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ORIGINAL ARTICLE

From Quarry to Monument: Considering Mardin Stone (SE, Türkiye) as the Symbol of Architectural and Cultural Heritage

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Abstract

The cultural and architectural significance of stone becomes evident as one traces its journey from quarry to monument. Located in southeastern Türkiye, Mardin City presents an urban landscape characterized by stone-built heritage. This transforms Mardin into an open-air museum where the final stone products are exhibited. In addition to its cultural and historical significance, the present study explores the geological, physical, mechanical, mineralogical, petrographic, and chemical properties of the Mardin Stone through the samples collected from the Artuklu, Midyat and Savur districts of Mardin. The Mardin Stone is represented by two different types of limestone deposited during the Cretaceous-Eocene period, categorized as fossiliferous micritic limestone and micritic limestone. The physicomechanical and thermal characteristics suggest that the samples collected from the Artuklu district exhibit better engineering properties than those from the Midyat and Savur districts. The study mapped ancient and modern quarries, illustrating the significance of the stone extraction and crafting techniques used to produce the Mardin Stone. Additionally, it emphasized the ongoing use of stone in contemporary structures, its vital role in heritage conservation, and its export to various countries, notably for use in the Syriac diaspora churches. The evaluations demonstrate that the Mardin Stone, with its diverse architectural applications and symbolic element of the collective memory, meets the essential standards and criteria of the International Union of Geological Sciences-Heritage Stone Subcommission (IUGS-HSS) as a potential candidate for designation as Heritage Stone.

Keywords Heritage stone · Limestone · Physicomechanical properties · Quarry · Mardin

Introduction

Stone is among the oldest construction materials in the history of human civilization. Although the exact date of the earliest stone-based constructions remains uncertain, recent radiocarbon dating investigations at Göbekli Tepe, Türkiye, reveal that the T-shaped limestone pillars date back more than twelve thousand years (Schmidt 2000; Török and Přikryl 2010; Dietrich 2011; Kazancı and Lopes 2022).

Even though stone plays such a dominant role in shaping architectural heritage on a global scale, studies on the use of stone in historic structures, its durability, repair techniques, and significance as a heritage element have gained widespread popularity over the past few decades. More recently, several experts and working groups have taken the initiatives to recognize and increase the importance of stone for cultural heritage. The Heritage Stones Subcommission (HSS), established by the International Union of Geological Sciences (IUGS), occupies a crucial niche among these initiatives (https://www.iugs.org). The foundation of the current heritage subcommittee was formed in 2008, during the 33rd International Geological Congress in Oslo, Norway, as a C10 task group (Commission 10: Building Stones and Ornamental Rocks) of the International Association of Engineering Geology and the Environment (IAEG) (https://iaeg.info/commission-10-building-stones-and-ornamental-rocks/).

The IUGS has several commissions and subcommissions focusing on geological themes (Kaur et al. 2020; https://www.iugs.org/). The International Commission on Geoheritage (ICG), established in 2016 at the 35th International

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Geological Congress in Cape Town, South Africa, is one of the IUGS's commissions dealing with geoheritage and heritage stones. The Heritage Stone Subcommission (HSS) has urged authorities and scientists to provide information regarding their distinctive heritage stones with cultural and worldwide significance in architectural heritage (Kaur et al. 2020; Pereira 2023). The IUGS Executive Committee has approved and acknowledged 32 stone types from 17 countries as Heritage Stones by 2024 due to their universal significance, including, e.g., Carrara Marble (Primavori 2015) from Italy, Bath Stone (Marker 2015b) and Portland Limestone (Hughes et al. 2013) from the United Kingdom, Makrana Marble (Garg et al. 2019) from India, and Villamayor (Golden) Stone (Garcia-Talegon et al. 2015) from Spain (https://iugs-geoheritage.org/designations-stones).

Stone, which has played a crucial role in shaping Türkiye's cultural and architectural heritage since ancient times, remains the principal material for numerous cultural assets. In addition to the country's natural stone resources with rich colors and textures, rock units of different ages and lithologies exposed due to geological events also play an influential role in forming this heritage. Türkiye has a total of 21 sites that have been inscribed on the UNESCO World Heritage List (https://whc.unesco.org/en/statesparties/tr). Among these sites, nineteen are characterized by stone-based structures, while two are distinguished by their use of mudbrick (Neolithic Site of Çatalhöyük) and timber (Wooden Hypostyle Mosques of Medieval Anatolia). Furthermore, Türkiye has a number of sites on the tentative list of UNESCO that also share the common characteristic of stone-based structures. Notable examples include Zerzevan Castle, Karain Cave, Sümela Monastery, Ahlat Tombstones, the archaeological site of Sagalassos, and Yesemek Quarry and Sculpture Workshop. Like their UNESCO-inscribed counterparts, these sites contribute to the rich cultural and historical tapestry of Türkiye, showcasing a diverse array of stone-based architectural and artistic achievements.

All these registered sites are globally recognized as shared heritage and possess outstanding universal value. These stone-based sites involve a variety of features such as wall paintings, fortified cities, mosaics, amphitheaters, T-shaped pillars, reliefs, mosques, Roman temples, churches, rock arts, iconic statues, and tombs. Their use of natural stone materials distinguishes all of these sites. The primary motivation behind this study originated from the observation that despite the significant dominance of stone in the country's cultural heritage, no stone sourced from Türkiye has been officially recognized as a "Heritage Stone" by the IUGS. The present study primarily examines the heritage stone value of the Mardin Stone, which is exposed in Mardin City, SE, Türkiye.

To nominate a stone for recognition as a "Heritage Stone", it is necessary to document a set of criteria. Marker (2015a) provides a comprehensive explanation regarding the definition and significance of these criteria. The features of the proposed stone include its local, commercial, and geological names; the geographic area where it is found (including a map for precise location); the locations of active and abandoned quarries; the geological age and setting; the petrographic name with a detailed mineralogical description; the primary color(s) and aesthetics; the natural variability; the technical properties; the heritage utilization, and the contemporary use (Marker 2015a; Pereira 2023).

The current research aims to propose the Mardin Stone for nomination as a "Heritage Stone" to the HSS. For this objective, the present study attempts to evaluate the Mardin Stone's petrographic, chemical, and physicomechanical properties, together with its geological characteristics, cultural significance, ancient and modern quarries, architectural heritage structures, and contemporary applications. The designation of this nominated stone as a heritage stone will promote the international recognition and preservation of the Mardin Stone and increase the geographic diversity of the adopted Heritage Stones within the frame of the HSS criteria.

The Mardin Stone, also known as "*Katori*" in certain localities, especially in the Midyat region, is the result of a geological unit exposed in the city of Mardin in southeastern Türkiye and represented by limestones. Because of its ease of workability and availability in various colors, including grey, cream, and honey, it was commonly used in structures both within and beyond Mardin. The use of stone in this ancient city is evident in various structures such as fortresses, city walls, churches, bridges, water systems, and rock tombs. The Mardin Stone, which is still being quarried today, is a commonly recognized dimension stone in the region and throughout Türkiye.

Study Area

Mardin is a medieval city located in southeastern Türkiye. It is situated on a scenic rocky hill featuring a castle that overlooks the Mesopotamian plain and the Syrian border (Gabriel 1940, 2014). The city has a characteristic landscape with its sloping land and stone structures. The houses and buildings that compose the city spread in terraces, complementing the natural contours of this sloping land. The inclination of the topography and orientation toward the Mesopotamian Plain are dominant factors shaping the pattern of the city. The houses are positioned not to block each other's views, light, or wind. This situation has given the Mardin a different urban fabric (Fig. 1).

Fig. 1 A panoramic view of Mardin City from the south, with its castle at the top, the urban fabric of the historical city, and the ancient stone quarries at the bottom (Kozbe and Güngör 2022)

It is known that the significance of a stone material can be best appreciated by examining its visible results, particularly its final use (Bloxam 2011). As a visible result, the final use of the stone material can be a well-known monument or, in the case of Mardin, a stone-based architectural landscape that characterizes a whole city. In this regard, Mardin can be considered an open-air museum where the final stone products are exhibited. The city hosts various religious and ethnic groups and remains from different cultures. These remains consist of diverse architectural components, including castles, fragments of city walls, churches, monasteries, pavilions, rock-hewn monasteries, bazaars, passages, mosques, madrasah, caravanserai (roadside inns), tombs, baths, streets, fountains, and stone quarries. According to the Ministry of Culture and Tourism (MoCT), Mardin City has 1612 registered cultural properties as of 2023 (http://tinyurl.com/2ew4jfsk). However, this number is much higher considering the number of unregistered assets or those whose cultural value has yet to be recognized. A recent inventory study by Kozbe and Güngör (2022) documented a total of 2959 tangible cultural assets within Mardin City, confirming this statement.

Heritage Monuments in Mardin City

Mardin City is home to a variety of cultural structures. A collection of the stone-built structures within the province of Mardin City is given in Fig. 2. As a visible landmark from virtually every corner of the city, the Mardin Castle is a landmark that ties together the diverse monuments and structures scattered throughout the city (Fig. 1). The connection between Mardin Castle, the descending urban fabric, and the ancient quarries is an example of integration and expansion, as shown in Fig. 1. Beyond their heritage value and geological significance, the ancient quarries exhibit strong influence due to their representation of close proximity to residential areas.

