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Unusual Use of Gypsum as a Building Stone in a Roman Bath: The Büyükteflek Bath (Central Anatolia, Türkiye)

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Abstract

The Büyükteflek Roman Bath, located near the Çiçekdağı district of Kırşehir in Central Anatolia, represents an important example of Roman public architecture that reflects both engineering traditions and local material utilization practices. This study investigates the architectural characteristics, geological context, and building materials of the bath complex through an integrated archaeological and geological approach. The structure, dated to the 2nd century AD, exhibits the typical spatial organization of Roman bath architecture, including the apodyterium, frigidarium, tepidarium, caldarium, and a hypocaust heating system. Architectural observations indicate that the hydraulic and thermal systems were designed according to established Roman engineering principles. Field observations reveal that the construction materials consist of a diverse assemblage of lithologies, including ultramafic, volcanic, magmatic, and sedimentary rocks, together with brick and marble elements used in different functional zones of the building. Hypocaust structures and high-temperature areas are predominantly constructed with sandstone and brick, while marble was mainly used as floor and pool lining in water-contact zones. A distinctive feature of the Büyükteflek Bath is the use of large gypsum blocks in certain wall sections. Considering the relatively low mechanical strength and high porosity of gypsum compared with commonly used Roman building stones such as marble or travertine, its use as a construction material is unusual. This choice appears to be closely related to the local evaporitic geology of the region and reflects the pragmatic use of locally available resources in Roman construction practices. Archaeological evidence also indicates that the building experienced significant functional transformations during Late Antiquity. Parts of the bath complex were reused as a small church and burial area, demonstrating the transition of the structure from a secular public facility to a religious space. Anthropological data from the associated burials further suggest that the cemetery was likely used by a socially restricted group. The Büyükteflek Roman Bath thus provides valuable insight into the relationship between Roman architectural traditions, local geological resources, and long-term building reuse processes. The results highlight the importance of considering both material properties and post-excavation environmental conditions in the conservation of archaeological structures constructed with evaporitic stones.

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Academic Editor: Jesús F. Jordá Pardo

Received: 23 September 2026
Revised: 21 October 2026
Accepted: 22 October 2026
Published: 25 October 2026

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Keywords: Roman bath architecture; building stones; gypsum; geoarchaeology; Central Anatolia

1. Introduction

The Büyükteflek settlement is an important ancient site located approximately 2 km south of Büyükteflek Village within the administrative boundaries of the Çiçekdağı district of Kırşehir Province in Central Anatolia. Rescue excavations carried out in the area between 2012 and 2014 revealed a large-scale Roman bath complex dated to the 2nd century AD. The bath structure consists of the characteristic spatial components of Roman bath architecture, including the changing room (*apodyterium*), cold room (*frigidarium*), warm room (*tepidarium*), hot room (*caldarium*), furnace (*praefurnium*), sweating room (*sudatorium*), and the hypocaust heating system [1]. Archaeological investigations at the site were initiated by the Kırşehir Museum Directorate as part of rescue excavations aimed at documenting and protecting architectural remains that were exposed following illicit excavations carried out by treasure hunters in 2011–2012.

Roman baths were not merely structures used for hygiene but were also important public spaces located at the center of urban life in antiquity [2,3]. In addition to their primary function of improving personal hygiene and health conditions, these buildings played a significant role as socio-cultural gathering places where urban inhabitants interacted with one another [4]. Recent archaeological investigations of the Central Bathhouse at Jerash have further demonstrated that Late Antique bathing complexes continued to serve as spaces for social interaction, including food consumption and recreational activities [5]. Roman baths therefore constituted multifunctional public environments whose significance extended beyond bathing practices.

The Büyükteflek Bath represents an important example of this architectural tradition within Roman settlements located in the interior regions of Anatolia. The plan layout and spatial organization of the structure indicate that it served a central public function in Roman urban life. However, significant changes in the building's function occurred during the 4th–5th centuries AD with the spread of Christianity in the region. During this period, the *frigidarium* of the bath was converted into a small-scale church, while one of the transitional spaces was reorganized as a burial area. Comparable processes of architectural modification and subsequent reuse have been documented at the Roman Bath of Parion, where successive construction phases were followed by the adaptation of part of the complex for lime production after bathing activities ceased [6]. More recently, the transformation of the Small Bath at Antiochia ad Cragum into a facility for wine and olive oil production has provided additional evidence of the diverse secondary functions acquired by Roman bathing complexes during Late Antiquity [7]. These examples provide a broader archaeological context for understanding the functional transformation of the Büyükteflek Bath.

Small finds recovered during the excavations, including pithoi, pitchers, unguentaria (perfume bottles), and oil lamps, indicate that the bath complex was intensively used. In addition, stone ball and discus fragments interpreted as sports equipment were discovered within a rectangular building complex located southwest of the bath. These finds suggest that the use of the bath was not limited solely to hygiene and bathing activities but also functioned as a multifunctional public space where physical activities were performed [1].

Roman baths represent some of the most advanced engineering and architectural achievements of the ancient world. The materials used in their construction were important not only for their structural properties but also for their ability to withstand high

temperatures, humidity, and continuous water use. In Roman architecture, bath buildings were generally constructed using a combination of stone, brick, lime mortar, concrete (*opus caementicium*), and various facing materials [8,9]. The combined use of these materials enabled efficient heat distribution within rooms heated by the hypocaust system and ensured the long-term durability of the structures.

In Roman bath architecture, the selection of building materials was often closely related to local geological resources. Roman engineering adopted a pragmatic approach in utilizing locally available stone sources. Consequently, different rock types such as travertine, limestone, marble, tuff, basalt, and sandstone were widely used in Roman bath construction [2,4,10]. These stones were typically used in load-bearing walls, pavements, and water channels, whereas brick and concrete were preferred for superstructural elements such as vaults and domes. In the Büyükteflek Roman Bath, it has been determined that ultramafic rocks together with volcanic, magmatic, and sedimentary rock types from the region were used in the construction of load-bearing walls. However, the use of gypsum blocks in the enclosed hall of the bath complex stands out as a noteworthy architectural application.

Evaporitic rocks, particularly gypsum and anhydrite, are among the materials that have been used in various architectural applications throughout history. These rocks are of chemical sedimentary origin and typically form in lagoonal environments characterized by intense evaporation processes. The relatively low hardness of evaporitic stones and their ease of workability allow the production of smooth surfaces, making them suitable for use as facing stones, block stones, or decorative architectural elements in ancient construction [11,12]. However, their high porosity and sensitivity to water generally restricted their use to architectural elements that were not in direct contact with water.

Historical evidence indicates that the use of gypsum as a building material and binder dates back to very early periods. One of the earliest known examples is gypsum-based plaster applications identified at the Neolithic settlement of Çatalhöyük in Anatolia [12]. Technical knowledge regarding gypsum production and use later spread throughout the Eastern Mediterranean. The technology is thought to have been transmitted from Egypt to Crete [12], and it is known that certain external walls of the Palace of Knossos were constructed using gypsum blocks [12]. In the Greek world, gypsum production and use were treated more systematically, and Theophrastus (372–287 BC), a natural scientist and student of Aristotle, provided detailed descriptions of gypsum production and applications in his writings on rocks and minerals [12]. This knowledge was later transmitted to Roman culture through Greek intermediaries and was further elaborated by Pliny the Elder (AD 23–79) [12]. Ancient sources indicate that gypsum was used not only in architectural applications but also in molding techniques and decorative elements [12]. Nevertheless, due to its low resistance to water, Romans generally preferred gypsum for interior plasters and decorative coatings, while its use in exterior architectural elements remained limited [12].

In Roman bath structures in Anatolia, durable rocks such as travertine, limestone, and tuff were commonly used as building materials. However, in some cases different stone types were also utilized depending on the availability of local geological resources. The gypsum block usage identified in the Büyükteflek Bath therefore represents a noteworthy example in this regard. This finding provides important evidence both for understanding how regional geological resources were transformed into architectural materials and for revealing the diversity of materials used in Roman bath architecture.

