ABBREVIATIONS USED FREQUENTLY IN THIS VOLUME

Blakely, "Date"	= J. A. Blakely, "A stratigraphically determined date for the inner fortification wall at Caesarea Maritima," H. O. Thompson (ed.), *The answers lie below: essays in honor of Lawrence Edmund Toombs* (Lanham, MD 1984) 3-38
Blakely, *Vault 1*	= J. Blakely, *Caesarea Maritima* IV. *The pottery and dating of vault 1: horreum, mithraeum, and later uses* (The Joint Expedition to Caesarea Maritima, Excavation Reports vol.4, ed. R. J. Bull, E. Krentz and O. Storvick, New York 1987)
Frova 1965	= A. Frova *et al.*, *Scavi di Caesarea Maritima* (Milano)
Gersht 1987	= *The sculpture of Caesarea Maritima* (Ph.D. thesis, Tel Aviv University)
Harbour Archaeology	= A. Raban (ed.), *Harbour Archaeology: Proceedings of the first international workshop on ancient Mediterranean harbours* (BAR S257, Oxford 1985)
Studies history	= C. T. Fritsch, *Studies in the history of Caesarea Maritima* (BASOR Suppl.19, Missoula 1975)
Jones	A. H. M. Jones, *The cities of the eastern Roman provinces* (Oxford 1971)
Herod's dream	= K. G. Holum *et al.*, *King Herod's dream: Caesarea on the sea* (New York and London 1988)
Kadman	= L. Kadman, *The coins of Caesarea Maritima* (Corpus Nummorum Palaestinensium vol.2, Tel Aviv 1957)
Levine, *Caesarea*	= Lee I. Levine, *Caesarea under Roman rule* (Leiden 1975)
Levine, Qedem 2	= Lee I. Levine, *Roman Caesarea: an archaeological-topographical study* (Qedem: Monographs of the Institute of Archaeology, The Hebrew University, no.2, Jerusalem 1975)
Levine & Netzer, Qedem 21	= L. I. Levine and E. Netzer, *Excavations at Caesarea Maritima* 1975, 1976, 1979, *final report* (Qedem: Monographs of the Institute of Archaeology, The Hebrew University, no.21, Jerusalem 1986)
Raban, "City walls"	A. Raban, "The city walls of Straton's Tower: some new archaeological data," *BASOR* 268 (1987) 71-88
Raban, *Harbours* 1	= A. Raban *et al.*, *The harbours of Caesarea Maritima* 1: *The site and the excavations.* Results of the Caesarea Ancient Harbour Excavation Project, 1980-1985 (ed. J. P. Oleson) (BAR S491, Oxford 1989)
Reifenberg, "Decline"	= A. Reifenberg, "Caesarea: a study in the decline of a town," *IEJ* 1 (1950-51) 20-32
Riley, "Hippodrome pottery"	= J. A. Riley, "The pottery from the first session of excavation in the Caesarea hippodrome," *BASOR* 218 (1975) 25-54
Ringel, *Césarée*	= J. Ringel, *Césarée de Palestine: étude historique et archéologique* (Paris 1975)
Vann, "Drusion"	= R. L. Vann, "The Drusion: a candidate for Herod's lighthouse at Caesarea Maritima," *IJNA* 20 (1991) 123-39
Harbour Project	Caesarea Ancient Harbour Excavation Project (elsewhere abbreviated as CAHEP)

Notes to the reader:
We have followed the spelling 'harbour' throughout regardless of the nationality of the authors.
We have followed the spelling 'Straton's Tower' throughout.
For the contributions relating to pottery, the system of references has been used; for other contributions, traditional footnotes are employed. References for the pottery contributions are found on pp.125-128.

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Acknowledgements

The symposium "King Herod's Dream: Caesarea on the Sea" was organized by the Smithsonian Institution Traveling Exhibition Service (particular responsibility by Myriam Springuel), the Center for Archaeology at the University of Maryland, the American Friends of the Israel Exploration Society (responsibility by Benjamin Adelman), and the Jewish Community Center of Greater Washington. At the symposium was presented some of the work of two projects, the Caesarea Ancient Harbour Excavation Project and the Joint Expedition to Caesarea Maritima. The sessions were held at the University of Maryland School of Architecture, College Park, the National Museum of Natural History of the Smithsonian Institution, and at the Jewish Community Center of Greater Washington. The symposium was supported by grants from the Maryland Humanities Council and the Graduate School and School of Architecture at the University of Maryland. I am grateful to the office of the Dean and to the staff and students of the School of Architecture for their help; special thanks go to B. Kelly and J. Jarvis Myers for help with the program notes. Neither the symposium nor the accompanying exhibition (see the published catalogue, K. G. Holum *et al.*, *King Herod's dream*, published by W. W. Norton & Co.) would have been possible without the collective efforts of hundreds of volunteers who contributed their time and money to work at Caesarea.

R. L. Vann

Introduction to this volume

At the symposium, Session 1, "The Exhibition and its Art", included papers by K. G. Holum, A. Zemer (Curator, Haifa Museum of Ancient Art), and M. Spiro; Session II, "Herod and his city", included papers by E. Netzer, J. P. Oleson, L. I. Levine, and E. Krentz; Session III, "Current Archaeological Finds", included papers by A. Raban, J. Blakely, and T. Hillard; Session IV, "The Exploration and Excavation of Caesarea Maritima", included papers by R. L. Vann, R. J. Bull, R. L. Hohlfelder, and J. Ringel (Director of the National Maritime Museum, Haifa). Not all of the papers delivered are printed here; and some further papers not delivered at the symposium have been added to the collection. The papers by A. Zemer, "The Roth collection of ancient art from Caesarea", E. Netzer, "Caesarea against the background of Herod's building projects", R. J. Bull, "Ten Seasons at Caesarea", and the final response by J. Ringel, are not printed. New papers include those by D. Roller, D. Everman, A. Raban (Two harbours for two entities?), J. A. Blakely and collaborators (Roman mortaria), M. L. Fischer and collaborators (Corinthian marble capitals), R. Gersht and Z. Pearl (sarcophagi), and the field report of the Combined Caesarea Expeditions for the 1989-1990 seasons by K. G. Holum, A. Raban and their many collaborators.

R. L. Vann

In search of Straton's Tower

Avner Raban

The exact location of Straton's Tower, the origin and meaning of the name, its date of establishment, and the archaeological evidence for its history are the subject of debate among scholars. As a result of recent work by the Harbour Project, we may gain a better idea of these aspects of Straton's Tower, particularly during the zenith of the town in the 2nd c. B.C. The surviving architecture of that period is also relevant for understanding the manner in which Herod integrated earlier monuments into the urban fabric of his new city.

Historical sources

The historical references to Straton's Tower have been discussed by earlier scholars. Roller published the earlier Greek and Latin sources;[1] Levine discussed the texts from the Roman and Byzantine periods, including rabbinic sources,[2] and so did Ringel.[3]

From historical texts such as the papyrus of Zenon, it was thought that Straton's Tower was a town or harbour station during the period of Ptolemaic rule.[4] That is the first reference to the name, but some scholars would place its existence at least a century earlier, in the 4th c. Towards the end of the 2nd c. B.C., Straton's Tower was the stronghold of the rebellious tyrant Zoilos who had challenged the Hasmonean king Alexander Jannaeus. Zoilos, 'who held Straton's Tower', was sufficiently strong to offer help to the people of Ptolemais (Akko) against the siege by Jannaeus (*AntJ* 13.326). Though the city of Dora (Dor) was also in his territory (*AntJ* 13.324), Zoilos always referred to Straton's Tower as his principal city, and Dor is not mentioned among the coastal cities that eventually passed to the Jews (*AntJ* 13.395), perhaps because it was considered a 'lesser maritime city' (*AntJ* 15.333).

Straton's Tower was in Jewish hands from 102/100 until 63 B.C., when it was freed by Pompey and added to the Roman province of Coele Syria. At that date it is called a city (πόλις), along with Gaza, Joppa, and Dora (*BJ* 1.156). Strabo (16.2.27) later counts it as the next coastal city after Akko (omitting Dor), with an anchorage or landing stage (πρόσορμον). In 30 B.C. Octavian added Straton's Tower, with other cities such as Gaza, Anthedon, and Joppa, to Herod's kingdom of Judaea (*AntJ* 15.217; *BJ* 1.396).

Even after the city of Caesarea was built in 22 B.C. on the 'deserted' or 'tumbled' (κάμνουσα) Straton's Tower (*AntJ* 15.331-33; *BJ* 1.408), the original name was used for the city (*AntJ* 17.320; Pliny, *NH* 5.14 [69]; see also Ringel 84, for Christian and Rabbinic references), or as an official mark by its citizens (Euseb., *Chron.* col.542) in a Roman military diploma of 71 ("Caesarea Stratonis", *CIL* 10.867), or as a landmark for the boundaries of the Holy Land as in the Rabbinic *Hallacha* that refers to the city walls of Straton's Tower (J Shevi'it 6.1.379).[5] The Rabbinic sources point to a long-lasting tradition concerning the term 'the city walls of Straton's Tower' (*Shurah de Migdal Sharshon*) and for the belief that the city was 'a peg driven into Israel, until the Hasmoneans captured it'.[6]

Archaeological data (fig.1)

The archaeological evidence has not been fully published. The Hellenistic and earlier finds made by

1 D. W. Roller, "The northern plain of Sharon in the Hellenistic period," *BASOR* 247 (1982) 45-46.
2 L. I. Levine, "A propos de la fondation de la Tour de Straton," *RBibl* 80 (1973) 75-88; id. *Caesarea* 5-8, 281-83.
3 Ringel, *Césarée* 18-26, 83-84.
4 F. M. Abel, "La liste géographique du papyrus 71 de Zénon," *RBibl* 32 (1923) 410-11.
5 See also Ringel 21; Levine (supra n.2); Levine, Qedem 2, 12, 57-59.
6 L. I. Levine, "The Hasmonean conquest of Straton's Tower," *IEJ* 24 (1974) 63-65.

Fig.1. General plan with locations of pre-Herodian remains.

Avi-Yonah and Negev in their excavations of 1956 and 1962 were treated in only a preliminary fashion.[7] Hellenistic finds made by the Italian Mission were omitted from their final publications, not being considered relevant to the architecture of the 'North Wall'.[8] The Joint Expedition conducted limited excavations in their Field G,[9] but they did not solve the questions of the original date of the North Wall or the location of Straton's Tower. The stratigraphy of the pre-Herodian structures was discussed only in the context of the North Wall and the fact that it was overlain by the High Level Aqueduct.[10] Other architectural features and small finds of Hellenistic date recovered by the Center for Maritime Studies and the Harbour Project have been incorporated into the final publications of the 1980-85 seasons[11] and were also mentioned in preliminary reports.

In 1956 Avi-Yonah excavated on the seashore some 100 m N of the Crusader City. He wrote (*IEJ* 1956, 260): "At the bottom of the excavation, Hellenistic and Persian foundations and pottery were found belonging to Straton's Tower which preceded Caesarea on this site".

In the early 1960s the Italian Mission excavated a stretch of fortification wall with two round towers and one polygonal tower near the shore about 100 m NE of Avi-Yonah's site (figs.2-3). The earliest datable finds, assigned to the 1st c. B.C., and parallels among Herodian buildings elsewhere in the country led to the structures being attributed to the Herodian period (Finocchi in Frova 1965, 269-83).

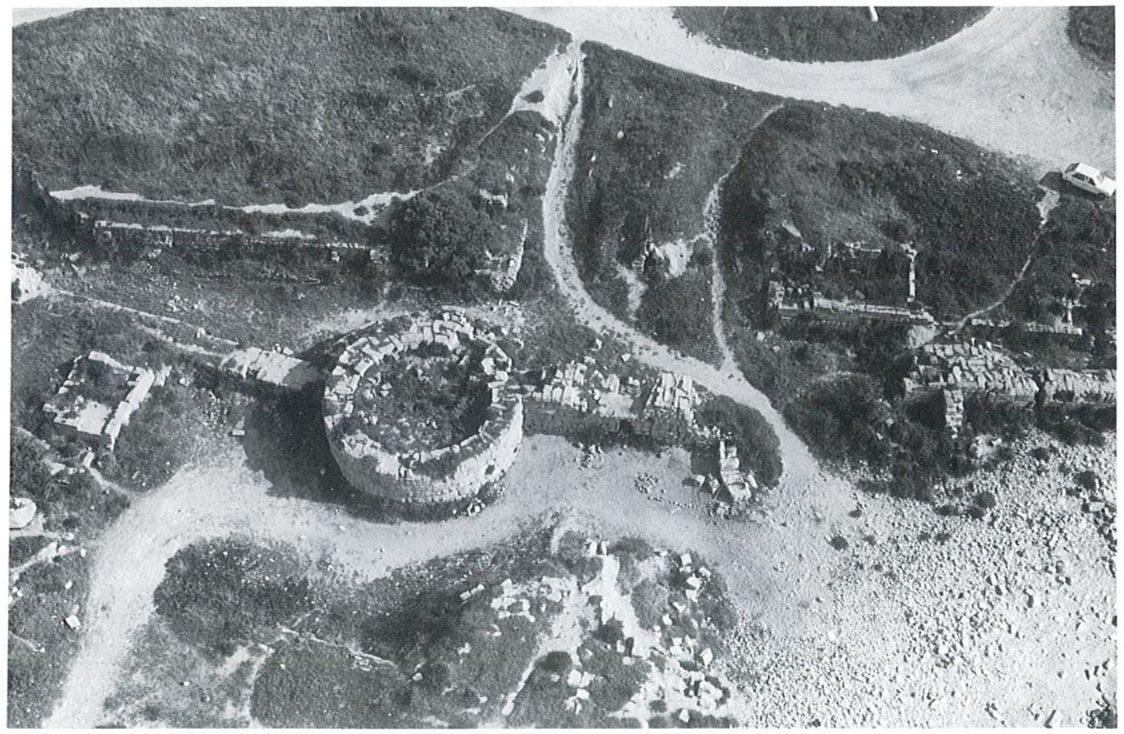

Fig.2. Aerial photograph of round towers and N wall.

In 1962, Avi-Yonah expanded his excavations of 1956. Three (A, C, D) of his five excavation areas yielded Hellenistic remains. In one (E), Herodian remains were found on virgin soil. In area A, stratum I included:

7 M. Avi-Yonah, *IEJ* 1956, 260-61; M. Avi-Yonah and A. Negev *IEJ* 13 (1963) 146-48; A. Negev, *Caesarea* (Tel Aviv 1967) 7-14; Negev in *Encyclopedia for archaeological excavations in the Holy Land* (1975) 271-73.
8 Finocchi in Frova 1965.
9 D. Roller, *BASOR* 238 (1980) 35-42; Roller, *BASOR* 252 (1983) 61-66; Blakely, "Date" 3-38.
10 Levine, Qedem 2, 10-13; Negev (1975, supra n.7) 273.
11 Raban, *Harbours* 1, 131-49, 177-81, 271-76.

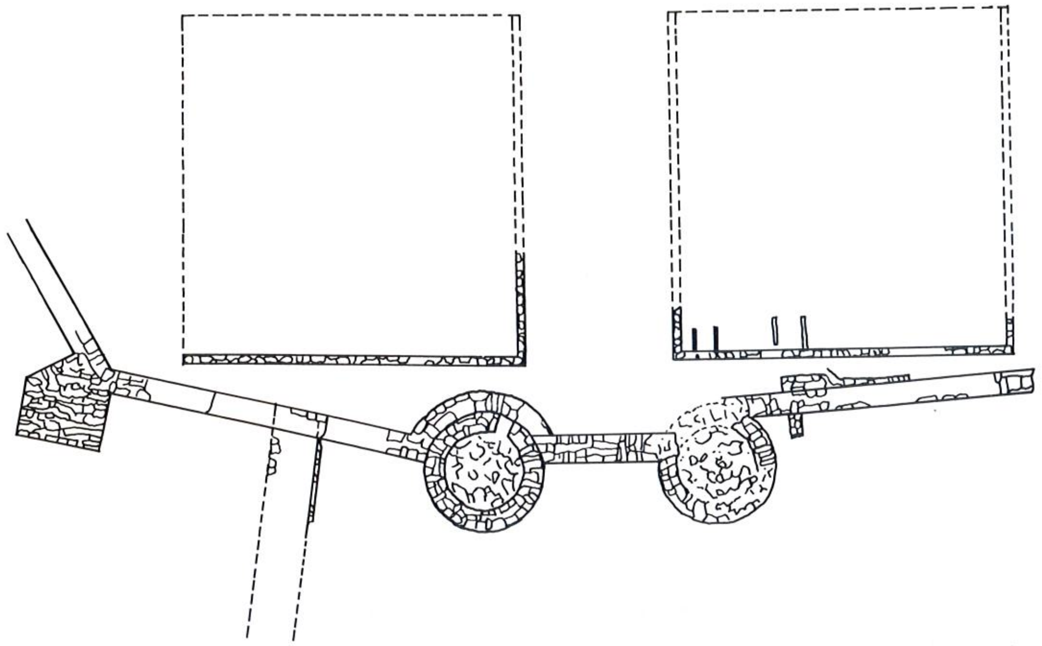

Fig.3. Plan of towers and N wall (after Italian Mission).

Hellenistic walls, mainly headers built on rubble foundations, at a level of 2.8 m above sea level. The foundations were laid on virgin soil. The pottery associated with this stratum included fishplates, 'Megarian' bowls and 'West slope ware'. The plan seems to indicate several rooms grouped around an open court. Possibly we have here the harbour quarter of Straton's Tower. No Persian pottery was found in this area (Avi-Yonah and Negev, *IEJ* 13 [1963] 146).

In area D a trench 50 m long and 10 m broad was dug. Close to the eastern end of the trench a considerable quantity of pottery sherds was discovered. It included a large collection of Rhodian, Coan, and Cnidian stamped jar handles, many fragments of 'Megarian' bowls, fishplates, early Hellenistic lamps, early types of 'Eastern Sigillata A' and their like; on the whole a typical Hellenistic context, paralleled to present only at Samaria. When this accumulation of pottery was cleared, a corner of a large house emerged. Of this only two courses were preserved, each course consisting of two headers and a stretcher. (ibid.147).

The examination of the pottery suggests that the building was abandoned sometime in the early first century B.C., possibly after Alexander Jannaeus' conquest of Straton's Tower. In the sea, close to the synagogue remains, a massive wall can be seen; this may well be part of a mole of the harbour of Straton's Tower. (ibid. 148).

In 1976, the present writer located the lower courses of a round tower (similar to those found by the Italian Mission) at the bottom of the rock-cut basin within the Crusader City (see p.81, fig.2). A trial trench was dug on its west side to its base on bedrock (2.7 m below sea level). Among various water-worn sherds was a crushed cooking pot partially embedded in the side of the tower; it resembled cooking pots of the 2nd c. B.C. Some of the ashlar headers had plastered surfaces on their long sides, indicating reuse from earlier structures on land.[12]

In 1978, D. Roller excavated on the high ground east of Avi-Yonah's excavation ('Field G'). Hellenistic pottery was found but not in association with Hellenistic structures.[13] The Hellenistic pot-tery was said to be in the fill into which the foundations for a late-antique farmhouse had been dug.[14]

Other casual Hellenistic finds have been made east[15] and south[16] of the Crusader city, but not associated with any architecture.

12 Raban and Linder, *IJNA* 7 (1978) 241-43; Raban, *IEJ* 34 (1984) 163-64; Raban, "City walls".
13 R. Bull *et al.*, *BASOR* suppl. 24 (1986) 45.
14 Roller 1980 (supra n.9) 35-42; Roller 1983 (supra n.9) 64.
15 S. Yeivin, *IEJ* 2 (1952) 143

In the 1980 season of the Harbour Project, the massive wall in the water close to Avi-Yonah's trench was studied.[17] A trench dug below water against its N face revealed below an ashlar wall with dove-tail cuttings for lead clamps set on an earlier mole or quay (fig.4).[18] In 1981[19] and 1982[20] work continued with a trench cut across the quay, continuing to the land on the S. When the bedrock on which the quay had been laid was cleared, a rock-cut-passage leading to double rock-cut chambers with their floors below present sea-level was revealed. On the paved floor of the chambers was found much Hellenistic pottery (fig.5), including a dozen cylindrical jars with double-holed mouths but no handles, and 20 cooking pots (to be illustrated in *Harbours* 2); there were also Megarian bowls, Eastern Sigillata A plates and bowls, and a few Rhodian amphoras (3 with stamped handles). The floor of a second chamber produced broken bag-shaped jars and fishplates.[21] The contents of these chambers and the fact that they were overlain by an undisturbed Herodian stratum points to a pre-Herodian date for the quay.

Fig.4. Quay at high tide, to E. Note overlaid ashlar wall. Joint Expedition's Field G lies on high ground beyond.

Fig.5. Herodian pottery from Area J, locus 20 (above) and Hellenistic pottery from locus 21 (below).

16 Roller (supra n.1) 65.
17 See Raban, *Harbours* 1, fig.III.94; Raban, *IEJ* 13 (1963) 148.
18 Raban, *IJNA* 10 (1981) 293 figs.13-14.
19 Raban, *Qadmoniot* 14 (1981) 87-88 (Hebrew).
20 Raban, *IJNA* 12 (1983) 248-49, fig.20.
21 Ibid. 248-51.

In work by the Harbour Project in 1986-87, excavations continued in the area above the rocky ledge between the quay and the 1962 excavations of Avi-Yonah[22] (figs.6-10). A third rock-cut chamber appeared, again with Hellenistic pottery typical of the 2nd c. B.C. The finds included Rhodian handles with names of maker and eponyms dated to 180-108 B.C. Hellenistic finds appeared in the floor formed of decomposed lime near the rocky base of the chamber (below present MSL) and in the layer adjacent to two rubble walls built across the filled-in chamber (60-90 cm above MSL). The walls joined to structures inland in the area of Avi-Yonah's excavation.

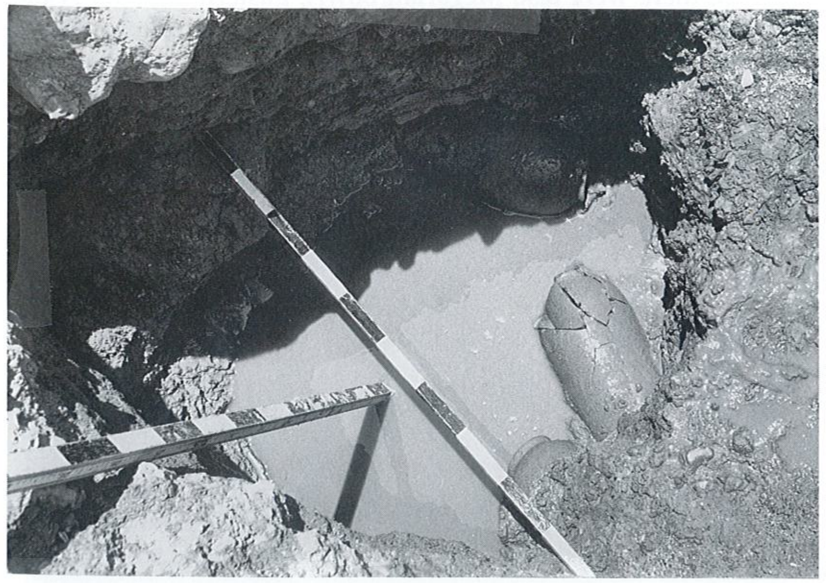

Fig.6. Area J, locus 21 during excavation in 1981.

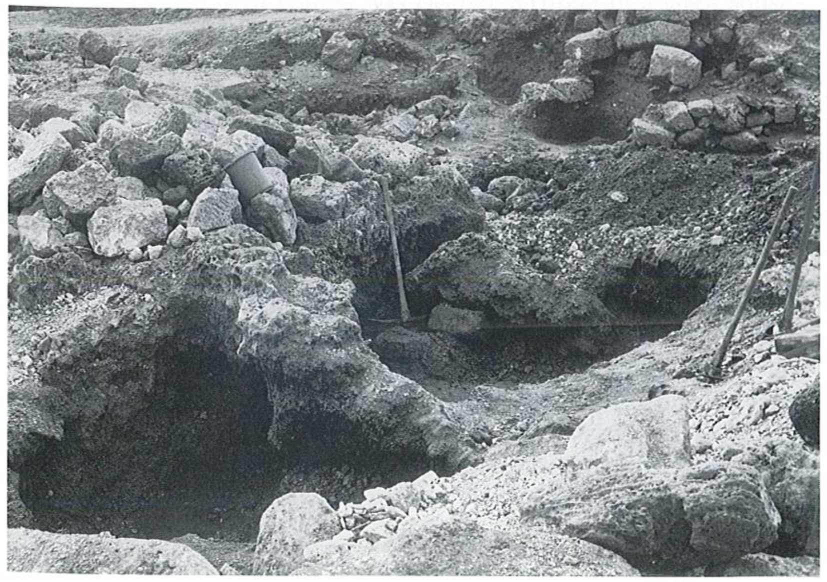

Fig.7. Area J-3, rock-cut chambers.

22 R. R. Stieglitz, *IEJ* 37 (1987) 187-88.

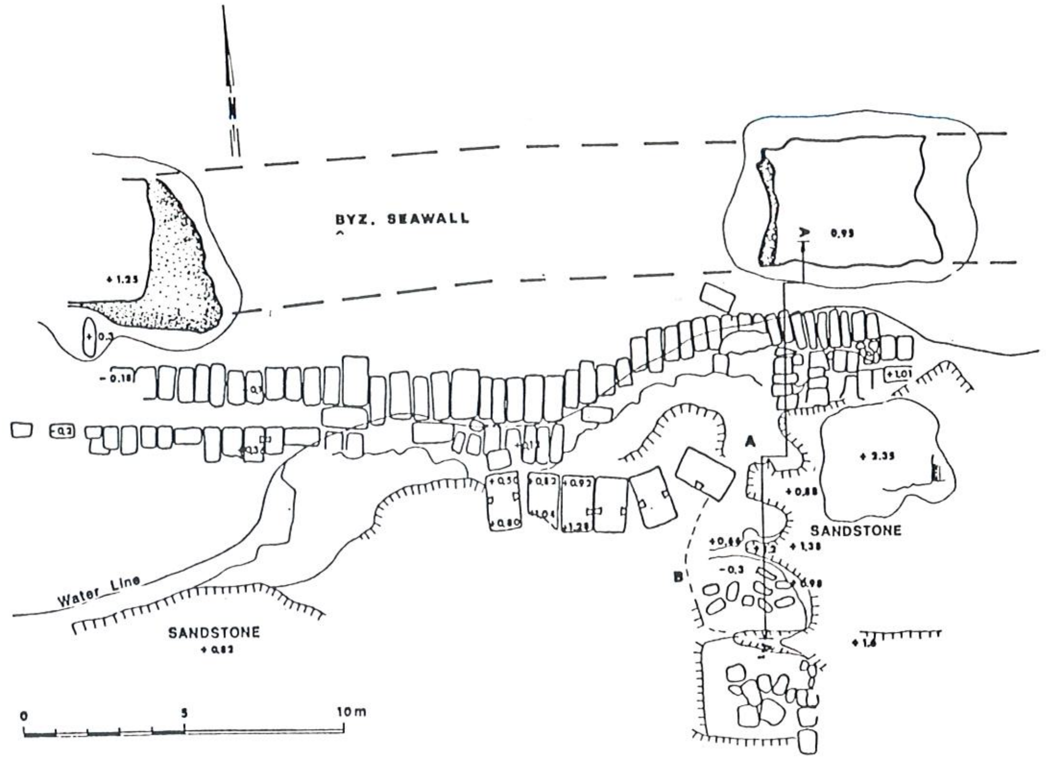

Fig.8. Area J, plan of quay.

