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CENTER FOR MARITIME STUDIES AT THE UNIVERSITY OF HAIFA

Recent maritime archaeological research in Israel—A preliminary report

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The project of continuous underwater survey

Since 1983 the CMS has been conducting survey of the near-shore sea bottom to detect random exposures of ancient relics such as sunken settlements, ship cargoes, ancient anchors and jettisoned material of ancient shipping. Such a day-to-day project has turned out to be an absolute necessity because of the growing activity of professional treasure hunters, diving fishermen and amateur divers who frequent the sea bottom in increasing numbers combing it for goodies. Recent coastal land reclamation and new off-shore structures such as breakwaters and groins have caused a reduction in seasonal shifting sand deposits on the sea bottom, and along the shore-line by trapping some of them permanently. This reduction affects the equilibrium of sand coverage on the sea-bed and creates exposures of more solidified sub-bottom. These exposures contain in many cases all kind of man-made remains in a very good state of preservation (see Raban, 1973). Treasure hunters are well aware of this phenomenon, and our surveying divers are on a daily campaign to locate such new exposures after each storm and before they would be 'cleaned off' by others.

The field director of the survey is Ehud Galili with the assistance of the divers of CMS and students of the Department of the History of Maritime Civilizations at the University of Haifa. Drs A. Raban and E. Linder serve as supervising scientists. The prehistoric sites are studied with Dr M. Evron for palynology and Professor A. Ronen helps as a scientific adviser. Some sites are studied in collaboration with Mr K. Raveh of the Archaeological Study Center at Kibbutz Nachsholim.

During the two years of operation almost one hundred new sites were traced. The following is the preliminary report on some of them.

Submerged prehistoric sites (see Fig. 1)

The Israeli coastline south of Haifa is delineated by a series of parallels, long-shore Eolianite ridges, probably calcified pleistocene coastal sand dunes. The consequent basins between those ridges are now embedded with clay and muddy deposits of ill drained marshes. The same geomorphological features are characteristic of the shallower part of the continental shelf—to a distance of over a mile off-shore. The coastal segment between Haifa and Atlit is of additional importance. There the coast is almost 1 km east and from Atlit's headland to the north two of the inshore ridges are well below the waves.

The sunken ridges are partially covered by shifting sand that is superimposed on the muddy fill of the basin between them. Yet, unlike the inshore basin the submerged one is tilted westward and has a gradient of 2–3%. Whenever the lack of sand causes an exposure of this substratum of compact mud and loam we can trace remains of oak roots and trunks—an indication that this basin was already tilted and reasonably well drained before its submergence. Among these remnants of prehistoric park forest there are many relics of man-made structures and habitations spread in a characteristic layout of farms or villages. Initial C^{14} datings for both the oak trees and some of the habitations have the time range of 6800–5600 years BP (see Raban, 1981*a*: 288–92; 1983*b*). During the last two years more sites of this type were explored and partially excavated.

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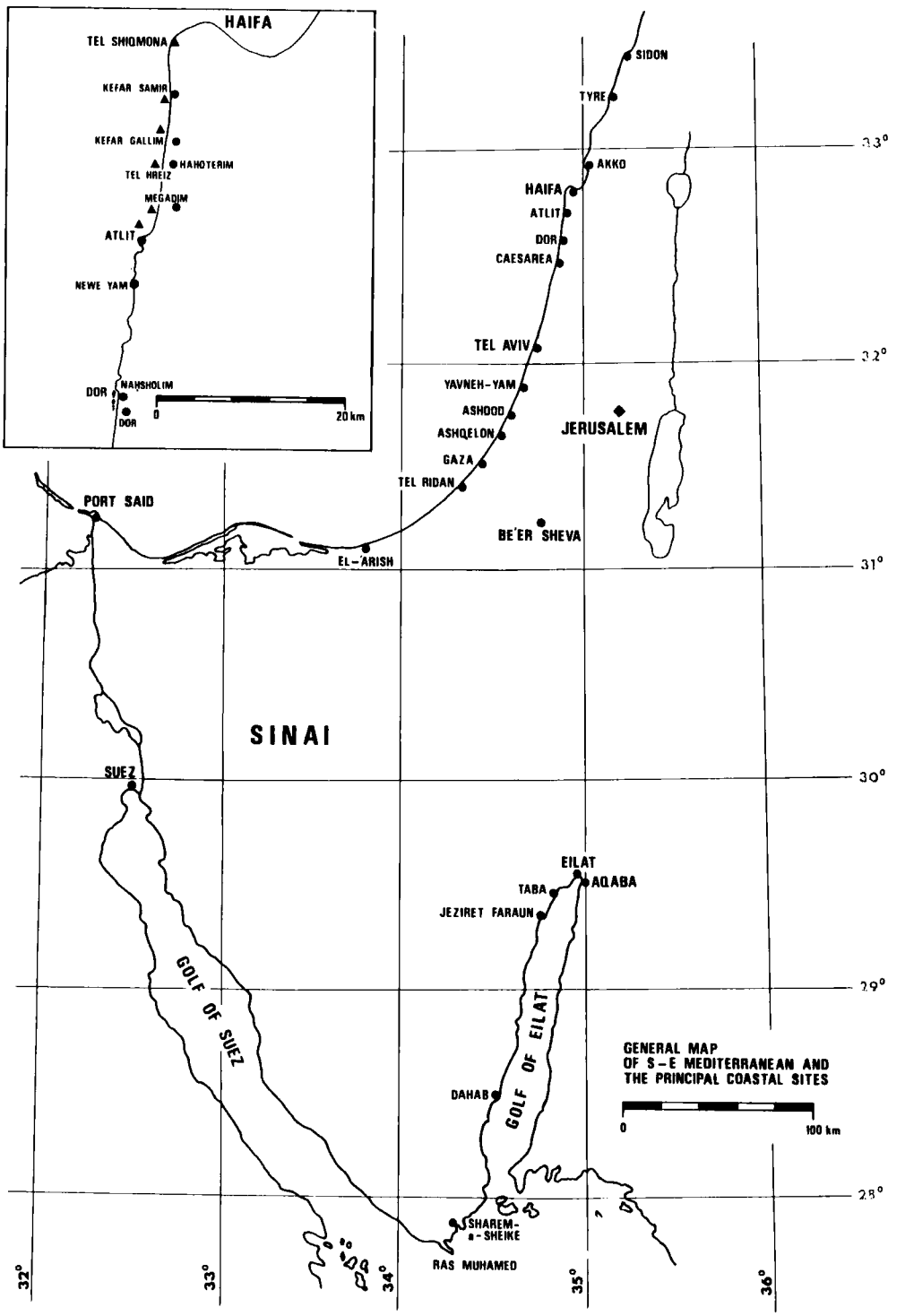


Figure 1. Map of the South Eastern Mediterranean and the sites mentioned below.

Figure 2. A submerged Neolithic structure (storage bin or well) off Kefar Samir.

Kefar Samir

The site—at 34°56½′E, 32°47½′N—is just off-shore, some 3 km south of Haifa and it stretches from a depth of 1 m of water to a distance of 200 m off-shore, at a depth of 5 m. So far over a dozen different structures have been traced in an area of about 400 × 200 m along the coast. Some of the structures are comprised of straight walls of rubble laid in two lines, with a total width of 0·40 m, and adjacent floors of flat flagstones. Seven structures are round circles of rubble with well defined inner face and a diameter of 1·0–1·6 m. One structure has a rather rectangular upper part and was excavated to a depth of almost 2 m. It appears that the structure was built of alternating courses of rubble and wooden beams of the then local oak branches (see Fig. 2). The structure seems to widen toward its lower part but the original bottom was not reached. In the fill there were bones of animals, olive pips, some pottery sherds of Neolithic type, and flint utensils. A C^{14} sample was checked in the laboratory for isotopes at the Weizman Institute (nos 682 a, b) and the corrected dates are 5540 ± 370 and 5380 ± 310 BCE. The original function of the round structure is not clear but we assume it was either a storage bin or a freshwater well dug down to the ancient water table on top of the coastal interfaced aquifer.

This site is being studied by E. Galili and M. Evron.

Kefar Galim's quarry

This site—34°57′E, 32°46′N—is similar to the previous one and located also from just off the present shoreline to about 150 m in the sea. So far 7 circular stone-made structures have been traced at that site and two partially cleared. Among the finds in the structures there were animal bones and a horn of a wild goat or gazelle, many sherds of typical Neolithic clay vessels and many stone mortars. Two mortars of basalt and some hearths were also found at this site. Close to the centre of the site there are several freshwater springs on the sea bottom—a possible reason for the ancient people to settle there.

This site is also being studied by E. Galili and M. Evron.

N. Oren's outlet

The site—at 34°56′E, 32°42½′N—is some 300–400 m offshore, at a depth of 8–10 m and some 600 m north of the Crusader castle at Atlit. It is the deepest submerged settlement to be found so far along the Israeli coastline and it seems as if it was originally located on the southern bank of a river (Nahal Oren), the sunken course of which can be traced by layers of rounded

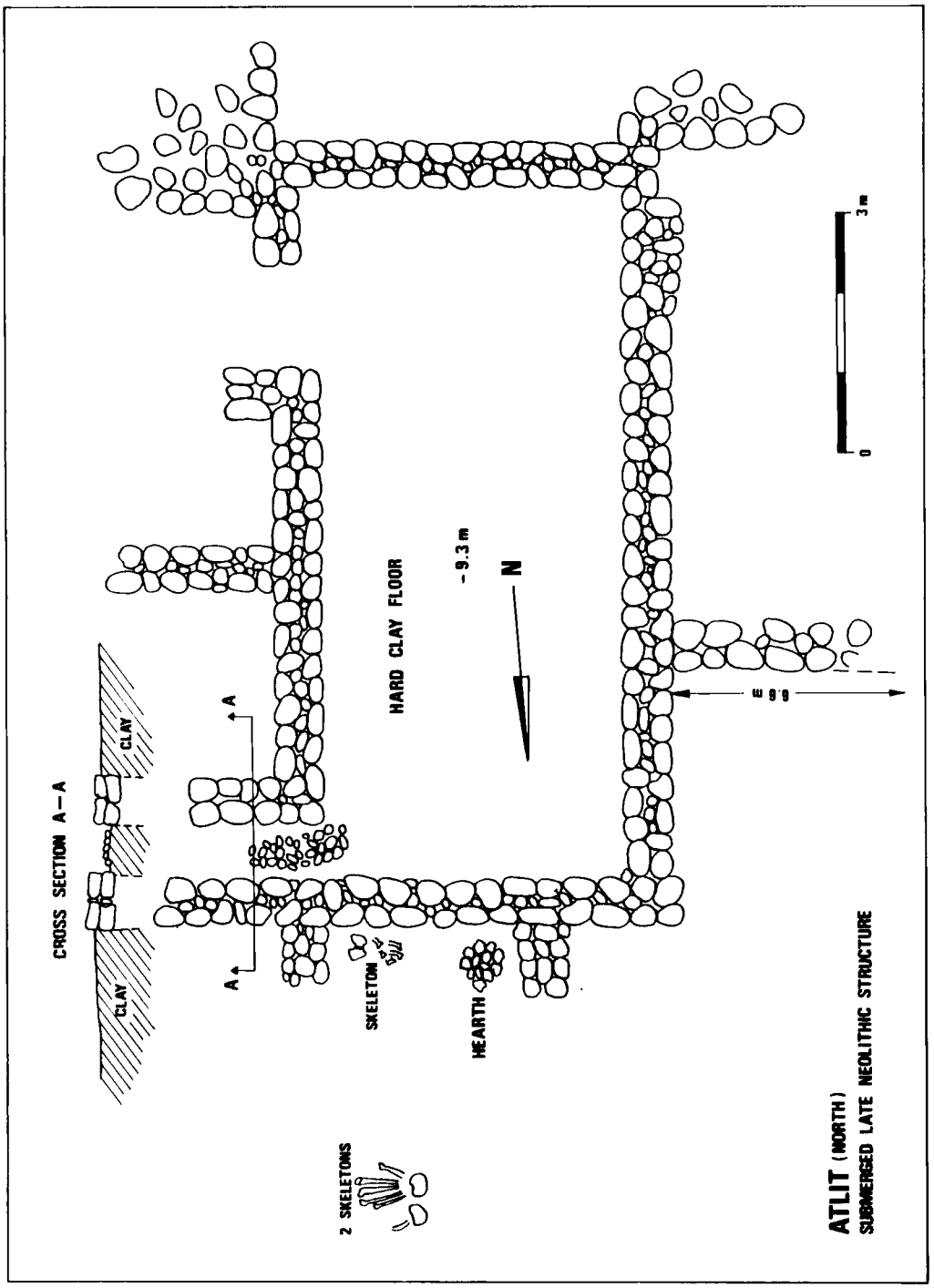


Figure 3. Plan of the main structure at the submerged Neolithic site off N. Oren's outlet.

