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Return to Naqsh-e Rostam: Archaeological Excavations to Investigate Water Management in an Achaemenid Site

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Abstract: *The Achaemenid royal necropolis, along with a structure known as the Kaʿba-ye Zartosht is located at the site of Naqsh-e Rostam, approximately 7 kilometers northwest of Persepolis. This large archaeological complex contains 23 historical features, including royal tombs, the Kaʿba-ye Zartosht , rock reliefs, and inscriptions. From a spatial and geographical perspective, the two major Achaemenid sites of Naqsh-e Rostam and Persepolis were closely interconnected during the Achaemenid period. Naqsh-e Rostam was actively managed during this era, and the Achaemenids, aware of the faults and water-related challenges such as floods, deliberately selected this area for constructing the Kaʿba-ye Zartosht and their royal tombs. They established a system for channeling, managing, and controlling seasonal waters. After the unfinished excavations conducted by the University of Chicago, this significant archaeological site was left unattended. In recent years, due to rainfall, numerous sinkholes, cracks, and cavities have emerged throughout the area. To address the water crisis at Naqsh-e Rostam, the archaeologist has aimed to identify, excavate, and restore the water management and drainage systems from the Achaemenid period. Through these archaeological excavations, a portion of the Achaemenid water management system has been identified, and strategies for the preservation of the site have been proposed.*

Keywords: Naqsh-e Rostam, Iran, Achaemenid, Water Management System, Water Channels, Erosion

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Introduction

The Achaemenid royal necropolis, together with a structure known as the Kaʿba-ye Zartosht is located at a site called Naqsh-e Rostam, approximately 7 kilometers northwest of the terrace of Persepolis. This extensive complex includes 23 archaeological features, such as royal tombs, the Kaʿba-ye Zartosht, rock reliefs, and inscriptions. Situated along the northern edge of the city of Parsa, this complex was spatially and functionally interconnected with the two major archaeological sites of Naqsh-e Rostam and the terrace of Persepolis [Fig. 1].

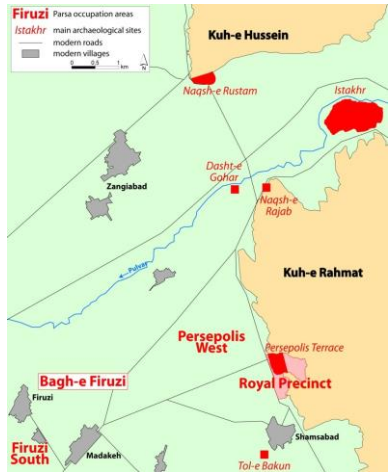

Fig. 1. The location of the Naqsh-e Rostam is in the northwest of Persepolis and other archaeological remains of Parsa (after Boucharlat, de Schacht & Gondet, 2012).

The city of Parsa was an urban unit composed of various sections spanning the Elamite, Achaemenid, Seleucid, Parthian, Sasanian, and Islamic periods. The reconstruction of this historic city within the boundaries of the first-degree protected zone of Persepolis is conceivable and understandable based on the surviving evidence. It appears that the boundaries of the city correspond with the first-degree protection zone, extending from the platform toward the north in the direction of Naqsh-e Rostam and Istakhr. Based on surviving written sources – such as Achaemenid cuneiform inscriptions and Sasanian-period scripts – the Naqsh-e Rostam complex was consistently in use and revered during the Achaemenid, Seleucid, Parthian, and Sasanian periods. In the Achaemenid era, the royal necropolis at Naqsh-e Rostam functioned as an important and integral part of the city of Parsa, located on its outskirts yet directly connected to the terrace of Persepolis. The burial tradition of deceased kings, according to Zoroastrian custom, was carried out at this location [Fig. 2].[1]

[1] Many travelers, travel writers, and archaeologists have visited Naqsh-e Rostam and produced numerous reports. However, among those who conducted field investigations and published scholarly studies on this

Fig. 2. The tombs of Naqsh-e Rostam, from right to left: Xerxes, Darius I, Artaxerxes I, Darius II, and the Ka'ba-ye Zartosht structure (Bon-Khang) (Photo: Vahid Younesi).

