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The Evolution of Akko Harbor and its Mediterranean Maritime Trade Links

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ABSTRACT

Archaeological investigations carried out in Akko Harbor from 1992 to 2004 are described and discussed, providing information on its long history. During the Bronze Age, Iron Age, and Persian periods, maritime activity in Akko relied on a natural anchorage. Sediments and artifacts suggest that the harbor was first constructed during the Hellenistic period and flourished since then. In the Byzantine period, the southern breakwater was in ruins and vessels anchored in the open sea. The exact location of the Early Islamic and Crusader harbors is unknown, but during the Crusades large vessels anchored in the open sea. The remnants of a fifteenth-century AD wooden pier indicate that maritime activity continued after the Crusader's defeat. These changes are illustrated through the discussion of stratigraphy, the distribution of archaeological remains, and tectonic and sea-level considerations.

Keywords Israel, Hellenistic, Roman, crusade, Islamic

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INTRODUCTION

The ancient cultural heritage of the Mediterranean encompasses numerous religions, cultures, and traditions, and reflects important processes in the history of humanity. During the middle Holocene the post-glacial sea level rise reached its present level. At about the same time the dawn of written history occurred, the large Near Eastern empires began to consolidate, and permanent urban centers appeared on the shores of the East Mediterranean. Intercultural trade intensified and included heavy and bulky items better transported by sea. The need arose for better and bigger sea-going ships and these encouraged the construction of effective shore facilities. As a result previously used natural shelters were being modified by ever intensifying human actions. Additionally, sedimentation and erosion processes caused by natural and human activities modified the dynamics of coastal processes. Shore facilities stopped functioning due to silting, as in Kition, Cyprus (Mariner and Morhange 2007) and erosion as in Caesarea, Israel (Galili and Sharvit 1998),

and required extensive repairs and dredging. Often the shoreline shifted seaward and many ancient anchorages and harbors are now inland. Understanding the history of shore facility modifications is crucial to examining the development of marine civilizations.

Akko is a classical model of a fortified Mediterranean coastal city and it has functioned for about 5,000 years as one of the main foci of maritime activity in the eastern Mediterranean. Underwater archaeological excavations and surveys in Akko first aimed mainly to enable the dredging and construction of a modern fishermen's harbor in the western basin and later to protect the sea front. There are now plans for a new marina in the eastern basin (Figures 2 and 3) and this coastal development will significantly affect the layout of the ancient harbor and impact archaeological remains.

Excavations at Tel Akko, east of the present city, revealed imported artifacts and evidence for maritime trade from the Middle Bronze Age (2200–1500 BC) onward (Dothan 1993). The finds indicate that the site must have had a marine anchorage or harbor, but

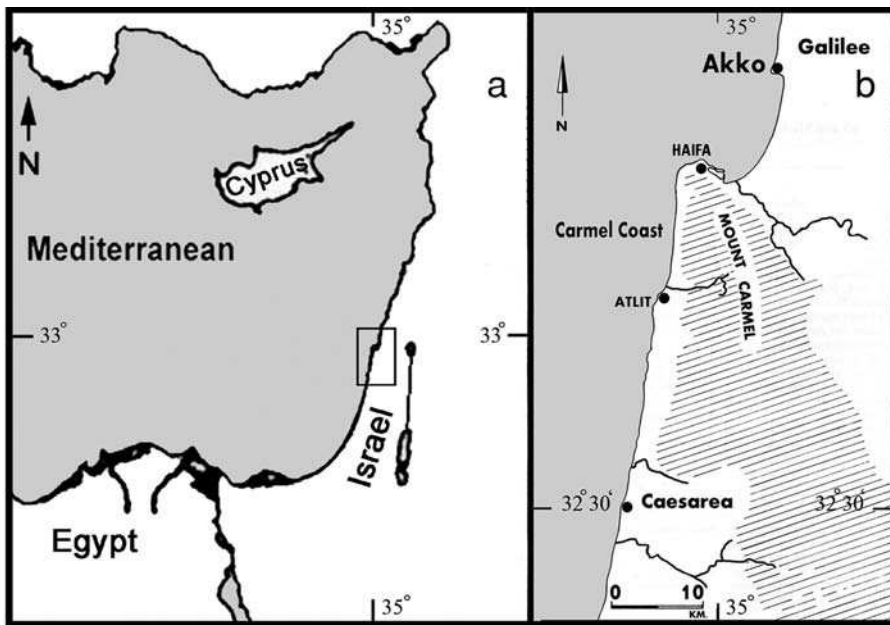


Figure 1. Location map: a) the eastern Mediterranean Basin; b) insert of the northern Israeli Coast.

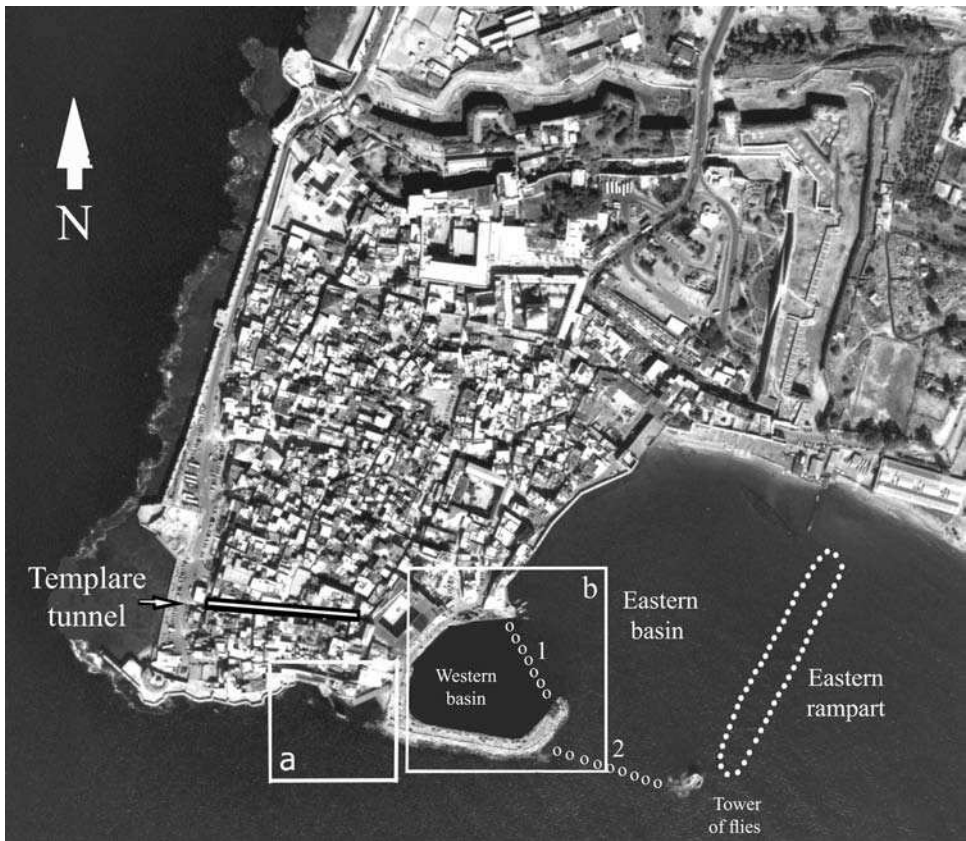


Figure 2. Akko Port: insert a) seafront of the Pisan Quarter (detailed insert in Figures 14 and 15); b) Western Basin (detailed insert in Figures 3a and 4b) and possible locations of the Early Islamic chain blocking the harbor: 1) the western basin according to Linder and Raban (1965); 2) the eastern basin according to Gertwagen (1996).

it is not known what the nature of these facilities was or where they were located. Tel Akko was also occupied during the Iron Age (1200–587 BC) (Dotan 1993), but there is a lack of archaeological evidence to determine the level or location of maritime activity.