One of the most characteristic features of Roman baths is the hypocaust system (underfloor heating system), which was an important factor influencing the selection of construction materials. In this system, hot air and smoke circulated through cavities beneath the floor to heat the rooms. Therefore, the materials used in bath buildings had to be resistant to high temperature fluctuations and continuous thermal stress [8]. In addition, properties such as thermal conductivity, porosity, and resistance to moisture directly affected the performance of construction materials. In the Büyükteflek Roman Bath, sandstone and brick were used in the construction of the hypocaust system.

2. Methodology and Study Area

The study area is located within the Roman settlement situated approximately 2 km south of Büyükteflek Village, in the eastern part of Kırşehir Province, Central Anatolia. This study aims to evaluate the architectural characteristics, building materials, and preservation conditions of the Büyükteflek Roman Bath through an interdisciplinary approach integrating archaeological observations and field-based geological assessments.

Within the scope of the archaeological investigation, the spatial organization, plan relationships, and architectural components of the bath complex were examined. In this context, the apodyterium, frigidarium, tepidarium, caldarium, and hypocaust sections were evaluated in terms of their architectural characteristics, spatial relationships, and construction techniques. Particular attention was given to the distribution and use of different building materials within the structure.

The geological assessment was based on macroscopic field observations of the building stones, including their color, grain size, texture, visible structural characteristics, and general physical appearance. The observed lithological characteristics were evaluated in relation to the regional geological setting and the distribution of surrounding rock units. The region is characterized by various geological formations, including evaporitic units containing gypsum. These geological characteristics provide a basis for discussing the possible local provenance of the building materials. However, no petrographic, mineralogical, geochemical, or laboratory-based physical and mechanical analyses were performed on the archaeological stone blocks. Therefore, the lithological classifications presented in this study should be regarded as preliminary interpretations based on macroscopic observations rather than definitive laboratory-confirmed identifications.

The preservation conditions and visible deterioration of the gypsum blocks were evaluated through field observations and a qualitative comparison of photographic documentation obtained during the 2012 archaeological excavations and observations conducted in 2025. Particular attention was given to visible surface changes, including cracking, material loss, and localized disintegration. However, no systematic environmental monitoring or quantitative deterioration measurements were conducted. The potential effects of environmental factors on the preservation of gypsum blocks were discussed as possible deterioration mechanisms rather than experimentally verified processes.

3. Geological Setting

The study area is located in the central–northern part of Central Anatolia and consists of ophiolitic, volcanic, sedimentary, and magmatic rock units that developed within a stratigraphic range from the Late Cretaceous to the Quaternary (Figure 1) [13,14]. The oldest units in the region are Late Cretaceous oceanic and magmatic rock assemblages, which are unconformably overlain by younger Eocene–Oligocene sedimentary deposits [15,16].

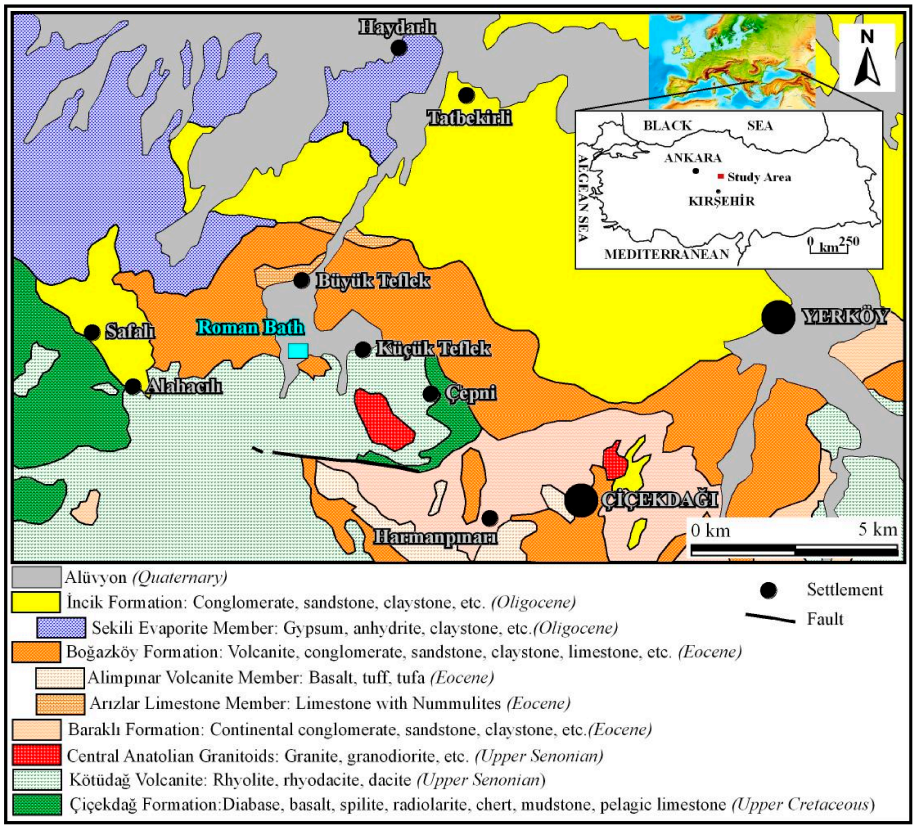


Figure 1. Geological map of the study area showing the main lithological units (modified from [17]).

The Çiçekdağı Formation (Late Cretaceous), which constitutes the basement units of the region, is composed of diabase, basalt, spilite, radiolarite, chert, mudstone, and pelagic limestones, representing an oceanic crust-derived stratigraphic sequence [13]. These units are overlain by the Kötüdağ Volcanics (Upper Senonian), consisting of felsic volcanic rocks with rhyolite, rhyodacite, and dacite compositions. Magmatic activity during the same period is represented by the Central Anatolian granitoids, composed mainly of granite and granodiorite, which reflect deep-seated magmatic processes in the region [14,18].

Eocene-aged units unconformably overlie this basement and are widely exposed in the region. The Boğazköy Formation exhibits a complex lithological succession consisting of volcanics, conglomerates, sandstones, claystones, and limestones, indicating transitional depositional environments between continental and shallow marine settings [13,17]. The contemporaneous Alimpınar Volcanic Member, composed of basalt, tuff, and tuffaceous lithologies, demonstrates that volcanic activity continued throughout the Eocene period. Marine carbonate deposition is represented by the Arızlar Limestone Member, characterized by limestones rich in Nummulites, indicating warm and shallow marine conditions [19]. The Eocene-aged Baraklı Formation reflects intra-basin clastic sedimentation with conglomerate, sandstone, and claystone lithologies [17].

Following the Eocene, the Oligocene-aged İncik Formation developed as a thick continental to semi-continental succession consisting of conglomerates, sandstones, and claystones. Within this formation, the Sekili Evaporite Member represents evaporitic deposition formed under closed-basin conditions and is composed of gypsum, anhydrite, and claystone lithologies [11,13]. The youngest units in the region are Quaternary alluvial deposits, which occur in limited extents along modern stream channels and low-lying topographic areas [17].

4. Architectural Description

The excavation area consists of two main trenches. The northern trench, where the bath structure and the associated architectural complex were uncovered, covers an area of approximately 625 m^2. The second trench, located to the south and covering approximately 50 m^2, revealed a small chapel that appears to have been constructed in a later period than the bath structure [1]. In addition to the bath building, the presence of a square-planned architectural complex was also identified in the northern trench.

When all spaces are considered together, the bath structure presents a rectangular plan measuring approximately 25 m in length and 10 m in width. On the eastern side of the building, adjacent to the caldarium, there is an apse-shaped projection that adds architectural articulation to the plan. The bath building is oriented along a north–south axis and consists sequentially of the apodyterium, frigidarium, tepidarium, and caldarium, starting from the southernmost section. A service corridor is located to the west of the tepidarium, while a building complex measuring 20 × 17 m lies to the southwest of the frigidarium and west of the apodyterium (Figure 2).

