The Preservation of Rock-cut Structures of Western Maharashtra and Conservation Challenges

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Abstract

The rock-cut structures of western Maharashtra, India, are among the earliest examples in basalt rock formations. A gradual development of rock-cut architecture could be noticed in this region, where these structures also evolved with the understanding of geological formations by the earliest excavators, thereby coping up with the deformations and irregularities in the rock formation processes. This led to an understanding for selecting suitable rock formations, which is clearly exhibited by rock excavations that date some 200–300 years later from the earliest excavations. The ancient dwellers also resolved the challenges of poor geological formations by adopting ingenious strategies. The modern-day challenges of conservation are equally difficult in comparison to the ancient ones. The conservation challenges are now well understood through a process of identifying the proper geological formation processes and their uniqueness, which vary from rock formation of different regions, evolving different strategies varying from structure to structure. The prominent rock-cut structures that were studied by Archaeological Survey of India (ASI) with the help of Geological Survey of India (GSI) are Ajanta, Ellora, Pitalkhora and Aurangabad Caves, whose time span ranges from 3rd to 2nd centuries BCE to 12th to 13th centuries CE and also represent the best examples of its kind. The conservation strategies adopted include rock-cut drains, contour and surface water drains to divert the rainwater entering into the cave system, identifying the various fault zones in the rock formations and adopting suitable remedial measures, challenges arising due to preservation of murals in many of the caves. This paper elaborates these challenges.

Keywords: Conservation, Preservation, Basalt, Rock-cut Cave, Green Bole, Red Bole

Introduction

The tradition of building memorial structures over the mortal remains of humans can be traced back at least to the Neolithic times in the South Asian context (Prabhakar 2015). This tradition developed into a detailed process of interment of dead during the Harappan times, and the tradition continued during late/post-urban phase of the Harappan culture. The erection of tumulus over the interred human corporeal remains is a tradition that can at least be traced back to the Harappan times and is substantiated from the evidence from Dholavira, Gujarat (Bisht 2014). *Stupa* is one type of funerary monument built in India from the ancient times. The tradition that Gautama Buddha, in his deathbed, suggested for the erection of *stupas* over his mortal remains is well known (Mitra 1971). Thus, the *stupa* became an essential part of the Buddhist ideology and architecture, the evolution of which can be seen in various manifestations, starting at least from 4th century BCE onwards. Similarly, the dwelling places associated with the various religious sects such as the Ajivikas and Buddhists also serve as an important component in the overall spread of these religious ideologies. The earliest of these dwellings for the monks and saints date back to at least 3rd century BCE as attested from the royal donations of the Mauryan period at a few places, for example, Sudama caves in Bihar. The tradition of housing the monastic settlements hewn out of solid rock formations, in particular, on granitic outcrop in the Sitamarhi and Nagarjuni Hills, Bihar, completely followed the wooden prototypes of the contemporary period. This is also a clear indication of the existence of similar monasteries and dwelling for the religious followers in perishable medium, which have not survived. The spread of Buddhism after the third Buddhist council at Pataliputra, which also coincided with the compilation of *Kathavastu,* duly supported by the emperor Asoka through his missionaries under religious leaders, is an important factor. This not only facilitated the spread of Buddhism but also the spread of traditions and customs followed in the Magadha region, in particular, the creation of rock-cut edifices for dwelling as well as worship (Mitra 1971). It has been recorded that the Maharashtra region was under the religious emissary known as *Mahadharmarakhita* and slowly the region was filled with numerous religious edifices duly supported by people from all walks of life.

The use of rock outcrops, high cliffs in the river valleys, have been preferred excavating the earliest settlements for religious purposes as indicated by examples at Barabar and Nagarjuni Hills (Bihar), western Maharashtra and Mahabalipuram (Tamil Nadu) (Fergusson and Burgess 1880). These rock-cut excavations probably started at Barabar and Nagarjuni Hills indicated by the examples of Lomas Rishi and Sudama Caves, the latter having inscriptional evidences of religious patronage it received. The Sudama Cave (Figs. 1 and 2) was the donation of Mauryan king Asoka (c. 273–236 BCE) for the Ajivikas sect, while the donor of the adjacent Lomas Rishi cave is unknown.

What probably started as a small-scale retreat for the religious mendicants in this part of India soon spread to other regions as well, wherever suitable rock media and locations were available. In

Fig. 1: General view of Sudama (left) and Lomas Rishi Caves (right), Bihar (Source : author).