Until the present study it has not been clear if the first harbor was constructed by the Phoenicians during the Persian period (587–332 BC) or later during the Hellenistic period (333–37 BC). The importance of Akko Harbor is documented by a long tradition of graphic depictions, starting with Roman coins; and from the fourteenth century by drawings, charts, maps, and written documents (Galili et al. 2004; Zviely et al. 2003).

However, the level of maritime activity during the Hellenistic, Roman (37 BC–AD 324), and Byzantine (AD 324–640) periods was not verified by underwater archaeological finds until recently.

The layout of the Early Islamic (AD 740–1099) harbor and the locations of the breakwater and the chain which blocked its entrance are not agreed upon. Some researchers suggest that Akko Harbor was built as two basins similar to that of Tyre (Shur 1990). According to Linder and Raban (1965) and Jacoby (1979), the Early Islamic and Crusader harbors (AD 1099–1291) were in the western basin. It is unclear whether the chain blocked the western basin entrance

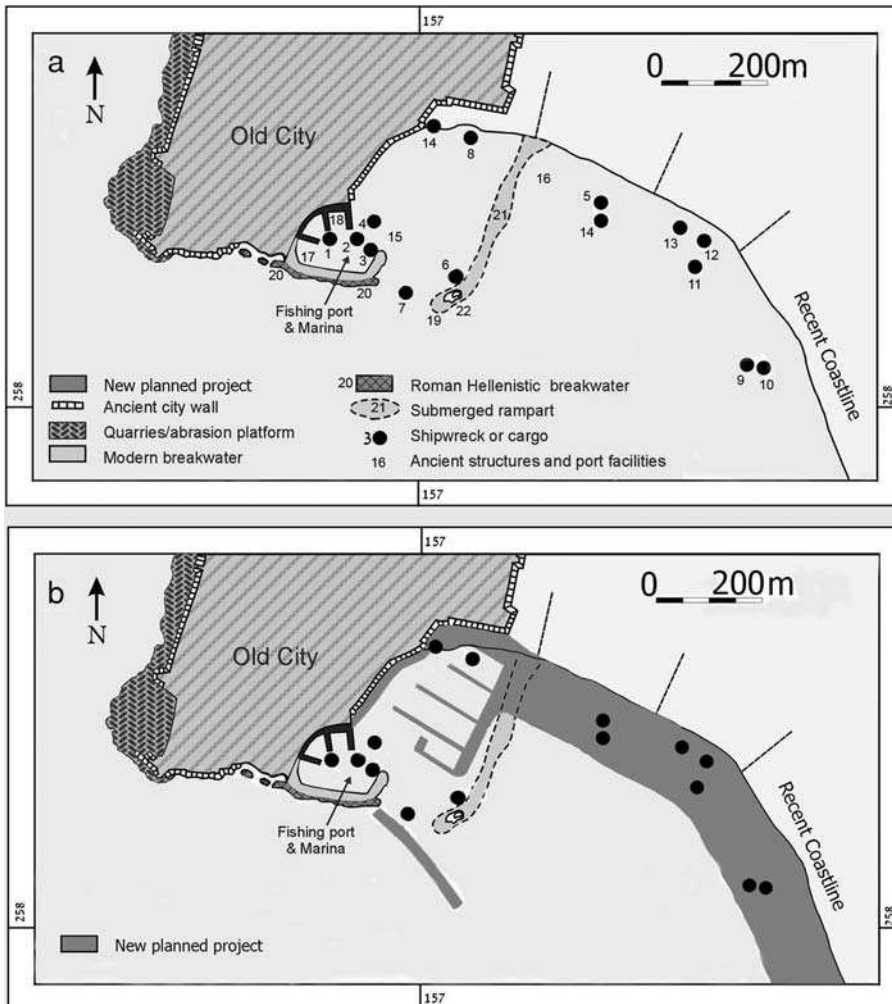


Figure 3. *a) Location of ancient structures and shipwrecks in Akko Port: (1) late Roman/Byzantine shipwreck; (2) Byzantine shipwreck; (3) Crusader shipwreck; (4) board of Crusaders gold florins; (5) seventeenth- to eighteenth-century shipwreck bull; (6) eighteenth-century shipwreck bull with schist stones ballast; (7) bull section of an eighteenth-century shipwreck; (8 and 9) bulls of nineteenth-century shipwrecks; (10, 11, 12, 13, and 14) nineteenth- to early twentieth-century Ottoman shipwreck bulls; (15) wooden poles of a thirteenth-century pier; (16) stone anchor; (17) mooring stone/anchor; (18) ancient dock made of ashlars kurkar blocks; (19) a submerged foundation of the Tower of Flies built of huge headers; (22) Tower of Flies; 3b) the proposed marina layout.*

(Flinder et al. 1993; Jacoby 1979; Raban 1982) (Figure 2.1), or the eastern basin entrance (Gertwagen 1996) (Figure 2.2). The location of an Early Islamic built harbor in the eastern basin is crucial for future planning of a modern marina in this place because state

planning policy in living historical cities is not to exceed the layout of the ancient harbors. According to the designers of the new marina, the ancient south breakwater and the modern breakwater built on it do not provide sufficient shelter for vessels in this

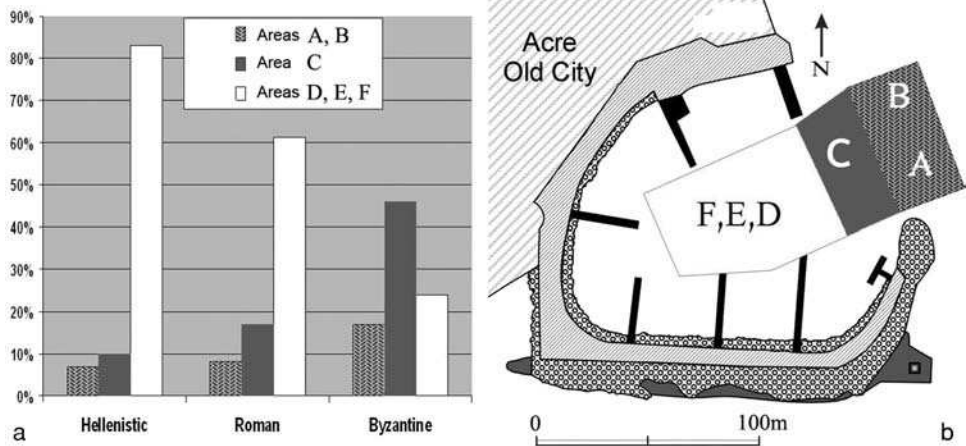


Figure 4. a) Distribution (%) of the Hellenistic, Roman, and Byzantine finds in the harbor; 4b) excavation areas.

basin (Raviv Rami, personal communication 1998). To improve the protection offered by the newly proposed marina in the eastern basin, there is a need to extend the south breakwater to a distance of about 300 m to the southeast (Figure 3b). This may suggest that in the past the eastern basin could not have provided sufficient shelter as expected from a built harbor, but rather a temporary anchorage. The existence of a separate harbor of the Italian Pisa commune (so called ‘Pisan Harbor’) during the Crusaders period was widely debated and the function of a Crusaders stone built tunnel crossing the city from east to west is not yet understood.

Human activity on the shores and natural coastal changes due to sea level rise, seismic activity, and tectonics are obliterating the maritime archaeological heritage. Massive coastal developments are executed by powerful mechanical agents financed with immense capital. The predicted sea level rise in the twenty-first century will also have crucial impact on archaeological sites along the world’s coastlines (Erlandson 2008). Urban centers and living human societies can adapt, change, or move, but coastal archaeological sites cannot. To establish integrated and sustainable coastal zone management programs, there is a need to develop a proper archaeological data base. There is a narrow window

to research, document, salvage, protect, and preserve the coastal and marine cultural resources before further damage is done. The ancient city of Akko (Acre) is an ideal case study for the Mediterranean and may serve as a model for preservation and protection.