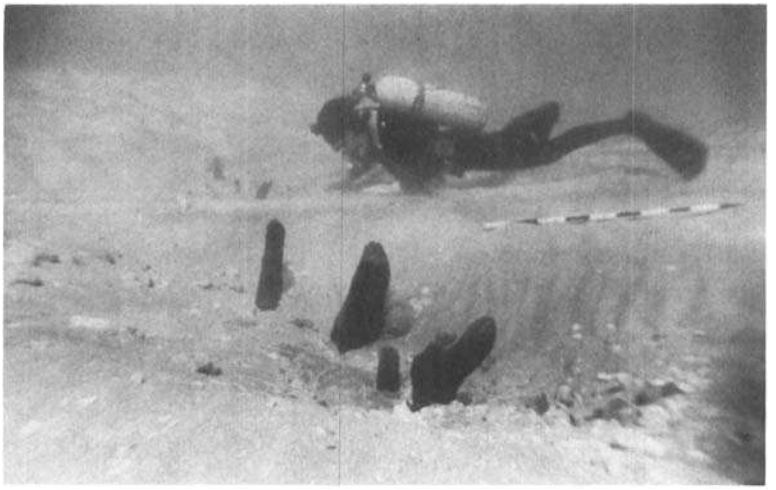


Figure 4. The wooden poles off Tel Hreis.

pebbles and gravel below the sand. There are several rectangular and round stone structures on the site and some human burials. The largest structure is the one furthest and deepest in the sea and it is the only one to be completely surveyed and partially excavated. It consists of a main rectangular area of about 9 × 5 m with two openings to the east. There are some additional walls indicating adjacent rooms to the east and to the west and a massive rubble paving to the south (see Fig. 3). The walls have been preserved to at least two courses high and were built of two lines of rubble stones with a total width of 0·40–0·60 m. There are at least two floors in the main building, made of a compact mud and some gravel. On top of the later floor there were remnants of one or two stone built hearths. The excavations that were carried out during the fall of 1984 have cleared the area inside the northern part of the structure. Many flint utensils, bones and other organic items were collected during the dig. Among the finds there were also fish bones, two polished stone axes, sickle blades with the typical lustre from being used, and some chopped and incised bovine bones. The human burials were recently exposed by the sea currents. One is some 50 m east of the main structure and contained a single skeleton of a young individual that was laid on its right side in crouched position, the head to the west and the face looking south. Another burial, a double one was found some 5 m north of the main structure and with the same disposition of the skeletons. During the excavation another human skeleton was found next to the northern wall of the main structure. Professor B. Aresburg of the University of Tel Aviv has studied it and found that the skeleton is of a 17-year old female. The site was first discovered in the spring of 1984 and is to be a multi-seasonal project for thorough survey of the settlements area and systematic excavation of selected structures. This project will be headed by E. Galili, A. Ronen, and M. Evron.

Tel Hreis (Chreiz)

This site—at 34°57′E, 32°44½′N—was first discovered by divers of the Undersea Exploration Society of Israel some 20 years ago (Raban, 1965; Ronen & Olami, 1978, site no. 4:3–4; Raban, 1983*b*:224). In December 1984 a different part of the same site was partly revealed due to reduced sandy coverage, created by a local rip current. The exposed sea bottom below the sand is of a rather compact dark and fine clay rich in various residues of organic materials such as bones, teeth, branches, twigs, flint flakes and utensils, and broken pottery sherds. The main man-made feature in that area is a line of vertical wooden poles, some of which have been preserved as high as 0·6–0·7 m. above the ground. The poles were fixed some 0·5–0·9 m apart, creating a line of several metres toward N–NE and there—on a right angle—westward for about three metres (Fig. 4). It seems as if there were more poles—some still covered

below the sand and some that were totally eroded during an earlier occurrence of temporary exposures. The initial checking suggests the poles to be of oak and the structure might be used as some kind of storage enclosure. Inside the NE corner of it there are remains of what seems to be an olive store, with thousands of olive pips still in place. Among other finds there are bones and parts of a carnivore skull and bovine bones, two hearths and a horn of a goat or a gazelle. The types of the pottery sherds indicate the Early or Mid Chalcolithic era.

A cargo of tin and lead ingots

This site—at 34°57′E, 32°47′N—is very probably where a merchantman was wrecked ashore and though her hull was soon completely destroyed by the surge, heavier items of the cargo were swept below the sand and safely deposited on the compact clayish substratum. Some 100 m off-shore, in 3 m of water, a group of 5 stone anchors, all of more or less the same size and shape have been found. They are of a semi-circular upper part with a single hole pierced from both sides. On one of the anchors

Figure 5. An Egyptian stone anchor from the tin and lead ingots site.

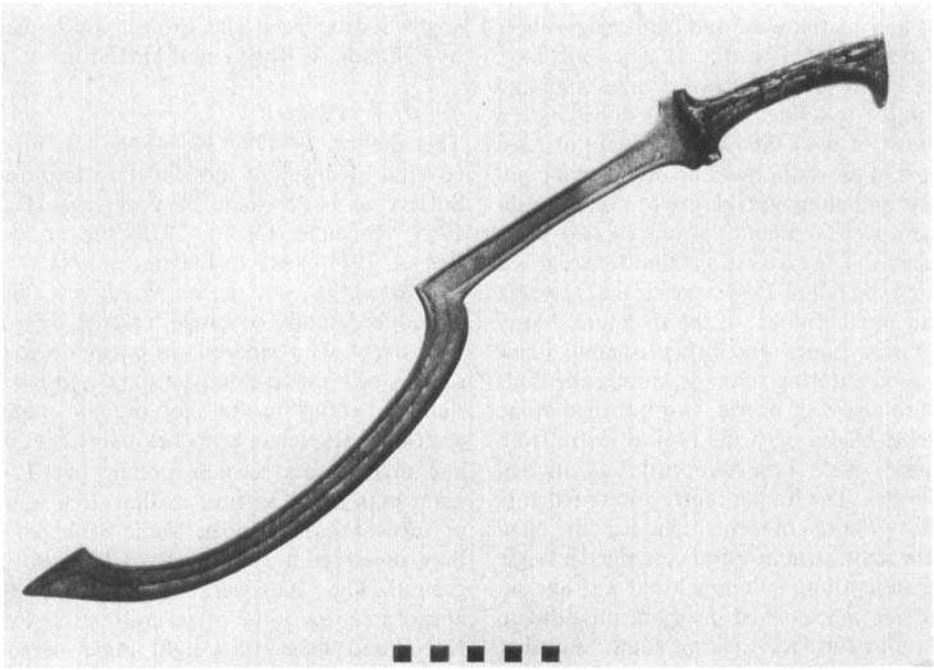


Figure 6. The Egyptian sickle sword of the Late Bronze Age.

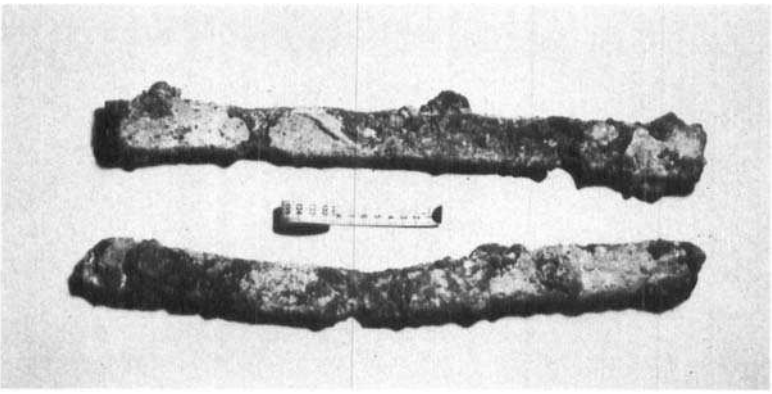


Figure 7. Bar-like tin ingots from the Late Bronze Age site.

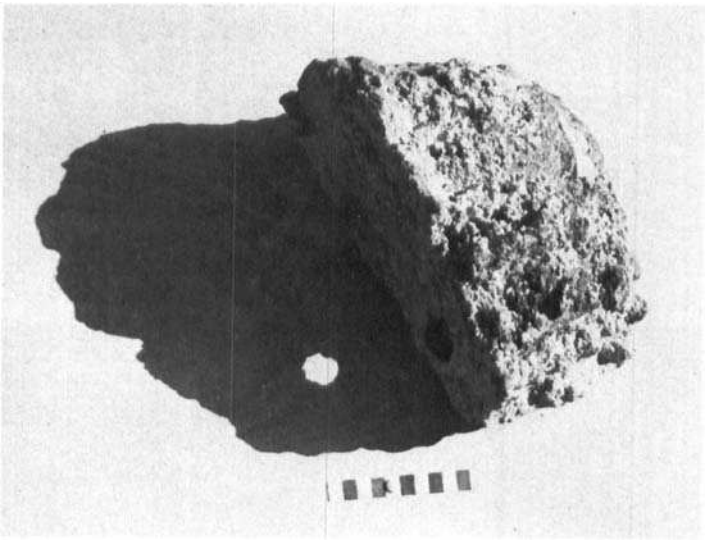


Figure 8. A 'Primary' loaf-like tin ingot of the Late Bronze Age site, cut in half.

there is a carving depicting a turtle or a beetle. [Egyptian scarab with the hieroglyphic value of Hafr (= life).] Both the shape and the bi-conical hole (Fig. 5) are characteristic of Syrian or Cypriot stone anchors of the Late Bronze Age (Frost, 1979; and a personal communication in her letter to E. Galili, 1981). Some 5 m off this anchor a typical Egyptian sickle sword was found with the wooden cheeks of the handle still preserved (Fig. 6). Other Egyptian bronze objects were salvaged there in the 1960s. A bronze plaque with a rather long Egyptian inscription on it was sold off by treasure hunters before being documented. Recently a group of 8 tin ingots was salvaged by our divers at the site. They are of bar shape and one of them bears badly eroded script signs of undefined character. While these ingots were shaped in a secondary refining, two other hemispheric ingots may very well represent the original smelting form. One of them was sawed and cut in half in antiquity. It is 36 kg in weight (see Figs 7, 8).

Five smaller ingots are of lead and each bears an incised sign on its convex side (Fig. 9). The best estimated date for these metal items and the stone anchors is 14–13th century BCE and their provenence is most likely to be in the Nile

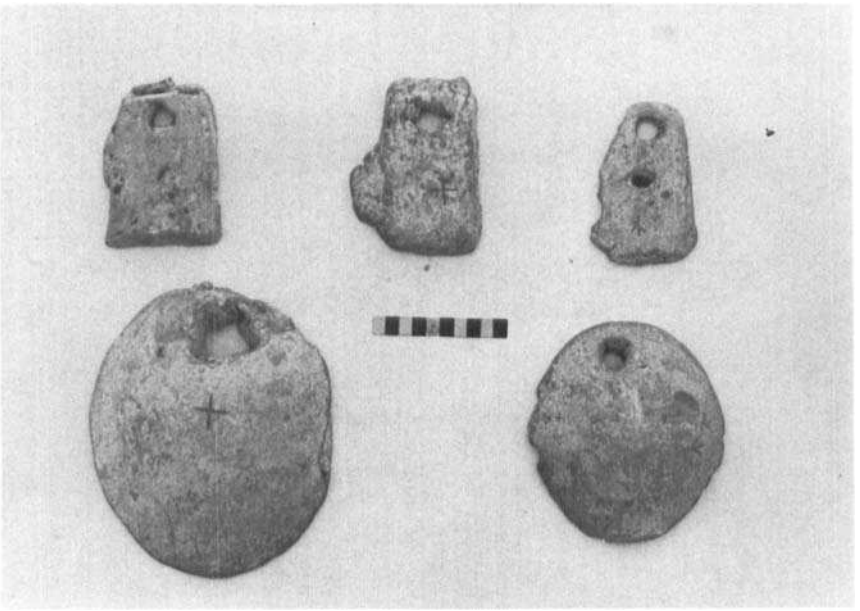


Figure 9. Group of lead ingots with incised syllabic signs.

Figure 10. Aerial photograph of Yavneh-Yam.

Figure 11. The impression of the cylinder seal from Yavneh-Yam.

valley. This is the third and the largest group of Late Bronze Age metal ingots to include tin. Of the other two one included an ox-hide copper ingot and was found less than 1 km south (Galili & Shmueli, 1983) and the third probably comprised broken pieces of copper and lead ingots. It was found a few miles down the coast (Wachsmann & Raveh, 1980:257; 1984*a*). This site is being studied by E. Galili, with the scientific assistance of Professor B. Rothenberg.

