400 m off the shore there are two small rocky reefs that were eroded by the sea and quarried by human hands to just above the sea level. These islets create a protected lee on the eastern side for over 100 m (Fig. 12A), at this lee there is a rocky ledge which slopes gently eastward, from a depth of 1·2 to 1·8–2·1 m. some 30 m away. At the eastern edge of this natural platform there are remnants of artificial paving made of large flag stones. This paving was very probably a quay that would be functioning at a sea level some 2 m lower than the present (see Fig. 12B). At the foot of the quay there is an abrupt drop to a depth of 4–5 m and the rocky ridge is buried below the silt and sand of the sea bottom. In this area many stone anchors were surveyed. Most of these anchors are of the three hole type, resembling those found at Kition, in Cyprus (Frost, 1970: 16–9). Others have a single hole and some are stone weights for the anchors-line. A unique item found there is a lead ingot with incised alphabetic signs on it. This site was studied in collaboration with K. Raveh of Israel's Department of Antiquities.

Dor-Yam

During 1983–4 the study and excavations at the sea-side of Tel Dor were carried out as part of the collaborative archaeological project headed by Professor E. Stern of the Archaeological Institute at the Hebrew University in Jerusalem. Several new areas were cleared and excavated in order to collect more data for the history of maritime activities at this 4000 years old site and in order to add more evidence to the various changes in land–sea relations and alternating topography through the ages. Some preliminary details of this work are given here (see also Raban, 1981*b*: 15–26; 1981*a*: 293–308; 1983*a*: 229–41; Wachsmann & Raveh, 1984*b*).

To establish the sequence of geomorphological events that took place around Dor during the Holocene a series of water jet prickings and deep trenches with the aid of a mechanical back-hoe were made at selected points along the shore and in the water. The data collected during that survey have yielded a reconstructed coastline, radically different from the present, for the early Holocene. The coastal ridge, now much eroded, partially submerged and segmented. forming a seaward screen of lagoons and small bays, was at that prehistoric period much more complete; at least enough to create continuous blockage for the drainage of the coastal plain. This feature had generated clayish sediments that have now in the lee of this ridge a thickness of 4–6 m (see nos 1–4 in Fig. 13). Clayish mud with organic residues was extracted from the cores and the trenches and was sent for checking of micro-faunal specimens that turned out to be of a species characteristic of fresh-water or brackish lagoons. The C^{14} dating of those samples covers a time span from around 8000 to 4500 BCE for the deposition of that marshy-lagoon sediment (Sneh & Klein, 1982). A trench made in area A, at the southern side of the tel, exposed the lower courses of the cyclopian headers of the Late Bronze Age which delineate the flagstone-made landing stage of the first phase at this place (See Raban, 1983; 229f, figs 1,2). The foundation course is based on a layer of shingle and coarse sand that had been disturbed by undertrenching wave energy some time around 1100 BCE. At 0·4 m below the base of the structure, about 1 m below the present sea level is the top of the mud. There we found several broken clay vessels of the Chalcolithic period. Other finds of this period (4th millenium BCE) were made on top of the mud further south, at the tombolo that nowadays separates southern bay of Dor from the Lagoon of Tantura (see Wachsmann & Raveh, 1984*b*: 221–9), along the beach of the lagoon and all the way to the coastal and partially submerged Chalcolithic-EB1 settlement that we surveyed years ago; the remnants of which covers a very large area along the shore from the lagoon south to the present outlet of the Dalia river. One can therefore reconstruct a proto-historic rural settlement of considerable size occupying the sea side of the coastal ridge, with its habitations and stone-built wells scattered over 2 km along the western side of ill drained and may be even well-inundated basins. Being separated from the sea by the then continuous ridge the water level in the basin cannot be indicative of the ocean level at that time. Yet it must have been lower by a few metres, at least, than the present one. The data show also different elevations for the top of the mud deposits in different places. On the in-shore southeast of Tantura lagoon it is about 2 m above MSL; at the tombolo it is as much as 4 m below MSL [yet at that point some of the clay

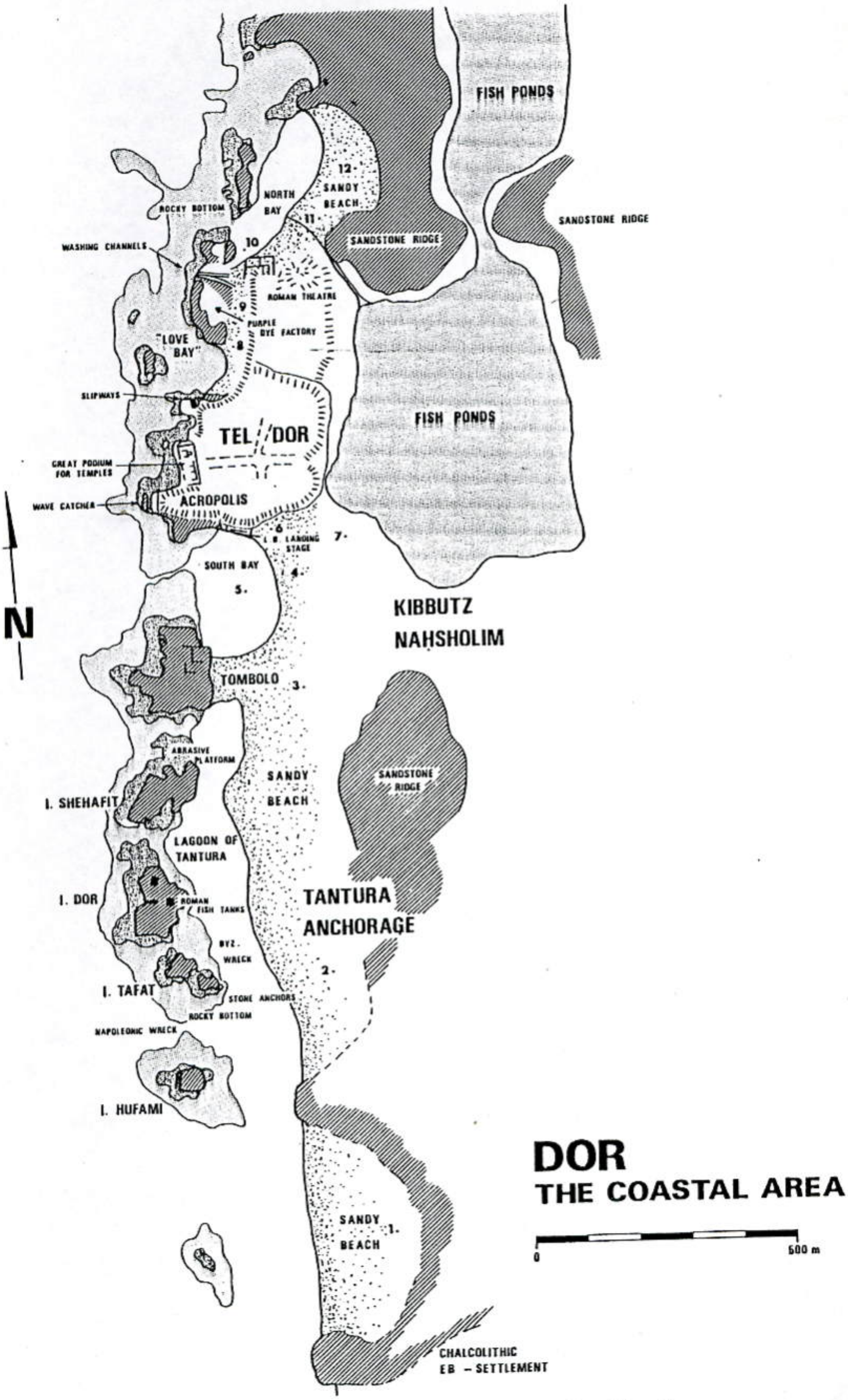


Figure 13. Plan of the Dor area and the principal working sites.