The present study summarizes and discusses the results of archaeological investigations carried out by the Israel Antiquities Authority (IAA) between 1990 and 2004. Detailed studies of numismatics, ceramics, fishing gear, and metal artifacts are being published separately. Based on the results of these studies, we aim to clarify issues concerning the location and duration of the harbor and its history.

METHODS

In 1990–1991, archaeologists from the IAA conducted underwater archaeological and geophysical surveys in Akko Bay using echo-sounder, sub-bottom profiler, and side-scan sonar to explore the sea floor of the harbor and nearby areas. In addition, water jet drillings were carried out to evaluate the thickness and nature of the unconsolidated sediments beneath the sea floor, to locate shipwrecks hidden in the sediments, and



Figure 5. *Bronze figurines (Persian period).*

check anomalies and targets identified by remote sensing. In 1992–1993, the harbor of Akko was dredged and archaeological material was examined and studied by the staff of the IAA. A crane lifted sediments containing archaeological materials from the harbor bed and deposited them on a barge. The sediments were then taken to dumping areas offshore, released, and examined by divers. To map the source of the archaeological artifacts, the harbor was divided into three main areas (Figure 4b) using a grid of 5×5 m squares. Although underwater surveys were carried out in wide areas in and around the harbor, only the western basin and a small portion of the eastern basin were dredged. Archaeological studies by

the IAA reported and discussed below were published in a series of preliminary reports (Galili et al. 1991; Galili and Rosen 2008a; Galili et al. 2002).

THE FINDS

Bronze Age, Iron Age, and Persian Periods

There are few finds assumed to be from the Bronze Age. These include two well-shaped stone anchors with one hole weighing 39,280 kg (Figure 3a: no. 16, 17) and a loaf-shaped copper ingot weighing 4.5 kg. The dating of stone anchors is not always accurate, but scholars suggest that large and

well-shaped stone anchors with a single wide hole (10–15 cm diameter) usually date to the Late Bronze Age (Frost 1963, 1970, 1973). An underwater survey in Neve-Yam, south of Atlit, ~25 km south of Akko (Figure 1) (Galili and Sharvit 1999), exposed a Late Bronze assemblage, including 83 loaf-shaped copper ingots identical to the one from Akko. This assemblage included hematite weights in the shape of wheat grains, a bronze adze, a socketed spear head, bronze tongs, and several large (80–150 kg) stone anchors with a single hole. The similarity of ingots and anchors recovered from Neve Yam, the Cape Gelidonia wreck (Bass 1961), and Akko support a Late Bronze Age dating of the latter. No artifacts from the Iron Age were found at Akko and very few ceramic sherds and two bronze figurines from the Persian period were recovered (Figure 5).

Hellenistic Period

Most of the Hellenistic artifacts were recovered from the western basin (Figures 2b, 4b: areas D, E, F). Hellenistic artifacts include amphorae, amphorae handles with stamps, black ware vessels, black and red Megarian bowls, eastern Terra Sigillata ware types A, B, C, and D as well as western Terra Sigillata ware (Silberstein et al. in press). The large number of amphorae, domestic vessels (Figure 6), and metal objects, point to extensive trade relations with Mediterranean countries and to large-scale imports from the Aegean (Figure 7a).

Amphorae used in maritime trade form a significant portion of the ceramic assemblage and originated in numerous sites in the Mediterranean Basin. Of these identified as Hellenistic, about 80% originated in the Aegean, 8% from the coasts of Syria and Palestine, 5% from Egypt and North Africa, and a few from Italy (Figure 7). This represents clear evidence of extensive economic connections with Greece during this time. About 50 stamped amphora handles were recovered during the excavations in addition to numerous unstamped specimens (Finkielsztejn in press). As elsewhere in Israel, most of the stamped handles originated in Rhodes and can be dated to the first half of the second



Figure 6. Hellenistic pottery vessel bearing inscription “AKRATON” (young wine).

century BC; a few were from the second half and the beginning of the first. More than half dated to the years 188–166 BC (Finkielsztejn in press). The high number of handles found may be associated with military activity by the Ptolemaic and the Seleucid armies, such as the Battle of Banias (198 BC), where Akko Harbor may have been used to supply the fighting force (Finkielsztejn in press).

Judging from the wealth of finds and their diversity, maritime activities in the western basin of the harbor underwent a fundamental change during the Hellenistic period relative to previous periods.

Roman Period

Most of the Roman material was recovered from the western basin (Figures 2b, 4b: areas D, E, F). The finds include the wooden hull of one or more medium-sized Roman/Byzantine ships (Figure 3a: no. 1). Timbers from the shipwreck were provisionally ¹⁴C dated to the second–fifth centuries AD (Kahanov Yaakov, personal communication). Recoveries included a few coins, other metal objects, and numerous whole and broken ceramic vessels representing imported and local amphorae, cooking pots, oil lamps, bowls, plates, and Eastern Terra Sigillata

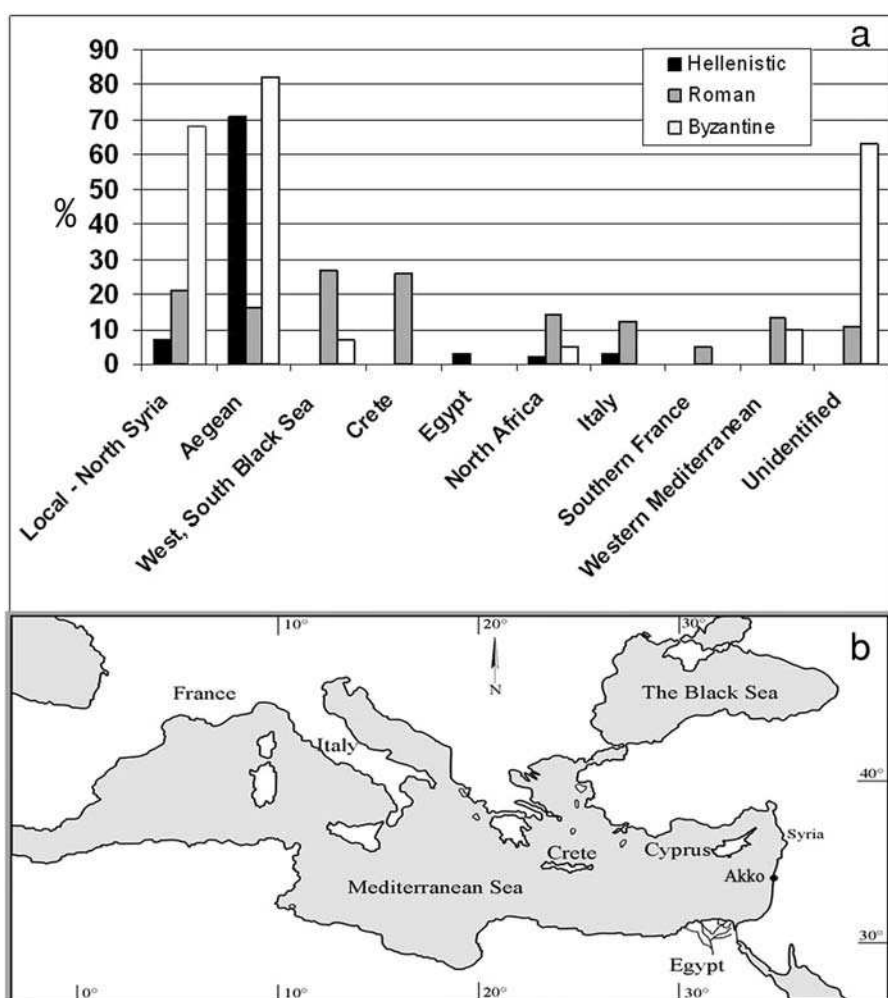


Figure 7. Origin of the amphorae from Akko Port; a) percentage (%) of distribution and origin; b) location in the Mediterranean.

ware. Western Terra Sigillata ware, found only rarely on inland sites, were also found in the harbor. Some of the pottery bears inscriptions and maritime themes (Figure 8). Half of the identified Roman amphorae originated from the Aegean and Black seas, 20% from Italy and the western Mediterranean, 16% from the coasts of Syria and Palestine, and 10% from North Africa (Silberstein et al. in press) (Figure 7). The amphorae served as food containers. The luxury pottery plates and western terra Sigillata vessels were imported

to provide for the needs of an emerging affluent society.