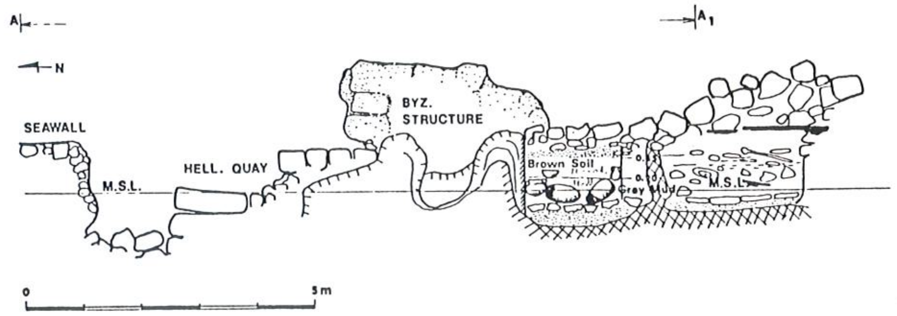

Fig.9. Area J, section drawing A-A[1] (see fig.8); rock-cut chambers at right (Harbour Project 1981-82).

On land, in 1978-80 the Joint Expedition cleared a segment of the city wall SE of the polygonal tower previously excavated by the Italian Mission. It exposed the foundations of the wall's external face for more than 5 m. Blakely published the stratigraphic data, which was interpreted as proving a Herodian date of construction.[23]

In the Crusader City in 1962 a series of vaults and the temple podium were exposed by Negev at the base of a large mound facing the basin. The N part of the podium sat on large rectangular cells which had been filled with crushed sandstone in antiquity; the S part contained 6-7 large vaults of which only that at the S end has been preserved. That vault is 21 m E-W, 7 m wide, and over 13 m high. Negev noted that the S and E walls supporting the vault were built of large dressed ashlars laid in courses of alternating stretchers and pairs of headers, and considered them Herodian. Pottery found in clearing down to its original floor was mostly early Roman, although a few late Hellenistic types were also present.[24] In 1984 the Harbour Project dug 2 trenches in the same vault, one against the S wall, the other against the N wall. Both continued below foundation level, and it was found that the N wall was a later addition to

23 Blakely (supra n.9) and p.26 below.
24 *ILN* no.6482 (2 November 1963) 728; Negev (1975, supra n.7) 273.

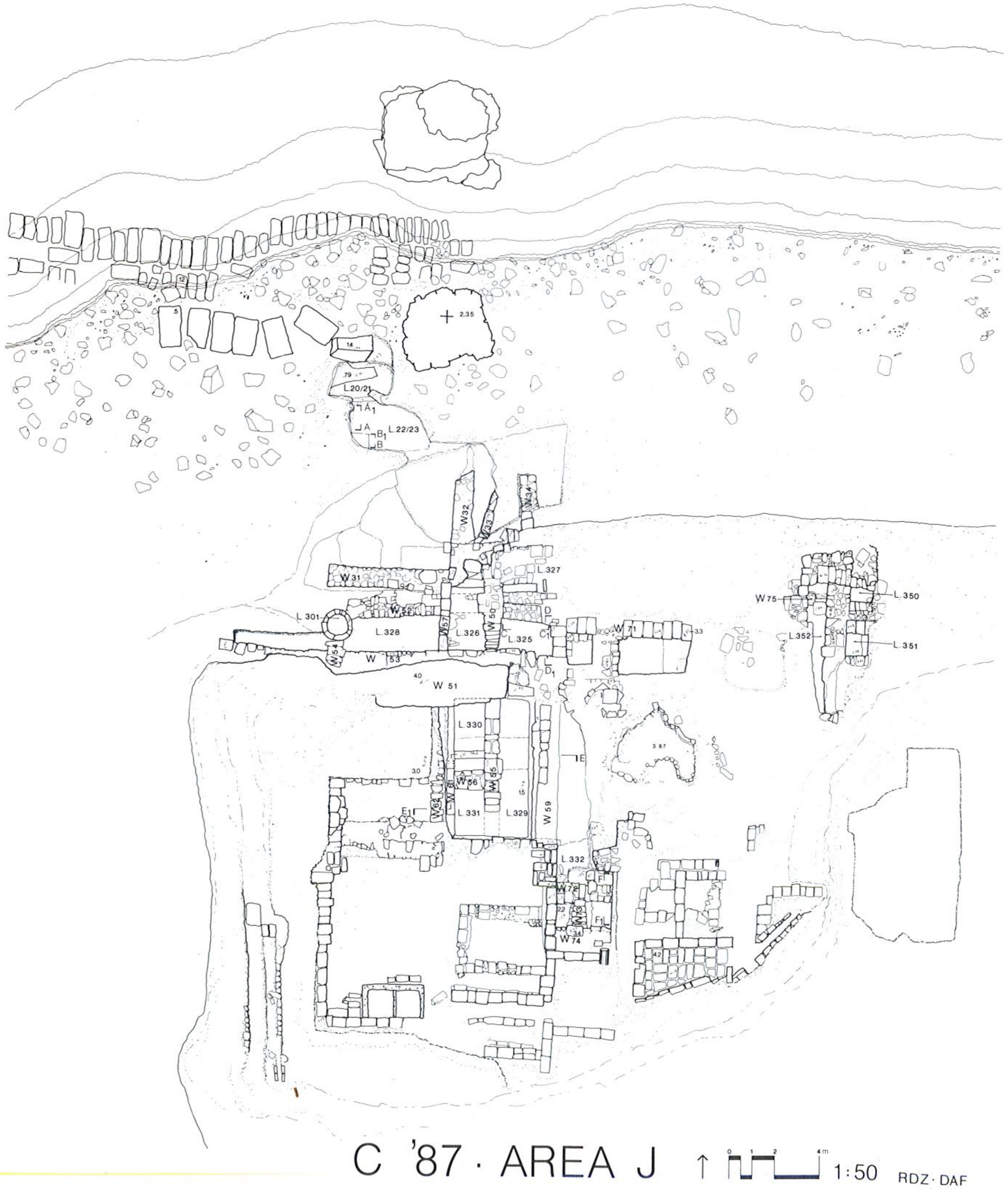

Fig.10. Area J-3, general plan after 1987 season.

the S and E walls. The lowest foundation courses and the ledge to support the floor were 80 cm higher than the corresponding features of the S wall (figs.11-12). The two construction phases followed different elevations and used different types and sizes of stones (see Raban, *Harbours*1, figs.III.82 and III.84).

The architects of the Harbour Project investigated this vault, the west face of the temple podium, and the North Fortification found by the Italian Mission. That survey showed that the inner face of the North Fortification, particularly the segment between the round and polygonal towers (fig.13), was built of the same type and size of dressed ashlars and with an identical pattern of alternate headers and stretchers as the S and E walls of the S vault of the temple podium. The architects suggested that the S and E walls of the vault were originally part of a continuation of the North Wall, perhaps its SE corner, since ashlars with drafted margins are not normally used to decorate the inner faces of closed and roofed structures, at least not when the boss is not dressed. A continuation westward of the S wall of the vault would arrive at the natural promontory which encompasses the inner bay, and which served to support the south stem of the Herodian harbour.

In the lower levels of these two trenches, I-3a, at the level of the ledge above the foundation course in a thin layer of dark grey-brown silt were 2 sherds of Eastern Sigillata A and a Rhodian amphora handle, suggesting a late 2nd or early 1st c. date for the original ground level on top of the foundation trench. On top of the foundation trench in I-3b a floor of beaten earth with crushed bricks and much carbonized material included cooking pots and a few fragments of Terra Sigillata A of the late 1st c. B.C. or early 1st c. A.D.

A review of previously published theories

1. The date of the foundation of Straton's Tower

There is the common presumption that the name Straton is the Greek form of the Phoenician name Abdashtart.[25] This is the name of 2 or even 3 kings of Sidon.[26] The linking of Straton's Tower to the name of a Sidonian king comes from the *Periplus* of pseudo-Scylax, in which the Palestinian coast is divided into alternating sections of Tyrian and Sidonian territories.[27] Although this may have been true in the later Persian period, it is not a secure argument for relating the city's name to a particular Sidonian king. This *Periplus* does not in fact mention Straton's Tower among the Phoenician coastal stations in Palestine. That led Ringel to assume that its founder was probably the last Abdashtart (the third?) who reigned under Alexander the Great. Roller, however, attributes the founding to Abdashtart I, and supposes that because he was called 'philhellene' the city must have had a classical Greek form.[28] Roller also claims that Straton's Tower was probably an agricultural storehouse in its earliest stages.[29]

There are therefore several theories. One could also argue that the Greek name Stratonos Pyrgos was the name given by the founders and was translated literally into Latin as Turris Stratonis and into Hebrew as Migdal Shorshon. But this seems unlikely for a Phoenician and local population that spoke Semitic dialects (Aramaean). It seems more likely that a 3rd-c. Ptolemaic king founded the city in the 3rd c. and named it for one of his generals (there was a general Straton who served Ptolemy III, for example, but he can not have been the founder) as there was a tower in the Hellenistic citadel in Jerusalem that was named Straton's Tower. In any case, we know of not one Phoenician town that was named after a person. If one prefers a pre-Hellenistic date for the foundation, the Semitic appellation might be considered the original one. For this view only relatively late rabbinic sources are available. The earliest

25 Only Ringel, *Césarée* 18 n.20, quoting Jones 231 n.1, questions the assumption that Straton must stand for Abdashtart. The equation Straton = Ashtart may refer either to the Semitic goddess or to the king who was called her servant.
26 Levine (supra n.2), Foerster in *Studies history* 9; Roller (supra n.9) 61; three — Ringel, *Césarée*, 19.
27 K. Galling, "Die syrisch-palästinische Küste nach der Beschriebung Pseudo-Sklyax," *ZDPV* 61 (1938) 66-96.
28 Roller (supra n.9) 61.
29 He cites Levine, *Caesarea* 6.

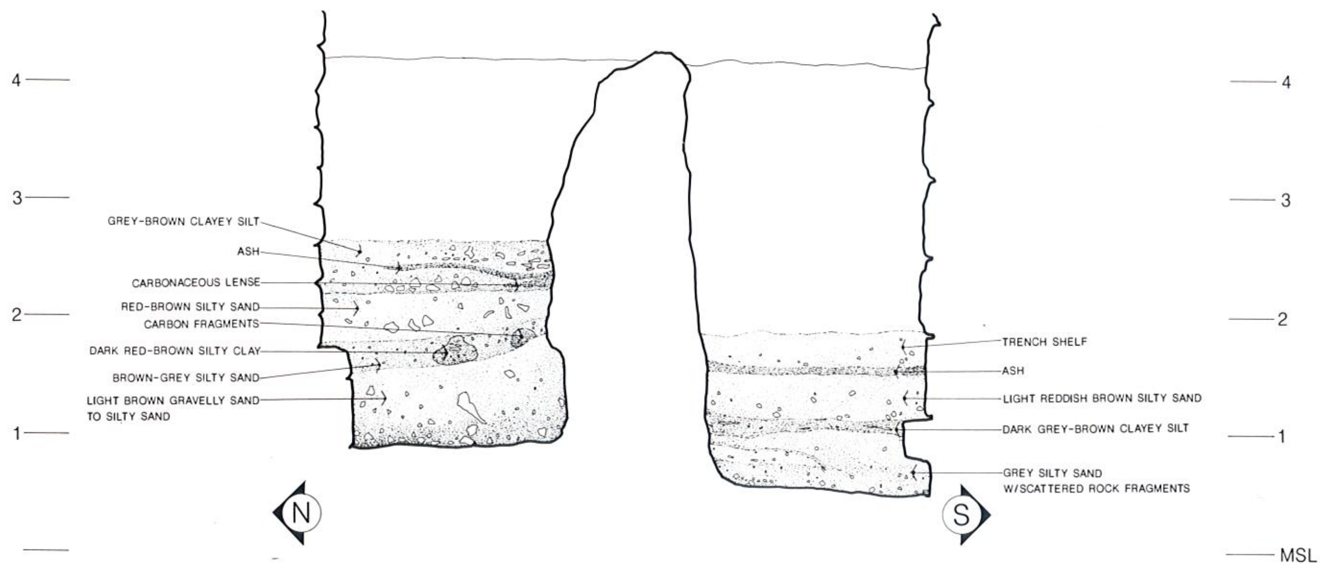

Fig.11. Herodian vault, section through probes I-3a (right) and I-3b (left); note different level of floor ledges either side.

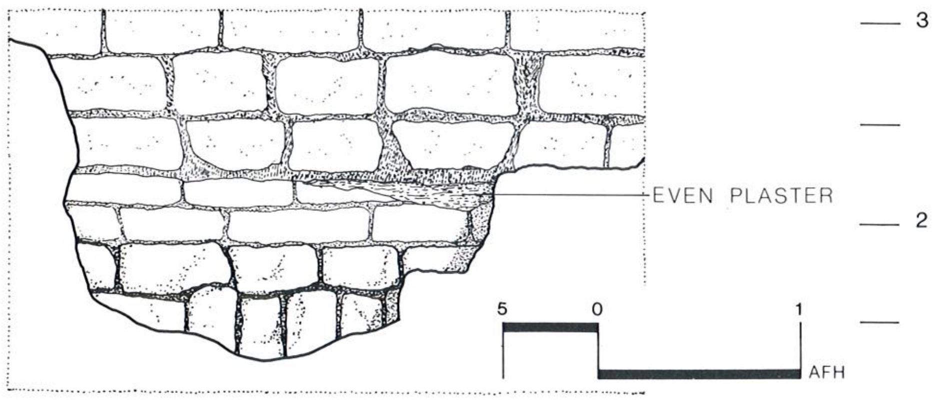

Fig.12. I-3b, north probe, elevation drawing of exposed foundations, to N.

Fig.13. North fortification wall, inner (S) face, looking towards round tower.

might be early 2nd c. A.D.,[30] when Straton's Tower was called Migdal Shir, Shar or Shed.[31] The form Migdal Shorshon or Sharshon is found mainly in later texts.[32] Though Shorshon or Sharshon can be argued to be a Semitic gloss of Straton, the other forms are far enough removed to be considered variations developed in order to give the original name some moral connotation in Hebrew, such as Shir = song, Shar = general or commander, Shed = demon. Earlier scholars suggested that Shorshon might come from the stem ShRSh, as Shomron (Samaria) may come from ShMR. Although relatively late, these rabbinic names seem to be of more value than the late Roman and Byzantine tradition about a certain Straton.[33] Overall, I think that a foundation date in the mid 4th c. is possible but far from probable.

2. *The character of Straton's Tower*

Straton's Tower is always referred to as a city and grouped with towns like Jerusalem and Jericho in the 3rd c. or with Ashkelon, Gaza, Apollonia, Dor, Jaffa, and Akko in the late 2nd c. B.C. Yet some scholars prefer to describe Straton's Tower as an "agricultural storehouse".[34] Ringel adduces geographical arguments — a wider and richer hinterland, and better accessibility from the inland valleys — for a preference for the location of Straton's Tower over that of Dor,[35] and Foerster contrasts Straton's Tower with Dor and Athlit which were full-scale Sidonian commercial centers for the transshipment of agricultural and other goods.[36]

Some scholars take the element of 'Tower' in the name too literally, as a prominent structure which was the main feature of the settlement,[37] or even as a silo rather than a lighthouse.[38] But no single silo as an architectural feature has ever been found on a Persian period site in Israel, and, while Roller is not right to say that a lighthouse was not needed at this point on the coast, it is true that we know of no lighthouses before the Hellenistic period. If the city was founded in the 3rd c., however, a harbour lighthouse would not be surprising. The element 'Tower' in place-names in Palestine is quite common at several periods. At the period we are considering it is found in Migdal Nunaiya (Taricheae) on the sea of Galilee, later called Migdal Zebo'iya, and translated into Greek as 'The tower of fishes' or 'fish industry'. A second example is Migdal Eder ('Tower of the herd') with the Greek name Boukolonpolis, 'city of herds', recorded in Strabo 16.2.27, and identified with the considerable Phoenician settlement and artificial harbour at Athlit.

Athlit, Dor, and Apollonia are known to have had substantial walled areas, but Roller has written that "were it not for the founding of Caesarea Straton's Tower would probably be no better known than Crocodile city or Mulberry city."[39] But those comparisons are not made by Josephus or any other source. Roller's Mulberry city refers to a small seaport in the northern plain of Sharon, and is a mistranslation of Strabo's Sykaminon, which may be translated as Sycamore city and was not located in the northern Sharon plain. Roller suggests that Krokodeilonpolis was more important in the earliest Hellenistic

30 M. Ta'anit, see Lichtenstein 1931-32, 281-82.
31 These could be mistakes in copied texts due to lack of vowel signs and the resemblance of the consonant marks for D and R in the Hebrew scripts.
32 See references in Levine (supra n.2); Ringel, *Césarée* 21 n.41; and discussion on the name from the text of the mosaic floor in the synagogue at Rehov in Y. Sussmann, "The boundaries of Eretz Israel," *Tarbiz* 45 (1976) 228-29, 256.
33 Ringel, *Césarée* 18, n.23; Roller (supra n.9) 61; see also the late tradition that Caesarea was founded by Vespasian (Ringel, *Césarée* 85).
34 Levine, *Caesarea* 6; Roller (supra n.9) 61. Negev (1967, supra n.7) 6 followed Galling (supra n.27) in considering it a Sidonian commercial center for the export of agricultural products of the hinterland (cf. the Ashmunazar inscription: 'The lord of the kings [the Persian king] would give us the mighty cereal countries which are at the field of Sharon — the city of Dor and the city of Jaffa').
35 Ringel, *Césarée* 22-23.
36 Foerster (supra n.26) 9-10.
37 Levine (supra n.2).
38 Levine, *Caesarea* 6; Roller (supra n.9) 61.
39 Roller (supra n.9) 61.

period, despite the fact that it is first mentioned only in the late 1st c. B.C.[40] He also believes that the immediate hinterland of Straton's Tower had "wealthy manor farms" during the 2nd c., and that "the Hellenistic population along the coast was dense".[41] Yet Roller's field survey yielded meager data. From an area of 150 km^2 he has archaeological evidence for the beginning of a period of prosperity for the area soon after the Seleucid conquest of 198 B.C. only from one small site at Tel Mevorakh.[42] The 6 other wealthy Hellenistic farms (we exclude Field G at Caesarea) are either outside the designated area (e.g. Tel Zeror) or lack adequate archaeological remains to substantiate the case. Unfortunately Roller did not include the data published in 1972 by Ne'eman and the data from various surveys undertaken by the Department of Antiquities (e.g. Berman's in the early 1970s). But there is in fact no clear evidence for densely scattered manor farms around the coastal plain at the S end of Mount Carmel, or any archaeological data pointing to great prosperity in the 2nd c. B.C.

We know simply that Straton's Tower in the time of Zoilos was his stronghold and capital, a 'peg into Israel', with fortification walls and an anchorage. It was probably of the same importance as Gaza, Ashkelon,[43] Apollonia and Ptolemais.[44] Next we should examine the pre-Herodian architectural remains in order to try to locate the Hellenistic site.

Architectural remains of the pre-Herodian period

1. *The North Wall.*

It was excavated by the Italian Mission and by the Joint Expedition (see Blakely p.26 f.), dated by the Italians to the Herodian period, but this was disputed by Levine[45] and Negev.[46] The main arguments are:

— a) The dressed ashlar blocks with smooth drafted margins may be compared with walls dating as early as the late Bronze age[47] and of the Hellenistic period[48] in Palestine: the rough bosses are less characteristic of the Herodian or Roman structures than they are of the Hellenistic era and before.

— b) The eastern of the two round towers (dated by the Italian Mission to the Herodian period) has two construction phases, ignored by the excavators, although they found 'first century B.C.' pottery on the level of the road associated with the later phase.

— c) The argument by the Italians that the high-level aqueduct was built in a later construction phase of Herod's city fails to explain why Herod's engineers would have built a fortification, with towers and gates, and then would dismantle part of them in order to build one of the supporting arches of the aqueduct above the partially dismantled wall.

— d) The Italians said that the best preserved part of the original wall is the part between the east round tower and the polygonal tower. That is the only part built with no mortar or other binding agents between the ashlar blocks. The eastern, better preserved part of the wall is the only one with a careful differentiation made between the internal and external faces: the external has smooth-faced blocks

40 Roller (supra n.1) 50. [Roller points out that, although Krokodeilonpolis is not mentioned in the *extant* literature before Strabo, it was probably mentioned in the *Periplus* of Pseudo-Scylax, and is so restored by Galling (supra n.27); see Roller supra n.1, pp.47-48 — Ed.]

41 Roller 1983 (supra n.9) 61, 65.

42 Roller 1983 (supra n.9) 64. [Roller points out that he uses historical evidence (Rostovtzeff's article "Syria and the East" in *CAH* 7, and Stern's report on Tel Mevorakh, Qedem 9, 1978), and not just archaeological evidence, to support the view that the site at Field G may have been parallel to Tel Mevorakh and that prosperity began in the 2nd c. Note also that Tel Mevorakh is the only well excavated site for this period — Ed.]

43 For its size see Stager 1987.

44 For Hellenistic Akko see M. Dothan, "Akko, interim excavation report, first season," *BASOR* 224 (1976) 41-45.

45 Qedem 2, 9-13.

46 Negev, *Mada* (Science) 10.6 (1966) 341-44 (Hebrew).

47 E. M. Laperrousaz, *Syria* 59 (1982) 223-37.

48 Id. *Syria* 56 (1979) 99-144.

Fig.14. G-8, external face of fortification wall, to W.

while the internal has drafted blocks. This differentiation was missing in the secondary phase, including the sector discussed by Blakely (fig.14). This original wall segment is similar to the S and E side walls in the great vault at the S end of the Herodian temple platform.

e) The two large rectangular structures inside the N fortification wall (fig.3), which seem to be oriented to the course of the wall and to the road that must have approached the opening between the round towers, were never fully excavated to their ground floors. The western one is next to the location where the Italians found Hellenistic pottery.[49]

These structures resemble a Hellenistic building exposed by Avi-Yonah and Negev near the synagogue *c.*100 m to the SW.[50]

f) The N wall is so sited that it would leave outside the city the hippodrome and amphitheatre as well as the main sewer which Josephus said ran under the city (*AntJ* 15.340). This seems surprising for a city wall. Blakely's probe examined only the outer, not the inner face inside the city. The data from this probe were published. Blakely considers the data conclusive for dating the wall no earlier than Herodian, but his stratigraphic analysis is puzzling.[51]

To conclude, the excavations by Blakely reveal a limited segment of the exterior of the fortification that underwent several phases of reconstruction and is stratigraphically disturbed. The ceramic content of layers **8124** and **8123** cannot predate the wall to which they are aligned. They may be used to date the original phase of the wall to the Hellenistic period.

49 Finocchi in Frova 1965, 258-61.

50 Avi-Yonah and Negev (supra n.7) 146.

51 A comparison of the elevation of the outer face of the wall (Blakely [supra n.9] fig.3) with the S section (his fig.4 and fig.19 here) poses a difficulty. The foundation trench G-**8125** ends next to the second foundation course from the top, leaving 2-3 courses to be lined by lower sand layers (G-**8123, 8124**), which included Hellenistic coins and 3rd-2nd c. pottery. Therefore, if the bottom of trench G-**8125** is some 80 cm higher than the base of the wall, it could not have been used as its foundation trench. But it could have had a function when the structure G-**8124** was added outside the fortification, when the city had expanded beyond its earlier limits. The exposed part of the wall was rebuilt at that stage to be incorporated into some public structure. This might explain the inconsistency of drafted blocks at the face of the wall, while in the intact segment of the wall (between the round and the polygonal towers) the outer face lacks drafted blocks completely.

2. The north shore

West of Field G of the Joint Expedition (fig.1) is a large Hellenistic building exposed by Avi-Yonah.[52] The pottery and plans of these excavations were never published, but the field plans exist at the Archaeological Institute of the Hebrew University and much of the important pottery is in storage at the Israel Department of Antiquities.[53] According to the plans there seem to be two large buildings using ashlar blocks on rubble foundations. The W one (area A) is *c*.20 x 18 m, its E wall well below the W wall of the synagogue of the 4th c. The courses include slim headers in the lower courses, with the same size of blocks as those used at the two square structures just inside the N wall (fig.3). The pottery from area A stratum 1 resembles that found in Area J, loci 21, 23 and that found in area J-3, fill between A 32 and W33.[54] The second building was in the E end of trench D; only its NE corner was preserved. Here is Negev's account:

> The most recent excavation aimed to the discovery of Strato's Tower was undertaken in the summer of 1962. The attempt was part of a dig by a team of the Hebrew University excavating in the northern sector of Caesarea — a sector which had already been identified as a Jewish quarter dating back to the Roman and Byzantine periods. The 1962 excavation in this area followed those carried out by the Hebrew University in 1956. The writer, who himself participated at that time as a student of archaeology, noticed a mound rising to the east of the site. Since the time allotted to the dig was short and the means of the expedition's disposal were limited, it was not feasible to examine the mound there and then.
>
> The opportunity came only in 1962, when excavations on the spot were renewed. Though the main purpose of the dig was examination of the Jewish quarter remains, renewed excavations extended over a wider area than hitherto, especially to the north and east of the Jewish quarter. Test trenches were dug in the area, some of which were as large as a hundred square meters, and one of the test ditches dug out extended to a length of 50 m at a width of five meters. After removal of a very thin layer of top soil, the excavators discovered many fragments of vessels. Normally such a discovery is nothing new in Caesarea, which is full of fragments. This however was something new. Sherds of the kind now revealed had not been found on the site hitherto.
>
> When baskets filled with these sherds were washed, fragments of bowls ornamented in relief, pieces of black-glazed vessels and many other utensils typical of the Hellenistic period were discovered among them. It became clear to the excavators that they had at long last succeeded in finding the location of 2nd and 3rd century B.C. Caesarea. In the wake of the first basket of fragments came many more — over a hundred in all — each one testifying and corroborating the evidence found in the first.
>
> A few days later, there emerged stones belonging to ancient buildings. A few more days of excavations served to convince the explorers that these stones were part of a public building of which one corner alone remained, two layers in height. Careful examination showed that building stones had been removed and used for the construction of new buildings. The people plundering these stones had dug channels that were a little wider than the wall in order to float them away. Later on, sea and wind filled up the channels with earth and the excavators could readily distinguish between the permanent soil and the earth that had later filled up the trenches.
>
> It is likely that when masons came in search of materials for new structures — perhaps at the time when Herod was engaged in the construction of his new city — they found this Hellenistic building filled with fragments of earthen vessels, which they swept into one corner of it in order not to disturb their work. When the task of dismantling the walls had been completed, the masons left this corner, which was filled and covered up with a mound of sherds and fragments.
>
> This is how Strato's Tower was discovered.
>
> The excavators uncovered layers of earlier periods at the main excavation site, where the remains of a Jewish synagogue were unearthed. Also here, traces of the first period in Caesarea could be discerned.[55]

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52 Avi-Yonah (supra n.7) 260.
53 I am most grateful to these institutions and to A. Negev and V. Zusman for allowing me to study the material.
54 R. Stieglitz, *IEJ* 37 (1987) 188.
55 Negev (supra n.7) 9-13.

