Part 1 / 1

The Harbours of Caesarea Maritima

Results of the Caesarea Ancient Harbour Excavation Project, 1980 – 1985

General Editor: John Peter Oleson

Volume I: The Site and the Excavations

by

Avner Raban

With Contributions by R. L. Hohlfelder, J. P. Oleson, R. L. Vann, and S. Breitstein, K. Emery, M. Fitzgerald, N. Flemming, E. Linder, D. Neev, Y. Nir, Y. Peleg, A. Sherwood, Y. Tur-Kaspa.

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A.R. Hands, B.Sc., M.A., D.Phil.
D.R. Walker, M.A.

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THIS BOOK IS DEDICATED
WITH GRATITUDE AND AFFECTION
TO ALL THE VOLUNTEERS AND BENEFACTORS
WHO MADE CAHEP POSSIBLE

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[J.P.O.]

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LIST OF ABBREVIATIONS

A.C.	after Christ
AJ	*Antiquitates Judaicae* (*Jewish Antiquities*)
BJ	*Bellum Judaicum* (*Jewish War*)
BL	Base-line
B.C.	before Christ
B.P.	Before the Present
CAHEP	Caesarea Ancient Harbour Excavation Project
CDC	Caesarea Development Corporation
CMS	Centre for Maritime Studies, University of Haifa
D	diameter
H	height
ha	hectare
IDAM	Israel Department of Antiquities and Museums
IEC	Israel Electric Company
IFUA	Israel Federation for Underwater Activities
IUES	Israel Undersea Exploration Society
JECM	Joint Expedition to Caesarea Maritima
L	length
m	metre
μ	micron
MSL	Mean Sea Level
NEH	National Endowment for the Humanities
PVC	polyvinylidene chloride
SCUBA	Self-Contained Underwater Breathing Apparatus
SL	Survey Line
SSHRC	Social Sciences and Humanities Research Council of Canada
Th	thickness
W	width

LIST OF CONTRIBUTING AUTHORS

S.B.	Steve Breitstein: Centre for Maritime Studies, University of Haifa.
K.O.E.	K.O. Emery: Woods Hole Oceanographic Institution, Woods Hole, MA.
M.F.	Michael Fitzgerald: Institute of Nautical Archaeology, College Station, TX.
N.C.F.	Nicholas C. Flemming: IOS Deacon Laboratory, Wormley, Godalming, Surrey.
R.L.H.	Robert L. Hohlfelder: Department of History, University of Colorado, Boulder, CO.
U.K-G.	Udelgard Körber-Grohne: Institut für Botanik, Universität Hohenheim, Stuttgart.
S.L-Y.	Simcha Lev-Yadun: Archaeometry Laboratory, Tel Aviv University.
E.L.	Elisha Linder: Center for Maritime Studies, University of Haifa.
N.L.	Nili Liphschitz: Archaeometry Laboratory, Tel Aviv University.
D.N.	David Neev: Geological Survey of Israel, Jerusalem.
Y.N.	Yaacov Nir: Geological Survey of Israel, Jerusalem.
J.P.O.	John Peter Oleson: Department of Classics, University of Victoria, Victoria, B.C.
Y.P.	Yehuda Peleg: Kibbutz Maayan Tzvi.
A.R.	Avner Raban: Center for Maritime Studies, University of Haifa.
A.N.S.	Andrew N. Sherwood: Department of Art and Archaeology, Princeton University, Princeton, NJ.
Y.T-K.	Yossi Tur-Kaspa: Centre for Maritime Studies, Haifa.
R.L.V.	Robert Lindley Vann: School of Architecture, University of Maryland, College Park, MD.
Y.W.	Yoav Waizel: Archaeometry Laboratory, Tel Aviv University.

FOREWORD

I feel privileged in writing the Foreword to this volume. Its major author, Avner Raban, has been associated with me for the last thirty years as a partner in creating and developing marine archaeology in Israel. In summing up many years of harbour exploration at Caesarea in this volume and presenting the results of this elaborately executed research, Raban and his co-authors have produced a model for the study of ancient ports of the Mediterranean. Being one of the largest ancient harbours in size and most advanced in technological innovations, Caesarea's harbour provides us with data on most of the problems and possible solutions with which harbour builders in antiquity coped during the various stages in the development of artificially constructed anchorages in the sea.

Here, over a span of many years, seamen, shipwrights and stone masons exchanged their experience and technical know-how, later to be transmitted to the harbour engineers who were invited by Herod the Great to build his port. However, unlike the favourable natural conditions for anchorage which prevail along most of the Mediterranean coasts, these craftsmen were confronted with the sand and mud which levelled the stretch of some 400 km of the coast between the Nile Delta and Lebanon, forming a straight shore-line with very few protected bays or large river estuaries. Such conditions posed a serious challenge to the Roman architects who were commissioned with the task of building a harbour of a magnitude not known before. It required innovations in harbour construction, while incorporating techniques that had already been in use for generations.

In a certain way, modern research at Caesarea has followed a similar pattern. Experience and knowledge acquired from earlier studies of this site and from the excavations of the more ancient harbours of Akko, Athlit, and Dor were utilised by the professional team which was formed by the Center of Maritime Studies. Furthermore, the experimental excavations by E. Link, the first use of the sub-bottom profiler for marine archaeology by H. Edgerton, and the introduction of historical coast-line studies based on the correlation between archaeology and geology in harbour research by N. Flemming, all carried out at Caesarea, have advanced the studies of this harbour site. When later a group of experts representing various universities and different disciplines joined in to create CAHEP, comprehensive harbour research reached its maturity. Four volumes, the first of which is hereby introduced, will describe the monumental architectural achievement in its historical and cultural setting. The collaborative efforts of many professionals and laymen are reflected in every chapter of this volume and serve as an example for international cooperation based on a common love of the sea and the maritime civilizations it produced.

[E.L.]

PREFACE

This is the first of a projected series of four volumes reporting the results of the Caesarea Ancient Harbour Excavation Project from 1980 through 1985. It includes as well a summary of some survey and excavation that took place before the formation of CAHEP, along with any results of the archaeological activity in the years 1986-88 that have a direct bearing on interpretation of the first five years of CAHEP research. Volume II, to appear in 1989, will be entitled *The Finds and the Ship*. It will concern the finds recovered during 1980-85, and the Roman ship excavated close to shore north of the city. Volume III, tentatively entitled *The History of the Harbours*, will assemble and interpret information concerning the historical development of Caesarea's harbours in antiquity, and the relationship between the port and the rest of the eastern Mediterranean world. Volume IV, the final volume in this first series of reports, will be entitled *The Origins and Development of the Harbours*. In it the four co-directors will attempt a synthesis of all the information compiled in the first three volumes, reconstructing the structures and function of the harbours from the Hellenistic through the Crusader periods.

I am serving as the general editor of these four volumes, working to ensure continuity in format and style, and the effective organization of subject matter. There will be a separate sub-editor for each of the four volumes, usually the principle author or contributor, whose responsibility it will be to assemble the manuscript and illustrations and organize them in a preliminary fashion before handing them over to the series editor. For Volume I it is A. Raban; for Volume II, J.P. Oleson; for Volume III, R.L. Hohlfelder; for Volume IV, R.L. Vann. Each volume will be self-sufficient in its illustrations, bibliography, and other documentary material, but Volume IV, as a synthesis of the the whole, will include as well a comprehensive bibliography of modern works on Caesarea and its harbours. Most of the reconstruction plans and drawings will be held for this volume as well.

The gratitude of the four co-directors of CAHEP to the individuals and institutions that assisted with the project's funding and research are expressed in the Acknowledgments, and the character of the funding and organization of CAHEP is outlined effectively by Raban in Section III.A and Hohlfelder in Section V.A. It will become obvious to anyone who reads this report with care that the site is a complex one, involving an enormous area, a wide variety of structures and materials above and below the water-line, and a long, exciting period of human history. In such circumstances it would be arrogant and self-deluding to claim that we had solved all the mysteries of Caesarea's harbour. Furthermore, it is normal, indeed healthy -- given the complexity of the site -- that the four co-directors do not always agree on the interpretation of the evidence we have all helped to recover. Fortunately, we all agree on the issues of major importance to our understanding of the construction and function of the harbours, but occasionally in this volume,

and in the three to follow, we will indicate that one or more of us disagree with the interpretation presented in the text. In cases where outside experts have contributed a section or chapter that contains interpretations at odds with the consensus of the CAHEP co-directors, the series editor will insert a note of clarification, to keep the reader aware of justifiable differences of opinion. In Volume IV, we will provide extensive discussion of some differing positions concerning the reconstruction and history of the harbour, both our own and those of scholars outside CAHEP.

As Avner Raban, the overall project director, notes in his Acknowledgments, the four co-directors brought to the project a diversity of skills that together made us a very effective team for carrying out the complicated tasks of excavation and research at this type of site. Avner Raban, both a Palestinian archaeologist and a nautical historian, brought his extensive experience with the material culture of this part of the Mediterranean, including inundated sites and shipwrecks. Robert L. Hohlfelder, a historian of the Byzantine period, contributed an intimate knowledge of the culture of the eastern Mediterranean during the time of Caesarea's greatest prosperity. In addition, he has participated in excavations at the harbours of Populonia, Halieis, Kenchreai and Cosa. Robert Lindley Vann brought a valuable combination of talents as both a historian of ancient Mediterranean architecture and city-planning and an archaeological field architect with long experience at Sardis and Carthage. He has supervised our teams of architects on land and in the sea over the years, and has overseen preparation of the plans and reconstructions. For my own part, as a classical archaeologist with a special interest in ancient technology, particularly harbour design and hydraulic concrete, the excavation of Caesarea has been a splendid opportunity. I have excavated previously in the ancient harbours of Cosa, Pyrgi, and Populonia in Italy.

Nevertheless, even a well-rounded research group of four individuals could not hope to cope by itself with a site like the harbour of Caesarea. The extensive help we have received from others can be seen in the List of Contributing Authors, which contains the names of fourteen other scholars and technicians. Some of these individuals participated directly in the CAHEP excavations, while others analyzed or interpreted material recovered in the excavation, or simply shared with us some of their expertise gained in the course of independent research in areas that overlap with the objectives of CAHEP. To all of these individuals the four co-directors owe a great debt. The identity of the author or authors of each section is indicated in abbreviated form at the end; a key is given in the List of Contributing Authors. Each author takes responsibility for the opinions expressed in his or her section. Avner Raban has contributed the bulk of the text for this volume, but, as he notes elsewhere, he has naturally made free use of the research and publications of the other three co-directors. At the same time, he has exercised his own uniquely vigorous powers of synthesis and reconstruction in preparing the text. Not all the co-directors necessarily agree with all of his conclusions.

Because Raban has been engaged in research at the site of Caesarea since the mid-1970's, the nomenclature for some of the excavation areas in the harbour that appears in his early reports sometimes differs from that later adapted by CAHEP. I have inserted editorial clarification wherever it seemed that confusion was possible. Throughout, we have put the names of all distinct structures or areas within the harbour, and of all excavation areas, in capital letters (e.g. Southern Breakwater, Outer Basin, Area F). More general references are in lower case. All dates not labelled B.C. can be assumed to be A.C. (note that, in accordance with archaeological usage, references to one particular year after Christ are labelled A.D.). All measurements are multiples or fractions of a metre, unless otherwise noted, and all depths are below Mean Sea Level, unless otherwise noted. Occasionally, where measurements of structures now lost are quoted from early British survey publications, dimensions are given in English units, with citation of the metric equivalents in parentheses. Unless specific clarification is given, all multiple measurements of a structure or feature are given in the order length, width, and height or thickness. For questions of style and format we have for the most part followed *The Chicago Manual of Style*. 13th ed. (Chicago, 1982). Any non-standard abbreviations are given in the List of Abbreviations. In spelling the names of Greek authors and their works, we have followed Liddell, Scott, and Jones, *Greek-English Lexicon* (Oxford, 1968); for Latin authors, the *Oxford Latin Dictionary* (Oxford, 1982). For authors not in either of these works, and for abbreviations of modern reference works, we have followed the entries and list of abbreviations in the *Oxford Classical Dictionary*. 2d ed. (Oxford, 1970). We have made use of the Social Sciences system for reference citation and bibliography, as explained in the *Chicago Manual of Style* chapters 15-17. Wherever possible, references have been incorporated in the text rather than in footnotes.

Because of the large scale of the site, and the generally large amounts of particulate matter in the water, it was often very difficult to obtain photographs of our excavation areas that would be clear enough for useful inclusion in a report of this type. As a result, we have had to rely on plans and drawings for illustrations to a much greater extent than is usual for reports of archaeological work on land, or on a shipwreck located in deep water. Wherever possible we have included photographs as well, even if the clarity of the image is not outstanding.

I prepared camera-ready copy of this book on the IBM Mainframe computer of the University of Victoria, using the Waterloo Script System to format text for printing on a Xerox 2700 Laser Printer. Most of the text was entered by Ms. Orissa Stel, my research assistant for several years. I am very grateful to her for her skillful and intelligent assistance, which made a difficult task much easier than I could have hoped. I am also grateful to the Faculty Committee on Research and Travel for grants to support her salary and my computing costs. Research and excavation grants are acknowledged in the next section.

[J.P.O.]

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A very great role in making this enormous project a reality was played by Professor Elisha Linder, the founder of the Israel Undersea Exploration Society, the Center for Maritime Studies, and the Graduate Department for the History of Maritime Civilizations at the University of Haifa. Professor Linder was the pioneer of the idea of the project and of the actual research in the early 1960's. It was his infectious enthusiasm and inspiring vision that first brought together supporting agencies and academic institutions from both sides of the Atlantic to pursue this initiative.

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Yet, the true authors of this report are the hundreds of volunteers -- scholars, laymen, students, businessmen and housewives -- from Israel, the United States, Canada, Australia, the United Kingdom, France, Germany, Yugoslavia, Japan, Italy, Sweden, and Peru, who left behind everything else and paid their way to contribute their energies to this project. They are the foundation on which this research is based (see the List of Volunteers below, Appendix V.A). To all these volunteers and benefactors, and to many others we could not mention by name, the four CAHEP co-directors dedicate this report.

[A.R.]

CHAPTER I: THE SITE

I.A. Natural Features: 1. Topography and Geography.

Caesarea is located on the southern part of the eastern coast of the Mediterranean (34°53.5' E; 32°30.5' N. Figs. I.1-2). This coast-line is determined by a low ridge of Quaternary, carbonate-cemented quartz sandstone known by the local name *kurkar*. This rocky ridge is the skeletal feature along the stretch of the coast from 'Athlit, 23 km north of Caesarea, to Giv'at Olga, 6 km south of Caesarea. The sandstone ridge is never higher than 10-15 m above MSL here, and in many places it has been abraded and downtilted to the wave level or even below. There are several wide gaps in this longshore ridge indicating protohistoric estuaries, such as the Nahal Hame'arot gap between Newe Yam and Habonim, the Nahal Daliya gap between Dor and Tel Tanninim (Krokodeilonpolis), which is common to Nahal Tanninim, and the gap of Nahal Hadera, between Kibbutz Sedot Yam and Giv'at Olga. Along all these gaps, residual rocky reefs remain just off shore, either at sea level or just below (figs. I.3-5). In these gaps the sea transgressed the general line of the ridge, creating sandy beaches and lagoonal recesses in its lee (such as at Tantura, near Dor, and just north of Caesarea), or in shore islets (such as Jaziret Nami and Jazirat el Hamam). These series of in shore islets are characteristic of the north sides of estuaries now silted in, such as at Newe Yam (of Nahal Hame'arot), Tanturah (Nahal Daliya), Jazirat Hamam (Nahal Tanninim), and Sedot Yam (Nahal Haderah).

The site of Caesarea is located on a better preserved part of this ridge, where a series of inlets create sandy bays which are divided by rocky headlands or promontories (figs. I.6, 12). These bays are partly separated from the open sea by almost continuous shallow reefs. The promontories are low (3-4 m above MSL) and are outlined by a raised abrasive platform 1.2-1.5 m above MSL (e.g. Area J).

The second dominant feature along this segment of the coast is the wave-carried and wind-blown sand. Sandy beaches and sand bars are found at every section of the shore that has some protection from the full fetch of the surge. The sand that reaches the shore is carried by the prevailing westerly winds farther inland, wherever there is a gap in the sandstone ridge or the ridge is relatively low. This phenomenon seems to be of fairly recent date, since Roman and Byzantine structures are found buried under the dunes or the sandy beaches, built directly on more consolidated substrata (Section I.A.2). These soils now buried by the sand are mainly red loam on higher ground and on the raised, abraded platform at the fringes of the sandstone ridge, and alluvial dark brown and hydromorphic grey soils at the basins between the kurkar ridges. These latter soils represent a stage when the coastal plain lost its gradient and the drainage pattern tapered off, turning the basins into marshes (Bar-Yoseph & Nir 1976: 115-17).

A second sandstone ridge runs parallel to the first about 1.2-1.6 km farther inland. It is much higher than the western one, although at present it is almost completely covered by sand dunes that reach elevations of 30-35 m above MSL. The main highway between Haifa and Tel Aviv was recently built along the lee side of this ridge (fig. I.4). In ancient times this ridge blocked the drainage of streams that reached the coastal plain from the hinterland, causing the basin on its east side to become seasonally inundated and marshy year-round. These marshes were in part drained artificially when cuts were quarried across the ridge for Nahal Daliya and Nahal Tanninim (Krokodeilon River) (Nir 1959). Later, during the Roman period, the artificial channel cut through for Nahal Tanninim (Krokodeilon River) was dammed, and another dam was built about 3 km to the north. These dams caused the formation of an artificial lake that covered an area of about 486 ha along the west side of the southern tip of Mount Carmel, between it and the main kurkar ridge. This lake supplied the water for the Low-Level Aqueduct serving Caesarea, and a series of water-mills built next to, and possibly on, the dam (Section I.B.8; Oleson 1984b).

South of Mount Carmel's southern tip there is a third sandstone ridge, the northernmost edge of which is at Tel Mevorakh (figs. I.4-5). The ridge continues southward under the modern settlements of Beit Hannanya, Or 'Aqiva, and Hadera. It is wider and more sand-covered than the other two to the west, and its highest peaks reach elevations of 45-50 m above MSL. East of this ridge extends an area covered by sand dunes, about 3 km wide on an east-west axis and over 4 km long (fig. I.31). These dunes are held in on the east by a ridge covered by red loam (*hamra*) over 2 km wide in some places, and rising 40-50 m above MSL. The settlements of Binyamina and Pardes Hanna were built on it.

Still further east, an area of low hills of red loam mixed with alluvial brown soil, with an average width of about 3 km, tends ENE to the foot of the limestone hills of the Menasheh region. This section of the coastal plain south of the southern tip of Mount Carmel is called Northern Sharon and in antiquity formed Caesarea's hinterland (figs. I.5-6). At present, over half of this area is covered by sand dunes, but in antiquity red loam and alluvial soils were still exposed on the surface over most of it (Section I.A.2). Since then, until the nineteenth century, most of the higher ground in this area of the northern Sharon was covered by oak forest, with some carob plantations on the lower ground near the coast (Dar & Applebaum 1973; fig. 4).

The postglacial rise of sea level and the obstructed drainage of the coastal plain have caused a relatively high water-table and significant hydraulic pressure around Caesarea. This phenomenon permitted extensive exploitation of fresh water for domestic use and for agriculture, even when the aqueducts were out of use (Porat 1975). The struggle between the natural process of accumulating sand dunes and human attempts at agriculture was a constant one throughout the history of Caesarea (Reifenberg 1955; Rim 1950-51).

The north and northeast reaches of Caesarea's territory embraced the southern tip of Mount Carmel, the artificial lake (later known as the Kabbara marsh), and the coastal strip from Krokodeilonpolis (Tel Tanninim) to the city (fig. I.7). This coastal strip was chosen for the course of the two aqueducts and for various

farms and villas east of them, below the main kurkar ridge. Farther north, along the coastal plain between Mount Carmel and the sea, the marshy estuary of Nahal Daliya (Choresos River) delineated the border between the territories of Caesarea and Dor. To the NE, the small alluvial valleys on the east side of Mount Carmel, toward the hill country of Manasseh, were an agricultural hinterland with vineyards and fruit orchards. The abundant springs in this area fed the High-Level Aqueduct (Section II.B.8). The southern boundary of the territory was marked by the lower course of the Bdellopotamos River (Nahal Poleg).

Being locked in by sand dunes and marshy low ground, Caesarea was situated away from the main roads and land trade routes, except perhaps for a summer road which followed the coastal sandstone ridge, which was hardly accessible during the rainy season due to the inundated river estuaries (fig. I.6). A better, perennial road led due east to either Tel Burgata (Kh. Tall al Bureiq) or Tel Dudaim, some 7 km inland. There this road met the main one that followed the foothills along the eastern edges of the Sharon Plain. Six km farther south along this main road was the junction with a road to the NE, through the Ire'on passage to Legio and the Great Valley. Eighteen km farther south along this main road was the junction with the road that led eastward to Sebastia and Neapolis (Nablus). Both roads led across the hill land of the interior toward the natural crossings of the Jordan and then up to the Royal Road leading NE to Damascus and Palmyra and south to Edom and to Eila on the Red Sea.

[A.R.]

I.A Natural Features: 2. Geology and Geomorphology.

[Editor's Comment: Readers will note that some of the conclusions presented in this section do not agree with those expressed elsewhere in this volume, in particular, the extent of the marine transgression in the post-Byzantine phase. We have decided that both sides of the question should be presented in this report, and we leave the choice of opinion up to the reader. With all due respect to the authors of this section, however, we would like to point out that it seems more difficult to explain the survival in relatively good condition of structures along the beach (e.g. the vaults) which were inundated gradually by the sea in this reconstructed transgression, than to explain the accumulation of shell beds at a high level on and behind the dunes. The authors of this section discuss objections to their theories in their impressive summary study (Neev, Bakler, Emery 1987: 31-32; note also p. 102). J.P.O.]

Introduction. The evolution of the geological structure at Caesarea and its tectonic history during the Holocene were discussed by Neev et al. (1978).[1] One

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of their specific conclusions, namely occurrence of a post-Roman oscillatory tectonic movement, provoked a controversy. The mechanism and origin of that movement, as well as a review and discussion of the contradictory concepts, are discussed by Neev et al. (1987: 97-102). Since then, several relevant new data have been noted and analyzed that corroborate the original conclusion. It is the purpose of this article to discuss them and to portray a more comprehensive tectonic history of Caesarea during the post-Roman period, preceded by a short review of some of the problems as background information.

A structural high at Caesarea is at the junction of three tectonic elements: (a) a northeast-southwest trending folded structure that formed after Early Cretaceous (and perhaps even before then) and folding activity continued until late Pleistocene; (b) a north-northeast trending post-Jurassic/pre-Cretaceous normal fault that roughly corresponds with the Recent coast-line as well as with the present coastal fault system; (c) the Or'Akiva east-west (transverse) trending fault (or graben) (Gvirtzman & Klang 1981; Neev & Greenfield 1981). Rejuvenated activities during the Recent along these three tectonic elements have produced a tilted fault block that is uplifted in the north (at the Caesarea harbour) and dips to the south. Similar structural features of analogous origin also formed at other sites along the coast of Israel, such as at Akhziv harbour (Neev et al. 1987: 39).

Three faults parallel to the coast are postulated along the littoral zone off Caesarea (Neev et al. 1978: fig. 6). Two of these faults (the two nearest the coast-line, figs. I.17, 20, II.19) were identified on the basis of on shore and off shore studies that included detailed stratigraphic analyses of boreholes (including precise elevations of the Pliocene-Pleistocene boundary) and detailed underwater archaeological excavations (Raban et al. 1976). Cumulative throws during the Holocene across these two faults total nearly 20 m within a distance of about 400 m. The Herodian harbour subsided about 6 m across the easternmost (F_1) fault, that corresponds with a submarine cliff along the western margin of the abraded terrace (fig. I.29A). This post-Roman faulting occurred in two phases: one during Byzantine times, and the other since then (perhaps during Mameluke times, or just a few hundred years ago). During both of these tectonic phases the downthrown block, on which the Herodian harbour is situated, subsided, whereas the upthrown block was subjected to oscillatory (downward followed by upward) movements. The mechanism and origin of the oscillatory movements were discussed by Neev et al. (1987: 97-99). Both phases of faulting are believed to be accompanied by renewal of massive supplies of quartz-sand from the Nile River. The net amount of vertical shift across the second fault (F_2, figs. I.17, 20, II.19) is about 13 m, most of which occurred in pre-Roman times, probably during the Iron Age. A third off shore fault (beyond the western limit of fig. I.20) was identified on the basis of shallow-penetration seismic profiles and geomorphic considerations.

The Byzantine Phase. A vertical tectonic movement at Caesarea during Byzantine times is inferred from the analysis of two sets of data:

(a) Changes in gradients and elevations of the water-supply system to Caesarea, namely the High-Level and Low-Level aqueducts at the north of the city during Late Roman, Byzantine, and Early Moslem times. These changes were deduced on the basis of data from Reifenberg (1950-51), Negev (1964), Olami and

Peleg (1977), and Nir (1985) as well as our own observations. As shown below, it is suggested that during the Byzantine period the upthrown block, east of the coastal fault, tectonically subsided by 2.5 m and then was uplifted again by the same amount.

(b) Shipwrecks, as well as an additional rampart built on top of the Roman breakwater (Raban et al. 1976; Raban 1985c). These data indicate that the harbour (i.e., the downthrown block) subsided twice since it was built; once during the Byzantine period and once again at a later date. Subsidence during each of these phases amounted to approximately 3 m.

During Roman and Byzantine times the High-Level Aqueduct carried fresh water to Caesarea from the southeastern flank of Mount Carmel (fig. I.8, no. 6, pl. I, no. 1). Upon approaching Caesarea from the north, at exactly the point where the Or'Akiva east-west transverse fault intersects the coast-line, the coast-parallel segment of that aqueduct abruptly terminates (figs. I.20, 34). Nir (1985) concluded that marine abrasion of the segment south of that point increased because of a new wave-diffraction pattern induced by construction of the Herodian Harbor. However, the correspondence of that point with the intersection of the Or'Akiva and the coastal faults suggests involvement of a tectonic factor as well. At its point of termination, the High-Level Aqueduct contains three separate channels (fig. I.20: A, B, and C). Channel A, the eastern one, was built by King Herod during the late first century B.C. Channel B was constructed and attached to Channel A along its west side during Hadrian's reign to double the water supply to the city as well as to support and repair damages to Channel A caused by small tectonic movements or earth compaction processes. Subsequently, both channels were repeatedly filled with layers of rubble cemented with mortar to raise their level. The much smaller Channel C (having only 10% the capacity of A and B) then was built on top of the rubble-filled Channel B, so that the cumulative rise in level reached 2.5 m. The same sequence of events is noted farther south, at the northern entrance to Roman Caesarea, where a small relic of the High-Level Aqueduct was found. The repeated efforts within such a short time (third to sixth centuries A.C.) to raise the level of that aqueduct by 2.5 m along its coastal segment suggest the effects of a tectonic subsidence process that disturbed the supply of water to Caesarea. Apparently, these troubles culminated during the sixth century (in the reign of Justinian) when, according to the Christian writer Choricius of Gaza, "the Caesarea aqueduct..., because of negligence, no longer allowed free passage of the running water...(although) the springs continued to flow." (quoted in Reifenberg 1950-51: 27).

The above interpretation is in agreement with one of the rationales suggested by Nir (1985: 187) for the raising of the aqueduct's level by 2.5 m: namely, the tectonic subsidence of part of the course of the aqueduct. On the other hand, it is in apparent disagreement with an observation made by Rim (1950-51: 35). He computed the slope of the High-Level Aqueduct between the foot of Mount Carmel and the coast-line, found it to be very low (1:10,000), and concluded that there had been practically no subsidence of the shore-line or any other vertical tectonic movement of the coastal zone during the the past two millennia. The contradiction between his conclusion and ours may be resolved if we assume the following: (a) Rim's data refers just to the upthrown block (the on-land area), so that

there should be no conflict with the subsidence of the downthrown (off shore) block as implied from the off shore data (the Herodian Harbor; see below); (b) the subsidence part of the Byzantine oscillatory tectonic phase was followed by a rebound movement that tectonically lifted the block again in the late sixth century. Consequently, it reached its original structural elevation and even slightly above it (at least along its western rim -- see fig. I.29C and Neev et al. 1978). The implied range of that oscillatory movement is thus 2.5 m.

The Low-Level Aqueduct follows the coast-line and for most of its course runs parallel to the High-Level Aqueduct, about 200 m east of it (figs. I.8, no. 7, I.22). It carried a large amount (2500 m^3/hr) of water to Caesarea from the Krokodeilon River located about 5 km N-NE of the harbour. The date of its construction is still not completely settled. Following indirect indications, such as architectural comparisons, Reifenberg (1950-51) conjectured that it was built during the third century A.C., whereas Olami and Peleg (1977) and Oleson (1984b) believe it was built during the fourth century. We suggest that the Low-Level Aqueduct was built during the sixth or early seventh century to replace the High-Level Aqueduct that by then was not functioning and apparently could no longer be repaired due to repeated damages caused by the oscillatory movement. The following data are relevant to the chronology of this aqueduct: (a) The Moslems penetrated the fortification walls of Byzantine Caesarea in 640 through the Low-Level Aqueduct (Reifenberg 1950-51: 29, quoting Al-Baladari and Yakut), so by then that aqueduct was already in existence. (b) According to the tenth-century Moslem geographer Muqqadasi, Caesarea of his time was a beautiful and flourishing town, but its drinking water was drawn from wells and cisterns located mostly in the swamps east of the city (cited in Reifenberg 1950-51: 29). This implies that by then the High-Level Aqueduct, which carried fresh water, no longer functioned. (c) The eleventh century Persian writer Nasir-i-Khusrau praises Caesarea as "a fine city with running waters...and with fountains that gush out within the city" (Reifenberg 1950-51: 29-30). As a relatively high dynamic head was needed to operate the fountains, the implication is that at that time some aqueduct, possibly the Low-Level Aqueduct, was still functioning.

The following data imply that the Herodian harbour (located on the downthrown block; figs. I.20, 29A-B), gradually subsided sometime between the third and sixth centuries. (a) Seventeen shipwrecks were found on top of the breakwater, ranging in ages from the third/fourth to the fifth centuries (Raban et al. 1976: 51; Raban 1985c: 158). (b) A complaint was made in an early sixth-century letter by the theologian Procopius of Gaza to the Emperor Anastasius regarding the poor condition of the harbour of Caesarea (Oleson et al. 1984: 294 n. 20). Apparently the breakwaters no longer kept out the waves. (c) An additional rampart was built on top of the Herodian breakwater to improve its functioning. The crest of that rampart is now a few metres below sea level. "Being post-5th century A.D. the rampart might well be part of the Byzantine Caesar Anastasius's effort to repair the Sebastos already in ruins" (Raban 1985: 158). As the top of the now submerged rampart originally protruded close to 2 m above sea level (fig. I.20), it can be assumed that it has subsided a few metres since then through tectonic action. It is therefore implied that the 6 m of tectonic subsidence of the downthrown block (see Introduction) occurred in two phases since Herodian times: 2.5 m during Byzantine times and 3-3.5 m afterward.

During Roman and Byzantine times Caesarea went through three major periods of construction activity. The first took place during the reign of Herod the Great, when the harbour and the infrastructure of the city were built (first century B.C.). The second stage took place during Late Roman or Early Byzantine times (third or fourth century). The third stage occurred during Late Byzantine times (late sixth century), when a dramatic rise in building activity and street repair is implied by archaeological evidence (Vann 1983b). We suggest that the second stage followed a very destructive event during which most of the Roman city was virtually destroyed (Bull & Toombs 1972). That event may correspond with the first (downward) movement of the Byzantine oscillatory phase. The third stage of construction and repairs followed the last (upward) movement of that oscillatory phase -- rebound of the upthrown block. Accordingly, the entire duration of the Byzantine oscillatory phase is estimated to have been about 300 years.

The occurrence of an oscillatory movement during Byzantine times is not limited to Caesarea (map, fig. I.18). Similar indications suggest down and up movements in the range of 4 m across the coast-line of Yavneh Yam south of Tel Aviv, sometime between Late Roman and Late Byzantine times (Neev et al. 1987: 65-66). Indications suggesting an oscillatory movement that ranged to about 8 m were noted at two sites on the coastal cliff at Tel Ashqelon (Neev: in preparation). These two sites are additional to that described by Neev et al. (1987: 73-75) along the same segment of coast-line but several hundred metres farther north. The date of the latter (whether Byzantine or Mamelukeian) still is unclear. Another event of the same date is described by Lewy et al. (1986) from the Akhziv-Nahariya coastal area near the Israel-Lebanon border (see also Neev et al. 1987: 39-41).

Pirazzoli (1988) reported evidence for sudden vertical displacements across several coasts in the northeastern part of the Eastern Mediterranean during the fifth and sixth centuries (but mostly around A.D. 450). He called this phase "The Early Byzantine Tectonic Paroxysm" and correlated it with several great earthquakes in the Eastern Mediterranean during the period from the middle of the fourth century to the middle of the sixth century. The movements included mostly emergence of the land (up to +10 m) but some examples of submergence (to -4.5m) also were mentioned. Nevertheless, oscillatory type of movements were not noted in his article. These tectonic paroxysms are ascribed by Pirazzoli to a subduction-thrust movement of the Ionian crust under the Hellenic Arc that caused a sudden narrowing of the Eastern Mediterranean Sea, and also to necessary readjustments of various blocks of the lithosphere. This mechanism is similar to that suggested by Neev et al. (1987: 99) to explain oscillatory movements along the coasts of Israel.

Two Post-Byzantine Phases (Early Moslem and Mameluke). Post-Byzantine vertical differential tectonic movements across the coast of Caesarea are inferred mostly from sedimentological evidence. A succession of man-made structures developed without interruption as an urban complex in Caesarea during the period between Hellenistic and Early Moslem times (for about 1000 years). That construction period terminated rather abruptly when the sea transgressed the coastal zone, and at least the segment south of the Crusader fortress was onlapped by a sequence of lagoonal and swamp sediments a few metres thick.

Such a change of regimen could have occurred only because of tectonic subsidence of the upthrown block, and transgression of the sea. Apparently, the transgressive regimen prevailed for several hundred years, although with some fluctuations. It terminated when the coastal zone gradually was uplifted again and returned to its pre-movement structural elevation sometime after the end of Crusader rule.

The presence of swamps during the early modern period along the topographic trough parallel to the coast south of the Crusader fortress of Caesarea was indicated by Neev et al. (1978: 56-60). That trough is now about 10 m above MSL (figs. I.8, 19, pl. I: Fields C, K, L, M). It is separated from the sea by a ridge 15 m above MSL that extends southward as far as the theatre (Vann 1983b: fig. 2). Large Early Roman to Byzantine public structures were excavated by Bull and Toombs (1972) at the northwestern end of that ridge. The tops of these relics are exposed now at about 10 m above MSL, where they are onlapped by a layer of beach or dune sands a few metres thick (Bull 1973a-b, 1974). Patches of loose shell lenses up to 0.20 m thick locally cover the sandy apexes of that ridge. That sandy unit interfingers eastward with sandy clay sediments of lagoonal or swamp origin, and with shell lenses (mostly *Glycymeris violacescens*). It was argued by Neev et al. (1978) that under present physiographic conditions swamp environments could not have prevailed along the coast-parallel trough. A swamp just a few tens of metres east of the coast-line would not hold water at an elevation of 10 m above MSL, where the subsoil (containing the ruins of the Roman to Byzantine structures) is very permeable down to present sea level. We assume that when these swamps first formed, the base level of erosion had to be appreciably higher than it is today and that the water of the swamp was in hydraulic equilibrium with that of the nearby sea.

Since 1978, archaeological investigations have been expanded within the trough about 100 m farther east of the coastal ridge, where an extensive complex of Byzantine structures topped by early Moslem ones was excavated and studied (Joint Expedition Fields C, K, L, and M; Vann 1983b: fig. 1; our figs. I.8, 19). Elevations of these Byzantine to Early Moslem relict structures in Fields C and K range from about 6 to 8 m above MSL. The respective thickness of the overlying swamp and shell-bed sequence, therefore, ranges from 4 to 2 m. Fresh outcrops exposed by the excavation enabled us to better observe details of sedimentary structures and textures within the overlying sedimentary sequence. As stated above, most of this sequence consists of lenticular shells, rounded and angular pottery sherds, and rubble, interbedded within sandy clay layers. Two prominent bands of more uniform dark grey-brown sandy clay deposits, each 0.20 to 0.40 m thick, occur at about the middle of the outcrop and near its top (fig. I.23). Traces of horizontal lamination as well as burrowers' tunnels (figs. I.24-25) are within these two bands, indicating an alternation of stagnant and bioturbated environments. These two bands are assumed to have been deposited within low-energy lagoonal or swamp environments that were in hydraulic equilibrium with the nearby sea. Occasionally, these swamps dried out completely, enabling restricted human activities. This is indicated by the presence of a horizontal layer of neatly carved building stones within the lower swamp bed (fig. I.23).

The interbedding of shell lenses and swamp beds within the post-Byzantine sedimentary sequence suggests appreciable changes in environments of deposition. Most shells are oriented with their concave surface downward and are densely packed with occasional "nestling textures" (see Neev et al. 1987: 31). Some chains of nestled shells form circular patterns, and elsewhere weak bedding is present (figs. I.26-27). Smaller lenses of broken shells and granul es with imbricated patterns also are interbedded within the sequence (fig. I.28). All of these features imply the activity of strong and persistent currents during deposition of the shell beds. The distribution pattern of these shell beds suggests their genetic relationship to the nearby shore-line. The shell accumulations are within and along the coast-parallel trough between the Crusader fortress and the Roman theatre (fig. I.8). They become rarer eastward and disappear completely about 300 m east of the coast-line.

Massive occurrences of the shells within the post-Byzantine sequence support their natural marine (beach) origin. The ratio of shells to the other coarse detrital components within that sedimentary sequence is estimated to range between one quarter and one half. Such a large and dense concentration of shells may be compared with that found north of Tel Dor (Neev et al. 1973; Neev et al. 1987). At the Dor site, however, well-cemented beach-rock layers dominate the lower part of the shell-bed sequence. At present these layers are situated both above and below the high-tide level. The presence of the beach-rock facies at Dor corroborates our interpretation of the natural beach origin of the overlying uncemented part of this shell-bed sequence and thereby indirectly also supports our conclusion of a natural beach environment for the uncemented shell beds at Caesarea.

Doubts have been expressed respecting the origin of the Caesarea shell beds, and alternative mechanisms have been offered to explain their presence at such a high elevation above MSL. For example, a human mechanism was suggested by Y. Porath (personal communication) involving an Early Moslem dredging operation at the bottom of the harbour at Caesarea, following which the shells were artificially dumped along the trough of Fields C, K, and farther to the south (fig. I.8). However, such a hypothesis is not realistic, as no appreciable accumulations of shells were noted during the submarine archaeological excavations that were carried out at the bottom of the nearby Herodian harbour (A. Raban, personal communication). Another, contradictory hypothesis along the same lines states that the shells could have been artificially brought to that place as a raw material to be mixed with mortar for building purposes (A. Raban, personal communication). This possibility also should be ruled out because, in the first place, no cement was found attached to the shells in the post-Byzantine sequence. Furthermore, at equivalent sites such as the Crusader fortress of Ashqelon, disintegrated shells fell and accumulated at the foot of the southern wall. In addition, the use of shells with concrete and cement by Romans and Byzantines as a building material for house and road construction is not mentioned in the detailed review of construction techniques at Caesarea made by Vann (1983b), a review based upon examination of the archaeological material and study of relevant ancient technical authors such as Vitruvius.

The specific sedimentary facies within the 2-4 m thick post-Byzantine sedimentary sequence indicates that it was deposited and accumulated by natural

beach and swamp processes and is not the product of an instantaneous catastrophic event such as a tsunami. In other words, this coast-parallel trough was transgressed by the sea and remained submerged for a relatively long time. As a result, the environments of deposition fluctuated from open beach to lagoon and swamp. Considering the postulated vertical dimensions of that transgression (10–15 m) and its duration (several tens to a few hundred years), as well as the estimated range of eustatic sea level change during the past 1500 years (less than 1 m), we suggest that this change in the land/sea relationship is related to an oscillatory tectonic movement rather than to other factors.

The following discussion is an attempt to further clarify and decipher the nature and timing of the post-Byzantine tectonic history at Caesarea. The succession of Roman, Byzantine, and Early Moslem man-made structures was transgressed by the sea sometime during the seventh or ninth centuries. Relics of Early Moslem structures that also are interbedded within the overlying sedimentary sequence may indicate temporary regressions. Most pottery sherds in that sequence are Early Moslem in age, or seventh to ninth centuries (I. Rol, personal communication), although some medieval ones also were also noted. Coins of various ages, the youngest from Crusader times (twelfth century), were found within the sequence.

Bull and Toombs (1972) stated that the area of Field C was a cemetery during Crusader and Moslem times. Some of the Moslem graves could be dated to the Early Moslem period by the Kufic script carved on their tombstones (Y. Porath, personal communication). The ages of others may range from Early Moslem through Mameluke to Bosnian (Moslems settled by the Turks during the nineteenth century). It is surprising that no mention was made of the presence or absence of tombstones on the reported Crusader graves at Caesarea, although they are abundant at the well-preserved and organized Crusader cemetery at Athlit, 25 km north of Caesarea. Moreover, we suspect that some of the few complete human skeletons and most of the many disarticulated bones scattered within the post-Byzantine sedimentary sequence in Field C were carried to their present place of burial by the same natural aquatic processes that transported and buried the other coarse detrital components of that sequence (shells, pebbles, and rubble). In examining a complete skeleton that is horizontally interbedded within the post-Byzantine sedimentary sequence in Field C, Neev did not notice any relict features or other signs that could testify to the existence of a man-made grave, such as vertical contacts of the dug walls or vertically oriented plate-like stones that usually mark limits of graves in Moslem cemeteries. Moreover, feeble bedding was noted both above and below as well as across the horizontal limits of the complete skeleton.

Support for the above interpretation might be found in a few expressions included within three different sentences extracted from a Hebrew poem written by an anonymous author sometime between the mid-eighth and mid-tenth centuries (Zulay 1936: 158; Prof. E. Fleischer, personal communication): "Multitudes drowned violently, those dwellers in the Shefela [coastal lowlands of Israel] and in the Sharon Valley.... A current appeared..., strangers were stormed angrily.... Women and children were drowned, along with preachers of the Bible and Mishnah...." These citations may reflect a disastrous event that occurred sometime

during the Early Moslem period along the coastal belt of the Sharon Plain. Caesarea is in the northern part of that plain. Shalem (1956) considered the horrors described in the poem to be related to the earthquake and tsunami of 746. However, as explained above, the facies of sediments involved in the post-Byzantine sequence suggest that the water body from which they were deposited was not a tsunami, but had to be associated with a relatively long-term transgression of the sea. The citations also corroborate the interpretation that the skeletons and bones could have been brought to their present places of burial by transgressive currents.

The facies distribution within the lower half of the early modern sedimentary sequence (fig. I.23) represents a full sedimentary cycle that started with a high-energy environment (turbidites composed of shells and rubble) and ended with a low-energy environment (swamp deposits). This sequence implies a deepening and a shoaling of the sea or a transgression and regression caused by a tectonic oscillatory movement. The upper half of the sequence is a replica of the lower one, another cycle of shells and swamp deposits that represents a second cycle of transgression-regression or another oscillatory movement after Crusader times.

It is speculated that the peaks of these two post-Byzantine oscillatory movements could have occurred during the seventh to ninth centuries and during the fourteenth century, respectively. There are practically no Moslem documents left from the seventh to ninth centuries that testify to civil or natural activities along the coastal zone of Israel during that period (I. Rol, personal communication). Moreover, during the tenth century that region, and especially the harbours at Acco and Ashqelon, underwent an intensive phase of building and reconstruction, which is related by Frenkel (in press) to a florescence of economic and trading ties in the eastern Mediterranean. This phase also could have resulted from a time of tectonic quiet. The second period followed the intentional destruction of vital installations carried out by the Mameluke sultans Baybars and al-Ashraf along the coastal zone of Palestine as a defensive measure against another Crusader invasion (Reifenberg 1950-51). Nevertheless, two physical changes occurred after the end of the Byzantine period: formation of a great swamp just east of Caesarea, and intensification of the inland sand-dune encroachment process (Reifenberg 1950-51: 31). These changes are believed to be due to natural processes and should not be related to the man-made destructive operations along the coastal zone (see also Neev et al. 1987). Several devastating earthquakes during the same period (early fourteenth century) around the eastern Mediterranean fit well with our interpretation.

Possibly the two post-Byzantine oscillatory movements constituted a multiple type of tectonic phase through which the coastal zone tectonically fluctuated downward and upward several times. Such a scenario is analogous to two oscillatory movements along the Pacific coast of Japan during the past 100 years. That interpretation is based on the analysis of continuous tidal records (Thatcher 1985; see also Neev et al. 1987: 99), which revealed land movements that lasted 30 years and had amplitudes of 2 m. The analogy from Japan proves that oscillatory tectonic movements are not just an imaginary construct but continue to occur at present. The tectonic model suggested by Neev et al. (1987) to explain the origin and mechanism of the oscillatory type of movement also agrees with that suggested by Thatcher. The common denominator of the two tectonic models is the

downwarping of continental margins after collision with oceanic crusts (direct collision off Japan and oblique collision off Israel) and resultant isostatic uplift of the continents.

The magnitude of the post-Byzantine oscillatory movements at Caesarea had to be appreciably larger than that of the Byzantine. The total amount of displacement across the coastal fault (F_1 of fig. I.20) after the Early Roman period is about 6 m (see Introduction). The net amount of subsidence of the Herodian harbour (on the downthrown side) during the Byzantine phase is 2.5 m. Therefore the subsidence during the post-Byzantine multiple phase is 3.5 m. Nevertheless, the vertical dimension of the oscillatory movement during that phase is postulated to range between 10 and 15 m. The implied discrepancy can be bridged under the assumption that the downthrown block participated in the downward movement of the upthrown block throughout the first stage of the oscillatory movement. However, during the rebound stage the downthrown block on the way upward lagged behind the upthrown one by 3 to 3.5 m. The net amount of total displacement since Roman times therefore was 6 m (fig. I.29). Such a mechanism is somewhat more complicated than that described by Neev et al. (1987: fig. 35), but it is implied from the facts. It also agrees better with the scenario described by Thatcher (1985) for the analogous movement across the coast of Japan.

Comments on the Illustrations.

Fig. I.18. Regional map. Note the limits of the administrative districts along the coast: Carmel, Sharon, and Pleshet (Yehudah).

Fig. I.19. Index map: sites at and near Caesarea discussed in text (after Neev et al. 1978: fig. 2). Note locations of Fields C, K, L, and M, as well as the point of abrupt termination of the High and Low-Level Aqueducts.

Fig. I.20. Transverse east-west geological cross-section through the late Pliocene to Recent sedimentary sequence at Caesarea. The section extends from west of the sunken Herodian breakwater to east of the Crusader city wall (after Neev et al. 1978: fig. 10). The pre-Roman (F_2) and post-Roman (F_1) faults were identified (13 and 6 m throws, respectively) from precise age analysis of stratigraphic contacts in drilling and present elevations of the now submerged man-made structures (breakwater, floor, and sluice). By permission of Israel Journal of Earth-Sciences, Jerusalem.

Fig. I.21. The High-Level Aqueduct. A southward view from its top near the point of its abrupt termination due to the combined effects of sea abrasion and of rejuvenated tectonic movements. At that point the coastal and Or'Akiva faults cross each other. Aqueduct C (10% of the joint capacity of A + B) was built on top of Aqueduct B. Both A and B were sequentially filled with layers of rubble and cement to raise their level by 2.5 m.

Fig. I.22. The Low-Level Aqueduct. A northward view of the channel, vaulted over to avoid clogging by the encroaching sand of the coastal dunes). Photographed from a point about 200 m east of the photo station for fig. I.21. It was built in the sixth century to replace the High-Level Aqueduct (seen on the left as a coast-parallel feature) following damages caused by the Byzantine oscillatory tectonic movement.

Fig. I.23. A 2-4 m thick sedimentary sequence overlying Byzantine and early Moslem structures about 100 m east of the coast-line. The presence of massive shell lenses with nestled packing structures, as well as the interbedded swamp sediments (a lower one near the middle part of the sequence and an upper one near its top), indicates the prevalence of marine-lagoonal environments, thereby the successive occurrence of subsidence-transgression-uplift events. The Early Moslem structure within the mid-sequence swamp bed (see also fig. I.24) suggests complete desiccation of that swamp. Two successive tectonic oscillations are implied. Twelfth-century coins found within the upper part of the sequence support the post-Crusader age of the latter oscillation.

Fig. I.24. Detail of fig. I.23. Swamp sediments. Horizontal lamination within the mid-sequence swamp layer suggesting stagnant conditions.

Fig. I.25. Detail of fig. I.23. Swamp sediments. Burrowers' tunnels, indicating bioturbation or aerobic conditions in the same bed as fig. I.24.

Fig. I.26. Shell lenses within the post-Byzantine sedimentary sequence indicating a natural marine (beach) environment of deposition (see also Neev et al., 1987, p. 29-35). Nestled packing of shells.

Fig. I.27. Shell lenses within the post-Byzantine sedimentary sequence indicating a natural marine (beach) environment of deposition (see also Neev et al., 1987, p. 29-35). Dominant concave-downward orientation.

Fig. I.28. Shell lenses within the post-Byzantine sedimentary sequence indicating a natural marine (beach) environment of deposition (see also Neev et al., 1987, p. 29-35). A lenticular layer of imbricated fragmented shells and pebbles.

Fig. I.29. Sketch diagrams of the three stages of post-Byzantine tectonic oscillatory movement across the coast-line at Caesarea (south of the harbour). A. A pre-movement stage. The top of the repaired breakwater (by adding a rampart on its top) is arbitrarily marked at 2 m above MSL. The coastal fault (F_1) separates the harbour and the Roman-Byzantine/Early Moslem city. B. A post-subsidence stage. Both the upthrown and the downthrown blocks subsided 10-15 m. A berm-like sand body accumulated on top of the Roman-Byzantine coastal structures, whereas lagoonal sediments were deposited along the trough farther east. Mostly sand and debris accumulated off shore, on top of the downthrown side of the fault. C. A post-rebound movement stage. Both the upthrown and downthrown blocks were uplifted tectonically again; the first one returned to its pre-subsidence structural elevation, whereas the downthrown block lagged and stabilized 3.5 m below its pre-oscillatory movement structural elevation.

[D.N., K.O.E.]

I.A. Natural Features: 3. Tectonics and Sea Levels.

