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# INVESTIGATION OF THE DETERIORATION TYPES OBSERVED AT THE ASLANLI TOMB IN THE PHRYGIAN VALLEY

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## ABSTRACT

Immovable cultural heritages, which are historical documents, were generally built with stone materials in order to be passed on to future generations. The monuments, in which stone material is used, were made of building stone in a masonry work system or by carving into the rocks. Low-strength rock types were generally used in historical buildings, built for functions such as worship, defense, and tombs carved into the rocks. As these rocks are easily affected by atmospheric processes such as freeze-thaw, wetting-drying, and salt crystallization, the types of deterioration in historical buildings develop rapidly and this can cause many problems in monuments from textural features to integrity. In this study, Aslanlı tomb, which is located in the Phrygian valley and where atmospheric effects are widely observed, was examined. The material properties of this monument, which was carved into the pyroclastic rock, were investigated by laboratory tests, and the deterioration types were macroscopically determined in the field. It was determined that the deterioration types in the monument ranged from millimeter scale to meter scale. It is thought that the results obtained from the study, together with defining the engineering properties of the pyroclastic rock in the region, will form an important base for the conservation and restoration planning of the Phrygian valley.

**Keywords:** Building stone, Deterioration processes, Aslanlı tomb, Phrygian valley.

## INTRODUCTION

The Phrygian Valley, located between the cities of Afyon, Eskişehir and Kütahya, has a very rich cultural texture, with churches, tombs, and civil architectural monuments all carved into the rock. This cultural texture has generally been shaped from the pyroclastic rock, which is easy to work. Atmospheric and biological effects, however, have deteriorated the rocks and are now threatening

this unique architectural texture. The Aslanlı Tomb, one of the historical structures carved into rock in Phrygian Valley, has been selected for study due to the numerous forms and advanced levels of deterioration (higher plant, biological colonization, crack, contour scaling, missing part and mechanical damage). Accordingly, a visual examination was carried out in the field during which potential sources of deterioration were examined. Furthermore, samples were obtained from a quarry opened in the location of the monument, the index and strength properties of which were determined in a laboratory. Although the method employed in this study was applied only to a single rock monument, the findings can be expected to contribute to the preservation of the historical texture of Phrygian Valley, ensuring its transfer to future generations thanks to the selection of similar procedures.

## DESCRIPTION OF THE ASLANLI TOMB

The monument is believed to have been built for an important family of the period, and is sited at an elevation that overlooks its surroundings. There are columns on both sides of the entrance door to the monument and a triangular pediment above featuring reliefs of medusa and a shield. Just above the door, there is a cradle arch and there are two lion reliefs facing each other inside. The tomb structure is estimated to have been built between the 5th and 2nd centuries BC.

## MATERIAL AND METHOD

This study was carried out in two phases, including in-situ and laboratory works. A visual examination was made and a photographic record was compiled during the on-site study to determine the level and types of deterioration. The deterioration types are based on the definitions in ICOMOS-ICSC (2008). For the laboratory phase, block samples were first obtained, from which 10 core samples were extracted using the method proposed in ISRM (2007). In the final stage, the P-wave velocity, dry density, porosity and water absorption characteristics of the rock were determined in the prepared carat samples based on the methods proposed in ISRM (2007). The strength properties of the rock (uniaxial compressive strength and Schmidt hammer rebound value) were determined according to standards ASTM D7012 (2014), and ASTM D5873 (2014).

## RESULTS AND DISCUSSIONS

### Index and Mechanical Properties of Sample

The index-mechanical properties of the rock samples collected from the ancient quarry are given in Table 1. Dry density ($\rho_d$), porosity (n) and P-wave velocity ($V_p$) values of the rock samples used in the monument are 1.68 g/cm$^3$, 26.50% and 2.35 km/s, respectively. The sample's Schmidt hammer rebound (SHR) value is 27.30. The unconfined compressive strength (UCS) value of the building stone was 18.95 MPa, classified as a "medium-strength" rock according to the ISRM (1979).

