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The Effects of Coastline and River Changes on Anchorages, Harbours, and Habitation Patterns

The case of Akko

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At the ancient site of Akko/Acre, positioned on the northern side of the Haifa Bay, habitation patterns and anchorage locations changed over time. Causes for this are attributed to ecological and geomorphological fluctuations as well as the impact of human processes. The area is influenced by the silt deposited by the River Na'aman, and coastal sedimentation controlled by littoral currents. Akko/Acre is a UNESCO World Heritage Site and one of the oldest continuously inhabited sites in the area. This article reviews a variety of attempts using ground penetrating radar, electric resistivity tomography, coring, and limited archaeological excavations, to reveal the changing locations of anchorages and harbours, and link these to variations in habitation patterns.

Keywords: Akko/Acre, harbours, anchorages, coastal geomorphology, habitation patterns.

Tel Akko is one of the earliest settled sites in the coastal Levant and is presently located about 1.5 km east of the coast and the centre of current-day Akko (Fig. 1). The site is known by the local inhabitants not as Tel Akko but by another name, associated with a legacy of the European imperialism of the late 18th century: 'The Hill of Napoleon'. In 1799, Napoleon Bonaparte laid siege to the coastal site but failed to conquer its walled city. It is assumed that he used the tell as a gun emplacement, although he probably never climbed it himself (Artzy and Quartermaine, 2016). Tel Akko was closely associated with the River Na'aman, Belos (or Belus), as it was known in antiquity, which today is an almost artificial canal, the water within which is used up before it reaches the sea. However, in the past, it had a much more important role in the area, as did the sands transported by the sea along the coast and used for the production of glass (Pliny,



Figure 1. Akko, with the tell in the centre (Photo M. Artzy).

NH 36: 190-191).¹ Although Pliny's account is dated to the 1st century CE, we assume that Akko sands were used for glass production in earlier periods, as well.

Furthermore, there are signs of human activity in the form of ceramics dating to c.3000 BCE at Tel Akko. In the middle of the MBIIa Period, slightly after 2000 BCE, major urbanization took place on the tell. This urbanization included a fortification in the form of an impressive rampart and at least one gate of this date in the north-western corner of the site, named 'The Sea Gate' by its excavator, Avner Raban (Dothan and Raban, 1980). The tell then remained an urban site for at least 1.5 millennia, with multiple changes in the activities carried out there over the centuries. The rampart was renewed and altered to accommodate the changes in habitation patterns on the tell. In its third phase, still in the Middle Bronze Age, the rampart, in the north, reached a height of over 25 m and a width of 60 m (Artzy and Be'eri, 2010). Today, when viewed from above, the shape of Tel Akko is reminiscent of a crescent with its summit located in the centre of its northern edge, some 27 m above sea-level.

The name of Akko may appear in the Ebla tablet texts, dating to c.2400-2250 BCE (Matthiae, 1981: fig. 9). Akko is one of several coastal sites, including Byblos, Sidon, Dor, Ashdod, and Gaza, on the itinerary of a merchant from Ebla who travelled along the coast of the eastern Med-

iterranean, although no archaeological remains dating to the Early Bronze II or III periods, contemporary to the apogee of Ebla, have so far been located on the tell. Akko and its Semitic ruler were mentioned among other Canaanite rulers in the early 2nd millennium BCE in the Egyptian Execration Texts (Posner, 1940: 31-34). It was mentioned several times in the 2nd millennium BCE. In the Amarna letters, dated to the 14th century BCE, Akko's kings (father and son) and Akko itself are mentioned in missives sent to the Pharaohs in Egypt (Artzy and Quartermaine, 2016; Artzy, 2018). Akko is mentioned in the Old Testament as a city 'not inherited' by the Israelites, but one that they settled among the Canaanites (Judges 1: 31-32). In the 1st millennium BCE, it is mentioned in various sources, including by the Assyrians and the Persians, who used it as an anchorage (Artzy and Beeri, 2010). The area of Akko underwent several name changes over many centuries, but the original name remained Akko or similar (Artzy and Quartermaine, 2016). During these periods, Akko was already part of the Levantine-coast economic network, as attested by the discovery of imports from Egypt, Cyprus, the Syro-Lebanese coast, the Aegean, and beyond, and noted as a result of excavations carried out since the 1970s (Dothan, 1976). These imports indicate that Akko and Haifa-Akko Bay formed a strategic link between maritime trade and a terrestrial route leading eastward to the Jordan Valley and on to Transjordan (Dothan and Raban, 1980; Artzy, 2006; Artzy and Be'eri, 2010). One possibility to be entertained is that, at least in the 2nd millennium BCE, Akko functioned as the anchorage for Beth Shan (Beit She'an), serving Egyptian interests (Artzy, 2018).

The site, especially its northern edge, attracted the attention of archaeologists from the 1930s onward. In 1935, William Badè visited Tel Akko, intending to start

1 'That part of Syria which is known as Phoenicia and borders on Judea contains a swamp called Candebia amid the lower slopes of Mount Carmel. This is supposed to be the source of the River Belus, which after traversing a distance of five miles flows into the sea near the colony of Ptolemais ...The river is muddy and flows in a deep channel, revealing its sands only when the tide ebbs ... The beach stretches for not more than half a mile, and yet for many centuries the production of glass depended on this area alone...' (Pliny, NH 36: 190-191).

