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Formation and Spatial Distribution of Underground Troglodytic Architecture in Teymareh, Khomeyn, Iran

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Abstract

Northern Teymareh, a subregion of the historical Teymareh area, corresponds to present-day Khomeyn County in Iran's modern political geography. Previous archaeological surveys in this county have identified several underground troglodytic structures, including those of Tahyagh, Danian, Kandeh-ha, Farnaq, Robat Aghaj, Nazi, Choqa Gorg, and Ashnakhor. Archaeological excavations at the Tahyagh and Robat Aghaj sites indicate that these locations were utilized during the Middle Islamic period (particularly during the 12-13 centuries CE). Montazer Zohouri and Sharahi have proposed interpretations regarding the functions of Tahyagh and Robat Aghaj. However, despite the considerable number of identified underground troglodytic structures in Khomeyn County, no comprehensive analytical study has yet been conducted on the causes of their formation, functions, or distribution within this region. Accordingly, the present study seeks to answer the following questions: what is the spatial distribution of underground troglodytic structures in the Northern Teymareh region relative to the landscape, and what factors influenced their formation? The results indicate, first, that several contemporaneous settlement sites are adjacent to some of the underground troglodytic structures. Second, analysis of their spatial distribution in relation to landscape features -such as slope, elevation, rivers, and land use- suggests that they were excavated in locations suitable for irrigated agriculture. Therefore, these sites can be interpreted as part of an agrarian settlement system, in which communities primarily relied on agriculture and lived near their farmlands in the plains, while constructing underground structures for refuge and defensive purposes.

Keywords: Rock-cut Structure, Islamic Archaeology, Troglodytic Architectures, Middle Islamic Centuries.

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Introduction

Underground troglodytic structures are a form of architecture created through the digging of corridors and rooms in bedrock (Mohamadifar & Hemati Azandaryani, 2016: 97). Nevertheless, most of the underground troglodytic structures identified in Iran to date belong to the period from the first millennium BCE to the present. The earliest known examples of troglodytic structures are primarily funerary spaces (rock-cut tombs). Some first-millennium BCE rock-cut structures with burial functions include those of Gowijeh Qal‘eh village (Sattarnejad *et al.*, 2021a: 113), two rock-cut tombs at Ismail Agha Fortress west of Urmia (Kleiss, 1986: 82), and the Sangar-e Maku rock-cut complex (Danişmaz, 2019: 123).

At the same time, rock-cut structures with multiple or uncertain functions have also been identified, such as the Sheytan-Abad of Miandoab and Darreh Khan sites along the Urmia–Oshnavieh axis (Van Hulsteyn, 1981: 121–123, 127–130) and the Bardeh Konteh site of Mahabad (Hejebri Nobari *et al.*, 2022: 47). It appears that this architectural tradition, which initially emerged with funerary functions, gradually developed to diverse residential, ritual, security and defensive, storage, livestock-keeping, and public uses (Sattarnejhad *et al.*, 2021b; Doostkafi *et al.*, 2023).

In later periods, particularly during the Islamic period, many of the rock-cut structures were carved. Notable examples include the Abazar complex of Nir (Ahmadi, 2000), Dash Hamami of Givi in Ardabil (Sattarnejhad *et al.*, 2018), Varjovi of Maragheh (Sattarnejhad *et al.*, 2021a), Qadamgah of Azarshahr (Sattarnejhad, 2020), the Kharaqan complexes of Qazvin (Maraqi & Parhizkari, 2018), Delik Dash of Mahneshan (Khosravi, 2018), Samen of Malayer and Arzanfud of Hamedan (Mohamadifar *et al.*, 2016), O’ee of Noush Abad, Kashan (Zera‘at Kashani, 2015), Narin Qal‘eh of Meybod (Nikzad & Ghafouri, 2018), and Meymand of Kerman (Azad, 2005a), (Fig 1).

The historical region of Teymareh, located in present-day Khomeyn County, also contains valuable underground troglodytic structures. The Robat Aghaj (Montazer Zohouri & Hosseinzadeh, 2018) and Tahyagh (Sharahi, 2021) complexes have previously been surveyed and excavated. The results of these excavations confirm the use of these sites during the Middle Islamic centuries, and researchers have proposed interpretations regarding their functions. However, despite the considerable number of identified underground spaces in Khomeyn County, no analytical study has yet examined their distribution and typology.

Accordingly, this paper explores two main objectives: 1) to investigate functions of underground troglodytic structures in Northern Teymareh

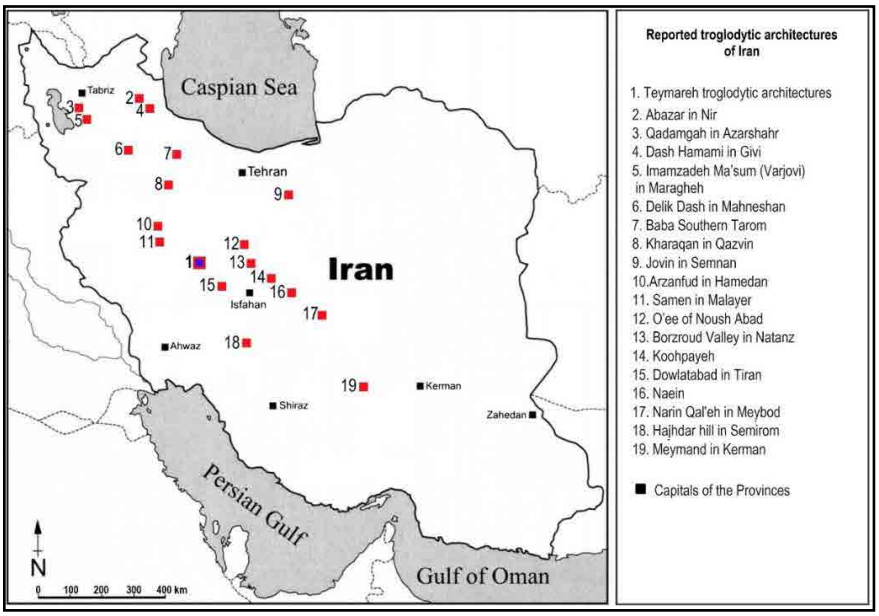


Fig. 1: Distribution of some reported troglodytic architectures in Iran (Second Author, 2026). ▶

based on archaeological evidence and landscape analysis, and 2) to examine the spatial distribution of these spaces in relation to landscape features and influencing factors. The authors seek to answer the following question: how is the spatial distribution of underground troglodytic structures in Northern Teymareh related to the regional landscape, and what factors contributed to their establishment?

Research Method

Primary data used in this study were collected through fieldwork and documentary research, including the GIS data. In the first stage, the results of previous archaeological surveys in Khomeyn County were reviewed, followed by surveys of the underground troglodytic structures in the region and their systematic documentation.

The dataset includes all identified underground troglodytic structures in the historical region of Northern Teymareh within present-day Khomeyn County, comprising eight sites: Tahyagh, Robat Aghaj, Kandeh-ha, Danian, Choqa Garg, Ashnakhor, Farnaq, and Nazi. Among these, documentation of the internal space of the Choqa Gorg, Ashnakhor, and Danian complexes was not possible due to lack of access. Only their locations, geographical features, and surrounding remains were recorded for use in spatial and landscape analyses. The internal spaces of the Nazi complex were documented partially because some areas were accessible while others were blocked. In contrast, the internal spaces of the four complexes of Farnaq, Tahyagh, Kandeh-ha, and Robat Aghaj were fully documented.

Following field surveys and documentation of accessible spaces, the spatial data were processed in ArcGIS. Various maps were produced to provide data for geographical analyses. Based on this process, archaeological evidence from the excavated sites of Tahyagh and Robat Aghaj was analyzed and compared with other subsurface complexes in Northern Teymareh in terms of location, architectural features, and cultural materials, leading to interpretations regarding the causes of formation and functions of these structures. In addition, using ArcGIS outputs and considering factors such as access to resources, arable lands and pastures, the locations of historical urban and rural settlements, security conditions, and historical events, the relationship between the underground troglodytic spaces and the landscape was examined.

Literature Review

Studies on rock-cut and underground troglodytic architecture in Iran and beyond have attracted scholarly attention for many years. However, the underground troglodytic structures of Northern Teymareh have received relatively little attention. Mohamadifar and Hemmati Azandaryani (2016) examined Iranian rock-cut complexes in terms of definition, formation factors, and typology. They concluded that the creation of rock-cut or troglodytic architecture depends on multiple factors, including climatic and geographical conditions, defensive and security concerns, durability and permanence, and religious motivations.

