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Building on Marl: The Case of Bāb adh-Dhrā‘

Environmental archaeology as practiced today assumes that the physiographic history of sites has a necessary role to play in explaining how sites were used by their human occupants. Whether research is focused on village or urban settlement, a starting point is the recognition that the natural features of sites had to be dealt with if settlement was to be successful. Natural vegetation and stony material had to be brought under control, trees had to be cut, and decisions had to be made about what parts of the site might be included within the perimeter of defense structures, if any. Subsequently, the site might continue to be affected by changes in the natural conditions, and this too would affect the settlement history.

As far as the Early Bronze Age urban sites of Palestine are concerned, much of what went into their planning remains unknown. What we do know is that the urban sites of this period were far from being haphazard constructions, and that they were designed with some care. In fact, it is possible to infer how Early Bronze Age site planning took place under certain conditions (Amiran 1970: 90-95). We also possess evidence to suggest how technicians of this period managed some of the practical aspects of construction in the face of particular challenges.

Regarding the natural features of a site, Rosen's study of the geoarchaeology of settlements has shown how human activity and the physiography interacted with each other. The natural conditions affecting settlement would have included the site's condition at the time settlement first began. But it would also have entailed environmental changes during the duration of settlement. Rosen (1986: 57) mentions groundwater fluctuation, soil development, erosional episodes, stream alluviation, and colluviation, all of which could shift over time, causing significant changes for those living at a site.

Since we are concerned here with the Early Bronze Age, a look at several excavated Early Bronze Age urban sites in different regions will illustrate the ways Early Bronze builders accommodated the architecture of their settlements to the conditions of the sites themselves. We shall then turn to a unique site in regard to a demanding physiography, that of Bāb adh-Dhrā‘.

Sites with a Stable Natural Base

In the hilly areas west of the Jordan River, where towns or cities like ‘Aī, Megiddo, or Ṭa‘annak were established, Early Bronze urban builders adapted their constructions to the natural features of this mountainous region. Although there were difficulties in building settlements here, an advantage as far as construction was concerned was the solid base of Upper Cretaceous limestone bedrock (Orni and Efrat 1976: 55). Pristine topsoil covered the bedrock unless removed by erosion, whereas cultural sediments from previous settlement might also have built up, contributing to the formation of the prominent *tulūl* of ancient Palestine (Rosen 1986: 9-24; Butzer 1982: 77-97). But it was the consolidated limestone bedrock of the hill country that provided the stable natural footing for laying up the great defensive walls known at Early Bronze sites, as well as stone walls for many of the interior structures.

The Early Bronze Age constructions at Tall Ṭa‘annak illustrate the influence of these natural conditions on construction. The earliest city wall of the EB II was laid directly on the solid bedrock (FIG. 1; see Lapp 1964: 10; 1967: 5, FIG. 2), the builders themselves having evidently cleared the soils above the bedrock. This earlier wall was over 4 m wide. Above this early wall was a later phase EB II or early EB III wall, a little less than 4 m in width, composed of interior and exterior faces with a massive core of rubble between. No clear information was obtained for the superstructure of the later of the two defensive walls (Lapp 1967: 7), nor for that of the earlier wall. Although bricks found on the floor of a tower associated with the later wall indicated a superstructure of mudbrick (Lapp 1964: 10; 1967: 7), the stratigraphy related to the fortifications suggested that the Early Bronze defensive walls at Ṭa‘annak were made of stone all the way to the top. Many of the other structures within the Early Bronze Age city were also made of stone, although

1. Early Bronze Age city wall at Tall Ṭa'annak, built directly on the bedrock of the site.

mudbrick was sometimes used in the upper sections of walls of domestic buildings.

Early Bronze Age 'Aī was another site of this type in the limestone bedrock hill country. The first city wall, Wall C, was constructed near bedrock, and even the huts of the preceding village at 'Aī were either removed or cut into as the Wall C builders placed the foundation for their first defensive system as close to the bedrock base as possible (Callaway 1980: 20). Wall B used much of Wall C in its rebuilding, while Wall A represented a new construction above the former. Information was apparently not available for the superstructure of the defensive systems at 'Aī, but stone to the top would have been possible, given the solid bedrock base on which the walls were built.

