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INFLUENCE OF GEOLOGICAL CONDITIONS AND EXTERNAL FACTORS ON THE STRUCTURE AND DECOR OF THE ROCK-CUT MONASTERIES OF CHINA

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Abstract

Factors influencing the formation of four major rock monastery complexes in China – Mogao, Yungang, Longmen, and Maijishan – are analyzed. It is argued that the main factor was the geology of the mountains in which the caves were excavated: this influenced their quantity, dimensions, volume-planning solutions, and – most importantly – the spread of frescoes or sculptures as the main decorative technique. The second important factor was the status of the complex—"popular" or "imperial." In the first case, this resulted in a smaller scale of the caves and the absence of pomp and gigantism; in the second case, the large size of the caves and gigantic sculptures of the Buddha were emphasized, which corresponded to the proclaimed theory "Emperor-Buddha." The geological characteristics of the rocks in which the caves are excavated are described, and the characteristics of the cave types, planning, and construction solutions are given. The technologies of fresco painting and sculpture are analyzed. The problems of the modern use of four complexes and their significance for world culture are characterized.

Keywords: *Influence; Geological conditions; External factors; Structure; Decor; Rock-cut monasteries; China*

Introduction

Using the example of four Chinese rock-cut monasteries (Mogao Caves, Yungang Caves, Longmen Caves, and Maijishan Caves), the influence of geology, natural and climatic features, and some external factors on the specific layout of cave complexes and the prevalence of cave types with a certain functional purpose is analyzed. This also argues for the use of fresco paintings in some caves and sculptural images in others.

If we are talking about a certain nature of the planning of rock-cut complexes, the construction of excavated caves, and especially the spread of one another type of decoration, then geological conditions come first here. Accordingly, the type of rock in which the caves were excavated determined the possibilities of their decoration and scale. The most famous monastic complex is the Mogao Cave

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complex in Dunhuang in Gansu province. The caves are dug into Mynsha mountain, composed of unconsolidated Quaternary gravel (Fig. 1). This led to the leveling of the sculptural images' role and, on the contrary, the widespread distribution of paintings that cover the entire caves' plane. The caves were as simple as possible in terms of layout and construction.

The Maijishan Cave Complex is located in Tianshui, in the Qingling Range of Gansu Province. The caves are dug into Mount Maijishan, which is composed of Cretaceous red sandstone with a loose structure and vertical faults (Fig. 2). These geological features, accordingly, resulted in the caves' multi-tiered structure and rock-cut-pavilion-like caves.

The Yungang Cave Complex is located in Datongshan, Shanxi Province. The caves are carved into the Wuzhou Mountains, a Jurassic sandstone formation characterized by a strong and uniform structure (Fig. 3). This has resulted in the prevalence of large caves and the predominance of sculpture as the primary decorative element.

The Longmen Grottoes are located in Luoyang, Henan Province. The caves are carved into the Yiqu Mountain massif, composed of highly durable Paleozoic limestone, resulting in a proliferation of large, open-to-the-surface caves and niches (Fig. 4).

In addition to geological conditions, several external factors influenced the development of the four rock-cut monasteries. The first of these factors is the peculiarities of local cultural traditions and external borrowings. It should be noted, first of all, that both local traditions and the directions of cultural borrowings differ in the provinces of Gansu, Shanxi, and Henan. Moreover, even within a single province, traditions and directions of borrowings can differ, as exemplified by two rock-cut monasteries in Gansu Province: Mogao in Dunhuang and Maijishan in Tianshui.

The image of the Mogao cave complex emerged from the intersection of the building and cultural traditions of Central China and Western Asia, which explains the spread of the Zen meditation caves, borrowed from the similar Kutsi caves, and the hall caves of the Central Chinese type. A different fusion of local and imported traditions occurred in the Maijishan cave complex, where the building and cultural traditions of Gansu Province overlapped with the hanging house construction traditions of the Ba-Shu culture. This combination led to the spread of the original pavilion-like structure of the caves