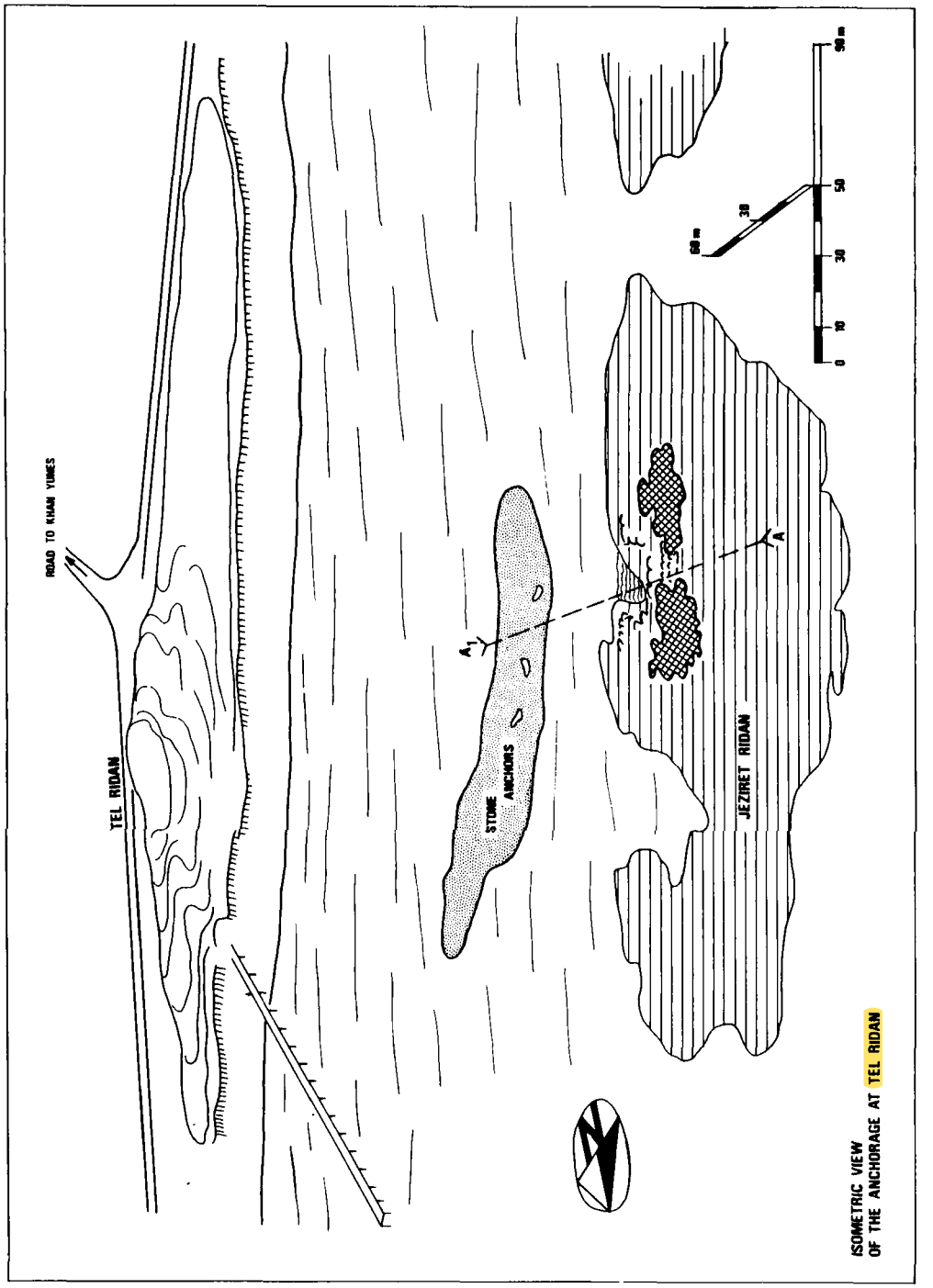
Yavneh-Yam—a Bronze Age anchorage

The ancient tel of Yavneh-Yam is about 20 km south of Tel Aviv on a headland next to the mouth of the river Shoreq—a natural age-old route from the shore to Jerusalem. This site—at 34°41½′E, 31°55½′N—was first settled as a port city fortified with large ramparts around 2000 BCE (see Kaplan, 1978). Since then the sea has eroded as much as one third of the fortified area and its NW and SW rocky base is now as far as 200–300 m off-shore—a series of small islets and reefs (Fig. 10). Recently we have started a research project studying the archaeological and geomorphological evidence for the causes and the stages of the partial submergence.

The archaeological finds collected during the survey include various artifacts and relics of maritime activities through the ages, down to the time of the Crusaders. Though it is obvious that a large part of the material now under the sea had been dragged there by the stormy waves from the land site, some items indicate that as early as the Late Bronze Age (1500–1200 BCE) there was an anchorage at the lee of the rocky islets at the south west. A large number of stone anchors with a sphere-like upper part and a single biconic pierced hole was found. Near the anchors there were some gold ornamental pieces, a cylinder seal of Syrian type, probably of the 13th century BC (Fig. 11), two metal figurines of Canaanite deities—one of bronze and one of lead and a group of biconic balance weights, made of hematite and typical also of Late Bronze Age Canaanite metrology (e.g., see Bass, 1967: 135–42).

The Bronze Age off-shore anchorage at Tel Ridan

Tel Ridan, 31°15½′E, 31°22′N, is a small tel on the shore at the southern part of the Gaza strip. About half a mile from the site, to the SW and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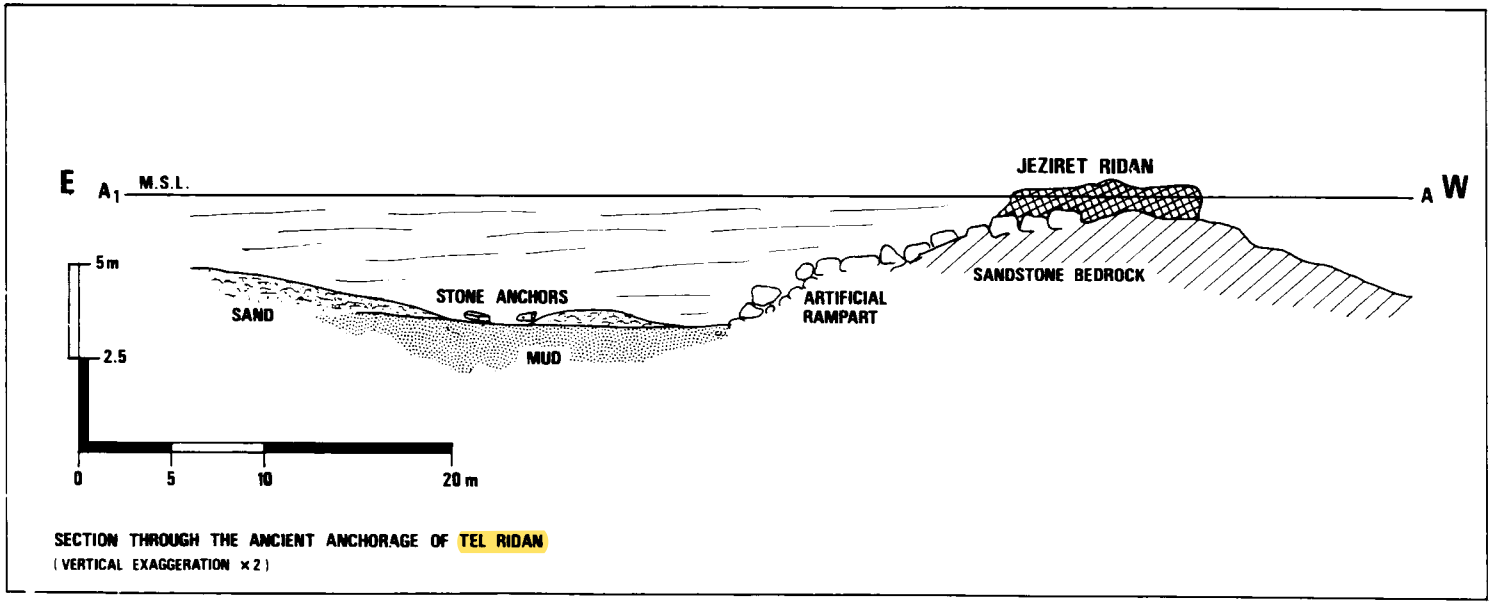


Figure 12 A—Plan of the off-shore anchorage at Tel Ridan; B—section of the off-shore anchorage at Tel Ridan.

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 freshwater 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

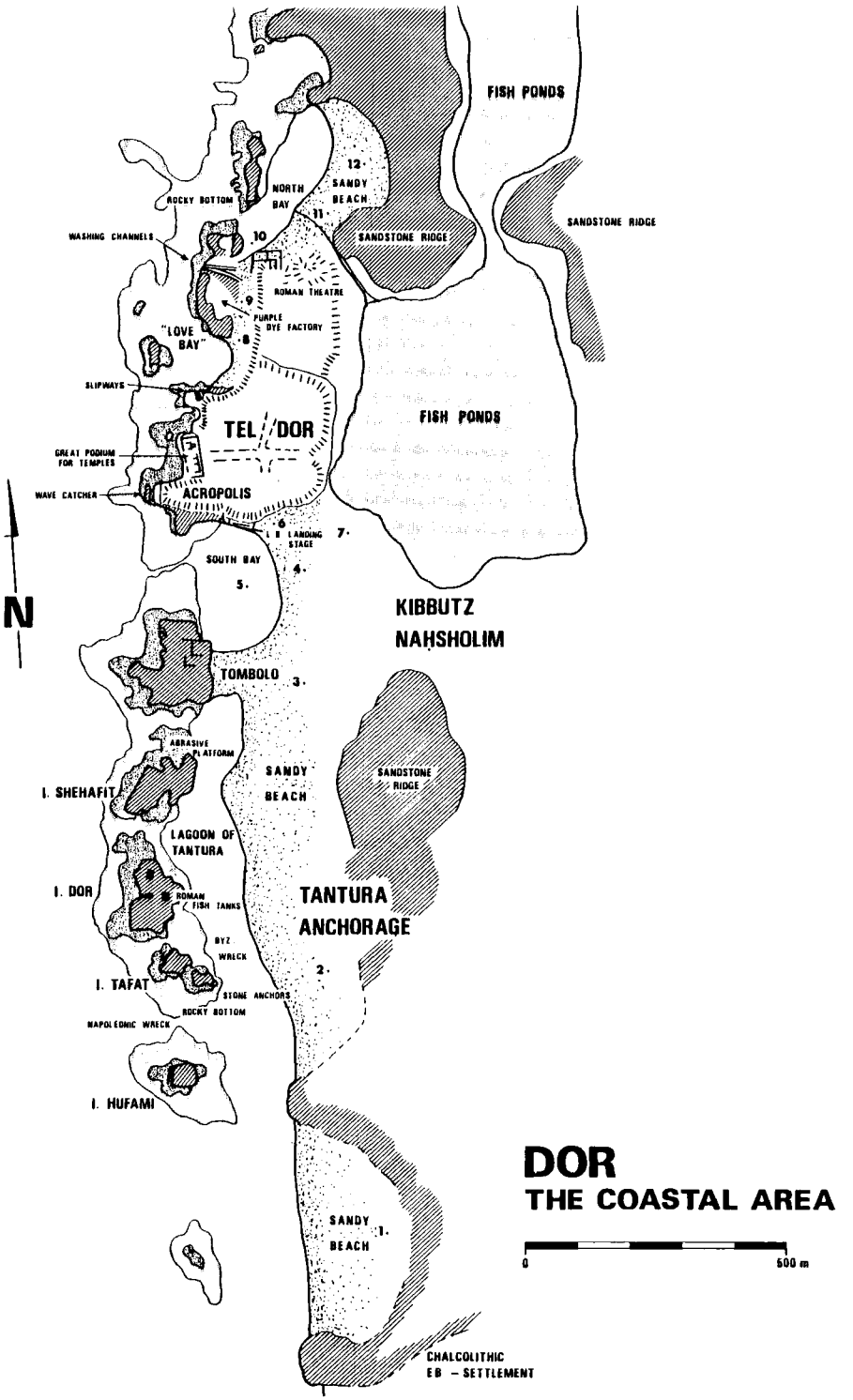


Figure 13. Plan of the Dor area and the principal working sites.

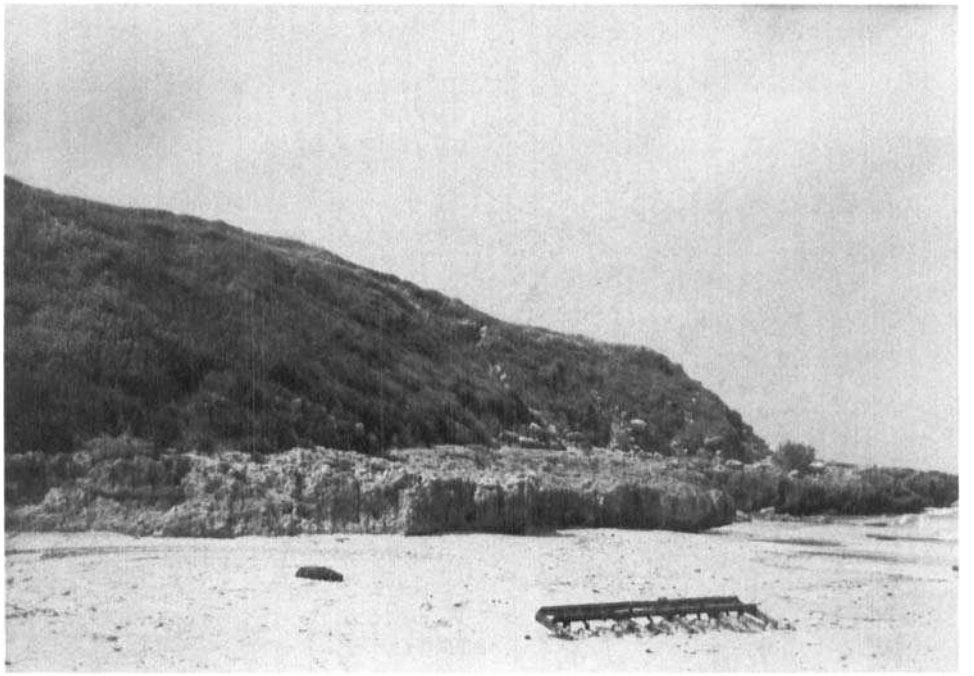


Figure 14. The uplifted erosion rock platform beneath Tel Dor.