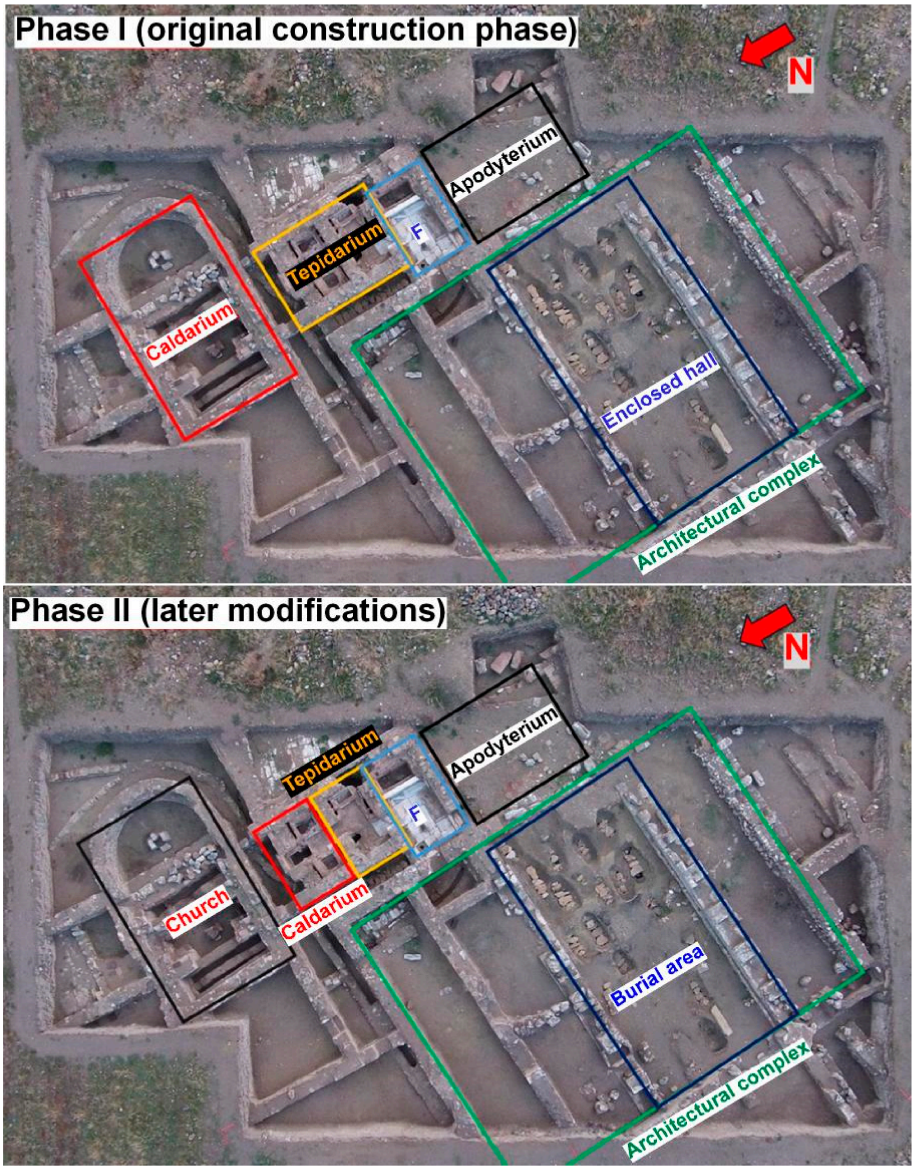


Figure 2. Architectural phases of the Büyükteflek Bath: Phase I (original construction phase) and Phase II (later modifications).

At the center of this complex there is a hall measuring approximately 16 × 6 m. It is thought that the complex contained spaces functionally related to the bath. In the initial excavation reports, the presence of stone balls and discus fragments led to the interpretation of this space as a palaestra. However, the presence of brick flooring remains and the enclosed architectural character of the space suggest that it was not a palaestra in the classical sense. Moreover, the use of gypsum blocks as building stones in the walls indicates that the area was not an open courtyard. It is also understood that the same space was later reused as a burial area where east–west oriented burials were carried out (Figure 2).

The apodyterium of the bath measures approximately 6 × 5 m internally, and its floor is covered with an opus sectile pavement composed of hexagonal tiles in two different colors. The best-preserved part of the room is the northern wall, where a doorway providing access to the frigidarium is located. The frigidarium measures approximately 5.7 m in length and 2.8 m in width. This space can be accessed through two separate entrances: one from the apodyterium and the other from the service corridor on the west. Both the floor and walls of the room are clad with marble slabs, many of which have survived to the present day (Figure 2).

On the eastern wall of the frigidarium there is a cold-water pool (piscina frigida) measuring 2.25 m in length, 1.35 m in width, and 1.30 m in depth. It is understood that this pool was supplied by an external cold-water line (aqua frigida), which continued eastward toward the water boiler (ahenum) located in the praefurnium. These findings indicate that part of the cold water brought to the bath was used in the frigidarium pool, while the continuation of the same pipeline served to supply water to the boiler. The gradual downward slope of the water channel after the frigidarium pool and the subsequent direction of heated water from the ahenum to the hot-water pool (piscina calida) demonstrate the application of hydraulic engineering principles characteristic of the Roman period [4,20].

Access to the tepidarium is provided through a doorway located on the northern side of the frigidarium. This room is divided into two parts by a brick wall, consisting of a front chamber measuring 1.85 × 3.85 m and a rear chamber measuring 2 × 3.85 m. In the front chamber, two basins (kurna) not connected to the water supply system were identified, which were likely used by manually filling them with water. One of these basins is damaged, while the preserved example measures approximately 60 × 30 cm. This space is interpreted as a cleansing area used before entering the hot room. In the second section of the tepidarium, two small pools are located near the eastern and western walls. The western pool measures approximately 1 m × 63 cm and is 60 cm deep, whereas the eastern pool measures 82 × 74 cm with a depth of 1 m. It was determined that hot water was delivered to these pools through pipes and that drainage outlets connected to a drainage system were present at the base of both pools. The floor and walls of the tepidarium were also covered with marble slabs.

The caldarium is located to the west of the tepidarium. The connection between the tepidarium and caldarium is provided by a passage 95 cm wide. Before reaching this passage, there is a narrow room measuring approximately 3 m in length and 1 m in width, where traces of a water drainage system can be observed on the floor. This arrangement does not fully conform to the classical plan scheme of Roman bath architecture and suggests that this section may have been modified in later periods. Furthermore, the area where the ahenum, used for heating water in the praefurnium, was installed also appears to be associated with this section.

The caldarium measures approximately 10.5 m in length and 6 m in width. On the eastern façade of the structure, there is an apsidal hot-water pool approximately 6 m wide

with a radius of about 4 m. The central square-plan area of the caldarium is divided into two parts by wall buttresses. In the eastern section, brick arches belonging to the hypocaust system were identified beneath the floor. It is understood that the caldarium lost its original function in later periods and was likely converted into a church. A later arrangement consisting of stone blocks bearing a cross motif and placed at the center of the apsidal pool suggests that this area may have functioned as a bema during its use as a church.

A total of 45 pilae belonging to the hypocaust system were identified. Thirty-six of these have a nearly square plan, while the remaining examples have circular sections. The height of the pilae was measured as 1.35 m in the second chamber of the tepidarium and 1.70 m in the first chamber. This difference in height appears to be related to variations in the floor level of the praefurnium.

When the architectural development of the structure is evaluated, it is understood that the bath was originally constructed with dimensions of approximately 25 × 10 m. In a later period, the connection between the caldarium and the praefurnium was cut off when the caldarium was converted into a church. During this process, the bath complex was reduced in size and part of the tepidarium appears to have been reorganized to function as a new caldarium. At the same time, a new entrance was opened from the north to the space converted into a church, although this entrance was closed during a later phase. Brick repairs observed in the wall masonry and the use of spolia indicate that these architectural modifications occurred in different phases.

Vitruvius (1999) [21] (V.11.1–3) describes palaestrae as sports areas surrounded by colonnaded porticoes with an open courtyard at the center. The space initially interpreted as a palaestra in the Büyükteflek Bath does not conform to the classical palaestra plan described by Vitruvius (1999) [21], as it has an enclosed architectural character, contains a brick-paved floor, and lacks an open courtyard arrangement. Considering its plan characteristics, construction technique, and its spatial relationship with the heated rooms of the bath, it appears more likely that this space functioned as a public hall rather than a sports area. This interpretation demonstrates that Roman baths were not solely structures used for hygiene but also multifunctional public buildings that included areas for social interaction and leisure.