Fig. 2: Inner view of Sudama cave, Bihar (left). Details of donor inscription by Asoka in Sudama cave (right) (Source : author).

particular, exploring various geological formations for excavation of religious settlements consisting of monasteries and *chaityagrihas* was soon mastered for various Buddhist settlements. A host of such settlements emerged at various locations in western Maharashtra, which also witnessed gradual development in the adaptation of natural rock formations, evolving different strategies to tackle such problems and also development of different styles in art and architecture. The earliest examples were clear reproductions of the existing wooden architecture, with even use of timber for ceilings, as clearly indicated by the surviving examples of rock-cut caves at Karla, Bhaja, Kondane and Bedsa. Soon, this permanent medium of religious settlements gained wide popularity and during subsequent time periods, large-scale excavations started, the culmination of which could be seen at Kailasa (Cave 16) at Ellora. Similarly, this popular medium spread to different parts of the country (Fig. 2) and examples could be seen at Kazhugumalai (Tamil Nadu) and Vizhinjam (Kerala).

Many of the earliest examples of rock-cut caves belonged to Buddhism, which also coincided with the period posterior to the royal edicts by Mauryan king Asoka at different strategic locations all over the sub-continent. The spurt in building of such monasteries and *viharas* also coincides with the spread of Buddhism. However, soon other religious faiths also adopted this medium, which can be seen from examples at Udayagiri-Khandagiri (Odisha), Udaigiri (Madhya Pradesh), Badami (Karnataka) and Mahabalipuram (Tamil Nadu).

Rock-cut edifices of western Maharashtra

It has been estimated that in western India alone, there are 1200 rock-cut caves of different religious attestations, which cover a time span of a little over 1000 years, from early 3rd to 2nd century BCE to the end of 13th century CE. This also indicates that the basalt rock formations in secluded locations that received plenty of water supply during the monsoon season, coinciding with the *varshavasa* of the Buddhists, was the most preferred medium for these excavations. Often, many of the standing examples of rock excavations clearly indicate the preference of high scarps overlooking a river valley. Some of the earliest rock-cut excavations for Buddhist settlements in western

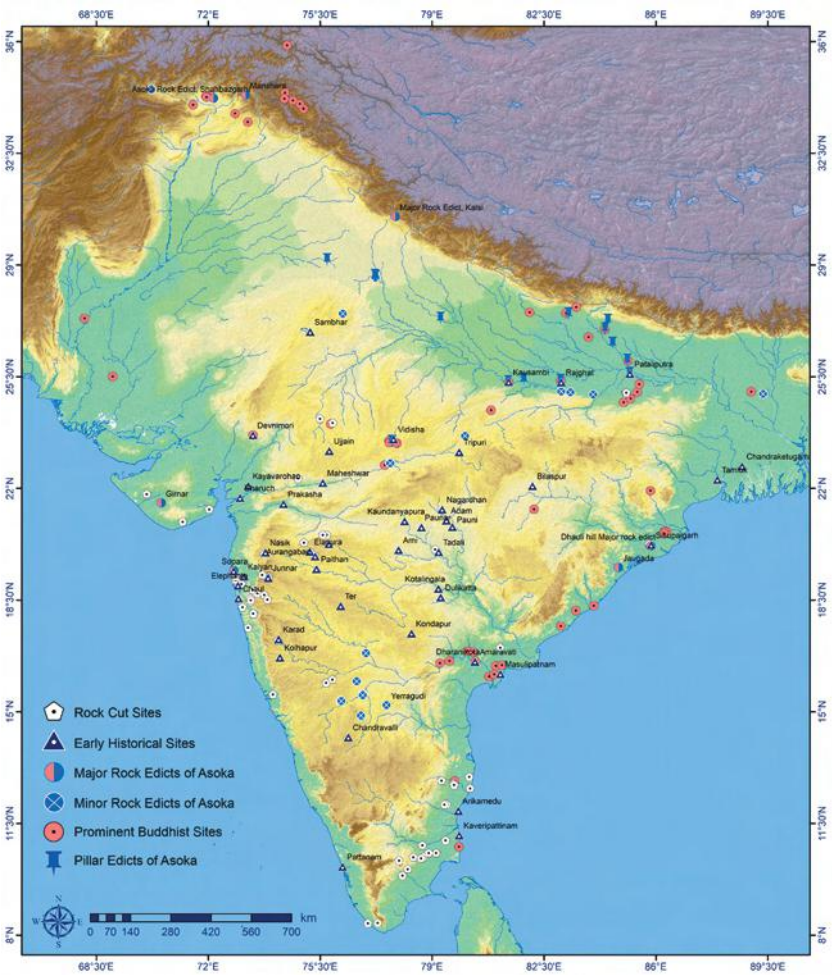

Fig. 3. Map showing the rock-cut sites in association with ancient cities (inscriptions of Asoka shown in relation with sites except Tamil Nadu) (Source : author).

India are Pitalkhora, Bhaja, Bedsa, Ajanta, Junnar, Kondane and Nasik (Fig. 4). These locations also indicate proximity to the early historic settlements nearby and were on an ancient trade route, which provided both sustenance as well as long-term support from people of different walks of society. The donor inscriptions from many of these locations

are a clear indication of the patronage they received from people of all walks of life.