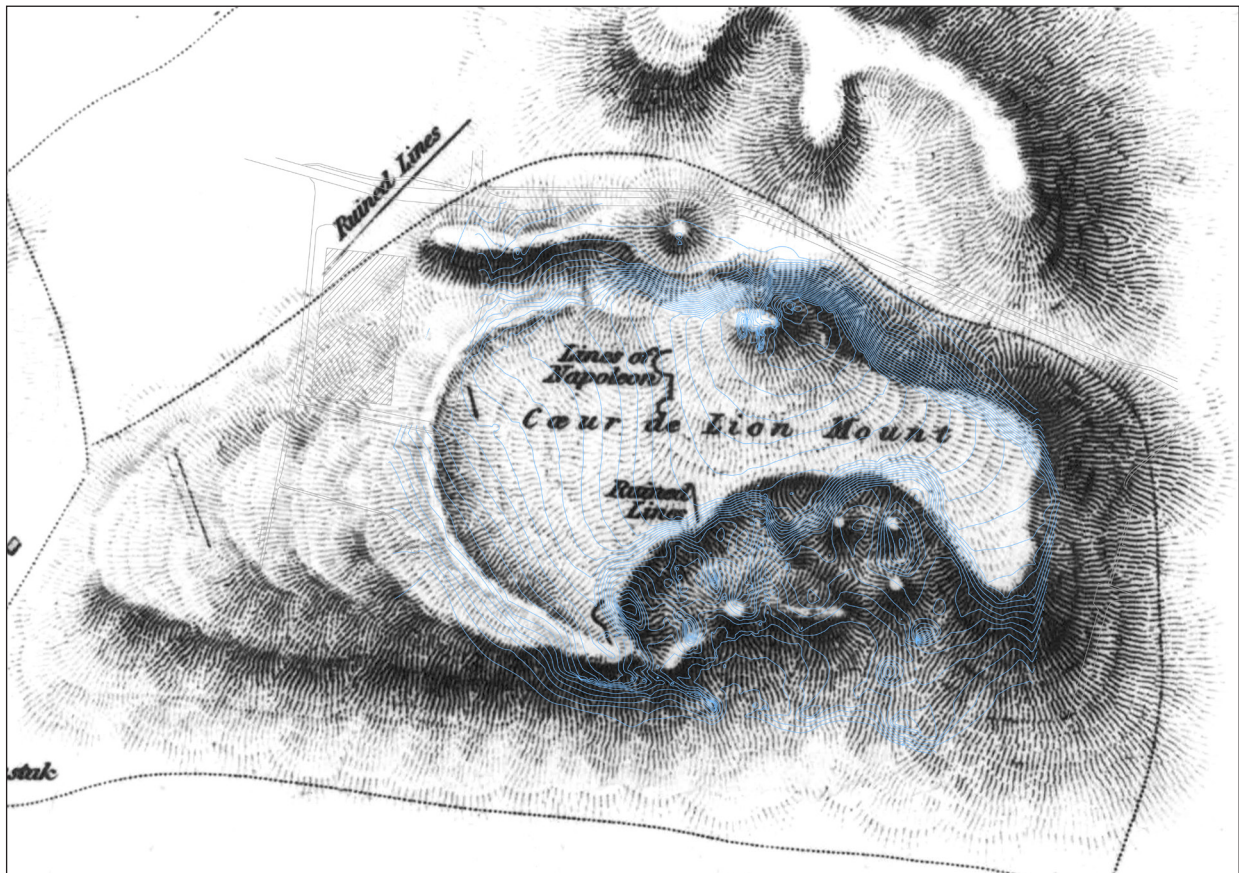


Figure 2. Tel Akko map superimposed on an 1841 map (Illustration J. Quartermaine).

excavation of the tell in 1936. He died shortly after: the photos from that visit are located in the archives of the Badè Museum at the Pacific School of Religion in Berkeley, California. It was only in the 1970s that the first excavations took place under the direction of Dothan, who had joined the ranks of the University of Haifa. Dothan's excavation was centred at first on the summit of the tell: only in later seasons did he expand towards the west, still concentrating on elements associated with the rampart. He sectioned the northern part of the rampart in an attempt to understand the ancient methods of construction of such monumental structures. At present, an educational project called Total Archaeology, directed by A. Killebrew and M. Artzy, is underway.

New studies indicate that the artificial rampart did not surround the site and that its shape was not oval or round as had been previously assumed (Artzy and Quartermaine, 2014). Questions as to its extent will have to wait for definitive answers, but methodical research presently being carried out on the landscape of the tell and its surroundings is slowly unravelling its construction techniques. What is now clear is that earth-removal works blamed on the British mandate in the 1940s were

limited in scope. Indeed, the shape of the tell has been similar to the present form since as far back as the mid 19th century or before (Fig. 2). In a pit survey carried out by the Total Archaeology project, a stone rampart or retaining wall was noted in the inner basin dating to the Persian Period (Artzy and Quartermaine, 2014).

While some archaeological questions have been answered by past projects, the present Total Archaeology research programme promises to reveal many more. These mainly relate to the habitation patterns on the tell and how the geomorphological evolution of the bay and the river affected them, and the subsequent relationships between coast and sea both south and west of the tell. Hence, we aim to understand more about the shifting positions of the anchorages and harbours of this coastal site.