5. Evaluation of the Geological and Material Properties of Building Materials

The Büyükteflek Roman Bath is located near the Kırşehir–Yozgat provincial boundary, approximately 2 km southwest of Büyükteflek Village (Figure 3). The structure is situated on a gently undulating plateau surface that is clearly distinguishable from the surrounding extensive agricultural fields. Three-dimensional topographic data obtained from Google Earth imagery indicate that the bath was constructed at a morphological level close to the valley floor but at a safe distance from the active stream channel, where the risk of flooding is relatively low (Figure 3a).

The bath area is surrounded by low-gradient ridges to the north and northeast and broader alluvial plains to the south and southwest. This setting suggests that the area likely provided both accessible transportation routes and favorable conditions for water supply during the Roman period. In particular, the natural drainage networks extending along the valley appear to have created morphological conditions that could facilitate the collection and redirection of water near the structure. Although the area has been partially disturbed by modern agricultural activities, the plan traces of the bath can still be identified in satellite imagery (Figure 3b).

High-resolution satellite images (Figure 3c) reveal light-colored, irregularly shaped remains and variations in soil texture surrounding the structure. These features clearly

distinguish the site from the surrounding agricultural parcels and indicate that archaeological remains are partially preserved on the surface. The slightly elevated position of the structure suggests a deliberate site selection aimed at ensuring effective drainage control and maintaining the stability of the building foundations.

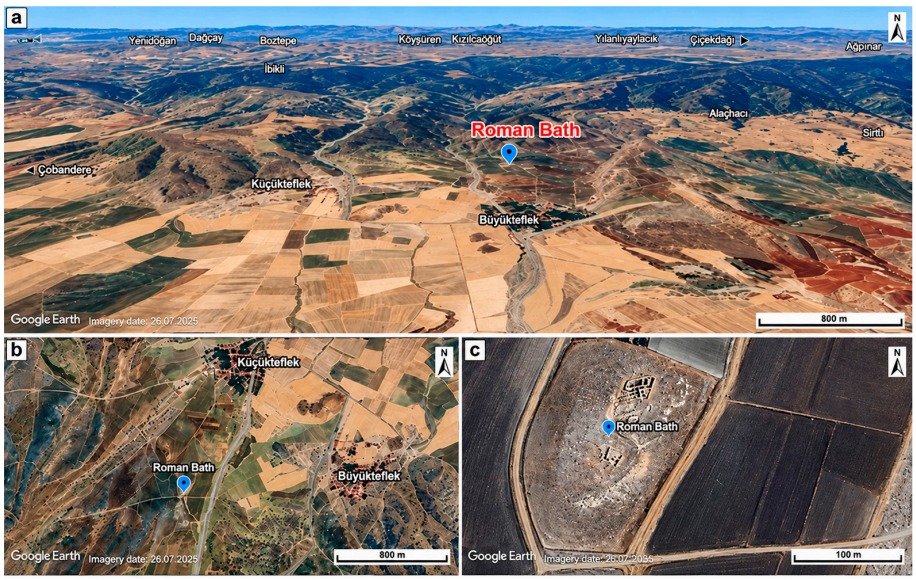


Figure 3. Google Earth satellite images of the Büyükteflek Roman Bath and its surrounding area: (**a**) regional topographic setting, (**b**) site location, (**c**) close-up view of the bath structure.

The lithological classification of the building stones was based on macroscopic field observations, including color, grain size, texture, and visible structural characteristics. No petrographic or mineralogical laboratory analyses were performed on the archaeological stone blocks. Therefore, the lithological identifications presented in this study should be considered preliminary field-based interpretations. Future petrographic and mineralogical investigations, including thin-section microscopy and X-ray diffraction analyses, would provide further confirmation of these classifications.

It is observed that rock blocks of different ages and lithologies, ranging in size from approximately 10 cm to 100 cm, were used in the outer walls of the Büyükteflek Roman Bath (Figure 4a–f). The distinctly rounded to sub-rounded morphology of the building stones suggests that these materials were most likely collected from nearby stream beds. The lithological composition of the rocks used in the structure includes ultramafic rocks (Ur), volcanic rocks (Vr), magmatic rocks (Mr), and sedimentary units such as sandstones (Ss) and limestones (Ls). Volcanic rocks can be distinguished by their dark reddish-brown coloration and massive textures (Figure 4e), whereas ultramafic rocks are characterized by dark greenish tones and high-density structures (Figure 4c). Sandstones are represented by fine- to medium-grained textures and locally visible bedding structures (Figure 4d,f), while limestones display light-colored and relatively homogeneous textures (Figure 4c). Magmatic rocks can be identified by their holocrystalline textures.

The presence of various rock types indicates that the construction materials were not obtained from a single lithological source but rather derived from different geological units, most likely from nearby fluvial deposits. This lithological heterogeneity suggests that geological suitability, mechanical durability, and local availability were jointly influential in the selection of building materials during the Roman period. Accordingly, the choice of building stones appears to reflect a pragmatic resource-use strategy rather than a strictly engineering-based material selection approach.

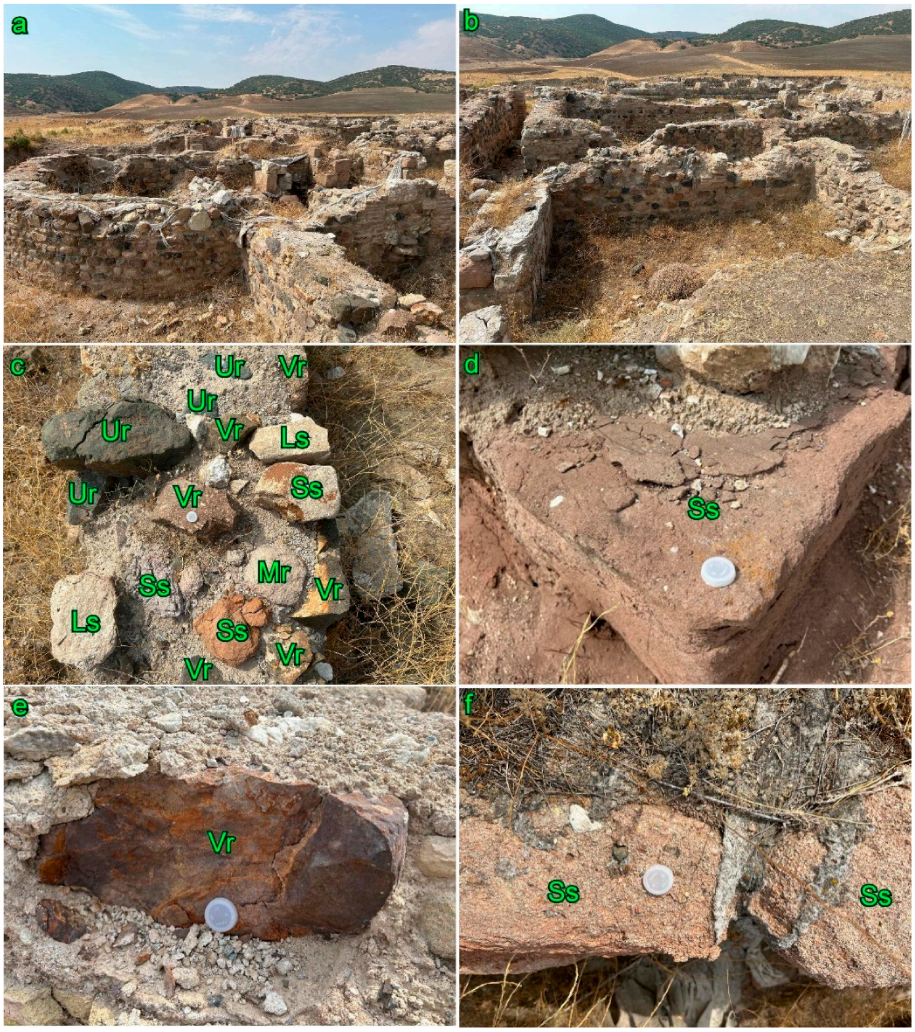


Figure 4. (**a**–**f**) Lithological types of stones used in the walls of the Büyükteflek Roman Bath (Ur: ultramafic rock, Vr: volcanic rock, Mr: magmatic rock, Ls: limestone, Ss: sandstone).