Introduction. During the winter of 1976, while studying the archaeological evidence for coastal tectonic movements and eustatic sea level changes in Israel, I visited about 35 sites on the coast, and compiled data on over 60.[2] Since many

[2] I am deeply indebted to the University of Haifa, the Department of the History of Maritime Civilisations, and particularly to Elisha Linder, for enabling me to

sites contained more than one datable archaeological horizon, the potential number of sites available to the study was 139. However, since many sites had not yet been excavated, or the levels were not conveniently close to the water-line, quantitative data relating to the sea level was only obtained at 42 datable levels located at 25 different sites. During January 1976 I was involved with Avner Raban and Stephen Breitstein in drafting the work programme for the research on sea level changes later carried out for the IEC (a revised version is presented here in Section II.B.2). The survey ultimatedly carried out was reliable and impartial, and the mapping and reporting of the data very thorough. Nevertheless, the deductions in this report concerning changes in sea level were made purely from the point of view of the archaeological evidence, without any speculation as to cause. The purpose of the present note is to comment on the possible implications of the data from Caesarea, and to relate these to the broader picture obtained by less detailed surveys at many other sites. The argument will be developed by discussing (a) the distribution of recent tectonics and eustatic changes in the Mediterranean, (b) the nature of archaeological evidence on the Mediterranean coast of Israel, and (c) the data gathered by the CMS at Caesarea.

The Mediterranean Context. The shore of the Mediterranean is tectonically unstable due to the continuing relative plate motions between Africa and Eurasia. The degree of vertical tectonic movement at a point on the coast is closely related to the distance of that point from zones of crustal convergence or subduction. Since the principal plate margin extends along the coast of Algeria, through Sicily and Italy and then passes via multiple smaller plate boundaries in the Aegean, Turkey, and near Cyprus, these are the regions of maximum vertical movement. Plate boundaries in the region of Sinai, the Levant Sea, and the Mediterranean coast of Israel are still a subject of uncertainty. No attempt will be made in this paper to discuss the position of such boundaries.

Any opinions concerning vertical tectonic movements must also take into account the possible eustatic movements of sea level over the same period. Since land movements due to tectonic, isostatic, or hydro-isostatic causes can be of a very broad nature, with uniform components extending over hundreds or thousands of kilometres, it is not generally possible to take a sea level curve from one part of the world and apply it to another region with an accuracy of better than a metre or so. Certainly any proposed "world eustatic sea level curve" for the last 5,000 years would have to be regarded as the average of an enormous variety of unknown errors as soon as one tries to define it with an accuracy of better than ±1 m. Thus the only valid approach is to assume that, over an area of study, the component of relative vertical movements which is uniformly time-dependent and synchronous at every site, is the eustatic factor. The components of relative vertical movement at each site which are location-dependent should then be of tectonic, isostatic, or compaction origin. In the last analysis, however, it must be borne in mind that the synchronous component over several hundred kilometres

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visit Israel between October 1975 and February 1976 in order to study archaeological sites on the shore-line. This discussion would have been impossible without the experience gained during this visit. I am also deeply indebted to Avner Raban and other members of this department, and former members of the IUES for sharing with me during that visit the results of their detailed fieldwork at Caesarea and other sites. Without their assistance my research would have been very difficult.

may itself be partly of tectonic or isostatic origin.

Applying these principles to the Mediterranean, a curve representing the uniform component at all known archaeological sites (about 300) for which sea level data have been determined can be derived. Because of the relatively small number of data points in any one region in any one time period, the curve has to be smoothed to give oscillations with a period of 500-1,000 years. The resulting curve indicates that the "eustatic" curve so-generated does not depart from present sea level by more than 0.5 metres at any time in the last 4,000 years. In contrast, there is considerable evidence that the eustatic sea level probably departed occasionally as much as 1-2 m from the present sea level for periods of a few hundred years. To be sure, it is very difficult to obtain sufficient data from every century and every coastal area to construct a statistically sound curve at this level of detail.

The areas far removed from plate boundaries, Eastern Spain, Southern France, the Gulf of Sidra, most of Cyrenaica, the south coast of Turkey from Antalya to Iskenderun, and Northern Cyprus, show no vertical displacement relative to present sea level greater than 0.5 m, smoothed to a 500 year periodicity, over the last 2-4,000 years. Certain areas of deltaic compaction or isostatic loading are of course local exceptions. In the active areas of plate boundary movement and/or volcanism, vertical movements appear to be of the order of 10% of the rate of horizontal convergence. That is, horizontal convergence is of the order of 0.02 m/year, while vertical earth movements are of the order of 0.002 m/year. Vertical earth movements are probably associated with transverse faults such as the Anatolian fault in Northern Turkey, but insufficient data are available on this area.

Vertical movements may be up or down, depending on the response of the regional geological structure to the compression, foreshortening, or subduction produced by plate convergence. In the South Aegean area the crust seems to respond as more or less rigid tilting blocks, with typical horizontal dimensions of about 150 x 75 km. The most rapid rate of movement detected so far is uplift of the southwest corner of Crete at a rate of 4.9 m/thousand years, with intermittent movements at approximately every 150 years. There is some evidence, though unchecked, that parts of the Albanian coast may be uplifted at the same rate. This rate is comparable with figures from the Indonesian arc, and Taiwan, where rates of the order of 10 m/thousand years have been reported. There is no evidence anywhere from the parts of the Mediterranean coast which have so far been examined for rates of movement as high as 10 m/thousand years, nor for single seismic events of the magnitude of recent events in Alaska. Historical investigations of reports of earthquakes by N.N. Ambraseys suggest that the seismicity of the Eastern Mediterranean has varied slightly about a mean level of activity very similar to that observed at present. The variation seems to be regional, with alternation between regions, rather than a large scale change of total seismicity.

Thus any consideration of the tectonic stability or instability of the Mediterranean coast of Israel should be carried out in this context. Although the presence of plate boundaries off shore has not yet been clearly documented, the nearness of the Dead Sea Rift suggests that the coast must be considered as a potentially active zone. On this basis alone, we should be prepared to find evidence of verti-

cal changes of the order of 2.0 m per millenium at some sites, either up or down. Many sites should be displaced by about 0.5 m, and one or two perhaps by as much as 3-5.0 m. Discussion of stability or instability should be seen as relative to this type of activity on a coast which is within 100 km or so of a plate boundary which may contain a component of convergent or divergent movement. In addition, the zone of intersection of the Haifa-Qishon Graben with the coast would be expected to be an area of higher activity than the average for the coast as a whole.

Nature of Archaeological Evidence on the Mediterranean Coast of Israel. Archaeological remains of tells, houses, roads, and harbour constructions occur all along the Mediterranean coast of Israel. The earliest remains are house walls and artefacts from the Neolithic and Chalcolithic periods, about 7,000-3,000 B.C. These remains date from a period when the world sea level was still rising after the last Ice Age, and therefore may be found several metres underwater without necessarily implying any tectonic activity. Although rafts or canoes were certainly used in this period, there is no evidence at all for any coastal structures or harbours, and all the known remains must be presumed to have been houses on dry land, some distance back from the original water-line.

For the Bronze Age period, 3,000-1,200 B.C., there are 32 tells close to the shore. The remarkable point about this distribution is that there are so many tells on the present water-line, but no evidence of any tell being significantly submerged, or even highly eroded. Where a tell is on a sharp promontory, such as Yavne Yam or Tell Nami, there has been some erosion around the cliffs of the promontory, but nowhere do we find the remains of a tell submerged by 5 m or rising as an eroded island 100 m off shore. At most Bronze Age sites, e.g. Nahariya, Tell Michal, or Tell Ridan, there is not enough evidence to establish the original sea level within ±2.0 metres, but within this limit it seems broadly true that the present shore-line must be very close, both vertically and horizontally, to its location in the Bronze Age. The only exception to this generalisation is for the region between Mikhmoret and Yavne Yam, for which there are practically no data. In view of the high cliffs on this part of the coast, it seems reasonaable to suppose that there has been considerable erosion. A few Bronze Age sites, such as Athlit and Tell Nami, provide sea level indications with an accuracy better than ±1.0 m. In the statistical analysis that follows, the Bronze Age sites in general are treated as having an error of ±1.0 m, but it must be understood that the range of error is probably ±2 m at many sites. For all later periods there is the evidence of harbour structures, fish tanks, and buildings close to the water, and some of these provide estimates of relative sea level change to an accuracy of ±0.20 m.

The data from the sites for which there were accurate dates and indications of sea level were summarised and analyzed to show the frequency of vertical displacement of different magnitudes and the distribution of the sites of different magnitudes of displacement along the coast. This analysis ignored the larger amplitude of movement now presumed to have occurred at Dor (see below), and the full range of movement now presumed to have occurred at Caesarea. The evidence obtained from all the sites has to be interpreted on the assumption that there have been eustatic oscillations of the order of ±1.0 m as well as tectonic movements during the last 4,000 years. A rigorous statistical solution of this problem is being carried out, but an approximatee solution, ignoring short-term eustas-

tic changes in the last 4,000 years (periods of less than a few hundred years) can already be presented. It must be stressed that all the data obtained refer strictly to the near shore zone (within ±100 m horizontally of the present water-line), and that no implications can be deduced from this with absolute certainty for points further inland or off shore. This is due to the extremely linear nature of the coast, which makes it impossible to construct contoured surfaces with any gradation or trends in the East-West direction.

Probability histograms of the error of the displacement estimate for each site and datable accurate level were constructed. The resulting data include the evidence for submergence at Caesarea and uplift at Dor. Sites were plotted on a kilometre grid from Tell Ridam to Rosh Haniqra. For each chronological period, the sites were plotted linearly along the coast, showing the upper and lower limits of the probability estimate for the original level of the site relative to present sea level. The cumulative data for each time zone were summed up to show the range, mean, and mode of all the estimates. The cumulative data for the Crusader and Roman periods were bimodal, in both cases due to the subsidence at Caesarea. This display of the data showed clearly a close correlation of ancient and modern sea level (to within ±1.0 m) for the great majority of sites after the Early Bronze Age. Although there are small relative displacements between sites of the same age, these are, with the exception of Akko, Dor and Caesarea, all less than 1.0 m. Thus the coast as a whole appears to be considerably more stable than predicted above. The instability from Caesarea to Akko will be discussed below.

The mean or mode of the level of all sites of the same period may be taken as the best available estimate of the eustatic sea level at that time. The accumulated data for each time zone were plotted as a time series. The mean, mode and vertical range of error of two standard deviations were plotted at the centre of each time zone. The sites for which particularly accurate observations of sea level could be made have had their readings corrected for the state of the tide at the time of observation.

The Neolithic and Chalcolithic sites studied were not necessarily originally founded on the coast, but they do indicate that the relative sea level must have been lower than the sites at that date. Typical estimates for the eustatic sea level at 8,000 B.C. are about -50 m, and -10 m at 5,000 B.C. Consequently, the most probable sea level curve for Israel is far below the early sites located in this study. Shore-line sites of the Neolithic probably were located on the kurkar ridges now off shore and submerged. It is generally assumed that the world eustatic sea level reached to within 1 m of its present geoid at about 3,000 B.C. Thus the Early Bronze Age data and the data for all subsequent periods should reveal the fine structure of both tectonic and eustatic changes. From the Early Bronze Age onwards there is no marked trend, except that the mean level of sites, including probability weightings, is consistently 0.5-1.0 m below present sea level, while in six of the eight periods for which data exist the modal number of sites actually plots on present sea level. The consistent discrepancy between the mean and mode is probably due to the fact that it is much easier to detect a slight submergence than a slight uplift. A significant number of sites identified as zero displacement probably should be classified as having an uplift of 0.2-0.4 m. This would raise the value of the mean towards present sea level, while scarcely alter-

ing the mode. This observation is valid, notwithstanding the fact that there are a number of slightly submerged sites (at depths of around 0.5 m) between Akko and Rosh Haniqra.

Overall, there is a slight statistical indication that the relative sea level on the Mediterranean coast of Israel has been 0.5 m lower throughout most of the last 4,000 years. This may be due to either eustatic or tectonic causes. If tectonic, it would imply a subsidence of the land by 0.5 m in the last 1,000 years, with stability for the preceding 3,000 years, which seems unlikely. In discussing the secondary implications of relative vertical displacements of the order of 0.5 m, the only general conclusion that can be drawn is that the coast has within this limit been remarkably stable for 4,000 years, with the exception of the zone from Caesarea to Akko.

Three anomalous sites disturb the simple picture presented above, and it is notable that the only clearly demonstrated vertical movements of 1.0 m or more are from Caesarea to Akko inclusive. These movements are all within the 50 km stretch of coast from 15 km north of Cape Carmel to 35 km south. This association of maximum vertical disturbance with the Carmel-Qishon Graben may be thought predictable, but the peculiar fact is that subsidence is not found for the archaeological sites on the alluvium within the graben, that is from Haifa to the Neaman. Nor is uplift found on either side of the graben. The subsidence observed at Akko may be due to its closeness to the graben axis, or to the strain-release phenomena between events of seismic uplift. Such alternations of uplift and subsidence may perhaps be correlated with the fact that Crusader materials at Akko appear to be submerged more than Phoenician.

However, the events south of the Carmel appear to be considerably more active than those to the north, although Athlit seems almost completely stable. The somewhat surprising picture is thus that the southern margin of the Qishon Graben itself and the Carmel Massif both appear to be stable, while vertical displacement is manifested vigorously only at Dor and Caesarea. The evidence from Dor is difficult to interpret, but suggests subsidence of the order of 1.25 m sometime between 100 B.C. and 100 A.D., followed by uplift of about 1.0 m. Again, reversal of movements of this kind are compatible with intermittent seismic and aseismic events on active faults.

Analysis of the data from Caesarea. Caesarea itself is the most complex site. Prior to 1975, a number of surveys had produced contradictory conclusions proposing that the site was either undisplaced, submerged by as much as 10 m, or even uplifted. Although Elisha Linder, Avner Raban, and other members of the IUES and CMS certainly had more experience with the site than any other group, they were unable to undertake a consistent survey of sufficient detail to provide a unifying explanation for the conflicting observations until commissioned by the IEC to provide such information. The data presented in this report effectively resolved most of the outstanding problems, and the following notes are a commentary on it. For a full description of the features mentioned here, see the revised version of the report in Section II.B.3 and the relevant sections of the description of the CAHEP research (location map: fig. III.1, pl. I).

The Piscina (fish tank) at the south end of the site (CAHEP Area P, Section III.M), surveyed by the present writer assisted by students from the Department of the History of Maritime Civilisations at the University of Haifa, indicates a very close correlation with present sea level. Due to tidal and seasonal cycles of local sea level, vertical rock surfaces are likely to be dissolved into two solution notches approximately 0.15 m above and below MSL. There are groups of notches around the Piscina up to a height of 0.40 m above present MSL, suggesting a possible uplift of 0.15-0.25 m since Roman times.

The large Sluice cut into the rock west of the Crusadel Citadel (CAHEP Area Q, Section III.O) correlates with modern sea level to within ±0.5 m, also indicating an almost unchanged relative sea level since Roman times. The levels of the Crusader Column Jetty and the Roman Quay at the north of the Intermediate Basin (CAHEP Area L, Section III.K), and the slope of the sewer outlet north of the city and of the aqueducts (Section I.B.8), all indicate minimal change of sea level (to within ±0.5 m). In spite of the frequent repairs to the aqueducts, their precise gradients seem to indicate no net change of the shore-line relative to the water sources since their construction (but see the discussion in Section I.A.2).

The only discrepancy with these indications of the stability of the shore line is the Crusader wall lying in 1-2 m of water at the back of the modern harbour basin (CAHEP Area T_2, Section II.R.2). This wall was examined very briefly by the present author in July 1974, who at that time suggested that the character of the site indicated multiple movements. Recent investigations have shown that this wall slopes from a depth of about 0.6-0.7 m at its northern end to about 1.5 m at the southern end. The courses of stonework also are curved along the slope. This implies some form of local compaction or slumping which may account for the subsidence of this wall in relation to the nearby shore-line indicators which are not displaced.

There is a Sunken Pavement (CAHEP Area F, Section III.E) that consists of a regular course of blocks on a gravel foundation, with the upper surface at a depth of 4.9 m. Whether this structure was intended as a dry working surface adjacent to the water, or the floor of a flooded tank, it appears to have been built within ±0.5 m of the ancient sea level, which would then have been between 4.4-5.4 m below present MSL.

There are several long stretches of large kurkar blocks arranged as headers, possibly the framing wall of the Herodian quay along the inside of the Southern Breakwater (CAHEP Areas A, B, C, Section III.B). This quay was probably built with its foundations in the water, but since its lowest courses are at least as deep as 6.4 m, this is consistent with a relative change of land-sea level of the order of -4 to -5 m. If the stone-gravel contact is at the original footing of the quay, then the ancient sea level must have been about 3-4 m below the present one, in order to allow ships to dock alongside. If the stone-gravel contact is the foundation of a road or floor close to the water, then the sea level must have been about 5 m lower than at present.

At the site of CAHEP's Area A there are rows of blocks in a header arrangment, probably *in situ*, with their foundations at a depth of 5.4-5.8 m, and a pavement nearby at about 3.8-4.2 m. The pavement surface may have subsided from a

higher level. Taken together, these two features provide a bracket from upper surface of quay to footing of quay wall (both presumed) of only 1.2 to 2.0 m. This is the absolute bare minimum depth that would have allowed vessels to dock and unload, and would imply a sea level at 4.8 m below the present one. However, if it is presumed that the upper pavement has suffered local subsidence, then the ancient sea level would have been 4.0-4.5 m lower than at present.

Conclusions. The original suspicion that the site of Caesarea contained sea level indicators resulting from multiple movements has been amply confirmed. The discontinuity on either side of an approximately north-south line about 150 m off shore is demonstrated by the data gathered by the CMS and CAHEP. The nature of this discontinuity is unknown, but to the shoreward of it most indicators are within 0.5 m of present sea level, while seaward of it, indicators are all compatible with a sea level at 4.5-5.0 m below present MSL. The relative submergence of the off shore segment of the harbour could be attributed to any one of the following causes:

(1) compaction or slumping of unconsolidated material, either under normal conditions, or due to the fluidisation of some underlying bed in an earthquake;
(2) differential subsidence due to the fact that the inner part of the city is built on the kurkar bed-rock while the outer part is built on unconsolidated sediments;
(3) presence of a local fault intersecting the site;
(4) presence of a major fault parallel to the coast intersecting the site.

Cause (1) is unlikely to operate in normal undisturbed conditions on account of the extremely low gradient of the sea floor. On the other hand, the disturbance or fluidisation of some bed of sand or clay in an earthquake is not so unlikely. On the assumption that the Crusader wall in Area T_2 is also built into the harbour basin where kurkar is absent, subsidence there may have been caused by a similar event at a later date. Such a mechanism is purely speculative, and would have to be verified by detailed evidence concerning the underlying beds, perhaps on the basis of bore holes.

Whatever the basic reason for subsidence, it is possible that the structures on kurkar bed-rock have subsided less than those on unconsolidated material. A phenomenon noted above as cause (2). This is only likely to have occurred if the clay or soft layers are not so deep as to underlie the kurkar also. Again, checking with bore holes would indicate whether this hypothesis is reasonable.

Causes (3) and (4) are the kind of proposals that arouse suspicion, since it seems inherently improbable that any particular outcrop of a fault plain should intersect such a small area as a particular city. However, the archaeological and geological data have demonstrated that there is a discontinuity across the site, so such an explanation becomes possible. Several features, however, make it difficult to give a clear answer. The subsidence of the Crusader wall in Area T_2 clearly indicates at least two phases of movement: the first to submerge the Southern Breakwater by a certain amount before the third to fourth centuries A.D., the second to submerge the Crusader wall sometime after the eleventh century. These two (or more) movements could be successive movements on the same non-planar fault surface, distinct movements on two quite different fault surfaces which are close together or intersecting, or the results of successive movements on two or more intersecting fault surfaces which were all activated on each occasion. In any case, the lack of damage to the aqueducts, and the precise adjustment to present sea level of the Piscina, seem to preclude any large scale vertical movement of the shore-line followed by return to the present sea level. It would be quite compatible with the present evidence for one fault of such a system to intersect the coast-line at quite a steep angle. Although earthquakes and faulting may have been the trigger for subsidence, it is still attractive to postulate such a process in association with the points made in 1 and 2 above.

Cause (4) suggesting the presence of a major north-south fault along the shore-line is not supported by the statistical evidence from other archaeological sites. The evidence suggests that Caesarea is an exceptional site on the coast of Israel in terms of its magnitude of vertical displacement. If it is proposed that a coastal fault or system of faults is present in the off shore zone, then other evidence must be produced, since the archaeological evidence is not applicable except right on the shore-line. That is to say, the archaeological evidence in general neither confirms nor denies an off shore fault; it is simply irrelevant. Only in the case of Caesarea is there archaeological evidence for a vertical discontinuity at about 150 m off shore, and that discontinuity of 4.5-50 m may or may not be due to faulting.

Summary. The author concludes that there is no archaeological evidence for vertical tectonic movements of more than 2-3 m anywhere on the present Mediterranean shore-line of Israel within a distance of 100 m or so on shore and off shore, within the last 4,000 years. However, at Caesarea there is ample evidence that there has been subsidence of the order of 5 m since the late first century B.C., off shore of a line which is approximately 150 m from the present shore. The shore-line at Caesarea is itself undisplaced. At many sites within 40 km of the Qishon Graben there is evidence of irregular vertical movements of the order of 0.5 m during the last 3,000 years, and evidence for submergence of 2 m at Akko in the last 1,000 years.

[N.C.F.]

I.A. Natural Features: 4. Beaches and Dunes.

> Now the city is located in Phoenicia, on the sea-route to Egypt between Joppa and Dora. These are small towns on the sea-shore and are poor harbours because *the southwest wind beats on them and always dredges sand from the sea upon the shore*, and thus does not permit a smooth landing. (Josephus *AJ* 15.333)

The Caesarea beaches are located on the northern section of the central Israeli Mediterranean coast, and belong to the edge of the Nile littoral cell.[3] This cell extends from the two outlets of the Nile River at Rosetta (Rashid) and Damietta (Dumyat) to the Sinai and Israeli coasts up to Akko (Acre), a total distance of about 650 km (Emery & Neev 1960; Shukri & Philip 1960; Nir 1980; Inman &

3 I would like to thank Miss Karen B. Levine and Miss C. Gotessman for the critical reading of the manuscript, and Dr. Avner Raban for discussions on sand supply to the Israeli beaches.

Jenkins 1984). The principal load of the Nile water averages 120-160 ton/yr and is composed mainly of fine sediments: silts and clays, with a coarse fraction (i.e. sand sizes) estimated by Nir (1984) to be on the order of only 2%-10%, whereas Simaika (1970) gives a much higher figure (30%) for the coarse fraction content. Nir (1984) estimates that, of this sand, approximately 70% is deposited off the shores of the delta, some 20% or more is deposited off Sinai, and only 5-10% reaches Israel (350-700,000 m^3/year). Because of the change in the direction of the shore-line, there is a very pronounced decrease in the longshore sand transport from south to north. In Hadera and Caesarea, where the main wave-fronts are almost parallel to the shore-line, the estimated northerly net transport of sand is only 80,000-100,000 m^3/year (Sauzy et al. 1974; Manoujian & Migniot 1975; Inman & Jenkins 1984). Additional sand is derived from the nearby eroded kurkar cliffs which supply about 50,000 m^3/year for the entire 110 km stretch of coastal cliff (Nir 1973). Sand supply from local sources such as rivers ("wadis") is very limited, since the Israeli hinterland of the Mediterranean watershed is composed mostly of carbonates such as limestones and dolomites, whereas some sandstones are found in the southern watershed of the Mediterranean. These rivers in general transport fine sediment: mostly eroded soils which are deposited in the deep sea.

The sands derived from the Nile are composed primarily of quartz accompanied by minute quantities of heavy minerals. These sands are characterized by very low carbonate content (Emery & Neev 1960; Shukri & Philip 1960; Nir 1973, 1982b, 1985). Most of the calcium carbonate found in the marine, beach and dune sediments originates from local sources: broken shell material is found in the shelf and beach sediments, while the dunes also contain shells of land snails (mostly *Helicella* sp.). The mean grain size of the Caesarea beaches is less than 200 μ (fine-grained sand; Emery & Neev 1960; Nir 1985) and so is given to easy transport by the wind.

Sand Dunes. The coasts of the Nile littoral cell are characterized by dune-sand fields quite significant in size: those of the northern Delta, northern Sinai, and Israel. The largest of these is the northern Sinai sand field covering about 9000 km^2 (Nir 1984). Israel has only 360 km^2 of coastal sand dunes, concentrated along the Gaza and Pleshet plains (fig. I.30). The Israeli sand field is directly connected to the huge northern Sinai sand fields and is divided into smaller sections by the different river outlets to the sea. North of Tel Aviv, where the coastal kurkar cliff blocks the sand from eastward aeolian transport, the dune fields are smaller, less spread out, and are isolated from each other by the local kurkar ridges. The most northern sand field belonging to the Nile littoral cell is found at Haifa Bay and acts as a "sink" for the "extra" sands reaching the edge of this littoral system.

Most of these sand fields are connected to river mouths which form a gap in the coastal kurkar cliff, thus enabling the sand to be blown inland from temporary accumulations on the beaches, or to be blown backwards from the dunes to the beach.

The Caesarea dune-sand field (figs. I.30-31) is found SSW of Mount Carmel and is the largest found north of Tel Aviv, covering an area of about 20 km^2. This figure does not include areas presently used for agriculture or covered with natural

vegetation, all of which are surrounded by the dunes. The southern section of the dunes stretches about 6 km inland from the present shore-line, where there is quite a bit of sand accumulation as compared to the northern section, which only extends 2-3 km inland. Its advancement here was blocked by the course of the Nahal 'Ada and perhaps by the High-Level Aqueduct. This aqueduct was periodically covered by sand during its 2000 year history, therefore acting as an obstacle to the eastward sand transport (A. Raban, personal communication). The Caesarea sand field is far larger than the Poleg sand field 25 km to the south, which covers only about 6 km^2. The Caesarea sand field was studied for its economic potential by Shiloni and Shahar (1964), Shiloni and Bogoch (1971) and Sudri et al. (1973), who estimate the entire sand volume to be in the order of 60 million m^3.

Although the breakwaters of the great Herodian harbour that protrude some 450 m from the original shore-line are located where the net northerly longshore transport is relatively small, they are considered to have had an enormous effect on both sand transport and coastal erosion. There is no doubt that the huge structure dammed the northerly transport of sand, thus causing the accumulation south of the harbour of sand which was then wind-blown inland, forming or adding to the large Caesarea sand field. North of the harbour, the combination of sand deficit and wave diffraction energy from the edges of the breakwaters caused enormous coastal erosion and damage. One such example is the destruction of a section of the southern end of the High-Level Aqueduct (Inman 1974; Nir 1981, 1985).

History of the Caesarea Dune Field. The enormous quantity of sand found in the Caesarea sand field (ca. 60 million m^3) results from two separate processes, one natural and the other artificial. In the first place, the natural topography fosters the situation. The Caesarea region is located north of the 110 km long coastal kurkar cliff of the Sharon, a cliff that acts as a natural barrier to eastward (i.e., inland) aeolian sand transport. Because of the region's relatively low relief, there is the potential for easy sand transport to and from the hinterland.

Out of the annual average net of about 110,000 m^3 of sand that is wind-blown onto the sand dunes of Israel from her Mediterranean beaches (Nir, forthcoming), an average of about 10,000 m^3 of sand has been deposited in the Caesarea dune fields annually over the last 6000 years. This deposition probably started after the sea reached its current level and the shore-line stabilized at its present location. According to field evidence elsewhere along the coastal plain of Israel, there have been periods varying between extremely low to very high sand accumulation in the dunes, indicating periods of a low rate of supply from the Nile River (Neev et al. 1978). Another reason for these differences in sand supply to the dunes might be a result of the long range changes in seasonal weather that result in higher or lower potential wave-energy for the net northerly longshore sand transport. As a result, varying volumes of sand were transported along the shore, interfering with the "aquatic equilibrium" of the coastal sand on the shallow shelf and its "aeolian equilibrium" in the dune fields. The possibility of sand transport from the dunes to the beaches and to the shallow shelf, in this region by the local easterly winds (the famous, very strong *Sharqiyas*), might also result in a non-uniform system of sand deposition, reflected later as sedimentary "pulses."

Secondly, the artificial accumulation of sands is a result of the blockage of the northerly longshore sand transport by the main breakwater of Herod's harbour. The tectonic subsidence of the harbour that had probably begun by at least the third century was in the order of 4-5 m (Raban et al. 1976). This phenomenon probably decreased the effect of the damming to a certain degree, but there is no doubt that even the submerged breakwater played a major role in the damming of sands in later historical periods.

Various historical sources reflect and describe the topographical conditions around Caesarea. The Caesarea sand fields were already mentioned in the *Talmud* (fourth to fifth century): "...and Caesarea, the daughter of Edom which sits in the sands" (*Megila*, 6a). Mukaddasi (1886: 174), in his detailed description of Palestine at the end of the tenth century, praises Caesarea and its various products, mentioning among other things that while in that region they travelled "...over the sand that is of the kind aforesaid, called Mekkah sand." Albert of Aachen (1879: 460; Hazard 1975), travelling in the region at the end of the eleventh century, describes the marsh found to the north of the city. Porat (1975) describes medieval Caesarea's gardens, located south of the city. They were dug into the sand almost to ground-water level in the ninth to tenth centuries, and later, during the mid-thirteenth century they were deserted and gradually covered by sand blown in from the nearby beaches. William of Tyre in the twelth century describes the high quality of Caesarea's sand as a raw material famous in the clear-glass industry (Ashkenasi 1931). According to Nir (1981, 1985), the sand dunes already partially covered sections of the High-Level Aqueduct near the shore during its operational period (i.e., not later than 1264). Later Pococke (1745: 451), in describing the two aqueducts, reports: "This aqueduct, as well as the other, is almost buried in the sand." The Napoleonic missions' maps of the Near East (Jacotin 1822), though not particularly detailed for this region, show some sand and some schematic plots of the agricultural areas east of the ruined city.

Aerial photographs of the mid-1940's show that the central part of the Caesarea dune field was covered by quite dense vegetation, both natural and cultivated. According to recent historical sources, there have been large cultivated areas around Caesarea, including both sand dune agriculture of *mawasi* type (fig. I.32) using the shallow ground-water table, and agriculture dependent on an outside water source supplied by the aqueducts.

There can be no doubt that in the post-destruction period (i.e., mainly after 1264; Rim 1949, 1950-1; Reifenberg 1950), the main dune body gradually expanded to cover large parts of the cultivated regions. Aerial photographs of this region show the barren areas of the southwest, east, and northwest sections of this sand field. It appears as if the dunes in the southwest and east regions are relatively young and were deposited on the old cultivated regions to the SW, and on the kurkar and *hamra* terrain in the eastern sector.

Summary. The Caesarea barchanoid sand field is the largest coastal sand body found north of Tel Aviv, covering an area of 20 km^2. The sand originates from the load of sediments brought by the Nile, and then transported from the Nile delta beaches to the Israeli beaches by means of waves and wave-induced longshore currents. The sand field existed already in historical periods, and there is no doubt

that Caesarea Maritima was constructed at least in part on a sand field. It seems that during the periods when Caesarea was inhabited, the advancement of the sand dunes was controlled, while in periods of desolation these dunes advanced freely and gradually covered both agricultural and metropolitan areas.

The main breakwater of the Herodian harbour played a role in the blocking of the northerly longshore sand transport, thereby increasing the free sand available for beach-building south of the harbour. This sand was later carried inland by the prevailing winds. The northern side of the harbour, in contrast, suffered from sand starvation, and the coast and its installations were damaged by erosion of the beach. The most obvious example is the southern tip of the High-Level Aqueduct, which needed permanent protection and/or repairs.

There is no doubt that the environment of Caesarea, its harbour, gardens, water-supply systems and other installations, were all affected by this sand field, both before and after the city's destruction.

[Y.N.]

I. The Site: B. Man-Made Features.

The following survey provides a brief description of all major architectural remains, plus others which were seen and reported by early visitors to the site but now no longer exist. This section also includes mention of many fragmentary structures both on land and underwater that have been excavated within the past thirty years, although a more comprehensive review of the early expeditions will be summarized elsewhere (Chap. II). Finally, mention is made of other buildings known from literary or epigraphic references which, as yet, remain undiscovered.

I.B. Man-Made Features: 1. Straton's Tower.

The earliest settlement on the site was Straton's Tower, established by the king of Sidon as one of a series of trade stations and anchorages along the Levantine coast (fig. I.2). The exact location and configuration of this first town have remained an enigma, but several discoveries during the past thirty years have shed some light on the problem (see esp. Holum et al. 1988: 25-54). In 1956 Avi-Yonah opened a trench approximately 100 m south of the two round towers of the inner fortification wall (Avi-Yonah 1956a: 260) (figs. I.8, no. 17, I.35-36). Hellenistic pottery was recovered, but not within an architectural context. Six years later Avi-Yonah returned with Negev to excavate five areas, three of which produced Hellenistic pottery. In the case of stratum 1 of Area A, the ceramic evidence was found in association with fragmentary wall remains (Avi-Yonah & Negev 1963a: 146-8). Area D, a massive trench measuring 10 x 50 m, revealed the corner of a large Hellenistic house. The datable material suggested that this structure was abandoned in the second century B.C., perhaps after the conquest of Alexander Jannaeus.

The area of the early harbor was first excavated by Negev at the base of a massive platform within the Crusader fortifications (Negev 1961: 81-3) (pl. I, no.

20-24). Digging at the foot of a long north-south wall uncovered in that previous campaign, the Center for Maritime Studies uncovered a horizontal erosion notch and associated marine incrustation, confirming the location of the Inner Harbor (Raban et al. 1976: 36-38). The lower levels were occupied by buildings of post-Herodian date, suggesting that only in a later period had this portion of the harbor been silted in, making space available for new construction. Continued excavations in the same location (Area I_1) by CAHEP during the 1983 and 1984 seasons uncovered a mooring stone in situ (Raban 1983: 263; Hohlfelder 1988: 8-10; Section III.H.1).

Another architectural feature associated with this harbor is the Round Tower (CAHEP's Area T; Section III.R) located by CMS divers in 1976 (Raban & Linder 1976: 241-3). The base, 13 m in diameter, at present located 20 m offshore in about 1.5 m of water, is similar in size to the two round towers of the inner fortification circuit at Caesarea (see below) and to securely dated Hellenistic towers at Samaria (Crowfoot 1942: 24-27) and Tel Akko (Dothan 1976: 40-1). The tower may have been a lighthouse and guard tower that overlooked the harbor entrance to the south and enclosed the basin of a typical Hellenistic *limēn kleistos* (fortified harbor) (Lehmann-Hartleben 1923: 65-74; Blackman 1982: 194-96).

A second harbor or anchorage has been located in excavations by CAHEP in Area J, 400 m north of the first harbor, between the much later concrete sea walls and synagogue remains (Section III.I). Blocks at the water-line set in a header pattern are probably part of a loading dock similar to those of Phoenician date at Athlit and Akko. This feature is assumed to be of Hellenistic date, based upon the discovery there of the greatest concentration of pottery from the third to second centuries B.C. yet found at the site. The large number of cigar-shaped jars associated with the storage and shipping of pickled fish uncovered in Area J suggested commercial or industrial activity.

There is no reference in Josephus to fortification walls for either Straton's Tower or Caesarea, yet we know of their existence during the Hellenistic period through Rabbinic sources (Levine 1975a: 11) and assume that, although the city is described by Josephus as being in a dilapidated state (*BJ* 1.408), earlier walls could have been repaired and employed by Herod for a portion of his new city. The twin towers and their associated inner circuit of fortification walls mentioned above have been dated to various periods by the scholars working at the site (see discussion, Sections II.A.5, H.3, R.1). In the late 1950's and early 1960's Italian excavators reported glass, pottery, and coins dating to the first century B.C. and cited architectural parallels to support their suggestion that the circuit walls and towers were Herodian (Frova et al. 1965: 251-2, 282ff.). Levine, on the other hand, pointed out several problems with the attribution and suggested an earlier, Hellenistic date (Levine 1975a: 10-11). The two towers, 12 m in diameter and 14 m apart, are of a perfect size and in the correct position to have formed a city gate (fig. I.35). Virtually the same dimensions appear on the round tower framing the west gate of Samaria (Crowfoot 1942-58: 40). Levine continued by pointing out that the plan of the towers and the indented trace pattern mentioned by Philo of Byzantium (Winter 1971: 116-19), were common features in fourth and third-century B.C. fortifications. Finally, he argued, if the circuit was of Herodian date, it defined a very small city and left certain major structures, notably the

theatre and amphitheatre, outside the city. Subsequent excavations near the polygonal tower and stretch of wall to the east have led the Joint Expedition to support the earlier, Herodian date. The basis is a stratified deposit of pottery from the east (exterior) side of the city wall (Blakely 1984). The CAHEP excavators, on the other hand, maintain that all three round towers were part of the same Hellenistic fortification system, probably reused by Herod during his building campaign.

An additional stretch of that Hellenistic wall has been identified in CAHEP's Area I_3 (figs. III.82-84). The largest of a series of vaults -- discussed below as part of the massive Herodian Temple Platform (Section II.H.3) -- was investigated in 1984 and clearly demonstrated to have been built in at least three phases. The south and east walls are of a similar pattern of masonry: a series of stretchers alternates with pairs of headers. The north wall is of two phases, set on slightly different orientations, and built of different sized materials. The northern fortification wall immediately east of the twin round towers shows the same style of masonry as the south and east walls of the vault, and the pottery associated with these walls -- which only later are used to support a Herodian vault -- is clearly Hellenistic.

As a result of the past few decades of field-work, the early town begins to emerge as a coastal settlement focused about its two harbours. The southern anchorage was probably the square or rectangular Inner Basin located by CAHEP's excavations (Area I, Section III.H), and the Round Tower nearby (Area T_2, Section III.R.2) may have served as an observation tower or lighthouse overlooking its entrance. It may, in fact, have been the coastal feature known as Straton's Tower. If not, one might look for such a structure to the south, along the rocky promontory that Herod was later to incorporate into his Southern Breakwater. The walls of the town were powerfully built in the tradition of Hellenistic fortifications, and its north gate is a good example of a same type known from sites of a similar period. Little more can be added other than the fragmentary remains of domestic and commercial areas that have been suggested by the associated ceramic evidence. Clearly, much more of the early city remains to be uncovered.

[R.L.V.]

I.B. Man-Made Features: 2. Herodian Caesarea.

Despite the massive scale of Herod's building programme at Caesarea very little remains visible from the late first century B.C. There is a summary of research on the city in Holum et al. (1988: 55-106). The success of Caesarea as a city ensured that continuous building would cover or perhaps even eradicate much of its earlier history. For example, according to Josephus, Herod built a city with a grid of streets. This grid presumably developed from the original Hellenistic alignments, although no street has been excavated to its Herodian level (Vann: 1983b). Numerous streets, uncovered by both the Joint Expedition and CAHEP, and others recorded from the study of aerial photographs, suggest a comprehensive city plan (fig. I.8, no. 26) (Reifenberg 1950-51; Holum et al. 1988: 83, 130, 163). The working hypothesis among scholars excavating at Caesarea is that eventually this grid will be dated to the Herodian building program.

The focus of Herod's city planners and CAHEP's research programme has been Sebastos, the harbour of Caesarea Maritima. Descriptions by Josephus provide an excellent eye-witness account of the port 70 years after the dedication of the city, and the passages have been valuable for the present group of researchers in interpreting archaeological evidence (*AJ* 15.331-41; *BJ* 1.408-14; see Appendix I.A). Only a small portion of this grand complex has remained above water: the eastern end of the Southern Breakwater. The remains of both breakwaters are clearly visible from the air and can even be seen from the roof of the citadel restaurant on a calm day.

Perhaps the only original feature preserved of this continuously employed Southern Breakwater is the sluice cut into the western extremity of the kurkar headland that formed its base (CAHEP Area Q; Section III.O). Beneath the surface, several other parts of the harbor can be easily identified. The Entrance Channel is located on the northwest side, while nearby were the towers mentioned by Josephus: two standing to the starboard of a ship entering the harbour, and one to port. These towers supported a series of six columns that in turn carried monumental sculpture. The foundation of the single tower is just north of the extreme northwest corner of the Northern Breakwater, where remains were discovered of the wooden formwork into which the concrete had been poured (Vann 1983; Oleson et al. 1984: 297-99). Finally, the casual diver or snorkeler swimming along the line of the Northern Breakwater can easily recognize the remains as man-made and can locate at its western end -- flanking the ancient entrance -- a tumble of huge concrete blocks (CAHEP's Area D) that are the remains of a substantial building which collapsed as the harbor fell into disrepair. The same swimmer would not be able to recognize as much of the original breakwater to the south and west, where prevailing seas have caused more damage. Yet there too, the casual visitor might recognize an even larger heap of huge concrete blocks, in one place reaching within 2 m of the surface. This collapsed structure was the largest in the harbor and is considered to have been the lighthouse, although none is specifically mentioned by Josephus. Instead, the description speaks of a pair of breakwaters 200 m wide, its central spine formed by a wall punctuated with towers. The inner portion was occupied docking space and warehouses while the outer part was the breakwater proper. Josephus notes that the tallest of the series of towers was named Drusion in memory of Augustus's son.

Although the many warehouses and associated buildings that once stood on the breakwaters are irretrievably lost, several of the vaulted horrea have been discovered on land and partially excavated by the Joint Expedition (Section II.A.6; (pl. I, no. 33). These huge, ashlar-vaulted storerooms were constructed along the shoreline south of the artificial harbor and were part of the expanded port facility of Sebastos. Their preservation has been due in part to the sand dunes they have helped stabilize along the beach. Although at least 20 vaults have been recorded, no coherent plan of their full extent can be provided until further investigation has been carried out (Bull, Krentz, Storvik 1986). Three of the vaulted chambers that have been recorded face west, toward the South Bay, and even though they are of different sizes, the complex might be reconstructed along the lines of a similar set of warehouses on the eastern breakwater at Leptis Magna in North Africa. This series of warehouses was faced by a portico (Bartoccini 1958: 123).

The arrangement of *horrea* at Caesarea, however, was more extensive. At least five other vaulted rooms faced north and south onto *decumani* (east-west cross streets) leading to the port, while others faced east onto a parallel *cardo* (north-south street) (Bull, Krentz, Storvick 1986: 41). No stratigraphic evidence can provide a date for the original construction of the vaults, but an enterprise of such scale presumably belonged to the Herodian period, when the maritime traffic -- or at least the anticipation of it -- was greatest. Excavation in the chambers produced large numbers of amphoras. At a later date, in the third century, one of the warehouses was remodeled as a Temple of Mithras (Section II.A.6, below).

Among the most important buildings of the city was a temple dedicated to the cult of Rome and the deified emperor Augustus, described by Josephus as standing on an eminence overlooking the harbour (fig. I.8, no. 20, pl. I, no. 20). That temple has disappeared, but a vaulted platform now situated in the centre of the Crusader fortifications is usually identified as its base. CAHEP Area I is located in front of and beneath this vaulted platform. In 1873 the site was referred to as a "mound," and occupied by late structures, which were demolished in turn within the next decade by a group of Bosnian settlers who arrived at Caesarea (Conder & Kitchner 1882: 18). The first excavations -- part of the Park Service's programmme to restore part of the site -- revealed a series of deep foundations to the north and a vaulted substructure to the south (Negev 1963b: 728). The Early Roman pottery found throughout the associated strata established a Herodian date for its construction.

Two further major public buildings mentioned by Josephus were the theatre and amphitheatre. He confuses their locations and places the latter south of the harbour, describing it as ideally situated for a view of the sea (*AJ* 15.341). In fact, it is the theatre that is in the southern part of the city, on a low bluff from which it commands an excellent panorama over the Mediterranean (fig. I.40, pl. I, no. 39). The theatre at Caesarea is one of the few public buildings of the city that has been identified and completely excavated (Frova et al. 1965). The selection of this particular building for thorough investigation was based, in part, on a reference in Josephus establishing it as one of the original structures of the Herodian building programme and thus as one of the earliest Roman theatres in the East. The building is noted for the famous series of painted floors which date throughout the early Roman period (Albricci 1966). The stage was rebuilt and vaulted entrances provided in the second century. Much of the architectural decoration now visible, including a *porticus post scaenam* and the *scaena* date from the third century, and a *colimbetra*, or pool, was added in the next century for the presentation of popular water shows. But among the numerous repairs carried out over the four or five centuries of service, the most important for archaeologists was the reuse of an inscribed block mentioning Pontius Pilate and his dedication of a building for the imperial cult of Tiberius (Degrassi 1964). The theatre continued to function throughout Late Antiquity and was closed only in the seventh century, when a Byzantine fortress was built adjacent to it. Today, the seating area has been partially restored, enabling visitors to the site once more to witness live performances in a magnificent Herodian setting.

Much less can be seen of the amphitheatre, at a site on the other side of the city (pl. I, no. 11). Although its outline is easily recognized from the air, only a

slight rise in the fields indicates the buried remains of its foundations. Its Hero-dian date is established by a reference in Josephus (*AJ* 15.341) describing the ded-catory games. The building was probably the site of bloody spectacles during the reign of Titus, at the close of the first Jewish rebellion against the Romans (Jose-phus, *BJ* 7.31,37-8). Christian martyrs met their deaths in this same arena during the persecutions of Diocletian (Eusebius, *De martyribus Palaestinae* 6.3, 7.4, 8.2). The amphitheatre remains completely unexcavated and the date of its original construction uncertain.

The third major building needed for public entertainment in any Roman city was the circus, and the remains of a large one can be seen at Caesarea. Although we know that horse races were a part of the festivities during the dedication of Herod's new city, once again there is no evidence for the existence of the present structure before the second century (Humphrey 1986: 489-90) (pl. I, no. 58). The building measures about 80 x 320 m -- an average size for such racecourses. In the centre of the track are remains of monuments that once decorated the *spina*, the central longitudinal barrier wall. Several large blocks of red Aswan granite are all that remains of the turning post (*meta*), and a huge obelisk. Although several attempts were made to cut the stones into smaller pieces for easier transport, they remain in the centre of the racetrack. The hippodrome was used through the fifth century, as it is mentioned in the Samaritan uprising of 484 (Procopius, *De aedificiis* 5.7.5-9).

The last major structure identified as part of the Herodian building pro-gramme is the High-Level Aqueduct entering the city from the north (fig. I.8, no. 6-7, pl. I, no. 1). The graceful arcade stretching 8 km down the beach is the most impressive and familiar monument of the ancient city and one of the best pre-served Roman aqueducts in the eastern provinces. The aqueduct presents a number of complicated problems. First, Josephus makes no mention of a water system, although this omission certainly does not preclude its existence. Even though cit-ies of this size could survive without grand municipal aqueducts, it is difficult to believe that, given the challenge of building a new, showcase city, a suitable water system would not be part of the master plan. Furthermore, Herod had built water systems for other cities, including an aqueduct in Laodicea and baths and a fountain at Ascalon (*BJ* 1.21.11).

Investigation of the aqueduct has shown that three separate channels were carried on two adjacent arcades with arches of slightly different spans. The pres-ence of exterior string courses on both the east and west sides of the eastern arcade indicate that it was built first and was designed to function by itself. The source of this early water system was the springs near the foot of the Carmel range, about 25 km NE of the city (fig. I.4).

A second aqueduct bridge was added later, presumably in the early second century by troops stationed in Judaea during the Bar Kochba revolt (fig. I.43). Several inscriptions can still be seen on the west face of the latter branch, includ-ing one naming the Legio VI Ferrata (Vilney 1928a-b). Three additional inscrip-tions have been published more recently (Hamburger 1959: 188-90; Lifshitz 1963: 784; Negev 1964: 237-49, 1972: 52-3). It seems plausible that a new water source would be associated with Hadrian, providing the water necessary for the large

standing army and at the same time appropriate to his image as a restorer of cit-ies. A case might also be made for construction of one branch by Vespasian during the first revolt, when a Samaritan chronicle states that the commander dammed a river and gathered its waters for transport into the city (Neubauer 1868: 402). The source of water for the second channel of the High-Level Aqueduct was also from the springs at the foot of Mount Carmel, but additional springs 15 km east of the city were also tapped and the water joined with the original sources. Part of the water channel in the latter system was cut through the mountain.

[R.L.V.]

I.B. Man-Made Features: 3. Post Herodian Caesarea.

The Post-Herodian period in Caesarea extends from the removal of Herod's son, Archelaus, in A.D. 6 through six centuries of Roman and Byzantine rule until the Sassanian and Arab invasions of the early seventh century. The period is long and complex. Although the earlier Roman phase remains relatively unknown through excavation, some structures are known from literary or epigraphic refer-ences. Archaeological research has, on the other hand, shed more light on the later centuries, as scholars intent upon discovering the origins of Herod's city have found it necessary to uncover the surprisingly prosperous later history of Caesarea (Holum et al. 1988: 107-200).

Public Buildings. If we accept the accounts provided by Josephus, Herod planned and built a city filled with all the architectural amenities necessary for Roman urban life. But one of the major structures for public entertainment during the Roman era, the hippodrome, seems to have been constructed during the post-Herodian era (pl. I, no. 58). Although we know that races were held in conjunction with the foundation of the city, small-scale excavations in 1974 and 1976 have led Humphrey to date the building no earlier than the second century A.C., perhaps associated with the local building programs of Hadrian (Humphrey 1974; Humphrey 1975; Riley 1975; Humphrey 1986: 447-91). The Caesarea hippodrome is oriented NNE-SSW, its rounded end to the south and its starting gates, or *carceres*, to the north. The racetrack is 450 x 90 m, about the average size of those in the eastern provinces. The huge blocks of red granite that can still be seen in a field now within the racecourse were parts of an obelisk and the two turning posts, the *meta prima* and the *meta secunda*, part of the decoration of the *spina*, or central spine. Another large block of the same material now located on the north side of the Southern Breakwater was carried to the harbour area for transport elsewhere, sometime in the early modern period. It can be seen embedded in a modern con-crete slab outside the local dive shop. This stone, measuring 1.95 x 1.92 x 0.95 m, has a series of four cuttings on its top and might have served as the base of one of these monuments.

Another building for public entertainment that has yet to be located was the odeum. According to Malalas (*Chronographia* 10.338; Niebuhr 1831), it was built by Vespasian within the structure of an older synagogue: "And out of the Jewish spoil, this same Vespasian even built in Caesarea of Palestine a very large odeum at a great distance from the theatre, and a synagogue of the Jews was formerly on

this site." The text does not make clear whether the earlier structure was destroyed or simply reused for a new purpose. This adaptive reuse would have been a logical solution for two buildings with such similar architectural programs. Both the odeum and synagogue were designed to provide assembly space for crowds and had plans similar to the earlier meeting halls of Greek architecture (McDonald 1943; Lawrence 1973: 274-79). The odeum at Caesarea was used for musical concerts, and as a lecture hall, law court, and popular assembly.