Tel Akko and its settlement history

The earliest noted settlement at Tel Akko is dated to the Early Bronze Age I period. It was found on a *kurkar* outcrop situated on the border of the inner southern depression of the tell, facing southeast, in Area S (Fig. 3). The data from the Total Archaeology project and an unpublished minor

survey carried out during the Dothan project in Area S mainly concern the ceramics found, rather than on any substantial architecture or clear stratigraphy. A concentration of Early Bronze I ceramics, as well as slight remains of walls in that area, indicate that some habitation activity took place there. The first interventions, substitutions, and transformations of the pristine ecosystems at Akko, promptly followed the earliest architectural structures, dated from the Middle Bronze Age IIA (c. 4000 BP). As the city rapidly developed with ramparts, buildings, industrial areas, and massive fortification, changes in the ecology also took place (Kaniewski *et al.*, 2013; 2014). An outstanding feature of the recorded urban environmental history of Akko/Acre is that the area rapidly shifted from resilient Mediterranean open forest to an open shrub steppe between c.3900 and 3300 years ago. In the same study, it was noted that during the first millennia of human occupation, there was a sharp decrease in agricultural productivity at 3250-3200 BP. This is associated with a slackening of the economy and reduction in habitation, showing that a drier period may have constrained the rate of urban growth and the economy. The period is also associated with sea-level rise.

A working hypothesis is that, at least in the earlier periods, the abandon of a given area of habitation was related to the position of the river estuary on the southern edge of the tell, or the coast, or both. This agrees well with the archaeological remains on the tell as very few of the excavated areas, if any, have a continuous chronological stratigraphy from the latest to the earliest periods. The changes in the outline of the bay followed ecological fluctuations. Whether the changes are human induced, due to fluctuating precipitation, the influx of sediment from the River Na'aman, or sedimentation from the littoral zone, all are parameters for understanding and trying to reconstruct the spatio-temporal transformations in the area. A salvage excavation, Area T (Fig. 3), carried out by the Israel Antiquities Authority (IAA), directed by Abu-Hamid and Artzy on the southwestern foothill of the tell, showed that, at least during the second part of the 1st millennium BCE, an active coastline was present (Fig. 4) (Artzy, 2012). As noted above, research undertaken more recently (Morhange *et al.*, 2016; Giaime *et al.*, 2018), supports the fact that the bay and the estuary were located southwest of the tell.

Geomorphology

Coastal Israel and the eastern Mediterranean, in general, have seen dynamic geologic, ecologic, geomorphic, and environmental changes over the past 11,000 years. These changes have been documented by a number of comprehensive overview studies along the northern Israeli coast (Sivan *et al.*, 1999; Sivan *et al.*, 2001; Kadosh *et al.*,

2004; Sivan *et al.*, 2004a; Sivan *et al.*, 2004b; Cohen-Seffer *et al.*, 2005; Zviely *et al.*, 2006; Avnaim-Katav *et al.*, 2012), all of which document near-shore coastal processes and changes in sea-level that have modified and actively shaped the coastline (Barkai *et al.*, 2018). The major phases of erosion, deposition, and accompanying transformations in the coastal landscape have dynamically altered the environment, and these changes have been accompanied by vacillations in marine, intertidal, and more protected coastal areas along the shore. Previous studies that focused on the coastal plain south of Mount Carmel and the modern city of Haifa have shown that some of the most dynamic changes have occurred in the past 6000 years, after sea-levels stabilized near their present level (Zviely, 2006; Zviely *et al.*, 2006). Geomorphic studies suggest that for this 6000-year period, relative sea-level stabilized near the present mean sea-level, which allowed coastal progradation in the bay of Haifa. The area was a coastal marsh or embayment, but periodically these environments were inundated with sediment as aeolian dunes prograded seaward (Zviely, 2006; Zviely *et al.*, 2006).

Pertaining to the Akko area, the River Na'aman meandered on the southern outskirts of the tell, where it changed its course numerous times, depositing clay in the vicinity of the site. Sediment influx and coastal processes and shoreline changes contributed to coastal progradation, especially on the eastern and southern part of the tell. This is made evident by the changes of habitation patterns on the tell itself as well as the area between the tell and the present 'Old City' of Akko, near the modern coast and the modern fishing harbour. Geomorphological studies have contributed to the general understanding of the area (Inbar and Sivan, 1984; Sivan *et al.*, 1999; Kadosh *et al.*, 2004; Sivan *et al.*, 2004a; Zviely *et al.*, 2006). Renewed studies are rechecking some of the earlier conclusions (Morhange *et al.*, 2016; Giaime *et al.*, 2018). Electric resistivity tomography (ERT) tests are presently being carried out by a team from the Worley Parsons Company in Canada headed by P. Bauman: Ground Penetrating Radar (GPR) is being carried out by H. Jol and Y. Salmon: and coring analysis and Optically Stimulated Luminescence (OSL) are being carried out by G. López.