Byzantine Period

A considerable amount of Byzantine pottery, a few pieces of wood, bronze nails, and a number of coins were found near the entrance of the harbor (Figure 4b: area C). Most of the amphorae belonged to three main types and probably originated from

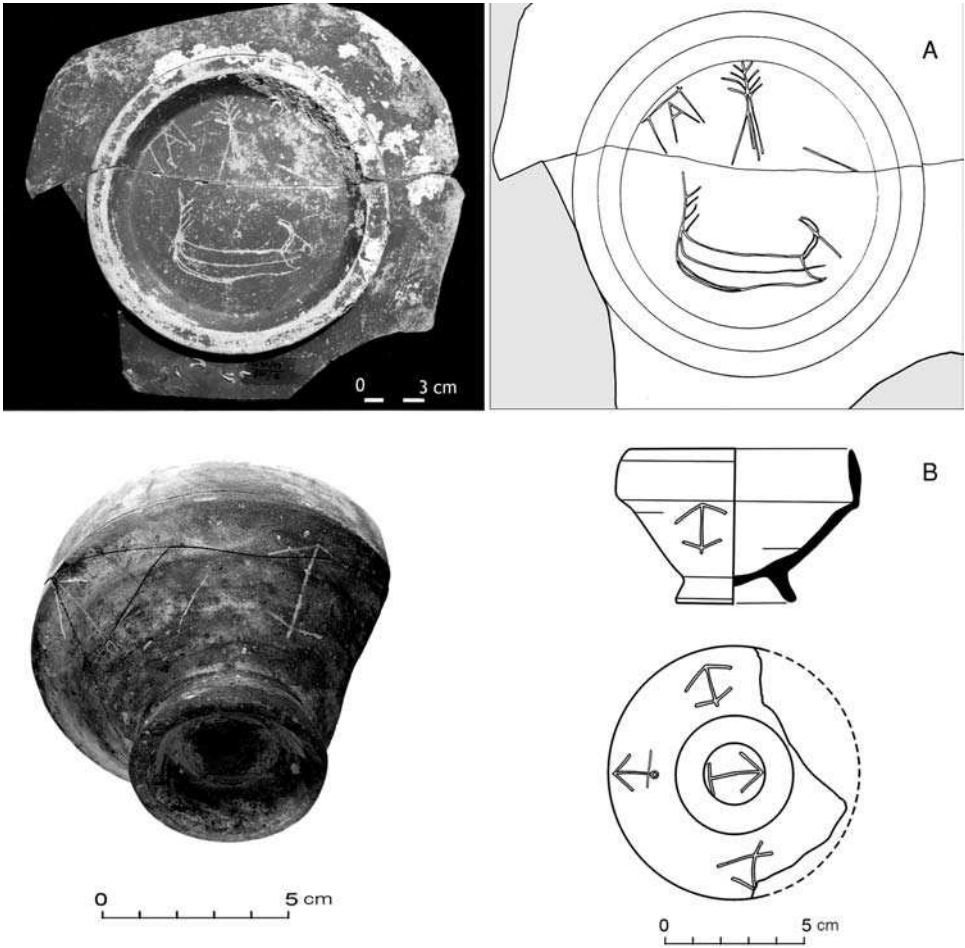


Figure 8. a) Terra sigillata plate with a depiction of a ship moored to a tree on the shore (a typical north Mediterranean anchorage); b) Roman bowl decorated with iron anchors.

a single wreck (Figure 3a: no. 2). Nearly half of the identified Byzantine amphorae originated from the Aegean and Black seas, 40% from the coasts of Syria and Palestine, 3% from North Africa, and 6% from the western Mediterranean (Silberstein et al. in press) (Figure 7). Eighth-century amphorae discovered in the remains of the Byzantine wreck indicate that maritime trade by Byzantine sailors continued into the Early Islamic period. A few broken Byzantine iron anchors were also recovered from the western basin (Figure 9). A concentration of 13 Byzantine iron anchors was observed on the sea bottom

some 2000 m southwest of the harbor, in 15 m of water (Kotzer Adam, personal communication 2004). They could represent a cargo of anchors, which was on a ship that wrecked on its way to the harbor.

Early Islamic Period

Very few finds from the Early Islamic period were found in the harbor—the only diagnostic pottery vessel recovered is one bowl base (Stern forthcoming). However the historian Al-Muqaddasi described the

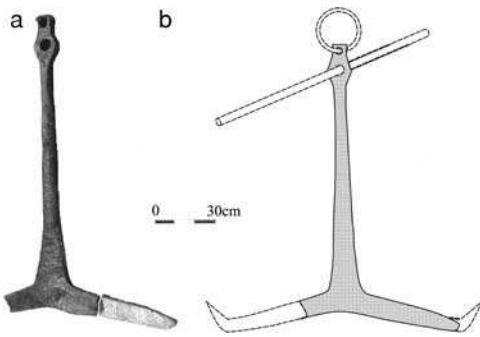


Figure 9. a) Broken Byzantine Iron anchor; b) a reconstruction of a Byzantine iron anchor.

construction of Akko Harbor by Ibn Tulun and its closure by a chain (Al-Muqaddasi 1906:11, 162–163).

Crusaders Period

Sections of the wooden hull of a ship dated by ^{14}C to AD 1062–1250 were discovered near the western basin entrance (Figure 3a: no. 3). The remains include a keel and a few frames and planks partly covered with

material used as ballast that resembles poured cement; however, this requires further examination. Crusader pottery vessels were recovered mainly east of the entrance to the western basin (Figure 4b: areas A, B). Some sherds from this period were retrieved from the western basin, including fragments of 50 bowls, 24 cooking pots, and 31 amphorae. Most of the bowls and the amphorae were imported from the eastern Mediterranean. However, the cooking vessels demonstrate a different pattern, with most of them being local and only 25% imported from Cyprus (Stern forthcoming). A hoard of 30 gold florins minted in Florence in the second half of the thirteenth century AD was recovered near the harbor entrance (Kool 2006) (Figures 10; 3a: no. 4). The coins show that the economic and political ascendancy of Florence had reached Akko by this time, presumably on board Pisan ships. Among possible explanations for the mishap is a critical moment in Akko's history. Historical documents report that on May 18, 1291, after a siege of several weeks, Frankish Akko fell to the advancing Mameluke army. Soldiers and citizens, desperate to escape the enemy, crowded into the harbor. Eye-witnesses, such as the anonymous 'Templar of Tyre' related



Figure 10. A board of Crusader gold florins recovered from area C.