During the Achaemenid period, the site of Naqsh-e Rostam was actively managed. The Achaemenids, aware of the presence of fault lines and issues related to water and flooding, deliberately chose this location for the construction of the Kaʿba-ye Zartosht and their rock-cut tombs. At this site, they created a system for channeling, managing, and controlling seasonal waters. They even sealed all fissures caused by faults in the rock – through which water could potentially seep into the tombs – with a bitumen mortar. More importantly, gutters were carved into the façades of the tombs and at the upper part of the cross-shaped sections of the rock-cut tombs to protect their façades from rainwater.

Following a torrential rainstorm on 2 May 2024, multiple cases of erosion and subsidence occurred across the valuable historical site of Naqsh-e Rostam. These appeared in two forms: linear (continuous) and point-like (cavity-shaped) [Fig. 3]. The linear erosions extended over a total length of approximately 302 meters, with an average depth of 3.00 meters and a width of 1.50 meters, creating longitudinal grooves that split much of the site. A total of nine cavity-like sinkholes were recorded, the most critical of which reached a depth of 3.00 meters and appeared just 2 meters away from the rock-cut well and water reservoir. The archaeological fieldwork program at the site included identifying the depth of subsidence, sinkholes, and erosional features, along with geophysical surveys, all aimed at organization, documentation, and protection of the site.

historical complex, the following figures can be mentioned: Dieulafoy (1884-1885), Herzfeld and Sarre (Herzfeld & Sarre 1910; Herzfeld 1928, 1941), Sprengling (1937), Erdmann (1949), Demandt (1968), Borger (1969), Schmidt (1939, 1970), Wurfel (1970), Hinz (1971), Schippmann (1971), Gotch (1972), Roaf (1974), Nadjmabadi (1979), Shahbazi (1978), Kleiss (1976), Börker-Klähn (1982: 52-54), and Sancisi-Weerdenburg (1983). Among all these scholars, Erich Schmidt stands out as the one who published the excavation records of this complex. It can be said that Schmidt's detailed publication provides the most comprehensive archaeological information available on Naqsh-e Rostam during the Achaemenid period.

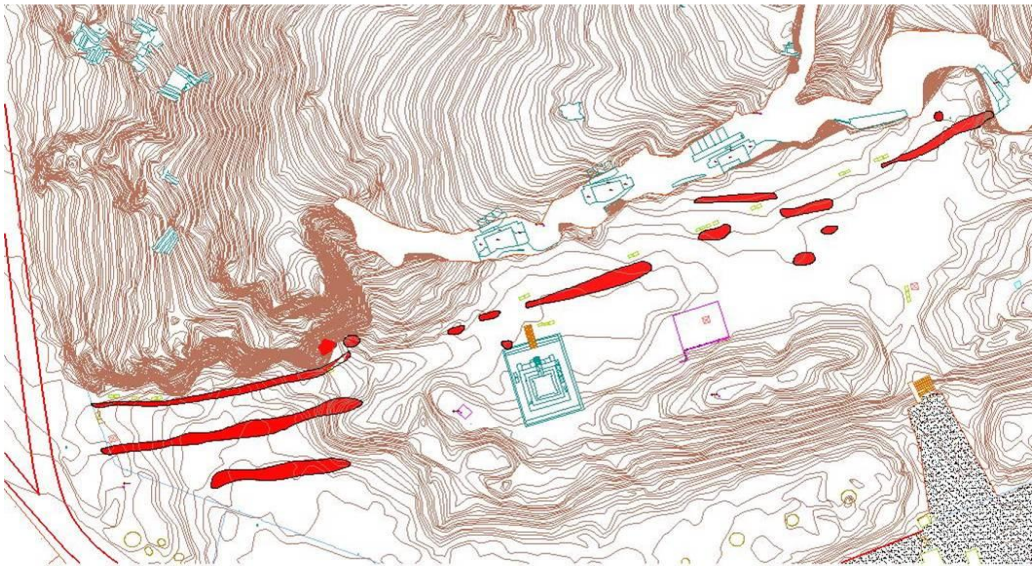

Fig. 3. Topographic map and longitudinal erosional cracks and sinkholes formed in the Naqsh-e Rostam site (Map by Ali Eqra).