A different example by reason of its location in an-Naqab is the Early Bronze Age city of Arād, built on a hilly area of Eocene chalk (Amiran 1978: 2). Only a small amount of Late Chalcolithic occupation preceded the use of this site in the Early Bronze Age, so that the builders of the latter period were able to lay the wall foundations close to the natural base of the site, with only a minimum of cultural debris below. Amiran's opinion was that the wall was of stone to its full height, since there was no evidence of the use of brick (Amiran 1978: 11-12).

These examples show that at many sites the Early Bronze technicians were able to assume a solid footing for their stone construction, given the natural conditions of the bedrock. They were aware of these advantages, and it is clear that such conditions simplified their work, because the locations where they built could be termed stable locations. That is, they were locations with a solid core of either hard bedrock or some sort of naturally compacted sterile conglomerate that would provide the best kind of support for heavy wall and building construction made of stone.

Sites with an Unstable Natural Base

The Jordan Valley and the southeastern Dead Sea Plain provided very different conditions from those of the hill country. In this region any type of true bedrock was so far below the surface that it could play no role as a stabilizing factor for construction. Rather, the natural soils characterizing much of the Jordan Valley generally, including those prime locations that were chosen for settlement, were laminated marls, gravels, sands, or conglomerate, all of which were laid down by the Pleistocene Lake Lisan between the Sea of Galilee and the Dead Sea (Orni and Efrat 1976: 91-98). These lacustrine deposits, having dried out after the earlier lake's retreat, offered conditions wholly different and certainly much less secure than those found in the hill country

At Jericho the effect of the relatively unstable topography on the settlement can be seen in a number of ways. The original site consisted of an alluvial tongue encroaching on the sterile lake deposits (Vita-Finzi 1978: 56). The town walls of all periods at Jericho were built of mudbrick, sometimes placed on a thin foundation of one or two courses of stone (Kenyon 1960a: 105-106). While it is true, as Kenyon noted (1960a: 105), that clay for unbaked mudbrick was the natural building material available in the area, the availability of this material alone does not seem to account for the extensive use of brick rather than stone, particularly in the fortifications. For one thing, stone is readily available as well in nearby wadis. But more importantly, the extensive use of mudbrick at this site must have been dictated by the potential problems that heavy stone walls would have created at a site composed of the kind of weak sedimentary base found at Jericho.

Other excavated sites in the Jordan Valley also show that brick was the main material used. Stone might some-

times be found in the foundations but normally not all the way to the tops of walls. Althoug the final publication of excavations at Tall as-Sa'īdiyyah contained little detailed geological information about the site (Pritchard 1985: 1), the natural makeup apparently consisted of conglomerate gravel, sand, and marl (Quennell 1952), which again would have made it an unstable site for heavy stone construction. The data from the Early Bronze levels have not yet been published, but it is interesting that the later builders of the Iron II city wall of Stratum VIIe employed a mudbrick superstructure on a stone foundation (Pritchard 1985: 4-5). Tall Dayr 'Allā was another Jordan Valley site whose constructions were largely of mudbrick (Franken 1976: 7).

The Unstable Site of Bāb adh-Dhrā'

At this point we may turn to Bāb adh-Dhrā' as a site representing an extreme example of instability. In fact, it was the physiography of Bāb adh-Dhrā', along with the fact that it was clearly not a *tall*, that led the early investigators to conclude that the remnants of wall ringing the site must have defined an enclosure rather than the defense system of an Early Bronze Age city (Schaub and Rast 1989: 17).

What the Early Bronze Age occupants found in the natural conditions of Bāb adh-Dhrā' was a series of marl knolls overlooking the Lisān plain to the west. Located on the south edge of Wādī al-Karak, several of these marl hillocks were sufficiently interconnected in an elliptical shape to make possible the construction of a continuous wall around their edge, and indeed this occurred as early as EB II when the first wall was built, to be succeeded by a later one in EB III.