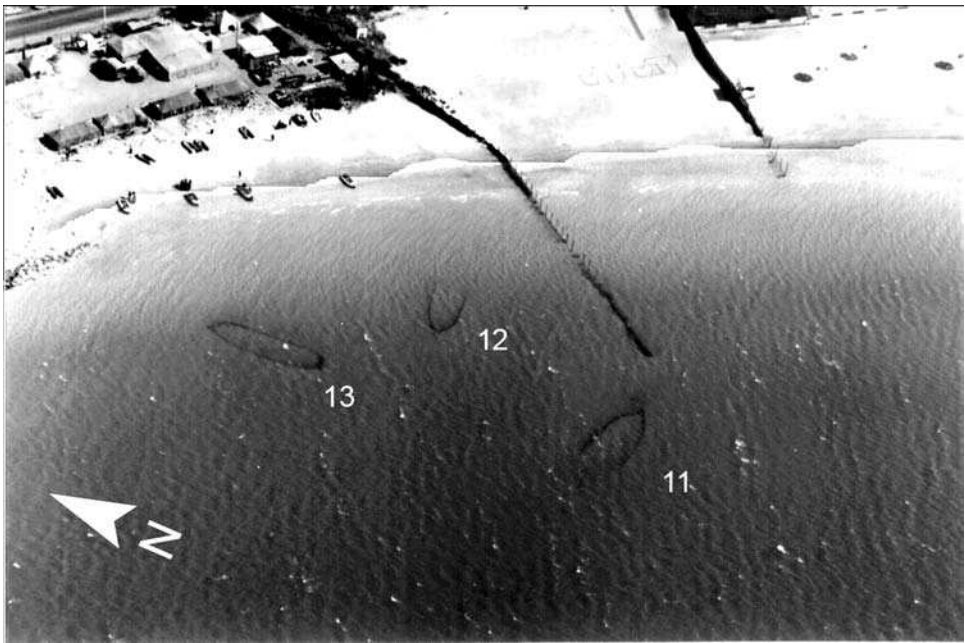


Figure 11. Three Ottoman shipwrecks with wooden hulls, which will be covered by the new marina project (Figure 4: 11, 12, 13).

that a few noble ladies and merchants escaped by bribing owners of small boats with jewelry and gold to be ferried offshore to ships heading for Cyprus. Many, however, drowned with their precious possessions (Kool 2006).

Underwater surveys discovered two large (ca. 5 m long) iron grapnel anchors at a depth of 12 m, 1800 m south of the harbor. The anchors, about 5 m long laying about 100 m apart with their tying rings pointing towards the east and the northeast, probably belonged to one or two large Crusader ships trying to anchor in the open sea south of the harbor. Their position and the two missing broken arms of the southern one could indicate that during a storm they were lost by vessels which drifted to be wrecked on the shore.

The Mameluke and Ottoman Periods

Several shipwrecks dating from the last 300 years were discovered, including whole wooden hulls (Figures 3a: nos. 5, 6, 7, 8, 9,

10, 11, 12, 13, 14; 11). Numerous pottery items were uncovered at the entrance to the western basin and to the east (Figure 4b: areas A, B). They include hundreds of glazed ceramic bowls, tobacco pipes, domestic pottery vessels, iron cannonballs, and lead bullets. The ceramics point to trade relations with Turkey, Syria, Lebanon, and Egypt. Several ceramic vessels dated to the fourteenth–seventeenth centuries AD were imports from Italy.

Near the entrance to the western basin, a group of 11 upright wooden piles with rectangular cross-sections was found (Figure 12a, 12b). Additional piles belonging to this construction were probably dislodged over the years by fishermen's nets, anchors, or dredging of the harbor entrance. Dating by ¹⁴C placed them in the fifteenth century (cal. AD 1425–1460). The wood was identified as non-local European pine (Liphschitz Nili, personal communication 2002). This construction probably served as a base for a quay or a pier used for mooring large vessels (with a draught of 2 to 3 m) near the harbor

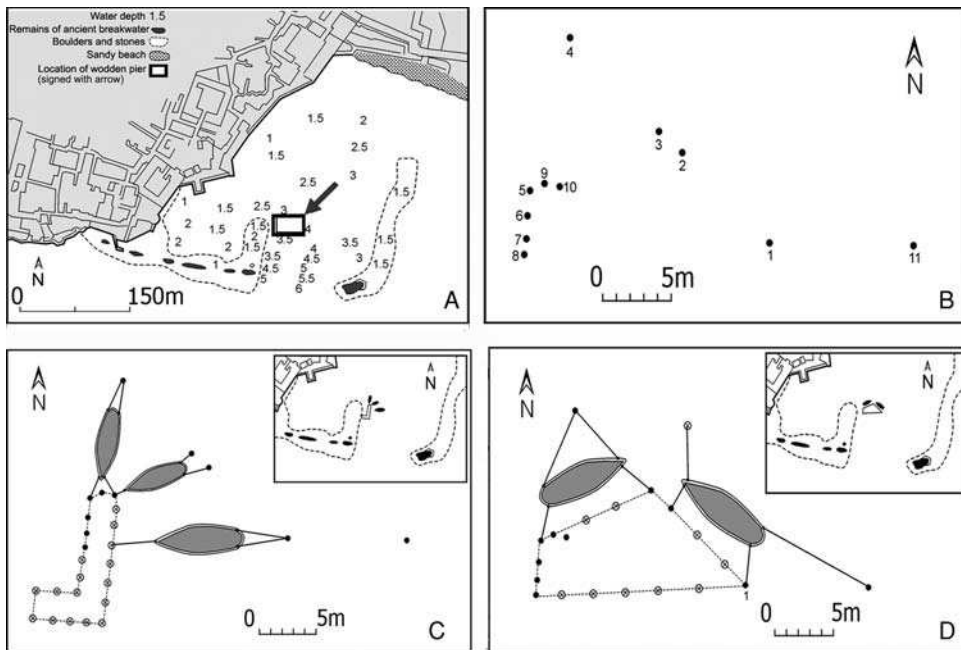


Figure 12. a) Location of the thirteenth-century wooden pier; b) plan of the pier; c and d) possible reconstructions of the wooden pier and its use.

entrance, but still in relatively deep water (Figure 12c, 12d). The structure may have been connected by a wooden bridge to the shallow rampart at the end of the southern breakwater, or it may have been completely detached from the shore.

DISCUSSION

Akko, a lively fishermen's harbor today, exists in what is basically a medieval town with an abundance of archaeological remains that should be protected and preserved. Our research here represents the long-term study of the harbor's massive construction, earthworks, and development over the past 20 years with the goal of recording the site's unique historical context.

For the Bronze Age, Iron Age, and Persian periods, Raban (1985) suggested that the Na'aman River served as an inland harbor for seagoing vessels. This idea has not yet been supported by archaeological or geomorphological evidence. The Israeli river

mouths during these periods were shallow and, as today, blocked by sandbars and were thus impassable for sea-going vessels (Galili 1986; Galili and Rosen 2008b; Porat et al. 2009; Zviely et al. 2006). Underwater research in the last 40 years indicated that Bronze Age anchorages along the Israeli Coast generally were located in areas partly protected by kurkar (calcareous sandstone) islands or sunken bars (Galili and Sharvit 1994). Based on a pottery sherd bearing a Phoenician inscription (fifth to sixth centuries BC) found out of context to the west of the harbor, and the header structure of the breakwater, it was suggested that Akko Harbor was built during the Persian period to accommodate Cambyses's fleet on its way to Egypt (Linder and Raban 1965; Raban 1982, 1983, 1993). Since no evidence for a harbor or anchorage has ever been found in the Na'aman River channel, it is suggested that the anchorage during these periods was in the lee of the promontory south of the city which was partly protected from the north