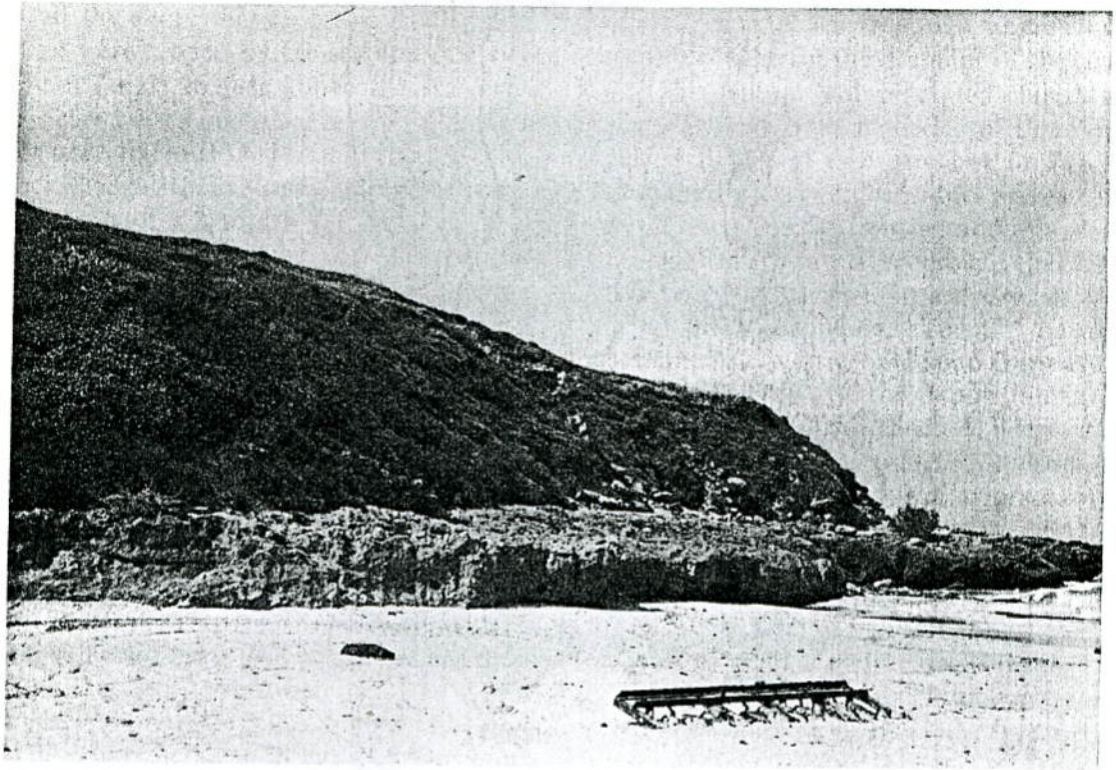


Figure 14. The uplifted erosion rock platform beneath Tel Dor.

might have been washed away during the transgression of the 3rd millenium BCE, see Raban (1984: 243)]; along the southern side of Tel Dor it is 1–1·4 m below MSL; yet at the north-western side of it the elevation of the top of the mud is only 0·1–0·3 m below MSL.

It is therefore tempting to assume that some local tectonic fracturing, tilting and displacement took place during the last rapid sea rise some time during 3000–2000 BCE. It is possible that that elusive event caused also tiltage of the part of the coastal sand-stone ridge on which Tel Dor is now. The bedrock exposures along the sea-side of the tel are characterized by a levelled topography that resembles an uplifted abrasive platform. This is now tilted, being about 5 m above MSL at the SW promontory and only 1·6 m at the northern part of the tel, east of 'Love Bay' (and see below), some 300 m N–NE. (Fig. 14).

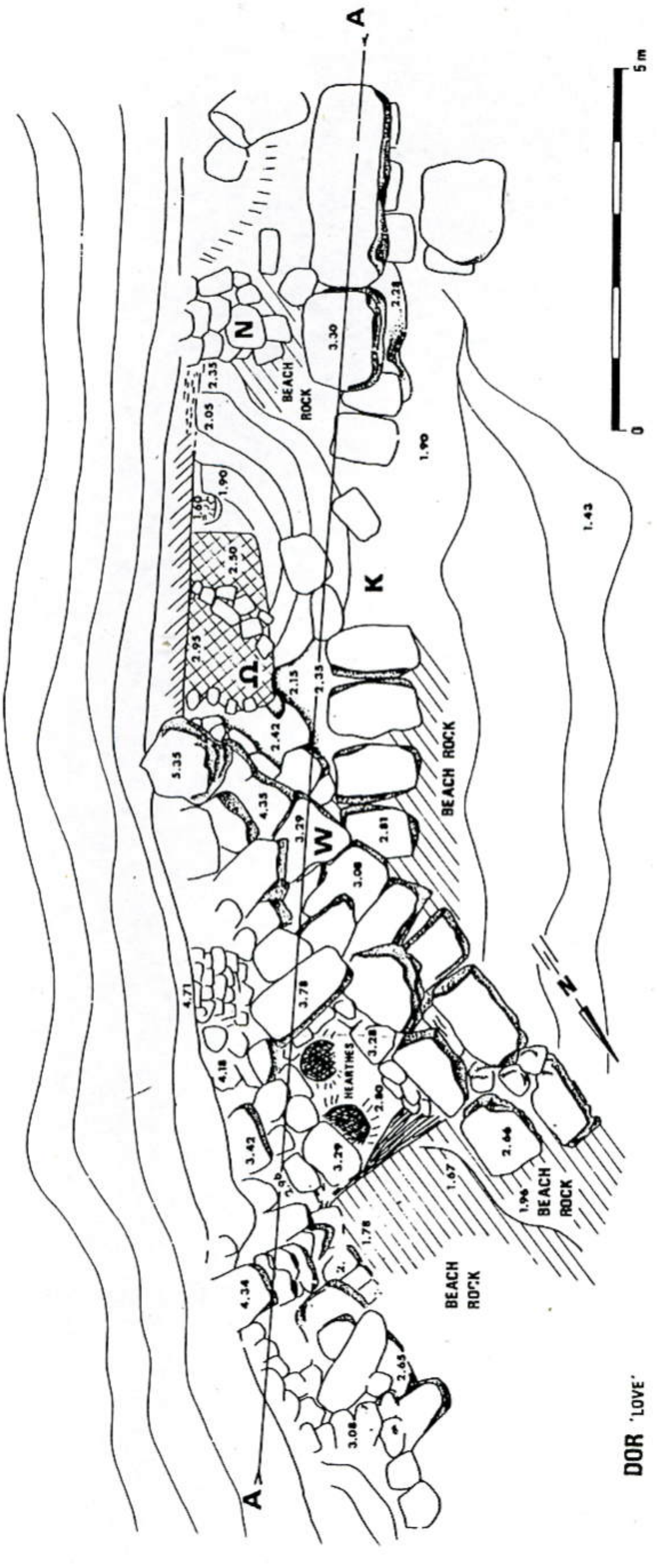
The first urban stage at Dor ('Love Bay')

