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# Material Properties of Basalt used in the Diyarbakır City Walls

Felat Dursun and Tamer Topal

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- 1 For thousands of years, natural stone has been extensively used as a building material to create monuments, tombs, and sculptures. In the building stone market, natural stone is favored because of its physical properties such as color and texture, but also because it is easy to process. It is regarded as one of the oldest building materials. Moreover, natural stone plays an important part in the characterization of a cultural landscape.
- 2 The Diyarbakır City Walls, shown here in Figure 1, is a significant historical and cultural structure that has become a central characteristic of the local cultural landscape. Like many historical centers settled in Mesopotamia, Diyarbakır was founded on the banks of the Tigris River and has always been a natural point of passage. Many civilizations (Hurrian, Hittites, Assyrians, Persians, Romans, Byzantines, Arabs, Seljuks...) have ruled the city. Each of these reigning civilizations contributed to the eternal nature of the city of Diyarbakır by leaving behind indelible marks of these different eras. Because each civilization integrated its culture with that of its predecessors, this once-wealthy city now serves as an “Open Air Museum” for the new generations.

Figure 1. Diyarbakır City Walls and Tigris River



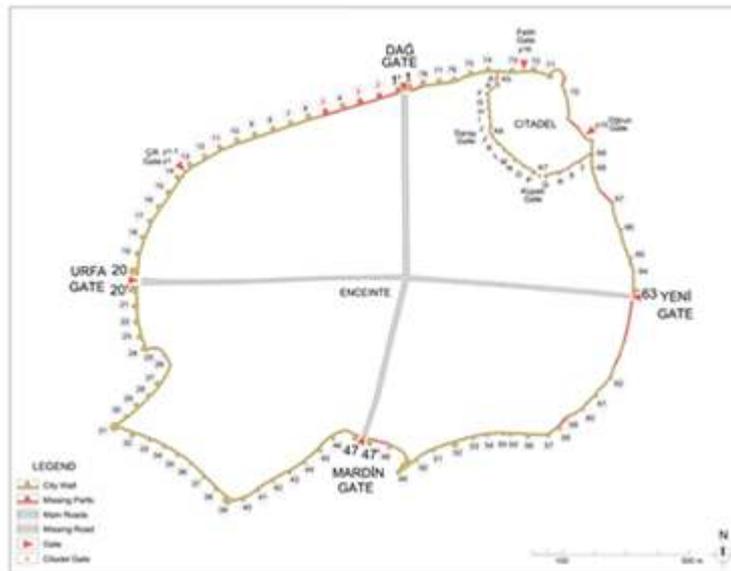
CAPTURED FROM GOOGLE EARTH

- 3 The province of Diyarbakır offers a characteristic example of a geographical region that bears the traces of many civilizations from prehistoric to modern times. The remains and artifacts of the great civilizations that reigned over Diyarbakır can be found all around the city.
- 4 The Diyarbakır City Walls that surround the city are among the unique remains. Diyarbakır Fortress, an important structural example of common human design, has safeguarded its importance right up until the 21<sup>st</sup> century.
- 5 The City Walls are located on an elevated terrace of the Tigris Valley and overlook a vast alluvial fan, known as Hevsel Gardens. As a cultivation land, Hevsel Gardens carry a significant role in the history of the city, regarding their historical background, cultural aspect and also agricultural productivity. Therefore, the City Walls and Hevsel Gardens were jointly nominated for UNESCO's World Heritage List. Eventually, as "an outstanding example of a type of building or architectural landscape which illustrates significant stages in human history," Diyarbakır Fortress and Hevsel Gardens Cultural Landscape were officially acknowledged the status of World Heritage Site by UNESCO in 2015 (UNESCO 2015).
- 6 The Diyarbakır City Walls spread over almost 6 km around the city, and it consists of 18 towers, erected along the Citadel, and 82 towers along the enceinte (Figure 2). (The term, *enceinte*, is used here to refer to the walls, towers, and gates that surrounded the fortress, including the Citadel). The height of the walls varies from 7.6 to 22 m, and their thickness from 0.8 to 5.25 m (Nabikoğlu and Dalkılıç 2013). As a historical and cultural structure, the Diyarbakır City Walls were constructed by using natural stones. Although the City Walls were subjected to numerous past interventions and scientific studies, the studies on long-term activity of stone material and its deterioration mechanisms have yet to be studied. Any restoration and repair work performed without understanding what the stone type is and how it functions in a structure can cause new and irreversible damages. This undesirable situation can be observed on the

Diyarbakır City Walls, with structural problems emerging as a result of inappropriate conservation interventions.

- 7 The Diyarbakır City Walls are built over the basalt of the Karacadağ Quaternary volcanic field (Ercan *et al.* 1991). Therefore, stones derived from basalt are the dominant natural building stone for a wide range of monuments located in the city center of Diyarbakır including churches, mosques, hammams, hans, minarets, traditional Diyarbakır houses, fountains, and others public buildings. The Diyarbakır City Walls themselves were built with these basaltic rocks.
- 8 The locally available basalt material is originated from the lava eruptions of Karacadağ Volcano, *ca.* 40 kilometers southwest of the city. This strato-volcano covers a wide area, especially in the western part of Diyarbakır where it is exposed in the form of a typical shield volcano. This volcanic basalt forms a flat plateau that expands at an altitude of almost 70 m on the western bank of the Tigris (Toprak 2012). The eruption history of the volcano is divided into three main phases, and the activities are dated as 11 to 0.01 Ma. (Ercan *et al.* 1991).

Figure 2. Plan of the Diyarbakır City Walls



Modified from Gabriel, 2014

- 9 The Diyarbakır City Walls reveal some forms of weathering, including cracks, detachments, material losses, discoloration, and deposits. Such weathering forms affecting the durability of the material used in the Diyarbakır City Walls.
- 10 The aim of this study is to evaluate the stones used in the Diyarbakır City Walls as a building material, determine which material properties have an influence on durability, and identify the deterioration mechanisms for further conservation investigations. In order to characterize these physical parameters, some index tests such as effective porosity, unit weight, water absorption, saturation coefficient, uniaxial compressive strength were done. Moreover, mineralogical, petrographic, and chemical analyses were carried out. Although basalt is known as a durable building material, the results demonstrate that the City Walls have suffered from weathering and are still under deterioration threat. The collected descriptive data are only a first

step for studying the deterioration of the stones of the Diyarbakır City Walls. In order to conduct further investigations on the diagnosis process, a detailed classification, *in situ* testing and mapping of the weathering types are required to assess the characterization, deterioration mechanisms and the long-term durability of the material.

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## ABSTRACTS

The Diyarbakır City Walls is a significant historical and cultural example of common human design. It was constructed by using natural stones. Although the City Walls were subjected to numerous past interventions and scientific studies, studies on long-term activity of stone material and its deterioration mechanisms have yet to be launched. The Diyarbakır City Walls reveal some forms of weathering, including cracks, detachments, material losses, discoloration, and deposits. Such weathering forms are affecting the durability of the material used in the Diyarbakır City Walls.

## INDEX

**Geographical index:** Diyarbakır, Turquie

**Keywords:** basalt, deterioration, material characterization

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