Every Roman town was well supplied with a variety of public and private baths, and Caesarea would have been no exception, even though the first specific reference to a bath dates to the middle of the second century (Malalas, *Chronographia* 11.367). Public baths were usually among the largest structures in the city and can be recognized today as being among the most prominent ruins on a site. Examples of large vaulted rooms can be seen in the two major *thermae* of Gerasa (Kraeling 1938: 23-24) or the smaller complex at Hammat Gader (Hirschfeld & Solar 1981). A survey of bath remains in other provinces such as Asia Minor or North Africa show a larger number of standing remains, but this degree of preservation is due in large part to the fact that the vaulting was built in concrete or mortared rubble rather than the ashlar masonry more common in Palestine and Syria. If earlier bath buildings in Caesarea were built of cut stone, it is very likely that those baths were dismantled at some time during the life of the city and the materials reused in other structures. The fact that no large bath has been found in the city is no surprise, considering the fact that the location of the agora itself is still unknown.

There are several literary references to baths in the city, including the fourth-century "Baths of Cornelius" mentioned in the *Itinerarium Burdigalense* and those collected by Levine (1975a: 37) concerning the role of the baths in the Jewish community. The only baths found to date in Caesarea are those partially excavated in 1976 and 1978 in Field E of the JECM, located in the northern suburbs (fig. I.33, pl. I, no. 4). They had been identified as a Christian chapel by the Italian Mission. An excellent series of drawings was completed by Ken Smith, then a student in the School of Architecture at the University of Maryland, but the structure has remained unpublished (Holum et al. 1988: 182-84, figs. 109, 134-35).

The baths are very small. The circular *frigidarium* is located on the south side of the complex, and the service court, *praefurnium* (furnace), and *caldarium* (hot baths) -- traditionally located on the south or southwest side of a bath in order to collect as much afternoon heat as possible -- are located at the north corner. The heated rooms and the medium temperature *tepidarium* are tiny, less than 2 m wide for the domed *caldarium*. The exterior of the structure is not completely excavated, but it appears that the entrance was from the north. Several other rooms decorated with floors of *opus sectile* have been cleared in the southeast and southwest corners, but others have remained unexcavated. In view of their scale, the baths were no doubt private rather than public. Although the building is located in an area north of the city known to have large villas, the complex is probably not designed for the use of a single household but instead might have served several. Two features suggest this interpretation. First, a large *piscina*, or fish tank, in the northeast corner seems to have too small a surface area to properly aerate the volume of water it contained. Thus the tank may have served as a storage pool

for fish that were to be cooked and served to the bathers, rather than as a breeding pool. Second, the latrine located on the west side of the building is too large for use by a single household.

As provincial capital of Judaea, Caesarea was the administrative base of the local Roman governor. We know about several of these men and something of the buildings that they used. The governors of the new province probably occupied Herod's palace immediately after annexation in A.D. 6., because we hear that in 58, after having been arrested by the Roman official in charge of the city of Jerusalem, Paul was brought to Caesarea for trial before the provincial governor, the right of a Roman citizen. Acts 21-25 describe the events and the long period of incarceration during which time Paul was kept in custody by the governor, Antonius Felix, "at his headquarters in Herod's palace."

The names of other Roman officials are known from the so-called "Honorific Esplanade" discovered by JECM in Field C south of the Inner Harbour (fig. I.8, no. 25, pl. I, no. 29) and built directly above several of Herod's vaulted *horrea* (Bull 1982: 34; Bull, Krentz, and Storvick 1986: 36). The structure is a colonnaded, U-shaped, marble-paved hall built around a court with its open side to the west overlooking the sea. Within the room, excavators found a series of short columns inscribed with the names of procurators of the third century, apparently bases that lined the walls and supported statues of the men named.

Field C of the JECM exposed what appears to have been a large administrative complex, including an archives building first discovered by Negev and later cleared by the Joint Expedition (pl. I, no. 30). The building is rectangular, measuring 15 x 19 m, with seven rooms arranged about a central hall (Holum et al. 1988: 169, fig. 121). The entrance was from the west, off one of the major streets of the city, a colonnaded *decumanus* leading from the general area of the theatre north toward the Inner Harbor Basin and Temple of Rome and Augustus. Each room was paved, most with mosaic panels that often included an inscription. The texts of the mosaic inscriptions identified the building as one used by the governor's tax service: one panel quoted a verse from Romans 13:3, "If you would not fear authority, do good and you will receive praise for it."

Another room within the same complex was decorated with perhaps the finest mosaic found thus far at the site (Holum et al. 1988: 170-71, figs. 122, 124). Two of the four personifications of the seasons that were set into the corners of the pavement have been preserved: "Winter" and "Spring." Both follow classical models and appear to have been products of an atelier of artists from the capital in Constantinople. They have been tentatively dated to the Early or Middle Byzantine period (A.C. 330-550). Nearby, in Area 26, there was a small, centralized structure with four steps (or benches) along its west, north and south sides. The JECM has suggested that this area served as a meeting hall, perhaps a small bouleuterion, and that it dates to their Phase 7 (Roman, 10 B.C. to A.D. 330) (Bull, Krentz, and Storvick 1986: 36-38, fig. 6). During the following phase, a crosswall was added and a small fountain installed. The resulting nymphaeum was richly decorated with colourful frescoes.

One of the latest additions to the complex in Field C was the large apse built in the Late Byzantine period (A.C. 550-640) (pl. I, no. 28). The foundation

trenches for it cut through a fine mosaic pavement of the Middle Byzantine phase. Although it is not clear whether or not the room associated with this apse was ever completed, its orientation and size are similar to audience halls from other provincial palaces in the late Roman period (Holum, personal communication).

The various structures found in this area -- the "Honorific Esplanade," an archives building, the superbly decorated "Room of the Four Seasons Mosaics," the so-called meeting room and later nymphaeum, as well as an incomplete audience hall -- would all have been integral parts of the administrative center of a provincial governor. Another role that appears to have been served by the governor's administrative center was that of a prison, for Paul was incarcerated here for two years while awaiting his journey to Rome (Acts 24: 27).

Several other public structures of the Roman period are known from literary references. A tetrapylon mentioned by the author of the *Exposito* was "...famous everywhere, it is a unique and marvelous sight," (Rougé 1966: 160). The same monument figured prominently in rabbinic sources, which define the portion of the city east of the tetrapylon as impure because of the presence of graves in the vicinity (*Midrash Oholot* 18.9). A four-way arch of this type was often situated at the intersection of the principal streets of Roman cities in the Near East, although their locations were not always central. There are two tetrapyla in Gerasa along the *decumanus maximus*, both within the original city walls, while at Leptis Magna the arch is located in the newer, southern portion of the town. The location of the Caesarea tetrapylon was probably along the *cardo maximus*, between the forum and east gate. If the story of Rabbi Akiba's burial in a cave near that monument is correct, its position might be sought closer to the eastern edge of the city (*Midrash Mishle* 9.18).

Another local monument, a triumphal arch, is known from four marble fragments. An inscription on them refers to a grant by Alexander Severus raising Caesarea to the rank of metropolis (Abel & Barrois 1931: 294-95). The discovery of these blocks in the vicinity of the hippodrome, near the eastern entrance to the city, suggests that the tetrapylon and the arch of Alexander Severus might be the same monument. A third structure associated with this part of the city is mentioned in the *Bourgos* inscription (see below).

Religious Buildings. Several major religious structures are known from the Roman and Byzantine period in Caesarea. Eusebius (*Martyrs of Palestine* 4.8) implies that the city had several pagan sanctuaries when he states: "Throughout the whole city of Caesarea by order of the governor, heralds were calling up men and women and children, too, to the temples of the idols...." The most prominent temple of the city was that built by Herod in honor of Rome and Augustus. From its elevated position on a raised podium, it commanded views of the harbor on one side, presumably the forum on another, and certainly would have been visible from many parts of the city (fig. VI.1, pl. I, no. 20).

There were also temples dedicated to Tiberius and Hadrian in the city, but their locations remain unknown. The existence of a *Tiberieum* was discovered by the Italians during their excavations in the Roman theatre (Degrassi 1964: 59-65). An inscription reused for a repair of the theatre steps stated that a temple had been dedicated to Tiberius by Pontius Pilate, prefect of Judaea. There has been some debate about whether the term *Tiberieum* referred to a temple or, as was the case when Herod dedicated the *Caesareum* and *Agrippeum* in his palaces in Jerusalem and Jericho, they were wings or specific rooms named in honor of Augustus and Marcus Agrippa. Despite the fact that Tacitus (*Annales* 5.2.1), Suetonius (*Tiberius* 26.1), and Dio (58.2.1) all report that Tiberius refused deification, temples, shrines, and altars in his honor have been found in Cyprus, Asia, and Africa (Levine 1975a: 20). Frova has suggested that the term *Tiberieum* refers to a portico or plaza and has identified it with the remains of a colonnaded court behind the stage building (Frova 1961: 434). Levine, on the other hand, argues that, since other temples were dedicated to Tiberius despite his objections, there appears to be no reason not to identify the *Tiberieum* with a shrine or temple. Levine is in agreement with Frova that the inscribed block had not been carried too far from its original position in order to be reused in the theatre repairs. He points out that in Leptis Magna there was a small temple dedicated to the imperial family built in the colonnaded *porticus post scaenam* of the theatre (Hanson 1959: 95). Levine postulates that small rectangular foundations in the vicinity of the portico might be those of the *Tiberieum* and continues by suggesting that construction of this shrine or temple and the dedication of golden shields to him in Jerusalem were both attempts to win favor with the emperor after the fall of Sejanus, whose open hostility to the Jews was shared by Pilate (Levine 1975a: 21).

The second imperial temple known from epigraphical evidence was the Hadrianeum. A sixth-century inscription stated that, during the tenure of Flavius Euelpidius, the steps of the Temple of Hadrian were repaired (Germer-Durand 1895: 75-76; Ellis & Murray 1896: 87-88; Moulton 1919-20: 86-90; Levine 1975a: 21). Although the temple has not yet been located, a colossal porphyry statue identified as Hadrian by Avi-Yonah might have originally stood in the building (Avi-Yonah 1970: 207-8). This temple, along with another dedicated to the same emperor in Tiberias, was probably built during one of his visits to Palestine, either 130/1 or 133/4 (Stinespring 1939: 360-65; Weber 1907: 240-45).

At some point in the third century, one of the vaulted chambers of Herod's warehouse district facing the South Bay was remodelled into a temple for the cult of Mithras (pl. I, nos. 31, 33). The room was 21 x 5 m with a clearance of 4.5 m beneath the vault (Bull 1978a). Benches (W 1.5 m) lined the flank walls, and several features, among them an altar, were found at the eastern end. Identification of the room as a Mithraeum was made certain by discovery of a small marble medallion depicting the traditional sacrifice (Bull 1972a; Holum et al. 1988: 152, fig. 108). Scenes from the life of Mithras have been identified in the poorly preserved wall paintings on the south wall. The focus of a Mithraeum was its central interior chamber, which was usually a long vaulted room with little or no fenestration other than its entrance. The spaces found in the vaulted substructures of large buildings were ideal, and the small size of Mithraea no doubt reflected a preference for small congregations.

Other pagan cults as well probably had temples in Caesarea. A well-preserved statue of Ephesian Artemis found by the Italians in the theatre excavations might have been a cult figure for her own shrine or temple (Frova 1962d). A coin of Caracalla minted early in the third century shows the city goddess Tyche standing in her temple (Kadman 1957: 110, no. 66). The Egyptian gods Serapis and Isis also appear frequently on coins of the city (Levine 1975b: 22-23).

One of the first major discoveries by the residents of kibbutz Sedot Yam was a fourth-century synagogue located in the northwestern sector of the city, just north of the Crusader fortifications (Avi-Yonah 1956a: 260-61, *idem* 1960; Avi-Yonah & Negev 1963: 146-48). The structure measures 9 x 18 m and was oriented to the south, with its entrance on the east (fig. I.8, no. 18, pl. I, no. 10). Despite the fragmentary condition of the synagogue, enough remained of its decoration to offer some idea of its original appearance. Mosaic pavements and marble fragments of capitals and cornices were uncovered by Avi-Yonah, along with pieces of a marble plaque containing a partial list of the twenty-four priestly courses (Avi-Yonah 1962: 137-39). The site has a very long building history: There was a Hellenistic structure beneath, and alterations later in the sixth or seventh century. Unfortunately the synagogue was never fully published, but both the Joint Expedition and CAHEP have recentle cleared portions of the site, and additional excavation has occurred nearby in CAHEP Area J.

Several Christian structures, including the homes of Cornelius and Philip (mentioned in *Peregrinatio Santae Paulae*. Levine 1975a: 45), a church of Procopius (Malalas, *Chronographia* 14. 93-4), and chapels of Cornelius and the Virgin Mary (Levine 1975a: 45) are also known from literary references but have never been located. Likewise, the famous library of Origin and Eusebius has yet to be found. No major church has been located in the city. The small cross painted in one of the heated rooms of the bath north of the city was interpreted by the Italians who first studied it as evidence of a Christian chapel. Perhaps at a later date the structure did serve that purpose, but it was obviously originally designed as a bath. A large structure decorated by a mosaic filled with medallions was located on a hilltop in the same vicinity. The building was first identified as a church, but firm evidence for that interpretation is lacking.

Elements of the Urban Plan. Evidence for alterations to the street system during the post-Herodian period appeared in the area between the Crusader city and theatre during the 1979 season of excavation by the JECM (Vann 1983b; Wiemken & Holum 1981). The objective of that year was to trace one of a series of north-south *decumani* previously discovered in Field C, and a series of sondages to the east in an attempt to uncover the series of east-west *cardines*. A series of probes in Fields C, K, L, and M (fig. I.8, no. 26) successfully revealed the pattern of streets including one in Field M that dated no earlier than the fourth century. The results of that season suggest that the cadastration of the city was altered somewhat by the inclusion of additional streets, but in a pattern consistent with the orientation of streets in the original grid. Another alteration in the street pattern appears in the "Byzantine Esplanade" (Yeivin 1955; 1957; Bull 1982).

The continued prosperity of the city up until its fall to the Arabs in the early seventh century has been convincingly demonstrated by current excavations both on land and underwater. The principal addition to Caesarea during this period was a new and much longer circuit of fortification walls that extended the protected area of the city in a much enlarged semi-circle measuring about 1.6 km N-S and 0.9 km E-W (pl. I, no. 6). The line of this later wall was mentioned by early travelers (Newman 1864: 340) and recorded for the first time by the Palestine Survey in 1873 (Conder & Kitchener 1882: 14). Reifenberg assigned it an early Roman date, first questioned by Avi-Yonah, who suggested the third century (Reifenberg

1950-51: pls. ix, xvi; Avi-Yonah 1957b: 80). The Italian Mission confirmed the later date in a series of probes along the circuit (Frova et al. 1965: 45-53).

The south gate of this late city wall was discovered in 1986 during expansion of the kibbutz tile factory. Neither the east nor the north gates have been located, but the discovery of the *Bourgos* inscription near the hippodrome has been associated with the site of the east entrance into the city (Levine 1975a: 39-40). Schwabe suggested that the tower mentioned in the text was built along the road to provide protection in case of attack (1950b). Lifschitz assumed that the tower was adjacent to the Byzantine wall and suggested that it was constructed when the fortification circuit was built (Lifschitz 1961: 124-25). A fortress in the southern part of the city is also dated to the Byzantine period. The Italian team partially cleared these walls during their excavation of the theatre, but a complete plan of the area is lacking (fig. I.40, pl. I, no. 40).

A second channel was added to the High-Level Aqueduct, presumably in the early second century by troops stationed in Judaea during the Bar Kochba revolt (figs. I.43-44, pl. I, no. 1). Several inscriptions can still be seen on the west face of the latter branch, including one naming the VI Legio Ferrata (Vilney 1928). Three additional inscriptions have been published more recently (Hamburger 1959: 188-90; Lifshitz 1963: 783; Negev 1964: 237-49, 1972: 52-3). It seems plausible to associate the enlarged water supply with Hadrian: it provided the water necessary for the large standing army and at the same time was appropriate to his image as a restorer of cities. A case might also be made for construction of one branch by Vespasian during the first Jewish revolt. A Samaritan chronicle states that at this time the commander dammed a river and gathered its waters for transport into the city (Neubauer 1868: 402). The source of water for the second channel of the High-Level Aqueduct was also the springs at the foot of Mount Carmel, but additional springs 15 km east of the city were also tapped and the water added to the original sources (fig. I.4). Part of the water channel in the latter system was cut through the mountain (Section I.B.8).

Another addition to the infrastructure of the late city, and the final addition to the ancient water system, was a new aqueduct that brought water from the Zerqa River 5 km north of the city, where it was collected behind a new dam (figs. I.4, 22). An industrial area near the dam has been studied several times, but little has been published besides Oleson 1984b. Water collected behind the dam was carried in an open rock-cut channel for 1.5 km. From a point 3.5 km north of the city this system was enclosed within a continuous rubble vault. Water from the Low-Level Aqueduct was not of the same quality as that from the springs of Mount Carmel and was probably always applied to uses other than drinking. The system is dated to the third or fourth century by Levine (1975a: 36) and Oleson (1984b) on the basis of its construction.

[R.L.V.]

I.B. *Man-Made Features: 4. Early Arab Caesarea.*

Caesarea fell to Arab armies commanded by Mu'awiya, the founder of the Umayyad dynasty of caliphs, in 640 or 641, after several decades of unrest in Pal-

estine that had seen Persian invasions, Byzantine reconquest, and finally Arab invasions. Very few remains of the early Arab period are preserved on the site. The city was refortified as a coastal station, but literary sources and the results of recent JECM excavations confirm that there was severe depopulation of the city and its territory in the years following the Arab victory (see Holum et al. 1988: 201-16). Several visitors to Caesarea during that period have left descriptions. Al-Muqaddasi, a native of Palestine wrote: "On the coast of the Greek sea, there is no city more beautiful, nor more filled with good things: plenty has its well-spring here, and useful products are on every hand. Its lands are excellent, and its fruits delicious; the town is also famous for its buffalo-milk and its white bread. To guard the city there is an impregnable fortress, with a well-founded wall encircling it. The drinking water of the inhabitants is drawn from wells and cisterns. Its Great Mosque is very beautiful." (Le Strange 1892: 55). This passage implies that both the High-Level and Low-Level Aqueducts were out of service during the late tenth century, but it leaves one with the impression that the town remained prosperous.

The Persian traveler Nasir-i-Khusrau provides a description of Arab Caesarea in 1047. He describes it as "...a fine city with running waters and palm-gardens, and orange and citron trees. Its walls are strong, and it has an iron gate. There are fountains that gush out within the city. The Great Mosque is a beautiful edifice. Seated in its courtyard, one may enjoy a view of the sea which is exceedingly pleasant." (Le Strange 1893: 20). Both accounts mention the powerful fortress protecting the city and the abundance of water.

Reifenberg (1950-51: 29-30) has suggested that the Low-Level Aqueduct was repaired in the tenth century, and Raban believes that part of the "running water" mentioned served a garden complex south of the city (personal communication). It seems likely that the aqueduct was still in use during the twelfth century, since the lake created by its dams was mentioned by a Crusader account (Röhricht 1887: 209, 247) and irrigated gardens noted by William of Tyre (Propst 1927: 14) and Jacques de Vitry (Stewart 1896: 4-5). Even if Reifenberg is correct in assuming that the Low-Level Aqueduct was reopened in the tenth century, during most of this period the city was limited to water available from wells dug within the city. Likewise, without the abundance of water offered by the aqueducts, sewers and drains fell into disrepair, and it was necessary to excavate refuse pits and cesspools.

Raban believes that the gardens mentioned above are those located among the sand dunes south of the city (personal communication). Rectangular plots are easily identifiable here from the air (fig. I.32), and they have been interpreted by some as an extension of the urban grid of Caesarea's streets (Reifenberg 1950-51; Kedar & Ziv 1964). The gardens were dug into the sand during the ninth and tenth centuries and fell into disrepair during the mid-thirteenth century (Porat 1975). These fields are very similar to the *muwatzi* cultivation currently found in the Gaza Strip. Loose sand is removed and piled into embankments surrounding the exposed soil. In order to stabilize the individual plots, the sand is covered with palm fronds in modern Gaza. The abundance of potsherds in the dunes south of Caesarea suggests that refuse heaps of waste material might have been transported here in antiquity and laid over the sand embankments to stabilize them.

The broken pottery might have come from the vicinity of the port, where it would have been necessary to discard the large numbers of damaged containers or containers that were emptied after being brought ashore. A similar refuse area in Rome can still be seen in Monte Testaccio just south of the Aventine Hill where an artificial mound of broken amphora still stands almost 50 m high. Raban has also suggested (personal communication) that water from the Low Level Aqueduct was carried around the city on the top of the Byzantine City Wall. This theory has not yet been confirmed by archaeological data.

Negev reported a continuity of building techniques from the Late Byzantine to the Early Arab Period, especially in the excavations just west of the Herodian Temple Platform (Section II.A.4). When Arabs first arrived at Caesarea, they no doubt found much of the city intact, making only simple repairs necessary in order to reuse existing structures. It is also clear that local artisans, if they survived the initial conquest of the city, were allowed to remain. In other words, at the beginning of the Arab period in Caesarea, the new nomadic population, which arrived without a tradition of urban life or monumental architecture, no doubt reused existing buildings and had at their disposal the skills of local craftsmen. An example of this continuity is the use of mosaic pavements throughout the Arab period. Floors of the eighth and ninth centuries resemble those of the Late Byzantine period, while during the tenth century one finds a combination of mosaic and *opus sectile* pavements. Examples of these floors were found in Negev's trench west of the Temple Podium (CAHEP's Area I) as well as the more recent excavations in Area Z (Raban & Stieglitz 1988). Although much of the ancient city fell into disrepair during the four and a half centuries of Arab rule before the Crusades, older buildings must have continued to serve contemporary needs, and, when necessary, new structures were probably built from the spoils of the ancient city.

The fortification walls of Arab Caesarea have not been preserved, but the discovery of the early Arab cemetery in Field C of JECM suggests that the south wall of the city was further north, perhaps in the same position where the later Crusader wall was built.

Excavations by Negev for the National Park Service (Section II.A.4), those of Levine and Netzer for the Hebrew University (Section II.A.3), and those of CAHEP have uncovered several industrial areas with oil vats and grain bins in Area S (Section III.Q) and Area I (Section III.H). Six of these vats (1.2 x 1.5 m) were discovered by Netzer and Levine and cleared by CAHEP in 1986. The walls are faced with ashlar blocks and the floors paved with small white tesserae. Each of these floors has a circular depression that might have served as a settling basin for a liquid such as olive oil, or the collection of moisture in a grain bin. Ceramic evidence suggested a date in the eighth century.

Another area of industrial activity during the early Arab period was within the vaulted substructures which supported the Herodian Temple Podium (Section III.H.3). Excavations by Negev uncovered a local metal workshop within the chamber (Negev 1968: 68). Several metres to the south, CAHEP excavated a series of five vaults in Area Z during the 1987 season (Raban & Stieglitz 1988). Two other vaults were cleared about twenty years ago and currently serve as tourist shops. The rooms open to the south and east and are clearly not part of the parallel rows

of much later Herodian vaults to the north. The chambers were much smaller than the Herodian rooms, averaging 3 x 4 m, with a maximum clearance of 2.6 m beneath the intrados of the vault. They were built of ashlar masonry. Excavation in thse vaults during the 1987 season revealed that the rooms had been abandoned and filled with debris before the fall of the city to the Crusaders in 1101. Rubbish above the floor consisted mostly of ninth- and tenth-century pottery. Late Byzantine mosaics 1 m beneath the floor had been cut through by cisterns in use during the time these vaults were occupied.

[R.L.V.]

I.B. Man-Made Features: 5. Medieval Caesarea.

The Crusader conquest of Caesarea began with the arrival of armies under the command of Godfrey of Bouillon and others in the spring of 1099. They stopped briefly to exact tribute before continuing on to Jerusalem. Despite this treaty with the local emir, King Baldwin I of Jerusalem returned to Caesarea in 1101 and, with the assistance of the Genoese fleet from Acre, besieged the city. Orchards in the surrounding territory were cut down and huge catapults employed to attack the fortifications. Although the local inhabitants took refuge in the Great Mosque, they were summarily slaughtered by the victorious Christians, according to the eye witness account of Fulcher of Chartres (Ryan 1969: 154-55).

The most substantial remains of Crusader Caesarea are the massive fortification walls constructed by Louis IX in 1251, some fourteen years before the final Arab conquest (for this period, see Holum et al. 1988: 217-36). The entire circuit of land walls was partially restored and the moat cleared of debris from 1960 to 1962 under the direction of Avi Yonah (Section II.A.4), but the western sea walls have completely disappeared.

Different stages of construction visible in the fortifications might date back to the earlier Arab walls. Unfortunately, the city was taken by both sides on several different occasions. Salah ed-Din captured Caesarea without a fight in 1187, but the city was retaken four years later during the march of Richard the Lion-Hearted from Acre to Jaffa. Al-Mu'azzam of Damascus attacked Caesarea in 1219. A garrison held out in citadel but, despite assistance from the Genoese ships from Acre, the Crusaders found it necessary to evacuate the city. Moslem soldiers entered the citadel and destroyed the buildings inside. Once again the city was recaptured, and in 1228 the walls were rebuilt by German pilgrims during the crusade of Frederick II Hohenstaufen.

The final circuit of walls at Caesarea was 650 x 275 m, enclosing a fortified town of 12.2 ha (fig. I.8, no. 20). As part of its thirteenth-century additions of ramparts and moat, the exterior was provided with a battered glacis 8 m high that carried a less substantial wall above with loopholes for the defenders. These walls were constructed of rough rubble faced with ashlar masonry, and surrounded by a dry moat 7 m wide and a masonry counterscarp. Gates on the north, south, and east sides gave access from timber bridges crossing the moat. Each of these gates was entered through a large, ribbed vaulted hall complete with overlooking balconies for guards, platforms for winches that operated draw bridges, and portcullis slots to secure the gates.

The means of access on the west from the direction of the harbour has disappeared. The East Gate was reconstructed in the early 1960's (pl. I, no. 14), the North Gate has been studied more recently during the 1986 season (Holum et al. 1988: 230-31), and the South Gate was never completely finished (pl. I, no. 26). A second gate on the north side of the city was located 45 m west of the first. The large masonry pier that supported its bridge suggests that the Northwest Gate, unlike the other three pedestrian gates, was designed for heavier wheeled traffic. The Crusader Citadel of Caesarea was built by Jean de Brienne on the remains of Herod's Southern Breakwater and separated from the remainder of the city by a wet moat 20 m wide. The remains of several towers and the citadel's *donjon* are discussed in Section III.L.

Several streets and houses of the Crusader period have been excavated immediately inside the East Gate (pl. I, no. 16). One street leading from the gate toward the harbor is paved with large blocks of marble reused from earlier Roman and Byzantine buildings. Two north-south streets can be identified, including one spanned by a series of arches set against the east wall of the Crusader city wall. While these pointed arches were characteristic of medieval Europe, the idea of covering the street was more familiar in the eastern Mediterranean.

The Cathedral of Caesarea remained unfinished on the platform of Herod's great temple, already occupied by the Arab period mosque (fig. I.38, pl. I, no. 18). The church (24 x 27 m) had a central nave (W 7.45 m) and side aisles (W 5.50 m), each terminating on the east with a semi-circular apse. Construction evidently halted when the north flank collapsed into the lower vaults of the Herodian platform, and the church was never completed (Negev 1967: 82-84).

A second church, identified by Benvenisti (1970: 145) as that of St. Lawrence, was seen by Conder and described in some detail (Conder & Kitchner 1882: 27-8). This church stood on the higher ground overlooking the small modern harbour, about 130 m south of the north wall of the Crusader city. The remains included two bays 6 m wide with walls standing 4 m high. Architectural details including a string course, corbels and ribbed vaulting were still in place. A door in the north wall was spanned by a flattened pointed arch. Conder noted that the masonry resembled that of the city wall. Another structure of Crusader date 110 m east of the church of St. Lawrence has not been identified but was measured and drawn by CAHEP architects during the 1986 season (pl. I, no. 13). It measures 9 x 15 m, with walls standing to a height of 7 m.

The harbour of the city was much smaller during the Crusader period. William of Tyre states that, "This city has great advantages, but is without a harbour." The anchorage was defined on the south side by the remaining portion of the Herodian Southern Breakwater, then the location of the Crusader Citadel. On the east, a submerged wall within the modern harbour has been interpreted by Raban as the sea wall during the Crusader period (Section III.R.2). There are two sections of wall at bearings of 203 degrees and 185 degrees built with reused ashlar blocks with dovetail clamp cuttings characteristic of the Herodian period. Identification of the north side is more difficult. If the Column Jetty (fig. II.14, pl. I, no. 51) was of Crusader date, the harbour was almost 120 x 150 m. But if the Column Jetty was of a later, eighteenth-century date and built by Jazzar Pasha of Akko, then

the size of the Crusader harbour appears to be much smaller and therefore in accordance with the contemporary descriptions.

Finally, Crusader burials have been located outside the city walls in Field C of the JECM (Bull, Krentz, Storvick 1986: 42-43) and further to the SE, in the midst of medieval orchards, were the remains of the hippodrome. The obelisk and meta stones that remained standing along the central spina were then known as "St. Peter's Finger" and "The Candlesticks of our Lord."

[R.L.V.]

I.B. Man-Made Features: 6. Bosnian Caesarea.

Caesarea was abandoned after 1265 when the Mameluke sultan Baybars defeated the last Crusader force to occupy the city. Several decades later, in 1291, all remaining fortifications were destroyed to prevent the Europeans from returning. Pilgrims visiting shrines in the Holy Land continued to visit the site as they traveled from Akko to Jerusalem, but a stop at Caesarea involved a significant detour into the swamps that surrounded the city. Reports from the fourteenth to nineteenth century describe Caesarea either as occupied by only a few people or as a totally abandoned city.

A dramatic change and the beginning of a new town occurred at Caesarea in 1882 with the arrival of a group of Bosnian immigrants (Holum et al. 1988: 237-41). Oliphant complained in "Notes and News" of the 1884 *Palestine Exploration Quarterly* that it was fortunate a thorough survey had been made recently by Conder, because the site was about to be built over by "...populations which have no other than a superstitious interest in old monuments." The Bosnians fled to the Ottoman Empire from Bosnia and Herzegovina after Austrian invasions and came to Palestine, where an extensive tract of land was granted them by Sultan Abdul Hamid II. The new settlers were Slavs, many of whom spoke no Turkish, but because they were Moslem they found it necessary to escape the Christian rule of Austria in those provinces that were transferred to her in the Treaty of Berlin at the end of the Russo-Turkish War.

By 1884 a broad street had been laid out from the South Gate of the Crusader fortifications leading into the heart of the medieval town. Oliphant reported that twenty houses had been built in the few months prior to his visit. These were built on a couryard plan and constructed of the reused blocks abundantly available on the site. Two of the houses were three stories high. The pitched roofs were covered with red tile, giving a European appearance to the new village. An adjacent tract of land was given to the Bosnians for cultivation, bordering another reserved for Circassian emigrants from Bulgaria. Evidently, conditions were not always favorable at the site, for two years later it is reported that Caesarea "...has been within the last month abandoned by all the Bosnian colonists on account of its deadly climate" (Oliphant 1886: 12).

The climatic problems appear to have been seasonal. Two years later the town was populated by forty-five Bosnian families, making necessary a survey of property within the old city walls. A sketch by Schumacher in 1886 followed the plan

of a government-appointed surveyor who laid out the restored town in seventy-five lots, forty-five of which were occupied at the time. Additional roads were planned, so that finally there were to be four north-south streets and four east-west. The principal north-south street, mentioned above, extended from the Crusader South Gate, the Jaffa Gate, and after two slight shifts of direction, exited the town at the Crusader Northeast Gate, or the Tantura Gate. A mosque was identified after the first shift in the street axis. The second shift occurred at the unidentified Crusader structure mentioned above (p. 41). The other three streets were to be laid out in a more orderly fashion. The eastern street is shown parallel to the Crusader east wall, extending for practically the full extent of the Medieval town. A second street was to have been between these two, extending SW-NE and parallel to the original street. After a shift in direction at the intersection where the Municipality Building is identified, it continued parallel to the east street and eastern Crusader Wall. This third street crossed the remains of the Crusader Cathedral just west of the triple apses. The fourth and last north-south street ran above the beach from the area designated as the *Suk*, or market, and continued past the Customs House toward the higher ground to the north beyond the indication of ruins which appear to be in the location where Conder had described the North Church (Conder & Kitchner 1882: 27-8).

The principal east-west street extended from the harbour across the village in the direction of the major road leading inland. This street did not exit though the Crusader East Gate which stood just to the north and at the time was simply labeled "Ancient Vault." The second east-west street followed the line of the south wall and extended from the vicinity of the Jaffa Gate west toward the New Government Building on the site of the Crusader Citadel immediately east to the limit of the medieval town. The *Kahn* was shown just inside the gate, and the remains of the Crusader Cathedral were just north of the street as it climbed the incline toward the east. A third east-west street only two "blocks" long was to be laid out at the point of the Crusader structure in the north central part of the site. A final street appeared to be parallel and just inside the north Crusader wall.

A later survey of unknown date prepared for the British during the Mandate period indicates that the master plan for restored Caesarea was not always followed (figs. I.14-15). The principal mosque, which remains the most impressive Bosnian structure still standing, was built at the southeast corner of the harbour. The street that was drawn by Schumacher above the beach was laid out instead on the western side of the mosque. A series of small houses that were aligned along that street north of the mosque have more recently been used as tourist shops. If the street continued north, it was only as a meandering path that followed the high ground above the Column Jetty and the position of the modern twentieth century breakwater.

The original street from the Jaffa Gate to the Tantura Gate appears on the British plan along practically the same route as Schumacher recorded. Its position appears to have followed a line very close to that of the modern fence which encloses the Negev excavations west of Herod's Temple platform. The mosque was apparently never built along this street, but another was located on one of the bastions of the Crusader south wall near the local school. Likewise, the east-west street which intersected this one at the large Crusader building in the north cen-

tral part of town was not built, and the northernmost street inside the Crusader wall was never finished but appears as a meandering path leading back to houses that occupied the north bastions. The later British plan shows several additional plots laid out north of the Crusader wall, but no houses were built there. The original north-south thoroughfare continued north on the high ground above the beach, along the same approximate path as the modern dirt road which leads past Area J (Section III.I) in the direction of the two round towers excavated by Frova (Section II.A.5). The area between the road and beach served as the local Moslem cemetery. Figure I.14 shows that the next north-south street crossing the high ground and the Crusader Cathedral was laid out as Schumacher had indicated but it was never completed to the north wall. The final street to be laid out parallel to the eastern wall was never built, although several houses were constructed on its bastions.

A large open space was reserved as the *Suk* just inside the Jaffa Gate and facing the Mosque, approximately in the same area that now serves as the heart of the modern National Park. A single long building containing the local bakery faced the open market along its northern limit. Two of the north-south streets defined the east and west sides of the *Suk*. Another large structure, built between this open market plaza and the citadel, was reserved primarily as warehouses and work space for local fishermen. The eastern end of the building, now the headquarters of the CDC, originally housed a grocery owned and operated by the father of Ekrem Akurgal, the famous Turkish archaeologist. Most houses were built along the earliest north-south street, on the higher ground of the Herodian Temple Platform, and on the bastions protruding from the Crusader fortification wall.

The Ottomans built a police station on the ruins of the Crusader Citadel in the early 1880's when the new settlers arrived at Caesarea. Before construction was possible, however, it was necessary to remove the considerable remains of those Medieval fortifications that had been the most prominent feature of the site and that had attracted the attention of most visitors who choose to illustrate their descriptions of Caesarea (Vann, forthcoming). Schumacher reports that "Many okes of powder were necessary to destroy this remarkable monument..." (Schumacher 1888: 135). The new structure contained water reservoirs and a prison in the preserved lower levels of Crusader rooms. With the loss of this territory in the First World War, the Turks abandoned the site to the Bosnians. The citadel structure was vacant by 1919, when it was acquired by the engineer Vilbouschitz who was in Caesarea seeking to establish an olive oil factory. Later, in the early 1920's, Rosh and Haefeli stayed here during their visits to the site.

[R.L.V.]

I.B. Man-Made Features: 7. Modern Caesarea.

The development of modern Caesarea dates back to the late nineteenth and early twentieth centuries when Baron Edmund de Rothschild aquired much of the land between the Krokodeilon River north of the site and the Hadera River to the south. A land company founded by the Baron bought much of the Bosnian property before the last members of that community fled in 1948. Meanwhile, a group of

twenty German Jewish immigrants arrived in Caesarea from Haifa in 1940, setting up camp in tents near the inner harbour beach. Kibbutz Sedot Yam ("Fields of the Sea") was later shifted from the harbour to the sand dunes south of the yet undiscovered Roman Theatre (pl. I, no. 59), as what had been originally a fishing economy diversified into agriculture and, later, the manufacture of furniture and ceramic tile. Much of the information about the first days of the kibbutz has been gathered by Schiler (1981) and Wegman (1981).

The Greek Orthodox Church also acquired land on the ancient site, and the last remains of its monastery can still be seen on the low hill north of the hippodrome. The small single arch on the modern road leading past the hippodrome (pl. I, no. 38) was built by one of the monks of that monastery, and as late as the mid-twentieth century there was a small church within the Bosnian village, near the remains of the old Crusader Cathedral.

After the War of Independence and the establishment of the State of Israel, the holdings of the Rothschild land company were given to the state and the CDC was created to organize the future of the site. A modern residential subdivision has been developed NE of the ancient city, as well as a luxury hotel with the only golf course in the country. Another, less formal, facility is the beach resort south of the kibbutz. The heart of the ancient city today is the rebuilt Crusader City, which is now under the control of the National Parks Authority. This area was excavated and partially restored from 1960-1962. Some of the remaining Bosnian houses were removed from the Crusader wall and its bastions during those years, but others continue to be used in one way or another as tourist facilities today.

Much of the development of Caesarea in the past few decades has taken place with tourism in mind. The Roman Theatre has been excavated and rebuilt once again to provide public performances during the summer season. Within the walls of the Crusader city, several shops and restaurants have been opened in the former Bosnian shops and houses; one unfortunately occupies the former Great Mosque (fig. I.16). Another restaurant, set on the first bastion along the south wall just east of the old Jaffa Gate, is built into the former Bosnian school and a second mosque. There is also a sculptor's studio in some of the recently excavated vaults of Arab date south of the Herodian Temple Platform. Within the former Bosnian commercial structure on the Herodian Southern Breakwater one can now find a dive shop and sculptor's studio at the west end, a beach club and tourist shop in the center, and at the east end, where the grocery store once served the needs of Bosnian Caesarea, one now finds a jewelry store on the ground floor and the offices of the CDC upstairs.

The harbor of Caesarea in its present configuration dates to the 1950's, when a new western breakwater was constructed in order to provide suitable anchorage for the fishing fleet based there (fig. I.13). Although the kibbutz is no longer in the fishing business, several Arab fishermen keep boats in the harbour. A second breakwater was built to the north in the 1960's in anticipation of construction of a yacht basin (fig. I.37, pl. I, no. 53). The most recent and most imposing structure in the environs of the city is the huge power plant built for IEC south of the site, for which Haifa University and the CMS carried out their first underwater investigations.

The most recent construction in the Caesarea harbour is on the Herodian Southern Breakwater immediately west of the Caesarea Citadel Restaurant, where the foundations of a new fish market were poured in the summer of 1988. Salvage excavation in this area was discussed above in Section III.L.

The future of the National Park, the archaeological site, the vicinity of Sedot Yam will continue to revolve, in part, around the fame of the ancient city and its ability to draw local and foreign visitors. An excellent collection of local artifacts has been saved, carefully studied, and displayed in a small museum on the kibbutz (Wegman 1981), and for several years the possibility of building a new and larger facility more centrally located to the ancient site has been discussed. From 1988 until 1990 a major museum exhibition entitled "King Herod's Dream: Caesarea on the Sea," will be touring the United States and Canada (Holum et al. 1988). It is hoped that many of the models, graphics, and artifacts that have been gathered for this show will at sometime in the near future be housed in a new museum on the site.

[R.L.V.]

I.B. Man-Made Features: 8. Water-Supply System.

Caesarea was founded at a time when a supply of running water had become a must for a town of any importance. Archaeological evidence shows that in the Roman and Byzantine period almost all the towns in Israel were supplied with water by an aqueduct. Literary sources usually praise Caesarea for its bountiful supply of flowing water, but some sources tell us that water was obtained from wells and cisterns, a sign that the functioning of the aqueducts was interrupted at times during the history of the town. Only one literary source -- the sixth-century Sophist Choricius of Gaza -- mentions any building or repair activity on the aqueducts (1929: 44-49, 60-62, *Oratio III: Laudatio Arati et Stephani*). Even Josephus, our best source on the founding of Caesarea, is disappointing in this respect. In his description of the many amenities of Caesarea in his time (*BJ* 1.408-16, *AJ* 15.331-41), there is no mention of an aqueduct. Perhaps Josephus takes it for granted that the existence of an aqueduct is implied by his description of the ingenious and elaborate sewer system of Caesarea. The water system developed in stages and underwent several changes during its history. Conder and Kitchener in their *Survey of Western Palestine* (1882: 18-23) first used the terms "High-Level Aqueduct" and "Low-Level Aqueduct" for the two major structures, each of which brought water from a different source. The system has since been the subject of several studies, most recently Olami and Peleg 1977, and Levine 1975a (pp. 30-36).

The High-Level Aqueducts. The first stage was the building of a single channel which brought to Caesarea the water of a group of springs located east of the Carmel range near Kfar Shumi (figs. I.4, 7). At the beginning of its course, the channel was built on a continuous wall, but further on, where the channel had to rise higher above the ground, it was carried on a series of arches built of sandstone blocks. The conduit itself was lined with hydraulic mortar. The arches were capped by a continuous, horizontal cornice (fig. I.41). After skirting the southern end of the Carmel range, the aqueduct turns due west, crossing the Kabbara swamp.

About 1 km from the coast the channel penetrates a sandstone ridge by means of a tunnel about 400 m long. Only one of the *putei*, shafts sunk for the excavation and maintenance of the tunnel, is known today. The square vertical shaft, which is encircled by a rock-cut stair, narrows as it descends.

At the end of the tunnel, the aqueduct turns to the SW, and upon reaching the coast, it turns south, straight to the city. Just north of the city, the sea has destroyed about 500 m of the aqueduct. (figs. I.21, 34). All traces of it disappear inside the city walls, so nothing is known about the distribution system. It seems that this first stage was built by Herod or the early Roman procurators.

Some 130 years later, at the time of the Bar Kochba revolt during the reign of Hadrian, a second branch was built (figs. I.43-44). Eight inscriptions mentioning Hadrian and various legions attest to the time of its construction (Vilnay 1928a, 1928b; Broshi 1936; Negev 1964; Barag 1964; Olami & Ringel 1975). The single inscription written in Greek belongs to a later period in the history of Caesarea (Hamburger 1959). That these inscriptions refer to the building of the branch and not merely to repairs is especially clear from an inscription of the Tenth Legion, found only in 1973 (Olami & Ringel 1975: 148). Here the word *fecit*, meaning "made," is used.

In order to bring more water to the city, an underground collection and conduction system was built. This system exploited a group of springs in the upper reaches of the Nahal Tanninim (Crocodile River), located in the eastern foothills of the Carmel (fig. I.4). The 6.5 km long tunnel is hewn in soft limestone without any support or lining. Access shafts have been found in those parts of the tunnel which have been explored, connecting the tunnel with the surface about every 40 m. This design is in accord with Vitruvius' recommendation (8.6.3). The best preserved and most accessible part of the underground system is not in the valley of Nahal Tanninim proper, but in one of its tributaries, Nahal Snunit. The subterranean channel here seems to be a branch contributing to the main channel in Nahal Tanninim.

An access shaft (*puteus*) descends obliquely to the tunnel, 6.8 m below the surface. This sloping shaft, incorporating 27 rock-cut steps, is 1.0-1.3 m wide, 2 m high, and meets the water tunnel at a right angle. The tunnel itself is 0.65 m wide and varies in height from 0.8 to 1.5 m. Tool marks on the walls reveal that the tunnel was cut outward in both directions from the shaft. Small lamp niches were cut into the rock near the ceiling, always to the right of the diggers. At this point the tunnel is accessible for 44 m in one direction and 100 m in the other. Two *putei* can be seen in the longer section, blocked from above. Only seven open shafts are known, but they indicate the course of the system.

Farther on, the aqueduct skirts the plain as an open channel on ground level and joins the earlier aqueduct at the southern end of the Carmel. From here it is built as a perfect architectural replica of the first channel, joined to its right (north or west) side. At any of the cuts it can be seen that the new channel has an ashlar facing only on the outside, and that the stone and mortar filling hides the continuous cornice of the first branch. The new branch was wider and deeper than the first.

During more than twelve centuries of use this system naturally underwent repairs and changes. The weak spot of the system was the crossing of the Kabbara swamp, since the piers supporting the arches tended to sink into the unstable ground. At some time a bypass was built around the worst part of the swamp. This bypass served only the first, or Herodian, branch. It is of a different construction and appears to belong to the Byzantine period (fig. I.45). The cornice is square, the channel is built of ashlars rather than the concrete of the original design, and the architecture underlines the horizontal lines. The second, Hadrianic branch continued as before, straight through the swamp. The structure here is a patchwork of repairs, reinforcement, and reconstruction.

Except for the bypass, there were no remarkable changes in the earlier channel. Contrary to recommended practice, both channels seem originally to have been open at the top. Evidently only at a later stage, when the dunes near the sea piled up and began to cover the aqueduct, was the first channel roofed. This was executed by erecting pairs of stones on the shoulders of the channel, leaning together like a gable. Every few metres a long stone slab, laid from one shoulder to the other like a tie beam, countered the outward thrust of the pair of stones. This covering was added on top of the smooth plaster on the channel shoulders.

The later channel underwent two distinct changes. Three clay pipelines were installed in the portion that crosses the swamp (fig. I.46). It can be assumed that this was done after repeated failures of the foundations caused the channel to sink, spilling water out at the low spots. It was decided to cross the trouble spot with a pressure pipeline, the pipes laid on the bottom of the channel and embedded in mortar. The flow in these pipes was only about ten percent of the flow in the original channel.

In at least three places in the pipelines we find pairs of elbow-bends pointing upwards. The devices were built about 100 m apart in a perfectly straight and level part of the pipeline. These bends indicate the construction of devices to relieve air and water pressure, perhaps the *colliviaria* mentioned by Vitruvius (8.6.6). A Byzantine date for the construction of the pipeline is suggested more by the general context of this work in the history of the town and its waterworks than by any tangible evidence.

Later on, the second or Hadrianic channel was completely blocked by crude masonry and a small, poorly-built channel was constructed on top of this (fig. I.21, C). It reached Caesarea at a level 2.5 m higher than the original channel. It seems that this small, high channel was constructed in the Crusader period, when Caesarea was a small town situated high on the ruins of earlier towns (but compare the interpretation by Neev and Emery in Section I.A.2). There is no evidence that the first or Herodian branch had ceased to function at this time.

The Slope and Flow-Capacity of the Various Branches. Measurement of the present condition of the channels reveal a significant sinking of the High-Level Aqueduct in the swamp area. Those sections of the structure built on stable ground show a fall of 0.16 m in 1 km, or 0.016 percent. Assuming that this fall is constant, the maximum flow-capacities would be:

First (Herodian) channel: 258 litres/second,
Second (Hadrianic) channel: 453 litres/second,
Third (Crusader) channel: 60 litres/second.

The capacity of the three clay pipes, taking into account the head available at the level of the supply channel, was only 41 litres/second.

The Low-Level Aqueduct. The High-Level Aqueduct exploited all the topographically suitable springs near Caesarea, but it seems that with the expansion of the city in the Byzantine period, demand still exceeded supply. There is an ample supply of water quite near the town provided by the many springs of the Kabbara swamp, but their level is only 3.0-3.5 m above sea level, too low to be conducted to Caesarea by gravity flow. The ancient engineers raised the level of the pooled water artificially by building a 200 m long dam at the point where the Krokodeilon River passes through a gap in the sandstone ridge and another, 900 m long, across the coastal plain to the north, forming an artificial lake of about 4800 ha (see Oleson 1984b) (fig. I.4). The water of the lake rose to approximately 6.5 m above sea level, allowing it to be conducted to Caesarea by a channel only 5 km long. Its beginning was cut in the rock, and farther on, when it reached the sand dunes, it was built as a channel of coarse masonry roofed with a barrel vault (fig. I.22).

A small exploratory excavation under the foundations of the aqueduct near the present termination of the channel revealed fourth-century potsherds (R. Bull, personal communication). Between corners, the High-Level Aqueduct is built in perfectly straight sections. In contrast, the channel of the Low-Level Aqueduct is far from straight. If it can be assumed that the Byzantine builders were familiar with Roman building technique yet did not attain the same degree of perfection and care in their work, then the generally low standard of finish of the Low-Level Aqueduct suggests a Byzantine date for its construction.

A ceramic pipeline brought water from the Herodian channel to the fifth century "Christian Building" and on its way crossed the Low-Level Aqueduct (Frova et al. 1965: 293-303) (fig. I.7, pl. I, no. 2, 4). This pipeline proves that at the time this building was constructed at least these two aqueduct channels were in operation.

The channel of the Low-Level Aqueduct was built without any slope. At all points where the floor of the channel was surveyed, it was 5.5 m above MSL. But its ample cross-section and relatively short length nevertheless allowed a flow of 710 litres/second.

The study of the water supply of Caesarea can serve two purposes. First, it can make a quite important contribution to the history of technology of water supply. Second, the study can provide clues to the history of the town and corroborate evidence from other sources.

[Y.P.]

APPENDIX I.A: JOSEPHUS' DESCRIPTION OF SEBASTOS.

Introduction. The historian Josephus, who was born around A.D. 37/8, published a history of the Jewish War between 75 and 79 and a history of the Jewish people in 93/4. Both these works contain a detailed description of the city of Caesarea and its harbour, Sebastos. Despite certain inevitable inaccuracies (Oleson 1988; Oleson et al. 1984), the data contained in these descriptions have been of the greatest value in assisting the reconstruction of the layout and appearance of the harbour in the Flavian period. The passages are quoted here *in extenso* to introduce the reader to the descriptions, and to avoid constant lengthy quotation of the passages in the text. The translation has been prepared by J.P. Oleson on the basis of the Greek text in the Loeb editions of Thackeray (1927: 192-96) for the *Jewish War* (or *Bellum Judaicum*, as it is usually cited in scholarly literature; abbv. *BJ*), and Marcus and Wikgren (1963: 158-64) for the *Jewish Antiquities* (or *Antiquitates Judaicae*, abbv. *AJ*). Transliterations of some of the important Greek vocabulary have been left in for those sections that deal with the design and construction of the harbour proper. Josephus' Greek is very idiosyncratic, so it is not always possible to render the text literally into English. The Caesar mentioned in the text is the emperor Augustus.

Jewish War 1.408-414.

(408) He [Herod] noticed a settlement on the coast -- it was called Straton's Tower (*Stratōnos pyrgos*) -- which, although much decayed, because of its favorable location was capable of benefitting from his generosity. He rebuilt the whole city in white marble (*leukō lithō*), and decorated it with the most splendid palaces, revealing here in particular his natural magnificence. (409) For the whole coastline between Dor and Joppa, midway between which the city lies, happened to lack a harbour, so that every ship coasting along Phoenicia towards Egypt had to ride out southwest head winds riding at anchor in the open sea. Even when this wind blows gently, such great waves are stirred up against the reefs that the backwash of the surge makes the sea wild far off shore. (410) But the King, through a great outlay of money and sustained by his ambition, conquered nature and built a harbour (*limena*) larger than the Piraeus, encompassing deep-water subsidiary anchorages within it (*en de tois muchois autou batheis hormous heterous*).