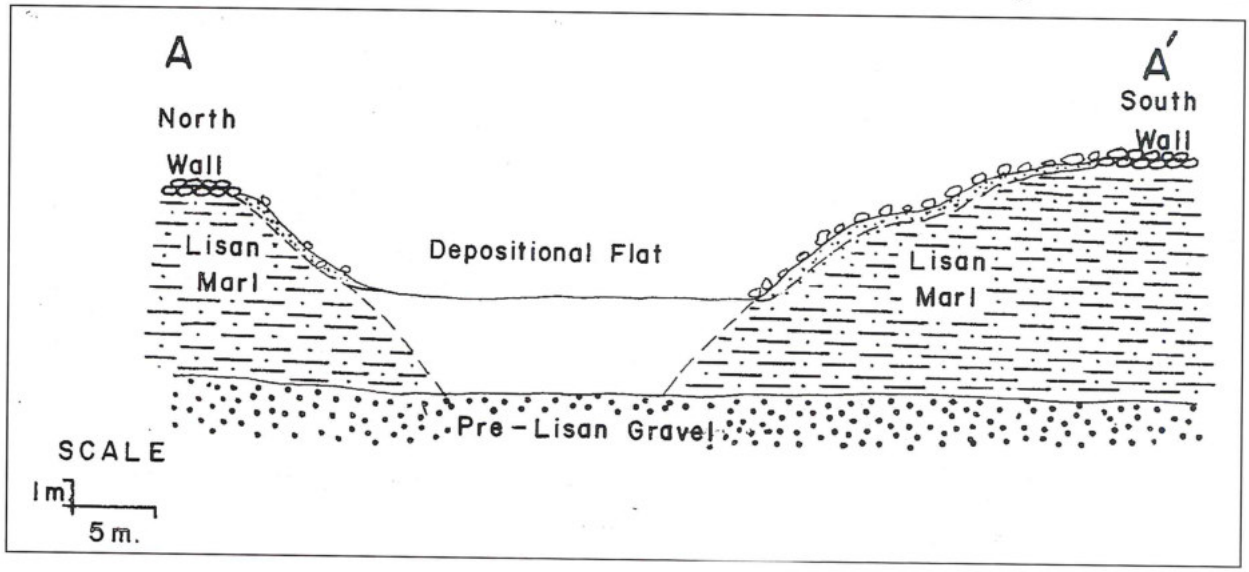
The instability of the natural site, however, was accentuated by the fact that the upper sediments of the site were of Lisan marl, from the highest surface elevation of -208 m to the base of the marl deposit at approximately -221 m (FIG. 2; see Donahue 1980: 46-49, FIGS. 19, 21-23; 1981: 144-146, and FIGS. 7-8). That is, the site's physiography most affecting the settlers was the 13 m of marl in its upper part. Capping the marl at some points was a layer of gravel that also provided difficulties for construction in some cases, as did the occasional troughs of channel gravel found within the marl deposits.

For the earliest Early Bronze Age occupants, those of EB IA who used the location as a burial site, this pervasive marl proved ideal for their traditional mode of interment, which consisted of digging underground tombs of the shaft and chamber type. Since the Lisan marls are impervious to water, the tombs were usually found to be well preserved wherever the blocking stones in the doorways had remained in position.

But it was also these same qualities of the marl that made the use of the site a difficult one for the subsequent EB IB village, and above all for the urban expansion that occurred during EB II and III. The poor condition of the EB IB village structures suggests that erosion of the soft marl was an ongoing problem for the EB IB occupants (Donahue 1980: 49). In addition, the marl was uncomfortable for year-round living since it was quickly pulverized when trampled on during dry seasons, or it became a quagmire of mud when walked on during wet seasons.

Only with ingenuity, therefore, could an urban site have sprung up on these less-than-ideal features. Thus Bāb adh-Dhrā' has presented an unusual opportunity to study the manner in which Early Bronze Age builders were able to adapt to a site that lacked the more secure properties that technicians in the hill country could depend upon at their sites. Nonetheless, a sizable number of inhabitants (estimated at approximately a thousand people at any one time during EB III) found the site inviting enough to try it.

There were compensations for these urban builders,



2. Geologic cross-section showing the depth of Lisan marl at Bāb adh-Dhrā' at the western end of the site (reproduced from Donahue 1980: 48, FIG. 22).

however. Bāb adh-Dhrā' had the advantage of a good water supply, probably by means of the same perennial spring that discharges into Wādī al-Karak at the base of the site today. The plain around Bāb adh-Dhrā' could be counted on for cultivation if water for irrigation could be brought to it. A fair stand of trees was also available for use as timber, as the evidence of felled wood found in the recent excavations has shown. The one thing that would have dissuaded the group from building a city there would have been the insecure make-up of the mostly marl and gravel site, and it was to this feature that the engineers of Bāb adh-Dhrā' brought some resourceful solutions.