Sattarnejhad *et al.*, (2021b) classified the rock-cut complexes of Maragheh County into residential, ritual, protective, and public types and analyzed the factors influencing their formation. In another study (2021a), they examined the nature and function of the so-called Imamzadeh Ma'sum (Varjovi) complex in Maragheh and identified its primary function as a Buddhist temple and its secondary function as an Ilkhanid Khānqāh[1]. In a further publication (2018), they introduced and analyzed the Dash Hamami complex. Moreover, Sattarnejhad (2020) identified the Qadamgah of Azarshahr as a rock-cut shrine or Khānqāh dating to the Middle Islamic centuries and rejected earlier interpretations linking it to Mithraism.

Mahnaz Ashrafi (2011) divided Iranian rock-cut complexes into horizontal and vertical types. According to her findings, the natural geological context, the initial mode of access (vertical or horizontal), and spatial functions are fundamental factors shaping rock-cut complexes and determining their typological diversity. Doostkafi *et al.*, (2023) analyzed the distribution patterns of troglodytic architectures in

Isfahan Province using ArcGIS. By studying 19 prominent examples and classifying them into "residential" and "defensive-ritual" categories, they concluded that environmental factors dominate the distribution of residential complexes, whereas cultural factors play a primary role in defensive and ritual complexes. Sarokhani (2015) studied the O'ee complex of Noush Abad and described the remains and spaces identified through archaeological excavations. Shekari-Niri (2000) identified the rock-cut villages near Nair, Ardabil as pre-Islamic military fortresses. In another work (2006) he examined Mithraic temple architecture and discussed the construction of such temples as rock-cut structures in remote mountainous areas. Azad *et al.*, (2018) investigated the rock-cut complexes of Naein and introduced examples located in residential spaces, mosques, and mills.

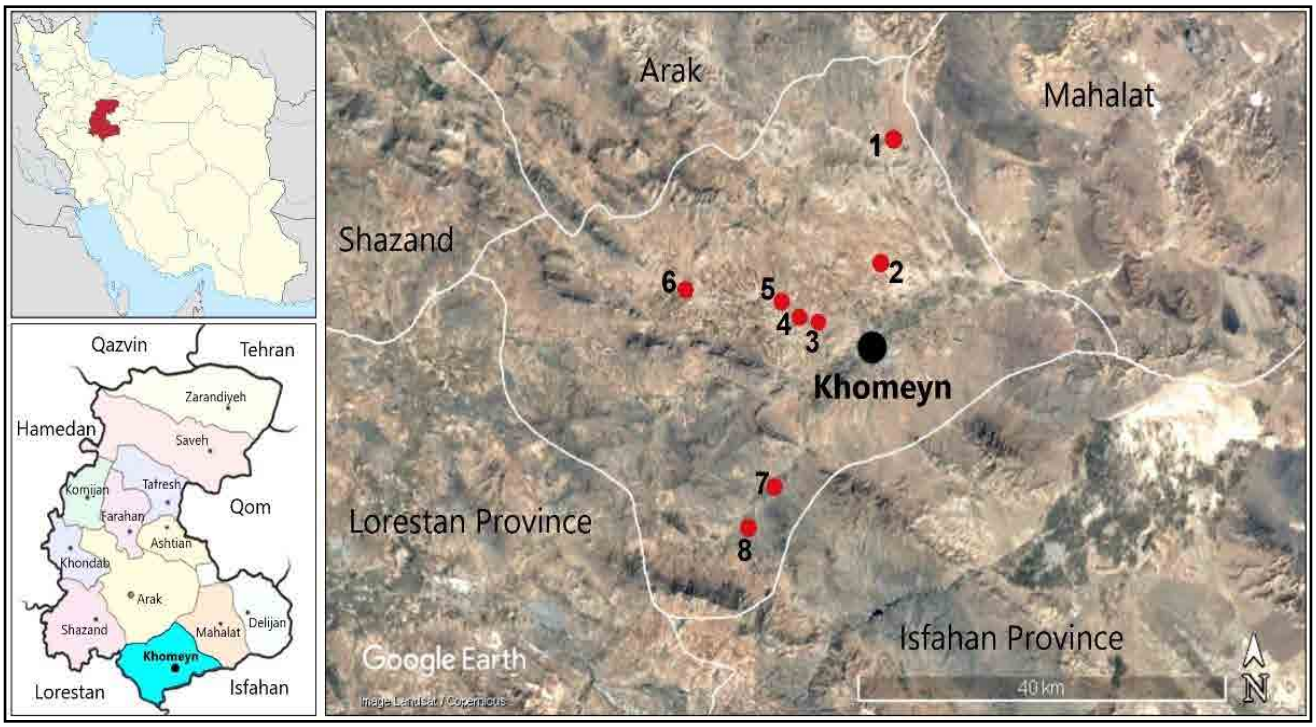
The rock-cut complexes of Northern Teymareh, as the geographical focus of the present study, have been addressed in only a limited number of previous works. Seyed Mehdi Mousavinia (2011) introduced one of the oldest complexes in the region, known as Qiz Qal'ehsi, and attributed it to the Sasanian period. However, according to the present authors' investigations, this site is not an underground complex but was excavated into a rock face at an elevation of approximately 1,000 m above the surrounding lands and functioned as a water reservoir. Therefore, it was excluded from this study.

The Robat Aghaj complex, located in the village of the same name in Khomeyn County, was excavated in 2016 by Majid Montazer Zohouri. Sołtysiak *et al.*, (2017) published a plan of this underground troglodytic architecture and analyzed the human bone remains from the site. The Tahyagh complex was excavated in 2014 by Esmaeil Sharahi, who later published the results in a book entitled "Tahyagh Troglodytic" (Sharahi, 2021), describing its architectural spaces and cultural materials. The excavated bone remains from Tahyagh were also published by Sołtysiak and Sharahi (2017). These remains include both animal and human bones. The human remains consist of two relatively complete skeletons and fragments belonging to at least three other individuals. The evidence suggests that these individuals sought refuge in Tahyagh during the Mongol invasion. Then, their bodies were left within the underground spaces following a possible massacre (Sołtysiak and Sharahi, 2017).

Consequently, among the eight underground troglodytic architectures examined in this study, only Robat Aghaj and Tahyagh have previously been the subject of detailed scholarly research.

Archaeological Study of the Underground Troglodytic Structures in Northern Teymareh

During archaeological field surveys conducted by the first author in April 2023 in the Northern Teymareh region, six underground troglodytic structures were identified, in addition to the previously known sites of Tahyagh and Robat Aghaj. In total, eight complexes were investigated: Robat Aghaj, Nazi, Danian, Tahyagh, Kandeh-ha, Choqa Gorg, Farnaq, and Ashnakhor (Fig. 2 and Table 1).



▲ Fig. 2: Location of underground troglodytic architectures in northern Teymareh in Khomeyn, Markazi Province; 1) Robat-Aghaj, 2) Nazi, 3) Danian, 4) Tahyagh, 5) Kendeh-ha, 6) Choqa Gorg, 7) Farnaq, 8) Ashnakhor (Authors, 2023)

The internal space of Robat Aghaj, Tahyagh, Kandeh-ha, and Farnaq were fully documented, while those of the Nazi were partially recorded. Due to blocked entrances and the lack of archaeological excavations, the internal space of Danian, Choqa Gorg, and Ashnakhor could not be surveyed or mapped, and documentation focused solely on their locations and surrounding features. Consequently, these three complexes were analyzed only in terms of spatial distribution and landscape relations.

Three complexes, Tahyagh, Kandeh-ha, and Choqa Gorg, were created in conglomerate formations. The geological context of Tahyagh also includes soft marl layers. Robat Aghaj was excavated in a sandy hill undergoing conglomeration. Thus, four complexes were created in predominantly conglomeratic contexts. The Nazi and Danian complexes were excavated in clayish substrates, while Ashnakhor and Farnaq were formed in sandstone deposits.

From a geomorphological perspective, Robat Aghaj, Nazi, Tahyagh, Kandeh-ha, and Choqa Gorg were carved into natural hills; in contrast, Danian, Farnaq, and Ashnakhor were formed within the present-day village on relatively flat terrain.