The ornaments, decorations, Kufic inscriptions, reliefs, and motifs carved into the Mardin Stone are like hidden treasures of the city. With their angular and geometric design, drop-shaped motifs, known as *Salbak* and Kufic inscriptions, occupy an essential role in Mardin's stone structures. These stone-carved motifs and inscriptions serve as repositories of knowledge, capturing the intellectual and cultural significance of different eras. The drop-shaped motifs decorating the Grand Mosque's minaret are among the examples of such applications (Fig. 2e-f).

The majority of structures have portals decorated with reliefs or muqarnas (Fig. 2d-i), a type of ornamental

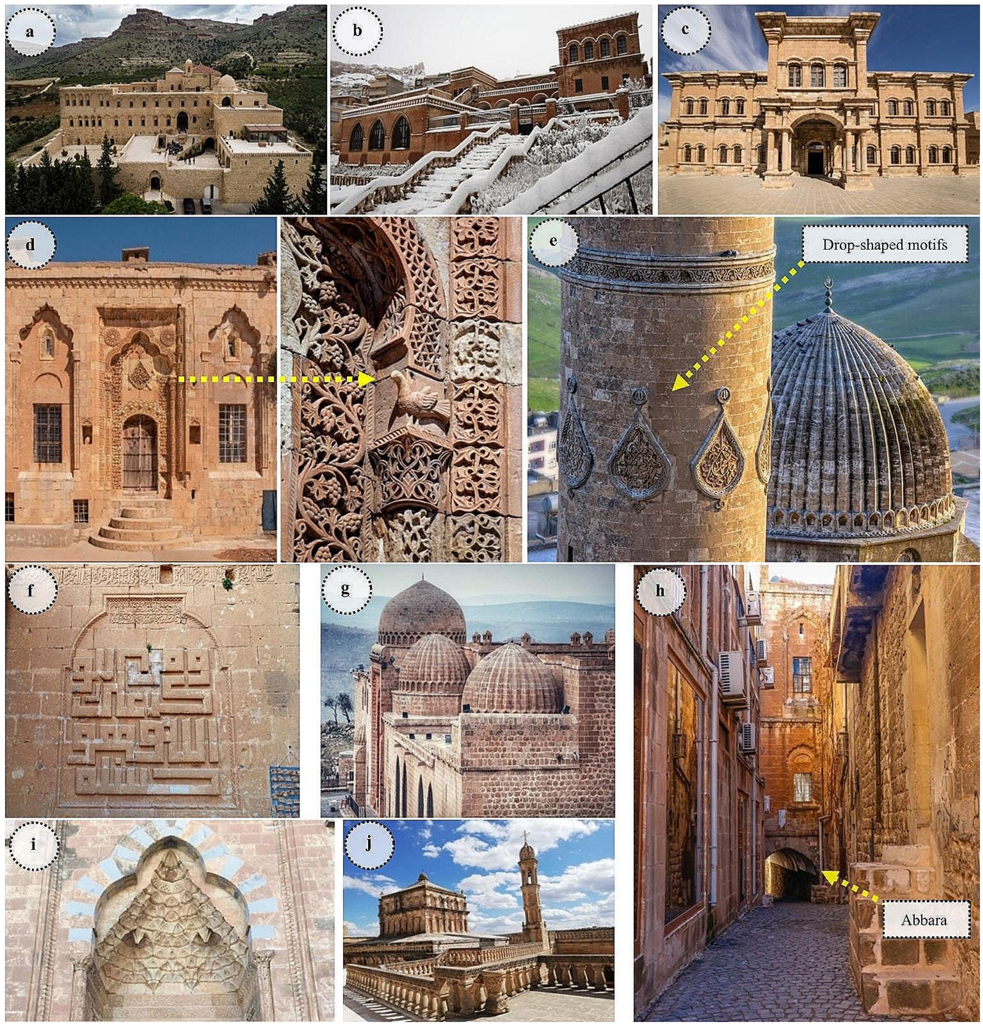

Fig. 2 A collection of monumental structures in Mardin City. (**a**) The Monastery of Deyrul Zafaran; (**b**) Mardin City Museum; (**c**) Olgunlaşma (adult education) Institute; (**d**) The entrance of the Midyat State Guest House and a dove relief carved into the Mardin Stone (IFSAK 2023); (**e**) The inscriptions embedded in drop-shaped motifs (known as *Salbak*) on the minaret of the *Grand Mosque* (http://tinyurl.com/s4r245ek); (**f**) A Kufic style inscription carved on the Minaret of the *Grand Mosque*; (**g**) Kasımiye Madrasah and its iconic onion domes; (**h**) A view of the characteristic narrow streets and *abbara*, vaulted passage (http://tinyurl.com/3kskpy98); (**i**) Details of the muqarnas application at the Latifiye (Abdüllatif) Mosque; (**j**) The Virgin Mary Church at Midyat.(Source for a, b, f and j: http://www.mardin.gov.tr/sehrimiz)

architectural element in Islamic art and architecture that features a three-dimensional geometric design and is commonly used to decorate portals, domes, and ceilings (Ettinghausen et al. 2003). The Zinciriye and Kasimiye Madrasahs are other significant structures demonstrating the city's architectural and cultural value (Fig. 2g). The churches and monasteries throughout the city serve as symbols of religious plurality, representing places where various communities have lived together (Fig. 2a-j).

Mardin has historical and contemporary ties with the Tur Abdin Region, known as "*the Mountain of the servants of God*" in Syriac (https://whc.unesco.org/en/tentativelists/6534/). The region is bounded by the Tigris River to the north and east, acting as a natural geographical boundary. The Mesopotamian plain defines the southern boundary, while the modern urban center of Mardin occupies the western vicinity.

The Tur Abdin Region covers eighty villages, hosting almost two hundred churches and monasteries (https://whc.unesco.org/en/tentativelists/6534/). Some of these monuments, built using of Mardin Stone exposed in the area, have been inscribed on the UNESCO World Heritage Tentative List as a testament to their universal value and cultural significance. Rock-hewn monasteries, found in rural environments of the Tur Abdin Region, are exceptional representations of the city's architectural and religious heritage. The rock-carved monasteries demonstrate the builders' knowledge and understanding of various aspects of the Mardin Stone, including its workability, rock hardness, geological structures, geometry, and groundwater conditions.

The city's architectural diversity is exemplified by stone-built public structures such as museums, post offices, and other educational institutions. These buildings, which have been reused and repurposed, serve as a memorial to the city's rich past and capacity to evolve and change. At this point, it is worth mentioning Mardin's narrow alleys and the *abbaras* (Fig. 2h). As integral parts of the city's historical and architectural heritage, these structures provide a distinct urban fabric. The interconnected paths form a complex network that curves through the urban landscape. In addition, it can be easily observed that the directional orientation of these alleys is significantly influenced by the sloping terrain upon which Mardin is situated. The *abbaras*, on the other hand, are narrow archways positioned under the houses, serving as passages connecting the streets. These passageways, vaulted with the Mardin Stone, inherently provide shade and cooling effects, creating a microclimatic condition that contributes to the thermal comfort of the urban environment (Yıldırım and Akın 2020).

Geological Setting

The present landmass of Türkiye consists of several continental fragments joined together in the late Tertiary. During most of the Phanerozoic, these continental fragments, called terranes, were separated by oceans, whose relicts - ophiolites and accretionary prisms - are widely distributed throughout Anatolia (Okay and Tüysüz 1999; Okay 2008). The southeastern part of Türkiye, where the study area is located, forms the northernmost extension of the Arabian platform and is represented by a Paleozoic succession dominated by clastic-carbonates and a Mesozoic succession dominated by carbonates (Yılmaz 1993; Okay 2008). The lower Paleozoic sequence, with restricted regional distribution, is essentially comprised of shallow marine clastics.

On the other hand, Mesozoic-Tertiary succession starts with neritic carbonate rocks from Devonian to Cretaceous time at the bottom and continues upward to Tertiary times with short-term disconformities. The sequence is composed of fine to coarse clastic rocks, medium-bedded limestone with some phosphate and chert layers, thin oolitic limestone, thinly bedded clayey micrite, and cherty limestone (Yılmaz 1993). The northern margin of the Arabian platform is defined by a suture represented by a Miocene thrust with a vergence from north to south (Fig. 3). The nappes in this zone belong to a tectonic terrane known as Anatolid-Tauride, which was emplaced during the Cretaceous and is composed of imbricated slices of ophiolites and metamorphic rocks (Yılmaz 1993). The most dominant structural feature observed in the area is the presence of several fold axes in almost E-W direction, parallel to the strike of the thrust in the north.