Fig. 1. General view of the Mogao caves, Photo by S. Wang

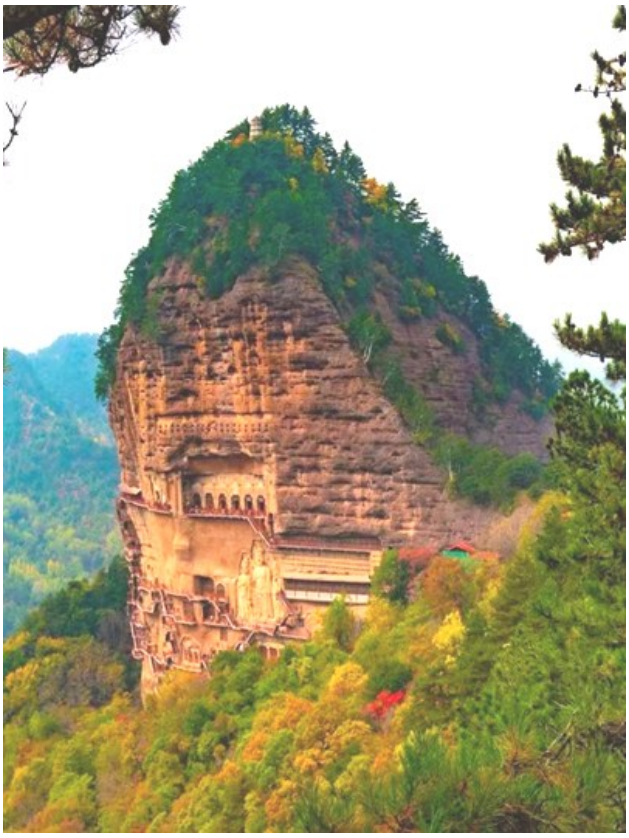


Fig. 2. General view of Maijishan Caves, Photo by S. Wang



Fig. 3. General view of the Yungang complex, Photo by S. Wang



Fig. 4. Longmen complex, Photo by S. Wang

The Yungang and Longmen cave complexes, based on local traditions of Central China, demonstrate significant similarities. Consequently, this led to the spread of local hall caves. Caves of this type became the standard for the central Chinese hall cave type.

Another important external factor was political, namely the support of the ruling circles of China for the spread of Buddhism and the active development of Buddhist architecture.

For example, the Yungang and Longmen cave complexes, as expressions of local Central Chinese traditions, were under the direct patronage of the imperial family, which determined the scale of the caves as expressions of the ideology of the fusion of rulers and religion. Particularly large in this series were the Nirvana Caves, with their gigantic sculptures of Buddha in Nirvana, and the caves with a central pillar. Individual caves reached 100 square meters in area. A distinctive feature was the reinterpretation of the Buddha's image, that is, not simply as a teacher and creator of teachings, but as a ruler, an emperor, which became the political and ideological doctrine of the Northern Wei Dynasty. This is precisely why the Five Yungang Caves contained "imperial sculptures"—relief stone images from the life of Buddha interspersed with scenes of imperial worship. During the Northern Wei Dynasty, the Yungang Complex had the status of a state monastery, so funds for its maintenance (as well as the necessary number of artisans) were provided by the emperor.

From 494 onward, the Longmen Temple Complex assumed the status of an imperial cave temple of the Northern Wei Dynasty, a status it retained during the Tang Dynasty. Significantly, the Tang period continued the tradition of treating Buddha as a ruler and the emperors of China as his successors: in addition to generous donations, Buddha sculptures were often fashioned in the likeness of a ruler (an example is the facial reproduction of Empress Wu Zetian in the Lushen Buddha sculpture).

The Mogao and Maijishan cave complexes, formed at the intersection of different cultures, were therefore more diverse in design and were not built centrally under the patronage of the imperial family. It could be said that their construction was supported by various social classes and wealthy benefactors, both laymen and monks, which is reflected in the Mogao cave paintings. And they were built not by imperial masters, but by monks and ordinary builders, resulting in the juxtaposition of caves with different compositional structures, layouts, scales, and decorations.

The study aimed to determine the natural, climatic, political, ideological, and cultural factors that influenced the specific appearance of the four largest rock monasteries in China.

The objectives of the study were as follows:

– to highlight the influence of rock type on the specific construction of certain caves;

– to analyze the influence of geology on the nature of decoration and the degree of detail (sculpture, frescoes);

– to identify problems associated with the preservation and restoration of decoration;

– to study the modern use of ancient cave complexes and their impact on the state of preservation of the caves.

The scientific novelty of the study was as follows:

– the relationship between "rock type – cave structure – decoration type – modern use – impact on decoration preservation" was demonstrated.

Despite the existence of fundamental studies devoted to the four rock-cut monasteries of China, which describe their history, the periodization of caves and their types, functional purpose, decorative style, and directions of influences, it is proposed to supplement them by linking together geological characteristics, their determining role in the structure and decoration of caves of different functional purposes, and the influence of modern use of cave complexes on the state of the caves and their unique sculptural and pictorial decoration.

To conduct the study, the following scientific sources were examined:

– publications by Chinese scholars on the four rock-cut monasteries of China [1]-[19];
– scientometric articles on Chinese culture, architecture, and art, as well as new restoration methods [20]-[24];
– articles on the Mogao Grottoes in Dunhuang [25]-[32];
– problems of art history [33],
– problems of restoration and restoration technologies [34]-[37];
– architectural education in the field of restoration and conservation [38].