The Robat Aghaj complex consists of two corridors, one running north–south with a length of 90 m and another running east–west with a length of 20 m (Fig. 3). Eight rooms were excavated along the north–south corridor and three along the east–west corridor. Except for one cruciform room, the others are square or rectangular with varying dimensions (Montazer Zohouri & Hosseinzadeh, 2018), (Fig. 4). The presence of wooden fragments, hinges, and metal fittings indicates that most rooms originally had wooden doors secured with internal wooden bolts. Ventilation shafts along the corridors facilitated air circulation (Fig. 5). However, erosion and rainfall have caused soil, stones, and surface materials to collapse into the complex, blocking the shafts and much of the corridors.

Fig. 3: Corridors of the Robat Aghaj complex (First Author, 2023). ▶

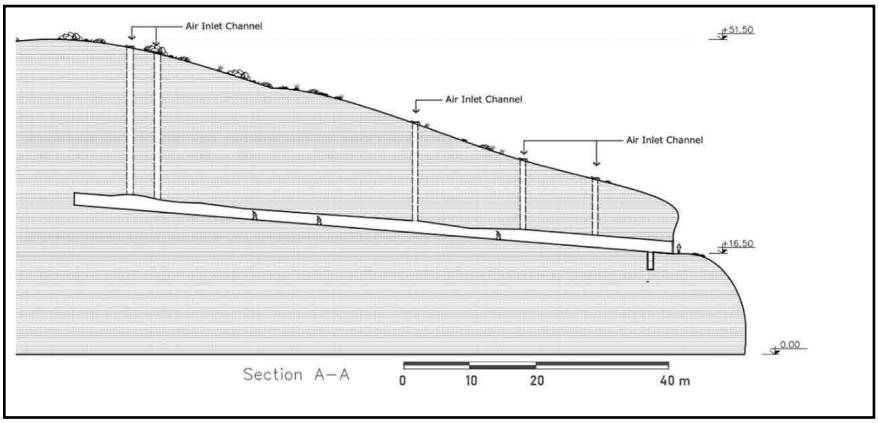
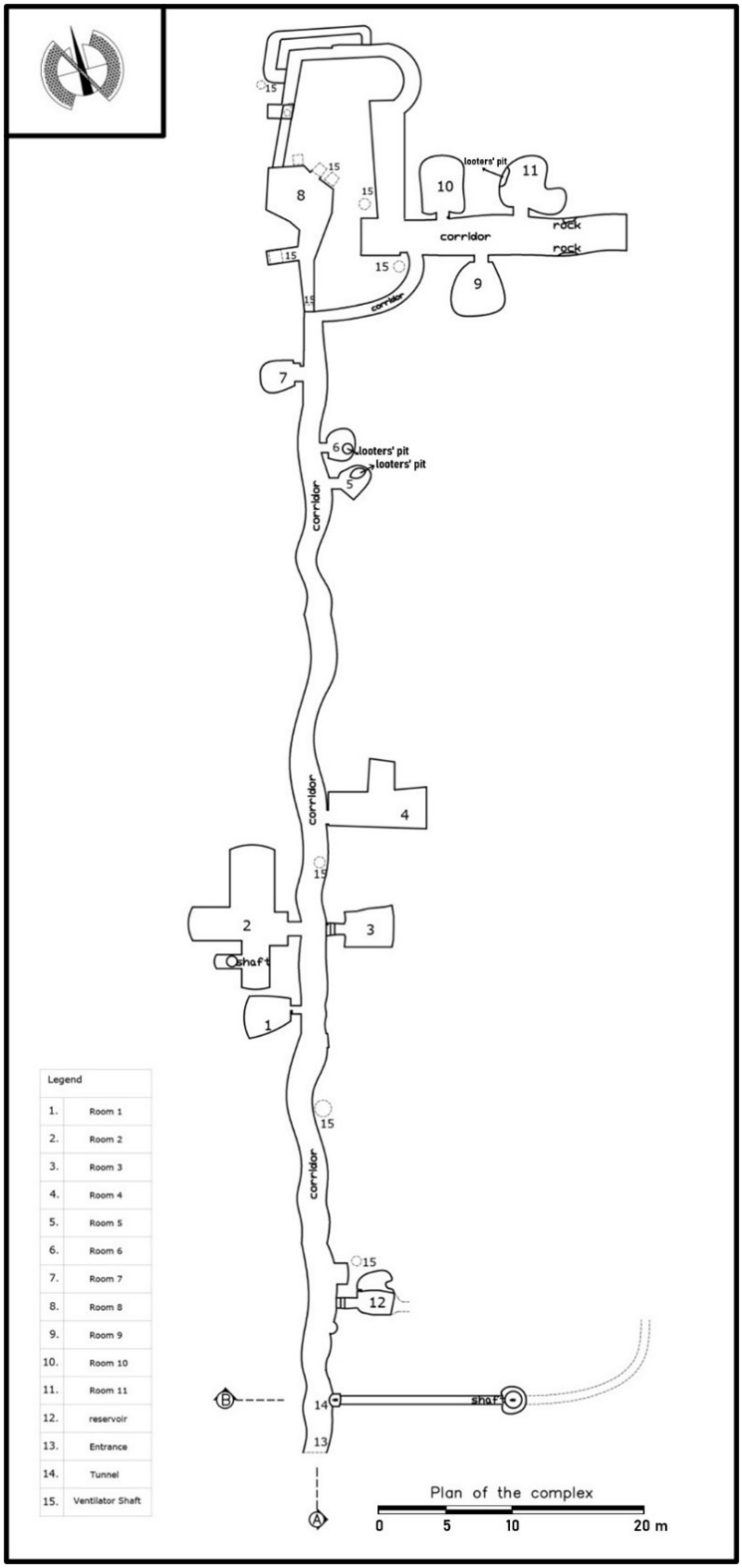


Fig. 5: Section of the Robat Aghaj complex and the location of its ventilation shafts (Montzar Zohouri, 2016: 251). ▶



◀ **Fig. 4: Plan of the Robat Aghaj's structures (Montazer Zohouri & Hosseinzadeh, 2018: 377).**

Although Robat Aghaj does not exhibit a funerary character, human bone remains were found in two rooms, providing some bioarcheological data. A skull discovered in the center of Room 1 was identified, based on cranial morphology and dental wear, as belonging most likely to an adult female. Bone porosity suggests a metabolic disease, possibly osteoporosis, rickets, or scurvy. High frequency of dental caries, especially on molars, indicates an abrasive diet rich in fermentable carbohydrates, likely common in the region (Sołtysiak *et al.*, 2017). Based on the cultural materials of Robat Aghaj, especially ceramic fragments, its chronology dates to the 12th and 13th centuries CE (Figs. 6, 7). These cultural materials are comparable to samples of Kashan (Fehervari, 2009; Grube, 2005; Yazdani *et al.*, 2016), Samen in Malayer (Hemmati Azandaryani *et al.*, 2017).

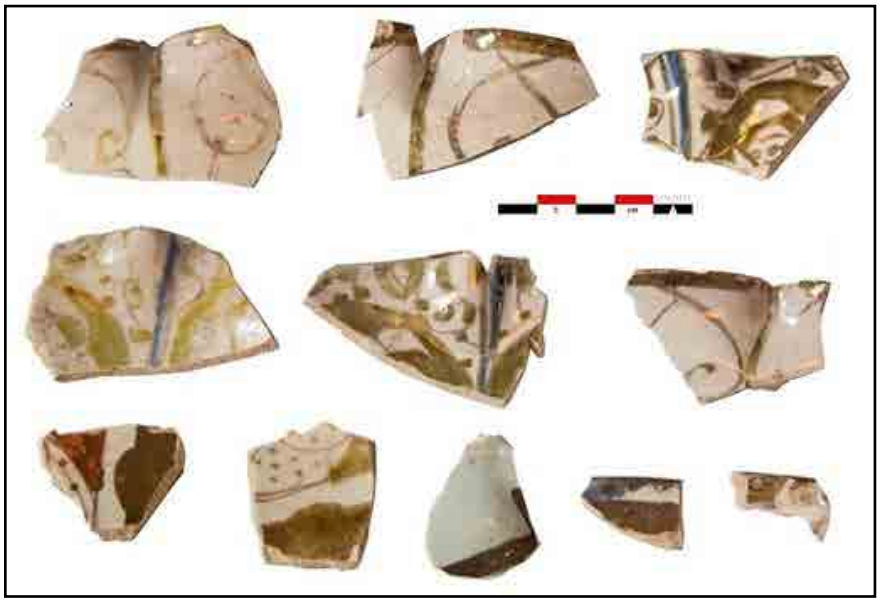


Fig. 6: Lusterware fragments from the Robat Aghaj complex, 12-13th centuries CE (Nikbakht *et al.*, 2019). ▶