In the wet floors and foundation structure of the Büyükteflek Roman Bath, architectural and lithological evidence documented in Figure 5 indicates that bricks (Br) and various rock types (sandstone and marble) were used together in a functional arrangement. In the foundation levels, particularly within the arched hypocaust systems that allow the circulation of hot air and smoke, reddish–orange sandstones (Ss) and bricks (Br) were predominantly used (Figure 5a,b). The coloration of these materials and the locally observed traces of thermal alteration clearly indicate that these units were employed in zones exposed to high temperatures.

At the floor levels above these arched structures, which were continuously exposed to moisture—especially in the frigidarium and tepidarium sections—claddings composed of marble slabs (Mar) approximately 2–3 cm thick are widely observed (Figure 5e,f). This feature suggests that the structure was designed not only for functional purposes but also with aesthetic considerations in mind. In addition, it was determined that block-shaped marble elements (Mar) were used in small water pools and bathtub-like installations, where they were positioned to withstand hydraulic conditions (Figure 5c,d).

This vertical and horizontal distribution of materials indicates that thermal zoning and functional differentiation were deliberately considered in the bath structure. Heat-resistant sandstone–brick assemblages were used in the substructure exposed to high temperatures, whereas marble was preferred in areas exposed to water and mechanical wear. These

findings clearly demonstrate that material selection in Roman bath architecture was carried out according to engineering criteria related to heat, humidity, and usage conditions.



Figure 5. (**a**–**f**) Building materials used in the foundations and wet-floor sections of the Büyükteflek Roman Bath (Mar: marble, Ss: sandstone, Br: brick).

In some walls of the Büyükteflek Roman Bath, as shown in Figure 6, a mixed masonry technique was employed in which bricks (Br) and rock blocks of different lithologies (Ro) were used together. In the lower and middle sections of the walls, rubble masonry composed of rock blocks with irregular sizes and shapes bonded with mortar is dominant. This masonry is intermittently interrupted by horizontal brick courses at certain levels (Figure 6a–f). The placement of bricks as bonding and leveling bands indicates a deliberate engineering practice aimed at increasing wall stability.

In some sections, bricks and stones were used together to form arched or semi-arched architectural elements (Figure 6c), suggesting that this material combination was not only applied as filling material but also preferred in load-bearing architectural components. The predominantly rounded to sub-rounded morphology of the rock blocks indicates that these materials were most likely obtained from nearby stream beds.

The brick–stone combination is particularly evident at corners, wall junctions, and zones where load transfer is more concentrated (Figure 6a). The irregular yet functional masonry pattern observed on the wall surfaces demonstrates that, in Roman bath construction, local material resources were pragmatically combined with engineering principles.

This approach emphasizes structural durability, continuity, and functionality rather than purely aesthetic considerations.



Figure 6. Mixed brick–stone masonry observed in the walls of the Büyükteflek Roman Bath: (**a**–**f**) rubble stone blocks of various lithologies (Ro) bonded with mortar and reinforced with horizontal brick courses (Br).

In the repaired walls of the Büyükteflek Roman Bath, as documented in Figure 6, architectural and material relationships indicate that bricks (Br) and rock blocks of different lithologies (Ro) were used together in an irregular masonry arrangement. In certain sections, the horizontal brick courses that dominate the original wall construction are interrupted by large stone blocks, suggesting secondary interventions or repair phases (Figure 7a,b). In particular, openings between brick walls—likely interpreted as doorways or passageways during the original construction phase—appear to have been blocked with stone masonry at a later stage, possibly in response to changes in the functional use of the structure (Figure 7a).

Furthermore, in some brick wall sections, stone block insertions distinguished by differences in mortar texture and material compatibility indicate repair or reinforcement activities carried out using construction techniques different from the original masonry (Figure 7b). The variation in size, shape, and lithology of the stone blocks used in these interventions suggests that the repairs relied on readily available materials obtained from nearby sources.



Figure 7. (**a**,**b**) Bricks and rock blocks used in the repaired walls of the Büyükteflek Roman Bath (Ro: rock, Br: brick).

The mixed wall fabric observed in Figure 7 clearly demonstrates that the bath structure does not belong to a single construction phase; rather, it underwent multiple phases of use, functional transformation, and successive repair processes. These later interventions appear to have partially altered the original architectural layout, indicating that post-Roman modifications played a significant role in the structural evolution of the building.

Despite the presence of nearby marble and limestone source rocks in the region, these lithologies were not widely used in the Büyükteflek Roman Bath. This situation becomes particularly notable when compared with similar structures in the surrounding area from the same period, such as the Sarıkaya Thermal Roman Bath, where travertine, marble, and limestone constitute the dominant building materials [10]. This difference is likely related to the scale of the structure, functional priorities, and economic conditions.

In particular, the use of large gypsum blocks measuring approximately 50 × 100 × 50 cm as building stones in the enclosed hall—interpreted as a space possibly intended for hosting guests—represents an unusual material choice (Figure 8a–f). Gypsum is a calcium sulfate mineral containing two molecules of water ($CaSO_4 \cdot 2H_2O$) and is generally considered to form through the hydration of natural anhydrite ($CaSO_4$) over geological timescales [22,23]. Mineralogically, gypsum is a very soft material with a Mohs hardness of 1.5–2 and a density ranging between 2.3 and 2.4 g/cm^3 [24].

The presence of gypsum-bearing source rocks in close proximity to the site, together with the ease of shaping gypsum and its ability to provide smooth and aesthetically pleasing surfaces, are considered the primary factors influencing the selection of this material. In terms of mechanical properties, the compressive strength of raw gypsum ranges between 15 and 40 MPa, while its tensile strength remains relatively low, between 1 and 3 MPa [25,26]. In addition, porosity values vary between 26% and 29% [26]. Considering the values reported in the literature, gypsum is expected to be highly susceptible to weathering under atmospheric conditions due to its low hardness, low strength, highly porous structure, and high water absorption capacity.

It should be emphasized that the compressive strength and porosity values presented above were obtained from previously published studies and do not represent direct measurements of the gypsum blocks used in the Büyükteflek Bath. The physical and mechanical properties of natural gypsum may vary considerably depending on mineralogical purity, porosity, microfractures, weathering degree, and environmental conditions. Therefore, these literature-based values are used only to provide a general engineering context rather than to quantitatively characterize the archaeological gypsum blocks.

When the physical and mechanical properties of gypsum are taken into account, its use as a building stone—particularly within a bath structure characterized by high humidity and water vapor—appears remarkable. Compared with travertine (50–60 MPa) and marble (90–100 MPa), which were commonly used in Roman bath structures [10],

gypsum exhibits significantly lower physical and mechanical performance. Nevertheless, the general construction approach of the building suggests that economically accessible and easily obtainable materials were prioritized. Marble, being relatively expensive, labor-intensive, and difficult to obtain, appears to have been used only in limited areas such as wet-floor coverings. In contrast, the use of gypsum blocks—despite their low mechanical strength and sensitivity to moisture—indicates that economic and aesthetic considerations may have been more influential than functional durability in the selection of building materials. In this respect, the Büyükteflek Roman Bath presents a noteworthy example of material selection practices in Roman architecture.



Figure 8. (**a**–**f**) Gypsum blocks used as building stones in the walls of the Büyükteflek Roman Bath (Gy: gypsum).

When the preservation state of the structure is evaluated in relation to its historical development and available photographic documentation, the gypsum (Gy) wall elements appear to have maintained relatively good structural and surface integrity at the time of the archaeological excavations in 2012 (Figure 9a,c,e). This preservation condition may be associated with the original placement of gypsum blocks within enclosed architectural spaces and their subsequent long-term burial beneath soil and collapsed structural materials following the abandonment of the building. Such conditions may have limited direct exposure to atmospheric influences and contributed to the preservation of this moisture-sensitive material.



