the tourism economy in the Fengfeng Mining District of Handan, but also effectively disseminate knowledge regarding Northern Wei cave culture and cultural heritage conservation, helping the public to gain a clearer understanding of the artistic significance of Northern Wei cave art and the importance of cultural heritage protection. Moving forward, channels for heritage and environmental education should be further expanded to encourage community participation and guide the public to take a proactive role. The implementation of research and study programmes should be strengthened, and reforms to the planning and management system deepened, whilst identifying development opportunities whilst strictly adhering to the bottom line of protecting the caves themselves and the surrounding ecology. We should reasonably advance the protective development of recreational, economic and social functions, integrating environmental education and heritage conservation into the traditional tourism ‘food, accommodation, transport, sightseeing, shopping and entertainment’ distinctive cultural brand identity for the Xiangtangshan Caves, and utilise technological means such as digitalisation and AI monitoring to empower conservation and development ,to achieve the sustainable advancement of heritage conservation, tourism development, ecological preservation, economic growth and educational outreach, thereby providing a practical reference for the establishment of a conservation paradigm for Northern Wei cave sites in China .

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