Materials and Methods

Since the presented study analyzes the volumetric and spatial characteristics of the caves of the four complexes and their decoration from the perspective of the rock's potential, while the issue of modern use is considered from the perspective of artifact preservation, this determined the choice of scientific methods. Historical analysis allowed for a brief description of the history of the complexes and the factors that influenced their formation. Geological analysis was important because it provides arguments for the dissemination of certain volumetric and cave planning concepts and their decoration. Analysis and synthesis allowed for the exploration of the directions of mutual influences and their results. Photographic recording and grapho-analytical methods formed the evidence base for the study. The cause-and-effect method allowed for an "if-then" analysis of the phenomenon, that is, to prove a direct relationship between rock type, decoration type, level of detail, decoration material, and restoration issues related to the material.

The present study distinguishes itself from others in that it emphasizes the primary role of geological rock in the creation of a particular type of decoration, the degree of detail, and the volumetric layout of the caves. While not excluding factors such as regional traditions and

external borrowings, as well as the complex's status as "imperial" or "popular," it should be emphasized that the primary role in the creation of a particular cave structure, and especially in the use of a particular type of decoration – sculpture or painting – was played by the type of geological rock, which was suitable or less suitable for a particular cave structure (purpose, plan type, ceiling type), and especially the type of decoration.

Results and Discussion

Characteristics of rock types

Quaternary sandstone (formed during the Quaternary period, anthropogenic, approximately 2.58 million years ago to the present) of a loose structure (Mogao Caves) is characterized as ill-suited for sculptural detailing and complex volumetric-spatial solutions for large caves. According to geological studies, Quaternary deposits lie as a mantle on base rock; they lack the folded structures characteristic of base rock and have not been affected by ancient tectonic processes. These are predominantly loose formations, not particularly durable. As a rule, the primary indicator in the study of Quaternary deposits is their origin (rather than their chronological subdivision into four periods), since this determines the structural qualities of Quaternary rocks.

The Maijishan Cave Complex is formed in a layer of Cretaceous red sandstone with a loose structure and vertical faults, which determined its suitability for the creation of multi-tiered structures in the rock mass.

The age of sandstones is determined by the age of the intervening layers of volcanic ash or limestone. A distinction is made between Old Red Sandstone (Devonian period, Paleozoic era, c. 419–359 million years BC) and New Red Sandstone (Triassic period, Mesozoic era, c. 251.9 to 201.3 million years BC). New Red Sandstone also includes the Cretaceous period (c. 145–66 million years BC). Old and New Red Sandstones differ in their structure, as Old Sandstone arose as a result of the destruction of mountains of the Caledonian orogeny, while New Red Sandstone formed from sedimentary deposits of the Triassic period. Distinguishing features of new sandstone include color—red or orange—and its component is sand with a fine- and medium-grained structure.

The characteristic features of red sandstone are its strength and porosity. The main problems are its susceptibility to erosion due to its natural porosity and the destruction of its structure by alternating heating-cooling and wetting-drying cycles. Biofouling by mosses and lichens also poses a negative impact.

The Yungang Caves are carved into a layer of Jurassic sandstone with a strong and uniform structure, suitable for sculptural decoration and for creating caves of a large area and height. The Jurassic period belongs to the middle of the Mesozoic Era and is dated to approximately 201–145 million years ago. This is also a type of new red sandstone.

The Longmen Grottoes are carved into a layer of Paleozoic limestone (Devonian period, Paleozoic era, c. 419–359 million years ago) of great strength, suitable for large, open-air caves and niches. This is an ancient type of limestone.

Thus, the structure of the Longmen Grottoes depended on the properties of the ancient, highly durable red limestone, while the Maijishan and Yungang Grottoes depended on the properties of the new red limestone.

Differences in the properties of the sandstone rocks determined the dominant type of cave decoration. The Mogao complex is dominated by frescoes painted with various paints on loose quaternary sandstone. Compared to the area occupied by the frescoes, sculptures play a lesser role, consisting of clay sculptures on stone bases. The Maijishan complex is dominated by clay sculptures of various types and sizes, leading to it being known as the "Chinese Clay Sculpture Museum."

The robust structure of the Jurassic sandstone of the Yungang Caves led to the prevalence of stone sculpture and bas-reliefs, with frescoes playing a minor role. Stone sculptures made from the durable Paleozoic limestone became the primary decorative element in the Longmen Caves complex, and the frescoes complement them.

General characteristics of cave complexes and differences between them

A distinctive feature of all four rock-cut monasteries in China is that the caves and niches have no front wall and open outward. This was also the case at the Mogao complex, but due to Mogao's desert climate and the presence of clay sculptures, doors were subsequently installed at all external entrances to protect against wind erosion. Furthermore, unlike other complexes, most Mogao caves consist of a front chamber, an aperture, and a rear chamber.

The Longmen and Yungang complexes were created in different geological and climatic conditions, so the caves and niches are open on one side. Most of the Maijishan caves are shallow niches. The complex was designated a unique heritage site later than the other rock-cut monasteries, and conservation work began accordingly later.