Engineering Techniques Employed at Bāb adh-Dhrā'

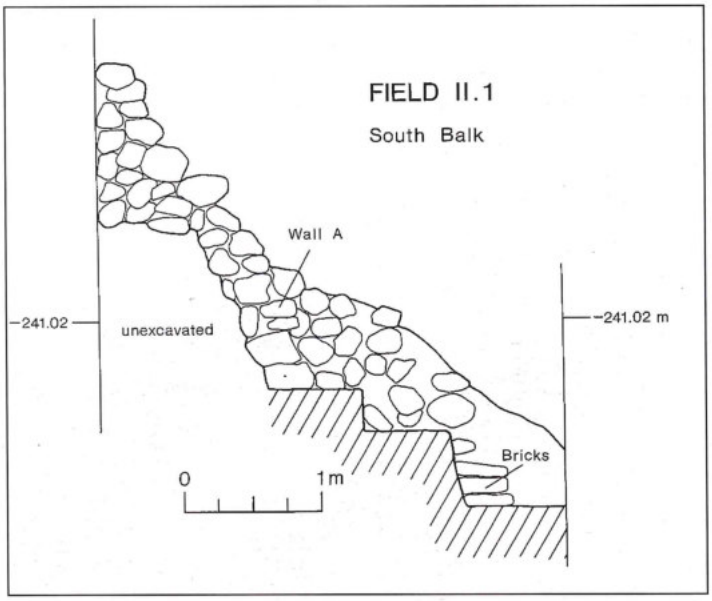
In what follows the techniques employed by the Early Bronze builders to control the recalcitrant natural marl will be discussed in relation to defenses, retaining systems, and pavements.

Defenses. First of all, it has to be said that the abundance of stone in the adjacent Wādī al-Karak must have been enticing to the Early Bronze Age builders, for it would have been considerably easier for workers to haul stones a short distance from the wadi than to have to gather clay and go through the tedious process of making bricks. Of course, the prevalent Lisan marl was also available for making bricks, and evidence has appeared that during the village phase of EB IB, many bricks were indeed made from this marl. But analysis of bricks of the subsequent periods of EB II and III suggests that clay beds in the wadi were sought out, so that a good bit of effort had to be put into obtaining the clay from these more distant sources, in addition to the actual manufacture of the bricks. In any case, the brick-making industry for construction flourished at Bāb adh-Dhrā' during the entire Early Bronze Age.

Why, then, did the Early Bronze Age occupants resort to such an extensive use of mudbrick at the site? The explanation that we propose here is that the widespread use of brick was a technical solution to the difficult features of the marl make-up of the site. Simply put, bricks were not as heavy as stone, and thus the effect of the weight of mudbricks laid on or into the marl would be less serious than that of many courses of stone laid upon such an unstable base.

The first city wall at Bāb adh-Dhrā' (Wall B), built during EB II, was made entirely of mudbrick from the foundation to the top. Subsequently in EB III the city wall (Wall A) had a 7 m wide stone foundation, but what is notable is that this stone foundation was only several courses high, sometimes even only one or two, along the higher elevations of the site, whereas in the two depressed areas at the west and east ends the stone foundation had to be built up to at least ten courses to even out with the natural ridge. This indicates that the builders were really working with a plan for a mudbrick city wall in EB III, and that the stone foundation served the purpose of providing a solid platform for the mudbrick wall. Geological observation showed that the stone base of the EB III wall along the entire south side made use of tabular stones bonded with sand and perhaps mortar into the natural marl below (Donahue 1981: 146-148 and FIG. 11). That the superstructure was of mudbrick was evident from the heaps of desiccated brick remains found to the sides of the city wall at all points excavated (Donahue 1985: 136-137).

When the Early Bronze Age wall builders dealt with the east side of the site, they found that the marl hillock here posed a difficult problem. A wide, flat ridge on which to lay the base of the wall did not exist at this end as it did on the south. Rather the marl sloped sharply inward toward the interior of the city, so that it was impossible to build a level stone foundation as on the south end. To overcome this problem the builders employed a notching technique. That is, they cut a series of steps into the slope of the marl in order to mortar in place the foundation stones on this slope (FIG. 3). This technique was found along an entire section of the eastern wall on the interior. With these boulders bonded into the slope, it was possible to build up the stone foundation to the normal level, adding once more the mudbrick superstructure, a resourceful solution to what could have been a serious deterrent to the construction of the city wall on this side. Needless to say, the technique was not foolproof, and it probably was not long before the wall here began to experience severe deterioration.



3. Section drawing through Field II at Bāb adh-Dhrā' showing the stepping cut into marl to lay the stone foundation of Wall A along the slope.