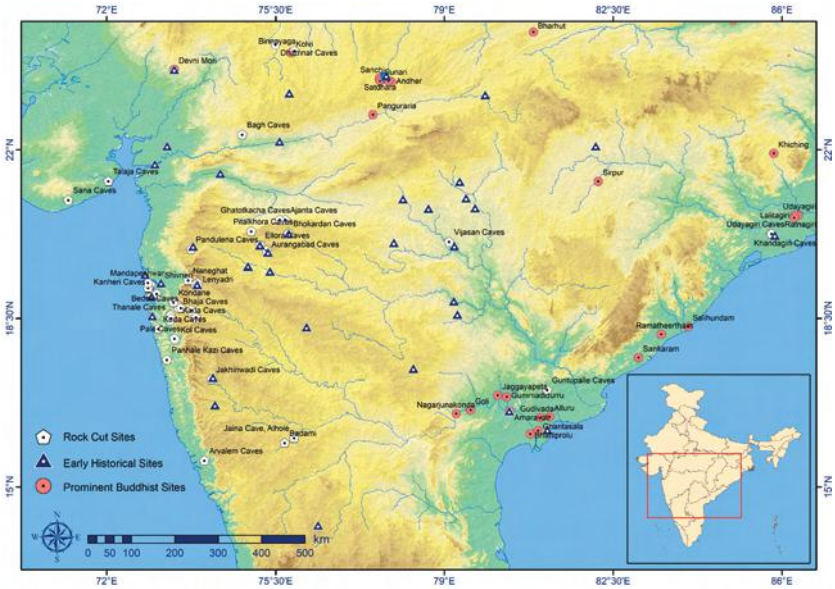

Fig. 4. Map showing the rock-cut sites of western Maharashtra along with early historical sites (Source : author).

The Buddhist rock-cut caves of western Maharashtra clearly indicate their proximity to early historic settlements such as Surparaka (Sopara), Jurnanagara (Junnar), Kalyana, Nasikya (Nasik), Nidhivasa (Nevasa), Pratishthana (Paithan) and Bhogavardana (Bhokardan) to name a few. At Ajanta, which hosts one among the earliest Buddhist establishments a historical site known as Lenapur, which can be seen nearly two kilometres upstream. Deshpande (1959) succinctly brings to light the two prominent trade routes (Fig. 5) of ancient India, which connected Pratishthana (modern Paithan), the capital of Satavahanas, one from Surparaka (Sopara) through Nasikya (Nasik) and passing through Pitangalya (Pitalkhora) and following more or less the modern Chalisgaon–Ellora–Aurangabad–Paithan route, while the other from

the northern India after passing through Ujjayini (Ujjain) reaches Mahishmati (Maheswar) and then splits into two routes, one reaching Bahal enroute Paithan via Pitalkhora, and the second also leading to Paithan through Ghatotkacha, Ajanta and Bhokardan (ancient Bhogavardana) (Deshpande 1959). This clearly explains the presence of large monastic establishments at Pitalkhora, Ellora, Aurangabad, Ghatotkacha, Ajanta, all of which are located on the ancient trade routes.

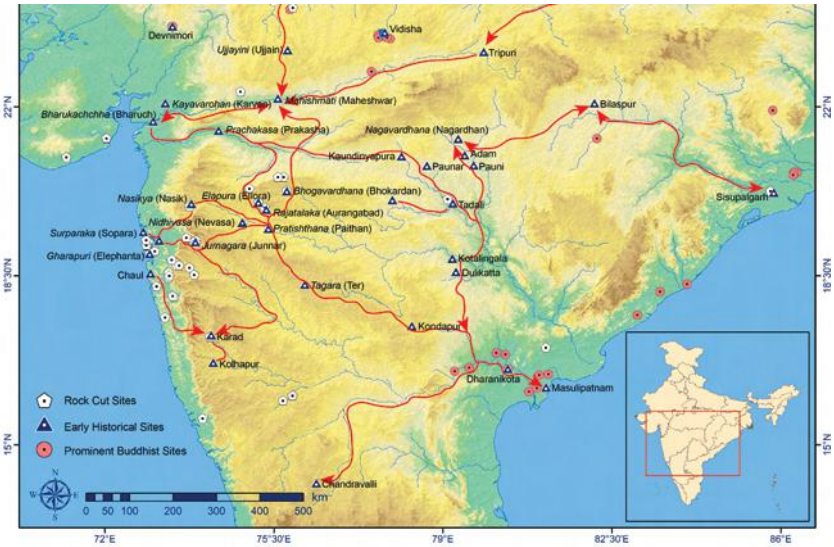

Fig. 5. Map showing the rock-cut sites of western Maharashtra along with early historical sites and ancient trade routes (Source : author).