It is odd that Roller sees 100 baskets of Hellenistic pottery of the 3rd-2nd c. from the corner of a building located well within the Herodian area as evidence for "a small settlement or villa of the second century B.C. rather than the earlier town of Straton's Tower."[56] Note in particular the similarity in the height and pattern of courses[57] with those in the eastern section of the north city wall, and in the walls beneath the vault.

3. The south vault below the Herodian temple platform

The work by Negev[58] showed that the S and E walls of the S vault predate the vault above and the N side wall. Because the S and E walls are built of the same drafted blocks with projecting bosses set in courses of the same order and height as those of the North fortification wall, they may belong to the same line of fortifications. This makes sense if one projects the S wall of the vault westwards across to the rocky promontory that later was to become the base of Herod's breakwater; earlier it could have served as a protective promontory for the harbour of Straton's Tower.[59] The close resemblance in diameter and building technique between the sunken round tower at the NW side of the entrance to the basin and the twin towers of the North fortification wall also supports this interpretation. Some problems are presented by the elevation of the sunken tower and by the reused blocks employed.[60] But it was certainly built in the pre-Herodian phase and probably saw two pre-Herodian phases.

We may therefore interpret the remains as a Hellenistic quay or landing stage (Strabo's πρόσορμον, 16.2.27) in Area J of the Harbour Project, with a fortification wall running W towards the natural N opening of the small lagoon that would have been the best natural haven along this stretch of coast.

A second segment of what seems to be the same fortification wall enclosed another natural haven, located on the SW side of the city. This southern inner bay might have been provided with a further rock-cut basin protected by a sea wall and a round tower.[61]

4. The ancient topography

Although there has been substantial erosion of the coast NW of the Crusader city and near the high-level aqueduct,[62] the topography of the rest of the site is more or less as it was in the 3rd c. B.C. It seems as if sea level in the Hellenistic period was somewhat lower than in the Herodian.[63] The difference was not more than 20-30 cm, yet it could explain why the foundation of the N wall in the S vault of the Temple platform was higher than the earlier walls on the S and E.[64] A lower sea level might also help to explain the submerged round tower in the south anchorage opposite that vault. The offshore reefs opposite Field G and the North fortification wall were doubtless more intact and offered much better protection to the lagoon on its lee. Since antiquity a longshore fault line has caused further submergence of the sea floor just W of the reefs, thus exposing them to stronger wave energies.[65] We do not know if there was less sand on the beaches than today, although indications are that lower mean sea-level brings less sand inshore. If the rock-cut inner harbour was originally Hellenistic, less sand would have been carried by waves along this shore, since otherwise it would not have been possible to keep an inland basin free from silt.

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56 Roller (supra n.9) 64. [See Roller 1983 (supra n.9) p.64, note 56, for a fuller explanation of his reasons for rejecting this interpretation — Ed.]
57 Avi-Yonah and Negev (supra n.7) 147.
58 Negev (1967, supra n.7) 21-25; id. (1975, supra n.7) 273-74.
59 Raban, *IJNA* 14 (1985) 166-73.
60 Raban *IJNA* 8 (1979) 158-60.
61 Raban, *BASOR* 268 (1987) 73-78, 86; *IEJ* 37 (1987) 188-90.
62 *Contra* Roller (supra n.9) 64, Field G was probably not on the coast; Raban, *Harbours* 1, 293-96.
63 Raban, *IJNA* 12 (1983) 250.
64 Raban (supra n.59) figs. 15, 17.
65 A. Neev *et al.*, "The Young (Post Lower Pliocene) geological history of the Caesarea structure," *Israel Journal of Earth Sciences* 27 (1978) 43-64.

In conclusion, the ancient topography seems to have been even better suited to the needs of a Hellenistic city than today's. Two separate harbour basins became a popular arrangement for ports in the 3rd and 2nd c.[66] The two segments of fortification wall were located at the right points to encompass two anchorages of the Hellenistic kind of λιμὴν κλειστός. The dimensions of the area enclosed by such a fortification would have been 650-700 m on its NNE-SSW axis and just over 200 m on the E-W axis, amounting to 35-40 acres, which is just above that of Dor or Apollonia but much smaller than Ptolemais and Ashkelon.

Conclusions

We have in hand sufficient evidence to reconstruct the outlines of a moderate-size fortified Hellenistic city with probably two harbours. The small finds date it to the second half of the 2nd c. The city lay mid way between the locations of the Herodian theatre at the S and the large sewer at the N. The architectural elements belonging to this city were almost always reused in the Herodian city, as, for example, with the fortification walls and towers, and to a lesser degree in Field G and in Negev's section D. Earlier walls evidently continued to be used in later structures in Avi-Yonah's area A and J-3 of the Harbour Project (fig.10).

I have suggested that the Hellenistic remains date only to the 2nd c. Why might this be? First, Straton's Tower reached its zenith during the tyranny of Zoilos. This ruler might have rebuilt its public structures, including the harbours and walls, leaving only meagre traces of earlier structures and levels. Secondly, and alternatively, archaeologists may not have been concentrating their efforts in the right places. Negev's work in his trench D and the Harbour Project's work on the rock-cut chambers of area J were fortunate, but the area to the south of J, between it and the Crusader city, still holds the promise of the best preserved early occupation levels, although much of the core of Straton's Tower was probably removed for Herod's constructions.

The Jewish tradition about the 'walls of Straton's Tower' which were a 'peg in Israel' was strong from the early 2nd c. A.D. until the mediaeval period. How did these Hellenistic walls function in Herod's city? I doubt whether they served as a defensive line for the proposed urban area.[67] Instead they may have served as a municipal and administrative boundary line between the city of Caesarea and the emporium of the royal harbour of Sebastos. Those special quarters included the whole Jewish quarter, probably referred to by Josephus when he wrote 'Herod reconstructed a fortress (φρούριον) to the entire Jewish nation at a place once called Straton's Tower, but named Caesarea by him' (*AntJ* 15.293). This administrative division might be deduced from circumstantial evidence such as the epithet Καισάρεια ἡ πρὸς Σεβαστῷ λιμένι on the coins of A.D. 44 (see p.68 f.) or those issued by Nero 23 years later.[68] The clear division between the two entities seems to have been lost by the time of Hadrian, perhaps because the royal harbour was no longer functioning in its original form. The walls of Straton's Tower were never dismantled, nor was the whole city ruined in the earthquake of 30 B.C. Josephus says that the quake affected only the SE part of Judaea near the Dead Sea (*AntJ* 15.121; *BJ* 1.370-72).

In short, the location of Straton's Tower of the period of Zoilos seems established. Further excavation is needed to study the Ptolemaic and earlier phases of the site.

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66 Blackman, *IJNA* 1982, 194-96.
67 *Contra* Levine, Qedem 2, 9-13; Negev (supra n.46) 343-44.
68 Ringel, *Césarée* 153-54.

Straton's Tower: some additional thoughts

Duane W. Roller

In a series of earlier articles I tried to elucidate the available informaton on the problems concerning Straton's Tower.[1] Continuing work at the site has produced much additional evidence without making the problems any less complex. At the suggestion of Avner Raban, I wish here to outline some of the unsolved problems and highlight the points where we have not reached agreement.[2]

1. When and by whom was Straton's Tower founded?

For many years the founding has been associated with the various fourth century B.C. kings of Sidon named Straton. Unfortunately, the earliest literary reference, *PCairZen* 59004, dates from the mid 3rd c. B.C. Moreover, there are too many Stratons: two or three kings of Sidon, and other royal personages such as the king of Tyre in 332 B.C. (Diod.17.47.1).

Raban has argued that the evidence linking Straton's Tower with any 4th-c. king Straton is too hypothetical, and that the city was founded shortly before it was mentioned in *PCairZen* 59004. We need, however, to keep in mind the following considerations:

— *PCairZen* 59004 implies that the city was well established by *c*.250; it is mentioned in the same context as Jericho and Jerusalem;
— Straton was a common Levantine royal name of the 4th c. B.C. and one would expect a city with the name Straton existing before 250 to have been founded by a 4th-c. king of that name. Since Hellenistic city foundation was chiefly a Greek or Greek-inspired activity, Straton I of Sidon, a philhellene with a strong interest in Greek culture and art, seems the best candidate;[3]
— the sparseness of archaeological evidence for the 4th c. does not mean that Straton's Tower did not exist then. Pottery of that period has been found in Field G[4] and examples of West Slope technique were found by Avi-Yonah in 1962.[5]

2. The character of Straton's Tower

The vague and contradictory literary and archaeological information is of little value in providing an accurate picture of the size of the city. In fact, there seems to be too little literary evidence and too much archaeological evidence. One would do well to remember what Thucydides (1.10) wrote about the relative value of such data.

Yet Josephus (*AntJ* 15.333) described the city by the diminutive πολισμάτιον. The other towns characterised in this way are obscure — Aigai in Aeolia (Plutarch, *Them.* 26) or Urium in Apulia (Strabo 6.3.9). For Josephus Straton's Tower was not a major city. Yet in *PCairZen* 59004 it is described on apparently equal footing with Jericho, and almost equal to Jerusalem. Strabo 16.2.27 provides important information: 'After Ake is Straton's Tower, which has an anchorage. Between it and Mount Carmel are more names — nothing more — of little places, Sykaminonpolis,[6] Boukolonpolis, and Krokodeilonpolis,

1 D. W. Roller, "Hellenistic pottery from Caesarea Maritima: a preliminary study," *BASOR* 238 (1980) 35-42; id., "The northern plain of Sharon in the Hellenistic period," *BASOR* 247 (1982) 43-52; id., "The problem of the location of Straton's Tower," *BASOR* 252 (1983) 61-66.
2 See in particular Raban, "City walls".
3 Roller 1983 (supra n.1), 61.
4 Roller 1980 (supra n.1), no.1.
5 M. Avi-Yonah and A. Negev, "Caesarea," *IEJ* 13 (1963) 146: this style began in the second half of the 4th c., see G. R. Edwards, *Corinthian Hellenistic Pottery (Corinth 7.3)* (Princeton 1975) 20, 24.
6 'Mulberry city' and not 'Sycamore city', Raban confuses sykaminos with sykamoros; for the meaning mulberry see Amphis 38, Ar., *Rhet.* 1413a21.

and other similar ones.' Strabo implies that Straton's Tower, like the other places cited, was little more than a name, and that all were πολίχνια, a diminutive of a word (πολίχνη) which itself had a connotation of smallness. So in Strabo's day, just before Herod's foundation, Straton's Tower was insignificant.

Despite the characterizations of Josephus and Strabo, however, the site was prosperous. This seeming paradox can be explained by its rôle as the seaport and market center for a rich hinterland in the northern Plain of Sharon.[7] This is why it is mentioned alongside Jericho and Jerusalem.

3. The character of the northern plain of Sharon in Hellenistic times

Raban is right to note the meager quality of the data in my article of 1982. That was not a field survey but a summary of known evidence. But the scantiness of the archaeological data should not be used to imply that the population was small or that resources of the countryside were lacking. Tel Mevorakh happens to be the only site to have been carefully excavated and published. The repeated interest in the northern Sharon plain by dynasts from Zoilos to Pompey and Herod shows its significance, and there is as yet no reason to doubt a general picture of agricultural wealth linked to the presence of the port at Straton's Tower.

4. The exact location of Straton's Tower

In the absence of firm epigraphic evidence, we must fall back on the consistent literary tradition that Herod built Caesarea at Straton's Tower. Raban has maintained that the center of the earlier city lay north of the Crusader fortress, some half kilometer from the center of the Herodian city. Is this close enough for Herod's city to have been said to lie on the same site? It is true that much more Hellenistic material has been found at the N edge of Caesarea than in its center, but that may be a result of the massive reconstruction of the center. Further, the seemingly extensive Hellenistic material at the N edge must be treated with caution: the pottery from the excavations by Avi-Yonah[8] totalled a hundred baskets, an impressive amount, but it was "swept into one corner" of the building and thus of questionable value in drawing general conclusions. Also, it was dated only vaguely to the "2nd and 3rd century B.C." Without more precise dating and evidence for the functional context of the pottery, its quantity becomes less important and therefore its relevance to the debate about Straton's Tower less critical.

Certainly there was a Hellenistic settlement on the north edge of what would be Caesarea, with a *terminus ante quem* of the 2nd c. B.C. But there is no evidence to prove that this was Straton's Tower. If one were to incorporate all the areas Raban proposes, his city would require 70-80 acres. If, instead, Straton's Tower included the area of the Crusader fort, itself over 100 acres, then the Hellenistic material found at the N should belong to a separate village. If a more reasonable size were 35-40 acres (like Dor or Apollonia), then the urban area of Caesarea would have to contain several Hellenistic villages, of which one was the πολίχνιον of Straton's Tower. This needs to be considered also in the light of the discovery of a Hellenistic quay[9] but must at the same time be reconciled with the sources which state that Straton's Tower had only a bad anchorage and that Herod built his harbour because there was none previously (Jos., *AntJ* 15. 332-34; Strabo 16.2.27).

5. Why was Caesarea built at Straton's Tower?

Raban dismissed the rôle of the earthquake of 31/30 B.C. in the foundation of Caesarea, but he misread the sources when he stated that Josephus said that it affected "only the southeastern part of Judaea, near the Dead Sea". In fact Josephus (*AntJ* 15.121) wrote: 'There was an earthquake in the land of Judaea, like none previously, which caused much destruction of the herds in the country. Moreover, about 30,000 people were killed in the collapse of their homes'. Elsewhere (*BJ* 1.371) Josephus added 'they believed that all

7 Roller 1982 (supra n.1) 43.
8 A. Negev, *Caesarea* (Tel Aviv 1967) 9-13
9 T. W. Hillard, "A Hellenistic quay in Caesarea's North Bay," *Mediterranean Archaeology* 2 (1989) 143-46.

of Judaea had been totally destroyed'. This was one of the major disasters of its time, but earthquakes do not stop at political boundaries. This may be why Josephus calls Straton's Tower κάμνουσα (*BJ* 1.408), a word used to refer to something or someone who has met with disaster, for example a storm at sea or a city destroyed. Recent severe damage to Straton's Tower may have been the best reason for its selection by Herod.

6. The other Straton's Tower

The riddle of the Straton's Tower in Jerusalem,[10] which was not a tower, remains a difficulty which cannot be ignored by those searching for the coastal town. How far did the two places become confused in the sources?

Much therefore remains to be learned about Straton's Tower. I agree with Raban that we need more substantial archaeological finds, and one hopes that continuing fieldwork will provide the necessary data. But all of the new finds must be carefully integrated with the existing evidence, literary and stratigraphic, in an effort to resolve seeming contradictions and confusions.

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10 Roller 1983 (supra n.1) 65.

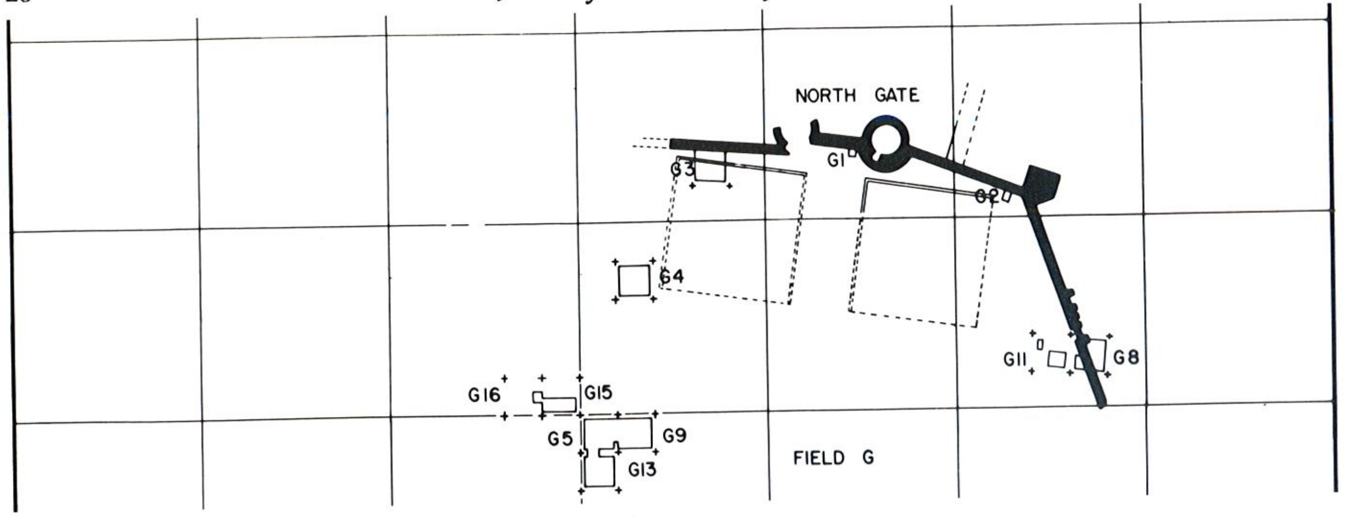

Fig.1. Detail of Field G, 1980 (M. Govars after G. Wing, Joint Expedition copyright).

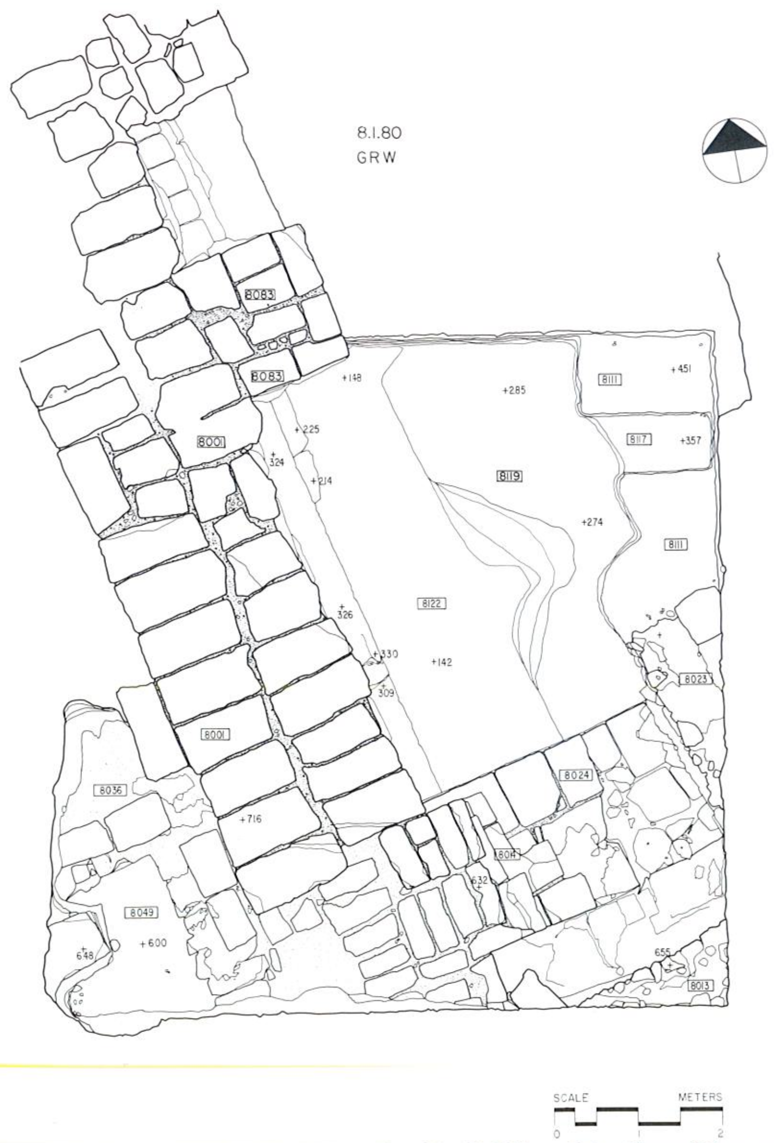

Fig.2. Field G, Area 8, final top plan (8.1.80, G. Wing, Joint Expedition copyright).

Stratigraphy and the North fortification wall of Herod's Caesarea

Jeffrey A. Blakely

In 1978 the Joint Expedition opened an excavation (Area G.8) over the North fortification wall in order to establish when it was constructed, its period of use, and date of abandonment. In the preliminary stratigraphic report, published in 1984,[1] the wall was attributed to Herod on the basis of the pottery and coins. Four years later Raban published an alternative interpretation.[2]

The kinds of questions asked of such classical sites have expanded since this excavation was conducted — for example, to include economic and environmental questions — yet the basis of all analyses remains the stratigraphic record, which must be as accurate as possible. The excavation of Area G.8 constitutes the deepest and most continuous stratigraphic section yet dug at Caesarea, and it was therefore selected for particular scrutiny of its ceramics. All rim, base and decorated sherds had been retained from the excavation, and the ceramics are part of an ongoing analysis tied to the stratigraphic record. The present chapter draws upon the stratigraphic data in order to date the phases of this fortification wall. Ceramic data that is valuable for other purposes will be presented later.

A few words may be added here about the use of pottery for dating the stratigraphic sequence. The stratigraphic matrix is dated by following the sequence of events dictated by rules of superimposition and by assigning to the various deposits a range of dates which are based upon the absolute dates of the material within them as well as upon the absolute dates of deposits which preceded and followed. It is of course entirely possible that the dates of the material found within a deposit are significantly earlier than the date of deposition itself. Sometimes this occurs because builders excavated pits into earlier levels and distributed that material around the new construction level, and if the construction process lasted only a short time little contemporary material may have been added to it.[3] Care should also be taken in the use of parallels from other sites for dating. Acceptance of the date range assigned must take into account the quality of the data upon which it is based. Errors in the analysis of the data can, therefore, occur at a number of points — in excavation when the stratigraphic sequence is being worked out, in the internal dating of the sequence, and in using external evidence to date to the sequence. The present chapter will not be immune to criticism because it attempts to present briefly certain data about a particular fortification wall, whose final publication should require several hundred pages. Here I intend to present the relevant sections and plans and selected ceramics and coins. I do not consider the period after this fortification was abandoned, which is placed in about the 4th c. A.D.

The excavation

Area G.8 is located *c.*250 m N of the N edge of the Crusader fort (fig.1). The Italian Mission was the first to excavate in the vicinity of the fortification in question, and they dated it to the Herodian period. Since then its chronology has been much debated.[4] In Area G.8 some 6-m depth of man-made layers were excavated down to the sterile natural sand (fig.2). In total 127 loci and 1767 rim, base and decorated

1 Blakely, "Date".
2 Raban, "City Walls"; I replied to his points in my article of 1989 (*BASOR* 273, 79-82).
3 For an example from Tell el-Hesi, see M. K. Risser and J. A. Blakely, "Imported Aegean fineware in the first millennium B.C.E." in W. J. Bennett, Jr. and J. A. Blakely, *Tell el-Hesi: the Persian period, stratum V* (Winona Lake 1989) 68-137.
4 Frova 1965; Levine, Qedem 2; Negev in *Encyclopedia of archaeological excavations in the Holy Land* vol.1 (1975) 270-85; Ringel, *Césarée*; D. W. Roller, "The Wilfrid Laurier University survey of northeastern Caesarea Maritima," *Levant* 14 (1982) 90-103 and id., "The problem of the location of Straton's Tower," *BASOR* 252 (1983) 61-66; Levine & Netzer, Qedem 21 (1986); Raban, "City Walls".

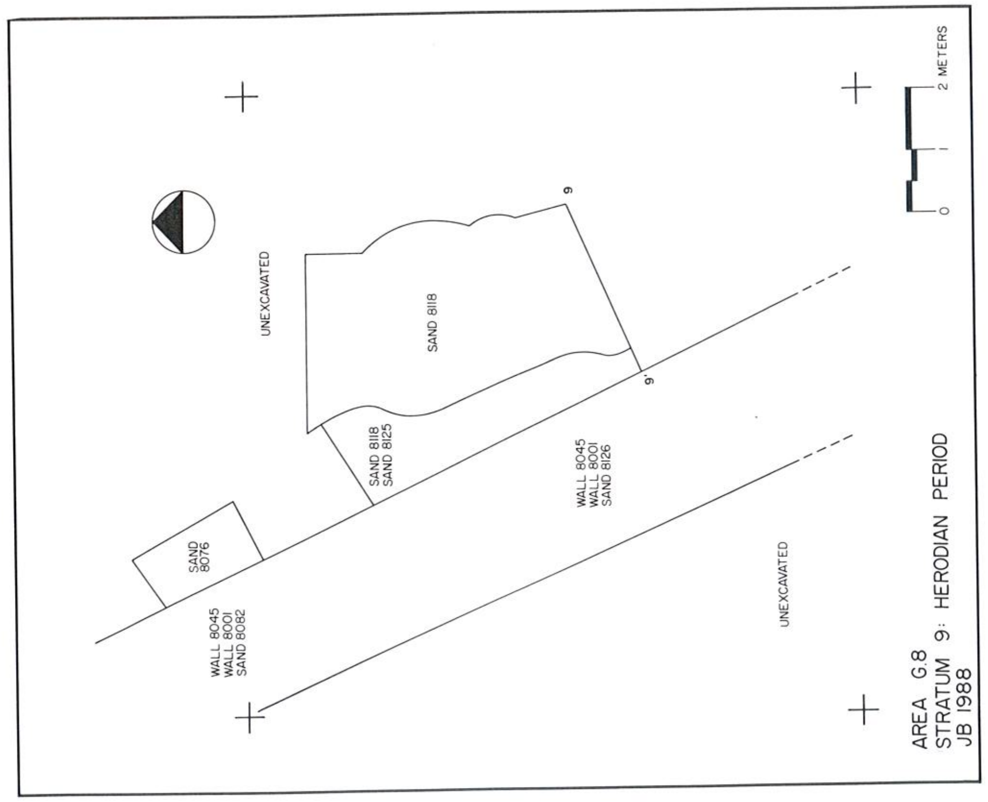

Fig.5. Block plan of stratum 9.

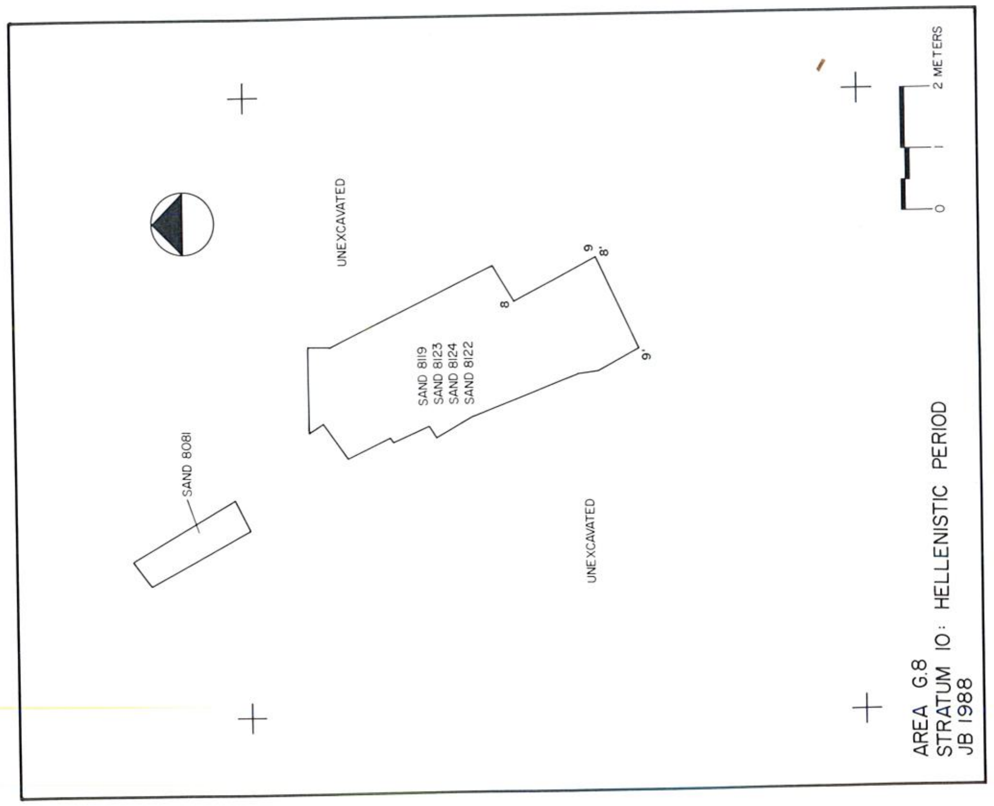

Fig.3. Block plan of stratum 10.