During the initial survey that was carried out at the beginning of the Dor-Yam project it was apparent that the first occupational level directly on top of the up-raised abrasion platform has to be dated to phase A of the Middle Bronze Age II period (2000–1800 BCE). When the slipway was later cleared and the adjacent structures excavated—in order to determine the stratigraphic datable sequence and the age of this rock-cut installation—the occupational levels that were cleared off in antiquity when the slipway was quarried turned out to be MBII only. In 1983 we started cleaning, surveying and partially excavating along the foot of the tel in the lee of the bay northeast of the slipway which is locally called 'Love Bay'. The area chosen is now some 20–30 m inshore from the water line with a sandy beach in-between. The sand covers a series of rocky plates gently sloping seaward—typical beachrock plates which had been calcified long ago directly on top of the sandstone bedrock (Fig. 15). A course of cyclopian blocks was founded directly on the beachrock as a headers base for the retaining wall, or a quay, parallel to the water line. On the lee side of the wall several floors of crushed mudbricks and of crushed sandstones mixed with lime were exposed. The pottery sherds extracted from

Figure 15. View of the MB II sea wall at Love Bay, Dor, looking NE.

those floors represent the MBIIa period on the lower levels (1·60–2·40 m above MSL) with later phases of MBII on top (2·45–3·10 m above MSL). Among the pottery sherds there was a large number of decorated White Painted types of Cypriot provenance. Between the floors there were at least three different layers of sea shells indicating wave depositions. The top of the retaining wall is over 2·5 m above the present sea level, so MBII wave depositions behind it would suggest a reconstructed sea level somewhat higher than the present one for the first half of the second millenium BCE. A corner of a huge ashlar structure was laid down into these MBII floors with the bottom of the foundation trench at 1·96 m and the face of the adjacent stone slabs of floor at 3·28 m above MSL. This large building was in use for about 200 years, from the early 13th to the mid 11th century BCE and was very probably a part of a public structure within the city of the Sikuli—one of the Sea People groups (Raban, 1983*a*: 241). The location of this structure is over 300 m north of the ashlar wall and the quays of contemporary date at the southern side of the tel, so one can have now a rough idea of the magnitude of the city of Dor at the time of the Sea People (see Figs 16, 17).

Figure 16. The great ashlar structure at the NW side of Dor in Love Bay.



A
A
5 m
0
N
BEACH ROCK
Ω
K
W
HEARTHES
BEACH ROCK
BEACH ROCK
BEACH ROCK
N
DOR 'LOVE'

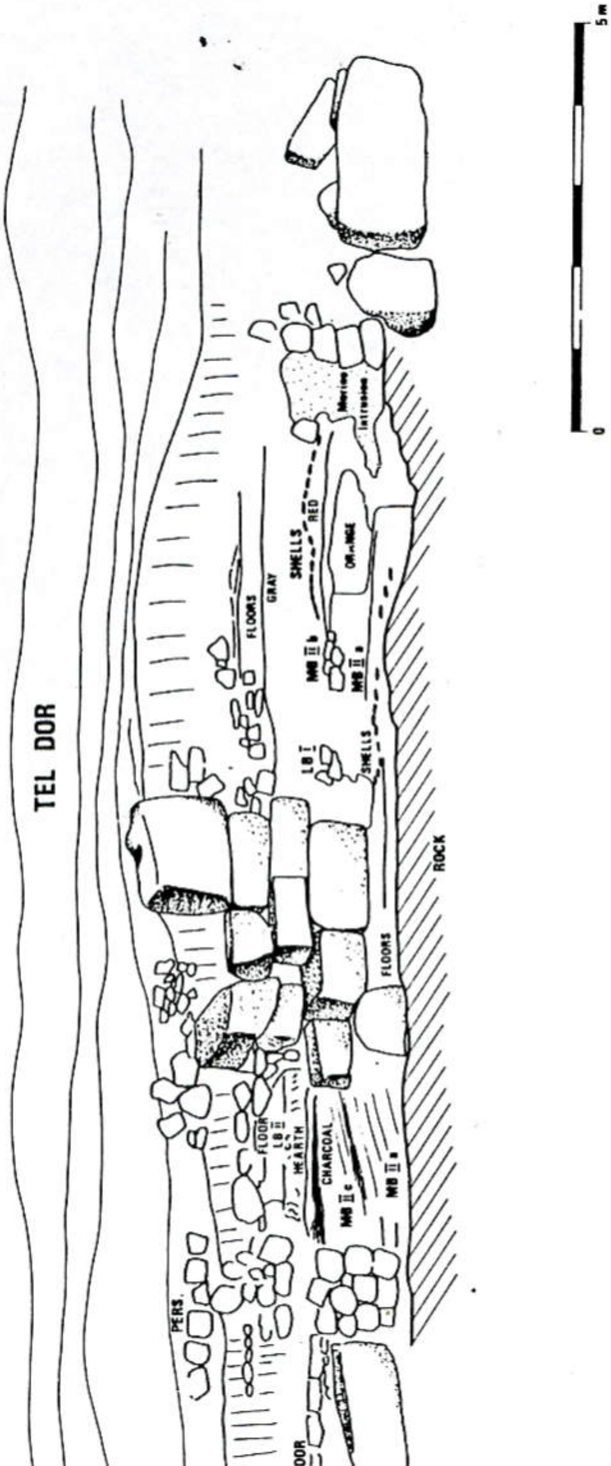


Figure 17. A—Plan of the excavated site at Love Bay; B—section of the excavated site at Love Bay.