(411) Although the location was generally unfavorable, he contended with the difficulties so well that the strength of the construction (*domēseōs*) could not be overcome by the sea, and its beauty seemed finished off without impediment. Having calculated the relative size of the harbour (*limēn*) as we have stated, he let down stone blocks (*lithous*) into the sea to a depth of 20 fathoms (ca. 37 m). Most of them were 50 feet long, 9 high, and 10 wide (15.25 x 2.7 x 3.05 m), some even larger. (412) When the submarine foundation (*hyphalon*) was finished, he then

laid out the mole (*teichos*) above sea level, 200 feet across (61.0 m). Of this, a 100-foot portion was built out to break the force of the waves, and consequently was called the breakwater (*prokumia*). The rest supported the stone wall (*teichos*) that encircled the harbour. At intervals along it were great towers (*pyrgois*), the tallest and most magnificent of which was named Drusion, after the stepson of Caesar.

(413) There were numerous vaulted chambers (*psalides*) for the reception (*katagōgē*) 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 (*eisplous*) faced north, for in this region the north wind always brings the clearest skies. At the harbour entrance (*stomatos*) there were colossal statues, three on either side, set up on columns. A massively-built tower (*pyrgos*) supported the columns on the port side of boats entering the harbour; those on the starboard side were supported by two upright blocks of stone yoked together (*sunezeugmenoi*), higher than the tower on the other side.

(414) There were buildings right next to the harbour also built of white marble, and the passageways of the city ran straight towards it, laid out at equal intervals. On a hill directly opposite the harbour entrance channel (*stomatos*) stood the temple of Caesar [Rome and Augustus, ed.], set apart by its scale and beauty. In it there was a colossal statue of Caesar, not inferior to the Zeus at Olympia on which it was modelled, and one of the Goddess Roma just like that of Hera at Argos. He dedicated the city to the province, the harbour to the men who sailed in these waters, and the honour of the foundation to Caesar: he consequently named it Caesarea.

Jewish Antiquities 15.331-41.

(331) Noticing a place on the coast-line very suitable for the foundation of a city -- formerly called Straton's Tower -- he undertook a magnificent project (*diagraphē*) and built the whole city not any old way but with structures of white marble, adorning it as well with very costly palaces and civic buildings. (332) But the greatest project and that which required the most effort was a harbour protected from the waves (*aklustō limeni*), equal to the Piraeus in size, with quays (*katagōgas*) and secondary anchorages (*deuterous huphormous*) inside. The remarkable thing about the construction was that he did not have any local supplies suitable for so great a project, but it was brought to completion with materials imported at enormous expense.

(333) Now this city is situated in Phoenicia, on the coasting route down to Egypt, halfway between Dor and Joppa. These are two little towns directly on the coast-line, poor mooring places (*dusorma*), since they lie open to the southwest wind, which constantly sweeps sand up from the sea bottom on to the shore and thus does not offer a smooth landing (*katagōgēn ou meilichion*). Most of the time merchants must ride unsteadily at anchor off shore. (334) To correct this drawback in the topography, he laid out a circular harbour (*kuklon tou limenos*) on a scale sufficient to allow large fleets to lie at anchor close to shore, and let down enormous blocks of stone (*lithous*) to a depth of 20 fathoms (ca. 37 m). Most were

50 feet long, not less than 18 feet wide, and 9 feet high (15.25 x 5.49 x 2.7 m). (335) The structure (*endomēsis*) 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 (*prokumatia*. This is the manuscript reading. The editors of this edition prefer to use *prokumia*). (336) The rest comprised a stone wall (*teichos*) set at intervals with towers (*pyrgois*), the tallest of which, quite a beautiful thing, was called Drusus -- taking its name from Drusus, the stepson of Caesar who died young. (337) A series of vaulted chambers (*psalides*) was built into it for the reception (*katagōgai*) of sailors, and in front of them a wide, curving quay (*abobasis*) encircled the whole harbour, very pleasant for those who wished to stroll around. The entrance (*eisplous*) or mouth (*stoma*) was built towards the north, for this wind brings the clearest skies. (338) The foundation (*basis*) of the whole encircling wall on the port side of those sailing into the harbour was a tower (*pyrgos*) built up on a broad base to withstand the water firmly, while on the starboard side were two great stone blocks (*lithoi*), taller than the tower on the opposite side, upright and yoked together (*sunezeugmenoi*).

(339) A continuous line of buildings finished off with highly polished stone formed a circle around the harbour, and in their midst was a low hill carrying a temple of Caesar visible from afar to those sailing towards the harbour. It contained images of both the Goddess Roma and of Caesar. The city itself is called Caesarea and is very beautiful both for its materials and its finish. (340) But the underground conduits (*hyponomoi*) and sewers (*laurai*) received no less attention than the structures built above them. Some of the drains led into the harbour and into the sea at regular intervals, and one transverse branch connected them all, so that rainwater and the waste water of the inhabitants was all carried off easily together. And whenever the sea was driven in from off shore, it would flow through the network and purge the whole city of its filth.

(341) Herod also set up in the city a stone theatre, and south of the harbour and set back from the shore, an amphitheatre capable of accommodating a large crowd of people, conveniently located for a view over the sea. Now the city was completed in such a fashion in the space of 12 years, since the king did not tire of the project, and his financial resources were sufficient.

[J.P.O.]

CHAPTER II: LAND AND SEA EXCAVATION BEFORE CAHEP

II.A: Summary of Land Excavation: 1. Introduction.

Although for over 700 years Caesarea was the largest and probably the most important urban centre in Palestine, and although its precise location was never lost, no serious attempts were made to unearth the remnants of her magnificent past until the second half of our century. Josephus devoted a long and detailed description to the building of the city by Herod the Great, specifying various public structures, architectural complexes, and monuments of engineering, along with their relative location within the city (*BJ* 1.408-415; *AJ* 15.331-341). Until recently, most scholars wrote monographs about the city's ancient topography without studying the physical remains at Caesarea in conjunction with Josephus' writing (e.g. Haefeli 1923). Even today, more than 30 years after large-scale excavations began, only a few isolated monuments from Herodian Caesarea have been throughly excavated and studied. The archaeologist's spade has not yet touched over 90% of the site within the city walls.

One reason for this neglect may be the very size of the site, which is so big that its proper excavation is a uniquely demanding project which only national or international agencies have the expertise and financial resources to undertake. Caesarea, although of prime historical significance to Christian and Jewish history, and the settlement of Eretz Israel, could never compete with the more renowned biblical sites of Jerusalem, Megiddo (Armageddon), or even Jericho. Another reason might be that the city several times endured destructions more complete and thorough than those suffered by other ancient cities in Israel. During the last 30 years it has become apparent from the relatively minor portion of Caesarea excavated that the original city built by Herod was altered radically in the later Roman period, during the Byzantine era, and at least once more during the Early Arab period. Muslim documentation of the extent of the destruction of the Crusader city by the Mamelukes in 1265 seems to ring true (Ringel 1975: 173, n. 47). Yet even this was not the last destruction of the site. Throughout the eighteenth, nineteenth and early twentieth centuries Caesarea was a major source of building materials for newly rebuilt coastal cities such as Akko, Jaffa, and even Alexandria in Egypt (Schiler 1981a: 69-72). Further architectural material was carried off and used as sources for lime or building stones for the British military camps nearby (Wegman 1981: 105).

In the absence of data from archaeological excavations, the features of the ancient topography of Caesarea were first defined by surface surveys of the site and its visible features, and their results compared with literary sources. Pococke was the first to do so in relatively modern times, in 1737 (Pococke 1745: 57-60).

After him, the main contributions were those of Guérin (1875: 321-39), and of Conder and Kitchener for the *Survey of Western Palestine* (1882: 13-29, 34, 40-43, 66-68).

In the twentieth century, first the German priest Haefeli (1923) and then the Israeli geographer Reifenberg (1950-51) wrote studies on Caesarea's ancient topography. Although both visited it several times, Reifenberg was the first to present an accurate picture of the entire site. In 1975, two new monographs incorporated recent data from archaeological excavations into their historical and topographical studies of Caesarea: Levine 1975a, and Ringel 1975. Levine also later compiled a thorough survey of the archaeological work done in Caesarea up to the 1980's (Levine & Netzer 1986: 3-14) but omitted the important monograph of A. Negev, perhaps because it was written for the general public (Negev 1967). This monograph included invaluable information about Negev's own excavations at Caesarea, some of which is not to be found elsewhere. Of the various full-scale archaeological excavations that were conducted in Caesarea since the early 1960's, only two final reports have appeared. The first is the volume published by the Italian Mission (Frova et al. 1965), which deals mainly with architectural remains. Sculpture and small finds such as pottery and coins are presented only as needed to establish a datable stratigraphy for the monuments. The second is the publication of the excavations of Hebrew University during the seasons of 1975, 1976, and 1979 (Levine & Netzer 1986). These two studies are of considerable importance for the stratigraphy of the occupation levels of the coastal area of Caesarea during the later Roman, Byzantine, and Early Arab periods. They do not, however, deal with any major public buildings or with the problem of ancient Caesarea's topography.

[A.R.]

II.A. Summary of Land Excavation: 2. Early Mandate and Israeli Excavations.

The first true archaeological dig in Caesarea, as opposed to the chance recovery of finds during surface surveys, the salvage of building materials, or plowing, was made by J. Ory for the Department of Antiquities of British Mandate Palestine. This excavation was located near the shore north of the Crusader city (fig. I.8, no. 18, pl. I, no. 10), at a site where part of a mosaic floor had been exposed by the winter rains of 1933 (Negev 1967: 65). The mosaic contained a Greek inscription that probably related it to a Jewish public building, possibly a synagogue. In 1945 the floor was unearthed and carefully studied (Schwabe 1950a). The inscription on the mosaic was a dedication: a quotation from the Bible plus the Hebrew word *Shalom*.

In 1951, three years after the founding of the State of Israel, the chance discovery of the upper part of a large statue in Kibbutz Sedot Yam's field east of the Crusader city led to a rescue excavation. This was later expanded to a full-scale dig by the Israeli Department of Antiquities. It continued for three seasons (Yeivin 1955) under the direction of S. Yeivin, the director of the Israel Department of Antiquities at that time.

The excavations exposed a wide, well-paved street of the Byzantine era, running on a north-south axis, flanked by shops on both sides (fig. I.8, no. 19, pl. I, no. 14). Towards the south the street descended through a wide staircase to an open public court. Around this court there were bases for various imperial statues. Two such statues over 3 m high were found on either side of the colonnaded street entrance at the north end of the court. The western statue, of white marble, depicted a seated male deity, dated to the late third or early fourth century. The eastern was also a seated male, fully dressed with a toga and tunic. It is of Egyptian porphyry and is considered to be a second-century statue of Hadrian. The missing head and limbs might have been carved from another type of stone. Both statues, like most of the architectural members, are reused Roman elements that were installed along the street and the court during the sixth century (Avi-Yonah 1970). The date for the street and the court is indicated by a mosaic inscription at the base of the staircase. While the street and the adjacent shops were paved with mosaic floors, the court was paved with various marble slabs that had been salvaged from earlier Roman structures and monuments.

[A.R.]

II.A. Summary of Land Excavation: 3. Hebrew University.

In 1956, a short season of excavation was carried out by the Department of Archaeology of the Hebrew University in Jerusalem. This was sponsored by the Louis M. Rabinowitz Fund for the Excavation of Ancient Synagogues, and directed by M. Avi-Yonah, with the assistance of A. Negev. The excavation took place at the spot where a Corinthian capital decorated with a seven-branch candlestick (the Jewish Menorah) had been found some time earlier (fig. I.8, no. 18, pl. I, no. 10), close to the site where Ory had excavated the mosaic floor on the shore north of the Crusader city.

An area about 30 x 20 m was excavated and in some places reached virgin soil 7 m below the surface. The excavators exposed five occupation levels from the Hellenistic through the Early Arab periods. Even fourth-century B.C. Persian pottery appeared, and foundations belonging to Straton's Tower, the settlement which preceded Caesarea on this site (Avi-Yonah 1956a: 260). The Herodian period was represented by foundations for large public buildings. These were reused in the fourth century for a larger structure within which many architectural members decorated with Jewish symbols were found. During the sixth century, the earlier structures were covered by a new building with mosaic floors, one including a dedicatory inscription in Greek: "Beryllus *archis[ynagogus?]* and administrator, son of Iutos, made the pavement work of the triclinium out of his own money." This building was destroyed by fire and was rebuilt soon after the Muslim occupation, about the mid-seventh century.

In the summer of 1962 the Department of Archaeology of the Hebrew University in Jerusalem resumed and expanded their field-work of 1956. They collaborated with a team from the Southern Theological Seminary (Eisenberg Museum) of Louisville, Kentucky, headed by Prof. J. Vardman, and were assisted by funding from the Israel National Parks Authority (at that time still called the Department

for the Improvement of Landscaping and Restoration of Historical Sites of the Office of the Prime Minister). Prof. M. Avi-Yonah was again director of the excavations, assisted by A. Negev. Four areas were designated for the season, all in the vicinity of the 1956 excavations.

In Area A the earlier excavations were cleaned and extended. Five strata were identified and more complete plans of the buildings were drawn for each stratum. Stratum I, including ashlar walls of headers on rubble foundations, was dated by imported Greek, East Greek, and local Hellenistic pottery to the second century B.C. In Stratum II, the large Herodian walls were cleared to a level 1.4 m above MSL. There were five courses of well-dressed stones, laid in alternating courses of headers and stretchers, associated with typical late-first-century B.C. pottery and some Hellenistic wares. Stratum III consisted of a secondary use of the Herodian buildings, during which part of it was converted into a large plastered pool that remained in use after the fourth century. Stratum IV was dated before 355 by a horde of over 3700 coins. Fragments of a lamp decorated with a menorah and a piece of a marble plaque with part of a Jewish "Priestly Order" inscription might belong to the fifth-century synagogue (Avi-Yonah 1962). Stratum V included the still later synagogue of the Byzantine period.

In Area B, a Byzantine house with mosaic paving was cleared. The mosaic depicted two pairs of sandals. In Area C only a few Early Arab tombs were found, cut down into a level that yielded some Hellenistic pottery.

A trench 50 m long and 10 m wide was laid out in Area D, east of the synagogue. In the eastern side of the trench a large, robbed-out ashlar structure was found. Only one corner remained *in situ*, covered by a heap of broken pottery of Hellenistic date, including stamped handles of Coan, Cnidian and Rhodian wine amphoras. The structure had been built in courses of alternating pairs of headers and stretchers. It was robbed out by Herod's masons while they were building Caesarea. At that time the pottery was dumped as well. These remains covered a portion of the town of Straton's Tower (Negev 1967: 12-13), abandoned when it was taken over by Alexander Jannaeus around 100 B.C. The excavators also noticed a massive wall by the sea west of the synagogue which they thought "might be part of the mole of the harbour of Straton's Tower" (Avi-Yonah & Negev 1963d: 148).

Excavations by the Hebrew University resumed at Caesarea in 1975, directed by L. Levine and E. Netzer and under the auspices of the Institute of Archaeology. The main areas for excavation were selected according to the special interests of each of the directors: Levine, who had written his dissertation on the history of Caesarea under Roman rule (1975b) and later published a monograph on Roman Caesarea (1975a), was looking for the southern part of the Jewish suburb and the famous Maradata Synagogue. He also wished to elucidate a passage in ancient Jewish texts referring to the existence of two separate synagogues in Caesarea (*J. Sanhedrin* X, 1, 28a; *J. Shabbat* VI, 2, 8a). At least one of these was on the shore (Josephus, *AJ* 14.258; see Levine 1975a: 40-45). With this in mind, an area within the Crusader city on the high ground just north of the present beach was selected (figs. I.8, no. 21, III.109, pl. I, no. 62). The choice of site was reinforced by the casual surface find of a column drum with an incised Hebrew inscription.

Netzer, who was studying the royal winter palaces of the Hasmonaean kings and of Herod at Jericho and at Herodion (Netzer 1977), hoped to find a similar palace with a swimming pool on the leveled promontory west of the theatre of Caesarea, on the South Bay (fig. I.8, no. 29, pl. I, no. 41). Following Josephus' description of the royal palace built by Herod in the city (*AJ* 15.331), and intrigued by the idea that the site of the rock-cut pool was known by the locals as "Cleopatra's Baths", he selected it for thorough, careful excavation. The field work was started in October 1975 and continued for a second season during April 1976. A third season was carried out in 1979, but only within the Crusader city. At that time four additional trenches were excavated in the area southeast of the main trench (Levine & Netzer 1986: 1, Plan 2). This additional dig was carried out at the initiative of the Caesarea Development Co. in order to check the buried strata before building on the land, so its results are not included in the above-mentioned final report. The building project ultimately was vetoed by Israel Department of Antiquities and shelved.

The excavations at the main area within the Crusader city have exposed about 1000 m^2, as a 10 m wide field extending as far as 70 m inland (east) of the actual shore-line. Four strata were identified and thoroughly studied.

Stratum I: Sparse remains of the Crusader period with no stratigraphic or architectural context.

Stratum II: This contained the well-preserved architectural remains of what seems to have been a habitation quarter. It had two phases in the earlier and later parts of the tenth century (the end of the Abbasid and the early Fatimid periods). In both phases the walls were built of small ashlar blocks of kurkar, and the pavements made of similar slabs.

Stratum III: This level was similar to the earlier Stratum II, but included structures of lesser quality. During this period the former road system became derelict and was covered with buildings. Many wells and cisterns that were still in use in the later stages were dug during this phase, indicating that the aqueduct feeding a central water supply had already broken down. The date suggested for this stratum runs from the second half of the eighth to the tenth century.

Stratum IV: This consisted mainly of a wide, well-paved street running along the north side of the excavated area toward the sea. South and west of it were the solid walls of a large rectangular complex, possibly a public warehouse or an important administrative centre. This phase seems to have been short, within the later Byzantine era. Earlier building stages were barely exposed during the excavations. Yet a quay built of ashlar blocks arranged as headers was noted in the water to the west and surveyed (Levine & Netzer 1986: 50-52, Plans 3, 11, ill. 73; see also Raban et al. 1976: 32-33, Plan 10, ill. 24). Near the water-line to the south, a series of wide ashlar walls of the Roman and Byzantine periods were surveyed and partially excavated. Between two north-south walls, there were six silos lined with ashlar paving slabs and floored with mosaic. These silos are tentatively dated to the late Byzantine or Early Arab period (Stratum III or IV). They were incorporated within the walls of an earlier phase (Levine & Netzer 1986: 58-63; Plan 14, ills. 91, 92; see also Raban & Stieglitz 1987; and below, Section III.Q).

The excavations at the promontory west of the theatre were carried out only during the 1976 season and were directed by E. Netzer with the assistance of Z. Ma'oz. In addition to surveying the central pool and the adjacent walls and rock-cut features, the excavation revealed four rooms on the south side of the promontory and re-exposed mosaic floors in three rooms east of the pool. The mosaics had been known since 1960, when Link's divers cleared them with water-jets and surveyed and published them (Flinder 1976a: 79-80). The final report of this excavation suggests tentatively that the complex was built initially as a palace with a fresh water swimming pool at its centre, and that in the later Roman period it was remodelled as a salt-water fish tank (Netzer, in Netzer & Levine 1986: 158-60, 176-77). It was the first time a carefully controlled stratigraphic excavation was carried out, but regrettably the data presented by Netzer concerning the depth of the pool's rocky floor, and the arrangement of the filling and draining channels disagree with Flinder's report and the CAHEP surveys (see Section III.N).

[A.R.]

II.A. Summary of Land Excavation: 4. National Park Service.

Scholars of the Hebrew University were also responsible for one of the most extensive excavations so far undertaken in Caesarea. During the years 1960-62, A. Negev directed a large-scale project of survey, clearing, and restoration of the fortifications and other main features of the Crusader city of Caesarea in order to develop the site as a National Park and tourist destination. Using mechanical shovels and manual labour, the entire circumference of the wall and the moat in front of it were cleared. A careful survey made during this work revealed that the city wall was built before the final Crusader project directed by King Louis IX (the Pious) of France during his stay in Caesarea (1251-52). The original plan of the fortifications was reestablished, and its eastern gate was restored up to a point above the floor of its second storey. Inside the Crusader city a street was cleared and reconstructed, leading from the eastern gate to the southeast corner tower of the fortification wall. Another street, paved with reused Roman and Byzantine architectural members of marble and porphyry, was also cleared. On top of the mound facing the sea on the south side of the Crusader city, the wall stubs of the three apses of the Crusader cathedral were cleared and restored. After exposure of the original paving of the church, it became apparent that the roof had never been completed, and that the structure had collapsed into a series of large vaults (fig. III.67). Excavation along the the western face probed the northern flank of this podium, exposing massive foundations with niches for statues, and remnants of painted stucco. This complex very likely should be associated with the temple built by Herod (*AJ* 15.337). At the southern end of the western face of the mound, a series of six large vaults was found. The southernmost vault was uncovered intact and partially cleared (Negev 1960b; 1963b). This chamber (21 x 7 x 13 m) was built in the Herodian period and might have been designed (with the neighbouring vaults) to serve as a podium for Herod's temple of Rome and Augustus. At the same time, they were open toward the Herodian Inner Harbour and could also have been used as warehouses (Negev 1967: 22-25).

Excavation of the low ground in front of the vault exposed storage bins, cistern, mosaic floors, and dwellings of the Late Byzantine and Early Arab periods. The absence of any earlier structures beneath suggest that at least during Herod's time and the Late Roman period this area was part of the basin of the inner harbour. A massive stone platform over 10 m wide was exposed about half-way between the vaults on the south and the temple podium on the north. This structure protrudes west of the mound and was interpreted by the excavator as a quay for the Herodian Inner Harbour (Negev 1967: 27-30) (later CAHEP Area I_1).

An impressive Byzantine complex was discovered south of the Crusader city, consisting of a series of rooms with mosaic floors surrounding a nicely paved court with an apse and a cupola on its west side. On the basis of *Romans* 13:3 and the discovery of a statue of St. Christopher, the excavator has suggested that this complex might be "the remains of the famous library of Origen, later used by Eusebius" (Negev 1960a: 22) (fig. I.8, no. 25).

As part of the overall restoration work undertaken by the Department of Landscape, Improvement and Conservation of Historic Monuments, Negev cleared 400 m of the High-Level Aqueduct along the sea-coast to the north. A series of arches was excavated to their base level, and the two adjacent channels were studied to clarify their relative chronology and various stages of use. Latin inscriptions found on marble plaques built into the structures record construction work carried out by several military units during Hadrian's reign (Negev 1964). The High-Level and Low-Level Aqueducts were thoroughly surveyed up to their water sources (Olami & Peleg 1977), and additional inscribed plaques were found along their course (Hamburger 1959; Olami & Ringel 1975). To the south of Caesarea, well-defined rectangular hollows, covered by sand dunes but visible in aerial photographs (fig. I.32), were interpreted as the streets of neighborhoods deserted after the Muslim occupation or after the neglect of the aqueducts which supplied water for irrigation (Reifenberg 1950-51; Kedar & Ziv 1964). Later field survey and trial excavations, however, have proven that these rectangular hollows are the typical Arab dune-cleared gardens common even today in the Gaza Strip, known as *muwatzi* (Porat 1975).

Many other individual structures have been found, surveyed and excavated by Israeli archaeologists in Caesarea and its vicinity over the years. Most of these sites were accidently discovered during land reclamation, building, or agricultural work. Most of the sites that were discovered in the fields of Kibbutz Sedot Yam were properly recorded and salvaged because of the diligence of Mr. A. Wegman. Some archaeological remains discovered during work carried out by the Caesarea Development Company were studied by the regional inspector of the Israel Department of Antiquities, Mr. A. Siegelman. Among such sites was a mosaic decorated with wild birds, probably from a Byzantine Church (fig. I.8, no. 12). On the mosaic of its central nave (13.5 m x 11.5 m) there are 120 medallions with depictions of animals, (bear, lion, elephant), flowers, and birds (Yeivin 1957: 260; Ovadiah 1970: 49-95). Another Byzantine mosaic and some broken sarcophagi were found NE of the hippodrome (Wegman 1950) (fig. I.7, no. 11).

[A.R.]

II.A. Summary of Land Excavation: 5. Italian Expedition.

For five seasons (1959-1963) the Italian Archaeological Mission of the Is... Lombardo di Scienze e Lettere di Milano, excavated in Caesarea under the dire... tion of A. Frova. Their main project was exposure and study of the city's ancie... theatre, mentioned by Josephus (*AJ* 15.341), although it seems that he confused... with the amphitheatre (Levine 1975a: 24, n. 161). The location of this monume... had already been identified in the nineteenth century by the surveyors of the Brit... ish Western Palestine Survey (Conder & Kitchener 1882: 15-17). The entire stru... ture of the theatre along with its surroundings were carefully cleared and partial... restored (figs. I.8, nos. 28, 30, I.40, pl. I, nos. 39-40).

The Italians have determined that the theatre was originally built at the ti... of Herod on a rather modest scale, with a capacity of no more than 4000 specta... tors. No marble was used in the construction of the *cavea* or the paving of the... orchestra. Instead, a plaster floor was painted to imitate the appearance of col... ourful marble slabs. This floor of the orchestra was renewed and repainted fr... quently, and the Italian archeologists recorded 14 such superimposed floors. Some... remarkable architectural fragments of marble, found in the later fill, seem to... belong to that initial phase. An inscription, also from this first phase, was incorpo... rated in the secondary use of a later staircase on the northern end of the *cavea* at... the orchestra level; it mentions Pontius Pilate and a sacred precinct called *Tiber... ieum* (Frova 1961b: 196). Of the original *cavea*, only the central part of the lower... five rows of seats was found, and part of a drainage system below the floor. In the... second phase, a fill of mortared rubble was laid on the earlier seats, covered by... carefully cut slabs of stone that have been preserved to a height of thirteen rows... of seats. Still later, the entire *praecinctio* was removed and replaced with seats of... mortared rubble. From the angular vaulted corridor six radial passages led to the... *praecinctio*. These entrance floors were paved with mosaic. Of the *summa cavea*... not much has been preserved, and it seems as if the entire upper structure, as well... as most of the *scaena*, had collapsed in late antiquity and its architectural mem... bers and ashlar blocks extensively robbed.

The *ima cavea* consisted of six *cunei* delimited by seven staircases. The... *summa cavea* had in its last phase at least seven *cunei*. During the second phase... two imposing arched *paradoi* were added on both sides of the *cavea*, leading to the... orchestra. They were blocked with vertical marble slabs sometime in the late... third or early fourth century when the *orchestra* and two *proscaenia* were rebuilt... to serve as a *colimbetra*, for water games.

The *orchestra*, which had a diameter of about 30 m, was paved with marble... slabs sometime in the post-Herodian period. The stage (*proscaenium*) was about... m wide and raised 1 m above ground level; it used a series of columns and vaulted... *hyposcaenium* as a base. Its facade was decorated by a series of alternating square... and semi-circular niches, paved with coloured marble slabs. A cache of approxi... mately 100 oil lamps of the double-spouted Herodian type was found associated... with it. The theatre itself was closed on the west by a scene building with its... *scaenae frons*, which probably reached the height of the *cavea* and, as typical of... Roman practice, had a large semicircular exedra in the centre flanked by smaller... square ones on either side. Little of that structure remained, and none of the stu...

...lies that most likely once decorated it. Some evidence led the excavator to believe ...that the original Herodian *scaenae frons* was of the Hellenistic type, with a square central niche flanked by semicircular ones (Frova et al. 1965: 57-234). Behind the scene building, the Italians exposed the foundations of a semicircular structure enclosing the area to the west. On the basis of Vitruvius 5.9 they considered it to be a third-century addition which served the spectators as a refuge from the sun or sudden rain-storms (Frova et al. 1965: 155-59).

While excavating the environs of the theatre, the Italian Mission exposed a Byzantine fortification wall extending from the northern side of the *cavea* west toward the sea-shore (figs. I.8, no. 30, I.40). Two circular towers built into the wall faced north toward the city. It seems, therefore, that during the later Byzantine era, the mound of the theatre was used as a fortified stronghold, surrounded by a massive wall and towers. These were incorporated into the southwestern termination of the semicircular enceinte that protected the entire city on its landward side. Further excavations carried out by the Italians along the eastern section of this urban wall yielded data dating it securely to the Byzantine period. North of the north side of that wall and east of the aqueduct, they discovered a Byzantine building interpreted as a Christian chapel (Frova et al. 1965: 293-95) (figs. I.7, no. 9, I.33, pl. I, no. 4).

One of the most surprising discoveries of the Italian Mission was a fortification wall with two round and one polygonal tower, extending east from the shore halfway between the north Crusader wall and the northwest end of the Byzantine enceinte (Frova et al. 1965: 247-92) (figs. I.8, no. 16, I.35, II.1-5, pl. I, no. 9). The eastern round tower was preserved to a height of over 3 m, while the western had been nearly destroyed by the sea. On the basis of ceramics and the style of the dressed ashlars, the two round towers were dated to the Herodian period, the original phase of the wall. Realizing that the High-Level Aqueduct was built on top of that wall, taking part of the eastern round tower out of use as a fortification line, they considered the water supply to be a later addition, though probably still Herodian in date (Frova et al. 1965: 274-75, 280-83). The wall and the towers were rebuilt during the second century, at which time the entrance between the round towers was blocked (fig. II.3). Excavations along the south side of the wall exposed a later Byzantine paved street running on top of this blocking wall. Another street dating to the original phase of the wall was unearthed parallel to its inner face. It was lined on the south by two large rectangular buildings. The date and function of the wall have been questioned by several scholars in recent years (Levine 1975a: 9-13; Ringel 1975: 75-77; Roller 1983; Blakely 1984; Raban 1987) and will be discussed below in Sections III.H.3 and R.1.

[A.R.]

II.A. Summary of Land Excavation: 6. Joint Expedition to Caesarea Maritima.

Over the years since the creation of the State of Israel, various national and foreign expeditions have conducted land excavations at Caesarea Maritima (Frova et al. 1965; Negev 1967; Levine & Netzer 1986). The archaeological team with the most sustained record of field-work at the site is the Joint Expedition to Cae-

sarea Maritima (JECM), formed in 1971 by Professor Robert J. Bull of Drew University to continue the excavations begun in 1959 by the Italian Archaeological Mission. This consortium of universities, colleges and seminaries has conducted summer excavations intermittently from its foundation until 1987, the last season of field-work directed by Professor Bull. During its life, the membership has fluctuated. Twenty-four different institutions have participated for at least one season of excavation. JECM has afforded hundreds of volunteers opportunities to experience archaeological discovery. A general analysis of the JECM field-work was published in 1982 (Bull 1982). Final reports are now in preparation.

The Joint Expedition concentrated its efforts on several areas of the city, all outside the Crusader fortifications. For the location of these excavation areas, see fig. I.8, nos. 9, 13, 15, 17, 19, 25-27, pl. I). Several seasons of excavation were conducted NE of the urban core of Caesarea at the site first identified by the Italian team as a Christian baptistry (Frova et al. 1965: 293-95) (JECM's Field E; fig. I.7, no. 9, pl. I, no. 4). The JECM investigation revealed that the structure was in fact a small but elegant bath and fish-tank (*piscina*), presumably part of a seaside villa of the sixth century (Holum et al. 1988: 182-85).

Within the confines of the Byzantine city walls, major investigations were undertaken by JECM in several areas. The Joint Expedition uncovered some Hellenistic and Byzantine remains in its Field G (Bull et al. 1985); excavated a segment of a fortification system, and assigned the city wall at that location to the Herodian Period (Blakely 1984; Holum et al. 1988: 79-82); provided a preliminary survey of the amphitheatre (Roller 1982a); conducted sondages in the southern section of the hippodrome (Humphrey 1975); and explored sections of the Byzantine esplanade. South of this late road, a marble Tyche personifying the city was uncovered in 1972. Later, a smaller figure was found, a stevedore probably representing Sebastos, the harbour complex. This group is the single most important artifact recovered by JECM to date (Gershit 1984; Wenning 1986).

The major concentration of JECM's effort has been on the area to the south of the Crusader enceinte and north of the theatre (JECM's Field C). In this section of the city, marked by a line of large sand dunes parallel to the shore, extensive excavations have occurred every season of JECM's field-work. An official residence from the Byzantine era complete with an archives repository was uncovered, perhaps the governor's palace, as well as a warehouse complex that fronted the bay (Wiemken & Holum 1981; Bull 1982; Bull et al. 1986). One of these *horrea* was excavated. Built during the Herodian era, it served many purposes over the centuries it was in use. Its most important role was as a Mithraeum during the Roman era (Hopfe & Lease 1975; Bull 1978a; Blakely 1987; Holum et al. 1988: 148-53). This excavation has provided evidence for extensive rebuilding of this part of the city during the sixth century, as well as some changes in the city plan (Wiemken & Holum 1981; Vann 1983b). Surprisingly, little of Herod's city has been revealed thus far.

To date, the major contribution of JECM has been to enhance our understanding of Byzantine Caesarea. Its excavations throughout the city have uncovered signs of well-being and growth through to the coming of the Arabs in 640 and its subsequent contraction (Holum et al. 1988: 203-6). As a port, Caesarea's economic

activities had an international flavour throughout this period. JECM's archaeological data point to a zenith of population and prosperity beginning in the sixth century, contrary to views once held by scholars (Levine 1975b: 135-36).

JECM conducted one short season of underwater excavations in 1978 (Hohlfelder & Oleson 1980; Section II.B.5). This initiative was assumed by CAHEP after its creation in 1980. At this moment, the future of JECM is uncertain, following the retirement of Professor Bull as field director.

[R.L.H.]

II.B: Underwater Survey and Excavation: 1. Link Expedition.

Edwin A. Link, an American inventor, engineer, and oceanographer, is widely remembered as the creator of the first submersible decompression chamber and various other marine research tools such as habitats and small research submarines (M.C. Link 1973; Wallis 1980).[4] Before his death in 1981, he had contributed as much as any individual to building the diving systems that would support man's explorations beneath the sea. His accomplishments in the field of marine archaeology, however, are less familiar, but they loom large in the development of this discipline and particularly in the history of underwater investigations at Caesarea. As a result, it seems appropriate to provide some detail on the background and organization of the Link expedition.

Link began his underwater investigations at Port Royal, Jamaica in 1956. This port city had been destroyed by a violent earthquake in 1692 that sent about two-thirds of the settlement into the sea along with some 20,000 of its inhabitants. Using a converted shrimp boat called the *Sea Diver* as his base, Link had carried out an archaeological investigation on this drowned site during the summer of that year with the co-operation of the Jamaican government. Working under adverse conditions caused by a mud layer covering the site that clouded the water whenever it was disturbed, his team uncovered numerous important artifacts, including an extensive collection of glass bottles. Link was urged to return again for another season of work (M.C. Link 1973).

He had also been approached by the America-Israel Society and the Israeli Department of Antiquities that same spring to explore another submerged port, Caesarea Maritima. Shortly after completing his field-work at Port Royal, Link and his wife Marion flew to Israel to dive on this site and other possible locations for underwater investigations. He spent three days of exploration at Caesarea in 1956, followed by discussions with various Israeli archaeologists about the possibil-

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4 I would like to thank Mrs. Marion C. Link, Dr. Charles T. Fritsch, Mr. Aaron Wegman, Dr. Elisha Linder, and Mr. Mussa Cohen for their help in preparing this report. Their memories of the expedition of 1960 provided material simply not available anywhere else. I am particularly in Mrs. Link's debt. She received me graciously in Link Port, Florida in 1984, answered my many questions patiently and completely, thought of pertinent things I had forgotten to ask, and then provided relevant sections of her personal, unpublished diary for the summer of 1960 and other unpublished material. I could not have written this report without her help.

Portions of this chapter will be published in my article, "A Pioneer of Underwater Archaeology: Edwin A. Link at Caesarea Maritima," in *Deutsche Hydrographische Zeitschrift*.

ity of conducting that country's first large-scale underwater archaeological project. His imagination had been ignited by what he had seen on his few dives. At the terminus of one of the breakwaters he had discovered mammoth stones that had been fastened together by iron clamps set in lead. He thought they might have been the remains of the six colossal statues that the Josephus said had adorned the harbour's entrance (*BJ* 1.408-414; *AJ* 15.331-41). He also discovered a sarcophagus lid, numerous whole and fragmentary amphoras, ancient ballast stones, and anchors of all vintages lodged in the breakwaters (Link 1956). There is even an apocryphal story that he saw a statue's hand reaching forth from the harbour bottom (Charles T. Fritsch, personal communication).

The tremendous size of the submerged area, the scale of the project, the technical problems it presented, and the encouragement of his Israeli colleagues afforded Link an irresistible challenge. He left Israel early in October determined to proceed with the search for Herod's harbour beneath the sea.

One thing Link had decided, however, was that his wooden trawler was not sufficient for either the demands of a trans-Atlantic crossing or the problems posed by excavation at Caesarea. He proceeded to build *Sea Diver II*, a 28 m steel-hull vessel featuring state of the art excavation, navigation, and communications equipment, along with a 5.5 m auxiliary cruiser, *Reef Diver*, that would sit in davits on the stern. His new ship was the first research ship designed specifically for underwater archaeological exploration.

Three years after the first preliminary sketches, the new vessel undertook her maiden voyage. After *Sea Diver* was launched at a shipyard in Quincy, Massachusets, she sailed from Boston in April 1959 to Port Royal to continue the investigations that Link had started three years earlier. It was a good summer, one that enabled Link to refine his excavation techniques and learn what his new ship could do. He returned to Miami with *Sea Diver* for the winter, to carry out the final changes and refitting needed for the trip to Israel in the spring.

Link departed for Israel from Puerto Rico on 11 May 1960 and arrived in Gibraltar on 27 May after a calm and routine crossing. On 1 June, *Sea Diver* left for the eastern Mediterranean. Rough seas and gale-force winds hit the ship the next day. A fire, broken equipment, and a range of storm-related difficulties made the next few days as challenging as the Atlantic crossing had been routine. On 12 June *Sea Diver* reached Haifa; three days later Link sailed his ship to Caesarea and moored in the small fishing harbour that still exists today amidst the ruins of the far greater ancient one. He was anxious to begin.

Link's small team (the number fluctuated, but was about 12 on any given day) included only amateur archaeologists: the ship's crew, U.S. Navy divers, a doctor, several volunteers from the U.S., and later various Israeli divers including Mussa Cohen and Dr. Elisha Linder, who would later found the Center for Maritime Studies at the University of Haifa. Not an archaeologist himself, Link had asked Drs. Charles T. Fritsch of Princeton Theological Seminary and Immanuel Ben-Dor of Emory University to serve as project directors. They joined him at Caesarea. Regrettably, neither man was a diver.

Although Link envisioned several seasons of exploration at Caesarea, he expected results immediately; in retrospect, far too quickly. His goals that summer included preparing a map of the underwater remains using underwater survey and aerial photographs, recovering the sarcophagus he had seen in 1956 (which, incidentally, he could never find again) lifting the colossal statues at the entrance of the harbour (for which purpose he had equipped *Sea Diver* with a six ton lift), recovering as many artifacts as possible, and determining why the harbour facilities of Caesarea had fallen into the sea. It was an ambitious agenda, but Link was a man accustomed to success on a grand scale and to viewing challenges as objectives not yet achieved.

Unfortunately nature did not co-operate with his Caesarea schedule. Although Link had carefully selected the summer season for his explorations to take maximum advantage of calm sea conditions in this part of the Mediterranean, in reality he had missed the best season by a month. What followed was a series of events that would have been impossible to anticipate.

Sailing in and out of the small harbour proved to be very hazardous, and mooring in this anchorage was even more dangerous. On Sunday, 19 June, when the crew was ashore, heavy seas rolled in from an off-shore storm. Waves crashed over the breakwater that defines the present harbour and threatened *Sea Diver*. Link pressed into service various overnight guests who had come to enjoy a relaxing evening in elegant circumstances. With this *ad hoc* crew he worked desperately to keep the ship from smashing into the concrete pier. Lines kept breaking during a very long night. Without his regular staff, Link could not attempt to run to the safety of the open sea. *Sea Diver* did not founder that night, but she was damaged.

The next day, with the forecast for continuing high seas, he decided to sail. This flight to safety was the first of three that *Sea Diver* would make from the site that summer because of adverse weather. His place of refuge was Haifa, since there were no other harbours nearby. It was this very lack of natural harbours along this section of the Levantine coast that had led Herod the Great to build the port of Caesarea in the first place.

When Link returned to Caesarea two days later, after the storm had abated, he decided to anchor out in the open sea to avoid the hazards posed by the fishing harbour. Although this location solved one set of problems, it afforded new ones. The sandy bottom did not permit firm purchase for his anchors. He had difficulty preventing his anchor lines from dragging. Several times the ship was in danger of running aground on off-shore islets. He also had trouble transporting people to and from shore on the *Reef Diver* in the constant high seas. In fact, on one occasion this boat smashed into the larger ship and tore a hole in its side, occasioning another retreat to Haifa. The heavy waves took an additional toll. All the while the expedition was at Caesarea, seasickness was common among even the seasoned hands (Link 1973).

Link grappled with other problems as well, as his expedition waited to begin its work. Just before his departure to Israel, he had learned that he had diabetes. He struggled throughout this summer to find the right dosage of his various medications but never seemed to achieve the appropriate balance. There were also serious clashes with members of his American crew. Personality differences, misunderstandings, and generally low morale caused by difficult sea conditions and

the inability to carry out the expedition's objectives added to his concerns. Several crew members were finally discharged in September. Marion Link writes in her diary of his growing fatigue and frustration with the endless delays and mounting problems. Diving in June was extremely limited. In fact, nothing really was accomplished. Early in July, Link decided to abandon Caesarea until late August, when the seas might be better, and to explore several alternative sites in the Sea of Galilee which he had seen during his 1956 trip. The *Reef Diver* was hauled from Haifa to serve as the research vessel for explorations on this inland lake that from his recent experience at Caesarea must have seemed blessedly calm. He began work immediately and soon discovered a shipwreck that yielded a cache of cooking pots from the first century A.C. Near the biblical site of Magdala the expedition found a structure under ca. 5 m of water that appeared to have been an area for drying nets when the level of the sea had been much lower.

After six weeks, Link decided to try Caesarea once again. On 6 August *Sea Diver* returned to the site and anchored near the ancient harbour entrance (fig. II.6). Heavy seas reappeared. For five days some excavation was attempted near the large blocks at the terminus of the Northern Breakwater, but there were many technical problems. On one occasion the airlift buried itself in the sand. Before work could resume, the primary underwater digging tool itself had to be rescued by excavation!

Link was also plagued by the other problems typical of excavations in shallow water on an open coast. In the heavy seas so common at Caesarea, working in ca. 5-6 m of water over the ruins near the ancient entrance is extremely difficult. There is usually a dangerous surge on the ocean floor. Visibility quickly deteriorates, as wave action disturbs the bottom. In addition, trenches dug one day will be filled by the next morning. In retrospect, and compared to the challenges of Caesarea, Port Royal must have seemed to Link to have been an ideal site. On 11 August *Sea Diver* left Caesarea once again and returned to Haifa. Nature had won another round.

The final effort to achieve some of the goals of the summer began on 1 September. The weather finally co-operated and the excavations, now conducted to a large degree by Israeli volunteers, proceeded smoothly. When heavy seas returned at the end of the month, 10 days of diving had been possible and considerable information had been retrieved for analysis by the topside archaeologists before *Sea Diver* set sail for Haifa for the last time on 2 October.

Before commenting on the results of this excavation, it is important to restate the obvious. Since Fritsch and Ben-Dor, the project archaeologists, were not themselves divers, they never had a chance to visit the excavation sites under their supervision or to see any artifacts *in situ* before their recovery. An analogy for this awkward situation would be that of a chief scientist in charge of a research laboratory which he could never visit. Moreover, since Link's divers were not trained in archaeology, their on-site interpretation of data could only be treated with the greatest caution.

Although the total diving time on the site was extremely limited (less than two weeks total), some parts of Link's ambitious research design were realized. It has been difficult, however, to assess this expedition properly, for publication of

the field-work was limited to one brief report in *Biblical Archaeologist* (Fritsch & Ben-Dor 1961), a popular story in *Life* magazine (MacLeish 1961), a short report to the American Philosophical Society (Fritsch 1961), and an abstract (Ben-Dor 1961: 190). Link also prepared several short papers that were never published, presenting slightly different, general versions of the summer's field-work.

One of the most important and lasting results of his work was to establish precisely the location of Sebastos, the harbour of Caesarea discussed in detail by Josephus. As recently as ten years before Link's expedition, it had been incorrectly placed in the bay immediately to the south (Reifenberg 1950-51). Working with aerial photographs supplemented by divers' surveys, Link was able to construct a basic plan of the submerged remains (fig. II.7). Although incomplete in most respects, it confirmed in a general way the description of the harbour provided by Josephus and established the veracity of this ancient account. Detractors of this historian's exegesis on Caesarea, including W. Thomson, who a century before had called Josephus' account an example of "grandiloquent hyperbole" (Thomson 1862), had finally been stilled.

Further, he was able to demonstrate that SCUBA divers had an important role to play in the exploration of submerged archaeological sites. Nothing on the scale of Link's expedition had been attempted before. Moreover, with the appearance of *Sea Diver*, a research vessel constructed specifically for underwater archaeology and fitted with the most modern equipment, a new chapter in this discipline had begun. In this respect, Link's expedition would become a model for those who followed.

He also heightened interest in Caesarea. Fritsch and Ben-Dor noted in their article that one of the expedition's objectives was to "...spark an extensive landside excavation of this important site" (Fritsch & Ben-Dor 1961). This statement, of course, failed to recognize the important field-work then in progress at the site by the Italian Mission, the Hebrew University, and the National Parks Authority. Notwithstanding, it was prophetic. In the 1970's and 1980's major projects conducted by JECM, CAHEP, and the Hebrew University have increased dramatically our knowledge of this important site (Raban 1985b). Caesarea Maritima has received its proper recognition as one of the major seaports and cosmopolitan cities of the ancient world (Holum et al. 1988).

These general accomplishments stand as positive, lasting achievements of Link's pioneer underwater explorations. The specific results of his expedition, however, have been superseded by subsequent research by CAHEP (Oleson et al. 1984; Hohlfelder 1988). For example, when working near the harbour's Entrance Channel, Link's divers uncovered a nearly complete amphora of the second century A.C. beneath a large wooden beam. Fritsch and Ben-Dor suggested that this artifact, in this particular context, provided evidence for an earthquake that had devastated Caesarea at some point in the second century. They went on to posit that in A.D. 130, buildings like the one of which this beam was an architectural member had been swept into the sea during this natural disaster and that the harbour of Herod was destroyed at that time (Fritsch & Ben-Dor 1961).

This hypothesis, however, can no longer be sustained. The earthquake, which in fact was dated to 128, is mentioned only in one ancient source, so its very exis-

tence is questionable. Further, it may not even have struck Caesarea Maritima. No incontrovertible archaeological evidence on land or in the sea has been uncovered by any subsequent excavation to support the Fritsch/Ben-Dor disaster theory.

Secondly, the ancient reference Fritsch cited as evidence, St. Jerome's gloss of the *Chronikon* of Eusebius (Migne 1844-79, 27: 468) employs a standard, formulaic phrase to describe the earthquake: "Nicopolis et Caesarea terrae motu conciderunt." Even if the Caesarea to which Jerome refers in this note is Caesarea Maritima -- and that is unlikely, since elsewhere in his glosses he usually specifically identifies this port by its full ancient name of Caesarea Palaestinae (Migne 1844-79, 27: 482) -- one could infer very little from this stock account. It would be particularly ill-advised to attempt to assess the natural damage visited on the site from such a tenuous source, although some scholars have tried to do so (Amiran 1950-51; 1952).

Against the Fritsch/Ben-Dor thesis of the Herodian harbour's destruction in 128 stands a massive body of archaeological data compiled by CAHEP since 1980, along with copious textual and historical evidence for the continued use of these facilities well into the seventh century too extensive to discuss in this context (e.g. Hohlfelder 1985). One can now say with complete confidence that their report of the harbour's demise was premature.

It must be remembered, however, that neither project archaeologist visited the excavation site where the amphora had been recovered. If either man had, his analysis might have been more cautious. Excavating in the same area where Link's divers made their find, CAHEP explorers uncovered beams that were part of the concrete formwork used in the harbour's original construction late in the first century B.C., and a wooden palette beneath a large stone that was dropped into the sea during a later, Byzantine repair in the late fifth or early sixth century. Either of these finds might have been what Link's divers had seen. Both CAHEP's discoveries were dated not only by their artifactual associations but also by carbon-14 analysis, something that was not done with the Link beam (Oleson et al. 1984; below, Appendix III.B).

The Link expedition also discovered a small medallion or token composed of a silver-lead alloy, identified at that time and subsequently by various scholars, as depicting the harbour of Caesarea at its inauguration (Oestreicher 1962). The obverse featured a river-god; the reverse a scene of a harbour entrance flanked by colossal statues and with the Greek letters KA in the upper right field. This small object, about which Link once said, "That little thing cost us about $100,000. I guess it's worth it" (MacLeish 1961), was identified as a commemorative piece issued at the port's dedication in 10/9 B.C. It is far more likely, however, that the lead token was struck in Alexandria, perhaps in the reign of Antoninus Pius (138-161) with no particular reference to Caesarea. Link's assessment of his littlest, but most expensive, artifact might be a bit different today.

Even though the specific results of Link's field-work have not been sustained by the later underwater exploration directly spawned by his research, one cannot diminish his general contributions to a new field of scholarly research. A true pioneer strikes a path for others to follow. Link did that at Caesarea even though he chose never to return to continue his search for the colossal statues. He was by

nature an impatient man, not suited for anything other than immediate success in his endeavors. In this regard, his comment on the medallion is revealing. Too little was accomplished at too great a cost of money and time. Although the difficult natural obstacles posed by this particular site and the demands of a discipline that rarely provides dramatic results ultimately discouraged Link from continued excavations there or elsewhere, the scientific community can be thankful that he continued to devote his considerable energies and genius to other aspects of oceanographic research.

In one of their unpublished papers, Edwin and Marion Link offered the following summation on their work at Caesarea:

> This relatively brief foray into the possibilities which lie beneath the sandy bottom at Caesarea reaffirmed our belief that given the time, equipment and cooperative weather the harbour would undoubtedly yield a fine cross section of historical and archaeological material. It also indicated such an ambitious project will never be carried out due to the prohibitive cost made necessary by adverse sea conditions.

Edwin Link had many talents. But as the last line of the above quotation proves, he was not totally prophetic. For this minor chink in his arsenal of talents, CAHEP is grateful.

[R.L.H.]

II.B. Underwater Survey and Excavation: 2. Israel Undersea Exploration Society.