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 northwestern 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

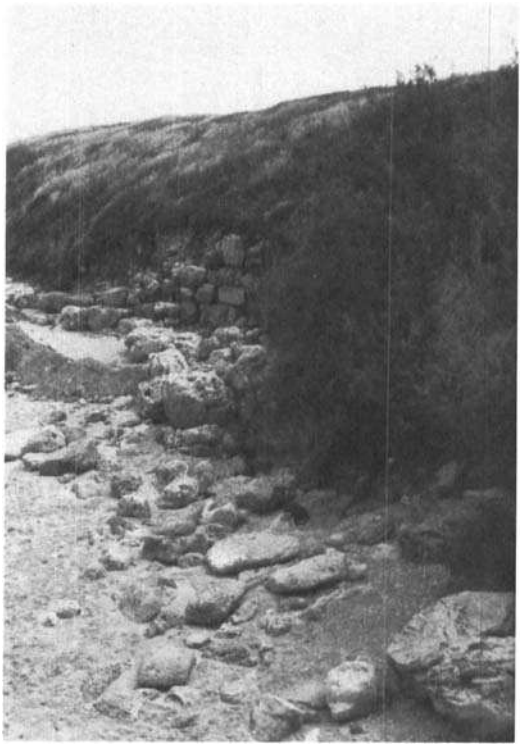
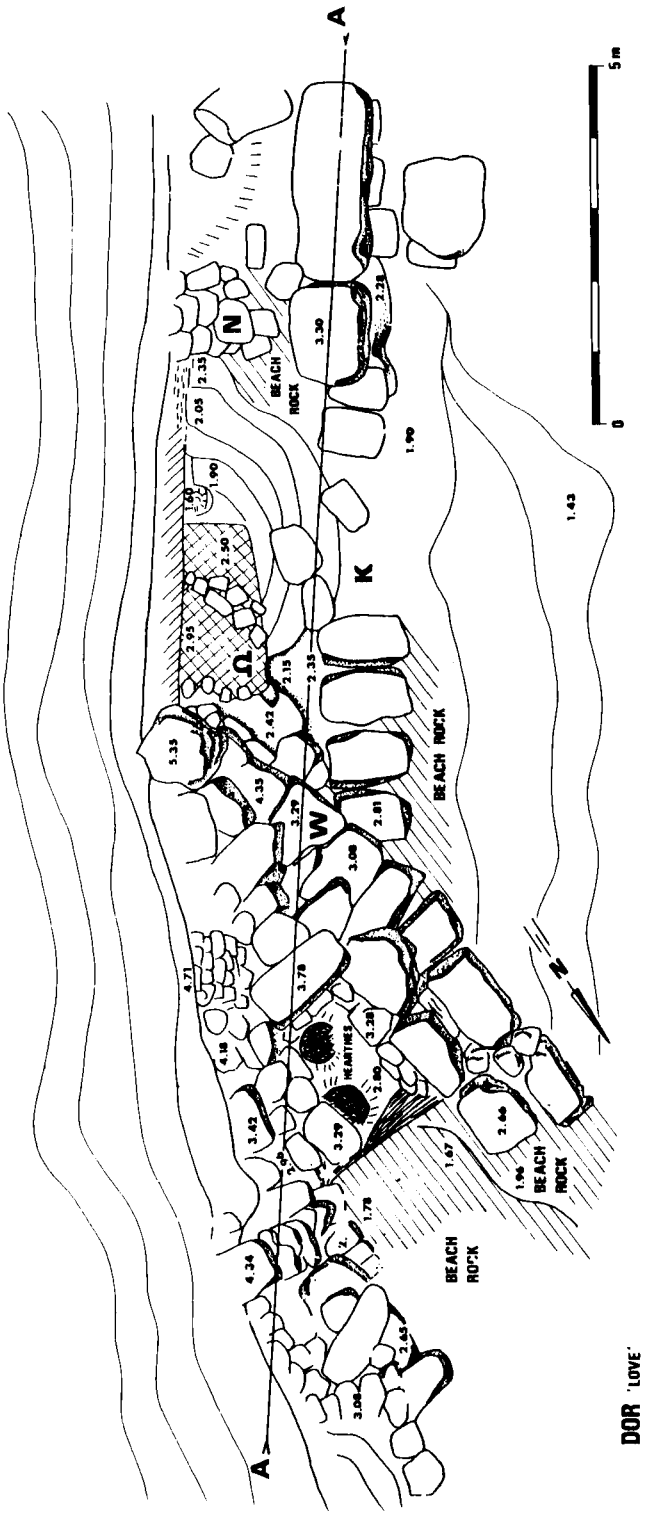


Figure 15. View of the MB II sea wall at Love Bay, Dor, looking NE.

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.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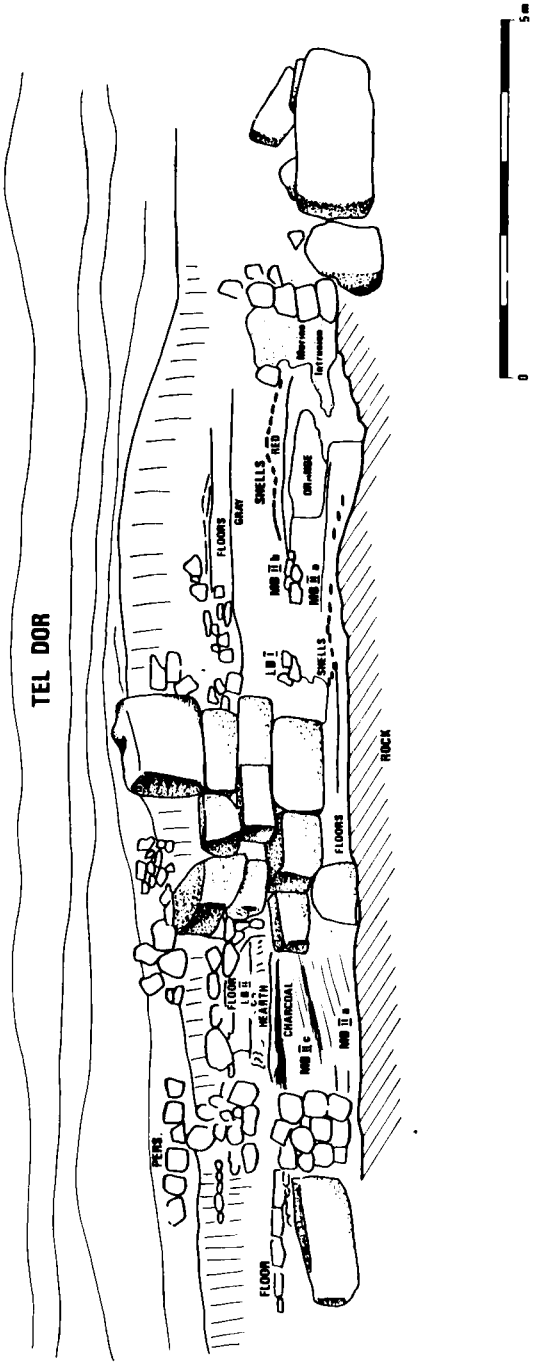

Figure 17. A—Plan of the excavated site at Love Bay; B—section of the excavated site at Love Bay.

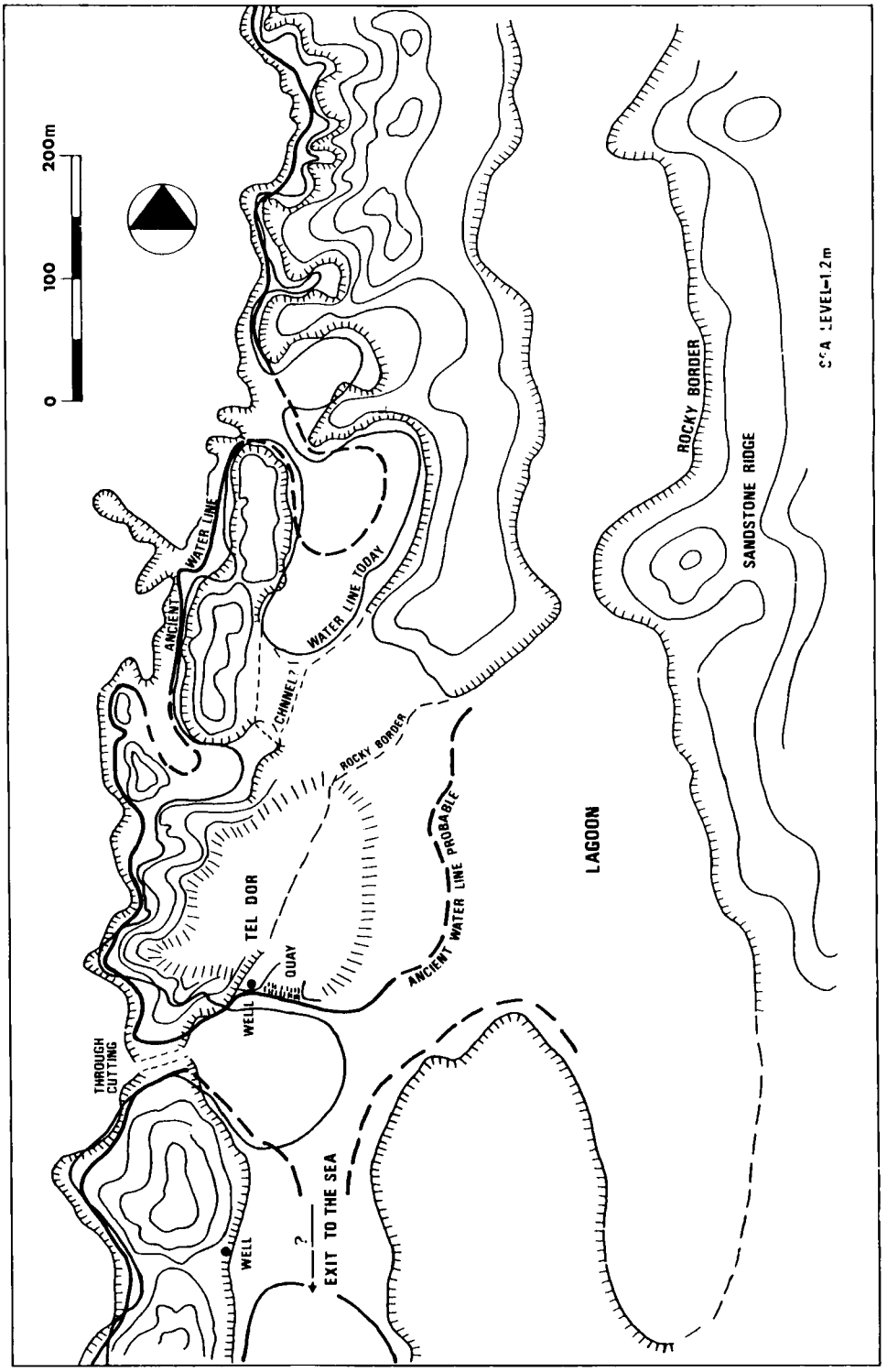

Figure 18. Reconstructured topography of Dor about 1200 BC.

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 $-0{\cdot}5$ m and $+0{\cdot}4$ 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.