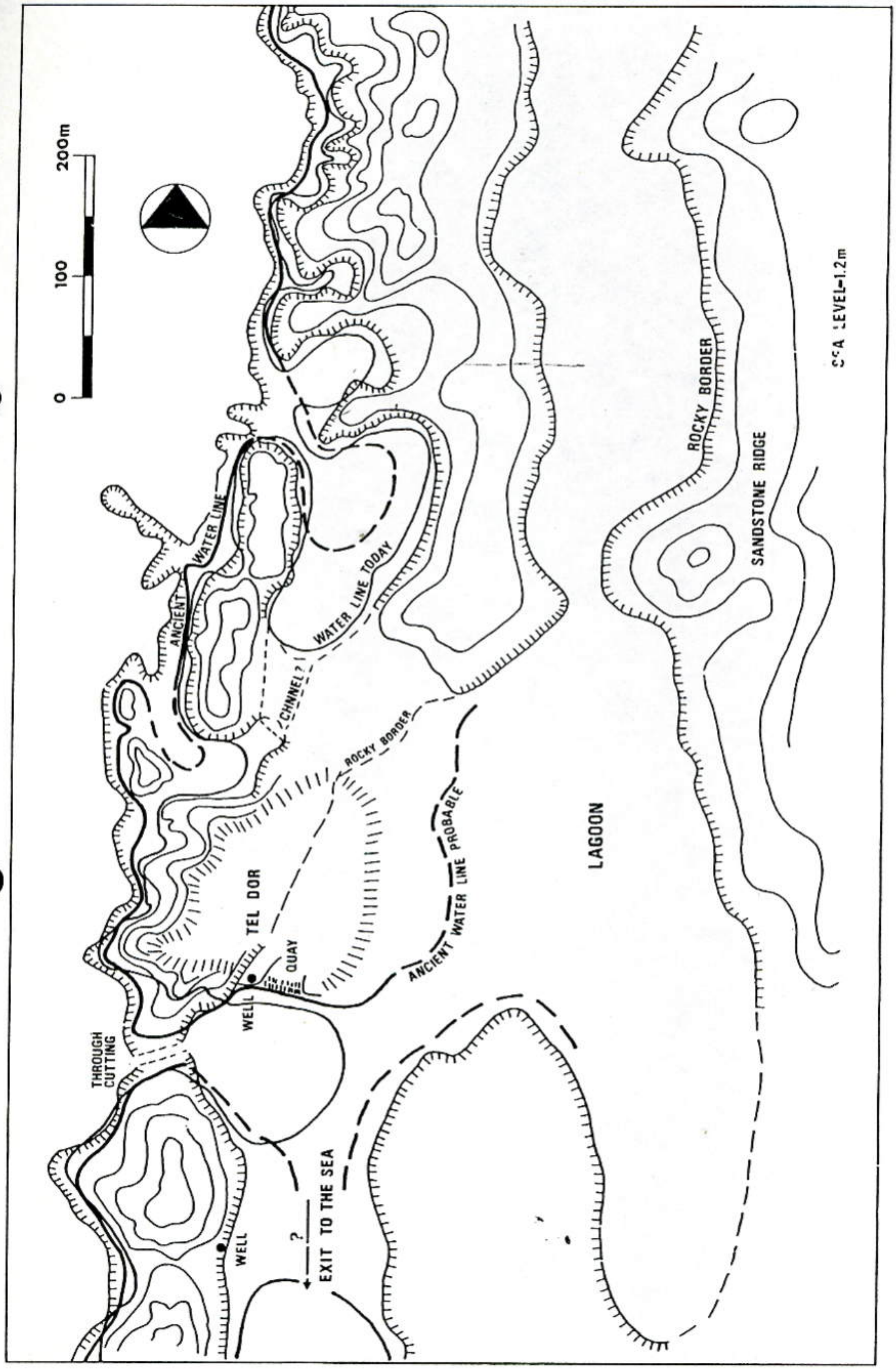


Figure 18. Reconstructured topography of Dor about 1200 BC.

Figure 19. The rectangular structure on the north shore of Dor looking east.

The upper levels, on top of this ashlar structure, are of the Persian period and later. Both at 'Love Bay' and near the slipway there are indications to suggest that the western side of the tel was not occupied during most of the Iron Age. Whether the reason was higher sea level, we do not have as yet enough data to tell.

The shore North-west of the tel

This area includes the well quarried sand stone ridge between Love Bay and the one to the north (Raban, 1981*a*: 297; 1981*b*: Figs 18–21) of the tombolo in its lee and the beach on its northern side. On the northeastern side of the tombolo there is a rectangular structure, which faces north towards the northern bay and has its northern wall based on a course of ashlar headers in typical maritime fashion. The eastern wall was also built of headers and delineates the lee side of the tombolo (Figs 19, 20). A deep trench was cut on both sides of that wall in order to determine its date, phases, relation to water front, and functions. The inner (eastern) side of that wall had at its last phase an additional course of ashlar stretchers just below the floor level. It seems that at that stage the entire structure was divided into a series of long and narrow rooms and was very probably a public storage place. The many broken amphoras and other storage vessels suggest it to be of the Roman period (2nd–3rd century AD). The trench along the western side of the wall revealed the fact that it was originally built down into the muddy layer below the sand and its foundation course is over a metre below MSL. There are at least two abrasion notches on the upper ashlar courses indicating a protected body of sea water at −0·5 m and +0·4 m in relation to the present MSL (Fig. 21). The lower notch is buried in the mud and there are no indications of its date. Yet the higher one is 0·7–0·8 m above the top of the clay and this was probably the depth of the water at that time. The large quantity of pottery sherds from the dump just on the clay's top are of the Roman period and might date the existence of this inner protected basin to the 2nd–4th centuries AD.

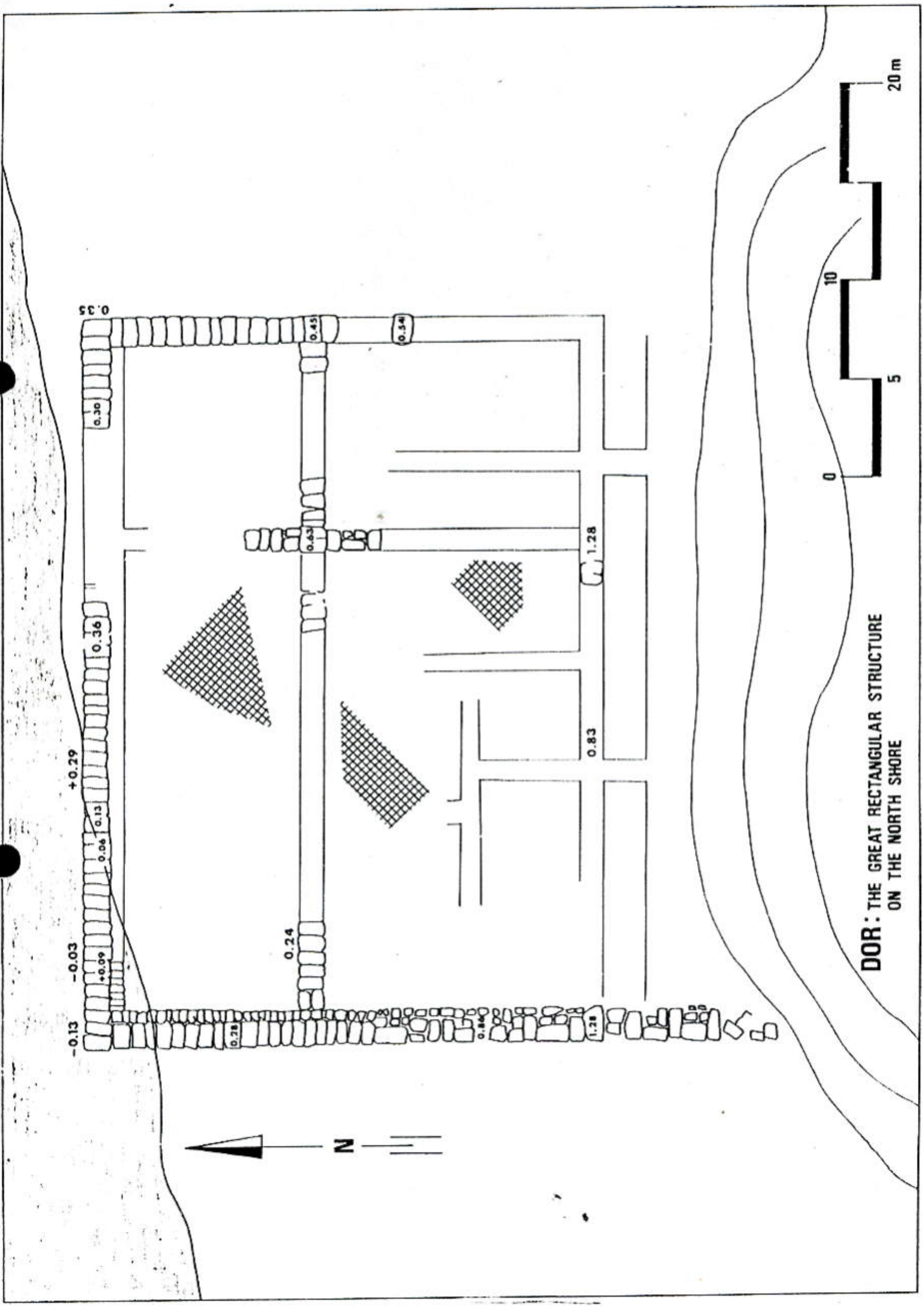


Figure 20. Plan of rectangular structure on the north shore of Dor.