It is interesting to note that some of these settlements area are also mentioned in the historical literature. For example, Pitalkhora finds mention in the Buddhist text *Mahamayuri*, as Pitangalya wherein the *yaksha* Sankarin was residing (Agrawal 1942). Pitalkhora is also identified with Petrigala of Ptolemy. Deshpande (1959) alludes that Pitangalya-Petrigala might have been a township on the Pratishthana-Bharukachchha route. The caves at Pitalkhora are obviously the outcome of the site being located on the trade route and hence attracted extensive

donations. It is also pertinent to note that Pitalkhora is strategically located connecting the Tapti valley in the west and Godavari valley in the east. Similarly, the Pandulena Caves at Nasik received extensive royal patronage by the Satavahanas as indicated by the inscriptions found here. It is also well known that Nasik is an ancient settlement, its antiquity dating back to the Chalcolithic period. Reverting back to the nature of donor inscriptions, examination of a few clearly indicates how people from different backgrounds and professions supported these religious settlements, either fully or even partially, for e.g. pillars, facades, roofs and complete monastic establishments.

The inscriptions were either chiselled on the rock surfaces directly (e.g. Cave 3, Pitalkhora) or on a smoothened surface (e.g. Cave 16 and 17, Ajanta). Instances of painted donor inscriptions are also noted from these caves, especially at Ajanta (Fig. 6). For example, the presence of two early inscriptions (Figs. 7 and 8), found from the pillars in Cave 3, records the gift by one Mitadeva of the Gadhika (perfumer?) family and the other by sons of Sanghaka, both hailing from Patithana (Pratishthana, modern Paithan). One inscription from Cave 4 mentions the gift of one Kanha (Krishna), the son of Samasa, of Dhenukakata (Dhanyakataka, modern Amaravati in Andhra Pradesh). The continuation of occupation of these caves during the Mahayana phase is attested by the painted figures of Buddha and Bodhisattva in Cave 3 along with painted records ascribable to 3rd to 6th centuries CE.

At Ajanta, which houses one of the finest specimens of Buddhist art and architecture, two monastic complexes were donated during the

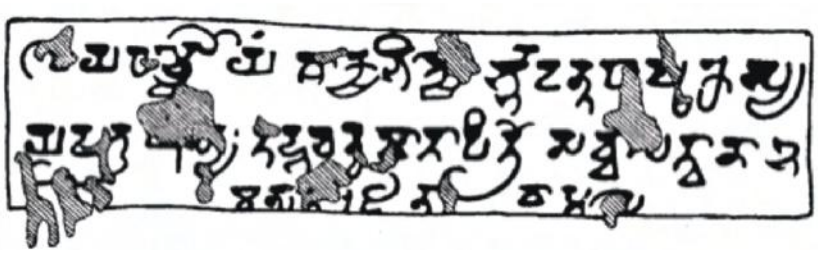

Fig. 6. Details of painted donor inscription, Ajanta caves, Maharashtra (Fergussion and Burgess 1880) (Source : author)

reign of Vakataka king Harishena, belonging to 5th century CE. The Cave 16 was the donation of Varahadeva, the minister of Harishena, while Cave 17 was by Upendragupta, a feudatory of the same king. The best example of royal patronage was by the Satavahana rulers like Gautamiputra Satakarni, Sri Pulumavi and Queen Gautami Balasri, mother of Gautamiputra Satakarni.

Nature of Geological Rock Formations

The rock-cut caves were excavated in the volcanic formation known as Deccan 'trap', which is a part of massive volcanic eruption now estimated to spread over an area of 3.2 lakh square km in most parts of Maharashtra, Gujarat, Karnataka and also in Madhya Pradesh. The volcanic eruption belongs to upper Cretaceous in age and the thickness varies from 10,000 feet near Mumbai to 100–200 feet in Sindh, its northern limit (Wadia 1919). The average thickness of individual lava flows is around 50 feet, while the thickness has been noticed even up to 500 feet. The individual lava flows are often separated by thin layers

The pillar donated by the son of Sanghaka, from Pratishthana
Fig. 7. Details of donor inscription, Cave 3,
Pitalkhora caves, Maharashtra (Source : author).

The pillar donated by Mitradeva, a perfumer, from Pratishthana
Fig. 8. Details of donor inscription, Cave 3,
Pitalkhora caves, Maharashtra (Source : author).

of ash, scoriae, green earth and also by sedimentary beds, which are termed as 'inter-trappean' beds (Wadia 1919).

The composition of the trap is undifferentiated from one place to another and the only variation is observed in colour, which varies from greyish-green tint to perfectly black and its various shades (Wadia 1919). The flows which are more acidic in composition have colours of rich brown or buff while the red and pink tints are uncommon (Wadia 1919). The texture varies from '……fine-textured crypto-crystalline, almost vitreous anamesite, through all gradations of coarseness, to a coarsely crystalline dolerite' (Wadia 1919). The rock is also '….often vesicular and scoraceous the amygdaloidal cavities being filled up by numerous secondary minerals like calcite, quartz and zeolites' (Wadia 1919).