The Link Expedition to Caesarea was the starting point for years of underwater research carried out by the Israel Undersea Exploration Society (IUES). Qualified Israeli navy divers who had been released from their regular service were organized and encouraged by Elisha Linder. They started a new type of underwater career by diving as volunteers for Link's project. From that time on they worked on weekends, holidays and, when it was necessary, took a few days or weeks from their regular occupations. They taught scholars and laymen to dive and joined them in various underwater exploration projects. Caesarea, which was being developed in the 1960's as a major tourist site, was the best place for training new divers and for testing experimental methods of underwater survey. In 1964 the first commercial diving centre along the Mediterranean coast of Israel was established within the ancient walls of Caesarea, as a joint project of Baron E. de Rothschild (who owned the area of the ruined city) and the diving instructors of IUES.

In April, 1963, the first international collaborative research was carried out by IUES in collaboration with Prof. H. Edgerton of M.I.T. and his assistant, Dr. Olivier Leenhardt of the Oceanographic Museum of Monaco (fig. II.8). The project was initiated through contacts made at the First International Congress for Underwater Sciences, held in Monaco two years previously. The goal was execution of a survey of structures and wrecks buried under the sandy sea-floor through the use of Edgerton's recent invention, the "Mud Penetrator". This device was a low frequency echo sounder (12 KHz) which could plot sub-bottom features. The new device was then experimental, and its use in Caesarea was the first attempt

to try it on a purely archaeological mission, as a stage in a larger project sponsored by the National Geographic Society. Using a small motor boat that was positioned from the shore by a pair of theodolites, the "Mud Penetrator" was operated in the area of the sunken Herodian breakwater that had been surveyed three years earlier by the Link Expedition. The sub-bottom survey was followed by visual examination carried out by the IUES divers. Six "targets of abnormal resolution" were plotted by the system and interpreted by O. Leenhardt as man-made features buried under the sand (fig. II.9).

Unfortunately there was no adequate airlift on site for properly exposing all these targets, so only the two shallower sites were dug; these turned out to be broken amphoras. The most interesting target recorded by the remote sensing survey seemed to be a buried wall some 5 m wide and about 50 m long, running south from the external (south) edge of the Southern Breakwater, near its base (Linder & Leenhardt 1964: 49-50, fig. 1). Though it was reportedly covered by only a metre of sand, the divers could not find it.

More informative were the series of survey dives that the IUES volunteers carried out along the course of the sunken breakwater. These surveys continued during the following years under the direction of E. Linder, with the purpose of gathering data about the causes for the submergence of the harbour. These surveys have never been published, but there is an interesting summary of them in the following letter, sent by E. Linder to D. Neev, a marine geologist of the Israel Geological Survey:

> Our repetitive dives within the ancient harbour enable us to come to the following conclusions:
>
> a. The coast-line for the Roman era was at least 150-200 m farther west of the present one. This can be deduced from: (i) Remnants of ancient constructions, Byzantine and Crusader, which are now covered by sea water some 50-100 m into the sea, west of the Bosnian Minaret. (ii) The great distance of the Herodian harbour entrance from the present shore, Link's supposition, is backed by our surveys. By the way, it is probable that the entrance was even farther out, northwest of the site pointed out by Link. Our divers have found two high rocky outcrops protruding, almost covered by sand now, which might be the entrance's towers.
>
> b. The entrance to the ancient harbour is now some 350-400 metres west of the tip of the northern Crusader wall which is cut by the sea. The farthest part of the semi-circular breakwater from the present shore is more than 450 m. Considering that fact, the water basin of Herod's harbour seems to be immense, greater than that of any other Roman harbour known to us. One may recall that this was not a harbour that was dug on land, such as Ostia, but was artificially built in open waters. So, I presume that in antiquity, its water basin was much smaller, maybe only the westernmost part of the present one.
>
> c. Some of the stone blocks on the sea-floor along the north and northwest lines of the sunken breakwaters are remnants of artificial structures. Blocks were carefully laid, and not simply heaped stones jettisoned into the water, to create a base for more consolidated above-water structures. Josephus tells us about stones that were thrown into the water in large quantities and to a great depth but what we now see underwater are *in situ* ashlar blocks of well-laid courses, remnants of what seems to have been vertical walls, and that at a depth of 8-10 metres!
>
> d. Even if we suppose that the ancient breakwater was built on a base of piled-up stones, it is still hard to believe that what we have here was built by the Romans in an underwater building technique. So, these ashlar blocks 4 x 3 m and more must have been laid during the Roman era in much shallower water, and only later, recent natural geological processes have caused the additional submergence of the western part of the harbour. Beyond that, for heaven's sake, why would Herod's engineers choose to build such a deep-water harbour. For the merchantmen of those days, 3-4 metres of water depth would be more than enough.
>
> I am sending you some photos we took at a depth of 8-10 m. Note the vertical block with the cross groove on its upper part, which teaches us the clamping technique of large blocks under the water in antiquity. Could you imagine laying such large ashlar blocks at such a depth without the help of divers such as ours?
>
> e. Due north of the sunken harbour at Caesarea, opposite my kibbutz (Ma'agan Micha'el) there are those isles known as Hayonim Island. I've already expressed to you in the past my idea that these off-shore reefs were originally terrestrial formations. Excavations that I've done on the island unearthed a large structure, a mosaic floor, and various glass and pottery sherds in a series of rooms belonging to one Byzantine complex.

This letter describes the basic data collected up to 1964, when another attempt was made to attract foreign scholars to an international collaborative research project at Caesarea. Dr. Joseph Shaw of the University of Toronto, who was working at that time on Prof. Scranton's excavation of the Late Roman harbour at Kenchreai (Shaw 1967), and A. Flinder, a diving architect from London who was then very active in helping to create the British Sub-Aqua Club, were invited by Linder to spend a week surveying the harbour at Caesarea, assisted by the volunteer divers of IUES (Flinder 1985b: 24-28). Although a detailed project programme was made, the course of events sent everybody elsewhere. Shaw went back to take over the underwater work at Kenchreai, and Linder, with the IUES, Flinder, and a team of British divers, was busy for the next three years at the Phoenician harbours of Athlit (Linder 1967) and Akko (Linder & Raban 1966). The project of building a modern breakwater on top of the ancient one in Akko made that site a much more urgent task. In the 1966 season at Akko the Proton-Magnetometer, a new type of remote-sensing device which could trace ferrous objects on or below the sea-floor, was used experimentally. This device was brought by T. Hall, an engineer from Oxford University, who also used it for a few days to survey the sea-bottom around the sunken harbour at Caesarea (Hall 1966).

While the main efforts of IUES were diverted to other sites, Caesarea remained the best location for casual surveys and for training new members and introducing them to the study of submerged structures. Among various discoveries made during these surveys, one of special importance was the observation of lead puddles *in situ* on the sea-bottom at a depth of over 8 m, embedded in the foot of what is described as a fallen tower on the west side of the Southern Breakwater (fig. II.10).

In the years 1968-1969 Raban, then an undergraduate student of archaeology at the Hebrew University, initiated renewed surveys at Caesarea for verification and completion of the data collected to that date as part of a research paper on Roman harbours in the Levant. During that survey, a sunken platform was located some 50 m west of the tip of the modern mole, and a general plan of the harbour was drawn up, basically following earlier ones prepared by Y. Aloni for IUES. These earlier plans suggest an inner basin and flushing channels across the base of the main breakwater (fig. II.11).

During the following years (1969-1973) it was the new potential of the Red Sea that attracted the attention of IUES. While E. Linder, with H. Edgerton, A.

Flinder, and some English volunteers from the British Sub-Aqua Club were ca
ing out underwater research at Jesirat Fara'un just south of Eilat (Flinder 19
1985b: 42-82), other teams were surveying the coasts of Sinai and its coas
waters and excavated three Arab wrecks (Raban 1973, 1975). Caesarea remain
a nearby site for training divers and for casual diving visits, increasingly so fo
lowing the establishment of the Center for Maritime Studies at the University o
Haifa in 1972, followed a year later by the inauguration of the graduate Depa
ment for the History of Maritime Civilizations.

[A.R

II.B. Underwater Survey and Excavation: 3. CMS Survey for Israel Electric Co.

A full-scale, systematic survey of the harbour complex at Caesarea was con
sidered again by the CMS after the 1973 war. N. C. Flemming of the Institute for
Oceanographic Sciences at Warmley, England and D. Neev of the Israel Geologica
Survey, began research relating to their interest in well-documented data about
submerged architectural features, designed to support their ongoing investigation
of the recent geological history of the coast-line (Flemming 1972; Neev et al.
1973). In the early summer of 1974, Flemming visited the CMS and was shown
some of the submerged features at Caesarea known through previous surveys,
among them a recently surveyed wall at a depth of 1.0-1.5 m in the shallow water
within the present anchorage basin. A year later, in the fall of 1975, the Israel
Electric Company (IEC) established a project to study various aspects concerning
a projected nuclear power station. It was obvious that the site for such a plant in
Israel must be along the sea-shore, since a reactor's annual demand for cooling
water is 20 times greater than the entire national reserves of fresh water. Sea-
water seemed to offer the only solution. Yet the selection of a sea-shore site pre-
cipitated an argument among geologists concerning the tectonic stability of the
Mediterranean shore-line of Israel (Mazor 1974; Neev 1974).

In order to bring in new and more conclusive data for settling this issue, the
IEC approached the CMS and asked it to carry out an underwater survey at Cae-
sarea, plotting submerged and offset man-made or natural features. Since Flem-
ming was at the time a visiting professor at the Department of History of
Maritime Civilizations, it was agreed that A. Raban would head the study as a
marine archaeologist while Flemming would serve as consultant geologist. By then
Flemming had already expressed his idea that the coast was tectonically stable.
Neev represented the Geological Survey of Israel (Neev et al. 1978).

The CMS survey had to be completed in time for submission of a final report
to IEC by 1 June 1976. In order to accomplish the proposed research plan, almost
every calm day during the early months of 1976 was used for working in the sea, in
a combined effort by the entire technical staff of CMS, volunteer divers of the
IUES, students of the Department of History of Maritime Civilizations, and some
professional contractors. The final report was submitted by 15 May.

Not all of the fifteen assignments within the CMS project were purely
archaeological in nature. Biological and geomorphological aspects were considered
part of the charter to establish a data base for tectonic study of the site. Engi-

neering and archaeology were means for that study and not goals in themselves,
with an archaeological bias was quite natural. The assignments were:

1. A detailed and accurate bathymetric survey of the sea-bottom in and around the harbour using a low frequency echo sounder, to produce a bathymetric map and an oblique computerized view of its topography.
2. Plotted sections of the sub-bottom using the "Mud Penetrator".
3. Excavation of at least five sections of the sea-floor in an attempt to expose the foundations of various submerged man-made structures.
4. Detailed plans for two 30 m long sections of the inner side of the main breakwater, to include details of the construction technique and the means of binding the individual blocks.
5. Survey of the various abrasion platforms near the harbour to measure the present elevation of each in comparison with the original elevation.
6. Careful survey of the Northern Breakwater for any indication of a vertical fault across it, or evidence for submergence of its tip.
7. Study of the now submerged cross-wall in the inner bay to establish its date of construction and to determine whether it was built on land or in the water.
8. Survey and trial excavation of the submerged projection southwest of the promontory and the base of the Southern Breakwater in order to establish its character, whether natural or artificial.
9. A biotopic search in deeper water and on dry land for remnants of organisms typical of the intertidal zone.
10. Trial excavation at the foot of the podium, extending below the foundation of the earliest structures, to look for the Inner Basin of the Herodian harbour and its water-level in relation to the present one.
11. Documented survey of coastal structures near the present water-line, and a study of their dates and construction techniques, in order to establish a data base for a typology of dated building techniques in Caesarea.
12. Survey of the abrasive shelves south of the harbour, at the Piscina and Kibbutz Sedot Yam, plotting their levels and dating the quarries and structures on them.
13. Tracing topographic discrepancies on the sea-bottom north and south of Caesarea, by a series of "Mud Penetrator" sections on a east-west axis.
14. Survey of the various man-made structures and quarries at Krokodeilonpolis and Ha'yonim islands, off Ma'agan Michael, in order to look for discrepancies with the present sea level.
15. Diver survey of the sea-bottom adjacent to these sites, to look for possible submerged man-made structures and offset geological features.

Having almost no budget limitations, the CMS project had at its disposal the whole range of technology available at that time in Israel. Advanced echo sounders and computerized, data processed maps, mini-rangers for pinpointing locations in the sea and the exact course of surveying boats, a rapid excavating blaster (a large diameter knee which is lowered behind the propellor of a tug-boat, to divert downward the current created by a rotating propellor and used to remove the sand and expose the buried structures underneath), airlifts, hookahs -- all were either built, rented, or bought for the project. A summary of the results as described in the final report (Raban et al. 1976: 27-58) is presented here for the first time in English.

[*Editorial note:* in order to integrate this report at least partially into the narrative of the CAHEP excavations, the text has been changed slightly in a few places to take account of some of the later discoveries, and note is made of the CAHEP terminology for the excavation areas. In addition, in order to avoid dupli-

cation, most of the illustrations for this section have been placed with the illustrations of the relevant CAHEP excavation or survey area in Chapters III and IV, and are keyed into both discussions. Location references for the most part refer to the master plan (fig. III.1). J.P.O.]

The Natural Topography of the Sea-Bottom.

(a) *Rocky bottom*, composed of kurkar (carbonate cemented quartz sandstone), is exposed in most areas on the northeast and north part of the harbour. These exposures are found only on the sea-bottom east of the meridional line of the western tips of the abrasive platforms found at sea level. North of the Crusader city, submerged ravines caused by the rip-current are dominant topographic features; they are rare south of its north wall. The maximum depth of the rocky bottom is less than 5 m; west of it there is a drop of several metres, an area seasonally covered by wave-carried sand. Almost the entire rocky bottom within the perimeter of the Crusader city is now covered by building debris and ashlar blocks eroded from structures on shore, some of which are well agglomerated and abraded to form abrasive platforms resembling beach-rock. The western extremities are covered with a heavy layer of building material, disguising the original layout of the foundation of the Herodian breakwaters.

About 30 m west of the tip of the kurkar promontory, at the base of the Southern Breakwater where the Herodian flushing channel and the sluice gate are located, there are some tilted and submerged rocky plates which seem to be part of an old abrasive shelf (CAHEP Area Q; figs. III.1, II.19, no. 8). At this point too, the transition from the rocky features to the artificial structure of the main Southern Breakwater is covered by huge displaced blocks of building stones and chunks fallen from the tip of the promontory.

There are few rocky exposures in the bay to the south of the harbour, between the Citadel and the Piscina, but numerous outcrops of building materials cemented by natural concretions (fig. I.11). These form topographic shallows separated by sandy hollows, some of which are over 7 m deep.

(b) *Sandy bottom* occurs within the present anchorage, with a particularly heavy accumulation of sand at its centre (figs. I.12, II.19). This bar changes seasonally and sometimes rises to within 1 m of sea level. There is a rip-current channel along its south and southwestern sides, which is 6-8 m wide along the modern quay. There, the western side of the sand bar slopes steeply to a depth of over 6 m. A trial trench that was made there with the "blasting knee" revealed thin, interbedded varves of gypsum at a depth of 4.6-4.8 m. Below, at a depth of just over 5.6 m, there was a stratum of grey clay mixed with rubble and pottery, resting on brown, sterile clay at a depth of 6.2 m. Laboratory analysis of the gypsum made by the Israel Geological Survey calculated its date to be between 3400-3900 B.P. Yet the underlying clay included pottery sherds of more recent periods that might have been brought there by the rip-current trench at a later date.

West of the meridional line of the abrasive shelves, the sea-bottom is sandy everywhere, except for those areas covered by the structure of the breakwaters and by associated man-made debris. The depth of the sandy sea floor is 6-8 m within the sunken harbour and over 9 m farther west.

In certain sites, wherever the topography of the sunken structures caused rip-currents to dig channels, there are deeper hollows exposing layers of rubble mixed with large quantities of broken amphoras at depths of 7.5 to 8 m. At sites within the submerged harbour basin, where the "blasting knee's" water flow cleared off the sand, there was a substratum of fine clay covered by a layer of rubble and flat pebbles. Link's expedition exposed such a layer of sterile clay at the harbour's Entrance Channel under 9 m of water and sand, and considered it to be the original sea-bottom on which the harbour was built (Fritsch & Ben-Dor 1961: 55).

Man-made Features near Sea Level.

(a) *Rock-cut installations* of a type that indicate activities close to sea level were investigated: e.g. *piscinae*, flushing channels, quarries for building stones, and rock-cut foundation trenches. The basic concept used in surveying these installations is that such structures must have had their surrounding edge at least a few centimetres above the highest tide. This basic concept and the selection of relevant installations were made in consultation with Flemming and the data for similar Roman facilities in Italy (Schmiedt 1972).

There is a flushing channel with a sluice gate at the southwest tip of the promontory, near the base of the main Herodian breakwater (CAHEP Area Q; figs. II.1, II.19, no. 8). Although most of the channel's course was filled in (probably by the Crusaders) and is now covered by a modern concrete slab, its original function seems to have been to flush the enclosed harbour basin by allowing the through passage of sea-water. In order to secure a controlled inflow, the base of the channel must have been just above the highest spring tides, with the sluice gates blocking an extra inflow of silt during stormy days (using sections of the channel between the sluices to trap the silt). Parallels are known from Sidon (H. Frost 1973) and other Roman harbours (Blackman 1973: 172). The present elevation of the channel is about right for flushing the harbour basin, or slightly too low. If it was originally used as a feeding channel for a fish-tank, its present elevation is too high by 0.20-0.30 m.

The Piscina, often referred to in popular literature as "Cleopatra's Baths," (CAHEP Area P) is a pool fed and drained by a complex of rock-cut channels, originally surrounded by various buildings. It is located on a small promontory west of the Roman theatre in a location now exposed to the marine elements and affected by waves most of the year (figs. I.11, 40). Both Flinder and Netzer, who studied this complex prior to the CAHEP campaigns, proposed that it was a coherent unit built to a master plan (Netzer 1976; Flinder 1976a). Considering the various feeding channels and the pool as a single unit, it is important to note that there is only one solution notch in the pool, about 0.10 m above the present sea level. The surface of the trimmed bed-rock around the pool is 0.20-0.25 m above that notch and its rocky bottom is 0.80-0.90 m below it (fig. III.148). The notch is at the maximum possible water capacity of the pool, at the same elevation as the base of the opening to the rock-cut over-flow channel on the west end. If one considers the fact that the water-level in the pool should have been somewhat higher than the sea level in order to permit water circulation, that notch suggests a sea level much like the present one during the time the pool was used, whether as a swimming pool during the Herodian period (Netzer) or as a fish-raising tank in the third to fourth centuries (Flinder). Flemming, however, suggests an uplift of the pool by as much as 0.25 m since antiquity (Flemming et al. 1978: 63, fig. 9).

The cuttings off Sedot Yam comprise two rectangular basins on the V-shaped reef opening westward from its point on the sandy beach of the kibbutz (figs. II.12-13, pl. I). There are three levels of abrasive shelves. The pools were cut on the lowest one, which is about 0.30-0.40 m below the present shelf. The edges of the pools are at least 0.10 m below water during low tide. Considering their probable function as fish-tanks, the sea level must have been at least half a metre lower when they were in use. Although we have no way of dating these pools, parallel elevations for similar structures at Dor and Athlit suggest a medieval date (Raban 1983d).

(b) *Foundation courses of stone walls at the water-line* were given special attention. Earlier surveys of CMS and IUES at Caesarea and other coastal sites have proved that the ancients used a special technique to build the lower portions of vertical stone walls which were vulnerable to wave action. These sections were usually different from those of other contemporary terrestrial walls, or even those parts of inundated walls which were above the water-line. The major damage to the lower zone at water-level was caused by the sucking effect of retreating water, which can tear off individual blocks from their place within the wall. In order to avoid this phenomenon, ancient builders used blocks incorporated deeply within the wall and assembled tightly enough with neighbouring members to cause maximum drag. Examples of such walls are known from Phoenician quays as early as the ninth century B.C. (Braidwood 1940: 201): long, slim, carefully-cut ashlar blocks laid in tight courses of headers. The efficiency and durability of that technique made Phoenician sea-walls the forerunners of Hellenistic fortifications, as seen at Samaria and Akko. So, a systematic survey of datable walls near the water-line that have such a component in their structural technique might indicate the proximity and relative elevation of the sea at the time they were built.

Among such walls are the most important remnants at the southeastern side of the harbour, those of the Crusader Citadel on the promontory (CAHEP Area M; figs. III.1, 122). This Citadel was built during the first half of the thirteenth century and was destroyed in 1265 along with rest of the city and its fortifications. The Crusaders had re-used Roman columns of marble and granite as reinforcing cross-beams within their fortifications throughout Caesarea (as in Ashkelon). Yet, in some cases, the foundation course of a fortification wall was composed exclusively of such columns, laid next to each other in a fashion resembling the coursing of Phoenician sea-walls. This is the case at the base of the southeastern tower of the harbour's citadel, where regular ashlars were replaced by a course of columns laid horizontally when near the water (fig. III.125). The same technique was used on the other side of the citadel, facing the inner bay, where the base course of the northwestern tower was also built only of columns (fig. III.129). The elevation of some of these column courses suggests a sea level for the thirteenth century somewhat below the present one, since the columns at the south side of the citadel are incorporated into the existing abrasive shelf (fig. III.125). The Citadel seems to have been built while the sea was at least 0.30-0.50 m lower than at present.

The ashlar quay at the northeast side of the harbour (CAHEP Area L; figs. II.19, no. 10, III.1) is located between the Column Jetty to its south and the modern quay to its north. This structure is about 15 m long and 6-7 m wide, and has

been preserved to a height of only two courses of ashlar headers (fig. III.113). The structure is now partially destroyed and might have been higher and longer in its original form. The great width, and the type of marine construction of massive ashlar components, indicate that it was most probably a quay or a jetty within the Roman harbour complex (Levine & Netzer 1986: 50-52, n. 73). The depth of the water around that pier is now just over 0.5 m, and although the surrounding abrasion platform is composed of concreted debris and not bed-rock, it is still very hard to reconstruct the depth of water needed for marine vessels to moor next to it unless the sea level was higher than the present one by 1 m or more. The same reconstruction of a higher sea level can be deduced from the large chunk of beach-rock embedded on top of the pier's tip. This feature was sampled by the geologists of the Israel Geological Survey (Bakler and Thome), who state it was made of aragonite, typical for an intertidal zone.

The Column Jetty, just south of the ashlar quay (figs. II.14-15, pl. I, no. 51) is a very prominent feature in the harbour of Caesarea and was described and depicted in the nineteenth century (Drake 1873; Schumacher 1888). It extends 75 m west of the shore, just below sea level. At its western tip the columns were laid in a different orientation, and the continuation of the jetty toward the SSW now lies well below sea level. The manner in which the columns were laid resembles the Crusader sea-walls described above, so it is very tempting to relate this jetty to the Crusader city (Ringel 1975: 171). Yet, it is at least possible that it was built by Jazzar Pasha late in the eighteenth century in order to facilitate trans-shipment of building materials from Caesarea to Akko (Abel 1914: 588). This possibility is, however, less probable in view of the incorporation within the jetty of an ashlar-built floor near the point where it bends, now under 0.20-0.30 m of water (fig. II.17). It does not seem likely that the Turkish governor of Akko could have built a jetty so carefully just for a plundering project. Moreover, the submergence of this floor matches the estimated sea level for the thirteenth century of 0.50 m below present sea level, as attested at the Crusader Citadel. The further submergence and downward tipping of the southwest continuation of the jetty is probably due to undertrenching and slumping which took place within the inner bay in a post-Crusader era (Flemming et al. 1978: 62, Fig. 8).

The ashlar courses below the north face of the modern pier (CAHEP Area Q; figs. III.1, 158) have been eroded down to the high-tide level and can be seen below the north face of the modern concrete slab. Though covered by marine incrustation, individual ashlar blocks can be distinguished, laid as headers (fig. III.159). In places these headers are laid above what seems to be natural rock, 1.2 m below the present sea level. This masonry seems to be part of the inner face of the base of the Herodian breakwater, and on it there is a base course of re-used columns from the western extremity of the Crusader Harbour Citadel. Similar ashlar headers of larger size can still be seen *in situ* on the southern side of the modern pier (fig. III.161). Stratigraphically, these ashlar headers on both sides of the promontory are clearly pre-Crusader in date, probably as early as the original Herodian harbour complex. Their present elevation in relation to the modern sea level seems to be much the same as their original one. These data correspond with other findings which document the sea level of the Herodian era to be much the same as the present one.

The ashlar wall at the northeastern shore of the inner bay (CAHEP Area S; figs. III.1, 164-66) was studied by Bloch in the late fifties (Bloch 1965). It has been preserved to a height of three to four courses and there are boreholes of marine *Lithophagae* on its top, some 1.2 m above the present sea level. This top course was built of ashlars bound by molten lead poured around clamps set into dovetail-shaped grooves, still seen on the top face of the wall (figs. III.171-72). Based on parallels of similar lead-clamped dovetail grooves from the Herodian era, Bloch reconstructed a post-Herodian sea level almost 1 m higher than the present MSL (Bloch 1965: 15-16). The western continuation of that wall has a somewhat different orientation and seems to have been built in a later period, from re-used Roman blocks.

When the base of the wall was cleared and exposed by removal of the surrounding debris, iron bar clamps were found in place, below present sea level. Since such iron clamps occur in the Crusader walls at Akko and the harbour citadel in Caesarea, their submerged location at the base of this wall is another indication for a sea level at least 0.5 m lower during the thirteenth century.

(c) *Summing up the data* from the rock-cut and built structures at the waterline in Caesarea, it seems that all data indicate a fairly stable ground surface during 2000 years of small changes of sea level, probably of eustatic character. It looks as if the sea level during the Roman era was higher than the present MSL by 0.30-0.50 m and might have been as high as 0.80-1.00 m above MSL toward the end of the Byzantine period, or soon after. The sea level was clearly lower than the present MSL during the thirteenth century by 0.40-0.70 m. These eustatic changes correspond with the general eustatic trends known from sites elsewhere around the eastern Mediterranean (Bloch 1965). There is no evidence for any local discrepancies along the shore-line of Caesarea.

Excavations on Land.

It was suggested that evidence for the relative stability of the shore at Caesarea since the Herodian era might be obtained by pursuing Negev's excavations at the foot of the podium on the Inner Basin, cleared in 1961-1962 (Negev 1967: 27-30; CAHEP Area I_1, figs. III.1, 67). Negev himself, when advised of the project, recalled reaching what seemed to him to be marine deposits at the low ground just west of the protruding structure he had designated as the pier of a Roman inner harbour (Negev 1975: 274). A site was selected for a limited sondage 2 m square next to the westernmost and lowest visible structure at the foot of that "Roman Pier". It was a line of ashlar slabs of white limestone that look like a lower stair or edge of a quay, and the trial dig was carried west and adjacent to it (fig. II.18). The excavation was carried out manually during the wettest month of the year, all through the second half of March 1976. The top of the ashlar course is 1.65 m above MSL and ground-water was reached at 1.2 m above MSL. Further digging necessitated continuous pumping of the the ground-water and the clearing of mixed gravel, sherds, and rubble which were already concreted together by the water-born calcium carbonate. At an elevation of 0.60-0.30 m above MSL a horizontal notch was observed along the eastern baulk, below the stair. The notch was found to be covered with intertidal marine fauna, *Dendrophorae cliythomelae*. Lower, from about 0.20 m above MSL and down, the surface of the wall was found to be covered with shells of *Ostrea*, a mollusc that lives below the low tide, constantly covered with sea-water. At 0.05-0.10 m above MSL there was a floor, or layer of large ashlar blocks laid roughly next to each other (fig. III.73). The vertical wall at the eastern baulk may represent the edge of a quay of an inner harbour of early Roman or even Herodian date, and its notch and faunal remains document a sea level about 0.20-0.30 m higher than the present one for that period. It also proves that at that time the sea was about 100 m farther inland, in what might have been the Herodian Inner Basin to which Josephus may allude (*AJ* 15.332).

Underwater Survey and Excavation.

The underwater work was the main component in the IEC project, also the costliest and most demanding one. The fact that it had to be carried out during the winter months radically limited the number of possible diving days and increased the odds against good visibility in the water and for ample documentation by photographs. Almost 200 dives were carried out within 28 diving days. Each dive was summed up by a detailed diving report filled out by the divers and through records on PVC drawing boards that were copied immediately by the architect, G. Kaplan. Points in the sea were plotted by interpolation of data from three theodolites stationed on reference points on land. The survey and collection of data for the 1:1000 general map was done by the civil engineer E. Sivan and the surveyor Y. Stoler. E. Adler was responsible for the biotopic and geomorphologic survey, and Y. Tur-Kaspa was in charge of the technical aspects of the underwater survey and the excavation gear. Trial probes on the sea-floor were carried out by a "blasting knee" and a 4-inch diameter airlift (Raban et al. 1976, appendix a: 59-61).

Vertical measurements underwater were taken by combined use of a metre tape and bubble hose, and the depth was established by three independent capillary depth-gauges, with reference to the exact time of the day in which the measurement was taken. On shore, M. Froelich was in charge of reading the water-level every 30 minutes through the day, plus wave height, length and direction. The wind was also measured every hour, and all these data were matched with the records of the mariograph and the meteorologic station at the port of Haifa for calibration of accurate MSL. The interpolated MSL was used as the basis for the maps and plans accompanying the final report.

The submerged man-made structures that were surveyed and partially cleared were referred to in the final report only when relevant to establishing accurate calibration of submergence.

(a) *A Sunken Pavement* (CAHEP Area F; figs. II.19, no. 2, III.1, 45) of regular kurkar slabs was noted about 50 m west of the northern tip of the modern southern breakwater. It is a rectangular structure which was discovered in earlier surveys of IUES and was studied in 1973 by two students from the Hebrew University, S. Wachsmann and T. Ben-Tzvee. The floor tilts from a depth of 4.90 m at the northwest side of its preserved surface toward the southeast, where its surface is at a depth of 5.05 m. It was constructed of ashlar slabs with mean dimensions of 0.45-0.50 m x 0.90-1.05 m. The height of the slabs ranged between 0.23-0.27 m. The floor was laid on a cushion of pebbles and small rubble, with pure sand underneath. While the northern and eastern edges of the surface are clearly defined, the other sides are covered with incrusted rubble and concreted debris. Farther south,

next to the inner face of the main breakwater, the rip-current has undertrenched the fallen structures, so it is now impossible to find out whether there was originally any architectural connection between the floor and the breakwater. It seems as if the floor continues at least 6 m farther to the west, but the covering debris makes it difficult to ascertain the actual dimensions. The slabs were laid without any cement or other binding, roughly joined on the western side and more tightly incrusted on the eastern part of the floor (fig. III.44). Trial trenches were made with an airlift in two sites along the edges of the floor in order to determine its base. Some potsherds that were found in the sand below the floor were too eroded to be dated. It seems as if they penetrated through gaps between the slabs after the floor was already submerged.

A course of long ashlar headers was found adjacent to the floor on its east side, at a depth of 5.6 m. This course may have served as the retaining wall for the fill above which the "floor" served as the topping pavement. The long ashlar blocks are 1.9-2.0 x 0.55-0.60 x 0.45-0.50 m -- typical dimensions for Phoenician and Hellenistic marine walls, and for those of the Roman Pier described above. There are no remains in the vicinity of the floor to indicate that it served as a base for a superstructure. The fact that its components are still more or less in their original positions despite having been exposed to the surge over many centuries, indicates careful construction that could hardly have been carried out under 5 m of water. It is very likely that the platform was part of a secondary quay or pier, and was originally well above the water. In that case, its present elevation documents a submergence of about 5-6 m. The fact that the floor is still close to horizontal speaks against the possible explanation of submergence by slumping, fluidization, or undertrenching (but see Flemming et al. 1978: 78-79). The proximity of the floor to other features of the ancient harbour which are still in much their original elevation, such as the quay and the flushing channel on the western tip of the promontory, indicates that its submergence was gradual rather than catastrophic. This is the only way the floor could maintain its present intact state, although geological cores suggest it is adjacent to a fault (Neev et al. 1978).

(b) *The Northern Breakwater* (CAHEP Area H; fig. III.1, pl. I, no. 55) was shown in preliminary surveys to lack any visible, architecturally well-defined structures which were still intact. The western tip is the more interesting part of the breakwater. Link's expedition carried out underwater excavations in this area, and though they went down 3 m below the sandy bottom, no intact structure was discovered. Yet the debris is well defined and retains more or less the original rectangular layout of the breakwater. The structure is composed of small stone rubble, except the westernmost 30-40 m of its southwest part, next to the inner side of the entrance, where a fallen and downward-tilted mass of huge rectangular blocks covers everything. The top of this mass is now under less than 2 m of water and its footing is sunk in the sandy bottom of the entrance, at a depth of over 7 m. The blocks are up to 7.0 x 1.0 x 1.2 m in size, and most of them tilt down toward the west and NW. The rest of the breakwater is rather even in shape, sloping gradually downward to the north, but with a steep slope of small rubble (50°-60°) on its south side. The sandy sea-bottom along the breakwater is under 4-6 m of water at the east and 7.4 m next to its tip at the west. Near the breakwater's base there is a gradual transition from a westward sloping bed-rock to rubble ram-

part about 15-20 m west of the present abrasive shelf (for CAHEP research in this area, see Section IV.C, Survey Line no. 12). Although no direct evidence was found for the rate of submergence of the Northern Breakwater, the fact that its base is now at least 1 m higher than that of the Southern Breakwater might indicate uneven subsidence of the sea-floor. The other notable fact is that the upper surface of the Northern Breakwater lies at nearly the same depth near its base as at its tip. So, any submergence must have been gradual and rather even on an east-west axis. The total absence of any remnants of ashlar blocks, or vertical features along the inner side of this breakwater might indicate that it was never used as a quay and no transshipment of goods was being carried out on it.

(c) *The inner face of the Southern Breakwater* (CAHEP Areas A, B, C; figs. III.1, 3) was the focus of most of the CMS underwater work for the IEC, particularly the southwest section. This is a huge structure, with its base at the southwest side of the modern mole (as a westward continuation of the rocky promontory), extending west for over 300 m and then bending gradually toward the north for another 300 m. Its entire original length was probably just under 700 m, and the width of its debris ranges from a minimum of just over 20 m at its southeastern base to over 200 m (on the west-east axis) close to its northern tip. The present depth of the water next to it is 7-9 m outside and 6-8 m inside. While in some places the debris of the breakwater is covered by sand, in other places nearby the remains of fallen structures are as high as 6 m above the seabed. Most of the surface of the debris is covered now with several centimetres of marine incrustation. One must break this organogenic coating in order to be able to study the character of the structural components and the types of building materials that were used for constructing the breakwater.

The entire project was initiated by the discovery of lead puddles on the base of one fallen structure at the northeast portion of that breakwater 12 years earlier (later CAHEP Area D; fig. II.10). Yet no lead pourings were traced during this survey, nor any other clamps found still *in situ*. The magnitude and variability of the debris suppressed any attempt to carry out a full-scale, detailed survey of the entire breakwater. Consulting the data from surveys made there during the previous 15 years, and after carrying out a preliminary visual survey, the study continued in selected sites that seemed to be more significant for the central issue of the project. In addition to a detailed survey of these sites, four trial trenches were excavated with the "blasting knee" to expose foundation levels.

Ashlar structures at the inner side of the breakwater, within its curve, are very prominent and cover a large area (figs. III.3, 5). These are also the only architectural features that seem to retain more or less their original layout. Over a distance of about 200 m along the inner edge of the western half of the breakwater, on low ground at the foot of tilted concrete blocks, there are segments of ashlar courses of long headers carefully cut from kurkar rock of prime quality. Their average dimensions are 1.80 x 0.70 x 0.60 m, with variations up to 10%. While at the south side there are three to four rows of ashlar headers, this type of coursing becomes more segmented and less frequent toward the northern part of the breakwater. There, the ashlar headers become a single, discontinuous course which is covered in places by sand or heaps of rubble. In places, the exposure of the ashlars caused extreme erosion by the shifting sand, and some blocks have lost

nearly half of their original volume. Most of the ashlar slabs are covered with organogenic coating, yet nowhere has that incrustation bound two or more slabs. This fact and the relative position of some of the blocks within the courses suggest that the present location is offset from the original one. Yet, the fact is that in most places the slabs are still level and parallel to each other. So, it is most improbable to assume that they fell or even slumped from a higher point within the complex. Only at the south end, where four rows of ashlars are laid now in a tilted position, one might reconstruct an original stage when they were on top of each other, before the undertrenching current dragged the lower courses away and spread the entire structure. This ashlar course disappears toward the southwest curve of the breakwater beneath kurkar rubble.

On the upper surface of the rubble nearby, there can be seen two types of huge blocks. Some are elongated in shape (3.50-12.1 x 1.2 x 1.0 m) and seem to be quarried from rock. Others, made of concrete, are more regular in size: 3-4 m on a side and 2.5-3.0 m high. Almost all the blocks of the second type are now tilted and seem to have shifted from their original positions. On the surface of some of these blocks there are crossed grooves left by decomposed wooden beams binding the frames within which the concrete was poured (cf. Bartoccini 1958: 120, fig. 35). The courses of ashlar headers are laid on a layer of pebbles at a depth of 6.10-6.70 m, so that the surface of the slabs is at 5.3-6.0 m below MSL. If one considers these courses to be the base courses for a vertical quay, such as in Leptis Magna (Bartoccini 1958: 125, fig. 33) and Kenchreai (Shaw 1967, pl. 61:2), the original depth would have been 2 to 3 m at most, and a total sumbergence of 4 m is a reasonable deduction.

(d) *The Subsidiary Breakwater* on the southeast side of the main breakwater is a sunken rampart of debris that splits into two parallel lines (CAHEP Area E; figs. III.1, I.13). The main one forms the breakwater itself, while the other section some 20 m to the south is much narrower. It is about 5-6 m wide at its base and tapers to less than 3 m at its tip, 2-3 m higher. The highest crest of this wall is at a depth of only 3.8 m of water and it is built of alternating segments of ashlars, much like those on the inner side of the Southern Breakwater, and rubble conglomerated with cement. A trial trench with the "blasting knee" exposed four to five courses roughly laid on a wider base of rubble, at 6.8 m below MSL. Below the base there is a regular cushion of pebbles.

The function of this Subsidiary Breakwater may have been an additional protection against the southwest winter storms. It may have broken the force of the surge before it hit the main structure, which contained goods stored for transshipment. In any case, the elevation of its base resembles that of the main breakwater, so both demonstrate the same degree of subsidence.

(e) *The South Bay* is an open body of water framed by the promontory of the Crusader Citadel to the north and the flattened promontory of the Piscina to the south (figs. I.11, IV.2; for CAHEP survey, see Section IV.B). It was considered to be the site of the Herodian harbour until Link identified the real one in 1960 (see e.g., Pococke 1745, II: 58-60; Haefeli 1923: 15; Reifenberg 1950-1: 24). Yet, the series of vaulted magazines that was discovered along the shore of this bay (Bull 1973a: 260-62) and which might have been built already during the Herodian

period, revived interest in the idea that there was a secondary anchorage in that bay contemporary with the main one to the north, or replacing it in some post-Herodian date. The reefs that spoil the bay and make it unnavigable are actually in part recently conglomerated debris that very probably was not there in antiquity.

A broad tapering projection pointing SW at the south side of the Crusader Citadel is now well below the waves, protruding 1.5-2.5 m above the surrounding sandy floor. It is about 150 m long and almost 80 m wide at its base. The "Mud Penetrator" survey of 1963 suggested that this feature might be the mole of a later harbour which replaced the subsidiary Herodian one (Linder & Leenhardt 1964). It also seemed to indicate that there was a wall 5 m wide running between this projection and the Herodian Southern Breakwater, now buried under the sand. An extensive trial trench with the "blasting knee" was made in order to expose that wall, but nothing was found in the sand. It was also difficult to learn much about the characteristics of the projection. Though its surface seems to be comprised of heaps of small rounded rubble, everything is coated with a thick layer of a non-organic carbonate substance that disguises any details. Since this covering of calcified sediment is absent farther north, it cannot be organic in origin. Although its chemical composition was not properly studied, it is possible that the substance comes from the tile factory of Kibbutz Sedot Yam that empties its sewage into the neighbouring bay to the south. This muddy pollution becomes apparent whenever there is a southwestern wind and northern current. During such days, the visibility underwater is almost nil.

(f) *The entrance to the Herodian harbour* (CAHEP Area D; figs. III.1, 16-17) is a special architectural unit, both very impressive and very difficult to study properly. The magnitude of the fallen blocks and the vertical extent of the debris necessitate the use of special heavy-duty gear. Link's divers excavated the eastern side of the entrance, and the entire area was surveyed by the IUES divers. The depth of the sea-floor in the entrance was 8 m during the survey, but other reports give diverse depths between 8.4 to 6.7 m, since the quantity of sand in the channel changes seasonally. The top of the nearby blocks on the east side rose to a depth of less than 1.5 m. Similar figures are valid for the huge blocks piled up on the Southern Breakwater, about 80 m NW of the Entrance Channel.

It is likely that the heap of blocks by the entrance represents what was once a very prominent and massive tower. Whether it is the Drusion mentioned by Josephus (*AJ* 15.336) as the most magnificent structure on the mole, or a lighthouse (Levine 1975a: 16), or perhaps both together, it is impossible to tell without further study. Another interesting feature of the Herodian harbour which Josephus referred to (*AJ* 15.339; see Appendix I.A) are two towers outside the entrance, to the right of those sailing in (CAHEP Area K; figs. III.1, 16). Their remains can be clearly distinguished in aerial photographs (fig. III.17). They are two adjacent blocks some 10 m off the tip of the Southern Breakwater, with square bases of about 8 x 8 m. The adjacent sea-floor is at a depth of 7.6-7.8 m, and the tops of these blocks are under less than 3 m of water. In clearing off the marine growth it became apparent that they are artificial structures. In several places around their sides there are horizontal grooves 1.5 m above each other, which are the imprints of wooden framing beams. Originally, these masses projected above the

water, so they are a good indication for a submergence of several metres, even if their superstructure has been stripped.

(g) *Reconstruction of the Southern Breakwater's original volume* was a complicated undertaking. At the start, some statistics concerning the present volume of the main breakwater were compiled using the echograms of the sonar survey (fig. II.19). It is easy to reconstruct the area of the cross-section of the main breakwater by these means. The echograms included over 20 such sections, and Dr. Z. Ben Avraham of Weisman Institute calibrated 15 sections and calculated the sectional area of the breakwater debris in square metres. Counting along the Southern Breakwater from north to south the calculated area of debris in the sections is as follows:

1. 173.8 m^2	6. 119.6 m^2	11. 68.2 m^2
2. 194.2 m^2	7. 135.6 m^2	12. 58.5 m^2
3. 194.1 m^2	8. 181.1 m^2	13. 48.8 m^2
4. 187.8 m^2	9. 123.8 m^2	14. 35.0 m^2
5. 187.4 m^2	10. 140.1 m^2	15. 33.8 m^2

Sections 1-5: avg. width of debris, 133 m; avg. depth of sea-floor, 8.1 m.
Sections 6-10: avg. width of debris, 110 m; avg. depth of sea-floor, 8.5 m.
Sections 11-15: avg. width of debris, 87.5 m; avg. depth of sea-floor, 7.0 m.

The average is 110.8 m^2 of debris over 110 m width, at a depth of 7.9 m. These figures are not exact, because in some sections it is obvious that the debris is now partially covered by 1-2 m of sand. So, it is reasonable to add to the sections as much as is needed for a base at 8.2 m of water on the inner end and 9-10 m to the external one. In that case the maximum area for the best preserved section would be just below 300 m^2.

According to Josephus (*AJ* 15.336-7; see Appendix I.A), the breakwater had an original width of over 63 m. The inner quay should have been about 1 m above the water, and the actual promenade somewhat higher (cf. Leptis Magna, Bartoccini 1958: fig. 33). It seems as if the side of the quay was a vertical wall. At the back of the promenade were vaulted magazines and behind them a crest wall with towers at intervals. The external half of the breakwater was also high enough above the water to block the strongest winter waves from hitting the wall and splashing the storage area within. So, an average height of about 3 m above the water-level for the entire section of "200 feet" (63 m) mentioned by Josephus for the part visible in his time, will be a moderate estimation (in Leptis Magna it is more). Calculating the original depth of the sea-bottom to have been 3.0 m below MSL inside the breakwater, and 4 m outside, we get a figure of just below 400 m^2 for the section area of the original intact structure. This figure corresponds with the present one of 300 m^2 if we consider the plundering of the better ashlar blocks from the superstructure and the volume of mortar that has decomposed and been carried away by the sea.

These figures are much more reasonable than the cross-section of over 700 m^2 necessary if reconstructing the breakwater to sea level from its present depth. Even apart from the other data cited, this statistical exercise suggests a vertical

submergence of the breakwater and the sea-floor of about 5 m since the time the harbour was built.

(h) *The date of the harbour's subsidence* can be tentatively calculated through archaeological data. During the survey of the Southern Breakwater, two shipwreck sites were located on top of the structure's debris. In each case, piles of broken amphoras cemented by marine incrustation occur above the higher components of collapsed structures (fig. II.21). There is no doubt that they were dumped there long after the destruction and submergence of the breakwater. One pile is about 20 m west of the ashlar courses of the quay (CAHEP Area A) and the other is some 50 m north of the first. They are both at a depth of about 4 m below MSL and can be dated to the late third or early fourth century on the basis of ceramic parallels. The piles of broken amphoras represent wreckage sites of merchantmen that attempted to come to the shore unaware of the existence or extent of a sunken structure underneath. One would assume that at that time the degree of submergence was just enough for the debris to be well hidden below the waves (probably no more than 1 m or so). A similar picture was depicted two or three centuries later by Procopius of Gaza, when describing the poor state of the harbour before the Emperor Anastasius took measures to restore it (Levine 1975a: 18). The great Herodian harbour may have begun to fall into disrepair soon after its completion because it was too big and too expensive to maintain, or the subsidence of the sea-floor may have begun very early (or both). There is, however, no real historical documentation for the claim that the harbour was destroyed by an earthquake in A.D. 130 (Fritsch & Ben-Dor 1961: 55). Caesarea continued to thrive as the most important economic centre of the country throughout the Roman era; perhaps the less sheltered anchorage in the South Bay was sufficient by itself.

(i) *The submerged wall in the inner bay* (CAHEP Area T_2; figs. III.1, 179) was known since the early surveys of IUES in Caesarea. During the project it was carefully recorded and two trial soundings were made along its eastern face (fig. III.180). It is a long, narrow structure built of small ashlar blocks, running south across the bay from a point just west of the wall with iron clamps described above (in CAHEP Area S). The eastern face of the wall is preserved to a maximum height of four courses, each ca. 0.30-0.40 m. The top course was built of ashlar headers (0.70 x 0.22 x 0.28 m); some stones have a double width of 0.45 m, and in two cases they are replaced by long stretchers. Stretchers frequently comprise the fifth and sixth courses that have been preserved only at the southern part of the wall. The wall tilts westward at 20°-30° and its surface is covered with rubble on the west side. Yet it is clear that its original width exceeded 2.6 m. The survey has followed the course of the wall for over 80 m and revealed that its southern third is now submerged by 0.50-0.60 m more than the northern part. A probe revealed that the foundation course was built without any binding mortar, directly on a sandy base. In the sand there was a mixture of clay, shingle, and seaworn potsherds of Roman and Byzantine date. Next to the well-preserved southern portion, the excavation exposed a more or less horizontal solution notch at the base of the third course, under 1.2-1.4 m of water.

From a typological survey of other buildings in Caesarea, it is clear that this wall is not earlier than the Byzantine era and might have been built much later, by the Crusaders. From its general orientation toward the lee side of the Crusader

moat that separated the harbour citadel from the rest of the city, one may predict that this wall was either an inner quay or part of the medieval sea-wall. Although there are not sufficient data for establishing the accurate date and function of the structure, it is obvious that it underwent different rates of tilting and subsidence along its length. The subsidence was about 0.60 m at its north end and 1.4 m at points 80 m farther south. Comparative data from other points in the harbour about eustatic changes in sea level suggest that a Byzantine date would add some 0.60 to 0.80 m to the present figures. In any case there is no apparent connection between the proposed submergence of this wall and that of the parts of the Herodian harbour west of the abrasive shelves. They seem to differ in date, character, and rate of change.

Conclusions. The archaeological data from the land site, the water-line, and submerged areas together present a picture of stability for all points east of the western tips of the present abrasive shelves, except in the case of the submerged wall at the east side of the inner bay. West of the shelves the sea-floor slopes westward and its depth increases from 4 or 5 m to 6 or 8 m below MSL over a distance of 30-40 m (compared to the overall gradient of 1% to 4% for the sandy bottom elsewhere along the coast). The harbour entrance is clearly visible even when partially disguised by heavy deposits of shifting sand. The foundations of both main breakwaters of the early harbour happened to be along this line, and they have subsided by at least 4 to 5 m. This conclusion is based on archaeological data only, without appeal to geomorphological or geological interpretation (for that, see Neev et al. 1978). Even the assumption that the submergence was gradual rather than catastrophic is based on the preservation of the Sunken Pavement and the present regular surface of the Northern Breakwater. Further study may prove otherwise. No evidence was found for continued subsidence of the western segment. Since at least the time of Pococke's visit in 1738, no additional features have disappeared below the waves.

Neev's claim (see Section I.A.2) that depositions of seaborne *Glycymeris violacescens* shells above Byzantine and Mameluke debris, at elevations of 10 m and more above the present sea level, testify that the entire coast was downfolded to below sea level in our millennium, is easily refuted by the consideration that these shells were used abundantly through the ages for the bedding fill of floors and as an admixture to cementing substances. In some parts of the Crusader fortifications walls these shells are over 10% of the total volume (fig. II.20). The destruction, plundering and decomposition processes of these structures enabled the elements to carry the leftovers to a natural deposit in any elevation.

It is difficult to establish how far along the coast this phenomenon of submerged sea-floor goes. So far we know of no other ancient man-made structures in this region that were built a considerable distance from the shore into the open sea. Other data might be provided by topographic and geomorphological surveys involving bore holes and corings in the sea and on land, as well as profiles of the in shore sea-floor with the "Mud Penetrator" or sub-bottom profilers. The survey of offset biotops have shown only that biologists are not confident in their deductions. The only other places that were surveyed during this study were the group of rocky islets off the shore of Ma'agan Michael and the sea-bottom west of the headland of Krokodeilonpolis.

On Hayonim Island off Ma'agan Michael (fig. I.3) there are remnants of quarries and Byzantine structures. Of particular interest is a quarry that was re-cut in order to make a fish-tank. The fish-tank is connected to a supply of sea-water through a rock-cut tunnel, leading to a resting chamber, and from it, through a channel controlled by sluice gates.