The region we're discussing is of significant geological importance, as it contains a wide variety of stones. Some of these stones have the potential to be considered "Heritage Stone" due to their extensive historical use in architectural heritage. The geological formations within the specified boundaries, illustrated in Fig. 3, serve as the foundation for the creation of various potential heritage stones, including the "*Havara Stone*" in Gaziantep province and the "*Nahit Stone*" in Şanlıurfa province. While these two stones share similarities in terms of texture, chemical composition, and physicomechanical properties with the Mardin Stone, their field distributions and geological formations differ from each other (Kazancı and Lopes 2022). Moreover, the region is distinguished by the widespread distribution of volcanic rocks, which can also be considered potential heritage stones. Among these, the "*Ahlat Stone*", an ignimbrite

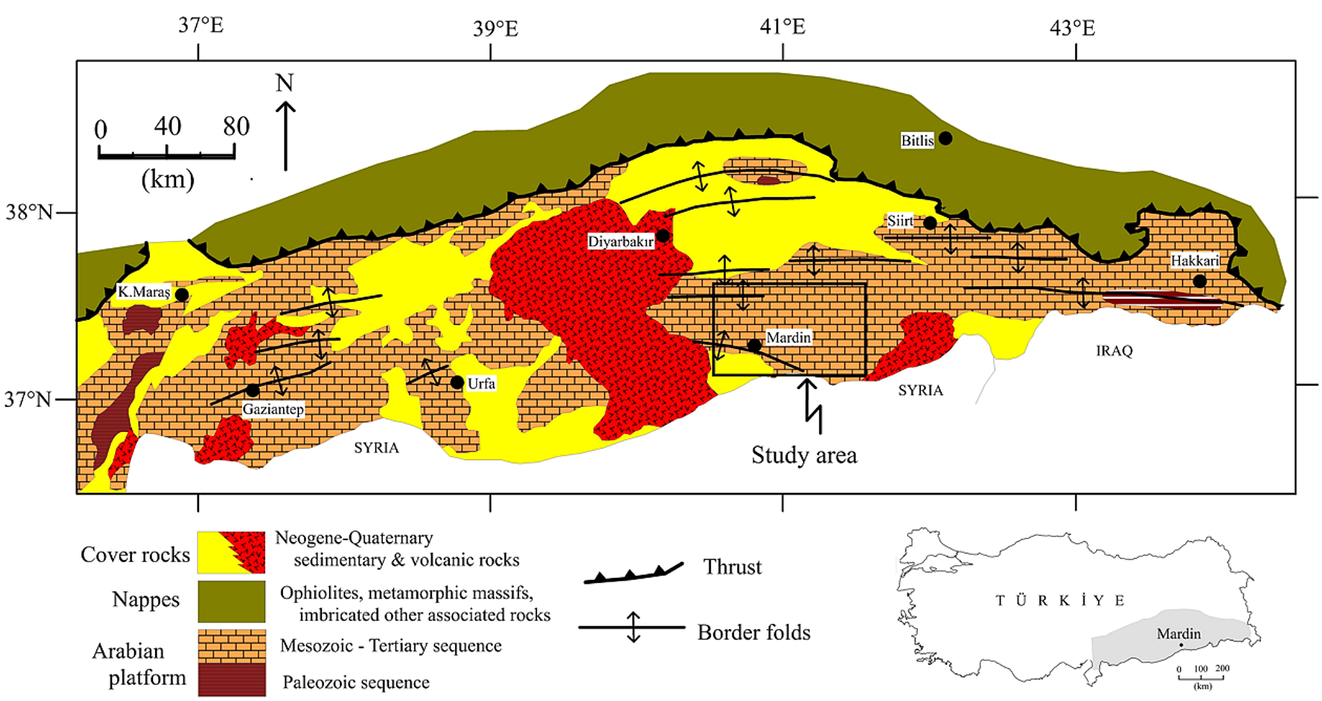

Fig. 3 Geological map of the region, simplified from Yılmaz (1993)

exposed in the Bitlis region, is extensively utilized in monumental Seljuk Tombstones and numerous historical structures. Additionally, the "*Karacadağ Basalt*", the principal construction material of the Diyarbakır City Walls inscribed on the UNESCO World Heritage List, is quarried within this region, exhibiting distinct characteristics of potential heritage stones (Kazancı and Gürbüz 2014; Dursun and Topal 2019). This rich geological diversity contributes to the scientific significance of the region in the context of potential heritage stones, shaping both its geological heritage and cultural identity.

The area investigated in this study is geologically located within carbonate dominant sequences of Arabian platform Mesozoic-Tertiary sequences (Figs. 3 and 4). The area is included within four 1/100.000 scaled geological maps of Türkiye, namely M45, M46, N45, and N46, which are

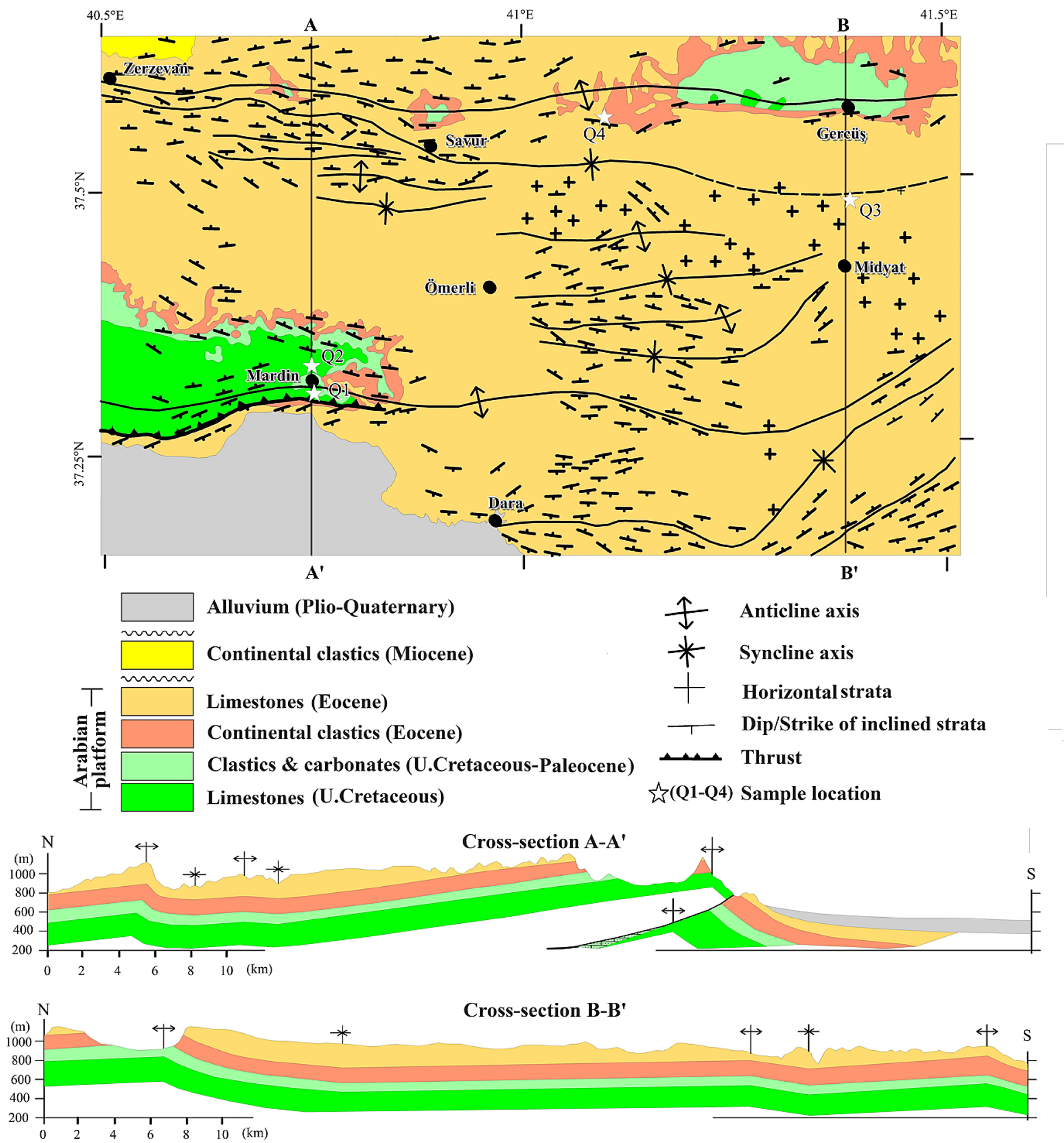

Fig. 4 Geological map of the study area. Map data from MTA (2007, 2008a, b, 2011). Cross sections are drawn by the author

separately published by Mineral Research and Exploration of Türkiye (MTA 2007, 2008 a, b, 2011).

The area contains four major rock sequences in the autochthonous Arabian platform. This platform stretches across a broad area in southeastern Türkiye and exhibits significant lateral and vertical facies changes. Thus, in certain instances, these units are conformable with each other, whereas in some other cases, an unconformity can be observed in the specified sequence. A brief description of each unit is provided here, based primarily on data from the geological reports published by MTA (2007, 2008 a, b, 2011).