The geological studies carried out by the Geological Survey of India (GSI 2005) have concluded that the basaltic flows exposed in the area have been subdivided into four stratigraphic formations. Deccan traps comprising 'compound pahoehoe', 'Aa' and megacryst basaltic

flows and younger intrusive belonging to the Lower Ratangarh, Upper Ratangarh, Ajanta and Chikli Formations of Sahyadhri Group of Upper cretaceous to Lower Eocene age are exposed in the area. The area is occupied by the Deccan Trap basaltic lava flows belonging to Upper Ratangarh Formation of Sahyadari Group. Five flows were delineated in the area between altitudes 620 and 728 m. The upper two are of 'Aa' type, while the lower three are compound 'pahoehoe' flows.

The lower three pahoehoe flows are intervened by a layer of red/green bole layer.

Flows IV and V are Aa type flows and are hard, massive and compact. Flow IV varies in thickness from 10 to 14 metres while the top contact of Flow V could not be delineated. In terms of understanding the geology of the caves, Flows III and II are important as they are excavated in these flows. Both Flows III and II are pahoehoe types and form the major portion of the scarp at Pitalkhora. Flow III consists of 14 pahoehoe-type units, the middle portion being massive and the lower units of this flow forms part of the top portion of the excavated caves. Flow III also forms part of the scarp with lot of negative slopes. Flow II consists of eight pahoehoe type units and the contact between Flow II and III is exposed 1–2 metres above the floor of caves. Flow II also forms part of the lower portion of scarp and extends up to the river base.

The geological investigations carried out by GSI have identified several factors for the damage caused to the caves (GSI 2005). The main causes of deterioration of the caves have been discussed below in order to understand the conservation and preservation initiatives.

'Slabbing' Effect Due to Which Inverted Step-like Feature Develops on the Façade of Caves

This effect of deterioration is particularly observed at the Pitalkhora caves, wherein the earliest attempts of rock excavation were carried out. Due to the slabbing effect, the individual rocks are loosened by the intersection of three sets of joints, one sub-horizontal and usually two sub-vertical planes. The façade keeps on receding due to the continuous falling of rocks due to which the exterior portion of the ceiling becomes higher than that of interior portion, thus producing an

inclined cross-section of the ceiling. The falling of rocks from the lower portion induces loosening of rocks above them and this phenomenon continues further, thereby leading to receding of façades.

Fig. 9. Falling of rocks from the ceiling of Cave 1 and further development of cracks (Source : author)

The best example of this phenomenon could be observed in Cave 1 at Pitalhora (Fig. 9), wherein the falling of rocks on the floor indicates the real threat posed due to this effect. The evidence of continuous falling of rocks could be further observed from the cracks developed between the still intact portion of the rock mass, which is further aggravated by water seepage and vegetation growth. Cave 4 is also affected due to slabbing. The preventive steps adopted by the ASI to provide basalt masonry props (Fig. 10) to withhold the deterioration process along with suitable drains to divert water away from the façade.

This phenomenon is noticed in many caves at Pitalkhora (Fig. 11) and the best examples can be seen at Caves 1, 4 and 6A, wherein a negative slope has been already created due to the creation of overhang. The receding of scarp, which is more prominent in the Pitalkhora caves,

Fig. 10. Providing basalt masonry pillars to support the weak portions of Cave 1, Pitalkhora (Source : author)

Receding of Scarp, Creation of Overhang Leading to Development of Cracks along Unit Contacts due to Lack of Support

Fig. 11. Receding of façade, Pitalkhora caves (Source : author)

is due to the slabbing effect. The falling of rock blocks, continuously aggravated by water seepage, creates receding of the façade. The entire façade of Cave 4 has disappeared for except a few portions at the top, preserving remains of the *chaitya*-arched decoration. This is a unique situation due to rock formation and the choice of location for excavating the caves for creating dwelling and worship by the Buddhists. The lesser knowledge of rock formations in this region by the excavators is another reason that led to locating the caves at the weaker zones.

Construction of Caves Coinciding with the Joints of Two Lava Flows

As the lava flows occurred in differential timeframes varying in thickness, often less than the height of the caves excavated across western Maharashtra, it is always bound to cut into two or three lava flows having unit contacts (Fig. 12). At Pitalkhora, the lower three units of Flow III form the upper portion and ceiling of many of the caves, while the contact between Flows III and II is exposed 1–2 metres above the floor level of some of the caves. The red/green bole layers mark the approximate zone between these two lava flows. They are extensively exposed in Caves 1, 3, 5 and 9. Along the lava flow unit contacts, rock fall often happens, as the excavators disturbed the equilibrium that had been set since millions of years. These unit contacts are also the main medium through which water seepage occurs across different lava flows and once a channel is cut across or opened, the seepage aggravates and penetrates different layers.

The unit contacts could be easily discernible at many caves in western Maharashtra. At Ajanta, one of the effects of cutting across different lava flows caused the fall of a portion of the ceiling in Cave 4 (Fig. 13).