The formation of Tel Akko is of special interest when looking at the habitation patterns. The coastal area has undergone extreme changes over the millennia. Zviely *et al.* (2006) have shown that the area was inundated in the early Holocene. The sandstone *kurkar* ledges in the southern depression noted by A. Raban (1991), were probably islands at that time, formed in the process of the inundations and the receding coastline, or the eroded evidence of once-elongated *kurkar* ridges. While some of these 'islands' are small *kurkar* hills, ERT tests carried out by P. Bauman and his team (Artzy, 2012), showed that

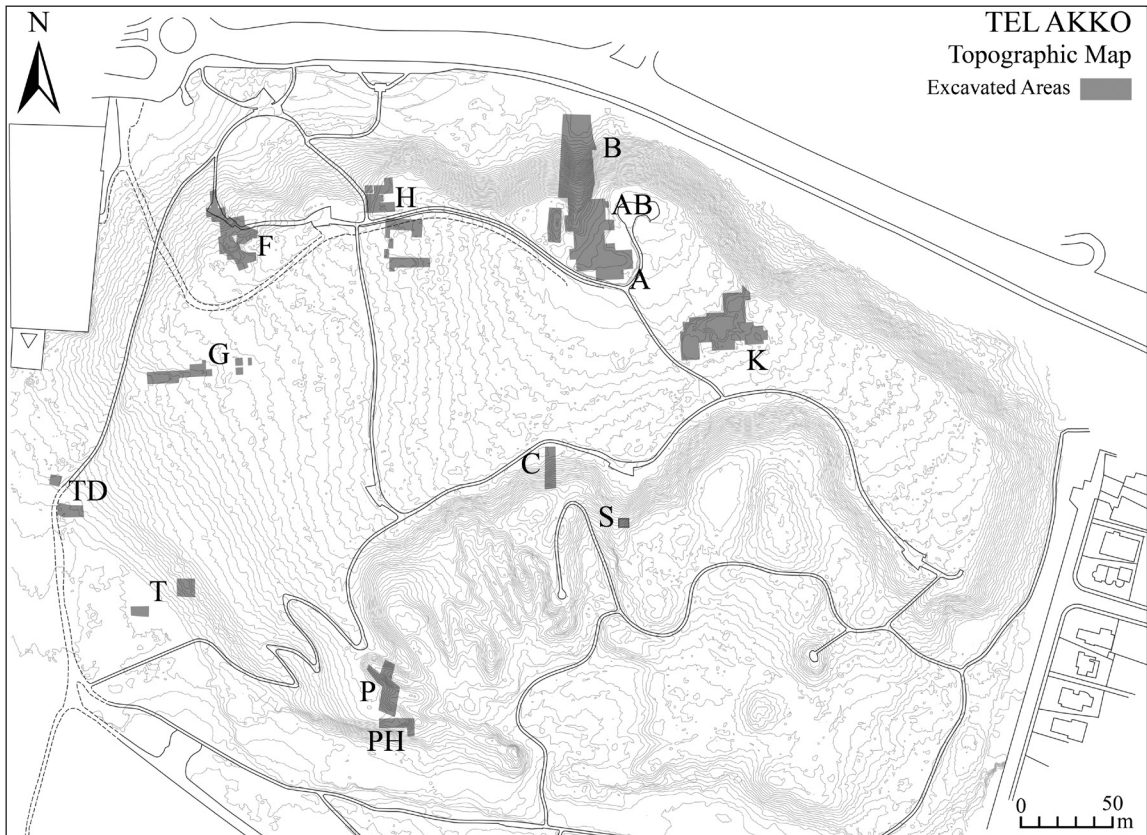


Figure 3 (above). Tel Akko excavated areas (Map J. Quartermaine).