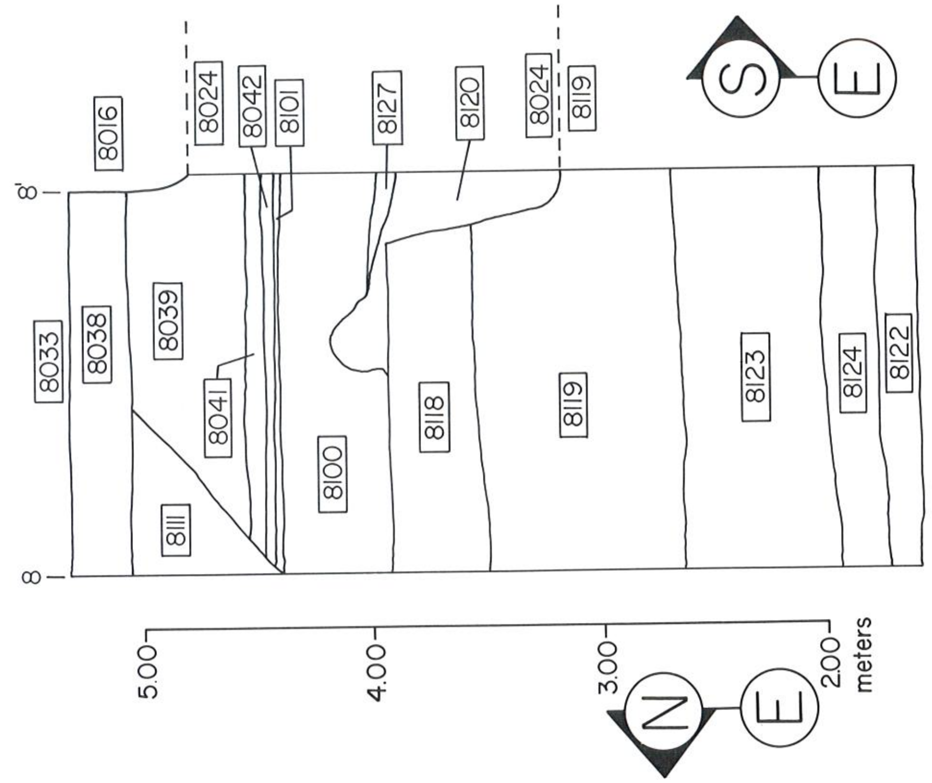

Fig.6. Section, subsidiary S baulk (MLG, LFL, 7.31.80, Area G.8).

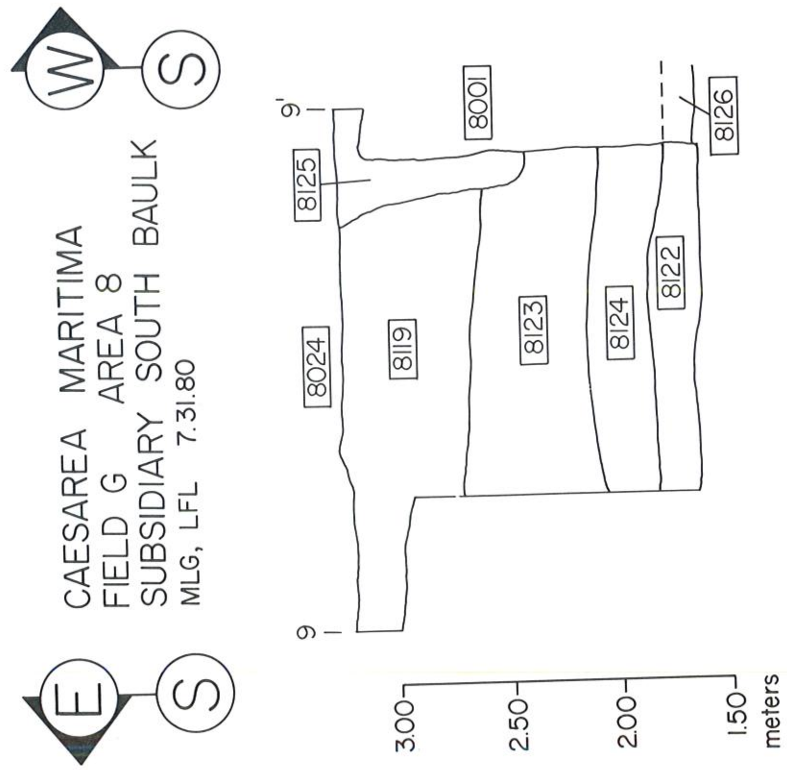

Fig.4. Section, subsidiary E baulk (JAB, JB 7.29.80, Area G.8).

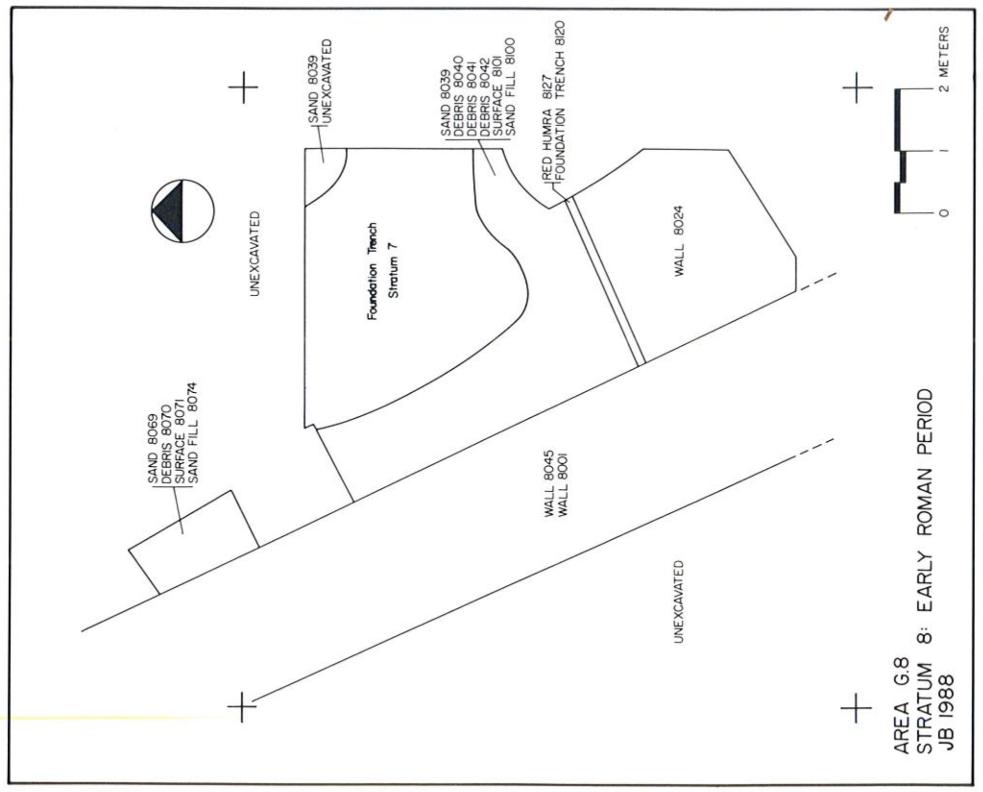

Fig.7. Block plan of stratum 8.

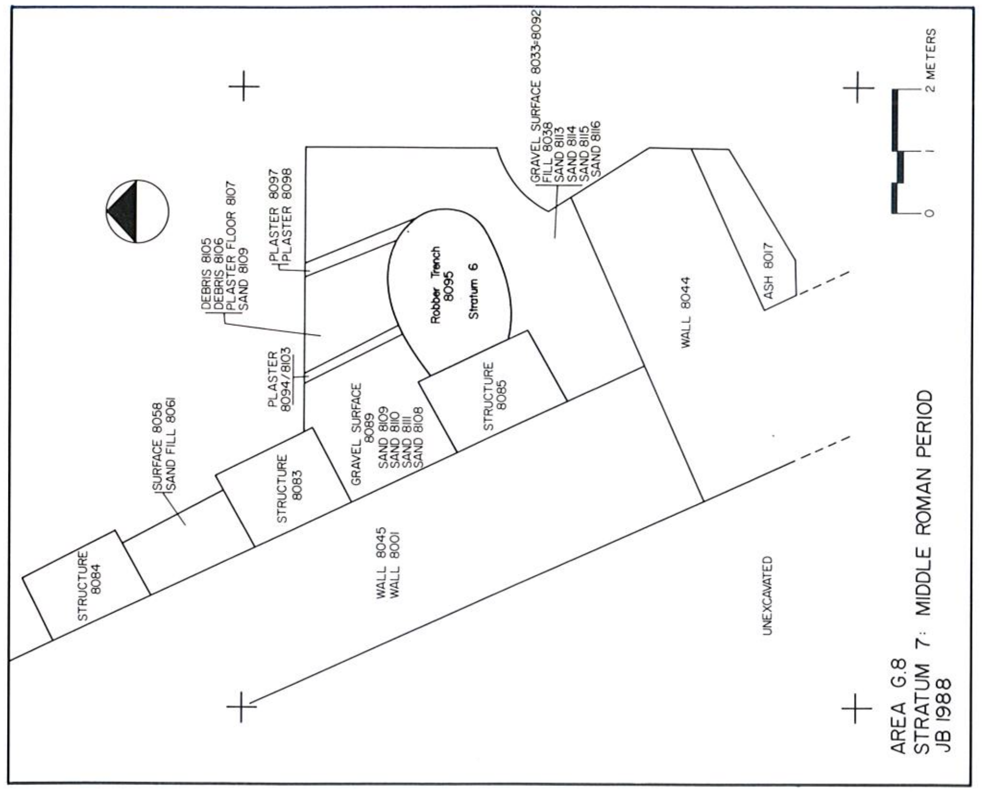

Fig.8. Block plan of stratum 7.

sherds were recorded, in addition to many other artifactual materials. The loci were divided into 10 identifiable strata, the earliest 6 of which will be summarized here. On the block drawings, loci shown above one another reflect their stratigraphic relationship. All vertical levels are in meters above absolute sea level.

Stratum 10 (fig.3)

The earliest deposits containing artifactual material were found directly above the compacted waterlogged sand **8122**. First came 3 horizontal layers of sand (**8124, 8123, 8119**) which contained increasing quantities of occupational débris (fig.4). No structures were found in these layers.

Stratum 9 (fig.5)

A foundation trench dug down to the natural sand **8122** (fig.6) was filled with a stone wall *c*.2.4 m wide, comprising a shallow foundation deposit **8126**, 4 courses of foundation, and 6-7 courses of superstructure **8001**. The wall had been built against the edge of the foundation trench and the intervening space **8125** refilled. Sand was then smoothed out to create the first occupation surface associated with this wall, **8118**.

Stratum 8 (fig.7)

A second foundation trench **8120** contained wall **8024**, over 2.8 m wide, added to and abutting wall **8001** at the W and running to the E. The wall was built on ashlar limestone blocks held together by a sticky hard red clay and sand (*humra*). The foundation trench was then filled in, and some additional mortar **8127** next to the same wall was covered by a layer of fill **8100**, which also covered **8118** and **8120** (fig.4). Above **8100** was an earthen surface **8101**, above which were occupation deposits **8042, 8041, 8040** and **8039** (figs.4 and 7).

Strata 7 and 6 (figs.8-9)

The top of wall **8024** and the parts of wall **8001** at and S of the junction with wall **8001** were removed down to contemporary ground level. A new wall of dry-laid ashlar **8044** was built on top of the remains of walls **8024** and **8001**. The E extension of **8044** appears to follow a slightly different orientation from the earlier wall **8024**. A fill **8038** was added outside these walls, and it was covered by a layer of sandstone and limestone chips **8033/8089/8092**, abutting walls **8044** and **8001** (fig.4). This was probably the first occupation layer used with this new fortification wall. Loci **8030, 8032** (fig.10) and **8050** were deposited on top of that surface. Other changes, more cosmetic in nature, were made to the earlier wall **8001**: the protruding panels on the drafted exterior face of **8001** were removed, apparently so that it would resemble the stones of wall **8044**; the panels were removed on and above the fourth course (figs.11-12). The point of change was at **8033/8089/8092**, the layer of stone chips, perhaps indeed deriving from the removal of the protrusions. The other structural elements belonging to this phase are not relevant to the present chapter; the construction and removal of some of those other structures distinguish stratum 7 from stratum 6, although walls **8044** and **8001** remained intact.

Stratum 5 (fig.13)

Robber trench **8016/8029/8043** was excavated to dismantle the E extension of wall **8044** (fig.10). Although portions of both walls **8001** and **8044** survived, this stratum should mark the end of the functioning of this fortification.

Dating of the stratigraphic matrix by internal evidence of the pottery

We are here concerned with the dating of strata 6-10. Data presented previously (Blakely, "Date") are simply summarized. In the 3 loci of stratum 10 were datable coins all of the 3rd or 2nd c. B.C., the latest minted 128-123 B.C. (fig.14). The ceramics allow a date range to *c*.100 B.C. or immediately thereafter (Blakely, "Date" figs.5-7). Pottery of the period *c*.100-25 B.C. was conspicuously absent in this excavation, raising the possibility that this part of the site was abandoned then. This observation makes the dating of stratum 9 and the construction of the wall more complicated. The pottery found in **8126** and **8125** (strat-

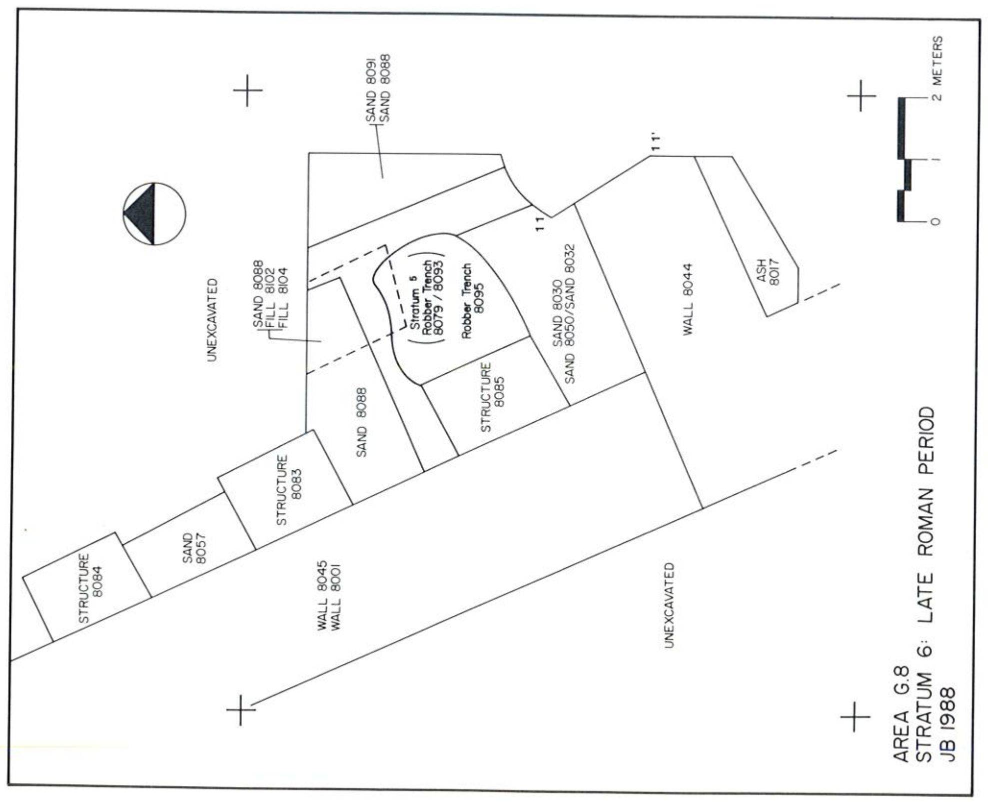

Fig.9. Block plan of stratum 6.

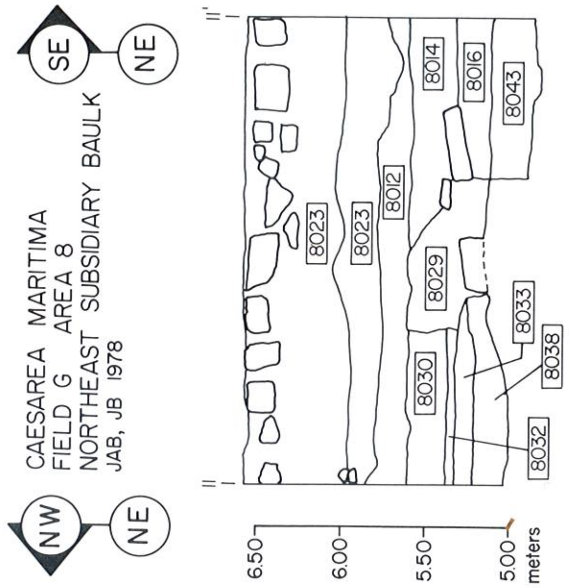

Fig.10. Section, subsidiary NE baulk.

Fig.12. Elevation of wall **8001** (A. M. Borys & G. Wing).

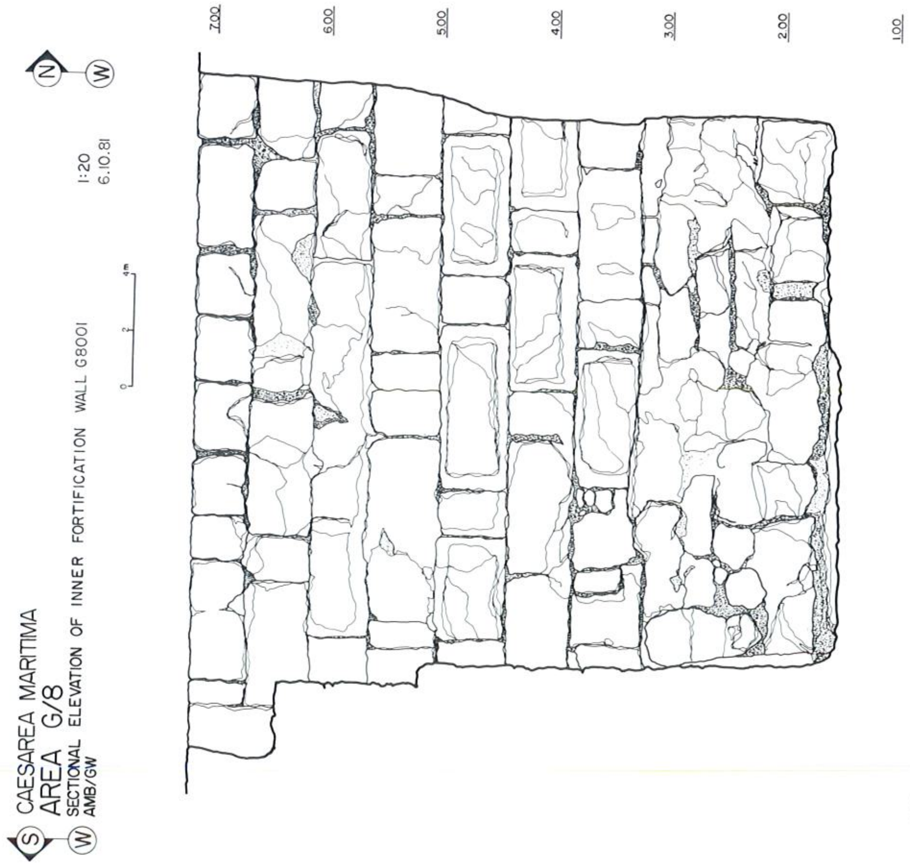

Fig.11. E face of wall **8001** with foundation courses (Joint Expedition, Ewald & Johnson).

um 9) seems to be exclusively 2nd c., down to *c.*100 (Blakely, "Date" figs.8-9); roughly half of the pottery in **8118** appeared to belong to the 2nd c. and half from *c.*1-50/70 A.D. (Blakely, "Date" figs.10-11). Thus it seems clear that the first use of the fortification continued until well into the 1st c. A.D. The stratigraphic data available to date the fortification are less precise than one might hope. Clearly it was built between 128 B.C. and the end of the 1st c. B.C. Because no artifactual material belonging to most of the 1st c. B.C. is present, no such material was available to be mixed into the foundations, whether they were built at the end of the 2nd c. B.C. or during the 1st c. B.C.

Since no late 2nd c. B.C. occupational surfaces were found over the foundation trench and no organic enrichment of **8118** occurred (which would have been likely if it had been exposed for a century next to a major wall system), and since there is no evidence that drifting sand accumulated during such an hypothesized abandonment, it may seem more likely that the fortification was built later rather than earlier within the available time span, but such a stratigraphic argument is tenuous.

When did **8118** (the first occupation surface used in conjunction with the fortification) go out of use and when was wall **8024** built? Occupation layer **8118** contains pottery produced until the middle of the 1st c. A.D. (Blakely, "Date" 11). The make-up layer **8100** below the earth floor contained a coin of A.D. 69/70 (fig.15). The pottery found on the first floor associated with wall **8024** and floor **8101** (stratum 8) contains numerous examples of late 1st-c. A.D. material (fig.16) — Pompeian Red Ware cooking lids (fig.16.2-4) and

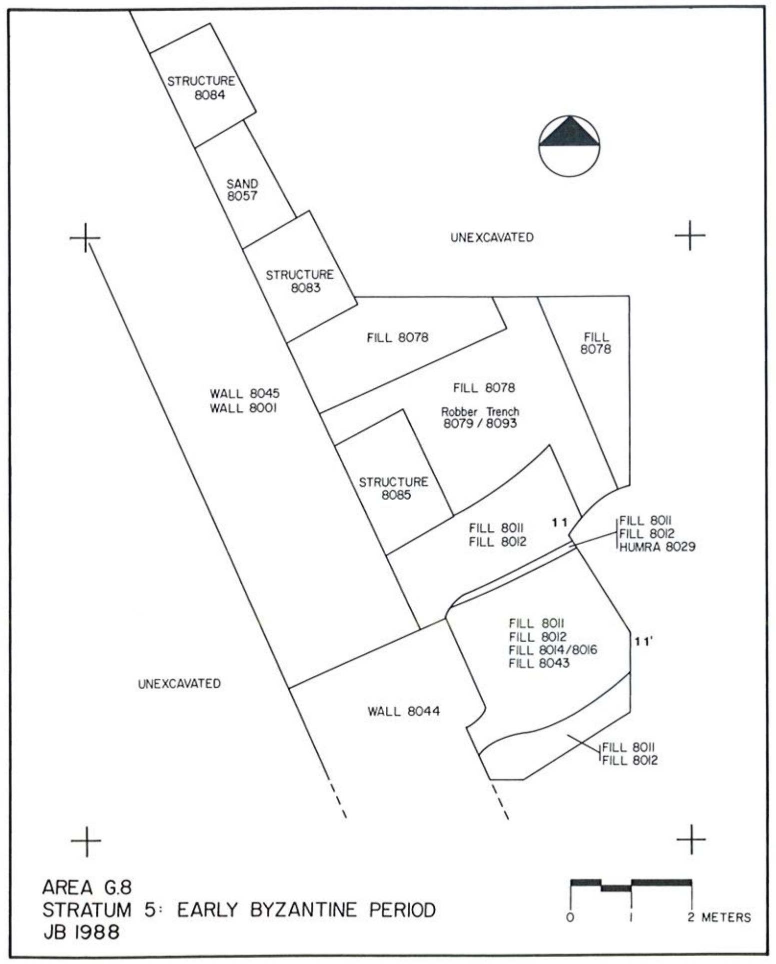

Fig.13. Block plan, Stratum 2.

Fig.14. Coin of Alexander III (128-123 B.C.), from locus **8119**.

Fig.15. Coin of First Jewish Revolt (A.D. 69), from locus **8100**.