Fig. 7: Potsherds of glazed Mina'ee style recovered from Robat Aghaj, 12-13th centuries CE (Nikbakht & Montazer Zohouri, 2021: 3). ▶

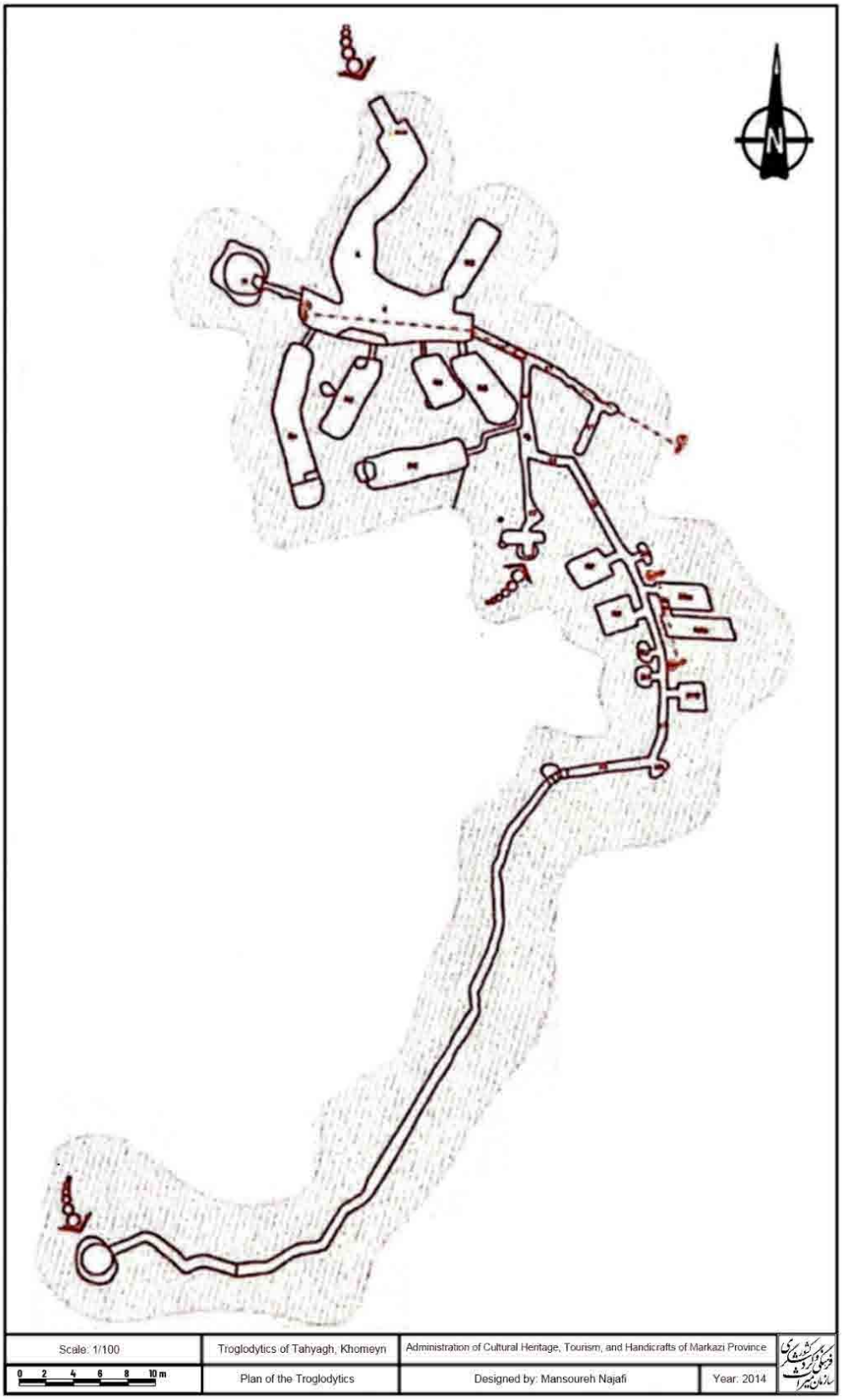
The Nazi complex has a 1×1 m entrance followed by a corridor of similar width and height extending for 30 m. Beyond this corridor, the

passage narrows and turns northward. Due to destruction, filling with soil, and the lack of excavation, other spaces remain unidentified (Fig 8). Cultural materials from Nazi also date back to the 12th and 13th centuries CE and are comparable to the samples of Samen in Malayer (Hemati Azandaryani, 2017), Zino-Abad in Hamadan (Mohammadi and Shabani, 2017), and Reyy (Treptow and Whitcomb, 2007), (Fig. 9).

At Tahyagh, spaces such as an entrance, entrance corridor, a hall, 11 rooms, four storage chambers, five corridors, three ventilation shafts, and two wells were identified and excavated (Sharahi, 2021: 43–44), (Fig. 10). Historically, access was provided through ventilation shafts equipped with footholds, which could be blocked for security purposes. The central hall is the largest space and provides access to other parts of the complex (Fig 11). A bioarcheological study provided evidence of violence at this site (Sołtysiak and Sharahi, 2017). Cultural materials, especially ceramic fragments, suggest a 12–13th century CE chronology for Tahyagh (Fig. 12). These ceramics are comparable to the samples of Moshkoyeh, Zarandiyeh, and Zolf-Abad (Sharahi, 2021), Siraf (Whitehouse, 1979: 49, pl. IIIa), Zino-Abad in Hamadan (Mohammadi and Shabani, 2017), Reyy (Treptow & Whitcomb, 2007), and Kashan (Fehervari, 2009; Yazdani *et al.*, 2016).

◀ **Fig. 8: Entrance of the Nazi complex (First author, 2023).**

◀ **Fig. 9: Some ceramics from the Nazi complex (First Author, 2023).**

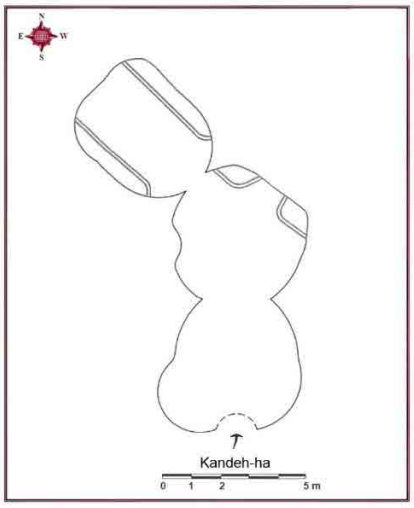


▲ Fig. 10: Plan of the Tahyagh complex (Sharahi, 2021: 77).

◀ Fig. 11: The main hall of the Tahyagh complex (Sharahi, 2021: 80).

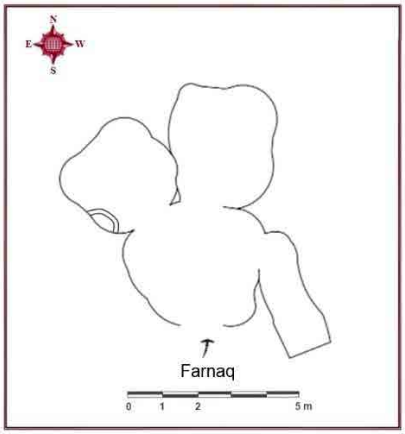
◀ Fig. 12: Some ceramics from the Tahyagh complex (After: Sharahi, 2021).

Parts of the Kandeh-ha complex became visible following recent earth-digging activities on a hill in the village. According to villagers, it originally had several entrances facing north and northeast, most of which are now blocked. The remaining spaces include three rooms measuring 4.5×5 m, 5×5 m, and 4×5 m (Fig. 13). In recent years, cob-built mangers have been added, and the complex has been used as a stable and storage area. The small size of these mangers suggests use for small livestock such as sheep and goats, and parts of such complexes were commonly used as lambing areas (Fig. 14).



▲ Fig. 13: Plan of the Kandeh-ha complex (First Author, 2023).

◀ Fig. 14: Two carved spaces in the Kandeh-ha complex (First Author, 2023).