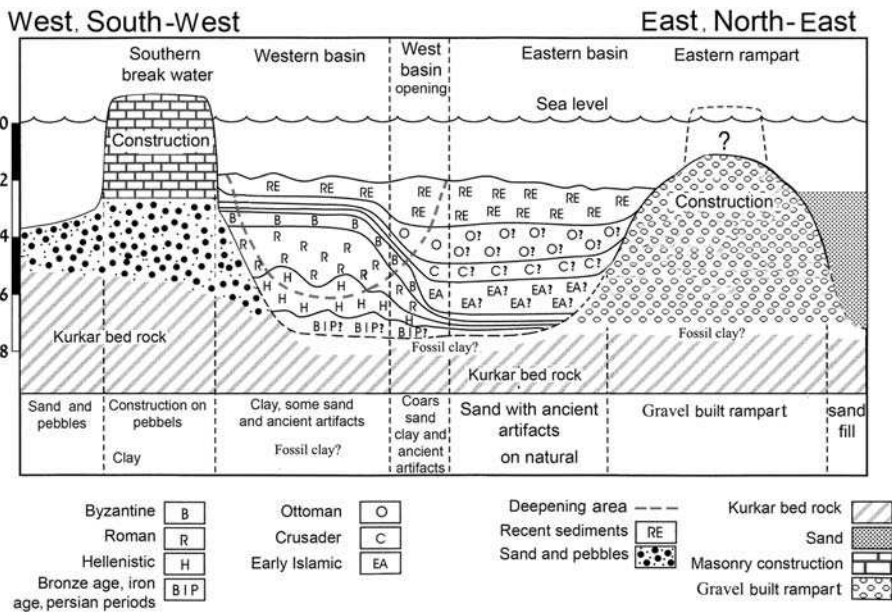


Figure 13. Schematic cross-section of the archaeological remains in Akko Port.

and north-west winds. The paucity of finds prior to the Hellenistic period suggests that the harbor had not yet been constructed (Figure 13). The absence of finds from the early periods stands in contrast to the rich findings from archaeological excavations at Tel Akko. This absence may be explained by the intensive harbor building activities since the Hellenistic period and modern deepening and dredging operations. It is also possible that such remains are still buried under thick sediments on the harbor bottom. The latest dredging carried out during the current study did not reach the kurkar bedrock as seen by the dashed line marking the deepening area (Figure 13).

Two additional small Bronze Age anchorages which provided protection from the north winds were identified on the Western Galilee Coast, north of Akko: one in Nahal (seasonal stream) Bet Ha-Emeq outlet (7 km north of Akko) and the other south of Achziv (13.5 km north of Akko). In both anchorages, stone anchors with a single hole, generally attributed to the Bronze Age, were found. It seems that in Akko and in the Western Galilee there are no submerged kurkar reefs

close to the shore to provide shelter from western and southwestern winds like those found in central and southern Israel. Thus, the anchorages on the Western Galilee Coast, including Akko, relied on east-west oriented natural raised rock features which provided temporary shelter from northern winds only.

The abundance of Hellenistic artifacts, embedded in fine silt sediment, attesting to low energy waves and good mooring conditions in the western basin, indicates that the southern breakwater was built during the Hellenistic period supporting the notion that the harbor was built at this time (Flinder et al. 1993; Gertwagen 1996; Jacoby 1979). The masonry header foundations and the early structures on the Tower of Flies were probably also built during the Hellenistic period. The port of Tyre, which was a major Eastern Mediterranean harbor, was demolished by Alexander in 332 BC, which may have encouraged the proliferation of Akko harbor.

In the Roman period, Akko harbor was the main Roman sea gate to the land of Israel until the construction of Caesarea's harbor by Herod. In 47/8 BC Julius Caesar

landed in Akko on his way to Alexandria. The biography of Herod indicates that Akko played an important role in his career. According to Josephus, Herod landed there in February 39 BC after the Roman Senate declared him king and there he drafted an army for fighting Antigonus, his rival. He met Octavian (Augustus) in Akko during the summer of 30 BC when the latter was on his way to Egypt to fight Anthony and Cleopatra (Kashtan 1988). Herod must have been aware of the critical role of Akko which was not included in his kingdom, as an access point to Rome as well as the entire Mediterranean. This may have very well encouraged him to build Caesarea harbor. In AD 56, St. Paul landed in Akko on his way from Asia Minor and the port was a base for Vespasian during the Jewish wars (Kashtan 1988). Ceramics from the harbor suggest that Akko enjoyed far-flung trade relations with Mediterranean countries in the first century AD. Luxury imports reveal that the harbor of Akko served a society that included wealthy consumers. Finds, including the hull of a medium-sized ship found in area E, indicate that maritime activity was concentrated in the western basin which was protected by the southern breakwater and provided shelter for vessels with a draught of up to 2.5–3 m. This agrees with numismatic depictions of maritime symbols and harbor constructions on Roman coins minted at Akko, including an enclosed harbor surrounded by store houses or ship sheds and possibly a lighthouse (Galili et al. 2004).

Archaeological materials dredged from the west basin bottom, at a depth of up to about 4 m contained numerous Hellenistic and Roman artifacts, from the second century BC to the third century AD. It demonstrates that at these periods, the western basin was a flourishing port with a depth of at least 4 m. The clay sediment in which the artifacts were embedded typifies a closed sedimentary basin and indicates that it was protected by an efficient south breakwater. The evidence shows wide commercial connections at this period with diverse Mediterranean regions and port cities. The amphorae corpus indicates a significant rise in the amount of trade and demonstrates the unity of the Mediterranean Basin under the rule of Rome.

For the Byzantine period, historical sources testify that there was a shipyard in the city, which was a regional center having its own Bishop. The quantity of Byzantine artifacts from the western basin relative to the amount of Roman and Hellenistic material (Figure 2b), and the discovery of broken iron anchors indicate subsequent unfavorable anchoring conditions during the Byzantine period. Due to the lack of proper maintenance after the Roman period, the southern breakwater probably ceased to protect seagoing craft, compelling sailors to anchor in the open sea. The cargo of 13 iron anchors discovered on the seabed southwest of the harbor may indicate a demand for anchors needed during the Byzantine period for anchoring in the open sea. The artifacts indicate that the main economic connections during the period were with the Byzantine Empire.

During the Early Islamic period:

Ibn Tulun saw the city of Tyre, its fortifications and the wall surrounding the port, and this is what he wanted to build in Acre. . . he hired an old architect from Jerusalem, Abu Bakr. This architect ordered the tying together of Sycamore trunks, floated them on the water according to the land fortification dimensions, and tied them together, and built upon them with stones and mortar. Each five course were tied by long stones/pillars? After the courses sunk they were left on the sea bottom for a year in order to stabilize. Then he returned to build where he had stopped. (Al-Muqaddasi 1906:162–163)

At night, the opening of the harbor was closed by an iron chain (Al-Muqaddasi 1906:162–163). To bridge so great a distance, the chain may have been suspended on floated beams or wooden barges. A similar technique was used several hundred years later by the Genoese who closed the harbor in 1258 by a chain floating on wooden beams (Gertwagen 1996). It is uncertain whether Ibn Tulun harbor was in the eastern basin which offers limited protection from the