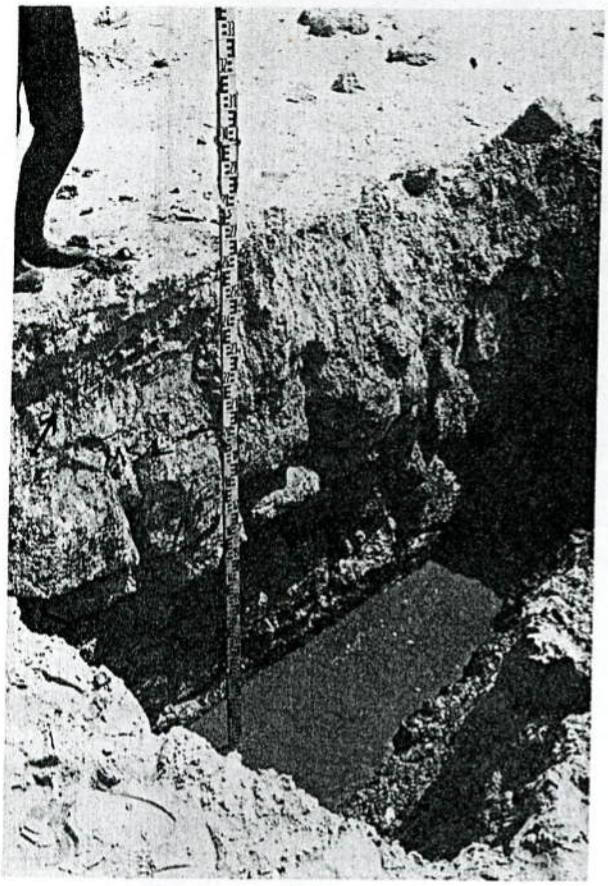


Figure 21. The western side of the rectangular structure, notice abrasion notches.

The tombolo between the ashlar wall and the quarried rock on the west covers muddy sediments with a top sloping westwards from 0·30 to 0·70 below MSL. The rocky substratum slopes eastwards and in most of the basins area is about 2·5 m below the present MSL. This basin has a rectangular area of about 30 × 40 m and most probably served as an inner harbour for small freighters and fishing boats, at least since the 5th century BC and until the Byzantine era. The inevitable creation of a sand tombolo and silting up processes were atificially avoided by cutting a washing channel across the quarried platform of the rocky ridge (Fig. 22a. b. c). Three such channels are there: The first was rock cut at a time the sea level was at least 0·35 m lower than the present one, judging from the height of the abrasion notch on its side walls. It was made before or during the Hellenistic period, for sherds of pottery vessels of that era were salvaged from under the sand in that channel. In a later phase the rise of the ocean level would inundate the quarried rocky platform to such a rate that no controlled one-way flow of washing current could be produced. So the channel was deliberately filled with rubble and an additional rampart of stones was laid across the platform in order to block off the sea waves. At that stage a new channel, on a much higher level was built south of the old one, with its threshold on the west at 0·9 m above the present MSL. The abrasion notch on the side wall of this later channel suggests water flowing into it at an elevation of almost 1 m above the present MSL, which means a sea level of +0·7–+0·8 m for what seems to be the 5–6th century AD (see Flemming *et al.*, 1978: 56–8; Raban, 1981*a*: 297, Figs 19–21; and also Figs 22, 23a,b).

South of the area where there was the inner harbour basin and its washing channels the tombolo and the eastern part of the rocky ridge were used in antiquity for industrial purposes (Fig. 24). An aqueduct brought freshwater to the area from the higher ground at the east. Some of the water fed a series of rock-cut shallow tanks that were arranged around a rectangular ashlar paved court. These tanks are 3 to the south of the court with their bottom 1·10 m above MSL (the court is +1·25 m). The other two are to the west with floors just above MSL and both surrounded by a rock-cut bench. They were fed with fresh water coming through a stone built and mortared narrow channel from the north, or by sea water through a channel that was cut in the rock at the west. The double tanks would be drained through another rock cut channel running south and furnished with double sets of grooves for wooden sluice gates. The maximum depth of water in those pools would be 0·45 m and they would be filled by sea water at sea level just higher than the present (maybe by 0·15–0·20 m only). In a later phase two other tanks were built of rubble and mortar to the east of the double tanks, between them and the central court floor. These tanks were carefully plastered with impermeable cement. A central structure stands at the NE side of the court. It is 9·5 × 10·4 m and not yet completely excavated. Yet it is clear that the main part of it consisted of large plastered basins for water or some liquid substance.

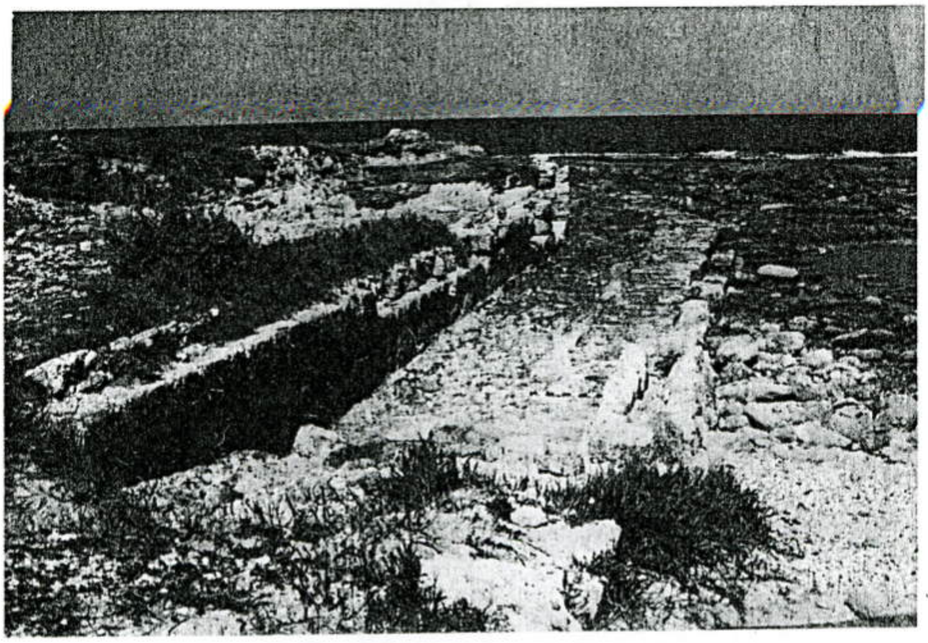


Figure 22A. The eastern end of the low-level channel looking north.

Figure 22B. Another of A.

These basins went through at least four successive stages of remodelling and replastering, each time at a higher level. In the northern part of the structure the plastered bottoms of those basins are at 0·50, 0·83, 1·22 and 1·73 m above MSL; while on the SE side the elevations of the bottoms of the various stages would be 0·72 (rock-cut and plastered), 1·10, 1·40 and 1·63 m above MSL. From these basins a channel led to other basins or tanks, some rock-cut and some stone-built and plastered, to the east, north and NW sides of the main structure (Fig. 25). The central and southern parts were roofed rooms with doors, thresholds, and stone-built storage

Figure 22C. Another of A.

places. In these rooms only the radically different stages could be architecturally and stratigraphically detected. The first is to be dated to the 2nd–3rd century AD and the second to the 6th century. The earliest datable finds are coins and pottery sherds of the Herodian period (late 1st century BCE–early 1st century AD) which were recovered in the fill of the lower, rock cut tank at the SE side of the main structure. On a flagstone paved floor of the first stage of the main room in the southern part of the main building (1·40 m above MSL), a large spot of a bright purple colour was exposed. Though the chemical components of this dye are still being checked in laboratories, the colour does add some strength to our initial assumption as to the original function of the entire complex as a purple dyeing factory. This function would explain basins with an alternating supply of freshwater and seawater, and with benches just covered with water. The salt water would be needed for better attachment of the pigment to the dyed cloth and for keeping it from fading, while rinsing the dyed cloth with freshwater would be necessary in the final stage of the dyeing process.