The development of the Mogao Caves spans the Northern Dynasties, Sui, Tang, Five Dynasties, Song, Xi Xia, Yuan, and other historical periods, spanning a thousand years. The Mogao cave complex in Dunhuang comprises more than 735 caves, making it the longest-developed complex of all four rock-cut monasteries in China and the most complete collection of Buddhist art.

The layout of the Mogao cave complex is clearly divided into functional zones: the southern part of the complex contains Zen caves and worship caves, while the northern part houses residential and burial caves. The southern part contains 492 caves with frescoes and sculptures, while the northern part contains 243. Compared to other cave complexes, Mogao has the largest number of caves serving various purposes.

The caves typically have simple square and rectangular floor plans, which were designed for various functions: plans with a central column, plans with a Buddhist altar, plans for collective meditation by monks, and so on. Cave ceilings can be flat or gabled, domed, or of the "fu-dou-ding" type, with each type of roof determined by its functional need. Flat ceilings were used in Zen caves and medium-sized and small dwellings. Gable ceilings derive from the traditional wooden structures of the Central Chinese region and were used primarily in Zen caves and dwellings. Ornamented domed ceilings were used in worship caves.

The Mogao complex contains approximately 45000 m² of frescoes (primarily in the southern part of the complex). Images depicting the life of Buddha, Buddhist scenes, feitian, and portraits of benefactors were painted with mineral and plant pigments, ensuring their good preservation (Figs. 5 and 6). A sketch of the image was first drawn with light ink, then color was applied, contours were outlined, and tone was washed. The technique combined the West Asian technique of contrasting washes for relief and the Central Chinese technique of linear outlining, which is particularly evident in the depiction of faces and clothing.

More than 2400 sculptures are on display (round sculptures (Buddha, bodhisattvas, kings of heaven), bas-reliefs (robe draperies) (Fig. 7). The sculptures were made from a mixture of clay, straw, and reed, had a wooden frame, and were coated with a special layer of chalk (creating a smooth surface for painting) and mineral pigments, along with gold and silver leaf. Large sculptures were mounted on a stone base.

First, a wooden frame was created for the round sculpture. A general clay base, without detailing, was then applied to it, after which the sculpture was modeled. The clay was applied in two stages. The main body of the form was made of local coarse clay, to which wheat straw was added to enhance its plasticity. The second stage of sculpture production consisted of detailing. Over the first base layer of clay with plastic additives, a layer of fine clay was applied, with the addition of fine sand, flax or cotton fibers, and sometimes rice syrup or egg white. This mixture was used to model the faces, arms, legs, and draperies of clothing. Then a finishing layer of chalk or lead white mixed with clay paste was applied. After this, the figures were painted. To

enhance the lifelike appearance of the figures, additional pigments were applied to areas of the faces, arms, and legs.



Fig. 5. Wall painting from the Golden Tang period. Mogao Complex, Photo by S. Wang

The Yungang Caves complex, approximately 1 km long, reached its peak in the 5th century during the Northern Wei Dynasty, when it was granted the status of "state monastery" under the patronage of six emperors of the Northern Wei Dynasty. While there are fewer caves here than in the Mogao complex—only 53 main caves, 209 secondary caves, and 252 niches on the eastern and western slopes of Mount Wuzhou (Yungang)—they are nevertheless large, and the complex itself is striking in its scale. In terms of characteristics, this complex stands out among other rock-cut monasteries precisely for its monumentality and grandeur, including its gigantic sculptures.

The caves can be divided into three zones: eastern, central, and western, and into three chronological periods: early, middle, and late. The main imperial caves, Caves 5–13, are located in the central part of the complex; the eastern part consists of small Zen caves, and the western part contains caves containing sculptures created with the help of ordinary donors.

The cave plans differ somewhat from those of the Mogao Caves: in the early period, horseshoe-shaped plans (Tangyao Caves 16–20) became common, oriented toward the installation and all-around viewing of gigantic Buddha sculptures. In the middle period, worship caves with a central pillar emerged, with niches containing sculptures on all four sides of the pillar and wide passages around the pillar necessary for worship. In the late period, these were primarily small, rectangular, single-person Zen caves and smaller, rectangular caves for worship with ordinary believers.



Fig. 6. Late Tang period painting. Mogao complex, Photo by S. Wang

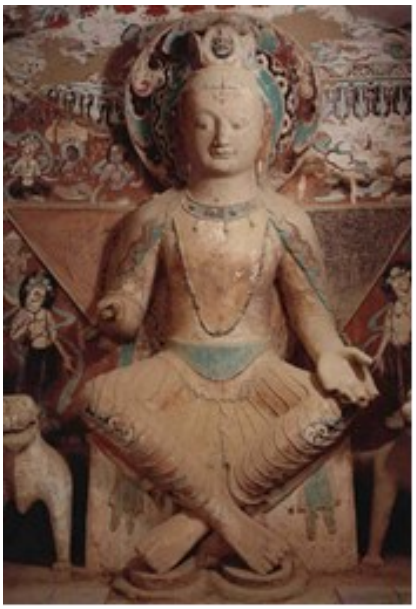


Fig. 7. Sculpture from the Northern Liang period at the Mogao Complex, Photo by S. Wang