Figure 9. (**a**–**f**) Comparative views of gypsum (Gy) blocks used in the walls of the Büyükteflek Roman Bath, showing their condition in 2012 and 2025.

A comparative visual assessment of photographic documentation from 2012 and field observations conducted in 2025 reveals noticeable differences in the condition of the gypsum wall elements (Figure 9a–f). While the 2012 photographs show relatively well-preserved block surfaces and wall arrangements (Figure 9a,c,e), the 2025 observations reveal cracking, material loss, and localized disintegration of exposed gypsum blocks (Figure 8d–f; Figure 9b,d,f). These changes may be associated with increased exposure to precipitation, atmospheric humidity, temperature fluctuations, surface runoff, and changes in local drainage conditions. However, differences in photographic angles and documentation conditions, together with the absence of systematic environmental monitoring and quantitative deterioration assessments, prevent definitive identification of the dominant deterioration mechanisms or accurate determination of deterioration rates.

Overall, these observations suggest that long-term burial may have contributed to the preservation of gypsum building elements, whereas subsequent exposure to environmental conditions may have facilitated their deterioration. Although the relative influence of individual factors remains uncertain, the findings highlight the vulnerability of gypsum as a building material and emphasize the importance of appropriate post-excavation conservation measures, particularly environmental protection and drainage management.

6. Anthropological Evidence and Functional Transformation of the Bath Complex

Archaeological and anthropological evidence from the Büyükteflek Roman Bath indicates that the structure underwent a substantial functional transformation during its later occupation phase. The presence of burials within the eastern enclosed hall suggests that the building was partially incorporated into a funerary context during the Early Byzantine period. The spatial relationship between the graves and the earlier architectural elements of the bath demonstrates that this was a deliberate reuse of the structure rather than an incidental burial activity. Similar transformations of abandoned Roman public buildings into ecclesiastical or funerary spaces are widely documented in Late Antique contexts across the eastern Mediterranean [27,28]. The east–west orientation of the graves and the positioning of the arms across the abdomen correspond with established Early Byzantine Christian burial practices [29,30], further supporting the interpretation that the site became associated with a Christian funerary landscape.

Anthropological analysis identified a minimum of seventeen individuals, including twelve adult males, four children and one infant [31]. The absence of female individuals is noteworthy and may indicate that the burial area did not represent a community-wide cemetery but rather a restricted burial group. Such demographic selectivity has been observed in other Late Antique burial contexts where cemeteries were associated with specific occupational groups, religious communities or institutional spaces [32–34]. The demographic composition therefore suggests that the burial population may represent a socially defined subgroup connected to the reuse of the bath complex.

The estimated average life expectancy of adult males, approximately 39 years [31], falls within the expected demographic range for populations living during the Roman–Byzantine transitional period in Anatolia [35,36]. Stature estimates calculated using Pearson and Trotter–Gleser regression equations yielded mean values of approximately 166.5 cm and 171.3 cm respectively [31]. Although methodological differences account for variation between these estimates, both values correspond closely with published stature ranges for contemporaneous populations in Anatolia and the eastern Mediterranean [37]. These results suggest that the individuals interred at the site do not represent a biologically distinct group in terms of body size or general physical development.

Skeletal stress indicators provide further insights into the lifestyle of the buried individuals. The presence of osteophytes, Schmorl's nodes and calcaneal spurs among adult males indicates repetitive mechanical loading and long-term physical strain [31]. Such pathologies are commonly associated with intensive physical labor and habitual biomechanical stress [35,38,39]. These observations support the interpretation that members of the burial group may have been engaged in physically demanding activities, potentially related to agricultural production, construction or other labor-intensive tasks within the regional economic system.

Dental evidence also contributes to reconstructing diet and health conditions. The relatively low frequencies of dental caries (5.66%) and calculus (1.88%), combined with a moderate rate of antemortem tooth loss (9.09%) [31], are broadly consistent with Early Byzantine populations in Anatolia [35,40]. These values suggest a diet that included carbohydrate-based foods but was not dominated by highly refined agricultural products. In contrast, the pronounced degree of dental wear observed in many individuals indicates the regular consumption of abrasive food components. Such wear patterns are frequently linked to traditional food-processing techniques, including grinding cereals with stone tools that introduce mineral particles into the diet [40,41]. The limited occurrence of enamel hypoplasia and the absence of abscesses further suggest that prolonged physiological stress or chronic malnutrition was not widespread within this population.

Taken together, the anthropological evidence indicates that the Büyükteflek Roman Bath was incorporated into a funerary landscape during the Early Byzantine period and that the burial population likely represents a socially restricted group rather than a general community cemetery. The predominance of adult males, the skeletal indicators of intensive physical activity and the dietary patterns inferred from dental evidence collectively suggest that the individuals may have belonged to a specific working community connected to the surrounding settlement. However, the limited sample size and preservation conditions require that such interpretations remain cautious. Future excavations and broader comparative bioarchaeological analyses will be necessary to clarify the demographic composition and social identity of the population associated with the site.

7. Discussion

The Büyükteflek Roman Bath reflects the classical scheme of Roman thermal architecture in terms of its plan organization. The sequence of apodyterium–frigidarium–tepidarium–caldarium and the presence of a hypocaust system indicate that the structure was constructed in accordance with advanced engineering knowledge and standardized architectural principles of the Roman period [2,4]. In particular, the hydraulic channels directing water from the frigidarium pool to the ahenum appear to have been arranged with controlled gradients, suggesting the application of hydraulic engineering principles characteristic of Roman baths. These architectural features indicate that the structure should be evaluated not merely as a regional building but as an example belonging to the broader technical tradition of Roman bath architecture.

However, one of the most distinctive features of the Büyükteflek Bath is the lithological diversity of its construction materials, particularly the unusual use of gypsum blocks. Roman bath structures commonly incorporated durable carbonate rocks such as travertine, limestone, and marble [8,9]. In contrast, the use of gypsum in the load-bearing walls of the Büyükteflek Bath suggests that the availability of local geological resources may have influenced material selection in Roman construction practices. Gypsum ($CaSO_4 \cdot 2H_2O$) is generally characterized by low hardness and sensitivity to water, while its physical and mechanical properties may vary considerably depending on mineralogical purity, porosity, microfracture development, and degree of weathering [11,12]. The mechanical properties discussed in this study are based on published literature rather than direct measurements of the archaeological gypsum blocks. Nevertheless, the use of gypsum in a bath structure characterized by humid conditions and temperature fluctuations remains particularly noteworthy.

This material selection appears to be associated with the geological characteristics of the region. The presence of Eocene–Oligocene evaporitic formations and gypsum-bearing units in the study area suggests that local geological resources may have influenced the selection and procurement of construction materials. In Roman architecture, material selection was often influenced not only by engineering considerations but also by economic and logistical factors [8]. In this respect, the Büyükteflek Bath may represent an example of how local geological availability, together with possible economic and logistical considerations, could have influenced material selection in Roman construction practices. However, since the lithological classifications are based primarily on macroscopic field observations and no petrographic, mineralogical, or geochemical provenance analyses were conducted, the proposed local origin of the building stones should be considered a preliminary interpretation requiring further investigation.

The spatial distribution of construction materials within the building suggests a possible functional differentiation. In areas exposed to high temperatures, particularly within the hypocaust system, bricks and stones macroscopically identified as sandstone were

used, possibly reflecting considerations related to thermal resistance. Conversely, marble claddings were observed in areas exposed to water, such as the frigidarium and tepidarium floors, suggesting that water resistance and durability may have influenced material selection. The use of gypsum blocks mainly in wall masonry suggests that this material may have been applied in zones subjected to relatively limited thermal and hydraulic stress. Overall, this distribution may reflect a pragmatic engineering approach in which locally available resources were selected in relation to architectural functions, although the absence of site-specific material testing prevents definitive conclusions regarding their engineering performance.