▲ Fig. 15: Plan of the Farnaq complex (First Author, 2023).

The Farnaq complex was identified following the formation of two well-like shafts in the courtyard of a fortress. Its original entrances are no longer visible. But after the collapse of the roof, two holes were created in the castle courtyard, which allowed entry to the site. Beyond the larger shaft lies a room measuring 4×4 m with a height of 2 m. To the east, a corridor extends for 6 m before being completely blocked by debris. A second room (3.5×3.5 m) lies to the north of the first, and a third room of similar size is located to the northwest (Fig. 15). An added cob-built manger indicates its latest use as a livestock shelter (Table 1), (Fig. 16).

Fig. 16: The Farnaq underground troglodytic space (First Author, 2023). ▶

Spatial Analysis

To analyze the relationship between the spatial distribution of the underground troglodytic structures and the landscape of Northern Teymareh, their locations were compared in terms of elevation (asl), slope, proximity to rivers, and land use. The altitudinal distribution map indicates that all eight complexes in Northern Teymareh were carved at a low altitude (Fig. 17), which can be interpreted as evidence of their "defensive and shelter" function. In these areas, there are no high mountains or naturally elevated features suitable for use as hideouts or shelters, and the inhabitants of the surface sites in this region were compelled to create such underground spaces as refugia.

These complexes were carved in areas with low slopes (Fig. 18). Slope is an important factor influencing water flow velocity, drainage, erosion, and degradation rates, type of vegetation cover, and plant species selection (Mousavinia, 2013: 132). Based on this, since water flow velocity increases on steep slopes, causing damage, the carving of the underground troglodytic architectures on low slopes is justifiable. Thus, the residents wisely carved the complexes on low slopes to minimize erosion, damage, and losses caused by floodwaters.

Table 1: Location and structural characteristics of the studied underground troglodytic structures in the Northern Teymareh Region (First Author, 2023). ▼

Name	Location	Features and characteristics
Robat Aghaj	39 S 416644.61 m E 3742942.45 m N 1940M North of Robat Aghaj Village, North-east of Khomeyn	- A castle measuring 100 × 150 m on top of the hill where the underground troglodytic architecture was excavated. The total area of the complex is approximately 345 m². - Linear plan (north-east and south-west direction) - Cultural materials include pottery fragments, glass vessels and ornaments, stone beads, iron and bronze tools, and bone remains (Nikbakht & Montazer Zohouri, 2021).
Nazi	39 S 415242.45 m E 3730749.28 m N 1809M 200 meters east of Nazi village, North-east of Khomeyn	- A castle on top of the hill where the underground troglodytic architecture was excavated. - The area of the identified space is 35 m² (other parts are blocked). - Linear plan (north-east and south-west direction) - Cultural materials include pottery fragments found around the complex.
Danian	39 S 408466.79 m E 3724889.52 m N 1846M In the village of Danian, North-west of Khomeyn	- One blocked entrance was recorded with the guidance of villagers. - A second entrance is reportedly located near the Khomeyn–Shazand road, close to the village. - The internal spaces could not be examined due to blockage.
Tahyagh	39 S 406461.82 m E 3725317.11 m N 1864M 100 meters east of Tahyagh village, North-west of Khomeyn	- Area of the complex is 175 m² with a linear plan (north and south direction). - storage spaces, including four small storerooms, large ceramic storage jars (*Lavak*), and vessels for water and food storage. - two-story room (Room 8). - A square stepped platform with traces of burning at the end of Room 1 (the largest room). - Narrow and low-ceiling corridors with a cruciform space functioning as a vestibule or waiting area in Corridor 2 (Sharahi, 2021). - Cultural materials include pottery, glassware, dinar coins, gold, silver, and bronze ornaments, iron agricultural and military tools, stone beads, and bone remains (ibid.).
Kandeh-ha	39 S 404547.56 m E 3726936.55 m N 1877 M In the village of Kandeh-ha, North-west of Khomeyn	- The complex covers an area of approximately 70 m². - Linear plan (north and south direction). - Small animal pens in two of the three rooms, likely for small livestock. - No cultural materials identified due to the spaces being filled with debris and rubble.
Choqa Gorg	39 S394029.06 m E 3728217.25 m N 1968 M 20 kilometers west of Khomeyn city	- A historic fortress atop the underground troglodytic structure. - According to villagers, one of the corridors was exposed as a result of unauthorized excavation. It was closed by the administration of Cultural Heritage in Khomeyn, making it impossible to access the interior. - Cultural materials around the fortress include pottery.
Farnaq	39 S 403438.02 m E 3708840. 65 m N 2013 M 16 kilometers southwest of Khomeyn city	- A historic fortress atop the underground troglodytic architecture. - The complex covers an area of approximately 48 m². - Centralized and radial plan (one central space with surrounding rooms). - Possible connection of the complex spaces with the Farnaq River (according to villagers).
Ashnakhor	39 S 400334.38 m E 3703203.65 m N 2120 M In the village of Ashnakhor, southwest of Khomeyn	- According to villagers, the complex had four entrances, all of which are now blocked. - The locations of two entrances were identified with guidance from villagers. - Access to the internal spaces was not possible.

Thermal fluctuations between day and night are less pronounced on low slopes compared to steep ones, which is an important factor in plant growth (Mousavinia, 2013). As argued earlier, although there is evidence of animal husbandry activities in the Northern Teymareh complexes, based on the study of the bones discovered in Robat-Aghaj, the storage rooms and ceramic jars, and the land use map (Fig. 20), it appears that the inhabitants of these complexes during the Islamic period were a community with an agriculture-based economy. Therefore, choosing a settlement location on a low slope was necessary to increase agricultural production in the community living in Northern Teymareh.

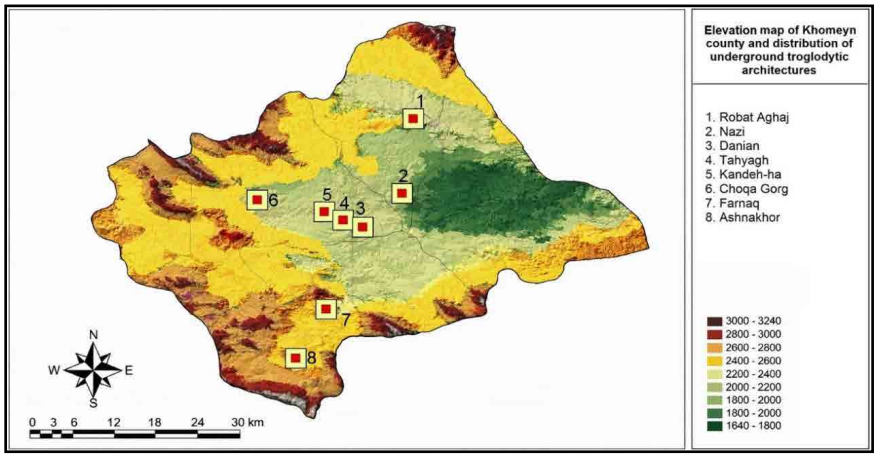


Fig. 17: Distribution of underground troglodytic architectures in relation to altitude (First Author, 2023). ▶