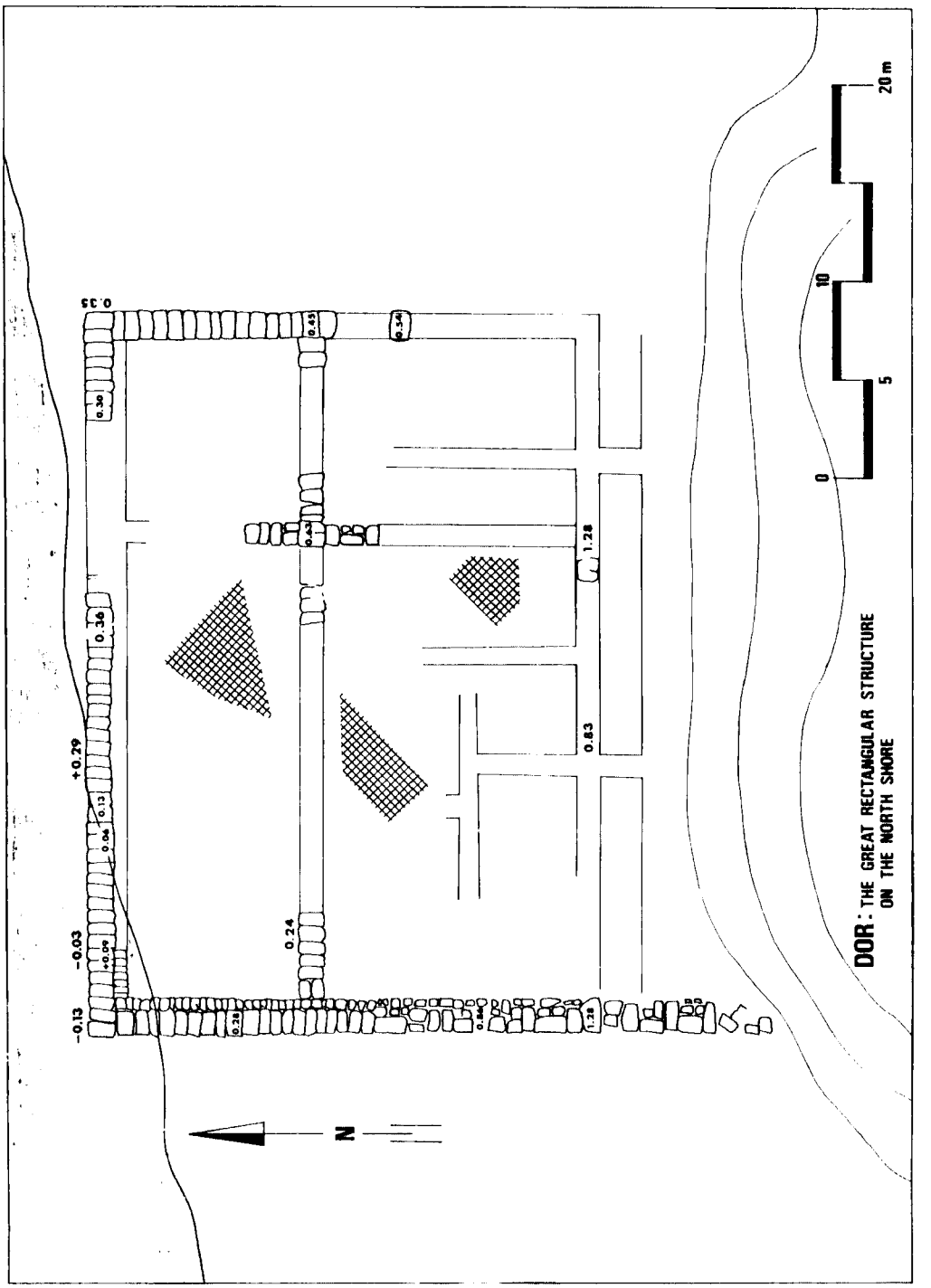

Figure 20. Plan of rectangular structure on the north shore of Dor.

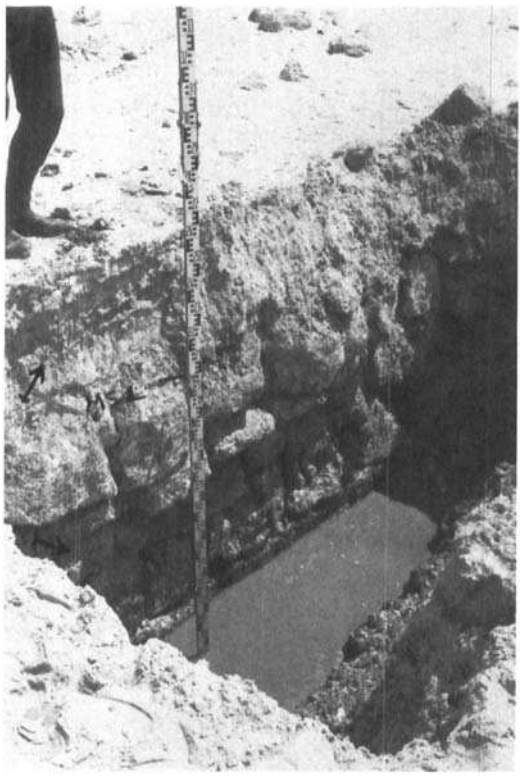

Figure 21. The western side of the rectangular structure, notice abrasion notches.

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.

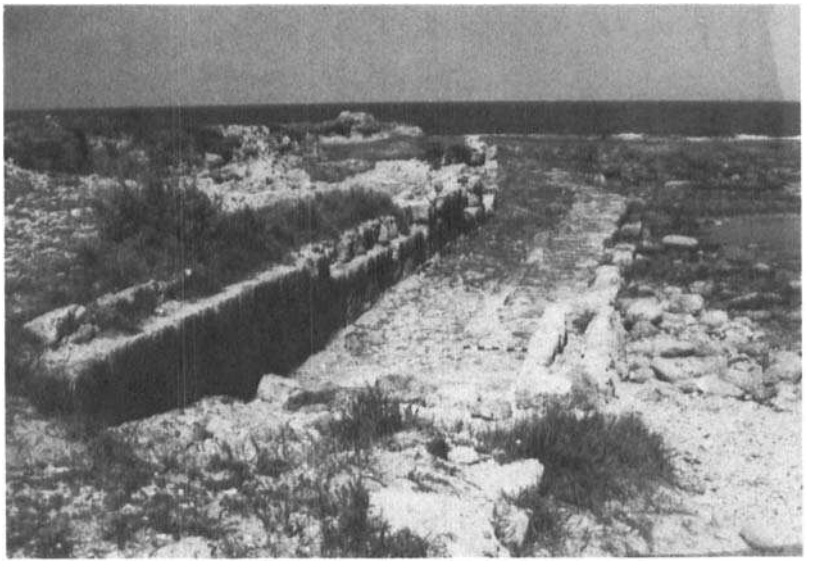

Figure 22A. The eastern end of the low-level channel looking north.

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

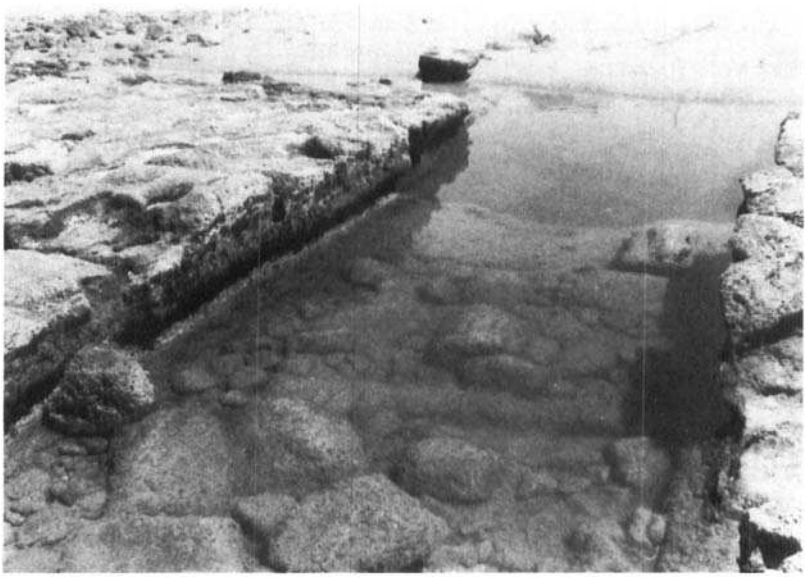

Figure 22C. Another of A.

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

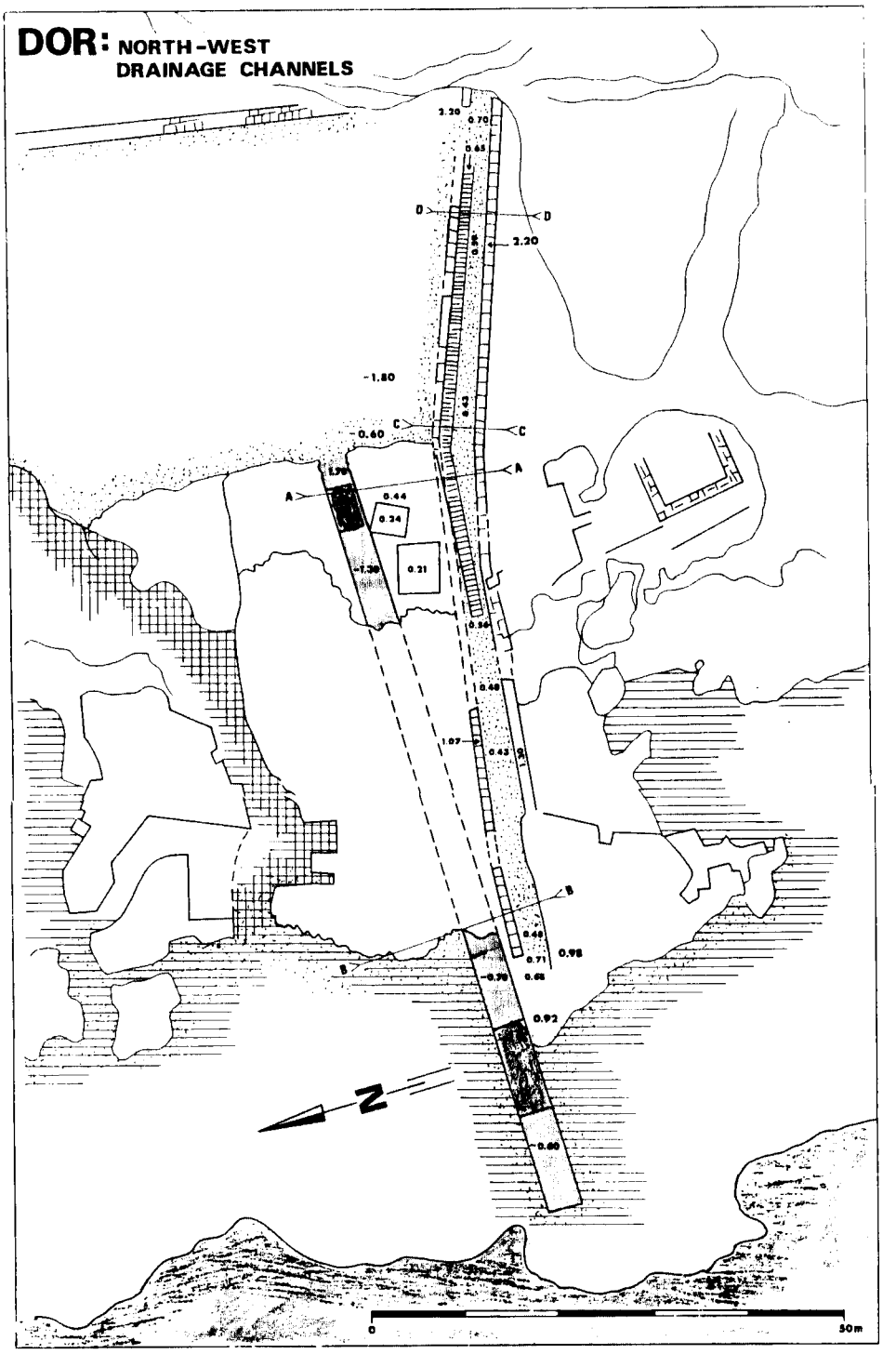

Figure 23A. Plan of the wash channels at north-west side of Tel Dor.