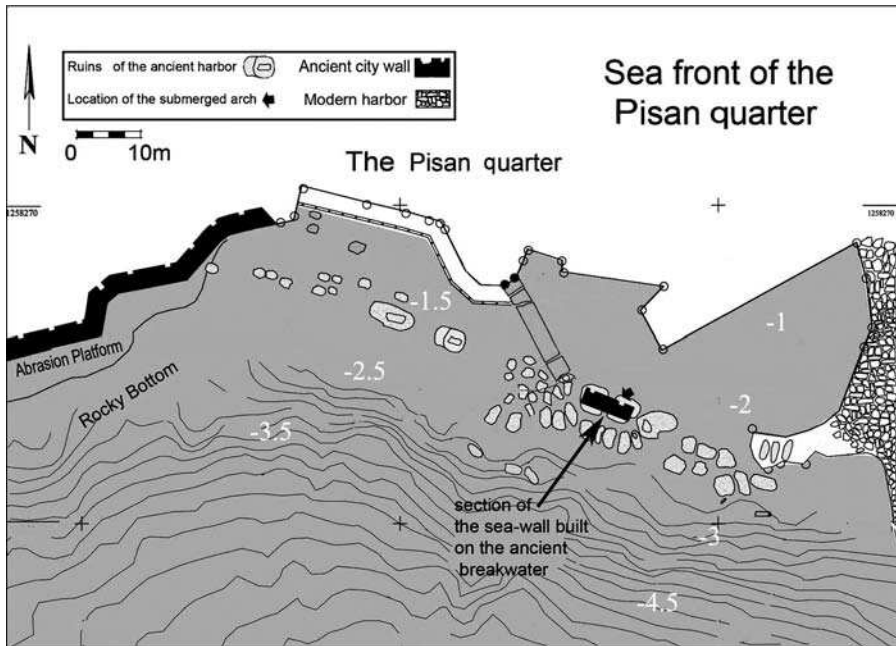


Figure 14. The seafront of the Pisan quarter, ruins of the Hellenistic-Roman breakwater, and a section of the seawall built on them (indicated by black arrow).

prevailing southwest storm winds. The nature of the eastern rampart was discussed by several archaeologists who have not yet succeeded in locating the Early Islamic harbor built by Abu Bakr. Judging by Al-Muqaddasi's description, the currently submerged eastern rampart, connecting the Tower of Flies to the shore, was thought to have been built as a breakwater during this period (Gertwagen 1996). However, underwater investigations indicated that this structure is built from loose rubble. No archaeological indications for using the construction or the methods described by Al-Muqaddasi have yet been found in the eastern rampart. Raban (1982) suggested that this rampart was built as a barrier to block sediments from the Na'aman River and prevent the silting of the harbor. He suggested that the Early Islamic harbor was located in the western basin. Gertwagen (1996) suggested that the eastern rampart was constructed as a breakwater to protect the harbor against easterly winds. However, the proximity of the eastern shore of the bay

to the harbor prevents easterly winds from raising high waves. Thus, the function of the eastern rampart as an effective breakwater must be questioned. Given the archaeological evidence to date, and the location and layout of the eastern rampart, it is proposed that it was built as an approach road for the building of structures on the Tower of Flies, and perhaps as a barrier preventing vessels from approaching the harbor from the east.

During the Crusader period, Akko Harbor was the country's major port. The numerous military, economic, and civil activities in the harbor area are well documented. Thus, the scarcity of Crusader remains on the harbor bed was unexpected. New evidence shows that during the Crusader period, the western basin was silted up due to neglect and poor maintenance, restricting most maritime activity in the bay to the partly exposed eastern basin. These conclusions support Jacoby's suggestion according to primary source (Theuderic, ca. AD 1172) that during the Crusades the western basin was shallow

East

West

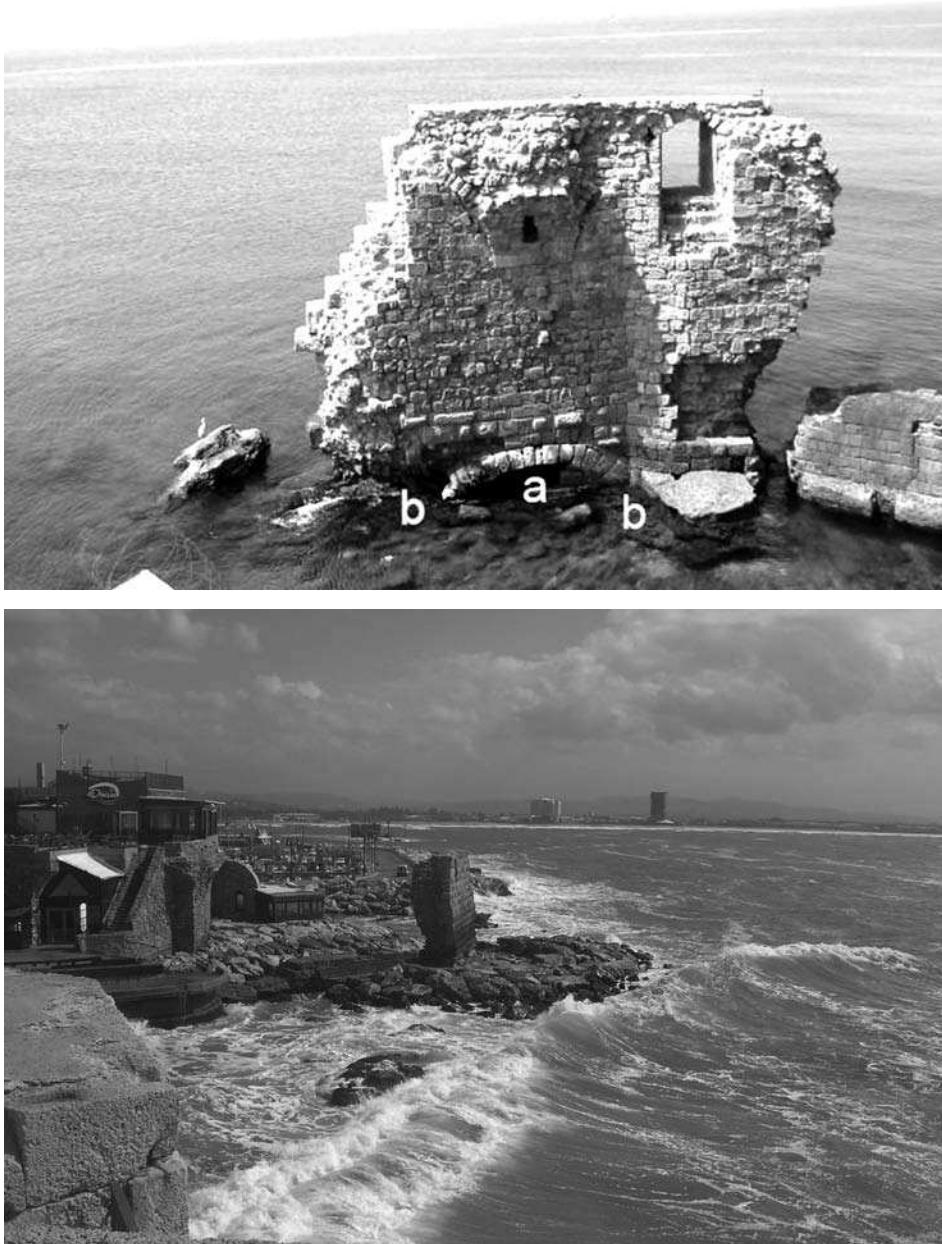


Figure 15. a) Section of the sea wall built on the ruins of the ancient breakwater. The partly submerged arch (marked by white “a”), connecting two blocks (remains of the Hellenistic/Roman breakwater and marked by white “b”). b) The sea wall after recent preservation and protection works.

and was not used by deep-drafted vessels which anchored in the open sea or the eastern basin (Jacoby 1979, 1985; Tobler 1865). The eastern basin was not dredged during the present investigation, a fact that may explain the paucity of artifacts from the Moslem and Crusader periods. Water jet drillings carried out in the eastern basin, however, indicate that the water depth in this basin could have reached up to 5 m. The delivery of a large number of iron anchors from Venice to Akko, that were to be rented to mariners, was recorded in AD 1288 (Jacoby 1985). It is suggested that the demand for reliable anchors resulted from the inability to anchor in the protected area during moderated southwestern storms. This forced ships to anchor in the open, unprotected, sea. The two large iron grapnel anchors recovered about 1.8 km south of Akko may be a confirmation of that. Large Crusader vessels had to anchor in the open sea south of the harbor, where the rocky sea bottom ensured proper anchor hold. An anchoring site in this area is indicated on Akko Harbor plans from AD 1707 and on modern nautical charts (Galili et al. 2004; Zviely et al. 2003).