The oldest unit observed in the area is the neritic limestone of the Middle-Late Cretaceous. The unit is composed of cream, grey, beige colored medium to thick-bedded fossiliferous limestones. The unit starts with pebbly limestones in some areas and progresses upwards with calcarenite, sandy, and clayey limestones. Chalky levels and silicified layers are frequently observed at the uppermost part of the formation. The estimated thickness of the unit in the area exceeds 200 m. The Cretaceous-Paleocene age sequence represents the next upward unit, which starts with a dominantly clastic section at the bottom with sandy, limy levels interbedded with marls and shales. The upper section of the sequence is composed of clayey limestone, limestone, calciturbidites, and sandy limestones with some conglomerate intercalations. While the overall thickness of this sequence can reach up to 1745 m in specific locations, the visible thickness of the unit in the area is approximately 110–130 m. The third unit from the bottom is composed of dominantly clastic units with chalky limestone layers at the upper units. Clastic rocks are represented by red, brown, green, and grey colored, thin, medium to thick-bedded cross-bedded sandstones, siltstones, and mudstones. Thin dolomitic and gypsum layers are also common as intercalation in the sequence. The observable thickness of this unit is about 180 m in the area, although it can reach a total thickness of 750 m somewhere else. The third unit from the bottom is composed of dominantly clastic units with chalky limestone layers at the upper units. Clastic rocks are characterized by sandstones, siltstones, and mudstones that exhibit a range of colors, including red, brown, green, and gray. These rocks are also distinguished by their thin, medium-to-thick bedding and cross-bedding patterns. Thin dolomitic and gypsum layers are also common as intercalation in the sequence. The apparent thickness of this unit is approximately 180 m in this study area; however, it can reach a maximum thickness of 750 m in the broader region (Yılmaz and Duran 1997).

The region's youngest unit of the Arabian platform sequence observed consists of Eocene limestones. They are predominantly characterized by their massive, medium to thick-bedded structure and range in color from cream to beige, with variations in shade from light to dark. The sequence often contains thin, medium to thick dolomites and a cream or beige color. Additionally, there are reported levels of limestone that exhibit characteristics of being cherty and chalky. Some areas also exhibit the formation of karstic structures. This unit covers extensive areas within the region. The observed thickness in the area exceeds 300 m (Yılmaz and Duran 1997).

The major structural features observed in the study area are anticlines and synclines with axes in almost E-W direction. The two most prominent anticlines exhibit asymmetry, evident by the varying widths of outcrops on both sides of the axis. The southern flanks of both anticlines have a more pronounced inclination, indicating a vergence from north to south. The older units of the Arabian platform are exposed in the cores of these anticlines (Fig. 4). The thrust fault in the study area results from the compression and is consistent with the structural characteristics.

The youngest units exposed in the area are Miocene continental clastics and Quaternary alluvial deposits. These units are considered as "cover units" of the Arabian platform. Their presence is confined to specific places within the region (Fig. 4).

The Mardin Stone, which is the main source of the cutstones supplied in the region for the construction of historic structures of the study area, stratigraphically, belongs to the carbonate levels of the so-called Arabian Platform sequence of the Cretaceous-Eocene age (Fig. 3). This sequence is widely exposed in Southeastern Anatolia and is the main target for petroleum exploration (Yılmaz and Duran 1997). Although there are some minor disconformities within the sequence at the regional scale, four mappable units investigated within the area of interest are conformable, as illustrated in cross sections (Fig. 3).

Due to intense lateral and vertical facies changes, different names have been proposed for these units in the literature, as indicated in the MTA Reports (2007, 2008 a, b, 2011). The primary cause for this diversity arises from the inconsistent member nomenclature within the Midyat Group, where different researchers utilize varying terms to describe the same geological units. While certain studies classify the Mardin Stone as part of the Gercüş Formation of the Midyat Group (e.g., MTA 2007; 2011), many others categorize it as part of the Hoya Formation of the Midyat Group (e.g., Sungurlu 1974; Duran et al. 1988; Yılmaz and Duran 1997; MTA 2008b). Hoya Formation is also defined as the Midyat Formation by different researchers (Özkaya 1974; Kazancı and Gürbüz 2014). This is the main reason for not using stratigraphic names of these units in this study to avoid confusion; rather, the lithological names are preferred.

Materials and Methods

In addition to the examination of the literature, this comprehensive investigation spans two primary phases: field studies and laboratory investigations. Four field studies were conducted between 2021 and 2023, and these studies encompass the identification of quarry sites, conducting oral interviews with contemporary quarry owners, stonemasons, and heads of church foundations, documenting historic structures, and collecting samples. The oral interviews focused on understanding the techniques utilized in stone quarrying and crafting, as well as the processes involved in transferring the stone to diaspora churches and assessing the global demand for Mardin Stone. Meanwhile, laboratory studies involve mineralogical, petrographic, and chemical analyses, along with experiments aimed at determining the physicomechanical, thermal, and ultrasonic velocity properties of the Mardin Stone.

It is worth noting that while some studies on "Heritage Stone" produce and use their original data on petrographic and physicomechanical properties of the investigated stone, some of these studies use data sourced from previously published literature or provided by commercial quarry companies, which was initially produced for various purposes. Although such sources can provide valuable information, using them as a base for scientific investigations may raise concerns about their reliability and objectivity. To mitigate the potential questions about representativity, all data presented in this study regarding the mineralogical, petrographic, and physicomechanical properties of the Mardin Stone have been derived from original data produced through experiments and analyses performed on samples collected during the field studies.

For the sampling stage of field studies, limestone blocks were collected from four quarries (one ancient and three modern quarries) located in the Artuklu, Midyat, and Savur districts of Mardin. The distribution of the sampled locations can be seen in Fig. 4. Quarry 1 (Q1) is an ancient quarry site located in the protected area of Artuklu district, and Quarry 2 (Q2) is a modern one located immediately outside the protected area. They were selected to compare ancient quarries with modern ones. On the other hand, Quarry 3 (Q3) and Quarry 4 (Q4) were selected from the Midyat and Savur districts, respectively. These two modern quarries are located where quarrying operations have recently escalated and were selected to identify the characteristics of modern quarries and compare them with others. Although the samples collected from Quarry 3 (Q3) in the Midyat district and Quarry 4 (Q4) in the Savur district are far from each other regarding location, they originate from two quarries opened in the same geological formation. The quarries in these two areas are now widely used in modern buildings and restoration campaigns in Mardin.

In this respect, it is essential to determine the petrographic, geochemical, and physicomechanical properties of the stones extracted from these quarries and to reveal their differences from those collected in Q1 and Q2. The collected stone blocks were then cut into 50 mm of cubic samples. For the laboratory studies, a total of 100 cubic samples (25 samples from each quarry) with 50 mm edge lengths were prepared. The samples were used to determine such physicomechanical properties of the stone material as effective porosity, unit weight, water absorption, uniaxial compressive strength (UCS), and sonic velocity. In addition to the abovementioned properties, the thermal properties of the Mardin Stone were also assessed in the present study.

Thermal properties of the natural building stones are important parameters since they influence building climate. It becomes especially critical when some parts of the building stones are directly exposed to solar radiation (Hall 2011). It is reported that stones with low thermal conductivity transmit heat very slowly from the surface to the inner part of the stone materials (Siegesmund and Dürrast 2011; Amaral et al. 2013). Therefore, lower thermal conductivity is favorable for building materials, indicating better insulation properties. On the other hand, high thermal conductivity can lead to increased heat transfer, impacting energy efficiency. Moreover, it is known that thermal conductivity tends to decrease as porosity increases due to the higher heat transfer capabilities of solid materials compared to air, water, or other fluids trapped in the pores (Thomas et al. 1973).

The laboratory investigations were conducted through a dual-phase approach, encompassing experimental studies and analyses. Experimental studies were carried out at the rock mechanics and natural stone laboratories within the Mining Engineering Department at Dicle University, aligning with the suggestions and standards outlined by ISRM (1981), TSE 699 (1987) and ASTM (2014).

Thermal measurements were executed following the procedures detailed in ASTM (2014). The thermal properties analysis involved assessing the response of the samples to heat flow impulses. Measurements were conducted on all faces of the cubic samples, and the mean values derived from these measurements were adopted as the conclusive thermal conductivity values. The samples from the four quarries, as mentioned above, served as the basis for mineralogical, petrographic, and geochemical analyses of the Mardin Stone.

Four petrographic thin sections were examined through optical microscopy for modal analysis (based on the chemical composition), grain size, texture, and classification. Microscopic examination and identification of the carbonate rocks were carried out in accordance with the classifications proposed by Dunham (1962). Chemical analyses of four samples collected from the same quarries were performed using X-ray fluorescence (XRF).