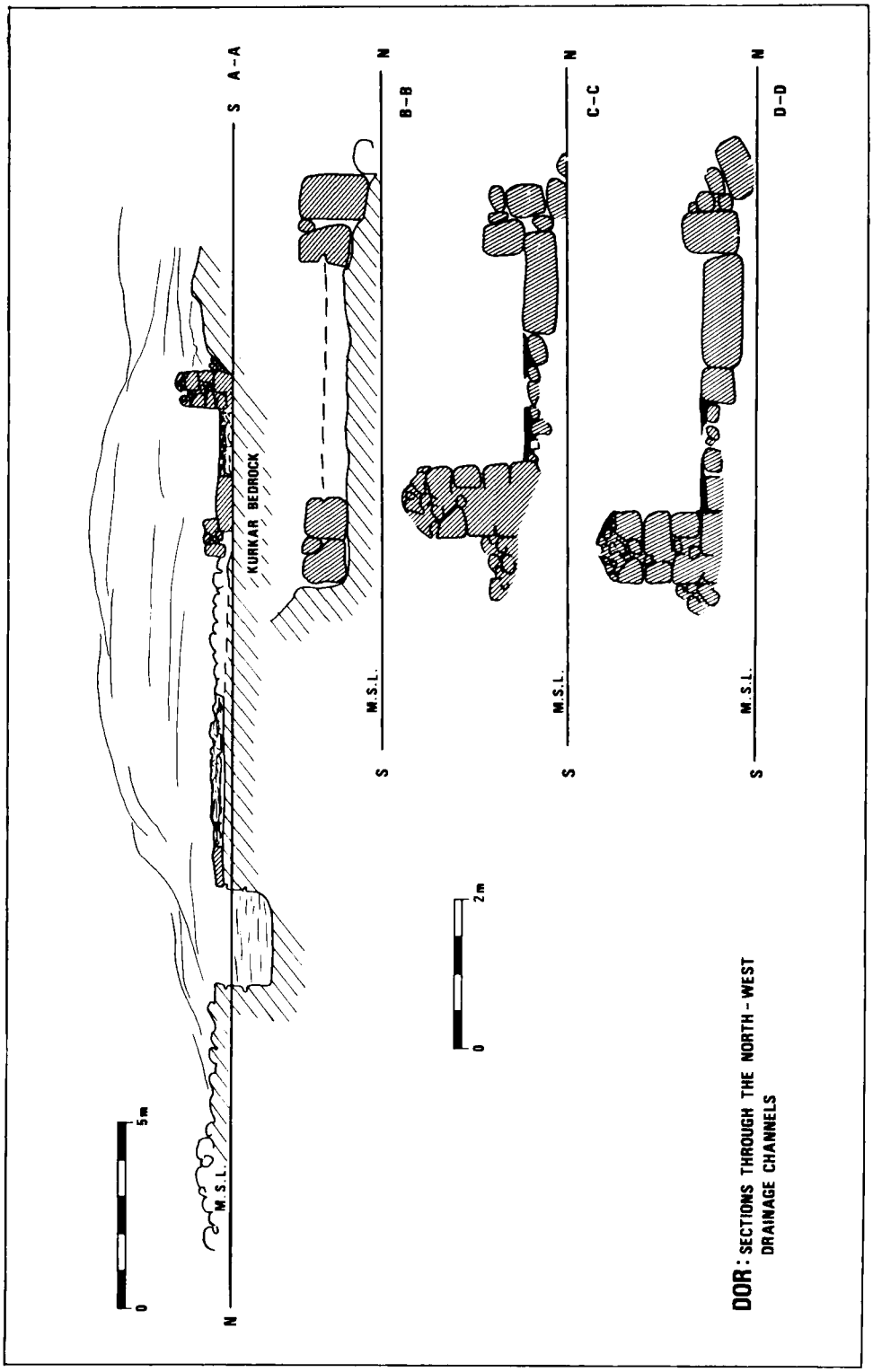

Figure 23. B—Section of the wash channels at the north-west side of Tel Dor.

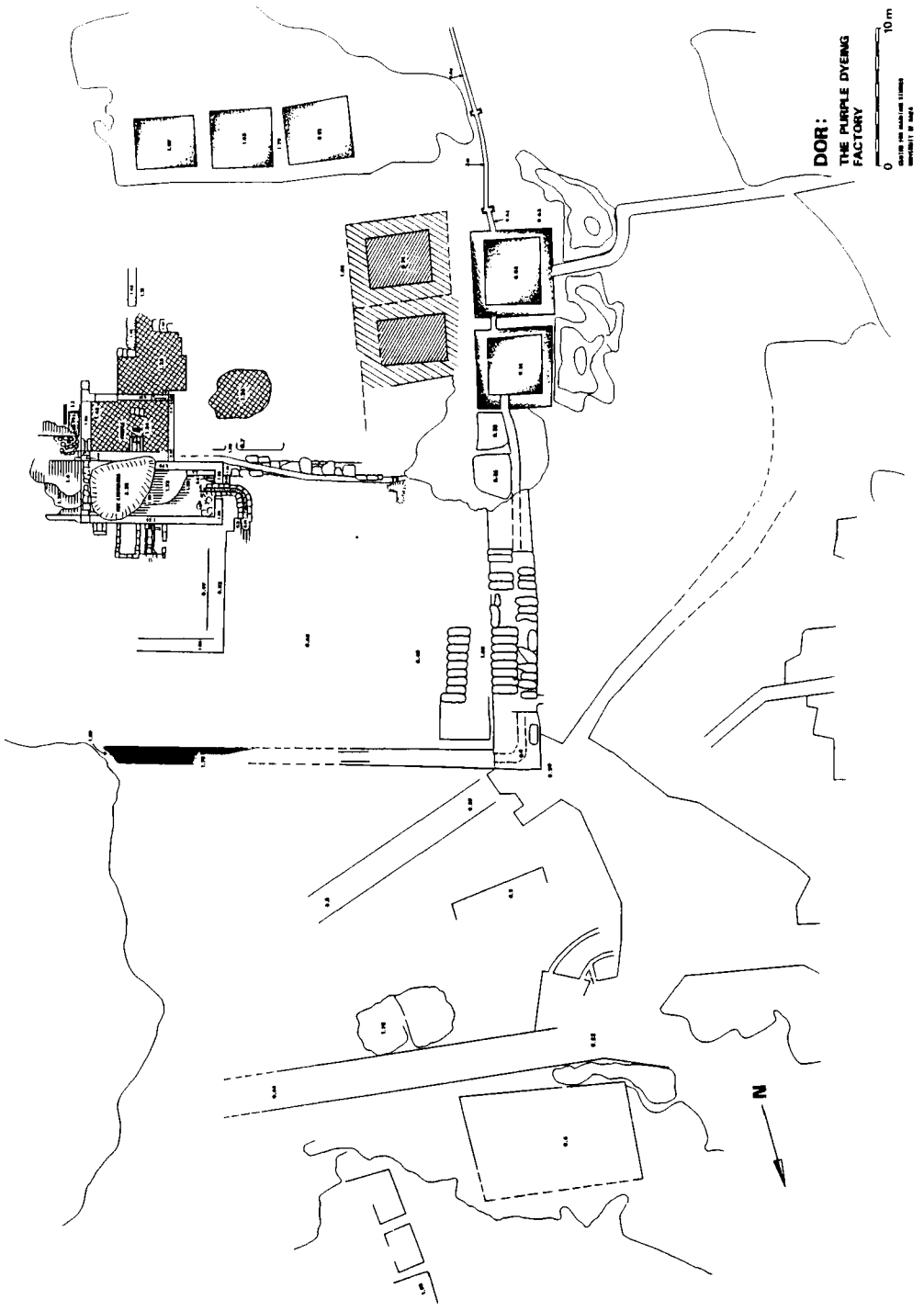

Figure 24. Plan of the 'industrial' area at Dor.

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

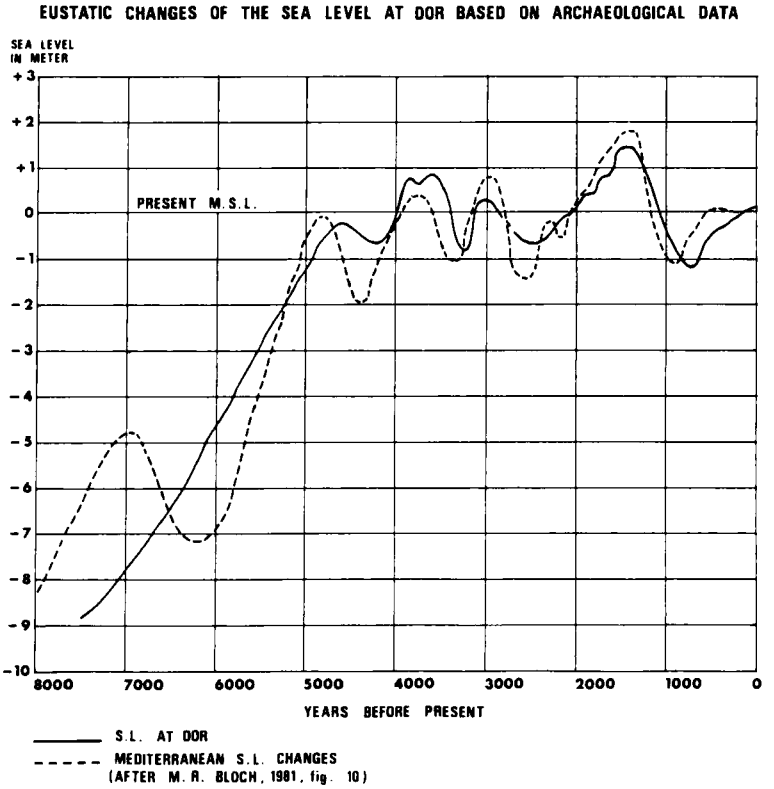

Figure 26. Reconstructed historical sea level changes at Dor.

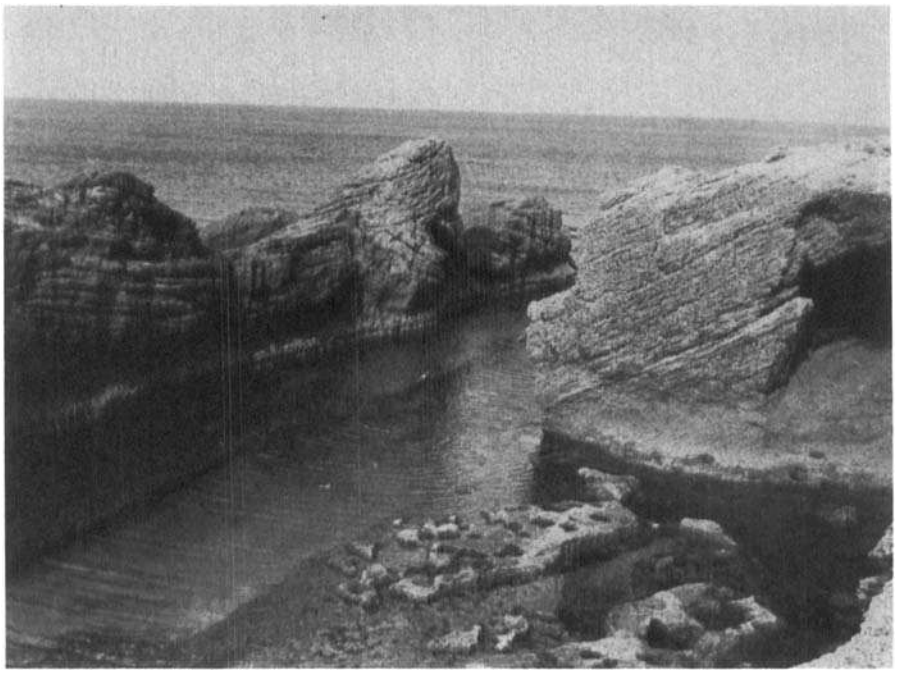

Figure 27. An artificial through cut (wave catcher) at the tip of the SW promontory at Tel Dor, looking NW; note four erosion notches.

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;

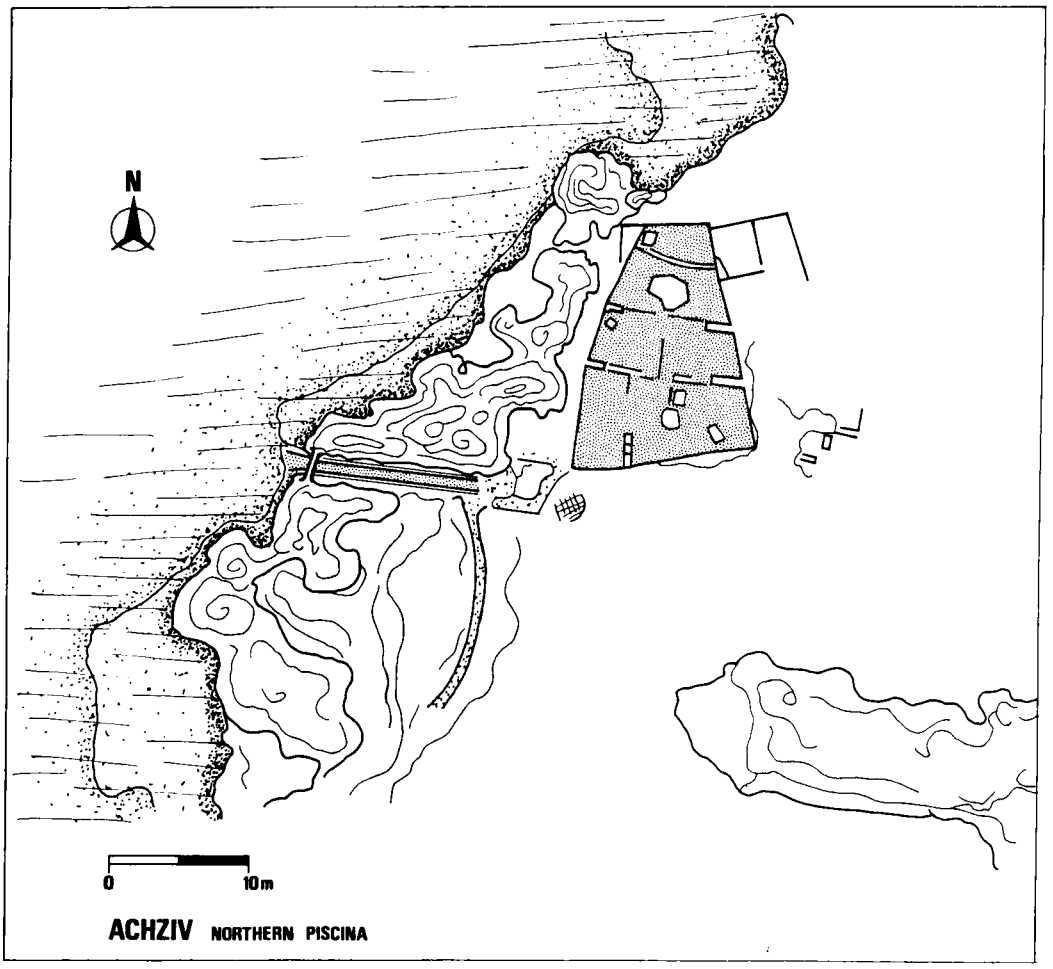

Figure 28. Plan of the site and piscina at Akhziv.