The excavators of the cave immediately understood the formation processes and readjusted the ceiling. The positive impression of the underlying pahoehoe flow was preserved in the lower portion of a later lava flow, which is exposed by the falling of the ceiling in antiquity. The ropy nature of the lava flow is witnessed here. The deterioration and detachment of individual rocks at the unit contact of two or more units of lava flows occurs easily and is a major concern of

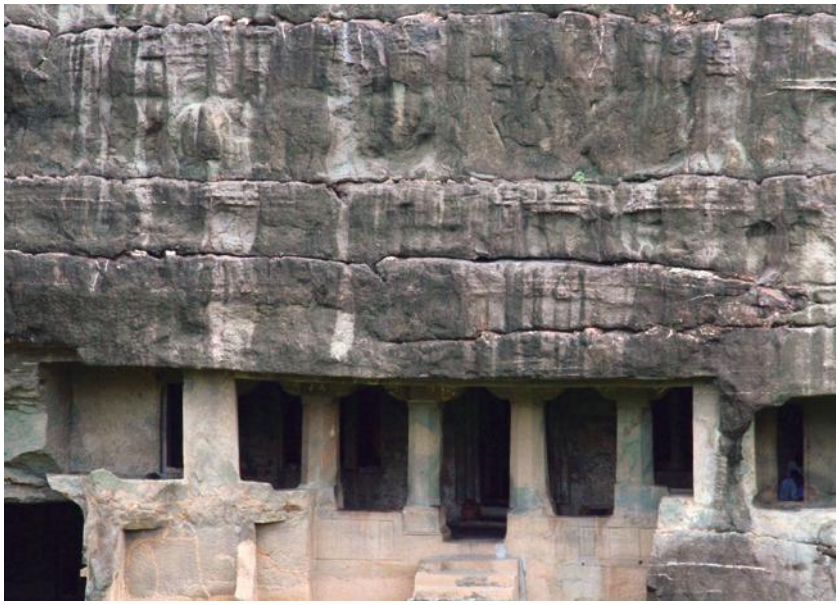

Fig. 12. Different lava flows and separated by unit contacts, Ajanta (Source : author)

Fig. 13. Different lava flows and separated by unit contacts, Ajanta (Source : author)

Fig. 14. Deterioration of elephant statues, Cave 4, Pitalkhora (Source : author)

the conservators. The deterioration is further aggravated by water action, which seeps into the crevices and causes micro-vegetational growth. The crevices gradually widen and lead to detachment, causing rock fall. The examples of such deterioration are again explicitly witnessed in Caves 4 and 5 in Pitalkhora caves. The row of elephants carved at the lower façade level has been badly affected and the front portion of head and trunk is missing in all of them (Fig. 14). Similarly, rock fall could be seen in the façade of Cave 5 due to this effect (Fig. 15).

Development of Cracks along the Valley Relief Joints

The valley relief joints are generally found parallel to the valley face. The valley relief joints could be noticed at several places all along the valley such as to the right of Cave 8, to the left of Cave 4, near Caves

Fig. 15. Rock fall, Cave 5, Pitalkhora (Source : author).

11, 12 and 13 at Pitalhora. The section exposed due to rock excavation near Cave 8 at Pitalkhora clearly shows a diagonal crack indicating the valley relief joint (Fig. 16). The entire rock mass above this crack tends to move down depending upon the support at the base of the valley. The rocks also loosen all along the valley relief joints and cracks gradually develop, which may ultimately fall. Similarly at Ellora Caves, at many locations, especially to the left of Cave 16 (Kailasa) and right of Cave 10 (Visvakarma cave) the valley relief joint could be observed. The excavation of caves exposes these valley relief joints, and at a few locations, it becomes active and may cause further deterioration and detachment of rocks.

Deterioration of Red / Green Bole Intermediary Layers due to Its Soft Nature

The red/green bole intermediary layers mark the approximate boundary between different lava flows and also indicates a lull in the volcanic activity (Fig. 17). They are also known as 'bole beds' in the Deccan Traps and may vary in colour like red to brown, green, purple and grey (Ghosh *et al.* 2006). These layers are formed due to the

Fig. 16. Valley relief joint near Cave 8, Pitalkhora (Source : author)

weathering of basalts, thereby indicating probable hiatus in the lava flows and a few of them are indicative of 'incipient palaeosols' (Ghosh *et al*. 2006). The green bole is susceptible to weathering due to its weak nature and crumbles when it comes in contact with moisture.

The reddening of these types of formations is particularly interpreted as due to the action of chemical and thermal processes that they had undergone. The green bole layers gradually weather and get converted into soil, thus endangering the caves (Fig. 18). At Pitalkhora, Cave 9 is the most affected one due to the complete weathering of green bole layer, approximately from the middle portion up to the floor level. Considerable portion of Caves 1 and 5 at Pitalkhora caves is also affected due to the deterioration of these layers, while in Cave 3 evidence for filling up the wall portion with cult basalt blocks is noticed all along the green bole layer.