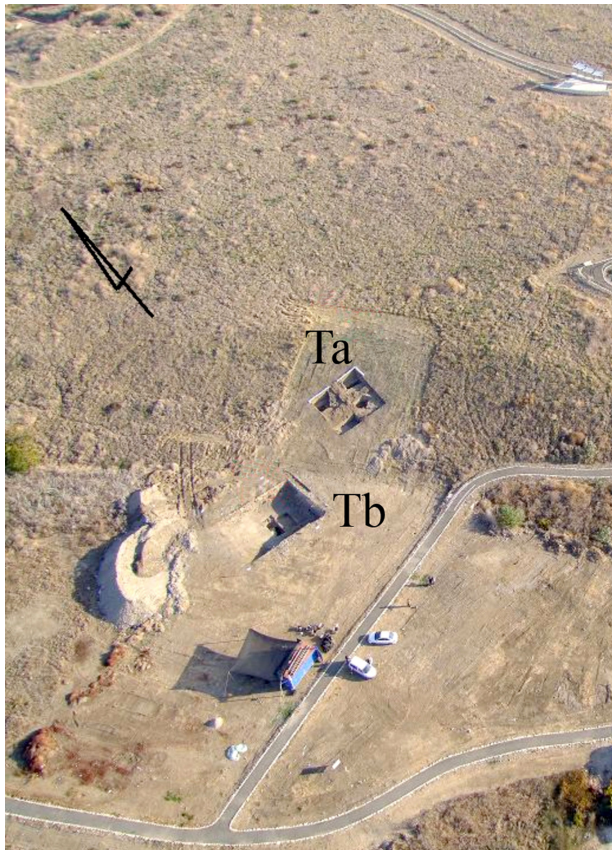


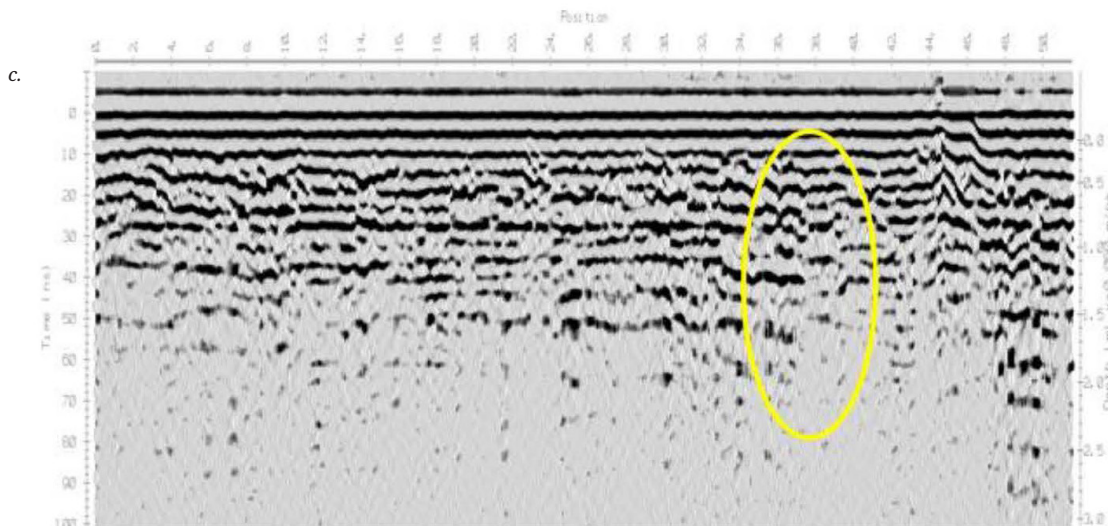
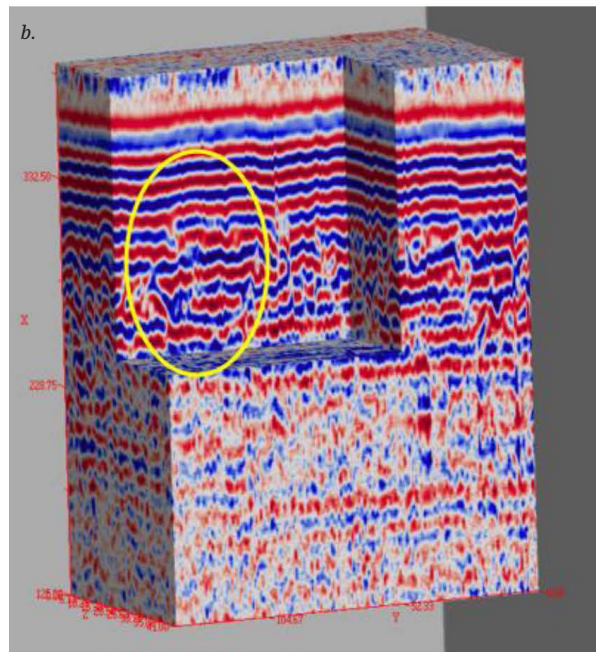
Figure 4. An active coastline below Tel Akko was seen in Area T excavations (Photos A. Abu-Hamid and M. Artzy).



some of these residual ‘islands’ do not protrude above the present land surface and are rather large, especially one situated on the northern side of the tell, near its summit. The highest part of the MBA rampart inclines towards the buried *kurkar* ‘island’ or a large sand dune and was most likely supported by it. A similar pattern of residual ‘islands’ can be observed in the Achziv area, just north of Akko, where they are situated in the sea near the shore.

The exact causes of changes in the Akko area, whether related to anthropogenic environmental disruption, changes in sediment influx along the coast, or climate change, or a combination of these, have yet not been determined. It is apparent that this coastline has seen very dynamic environmental changes in the past and will continue to do so in the future, as can be seen by comparing a map drawn by Joseph Treidel in 1925-1926 to the recent coastline; it is apparent that changes in sea-level and reduced sediment transport are causing areas on the coast to be inundated anew (Artzy, 2012).

Figure 5. a) Ground Penetrating Radar grid data collected on the southern portion of Tel Akko using a Sensors and Software pulseEKKO system with 225 MHz antennae; b) three-dimensional rendering of the collected grid data using Golden Voxler software showing the subsurface stratigraphy, with the yellow oval highlighting the possible area where the kurkar plateau drops off/ is eroded; c) two-dimensional transect highlighting the horizontal to sub-horizontal, continuous to semi-continuous subsurface reflections, which are truncated at approximately 37 m along the transect. The area outlined in yellow shows where we interpret the kurkar plateau is truncated. A coring programme has confirmed the significant change in kurkar depth below the surface in this location of the tell (Prepared by H. Jo).