The entire complex could have been operated through the year if the sea level was 0.50-0.60 m higher than at present. The same figures apply to a second fish-tank on the other side of the island. It seems that the island, which is a remnant of the same coastal ridge on which Krokodeilonpolis and Caesarea are located, kept its relative elevation at least since the Byzantine era. Yet, on the rocky sea-bottom some 20 m west of the island there is a topographic drop of about 2 m. While the bed-rock is intact east of it (at a depth of 3.6-3.8 m), to the west it consists of scattered piles of broken chunks, and, farther away, smaller and rounder rubble (at a depth of 5.8-6.3 m). Such a drop may or may not represent the same natural event as in Caesarea, some 7 km farther south.

The survey at Krokodeilonpolis was less informative concerning faulting. The headland has undergone extensive erosion since antiquity and many Byzantine mosaic floors and cisterns are now exposed and hang over the edge of the cliff. There is a wide platform and abrasive shelf west of the cliff which in places is covered with beach-rock just above present sea level. There is no archaeological or other evidence for any vertical offset in the historical era. Farther west, in the sea, the headland continues toward the NW as a rocky exposure on the sea-bottom (fig. I.7, no. 5). There are two hollows nearby on its north side partially filled by sand, and the edge of the rocky exposure is covered by a rampart of rubble along the entire north and northwest sides. Yet no apparent topographic drop-off was detected. To be sure, this survey was not thorough enough due to bad weather and limited time, so additional efforts might yield more accurate data.

[A.R.]

II.B. Underwater Survey and Excavation: 4. CMS Field Workshops.

During the early summers of 1978-1980, three workshops were conducted by the technical staff of the Center for Maritime Studies for the graduate students of the Department of the History of Maritime Civilizations of the University of Haifa. These workshops were directed by Raban as a part of the on-going project to study the submerged harbours at Caesarea. The students, who were trained in the techniques of underwater survey, excavation, and documentation were joined by volunteers from IUES and, in 1979, by several scholars and students from abroad, as a first step towards establishing the international consortium of CAHEP in 1980. J.P. Oleson represented the foreign collaborators during the 1979 field-workshop, assisted by A.N. Sherwood. During the relatively short seasons, three main features were studied: the Round Tower in the inner harbour, the "Inner Quay" of the Southern Breakwater, and the Column Jetty.

The base of the Round Tower (CAHEP Area T_1; figs. III.1, 174) was found in 1978, submerged in just over 1 m of water, about 20-30 m from the public beach within the Crusader city and some distance north of the promontory that protects

the inner bay from the south (Raban & Linder 1978: 243). The tower is about 13 m in diameter, its circular wall built of long, slim blocks oriented radially as headers (avg. 1.5 x 0.50 x 0.60 m). Two courses of these blocks were observed above the sandy bottom, the top surface of the upper one at a depth of 0.7 m below MSL on its eastern side and 0.9 m on the western side. Inside the tower there was a pavement of ashlar slabs just over 2 m wide, running around the entire circumference. This was revetted on its inner circumference by a circular course of narrow blocks forming a circle about 5 m in diameter. The level of the pavement corresponded more or less with the upper surface of the lower facing course of headers. At the north side of the tower, the facing course is replaced by remnants of bonding courses that joined the tower to a wall less than 5 m wide. It is also possible to reconstruct at that point a corner of a slimmer wall which was originally incorporated with the tower. In that case, the tower would be at its southwestern corner. There is a close resemblance in construction and size between this tower and the two round towers excavated in the early 1960's on the shore north of the Crusader city (fig. II.1; Section II.A.5).

During the field-work of the following year (1979), a trial trench was dug next to the western side of the tower. A narrow space between the side of the tower and a nearby pile of large ashlar blocks was cleared to about 1 m below the sea-bottom. Two more courses of radially-laid headers were exposed. At least three blocks within the second and third courses proved to have been re-used, since smooth plaster could be seen on one of their longer sides, as if they once formed part of the face of a plastered wall. The similar reuse of ashlar blocks with plastered faces in a course of headers was noted at Area E in Akko in 1973, in a fortification wall dated to the second century B.C. (M. Dothan 1976: 40-41).

Most of the potsherds that were found in the cleared area were heavily worn pieces of Late Roman and Byzantine vessels, but there were also some better-preserved pieces of "Megarian" bowls and Eastern Sigillata A types, which might attest a Late Hellenistic date.

The Inner Quay along the Southern Breakwater (CAHEP Areas A, B, C) was re-surveyed and re-drawn during this campaign, with careful use of the bubble-hose for an accurate elevation for each block. The courses lay at different depths, between 7.1 m and 4.9 m below MSL. It was also noticed that the shallower portions were associated with abundant rubble and fallen debris, while the deeper portions were usually in hollows with sand fill. A lower course of blocks was detected only for three short segments of the 150 m surveyed. In two of these places the top course is rather deep, under more than 6.5 m of water, while in the third place the top course is at a depth of only 5.0 m.

During the 1979 workshop this survey was repeated once more as an exercise for new students. This time the survey also included other fragmentary courses of ashlar headers which ran parallel or at a right angle to the Inner Quay, adjacent to it, or as far as 10 m farther west. It was also observed that the main part of the quay extends about 120 m on a north-south axis, while an additional 35 m section on its north diverged in orientation by 15° toward the east, and a section at the south diverged 60° to the east, following the configuration of the southern part of the breakwater (fig. III.3). A trial trench was dug at a point about half-way along

the feature. The surface of the ashlar course at that point is now under 6.2 m of water. There is another course below that one, built of thinner slabs and somewhat less well preserved. It was found on a bed of rubble and pebbles at 6.8 m below MSL. Below that, at 7.2 m, there is sand. Water-jet probes were executed in this sandy bottom, and the metal pipe hit a layer of rubble or pebbles 3 m deeper at 11.2-11.7 m below MSL: this may be the original base for the breakwater.

The Column Jetty at the north side of the Intermediate Basin (fig. II.14) was surveyed, and every column was measured and drawn. The base of that structure is just west of the present shore-line, and the easternmost section *in situ* is now about 30 m west of what seems to be the remnant of a tower within the Crusader sea-wall. The largest columns are over 5.7 m long, with a diameter of about 0.65 m at the thicker end. The average length of the more complete columns is 5.35-5.50 m, with 0.60 m diameters. In three places the gap between the two groups of columns is paved with ashlar slabs lying at a depth of 0.30-0.40 m of water. One section of pavement is 4.35 m wide, filling a gap of 3.8 m, and is built of rectangular slabs from 1.10-1.40 m long and 0.80-0.90 m wide (fig. II.17).

The drawing of the submerged southwestern portion was completed by the students in 1979. In some places beach-rock was found partially covering the columns or incorporated around and between columns. This fact might indicate that at one time since the jetty was built, there was a sandy beach covering its eastern end. It must also have been built long enough before the present to allow these gradual changes to take place. This consideration, and the quality of the paved sections, makes attribution of the jetty to the Crusaders more likely than to Jazzar Pasha. The elevation of the pavement and of the abraded debris on which the jetty was laid fits a sea level lower than the present one by at least 0.60-0.70 m.

A second workshop was carried out for a longer period in 1979, and on a larger scale. Two airlifts, a dredge, and a water-jet probe were used, and the students practiced plotting points of reference in the water with theodolites. Several additional research areas were added to those identified in 1978.

The area around several sea-walls near the synagogue on the shore north of the Crusader fortifications was designated as Area J (CAHEP Area J; figs. III.1, 92, pl. I, no. 57). The synagogue and its surrounding area had been excavated by M. Avi-Yonah and A. Negev in the mid-fifties and early sixties. Although never fully published, reference was made in their preliminary report (Avi-Yonah & Negev 1963: 148) to a wall in the sea, possibly a mole of the Hellenistic town of Straton's Tower. This suggestion, and the fact that this area is just SW of the fortification wall and two round towers excavated by the Italian Mission drew our attention to this area. In fact, there is a series of walls of various periods and types of construction at the water-line NW of the synagogue, along the south edge of what is now a very shallow inlet open to the sea toward the north and protected from its surge by a series of rocky reefs to the west. In antiquity, before this body of water was silted up by wave-carried building debris and the reefs affected by erosion, it might have been a naturally well-protected haven, large and deep enough for small merchant and military ships to moor safely in it.

The last wall to be built in the water is a structure over 4.3 m wide, its preserved upper surface at 1.4 m above MSL. It is composed of a concrete made of

mortar mixed with small pieces of rubble and a large quantity of potsherds. While most of it has now decomposed and been carried off by the waves, three segments are still intact. Over 6 m of the largest section is still *in situ* on a rocky shelf (fig. III.93). Another (shorter) segment is also *in situ* just east of the eastern end of the earlier structures, 15 m north of the western corner of the synagogue. Some remains of wooden formwork were found embedded in the beach-rock at its south face some 0.30 m below present MSL. The latest datable potsherds within the concrete structure and the carbon-14 date of a wooden plank from the formwork (ca. 1430 B.P.) date the structure to the sixth or early seventh century. Possibly the sea was higher at the time and the structure was needed by the adjacent Jewish quarter as a protective measure against the waves.

A few metres west of this segment of wall there is another which has been dislodged northward into the water by the waves. Between these two segments, on their lee, are a series of ashlar walls, mosaic floor, and rubble fill, remnants of at least four superimposed building phases, from the bed-rock at 0.30 m to 2.35 m above MSL. A couple of metres west of this debris there are scattered remains of a course of ashlar blocks (1.50 x 0.80 x 0.50 m). Six blocks are laid on bed-rock that resembles an uplifted abrasive shelf, superimposed on a lower pavement. The upper edges of the blocks carry dovetail grooves for clamps; these recesses are still in line with each other, indicating that this remnant is at its original position (figs. III.96-97). Farther west and almost 2 m farther north there is another course, at a lower level and on the same orientation. It is built of smaller blocks which were laid in a random order of headers and stretchers. Only a stretch of about 8 m of the north face of this structure survives, and it terminates at the west in what might have been a corner turning south. This course runs at the foot of the rocky shelf and in places it is underlaid by an additional course of the same type. Its surviving eastern part overlies an ashlar pavement. Three of the existing blocks within that course retain dovetail grooves similar to that on the other, more massive one. This similarity and the common orientation might indicate that both courses were originally of the same structure. The pavement which is overlaid by these courses is now approximately at water-level, 0.16 m below MSL on the west end, and 0.12 m above at the easternmost existing end, 18 m away. The seaward edge of this pavement was made of long, slim headers of unequal dimensions (0.80-2.10 x 0.40-0.70 m) that give the impression of a curved quay (fig. III.95). There is no doubt that this quay was in use before the ashlar blocks with dovetail clamps were laid and that it pre-dates the overlying structure. Since dovetail clamps at Caesarea are typical of Herodian structures the quay might well be dated to a pre-Herodian phase.

During a short training session for the students of the Department for the History of Maritime Civilizations in 1980, just before the first CAHEP season, a trial excavation was carried out under the supervision of M. Artzy, at the foot of the quay next to its east end. The debris in the water was cleared by hand and a dredge, and an additional two courses of headers were exposed, to a total depth of 1.2 m below present MSL. Though the sea-bottom at this point seems to be beach-rock rather than the usual kurkar, it might well preserve the original depth of the water next to this side of the quay when it was built. The potsherds found during the excavation were all badly eroded by the waves and unstratified; they date to all periods from the Hellenistic to Byzantine.

A second survey for shipwreck remains on top of the Southern Breakwater was carried out, as a complement to the 1976 effort. The idea was to train students' eyes in identifying heaps of ballast stones, which are composed of dense minerals and shaped differently than building stones, and spills of broken pieces of cargo: roof tiles, amphoras, or other pottery vessels. The survey was carried out by small teams of divers starting from a point on the breakwater which was marked with a buoy. When they came upon something that appeared to be the site of a wreck, the divers tied a numbered buoy to the sea-bottom nearby.

During this survey, seven new wreck sites were traced, including one near the base of the Northern Breakwater and two on the southern side of the Southern Breakwater. One such site on the inner part of the Southern Breakwater is composed only of basalt ballast stones which were carefully cut to a regular shape: a rectangle the long sides of which were concave (0.59 x 0.42 x 0.24 m). An example recovered in 1984 from Area N_1 will be published in Volume II. The shape may have facilitated shifting or lashing the blocks. Three other sites were composed entirely of heaps of rounded ballast stones of fine-grained basalt. None of these three sites yielded any securely dated potsherds in a clear context. The other four sites comprised mostly broken pottery, three with amphoras and one with roof tiles. The last is post-Antique in date, for the type of tile, now heavily incrusted in the upper debris of the structure of the Southern Breakwater, is found in use from A.D. 1500. Of the three amphora groups, that on top of the northeastern side of the Northern Breakwater might be dated to the Early Byzantine period. Another, at the southwestern side of the Southern Breakwater, is clearly of later Byzantine date, and the last, found on the western curve of the Southern Breakwater, is composed of amphoras typical of the late third or early fourth century (fig. II.21).

The so-called Subsidiary Breakwater at the foot of the Southern Breakwater (CAHEP Area E; fig. III.1, pl. I, no. 46), first surveyed in 1976, was surveyed again in 1980. The first goal was to try to find out if it stemmed from a common base with the main breakwater, as the aerial photographs seem to indicate. It was found that exposed bed-rock on the sea-floor continued to approximately 20 m west of the tip of the present promontory, where it disappeared under piles of fallen building blocks and fragments of kurkar plates. To the SW, the rocky bottom was furrowed by rip-currents and covered with broken kurkar. At a distance of approximately 30 m in that direction, the edge of the bed-rock is covered by sand, at a depth of about 5 m. The rock/sand margin is increasingly covered with rubble toward the west, and at a point about 10 m east of the meridian line of the Sunken Pavement (CAHEP Area F) it clearly has become a man-made wall, the easternmost distinguishable portion of the Subsidiary Breakwater. The southern side of the Southern Breakwater is distinguished in that area by a steep edge of huge broken masses of concreted building material. This edge is parallel to the course of the Subsidiary Breakwater (278°) some 22 m to the south. At this eastern segment, the crest of the Subsidiary Breakwater is at a depth of 4.3-5.1 m of water and is less than 3 m wide. Farther west it was found deeply embedded and almost covered by wave-carried sand.

The Sunken Pavement was found itself to be almost totally covered by sand, yet recent high seas had cleared the sand from the sea-bottom east of the floor.

There, the east-west course of ashlar headers first noticed in 1976 was fully exposed (see Section III.E). Of the 13 blocks visible, only six were in a compact group, at the western end. Most of the blocks are now badly eroded by the sea, and the entire course is tilted, undercut, and considerably disturbed. The blocks seem originally to have been the same shape and size as the headers of the pier on the northeast shore by the column jetty (2.00-2.20 x 0.50-0.60 x 0.60-0.70 m). The top of the better-preserved and more even segment of the feature is at present at a depth of 5.8 m. It is based on a layer of small rubble and pebbles, above a layer of sand mixed with badly eroded potsherds. So it seems as if the entire area has been re-exposed many times since being submerged, and no meaningful stratigraphy has been preserved.

To the south were scattered blocks of even larger sizes (2.4-3.2 x 1.2 x 1.0 m) that may or may not originally have been components of the same structure. Next to these blocks, to the west, just sticking out the sand, are huge blocks of marble coated with brown marine algae. These marble blocks might once have been architectural parts of some superstructure on the mole, as the temples at Leptis Magna, or a remnant of a cargo carried to the harbour during the plundering activities of the late eighteenth and early nineteenth centuries.

The submerged wall within the Inner Bay (CAHEP Area T_2), studied initially during 1976, was more extensively surveyed and excavated during the 1979 season (see Section III.R.2). Rubble and debris were cleared away to expose its southern continuation. Then square metal grids were laid along its course to allow detailed three-dimensional measurements of sections 2 x 2 m each. A 56 m section of the eastern face of the wall was surveyed. This section has been preserved to a height of several courses above the present sea-floor and was found to be tilted to the west and south. Its long axis is oriented to 207°, but the last, better-preserved southern segment of about 42 m has an orientation of 186°. This additional segment is preserved to just below the level of the present sea-bottom, in almost 2 m of water. Trial excavations revealed lower courses underneath, and in one place the foundation was exposed, showing it to have been laid at a depth of 2.6 m, on a thin layer of gravel mixed with pottery sherds and decomposed kurkar from its bedding trench, which is now at 2.87 m below MSL. The base of the southern segment was excavated for its entire width. The width of the structure here is 4.8 m: each face was built of small ashlar blocks containing a mixed fill of blocks, rubble, and a few reused Roman column drums. Adjacent to the west side of the southern end of the wall there are remnants of a tower 12 m square. Its state of preservation makes it difficult to establish accurately the original dimensions and plan. A long column projects north for over 5 m from the tower's northeast corner, and a few large ashlar blocks have tumbled from its southwest corner. The general layout, however, suggests that the tower was incorporated into the west side of the south termination of the broad wall or rampart. The tower faces the tower on the northeast side of the moat that separated the Crusader Harbour Citadel from the rest of the fortified city, across an opening about 50 m wide. It is still not clear whether the rampart adjacent to the square tower was a pier, sea-wall, or fortification along the medieval water front, or perhaps a combined structure with more than one function. Although there is no doubt that the sea came all the way up to its west face, it is not easy to tell whether the area on its east side was inundated

at the time of the Crusaders. West of the northern half of the wall, parallel to its courses, there are several irregular clusters of column drums embedded into concreted blocks of rubble, or laid close and parallel to each other. More columns are spread nearby. It looks as if these are remnants of the western face of the rampart, which was built at its base of courses of re-used columns, as elsewhere at Caesarea for Crusader sea-walls. If this is the case, the original width of the southern section was over 10 m, of which possibly the western 2-3 m served as the base for the fortification wall.

The CMS survey of the South Bay included two main objectives: to study the submerged projection SW of the Crusader Citadel, and to learn about the submerged features of the south promontory -- north and NW of the Piscina.

The shoreward end of the submerged projection (pl. I, no. O), like most of the sea-floor at the bottom of the north part of the South Bay, turned out to be composed of rubble piled well above the sandy sea-floor (cf. Section IV.B). Although no courses of actual structures were traced, it is possible that this spill of rubble was intentionally dumped in antiquity. The greater visible portion of the projection, however, consists of eroded bed-rock. The best parallels are those from Kenchreai (Shaw 1967) and Phasaelis (Blackman 1973), where the mooring area for merchantment in the Roman era was partially protected by artificial ramparts of similar character. These are far more prominent, however, than the feature at Caesarea, and the heavy marine incrustation makes it difficult to determine the details of the individual components here. The spill, or bed-rock projection, extends farther west than the westernmost tips of natural rocky outcrops and behind what is almost certainly a relatively recent fault line.

At the other side of the bay, near the Piscina, there are also remnants of rubble at the base of the northwest tip of the natural promontory. Yet the shape and volume of the spill are not significant enough to indicate another artificial protective feature for the anchorage in the South Bay. It may have been deeply covered in the sandy bottom or swept away by winter storms; in any case not much rubble now projects above the sea bed.

An interesting and surprising feature by this promontory is an area paved with ashlar blocks at a depth of 1.5 m in a pocket between two abrasive platforms (fig. II.22, pl. I, no. 43). The paving slabs are fairly regular in size (1.0-1.9 x 0.5-0.4 m) and cover an irregular area of about 7 x 5 m. The fact that almost all the slabs are now flat on the sea-floor and the entire floor is fairly coherent makes it unlikely that the entire pavement slipped from a much higher level. The slabs rest almost directly on the rocky bottom and are partially covered by sand. The location is such that even in relatively moderate seas the surge is strong, so no sherds of pottery or other small finds are to be found within the original context of the pavement.

During the survey in the South Bay, a training session was carried out to instruct students in the use of the water-jet probe to trace sub-bottom stratigraphy on sandy sea-floors. Through the 1979 workshop five series of such probings were carried out, under the instruction of Y. Tur-Kaspa, within the basin of the ancient harbour and at the South Bay. The data gathered in such probes is useful for attesting the location and elevation of sand-covered architectural or geolog-

ical features, clay layers within sheltered harbour basins, and prehistoric strata predating the presently inundated areas of in shore waters (see Section IV.E).

Some important data were recovered in these probes. Although the probes encountered a thin layer of clay at a depth of about 8.1 m below MSL over almost the whole area of the now submerged basin of the Herodian harbour, such a layer is missing in the immediate vicinity of the inner edge of the Southern Breakwater. Since that layer probably represents a still water deposition of sediments within a well-protected harbour basin, there may have been a rip-current initiated by the flushing channel that flowed along the bases of the quays at the circumference of that basin, sweeping away the fine particles of clay.

A series of probes that ran westward from just outside the tip of the modern breakwater traced what seems to be a rocky bottom at about 7.2-7.6 m below MSL for a distance of 40-60 m west of the modern breakwater, dropping to a depth of 10.8-11.3 m below MSL 20-30 m further west. Farther on, the probes reached a layer of shingle and pebbles at a depth of 11-12 m. These data back the theory of a fault line and might suggest its actual location.

Probes that were carried out along the sandy hollow between the Southern Breakwater and the parallel Subsidiary Breakwater went down to over 8 m below the sea-floor without encountering anything but sand (but cf. the results of CAHEP Survey Line no. 2: m 40-82; Section IV.C). These two structures apparently had no common foundation. Only at the eastern edge of the sandy hollow did the probe reach a layer of either small rubble or pebbles at a depth of 4.2 m below the sand, at a total depth of 8.3 m below MSL.

A series of 17 probes was carried out later in the summer of 1979, as a preparation for the first CAHEP season, along a line running SE of the tip of the submerged projection at the northwest side of the South Bay (see above). The probings were done toward the centre of the bay, up to the point where there is an outcrop of concreted debris on the sea floor. What seems to be rocky floor (or well-concreted debris) was reached in every case at depths (from north to south) of 5.2, 6.1, 6.3, 8.2, 8.4, 8.8, 9.3, 9.5, 8.7, 7.1, 6.8, 8.7, 7.0, 7.1, 6.5, 6.4, and 5.9 m below MSL. These probes were spaced at intervals of about 10 m, along that line. The data for the depth of the consolidated sea-floor at that area, which is now only 3-4 m deep, indicate that there was a potential depth for mooring merchantships during the time in antiquity that predates the proposed 5 m subsidence of the sea-floor.

[A.R.]

II.B. Underwater Survey and Excavation: 5. Joint Expedition Underwater Survey.

From the 28th of May to the 21st of June, 1978, a team of three investigators conducted a preliminary survey of underwater and coastal remains at Caesarea. This effort was part of the archaeological campaign of JECM (Section II.A.6). During the last week of that short season, an aerial photographic survey of the coast-line and maritime structures was also carried out from a tethered aerodynamic balloon operated by Professor and Mrs. J. Wilson Myers, affiliated at that time with Michigan State University (figs. I.33-40).

JECM up to that point had been concerned exclusively with land excavations. But recent discoveries of *horrea* or warehouses in JECM's C Field, on the coast immediately south of the Outer Basin of Sebastos, had heightened interest in learning more about maritime structures on shore, obscured by a recent coastal road, or in the water, and how they may have served these installations (Wiemken & Holum 1981). Land surveys along the ca. 500 m of coast from the Outer Basin in the north to the Piscina in the south had produced no conclusive evidence for an ancient quay fronting these storage facilities, although some such loading platform was assumed to have existed to accommodate easy use of the warehouses. It was thought that such a structure was to be found in the sea.

The primary area of archaeological concern was the section of the coast called the Southern or South Bay by JECM investigators, although the rest of the submerged harbour facilities were examined as carefully as limited time and resources permitted. The team consisted of two archaeologists, R.L. Hohlfelder and J.P. Oleson, and an underwater photographer, H. Wadsworth, then of Denver, Colorado.

These three individuals dove together for safety reasons and to increase the area that could be surveyed during each dive. The team conducted its underwater investigations primarily through a series of shore dives, although a boat was rented from nearby Kibbutz Sedot Yam for work in deeper waters. Notes were taken on the character of bottom conditions and structures encountered; samples of bed-rock and building materials were collected; and relevant data were recorded on a map of the submerged areas that had been examined. At the same time, a survey of coastal land installations was undertaken on foot, with similar recording procedures followed. About 100 hours of underwater exploration were accomplished by the team. The land component of the survey received equal attention.

In view of the fact that preliminary exploration had been carried out previously by Link, the CMS, and the IUES, the JECM team sought only to expand previous work and to prepare a record of extant remains both on land and in the sea that were associated with the ancient harbour facilities. In addition, a major goal was to identify zones of archaeological concern where excavations might solve certain topographical, geophysical, and chronological problems. These objectives were accomplished and were published by Hohlfelder and Oleson (1980) on behalf of the Joint Expedition.

This 1978 season of underwater work was the only one sponsored by JECM, and it was shorter than had been planned. As required by Israeli law, JECM had sought a renewal of its license to continue its excavations at Caesarea through a letter submitted to the Israeli Department of Antiquities and Museums (IDAM). It had arrived at IDAM late in the spring of 1978 while the then director of this agency, Avraham Eitan, was abroad. In his letter, Professor Bull asked permission to begin some new projects as well as to continue those in progress. One new effort was to be the underwater survey discussed above. He had made his request unaware of the exclusive license already issued to the University of Haifa to conduct all marine invesigations at Caesarea. Nevertheless, he was given temporary approval by IDAM officials to begin his field season as outlined in his letter, with

final official approval withheld until his application could be formally reviewed by the Archaeological Council of Israel. His specific request for permission to engage in underwater explorations went unnoticed at that time.

When Avraham Eitan returned and examined the JECM renewal application, he realized that it contained a request to conduct underwater field-work already assigned to the University of Haifa. He immediately notified Professor Bull of this conflict and asked that any JECM underwater work in progress be stopped immediately. Professors Hohlfelder and Oleson ended their field-work and opened negotiations with E. Linder and A. Raban of the University of Haifa, along with R.J. Bull, to resolve this awkward situation and to see if an expanded effort to explore Caesarea's harbours was possible through a larger, international effort under the aegis of the University of Haifa. These discussions eventually led to the creation of CAHEP. Hohlfelder and Oleson left JECM to become co-directors of the new organization. Regrettably, co-operation between JECM and CAHEP on issues of common concerns has not been sustained.

[R.L.H.]

APPENDIX II.A: BIBLIOGRAPHICAL LIST OF SITES AND STRUCTURES ON LAND AT OR NEAR CAESAREA.

This list includes land sites that were studied and at least partially excavated within the context of Caesarea and Straton's Tower, from north to south, and within it from east to west. The entry numbers are keyed into the maps reproduced as figs. I.7-8.

1. *Water Sources of the High-Level Aqueduct:* Conder & Kitchener 1888: 18-23; Drake 1873: 105-110; Guérin, II, 1875: 304; Oliphant 1886; Olami & Peleg 1977.
2. *Water Source of the Low-Level Aqueduct:* Conder & Kitchener 1888: 16-20; Schumacher 1887: 80; Thomson 1880-86: 497; Reifenberg 1950-51: 29; Avitsur 1971; Olami & Peleg 1977: 135-37; Oleson 1984b.
3. *Theatre at Khirbet Shumi (Mi'amas):* Drake 1873: 110; Conder 1873; 1874: 15; Conder & Kitchener 1888: 43; Mülinen 1908: 320-22; Lange & Burkitt 1920.
4. *Necropolis at Tel Mevorakh:* Garstang 1924; Guy 1924; Rosh 1964: 30; Avi-Yonah 1967.
5. *Krokodeilonpolis:* Conder & Kitchener 1888: 13, 29; Schumacher 1887: 78-84; Siegelman & Yankelevitch 1981; Oleson 1984b.
6. *High-Level Aqueduct and its Inscriptions:* Thomson 1880-86: 492-98; Conder & Kitchener 1888 II: 20-23, 40, 43, 68; Mülinen 1908: 320-22; Vilnay 1928a, 1928b; Broshi 1936; Hamburger 1959; Barag 1964, Negev 1964, 1966c, 1972; Frova et al. 1965: 30-36; Ringel 1975: 59-73; Olami & Ringel 1975; Olami & Peleg 1973; 1977; Bull 1975b: 27; Nir 1985.
7. *Low-Level Aqueduct:* Conder & Kitchener 1888: 18-19; Schumacher 1887: 90; Reifenberg 1950-1: 20; 1955: 72-73; Kedar & Ziv 1964; Frova et al. 1965: 30-36, 293-303; Negev 1967: 38-42; Ringel 1975: 65-66; Olami & Peleg 1973; 1977: 135-37.
8. *Byzantine Villa with Mosaic Floor:* Siegelman 1973; 1974.
9. *Byzantine Bath and Chapel:* Frova 1964a; Frova et al. 1965: 293-304; Bull 1975b.
10. *Byzantine Villa with Piscina:* Edelstein 1975; Bull 1976: 23; 1978b: 27.
11. *Sarcophagus:* Siegelman 1974, 1983.
12. *"Bird Mosaic:"* Yeivin 1957: 260; Rosh 1964: 19; Ovadiah 1970: 44-45; Newman 1971; Spiro 1981; Holum et al. 1988: 181-82.
13. *Sewer Tunnel on the North Shore:* Drake 1873: 108; Bull 1972b: 14; Bull & Toombs 1972: 180.
14. *Byzantine Eastern City Gate:* Schwabe 1950b; Applebaum 1954; Frova 1962a: 415; Frova et al. 1965: 45-53, 247-49.

15. *Hippodrome:* Conder & Kitchener 1888: II: 17; Knight 1920; Jeremias 1931; Lifshitz 1957; Bull 1973a: 262; 1973b: 8; 1974: 14; Humphrey 1974, 1975, 1986; Riley 1975.
16. *Early North Wall:* Frova 1959: 14-16; Frova et al. 1965: 247-92; 1963a: 20; Negev 1975: 271-73; Levine 1975a: 9-13; Ringel 1975: 75-78; Bull 1976: 23; 1978b: 27; Blakely 1984; Raban 1985c: 170-73; 1987.
17. *Field G of the Joint Expedition:* Bull 1976: 23; 1978b: 27; 1984: 16; Roller 1982a, 1983.
18. *Synagogue and "Straton's Tower:"* Schwabe 1950a; Avi-Yonah 1956a-b, 1957, 1962, 1964; Avi-Yonah & Negev 1963a; Negev 1967: 5-14; 1975: 270-74; Levine 1975a: 40-45; Raban 1981b: 293; 1983c: 28-29; 1987; Roller 1983; Hohlfelder 1983a; Oleson et al. 1984: 301-302.
19. *Byzantine Court and Statues:* Yeivin 1950-1, 1952, 1955, 1957; Avi-Yonah 1970; Diplock 1971; Bull 1971, 1972b: 13; 1973a: 260-61; 1974: 280-81; 1976: 59; Bull & Toombs 1972; Toombs 1978; Vann 1983b.
20. *Crusader City Wall and East Gate:* Negev 1960a, 1960b, 1966a, 1967: 71-87; 1975: 282-85; Benvenisti 1970: 135-45; Ringel 1975: 170-72.
21. *Levine and Netzer Excavations inside the Crusader City:* Netzer & Levine 1976; Levine 1978; Netzer 1982; Levine & Netzer 1986: 16-148; Raban & Stieglitz 1987.
22. *Temple Podium, Crusader Cathedral, and Herodian Vault:* Negev 1960b, 1963b, 1966b, 1967: 21-27; 1975: 273-74; Levy 1964; Rosh 1964: 13-15; Raban 1985c: 169-73; 1987.
23. *Inner Harbour Basin:* Negev 1961, 1963b, 1966a-b, 1967: 27-30; Raban et al. 1976: 36-38; Oleson et al. 1984: 299-300; Raban 1985c: 166-69; 1987.
24. *Harbour Citadel:* Schumacher 1888: 134-37; Negev 1967: 77-81; Oleson et al. 1984: 302-34; Raban 1985c: 165.
25. *Byzantine "Archive Building:"* Negev 1960b: 22; 1961: 83; 1962: 414-15; 1963b: 730-31; 1967: 51-65; Bull & Toombs 1972: 179; Bull 1973a, 1974, 1975b, 1976, 1982; Weimken & Holum 1981: 27-30.
26. *Byzantine Street Grid in Field C of the Joint Expedition:* Bull 1976, 1977, 1978a-b, 1982, 1984; Weimken & Holum 1981; Spiro 1981; Vann 1983b.
27. *Mithraeum and Horrea:* Bull 1973a, 1974, 1975b, 1978a, 1982, 1984; Holland 1971-72, 1972, 1972-73; Hopfe & Lense 1975: 2-10; Vann 1983b.
28. *Roman Theatre:* Albricci 1962; Frova: 1959, 1961a-b, 1962a-f, 1963a-c, 1964a-b, 1970; Calderini 1963; Degrassi 1964; Frova et al. 1965: 57-234; Volkman 1968: Negev 1969; Ringel 1975: 47-51; Plommer 1983.
29. *Piscina ("Cleopatra's Baths"):* Raban et al. 1976: 31; Flinder 1976a, 1985a; Netzer & Levine 1976: 21; Levine 1978; Levine & Netzer 1986: 149-77.
30. *Byzantine Fortress and Southern City Wall:* Frova 1959, 1962e, 1963a, 1963c; Frova et al. 1965: 229-35; Peleg & Reich 1985.
31. *Southeast Necropolis:* Alt 1924; Lifshitz 1961, 1964b, 1965, 1967; Porat 1965.
32. *Caesarea's "Gardens:"* Reifenberg 1955: 82-83; Kedar & Ziv 1964; Prausnitz 1971, 1973; Porat 1975.

[A.R.]

CHAPTER III: THE CAHEP EXCAVATIONS

III.A. Introduction: Evolution of the Project, 1980-87.

The Caesarea Ancient Harbour Excavation Project was established in several stages and has gone through various changes of co-directorship and institutional participation over the years. As noted above, the Centre for Maritime Studies (CMS) and the Israel Undersea Exploration (IUES) Society were active in surveying, studying, and diving at the site almost every year since the Link expedition of 1960. These activities culminated in the three-month study carried out for the Israel Electric Company (IEC) during the early part of 1976. For the first time, the expertise and experience of marine geologists, oceanographers, and the trained divers of the IUES were combined with adequate funding. This opportunity enabled the CMS to undertake an interdisciplinary study combining oceanography, geology, archaeology, and history. Being one of the first projects of its type in Israel, this study suffered many setbacks, but the data acquired from it served as a solid base for further research. It was natural that the unfinished task of recording all the available archaeological remains within the sunken harbour would spawn continued study beyond the parameters set by the IEC. In subsequent years the CMS continued the project on a much more modest scale, with the same staff, but depending more on students of the Department for Maritime Civilizations and less on IUES volunteers. These annual workshops were carried on until 1981, when they were incorporated into the CAHEP seasons.

It was frustrating, after the large-scale start of 1976 and the first real appreciation of the magnitude and sophistication of the marine site, to have to go back to the limited pace of small-scale and poorly-funded research. In response, Linder contacted the Baron Edmond de Rothschild, through whom the IUES had established a diving centre at Caesarea in 1965, and the "Caesarea Foundation" started supporting the study of Caesarea's ancient harbours. Annual contributions have continued since 1978. This was a good start and sound base for carrying on the research every year, but the project was of limited scale and depended on local volunteers and students who commuted daily from their homes, bringing their meals with them.

The CMS team approached the directors of the Joint Expedition to Caesarea Maritima (JECM), which had been digging several land sites at Caesarea since 1971, with a proposal to create a collaborative underwater project. Although the beginning seemed promising, by the end of two years nothing had materialized. In 1978, two scientists of the JECM were delegated by its director to carry out an underwater survey around the sunken harbour of Caesarea (see Section II.B.5), and application was made to the Department of Antiquities for a permit. Although this

initially caused a conflict with the CMS team, the experience of this survey and subsequent discussions initiated a long lasting collaboration and amicable scientific partnership that evolved into CAHEP.

During 1979 the CMS and the University of Colorado joined to form CAHEP, directed by A. Raban, with R. L. Hohlfelder as a co-director. Hohlfelder subsequently applied to the National Endowment for the Humanities and the National Geographic Society for financial support. Both agencies have supported CAHEP intermittently since its foundation. During the CMS workshop of 1979, J.P. Oleson participated in the field-work, along with his graduate student, A.N. Sherwood. The following year was the first official season of CAHEP. Oleson could not participate that year, so Hohlfelder came as co-director with his own team and the institutional collaboration of the University of Colorado at Boulder. The season lasted from May 22 until July 4, and for the first time there was a working barge over the excavation site. The bulk of the staff and diving volunteers were still Israelis, who commuted home every day. However, the Caesarea Development Company (CDC) donated two rooms at the site in which some of the volunteers resided. This season was also the first to make use of the Caesarea Diving Centre as its work base and as the storage place for the diving and working gear, and to contract with the Harbour Citadel Restaurant for a pleasant dining place and a continuous source of practical assistance. The American, Canadian, and Israeli teams were worked into a single research unit.

The season of 1981 was the first large-scale expedition, with a large group of volunteers from abroad that lived in a shelter built on the grass by the beach near the site. Oleson joined as co-director, with his university collaborating in CAHEP on an institutional basis, and brought a three-year grant from the Social Sciences and Humanities Research Council of Canada. R.L. Vann, from the School of Architecture of the University of Maryland at College Park, came with three of his graduate students and worked as the architect of both the Joint Expedition and CAHEP. His work this season was funded by the National Endowment for the Humanities. This group redrew and coordinated all the previous plans, maps, and survey data of CMS and CAHEP with those of the land survey. The foreign volunteers stayed four weeks (May 23-June 20), but the season continued until July 10, with the final weeks serving as a CMS workshop for the students of the University of Haifa, the volunteers of IUES, and the Israel Federation for Underwater Activities (IFUA).

The 1982 season was on an even larger scale. It was divided into two sessions of three weeks each (with a week of preparation ahead of time) from May 23 to July 2. R.L. Vann joined as the architect of CAHEP and as an additional co-director with his school collaborating on an institutional basis. The primitive residential facilities on the beach were abandoned in favour of the dormitories of Hapo'el Sport Center at the south end of Kibbutz Sedot Yam, living quarters that turned out to be very agreeable for years to come. The season was extremely productive due to the atypically calm sea and thin sand deposits.

The 1983 season lasted from May 22 to July 1. This was the first season of CAHEP to incorporate land excavations, using the volunteer divers on land between dives and during rough seas. Excavation was begun of parts of the Inner

Basin and the architectural remains relevant to the earlier port of Straton's Tower. The scientific staff was expanded by the arrival of S. Sidebotham of the University of Delaware, W.M. Murray from the University of South Florida at Tampa, and T. Hillard of the New England University of Australia. During the last week of the field season CAHEP hosted the First International Workshop on Ancient Mediterranean Harbours that brought together over 30 scholars from all over the world for lectures, field trips, and discussions (see Raban 1985b).

The 1984 season involved the same team, facilities, and sponsorships. It lasted from May 20 to June 30, but suffered bad weather during its second half. The land dig progressed as a result: significant portions of the Inner Basin were exposed, and trial trenches were laid out in the Great Vault of the Herodian temple podium. The presence of Bill Curtsinger, a photographer for *National Geographic*, contributed much to the visual documentation of the project, including a very important series of aerial photographs. This season terminated the initial five-year collaboration of CAHEP, and it was decided to take a year off for study of the material found, before resuming field-work.

The month of June 1985 was devoted to a study season for the co-directors of CAHEP, A.N. Sherwood and S. Sidebotham (who were working on some of the ceramics), and M. Fitzgerald (who worked on the data and finds recovered from the Roman wreck at Area Y). This time was devoted to discussions and diving surveys, aiming to clarify ambiguous issues and settling some of the differences among the co-directors in interpretation of data. Eventually, the character of the final publication was fixed and responsibility was agreed upon for the various parts of the written reports.

CAHEP changed somewhat after 1985. A new five-year programme is under way with full-scale underwater work scheduled for only every second year (1986, 1988, 1990). J.P. Oleson and the University of Victoria withdrew from active field-work at this stage to concentrate on publication and other research projects. The land side of the project has expanded, with R.R. Stieglitz of Rutgers University at Newark joining as co-director on an institutional basis. K. Holum, of the University of Maryland's Department of History and the Center of Mediterranean Archaeology, is helping to direct the land work, in addition to the remaining co-directors of the earlier stage of CAHEP.

The 1986 season of CAHEP was carried out between May 18 and July 7 and was affected by the need to help the movie team of the National Geographic Society in the project of documenting the land and the underwater work with video cameras. Stormy days during the latter part of the season cut short most of the underwater work. The areas excavated in the water were D_1, D_3, D_4, C_3 and Y, J_3, S_1 and S_2, on the shore-line. Some relevant data are described below in the sections on Area C and Y (Sections III.A and S).

The 1987 season of CAHEP was focused mainly on land excavation, with limited underwater work carried out by the CMS team and students of the University of Haifa. It lasted from June 7 to July 17. The areas excavated in the sea were Areas A_2, C_4-C_5, D_5, H_3-H_4, and R_2. On land the work was mainly in two medieval sites: Areas M_4 and Z, but also in Areas L and J_3.

As has been noted in the Acknowledgments to this volume, the following text is in general a factual description of the physical data of CAHEP's excavations and field surveys. Even the illustrative part is only as extensive as is necessary for a clear understanding of the narration. As noted in the Preface, the water conditions and the scale of the site have necessitated reliance more on plans and drawings than on photographs. Under most working conditions at Caesarea photographs of areas or objects more than 2 m distant from the camera tended to be to fuzzy to allow satisfactory reproduction with the printing techniques available to us. Although this report is focused on CAHEP field-work up to the end of 1984, some data gathered earlier by CMS and a certain amount of critical additional information provided by later research have been taken into consideration where necessary. This is the case in particular for Areas D_3, C_2, I_3, L, and S, where excavations during 1986 and 1987 have yielded more information and helped supplement information which had been gathered previously.

[A.R.]

III.B. Areas A, B, C: Inner Edge of the Southern Breakwater.

The most prominent feature along the inner (eastern) side of the mid-portion of the Southern Breakwater is a long course of large ashlar slabs laid in a header formation for a distance of about 165 m. CAHEP Areas A and B are located toward the south end of this feature; Area C is at its north end (figs. III.1, 3). This feature, or at least parts of it, was first noticed by the divers of Link's expedition in 1960, who mistook it for a series of columns (fig. III.5). It was later interpreted as an Inner Quay by the divers of IUES, who investigated it during the mid-1960's, and it was surveyed and drawn by CMS in 1976 (Raban et al. 1976: 45-47) and again during a 1979 workshop.

In 1980, the first season of CAHEP, several areas along this feature were selected for excavation, with the aim of finding out whether there were additional courses underneath, or what sort of foundation there was, and how the structure was related to the original layout of the breakwater. As the only feature in this area of the harbour that seemed to be more or less intact and *in situ*, it was thought that this area might yield some datable finds in an undisturbed stratigraphic context. The excavations began at two adjacent locations at the south end of the line (Areas A and B), with the newly-built operations barge moored almost directly above. The first three days of June were used for installing the barge and the air-supply hoses, and the actual excavation commenced on June 5, after the designated areas had been properly surveyed and marked. The work in both areas was carried out simultaneously until June 12, during which Area A was excavated with a 4-inch airlift and B with one of 6-inch diameter. During this time a team of diving draftsmen, led by the volunteer architect G. Kaplan, redrew the excavated areas stone by stone and completed the corrections of the general plan for the entire course. R.L. Hohlfelder was in charge of the work in Area B, assisted by Y. Tur-Kaspa, and W. Murray was responsible for the work in Area A, under the guidance of Hohlfelder.

On June 20, the airlifts, the air supply, and the barge were shifted about 120 m northward, to the vicinity of Area C. The next day this area was marked with ropes, and the excavations resumed on the 22nd with a 4-inch airlift. The following day the 6-inch airlift was installed in an adjacent area, designated as C_2, at the very north end of the ashlar course. The excavations in both areas continued until the end of the month with Raban in charge, assisted by W. Murray.

The course of blocks that was termed the Inner Quay is visible at the concave part of the Southern Breakwater, just north of the point where it bends from a northwest to a northerly direction (fig. III.1). This point is near an area of the breakwater that slopes toward the harbour basin and is surrounded on its outer face by a higher mound of badly eroded and tumbled concrete blocks. There, during 1976, a series of at least four adjacent courses of ashlar headers was recorded (Section II.B.3 above; Raban et al. 1976: 46). Area B_1 is about 15 m north of this feature and B_2 is 6 m from its southwest edge, to the west of the very south end of the base-line, and what was designated as the Inner Quay (fig. III.9). The base-line (BL), a fixed rope marked every metre to a total length of 165 m, had been installed during the earlier part of the season. The zero point at its north end was fixed beyond the northernmost visible slab of the quay, continued at a direction of 203° for 35 m, then at 188° for an additional 130 m, terminating at area B_2. The ashlar slabs along this line were of almost standard dimensions of 1.8 x 0.7 x 0.6 m, and all were cut of kurkar rock. Some segments were so extensively coated with marine organogenic incrustation that they were hardly distinguishable. In some places (BL m 85-105) the additional cemented spill of small rubble made it virtually impossible to draw individual blocks. Many slabs were abraded by wave carried sand or broken into two or more parts, so their dimensions were much reduced.

Although most of the blocks are horizontal, the upper surface of the course slumps gradually toward the south. It lies at a depth of 4.95 m below MSL at BL m 0 (Area C_2), 5.88 m at m 30 (Area C_1), 6.82 m at m 86, 7.20 m at m 125, 7.50 m at m 145 (Area A), 7.92 m at m 160 (Area B_1), and 6.91 m at m 165 (Area B_2). It seems as if the additional submergence was a gradual one and caused by undertrenching and slumping of these segments after the original bedding of rubble was carried away by the waves and the underlying sand was exposed to the open water.

A survey that was carried out during the 1987 season traced several additional segments of similar courses of blocks, some further east of the northern part of the quay (at Area C) and others west of Area A. The total width of this paved platform did not exceed 8-9 m, and some groups of slabs further toward the Harbour Basin (as at BL m 45-52, m 102-105, m 145-160) have very probably slumped out of position or been dragged off by the sea. In at least three places there are series of ashlars oriented in a direction perpendicular to the main course: two in Area C and at least one at BL m 127 (figs. III.3, 12). In many sections there are clearly two or three parallel courses, and though their present arrangement at the very southeast end might indicate that they were originally on top of each other, in other cases, such as Areas A, B_1, and C, it is quite obvious that they belong to the same surface. For some sections across the Inner Quay and the adjacent breakwater core, see Section IV.C: Survey Lines nos. 4, 5, and 7.

Area A. A square grid 10 m on a side was laid out on an E-W, N-S magnetic compass orientation (deviating about 2 degrees east of true north), along BL m 140-150 with its northeast and southeast corners 1.0 m east of the line (fig. III.4). Several probes that had been carried out in this area earlier in the season revealed a stratum of small rubble 0.3-0.6 m thick, situated above sand which extended to a depth of at least 2 m. The designated square covered a gently sloping area, with scattered slabs on an incrusted spill of small rubble (D 0.2-0.4 m) at a depth of 6.4 m at the west side of the square and 7.3 m at its eastern edge. East of the square and next to it on a sandy floor, there are additional curved courses of ashlar blocks, arched toward the east and composed of 11 headers set close together (figs. III.5-6). The main course, next to it on the west, is composed of poorly preserved ashlars, some abraded down to less than a third of their projected original volume and partially tilted, with their eastern ends buried in the sand and rubble. Some scattered blocks lay at the north and south sides of the square, and a few at the west edge, just at the foot of the steep rise of heaped, concreted rubble, about 1.5-1.8 m above the general level of the squared platform.

In order to facilitate an accurate mapping of every stone within the square, the perimeter of the grid was marked in metres. A 10 m measuring tape was then attached to the east and west sides of the perimeter and fill was removed by 1 m increments from the south to the north, while a draftsman surveyed and recorded the various blocks along it. Due to poor visibility and a strong surge, it took two teams of three divers four dives of over one hour each to accomplish this survey.

The first excavation was carried out along the eastern side of the square, from its southeast corner: a trench 5.2 m long was excavated along the eastern visible edge of the slabs comprising the main course of the quay. The trench went down 0.4 m below the bases of six blocks, revealing that they were resting on sand and occasional piles of small rubble and pebbles. Deepening the trench exposed a further stratum of greyish sand with some clay and many *Glycymeris violacescens* shells under 0.3-0.5 m of sand. It contained many amphora sherds so abraded as to be undatable, except one combed Late Roman piece and the lower part of what seems to be an Early Byzantine juglet. Below this layer, some 0.3 m deeper at a depth of 8.05 m below MSL, there was a thin but very marked layer of compact clay, with no shells or pottery. Beneath, at a depth of 8.2 m, sterile sand with some coarse particles but no shells or potsherds was traced to a depth of 8.6 m below MSL. In view of the absence of foundations underneath this course, the presence of abraded, late pottery, and the proximity of the clay layer that might present the original floor of the Herodian Harbour Basin, it is reasonable to assume that this segment of the so-called Inner Quay is not at its original place but has fallen or slumped down and inward from its position on the breakwater.

The next trench was cut along the north side of the square, from about 1 m west of the northeast corner (the west edge of the offset main course of the jetty) all the way to the northwest corner, next to the foot of the pile of concrete blocks (fig. III.7). The average width of the trench was 0.7-0.8 m, and the entire excavated area was just over 7 m square.

At the eastern part of the trench the following stratigraphy was established (the figures are depths below MSL) (fig. III.8):

A. -7.7 to -7.9 m: regular bottom sand, some shells and a few shapeless potsherds.
B. -7.9 to -8.1 m: grey sand with many shells, pebbles and abraded potsherds, mostly body sherds of Roman amphoras.
C. -8.1 to -8.25 m: compact grey clay with no shells and some pottery. This layer extends westward and tapers off at a point 5.4 m west of the northeast corner of the square.
D. -8.25 to -10.00 m: very uniform grey sand with some dark inclusions, without any pottery and only a few shells. The maximum depth was reached in two deep probes with the airlift.

The western part of the trench was dug by hand removal of the lower extention of the steep spill of what seems to be the very body of the breakwater's mass. Below there was a compact mass of rubble to a depth of 7.6 m below MSL. Underneath there was nothing but the same fine greyish sand, with some lighter interbeds and no potsherds at all. This virgin substratum was traced down as far as the probes could be continued. Two water-jet probes were done at that section, and the metal pipe went down 5 m (to a total of 12.3 m below MSL) through sand without hitting any more consolidated layers (fig. III.7). The absence of the clay layer at the western part of the square and its coinciding with a superimposed better-preserved layer of compact rubble, might indicate that this is the original inner line of the breakwater. In that case, one might suppose that the entire southern segment of the quay is now offset over 5 m eastward and over 1.5 m deeper than its original position (see Area C, below). Yet, the almost horizontal present position of all the slabs and the close resemblance and proximity of most of the blocks within the course seem to contradict displacement of such a magnitude.

Following Josephus (*AJ* 15.337), a vertical wall should face the inner side of the mole, facilitating trans-shipment of goods from moored vessels to the storage vaults on the quay. The ashlar header courses may actually be remnants of such a vertical wall, as many parallels suggest from neighbouring Phoenician harbours such as Athlit, Akko, Tyre, and Sidon (see Raban 1985b: 30-40). The only reasonable location for the base of such a vertical wall in Area A is either at the foot of the rubble ledge, some 4.5 m west of the northeast corner of the square, or on top of it, about 1.4 m farther back. This suggestion is based on the presumption that the clay layer can only represent the sediment sunk on the basin floor during the time the harbour was still intact (see Section III.M). Considering most of the existing header blocks as components in such a proposed vertical quay, it is possible to attribute slabs of parallel course or those scattered nearby as members of the paved surface of such a quay, originally on top of rubble fill.