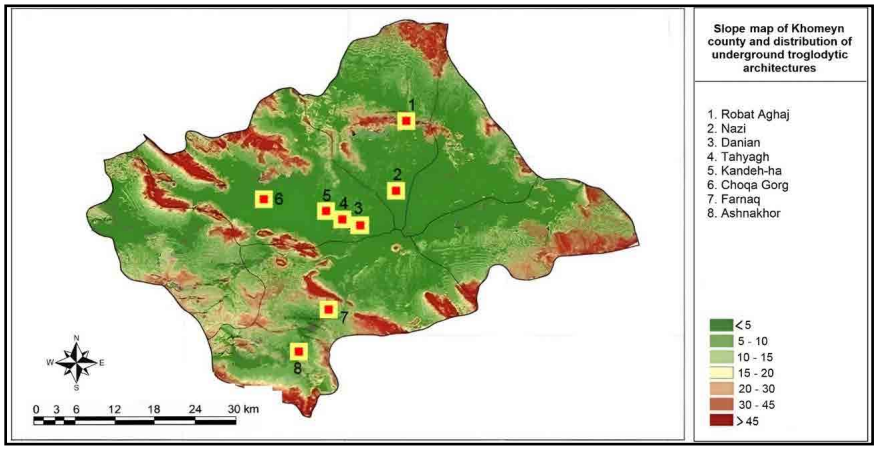
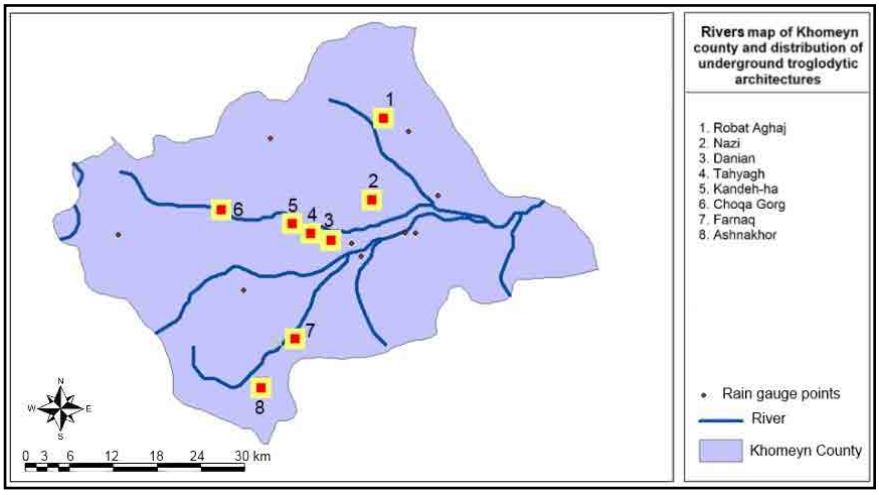


Fig. 18: Distribution of underground troglodytic architectures in relation to slope (Second Author, 2023). ▶

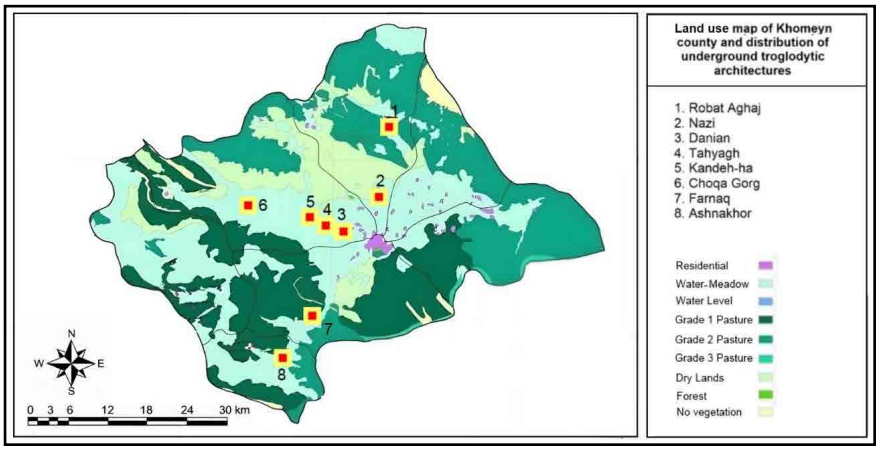
According to the map showing the distribution of the underground troglodytic architectures relative to the rivers of Khomeyn County, except for the Nazi complex, which is located near a very large spring, the other complexes are situated close to rivers, which have been the primary and strong sources of irrigation water for the inhabitants (Fig 19). Furthermore, based on the distribution map of the complexes relative to land use, all eight spaces are located in irrigated agricultural lands (Fig 20). Thus, the inhabitants of the complexes were engaged in agriculture

for their livelihood, and agricultural activities usually require a sedentary lifestyle with permanent settlements. This provides strong evidence for the residential function of the complexes in this region.

Another important point is the existence of Qanats very close to Robat Aghaj, Choqa Gorg, and Tahyagh. This suggests that the community living in the nearby surface settlements, who had experience in Qanat carving, were fully aware of the land's geological conditions and features. With knowledge of the substrate and valuable experience in Qanat digging, they also undertook the carving of the underground troglodytic architectures to be used when necessary. For instance, the builders of Tahyagh, with thorough understanding of the substrate, carved spaces within a marl soft layer. The height of the spaces in this complex corresponds directly to the thickness of the marl layer. In some parts, the height of the space reaches 170 cm, while in others it is as low as 80 cm (Sharahi, 2021: 43).



◄ **Fig. 19: Distribution of underground troglodytic architectures in relation to rivers (Second Author, 2023).**



◄ **Fig. 20: Distribution of underground troglodytic architectures in relation to land use (Second Author, 2023).**

Another important point is that ensuring the security of the Teymareh plain dwellers, especially in the context of the political and military events of the 12th and 13th centuries CE[2], was an important issue. Given

the considerable distance between the settlement sites in the plain and the surrounding mountains, it was difficult for the people to seek refuge in the mountains during invasions by hostile tribes or other threats. Thus, their security was ensured either by building defensive walls and fortifications around villages and towns, by carving underground living spaces in the form of rock-cut complexes.

Classification of Underground Structures

The underground troglodytic architectures in Northern Teymareh can be classified into two categories based on their architectural plan and structural organization: 1) complex, large-scale spaces characterized by diverse architectural elements and multi-part spatial organization, and 2) small, simple spaces with limited internal differentiation.

The Robat Aghaj and Tahyagh complexes fall within the first category. Both exhibit sophisticated architectural planning, including carved rooms and clearly defined spatial organization. In the Robat Aghaj complex, the identification of eleven rooms, a 90-m-long corridor, an additional 20-m-long passage, and multiple ventilation shafts underscores the structural complexity and functional significance of the site. Similarly, the Tahyagh complex comprises a well-defined entrance corridor, a central hall, eleven rooms, four storage spaces, five corridors, three ventilation shafts, and two wells. This spatial configuration reflects a high degree of internal organization and architectural planning.

In contrast, the Kande-ha and Farnaq spaces represent the second category. These spaces are comparatively small and architecturally simple, with limited spatial organization and no identifiable ventilation features.

In addition, the functional differentiation of these spaces is also important. Through comparative studies of the underground troglodytic structures of Northern Teymareh with examples from other regions of Iran, and by analyzing the social, political, religious, and geographical contexts of Northern Teymareh, the reasons for the carving of these complexes can be explained. One important aim of carving rock-cut spaces in Iran was providing space for human dwelling (mostly temporary or seasonal). The rock-cut villages of Maragheh (Sattarnejhad *et al.*, 2021b: 60), Hilevar and Kandovan in East Azerbaijan, and the rock-cut village of Meymand in Kerman (Zeinali Qutb-Abadi, 2015) are examples of architecture carved or used for settlement purposes.

Religious and ritual rock-cut complexes are another category, featuring a broad range of functions such as mosques, Khānqāhs (Sufi lodges), churches, Buddhist temples, open-air shrines, and funerary spaces

(Sattarnejhad *et al.*, 2021b: 61). For example, the rock-cut complex of Ghadamgah in Azarshahr is known as a Khānqāh (Sattarnejhad, 2020: 103), and the Imamzadeh Ma'sum or Varjovi complex in Maragheh has a similar function (Sattarnejhad *et al.*, 2021a). Additionally, rock-cut mosques such as Darab (Ahmadi, 2000), the rock mosque of Eyj (Azad, 2005b), and the Cheraghil rock mosque (Safaei *et al.*, 2018) are among the religious rock-cut complexes.

Furthermore, the architectural structure and plans of some rock-cut complexes indicate military and security objectives in their construction, such as the castle complexes of Alamut or the subsurface complexes of Noush Abad, Kashan (Sarokhani, 2015). Some rock-cut complexes were used for livestock keeping, while others served as water reservoirs and baths; for instance, Qiz Qal'asi in Khomeyn (Mousavinia, 2011), the water reservoirs of Shushtar (Askari & Aghaeian, 2015), the rock-cut bath of Pish-osta in Kerman (Riyahian & Labaf-Khaniki, 2015), and Dash-Hamami in Ardabil (Sattarnejhad *et al.*, 2018).

Therefore, examination of rock-cut complexes in Iran shows that these spaces were carved for multiple reasons, including settlement, religious worship and rituals, defense and security, livestock protection, storage, and preservation.

In the Tahyagh complex, Room 9 had a wooden door, and the discovered artifacts suggest it was a private space used residentially by a family. Room 8 was carved with high precision over two levels, indicating social hierarchy among the inhabitants of Tahyagh. The discovery of gold jewelry in Room 6 further reflects the social stratification of the residents. Notably, many of these adornments belonged to women, revealing a significant female population in this complex (Sharahi, 2021: 156). This evidence suggests that the primary function of Rooms 9, 8, 6, and likely other rooms in the complex was residential.