The purple dyeing factory at Dor is the first one found which can be safely defined as such, and with enough architectural and structural remains to enable a detailed reconstruction of the technical and industrial processes of producing the most famous ancient manufacture of the 'Royal Purple' (see Spanier, 1982). The archaeological excavations in this area are not yet finished, but the data relative to ancient sea levels are very useful, being in perfect accordance with what could be learned elsewhere at Dor and in other coastal sites.

Reconstructed Historical Sea Level Changes at Dor (Fig. 26)

The archaeological remains of marine and coastal man-made structures at the ancient site of Dor have so far yielded over one hundred data items of sea levels different from the present and—in most cases—properly dated. It is the richest corpus of such data for one site and though some of it would be claimed as being affected by tectonic slumping and other local displacements, we summarize some of them as a tentative base for reconstructing the eustatic curve of sea level change during the historical

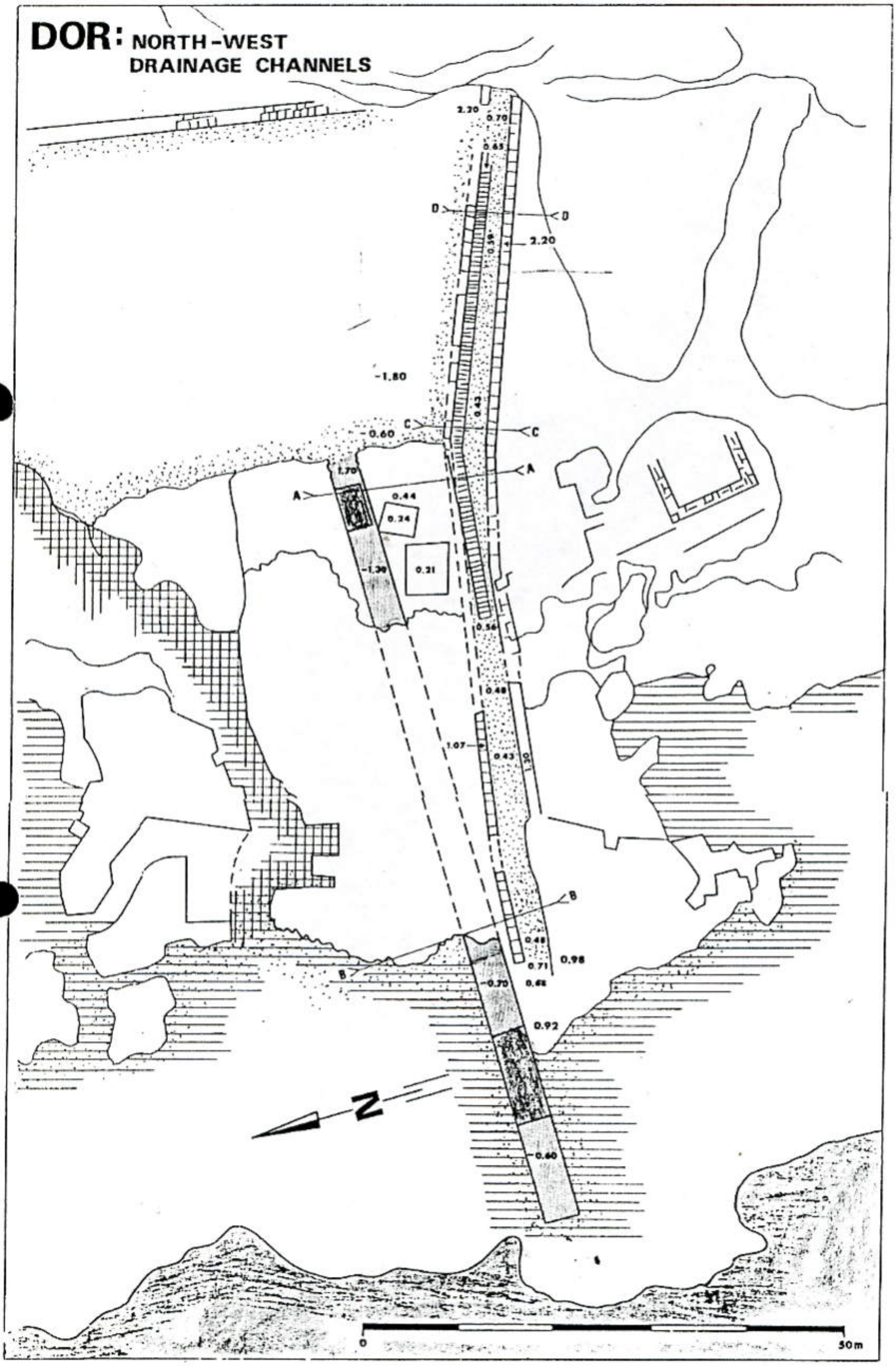


Figure 23A. Plan of the wash channels at north-west side of Tel Dor.