Ceiling types were influenced by West Asian styles and the local traditions of Central China. Small and medium-sized caves feature flat ceilings, as well as domed ceilings, inheriting the features of the Gandhara rock-cut complexes of Western Asia. These domed ceilings imitate the vault of heaven and emphasize the grandeur of the Buddha sculptures. Ceiling types were also influenced by the traditional wooden construction of Central China: this influence is noticeable in several "imperial" caves with so-called "diamond ceilings" featuring carved brackets and beams. Such examples are believed to be an example of the Northern Wei period's fusion of rock-cut caves with above-ground imperial palaces.

Unlike the Mogao complex, there are very few frescoes, and those that exist date to the late period (Cave 12). These frescoes from the Northern Wei period depict feitians (celestial apsaras) and ornamental motifs. The rarity of frescoes was due to the special properties of Jurassic sandstone. Therefore, sculptures, of which there are more than 59000 in the complex, became the main decorative element. Unlike the Mogao sculptures, these are stone sculptures ranging in size from 2 cm to 17 m (Figs. 8 and 9).



Fig. 8. Buddha sculpture. Yungang Temple Complex, Photo by S. Wang



Fig. 9. Multi-scale sculptures in the interior. Yungang Complex, Photo by S. Wang

The early period was marked by the appearance of giant sculptures of seated or standing Buddhas (Five Tanyao Caves 16–20), the middle period by reliefs depicting the life of Buddha (Cave 6), and the late period by small sculptures in caves created with funds from ordinary donors. If in the early period the style of sculpture inherited the Gandhara influence of Western Asia, then gradually it developed purely local Central Chinese characteristics.

The sculpture production technology involved the following stages: creation of a rough form, modeling of the form, and final processing. First, the outlines of the cave walls and ceilings were carved, and the general volumes of the sculptures were defined. Then, the figures, faces, and clothing were modeled, followed by the final stage of processing, grinding, and polishing the stone surface. In some caves, a combination of different types of sculpture was used: in-the-round sculpture and bas-reliefs.

The sculpture style is divided into three periods: early, middle, and late.

The early period is represented by the five caves (16–20) of Tanyao. The sculptures correspond to the "Buddha-Emperor" doctrine, and the images are 13÷17 m tall. The Buddha's facial features include a high nose, deep-set eyes, thin lips, and large ears. He is depicted wearing a robe with the right shoulder open or with the shoulders closed, featuring coarse, massive folds.

The middle period is represented by caves 5–13. The sculptures acquire a local character. The Buddha's facial expression changes, and the sculptures' robes are traditional for Central China, with smooth, detailed folds.

The late period is represented by the late Northern Wei period. The sculptures decrease in scale, becoming slenderer, and the canon of "slender and graceful form" (*Xiu gu qing xiang*) is established. This period was dominated by local artistic traditions, which replaced the pompous imperial monumentality of the earlier period.

The Longmen Grottoes also began to develop during the Northern Wei Dynasty in the 5th century, and their main period of development continued until the 10th century, during the reign of Wu Zhou of the Tang Dynasty (690–705). Development continued thereafter, but at a lesser rate. Thus, the complex developed during the Northern Wei, Sui, Tang, and Five Dynasties, but the Northern Wei and Tang periods are considered the main periods. The complex contains many more caves than Yungang, with more than 2300 caves and niches carved into the cliffs of the Longmen and Xianshan Mountains (West and East) along both banks of the Wu River. The complex stretches for several kilometers. Its main distinction from the other three monasteries is its greater concentration of caves and niches within the site and the largest number of niches. The main caves of the Northern Wei period are Guyaoyang and Central Binyang, while those of the Tang period are Fenxian Temple and the Thousand Buddha Cave.

Cave layouts are rectangular and square. The liturgical caves of the Northern Wei period are rectangular in plan, with niches containing sculptures in the walls, designed for worship by a small group of high-ranking nobles. During the Tang period, rectangular and square caves with a central Buddhist altar (a complex of sculptures—a Buddha, two bodhisattvas, two disciples, etc.) became common. This layout replaced the earlier liturgical cave with a central pillar, designed for a limited number of people, and allowed for the presence of a larger number of worshippers. This marked the transition from "limited worship" to "collective worship."

Over the course of the complex's development, three main types of cave ceilings emerged: flat, arched, domed, and the "fu-dou-ding" type. Flat ceilings were used for small and medium-sized Zen caves and niches. The arched roof was dictated by the presence of a Buddhist altar in the center during the Tang period. The domed roof became the main type of liturgical cave (Central Binyan Cave). This design features sloping corners at the top and central ornamentation; it is believed that this type of ceiling originates from the domes of central Chinese imperial palaces. The shapes and scale of the sculptures led to the appearance of lotus-shaped and elliptical

ceilings in the Tang period caves. The ceiling shape of the Longmen Grottoes gradually shifted from Western Asian models to a distinctly local Central Chinese style.