The existence of a separate Pisan Harbor had been assumed by several scholars. It has been proposed that part of the south seafront of the Pisan Quarter functioned as an external anchorage, and that there was a gate to an inner Pisan Harbor, located in Khan Esh-Shuna (Raban 1982, 1993). The present underwater surveys indicate that the sea wall was built on top of the ancient breakwater remnants (Figures 14 and 15). These remnants and the later seawalls built on them blocked any potential entrance to the Pisan quarter from the south. Thus there could not have been an entrance to an inner harbor in this area (Kesten 1993).

Excavations in Akko in 1993–1994 exposed the arched ashlar tunnel leading from Khan Al-Umdan, near the harbor, to the supposed location of the Templar fortress on the west shore of Akko (Figure 2, depicted in black lines). The tunnel is about 200 m long and 3 m wide. About 100 m east of its west end, it splits into two parallel tunnels, each 1.5 m wide (Avisar and Stern 1996). The floor of the tunnel is presently under

about 0.5 m of water. Bivalve shells attached to the bottom of the channel walls indicate that it was partly flooded by seawater or brackish water, probably soon after it was constructed, and before it silted up. Several vertical grooves on the walls probably served to hold wooden partitions or cofferdams intended to cut off and seal portions of it. It was suggested that the tunnel could have served as a strategic subterranean passage (Stern Eliezer, personal communication). Normally it may have been used to convey materials and passengers from the harbor to the Templar fortress, as a sewer outlet, or both. The lower part of the tunnel was excavated in the kurkar to a level ensuring partial flooding by groundwater mixed with seawater on which rafts or boats carrying goods may have been floated. The cofferdams enabled tunneling and maintenance below sea level. Thus, the flooded tunnel floor indicates that during the Crusader period, sea level was similar to that at present. Underwater and coastal surveys carried on the western seafront show that the tunnel did not reach the sea at its western end (Sharvit and Galili 2002). The use of canals to convey goods and passengers was already known in medieval Europe; the Naviglio Grande canal was built between AD 1179 and 1209 to bring marble from Lake Maggiore to Milan Cathedral (Majo 1999). As such, the use of a hidden underground canal supplying a medieval fortress through a hostile quarter is not surprising.

During the Mameluk and Ottoman periods, iconographic evidence and archaeological finds indicate that large deep-draught vessels anchored in the partly protected eastern basin and merchandise was transported from the ship to shore by small boats. After AD 1291, Akko was razed by the Mamelukes, and the remaining, already neglected, harbor facilities were probably destroyed and blocked to prevent the return of Christians. Nevertheless, testimonies by travelers and pilgrims who visited the harbor of Akko indicate that despite the destruction, the harbor continued to function during the fourteenth and fifteenth centuries (Shur 1990:161–163). The previously destroyed shrunken city contained warehouses of Venetian traders arriving from Damascus who exported cotton

to Europe through the harbor. The Post-Crusader Italian ceramics and ceramics testifying to connections with Venice found in Tel Yassaf, 4 km north of Akko (Stern 1999), may support the written sources and indicate that cotton-trading activity from Akko harbor continued after the Crusader period. The wooden pier discovered close to the entrance to the western basin was probably built in this period for the cotton trade and for loading and unloading local merchandise and passengers. This pier probably replaced the facilities destroyed by the Muslims and the neglected, non-functioning silted-up harbor. Similar installations, consisting of rows of wooden pillars of similar size and shape, were found in the northern bay of Atlit (Galili 1986; Rosen et al. 2004) and west of Tel Ashkelon. The Atlit structure was dated to the twelfth to thirteenth centuries AD and the one at Ashkelon to the fifth–sixth centuries AD. The construction of wooden marine installations is an uncommon occurrence in the material culture of the area, where large trees are rare and costly. In the early Islamic period, the local timber available for marine construction in Akko was sycamore which was useful as a temporary frame for stone construction because it decayed fast under water, thereby allowing the stone-built superstructure to settle into the seabed. For the very same reason it was useless for permanent wooden marine structures. Evidence of imported timber from Europe for building breakwaters was uncovered in the Roman harbor at Caesarea and the Byzantine harbor at Tiberias (Brandon 1996). There the timber was used in the construction of wooden forms, into which cement was poured. Evidence of a Roman period dam constructed of timber was recently uncovered in excavations at Nahal Tanninim north of Caesarea. Such building techniques and construction materials were apparently imported to the region from Europe by the Romans and the Crusaders. But later, during the Islamic conquest, the use of timber in marine construction decreased and knowledge of the technology was probably lost. Medieval construction of wooden marine installations is known from Alexandretta Bay, where a harbor called *Portus Palorum* (*Porto Pali* in Italian) was built

at ancient Mallus, near the trading city of Ayas (Italian Layazzo, now Yumurtalik) (Mutafian 1993:119–126). Depictions of Akko harbor in a drawing from AD 1686 and in maps from later periods indicate that at the end of the seventeenth century, large buildings, which did not survive long, were erected on the southern breakwater.

CONCLUSIONS

The archaeology and geology of Akko area indicate that the region has been tectonically stable for the last 2,200 years. No significant vertical tectonic or sea level changes ($> \pm 25$ cm) have occurred in the area (Galili and Sharvit 1998; Sivan and Galili 1999). In the southern seafront of the Pisan Quarter, an ashlar-built arch partially sunk in the sea is visible in a section of the sea-wall that was built on the ancient breakwater remnants (Figure 15a). Previous researchers have used this arch as a sea level marker for Crusader times, suggesting that sea level was 1–2 m lower than today (Flemming et al. 1978; Gertwagen 1989, 1996; Neev et al. 1987). Recent underwater research indicates that this arch bridges a 2 m wide gap between two underwater blocks remaining from an ancient breakwater and that there is no ashlar-built opening under the arch (Figure 15b). Rather the arch supported the foundations of the sea-wall over the gap (Figure 14). Thus this arch is not a good indicator for sea level rise or tectonic subsidence.

During the Bronze Age, Iron Age, and Persian period, Akko Bay was probably used as a natural anchorage. The harbor was constructed in the Hellenistic period. The distribution of finds reveals shifting of the marine activity from the western basin in the earlier periods to the entrance of the modern harbor and outside it, to the partially protected eastern basin in the later periods. Most finds from the Hellenistic and Roman periods were recovered from the western basin. Numerous Byzantine artifacts recovered at the entrance of this basin may indicate intensive marine activity in this area during that period, or may come from a single shipwreck. Crusader remains were retrieved

mainly near the entrance to the western basin. This distribution attests to fundamental changes in the anchorage conditions inside the harbor, with siltation preventing deep-draught vessels from entering the western basin. Archaeological finds indicate that the western basin reached the peak of its prosperity during the Hellenistic and Roman periods. The Byzantine period saw a worsening of the anchoring conditions, and the southern breakwater seems to have deteriorated severely by that time. After the Byzantine period the western basin apparently silted up further so that only small vessels were able to use it. The eastern rampart was constructed from gravel and field stones to allow passage to the Tower of Flies for construction purposes and possibly to hinder vessels from approaching the harbor from the east. During the fifteenth century AD a mooring facility using wooden pillars was constructed close to the entrance of the western basin. At the end of the seventeenth century CE, large buildings, which did not survive long, were erected on the southern breakwater.

As noted in our introduction, Akko is a classic and historically significant fortified Mediterranean coastal city. It has functioned for roughly 5,000 years as one of the main centers of maritime trade and other activities in the eastern Mediterranean. Archaeological studies of the historical development of Akko Harbor provide a wealth of information about the history of the city and the maritime foundations of its economy. A planned coastal development in the port of Akko which will exceed the layout of the ancient harbor will interfere with highly significant archaeological resources that should be preserved for future generations and further research.

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