Site Description

At Naqsh-e Rostam, four royal tombs are carved into a cliff face approximately 60 meters high. These tombs belong to Darius I (521-486 BCE), Xerxes I (486-465 BCE), Artaxerxes I (465-425 BCE), and Darius II (423-404 BCE) [Fig. 2]. A structure known as the Kaʿba-ye Zartosht was also built at this site during the Achaemenid period. Due to its architectural structure and functional role, this building holds significant importance alongside the tombs. Numerous highly significant rock reliefs exist at Naqsh-e Rostam, which can be chronologically classified as follows: 1. An Elamite relief from the Middle/Late Elamite period, 2. The tomb of Darius the Great (Achaemenid), 3. The tomb of Xerxes I (Achaemenid), 4. The tomb of Artaxerxes I (Achaemenid), 5. The tomb of Darius II (Achaemenid), 6. Relief no. 1: Investiture of Ardashir I by Ahura Mazda (Sasanian), 7. Relief no. 2: Bahram II with courtiers (Sasanian), 8. Relief no. 3: Battle scene of Shapur II (Sasanian), 9. Relief no. 4: Battle scene of Hormizd II (Sasanian), 10. Relief no. 5: Unfinished relief of Azarnarseh (Sasanian), 11. Relief no. 6: Victory of Shapur I over Roman emperors and depiction of the high priest Kartir in prayer (Sasanian), 12. Relief no. 7: Bahram II and Bahram III in a battlefield scene (Sasanian), 13. Relief no. 8: Coronation of Narseh by Anahita (Sasanian), 14. A smoothed, undecorated rock panel (Sasanian), 15. The structure known as the Kaʿba-ye Zartosht, 16. The large mudbrick fortification surrounding the Naqsh-e Rostam site. During the Sasanian period, a massive mudbrick wall was constructed around the site, enclosing an area of

approximately three hectares. This wall protected all the Achaemenid tombs, the Kaʿba-ye Zartosht (a structure known as a *bon-khang*), and several Sasanian rock reliefs [Fig. 4]. The wall is located about 100 meters from the cliff face and connects to the mountain on both the eastern and western corners. The archaeological team from the University of Chicago, led by Erich Schmidt, excavated parts of the mudbrick fortification, areas around the Kaʿba-ye Zartosht , and a large trench in the central part of the site. However, due to the outbreak of World War II, the American excavation program was halted in 1939.[2]

Description of Field Operations

The seasonal waterfall at Naqsh-e Rostam originates from a 13-hectare watershed in the surrounding mountains [Fig. 5], which consists mainly of rocky terrain and has an elevation difference of 130 meters from the archaeological site. This significant height difference causes rapid flood formation following intense spring rainfall [Fig. 4]. Such downpours, although sometimes lasting only a few minutes, can quickly generate flash floods due to the wide catchment area, steep slopes, and impermeable rocky surfaces. This results in the rapid flow of water toward the waterfall at Naqsh-e Rostam, passing between the tombs of Darius I and Xerxes I [Fig. 4].

The Achaemenid engineers and architects, aware of the flooding risks, constructed a settling basin just above the cliff and at the edge of the waterfall to reduce the intensity and speed of water entering the Naqsh-e Rostam complex [Fig. 6].

Today, due to sediment accumulation and lack of maintenance, this basin has lost its functionality. Seasonal waters, now filled with mud and debris, fall rapidly from a height of 60 meters toward the site because the basin no longer mitigates the flow [Fig. 6]. During heavy rainfall, especially in spring, the seasonal waterfall flows into the site, causing widespread flooding across the area. According to Erich Schmidt's excavation reports, water channels existed at Naqsh-e Rostam during the Achaemenid period to direct surface runoff away from the site. Remains of these channels were uncovered in the southern and western sections of the Kaʿba-ye Zartosht near the fortification walls during excavations [Fig. 7].[3] In the 1930s, the American team not only excavated around the Kaʿba-ye Zartosht in the central part of the site [Fig. 8], but also opened a longitudinal trench approximately 30 meters below the tomb of Artaxerxes I extending to the mudbrick fortification.[4] Additionally, they excavated part of a water reservoir outside the mudbrick fortification in the western part of the site [Fig. 9].[5]

[2] Schmidt, 1970.
[3] Schmidt, 1970: Figs. 21E, 21F, 23D.
[4] Schmidt, 1970: 59, Fig. 24.
[5] Schmidt, 1970: 59, Fig. 24.

