Abstracts: Mogao Grottoes is located in Dunhuang City, Gansu Province, which is an extremely arid climate zone. The Mogao Grottoes encompasses a total length of 1,600 meters, has more than 492 caves, of which 45,000 square meters of murals have been accumulated along with 3,000 painted plastic bodies. This makes this the largest Buddhist grotto with the longest continuous construction time and richest content in the world, a combination of grotto architecture, painted sculpture and fresco. It is of great significance to explore this grotto to develop a deeper understanding of Chinese grottoes. However, at present, most papers referring to Mogao Grottoes discuss the cultural and artistic value of the grottoes, the protection and restoration methods of the murals and grottoes, etc. Further, discussions on the site selection of Mogao Grottoes are based on religious and transportation perspectives. At present, no article specifically elaborates the relationship between the site selection of the Mogao Grottoes and the geological background. Mogao Grottoes is a world cultural heritage and a UNESCO global geoheritage. Understanding the geological factors contributing to this site selection is important to develop an in-depth understanding of Mogao Grottoes.

Through field investigation, strata profile measurement, and lithology analysis, this paper analyses the site selection of Mogao Grottoes in detail, including aspects of topography, hydrological conditions, strata, and lithology.

Firstly, the site selection of Mogao Grottoes is based on topography. Mogao Grottoes is located in the southeastern margin of the Dunhuang Basin, with Sanwei Mountains in the east, Mount Mingshashan in the west, Daquan River valley in the south and Gobi in the north. Daquan River is passing by Mogao Grottoes and well-developed. The formation of 3rd-4th river terraces resulted from long-term tectonic uplift in this area. Among these, the first terrace is 3-5 meters above river level and the second terrace is 15-30 meters above river level. The Mogao Grottoes were carved into the vertical steep cliff face seated on the second terrace along the west bank of the Daquanhe River (Fig. 1.). More than 1,600 meters long, displaying anorth-south orientation, and facing south. The caves, located on the second terrace, can prevent damage from water during flood season. Furthermore, the steep cliffs are not easily washed away and can thus be preserved for a long time. The cliff extends in a north-south direction, with an obvious warming effect occurring during the strong sunshine hours before noon. In the afternoon, the cliff blocks sunshine, keeping the cave from becoming too hot and releases the heat absorbed during the day at night, maintaining a high daily minimum temperature. The daily temperature range is relatively small, which is suitable for the long-term preservation of art in the caves. On a large scale, the Mogao Grottoes lie in an extremely arid area surrounded by deserts, Gobi, and sand dunes, which are characterized by drought, intense sunshine, and frequent sandstorms. However, this choice of location greatly reduces the impact of sand and dust brought by strong winds to the Mogao Grottoes. Secondly, the lithology of the grotto stratum determines the stability and difficulty of the excavation, making it the decisive factor for the site selection. The Mogao Grottoes stratum is composed of calcareous and argillaceous gravel layers formed by fluvial and proluvial processes, and are generally about 20-40m thick. The strata in which the Mogao Grottoes are located are divided into three layers (Fig. 2.). The bottom layer is the Yumen Formation of the Lower Pleistocene (Qp1). Above this is the Jiuquan Formation of the Middle Pleistocene (Qp2), while the top is composed of the Upper Pleistocene Gobi Formation (Qp3). The Mogao Grottoes are mainly distributed in the Jiuquan Formation, which is composed of a gravel layer, with gravel, sand and clay accounting for 70%, 25% and 5% respectively. Diagenesis is weak due to a formation time of only hundreds of thousands of years. However,
eluviation in the arid climate is conducive to calcium enrichment, so the gravel layer is still relatively solid even in a semi-diagenetic state. The thick sand and gravel layer is the most feasible layer for cave excavation as it lies nearly horizontal with a dense structure and can form a good vault. About 95% of the caves in the southern area of the Mogao Grottoes were excavated in this sand and gravel layer. The Gobi formation above is made of a set of sand and gravel layers that are nearly horizontal. Due to the 10,000-year formation time, it is relatively loose in lithology. Although it can be excavated, the arch performance is poor and easily collapses. Close to the surface, this layer tends to be weathered and has commonly developed fissures. Cave deformations, falling gravel, irregularities, and shattered walls are easy to see in this layer, so the Gobi formation cannot be the main grotto formation. While the Lower Pleistocene Yumen Formation is mainly composed of a gravel layer, which has been deposited for nearly one million years. Therefore, it is well consolidated and is difficult to excavate for grottoes. Thirdly, water is also a consideration for the Mogao Grottoes site selection. Daquanhe River flows from south to north. The river nearby the caves supply enough water, which not only provide necessary living conditions but also convenience for construction.

Key words: Mogao Grottoes, site selection, geological background

References

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