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

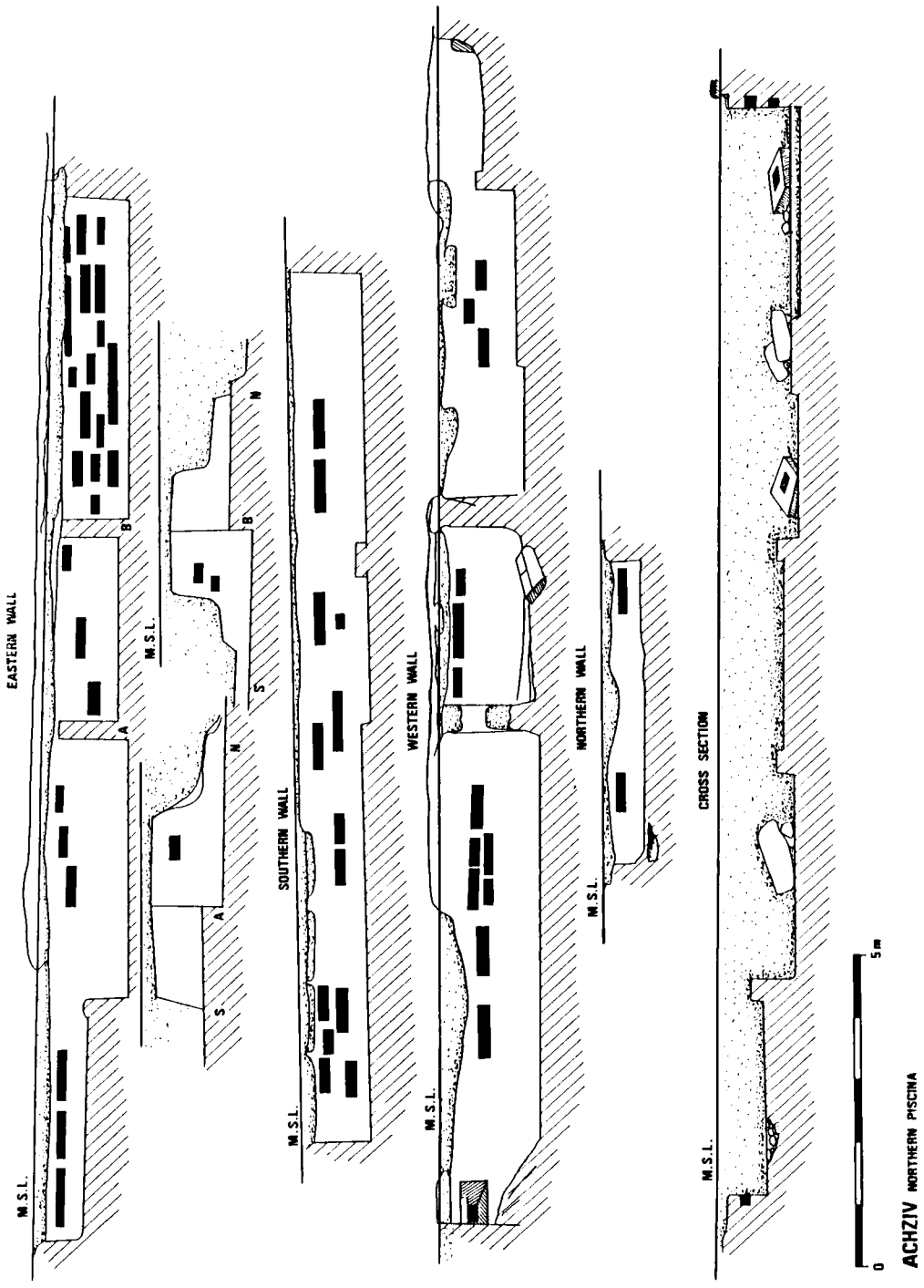

Figure 29. Sections of the piscina and the rectangular notches.

platforms which were quarried in antiquity down to below the present sea level, leaving the external, sea side rim intact and serving as a natural sea wall—a typical Phoenician tradition (Frost, 1973; 76–9). In the lee of that sea wall, on the northern side of the site a trapezoid basin was cut with some partition walls left in it. This basin is 5 m wide at its northern side, 14 m on the southern, 17 m on the eastern, and the western wall is a shallow concave line of about 20 m. The depth is 0·9 m on the southern side but only 0·35 m at its northern part. The shallower section was originally separated from the main basin by a rock-cut partition cross wall with its face just below the water. The other, deeper part was also divided into three sub-basins by E–W cross walls that were pierced through by openings which would enable a constant flow of water. The southern, bigger basin had its western third separated in a similar manner. These rock-cut partition walls are now well eroded, but their entire course is still tracable on the floors of the basins (Fig. 29). The central basin has a floor somewhat higher than the others, so its depth of water was only 0·6–0·7 m.

A rock-cut channel feeds the basin with sea water, through a passage cut in the sea wall. It is 14 m long, and enters the basin through a 2 m long underground passage. An 0·6 × 0·4 m opening for the inflow is now below the water level at the SW corner of the basin. It seems as if the overflow was drained back to the sea by a channel at the northern side of the basin—now too badly eroded by the sea to be accurately restored. The new supply of oxygen-rich seawater through the feeding channel was ensured by the use of the sucking effect of the syphon at its lee end. The submerged chamber in that part was deliberately filled with big rubble—still enabling the water to flow through, but blocking the way out for the fish (see Flinder, 1976: 138–9).

The interesting feature of the basin is the multitude of rectangular niches on the sides and partition walls. Each niche was 0·3 m high, 0·22–0·18 m deep, and 0·4–1·8 m long. In some places, mostly around the southern deeper side of the basin these niches are arranged in 3–4 horizontal lines. We know of no exact parallel to these niches from elsewhere in the Mediterranean. The closest resembling water basins are all artificially built structures with plastered walls which include neckless amphoras that were installed horizontally within the side walls with their opening towards the basin (Fig. 30). The most elaborate is on the Tyrrhenian coast of Italy (Schmiedt, 1972: 124–32). This is a circular basin with radial partition walls built near the water line and with an adjacent domed structure, which was identified as a piscina for fish farming. According to that interpretation the niches were nurseries. Two similar, yet much smaller piscinas were recently excavated in Israel. One at Caesarea was probably filled with sea water and was identified by the excavators as a Byzantine decorative fishpond of a private mansion (Bull, 1976: 23). The other is also dated to the Byzantine period and was found inland, far from the sea, with an adjacent aqueduct for fresh water supply (Ayalon, 1979).

The piscina at Akhziv had two different stages of operation in two different time periods. The original one was entirely rock-cut with the top of the basins and the feeding channel walls at an elevation of 0·2–0·3 m below the present MSL. In the second phase the entire area around the basin was filled with small rubble and paved with cemented gravels to achieve an additional height of 0·4–0·5 m, burying various rock cuts and foundation courses of ashlar structures. The feeding channel was widened from 0·8 m to 1·3 m and its old part was filled with rubble. It seems that in some later period the sea had flooded the higher level too and the entire area fell into disuse. This stage is documented by a horizontal abrasion notch clearly traced on the lee side of the rocky sea wall at a level of more than one metre above the present MSL.

It is not possible to date directly the piscina and the three phases of altered sea levels. Yet, judging from other coastal sites, such as Dor (see above) or Caesarea (Raban, 1983*a*: 250–1) one would suggest the original phase to be before the 2nd century BC, the second to 1st–2nd century AD, and the highest sea to the 8–9th century of our era.

Megadim's wrecks (E. Galili and K. Raveh)

During repeated underwater surveys that were carried out during the 1960s by the divers of the Undersea Exploration Society of Israel in a campaign against some professional treasure hunters an accumulated quantity of 'goodies'

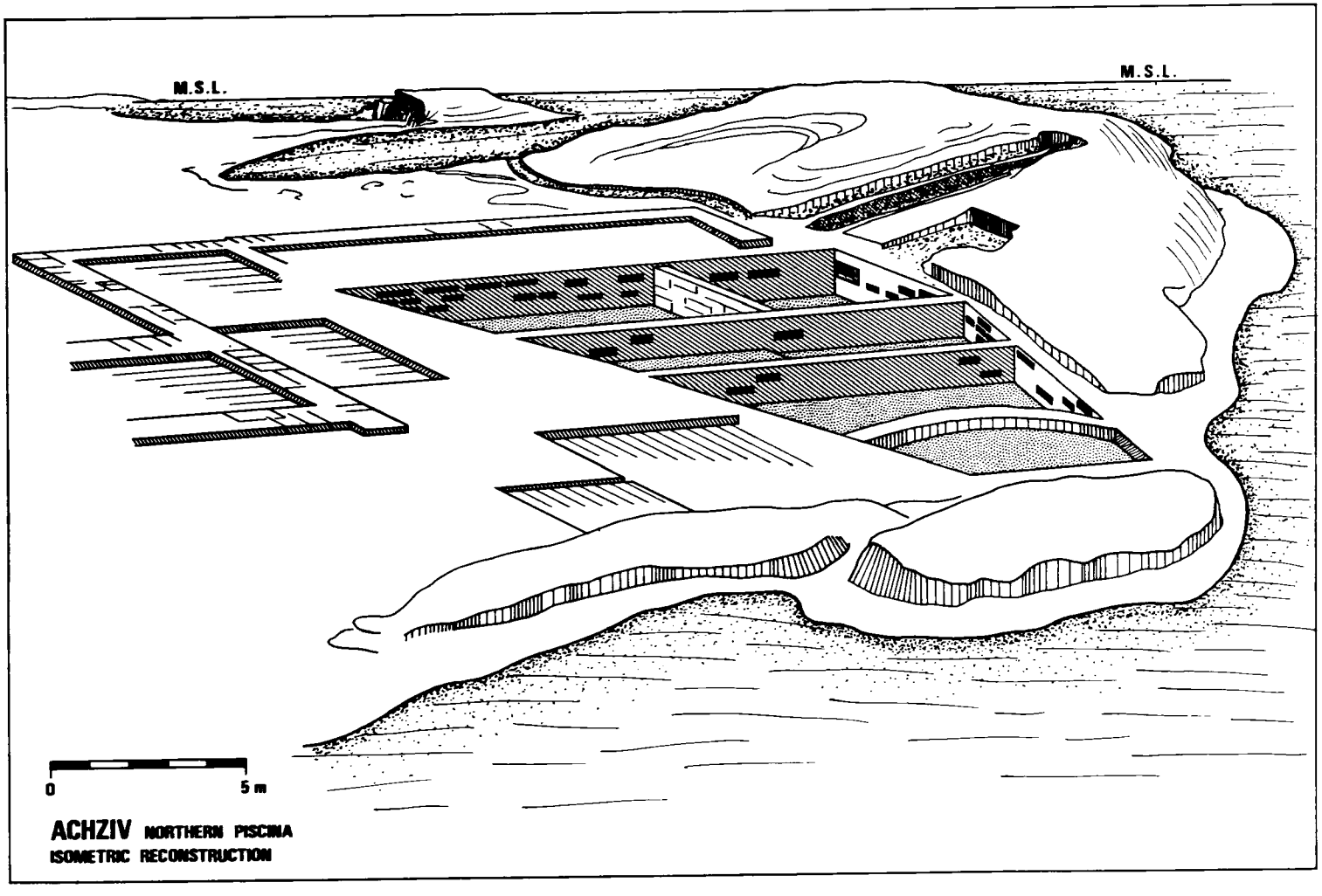

Figure 30. Isometric reconstruction of the piscina.

Figure 31. Parts of bronze statues from Megadim Hellenistic wreck.

were salvaged from the sea off Megadim—34°56½′E, 32°43½′N. Among these there were many broken pieces of large Greek bronze statues (Fig. 31), some Ptolemaic coins of the 3rd–2nd century BCE, various copper nails, utensils and bracelets, many bronze vessels, coins and other metal objects of the Mameluk period (14th century AD), including silver and gold (see *Hadashot Archaeologiot*, **34–35,** 1978: 11, Hebrew). In 1983, during a current survey, the divers came upon what seemed to be the nucleus of the site. A rescue mission was organized by the Marine Division of Israel's Department of Antiquities, in collaboration with CMS. Within 10 days of dredging and sub-bottom surveying, most of the surviving content of two vessels which were wrecked there, on the breakers line was documented and recovered.

It is quite obvious that the two vessels were wrecked in the very same place some 16 centuries apart, and in both cases the sea level was somewhat lower than the present one. Both vessels were carrying metal objects as part of the cargo and, though the hull and other less rigid components were completely disintegrated by the breakers, the heavier parts found their way below the sand to a final, protected rest on the sub-bottom layer of compact mud and survived in the best state of preservation.