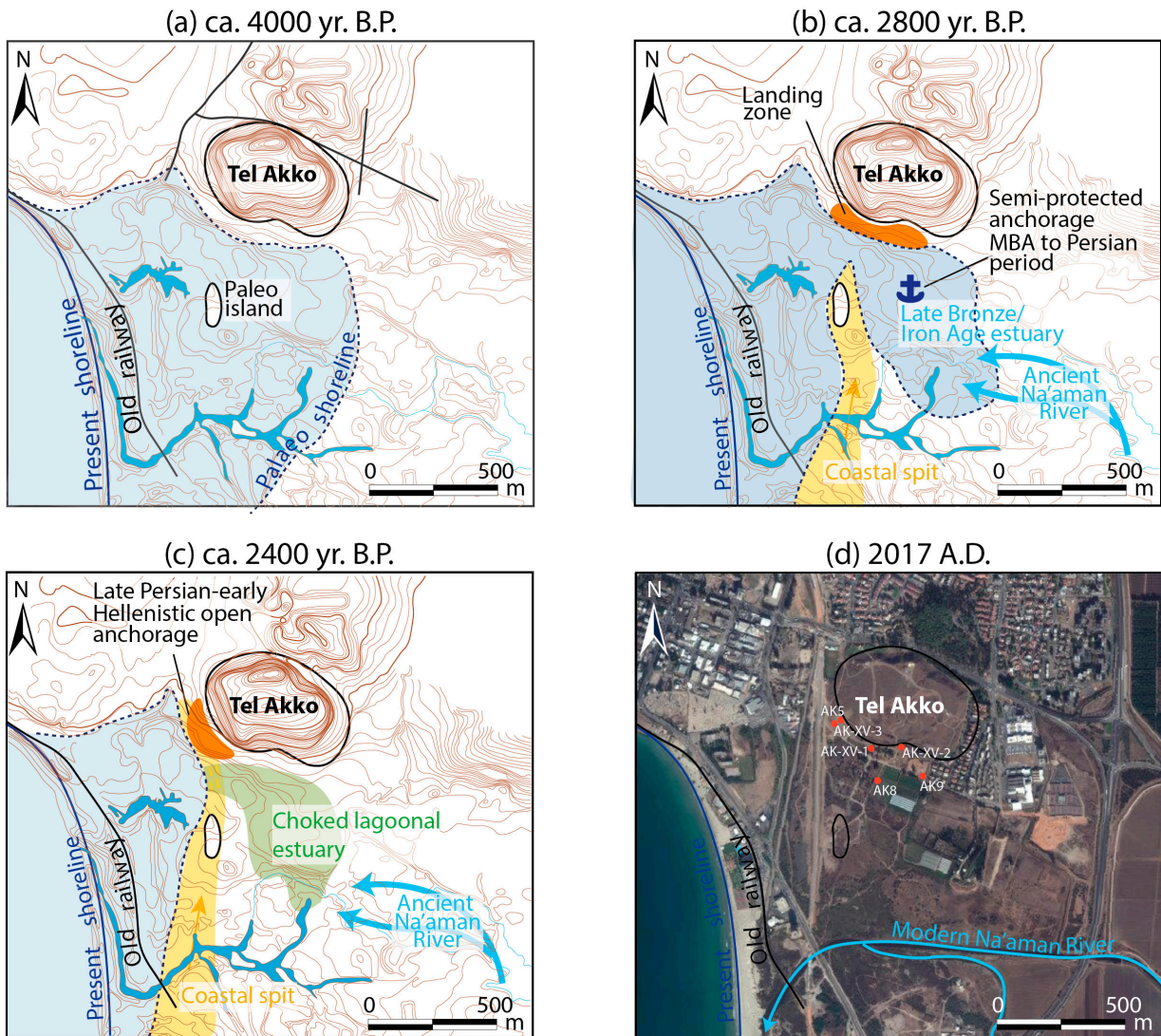


Figure 6. Proposed changes in the bay (Prepared by M. Giaime).

The search for the anchorages

For the Bronze Age, the 2nd millennium BCE, Raban proposed an inner harbour in the inner basin of Tel Akko (Raban, 1991). This suggestion followed a model he proposed in which he showed that many of the coastal sites of the Bronze Age were situated near river estuaries. In his 1991 article Raban states that:

...sea level, stabilized at a relatively high level, flooding the low lagoonal areas around the tell, i.e., the extracting activity might have helped keep the area at the foot of the tell to the south and south west deep enough for navigation, all the way to the anchorage that lay within the protection of the city's rampart. (Raban, 1991: 32)

This hypothesis was based on the fact that most of the southern Levant's coast lacked protective bays, and thus many of its anchorages were dependent on rivers. There is no doubt that Akko played a major role in the eastern Mediterranean maritime trade in the early 2nd millennium BCE (Dothan, 1976; Marcus, 1998).

Our studies, which included coring in Raban's 'inner harbour', negate the inner-harbour theory. We found that the bedrock, the *kurkar*, is far too high and hence the water column too shallow for any boat, even a barge, to enter the area – even at the high sea-level

Raban suggested. The research, along with GPR surveys and coring, showed that, just beyond the depression, a rapid drop in the *kurkar* was noted (Fig. 5), precisely in an area where the bay or river could have been present in the Middle and likely Late Bronze Ages, and that boats could have sailed from the coast towards the tell, but not into the depression (Artzy *et al.*, 2014). Detailed sediment-core analyses substantiated this possibility (Morhange *et al.*, 2016; Giaime *et al.*, 2018). Raban (1991) also published interesting results following his archaeological excavation in Area P at Tel Akko in the 1980s. Among the architectural remains is a massive structure that he interpreted as a gate. If we accept his interpretation, this monument would have been the entrance gate to the site from the sea, lagoon, river, or estuary present at the time, an important addition to understanding Bronze Age Tel Akko as a true coastal site. The limited number, state, and typological identification of ceramics retrieved from some of the sediment cores collected in this southern area of the tell (Fig. 6) indicate that in the 2nd millennium BCE, activities took place in this area associated with the bay below the tell (Giaime *et al.*, 2018).