Results and Discussion

Petrographic and Chemical Analyses

The samples collected from Quarry 1 (Q1) and Quarry 2 (Q2) are close in proximity and originate from the same geological formation. These samples are yellowish gray in color with a matrix-supported texture visible at the macroscale, as shown in Fig. 5a-b. Under the polarized microscope, the samples from both quarries display micritic matrix containing > 10% sparry calcitic allochems and occasionally appearing sparry calcites as cavity-fills. The grain sizes of the calcite minerals observed in both samples vary between 1.9 µm and 3.9 µm, with an average grain size of 2.42 µm. Modal analysis was used to determine the percentage of major minerals. According to the results, sample Q1, which belongs to the ancient quarry, consists of 98.1% calcite and 1.9% dolomite, while sample Q2 consists of 97.7% calcite and 2.3% dolomite. The results indicate that there is no statistically significant variation in the chemical composition of the two samples. The analyzed Q1 sample is matrix-supported; almost all of the allochems are bioclasts, and it is defined as wackestone-biomicrite (Fig. 5a). Equivalent of wackestone microfacies with benthic foraminifera abundant microfacies separated by Yeşilova and Örçen (2017). The fossils observed in the thin sections are homogeneously distributed and identified as foraminifera, echinoids and bivalve fragments. Among these fossils, larger benthic foraminifera such as *Rotalia*, *Operculina*, *Amphystegina*, and *Assylina* are prominent. These are characteristic for shallow marine depositional environments of the Eocene (Kazancı and Gürbüz 2014). Contrary to Q1, opaque minerals in clustered form can be observed in sample Q2, (Fig. 5b). These

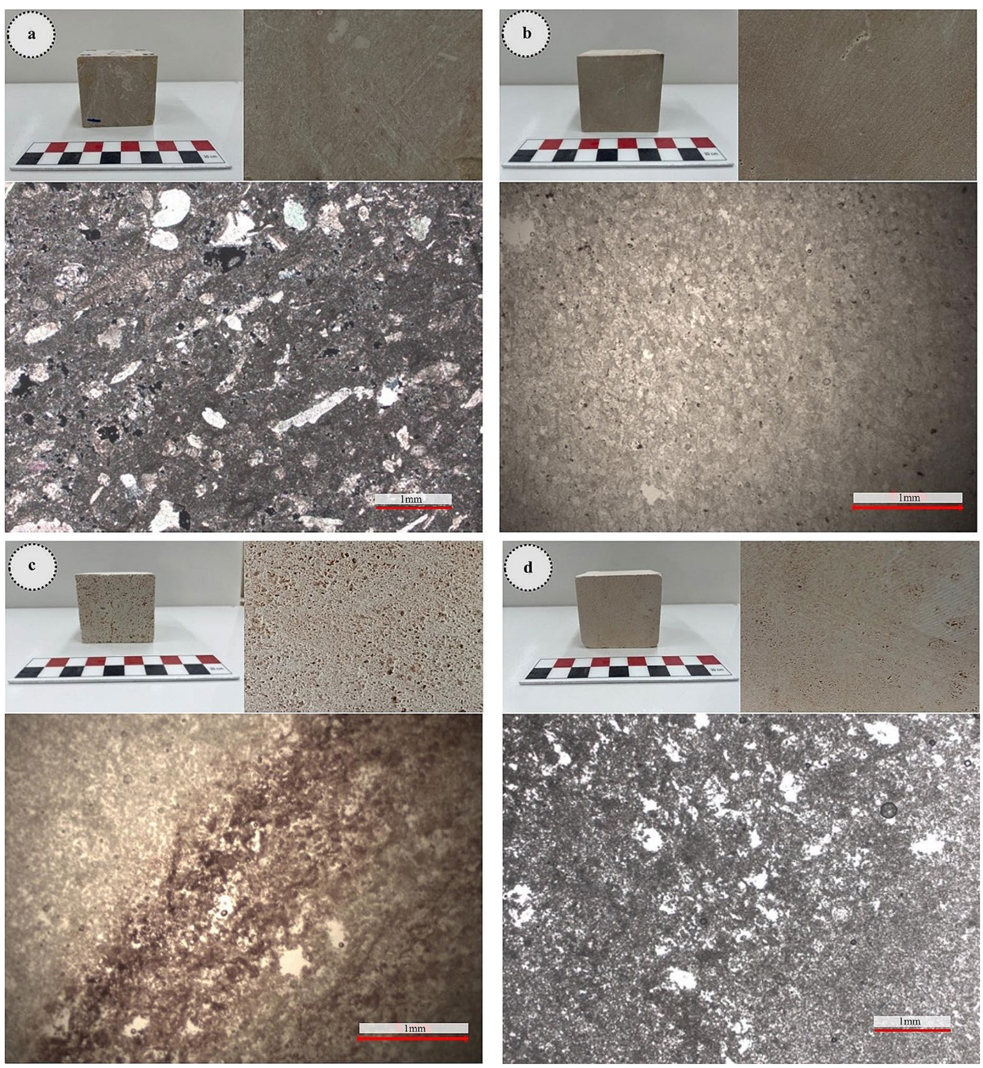

Fig. 5 Hand specimen, close-up views, and photomicrographs illustrating overall mineralogical and textural features of the investigated samples: (**a**) Q1 sample; (**b**) Q2 sample; (**c**) Q3 sample and (**d**) Q4 sample

results suggest that the analyzed samples can be classified as fossiliferous micritic limestone.

In hand specimens, the samples from Q3 and Q4 have a fine- to medium granular texture (Fig. 5c-d) and a yellowish gray color. The samples from Q3 display a thin band of veins filled with iron oxide and hydroxide minerals (Fig. 5c). This veined-filling structure is thought to be the source of the reddish tone of the dominant color in some areas and cut stones produced in this quarry. This structure is filled with opaque iron oxide and hydroxide minerals in fine-medium widths and different lengths in the thin sections and can be observed as opaque mineral staining along the fractures observed on the surface.

Under the polarized microscope, as in samples collected from Q1 and Q2, the samples from both quarries display micritic texture. Calcite and dolomite occur as major mineral constituents of the samples from Q3 and Q4 (Fig. 5c-d). The shape of the calcite and dolomite minerals in these rocks varies from subhedral to anhedral. The sizes of the calcite minerals observed in the thin sections vary between 1.9 µm and 4.3 µm with an average size of 2.4 µm, while the sizes of the micro-crystalline dolomites vary between 1.8 µm and 3.5 µm with an average size of 2.5 µm. Modal analysis shows that the samples from Q3 consist of 85.6% calcite and 14.4% dolomite, while the samples from Q4 consist of 84.1% calcite and 15.9% dolomite. These results indicate that the analyzed samples can be classified as micritic limestone (Fig. 5c, d).

The chemical composition of the Mardin Stone, as determined through X-ray fluorescence (XRF), is detailed in Table 1. The samples collected from ancient (Q1) and modern (Q2) quarries within the Artuklu district exhibit notable consistencies. Specifically, the high CaO content (54.5% and 54.2%, respectively) and low MgO content (0.4% and 0.5%, respectively) are consistent with the findings from the petrographic analysis, confirming that the stones derived from these quarries are limestone. The loss on ignition (LoI) of the samples, fired at 1,000 °C, is 44.20 wt% for the Q1 sample and 43.85 wt% for the Q2 sample. These values represent the release of volatile substances, including carbon dioxide, organic matter, and hygroscopic water, during the heating process. Other components are present in relatively low amounts (less than 1%), underscoring the predominant composition of calcium oxide in these samples.

The chemical composition of the samples collected from Q3 and Q4 exhibited some variation compared to Q1 and Q2. Although CaO is the dominant component in these two samples (32.4% and 34.8%, respectively), the MgO contents (18.5% and 17.2%, respectively) differ from the Q1 and Q2 samples. The abundance of MgO supports the petrographic investigation that the Q3 and Q4 samples are micritic limestone. In comparison to Q1 and Q2 samples, Q3 and Q4 samples display higher LoI values of 48.20% and 47.25%, respectively. The elevated LoI in micritic limestone can be attributed to the release of CO_2 from both $CaCO_3$ and $MgCO_3$ during ignition, which is typical for micritic limestone. Similar to Q1 and Q2, other components are present in relatively low amounts (less than 1%), indicating a predominant composition of calcium oxide and magnesium oxide.

A noteworthy detail emerges in the analysis of Q3, where a slight increase in iron oxides is noted. This increment could be linked to surface sampling, as iron oxides fill joints and bedding planes. The presence of iron oxides-hydroxide along the bedding and/or lamina planes may contribute to the reddish veins observed in thin sections. The veined-filling structure in Q3, filled with iron oxide and hydroxide minerals, likely serves as the source of the reddish tone observed in cut stones (Fig. 5c). The presence of iron oxides may contribute to the coloration of cut stones produced from this quarry.

Technical Properties

Experimental studies have been performed on the samples collected from four quarries to analyze the physical and mechanical properties of the Mardin Stone. The technical properties of the samples were defined, and the results are tabulated in Table 2. Effective porosity and unit weight are important engineering properties of rock material that can affect its durability. Those two index properties can be measured with the same test. The effective porosity and the dry and saturated unit weights of the questioned samples were determined using the saturation and buoyancy techniques suggested by ISRM (1981) and TSE 699 (1987).