With such a theoretical reconstruction in mind, we counted the number of surviving blocks along the entire main course and the adjacent ones that seemed originally to stem from it. Then, reconstructing the minimum required depth of water to such a wall as 2 m, and adding another 0.5 m as a minimum height of the wall above the water, there are 600-800 blocks missing from the present vicinity of the main course. Surveying the architectural remains of the land site during the CMS project of 1976, we searched later structures around the harbour, looking for these missing blocks in secondary use. During that survey, about 180 blocks resembling in dimensions and shape those from the Inner Quay were detected, mostly at the lowest above-water courses of the northern and southern faces of the Crusader Harbour Citadel (figs. III.128-29). Considering the lower sea level reconstructed

for the Medieval era (see Sections I.A.2-3) and the limited resources of the Cru-saders, who always sought re-used building material (as is so clearly visible for the case of the column drums), it is very tempting to attribute the plundering of these proposed missing components of the Inner Quay to this late stage in the history of Caesarea.

Area B. Two adjacent excavation areas were designated at the southernmost point of the Inner Quay, at the best preserved and largest area of close-set courses of ashlar headers (figs. III.1, 3, 9, 11). The survey and plans of 1976 suggested that in this specific location the ashlar structures were at a higher elevation than in the area farther north, and closer to the concrete blocks on the crest of the breakwater. It was therefore estimated that at this location the layers below the blocks might have kept their original stratigraphy and volume. Toward the SW, the piled concrete blocks rise to about 3 m below MSL, and some large, tipped chunks of concrete about 3 x 3 x 1.6 m cover the edges of the paved area on its southwest and northwest sides. Two pairs of larger than usual rectangular blocks of kurkar (2.2 x 1.1 x 0.9 m) lie west (somewhat higher) and east (on the sand) of the southern part of the paved area, and three still larger blocks (2.6 x 1.5 x 1.2 m) lie north of it, separating the group of ashlar slabs from the southern end of the Inner Quay (fig. III.10). The original plan, made in 1976, was corrected during the May 1980 CMS workshop. During this work, a line was fixed around a rectangular perimeter at the north part of the pavement. It was 6.5 m long on the course of the Base Line (its northeast corner at BL m 165) and 3 m wide. This area was designated as B_2, while B_1 was marked by a line fixed perpendicular to the Base Line at BL m 160, extending toward the east for 10 m.

Area B_1 includes a line of three ashlars; the first two rest on rubble and the third on a sandy bottom at a depth of 8.2 m. The total distance from the Base Line to the farthest edge of the third block was 8.7 m.

The excavation was carried out as a series of probes along that line, between the blocks. The first probe was dug at the first metre east of BL m 160 on the south side of the the marking line. The tops of the two neighbouring blocks of the main course were at a depth of 7.85 m, and in order to expose their base, some 0.60 m deeper, a thin layer of small rubble (D 0.1-0.2 m) was removed, then about 0.20 m of wave-carried sand. Beneath, there was a layer of greyish sand mixed with gravel and concentrations of sea-shells (mostly *Glycymeris violacescens*). The second probe was made 3 m farther down the line. Here too, under a shifted surface layer of about 0.20 m of sand mixed with some rubble and large pebbles, the same substratum of gravel and shell was found to extend below and underneath the bases of the ashlar blocks. A few abraded potsherds at that underlying level indicate that this part of the ashlar structure is offset from its original place.

The third probe was made next to the north side of the last blocks and the marking line, at a depth of 8.2 m below MSL. The base of the block was exposed at a depth of 8.8 m, buried in recently shifted sand with no pottery. At a depth of 9.1 m the sand turned greyer and coarser, with a small amount of gravel. No clay layer was detected at a depth of 10.2 m. A water-jet probe seemed to hit and go through a layer of gravel at a depth of 12.3 m below MSL. No potsherds were found in the second and third probes.

The depth at which the slabs now lie and the absence of underlying clay or other stable sediments indicate that this part of the sea-bottom has undergone extensive trenching by currents and its stratigraphy has been badly disturbed.

Area B_2 (fig. III.3) was surveyed by the same method of trial probes. In this higher area, the compact surface is composed of rubble incrusted with some abraded potsherds and small chunks of mortar. This upper layer was loosened manually with picks and cleared before the airlift went into effective use.

The first probe was made just inside the western edge of the designated area, at a gap between the paving slabs to the south and one of the three large blocks to the north. The surface of the rubble at that point is at at a depth of 5.8 m below MSL, with the face of the pavement at 5.2 m and the top of the block to the north at 4.7 m. At a depth of 6.2-6.3 m the rubble was less compacted, mixed with gravel, and underlaid by grey sand mixed with quantities of shells, but no potsherds. Deeper, the sand became more uniform and contained fewer shells. The probe went down to a depth of 7 m below MSL without any change of sediments and no pottery or other artifacts. The airlift was then replaced by a water-jet that went 3 m deeper into the sand without encountering any apparent layers of clay or gravel on its way. The nearby pavement lies on about 0.3 m of rubble, with the sand and shells underneath. The same stratigraphy was found in the third probe, just NW of the southwest corner of the perimeter.

The second probe was made on somewhat higher ground, west of the westernmost visible ashlar slabs. The surface of the rubble at that point is at a depth of 5.3 m below MSL, and the top of the neighbouring slabs is about 0.5 m shallower. The probe had to be discontinued after two days of efforts to clear the rubble by hand. A pit almost 1 m deep was dug, but as it was continued, the rubble became larger and more tightly packed. Eventually, the tops of large, square tilted blocks were revealed. Every attempt to penetrate this level with the water-jet failed. It is probable that the site of this second probe at Area B_2 constitutes the central mass of the breakwater.

The third probe, a pit 1.4 m deep, was dug half-way along the eastern side of the perimeter, between two blocks of the eastern course of the pavement. The sea-bottom at this spot is composed of rubble at a depth of 5.8 m below MSL, with the top of the neighbouring slabs at 5.2 m. The paving slabs (or course of ashlars) are laid on the rubble (D 0.2-0.3 m) which covers a substratum of gravel and shells. The following stratigraphy was revealed at that probe (the figures represent depth below MSL):

-5.8 to -6.2 m: rubble, compacted and with no potsherds.
-6.2 to -6.4 m: shells and gravel mixed with coarse grey sand, no pottery.
-6.4 to -7.2 m: light grey sand with some whiter inclusions, a few pieces of broken shells, no pottery or other man-made artifact.

A water-jet probe at the bottom of the trench went down more than 3 m. At a depth of 8.3 m below MSL it found some clay or more clayish sand, and beneath it, clean white sand.

The data gained by the Area B probes did not add much new information to that recovered from Area A, yet it tended to confirm several earlier, tentative conclusions:

1. The ashlar slabs of the pavement were originally laid on a cushioning layer of rubble. This is attested in the shallower probe sites where no intrusive potsherds were found (B_2: probes 1, 2, 3).

2. The westernmost part of the pavement is actually on the breakwater (B_2: 2), and although not necessarily *in situ*, gives some indications for its relative elevation within the subsided mass.

3. The segments of the ashlar courses that are most intact lie almost directly on sand and shells. These recurring circumstances, especially for those portions which are now in less than 6 m of water, may indicate that there was sand fill almost to sea level this far from the shore-line already at the time the breakwater was built. Even the assumption that all the ashlar courses are remainders of some post-Herodian attempt to reconstruct the breakwater does not fit the fact that there are now potsherds in the substrata of these slabs.

4. The absence of underlying clay in three (and maybe all) the B_2 probes might indicate that the area was within the original outline of the breakwater mass and the various ashlar courses were not carried away as far as the harbour's floor.

Area C. The objectives of the probes at Area C, next to the northern part of the line of the Inner Quay (figs. III.1, 3), were basically the same as for those in Areas A and B: to understand the composition of the inner side of the Southern Breakwater. Answers were sought for the following series of questions: Why does the orientation of the course of blocks change for the last 35 m to the north? Are there underlying courses below the one visible on the sea-floor? If not, what kind of substrata are there at a segment that seems more intact and much farther west of the border between the breakwater spill and the sandy bottom of the submerged harbour basin? What is the character of the even and levelled area west of the main course, toward the high pile of concrete blocks, and what was the original function of the additional courses of ashlar slabs on that platform? Does the underlying clay exist also next to the northern part of the quay as a benchmark for the floor of the original harbour, and if it does, how far west below the debris does it continue? Why do the ashlar blocks disappear 100 m short of the northern tip of the breakwater, and where might a continuation be sought?

Field research directed at answering these questions was planned for the later stage of the 1980 season, but it had to be cut short and left incomplete due to rough seas during the third week of June. Excavation was, however, undertaken again during the 1986 and 1987 CAHEP seasons, and the results of this later work are taken into consideration here. Nevertheless, some questions remain, and some of the answers are tentative.

Area C_1 is a square 10 m on a side (fig. III.12) Its eastern perimeter was marked by the Base Line, while the southern and northern limits were delimited by lines installed perpendicular to it, leading west from BL m 30 and BL m 40. Two trenches were then dug along the inner side of each line as far west as the base of the higher ledge of blocks and compacted rubble. The southern trench was dug along the stretch of three consecutive blocks of three parallel courses of ashlar headers, for 6.6 m westward (fig. III.13). The face of these slabs is extensively abraded, and they seem to be lacking as much as 0.10 m of their original height. At present, they compose a level pavement 5.8-5.9 m below MSL. The three blocks along the north side of the trench measure (from east to west) 1.8 x 0.7 x 0.6 m, 2.1 x 0.7 x 0.5-0.3 m, 2.15 x 0.7-0.5 x 0.4-0.3 m. East of these courses there is a spill of loose rubble, gradually sloping eastward (6.3 m below MSL at 10 m east of BL m 40). West of the western course there is a sand-filled hollow 2.7 m wide, at the foot of the concrete blocks, at a depth of 5.9 m below MSL.

Below the cut stone blocks and the sand (section, fig. III.13) there is a layer of rubble: mainly angular fragments up to 0.5 m in length and 0.3 m in width, only 0.2-0.3 m thick under the eastern ashlar course and as much as 0.6 m under the sandy patch on the west. Under the base of the concrete block with a height of about 2.5 m (its crest at 3.6 m below MSL and its base at 6.1-6.3 m), the substratum is composed mostly of much larger pieces of limestone rubble, with some fragments as large as 0.9 x 0.4 m. The probe went below this layer as far as 1.7 m under the concrete block, where it was stopped by what seemed to be either the side of a huge ashlar block or a further mass of concrete. From that point, at a depth of 6.6 m below MSL, three pieces of pottery of the Late Hellenistic period were recovered: the lower part of a spindle-shaped juglet, a fragment of a glossy red Eastern Sigillata bowl, and a tiny piece of a mould-made ("Megarian") bowl.

Below the 6.6 m depth there was a 0.15 m thick layer of coarse sand containing numerous shells and some gravel. Underneath this there was uniform greyish sand with a few broken shells and no potsherds. At a depth of 7.1 m below MSL there were interbedded layers of coarser sand and pebbles. Beyond the ashlar courses, next to the concrete block, the trench was deepened for 1 m (to 8 m below MSL), through the same fine, light grey sand.

The other trench, along the north section of the perimeter, extended 4.6 m west of BL m 30. Farther west there was a mix of spilled rubble and tilted blocks that would have necessitated much manual work in clearing. On the north, just outside the designated grid, there was a course of four ashlar headers on an east-west line, perpendicular to the main course. These blocks were broader but thinner than those of the Inner Quay. The best preserved example is 2.2 x 1.05 x 0.35 m, its upper surface at a depth of 5.7 m. The area next to this course, to the south and west of the blocks offset from the main course, is in part occupied by a hollow where some of the rubble fill has been lost and replaced by wave-carried sand. Beneath the sand, the stratigraphy was the same as in the trench farther south, at the other end of the perimeter. No second underlying course was to be traced anywhere in the area, and no artifacts were found below the layer of shells (that is, below the depth of 6.8 m).

Area C_2 (figs. III.3, 14-15) straddled the Base Line just south of the 0 mark, extending 8 m east and 4 m west of it. At present, the last offset blocks of the Inner Quay next to BL m 0 are in less than 5 m of water and are surrounded by heaps of rubble and partially decomposed concrete blocks. This uneven surface continues about 6.0 m farther east to about 5 m east of BL m 0. At that point there is a large stone block (2.2 x 0.8 x 0.7 m) tilted steeply eastward toward the sandy sea-floor, with some other blocks underneath. The higher edge of the tilted block is at a depth of 3.9 m, the sand surface at 5.2 m.

In order to determine whether this feature formed part of a vertical wall of ashlar headers, it was decided to probe the lower part of this block and expose the underlying structures (fig. III.14). A second ashlar block oriented on a north-south

axis was soon exposed 0.5 m to the east, with its upper surface at 5.3 m below MSL and its base at 6.1 m. It is a large ashlar (2.1 x 1.1 x 0.8 m) found lying horizontally in the sand. Widening the probe southward, another block was recovered, tilted somewhat down and away from the trench. The northern, higher end of that block, just below the sand, had rounded edges and a recessed face on one side. A hole (D 0.3 m) was sunk about 1.2 m in the centre of this recessed face. Since it is now filled with naturally concreted shells and pebbles, it was impossible to determine whether it continued through to the other side, which was still buried. This ashlar was cleared to a depth of 1.5 m below the sandy sea-floor, and over 3 m of it were exposed (it is 1.2 x 1.5 m). Unfortunately, bad sea conditions forced abandonment of the trench. There is no doubt that none of the three ashlars is in its original position and that they have all fallen from a construction on higher ground. As for the uniquely shaped, half-buried slab, it might be a long mooring stone, once incorporated within the vertical face of the Inner Quay, like the one found later in the Inner Basin (Section III.H.1) or a component in the base of a tower similar to those comprising the debris on the tip of the Northern Breakwater (Section III.C.1, and Raban 1981b, fig. 11). Excavation below the upper block and the second one in the sand, made it clear that there was neither any underlying course of blocks at this point nor any rubble cushion as in the areas described above. The fill is composed of sand all the way to the bottom of the probe, from a depth of 5.1-5.2 m to 7.1 m and more (the water-jet probe went 3 m farther through a light yellow sand only).

The first metre of fill was composed of well sorted, different types of sand: from a depth of 5.2 m at the surface to 5.4 m, there was recent wave-carried sand. At that depth there was a 0.05 m layer of shells and some abraded potsherds. Below some 0.10 m of underlying greyish sand at a depth of 5.7 m, there was again a thin, but very distinctive black layer (Th 0.02-0.03 m), composed of partially carbonized twigs and tiny chips of wood. Below that layer the sand is finer, changing again to a coarser type with shingle and shells at a depth of 6.1 m below MSL. Beneath this, there were alternating layers of light yellow and grey sand with few shells and no artifacts. Below a depth of 6.4 m the sand seemed to be more yellowish all the way to the bottom of the probe.

The data gathered from the limited excavation and the many probes along the Inner Quay facing the inside of the Southern Breakwater can be summarized as follows:

a. The main feature is composed of various segments of courses of ashlar blocks, all arranged as headers. Some of the blocks have been pulled from their original positions, others have subsided through the fluidization of the underlying sand. These courses are composed of two types of blocks: the first, almost equal in height and width, is found along the edge of the feature termed the Inner Quay and may have been used in the face of the quay as a retaining wall. The second is thinner and broader, like paving slabs, and probably stems from the paving of the promenade held by the retaining wall.

b. The ashlar paving was laid on a cushion of rubble, above sand fill, the thickness of these layers probably representing the depth of the sea at the time of construction. In most places, the bulk of this fill has been dissipated by the action of the sea since the delapidation of the retaining wall.

c. There are no indications of the exact configuration of the Inner Quay or the manner of its construction. It is unlikely but at least possible that its base was built of now-decomposed concrete blocks, topped by one or two courses of ashlar headers. There are no indications of adjacent secondary quays or jetties along the inner face of the Southern Breakwater within the 165 m marked by the base-line.

d. There is no architectural, stratigraphical, or ceramic evidence for later building attempts during the post-Herodian period.

[A.R.]

III.C. Area D: Entrance Channel and Head of Northern Breakwater.

III.C. Area D: 1. Head of the Northern Breakwater. In its larger sense, Area D consists of the Entrance Channel to the Herodian harbour and the nearby sea-bottom, now covered with the debris of the northeast edge of the Southern Breakwater and the head of the Northern Breakwater (figs. III.1, 16-18). In the original terminology, Area D was the collapsed pile of huge, rectangular kurkar blocks above and off the western tip of the Northern Breakwater, studied mostly during the 1980 CAHEP season (fig. III.18). There are three sub-areas (fig. III.19): Area D_1 is the floor of the Entrance Channel itself, excavated during 1981 and 1982. Area D_2 is a trench cut through the sloping debris on the southwest side of the entrance, excavated during the 1982-1983 seasons. Area D_3 is the top of the rubble platform at the northern edge of the spill of the Southern Breakwater, 30 m west of Area D_2, excavated during the 1984 and 1986 seasons.

Since the three sub-areas are described and discussed in the following section, this section deals only with the head of the Northern Breakwater and the general issue of the Entrance Channel of the Herodian harbour.

The western tip of the Northern Breakwater can be clearly distinguished from the air (fig. III.17) or a high viewpoint on the shore, and it was originally traced in 1860 by the surveyors of the anchorages of Palestine (Mansell 1863). The configuration of this feature as seen from the air includes two adjacent elements: a semi-circular pile of huge blocks rising to less than 2 m below the waves, and a deeper area of debris next to it to the north, projecting beyond the otherwise straight east-west line of the northern edge of the breakwater. This second feature (Area G; figs. III.1, 16) is described below (Section III.F). The pile of blocks in Area D has a crescent shape with ends tapering eastward along both edges of the breakwater. Its widest part is the southern third, due east of the narrowest passage in the entrance. At this point several crowning blocks give it a total height of over 6 m (fig. III.18). This is the only section of the Northern Breakwater that is not covered with small rubble, and its debris is now higher than the rest by 2-3 m.

Although the original layout of the structure to which this pile belongs can no longer be determined, it must have been a massive one, undoubtedly a dominant feature among the breakwater's upper structures. The blocks are over 5.5 m long and almost 2 m on a side, and were originally laid side by side as headers (fig. III.18). The face of the best-preserved section is now at a depth of 3.8 m, but here too the blocks are somewhat shaken apart and tilted westward. The blocks grouped at the southern end of the crest of the pile have fallen some distance and clearly

have twisted off their original positions. Discounting the possibility that they were carried up by the waves during or after their submergence, their present shallow position (from a depth of 1.5 m below MSL on the east to 3.3 m at the western upper face of the same block) indicates an original elevation of at least 3-4 m above the ancient sea level.

The main section of the tumbled structure extends about 20 m from north to south and over 12 m east to west. There are basically three courses of headers, although at present it is impossible to tell whether the courses were composed of blocks of uniform dimensions or if there was some kind of interlocking arrangement of blocks of different lengths. At present, many blocks are broken and their original length unknown. The lowest series of blocks projects out farther than the blocks above, very probably due to the combined effects of wave action, tectonic submergence, and the fluidization of the substratum. The blocks of this series are partially or entirely buried under the sandy sea-bottom of the Entrance Channel. The deepest point to which these blocks have tumbled is at present about 8 m below MSL (fig. III.20, pl. IV, SL 12).

Some of the blocks of this series have a distinctive shape (figs. III.21-22). At one end, probably the end that originally faced west towards the entrance, several blocks were provided with a flat, recessed face extending the whole width of the block. At the centre of the recessed face, a deep round hollow (D 0.4 m) was carved. Oleson (Oleson et al. 1984: 295) proposed that these were half-lap joints intended to help the blocks interlock as a stable breakwater head. After the crusty layer of marine growth was removed from some of the blocks during the survey of the 1980 CAHEP season, two additional features were exposed. First, a groove was traced across the base of the trimmed part. Second, a series of four cuttings for iron C-clamps was observed, two on each edge of the same side of a block. Some of these cuttings still carried the lead casting poured around the clamps to hold them in place. These castings look like rectangular sockets, preserving the form of the iron clamps that have corroded away (fig. III.23). The dimensions of the clamps and the intervals between them seem to have varied from block to block. Those blocks which seem to have retained their original length vary from 4.5 m to 5.5 m. Their sections seem, however, to be quite standard: 1.25 x 1.25 m. All the blocks were cut from the local kurkar. On some blocks, the recessed face of the lap-joint is oriented toward the same side as the clamp holes; on others it is turned 90 degrees. The clamps were traced only on this type of block or on broken chunks that, judging from their present positions, are very likely fragments of such blocks. It may be that clamp grooves could be traced on other blocks with no visible remains after systematic removal of the marine incrustation.

Grooves for clamps are quite common in various buildings at Caesarea attributed to the Herodian period, whether in the Theatre (Frova et al. 1965), Area J (Section III.I; Raban 1983b: 250, fig. 20), or Area S (Section III.Q). They can be seen as well on the pre-Herodian wall at the south side of the Great Vault in Area I_3 (Section III.H.3). The technique has a long tradition in Greek construction, and it was also used in various structures of the Neronian and the Severan harbours of Leptis Magna (Bartoccini 1958: 20, fig. 4). Caesarea, however, is the only site where such clamps may have been installed under water, in order to bind the

external blocks at the head of the Northern Breakwater. Although it is possible, judging from their present position, that the molten metal in some of the lead-filled clamp sockets was poured into grooves which were then above sea level, the lead pourings on the west side of the breakwater are now in almost 8 m of water. They may have been installed in a structure which was originally built below the water-level, by means of coffer-dams.

The function of the recessed face at the tip of every second or third block of the western course is far from obvious, and no close parallels are known from other Roman ports. Although Oleson assumes they served as lap-joints, other explanations can be proposed. If all the hollowed recesses are reconstructed as originally facing upwards, one might suggest that they were sockets for bollards, either for mooring tug-boats or for temporarily tethering or guiding approaching ships (Blackman 1982: 203-4, n. 100). If the hollows are reconstructed in a horizontal orientation, one could restore an anchoring device for fixing a wooden gangway or staircase leading down to the water-line, as it is depicted in the famous Torlonia relief. Another possible function might have been to receive and anchor a wooden framework for a large windlass or a similar mechanism for pulling a chain used for closing the harbour Entrance Channel overnight or in time of war. No actual devices for such purposes, however, have ever been found in any of the commercial harbours of the Roman era. The device reconstructed by Jameson for Halieis (Jameson 1969: 335-37, fig. 7) has recently been challenged (Frost 1985; Blackman 1982: 194-96).

Whatever their function, it is remarkable that the Roman engineers felt the need for additional means of binding on such huge blocks, which weigh over 20 tons each and were held tightly in place not only by massive iron clamps, but also by friction against the adjoining blocks over an area of about 13 square metres. This reaction suggests some function that imposed considerable drag and stress upon these blocks.

[A.R., J.P.O.]

III.C.2. Area D_1-D_2: Harbour Entrance Channel. At present, the harbour Entrance Channel is a funnel-shaped passage with a sandy floor, framed on the exterior by Areas G and K, on the interior by Areas H_2 and R, and straddled at its narrowest point about midway through the channel by Area D (figs. III.16, 19). The apparent shape and width of the channel as seen in aerial photographs changes from year to year depending on the transport of sand by winter storms. Because of the low relief and gentle slope of the rubble forming the present termination of the Southern Breakwater, even a relatively slight change in the depth of sand in the channel changes its apparent outline significantly at this point. In 1982 the surface of the sand was 7.6 m below sea level.

The location of the Entrance Channel has never been in doubt since identification of the harbour itself: it is clearly visible and corresponds in location to the channel described by Josephus (*BJ* 1.413; *AJ* 15.337; see Appendix I.A). The exact dimensions and construction of the original Herodian entrance, however, are more difficult to determine. The east side of the channel seems still to retain approximately its original configuration, although some of the rubble berm around the

blocks in Area G has been destroyed and the blocks forming the termination of the Northern Breakwater have tumbled from their structural positions. Because of the massive dimensions and the careful reinforcement of the materials used at these locations, the blocks have not travelled far, if they have moved at all. As a result, the profile of the remains of the tip of the Northern Breakwater is still steep and easy to trace. The immediately adjacent portion of the channel, too, although filled with sand, is more or less unencumbered by later debris: one large block has slipped off the Northern Breakwater into the channel at the south end of Area D_1 (figs. III.19, 31), and another at the north end of the area may have been dropped there during renovation of the harbour in the reign of Anastasius (fig. III.25; see below).

It is the determination of the location of the west side of the channel that has caused difficulty and still remains problematic after eight years of excavation and survey. The uncertainty stems from the exposed position of the Southern Breakwater and the consequent movement of its superstructure and core after the submergence and decay of the outer portion. Since storms generally approach the harbour from the SW, the movement of building materials of smaller dimensions has tended to be towards the NE. The present low, sloping profile of the tip of the Southern Breakwater adjacent to the entrance may be the result of this phenomenon. No large blocks of concrete or kurkar are presently visible here, only rounded pieces of concrete or kurkar rubble, ca. 0.15-0.40 m in diameter. This deposit was probed with a trench in Area D_2 (see below). Enormous blocks of kurkar and concrete are visible only 30 m west of the present channel, and a probe was made in this area (Area D_3) to investigate the character of the structure (see below). Another hypothesis, that the rubble in the channel is fill dumped there intentionally during restoration of the harbour in the late fifth century, has been proposed by Raban (see Section VI.G).

Excavation of the sandy fill in the channel with airlifts was begun in 1980, in an attempt to reveal the structural design of the head of the Northern Breakwater (fig. III.24). The Link expedition had carried out some probing in this same area in 1960 (Section II.B.1). Removal of the loose white sand quickly exposed the large kurkar blocks of the breakwater head, and it was hoped that the original channel floor would be shallow enough to allow relatively quick identification. In 1980 and 1981, however, only a few small, isolated blocks of kurkar and a large quantity of wave-worn sherds and scattered small finds appeared in the loose fill, along with two large kurkar blocks projecting out into the channel from the face of the Northern Breakwater. The larger of the two, which forms the southern boundary of Area D_1, is approximately the same size as the large blocks of the breakwater head (3.2 x 1.6 x 1.2 m) and probably has fallen from its original position, coming to rest on top of a layer composed of rubble and worn potsherds tumbled off the Southern Breakwater. A somewhat smaller kurkar block at the north end of Area D_1 (ca. 2.0 x 1.2 x 1.3 m) also lay on the rubble spill. Several timbers (ca. 0.15 m sq.) lay crushed beneath it in a regular pattern not unlike a lifting frame or pallet (fig. III.25). Since the timbers yielded a carbon-14 date of 1470±50 B.P. (462-562 A.C.), the block may have been dropped here during the reconstruction of the harbour carried out by the emperor Anastasius (491-518) (Appendix III.B, no. 1; also Carmi 1987).

The identifiable ceramics from the sand fill dated from the first to the seventh centuries and included amphoras, utilitarian ware, lamps, and *terra sigillata*. The trench also yielded bronze fish-hooks, cosmetic instruments, spikes, nails, and vessel handles, numerous lead fishing and net weights, and a Late Roman inscribed ring, the one piece of gold jewelery found in the entire series of CAHEP campaigns. The uniform character of the sand fill and the unstratified arrangement of the finds (including the discovery of a tennis shoe and a modern inscribed rooftile at a depth of 1.5 m below the surface) show that all of the upper fill is a secondary deposit.

In 1982, further excavation was carried out in the channel with the aid of fiberglass sheeting. This was anchored in such a way as to hold back the fluidized sand fill and allow deeper penetration of the sediments. Continuous efforts with several airlifts laid bare an irregular, sloping stratum (Th ca. 1 m) of concrete and kurkar rubble washed off the body of the Southern Breakwater. This stratum overlay a series of irregular strata and lenses of sand and pebbles 0.9 m thick that contained shell and wood fragments and a rich deposit of wave-worn pottery dating from the early Empire to the Byzantine period (figs. III.27-28). The worn character of the pottery found just below the rubble shows that it too, like the pottery found in the sand fill of the channel, had spent some period of time in movement along the harbour floor before being covered by rubble swept off the Southern Breakwater (fig. III.26).

The original channel floor was finally reached after several weeks of intensive excavation. It consisted of a well-marked stratum of very fine, viscous grey clay incorporating lenses of grey sand. This stratum varied in thickness from ca. 1.0 m to 0.25 m and sloped from 10.5 to 11.0 m below MSL. It lay directly on fine, clear white sand, which presumably marked the original sea-bottom, since excavation 0.4 m into it did not yield any further strata or cultural materials. The upper surface of the clay was exposed over an area approximately 2.0 m square, revealing a large number of intact or nearly complete pottery vessels dating for the most part from the late first century B.C. through the second century A.C., including a Herodian type lamp, local coarse wares, amphoras, and a variety of wares imported from Italy: stamped *terra sigillata*, volute lamps, kitchen and coarse wares, and amphoras (figs. III.29-30). One group of ridged amphoras is Byzantine in date. Well-preserved pieces of rope, miscellaneous bits of worked wood, and an intact wooden sheave block also were recovered, along with a bronze aryballos, bronze spikes, and lead sheeting and fishing weights (Oleson 1983a). All this material will be published in Volume II. Some of this cultural material had sunk into the clay, while other pieces -- the possibly Byzantine ceramics in particular -- lay on the upper surface. Virtually all the ceramics had been stained a light grey by the associated sediment, but the mechanical properties of the clay had saved them from being broken, dispersed, and worn by the action of waves and currents. Unfortunately, the intersection of this layer with the heads of the two breakwaters could not be traced: to the east the stratum disappeared beneath the large blocks fallen from the Northern Breakwater and to the west beneath the rubble that has rolled off the Southern Breakwater.

It is clear that this stratum can be associated with the first two centuries of harbour use. The fine particles of which the clay is composed differ markedly

from the crisp, white quartz sand forming the sea-bottom, and they may stem from building activities and dredge-and-fill operations connected with the construction of Sebastos. Excavation or clearing of the Inner Basin, for example, would have involved the removal of Pleistocene soils and sediments, some of which might well have been carried elsewhere in the harbour basin in suspension and then deposited. At Dor and other sites farther south along the coast of Israel, clays similar to that found in secondary deposition at Caesarea (but more compact and lighter in colour) have been identified as lagoonal deposits formed behind fossilized Pleistocene sand dunes now submerged just off shore (Raban & Galili 1980: 331-32). Certainly, the same clay layer was observed at Caesarea in Areas E_2, H_1, and N_2, at a level of ca. 8.0 m below MSL (Sections II.D, G, M; fig. III.134). The clay may also be the product of harbour pollution associated with maritime trade, nearby craft activities, and general human occupation. In terms of sedimentology, the very fine particles composing the clay could only have come to rest in an area of minimal kinetic energy. The present location of the clay inside the harbour Entrance Channel and within the Outer Basin indicates that it originated somewhere inside the harbour at a time when the breakwaters still provided a calm anchorage. Whatever its source, calculation of the relationship between the level of the clay, the structural remains of the sunken harbour, and present sea level provides invaluable information on the original configuration of Sebastos and the process of its destruction.

In 1982 a second trench was laid out in an area termed Area D_2, extending west from the south end of the pit excavated in the Entrance Channel at Area D_1 (figs. III.31-32). It was 2 m wide at the surface and extended west up the sloping face of the rubble spill. The objective of this difficult excavation was determination of the original width of the harbour channel through isolation of the structural termination of the Southern Breakwater. It was assumed that this feature, like the head of the Northern Breakwater, would have been constructed of large, regular blocks of kurkar or concrete. The dimensions of these blocks may not have been as colossal as those of the blocks across the channel, since the head of the Southern Breakwater faced east, away from the full force of the sea, and the arrangements for bonding may not have been as elaborate. Nevertheless, framing the channel properly must still have involved significant forethought and effort.

The naturally concreted rubble was loosened with crowbars and pickaxes, cleaned with airlifts, and removed by hand in steps down to ca. 10.0 m below MSL (fig. III.34). It was underlaid by stratified, interbedded sand, shells, pebbles, and clay. Progress was very difficult and slow, but by the end of the first season the trench reached 10 m east of its intersection with Area D_1. In 1984 excavation with a reduced team extended the trench 3 m further. The work yielded only negative results: although small kurkar blocks (ca. 0.8 x 0.3 x 0.3 m) appeared occasionally in the otherwise undifferentiated spill of kurkar rubble (D ca. 0.15-0.3 m), they were always sporadic, unconnected with any coherent structure. The very meager sherd material was heavily abraded by the sea and incrusted with marine growth that seems to have formed in antiquity. The result of this enormous effort was determination that the channel of the Herodian harbour must have been at least 20 m wide. This figure represents the sum of the 13 m length of the trench in Area D_2, the 5.5 m distance from the beginning of the trench to the foot of the

Northern Breakwater, and an allowance of 1.5 m for tumble in front of the original face of the breakwater at this point. Fortunately, further information on the width of the Entrance Channel was contributed by the probe in Area D_3.

[J.P.O.]

III.C.3. Area D_3: Probe for West Wall of Entrance Channel. While a width of 20 m would probably have been sufficient to allow navigation into the outer basin of Sebastos, in many conditions such a dimension would have made entry and exit hazardous for the larger, sail-powered craft used for long-distance trade. The typical oar-powered warship of the period, the re-worked Roman trireme, would have required a channel of at least 20 m, even allowing only 5 m clearance on either side of the sweeps of oars (Casson 1971: 141; Landels 1978: 145). The larger warcraft, such as the *tetrereis* and *pentereis*, would have needed even more room.

In any case, the figure of 20 m represents only a minimum, and the surface of the Southern Breakwater west of the termination of Area D_2 was searched carefully for any indication of a breakwater head or other substantial structure. Along a line projected from the trench, the breakwater presented only a featureless surface of rubble, broken occasionally by small reefs formed through the natural concretion of the kurkar rubble that constitutes the bulk of the breakwater's core. Large kurkar and concrete blocks were observed only farther toward the outer face of the Breakwater. Those closest to the present channel project from the rubble surface approximately 27 m NNW of the termination of the trench in Area D_2. In 1984, a spot was selected for excavation at the foot of a large concrete block (4.3 x 3.5 x 1.8 m) and given the designation Area D_3 (figs. III.1, 35). This represents the eastern extension of a field of scattered construction materials extending north and west to the enormous blocks forming the outer face of the Southern Breakwater. This area had the further recommendation of lying almost on line with the wall of the Inner Quay identified in Areas A, B, and C.

Area D_3 consisted of a sandy pocket framed by the large concrete block on the west (upper surface at 4.1 m below MSL) and several irregular fragments of concrete and kurkar blocks on the north and south (ca. 1.5-2.0 x 1.0 x 0.5-1.0 m). Clearing of the sand with an airlift revealed that the concrete block lay on a surface cushion of rubble 0.20 m thick at 5.2 m below MSL. The following strata were encountered beneath it (figures represent depth below MSL) (figs. III.36-37):

-5.2 to -5.6 m: greyish sand with some loose rubble.
-5.6 to -5.8 m: mixed gravel, shells, and kurkar lumps in sand.
-6.1 to -8.6 m: strata of well-sorted sand and gravel, and three lenses of twigs and wood chips, at depths of 6.6, 6.8, and 7.4 m.
-8.3 to -8.6 m: sand becomes white, with coarser particles and shells.

Sherds were observed only in this last stratum of gravel: some unidentifiable amphora body sherds and a fragment of a red-gloss bowl.

Raban (1985b: 155-58) has interpreted this pocket of sand as part of a compartment built into the body of the breakwater during its initial construction and designed to be filled by the natural movement of sand along the sea-bottom. Whether this interpretation is correct or not (see the discussion in Vol. IV), the probe in Area D_3 did not provide any conclusive evidence for the presence of a

harbour channel at this point. On the one hand, the probe did not encounter the rubble spill characteristic of the trench in Area D_2, but on the other, it also was not possible to extend the probe deep enough in the shifting sand to verify the presence of the stratum of clay found in Area D_1. Furthermore, the large blocks visible on the surface of the breakwater around the probe did not connect with any structure which could be identified as the west face of the harbour Entrance Channel.

Had the head of the Southern Breakwater been identified here, it would have framed a channel approximately 60 m wide. In contrast to the minimum figure of 20 m proposed above, which appears barely sufficient, this dimension seems excessive. While such a wide channel would have allowed the free and relatively uncongested passage of maritime traffic into and out of the harbour basin, it would also have made the head of the Northern Breakwater, the quays along the inner face of the Southern Breakwater, and the general anchorage within the basin vulnerable to storms from the NW. As Josephus notes (*BJ* 1.413; *AJ* 15.337; see Appendix I.A), the north wind brought the fairest weather in this region, but there are exceptions. Even in a west or west-northwest wind waves could have curled around the tip of the Southern Breakwater to break directly against the face of the northern one, and their reflux would have continued on to disturb the Outer Basin. Such a wide entrance would also have made siltation a greater problem, by allowing storm waves to sweep sand into the harbour basin and by making it more difficult for any slow cleansing currents set up by sluices through the Southern Breakwater to carry sediment out the channel. A narrower channel would tend to speed up the current at this critical point and thus maintain the proper depth at the entrance. One argument in favor of such a wide channel is that a tower or towers would then stand immediately outside and in line with each of its faces. The tower in Area G can now be seen to line up with the east face of the entrance. If the towers in Area K were located in line with the west face, they may have been designed to break the force of waves just outside the Entrance Channel, both to protect the breakwaters and to help control siltation at this point. Resolution of this problem is important, but unfortunately the present series of excavations has not been able to document the original width of the Herodian harbour channel (for further discussion, see Section VI.D-E).

[J.P.O.]

III.D. Area E: Subsidiary Breakwater.

There is a well-defined wall built of kurkar blocks and rubble and incorporating a few large masses of concrete that branches off from the southern face of the main body of the Southern Breakwater close to its east end. It is always clearly visible in aerial photographs (figs. I.13, III.38). This feature extends for ca. 130 m in a straight line to the NW, finally tapering out in several small heaps of rubble. The level upper surface, at a depth of 6 m below MSL, varies from 4 to 8 m in width and usually rises 1 to 2 m above the surrounding sand. The top 1 m of the north and south face, composed of irregular masses of kurkar ca. 1-1.5 m in diameter, is regular and nearly vertical, but the lower portions, consisting of

smaller pieces of kurkar rubble (D 0.5-0.8 m), spread outward to a total width of 10 to 14 m, depending on the location.

It is unlikely that this wall is an accidental feature created by the destruction through wave action of a portion of the main Southern Breakwater. The missing segment is too large, the depth of sterile sand on the inside too great, and the resulting pattern too regular to be the result of such a process. Furthermore, sections across the main breakwater in this area show the same patterns of materials and construction that are found farther along its length: it is a great heap of tumbled kurkar rubble faced on the inside by kurkar blocks and on the outside by concrete blocks (Section IV.C: Survey Lines nos. 1 and 2).

If this feature is in fact an intentional construction, it may have been designed to serve as a Subsidiary Breakwater causing waves to break some distance away from the main one. The wall would not have had to be at sea level to cause swells to crest and break, dissipating some of their energy, so its relatively low relief and flimsy structure are not impediments to such a function. By their very design, rubble-mound breakwaters of the type used elsewhere in the Mediterranean in antiquity bring about this same "premature" breaking of waves, and the principle is still applied in harbour design today (Quinn 1961: 153-54, 205; Cornick 1959: 116, 118-22). In order to explore this hypothesis, excavation and water- and air-jet probes were carried out around the Subsidiary Breakwater in 1980 and 1983.

Area E_1. The work in 1980 was centred around the westernmost point of the feature visible that season, termed Area E_1 (figs. III.1, 38). Two locations were selected along the western part of the feature. The first, Area E_1a was located 105 m west of the base of this feature, where it diverges from the Southern Breakwater. The second, Area E_1b, was laid out 10 m east of Area E_1a.

Area E_1a was excavated only at the inner, northern side of the Subsidiary Breakwater, at a point where its features seemed to be more coherent and better preserved than at nearby points (fig. III.39). At that spot, the feature has a flattened crest at a depth of ca. 5.8 m, and a total visible width of 3.6 m. Its south side slopes steeply, almost vertically, and is partially buried in the sand 1 m below its crest. The northern face lacks its upper part, but the rest seems to be built of roughly cut kurkar blocks (avg. 0.8 x 0.6 x 0.3 m). The stones fallen from the upper part are now scattered on a bed of sand at a depth of 7.2 m below MSL, 1 m below the present level of the sea-bottom.

The base course of kurkar blocks was laid on top of what may have been a concrete block, at a depth of 7.6 m. The probe encountered a thin layer of pebbles and chunks of kurkar at a depth of 8.5 m. Beneath were found fragments of weathered concrete mixed with quantities of sand. At its base the structure seems to have been more than 6 m wide.

Area E_1b was a trench excavated across the Subsidiary Breakwater from north to south, 10 m east of the first probe (fig. III.40). Because of a very heavy surge resulting from poor weather, it was difficult to keep the trench clear of spoil, and it proved impossible to reach the base of the breakwater on the exterior. On the north side, a layer of rubble and pebbles lay on clear sand at a depth of 8.5 m below MSL. Fragments of two Herodian-type lamps were found here, along with

three fragments of Eastern Sigillata A ware vessels. Strangely, the width of the breakwater itself was no more than 3 m at this point, although the sloping debris of the decaying upper portion has spilled out 3 m beyond the north face.

Area E2. A point 70 m west of the base of the Subsidiary Breakwater, where the wall was easily visible and seemed best preserved or most coherent, was surveyed, labelled as Area E_2, and excavated in 1983. Trenches approximately 5 m wide were marked off on either side of the visible portion of the wall, approximately 7.5 m wide at this point at the beginning of the season (figs. III.38, 41). The midpoint of the wall is 5.0 m below MSL. The western edge of the northern trench was defined by a large concrete block (ca. 3 x 2 x 1.2 m), the eastern by several large, irregular pieces of kurkar (1.5-3 x 0.5-0.8 m). Since all of these blocks rest on sand, scattered chunks of kurkar, and seaworn sherds, they must have migrated here from somewhere else, possibly from the south off the crest of the Subsidiary Breakwater. The surface over and around the southern trench was occupied only by small, scattered chunks of kurkar. As excavation of the sand was carried out with airlifts down each face of the wall within the marked boundaries, the adjacent sand naturally tended to flow inward toward the intake pipes. On the north side of the Subsidiary Breakwater the presence of the concrete and kurkar blocks helped to inhibit this movement, but on its south face the structure ultimately formed one side of a semicircular excavation pit with steeply sloping sides, approximately 4 m in diameter.

Removal of the loose surface rubble and surrounding sand revealed that the upper surface of the breakwater, approximately the top 1.0 m, was built of irregular, eroded kurkar blocks ranging from 0.30 to 1.2 m in maximum length (fig. III.41). There was no sign of mortar or concrete in this stratum, and no identifiable coursing of the stones. Immediately below was a layer 0.40 m thick of small, wave-worn kurkar rubble (D ca. 0.1 m) including occasional rounded lumps of the characteristic blue-green Herodian mortar (figs. III.42-43). The lumps of mortar probably represent debris from the construction of the large concrete blocks on the adjacent outer face of the main breakwater, either spill that lodged in the structure until hard and rolled into the foundation of the Subsidiary Breakwater during its construction, or chunks broken or trimmed off the large blocks, transported across the sea-bottom in the same fashion. The outer edge of this layer and the surrounding sand were filled with wave-worn pottery, mostly amphora body sherds. This deposit continued beneath the adjacent large concrete block on the west and the kurkar masses on the east of the northern trench. There was significantly less pottery along the more exposed southern face of the structure, but its character and deposition were the same.

The lowest structural deposit lay directly on the virgin sand of the sea-bottom at 8.05 m below MSL. It consisted of a 1.10 m thick stratum of small kurkar pebbles and the dark sand produced by the decomposition of kurkar (fig. III.43). Since this type of material is very different from the white quartz sand of the original sea-bottom here and elsewhere in the harbour, it probably indicates construction activity. In view of the presence of wave-worn chunks of mortar in the level above, this lowest stratum may be composed of the smallest type of debris generated by the dumping of kurkar rubble for the foundation or core of the main breakwater. Wave action around the new structure would have reduced it further

in size, and spread the layer seaward, while sorting the particles by density and size. The depth of the original sea-floor here corresponds with that found in Areas D_1, H_1, and N_2.

In plan, the present remains of the Subsidiary Breakwater, if totally cleared of sand, would undoubtedly have a very ragged outline. The layer of dark kurkar sand extended north and south beyond the limits of our trenches, while the layer of rubble above it seemed to slope outward from the outer face of the courses of eroded blocks at the crest of the feature. Some of this material had tumbled before construction of the structure, other material has been eroded and mixed more recently, during its decay. In its present disturbed condition, even the substantial kurkar blocks forming the main body of the wall have not kept their original position. It may well be that, owing to its exposed position, and in default of routine maintenance, most of the upper portion of the original structure has been lost. Blocks of convenient dimensions may also have been removed during the nineteenth century for local reuse or export to Akko. The large concrete block adjacent to the northern edge of the wall in Area E_2 is more of a puzzle. It is unlikely that such a large block could have gradually migrated 30 m seaward from the main breakwater over the centuries, but no other concrete blocks of similar dimensions are visible at present along the Subsidiary Breakwater. They may be there, of course, and are now obscured by the thick marine incrustation or tumbled rubble and blocks. The inclusion of large concrete blocks of this type at regular intervals along the structure would have helped to anchor the smaller kurkar blocks and prevent total disintegration of the breakwater at times of particular stress.

Air-Jet Probes. The water-jet probes carried out around the tip of the Subsidiary Breakwater in 1980 were perfunctory in character, intended merely to provide a preliminary indication of the sub-bottom around Area E_1. In 1982, however, the final 30 m of Survey Line no. 1 (SL 1) and the final 20 m of Survey Line no. 2 (SL 2) crossed the Subsidiary Breakwater close to its base and at Area E_1, respectively (Section IV.C). Where the lines passed over sand, air-jet probes were used to plot the configuration of the sub-bottom. Along the final stretch of SL 1, the outlines of the Subsidiary Breakwater were clear, standing about 1.0 m above a field of scattered kurkar rubble that sloped gradually up towards the core of the structure. On the south, sand covered what seemed to be a continuation of the rubble spill. Probing at this point revealed a marked 1 m drop-off 8 m south of the visible north face, at the interface with the sand, and a gradual, irregular slope beyond. The slope reached a depth of 2.0 m (the limit of the probe's reach) 10 m beyond the drop-off. The wide spread of the rubble does not necessarily indicate the original dimensions of the structure. The core of the wall, originally composed of blocks, has broken and been scattered, covering the original sloping foundation cushion of small rubble with a thin layer of larger fragments. This stratum cannot be penetrated by the probe and consequently gives the impression of a solid mass.

At the point where SL 2 crossed it, the visible portion of the Subsidiary Breakwater was only 3 m across, and the sub-bottom profile did not provide any clear indication of the original dimensions at that point. There was, however, a 0.7 m drop-off within 1.0 m of both visible faces, and a further 0.9 m decline over the next 5 m to the south, which may indicate an original width of 8 or 9 m for the wall. North of the wall, the sub-bottom profile fluctuated between 1.0 and 1.7 m

below the present bottom until it sloped upward to meet the outer face of the main breakwater.

In 1983 air-jet probes were carried out from Area E_1 along the longitudinal axis of the Subsidiary Breakwater for 30 m beyond the point where it disappeared below the sand. Probes taken at 1.0 m intervals revealed that the structure continued along the same orientation, approximately 1 to 1.6 m below the present surface. Between metre marks 14 and 24 the structure was actually visible as piles of rubble on the surface. The depth measurements below or above the sea-bottom were the following, given at 1 m intervals:

1.0, 1.1, 1.2, 1.2, 1.5, 1.1, 1.2, 1.5, 1.1, 1.3 (10 m mark);
1.2, 0.7, 0.6, +0.1, +0.2, +0.2, +0.3, +0.2, +0.2, +0.2 (20 m mark);
+0.2, +0.2, +0.1, +0.1, 0.7, 0.3, 1.1, 1.2, 1.2, 1.7 (30 m mark).

At the 10 and 20 m marks, probe lines 20 m long were laid out perpendicular to the main line, extending 10 m to either side. Probes at 1 m intervals along these lines revealed a spill of rubble sloping gently downward to a depth of more than 2 m over the 10 m interval on either side. The following figures give the depth below the surface of the sand at 1 m intervals:

N of 10 m mark: 1.2, 1.1, 1.5, 1.5, 1.75, >2.0, 1.9, >2.0, >2.0, >2.0 m.
S of 10 m mark: 0.8, 1.6, 1.2, 1.1, 1.4, 1.5, 1.75, 1.6, 1.6, 2.0 m.
N of 20 m mark: 0.4, 0.6, 1.0, 0.8, 0.8, 0.8, 1.0, 0.75, 1.6, >2.0 m.
S of 20 m mark: +0.2, +0.1, 0.7, 1.0, 1.0, 1.4, 1.5, 1.5, 2.0, >2.0 m.

The general consistency in the depth of the feature over the 30 m stretch sampled, suggests that it may extend almost as far as the main body of the breakwater, some 70 m beyond the end of our survey line. Nevertheless, a small opening somewhere along the course of the Subsidiary Breakwater would make sense, since it would have allowed for the escape of water from the waves that broke over it. It is particularly important to note that the probes to the north of the 10 m and 20 m marks encountered depths of sand greater than 2 m at their outer ends. This circumstance suggests once again that there is no structural connection between the Subsidiary and Southern Breakwaters other than at their base.

[J.P.O.]

III.E. Area F: Sunken Pavement.

This feature is located near the southeast side of the harbour's Outer Basin (figs. III.1, 38). It is a section of pavement built of kurkar slabs of approximately standard size (ca. 1.05 x 0.50 x 0.45 m), laid with no apparent means of binding such as mortar, cement, or clamps. The paving is located about 50 m due west of the tip of the modern quay, and its upper surface is now at a depth of about 5 m below MSL (4.9 m at its northeast corner and 5.05 m at its southwest edge). It is preserved for about 17 m along its north face and 8.2 m along its south face, and was found more or less intact for a width of 4.2 m on the N-S axis (figs. III.44-45, 48). The slabs of the pavement are laid as headers along the northern and eastern edges of the paved area, while within it the order is more varied. In consequence, these sides may be the original edges of the pavement.

The pavement was first noted by IUES divers in 1965 and was surveyed and drawn in detail by two students of the Department of Archaeology at Hebrew University in 1973 as part of a field work assignment. It was re-surveyed and a more accurate plan made during the 1976 CMS research for IEC (Section II.B.3; Raban et al. 1976: 42-43, figs. 45-51, plan no. 2). During the CMS marine workshop for the students of the Department for the History of Maritime Civilizations in 1978, two trial probes made on the north and the south sides of the pavement found no underlying courses or substructure (Section II.B.4). During CAHEP's 1983 season the excavations on both sides of the pavement were expanded and part of it was removed to study the stratigraphy underneath (figs. III.46-47). The area farther to the south, toward the inner edge of the Southern Breakwater, was then thoroughly surveyed, and some additional probes were made along this area (Oleson et al. 1984: 290, fig. 7; Raban 1985c: 163, figs. 6-7).