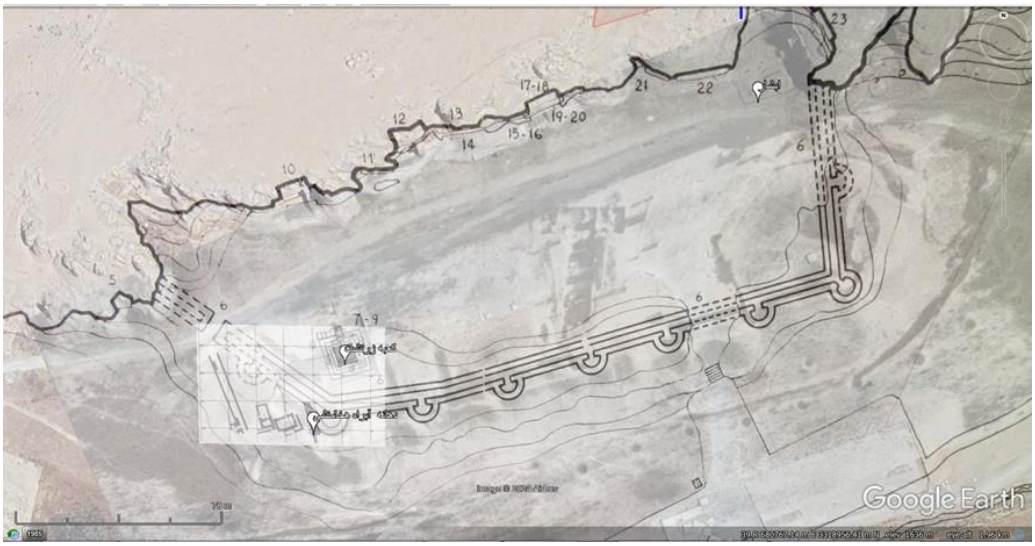

Fig. 4. Mudbrick fortification wall, site of the University of Chicago excavations, and water channels in the western section of the Naqsh-e Rostam site (after Schmidt, 1970: 16; Shahbazi 1978: 20).

Fig. 5. The 13-hectare watershed of the elevated section of Mount Hossein and the waterfall catchment area at Naqsh-e Rostam (Redesigned by: Fahimeh Homayoun).

Fig. 6. Waterfall and surface flooding at the Naqsh-e Rostam site, May 2024 (Photo: Fazlollah Habibi).

Fig. 7. Water accumulation on the surface of the Naqsh-e Rostam site, May 2024 (Photo: Mostafa Rakhshandekhah).

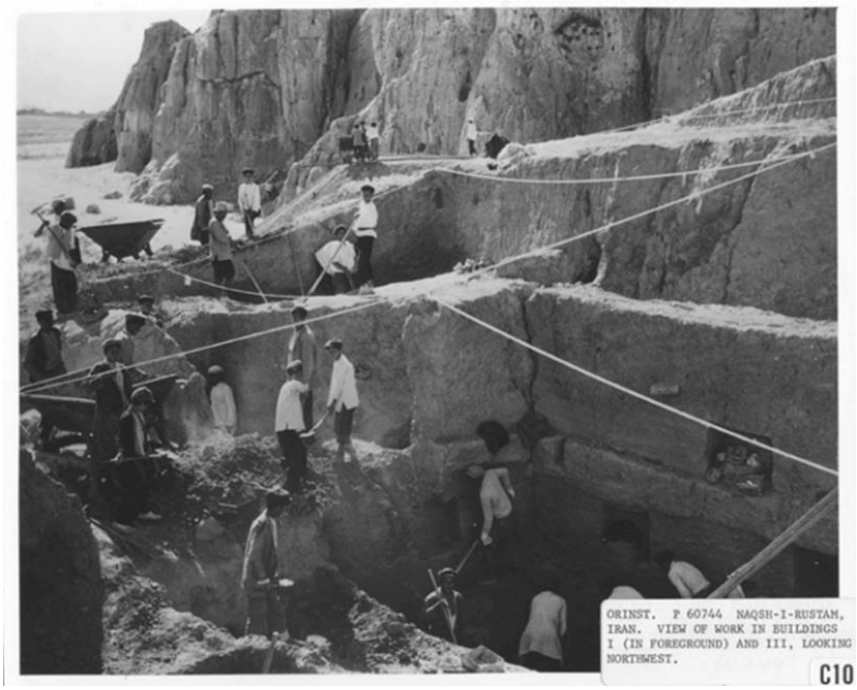

Fig. 8. Vertical and horizontal cracks visible in the profile of the trench excavated by the American team west of the Ka'ba-ye Zartosht, Naqsh-e Rostam, 1939 (Schmidt 1970).