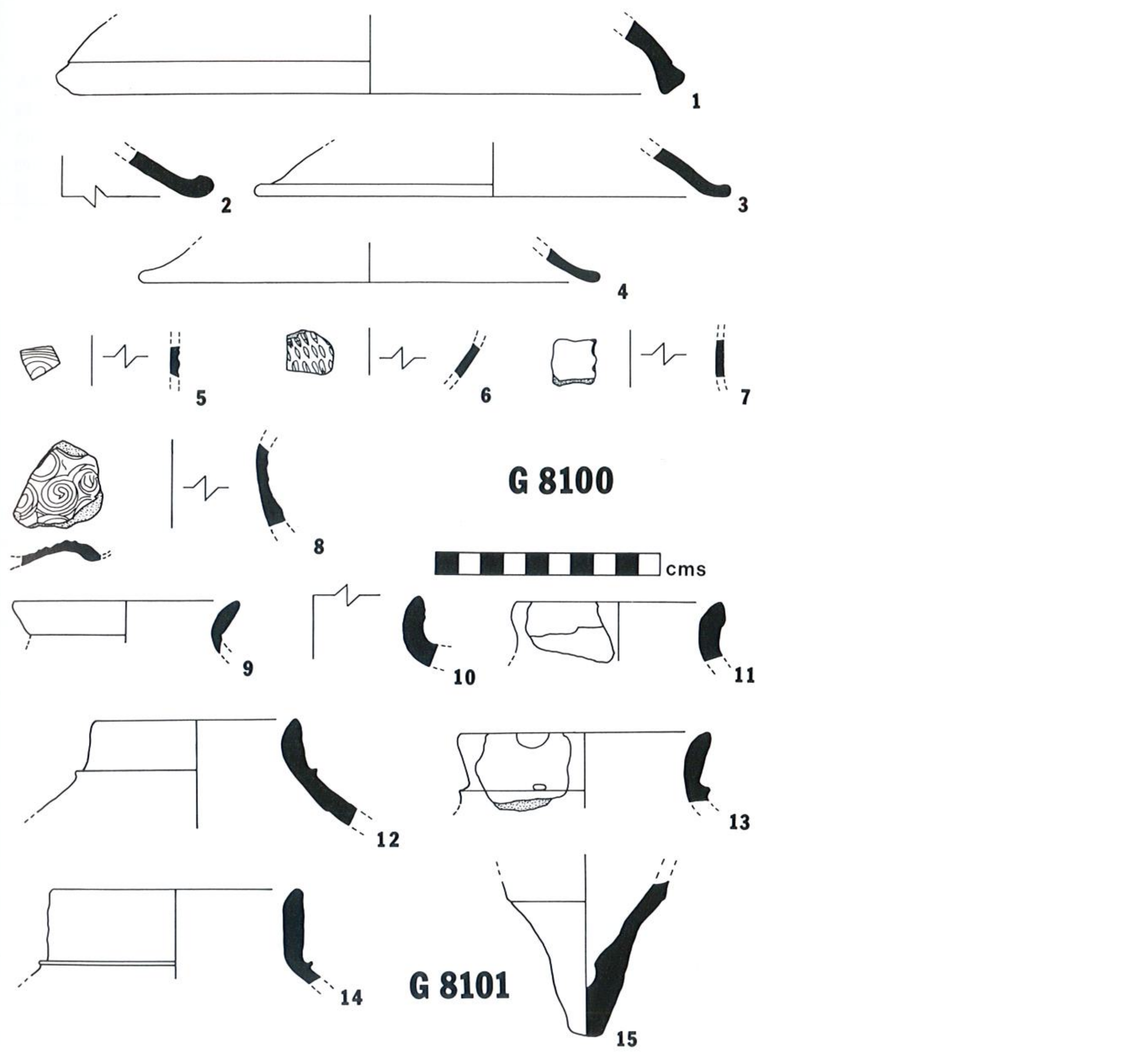

Fig.16. Pottery from 8100 and 8101

1	G8100	G.8.482.3	Baking tray	ext brown (7.5YR 5/2). Int pink (5YR 7/3). Core pink (7.5YR 8/4). Ext smoke-blackened
2	G8100	G.8.466.1	Pomp.red lid	ext and int dark gray (5YR 4/1). Core black (5YR 2.5/1)
3	G8100	G.8.479.5	Pomp.red lid	ext and int reddish yellow (5YR 7/6). Core light red (2.5YR 6/8). Rim smoke blackened
4	G8100	G.8.466.4	Pomp.red lid	ext and int reddish yellow (5YR 7/8). Core reddish yellow (5YR 6/8)
5	G8100	G.8.466.12	Body	ext red slip (2.5YR 4/6). Int and core reddish yellow (5YR 7/6)
6	G8100	G.8.479.10	Body	ext and int red slip (2.5YR 5/8). Core reddish yellow (7.5YR 8/6)
7	G8100	G.8.335 (no #)	Body	ext and int red slip (2.5YR 4/8). Core light red (2.5YR 6/8)
8	G8100	G.8.479.1	Body	ext red slip (10R 5/8). Int and core reddish yellow (5YR 7/6)
9	G8101	G.8.464.4	Amphora	ext and int very pale brown (10YR 8/3). Core pink (5YR 7/3)
10	G8101	G.8.478.4	Jar	ext, int and core reddish yellow (5YR 7/6)
11	G8101	G.8.465.1	Amphora	ext and int reddish yellow (5YR 7/6). Core grayish brown (10YR 5/2)
12	G8101	G.8.465.2,4,5	Amphora	ext and int reddish yellow (5YR 7/6). Core grayish brown (10YR 5/2)
13	G8101	G.8.478.3	Amphora	ext, int and core reddish yellow (5YR 7/6)
14	G8101	G.8.464.2	Amphora	ext and int pink (5YR 8/4), core light red (2.5YR 6/6)
15	G8101	G.8.464.8	Amphora base	ext and int reddish yellow (5YR 7/6). Core reddish yellow (5YR 6/6).

amphoras (fig.16.11-14).[5] These three pieces of evidence combine to point to a date of *c*.A.D. 70 for this activity. Thus, at about that time a major addition was made to the fortification wall. The line of this fortification can be extrapolated to enclose the amphitheatre some 300-400 m to the E, which should in turn point to a massive increase in the territory being enclosed. Wall **8024** may have been built at the same time as the so-called curtain wall that closed the gate at the two round towers of the original wall (fig.17). Thus we may suggest that the gate was closed then and a new gate built, as part of wall **8024**, at some point further inland.

Fig.17. Round tower (top), curtain wall (center), and fragmentary round tower (bottom) in Field G.

5 D. P. S. Peacock and D. F. Williams, *Amphorae and the Roman economy* (New York 1986) 109-10, 215-17; Blakely, *Vault 1*, 40, 239-40 no.6.

Stratum 8 probably runs into the early decades of the 2nd c. A.D. on the basis of cooking pots (fig.18:3-6) of the grooved rim Early Roman type III-IV[6] and amphoras (fig.19:5 and 19:7-14) of class 62.[7] Three essentially complete vessels were discovered in this stratum. One is an imported lamp *in planta pedis* (fig.20), *c*.70-90;[8] another is a barbotine cup (fig.22) probably from the Po Valley, dating *c*.70-90,[9] found, like the first, on the earth floor. The third is a complete Early Roman Palestinian cooking pot (fig.21)

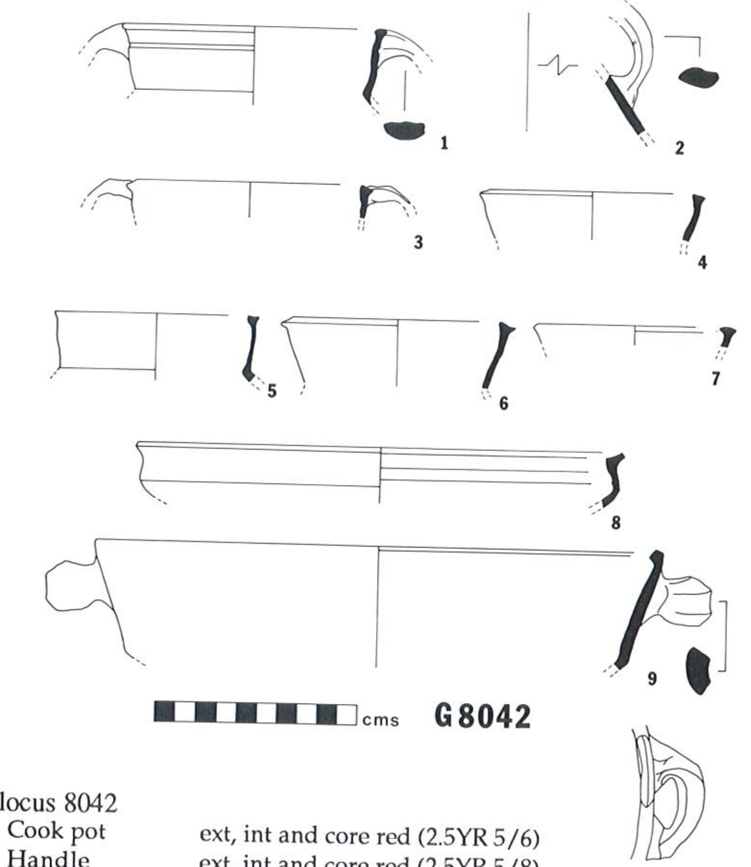

Fig.18. Pottery from locus 8042

1	G.8.408 no #	Cook pot	ext, int and core red (2.5YR 5/6)
2	G.8.408 no #	Handle	ext, int and core red (2.5YR 5/8)
3	G.8.411.1	Cook pot	ext, int and core light red (2.5YR 6/6)
4	G.8.412.4	Cook pot	ext, int and core light red (2.5YR 6/8)
5	G.8.412.5	Cook pot	ext and int reddish brown (2.5YR 5/4). Core red (2.5YR 5/6)
6	G.8.412.2	Cook pot	ext and int light red (2.5YR 6/6). Core gray (5YR 5/1)
7	G.8.412.3	Cook pot	ext, int and core red (2.5YR 5/6)
8	G.8.408 no #	Casserole	ext and int light red (2.5YR 6/8). Core red (2.5YR 5/8)
9	G.8.410.1,2,3; G.8.411.16	Casserole	ext and int light reddish brown (5YR 6/3). Core dark reddish gray (5YR 4/2). Rim smoke blackened.

6 As described by J. A. Sauer, *Hesbon pottery 1971: a preliminary report on the pottery from the 1971 excavations at Tell Ḥesbân* (Andrews University Monographs VII, 1973) 18.

7 Blakely, *Vault 1* 89-90; Peacock and Williams (supra n.5) 215; N. L. Lapp and G. W. E. Nickelsburg, Jr., "The Roman occupation and pottery of Araq en-Naʿsaneh (Cave II)" in P. W. and N. L. Lapp (edd.), *Discoveries in the Wâdī ed-Dâliyeh* (AASOR 41, 1974) 49-54.

8 Cf. D. M. Bailey, *A catalogue of the lamps in the British Museum* II: *Roman lamps made in Italy* (London 1980) 90; O. Broneer, *Corinth* vol.IV, pt. II, *Terracotta lamps* (Cambridge MA 1930) 95-98, Types XXV and XXVII.

9 E. B. Bonis, "Pottery" in A. Lengyel and G. T. B. Radan (edd.), *The archaeology of Roman Pannonia* (Lexington KY 1980) 360; P. Baldacci *et al.*, *I problemi della ceramica romana di Ravenna, della Valle Padana e dell'alto Adriatico* (Atti del convegno Ravenna 1969, Bologna 1972); M. G. Maioli, "Vasi a pareti sottili grigie dal Ravennate," *RCRF* 14-15 (1972--73) 106-24; G. C. Duncan, "A Roman pottery near Sutri," *PBSR* 32 (1964) 53.

A mid-1st c. B.C. date for the walls of Straton's Tower?

T. W. Hillard

The wall and two bastions (figs.1-2) already discussed by Raban *et al.* (see p.7 ff.) were regarded as Herodian by the Italian team which excavated them in 1959.[1] More recently, Blakely argued from the stratigraphical evidence found against the external wall in Area G-8 that the walls must date between *c*.100 B.C.[2] and the start of the present era (an argument he refines above, p.27 f.); and, since he was of the opinion at the time that after 106 "there is no evidence of occupation" until the Herodian period, he believed this proved the walls to be Herodian. Others have presented arguments against a Herodian dating[3] and I agree with Raban that there are good reasons for rejecting such a dating. The search for Herodian walls may indeed be misguided: it is remarkable that Josephus makes no mention of walls of Caesarea, though the 'magnificent' walls at Samaria and those at Jericho, Herodium, and Byblos are mentioned (*BJ* 1.403; 417; 420; 422). It is usually *assumed* that Herod fortified Caesarea. Levine argued that Caesarea was an integral part of an overall defensive system — *against* the Jews as much as protection against external aggression. Josephus does, it is true, call Caesarea a 'fortress for the entire nation' (*AntJ* 15. 292-93), but although the word φρούριον is elsewhere used by Josephus literally, in this instance it must be metaphorical, for the nation in question is the Jewish people (τὸ ἔθνος used singularly), and Caesarea could not have been intended to serve literally as a fortress for the Jewish nation.[4] Rabbinic tradition specifically excluded Straton's Tower from Jewish Palestine.[5] Thus Caesarea was a fortress in the sense that it ensured Roman goodwill and advertised the Roman presence. This 'exhibition' city was to be of easy access: Herod did not intend to impede access.

The purpose of this paper is to consider other historical occasions between *c*.100 and the reign of Herod when walls might have been built, and to propose a phase of construction directly following Pompey the Great's involvement in the area.

Straton's Tower certainly had walls; or, at least borders by which rabbinical literature could delimit the border of the people which returned from Babylon. Raban suggested that they were built under the tyrant Zoilos in the second half of the 2nd c.[6] That would fall well outside the chronological limits allowed by Blakely for the existing walls.[7] Were the defences of the Hellenistic town significant? Although the city withstood Alexander Jannaeus for a time (Jos., *AntJ* 13. 324-26), it seems to have relied more upon its fighting men than upon its defences.[8] The *Letter of Aristeas* 115 registers only Ashkelon, Joppa, Gaza, and Ptolemais of the coastal cities. Straton's Tower was a modest settlement.

The Roman advent

Another possible context for the walls needs therefore to be considered — the republican period (64-

1 Frova *et al.* 251-63, 282-86. See also Blakely, "Date" 3-6 for a survey of the debate.

2 Just after the possible destruction of Straton's Tower by Alexander Jannaeus, as posited by L. Levine, "The Hasmonean conquest of Straton's Tower," *IEJ* 24 (1974) 62-69.

3 A, Negev, *Mada* 10 (1966) 343-44 (Hebrew) ibid. 11 (1966) 142-43 (Hebrew) and Blakely's summary (supra n.1) 4-5; Levine, Qedem 2, 10-12, and Raban, "City walls" 78-82.

4 In the absence of a preposition the dative τῷ ἔθνει παντί is usually read as a dative of advantage (i.e. Caesarea was for the benefit of the nation). Samaria is spoken of in the same passage as an Herodian rampart *against* all the people (παντὶ τῷ λαῷ). It might seem then that the similar formula used for Caesarea was similarly a dative of disadvantage, but would Josephus have said that the city guarded against the *nation* of which Herod was king (rather than, as in the case of Samaria, against recalcitrant subjects — i.e. the people/mob (τῷ λαῷ)?

5 Levine, *Caesarea* 10 and 149 n.49.

6 Raban, "City walls" 87. On this 'border' see Levine, Qedem 2, 11, n.51, citing T Shevi'it 4.11 (ed. Lieberman, p.181).

7 Blakely conceded the possibility of an earlier *terminus post quem* in discussion at the Washington conference.

8 5th c. scholion on the 2nd c. Megillat Ta'anit, quoted by Levine (supra n.2) 63. Cf. Levine, *IEJ* 1974, 63-64 and nn. 15-16 on the identification of Migdal Ẓur with Straton's Tower.

Fig.1. External face of northern gateway at Straton's Tower, east bastion.

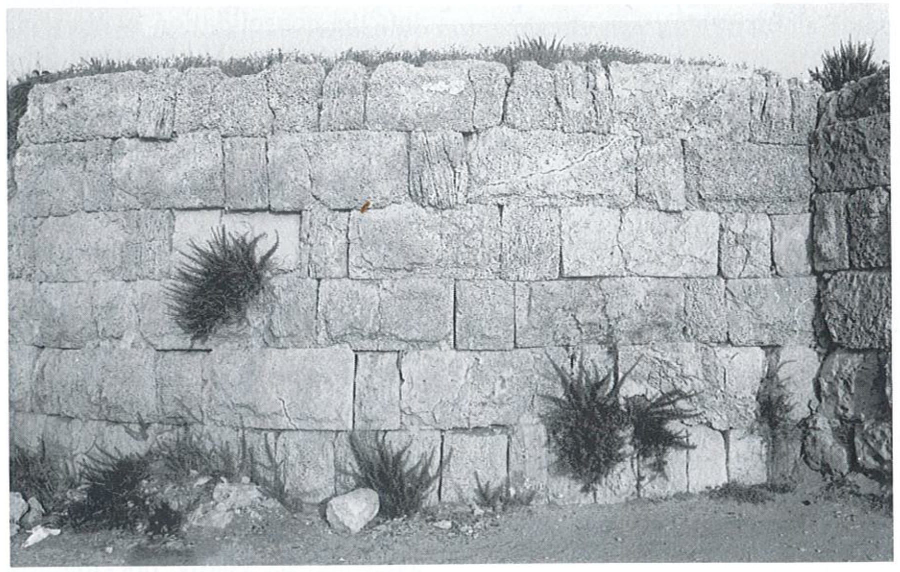

Fig.2. East bastion, Straton's Tower.

31), so often overlooked at Levantine sites. Pompey had moved into Syria in 64, preceded by his quaestor M. Aemilius Scaurus in 66. By the end of 63 Pompey had entered Palestine, taken Jerusalem by storm, and then departed. But the effects of his coming would be long felt, for he had taken more than a passing interest in the area. Josephus (*AntJ* 14. 73-76) reports that 'not only these cities in the interior, in addition to those that had been demolished,[9] but also the coast cities of Gaza, Joppa, Dora, and Straton's Tower — all these Pompey set free and annexed to the province.' At *BJ* 1.157 Josephus makes clear that the same four cities were included in a process of recolonization, asserting that they were returned to their 'legitimate citizens'. One of the prime Roman goals was to reestablish an order which suited Roman

9 The parallel text in *BJ* 1.156 might suggest the reading 'aside from those which had previously been destroyed'. Certainly some of the cities listed are reported to have been destroyed (Pella, Samaria, Gaza), but how literally reports of "destruction" should be taken is another matter; cf. R. H. Smith *et al.*, *Pella of the Decapolis* vol.1 (1973) 38.

interests. Pompey, therefore, followed a policy of active Hellenization and it was in line with this policy that he granted autonomy to the coastal cities and fostered the Hellenistic cities of Transjordan, freeing those that had come under Hasmonean control through the conquests of Alexander Jannaeus. With this program came a degree of rebuilding. Gadara (modern Umm Qeis) became, for instance, 'Pompeian' Gadara (or simply Pompeia) and subsequently dated its calendar from the advent of Pompey. Its coinage bore Pompeian symbols.

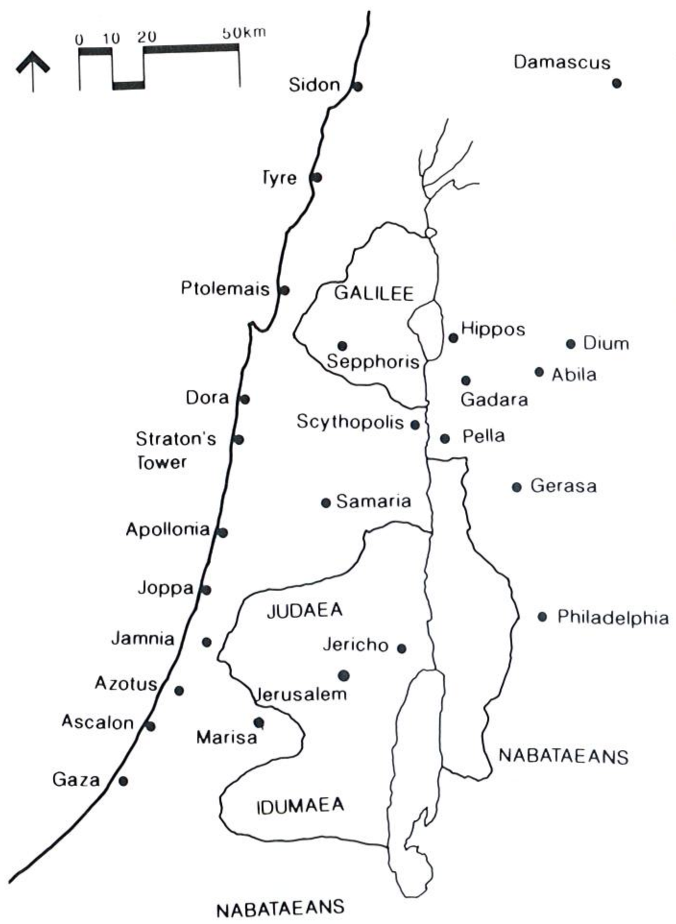

Fig.3. Hasmonean Palestine & Decapolis cities.

Pompey (or his advisors) recognized that the Jewish kingdom was a problem whose internecine strife threatened the new order. At the same time, he wished to avoid unnecessary annexation where alternatives could be equally secure. The more placid claimant to the Jewish throne was installed and the kingdom itself was stripped back, as A. H. M. Jones put it, to its rural core. The cities of the coast were freed from Hasmonean dominion, and an independent Samaritan enclave was established, dividing Galilee from Judaea (fig.3). In the east the kingdom was contained by the cities of the Decapolis. Pompey left the consolidation of these arrangements to his successors, M. Aemilius Scaurus (63-61), L. Marcius Philippus (61-60), Cn Cornelius Lentulus Marcellinus (59-58), and above all to Aulus Gabinius who arrived in 57 as the first consular governor of Syria (he had previously served in the area under Pompey, and now stayed for 3 years). Gabinius' sweeping policy included an active program of rebuilding that focused on the urban centres freed from Hasmonean control. Josephus reports (*BJ* 1.165-66) that Gabinius toured the country 'settling the affairs of the unravaged cities and refounding (building up?) those which had been devastated. By his order, Scythopolis, Samaria, Anthedon, Apollonia, Jamnia, Raphia, Marisa, Adoreos, Gamala (Gaza?), Azotos, and many others were repeopled, colonists gladly flocking to each.' The parallel passage from *AntJ* 14.87-88 (which offers a shorter list of cities affected, but with a qualification 'and not a few others') is more explicit: 'and whenever [Gabinius] came upon a ruined city, he ordered it (re)built ... and as the people obeyed Gabinius, it came about that these cities, which had long been desolate, could now be safely inhabited'. Thus, wherever the situation demanded, political and/or material reconstruction took place.

The impact of this program must not be underestimated. Many of the cities involved adopted a Roman era and the numismatic evidence shows that this calendrical arrangement remained in place for at least three centuries.[10] Cities were renamed,[11] and in a city like Samaria, which had been utterly destroyed by

10 Y. Meshorer, *City coins of Eretz-Israel and the Decapolis in the Roman period* (Jerusalem 1985) 110, 113, 117, 78, 118, 117, 119, 120. Inscriptional evidence shows that two villages in Abila's territory also used the Pompeian era (Jones 457, n.45); R. H. Smith *et al.*, ibid 33-35.

11 Meshorer (supra n.10) 76 (on Gabinian Canatha); cf. Jones 258; Meshorer (supra n.10) 113 (on Gabinian Nysa=Beth Shean/Scythopolis); cf. E. Bammel, *JJS* 12 (1961) 160; Jones 257-58; 456 n.42.

John Hyrcanus in 106 and where the restoration must have been extensive, the citizens of the new polity took the name *Gabinieis* (Gabinians).[12] It is remarkable, then, how little of all this is recognized in the archaeological record.[13] The primary reason, one must suspect, is that archaeologists simply do not expect to find the republican stratum.[14] The imperial phase which follows has often obliterated trace of that which immediately preceded. At many sites, then, there is a gap in the archaeological record from *c.*63 to 30 B.C. Yet Roman republican governors, transient though they were, had the time and the inclination to leave their mark. The archaeological remnants of a hippodrome in Antioch may never have been associated with the two-year governorship of Cilicia by Q. Marcius Rex from 67 to 66 B.C. had not a local tradition preserved in garbled fashion the memory of his association with its construction.[15] The extent of this general oversight was a theme which I elaborated at the Washington symposium, but which the constraints of the present volume dictate be held over for fuller discussion elsewhere.

Implications for Straton's Tower

Straton's Tower must have played a part in any plan to sabotage commercially and to encircle the Hasmonean kingdom with autonomous cities possessing substantially different cultures. In the 50s B.C. the ethnicity of its population probably changed markedly. It probably benefitted from the building program also. Josephus tells us that the city was granted autonomy in local administration but fell under the oversight of the governor of Syria, and that the population was again to be gentile. Josephus' lists of cities benefitting from Pompey's grant are implicitly comprehensive but in fact "manifestly incomplete"[16] while his lists of Gabinius' restorations (which do not explicitly mention Straton's Tower) do not purport to be exhaustive.

Negev and Foerster both assume (correctly, in my view) that Straton's Tower was rebuilt by Gabinius.[17] Gabinius was certainly interested in the coastline and in considerations of security. His building program in this region would have been not simply cultural but strategic;[18] against pirates, and against the population of the hinterland hostile to the re-established Hellenistic style polities.[19] (This holds true

12 For a full discussion of this problem, which also favours Gabinius as the real force behind the reorganization, see R. Tracey, *Romanization in Syria and Palestine in the late republic and early empire* (Unpublished diss., Macquarie University 1985) 8 ff.

13 Five blocks of Roman insulae below the podium of Herod's temple to Augustus (J. W. Crowfoot, K. M. Kenyon and E. L. Sukenik, *Samaria-Sebaste. Reports on the work of the Joint Expedition in 1931-1933 and of the British Expedition in 1935*. 1. *The buildings of Samaria* (London 1942) 30-31; cf. Tracey [supra n.12] 10), and perhaps traces of a bastion just W of Samaria's W gate (G. A. Reisner *et al.*, *Harvard Excavations at Samaria 1908-1910* (Cambridge MA 1924) plan 10 [West Gate].

14 By way of exception I might cite Z. Meshel, "A siege system and an ancient road at Alexandrium," in *Eretz Israel, Professor Y. Yadin commemorative volume* (1989) 292-301 (in Hebrew), who makes a strong case for identifying siege installations with those of Gabinius; Gabinius' is the only recorded siege of Alexandrium, and the nature of the finds suits the circumstances of 57 B.C. The excavators of Pella also are alert to the possibility of a Gabinian phase (A. W. McNicoll, R. H. Smith, B. Hennessey *et al.*, *Pella in Jordan* 1. *An interim report of the University of Sydney and the College of Wooster Excavations at Pella 1971-1981* (1982). For similar awareness, see A. Rowe, *The topography and history of Beth-Shean* (Philadelphia 1930) 46 and pl.7, and I. Anati and C. Epstein, *IEJ* 3 (1953) 133; cf. Epstein, "Hippos" in M. Avi-Yonah, *Encyclopedia of archaeological excavations in the Holy Land* 2 (London 1976) 521. At Marisa (Mareshah), on the other hand, the impact of Gabinius, which the archaeological explorations of Bliss and Macalister might have supported, has been denied outright (M. Avi-Yonah, "Mareshah", *Encyclopedia* ibid. vol.3, 788).

15 G. Downey, "Q Marcius Rex at Antioch," *CP* 32 (1937) 144-51.

16 Jones 455 n.42; cf. C. H. Kraeling, *Gerasa. City of the Decapolis* (New Haven 1938) 34, n.37.

17 A. Negev in *Encyclopedia of archaeological excavations in the Holy Land* 1 (London 1975) 271; Foerster in *Studies history* 10.

18 Cf. R. S. Williams, *CJ* 8 (1925) 33-38.

19 Cf. Levine, *Caesarea* 149 n.49. Note that Gabinius' tour of inspection was undertaken during his first year of office an during a military campaign (Jos., *BJ* 1.164-67).

whether the citizens of the revitalised city were new colonists or the previously displaced citizens, and whether or not the site was inhabited by a Jewish population from 100 to 63.[20]) Gabinius' concern was for the safety of the inhabitants of his refounded cities.

Historical circumstances therefore render it possible that fortifications at Straton's Tower were built by order of Gabinius between 57 and 55. It is not possible to establish in what style such fortifications should have been built. Although Italian forms may have been introduced in places, local styles would have persisted and perhaps prevailed. The character of construction work differed markedly with the local building materials. Stylistic criteria for dating the existing bastions to the Hellenistic or the Roman period are lacking: the style of masonry could have been the same in either period. The Romans adopted what they found. Negev argued that the Caesarea towers bear a resemblance to the Hellenistic towers of Samaria,[21] but the Samaria towers (with their header construction) in fact resemble more the earlier towers of Dora.[22] The best parallel may be between the Caesarea bastions and the corner tower just N of the western gate at Samaria (figs.4-5). The latter is part of the Herodian wall but quite distinct from the two Herodian bastions which flank the gate. Josephus reports (*AntJ* 13.281) that the Hellenistic city was destroyed by Hyrcanus in 108 with such violence that it was not possible to see that a city had ever existed on the site; thus, it is unlikely that any Hellenistic bastions could be incorporated into Herod's wall. Gabinian fortifications, however, may still have stood to be integrated into Herod's refurbishment.

Yet if the fortifications are Gabinian, how could Josephus (*BJ* 1.408) describe the site as dilapidated in 30 B.C. when control of its territory was granted to Herod by the Romans? Perhaps Josephus exaggerated its ruinous state so as to give greater glory to Herod. Strabo 16.2.27 indicates that its anchorage continued to function, even though Josephus plausibly could have described it as unsatisfactory. Alternatively, the city may have been badly affected by the devastating earthquake of 31 (see Roller p.24).[23] El-Isa estimated a magnitude of 7, with epicenter at Jericho,[24] which would make it as great as any in the region since then except for those of A.D. 746 and 1546. Although precise knowledge of its effects is impossible, and multiple epicenters are possible, there is no doubt that its impact was felt on both sides of the Jordan valley. Arabs stepped up military activity in the belief that the land of the Jews had been devastated (Jos., *AntJ* 15.121 ff.). Overall, and even if not the direct result of the earthquake, the decayed state of Straton's Tower in 30 need cause no surprise. Agrippa found the hippodrome of Marcius Rex at Antioch, built in the late 60s, ruined by the 20s. Warfare and other factors can easily be imagined to explain dilapidation. Anthedon, another town which had received Gabinius' attention, was, according to Josephus (*BJ* 1.416), rebuilt by Herod because of the damage it has sustained in war. Whatever that particular incident of destruction had been, it is not recorded elsewhere.