As mentioned, the properties of limestone rock led to the proliferation of sculptures, of which there are over 100,000. These are primarily stone sculptures, with a small number featuring clay surfaces on stone bases. The Lushen Buddha sculpture in Fenxian Temple is 17.14 m tall. A comparison of the sculpture in Guyaoyang Cave from the Northern Wei period and the Lushen Buddha sculpture in Fenxian Temple from the Tang period reveals a transition from slenderness and elegance to scale and monumentality, accompanied by a diversification and refinement of stone carving techniques.

The local limestone allowed for fine carving of sculptures. Sculpture production was a three-stage process: carving the solid form, detailing and polishing, and finishing. During the Northern Wei period (Guyaoyang Cave, Central Binyang Cave), linear carving, with a predominance of fine lines and sometimes distorted proportions, dominated. During the Tang period (Fenxian Temple, Qianxi Cave, Thousand Buddha Cave), rounded carving was used to create a three-dimensional effect, with perfect proportions. During the Tang Dynasty, stone carving reached its peak, a notable example being the 17.14-meter-tall Lushen Buddha figure in Fenxian Temple, with its extremely realistic facial features and drapery. According to legend, the Buddha's face, with its calm expression and gentle smile, was modeled on that of Empress Wu Zetian, during whose reign the complex reached its peak. She took the title of "emperor" (huangdi) and was formally the only woman in the entire four-thousand-year history of China to hold the supreme title.

Approximately 1,300 m² of fresco painting, primarily from the Tang period, have survived. As with the Mogao complex, the Tang period at the Longmen complex marked the peak of sculpture and painting, with varied themes in the paintings, including the life of Buddha, feitian, and donor galleries. The frescoes utilized the Central Chinese technique of applying mineral paints, with ochre-yellow, light green, and orange-brown colors predominating. Natural erosion has left some frescoes fragmentary.

The Maijishan Cave Complex in the western Qingling Mountains developed from the 5th to the 13th centuries, primarily during the reigns of the Late Qin, Northern Wei, Western Wei, and Northern Zhou dynasties, before the Song Dynasty. The complex's foundations were laid during the Northern Dynasties, reaching its peak during the Tang Dynasty and continuing to develop during the late Song Dynasty. 194 caves remain, clustered vertically along the northern and southern slopes of Maiji Mountain. The entire complex is divided into two zones: the western zone with 54 caves and the eastern zone with 140 caves. The main pavilion-style rock caves (Cave 4 – the Pavilion of the Seven Buddhas) are located in the eastern zone.

As in the Mogao complex, the basic cave plans are square and rectangular. The main difference from the other three rock complexes is the creation of multi-tiered rock-cut pavilion structures, which arose due to the elevation changes within the mountain. This is where the multi-tiered caves, connected by gangways and wooden walkways, originated. As in the Yungang and Longmen imperial complexes, the technique of imitating an imperial pavilion was used in the rock-cut temple complex (Cave 4 – Pavilion of the Seven Buddhas from the Northern Zhou era), literally reproducing the imperial palace with seven rooms and eight columns. In contrast, there are many simple individual Zen caves and small worship caves.

The ceiling forms are flat and low-arched, adapted to the structural properties of limestone. Flat ceilings are primarily used in small and medium-sized Zen caves, while arched ceilings are used in worship caves. The low arch of the ceiling prevents the vault from collapsing. Occasionally, the ceilings and walls were decorated with simple paintings of lotuses and other plants, but their level of sophistication is significantly lower than that of the Mogao and Longmen cave complexes. The main distinguishing feature of the Maijishan complex from other rock-cut complexes is its rejection of lavish decoration, spaciousness, restraint, and maximum conformity of the structures to the properties of the rock.

The surviving frescoes cover approximately 1,000 m² and date from the Northern Dynasties to the Tang period. They typically depict Buddha in meditation, bodhisattvas, and scenes from the Buddha's life. Mineral and organic paints were used to paint the frescoes. Some frescoes have survived only in fragments due to the unique nature of the substrate—red sandstone with a loose structure. The surviving frescoes are primarily from cave paintings from the Northern Dynasties to the Tang period. The paints were made from a mixture of crushed natural minerals and organic substances (gum, egg white). The dominant technique was to apply paint without complex wash-outs. Compared with the Mogao paintings, the Maijishan paintings have a more modest and restrained character, corresponding to the simplicity of the clay sculptures and the simple layout and composition of the caves (frescoes depicting feitian and clay sculptures of bodhisattvas in Cave No. 285 of the Western Wei period).