Fig. 9. Excavation of the water reservoir in the western section of the Naqsh-e Rostam site; Trench No. 3 (Photo: Abouzar Tavakkol).

Fig. 10. Discovered well in Trench No. 1 in the eastern section of the Naqsh-e Rostam site (Photo: Abouzar Tavakkol).

However, in 1939, due to the sudden departure of the American team as a result of the outbreak of World War II, many excavation and consolidation plans – particularly those concerning the water channeling routes, the settling basin above the cliff, fissures in the rock face, and the cleaning and excavation of central water channels and the rock-cut well or cistern – were abandoned. Since then, the Technical Office of Persepolis has stabilized most of the open trenches left by the excavations. With the help of the IsMEO mission, a protective brick-and-cement wall was built around the Kaʿba-ye Zartosht , within the area of the large trench dug by the American team, to prevent soil collapse toward the monument [Fig. 7]. Over time, due to climatic changes, land subsidence has occurred in the Marvdasht plain. This, coupled with the loosened soil in the old trenches, water accumulation, the overflowing of the upper waterfall (caused by a blocked basin), and the failure of other drainage channels and the rock-cut well, has led to several landslides and erosional events at Naqsh-e Rostam. In fact, the University of Chicago's archaeological team should have excavated, restored, and rehabilitated the collapsed water management system of Naqsh-e Rostam from the Achaemenid period – specifically the upper settling basin, the rock-cut well or cistern, the water channels beneath the mudbrick fortification, and the other channels in the site's central area. Therefore, in this new phase of excavations, the Iranian team sought to continue the unfinished work of the University of Chicago expedition. By excavating four test trenches and conducting geophysical surveys, part of the subsurface issues – including sinkholes, erosional channels, and problems with surface water – were identified, and sections of the Achaemenid-period water management system at Naqsh-e Rostam were restored. The archaeological test trenches, aimed at reviving the water management system at Naqsh-e Rostam, were conducted as follows:

Trench No. 1: This trench, measuring 5 by 5 meters, was opened approximately 20 meters west of the tomb of Xerxes I to investigate a cavity measuring 140 by 190 centimeters, which had formed due to water-induced subsidence [Fig. 10]. Within this trench, a well was identified, featuring a circular opening with a diameter of 70 centimeters. The well was excavated to a depth of 4.3 meters. The mouth of the well was lined with cobblestones and clay mortar, while from a depth of one meter downward, the well shaft – still circular in plan with a diameter of 80 centimeters – was unlined and composed of compacted clay. Next to the well, a broken stone sarcophagus was discovered, approximately 120 centimeters long, 40 centimeters wide, and 26 centimeters deep. Its damaged portion had been repaired using cobblestones and clay mortar [Fig. 10]. It is likely that the inhabitants of the site at that time used it as a small basin next to the well, possibly for watering sheep or for other domestic purposes. In this trench, a longitudinal east-west erosion channel was excavated. The cause of the cavity and resulting sinkhole was identified: water had penetrated through the clay wall of the well at a depth of 150 centimeters in the central part of the trench, leading to the formation of the sinkhole. At the eastern end of this trench's erosion channel, a fragment of a broken inscription was discovered. It appears to have been carried to this location by floodwaters and is probably not associated with the same occupational phase.[6] Due to the trench's proximity to the rock face of Naqsh-e Rostam, large rocky outcrops appeared at a depth of just one meter, and no further evidence of occupation was found beneath this level.

Fig. 11. Architectural structures with a mudbrick residential surface and a continuous subsidence crack in the central section of the site, in view of the Tomb of Darius I (Photo: Younes Zare').

[6] This broken uncomplete inscription is currently under study.