The blocking of the north gate of Straton's Tower and a possible historical context

The space of 14 m between the two bastions clearly served as a north gate after the initial construction; it was then blocked by an interconnecting wall (figs.6-7). Its present height of 12 m is probably its original height; it is 3-4 m thick and consists of an irregular base of uneven elements topped by more regular mason-

20 Some evidence suggests Jewish occupation during that period; cf. Levine, *Caesarea* 9; 149, n.44; and S. Applebaum, "Hellenistic cities of Judaea and its vicinity," in B. Levick (ed.), *The ancient historian and his materials. Essays in honour of C. E. V. Stevens* (1975) 62-64.

21 A resemblance which J. Ringel, *Césarée* 76, finds "apparent only".

22 On which see Stern, *IEJ* 33 (1983) 118.

23 Arguments based on archaeoseismology need to be advanced with great caution. J. Karcz, U. Kafri and Z. Meshel emphasize the ambivalence of the evidence ("Archaeological evidence for subrecent seismic activity along the Dead Sea–Jordan rift," *Nature* 260 (1977) 234-35); and, for important methodological problems, see K. W. Russell, "The earthquake chronology of Palestine and northwestern Arabia for the second through the mid-eighth century A.D.," *BASOR* 258 (1985) esp.39-40. Russell now believes that Straton's Tower was affected in 31 B.C. (pers. comm.).

24 Z. H. El-Isa, "Earthquake studies of some archaeological sites in Jordan" in *Studies in the history and archaeology of Jordan* 2 (London 1985) 233, Table 1.

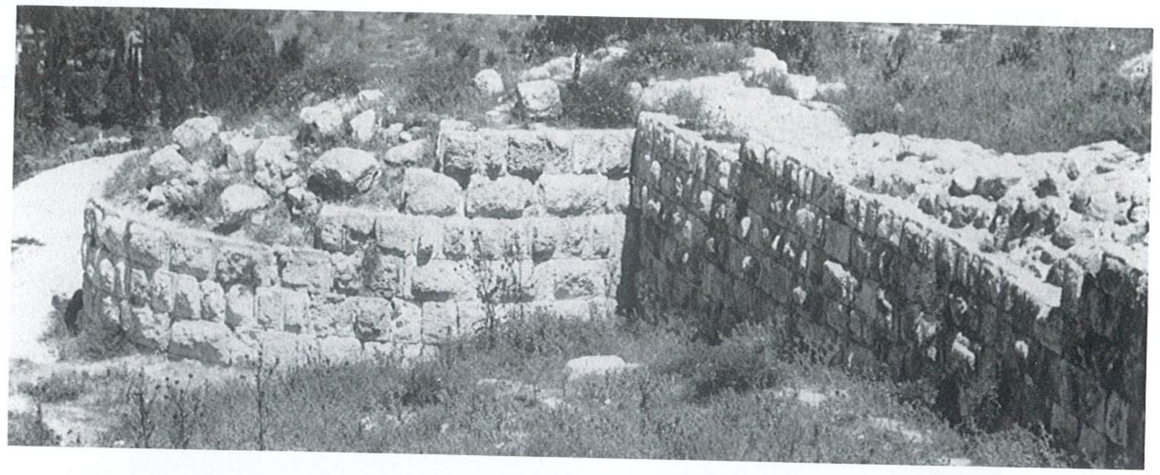

Fig.4. Bastion in Herod's fortification wall of Samaria, N of western gate.

Fig.5. Detail of earlier (?) bastion at Samaria.

-ry. Where it abuts the standing east bastion the wall does not bond with it, suggesting subsequent construction. Yet some effort seems to have been made to see that the courses were aligned. A rectangular aperture cut through the centre of the wall to allow passage for a subterranean (probably Byzantine) sewer provides evidence of the wall's relative date; and, it might tentatively be suggested, points to a pre-imperial construction.[25] *If* cracks observable in the east bastion are due to the earthquake of 31, it has to be noted that the interconnecting wall, built later than the bastion, bears similar marks.

Why was the north gate closed so soon after its construction? Possibly this can be linked to historical events. In 40 the Parthians, having seized much of Asia Minor, invaded Palestine. Pacorus, the king's son, led a force down the coast, Sidon and Ptolemais capitulating. When he reached Mount Carmel many Jews joined him and he turned his attention to the north Sharon plain.[26] As the Parthians moved south along the narrow corridor between the sea and the mountains of the Carmel range, the autonomous centres of

25 One might well wonder if 12 m of débris would accumulate here during the continuous occupation of the Roman period at a point which ought to have been a thoroughfare if the bastions had been Herodian also. Negev (glossed by Blakely, "Date" 4) understandably found this a major stumbling-block to a Herodian dating for the fortifications in general.

26 Dio 48.24.-26; Jos., *AntJ* 14. 365-66; *BJ* 1. 248-49.

Dora and Straton's Tower must have felt particularly threatened. Dora may even have succumbed.[27] In fact, the Parthians turned inland to Jerusalem, but the threat could have been enough reason for hasty alterations to the walls of Stratons's Tower.

An association of the fortifications now visible to the north of Caesarea with Aulus Gabinius cannot, of course, be proved. Yet the possibility ought to be entertained.

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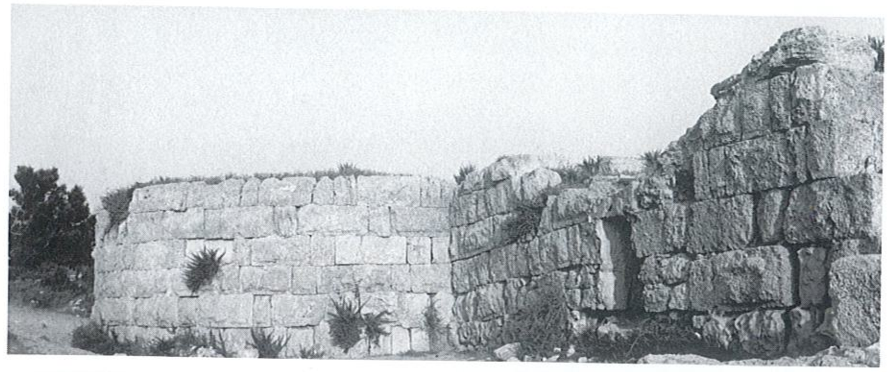

Fig.6. Wall connecting bastions blocking gateway (external face), Straton's Tower.

Fig.7. Wall connecting bastions, abutting E bastion, Straton's Tower.

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27 Since Dio 48.24.1 speaks of all Syria (except for Tyre) having been subjugated, and since the Krokodeilon river marked the boundary of Palestine and Phoenicia (Pl., *NH* 5.75), it is quite possible that Dora was taken.

The technology of King Herod's harbour

John Peter Oleson and Graham Branton

This paper will concentrate on the harbour as a centre of technological activity and innovation. This was a critical facet of the character of all ancient harbours, because of their location at the interface of sea and land and their rôle as the portal between local land commerce and sea trade with the rest of the known world.[1] The structures composing a harbour had to be capable of resisting the force of the sea and the hazards of both wet and dry environments, including the erosive effects of wind and salt.[2] Obviously the selection and placement of materials were crucial considerations, along with the preparation of a firm foundation on sand or mud. The development of an appropriate design also required special care, for a basin that protected the ships within it might also attract deposits of sand or silt that would soon render it useless or require expensive dredging. The ships themselves were the largest and most complicated machines known to the ancient world, and they carried goods that could be either bulky and cheap – but often perishable – or fragile and expensive. Facilities had to be provided for navigation, anchorage, and mooring, for the unloading, sorting, storage and loading of cargo, for the revictualing and refitting of the ships, and the accommodation of their crews.[3]

The excavations on land and in the sea at Caesarea have yielded extensive information on the design, construction, and functioning of the harbour. We cannot yet describe how Herod's harbour (or its successors) responded to all the challenges listed above, but we now have a good idea of the remarkable scale of the project and the innovative approach of both the patron and his engineers. In particular, this paper will focus on the design of the harbour, the selection and preparation of materials (including some exciting new information on their importation) and the procedures developed for placing materials on the structure. The character of a site and the nature of the materials available for building always have a marked effect on architecture, and harbours are no exception.

The natural location

The location of Sebastos presented Herod's engineers with a series of major challenges. The coast-line along this portion of the Levant is low and for the most part straight, with few prominent hills, headlands, bays or inlets to serve as navigational landmarks or as refuge. Between Jaffa on the south and Akko on the north there is virtually no natural shelter from the sea, and the waters close to shore are shallow and sprinkled with dangerous reefs. The prevailing storms hit the coast from the southwest or west, and from the Early Bronze Age onward they have littered the coastal waters with wrecks. A strong longshore current that runs counter-clockwise around the coasts of the eastern Mediterranean carries a

1 The bibliography on ancient harbours is large and quite scattered, but the most important articles and books are collected in D. J. Blackman, "Ancient harbours in the Mediterranean," *IJNA* 11 (1982) 79-104, 185-211. For an annotated bibliography see J. P. Oleson, *Greek and Roman mechanical water-lifting devices: the history of a technology* (Toronto 1986) 395-405. The best overall historical discussion is still that in K. Lehmann-Hartleben, *Die antiken Hafenanlagen des Mittelmeeres* (Leipzig 1923). For technology in harbours, see J. P. Oleson, "The technology of Roman harbours," *IJNA* 17 (1988) 147-57.

2 The bibliography on concrete in marine environments is enormous and highly specialized. For a summary of the major problems affecting the material and recent advances in the technology see H. F. Cornick, *Dock and harbour engineering* IV: *construction* (London 1962) 105-38; S. Mindess and J. F. Young, *Concrete* (Englewood Cliffs, NJ 1981) 114-15, 287 and 551-52; W. H. Taylor, *Concrete technology and practice* (4th ed., London 1977) 327-33, and 543-46; D. C. Tibbetts, "Performance of concrete in sea water: some examples from Halifax, N.S.," in E. G. Swenson (ed.), *Performance of concrete* (Toronto 1968) 159-80; and J. H. van Loenen, "Concreting underwater — some results of studies and tests," in P. V. Maxwell-Cook (ed.), *Symposium on concrete sea structures, Tiblisi 1972* (London 1973) 197-201.

3 G. Rickman in *Harbour technology* 105-14; J. Rougé, *Recherches sur l'organisation du commerce maritime en Méditerranée sous l'empire romain* (Paris 1966) 147-71.

heavy load of sand picked up along the north coast of Africa and off the mouths of the Nile. As sea level rose in the Bronze Age and Graeco-Roman period, this current tended to drop sand around any remaining inlets and headlands, building beaches that buried many natural and man-made features along the shore — for example, the Bronze-Age harbour at Tel Nami, 17 km north of Caesarea.[4] All these natural hazards and processes were appreciated in antiquity, and Josephus, for example, records the character of the coast in the introduction to each of his two descriptions of the city and its harbour as they existed in his day:

> The stretch of coast-line from Dora to Joppa, between which the city lies, was completely devoid of harbours, so that every ship sailing from Egypt along the coast of Phoenicia had to ride at anchor in the open when menaced by the southwest wind, for even a moderate breeze from this quarter dashes the waves to such a height against the cliffs that their reflux spreads a great commotion far out to sea. (*BJ* 1.409)
> Now this city is located in Phoenicia, on the sea-route to Egypt, between Joppa and Dora. These are small towns on the seashore and are poor harbours because the southwest wind beats on them and always dredges up sand from the sea upon the shore, and thus does not permit a smooth landing; instead, it is usually necessary for merchants to ride unsteadily at anchor off shore. (*AntJ* 15.333)

Furthermore, the local building stone, now called by its Arab name *kurkar*, is a relatively soft and porous carbonate-cemented quartz eolianite sandstone. It appears in great beds throughout the region and is easily quarried, but it cannot take detailed cutting, and some grades erode rapidly when exposed to the sea or the wind. Limestone can be taken from the Mt. Carmel range, but this lies 15 km inland from Caesarea and meets the sea only at the site of present-day Haifa, 37 km to the north.

Herod's design

Nevertheless, Herod was determined to construct a magnificent harbour at this point, to serve as a commercial link with the rest of the Roman empire and as a gentile counterpart to the Jewish capital of Jerusalem. The nature of Herod's goals and the character of his solution are hinted at in Josephus' detailed descriptions of the harbour. This literary evidence, as a background to the results of the Caesarea Ancient Harbour Excavation Project, highlights the technology Herod had at his disposal.[5]

> Having calculated the relative size of the harbour (λιμήν) as we have stated, he let down stone blocks (λίθοι) into the sea to a depth of 20 fathoms [*c*.37 m]. Most of them were 50 feet long, 9 high, and 10 wide [15.25 x 2.70 x 3.05 m], some even larger. When the submarine foundation (τὸ ὕφαλον) was finished, he then laid out the mole (τεῖχος) above sea level, 200 feet across (61 m). Of this, a 100-foot portion was built out to break the force of the waves, and consequently was called the breakwater (προκυμία). The rest supported the stone wall (τεῖχος) that encircled the harbour. At intervals along it were great towers (πύργοι), the tallest and most magnificent of which was named Drusion, after the stepson of Caesar.
> There were numerous vaulted chambers (ψαλίδες) for the reception (καταγωγή) of those entering the harbour, and the whole curving structure in front of them was a wide promenade for those who disembarked. The entrance channel faced north, for in this region the north wind always brings the clearest skies. At the harbour entrance were colossal statues, three on either side, set up on columns. A massively built tower (πύργος) supported the columns on the port side of boats entering harbour, those on the starboard side, two upright blocks of stone yoked together, higher than the tower on the right side. (*BJ* 1.411-13)

> To correct this drawback in the topography, he laid out a circular harbour (λιμήν) on a scale sufficient to allow large fleets to lie at anchor close to shore, and let down enormous blocks of stone (λίθοι) to a depth of 20 fathoms [*c*.37 m]. Most were 50 feet long, not less than 18 feet wide and 9 feet high [15.25 x 5.50 x. 2.70 m]. The structure which he threw up as a barrier against the sea was 200 feet [wide]. Half of this opposed the breaking waves, warding off the surge breaking there on all sides. Consequently it was called a breakwater (προκυμάτια or προκυμία). The rest comprised a stone wall (τεῖχος) set at intervals with towers (πύργοι), the tallest of which, quite a beautiful thing, was called Drusion, taking its name from Drusus, the stepson of Caesar who died young. A series of vaulted chambers (ψαλίδες) was built into it for the reception (καταγωγαί) of sailors, and in front of them a wide, curving quay (ἀπόβασις) encircled the whole harbour, very pleasant for those who wished to stroll around. The entrance (εἴσπλους) or mouth (στόμα) was built towards the north, for this wind brings the clearest skies. The foundation (βάσις) of the whole encircling wall on the port side of those sailing into the harbour was a tower (πύργος) built up on a broad base to withstand the water firmly, while on the starboard side were two great blocks (λίθοι), taller than the tower on the opposite side, upright and yoked together. (*AntJ* 15.334-338)

4 Raban in *Harbour archaeology* 11-27.

5 This translation was prepared by Oleson from the Greek text in H. St. J. Thackeray, *Josephus, The Jewish War, books I-III* (Cambridge, MA 1927) 192-94 and R. Marcus, *Josephus, Jewish Antiquities, books XV-XVII* (Cambridge, MA 1963) 160-62.

These two passages describe harbour facilities that were truly magnificent in scale and elaboration. The outer basin alone, defined by two breakwaters built of concrete blocks on a rubble foundation, encompassed an area of *c*.20 ha. There was an inner basin as well, now silted in, and Josephus described wide quays, vaulted disembarking or storage areas, and towers, some of which supported colossal statues. The descriptions hint at the response of Herod's engineers to some of the problems posed by the site. The harbour entrance, for example, is oriented to the north, away from the prevailing storms. The width of the quays and presence of covered storage areas on them would have not only facilitated commerce but also offered protection from the spray generated by waves crashing against the breakwater. In addition, Josephus notes that Herod wanted to provide a space for 'large fleets to lie at anchor close to shore' as well as quays for active loading and unloading of cargo, implying that the enormous outer basin may in fact have been designed in part as a refuge for passing fleets — perhaps the great grain fleets that left Alexandria for Rome. Finally, Josephus clearly realized that Herod's engineers had taken great care with the design of the foundations of the breakwater, and the shaping and placement of the 'great stones' (as he calls them) that formed its mass.

The results of the Harbour Project's survey and excavation supplement these descriptions to provide an excellent idea of the original appearance of the harbour and the solutions to some further technological challenges (fig.1). We know now, for example, that in addition to an outer basin, there was a small, nearly enclosed inner basin at the foot of the mound carrying the Temple of Rome and Augustus. This may have been designed for the reception of warships or miscellaneous small coastal craft, or it may have been merely a survivor of the harbour of Straton's Tower. In addition, historical probability, along with the remains of enormous concrete blocks near the head of the southern breakwater, suggest that there was a great lighthouse at that point. The lighthouse would have been a crucial navigational aid along this low-lying coast both by day and night, and it would have served well as a symbol of the greatness of the

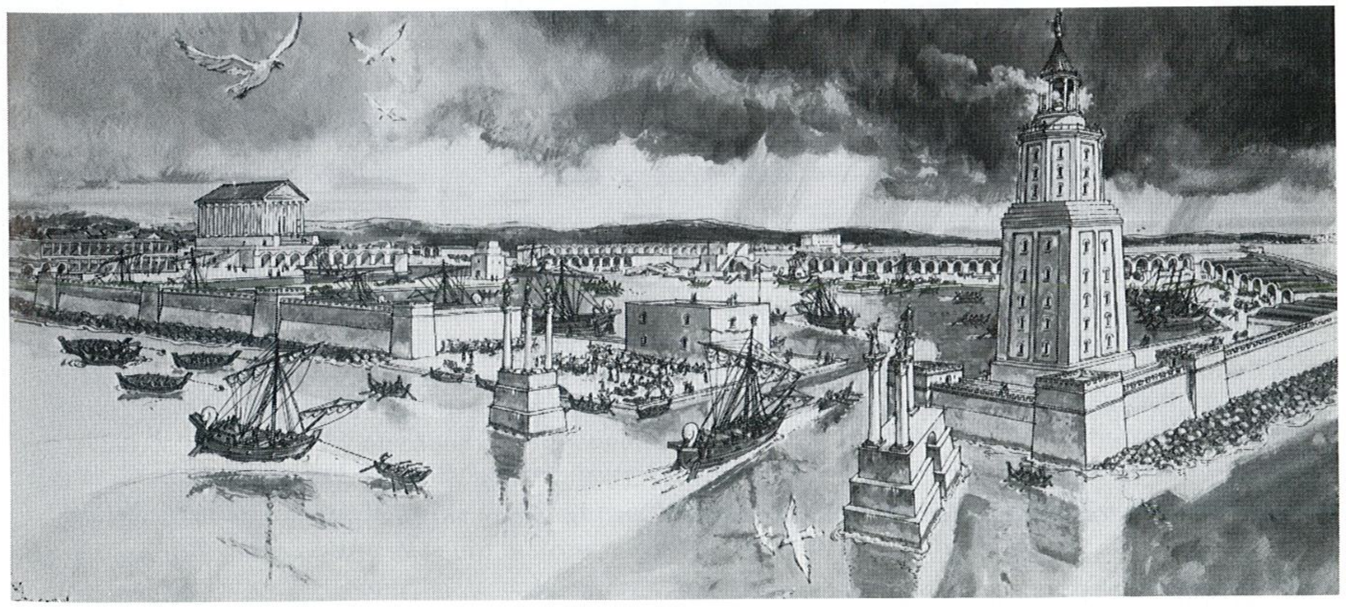


Fig.1. Reconstruction of Herod's harbour (R. Teringo, National Geographic Society, copyright).

harbour — demanding direct comparison with the famous Pharos of Alexandria, 475 km to the southwest.[6] Herod wished to rival the Ptolemaic kings in the economic iconography of sea trade.

Nevertheless, the orchestration of materials in the two great breakwaters, their choice and placement around the harbour, is less well understood from Josephus' account. This is the fault in part of his training or prejudices, but it also results from the fact that, when he visited the site, the portions of the harbour most interesting from the engineering point of view lay hidden from his view below the waves or in the very bowels of the structure. It is here that excavation has provided irreplaceable information. The southern breakwater, founded on a projecting reef of the local *kurkar* bed-rock, curves around for 500 m towards the harbour entrance channel to the north (fig.2). The present spill of rubble varies in width from 80 to 220 m. Its constituents originated in the collapse of structures built on top of or inward from the main breakwater mass, and the spread of materials was caused by the waves and hastened by the plundering of ashlar blocks for reuse elsewhere. The original width seems to have been *c.*70 m; Josephus mentions a width of '200 feet' (*c.*60 m?), which is about right. The external face of the breakwater was built of stag-

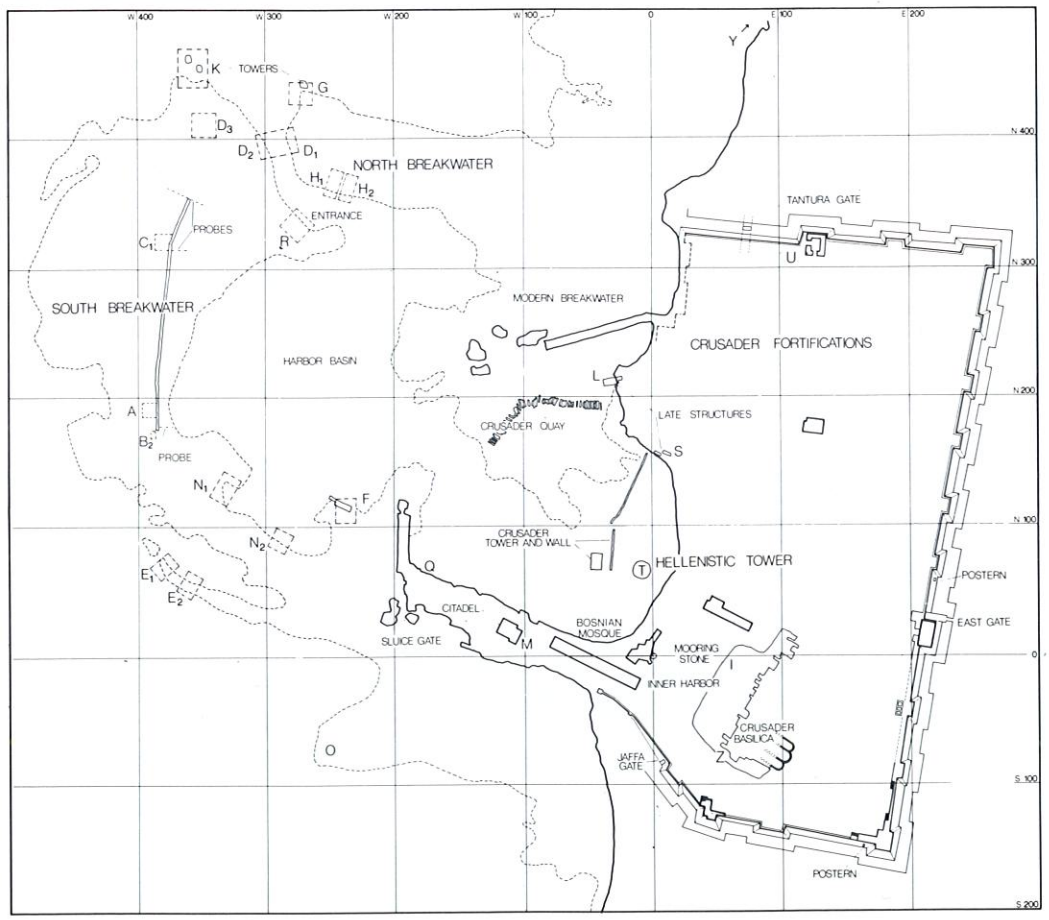


Fig.2. Plan of Herodian harbour and excavation areas (R. L. Vann).

6 H. Thiersch, H., *Pharos: Antike, Islam und Occident. Ein Beitrag zur Architekturgeschichte* (Berlin 1909); M. Reddé, "Les répresentations des phares à l'époque romaine," *MEFRA* 91 (1979) 845-72; Blackman (supra n.1) 207-8; Vann, "Drusion".

gered rows of immense concrete blocks, many with a volume of 30 m^3, some as large as 100 or 125 m^3, laid on a cushion of small rubble (*c.*0.5 m in diameter) and pebbles. This type of foundation, which still appears in modern rubble breakwaters laid on sandy bottoms, is designed to prevent undercutting of the breakwater mass through movement of the sand.[7] There is also a subsidiary breakwater along the southernmost portion of the outer face of the breakwater at Caesarea, designed to disperse the force of the waves before they reached the main structure. The inner face of the breakwater was skirted by wide quays and landing platforms built of rubble, held by facing walls of *kurkar* blocks and paved with slabs of the same material.

The northern breakwater was a long rectangular structure projecting almost due west for 240 m from bedrock on the shoreline to the harbour entrance channel. Because of its partially protected position, this breakwater is better preserved than the southern one and is more regular in outline. It is at present about 60 m wide, built of concrete and quarried kurkar blocks on a rubble foundation. So far, excavation has not yielded any evidence that there were landing stages along its inner face, like those on the inside of the southern breakwater.

The western terminus of the northern breakwater was composed of very large, rectangular *kurkar* blocks (*c.*70 m long, 1.3 m wide and 1.3 m high) which now form a tumbled heap partially blocking the entrance channel (fig.3). The ends of several of the blocks have been carved into half-lap-joints, the flat faces of which carried large circular depressions, probably designed to receive corresponding projections on adjacent blocks. Several of these massive blocks, and some additional shorter rectangular blocks in the same area, also carried square lead sockets (0.08 m square, 0.12 m deep) symmetrically located along their outer edges. This lead had apparently been poured around iron clamps that have now disappeared. Erosion of the softer stone around them has left several of the pourings perched on the surface.

Fig.3. Blocks at tip of northern breakwater (S. Giannetti).

For reasons of security, structural stability, and architectural display, this pierhead must have been one of the most important points in the harbour basin. Even though it was protected by the southern breakwater from the great southwesterly storms typical of this area, damage to the head of the northern breakwater would have exposed the less coherent interior fill and put the whole structure in jeopardy.[8] As a result, Herod's engineers built the channel face of an interlocking mass of huge blocks held together with clamps and braced by one another. Although the blocks have been shaken out of position, their very size and weight have kept them stacked in a steep pile.

For the same reason, and perhaps to provide it with even more reliable reinforcement, at the northwest tip of the northern breakwater an enormous concrete block (15.0 m long, 11.5 m wide and *c.* 2.0 m high) was

7 P. Brunn, *Port engineering* (2nd ed., Houston 1976) 95-98; *Shore protection, planning and design*, U. S. Army Coastal Engineering Research Center, Technical Report No.4, 3rd ed. (Washington, D. C. 1966) vol 2, 7.211-12.