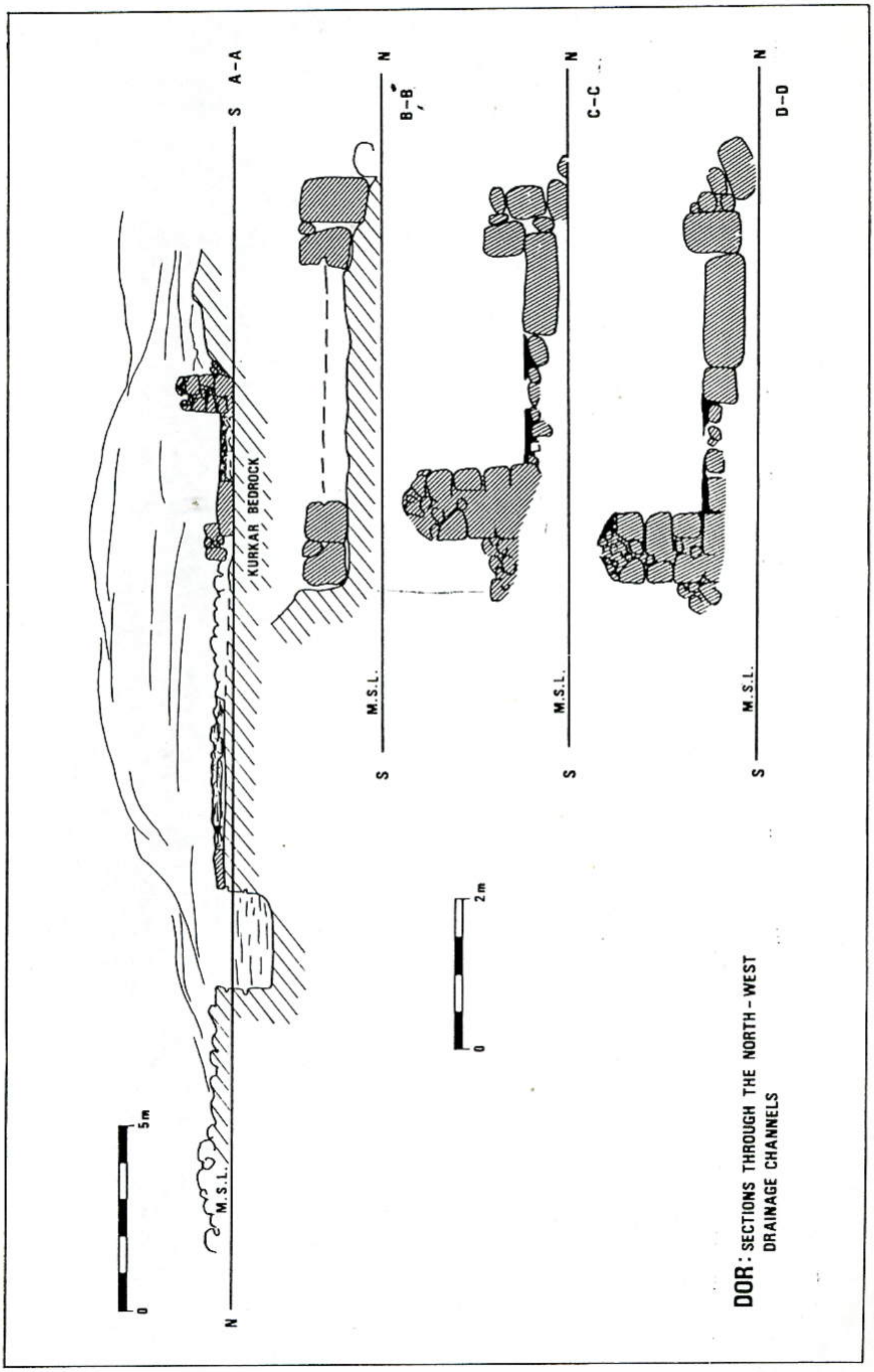


Figure 23. B—Section of the wash channels at the north-west side of Tel Dor.

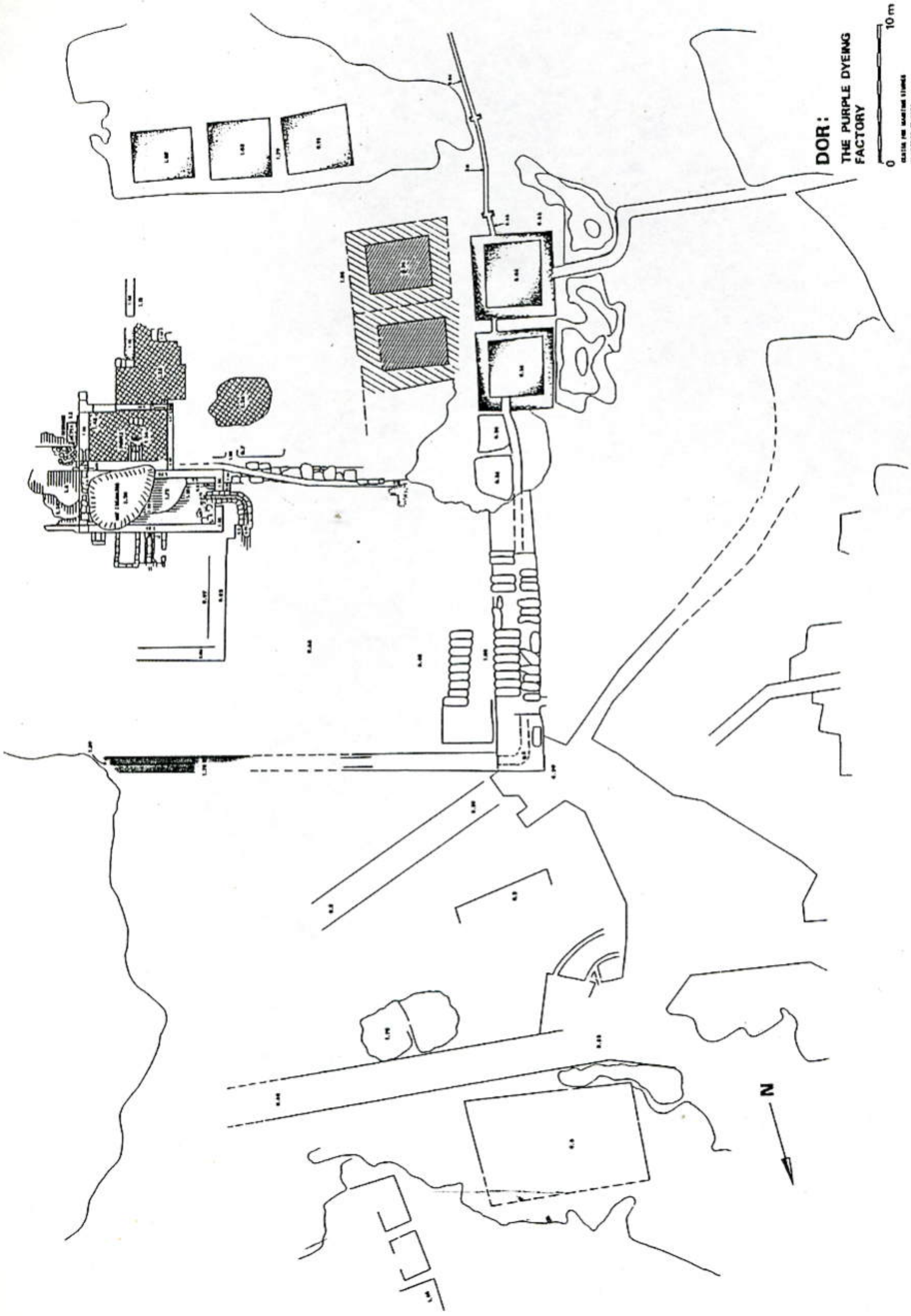


Figure 24. Plan of the 'industrial' area at Dor.

Figure 25. The main building of the purple dyeing factory, looking west.

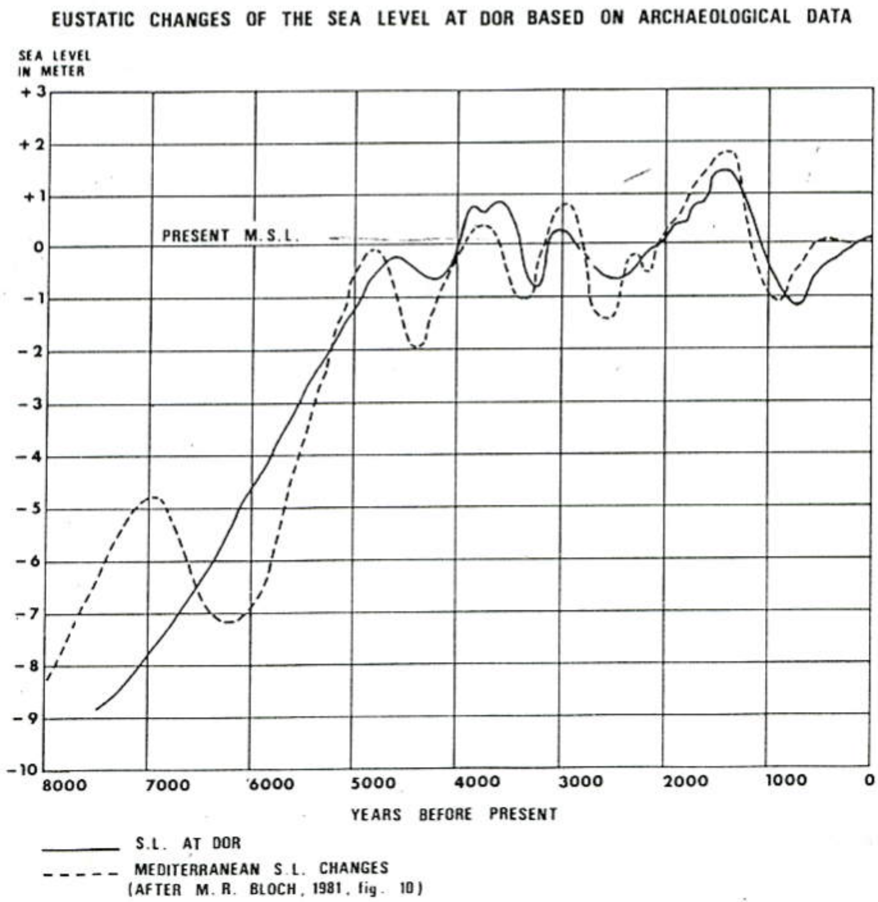


Figure 26. Reconstructed historical sea level changes at Dor.