The complex contains over 7,800 sculptures, 90% of which are clay, some of which are on stone bases with clay surfaces. This is why the Maijishan complex is also called the "Chinese Clay Sculpture Museum" (Figs. 10 and 11). Here, we can also note the stylistic shift we discussed in the case of the "imperial complexes" of Yungang and Longmen, namely, a departure from the slender, graceful sculptures of the Northern Dynasties to the opulent forms of the Tang Dynasty.

A technology for making clay sculptures was developed to decorate the caves. As in the Mogao complex, the sculptures had wooden frames, but only large sculptures were mounted on stone bases. The sculpture production process consisted of two or three stages. Local loess clay was mixed with flax fiber (sometimes with cotton fiber), fine sand, wheat straw, or reeds.



Fig. 10. Polychrome clay sculptures.
Maijishan Complex. Photo by S. Wang



Fig. 11. Sculptures in a niche.
Maijishan Complex. Photo by S. Wang

First, a stone base was constructed, then a wooden frame for the sculpture. Next, a general layer of coarse clay was applied for a rough form without detailing, followed by fine clay with the addition of flax or cotton fibers, rice syrup, or egg white for detailing. The figure was sculpted using techniques of kneading, modeling, overlapping, pressing, trimming, and carving. Detailing of the clay sculptures was achieved with fingers and wooden tools. For larger sculptures on a stone base, holes were additionally drilled into the stone, and wooden curtains

were inserted to enhance the adhesion of the clay mass. After the clay had completely dried, the final detailing was completed, after which the sculptures were coated with a ground of chalk and glue clay, painted, and gilded as needed.

The sculpture demonstrates the evolution of style across three periods. The early period is the reign of the Northern Dynasties (Northern Wei, Western Wei, and Northern Zhou). It is marked by a predominance of slender figures. The Buddha in caves 74 and 78 is depicted in a meditative state, with a calm expression and flowing robes. However, alongside the canonical sculptures, others clearly indicate the influence of folk traditions. These include the sculptures of a boy and a girl in cave 123, with their lively expressions on their children's faces. These sculptures date to the Western Wei period and demonstrate the penetration of folk traditions even in the early period.

The middle period of the Tang Dynasty was marked by the appearance of majestic, representative sculptures with full faces and emphasized form detail. The style of Tang-era sculpture is similar to the Tang-style sculptures of the Mogao and Longmen complexes but retains regional distinctiveness.

The late Song Dynasty later reveals greater realism in sculpture and a move toward detail. A notable example is the patron saint figures from Cave 165, whose clothing and appearance correspond to the Song period population.

Thus, a brief analysis of the correspondence between the volumetric layouts of the caves in China's four largest rock formations and the prevailing types of construction and decoration with the geological conditions demonstrates that the choice of a particular cave design or decoration type – fresco, sculpture, or a combination of both – depended primarily on geological conditions and only then on political and ideological factors.

In terms of the number of caves and niches, the statistics are as follows: Longmen Temple – 2,345, Mogao Temple – 735, Yungan Temple – 252, and Maijishan Temple – 194. The greatest diversity of functions (Zen caves, liturgical caves, residential caves, and burial caves) is found in the Mogao Temple. The highest density of caves and niches is found in the Longmen Temple.

Thus, the differences between the four major rock-cut monasteries of China were influenced by geological and climatic conditions, as well as political and ideological factors. Those complexes that were considered "popular," such as Mogao and Maijishan, were distinguished by a greater diversity of functional cave types, smaller cave scale, and a lack of pomp in size and decoration. "Imperial" complexes, such as Yungang and Longmen, defined a more limited range of cave functions but were distinguished by their emphasized pomp and grandeur, embodying the idea of "Buddha as Emperor." A common theme across all the complexes was a gradual shift away from West Asian influences toward local Central Chinese traditions.

Modern Use of Rock Monasteries and the Challenges of Their Preservation

The Mogao Complex in Dunhuang. The cave complex is a UNESCO World Heritage Site and a renowned tourist attraction. Although the complex is open to tourists year-round, the specific rock formations of the caves and the state of the frescoes limit tourist flow. To this end, the "Virtual Dunhuang" project was created, offering visitors a virtual tour of the complex's main caves. The project was created using scanned images and their systematization. Research on the caves is actively being conducted at the Dunhuang Institute, where scientific conferences, symposia, and seminars are organized.

Yungang complex. The temple complex is an important tourist attraction. Since visitor numbers are also limited, the "Virtual Yungang" project was created using 3D modeling and panoramic display technologies. Active research is underway, and scientific conferences, symposiums, and seminars are organized.

Longmen Complex. This complex is an important tourist attraction. As with the Mogao and Yungang complexes, the main caves, such as Guyaoyang Cave and Fenxian Temple, are

open to tourists to preserve the caves. The "Virtual Longmen" project has been created for a similar purpose. Active research is underway, and scientific conferences, symposiums, and seminars are organized.