The earlier vessel was very probably a small coaster operating as a floating metalsmith—much like that earlier wreck of Cape Gelidonya (Bass, 1967) or the classical Porticello wreck in the Straits of Messina (Owen, 1971). Of the ships hull only few scattered copper nails were found, but many other metal objects were located in an area of 100 × 50 m (Fig. 32).

The better preserved finds were in two neckless Hellenistic amphoras. One was found broken, with its content spread nearby, while the other was still filled with bronze bracelets in various stages of making and some already finished (Fig. 33), winged arrow heads, gilded weighing balance-plates, golden leaves of diadems, and various silversmiths working tools. Other objects that were on the vessel were copper bar ingots marked with Greek letters, and hoards of copper shipnails. Near the amphora there were broken bits of ornamented silver inlay on bronze that would create a strip of over one metre, very probably for decorating a toga or other garment. There were also an intact basalt bowl, door pivots made of bronze, many broken parts of life-size bronze statues of human and animal figures, and dozens of Ptolemaic coins minted at Paphos and Kition in Cyprus and some Seleucid bronze coins. The latest coins are of the 30s of the 2nd century BCE so the wreckage might have happened soon after that time. The historical background

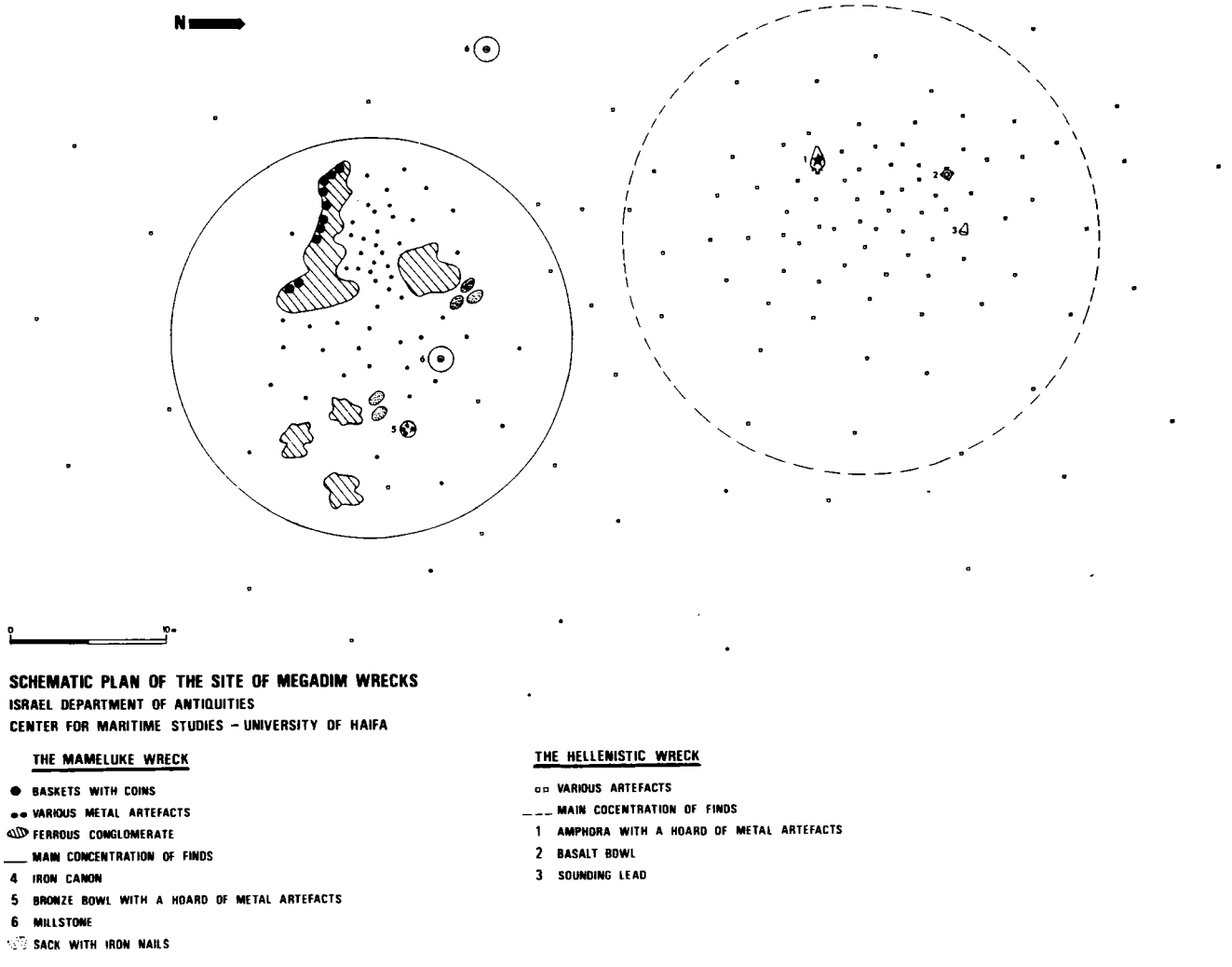

Figure 32. Schematic plan of the wreck site off Megadim.

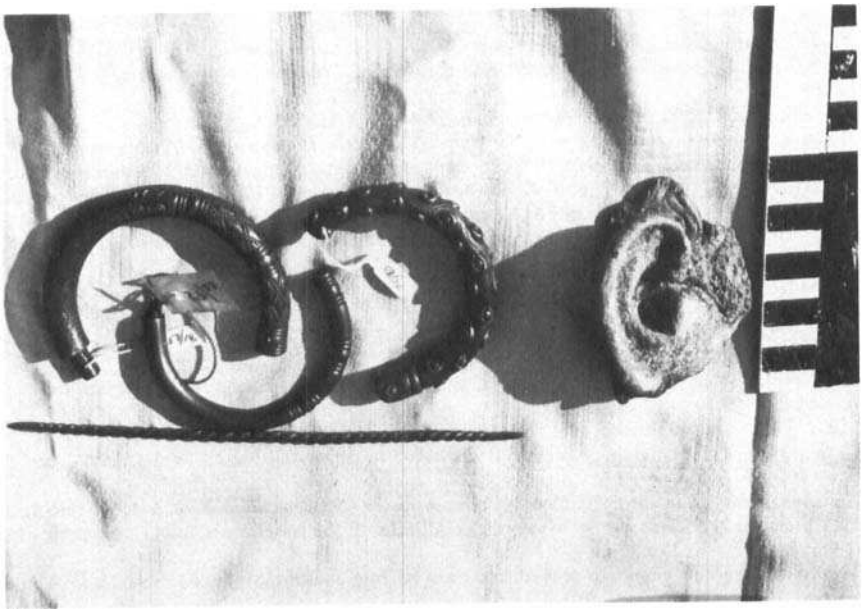

Figure 33. Some Hellenistic bracelets from Megadim.

for the presence of this vessel on this coast might have been on the occasion of Ptolemy Lathyros's invasion of the coast of Haifa with his Cypriot fleet (see Josephus, *Antiquities*, **XIII,** 12, 2–3) at the end of the 2nd century BCE (and see also, for the Greek camp at near-by site of Shikmona, Elgavish, 1974: 15–18).

The main item of the other wreck was found just 14 m away from the resting place of the Hellenistic amphora. It turned out to be the contents of at least a dozen reed-made baskets, now completely disintegrated, full of copper coins. The impression of the baskets fabric is still traceable on the external side of the roughly agglomerated coins. All together several hundred thousand coins of total weight of almost half a ton were recovered. Though most of the coins are in perfect condition and easily identified, only a small portion of the hoard was preliminarily studied by the numismatist A. Berman, consisting of those coins that were found there in the 1960s. In the portion studied so far there are over 30 different types of Mameluk coins, most of them of the Sultan Naser el Farag (1399–1412), and his father Barquque (1382–1399), some of which were minted as far north and inland as Afghanistan and Kurdistan, but the bulk were of north Syrian mints of the coastal metropolis of Antiochia.

This is probably the largest hoard of coins to be found in the Levant and their study might take some years. The latest dated coin to be studied so far was minted in the year 1404, probably dating the wreckage soon after. Other objects from the wreck that were found within an area of about 15 × 15 m were two millstones made of basalt with a diameter of 1·5 m, maybe used as a ballast for the vessel, dozens of decorated bronze torches, pestles, mortars, bowls, craters, buckets, and dining utensils. In some of the bronze vessels there were still remains of carob fruits. There were also several sacks of iron nails, bronze plaques with Cufic Arabic inscriptions and heraldic motifs of the Mameluk Sultans.

Of the hull of the ship only two frames with iron nails and pieces of the planking in poor condition have been preserved, being buried below the cargo of coins.

References

Ayalon, E., 1979, The jar installation of Khirbet Sabiya, *Israel Exploration Journal*, **29.3–4**: 175–81.

Bass, G. F., 1967, Cape Gelidonya—a Bronze Age shipwreck, *Transactions of the Amer. Philos. Soc.*, **58**(8), Philadelphia.

Bull, R., 1976, Caesarea 1976, *Hadashot Archaeologioth*, **59–60**:22–3 (Hebrew).

Elgavish, J., 1974, *Archaeological Excavations at Shikmona, Vol. 2: The Hellenistic level*, Haifa (Hebrew).

Flemming, N. C., A. Raban & C. Goatschel, 1978, Tectonic and eustatic changes in the Mediterranean coast of Israel in the last 9000 years, in J. C. Gamble & R. A. Yorke (eds) *Progress in the Underwater Science*, London: 33–94.

Flinder, A., 1976, Ancient fish-tanks at Lapithos, Cyprus: 2. The fish-tanks *IJNA*, **5.2**: 136–41.

Frost, H., 1970, 'Some Cypriot stone anchors from land sites and from the sea, *Report of the Dept. of Antiquities Cyprus:* 14–24.

Frost, H., 1973, The offshore island Harbour of Sidon and other Phoenician sites in the light of new dating evidence, *IJNA*, **2.1**: 75–94.

Frost, H, 1979, Egypt and stone anchors, *The Mariner's Mirror*, **LXV.2**: 137–61.

Galili, E. & N. Shmueli, 1983, News from Israel, *IJNA*, **12.2**:178.

Kaplan, J., 1978, Yavneh-Yam, in M. Avi-Yonah & E. Stern (ed.) *Encyclopaedia of Archaeological Excavations in the Holy Land*, vol. IV: 1216–8.

Owen, D. I., 1971, Excavating a Classical Age shipwreck, *Archaeology*, **24:** 118–29.

Prausnitz, M. W., 1975, The planning of Middle Bronze Age town at Ashziv and its defences, *Israel Exploration Journal*, **25.4**: 202–10.

Raban, A, 1965. Tel Harez: Chalcolithic and Persian remains in the sea. *Bemzuloth-Yam*, **3–4:** 6–9 (Hebrew).

Raban, A, 1973, Survival of ancient wrecks in varying conditions off the Israel coast, in N.C. Flemming (ed.) *Science Diving International:* 29–40, London.

Raban, A., 1980, Siting and development of mediterranean harbors in antiquity, in M. Sears & D. Merriman (ed.), *Oceanography–the past*, New York: 750–65.

Raban, A., 1981*a*, Recent maritime archaeological research in Israel, *IJNA*, **10.4**: 287–308.

Raban, A., 1981*b*, Some archaeological evidence for ancient maritime activities at Dor, *Sefunim*, **VI** 15–26, Haifa.

Raban, A., 1981*c*, Die antiken Haefen des Mittelmeeres, *Ruperto Carola:* 39–84, Heidelberg.

Raban, A., 1983*a*, Recent maritime archaeological research in Israel, *IJNA* **12.3**: 229–51.

Raban, A., 1983*b*, Submerged Prehistoric sites off the Mediterranean coast of Israel, in P. M. Masters & N. C. Flemming (eds), *Quarternary Coastlines and Marine Archaeology:* 215–32, London.

Raban, A, 1984, The ports of the Holy Land in Biblical Times, in E. Schiller (ed.), *Zev Vilnay's Jubilee Volume*, 241–53 Jerusalem (Hebrew).

Ronen, A. & Y. Olami, 1978, *Archaeological Survey of Atlit Map*, Israel Archaeological Survey, Jersulem.

Schmiedt, G., 1972, *Il livello antico del mar Tirreno*, Rome.

Spanier, E. & I. Ziderman, 1982, The royal purple: The glorious dye of ancient textiles factory, *Mada* (Science), **26.4**: 184–7 (Hebrew).

Sneh, Y. & M. Klein, 1982, Holocenian Sea level changes at the Coastal Area of Dor, in M. Inbar (ed.), *The Geomorphology of the Mediterranean Coastline of Israel*, CMS, Haifa, 1982.

Wachsmann, R. & K. Raveh, 1980, Underwater work carried out by the Israel Dept. of Antiquities, *IJNA*, **9.3**: 256–64.

Wachsmann, S. & K. Raveh, 1984*a*, Concerning a lead ingot fragment from ha-Hotrim, Israel, *IJNA*, **13.2**: 169–76.

Wachsmann, S. & K. Raveh, 1984*b*, A concise nautical history of Dor/Tantura, *IJNA*, **13.3**: 223–41.