Figure 27. An artificial through cut (wave catcher) at the tip of the SW promontory at Tel Dor, looking NW; note four erosion notches.

era (see also Flemming *et al.*, 1978: 75–9; Raban, 1981*a*; 295–308; 1983*a:* 236–8)

4000–3000 BCE—The sea was considerably lower and further west. The coastal ridge was not yet eroded and sand did not reach the present coast line. It might be deduced that during this period the sea was rising.

3000–2000 BCE—The transgression continued, with contemporaneous tectonic down-wrapping and tilted fracturing. The rural settlement at the coastal plain was abandoned early in this phase. No evidence for sand deposits in the lee of the coastal ridge may indicate sea level still lower than the present during this period.

2000–1000 BCE—Sea level exceeding its present elevation and the peak of the transgression was higher by 0·5–0·8 m. That peak was probably reached twice: around 1800 and again two centuries later.

1600–1300 BCE—The water subsided. At the end of this period the sea level was about – 1·0 m lower than the present. The southern bay was not open to the sea, but was connected through water channels to the lagoon of Tantura and to the brackish lagoon in the lee of the tel.

1300–1150 BCE—Gradual transgression that would necessitate repeated rebuilding of the quays and the wall at the southern side of the tel. Towards the end of this period and with the sea level just below the present one, there was a certain regression of a few inches.

1150–1000 BCE—At first a rising sea had reached an elevation a few inches higher than the present and probably that level remained through most of this period.

1000–400 BCE—We do not have good indicative data for this time span, yet there is strong circumstantial evidence for the overall reconstruction of a sea level constantly subsiding and reaching a low of 0·5–0·8 m below the present MSL in the 5th century BCE.

400 BCE–700 AD continuous, if not constant rise of the sea. It seems as if there were certain periods of stabilization which are indicated by well-defined abrasion notches:

2nd century BCE—at 0·3–0·4 m below MSL;

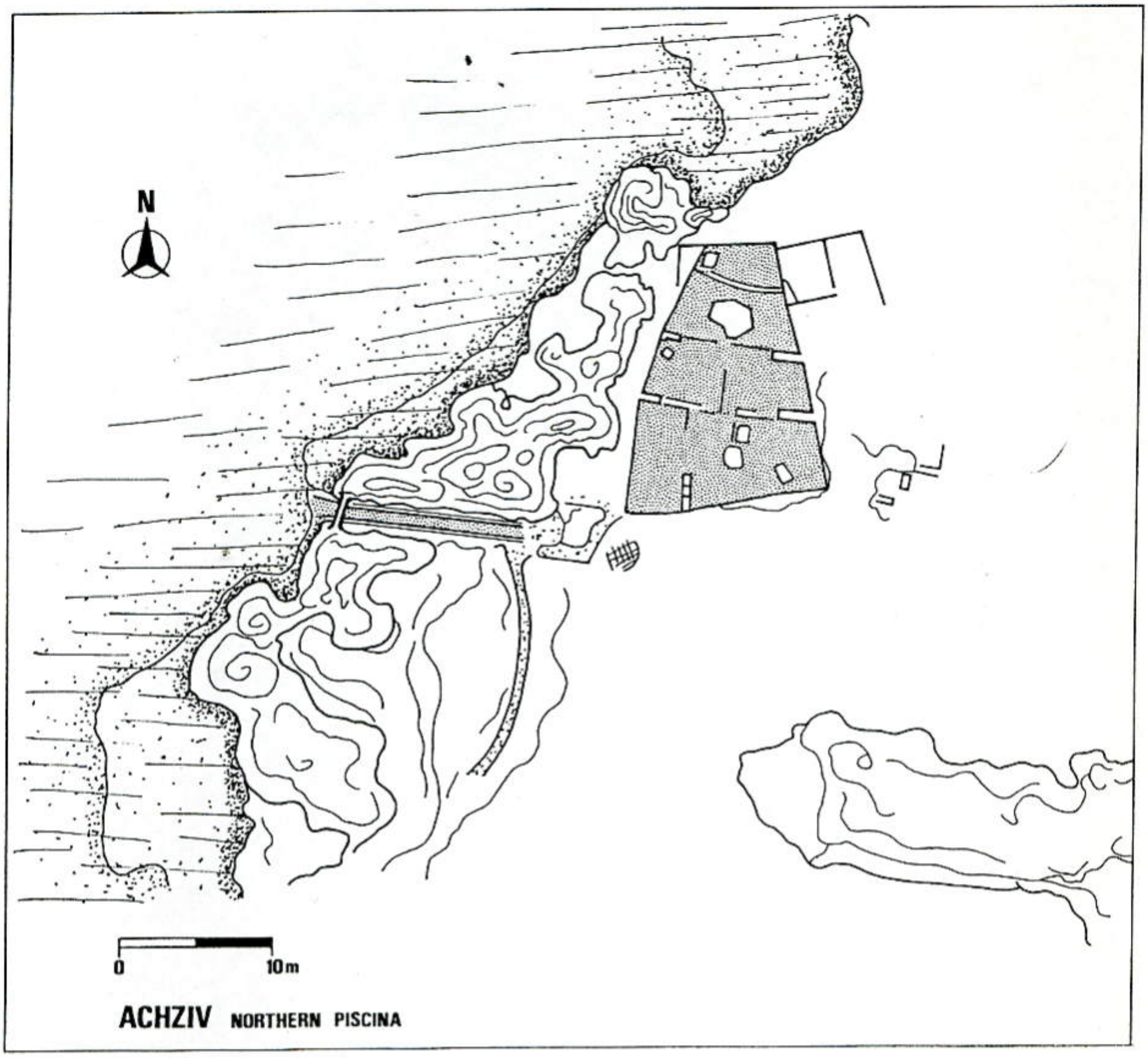


Figure 28. Plan of the site and piscina at Akhziv.

1st century AD—at 0·1–0·2 m. above MSL;
early 3rd century AD—at 0·7–0·8 above MSL;
around 600 AD—at about 1·2 m above MSL;
13th century AD—The Crusader period was an era of low sea. The regression probably started in the 8th century and reached a low of around 1 m below the present MSL in the 13th century. The rise initiated at that stage might be still the present trend.

The vertical cut through the tip of the south-west promontory at Tel Dor (Fig. 13) that was made to serve as a 'wave catcher' carries four horizontal abrasion notches indicating four different rather stable, sea levels (Fig. 27). Following the reconstruction of datable sea levels given above, it seems as if the highest was around 600 AD; the one below, of the 3rd century AD, and the submerged one (on the sides of the present submerged rectangular basin) of the crusader period.

The Piscina at Akhziv (Fig. 28)

The ancient site of Akhziv is located a few miles south of the Lebanese border on a low rocky coastal ridge. The port city was first settled during the first phase of MBII on what was then a headland on the northern side of the estuary (Prausniz, 1975: 203–7; Raban, 1980: 753; 1981*c*: 48–9). The place kept its maritime function all through ancient history, to the end of the Byzantine era. The sea front of the settlement comprises a series of partially eroded rocky