The evidence of ancient conservation by the original occupants could be witnessed at several locations in Cave 3, Pitalkhora. The green bole layer runs continuously from Caves 1 to 9, with varying thickness,

Fig. 17. Red bole layer near Karla Caves, Maharashtra
(Source : author)

with the maximum thickness noticed in Caves 5 and 9. That the necessity arose to prevent the collapsing of rock due to the deterioration of green bole layer was felt and hence the original basalt rock blocks were cut and fashioned to fill the gaps along the walls of Cave 3. The wall surfaces wherever the green bole layer run was properly chiselled to accommodate the basalt rock blocks. Subsequently, these repaired wall surfaces were used for the murals (Fig. 19). Similarly, even the deformations on the floor of Cave 3 were filled in by cutting the proper basalt stones and fitting them according to the requirements. This is a clear indication of the strategies adopted by the original occupants to overcome the deformities in the rock formations at Pitalkhora. This may also be seen as an attempt to understand the geology of the region and also as coping up with the situation as lot of efforts were already taken on excavating the massive and elaborately decorated caves. Similar repairing of deformities in the rock formation can also be seen on the right triforium of Cave 10 at Ajanta, which is slightly later in date when compared to Cave 3 of Pitalkhora.

The ASI has also adopted different strategies to control the weathering of green bole layer in Pitalkhora caves, particularly during the monsoon season, which aggravates weathering due to moisture retention. The experimental studies indicated that if the exposed green bole layers are concealed using cut-basalt stone blocks, the weathering activities could be considerably arrested. This was the same technique used by the ancient conservators, particularly at Pitalkhora caves. In Cave 1 of Pitalkhora, ASI used the dressed and properly chiselled and shaped basalt stone blocks of proper sizes to conceal the green bole layers, before raking out the loose and weathered layers (Fig. 20). This preventive step has arrested further weathering.

Issues Related to Water Seepage and Control of Surface Water Flow

The excavation of caves on the rock scarps and valley faces has not only exposed the original geological rock formations, but also helped in exposing the voids and joints and served as an avenue for

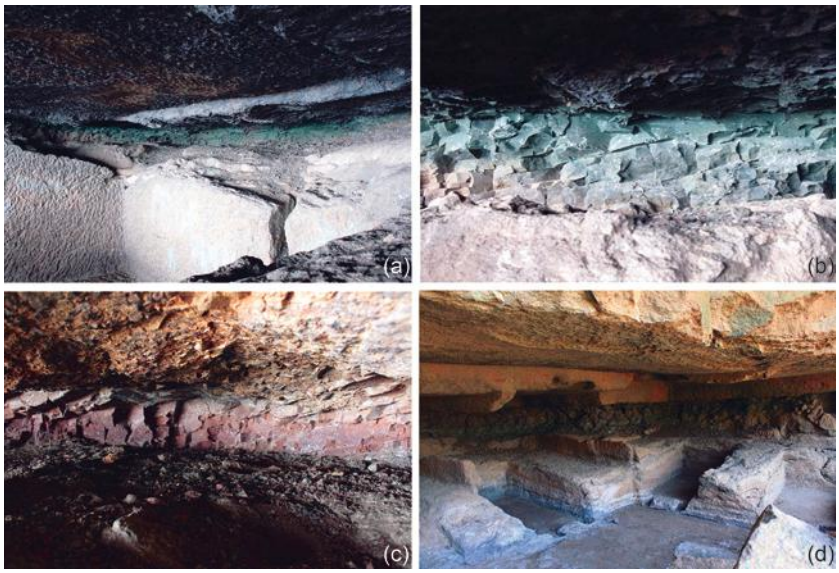

Fig. 18. (a) and (b) Green bole layer, Junnar Caves, Maharashtra; (c) Red bole layer, Junnar Caves, Maharashtra; (d) Green bole layer, Pitalkhora Caves, Maharashtra (Source : author).

Fig. 19. Instances of ancient conservation of rock deformities, Pitalkhora Caves, Maharashtra; Stone blocks were cut and used to fill suitably prepared wall portions and painted with murals during the later period (Source : author).

the flow of water. The water flow on the hill and mountain tops finds its way into voids, gaps and inter-trapean joints and ultimately emerge from the valley faces and scarps. Wherever the excavation of caves occurred on the flow path, the water oozes and emerges from inside the caves. The action of water is detrimental for the painted surfaces as they considerably damage the painted layers, resulting in their ultimate loss. Further, the continuous water flow over the sculpted façade of caves considerably damages and deteriorates them.