The preservation state of the structure also highlights the sensitivity of gypsum building elements to environmental conditions. Due to its water sensitivity and relatively high solubility, gypsum is vulnerable to deterioration under prolonged moisture exposure [11]. The relatively good preservation of gypsum blocks documented during the 2012 excavations may have been partly associated with their long-term burial beneath soil, which could have reduced direct exposure to atmospheric conditions. In contrast, surface deterioration, cracking, and material loss observed on gypsum walls following excavation suggest that increased environmental exposure may have contributed to their deterioration (Figure 8d–f; Figure 9a–f). However, other factors, including direct water exposure, surface runoff, changes in drainage conditions, and possible conservation-related interventions, may also have influenced these changes. Furthermore, differences in photographic perspectives and documentation conditions limit the comparability of the available images. In the absence of quantitative deterioration assessments and systematic environmental monitoring, the relative contributions of these factors cannot be conclusively determined. These observations therefore provide qualitative evidence of changes in preservation conditions and emphasize the importance of appropriate post-excavation conservation measures.

Another important aspect of the Büyükteflek Bath is the transformation of the structure during Late Antiquity, when it appears to have been reused as a church and burial area. Liturgical arrangements identified in the caldarium and east–west oriented burials indicate that the structure was reorganized as a Christian religious space. The conversion of a public and secular Roman bath into a religious structure during Late Antiquity is consistent with the spatial reuse processes frequently observed in Roman urban architecture [27,28]. This transformation represents not only an architectural modification but also a shift in the social and symbolic meaning of the space.

Anthropological evidence further supports the social dimension of this transformation. The demographic composition of individuals identified within the burial area, particularly the predominance of adult males, suggests that the burials may belong to a specific social group. Skeletal changes, including osteophyte formation, Schmorl's nodes, and calcaneal spurs, may be associated with repetitive physical loading and age-related degenerative processes [35,38]. These findings may be compatible with participation in agricultural production or other labor-intensive activities, although specific occupational activities cannot be established solely from skeletal evidence.

Overall, the Büyükteflek Roman Bath provides an important archaeological example illustrating how a public Roman structure could undergo multiple phases of use and functional transformation. The structure is significant both for its reflection of Roman engineering traditions in its architectural organization and for the unusual incorporation of gypsum among its building materials. Its subsequent conversion into a religious structure and burial area provides valuable insights into processes of spatial continuity and social transformation during Late Antiquity. The findings suggest that material selection in Roman construction may have been influenced by a combination of engineering requirements, local geological availability, and possible economic considerations. Furthermore,

the observed deterioration of exposed gypsum elements highlights the importance of environmental protection, drainage management, and systematic monitoring in the post-excavation conservation of archaeological structures constructed with evaporitic stones. Future petrographic and mineralogical investigations, site-specific engineering tests, and quantitative deterioration assessments would contribute to a more comprehensive understanding of the geological provenance, material performance, and long-term preservation requirements of the building stones.

8. Conclusions

This study presents an integrated evaluation of the architectural plan, building materials, and phases of use of the Büyükteflek Roman Bath, located in the Kırşehir–Çiçekdağı region, based on archaeological documentation and field-based geological observations. The findings indicate that the structure reflects the classical plan scheme characteristic of Roman bath architecture. The sequence of apodyterium–frigidarium–tepidarium–caldarium, together with the hypocaust system, suggests that the building was designed in accordance with the architectural and engineering principles of Roman thermal architecture. The hydraulic system, which directed water from the frigidarium pool to the ahenum, further illustrates the application of water-management techniques within the bath complex.

The macroscopic evaluation of building materials suggests that rocks with diverse lithological characteristics were incorporated into the construction of the bath. Stones preliminarily classified as ultramafic, volcanic, magmatic, and sedimentary rocks were observed in the wall masonry, while bricks and stones macroscopically interpreted as sandstone were used in the hypocaust system and other high-temperature areas. Marble claddings were also documented in water-related spaces. This distribution suggests that architectural function and material characteristics may have influenced construction practices. Particularly noteworthy is the use of gypsum blocks in certain wall sections, despite the generally recognized water sensitivity and variable mechanical properties of this material. Their use may be associated with the availability of gypsum-bearing geological formations in the surrounding region, potentially reflecting practical, economic, and logistical considerations. However, the proposed lithological classifications and local provenance interpretations remain preliminary because no petrographic, mineralogical, or geochemical analyses were conducted on the archaeological building stones.

The preservation condition of the structure also highlights the potential vulnerability of gypsum building elements following archaeological excavation. The relatively good preservation of gypsum blocks documented in 2012 may have been partly associated with the protective effects of long-term burial. In contrast, comparative photographic observations from 2025 reveal visible surface deterioration, cracking, and localized material loss in exposed gypsum elements. These changes may be related to increased environmental exposure, although the possible contributions of direct water contact, surface runoff, drainage conditions, and other site-specific factors cannot be excluded. In the absence of systematic environmental monitoring and quantitative deterioration assessments, the dominant deterioration mechanisms and rates cannot be conclusively determined. Nevertheless, these observations emphasize the importance of appropriate post-excavation conservation measures, particularly water management, drainage control, and systematic condition monitoring.

The architectural and anthropological evidence further suggests that the Büyükteflek Bath experienced multiple phases of use. Originally constructed as a public bath during the Roman period, the structure appears to have undergone a functional transformation in Late Antiquity, when parts of the complex were adapted for religious purposes and certain areas were used for burials. This transformation is consistent with broader processes of

architectural reuse and changing social practices during Late Antiquity. The demographic characteristics and skeletal changes observed among the buried individuals provide additional information about the population associated with the later phases of the site, although their specific social or occupational identities cannot be established conclusively from the available evidence.

Overall, the Büyükteflek Roman Bath represents a valuable case study illustrating the relationship between Roman architectural traditions, regional geological resources, and the transformation of built environments over time. The unusual incorporation of gypsum suggests that local material availability, together with possible economic and functional considerations, may have influenced construction practices. Furthermore, the observed changes in the preservation condition of exposed gypsum blocks highlight the importance of conservation planning for archaeological structures containing water-sensitive evaporitic stones. Future petrographic and mineralogical investigations, site-specific physical and mechanical testing, and quantitative environmental monitoring would contribute to a more comprehensive understanding of the building materials, their geological provenance, and their long-term preservation requirements.

Author Contributions: Conceptualization: Z.B., Y.A. and A.G.; Methodology: Z.B. and Y.A.; Investigation: Z.B., Y.A., A.G., M.D. and G.E.; Formal Analysis: Z.B. and Y.A.; Data Curation: Y.A., İ.K.A. and H.D.; Visualization: Z.B., İ.K.A. and H.D.; Resources: Z.B., M.D. and A.G.; Writing, Original Draft: Z.B., A.G. and Y.A.; Writing, Review and Editing: All authors. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: Data will be made available on request.