The Phoenician/Persian harbour?

This brings us to the question as to where the 1st millennium Phoenician or Persian harbour was situated. For many years, the accepted notion was that the mid 1st-millennium harbour was built somewhere near the modern small harbour of Akko. It was surveyed and partially excavated by Linder and Raban in the mid 1960s (Linder and Raban, 1965; Raban, 1993b; 1993c). Work was concentrated on a tower, named the ‘Tower of Flies’, which is still a landmark feature in Akko bay. Raban dated the construction of the tower, built in the Phoenician style, to the mid 6th century BCE and felt that the construction of the harbour was part of Persian king Cambyses II’s effort to conquer Egypt. Raban (1986) further stated that only minor modifications were made in the later Hellenistic period. There is no doubt that the tower was, at its base, constructed in the ‘Phoenician manner’, but the dating of such a construction could be as late as the Hellenistic period. Dredging carried out by the IAA team headed by Ehud Galili collected pottery dating mainly from that period (Galili *et al.*, 2010). Further archaeological data from the area surrounding the assumed harbour indicated that it was not developed until the Hellenistic period (Artzy, 2012). ‘Phoenician-type’ harbours continued to be constructed in the southern eastern Mediterranean well after the Phoenician Period. One example is the harbour at Amathus, Cyprus (Empereur and Verlinder, 1987; Empereur, 1995; Empereur *et al.*, 2018) that, despite showing some Hellenic elements, was still mainly constructed in the Phoenician style in about

300 BCE. Raban noted similarities in the construction of the two harbours (Raban, 1993b). Cambysis, in the 6th century BCE, may have stopped in Akko on his way from Tyre to Egypt, but Akko’s importance to the Persians is attested only in the 4th century BCE, at the time of Artaxerxes II (Gambash, 2012; 2014).

In Dothan’s archaeological project at Tel Akko in the 1970s and 1980s, rich remains from the later Persian Period (late 5th-4th century BCE), as well as numerous imports from the Aegean world, were found (Artzy and Be’eri, 2010; Dothan, 1976; 1985a), especially in Area F (Raban, 1993a). On the summit of the tell, a Phoenician *ostrakon*, the longest ever found, was unearthed (Dothan, 1985b). More Phoenician *ostraca*, not yet published, were found in a later project and in other areas on the tell. The extent of the Phoenician or Persian settlement area on and around the tell indicates a major expansion, due probably to the Persian interest in Akko’s strategic coastal position in their quest to conquer Egypt. This phenomenon was corroborated by the results of the present Total Archaeology project.

Historical records describe Akko as one of the sites where the Persian army and mercenaries, especially Greeks from Western Anatolia and the Islands who were under Persian command, gathered (Gambash, 2012; Gambash, 2014; Diod. Sic. XV.41). Akko was indeed a major hub in the eastern Mediterranean trade network during that period. The wealth of imports found on the tell further accentuates the problems associated with having the harbour 2 km from the main habitation area of the period, namely on the tell: a partial testimony is the many Aegean stamped-handles found on the tell and in its vicinity (Finkielsztejn, 2000). The town moved down to the peninsula, the old city of Akko/Acre, sometime in the 3rd-early 2nd century BCE. The coins found on the tell date only up to the early part of the 2nd century BCE. Following its abandonment, the tell was not inhabited during the ensuing centuries, including the Roman period, until the Crusader times in the 12th century CE, when the Templar Order built a fortress, named Toron, on its top where gardens and vineyards were tilled (Artzy, 2015).

While no clear architecture and a minuscule number of ceramics dating to the Roman period have been found on the tell, some Crusader-period ceramics were noted (see Antaki-Masson, this volume) alongside later Hellenistic finds (2nd century BCE), north of the peninsula (Abu-Hamid, 2012). In these areas, following salvage excavations carried out by the IAA Roman and early Byzantine finds were reported (Feig, 2011; Tatcher, 2011; Abu-Hamid, 2013). A part of a Roman road, likely connecting the city with Damascus, was also noted (Finkielsztejn, 2007). A large Roman cemetery was found in the northwestern foothill of the tell (Tepper, 2010). It was of no surprise that in an underwater excavation carried out by J. Sharvit of the IAA, Hellenistic harbour installations dating to the 3rd-1st