On the other hand, weapons such as dagger blades, spearheads, bayonets, and axe blades were found in this complex (Ibid: 186), indicating a need for defense against attacks. But these weapons may reflect the final stage of the occupation, when it was used as a refuge. Meanwhile, the presence of storage rooms 1 to 4 and the discovery of agricultural tools such as a shovel and two sickles during excavations (Ibid: 187) is important to understand the livelihood and economic model of the resident community.

Accordingly, it appears that the Tahyagh complex was a residential and possibly a refugial settlement. However, the distance between this complex and the nearest surface settlement is about 10 kilometers (Fig 21), and there is only a small hill from the Sassanian period, a Qajar

landlord's castle, and a Qajar cemetery around the Tahyagh (Sharahi, 2021: 16-18). Therefore, there seems to be no significant relationship between Tahyagh (a 12-13th century CE site) and the Sasanian and Qajar surface sites. Instead, Tahyagh should be considered in relation to the two underground complexes of Danian and Kandeh-ha, as the distance from Tahyagh to these two is less than four kilometers, and these three complexes should be studied together.

In Robat Aghaj, all rooms have traces of doors and locks, which not only indicate the concept of privacy among the inhabitants but also likely reflect its residential use. The large number of ceramic fragments related to everyday and kitchen use, glass objects, bangles, and other daily life tools (Montazer Zohouri & Hosseinzadeh, 2018: 376) further confirms the residential function of the Robat Aghaj complex. The use of rooms 5 and 6 as storage spaces (Ibid) probably correlates with relatively long-term habitation in this complex.

However, since one of the entrances of the Robat Aghaj is from within a castle situated atop a mound, the excavator has suggested the possibility that the complex was carved in connection with the castle (Ibid: 375). Therefore, the function of the complex should also be interpreted in relation to passive defense and with military and refugial purposes.

At the same time, archaeological evidence from room 1 of the Robat-Aghaj and the existence of a cruciform space (room 2) within the complex provide different results, suggesting a probable ritual use, related to Sufism, for this space (Fig. 4). First, unlike other rooms, the cruciform room shows the least archaeological evidence related to daily life. Second, the cruciform plan is a traditional ritual arrangement in Iranian architecture. Additionally, the presence of a square platform in the cruciform room, similar to the votive platforms in Iranian ritual architecture[3], on which traces of burnt layers can be seen, is probably related to ritual function. Third, given the cruciform plan and the well dug within it, this space closely resembles one of the ritual rock-cut architectures, namely the stone mosque of Darab, which was used as a mosque during the 12th and 13th centuries CE (Hasani, 2017), contemporary with the Robat Aghaj complex. Meanwhile, as mentioned earlier, other rooms with doors and locks indicate private ownership and were used for residence, shelter during emergencies or seasonal changes, and as storage spaces.

Overall, except for the suspected ritual space at Robat Aghaj, the main function of these complexes was residential, with lower-ceiling rooms serving as storage.

Chronology of the cultural materials (Table 2) attributes these complexes to the medieval Islamic centuries, particularly the 12th and 13th centuries CE (Sharahi, 2021: 127-129; Montazer Zohouri & Hosseinzadeh, 2018: 376). Although the reasons for initially carving these complexes in the 12th century CE are unclear, it seems their expansion in the 13th century CE and continued use was a response to the Mongol invasions, unrest, and dangers of that period. In other words, many rock-cut complexes in Iran were developed during the Mongol and Ilkhanid era, and as previously referenced, very few subsistence, residential, and defensive underground spaces can be found that do not have evidence from the 12th and 13th centuries CE. Therefore, it seems the Northern Teymareh complexes were also reused for security and defense during this era.

In the Kandeh-ha complex, the presence of small layered animal stalls indicates its use for housing small livestock like goats and sheep. This can be linked to an economy based on pastoralism and agriculture. Since these small stalls are later additions and postdate the initial carving, the secondary function of the complex should be interpreted as related to a community engaged in pastoralism and agriculture.

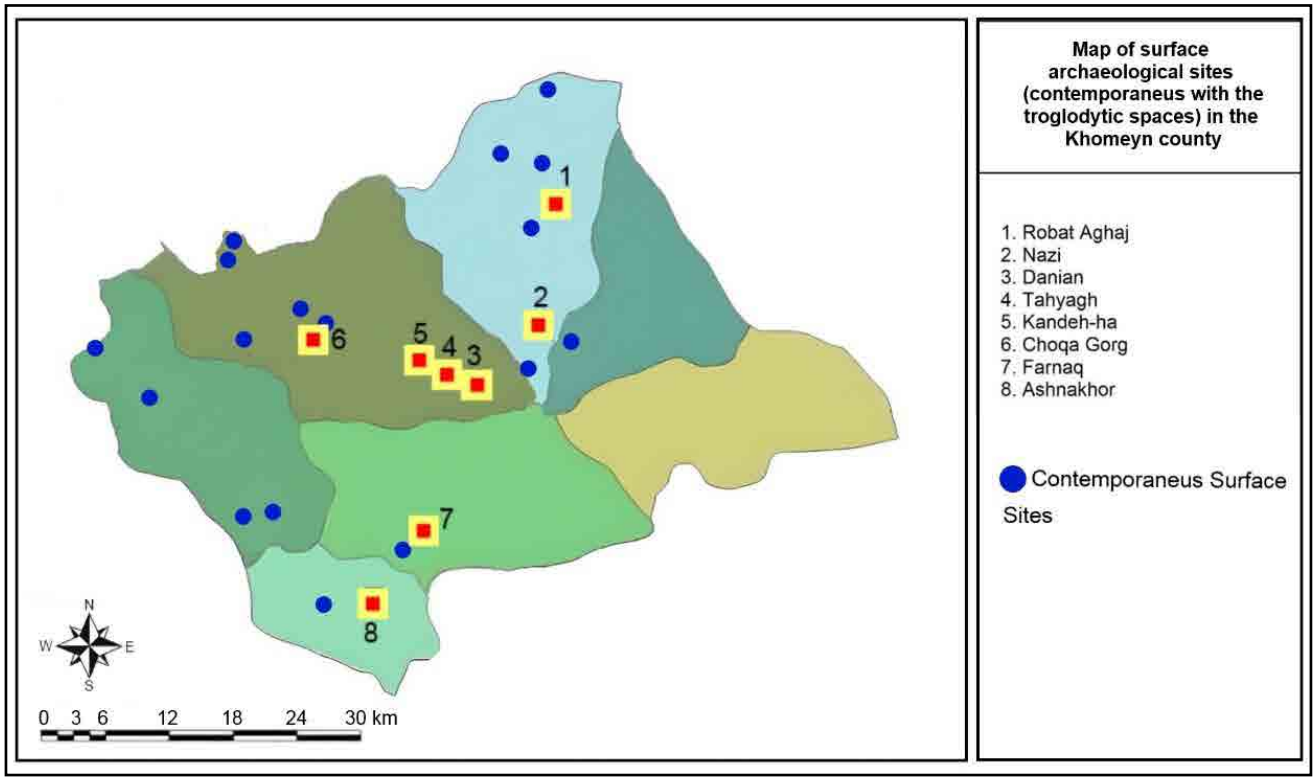
Another important point is that based on spatial distribution maps of underground troglodytic architectures and medieval surface sites in the region, five complexes, Farnaq, Chogaharg, Robat-Aghaj, Nazi, and Ashnakhor, were carved very close to or adjacent to contemporary surface settlements (Fig 21). This proximity is crucial for interpreting the reasons and purposes behind their carving and use. If these complexes served as residential refuges during crises and attacks, then considering the necessity of rapid evacuation and movement during danger, their proximity to contemporary surface settlements (within about two kilometers) is understandable.

Simultaneously, the pattern common in other Iranian regions, like the Sahand and Sabalan mountain slopes, might also apply here: underground rock-cut spaces served as storage and utility spaces supporting residential surface settlements. The existence of four historic castles adjacent to three complexes, Robat-Aghaj, Nazi, Farnaq, and Choqa Gorg, and the presence of contemporary surface settlements near these complexes support this hypothesis. A similar pattern is seen in the "Aghol Chavan" complex in Maragheh (Sattarnejhad *et al.*, 2021b: 64).