Trench No. 2: This trench, measuring 4 by 10 meters, was opened longitudinally along an extended fissure, from the eastern front toward the west, and excavated approximately 5 meters below the tomb of Darius I and the relief of Shapur I. The purpose of this excavation was to determine the depth of the fissure, investigate its cause, and assess the extent of damage to any possible architectural structures [Fig. 11]. Excavation in this trench reached less than 1 meter in depth. After just 15 centimeters of loose filling, architectural remains began to emerge. A habitation phase was identified, with architectural features consisting of walls approximately 70 centimeters thick. These walls were constructed from medium-sized rubble stones (approximately 20 × 30 cm) combined with smaller cobblestones (approximately 5 × 10 cm), all set in clay mortar. The occupation surface associated with this architectural phase was a compacted clay layer over which mudbricks had been laid. Due to their shallow depth, these structures and the occupational surface had suffered significant disturbance and collapse [Fig. 11]. The identified fissure in this trench measured 10 meters in length and up to 2 meters in depth, having severely disrupted and fractured the architectural remains of this phase [Fig. 11]. The fissure could be traced beyond the limits of the trench – extending up to 30 meters eastward and 20 meters westward [Fig. 3]. The cause of this subsidence and resulting fissure was water infiltration in the central part of the Naqsh-e Rostam site, particularly through the central trench previously excavated by Schmidt [Figs. 4, 8]. At that location, water had penetrated beneath the surface through the trench walls due to the looseness of the soil. As the soil in the central part of the site collapsed, a longitudinal fissure formed at the edge of the site, alongside the bedrock base of the mountain [Fig. 3]. Geophysical studies revealed that the bedrock of Naqsh-e Rostam extends approximately 5 meters below the surface toward the center of the site in this area. As the loose soil within the trenches of the American team's earlier excavations in the site's center subsided due to water infiltration, this section of the mountain slope also shifted. The approximately one-meter height difference and the sloping bedrock contributed to a soil slide toward the site's center, creating a continuous longitudinal fissure approximately 60 meters long, located 5 meters from the main rock face [Fig. 3].

Trench No. 3: The cistern, water reservoir, or stone-cut well is a pentagonal structure carved into the bedrock, located outside the mudbrick fortification on the western side of the Naqsh-e Rostam site. The Chicago team had excavated less than one meter of it [Fig. 9].[7] This reservoir lies at the foot of the cliff with an east-west orientation, measuring 7.20 meters in length. Its eastern and western sides each extend approximately 4.20 and 3.20 meters, respectively; the southern side is 5 meters, and

[7] Schmidt, 1970: 65.

the southwestern side is 2 meters. Excavation reached a depth of 5 meters into the rocky mountain bed, but the leading trench indicated that its depth continues further [Fig. 9]. The inner rock surface of the reservoir was finely carved to a depth of 3 meters across all five sides, but below this level, the carving becomes rough and coarsely finished. According to Erich Schmidt, the Naqsh-e Rostam reservoir resembles the stone well at Persepolis and dates back to the Achaemenid period, with the distinction that the Naqsh-e Rostam cistern was fed by a spring.[8] Excavation layers within this reservoir up to a depth of 3 meters consisted of clay and successive alluvial deposits. Below this level, large, heavy stones measuring around one meter in size were uncovered. These rocks likely fell into the reservoir either due to natural detachment from the mountainside or possibly as a result of quarrying a flat surface for creating the Sasanian-era relief located above the reservoir. The reason for excavating this reservoir was to revive the Achaemenid water management system at Naqsh-e Rostam. In the western part of the site – from approximately the tomb of Darius II to the relief of Ardashir I – numerous sinkholes are visible, some linear and others pit-like [Fig. 3]. This area at the base of the mountain once contained a water reservoir or well carved during the Achaemenid period, which served to collect and manage runoff from the western side of the site during rainy seasons. Additionally, a seasonal spring emerging from the rock face was channeled into this reservoir.

Trench No. 4: In the area around the tomb of Xerxes, another reason for the torrent-like flow of water cascading down the mountain as a large waterfall has been identified [Fig. 4]. During the Achaemenid period, before runoff from the streams of a 13-hectare area at the elevated part of Mount Hossein descended [Fig. 6], a small dam – particularly a stilling basin – had been constructed to prevent mud and silt from being carried into the Naqsh-e Rostam site [Fig. 12]. The silting up of this stilling basin, the collapse of the dam, and more critically, the destruction and clogging of the water channels within the site, caused a recent heavy rain to unleash a large volume of uncontrolled water into the area, bringing with it numerous cobbles [Fig. 4]. Similarly, the malfunction of the internal drainage channels led to water accumulation and ultimately to erosion in the eastern part of the site. Therefore, in the eastern sector of Naqsh-e Rostam, it was first necessary to restore the dam and stilling basin at the top of the mountain, followed by the dredging, rehabilitation, and organization of the Achaemenid-era water channels and drainage routes throughout the site. The stilling basin was carved into the mountain bedrock and measured approximately 4.65 meters in width, 6.70 meters in length, and had a maximum depth of 2 meters [Fig. 12]. The excavated layer in this basin consisted of clay mixed with gravel, and various types of pottery from different historical and Islamic periods were found within it. Several large cobbles, about one meter in size, had settled at the bottom, indicating

[8] Schmidt, 1970: 65.

the critical function of this basin in preventing rockfall hazards during heavy rainfall in one of the historical periods [Fig. 12]. The style of carving and chiseling of this feature is similar to that of the Naqsh-e Rostam reservoir and the stone well at Persepolis. However, the purpose of this basin was to calm the water flow and prevent cobbles from falling into the Naqsh-e Rostam site.