The Maijishan complex is also a tourist attraction and has its own restrictions on tourist access. In this case, the difficulty lies in the difficult accessibility of several caves due to the complex natural terrain: they can only be reached via a system of wooden walkways. The visitor restrictions are due to the preservation of the frescoes and clay sculptures. As with previous complexes, the "Virtual Maijishan" project was created for this purpose. Active research is underway, and scientific conferences, symposia, and seminars are organized.

It should be noted that the unique decorative features of the caves in all four complexes require a limit on the number of visitors. To this end, highly accurate virtual tours of the main caves have been created. Tourist activity is combined with active scientific research.

Conclusions

In conclusion, we emphasize a point that has already been made repeatedly in previous articles by the authors devoted to the Mogao complex in Dunhuang: a shift away from external borrowings toward local Central Chinese traditions, both in the layout and spatial design of cave types, and in approaches to decoration. This suggests a global phenomenon of "Sinicization" of imported traditions, whereby local characteristics gradually became superimposed on Buddhism.

In the case of the Mogao complex, this is the influence of the Gandhara style in the early period and a shift toward local traditions beginning in the middle period. Thus, the Mogao complex exemplifies the synthesis of imported and local traditions, particularly evident in the transformation of the 45,000 m² frescoes, which are rightly called "a visual encyclopedia of Buddhist art over a thousand years."

The Yungang complex symbolized the divinity of imperial power beginning in the Northern Wei period. It also gradually embodied local Central Chinese traditions in the middle and late periods, completing the transformation from elite pomp to folk aesthetics. The lack of a significant number of frescoes was due to the complex's short development period compared to the Mogao complex and the rough, permeable nature of the Jurassic sandstone, unsuitable for the long-term preservation of frescoes. Only a few fragments of Northern Wei frescoes survive, clearly secondary to the sculptures.

The Longmen complex developed on a purely local basis; it shows no traces of Western Asian influence. Unlike the Yungang complex, the frescoes occupy a more prominent place alongside the sculpture, although their area of 1,300 m^2 is significantly smaller than that of the Mogao frescoes. Local influence is already evident in the early period of the Maijishan complex, with its combination of canonical sculpture and secular realistic art. There are also frescoes preserved in fragmentary form here, but the area they cover, 1,000 m², is even smaller than that of the Longmen complex.

In addition to the geological differences and differences in the ideological status of the complex, it is also worth noting the differences in the themes of decoration.

Since the Mogao complex took longer to develop than other complexes and was initially a "popular" complex, this led to a shift in styles, themes, techniques, and diversity. The Mogao frescoes encompass various canonical aspects of Buddhism, such as sutra themes and stories from the life of the Buddha, combined with genre scenes and benefactors' portraits. Here, it is appropriate to speak of a combination of Xiyu painting techniques with their washed-out color patches and local Chinese techniques of linear delineation of images. This, combined with the vibrant polychromy of mineral paints, created a visual image of a "synthesis in art of the Xiyu and Central Chinese traditions."

In contrast to the "popular" image of the Mogao complex, the "imperial" Yungang complex focuses on the visual realization of the concept of the emperor's deification, "Buddha as Emperor." Therefore, religious doctrine is presented here in the most concentrated form.

Differences in the geological properties of the rocks influenced the style of the sculptures. The Longmen complex boasts the most accomplished sculptures, numbering over 100,000 graceful and slender figures from the Northern Wei period and majestic and splendid ones from the Tang period. This complex is considered to be the pinnacle of stone carving. The Yungang complex, with over 59,000 stone sculptures, illustrates the evolution of Buddhist sculpture from the early Gandhara style to the late Central Chinese style. The Maijishan complex boasts over 7,800 sculptures, mostly clay, which distinguishes it from other rock-cut complexes. The Mogao complex has the fewest sculptures due to its geological and climatic conditions. Mogao has over 2,400 sculptures, the style of which initially reproduced Western Asian motifs but gradually evolved to incorporate and eventually dominate local traditions.

The number of sculptures, their materials, and their scale depended not only on geology and natural conditions but also on the monastery's status. For example, the "imperial" complexes of Yungang and Longmen were financed by the treasury and patronized by emperors, so they are distinguished by gigantic sculptures with intricate stone carvings. In contrast, the "popular" complexes of Mogao and especially Maijishan were financed by representatives of various social groups, so their sculptures are small.

A comparative analysis of four cave complexes confirmed a shift away from external borrowings toward local traditions, creating a central Chinese image of the rock-cut monastery. The scale of these borrowings varied: in the Mogao complex, they are most pronounced, ranging from Xiyu traditions in the early stage to the predominance of local traditions in the middle and late stages, thus turning the complex into an example of multiculturalism. The Yungang complex exemplifies the creation of a distinctive style in accordance with state ideology, the Longmen complex exemplifies a central Chinese style, and finally, the Maijishan complex is "popular" in its social orientation, formed without pathos and grandiosity.

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