8 H. F. Cornick, *Dock and harbour engineering*, II: *The design of harbours* (London 1959) 128-29.

poured directly on the original sand sea-bottom (fig.4). The block was riddled with holes left behind by the horizontal tie-beams of the original formwork, and their vertical supports. In addition, substantial remains of the wooden form itself survived along the bottom edge of the block (described below). The upper surface of the block seems to have been paved with *kurkar* slabs.[9]

Although they were not subjected to the same amount of stress as the tips of the southern and northern breakwaters, the walls forming the outer faces of the quays along the inside of the southern breakwater nevertheless had to be designed with care. These facing walls, which retained a fill of loose rubble topped with paving slabs, had to be capable of resisting both the erosive effect of the sea lapping against them and mechanical damage caused by the bumping of ships and the movement of cargo. In order to provide maximum stability and resistance to these hazards, Herod's engineers built these walls with courses of long *kurkar* blocks arranged as 'headers', that is, laid side by side with their ends facing outward. This technique which maximizes friction between the blocks and minimizes the potential structural damage caused by erosion was traditional in this region. It first appeared in the quay walls and breakwaters of the Early Iron-Age Phoenician ports at Tabat el-Hamam, Akko, and Athlit,

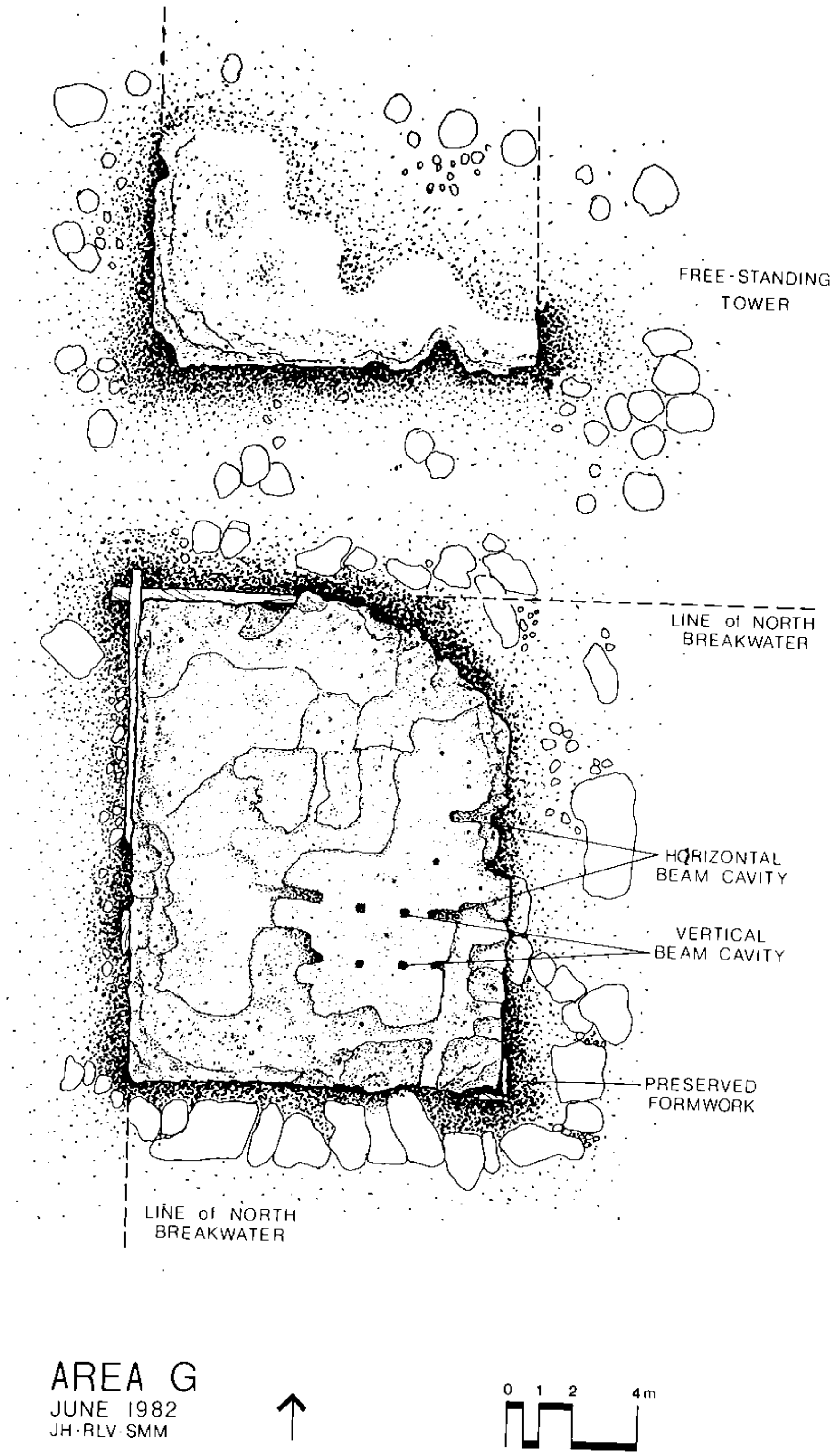


Fig.4. Plan of Area G (R. L. Vann).

9 See J. P. Oleson, R. L. Hohlfelder, A. Raban, R. L. Vann, "The Caesarea Ancient Harbour Excavation Project: preliminary field report on the 1980-83 seasons," *JFA* 11 (1984) 297-99; Oleson in *Harbour Technology*.

and it continued in use through the Hellenistic period.[10]

De-silting system

Another technique possibly of local inspiration was the incorporation of a de-silting system in the harbour design. As Josephus himself noted in one of the passages quoted above, the longshore current carries enormous amounts of silt, which tends to fall out of suspension wherever the water loses kinetic energy. It has been calculated that 10,000 m^3 are still dumped every year around the harbour of Caesarea, even though the breakwaters now represent less of a barrier to the flow than they did when intact.[11] Herod's engineers undoubtedly realized that, without some measures to counteract siltation, their harbour would soon become useless as the sand-bearing water lost momentum at the mouth of the harbour and in the basin and dropped its load. Although the archaeological evidence is not yet complete, we have found features suggesting that there was one or possibly a series of sluices built into the shoreward section of the southern breakwater, or cut into the bed-rock at its base. Such a sluice would have allowed some water (the amount could be regulated by sluice-gates) to flow into the harbour basin from the south, driven either by the current or by the action of the waves breaking against this face of the breakwater. The accumulation of water within the basin would have then set up a slow but significant current from its farthest corner out through the entrance channel, helping to clear sediment out and to divert sand-bearing currents from the basin and entrance area. This may sound like an unlikely result, but Phoenician harbours all along this coast made use of such a feature — for example, Sidon and Dor.[12] At Sidon the channels were used until recently to keep the harbour clear.

The towers at the entrance

Just outside the harbour entrance, there were 3 large concrete foundations or towers approximately 8 m distant from the outer breakwater faces: two on the starboard (right) side of boats entering the harbour, and one on the port. These were intended at least in part as platforms for the display of statues carried on columns, undoubtedly meant to contribute to the element of political propaganda that was so strong at Sebastos. Their appearance in the 1st c. is described by Josephus:

> At the harbour entrance there were colossal statues, three on either side, set up on columns. A massively built tower supported the columns on the port side of boats entering the harbour, those on the starboard side, two upright blocks of stone yoked together, higher than the tower on the other side. (*BJ* 1.413)

In view of their prominent position and their use as bases for the display of statuary (fig.1), at least the upper portions of these towers must have been clad in the gleaming marble mentioned by Josephus elsewhere along the sea front.[13] In view of this revetment, Josephus' mistake in confusing masses of concrete with cut stone monoliths is understandable, but it is more difficult to comprehend what he means by 'yoked together' (συνεζευγμένοι) in his description of the two western towers. The battered concrete cores of these towers project from the sandy sea-bottom *c*.6 m apart. The western of the pair, *c*.6 m on a side, rises 3 m from the present sea-bed to a sloping upper surface marked by a great notch (*c*.0.70 m wide and *c*.0.90 m high). The eastern tower has more regular vertical surfaces and is *c*.4 x 3 m in plan and 4 m in height. The rough upper termination of this tower is presently only *c*.1.2 m below mean sea level. It would have been difficult to bridge the 6 m gap separating the two foundations with a platform sturdy enough for the erection of heavy columns, but probably not impossible. In any case, no traces of any bridging survive. Perhaps Josephus intended only 'paired' by the term quoted above. But in that case, how would three statues have been divided between them?

10 Blackman (supra n.1) 92; H. Frost, "Ancient harbours and anchorages in the eastern Mediterranean," *Underwater archaeology: A nascent discipline* (Paris and London 1972); Raban in *Harbour archaeology* 27-38.

11 Y. Nir, "Beaches and dunes," in Raban, *Harbours I*, 23.

12 A. Poidebard and J. Lauffray, *Sidon: aménagements antiques du Port de Saida* (Beirut 1951); A. Raban and E. Galili, "Recent maritime archaeological research in Israel — a preliminary report," *IJNA* 14 (1985) 339-49.

13 *BJ* 1.408; *AntJ* 15.331, 339.

The solution may be suggested by the position and orientation of the two western towers, and it provides some support for the proposal we make below of a central Italian origin for much of the engineering expertise displayed at Sebastos. It is remarkable that these two foundations were located just outside the harbour entrance, in a position where they seem to create a hazard to navigation. Their use as a platform for statuary hardly seems sufficient justification, especially since there was ample room for statues along the breakwaters themselves. Furthermore, the two foundations are not placed in any obviously symmetrical relationship to the axis of the harbour entrance or the outer face of the southern breakwater. The bearing of a line sighted across the central axes of the structures from outside is approximately 110°, while that of the entrance channel was about 156° (fig.2).

It may be that the two foundation towers, with their tall columns and gleaming bronze statues, served as navigational guides. Ships sailing in from either direction along the coast, or from out to sea, would have stood well away from the dangerous reefs and the spreading breakwater foundation. Observation of the relative position of the two supports for the statuary platform would then have helped provide the proper course for a safe approach to the harbour entrance: when the two appeared as one, the ship was on a correct bearing to run for the harbour, and, as she entered, she would keep the columns on her right. The single tower on the left would have helped bracket the entrance as the ship bore down on it.

By itself this may seem like a weak explanation, but there may be a further reason for the location of the towers here. Taken as a unit, with some sort of high concrete arch carrying the platform that united them, the two towers on the west resemble the large, square concrete piers (*pilae*) that made up the late republican breakwater of the harbour at Puteoli in Italy. The *pilae* at that site apparently were meant to break the force of the waves while allowing free circulation of silt. They also carried a broad promenade, supported on high concrete segmental arches that united each to its neighbors. Some of these arches can be seen in 18th-c. engravings of the structure.[14] Other examples of the same design were built at Baiae and Misenum, also on the Bay of Naples, at Cosa in Etruria, and possibly at Antium and Terracina as well, south of Rome.[15] To modern eyes this design seems to leave ships in the basin curiously vulnerable to the waves, but it was typical of early Roman harbours along the Italian coast, where the longshore currents carry enormous amounts of sediment. The *pilae* at these sites broke the brunt of the sea's force but at the same time allowed free enough circulation of water within the basin that the sand and silt stayed in suspension. Closed basins such as that at Portus, the Claudian port of Rome, quickly ran into difficulties with sediment.

The truncated series of *pilae* outside the entrance to the harbour at Caesarea may be part of the same engineering tradition. They may have been designed to break the force of waves rolling around the barrier of the southern breakwater towards the harbour entrance, providing easier passage to ships and shielding the inner basin from disturbance. The potential problem with siltation at Caesarea may also have stimulated the use of this device.

Hydraulic concrete

As the discussion so far has shown, the scale and design of the harbour at Caesarea reveal a sensitive combination of Roman technological, financial, and social resources with long-standing local construction techniques that had developed in response to local conditions. The key to the harbour design, however, hydraulic concrete, is completely Roman in character.[16] Great blocks of concrete appear everywhere in the

14 Blackman (supra n.1) 195.
15 Blackman (supra n.1) 197 and n.86; A. M. McCann, *The Roman port and fishery of Cosa* (Princeton 1987) 137-41, 337.
16 The scholarly literature concerned with the origins and technology of Roman concrete is enormous, although there is as yet no full treatment of hydraulic concrete (see Oleson in *Harbour technology*). Some excellent general discussions with full documentation and bibliography can be found in M. Blake, *Ancient Roman construction in Italy from the prehistoric period to Augustus* (Washington D.C. 1947); G. Lugli, *La tecnica edilizia romana* (Roma 1957) 363-444 and W. L. MacDonald, *The architecture of the Roman empire*, I: *an introductory study* (rev. ed., New Haven 1983) 3-19, and 143-66; J. B. Ward-Perkins, *Roman imperial architecture*

harbour structures, from the foundations to the superstructure, and it is these blocks — designed to be far larger than any usable quarried block could ever have been — that gave the breakwater its form and permanence. The special mortar used in hydraulic concrete was made by substituting *pozzolana*, a powdery volcanic ash, for sand in the typical sand-lime mixture; the aggregate could be of local stone, lumps of tufa, or potsherds. Hydraulic concrete had the benefit of extraordinary tenacity and longevity in terrestrial structures, but also the added attraction of an ability to set and cure while immersed in fresh or salt water. The use of this material, which seems to have become customary in Roman structures in central Italy by the beginning of the 2nd c. B.C.,[17] carried with it a host of ancillary techniques and tools involved with preparation of formwork, mixing of the mortar, and placement of the aggregate. It is not certain when or where this discovery was made, but 3rd-c. B.C. Puteoli is a distinct possibility,[18] since it was easy in antiquity to observe *pozzolana* deposits along the shore that become cemented through natural processes.[19] The suitability of this superb new material for structures connected with water — bridge-footings, harbours, and aqueducts for example — must immediately have been obvious. Certainly it was an important factor at Caesarea, where many of the concrete blocks still preserve the marks of the formwork into which they were poured, and the mortar itself is rich with the volcanic powder and tufa that gave it its hydraulic properties.

The earliest datable example so far known of pozzolana-mortar concrete used in an inundated structure has been found in the harbour of Cosa, which was laid out in the late 2nd or early 1st c. B.C.[20] As noted above, the breakwater at Cosa consists of a series of stout rectangular piers like those at Puteoli, built of hydraulic concrete on top of a rubble mound foundation.

The key to the production of hydraulic concrete is employment of powdery volcanic ash in the mixture. By the 2nd and 3rd c. A.D., Roman engineers understood that virtually any such ash would do, including trass from the Rhineland, which is different in appearance from the central Italian material.[21] But at the time Herod was building his harbour, in the last quarter of the 1st c. B.C., Roman engineers seem generally to have believed that the area around Puteoli (modern Pozzuoli) in the Bay of Naples was the best or only suitable source. The modern term "pozzolana" used for this type of additive to cementing substances is derived from the name of this city. The Romans called the material *pulvis puteolanus*, "dust from Puteoli". In his handbook of architecture, written at just about the time the harbour was under construction, Vitruvius assumes the use of *pozzolana* from that source (2.6.1):[22]

> Est etiam genus pulveris, quod efficit naturaliter res admirandas. Nascitur in regionibus Baianis in agris municipiorum, quae sunt circa Vesuvium montem. Quod conmixtum cum calce et caemento non modo ceteris aedificiis praestat firmitates, sed etiam moles cum struuntur in mari, sub aqua solidescunt.
> There is a kind of powder which, by nature, produces wonderful results. It is found in the neighborhood of Baiae (near Puteoli) and in the lands of the municipalities around Mount Vesuvius. This, when mixed with lime and rubble, not only furnishes the strength to other buildings, but also, when piers are built in the sea, they set under water.

More or less the same description appears in Strabo (5.245). Again, in a famous passage concerned with

(2nd ed., Harmondsworth 1981) 97-120. The most graphic reconstruction of the ancillary techniques and tools used for concrete work on land appears in J. P. Adam, *La construction romaine: materiaux et techniques* (Paris 1984).
17 Gazda in McCann (supra n.15) 145-46, 337.
18 Gazda and McCann, ibid. 146 n.44.
19 Pliny, *NH* 35.166.
20 McCann (supra n.15) 34, 325-27.
21 F. Quietmeyer, *Geschichte der Erfindung des Portland-Zementes* (Berlin 1912) 14-18; V. Scrinari, "Il porto di Claudio ed osservazioni sulla tecnica del conglomerato presso i Romani," *L'industria italiana del cemento* 33 (1963) 527; H.-O. Lamprecht, *Opus caementicium: Wie die Römer bauten* (Düsseldorf 1968).
22 This edition quoted in this and the following passage is that of F. Granger, *Vitruvius on architecture*, Cambridge (MA 1931) 312; essentially the same as F. Krohn, *Vitruvii de architectura libri decem* (Leipzig 1912) 118-19. The translation is Oleson's.

the construction of breakwaters (to be discussed below), Vitruvius assumes that this source will be used for the ash (5.12.2):

> Eae autem structurae, quae in aqua sunt futurae, videntur sic esse faciendae, uti portetur pulvis a regionibus, quae sunt a Cumis continuatae ad promunturium Minervae, isque misceatur, uti in mortario duo ad unum respondeat.
> The masonry which is to be in the sea must be constructed in this way. Earthy material is to be brought from the district which runs from Cumae to the promontory of Minerva (Sorrento), and mixed in the mortar, two parts of it to one of lime.

Once we had observed that *pozzolana* and tufa had been used as additives in the concrete at Caesarea, the search immediately began for the source from which Herod's engineers obtained these materials. Although the local geology of the Caesarea region is not propitious, there are in fact a few small deposits of volcanic tufa and ash nearby, probably for the most part wind-deposited from eruptions elsewhere. Visual examination, however, suggested that these tufas and powdery ash were very different in character from the *pozzolana* and tufa used in Sebastos. The Galilee region contains many igneous deposits, but land transport of such bulky materials to Caesarea or to a nearby shore seemed unlikely.

From the very start we thought it possible that Herod's engineers had imported their *pozzolana* from the deposits in the Bay of Naples area. There are, to be sure, several places in the eastern Mediterranean where suitable pozzolanas could be mined close to the sea-shore — at Santorini and Melos, for example, in the Aegean.[23] Nevertheless, we were struck by the ambitious character of Herod's project, the manner in which the design was imposed on the landscape, the important rôle played by hydraulic concrete in the design despite the lack of precedent for the use of such concrete in the region, and — finally — the Italian character of such details as the *pilae* at the harbour entrance. All of these details are more in character with Roman harbour engineering than with the Iron-age and Hellenistic traditions in the eastern Mediterranean. If Herod had hired Italian engineers to execute his plans, it seems likely that they would have preferred to import the *pozzolana* they were accustomed to using at home. In this context, it is interesting to note that the use of *opus reticulatum* facing on concrete walls near Herod's winter palace near Jericho has been attributed to the presence of Italian engineers working on that project, making use of a central Italian facing foreign to the eastern Mediterranean.[24]

Scientific analysis of pozzolana

Faced with this historical possibility, one of the authors (Oleson) prepared samples of *pozzolana* and tufa from Caesarea and Puteoli, and from volcanic quarries and Roman concrete buildings elsewhere in Italy and the Aegean, and the other (Branton) subjected them to scientific analysis at the University of Victoria. We have proved beyond any reasonable doubt that Herod's engineers imported their *pozzolana* from the quarries around Puteoli in the Bay of Naples, a source over 2000 km away. This is not only a great advance in our study of the technological genesis of Caesarea's harbour, but it also represents the first time (to our knowledge) that the export of *pulvis puteolanus* outside of Italy has been documented. Scholars have long assumed such an export trade,[25] and it has recently been shown that pozzolana from this source was used in the Italian port of Cosa,[26] but until now there has been no documentation of its use outside Italy.[27] The ramifications of this discovery go far beyond our work at Caesarea, but that is another

23 D. F. Orchard, *Concrete technology* (4th ed., London 1979) I, 17; F. M. Lea, "Investigations on pozzolanas, I: Pozzolanas and lime-pozzolana mixes," *Building Research, Technical Papers*, 27 (London 1940) 1-16.

24 F. W. Deichmann, "Westliche Bautecknik im römischen und Rhomäischen Osten," *RömMitt* 86 (1979) 474.

25 C. Dubois, *Pozzuoles antique: histoire et topographie* (Paris 1907) 119; M. Frederiksen, *Campania* (Roma 1984) 329, n.107.

26 Gazda in McCann (supra n.15) 76-77, n.5, 337.

27 French scholars excavating at Delos cannot verify or explain the reference in C. Dubois, "Observations sur une passage de Vitruve," *MEFRA* 22 (1902) 447, n.2 to the discovery of a "heap of pozzolana" in the ancient strata of that site. It is possible that such materials were imported from Puteoli in the Roman period, but in the absence of scientific verification this otherwise undocumented assertion must be ignored.

topic altogether. Although a full scientific report will appear elsewhere, we will outline here the method we used to document this extraordinary loyalty of Herod's engineers to Italian building materials.[28]

Volcanic materials from a given flow have been shown to be fairly homogeneous, and in many cases the composition of minor and trace elements is characteristic of the individual sources.[29] We thus thought that an investigation of the composition of the volcanic components of the Caesarea concrete might help us identify possible sources of the material. Preliminary investigations using direct current arc emission spectrography and Scanning Electron Microscope/Energy Dispersive X-Ray Florescence (henceforth abbreviated to SEM-EDX) were carried out on a limited range of samples to test whether there were indications that the compositions of samples from different sources were sufficiently different that they could be distinguished from one another. Samples of hydraulic concrete and of the volcanic components tufa, pumice, and *pozzolana* were taken for examination from Caesarea, Cosa, Kerem Maharal (a quarry located near Caesarea), Santorini, Vesuvius, and Pozzuoli. Analysis of the whole concrete samples showed relatively little promise, but the spectrographic analyses of the volcanic tufa and the SEM-EDX analyses of the volcanic particles within the concrete both gave indications that the variations in trace-element composition of these volcanic materials were deserving of further investigation.

Subsequently we collected samples of volcanic materials from 11 different sources and analyzed them for bulk and trace-elements via Inductively Coupled Argon Plasma emission after careful dissolution using an acid digestion. The sources of the samples were chosen to test our ability to distinguish samples which should clearly be different (for example, Vesuvian samples relative to Kerem Maharal) and to include samples from the two sources near Caesarea (Kerem Marahal and Zikhron Ya'agov) and from a variety of other possible sources around the Mediterranean region. Besides Caesarea and the two nearby quarries noted above, we prepared samples of volcanic materials from modern quarries at Santorini in the Aegean, at Pitligiano in northern Lazio, and at Baiae, Pozzuoli, Lago di Averno, and the summit of Vesuvius in the Naples area. Other samples came from Roman harbour structures at Cosa in Tuscany, Anzio in Latium, and Baiae and Pozzuoli in the Naples area.[30]

Analyses were carried out on 24 samples taken from these 11 source regions. Where possible, homogeneity of the samples from a given site was tested by taking two or more samples from the site. The reproducibility of the analytical procedure was tested by the inclusion of a series of blind duplicate samples among the samples analyzed.

Data were acquired for 32 elements at minor component or trace-levels for each sample. This was reduced to 23 elements by the elimination of those below the accepted detection limit (for quantitative analysis) of the analytical procedure employed. Use of the blind duplicate analyses to examine the reproducibility of the data for individual elemental analyses indicated that a further 8 elements were not sufficiently reliable and thus the data-set was reduced to the data for 15 elements: aluminum, iron, potassium, magnesium, manganese, sodium, strontium, titanium, beryllium, chromium, copper, nickel, lead, thorium, and zinc.

The data for these 15 elements on the 24 samples were examined using pattern-recognition after a principal component analysis. The data were mean centred and several different scaling techniques applied. The results were relatively insensitive to the scaling procedure chosen, but autoscaling to unit

28 See J. P. Oleson and G. Branton, "The harbour of Caesarea Palestinae: a case study of technology transfer in the Roman empire," *Schriftenreihe der Frontinus-Gesellschaft* 1992 (forthcoming).

29 J. R. Cann and C. Renfrew,"The characterization of obsidian and its application to the Mediterranean region," *PPS* 30 (1964) 116-19; D. P. Stevenson, F. H. Stross, and R. F. Heizer, "Evaluation of X-ray florescence analysis as a method for correlating obsidian artifacts with source location," *Archaeometry* 13 (1971) 17-25; B. R. Kowalski, T. F. Schatzki, and F. H. Stross, "Classification of archaeological artifacts by applying pattern recognition to trace element analysis," *Analytical Chemistry* 44 (1972) 2176.

30 Several of the Italian samples were generously supplied by Elaine Gazda of the University of Michigan, with whom Oleson is writing a monograph on Roman hydraulic concrete. Lindley Vann graciously collected the sample on Santorini for us, and Yehuda Peleg the sample at Zikhron Ya'agov.

variance was chosen for the detailed analysis. Over 85% of the total variance in the analyses was contained in the first 3 principal components, i.e. over 85% of the differences between the samples could be described by examining just 3 parameters formed by linear combinations of the 15 elements, thus making it possible to categorize samples by examination of only 3 parameters for each sample (figs.5-7).

It was clear, from an examination of the first 3 principal components, that the homogeneity of samples taken from the same site was in general good. Only in the cases of Baiae and Cosa were there significant differences, and these were not large. The blind duplicate sample analyses were almost identical to each other — not surprisingly, as these data had been used to eliminate elements which were not reproducible.

Having established some confidence in the experimental results concerning reproducibility and reliability of the data on the samples from a particular source, it was then possible to look for differences and similarities between samples from different sources. The Principal Component Analysis data showed that the samples examined from Kerem Maharal and Zikhron Ya'agov in Israel, from Santorini in the Aegean, and from Pitigliano, Anzio, and Vesuvius in Italy were all quite distinct from the samples from the other 5 sites, and in most instances were quite distinct from each other as well. There was more similarity between some of the samples from Caesarea and those from the site of Cosa in Toscana and Lago di Averno, Baiae, and Pozzuoli in the Bay of Naples. Examination of the 3 principal components, however, allowed further distinctions to be made. The only samples that were similar in all 3 principal components were those from Caesarea and Pozzuoli. Of the 3 Baiae samples, one modern and one ancient example were clearly distinguishable from the Caesarea and Pozzuoli samples, but the other ancient one was similar. The Cosa and Lago di Averno samples were also clearly distinguishable from the Caesarea and Pozzuoli samples. Overall, the analysis indicates that volcanic tufa material used in the Caesarea concrete is not distinguishable from that obtained from authentic Pozzuoli tufa samples, and it is distinct from the tufa samples from the other sources examined.

In other words, this study shows that the tufa used in the concrete at Caesarea does not match the tufa from any of the local Palestinian sources examined. While the tufa from Caesarea is similar in composition to that from several Italian sources, the only one of those tested from which it is essentially indistinguishable by the techniques used is the sample taken from Pozzuoli. Scientifically, of course, one can never say that the tufa used at Caesarea was in fact mined near Pozzuoli; only an eye-witness account could prove it absolutely. But it is extremely unlikely that our scientific tests would have yielded the results outlined above had not Herod's engineers imported *pulvis puteolanus* for their work at Caesarea. It has been very difficult to calculate the amount of this powdery volcanic ash that would have been required to complete the harbour, but the total is probably in the hundreds of thousands of tons, most likely representing several hundred large shiploads of the material imported over several years. Lime could have been produced locally, by burning limestone quarried from Mt. Carmel.