It is understood from the measurements that the samples have effective porosities varying from 20.8% (Q1) to 43.7% (Q3) (Table 2). The ranges of dry and saturated unit weights of the samples are 15 (Q3) and 20.18 (Q2) kN/m^3 (for dry

Table 1 Chemical composition (wt%) of the collected samples determined by XRF

	Oxides (wt%)										
Sample	Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	MnO	Na_2O	P_2O_5	SiO_2	TiO_2	LoI
Quarry-1	0.1	54.5	0.1	< 0.1	0.4	< 0.1	0.1	< 0.1	0.3	< 0.1	44.20
Quarry-2	0.2	54.2	0.1	< 0.1	0.5	< 0.1	0.2	< 0.1	0.6	< 0.1	43.85
Quarry-3	0.1	32.4	0.3	< 0.1	18.5	< 0.1	0.1	< 0.1	0.3	< 0.1	48.20
Quarry-4	0.1	34.8	< 0.1	< 0.1	17.2	< 0.1	0.2	< 0.1	0.4	< 0.1	47.25

Table 2 Technical properties of the Mardin Stone based on the laboratory studies

Material properties	Number of Tested Samples	Test Results (Mean ± SD†)			
		Quarry-1	Quarry-2	Quarry-3	Quarry-4
Effective porosity (%)	100 (4×25)	20.8 ± 1.2	23.1 ± 0.8	43.7 ± 1.4	37.2 ± 1.3
Dry unit weight (kN/m^3)	100 (4×25)	19 ± 0.7	20.2 ± 1.2	15 ± 0.3	16.8 ± 0.3
Saturated unit weight (kN/m^3)	100 (4×25)	21.8 ± 0.7	22.3 ± 0.5	19.3 ± 0.2	20.5 ± 0.2
Water absorption by weight (%)	100 (4×25)	10.7 ± 1.4	11.5 ± 2.2	28.6 ± 1.5	21.7 ± 1.2
Water absorption by volume (%)	100 (4×25)	17.2 ± 1.3	18.3 ± 3.2	22.9 ± 1.7	31.5 ± 1.2
Uniaxial compressive strength (MPa)	40 (4×10)	19 ± 1.7	17.6 ± 1.3	12.5 ± 1.9	14.2 ± 1.7
Thermal conductivity (W/mK)	60 (4×15)	1.9 ± 0.2	1.7 ± 0.2	1.3 ± 0.1	1.4 ± 0.1
P-wave velocity (m/s)	100 (4×25)	3492.6 ± 7.3	3382.71 ± 10.4	2493.2 ± 47.6	2392.7 ± 17.9

†: Standard Deviation

unit weight) and 19.3 (Q3) and 22.3 (Q2) kN/m^3 (for saturated unit weight) (Table 2). According to Anon (1979), Q1 and Q2 samples have high porosity and very low unit weight, whereas Q3 and Q4 samples have very high porosity and very low unit weight. Water absorption is also a critical parameter that affects the durability of stone materials. Water absorption test was conducted to calculate the amount of water that stone material can absorb under atmospheric and vacuum pressure. The ranges of water absorption by weight and water absorption by volume of the questioned samples are 10.7–28.6% and 17.2–31.5%, respectively (Table 2).

The Uniaxial Compressive Strength (UCS) of the samples was determined using the procedure described in ISRM (1981) and TSE 699 (1987). The UCS values of the samples are defined as 19 MPa for Q1, 17.6 MPa for Q2, 12.5 MPa for Q3, and 14.2 MPa for Q4 (Table 2). According to the rock classifications for the strength of rocks proposed by Anon (1979), the examined samples are classified as “moderately strong” for Q1 and Q2; and “weak” for Q3 and Q4.

To assess the thermal properties of the Mardin Stone, 15 cubic samples were utilized. The results of the thermal properties are also tabulated in Table 2. It is found that the samples have thermal conductivity results ranging from 1.37 to 1.96 W/mK. The results confirm the inverse relationship between porosity and thermal conductivity (Thomas et al. 1973). Specifically, the Q3, characterized by the highest effective porosity (43.69%), demonstrated the lowest thermal conductivity value (1.37 W/mK), whereas the Q1, with the lowest effective porosity (20.76%), exhibited the highest thermal conductivity value (1.96 W/mK) (see Table 2). To assess the sonic velocity of the Mardin Stone, 25 cubic samples were used. The results of the P-wave velocities are tabulated in Table 2. It is found that the samples have ultrasonic pulse velocity results ranging from 2392.71 (Q4) to 3492.61 (Q1) m/s. The findings indicate that the samples collected from quarries exhibit consistency with each other. Based on the proposed classification of Anon (1979), all the samples are classified as “low velocity” (Table 2).

Ancient Quarries and Their Significance

As pointed out in the geology section, the study area is dominated by lithological units that can be used as dimension stones. The availability of local materials in diverse regions allows for opening quarries in these formations. Indeed, large and small quarry remains can be found close to several religious buildings, archaeological sites, military sites, and settlements in the study area. Although the first use of the Mardin Stone as a building material is uncertain, its use in the ancient city of Dara opens a window of opportunity to trace this question (Fig. 6a). Dara, an ancient city, is roughly 25 km southeast of the city center, close to the Syrian border. Its history dates back to the sixth century (Ahunbay 1991; Keser Kayaalp and Erdogan 2017). In addition to those in Dara, there are several ancient quarries in the study area of varying types, sizes, and functions.

Although quarrying has been practiced in the area since antiquity, there are limited studies on the workers, owners, techniques and heritage value of these quarries (Kozbe and Güngör 2022; Karataş et al. 2023). The lack of such investigations makes it challenging to quantify the volume of material extracted, track the progress of quarrying processes, and identify changes in practice on a periodic basis. Furthermore, because many quarries have been adversely affected by urbanization and anthropogenic pressure, and their original function has been modified (rock shelter, necropolis, residential area, rock shelter, etc.), it is difficult to determine the exact boundaries of these areas, map them, and evaluate their quarrying techniques.

Through the present study, several site investigations were conducted to locate and categorize ancient quarries in

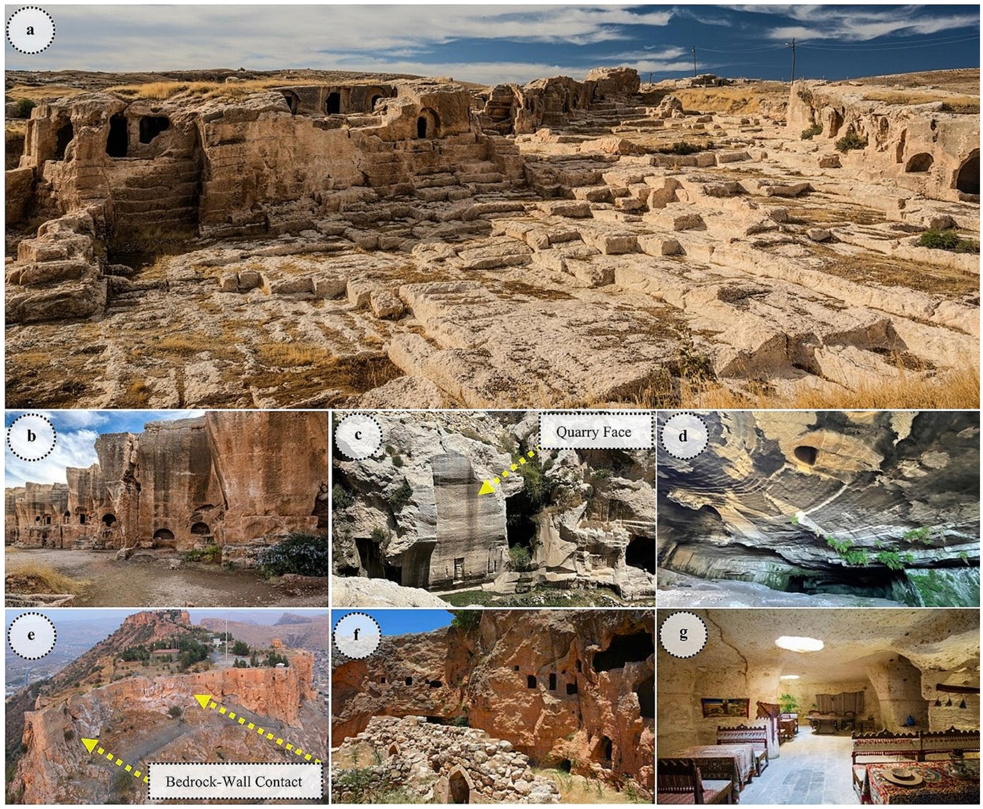

Fig. 6 Some of the ancient quarries in the study area: (**a**, **b**) Stone quarries of the Dara Ancient City (IFSAK 2023); (**c**) A quarry face view of the Ensar ancient quarry; (**d**) Gizzelin (İplik) quarry and caves; (**e**) Mardin Castle with contact zones of the modified bedrock and city walls; (**f**) Mor Behnam rock-hewn monastery (Kozbe and Güngör 2022); (**g**) A repurposed and furnished quarry in Midyat (http://tinyurl.com/3cbn9py7)

the study area. The quarries from which the Mardin Stone was sourced were not restricted solely to the regions where production steps or tool marks were visible.

In addition to regular quarries, this study considers the locations of rock-hewn monasteries, hillforts, certain necropolises, rocky settlements, and some of the caves as ancient quarries. A map showing the distribution of these quarries is given in Fig. 7. Based on the fieldwork and literature review, 108 accessible or traceable ancient quarries have been identified within Mardin's province. Some of these quarries are illustrated in Fig. 6. Most of the ancient quarries are located in Midyat and Artuklu, a pair of districts with a high concentration of historic structures. Considering the dimensions of the quarries in Artuklu, it is easy to infer that production was carried out in an area larger than the total area covered by the quarries in other districts. The most notable quarries are those located in the 6th-century Late Roman settlement of the ancient city of Dara (Fig. 6a-b) and the ancient quarries of Ensar (Figs. 1 and 6c), which are located on the outskirts of the historical fabric of Mardin city center. These sites hold significant influence due to their representation of classic ancient quarries and their proximity to residential areas. Traces of some of the quarries can also be observed in castles, defined as hillforts built in accordance with the topography. In this respect, Mardin Castle (Figs. 1 and 6e) and rock-hewn monasteries (Fig. 6f) are prominent examples of such quarries.