It has been observed that the best way to mitigate the damage caused to the painted surfaces, façades of caves is to divert the water flow away from the caves. Further, in certain caves in Ajanta and Pitalkhora, it has been observed that the water seepage occurs right inside the caves from the ceiling due to the exposure of voids and joints originally present. In order to mitigate the flow of water inside the Cave 1 at Ajanta, a concealed ceiling drain has been constructed, which collects the water flow and diverts it outside the cave.

Fig. 20. Concealing of green bole by dressed basalt stones, Cave 1, Pitalkhora (Source : author)

The construction of contour drains (Fig. 21) and surface water drains (Fig. 22) has been a major factor in mitigating water seepage inside and on the façade of the caves. At Ajanta, at least four levels of contour drains have been constructed to divert the flow of water and two levels of surface water drains to divert away the water flow from even the surface. It has been observed that nearly 70% of water seepage was reduced after the construction of surface water drains alone. Similarly, the façades of Pitalkhora caves have undergone deterioration due to the continuous ingress of water over its surface. The geological investigations at both Ajanta and Pitalkhora suggested providing for surface drains that can suitably divert the water flow away from the caves (Fig. 23). The location and contour of these surface drains were also decided based on these studies and the ASI successfully provided additional surface drains on the hill tops, which proved to be highly beneficial in reducing water seepage.

Future Conservation Methods and Mechanism

The ongoing discussion clearly demonstrates the methodology adopted for the better conservation and preservation of rock-cut structures

Fig. 21. Contour drains, Ajanta caves (Source : author)

of western Maharashtra. In order to adhere to universal standards, till recently, the conservation initiatives were proposed, discussed and analysed in detail by a panel of experts consisting of international and Indian experts before execution. The detailed geological studies of the caves at Ajanta, Ellora, Pitalkhora and Aurangabad have helped in formulating future strategies. The future conservation methods have to follow the time-tested and decades-long mechanism of finding suitable techniques for arresting the water seepage into the caves, by evolving scientific techniques and methods. The time-tested mechanism has always indicated the importance of arresting water seepage, thereby decelerating the deterioration process.

Further, scientific studies are necessary to evolve suitable binding materials and consolidating agents to strengthen the weakening basalt layers. The necessity of evolving reversible agents of strengthening is deeply felt while conservation of caves, in particular, wherever sculptural and decorative panels and inscriptions are present. These activities will be supplemented by a suitable monitoring mechanism by the custodians of the heritage structures, in order to understand the deterioration processes in a better manner. The monitoring mechanism aided by a suitable GIS-enabled technique will enormously help in the decision-making process and designing better strategies based on past experiences and conservation methodologies.

Participation of Stakeholders Including Local Communities in Conservation Initiatives

It has often been felt that the local communities play a major role,

Fig. 22. Surface water drains, Ajanta Caves (Source : author)

as they are the chief stakeholders, who have been residing adjacent to these heritage structures since time immemorial. The local communities view these heritage structures as a main source of livelihood in many aspects. This often leads to a level of conflict between them and the administrators of these structures. The restrictions imposed for the better management and security of these caves are also seen as a challenge for their free access. The involvement of communities who

Fig. 23. Surface water drain, Pitalkhora; Before (left), After (right) (Source : author)

often traverse the caves for access to their livelihood resources is an important component in the success of conservation and preservation initiatives. A sense of belonging among the locals towards the heritage, which often is inscribed in World Heritage List needs to be developed, as they impart this belief to the future generations, who ultimately will be the custodians of this heritage. The ASI organises a series of awareness programmes and involves the local communities in such events to make them understand and also to participate in the overall management of these heritage structures as well. It is also felt that the local communities participate in a major way in the actual conservation and they form the workforce in the execution of such activities. Continuous participation in the conservation work fine-tunes their expertise, which adds to the perfection of conservation methodologies. This participation also helps to instil confidence among the locals as they actually participate in the conservation initiatives with the administrators and feel proud of their heritage.

Conclusion

A brief discussion on the understanding of the rock excavations for religious purposes, its origin, evolution and introduction in western Maharashtra has been presented in this paper. It has been understood that these excavations gained prominence in western Maharashtra after the introduction of Buddhism during the 3rd to 2nd centuries BCE. Initially, the early excavators could not understand the geological formations and basaltic flows, which resulted in excavating faulty layers, leading

to deterioration of caves that resulted in their ultimate abandonment. Attempts by these early occupants to repair and conserve the rock deformities could also be noticed at places like Ajanta and Pitalkhora. However, the conservation of these rock-cut caves is a stupendous task as the deterioration process set in when the original equilibrium was disturbed while excavating them. The ASI has adopted different strategies to study and analyse the problems related to preservation and adopt suitable indigenous techniques to mitigate them. The mitigation steps include preventive measures of providing supports and props to arrest the destabilised portions, providing drains on the surface as well as different contour levels to divert the water flow, which is a major cause for deterioration. The conservation and preservation is an ongoing process. Documentation and research strategies are adopted to understand them with respect to the latest technologies and suitable steps are initiated to mitigate the deterioration process.

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