Findings

The most significant discoveries resulting from this season's excavation and restoration of the Naqsh-e Rostam water system included numerous pottery sherds along with animal bones. Among the notable finds was a Sasanian clay seal discovered in the western area of the site near the Sasanian fortification wall close to the water reservoir. Additionally, a fragment of a broken stone inscription in Middle Persian, possibly dating to the 3rd century CE, was uncovered inside a fissure in Trench 1 on the eastern side of the site [Figs. 13, 14].

Fig. 12. Excavation of the settling basin in the elevated section of the Naqsh-e Rostam site, to the left of the Tomb of Xerxes; Trench No. 4 (Photo: Homayoun Abbasnia).

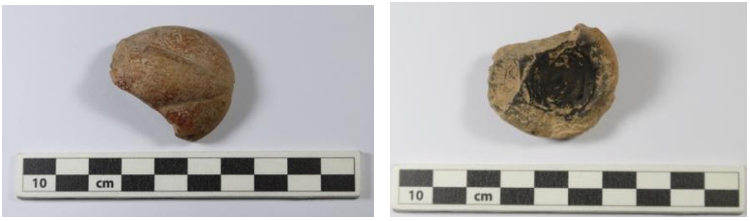

Fig. 13. Sasanian seal impression discovered at Naqsh-e Rostam (Photo: Abouzar Tavakkol).


Fig. 14. Fragment of a stone inscription in Sasanian Pahlavi script, 3rd century CE, Naqsh-e Rostam (Photo: Aleksander Engeskaug).

Conclusion

Based on archaeological studies, topographic map analyses, site monitoring, and documentation, the internal issues and challenges of the Naqsh-e Rostam site can be classified in order of severity as follows: 1. The Central Sector, 2. The Western Sector, and 3. The Eastern Sector. This classification is due to the scale of the site, with each of these three areas presenting distinct and relatively independent problems:

1. Central Sector of Naqsh-e Rostam: The central area of the Naqsh-e Rostam site – between the tombs of Darius the Great, Artaxerxes I, and Darius II, extending to the Kaʿba-ye Zartosht – has consistently faced repeated threats such as erosion, landslides, subsidence, and sinkholes [Figs. 3, 7]. An examination of archival photographs from the 1930s excavations shows large fissures in the soil along the excavation trenches around the Ka'ba-ye Zartosht [Fig. 8]. These fissures are clearly visible in the excavation trenches documented at the time.[9] Due to the immense volume of accumulated soil and debris, the University of Chicago team only excavated the immediate area around the Ka'ba-ye Zartosht and conducted limited sondages in other parts of the site. Given the architectural and historical significance of the Ka'ba-ye Zartosht, the archaeological team excavated a 40 x 50 meter area surrounding the structure.[10] In the decades that followed, in an effort to organize the site, a protective mud-brick wall was constructed around the excavation trench. This wall, reinforced with mud plaster, enabled visitors to view the full facade of

[9] Schmidt, 1970: 51.
[10] Schmidt, 1970.

the Ka'ba-ye Zartosht and its inscribed lower panels [Fig. 7]. Over the past 15 years, this protective mud-plaster wall has cracked and split due to pressure and soil displacement. In fact, water infiltration into the soil in the central part of the site, coupled with the collapse of the loose soil in the old American excavation trenches, has exerted pressure on the protective wall surrounding the Ka'ba-ye Zartosht, causing it to fracture. In recent decades, flooding and the inherently loose soil of the site have led to multiple episodes of erosion and slope failure. Thus, most of the site's issues – which only emerge during periods of rainfall – are rooted in internal drainage failures, water accumulation, insufficient water runoff, weakened trench soil from past excavations, and the site's subsurface slope from the cliffs toward the fortifications. While climate change and the broader issue of land subsidence in the Marvdasht plain may also impact this foothill area, in recent years remediation efforts have been limited to simply filling elongated depressions. During the most recent rains, runoff once again flowed into old trenches in the central part of the site, further weakening the protective walls surrounding the Ka'ba-ye Zartosht and exacerbating soil displacement.