There are also some quarries that have now been repurposed. These structures may have formerly served as quarries and have since been converted into settlements or caves for tourist attractions (Fig. 6g). A recent research conducted by Dursun et al. (2023) on Zerzevan Castle, located in SE of Türkiye (Fig. 4), provides an example of such quarries, outlines the details of this practice by making volumetric calculations in the light of morphological and petrophysical analysis (Dursun et al. 2023).

Modern Quarries and Stone Extraction Process of the Mardin Stone

With the expansion of the city, the ancient quarries remained within the borders of the modern city. In 1979, the city's historical area was registered and protected by the Ministry of Culture and Tourism (MMM 2022). Over time, the protected zones expanded to include the quarries at the city center, which were registered and safeguarded by the conservation board in 2009 (http://tinyurl.com/2ew4jfsk; http://tinyurl.com/4ypj7k84). Since the designation of protected areas means that no construction or operation activities are permitted in such regions, extraction of block stone from these sites is also terminated. This situation has forced a search for new quarries with similar material properties to those obtained from the ancient quarries for new buildings and ongoing restoration efforts in Mardin City. Hence, new

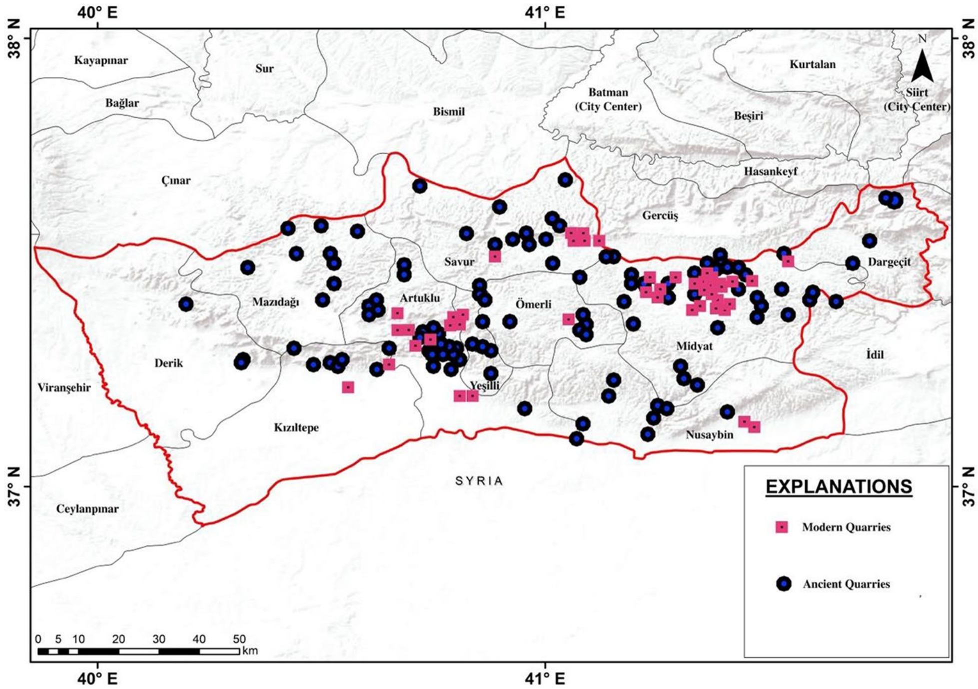

Fig. 7 Distribution map of the ancient and modern quarries within Mardin City

quarries with similar characteristics, particularly color and texture, began to open. Midyat and Savur, two districts of Mardin City, have recently become popular regions where new quarries are opened to meet the increasing demand for stone materials.

Field investigations and data provided by the Directorate General of Mining and Petroleum Affairs (MAPEG) indicate that approximately forty modern quarries in Mardin province are either currently in operation or have been abandoned (Fig. 7). Furthermore, there are also some quarries in the region that supply raw materials specifically for cement plants. It is evident from the map that the majority of these areas are clustered in the Midyat region. In addition to the protected status of quarry sites in the Artuklu region, the primary factors contributing to this trend in these regions can be listed as low labor costs, limited urban development, and the accessibility of locally available materials.

Today, stones from active quarries in the Mardin region are quarried and processed using methods similar to traditional ones. Almost all of these are surface quarries, meaning the stone is extracted directly from the surface. The stone blocks are extracted from the quarries using vertical and horizontal circular saws and transported to an adjacent stone cutting unit (Fig. 8a). Stone blocks are cut using circular cutting saws, as shown in Fig. 8a. The standard dimensions for cut stones are 19 × 20 × 30 cm, which might vary based on market demand.

While most of the cut stones are nowadays dressed in modern machines, in the past and to a limited extent today, this process was done by stonemasons using traditional methods. The most common stone dressing method employed with Mardin stone is the narrow tooth-chiseling method, known locally as "*Şahota.*" In this technique, the stone face is chiseled at parallel and closely spaced intervals (approximately 2–3 mm) to diminish the whiteness of the stone and give it a matte appearance.

Although the Mardin Stone is widely used as a cut stone, it is also an ornamental stone. The decorative application of the Mardin Stone, which has been practiced for centuries, is an important process that enhances its cultural and historical value (Figs. 2e-h and 8b). As a tradition passed down through the master-apprentice relationship, the ornamental stone carving includes the following stages. The desired patterns are sketched on the stone's surface to be decorated with cardboard molds (Fig. 8b). The stonemason subsequently follows these marks using a chisel and hammer to craft a surface adorned with decorative patterns (Fig. 8b). Finally, the surface is sanded to complete the stone crafting process.

Contemporary Use of the Mardin Stone

Stone should not be considered solely as a building material in Mardin. While stone characterizes the city, it is also perceived as a unifying element in culture and society. Although this long-standing link has evolved, this binding form of stone can still be witnessed in various aspects like architecture, culture, art, and other areas of creation involving those who reside in the city or have had to migrate.

The cultural richness of Mardin has contributed to the variation in the construction of religious buildings and traditional housing, as well as serving as an essential symbol in

Fig. 8 Stone extraction and carving. (**a**) extraction of stone from a surface quarry; (**b**) Drawing and carving the desired pattern onto the stone surface by cardboard stencils and chisels; (**c**) A stonemason practicing his art on the Mardin Stone (http://tinyurl.com/mv48uaya)

its modern use. The strong tendency towards the stone, particularly in modern applications, cannot be attributed only to its functionality as a construction material but to its significance as a prominent cultural symbol. As a result, practically all modern public buildings in Mardin today, including universities, mosques, cultural centers, guest houses, and bank branches, have been constructed of the Mardin Stone (Fig. 9a-c).

In addition to authentic architectural structures, stone plays a vital role in the preservation of historic buildings of Mardin (Fig. 9b). Several structures have been recently restored as part of the city's conservation campaigns. The locally available Mardin Stone is the principal material used for the repairs in these projects. In addition to its dimension stone characteristic, the Mardin Stone is widely used as an ornamental stone and an essential mortar component in these conservation campaigns.

The Mardin Stone has assisted in shaping the character of numerous landmarks in the study area. In addition to traditional housing and hotels, this stone was widely used in historic structures erected in the city's center. Figure 9d shows the clock tower constructed with the Mardin Stone in the city center of Midyat.

As mentioned, many Syriac Villages in the study area were abandoned following the migrations. The Syriac houses in these villages are examples of domestic and civil architecture built with the Mardin Stone, which is now in ruins. Recently, some Syriac families have decided to return to their homeland and begin repairing and rebuilding the houses in these abandoned villages. Figure 9h shows a modern stone masonry structure built following the returns. As evidenced by this building, the Mardin Stone, which is regarded as a critical element of culture and collective memory, was used as the primary construction material for these newly constructed residences.