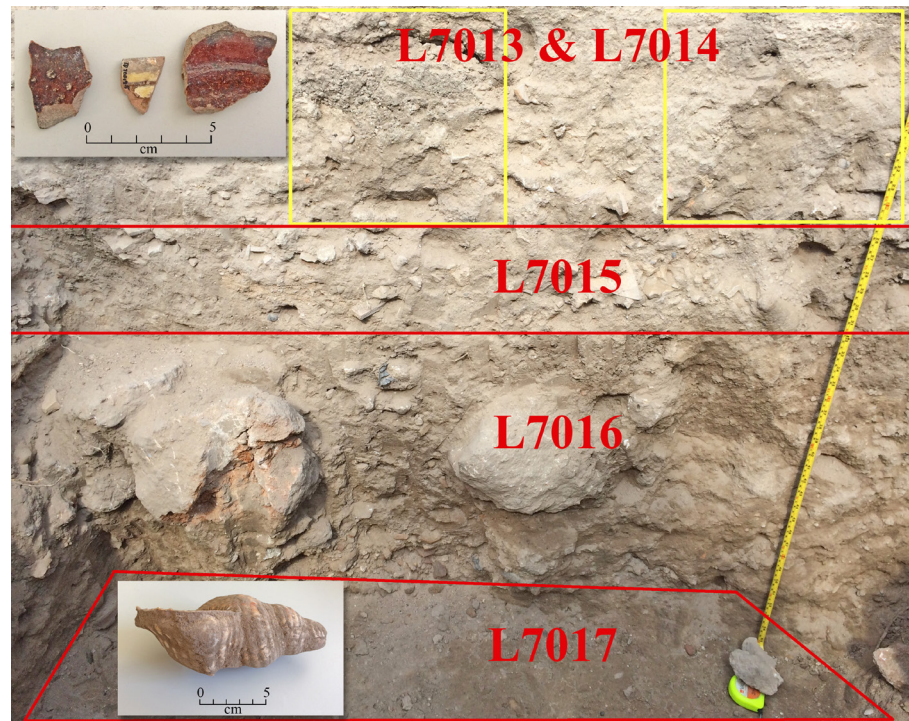


Figure 7. Area TD section (Photo M. Artzy. Prepared by R. Stidsing).

centuries BCE were located (Sharvit *et al.*, 2013). A lecture delivered at the American Schools of Oriental Research Annual Meeting in 2018, on the pottery found in constructed harbour installation, corroborate the later Hellenistic dates (Ratzlaff, 2018: 83; Constantine, 2018: 82-83).

Following the salvage excavation in Area T, mentioned above, and more recent studies (Morhange *et al.*, 2016; Giaime *et al.*, 2018), it was decided to attempt to locate an anchorage or a harbour in the southern and southwestern areas below the tell. Searching for the position of the possible anchorage used in the 2nd millennium BCE Bronze Age was impossible, due mainly to the depth of excavation necessary to locate it of at least 8 m. It was then decided to try to locate the possible Phoenician or Persian anchorage, or a proto-harbour. The excavation took place west of Area T where an active beach area was located (Artzy, 2012; Morhange *et al.*, 2016; Giaime *et al.*, 2018). However, no construction attributable to the period has yet been found, although the area did reveal an interesting stratigraphy (Fig. 7). About the first 0.5 m of soil was refuse from the modern city – a dump. Below it, starting from the bottom, the lowest *locus*, contained remains which we associate with the Persian and Late Persian periods, namely 5th-4th centuries BCE. Ceramics from *loci* 7016 and 7015 were datable to the Persian or Late Persian and Early Hellenistic time and are likely a human-generated fill; on top of these *loci*, further signs of fill were noted in *loci* 7013 and 7014, just below the modern refuse. In these *loci*, there were tree negatives about 0.5-1 m diameter, semi-circle-like pits (in section)

with changed mixed-matrix, in which no stones were found. Alongside the ceramics associated with the fill, Crusader-period 13th-century CE ceramics were found. Historical records of the crusaders, published by Rey (1889: 10-13) mention orchards extending from the northern banks of the Na'aman River to the southern outskirts of the tell, which were cultivated by the Genoese. The Crusader sherds found in the tree-root negatives are the remains of this cultivation.

Conclusion

Vicissitudes in habitation zones within the Tel Akko and its environs dating from the earliest periods of activity, namely the Early Bronze and Middle Bronze periods, were noted during the archaeological excavations. The use of geoscientific methods, such as ground penetrating radar, electric resistivity tomography, bio-sedimentological analyses of cores, and radiochronology (Carbon 14 and OSL), has added to the spatio-temporal understanding of the evolution of the landscape modifications.

With the advent of urbanism in the early part of the 2nd millennium BCE, an impressive defensive rampart, especially on the northern part of the tell, was constructed. An entrance was left in the defences on the southern part of the tell where an anchorage functioned. The anchorage depended on the coast and the estuary of the Na'aman River, in an area that is now landlocked. Over the millennia, climatic and geomorphological changes, in both the river and sea transport of sediments, were

involved in the modification of the area south and southwest of the tell, which in turn affected the habitation patterns and the anchorages, proto-harbours, and harbours in the Akko area. While the 2nd- and most of the 1st-millennia-BCE anchorages were in the general area of the tell, by the 3rd-2nd century BCE, the tell was mostly abandoned and maritime activity was relocated, roughly to the area where Akko/Acre's fishing harbour is located today. While underwater harbour constructions have at times been associated with the Phoenician expansion to the Akko/Acre peninsula, almost no signs of habitation earlier than the 3rd and 2nd centuries BCE were noted there. The harbour/anchorage utilized by the Phoenicians and the Persian army and their mercenaries was still in the close vicinity of the tell itself, likely below its protected southwestern confines. Remains on the tell, from Dothan's excavations of the 1970s and 1980s and Total Archaeology project show it was an important centre for maritime contact during the Phoenician, Persian, and early Hellenistic periods. Following that time, the 2nd millennium BCE and the first part of the 1st millennium BCE, the southern estuary was infilled by sediments and no longer accessible and a move to a peripheral habitation took place for a short period. Following its abandonment, habitation was renewed only in the Crusader period, when the tell was peripheral to urban Saint-Jean d'Acre. The Templars constructed a fortress on the tell with gardens and vineyards surrounding it. Below the tell, in its southern confines, completely landlocked, were orchards tilled by the Genoese Crusaders.

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