2. Western part of the Naqsh-e Rostam: In this part of the site, due to the filling and non-functionality of the water reservoir and the pouring of water into the soft clay soil in this part of the foothill, we are witnessing the formation of sinkholes that extend up to a distance of 50 meters from the rock cliff, where a ruined qanat also exists. The elevation difference between the surface of the Naqsh-e Rostam and the qanats located in this area is about 5 meters. Therefore, the reason for the soil displacement and cracking in this part is the heavy water erosion caused by the overflowing of the filled reservoir downwards toward the qanats, where water entered the qanats. Of course, the existence of an asphalt road around this part and the soils resulting from previous excavations have turned the entire western part of the Naqsh-e Rostam into a place for the formation of a small seasonal lake. Therefore, among the causes and reasons for the formation of erosions and sinkholes in the western part of the Naqsh-e Rostam were the water accumulation in this area around the qanats, the formation of a seasonal lake, the fine soil resulting from previous excavations, the asphalt road, and the filling and non-functionality of the water reservoir [Fig. 3]. For this reason, efforts were made to excavate this water reservoir so that the water of this part of the site would be directed into the reservoir and prevent the flooding of seasonal rains and their accumulation in the qanat area and at the base of the mudbrick fortifications of Naqsh-e Rostam.

3. Eastern part of the site: With the excavation of the stone basin above the cliff, part of the Naqsh-e Rostam water management system from the Achaemenid period was restored, and the site was protected from the danger of rockfall due to the creation of a flood waterfall during rainfall [Fig. 12]. Because this basin had been filled, and during rain, rubble along with numerous pebbles flowed down into the site. Also, the cause of soil subsidence and the formation of a sinkhole on the surface of the site

near the Tomb of Xerxes was determined by identifying a well shaft and the falling of water into it [Fig. 10].

In addition to the four aforementioned trenches, the continuous longitudinal cracks that had formed in the central part of the Naqsh-e Rostam were first cleaned, and then in all sections where the cracks extended to a depth of 3 meters, in order to fill them, pebbles were used at the lowest part, followed by a layer of gravel, sand, and at the topmost section a mixture of clay and lime mortar was applied. Finally, the necessary grading was carried out on the surface of the site so that rainwater would exit the site before penetrating into the cracks. As a result of the archaeological studies of this season, most of the probable paths and the existence of water channels and conduits from the Achaemenid period were identified. The probable paths of qanats, a seasonal spring along the fault lines, and a water storage well were identified. The areas of previous excavations were marked on the maps and, in coordination with the newly formed erosions and pits, their locations were matched with the previous excavations. The internal water channels of the site were cleaned and reactivated, and the stilling basin and the dams above the cliff of the Naqsh-e Rostam mountain were dredged and restored, and surface drainage of the lowland area was carried out.

For the long-term protection and management of the Naqsh-e Rostam site, it is necessary that the soil accumulations resulting from previous excavations be transferred to another area, and the main structure of the mudbrick fortification of the Naqsh-e Rostam site be organized. For the protection of the cliff face, it is necessary to restore and protect the stone gutters of the tombs and to perform bitumen mortaring in the fault beds and water channels.

All the tombs at Naqsh-e Rostam should be examined and monitored through GPR studies, and the mountain water outlets in the area of the tombs and reliefs should be identified and bitumen application should be carried out.

Regarding the landslide and monitoring of the Ka'ba-ye Zartosht structure, in addition to employing a static GPS device on the roof of the building, temporary drainage operations around the entire building should be carried out; however, for the full protection of the structure, in addition to restoration and conservation of the building’s structure, a geotechnical soil test should be conducted to identify the original ground bed up to a depth of 100 meters in the Naqsh-e Rostam area.

In the eastern part of the site, after every rainfall, the annual dredging of the stilling basin in the high mountain section should be carried out, and likewise, in the western part, the water paths of this section should be directed toward the water reservoir to prevent waterlogging of the qanats and the formation of a lake in this area. Furthermore, the leveling of the surface in the central part of the site should be monitored, and tourist routes should be defined so that the surface soil is not displaced by visitors’ walking, and the gradient of the slope for directing rainwater outward from the site remains stable.

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