Acknowledgments: This study was conducted with the permission of the Republic of Türkiye Ministry of Culture and Tourism, General Directorate of Cultural Heritage and Museums. The authors thank the Kırşehir Provincial Directorate of Culture and Tourism and the Kırşehir Museum Directorate for their support and assistance during the geoarchaeological investigations at the Büyükteflek Roman Bath.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Güçlü, A. Büyük Teflek yerleşim yeri. In *24. Müze Kurtarma Kazıları Sempozyumu Ve 1. Uluslararası Müzecilik Çalıştayı Bildirileri*; Kültür ve Turizm Bakanlığı: Ankara, Turkey, 2015; pp. 419–434.
2. Nielsen, I. *Thermae et Balnea: The Architecture and Cultural History of Roman Public Baths*; Aarhus University Press: Aarhus, Denmark, 1990; Volumes 1–2.
3. Fagan, G.G. *Bathing in Public in the Roman World*; University of Michigan Press: Ann Arbor, MI, USA, 2002.
4. Yegül, F.K. *Baths and Bathing in Classical Antiquity*, 2nd ed.; MIT Press: Cambridge, MA, USA, 2011.
5. Blanke, L.; Bangsgaard, P.; McPhillips, S.; Pappalardo, R.; Penn, T. Down the drain: Reconstructing social practice from the content of two sewers in a Late Antique bathhouse in Jerash, Jordan. *J. Rom. Archaeol.* **2024**, *37*, 241–263. [CrossRef]
6. Yılmaz, A.; Yılmaz, Z. The Roman Bath at Parıon: Hıstorıcal Development and the Datıng by14c Of Its Reused Phase. *Mediterr. Archaeol. Archaeom.* **2023**, *23*, 77–92. [CrossRef]
7. Dodd, E.; Rodriguez, L.R. Bathing in wine and olive oil: Late Roman agricultural production in the Small Bath at Antiochia ad Cragum, Rough Cilicia. *J. Rom. Archaeol.* **2026**, 1–32. [CrossRef]
8. DeLaine, J. The baths of Caracalla: A study in the design, construction, and economics of large-scale building projects in imperial Rome. *J. Rom. Archaeol.* **1997**.
9. Adam, J.P.; Mathews, A. *Roman Building: Materials and Techniques*; Routledge: Abingdon, UK, 2005.
10. Başıbüyük, Z.; Ekincioğlu, G.; Önal, M.M. Yozgat Sarıkaya Termal Roma Hamamı'nda kullanılan doğal yapı taşları ve mühendislik özellikleri. *Çukurova Üniversitesi Mühendislik-Mimar. Fakültesi Derg.* **2019**, *34*, 233–244. [CrossRef]
11. Warren, J.K. *Evaporites: A Geological Compendium*, 2nd ed.; Springer: Berlin/Heidelberg, Germany, 2016.
12. Singh, M. *Gypsum and Gypsum Products: Their Science and Technology*; CRC Press: Boca Raton, FL, USA, 2022.

13. Göncüoğlu, M.C.; Turhan, N.; Şentürk, K.; Özcan, A.; Uysal, Ş.; Yalınız, M.K. *Orta Anadolu Masifi'nin Jeolojisi*; MTA Yayınları: Ankara, Turkey, 1997.
14. Boztuğ, D.; Arehart, G.B.; Platevoet, B.; Harlavan, Y.; Bonin, B. High-K, calc-alkaline I-type granitoids from the composite Yozgat batholith generated in a post-collisional setting following continent-oceanic island arc collision in central Anatolia, Turkey. *Mineral. Petrol.* **2007**, *91*, 191–223. [CrossRef]
15. Göncüoğlu, M.C.; Dirik, K.; Kozlu, H. General characteristics of pre-Alpine and Alpine terranes in Turkey. *Ann. Geol. Des. Pays Hell.* **1991**, *35*, 515–536.
16. Tüysüz, O.; Dellaloğlu, A.A.; Terzioğlu, N. A magmatic belt within the Neo-Tethyan suture zone and its role in the tectonic evolution of northern Turkey. *Tectonophysics* **1995**, *243*, 173–191. [CrossRef]
17. MTA. *1:100.000 Ölçekli Açınsama Nitelikli Türkiye Jeoloji Haritaları Serisi, Kırşehir–I32 Paftası*; MTA Yayınları: Ankara, Türkiye, 1991. Available online: https://eticaret.mta.gov.tr/index.php?route=product/product&product_id=17819 (accessed on 1 January 2026). (In Turkish)
18. Kadıoğlu, Y.K.; Dilek, Y.; Foland, K.A. Slab break-off and syncollisional origin of the Late Cretaceous–Early Tertiary magmatism in Central Anatolia. *Geol. Soc. Am. Bull.* **2006**, *118*, 114–130. [CrossRef]
19. Okay, A.I.; Tüysüz, O. Tethyan sutures of northern Turkey. In *The Mediterranean Basins: Tertiary Extension Within the Alpine Orogen*; Durand, B., Jolivet, L., Horváth, F., Séranne, M., Eds.; Geological Society of London: London, UK, 1999; pp. 475–515.
20. Waelkens, M.; Vermeersch, P.M.; Paulissen, E.; Owens, E. The Sagalassos territory: Water supply and environmental changes. In *Sagalassos IV*; Waelkens, M., Poblome, J., Eds.; Leuven University Press: Leuven, Belgium, 1997; pp. 369–379.
21. Vitruvius. *De Architectura (Ten Books on Architecture)*; Granger, F., Translator; Harvard University Press: Cambridge, UK, 1999.
22. Bates, R.L. *Geology of the Industrial Rocks and Minerals*; Dover Publications: Garden City, NY, USA, 1969.
23. İstanbulluoğlu, Y.S. Alçıtaşı ve anhidrit üzerine bir çalışma. *Madencilik Derg.* **1997**, *36*, 13–24.
24. Giambastiani, M. Geomechanical Characterization of Evaporitic Rocks. In *Soft Rock Mechanics and Engineering*; Kanji, M., He, M., Ribeiro e Sousa, L., Eds.; Springer: Cham, Switzerland, 2020.
25. Gireson, K. Kızılyer (Denizli) jips ve dolomitlerinin jeomekanik özelliklerinin araştırılması. Master's Thesis, Pamukkale Üniversitesi, Denizli, Turkey, 2013.
26. Çomaklı, R. Alçıtaşı üretiminde delme—Patlatma yöntemi yerine mekanik kazı yönteminin kullanılabilirliğinin araştırılması. *Niğde Ömer Halisdemir Üniversitesi Mühendislik Bilim. Derg.* **2021**, *10*, 746–752. [CrossRef]
27. Ward-Perkins, B. *The Fall of Rome and the End of Civilization*; Oxford University Press: Oxford, UK, 2005.
28. Saradi, H. *The Byzantine City in the Sixth Century*; Society of Messenian Archaeological Studies: Athens, Greece, 2006.
29. Parker Pearson, M. *The Archaeology of Death and Burial*; Texas A&M University Press: College Station, TX, USA, 1999.
30. Duday, H.; Cipriani, A.M. *The Archaeology of the Dead: Lectures in Archaeothanatology*; Oxbow Books: Oxford, UK, 2009.
31. Alkan, Y.; Erkman, A.C.; Kaplan, İ. Çiçekdağı iskeletlerinin paleoantropolojik analizi. In *29. Arkeometri Sonuçları Toplantısı*; T.C. Kültür ve Turizm Bakanlığı: Ankara, Turkey, 2014; pp. 77–82.
32. Buikstra, J.E.; Ubelaker, D.H. *Standards for Data Collection from Human Skeletal Remains*; Arkansas Archaeological Survey Research Series No. 44; Arkansas Archaeological Survey: Fayetteville, AR, USA, 1994.
33. Buikstra, J.E.; Beck, L.A. *Bioarchaeology: The Contextual Analysis of Human Remains*, 2nd ed.; Routledge: Abingdon, UK, 2017.
34. Knüsel, C. Bioarchaeology and social theory. In *The Routledge Handbook of the Bioarchaeology of Human Conflict*; Knüsel, C., Smith, M., Eds.; Routledge: Abingdon, UK, 2014.
35. Roberts, C.; Manchester, K. *The Archaeology of Disease*, 3rd ed.; Cornell University Press: Ithaca, NY, USA, 2007.
36. Scheidel, W. Demography. In *The Cambridge Economic History of the Greco-Roman World*; Scheidel, W., Morris, I., Saller, R., Eds.; Cambridge University Press: Cambridge, UK, 2007.
37. Ruff, C.; Holt, B.; Niskanen, M. Stature and body mass estimation from skeletal remains in archaeological populations. *Am. J. Phys. Anthropol.* **2012**, *148*, 601–617. [CrossRef] [PubMed]
38. Ortner, D.J. *Identification of Pathological Conditions in Human Skeletal Remains*; Academic Press: Cambridge, MA, USA, 2003.
39. Waldron, T. *Palaeopathology*, 2nd ed.; Cambridge University Press: Cambridge, UK, 2021.
40. Hillson, S. Recording dental caries in archaeological human remains. *Int. J. Osteoarchaeol.* **2001**, *11*, 249–289. [CrossRef]
41. Mays, S. *The Archaeology of Human Bones*, 2nd ed.; Routledge: Abingdon, UK, 2010.

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