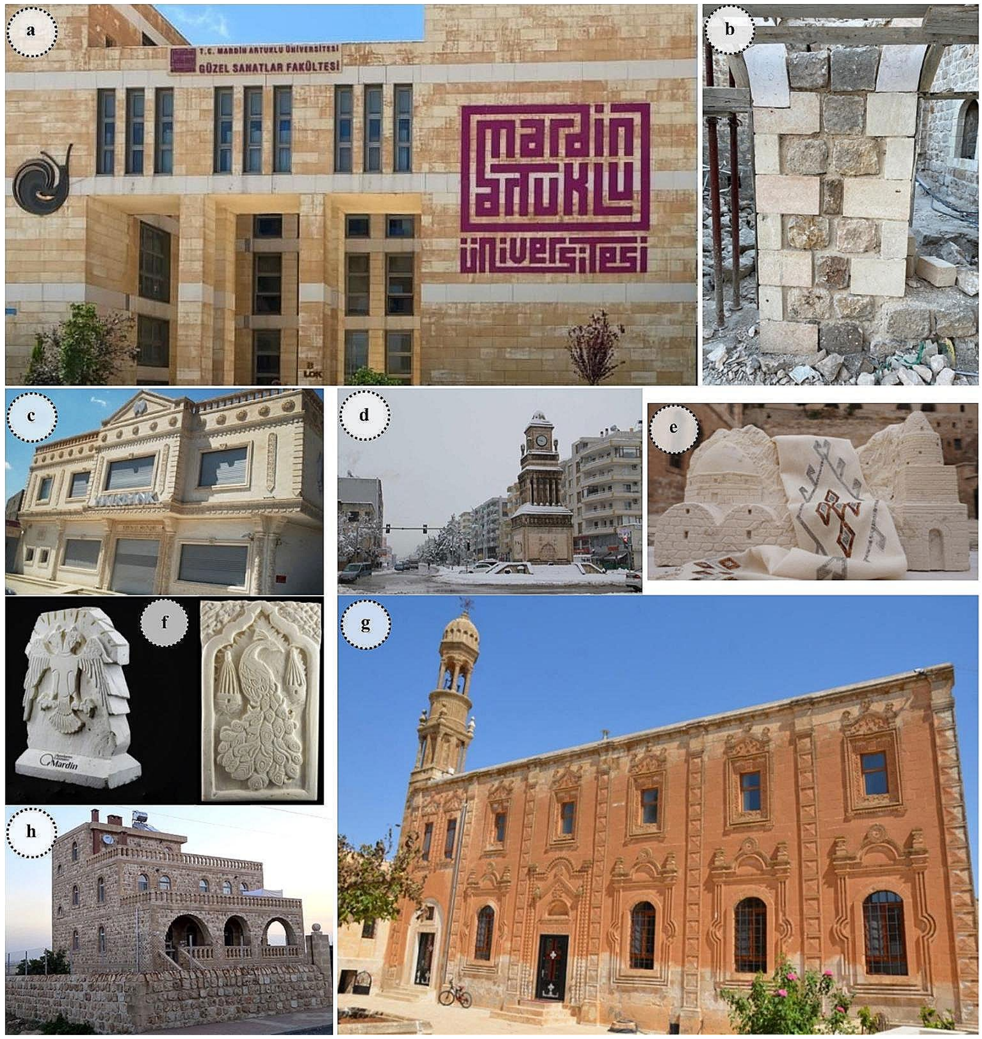

Fig. 9 Contemporary use of the Mardin Stone. (**a**) The campus of Mardin Artuklu University; (**b**) The application of the Mardin Stone in the restoration of a historical structure; (**c**) A bank branch in Midyat; (**d**) A clock tower at the city center of Midyat; (**e-f**) Miniatures carved into the Mardin Stone (http://tinyurl.com/4ujzm6yh); (**g**) Mor Şarbel Church, Midyat, the last church built in the study area; (**h**) A modern masonry structure in a Syriac village constructed with the Mardin Stone

Mardin Stone is widely used for crafting sculptures, ornaments, miniatures, statues, fountains, tombstones, garden benches, and chairs (Fig. 9e-f). The stone's modern application also includes its use in mosques and churches. The Mor Şarbel Church, constructed in 1956, the last church built in the study area (Ayduslu 2005), is an example of a religious building constructed using the Mardin Stone (Fig. 9g).

Mardin Stone is renowned beyond the boundaries of Mardin province as well. The Tarlabaşı Virgin Mary Syriac Metropolitan Church in Istanbul is a notable example of its utilization. Renovated in 1961, this church utilized stones quarried from Mardin (Fig. 10a) despite being located approximately 1500 km away from Mardin province. Given this considerable distance from Mardin City and the presence of stones with similar color and texture in the surrounding region of the church, one can further appreciate the symbolic significance of Mardin Stone. Another instance of Mardin Stone application is observed in a public building in Kocaeli province, approximately 1300 km from Mardin, in northwestern Türkiye. The building's façade features Mardin Stone in its portal, enhancing its architectural significance (Fig. 10b). Figure 10c illustrates its use in restoring a historic fountain in Istanbul. Furthermore, Mardin Stone has extensive applications in constructing hotels, spas, and private properties across various regions of Türkiye.

Interviews conducted with local quarry owners and officials from the Mardin Chamber of Commerce and Industry have revealed that Mardin Stone is exported to other countries, such as Iraq and Canada, primarily for use in private properties.

The most interesting examples of using the Mardin Stone beyond the study area are found in the churches constructed by the Syriac community in the diaspora. During the 1970s and 1980s, the Syriacs, a prominent group in Mardin's diverse population, migrated to Europe and the USA (Çaglar 2007; Mack 2017). In these regions, the Syriac community has established approximately 100 churches (Gabriel 2013).

Interviews conducted with members of the Mardin Syriac Orthodox Community and local quarry owners reveal that the Mardin Stone is exported to Europe and the USA,

Fig. 10 The use of Mardin Stone beyond the study area. (**a**) Feyzullah Efendi Fountain, Maltepe, İstanbul, an eighteenth-century fountain, restored using the Mardin Stone (http://tinyurl.com/4shx7fat); (**b**) The portal of a modern public institution structure constructed by using the Mardin Stone in Kocaeli, NW, Türkiye; (**c**) The Virgin Mary Syriac Metropolitan Church, Tarlabaşı, İstanbul, Türkiye; restored in 1961 by using the Mardin Stone (http://tinyurl.com/3cuzbdnf); (**d**) Use of the Mardin Stone in the altar of Mor Afrem Orthodox Church, Södertälje, Sweden (https://stafrem.se/kyrkan/om-oss/); (**e-f**) Use of the Mardin Stone in the altar of Mor Gabriel Syriac Orthodox Church, New Jersey, USA (https://tinyurl.com/4u96n8ap)

specifically to countries with high Syriac populations, such as Germany, the Netherlands, Belgium, Sweden, and the USA. It is known that the community has established important ties with Mardin and the stone, which is the symbol of Mardin. Interviews with the head of the Midyat Syriac Churches Foundation reveal that the Syriac community symbolically employs the Mardin Stone in specific sections of churches, such as the altar, altar entrance, and bell tower, built in these countries.

According to the head of the foundation, the stones quarried in Mardin's Midyat district are locally crafted and transported to various diaspora churches, including those in Sweden (Mor Afrem Orthodox Church, Södertälje); Germany (Mor Gabriel Church, Frankfurt); Austria (Mor

Afrem Church, Vienna); Belgium (Virgin Mary Church, Brussels) and the United States of America (Mor Gabriel Syriac Orthodox Church, New Jersey). Examples of Mardin Stone application in the altars of the Mor Afrem Orthodox Church in Södertälje, Sweden, and the Mor Gabriel Syriac Orthodox Church in New Jersey, USA, are illustrated in Fig. 10d-f. These applications of Mardin Stone are noteworthy because migrants perceive it as a symbolic representation of their homeland.

Conclusion

The significance of a stone material can be appreciated by tracing its journey from the quarry to the monument. Mardin City's urban structure, distinguished by its extensive use of stone, is an uncommon example of the integration of a variety of ethnic, religious, and cultural communities. This transforms the city into an outdoor museum, where the monumental forms of the stone are exhibited.

The Mardin Stone originates from the limestones of the Midyat Group, which are widely exposed in and around the Mardin City and southeastern Anatolia, Türkiye. The depositional environment of limestone units is claimed to be neritic, which is intercalated with other shallow sea clastic-carbonate units. Petrographic analyses indicate that the studied samples are fossiliferous micritic limestone and micritic limestone. Chemical analyses reveal that, with the exception of samples Q3 and Q4, which exhibit relatively high MgO content, there are no significant differences in composition of the studied samples. These analyses further reveal that the reddish color observed in stones extracted from some specific quarries in the Midyat region can be attributed to the presence of iron oxide and hydroxide minerals along the bedding and/or lamina planes. The results of physical, mechanical, and thermal analyses suggest that the samples collected from the Artuklu district (i.e., Q1 and Q2) exhibit better engineering properties compared to those from the Midyat and Savur districts (i.e., Q3 and Q4).

Many ancient quarries from which the Mardin Stone was extracted are currently in the city's protected areas. Following the field surveys carried out as part of the study, a total of 108 ancient quarries were identified, and their geographical distribution was mapped. The Mardin Stone continues to be widely appreciated in contemporary times. The stones extracted from about 40 active modern quarries in the region are used in buildings within the borders of Mardin and other cities in Türkiye. Mardin Stone is also employed in structures beyond the border of Mardin City. Although mainly employed as a cladding and decorative stone, it has also been used to some extent in the diaspora churches constructed by the religious communities that migrated to the Europe and the USA. The diverse cultural composition of the study area has facilitated the interpretation of the Mardin Stone as a representation of the collective memory. Therefore, the use of stone, especially in religious buildings outside Mardin City, is not primarily driven by its aesthetic appeal or durability but rather by its symbolic representation.

Given its significance in collective memory and its extensive use in architectural heritage assets, the Mardin Stone is considered a notable stone with the potential to be proposed as a candidate for heritage stone designation.

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Data Availability Field data collected during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethical Conduct This article contains no studies with human or animal subjects.

Conflict of Interest The author declares no competing interests.

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