Furthermore, another factor in the formation of Northern Teymareh's underground complexes could be protecting inhabitants from harsh winter cold. The architecture of underground complexes, embedded within rock

and earth, reduces heat exchange between inside and outside spaces, maintaining relatively stable internal temperatures. The high thermal capacity of the earth in these spaces minimizes temperature fluctuations and heat load. Additionally, thick walls limit heat transfer with the outside environment. Generally, underground complexes have cool air in summer and warm air in winter (Sattarnejhad *et al.*, 2021b: 58). In other words, in the summer, they have much lower (sometimes minimal) amplitude of temperature. But in the winter, using heating methods and stoves, they retained more heat, since they had no heat exchange with the outside.

Given that Khomeyn County is a cold to temperate region with recorded minimum temperatures reaching -16°C (Encyclopedia of Islam, Khomeyn: 184), it seems these underground spaces, with residential use, played a role in protecting inhabitants from severe winter cold. Such a role was important in other parts of Iran as well. For example, some villagers on the slopes of the Sahand mountains in Azerbaijan, until a few decades ago, carved underground rooms beneath their homes to shelter livestock from cold (Sattarnejhad *et al.*, 2021b: 59-60).



▲ **Fig. 21: Distribution of underground troglodytic architectures in relation to contemporary Islamic sites (First author, 2023)**

Conclusion

Based on the spatial distribution map of the underground troglodytic complexes in Northern Teymareh in relation to the surface settlement sites, and considering less than two-kilometer distance between some of these

complexes and surface sites, as well as the cultural materials discovered or recorded from these underground spaces, it appears that the complexes in Northern Teymareh were either carved by the inhabitants of the surface settlements during the medieval Islamic period, between the 11th and 14th centuries CE. Familiar with Qanat digging techniques and well aware of the bedrock, these people carved these complexes, taking into account the geological conditions and features.

In response to the research question, the location of underground troglodytic architectures of Northern Teymareh in irrigated and arable lands, along with their access to water sources, and the existence of storage rooms and jars in some complexes, especially in Robat Aghaj and Tahyagh, reflect the presence of a farmer community. The agricultural activities of such a community require a "sedentary" settlement or a "short-distance mobile" lifestyle. Also, the placement of complexes on low slopes facilitated resident movement, reduced damage from floodwaters, and increased agricultural productivity.

Moreover, the carving of these complexes at low elevation levels indicates their defensive and security purposes, since in these locations there are no high natural features like mountains for refuge, compelling the inhabitants of surface settlements for strategic and defensive reasons to create underground refuges near their settlements. The agricultural-based livelihood also required proximity to irrigated farmlands, thus prompting the inhabitants to create residential and sheltering rock-cut complexes around their lands for habitation and protection during crises.

On the other hand, unfinished spaces in Tahyagh and discontinuous use in later periods show that it was carved quickly in several stages to be used occasionally as a refuge. Furthermore, the architecture of private spaces with doors and the cultural finds suggest family life within these spaces.

Possible ritual functions of some spaces require further archaeological investigation. For example, at the Robat Aghaj, there are several reasons to propose a ritual function for the cruciform space: first, the cruciform plan is an ancient ritual archetype in Iranian architecture; second, there is a square platform with burn evidence in this space; third, this space yields the least archaeological evidence of daily life; fourth, the cruciform plan and the well dug inside closely resemble a known ritual rock-cut complex, the stone mosque of Darab, used as a mosque in the 12th and 13th centuries CE and contemporary with the Robat Aghaj complex. Therefore, it is likely that the cruciform space of Robat Aghaj was associated with ritual practices at that time, possibly connected to Sufi currents which were popular in the

Markazi Province region. Nonetheless, confirming this hypothesis requires further archaeological evidence.

In general, the underground troglodytic complexes of Northern Teymareh reflect a strategic response to security, environmental, and economic needs. Located on low slopes near irrigated agricultural lands and water sources, these spaces served primarily as residential and refugial shelters for farmer communities, with some areas possibly used for ritual purposes. Their architectural diversity, from large, multi-room complexes with ventilation and storage facilities to smaller, simpler spaces, demonstrates adaptation to defense, climate, and social organization. Collectively, these complexes illustrate how medieval Islamic inhabitants integrated underground architecture into protection strategies, daily life, and agriculture.

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Author Contributions

This article is derived from the first author's Master's thesis, which was written under the supervision of the second author and the advisory guidance of the third and fourth authors.

Conflict of Interest

The Authors, while observing publication ethics in referencing, declare the absence of conflict of interest.

Endnote

1. Khanqah is a building for the residence, rituals, worship, and education of Sufis. A Sufi is a follower of Islamic mysticism who seeks a direct, personal experience of God through spiritual practice and inner purification. He is committed to performing acts of worship and enduring austerities and hardships to purify his soul (Mirbagherifard and Rezaei, 2010).

2 Most important political and military events include: Battles and riots during the Saljuq, Khwārazmshāhiyān, and Mongol period (Ravandi, 264-305; Grousset, 2009; Saunders, 2004; Bondari, 1977).

3 For example, at Hasanlu (Dehghani and Fazeli Nashli, 58).

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چکیده

تیمرهٔ علیا به‌عنوان بخشی از ناحیهٔ تاریخی تیمره، در جغرافیای سیاسی امروزی با شهرستان خمین مطابقت دارد. در بررسی‌های پیشینِ باستان‌شناسی در شهرستان، شماری دستکند زیرسطحی شامل دستکندهای تهیق، دانیان، کنده‌ها، فرنق، رباط آغاج، نازی، چغاگرگ و آشناخور شناسایی شده است. یافته‌های کاوش‌های باستان‌شناسی در دو دستکند تهیق و رباط آغاج مؤید استفاده از این فضاها در سده‌های میانی اسلامی، به‌ویژه سده‌های ششم و هفتم هجری‌قمری است و کاوشگران -مجید منتظرظهوری و اسماعیل شراهی- نظراتی را دربارهٔ کارکردها و علل حفر دو دستکند رباط آغاج و تهیق ارائه کرده‌اند. اما با وجود تعداد قابل‌توجه دستکندهای زیرسطحیِ شناسایی‌شده در شهرستان خمین، تاکنون مطالعاتی تحلیلی دربارهٔ علل شکل‌گیری، کارکردها، دلایل فراوانی آن‌ها در این ناحیه و رابطهٔ توزیع فضایی آن‌ها با چشم‌انداز و زمین‌سیمای منطقه صورت نگرفته است؛ بنابراین، در پژوهش حاضر تلاش شده است به این پرسش پاسخ داده شود که، توزیع مکانی دستکندهای زیرسطحی در ناحیهٔ تیمرهٔ علیا در ارتباط با زمین‌سیمای منطقه چگونه است و دلایل و عوامل مؤثر بر شکل‌گیری آن‌ها چیست؟ بر این‌اساس، تحلیل مواد فرهنگیِ دو دستکند کاوش‌شدهٔ تهیق و رباط آغاج و مقایسهٔ آن‌ها با سایر دستکندهای منطقه صورت گرفته و بستر شکل‌گیری و مؤلفه‌های مؤثر بر توزیع مکانی دستکندها در پیوند با زمین‌سیما با استفاده از سیستم اطلاعات جغرافیایی (GIS) و برپایهٔ مؤلفه‌های دسترسی به منابع و نقش رخدادهای تاریخی مطالعه شده است. یافته‌های پژوهش اولاً نشانگر وجود شماری از محوطه‌های استقراری هم‌دوره با دستکندها در مجاورت برخی دستکندها است. ثانیاً توزیع مکانی دستکندها در ارتباط با زمین‌سیما، شامل شیب، ارتفاع، رودخانه‌ها و کاربری اراضی نشانگر حفر دستکندها در محل‌های مناسب برای کشت آبی است؛ بنابراین، این محوطه‌ها را می‌توان به‌عنوان بخشی از یک سیستم استقراری کشاورزی تفسیر کرد که در آن جوامع در درجهٔ اول به کشاورزی متکی بودند و در نزدیکی زمین‌های کشاورزی خود در دشت‌ها زندگی می‌کردند، درحالی‌که فضاهای زیرزمینی را با اهداف پناهگاهی و دفاعی می‌ساختند.

کلیدواژگان: معماری صخره‌ای، باستان‌شناسی اسلامی، معماری دستکند، سده‌های میانی اسلامی.

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