Retaining Systems. Over shorter or longer periods of time serious erosional problems occurred in all parts of the city, including the interior, due to the brittle character of the marl. The city builders were aware of this as an inevitable contingency. Along one area on the interior of the city they placed a retaining wall of mudbrick along the entire slope. This allowed for domestic structures to be built on areas that would otherwise have been threatened with serious erosion. That the system of retaining walls of this type was effective was evident from a mudbrick building whose walls and floors were well preserved, discovered immediately behind the retaining wall. At the same time, the excavations showed that one entire section of this retaining wall had at some point slipped into a horizontal position away from the slope, with the result that structures behind it were either poorly preserved or entirely eroded.

In an area on the west end of the site the Early Bronze builders used supporting walls of mudbrick along the slopes in order to create more stable possibilities for structures built in this area (FIG. 4). Part of the area was already a considerable incline at the time of settlement during EB III, and it was evident that the supporting walls had a significant function in making the erosion-prone slope livable by stabilizing it. The supporting walls were bonded into the slope behind, and crosswalls of buildings could then be tied into them. This procedure was extremely valuable, and the small section excavated in Field XIX suggests that the same system was used all along this area of the site.

Pavements. The most challenging aspect of occupying the site of Bāb adh-Dhrā', however, would have been simply having to live on the extremely chalky marl and occasional pockets of loose gravel. Even though the Early Bronze occupants may have been more patient than moderns with this unpleasant feature, their builders clearly took pains to do something about it.

4. Mudbrick buttressing used along the slopes of Field XIX at Bāb adh-Dhrā'.

The best preserved place where their construction of an expansive brick pavement could be traced was in the court around the sanctuary in Field XII. In connection with the excavations around the sanctuary it was found that the entire courtyard was paved, with horizontal lines of bricks appearing regularly in all areas of the court excavated. This was the only place where such pavement was found, and it may be that it was the special character of the sanctuary area that produced such a pavement.

Summary

What is notable at Bāb adh-Dhrā' is the great amount of mudbrick that was employed. In two cases stone foundations were found — in the city wall of EB III, and in the sanctuaries of EB II and III. This would indicate that stone foundations were used for special structures, and from surface remains it is evident that there were other important buildings built in this manner. Stone was also used for the exterior faces of the two towers at the northeast end of the site, although alternating courses of brick and wooden beams were used to create the solid interiors of the towers. The majority of buildings, however, at least those that belonged to the ordinary population, were of mudbrick from the foundations upward, and this indicates that brick was preferred because it worked better than stone on this marl site.

Corresponding to these building techniques in the town were those used in the construction of the charnel houses of EB II and III. The usual procedure at other Early Bronze Age sites was that burials were made in natural caves, or in artificial chambers such as those cut into the soft limestone *ḥuwwār* at Jericho (Kenyon 1960b: 1-2). The Early Bronze II and III tomb builders at Bāb adh-Dhrā' rose to the challenge of a site with no caves, and one where room in the marl for further underground tombs had been depleted by the previous EB IA and IB tomb diggers. Thus they adapted the idea of a building in which to house their dead, basing the idea on the rectangular houses they were accustomed to in real life.

As public buildings, the charnel houses were often quite elaborate. They were constructed of custom-made bricks produced apparently by the same brick-makers who supplied these materials for the city construction projects. Slabs and lintels that framed the doorways were skilfully prepared. Above all, these mortuary buildings show once again that it was in mudbrick that the Early Bronze people in the Southeastern Plain of the Dead Sea excelled. And, once again, their attention to the craft of brick-making and brick-laying seems to have been dictated to a large degree by the requirements of this site.

As a final note, it is instructive to compare the nearby smaller site of Numayra with Bāb adh-Dhrā'. The best

explanation for the founding of Numayra during the EB III is that this new town was colonized by settlers who moved from Bāb adh-Dhrā'. It is interesting that even though Numayra has an abundance of natural stone material available, and that the natural site consists of compact gravel and sand at least 50 m deep to the base of the adjacent wadi (Donahue 1985: 137-139), the Numayra builders made bricks from their local clay with which to lay up the superstructures of many of their buildings. If any site would have been conducive to using stone up to the tops of buildings, Numayra would certainly have been it. Thus we would have to assume that the builders at Numayra followed the tradition of mudbrick construction learned at Bāb adh-Dhrā'. In fact, we might conclude that the Numayra builders were greater traditionalists than the technicians at Bāb adh-Dhrā', and that it was the dexterity of the Bāb adh-Dhrā' technicians in relating to their difficult marl site that facilitated urban occupation there for more than half a millennium.

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