Pouring the concrete blocks

Even apart from the need to import building materials such as *pozzolana* or marble on a large scale, the task of pouring concrete blocks to the required size in the open sea was a very challenging task. Placement of this material in an inundated marine site is not simple. The boards or beams of the formwork used rarely survive in the context of Roman breakwater structures, but marks of boards and long horizontal holes left in the mass of blocks at Caesarea and other Roman harbours reveal that concrete was laid in box-like forms with vertical or horizontal shuttering along the sides held in place by exterior beams, reinforced by horizontal tie beams that ran across the interior. The use of *pozzolana* mortar meant that the forms could be left full of sea-water during construction, but securing of the forms in position for filling must have taxed the ingenuity of the engineers involved. Forms intended for submerged locations must have been floated into position, then somehow ballasted to sink upright on the prepared sand, rubble, or ashlar block foundation.[31] Vitruvius, in his famous, often-quoted passage concerned with harbour con-

31 For discussion of the technique of erecting and filling forms, see Dubois (supra n.27); H. Schläger, "Die Texte Vitruvius im Lichte der Untersuchungen am Hafen von Side," *BJbb* 171 (1971) 150-61; Oleson in *Harbour archaeology* 165-72.

Figure 5: Plotting of the Scores of Principal Components 1 and 2

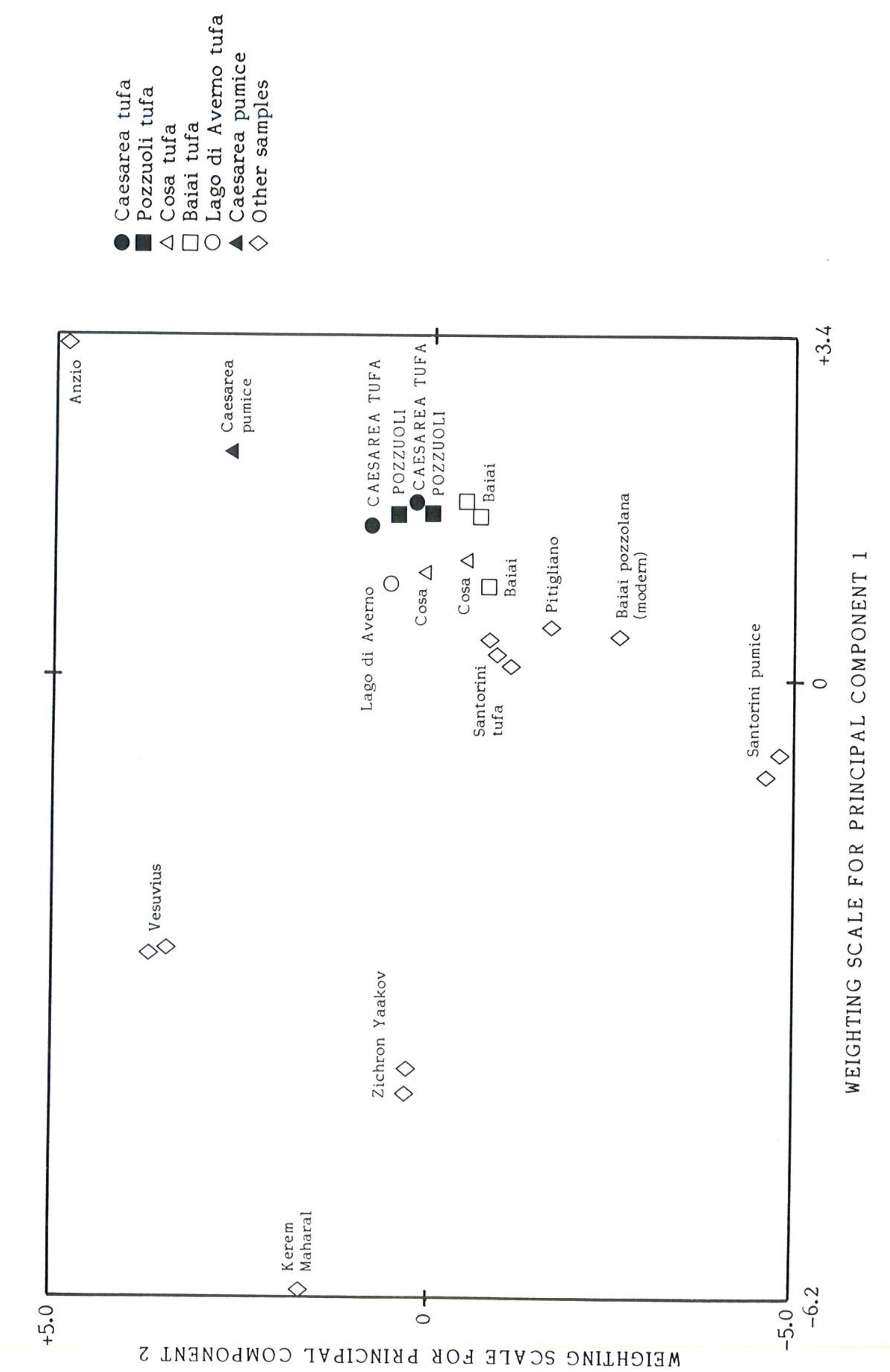


Figure 6: Plotting of the Scores of Principal Components 1 and 3

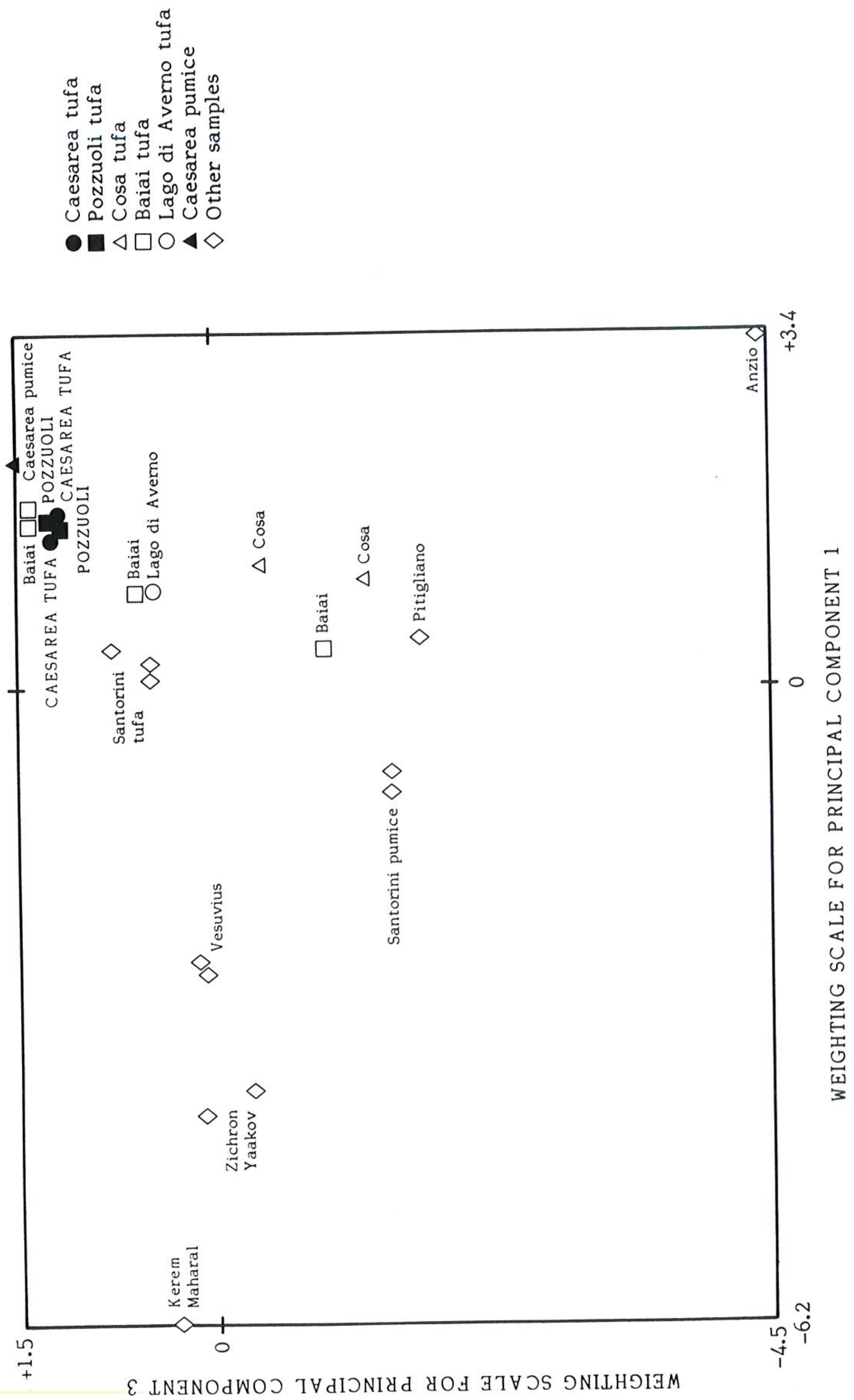
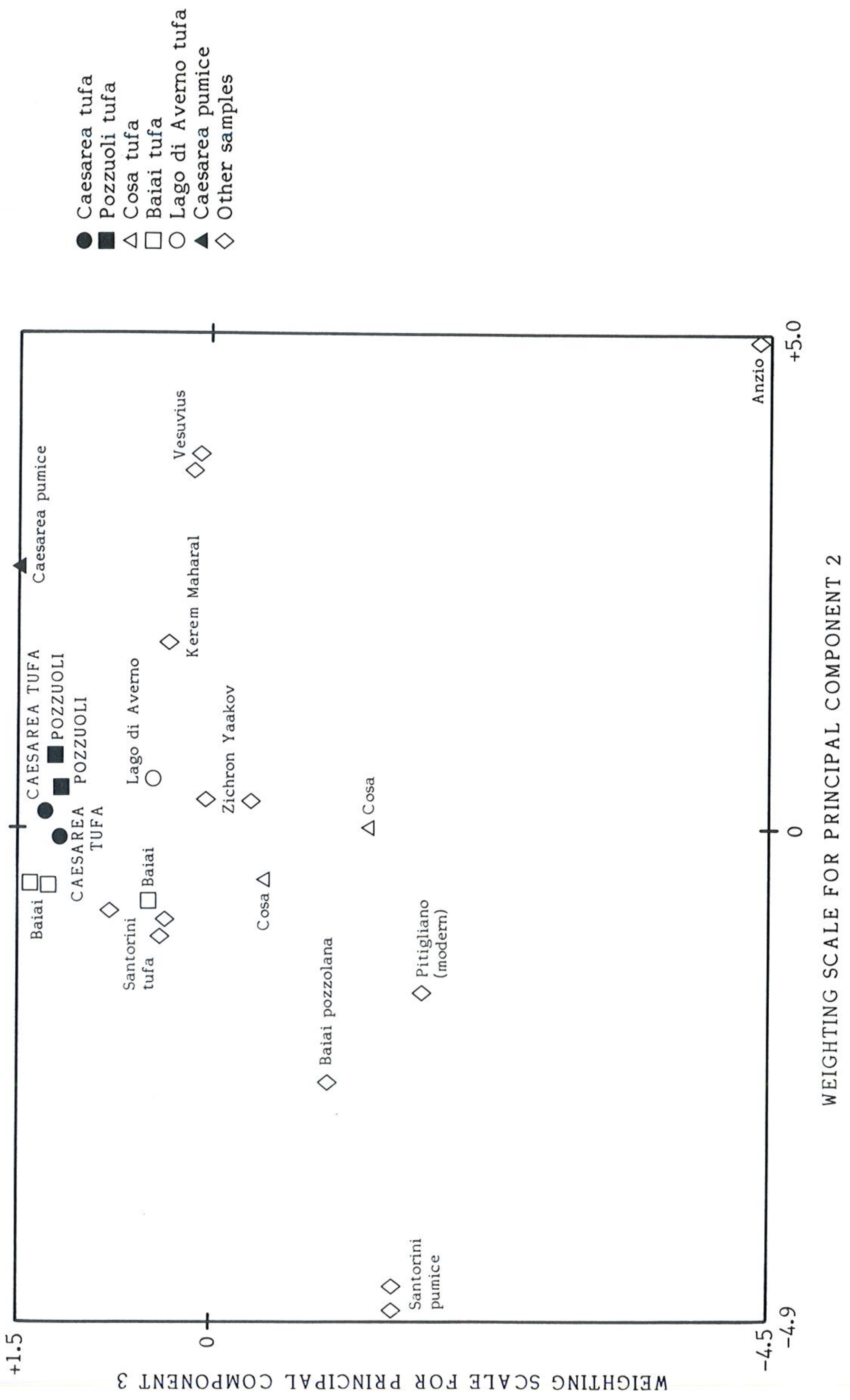


Figure 7: Plotting of the Scores of Principal Components 2 and 3



struction (5.12.3) unfortunately is ambiguous about the solutions to most of the practical problems of placement:

> Deinde tunc in eo loco, qui definitus erit, arcae stipitibus robusteis et catenis inclusae in aquam demittendae destinandaeque firmiter; deinde inter ea ex trastilis inferior pars sub aqua exaequanda et purganda, et caementis ex mortario materia mixta, quemadmodum supra scriptum est, ibi congerendum, denique conpleatur structurae spatium, quod fuerit inter arcas.
> Next, in the designated spot, formwork enclosed by stout posts and tie beams is to be let down into the water and fixed firmly in position. Then the area within it at the bottom, below the water, is to be levelled and cleared out, (working) from a platform of small cross beams. The building is to be carried on there with a mixture of aggregate and mortar, as described above, until the space left for the structure within the form has been filled.

In the subsequent paragraph (5.12.4) Vitruvius alludes to problems in setting up formwork in rough seas and proposes a method of preparing and curing concrete blocks on land for transport to the breakwater site by the natural forces of beach-movement. Frankly, it does not sound very practical, but the context reveals that Vitruvius had at least heard of attempts to cope with sites on exposed coasts. He goes on to describe a type of double-walled form that could be drained for use with non-*pozzolana* mortar concrete (5.12.5):

> ... uti arcae duplices relatis tabulis et catenis conligatae in eo loco, qui finitus erit, constituantur, et inter destinas creta in eronibus ex ulva palustri factis calcetur. Cum ita bene calcatum et quam densissime fuerit, tunc cocleis rotis tympanis conlocatis locus qui ea septione finitus fuerit, exinaniatur sicceturque, et ibi inter septiones fundamenta fodiantur.
> Let double-walled formwork be set up in the designated spot, held together by close set planks and tie beams, and between the anchoring supports have clay packed down in baskets made of swamp reeds. When it has been well tamped down in this manner, and is as compact as possible, then have the area bounded by the cofferdam emptied and dried out by means of water-screw installations and water-wheels with compartmented rims and bodies. The foundations are to be dug there, within the cofferdam.

One would like, of course, to know precisely how the forms were to be "set up in the designated spot". The terminology used, archaeological parallels, and modern practices suggest that upright posts (*destinae*) were driven into the bottom at close intervals to support horizontal planks (*tabulae*), and the whole reinforced by tie beams (*catenae*). The erection of isolated uprights implies the use of a pile-driver mounted on a raft. The addition of planks to isolated pilings would have been very difficult for even the most skilled team of ancient breath-hold divers. Alternatively, the whole form could have been built in shallow water with the sharp ends of the uprights projecting below the level of the planks, floated into position, upended, ballasted, and the main supports carefully driven into the sea bottom with simultaneous blows all around. It would have been difficult to carry out this last operation on a completed box-like form without subjecting it to intolerable strains, so perhaps – although Vitruvius does not mention it – the 4 double-walled sides of the form were prefabricated separately, then floated into position and driven into place. Making the corners watertight and firm afterwards would have presented difficulties, but probably not insuperable ones.

Once the formwork was in position, pumping machinery might have to be transported out from shore and installed (depending on the type of form and mortar[32]), and enormous amounts of mortar and aggregate prepared and laid according to schedule. Presumably, specially designed boats were used, such as those used to carry rubble for the construction of the harbour of Centumcellae.[33] The placing of concrete is not at all straightforward in inundated formwork. Even modern marine concrete, which is much more homogeneous in consistency than its ancient counterpart, cannot simply be dumped into inundated formwork from the surface of the water. It must be carried to the bottom of the form by means of a tube (called a "tremie"), or carefully released from the bottom of hoppers lowered to the floor.[34] Otherwise, in

32 Oleson (supra n.1) 108-9.

33 Pliny, *Ep.* 6.31.15-17.

34 C. E. Reynolds, *Concrete construction* (3rd ed., London 1967) 226-27; W. H. Taylor, *Concrete technology and practice* (4th ed., London 1977) 330, 543-46; J. H. Van Loenen, "Concreting underwater — some results of studies

falling through the water the mortar and aggregate are sorted by size and density and the result is a series of strata with little or no strength.[35] Vitruvius, unfortunately, says only that "building is to be carried on there with a mixture of aggregate and mortar" (5.12.3).

Judging from the size and irregularity of the aggregate used in Roman marine structures, it is very unlikely that a mortar and aggregate mixture could have been poured into inundated forms through stiff leather tubes or wooden conduits.[36] The mortar alone could have been poured through a wooden or leather tube, raked level to the required thickness around the form, a stratum of aggregate thrown in and raked and pressed into place, and the whole procedure repeated until the form was full. It seems strange, however, that the long, clumsy pipes necessary for this hypothetical procedure have totally escaped comment in Vitruvius. Any such leather or wood pipe would have had to be manufactured in sections that could be disconnected one by one as the form filled, in order to allow raising of the pipe bit by bit to keep the outlet level with the rising upper surface of the mortar and at the same time to permit continued introduction of mortar and aggregate at the upper end. These sections would have had to be strong, flexible, tight-fitting, smooth on the interior, and capable of being disassembled quickly and easily. Such specifications are unparalleled in surviving Roman pipes or hydraulic fittings. An open, U-shaped wooden gutter pipe could have functioned without joints, since it was not restricted to a single intake opening, and in consequence the slope could be adjusted more easily. Nevertheless, even this would have been very clumsy, and it seems unlikely that the stiff mortar mix required for submarine construction would have slid down it quickly enough. Furthermore, even with this arrangement, the presence of aggregate could have caused jamming, and turbulence would have washed some mortar out of the open side. A more feasible procedure would have been the use of numerous deep baskets with two stout handles at the upper rim for ropes to lower each container to the bottom of the form full of mortar, or of aggregate, or of both mixed together in the proper proportions, along with a handle at the bottom for a tip-rope used to spill the contents gently once the basket was at its proper position. Ancient representations of Roman construction projects show that baskets were the most common container for moving mortar and other building materials around construction sites.[37]

Wooden forms of a new type

Many of the concrete blocks at Caesarea still carry marks of simple box-like forms with horizontal tie-beams such as we have already heard described by Vitruvius. But, in addition, in 1982 extensive physical remains were discovered of wooden forms of a new type. Excavation showed that the structurally crucial tip of the northern breakwater was reinforced by an enormous concrete block approximately 15 m long, 12 m wide and 2 m thick, laid directly on the sand of the original sea-bottom. This block was riddled with holes left by the horizontal tie beams and vertical interior supports necessary for the huge wooden form in which the concrete was laid (fig.4). In addition, massive lower sleeper beams and portions of the upright walls were preserved below a layer of rubble and sand.

The forms were double-walled, like the design specified by Vitruvius for use with non-*pozzolana* mortar concrete, which had to be poured in a dry environment. Remember that the double walls in Vitruvius were to be packed with clay to allow pumping out of the interior. This concrete, however, had in fact been made with volcanic additives, and the wall compartments were filled with puddled mortar, which is permeable to water until hard. Furthermore, the interior could never have been pumped dry, because the heavy beams along the base of the form simply rest on the sand surface: any water removed from the interior of the form would have been immediately replaced by water bubbling up into it from

and tests," in P. V. Maxwell-Cook (ed.), *Symposium on concrete sea structures, Tiblisi, 1972* (London 1973) 197-201.

35 A famous early French edition of Vitruvius contains an engraving incorrectly showing workers pouring the concrete mix directly in the water-filled form from a mixing trough carried by a boat (C. Perrault [1673], *Vitruve. Les dix livres d'architecture*, A. Dalmas [ed.] [Paris 1965] pl. following p.162).

36 For literary and archaeological evidence for Roman pipes, see Oleson (supra n.1), n.13.

37 MacDonald (supra n.16) 158, pl.127, 130b; Adam (supra n.16) 76-79, 87-90.

below, through the sand or under the walls. To be water-tight, such forms must have a floor or be surrounded by upright beams that have been pounded deep into the bottom.

If the mortar-packed double wall of the Caesarea formwork was not meant to make it waterproof, then what purpose did it serve? It may be that we see here a conflation of two major types of formwork described by Vitruvius, in an adaptation of the basic principles involved to a third type of situation. The engineer knew from the start that he was working with a hydraulic concrete that could be poured directly in sea water, but either the exposure of the site to the open sea or the character of the sandy sea-bottom and rubble breakwater foundation (or both) made it difficult to fix prefabricated forms in place by means of pilings. In consequence, bottomless, double-walled wooden forms were constructed on shore and floated to their final positions (fig.8). Once the footings had been cleared and levelled by divers, mortar was poured into the sections of the hollow wall, with careful attention to balance, until the buoyancy of the wood was overcome and the form settled into position on the prepared surface. While the inundated form was being filled with mortar and aggregate, rubble was also dumped around the periphery to prevent shifting of the formwork prior to the curing of the concrete, or undermining of the final block. The presence of tie-beams passing through the mass of the concrete would have prevented salvage of the formwork intact, but portions may well have been pulled free for reuse: no traces of the double wall or its mortar packing were found, for example along the north face of the block. Mortar would have been preferable to stones as ballast because it was uniform in weight, easily handled, and would fill completely the sections into which it was poured.

Such a procedure would have allowed a rapid and flexible schedule of construction. The most complex part of the job, preparation of the form, could have been carried out conveniently on shore or in shallow water, without the danger of damage to partially completed formwork by storms. It is difficult to see how the Caesarea formwork could have been fitted together underwater without enormous effort. In the absence of pilings there would have been no firm anchor for any of the uprights or planks, and none of the heavy work could have been executed from the surface. In contrast, as the weather and preparation of materials for the concrete allowed, prefabricated forms could have been assembled and towed to various parts of the harbour and put in place by a few trained workers. Although Vitruvius' single-walled forms were prefabricated, pounding their uprights into the harbour floor would have been a tricky and time-consuming business. As long as the 4 massive sleeper beams of the Caesarea formwork had settled firmly on a level sand surface, little concrete would have leaked out as the form was filled. This procedure conforms more closely with Josephus' assertion[38] that Herod "let down enormous blocks of stone into the sea" than the alternative — construction of caissons on the spot by pile-driving or submarine assembly.

Summary

Ports depend on complex structures that must be capable of resisting the stress of two environments at once, while accommodating ships, the heaviest and most complex machines of the ancient world. The invention of hydraulic concrete in Italy during the 3rd or 2nd c. B.C. made possible revolutionary changes in harbour design, and the ultimate success of Herod's project. But some of the same techniques and materials that appeared in Iron-age and hellenistic harbours continue in use in Sebastos. Although it seems likely that Italian engineers were imported to direct the project, they were far-sighted enough to adapt to local conditions, traditions, and materials — although they did go so far as to import one critical ingredient for their concrete from Puteoli. The placement of materials during the construction of Sebastos required innovative procedures and devices, too: floating cranes and pile drivers, prefabricated caissons, pumps, and professional divers. Technology at Sebastos includes as well ancillary structures such as lighthouses, warehouses, dry docks or repair slips, and the infrastructure of support services, such as cranes, water supply and associated transport canals or roads. In Roman ports on this scale we can see a wide variety of interrelated technologies responding to the need for economical bulk transport over long distances. King Herod's dream was based on a very impressive and practical complex of technologies.

38 *BJ* 1.411; *AntJ* 15.334.

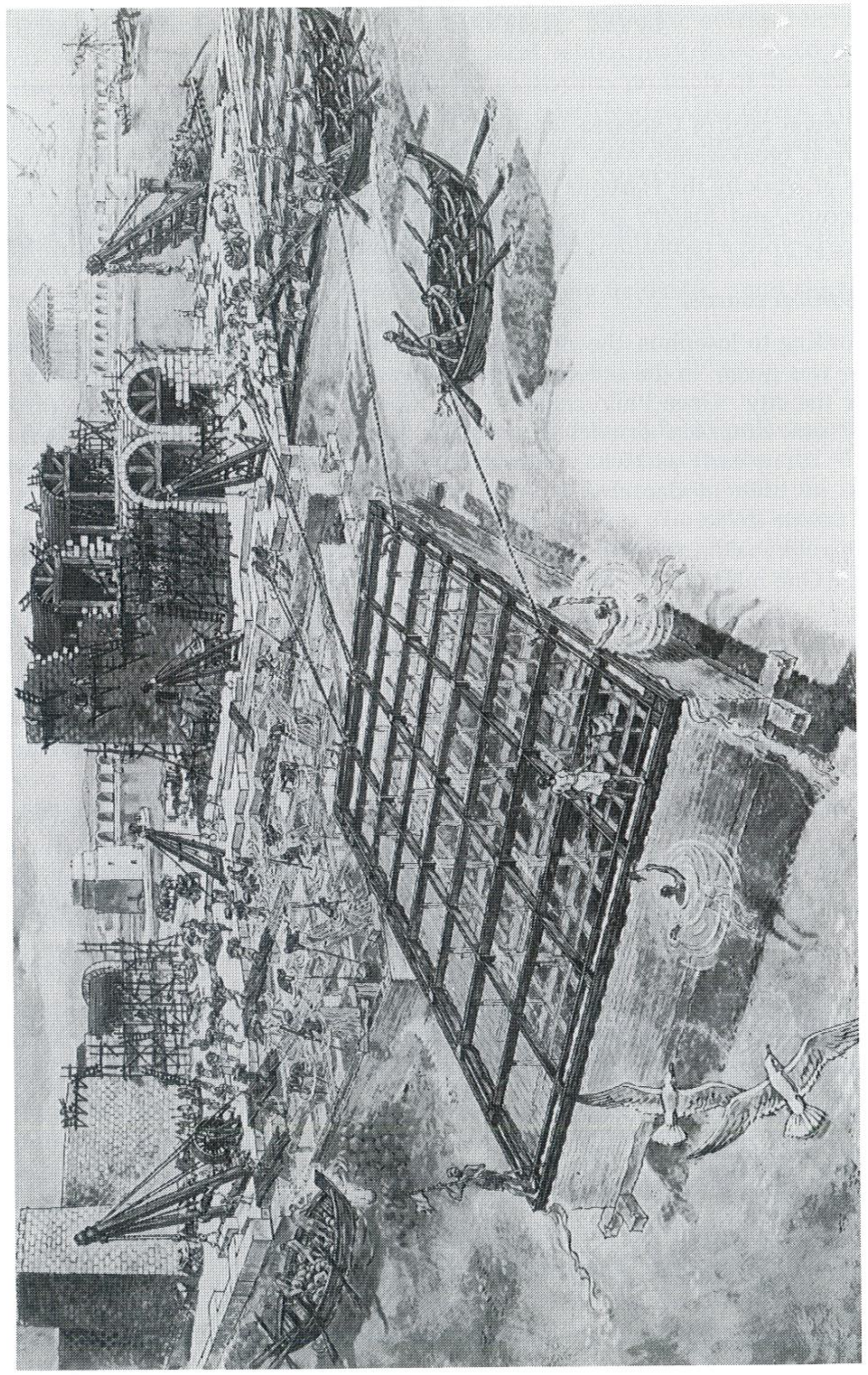


Fig 8. Reconstruction of formwork during construction of Herod's harbour (R. Teringo, National Geographic Society, copyright).