**Table 1. Physical and Mechanical Properties of the Samples**

| $\rho_d$-g/cm$^3$ | n- % | $V_p$-km/s | UCS-MPa | SHR |
|---|---|---|---|---|
| 1.68 | 26.50 | 2.35 | 18.95 | 27.30 |

### Deterioration observed in the Monument

The index and strength properties of the pyroclastic rock used for the Aslanlı Tomb contributed considerably to the deterioration processes. In addition, the cold and snowy winter months and hot and dry summers in the region facilitated an effective freeze-thaw cycle, which has been the main source

of deterioration. As a result of this atmospheric process, contour scaling on a mm–cm scale can be observed on the structure (Figure 1).

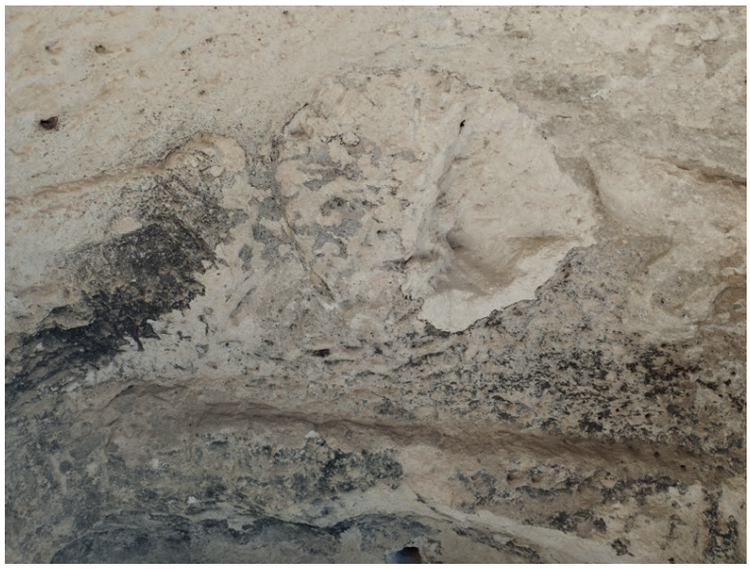

**Figure 1. Contour Scaling Type At mm Scale Observed On The Structure**

The this type of deterioration on the columns at the entrance door of the tomb structure has progressed up to a maximum of 13.2 cm (Figure 2). Furthermore, as a result of the progression of this process, a missing part anomaly can be observed on either side of the entrance door (Figure 3).

**Figure 2. Contour Scaling With The Maximum Depth Observed On The Monument**

As a result of these missing parts, a crack has developed on the entrance door to the tomb as the tensile strength has been exceeded (Figure 3). There is also evidence of biodegradation on the monument resulting from the atmospheric effects to which it is subjected. While runoff has led to lichen growth on the triangular pediment of the monument, a higher plant developed in the ground area (Figure 3). In addition, mechanical damage resulting from vandalism can be observed on the structure (Figure 4).

**Figure 3. Missing Part Anomaly**

**Figure 4. Anthropologic Effect Observed On Figures**

## CONCLUSION

The study has found that the Aslanlı Tomb has been affected by different forms of deterioration in the Phrygian Valley, threatening this important item of heritage. In addition, the index and strength values of the pyroclastic unit from which the monument has been carved has been determined. The different types of deterioration observed on the tomb structure can generally be attributed to the lithology of the rock and local climatic conditions. Deterioration types on the monument range between mm scale (contour scaling) and m (crack) scale. It damages the aesthetic integrity of the monument because of atmospheric and biological effects as well as human effects on this unique heritage. In addition, the deterioration process was faster in sections also showing signs of damage caused by people. Since all these types of deterioration in the building have come to affect the structural properties of the monument, it is recommended to carry out urgent restoration works on it.

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