A series of large ashlar headers was traced during the 1976 survey on a deeper level to the east. This lower course was surveyed again in 1980 and additional blocks were found to the SW. These additional blocks (2.0 x 0.6 x 0.7 m) are still close together, in their original relation to one another. Their western ends are incorporated at present within well-concreted debris that is just below the eastern edge of the pavement. Considering the fact that these headers are now tilted gently eastward to a depth of almost 6.5 m below MSL, it is very likely that in their original state, before wave action and submergence disturbed their substrata, they were part of a supporting wall for the pavement. Several blocks of similar size and shape, also at a level deeper than that of the pavement, were located during the 1983 season, scattered just SW of the westernmost part. They might very well represent the remnants of the opposite (western) supporting wall for the pavement.

Excavation was carried out in the sandy sea-bottom (depth 5.3 m below MSL) along the north side of the pavement (fig. III.49). The probe extended down 2.7 m to a depth of over 8 m. The slabs were found to be 0.3-0.4 m thick and laid on a 0.3 m thick cushion of small kurkar rubble (avg. D 0.1-0.25 m) which in turn was bedded on a 0.1-0.2 m thick layer of grey sand mixed with some small pebbles and abraded potsherds. This layer is superimposed on one about 0.10 m thick, composed of coarser pieces of rubble. Beneath, to the bottom of the excavated pit, there was clear yellowish sand with a few broken shells but no pottery or other artifacts. It is intriguing that no blocks that might be interpreted as components of a northern supporting wall for the pavement were traced in that probe. The fact that the pavement remained relatively even and intact for a considerable area despite the absence of any support but sand is strange and unlike the condition of other submerged structures in the harbour. It is difficult to see how the pavement survived subsidence without substantial support. The absence of such support might be explained by plundering in later antiquity, or that it was made of easily decomposed substances such as wood or poor-quality concrete blocks.

The second probe was made at the other side of the pavement, in a sand-filled hollow of about 2 x 3 m, adjacent to the middle of the southern edge. The area was covered by the debris of large tilted blocks, incrusted together, at a higher elevation than the pavement itself. Some loose slabs of a similar size as those of the pavement, found at the south edge of the trench, might be remnants of its

continuation southward toward the main breakwater. Other slabs were found scattered in the excavated area, within a rich deposit of broken pottery, mainly amphoras, dating from the Herodian to the Byzantine period. Beneath this surface level there was a layer of rubble at a depth of about 6.2 m below MSL, well cemented by marine incrustation. Below that layer another hollow was exposed, filled with some additional tumbled ashlar slabs and a large quantity of potsherds, most of which were evidently pushed into it by the surge and currents. The ceramic repertory extends from the Early Roman to the Late Byzantine periods. The hollow and the pottery fill extended to a depth of 7.3 m below MSL. Underneath, there was a pure fine sand with no pottery and a few broken shells. At a depth of 7.9 m there was a layer of clay, typical of the original bottom of the harbour basin in the Herodian period. This level seems to be far deeper than the foundation of the pavement.

The multitude of wave-carried potsherds found below the pavement might indicate either that it is a post-Byzantine addition to the harbour complex, or that it had already shifted from its original position in antiquity. The second supposition might be explained by the close proximity of the proposed fault line that runs parallel to the coast just east of this location.

All the probing attempts and the trial trenches that were made farther south in search of additional segments of the pavement came upon only scattered debris. Among this was a pile of huge marble blocks, now badly eroded by wave-carried sand. The better preserved examples have the dimensions 4 x 2.1 x 1.8 m. It may be that these blocks formed part of a jettisoned cargo or cargo that fell off a vessel. None of the blocks preserves any signs of carving or of use as an architectural member. In consequence, it is unlikely that they were plundered from a land monument or had been components of some superstructure that once stood on the quay, of which the nearby pavement might be almost the sole remnant.

The area between the Sunken Pavement and the Southern Breakwater is now occupied by a rectangular spill of debris markedly higher than the surrounding area. It projects northward for some 50 m from the inner side of the Southern Breakwater base and is about 20-25 m wide (figs. I.13, III.38). It is tempting to see in this feature a secondary pier, of which the pavement was a surface paving, and which was used to divide outer and intermediate basins in the harbour (fig. VI.1). Such a subdivision of the Herodian harbour might be referred to by Josephus in his mention of "secondary anchorages" (*AJ* 15.332; see Appendix I.A). Such a subdivision existed also at Cantharus, the ancient harbour of Piraeus, to which Josephus compared the Herodian harbour of Caesarea (Judeich 1931: 446-48). The projection at Caesarea would have been about 20-22 m wide and about 50 m long, with vertical sides built of several courses of large headers up to just above the water level, containing a sand fill in between. This fill was then covered by a layer of rubble as the base for paving.

This reconstruction (Raban 1985c, fig. 7) is very problematic. The clay layer below the southern side of the pavement, if a typical deposit within a closed harbour, could not have been deposited within the base of an existing structure. So the alleged pier would have had to be either a hollow structure on upright poles or arches (cf. the famous wall painting from Stabii and the various numismatic

depictions in Blackman 1982, figs. 1, 5), or a later feature built some time after the completion of the breakwater. The first alternative is not supported by our archaeological and architectural data from Area F. If raised on a platform supported by arches or pilings, the pavement must have some kind of a substructure much more solid than the existing layer of small loose rubble, unless the supporting arch was built of cemented rubble that has decayed or decomposed in the course of submergence and subsequent to it. If the pier was built as a later addition, after the main breakwaters had been completed (as might be concluded from the presence of a layer of the fine clay underneath its foundations), the sand fill between the mud and the pavement could not have accumulated naturally, but would have been poured in artificially. All in all, the surviving remnants in Area F are short of giving us enough data for secure reconstruction of the original shape of the pier or the pavement, their date, or their function.

[A.R.]

III.F. Area G: Northwest Tip of Northern Breakwater and Adjacent Tower.

In contrast to the east face of the Entrance Channel, the northwest tip of the Northern Breakwater was built of concrete. In aerial photographs it appears as a large, square projection at the west end of the north face (figs. I.16, III.17). Even before excavation in 1982, the outlines of eroded concrete blocks could be seen, topped by the remains of what may have been limestone paving blocks. During the 1982 season, sand and rubble were removed by hand and with airlifts at several points in this area in an effort to determine the nature of the structure. Excavation ultimately revealed a concrete block ca. 11.5 m wide (E-W) and 15.0 m long (N-S), with an irregular, eroded upper surface ca. 4.0 to 5.1 m below MSL (fig. III.51). When exposed, the vertical faces of the block were well preserved, and extensive remains of the wooden formwork into which the concrete had been poured were found on the east, west, and north sides (figs. III.53-56).

In plan, the block now appears as a regular rectangle that has lost its northeast corner and has suffered some erosion along its east face. It is surrounded on all but the north side by a well-defined trench 0.4 to 0.8 m wide left behind by the decay of the upper portion of the double-walled wooden formwork (figs. III.57-58). Along the east and south faces the wooden form has been destroyed above the level of the sleeper beams. Excavation revealed that the gap left at these points had been filled with a mixture of rubble, sand and artifacts: mostly amphora body sherds badly eroded by the sand but also a few fragments of fine wares, lead fishing weights, and a corroded bronze statuette of Zeus (see Volume II). The deposit clearly was not coherent but has resulted from the accumulation over time of harbour debris swept into the gap at random. Excavation within the trench along the west face of the block quickly exposed remains of the blue-green mortar that had been poured into the hollow walls of the form. Disappearance of the wood left it behind in the form of tall, free-standing oblong blocks (fig. III.57). The upper surfaces of the surviving planks and uprights could be seen hidden deep within the recesses around the masses of mortar. Before excavation, the north face of the block was encumbered by a sloping pile of kurkar and limestone rubble (D 0.3 to

1.0 m) laid directly against the exposed concrete face. Removal of the rubble subsequently revealed that the upper portion of the formwork along this face, above the main sleeper beam, had been taken away in antiquity, before placement of the rubble berm.

This intentional rubble packing survived as well along the outside of the formwork trench along the east face and the northern half of the west, and here, as along the north face, its presence had preserved the wood from damage and decay. Several paving slabs survive on the upper surface of the block, now at a level of 3.4-3.6 m below MSL (fig. III.52). Traces of iron chain were found fused by corrosion to the kurkar blocks adjacent to the southeast and northeast corners of the block.

Along the east and south faces the trench was wider (ca. 0.5-0.8 m) and the outer face was composed of a more irregular packing of boulders and eroded blocks (fig. III.50). While the sloping berm around the east, west, and north faces probably was intended to weigh down and buttress the form during placement of the concrete, and to prevent subsequent erosion of the sand foundation on which the block was laid, the larger blocks and rubble around the south face may represent packing placed between the finished northwest block and adjacent blocks of kurkar or concrete laid or poured previously. There seem to be three courses of large kurkar blocks along this face, now incorporated in the naturally concreted mass of the Northern Breakwater (Raban 1983b; 1984b, fig. 2). Such packing would have been necessary whatever the material of the adjacent portions of the breakwater, in order to prevent the erosive surge of waves through the crevices left between the blocks by removal or decay of the wooden forms. The installation of several courses of blocks and paving stones would have made this precaution even more essential, since waves funneled between the blocks would have quickly forced capping slabs out of position.

Excavation with an airlift was carried out at the southwest corner of the block after removal of the loose surface rubble: wave action at this point had already removed the rubble berm and packing of the adjacent portions of the west and south faces. The lower surface of the block was exposed at a depth of 6.4 m. It was level and smooth, and excavation beneath the block beyond the area disturbed by wave action proved that it had been poured directly on a foundation of the same sterile white sand forming the original sea-bottom. No wooden flooring designed to serve as the bottom of the form was observed, despite removal of the fill for a distance of 2 m in from the corner. Had it existed, the wood should have been preserved in this protected environment. In 1984, removal of a section of the sleeper beam along the base of the north face of the block (fig. III.195) permitted examination of the lower surface of the block at this point as well. Here too there was no evidence for flooring planks, and preservation of the adjacent beam suggests strongly that they never existed.

Although the upper surface of the block is now very uneven as a result of erosion and the formation of marine concretions, a regular series of channels and holes ca. 0.18 m sq. in the upper surface of the block were observed and drawn in 1982 and 1983 (figs. III.50, 55, 60). These channels were made by the horizontal wooden tie beams that crossed the formwork in an east-west direction at intervals

of approximately 1.6 m, and by uprights (possibly spaced 1.3 m apart) intended to support and reinforce them until placement of the concrete. Although no traces were found, there may have been north-south tie beams as well, designed to brace the other two sides of the form. These braces apparently were felt to be necessary only at the upper portion of the form, since the holes left by their decay were not observed along the lower portions of any of the exposed faces of the block. Nor did exposure of 4 m of the northern sleeper beam reveal any joints other than the lap-joints at either end bonding it with the adjacent sleeper beams.

Excavation in 1982 along the northern half of the west face and the western half of the north face of the block provided the most information on the design of the form (figs. III.53-59). The formwork, best preserved at the northwest corner, was built on massive pine (*Pinus*) and fir (*Abies*) sleeper beams ca. 0.29 m square that ran along the base of each face of the block and interlocked at the corners with simple lap-joints. A series of pine and possibly fir (*Abies*) uprights (ca. 0.12-0.15 x 0.23 m), mortised into the horizontal beams at 1.60 m intervals, carried an external and internal wall of horizontal pine planks 0.08 m thick and 0.14 m wide. The lowest of the planks on the inner face of the formwork was inset slightly into the upper surface of the large sleeper beam and fastened with mortise and tenon joints. In the examples recovered, the tenons were of oak (*Quercus*) and poplar (*Populus*). Mortise and tenon joints have also been reported from formwork around inundated concrete structures in North Africa (Yorke & Davidson 1985). The planks must have been nailed to the uprights, but it was not possible to examine any surviving joints for verification. The wood species are not indigenous to this area (see Appendix III.A).

At present the seams between the various planks and beams making up the formwork are filled with a sandy white mortar. This substance may be intentional packing designed to seal the seams, but it could also be cement that was forced into loose seams when the interior of the formwork and its hollow walls were filled with concrete and mortar. A translucent material resembling gypsum has crystallized on some of the wooden surfaces through reaction with the sea-water since the time of construction.

The hollow spaces formed by the lower beams, uprights, and double wall of planks were filled with a blue-green, sandy mortar containing large particles of tuff, pumice, and lime. Striations in the mortar show that the substance was poured in quickly in a semi-liquid state and puddled as it filled the cavities. The fabric of the block is composed of the same material, but with the addition of a high proportion of aggregate consisting of irregular chunks of kurkar (D ca. 0.10-0.20 m) and sea-worn boulders of a harder limestone. Chunks of the greenish, granular tuff (concreted volcanic ash) and fibrous pumice used in the mortar were recovered from the fill in the harbour channel (Area D). For the chemical analysis of the mortar, tuff, and pumice, see Appendix III.C. The character of the concrete, its constituents, and the sources of the materials and technology will be discussed in Volume IV.

A second concrete block was discovered projecting from the sand 6.6 m north of the first block in Area G, separate from the rest of the breakwater mass (figs. III.50, 62-63). Excavation in 1982 revealed that this second block was built of the

same materials and in the same manner as the first one investigated, that ... blocks had approximately the same orientation, and that their west faces ... aligned. At its southwest corner, where it is best preserved, the irregular ... surface of the block is at 5.8 m below MSL, and the smooth, flat lower surface ... 7.7 m. Although traces of what may have been a rubble berm survive around ... block, only a few pieces of wooden formwork had been preserved, and the ... crete mass itself was badly fractured and incomplete. The lower surface has ... percent tilt to the west. The best preserved fragment of the sleeper beam ... ures 0.15 x 0.15 m. The lower edge of the south face of the block (fig. III.... which rests on a stratum of sterile white sand, slopes upward slightly from west ... east, from 7.7 m to ca. 7.2 m below sea level and is interrupted by several ... fissures 6.9 m and 8.0 m east of its southwest corner. The block tapers to a thin... ness of only 0.17 m before ending abruptly in a small heap of rubble 12 m east ... the southwest corner, possibly at or near the original southeast corner. The west ... face of the block was excavated for 6 m to the north, uncovering several ... left by horizontal tie beams 0.13 m and 0.18 m sq., 1.5 m and 1.3 m above ... lower surface. No beam holes were found along the south face of the block, ... the formwork for this mass of concrete, like that of the block to the south, ... have made use of tie beams only in the east-west orientation. Excavation along ... the west face of the block did not expose the northwest corner, and an auxiliary ... trench sunk 2 m into the loose sand on the line of the west face and 12 m north of ... the southwest corner did not encounter any structural remains. An air-jet probe ... parallel to and 1 m east of the east face, however, recorded an irregular upper ... surface sloping down to 2 m below the present sea-bottom, 14 m north of the ... south face of the block. The depth of sand was too great to allow precise documentation of its north-south dimensions.

It seems likely that the block tipped and fractured during the fault slippage or ... bottom slumping which seems to have affected much of the outer harbour some ... time during the Empire. This block probably served as the foundation for the ... gle Tower mentioned by Josephus as standing to the port side of a ship entering ... the harbour (*AJ* 15.338; *BJ* 1.413; see Appendix I.A). The Twin Towers he men... tions on the starboard side are discussed below, under Area K.

[J.P.O.]

III.G. Area H: Southern Face of Northern Breakwater.

In 1984 two trenches were opened along the southern, inner face of the North... ern Breakwater, just inside the harbour Entrance Channel in an area termed Area H (figs. III.1, 64-65). Although the breakwater at this point is composed of heavily-concreted kurkar rubble (D 0.2-0.8 m), its profile is steep and its outline ... regular, providing hope that it might be possible to recover evidence for the original arrangement of any quays or promenades along the inner face of the breakwater.

III.G.1: Area H_1. The trench in Area H_1 was located across the southern ... gin of the rubble spill from the Northern Breakwater, 40 m SE of the tumbled ... blocks in Area D forming the east face of the channel (fig. III.64). The spot was

selected on the basis of a judgmental survey of this portion of the structure: it ... represents a point approximately two-thirds of the distance between its base and ... where the configuration of the structure appears regular and the slope of the ... rubble steep and high, and where the sediments promised to be deep enough to ... have protected ancient structural remains. A trench ca. 2.0 m wide was marked ... off up the rubble slope with ropes and the heavily concreted surface rubble removed. Axes and crowbars were used to detach the rubble and airlifts to remove embedded sand and gravel (fig. III.66). Progress was difficult and very slow, since the concretions were thick and tenacious, and removal of the small rubble occasionally revealed the presence of larger, irregular kurkar masses or eroded blocks (D ca. 1.0-2.0 m) that had to be lifted out with airbags. Four weeks of excavation produced a section through the outer edge of the breakwater from the upper surface (at 3.4 m below MSL) to the layer of grey clay representing the ancient harbour floor (at 9.0 m below MSL), extending approximately 2.5 m into its core (fig. III.64).

Unfortunately, no coherent structural remains were identified in this trench. The bulk of the material removed consisted of kurkar rubble that had rolled or been dumped along the original breakwater face from above. That this rubble is not part of the Herodian structure is shown by the appearance within it of sporadic tumbled kurkar blocks (ca. 0.6 x 0.3 x 0.2 m) and of heavily worn and concreted potsherds dating from the Early Roman through the Byzantine period. The rubble also overlay a rich deposit of pottery that included well-preserved Early Imperial utilitarian and table wares and a deposit of 41 mid-fourth century coins (see Volume II). Much of the Early Imperial kitchen ware was recovered from a layer of kurkar gravel 0.8 m thick which rested on a stratum of grey sand directly above the clay. The grey clay disappeared beneath the rubble spill, continuing north toward the original face of the breakwater.

III.G.2: Area H_2. A second trench, termed Area H_2, was opened 10 m west of Area H_1, at a point where several large kurkar blocks (ca. 1.5 x 1.0 x 1.0 m) projected from the face of the breakwater, clear of any rubble covering (fig. III.65). The upper surface of the structure at this point is 4.0 m below MSL. Removal of the concreted rubble below the blocks, however, revealed that they did not form part of any coherent structure and that the arrangement of materials was the same as at H_1: kurkar rubble with occasional loose blocks or fragments of blocks (0.6 x 0.3 x 0.2 m), a 0.8 m thick layer of gravelly kurkar sand rich with pottery, a layer of sterile grey sand, and grey clay below at 9.0 m below MSL, representing once again the ancient harbour floor.

[J.P.O.]

III.H. Area I: Inner Harbour Basin.

Land excavation turned out to be increasingly relevant through the seasons of CAHEP. First and foremost, there is the principle that marine archaeology is not synonymous with underwater archaeology but is rather a discipline that studies the material remains of ancient maritime activities, wherever they are found. In the particular case of ancient harbours and the marine aspects of a port city, this

might involve the study of the components of the urban master plan that were parts of the harbour complex, such as storage places, shipyards, seaborne industries, and the interrelationship between the city and its port. This approach is particularly relevant in the case of Caesarea, a city that was built as a pre-planned royal endeavor, with its harbour as the very cause for its establishment -- intended to be an autonomous urban unit, an international emporium for royal and imperial seaborne commerce. That the intention became reality, we can learn from later epithets for Caesarea, such as *pros Sebaston*, that is, "next to the harbour Sebastos", as the city was called on its coins in the reign of Nero (see further discussion in Ringel 1975: 83-86, and Volume III).

Another reason that makes land excavation almost a necessity in studying ancient harbours is that there are severe problems in dating submerged or inundated structures, or even those structures which are only seldom affected by the waves, because of the lack of small finds in an undisturbed stratigraphy and in a secure context with the various architectural phases. For that reason it is often necessary to excavate toward the shore in search of the strata that have escaped wave disturbance (e.g. Raban 1981b: 295-308, for Dor; below, Sections III.I, III.K). In the case of Caesarea, with its harbour intersected by a fault line and with the diverse submergence of architectural remains of various periods, it was almost imperative to have a comprehensive study.

There are also the practical considerations that there are days of rough sea when work underwater is impossible, and occasionally divers are unable to work underwater for physical reasons or must remain idle during a long break between shifts on the airlift. So, expanding the project toward the land became not only a scientific requirement, but also a very practical procedure, a way of maximizing the use of manpower.

In the early 1960's, Negev had excavated what he proposed was a Roman pier, inside the walls of the Crusader fortress (Negev 1967: 27-30; above, Section II.A.4). This Inner Harbour Quay had been further exposed during the 1976 CMS project (Raban et al. 1976: 36-38; Section II.B.3) (fig. II.18). Both, however, were far from being fully uncovered or properly studied.

Area I_1: Quay Wall, Northern End. For both scientific and practical reasons, the site of the hypothetical Roman Pier probed in 1976 was selected for excavation in 1983 by whoever was spared from the underwater work. S.E. Sidebotham, from the Department of History at the University of Delaware, was the field supervisor for the excavations at that site which were carried out during the second half of the 1983 season and all through the 1984 season.

The site is about 100 m inland from the present beach, at the back of the Inner Bay (about 300 m ESE of the tip of the promontory) (figs. I.38, III.1, 67). It is the northwestern part of the archaeological field excavated by Negev in 1961-62 along the western foot of the Temple Podium (Negev 1963a-b). During the 1982 season, the team of CAHEP architects directed by R.L. Vann had made a thorough survey of this field, redrawing every visible feature and completing an up-to-date plan of the site (fig. III.68). In view of the relatively late date of most of the structures that cover this area (mostly Early Arab with some Byzantine), it seemed wise to make some trial probes in order to locate sites where excavation

might expose the earlier harbour installations beneath. Two such sites were selected: the one at the northwest end of the course of blocks at the foot of the Roman Pier was designated as Area I_1a. It was about 10 m north of the site of the 1976 probe.

Area I_1a started as a 4 x 4 m square with the north end of the visible ashlar course at its centre (figs. III.69-71). The surface elevation was at 1.70 m above MSL. At the mid-section of the north baulk there was a drainage channel, just below the surface, with a base of small, cemented ashlars and framed by two long kurkar ashlars protruding from the baulk. The drain, about 0.5 m deep and 0.4 m wide, was inserted through an earlier ashlar floor at 1.95 m above MSL. The floor continues eastward and is incorporated into the northwest corner of the bottom course of the Roman Pier 2 m away. Parallel to the floor, 1 m to the south, there is a large rectangular slab 0.8 x 0.5 m, with a small one on its west side, lining up to make a northern face and northwest corner to the white ashlar course that overlies the quay. The corner and the course are bordering an unpaved area 1.4 m wide (E-W) and over 9 m long, in front of the pier. Yet, being detached from its base course of kurkar headers, it is impossible to determine whether it is of the same phase or later.

Southwest of the drain, at an elevation suitable for the inserted floor, there was a segment of a base course for a wall made of ashlar headers 0.6 x 0.3 x 0.3 m, of which only four blocks remained *in situ*, with no apparent substructure or architectural context. A similar wall was exposed about 1 m farther SW, at about the same elevation (1.52 m above MSL), in a somewhat different orientation, continuing for about 2 m toward the southwest corner of the excavated square. This wall makes a corner toward the west and has more courses below.

The drainage channel was found to continue, with no apparent side wall on its west side and with no real floor except for the cemented fill (probably a natural phenomenon due to the proximity of the lime-saturated water-table). This drain slopes northward as it continues along the upper side of the quay wall, until it reaches a concave hollow carved into the top of an angular block protruding from it, at 0.9 m above MSL. This block has a horizontal pierced hole (D 0.20 m) with clear marks of rope cuts along its front upper edges (figs. III.72, 74). It is undoubtedly a mooring stone, still in its original position within the face of the quay.

The mooring stone seems to have originally been 0.45 m high, 0.38 m thick, and to have protruded 0.45 m west of the wall's face. It is built into the second course from the top of the quay, although at present the natural concretion disguises the original face of this structure to such a degree that it is rather difficult to distinguish individual blocks within its structure.

A re-used, eroded marble slab depicting a vine leaf motif, probably from a chancel screen of a church or synagogue, was found in the drain. This suggests the channel to be later than the Byzantine period. The dig at this level had to cut through a dump of well-cemented debris with no apparent floors or stratified interbeds. The small pieces of pottery were found with no clear context and were mostly undatable. Yet all the way to just below the drain there were glazed medieval sherds. The actual ground-water table was encountered at 0.6-0.5 m above

MSL (changes following the tide), and excavation could continue only if the water was continuously pumped off.

A second probe was begun at the site of the 1976 trench, designated as Area I_1b (fig. III.73, background). At this point a 2 m wide trench was cut through the water-soaked, concreted fill, starting at the upper edge of the quay and continuing down to the ashlar slab pavement at 0.16 m above MSL. This pavement was eventually exposed for about 5 m along the base of the quay (figs. III.71-73). The slabs are laid in a loose arrangement of headers next to the quay: avg. 1.1 x 0.6 x 0.5 m. A second course was uncovered adjacent, to the west, with a gap of 0.03-0.05 m between the two. At the north end of the trench there is a cross-wall of very similar blocks, on top of the pavement, running westward (fig. III.76). The stratigraphy of the fill within the trench was identical to that found in 1976 (fig. III.70). Below mixed surface debris there was a westward sloping stratum of sand, mud, coins, and numerous small pieces of pottery. The bulk of the datable material was from the Byzantine era, with the latest coins from the beginning of the sixth century. This spill is at 1.4-1.2 m above MSL at the quay, and at 1.0-0.7 m at the western side of the trench. At that point, it is overlaid by interbedded layers of sand, shingle and shell in a typical beach deposition. These layers indicate that the beach reached almost to the quay late in the Byzantine era or soon after. The nearby structures to the south and southwest are clearly above these beach deposits. Since they are dated by Negev to the Early Arab period (eighth century), they give the ancient beach a tentative date within the late sixth-early seventh century.

This season of excavation confirmed the presence of a quay with its upper surface at 1.46-1.42 m above MSL, and with at least one mooring stone still *in situ*. This mooring stone is still unique at Caesarea. The line of the quay wall diverges in orientation 5 degrees east from the superimposed course of blocks, and it is undoubtedly of earlier date. The date and original function of the paved platform of loosely laid slabs had to be settled by further investigation. During the 1984 season, Area I_1a was widened westward 4.7 m from the face of the Inner Quay, following the configuration of the late ashlar structure. The interior of what seems to have been a room 2 x 3 m was excavated. The base of the southwestern corner had been cut into a layer of sand that showed patterning typical of calm water. There was some darker fill of red-brown clay about 0.1 m above the sand, with a very thin, more solid layer of grey floor at 1.1 m above MSL. Toward the corner, the floor is incorporated into a solidly-cemented matrix which encompasses the base wall at the southwest corner (fig. III.73). Just east of the corner and above the floor, a large number of pottery vessels were piled together, also incrusted and cemented by the same carbonate substance derived from the ground-water just below.

Among the vessels, there are about a dozen cooking pots of thin, poorly fired, dark red-brown clay, glazed in a dark purple-brown vitreous substance only at the lower external part (and inside), and with everted loop handles, twisted vertically and also quite thin. There are also about twenty glazed bowls, mostly of the shallow type with flattened rim, decorated inside with arabesque patterns and glazed yellow or green. Other bowls are of hemispheric shape, with brown painted decoration underneath the bright matte glaze. The corpus can be best dated to the thirteenth or fourteenth century, from a local Mameluke factory (see Holum et al.

1988, figs. 161, 163; Ben-Tor et al. 1979: 74-77, fig. 5: 2, 12; Levine & Netzer 1986: 69-70, fig. 3: 2, fig. 4: 14-17).

Below the floor, which slopes upward to the east, there are interbedded layers of beach sand, clay, and shell (fig. III.76). It has a total thickness of about 0.3 m, standing at 1.0-0.7 m above MSL (somewhat higher at the east). In the proximity of the quay these sand layers tapered off and alternated with land sediments. Below this series of beach deposits there is a fill of some tumbled blocks, small angular rubble pieces of kurkar mixed with grey to brown mud, and some potsherds. This fill is over 1 m thick above the ashlar paving blocks next to the quay wall and slopes gently westward so it is only 0.15 m thick and 0.3 m above the paving at the western baulk of Area I_1a, 4.2 m west of the quay. The upper 0.10-0.15 m of that fill is composed almost exclusively of small, water-rounded potsherds, generally of Byzantine date. A few coins that had been recovered from this layer date to the fourth or fifth centuries, but they may indicate only the earliest possible date for the fill, which might be a considerably later, secondary wave deposit. At the base of the western baulk of Area I_1a there is a single course of flat ashlar and rubble slabs, laid almost directly on top of the flagstones of the paving. This course continues eastward, below the south baulk, and changes to a construction of well defined ashlars (W 1.05 m) extending all the way to the quay (fig. III.70). The top of the course on the second block from the quay is 0.73 m above MSL, but only 0.61 m above on top of the last visible block at the north end of the west baulk.

Although the western part of this course was found to be coated with a lime deposit, there are no remnants of artificial cement or mortar for binding or coating the structure. This course may have been either a later addition to the actual paving on which it was laid or of the same structural phase. It looks like some kind of partition wall dividing the pavement into north and south units.

The paving-stones are laid in loose header order, in four consecutive rows. Being roughly aligned and each block only loosely set, without any mortar or any other solid fill in the wide and deep joints (W 0.02-0.10 m), it is hard to consider them as components of a paved surface to be walked on. The overall surface of these flagstones covers the entire exposed area to the west of the foot of the quay, an area of at least 12 x 4 m. Although it is mostly horizontal, there are differences in elevation between individual blocks, ranging from 0.31 m to 0.09 m above MSL.

Toward the end of the 1984 season, some of the blocks were pulled from the second and third rows at the centre of Area I_1a to reveal the underlying strata. Another very similar layer of flagstones was exposed below, and the lifting of one block from the third row of that layer, exposed yet another layer below. These layers were composed of rectangular ashlar blocks of kurkar, some of which have cuttings and recesses indicating that they are re-used from earlier structures. They were laid in horizontal layers over a westward-sloping topography in order to achieve a level surface at the desired elevation. Because the blocks of each layer were laid in overlapping order on top of the lower one, it was impossible to pull off blocks from the third underlying level without removing considerable sections of the first and second layers. Since even the upper paving was well below the

water-table, this project could not be carried out. Probing with poles disclosed that there was kurkar bed-rock below the third layer of flagstones at a depth of 1.47 m below MSL, 2 m west of the quay opposite the mooring stone. As far as can be determined by such probing, it seems as if the bed-rock had been cushioned with small rubble and chipped kurkar pieces in order to gain an even base for the bottom course of flagstones. So the original ground is somewhat deeper.

A second probe was made through the paving slabs next to the quay 10 m farther south, at the site of the 1976 probe. Three flagstones were pulled from the course adjacent to the quay and one of the blocks of the second course was also raised from its place. Through constant pumping during excavation, the face of the lower part of the quay wall was exposed down to its base on the kurkar bedrock at 1.05 m below MSL. The surface of the quay and the adjacent bottom at the time it was functioning could be traced easily by the coating of marine incrustation of *Ostrea* shells (figs. III.77-78). These shells cover the face of the quay wall below 0.1 m above MSL, and the coating is buried under a fill of chipped pieces of kurkar gravel added at some later phase in order to attain a leveled base for the flagstones, after recession of the sea. Careful clearing of this fill revealed a thin layer of mud and *Ostrea* shells overlying very crumbly kurkar similar in character to the fill above. This dividing layer slopes toward the west at about 40 degrees, and the *Ostrea* and mud are at a level of 1.41 m to 1.53 m below MSL at a point 1.3 m west of the quay. The mud was carefully washed and screened for small finds, revealing two coins and some small potsherds from the first century A.C. The coins are both of the last regnal year of Nero (A.D. 68) bearing a countermark of the Tenth Roman Legion (cf. Ringel 1975: 155-56, pl. 20.14; also Volume II). On the face of the quay wall there is a clearly defined horizontal recess or abrasive notch at 0.15-0.40 m above MSL, covered with remains of *Vermetus* (figs. III.70, 72). This feature gives an estimated sea level of about 0.20 m above the present one for the first century of our era. The slope of the bed-rock and its decomposed condition suggest that the Inner Basin was artificially deepened in order to achieve sufficient depth next to the quay.

The mud layer became thicker west of the quay and below the second row of flagstones. This might indicate that the gradient of the quarried bed-rock does not continue at the same steep rate much farther west, beyond the limits of the probe, and possibly a depth of just over 2 m was the average for the Inner Basin (Section III.R.1). No shells of *Ostrea*, *Vermetus*, or any other type of marine incrustation was traced either at the kurkar fill above the mud or on any of the paving flagstones. The floor or platform of flagstones is clearly of a later date than the quay and must have taken this part of the Inner Basin out of use. The flagstones are less than 0.30 m below the mooring stone, so there is no way boats could have been tied up adjacent to it while afloat. The absence of marine incrustation suggests that at the time the substratum was leveled and the platform was built, the Inner Basin was already separate from the main harbour basin, perhaps because of siltation of the eastern part of the Intermediate Basin.

It is difficult to determine the function of the paving. At the present sea level, the flagstone paving is under at least 0.50 m of fresh ground-water all year round. It could not have been easily kept dry in antiquity. If the shore in antiquity was at its present location, the water-table would have had to be 0.6-0.8 m lower.

This would have required a sea level almost 1 m lower than the present one at the time the pavement was laid. The loose arrangment of the stones suits the careful paving of a well-confined hollow. Since we have no indication of a sea level 1 m lower than the present one during the period between the first century A.C. and the Byzantine era, it seems preferable to restore a tank at this point, filled with ground-water at least to its present height. Moreover, there are many indications from structures elsewhere at Caesarea and along the Israeli coast-line that the sea level was higher than the present one all through the Later Roman and Byzantine periods, rising to a maximum transgression of about 1 m above the MSL sometime in the Early Arab period (Flemming et al. 1978; Raban & Galili 1985: 343-51; cf. Section I.A.2). The paving may, therefore, have been laid in ground-water, possibly with sea-water coming in occasionally from beneath as the increasing hydrostatic pressure of the rising sea pushed the interface of the ground-water higher, and farther inland.

These observations suggest that the paving stones were laid in a water-filled hollow already separate from the sea, as the floor of a freshwater basin. The surface of the floor was laid at a level above the interface with brackish water to keep the water within it fresh (for similar practices in coastal wells, see Raban 1983b: 236-38; Nir & Eldar 1987). The flagstones may have been laid to counteract the rise of the interface of fresh and brackish ground-water within a rectangular spring basin relying on ground-water. The conduit that was exposed during the 1983 season in Area I_1a might have channeled water to such a basin in its later phase.

There is no direct evidence for the date of the pavement. It most likely was built long after the Inner Basin had gone out of use, and after the silted area to the west had been incorporated into some kind of overall attempt to renovate the public facilities of the city. Considering that this area was flooded again by the sea in the later Byzantine or Early Arab period, the most likely period for such an attempt would be during the time either of Anastasius (491-518), who was praised for his attempt to renovate the Herodian harbour, or of Justinian (527-557), probably the last Byzantine emperor to devote financial efforts to public building (Downey 1975: 36-37).

Area I_2: Quay Wall, Southern End. This area was selected during the 1984 season following the architectural survey, which suggested that the Inner Quay might continue south from Area I_1 on a line parallel to the western facade of the Herodian temple podium. A section of low ground that semed free of later structures was chosen along the tentative line of the quay, 20 m south of the south corner of Area I_1b (figs. III.68, 79). A square 5 x 2 m was marked out on a surface 2.2 m above MSL, its long axis oriented N-S, directly over the projected line of the Inner Quay.

Just below the surface, a wall of irregular kurkar blocks was found, its face just outside the west edge of the excavated area, buried under a flimsy structure cleared during Negev's excavation in 1962 and dated to the Early Arab period (fig. III.79). The upper surface of the block is at 2.21 m above MSL at the southwest corner of the excavated area, and at 2.13 m next to the northwest corner. The floor of the Early Arab building to the west is at 2.6 m above MSL. Most of the

area in the centre of the square is occupied by a flat flagstone pavement which might have belonged to a secondary phase of the wall west of it. The average level of the paving is at 1.77 m above MSL, and it overlies a flimsy wall (W 0.7 m), parallel to the western one. This is built of roughly-cut ashlar and small rubble and runs N-S. Its upper surface is at 1.5 m above MSL, and it was exposed down to 0.62 m above MSL next to the south baulk of the probe.

East of this wall, in a square about 1 m on a side next to the southeast corner of the excavated area, a probe went down through a waterlogged mixture of brown soil, gravel, and badly abraded pottery fragments of mostly Late Roman and Byzantine date. There, at about 0.7 m above MSL, two fourth-century coins were recovered. Work was stopped at the surface of the water-table, about 0.5 m above MSL, when no additional structures were encountered, or typical beach deposits as exposed at Area I_1. The same general picture was revealed at the northeast side of the trench, in the open space between the paving flagstones and the back of the badly preserved wall running east along the north baulk.

The excavations revealed that there are no remnants of the quay in this area, either because it was not preserved to its original height as in I_1, or because it has to be sought farther to the west. The back part of the wall along the west edge of the excavations might be part of the quay or a later superimposed structure that used the quay as its base. If this is the case, the later, Early Arab structure must be taken away before the excavations can be pursued westward, in order to expose the face of that wall and to follow it down. Unfortunately, there was no time left for this assignment at the end of the 1984 season, and it will have to be carried out in the future.

Area I_3: Podium Vault. Area I_3 is the notation for two trial trenches made during the 1984 season inside the vault at the southwest side of the the raised area that probably supported Herod's temple of Rome and Augustus (figs. III.67, 80). The vault (21 x 7 x 13 m) was excavated for the Israel Park Authority by A. Negev in 1960-1961 (Section II.A.4). The vault was only one of five or six in a series. The others had collapsed, some during the Late Roman period and the remainder at later dates (Negev 1967: 22). Particular interest was aroused by the south and east walls of the building. The blocks from which these were constructed differ in dimensions from those in the rest of the structure.

The vault was found filled with earth almost to its roof, and excavation revealed that the latest occupation within it was of the Fatimid period, just before the Crusaders conquered the city in 1101 (Negev 1960b: 21, pl. II:2). At that time there was a metal-working centre just outside the vault, and the refuse of copper- and iron-casting was found inside it. Several metres of occupational levels were removed above the original floor, which was expected to be of the Herodian period (Negev 1960b: 21, pl. II:2). During this work, two hordes of Early Arab jewelry were found in sealed jugs hidden in pits dug at the inner, eastern part of the vault (Negev 1967: 68). The original floor was reached at about 2 m above MSL only in one small area next to the north wall. It was found to be made of a heavy fill of crushed kurkar. Numerous Late Hellenistic and Herodian potsherds were found on the paving (Negev 1963b: 728; 1975: 273).

Negev noticed that the south and east walls in the vault differ in the height of courses, surface treatment, and means of binding from the north wall and the vaulted roof itself (figs. III.81-84). In these latter areas the blocks are smooth-faced, smaller, and laid in mortar. Clearly this vault was constructed in two different stages. During the first, the vertical portions of the south and east walls were built, with ashlar blocks carrying drafted edges of their front surfaces, held together with clamps set in lead. The robbing holes above the level of the Early Arab floor are still visible on the face of the south wall (fig. III.83). In the second phase, an additional wall was built parallel to the south one, 7 m to the north, extending eastward to the eastern wall. This chamber was then roofed with a vault that rested on top of the earlier wall (fig. III.81). This rebuilding has a bearing on the chronology of the north gate.

CAHEP found in Area J on the shore north of the Herodian harbour what may be the quay of a Hellenistic harbour of Straton's Tower (Section III.I; figs. III.1, 92). Nearby, the Italian Mission had excavated two round towers in a city wall (figs. I.35, II.1), and proposed a Herodian date. A similar, inundated tower was found by CAHEP in Area T (Section III.R.1; fig. III.174). The date of the northern towers was considered questionable (Levine 1975a: 10-15, n. 50), so the JECM carried out a probe outside the southeastern extension of the fortification wall, adjacent to the twin round towers (their Field G-8). Ultimately, they also accepted the Herodian date (Blakely 1984).

CAHEP architects and researchers, however, noticed that the only section of the northern fortification that showed no signs of rebuilding lay between the eastern of the two round towers and a polygonal one farther east, at the point where the High-Level Aqueduct crosses it. In that section, the outer, northern face of the wall is composed of ashlars with smooth surfaces laid in a tight order without any binding cement (fig II.4). On the inner side, which is built in a similar manner, only the edges of the blocks have been finished, leaving rusticated bossing in the centre (figs. II.5, III.85). This clear distinction between the two sides of the wall was not retained in the segments of the wall altered later, including that which was excavated by Blakely. The finish, size, and coursing of the blocks in the inside face of the original part of this wall resemble those of the blocks in the vertical part of the southern and eastern (rear) walls of the vault in Area I_3. It may be that they belong to the same fortification wall.

The most reasonable historical circumstances for the construction of such pre-Herodian fortifications would be the reign of the tyrant Zoilus, who turned Straton's Tower into a stronghold and the capital of his small kingdom which included also Dor and the hinterland of the northern Sharon (Josephus, *AJ* 13.324-35). The walls had withstood the military attacks of the Jewish king Alexander Jannaeus and never been destroyed in war. Furthermore, there are many parallels for the architectural finish of these walls from the Late Hellenistic period: at Samaria (Reisner et al. 1924, I: 201), Akko (Dothan 1976: 41-43), Dor (Sharon 1987: 38, fig. 5), and Sha'ar Ha'amagim (Segal 1987; see also on this subject Maoz 1985: 47, n. 8; Laperrousaz 1974, 1979: 113-24). In short, historical probability and architectural parallels for the towers are to be found in the later second century B.C. rather than early in the fourth century, the date suggested for the foundation of the Phoenician outpost (Negev 1975: 273; Foerster 1975: 9;

Ringel 1975: 19-21). This issue will be discussed further in Volume IV, and was recently summarized by Raban (1987).

Negev's data suggesting a Herodian date for the vault in the Temple Podium was based on his probe along the north, later wall. In consequence, the other two walls might be either pre-Herodian or just an earlier phase of the Herodian plan. In order to sort out those alternatives, two probes were made inside the vault during 1984 down to the foundation level of both the southern and the northern walls. Area I3a designated the trench along the southern wall (figs. III.86, 89). At the point selected, the existing surface, left unexcavated by Negev, is at 3.2 m above MSL. It probably represents the latest Byzantine phase, being composed of crushed body sherds of typical cigar-shaped amphoras of the Gaza type (Riley 1975: 30; Adan-Bayewitz in Levine & Netzer 1986: 97-99). It was covered with broken bricks and iron slag of Early Arab smelting activities. The trench was 2 m wide and extended 6 m along the face of the south wall. Its west end was 2 m inside the west end of the vault. In excavating ill-stratified fill of the Byzantine period, a chamber was found, extending from a lime floor at 2.70 m above MSL to its base at 2.17 m. There was a spill of ash and burned organic substances in the northwestern corner of the chamber. The ash surrounding a collapsed brick structure belongs to a kiln that was dated by a small hoard of bronze coins to the second half of the fourth century.

In 1987 this chamber was cleared further and a small mosaic floor was exposed at its base. The mosaic, 1.2 x 1.2 m in size, was inserted into the bottom of a rectangular lime-plastered basin of which only the lower part has been preserved. It should be dated to the Late Roman period, and, although no good datable finds were recovered from a secure context, it was either already destroyed when the kiln was built, or inserted into it from the higher, lime floor. The mosaic at 2.05 m above MSL is made of fine tesserae 0.008 m on a side in a squared border of lime mortar. Below it there is a fill of small rubble mixed with some undiagnostic potsherds and dark brown soil. The ground is very damp and becomes watersoaked below 1.9 m above MSL. There are faint traces of a bright grey layer at approximately this level that might have been a floor or an occupational level. It lines up with the lower part of the second course of dressed blocks above the foundation course.

Beneath, at 1.82 m above MSL, the fill changes to a light reddish-brown, silty sand mixed with angular fragments of kurkar (D 0.05-0.06 m). Very few datable sherds were found in that layer, but two pieces of Eastern Sigillata A were recovered that date to the first century B.C. At 1.40-1.44 m above MSL there was a thin layer of ash.

At 1.07 m above MSL the foundation course projects 0.18 m from the face of the wall. The top of the block is 0.13-0.15 m above the ledge, so there is a kind of narrow base on the ledge, probably for resting the floor or the top of its leveled surface. The next course above is carefully dressed, so it was probably meant to be visible above the surface when the wall was built. The base course is about 0.60 m high, but about 0.40 m below the ledge it tapers backward and rests on the uneven bottom of its foundation trench, at 0.62 m above MSL, now just below the water-table.

The fill of the foundation trench, clearly visible in the section, is composed of a brighter buff-yellow aggregate of crushed kurkar (see section, fig. III.86). Above the fill and the top of the foundation trench there is a darker, grey-brown clay-like silt, the upper surface of which is at 1.10-1.12 m above MSL. This seems to have been the surface of the ground next to the wall until the vault was built. Of the very few potsherds found in that layer, there were two fragments of Eastern Sigillata A and a badly eroded Rhodian amphora handle of late second-early first century B.C. In 1987 this trench was expanded in search of further diagnostic finds, but except for additional small pieces of Eastern Sigillata A and the bottom section of a Late Hellenistic unguentarium, no significant additional data have been recovered.

Area I3b designated the trench along the base of the northern wall of the vault (figs. III.87-88). This trench was 2 m wide and extended for 4 m along the wall about half-way down the length of the vault. This spot was excavated in 1962 to the base of the wall by Negev, in a 1 x 1 m probe. This pit was now cleaned and expanded. First the surface around it was leveled to the top of a white lime floor at 3.05 m above MSL. This floor might represent either the last Byzantine phase or (more likely) the Early Arab occupation in the seventh or early eighth century. The iron slag and some partition walls that were exposed in 1961 are farther inside, toward the back of the vault, on a level some 0.20 m higher.

Beneath it there is another floor of much the same type, 2.60-2.65 m above MSL (sloping up gently away from the wall). The fill between the two floors is composed of grey-brown soil mixed with gravel and broken body sherds of Byzantine amphoras, most of the Gaza type. Below the lower floor, along the face of the wall, there is a fill of a light grey mixture of decomposed mortar with crushed lime particles that are incorporated into an underlying floor at 2.18 m above MSL. This fill looks as if it is in a hollow cut along the lower part of the wall through the layer of red-brown mixture of broken pottery, silt, and some lenses of carbonized wood and bright sand. The hollow was cut to a level about 0.25-0.30 m above the top ledge of the original edge, just below the upper part of a horizontal recess in the wall, 0.35 m high and about 0.10 m deep. It looks as if there was some renovation effort through which new, heavily cemented courses of ashlar were used for the face of the wall above the base of this narrow foundation trench. Judging from the narrowness of this hollow, it is quite likely that the renovation was only intended to strengthen the existing wall by inserting additional cement between the blocks. The fill through which this hollow was cut includes a few potsherds datable to the second-third century.

This stratigraphy was not clearly observed during the 1984 season, so the baulks on both the eastern and western side of the excavation were cleared and expanded during the 1987 season. Then the hollow was detected in both baulks.

The floor that this hollow cut through is a thick and compact layer of crushed kurkar mixed with lime. On it there were parts of at least three cooking pots of Early Roman type (first-second century). This floor has its face at 2.35 m above MSL, and it is underlaid by another one, at the base of the hollow, which was found covered with scattered pieces of carbonized wood and possibly cloth. A single coin and some *terra sigillata* sherds may date it to the first century A.C. The

layer below is based on a horizontally stratified fill of crushed kurkar chunks just below the ledge (1.82 m above MSL). It also contains pieces of charcoal and a considerable number of lustrous red sherds of sigillata vessels, a major portion of an Eastern Sigillata bowl, and a complete cooking pot crushed on top of the underlying kurkar fill. This corpus seems to be uniformly Herodian in character.

The ledge itself is 0.15 m broad and composed of ashlar stringers about 0.35 m high. The top of the ledge is at 1.86 m above MSL, about 0.80 m higher than the ledge at the base of the south wall (fig. III.88). The ashlar course of the ledge is laid on a foundation made of a course of header blocks on top of which there is a cushion of flat, smaller bits of rubble. The very bottom of the foundation is at 1.10 m above MSL. The fill next to the foundation and up to the level of the ledge reveals no signs of a foundation trench on either of the baulks on the eastern and western sides of the dig. If the foundations were laid down below the contemporary surface, the trench might have been broader than the excavated area.

It is more likely that, when the series of vaulted chambers was built as part of the Herodian Temple Podium (see Negev 1967: 22), the ground was prepared by adding chunks of decomposed kurkar for leveling floor beds and filling depressions (Negev 1960b: 21). This might be the reason why the base of the north wall and the ledge for the floor next to it are so much higher than those at the other side of the same structure.

The two trenches in Area I_3 yielded clear-cut stratigraphic evidence that the northern and southern walls of the southern vault were built at different periods. Since the north wall is not only related in its earliest stage to a floor or occupational level 0.80 m higher, but also to a later historical phase, they should be later than the south wall. It could be that the existing, massive southern and eastern walls were taken into account and its better preserved parts re-used when the master plan for Caesarea was laid out.

If, as is argued in Section III.I, this wall is actually the inner face of the south-eastern corner of the wall of Straton's Tower, it may be that Herod's town-planners decided to keep the wall as a boundary between the city of Caesarea and the emporium of Sebastos (Levine 1975a: 11, n. 50). Literary sources reveal that the walls of Straton's Tower remained physical landmarks all through the Roman era (Klein 1928: 199-228), so their outline must have been easily distinguishable within the built-up area of Caesarea. As their confinement had a religious and juridistic meaning for the Jewish *halacha*, it might have also had an administrative role. One of Caesarea's epithets on coins from the reign of Agrippa I (37-44) is *Kaisaria pros Sebaston* (Caesarea by Sebastos) (Ringel 1975: 153), implying that the two are separate entities. This assumption solves the difficulty of attributing the north wall and twin towers to the Herodian city walls of Caesarea (Levine 1975a: 9-13; Negev 1975: 273-74).

[A.R.]

III.I. Area J: Hellenistic Quay.

The area designated as Area J is on the shore-line north of the Herodian harbour and the Crusader city, west of Field G of the Joint Expedition, and southwest of the wall and two round towers excavated by the Italian Mission (figs. I.36, III.1, 90). It is located at the only point along this stretch of coast-line that is recessed toward the east, providing about 100 m of shore-line facing north and protected from the waves by a wide strip of rocky shallows and scattered abrasive shelves (fig. III.91).

There is a semi-lagoonal cove of calm water extending for about 120 m to the NNE from the southwestern tip of this offset shore, toward the western end of the north city wall (fig. III.90). This lagoon is navigable at its north end and, although not fully protected at present from the wave energy that comes from the west, it is likely that these rocky reefs were less abraded and less segmented in the past and thus gave better protection from the waves. The south shore of this lagoon is an uplifted ancient abrasive platform of kurkar rock, which is at present just over 1 m above MSL (fig. III.94). The date and the cause for the upheaval of this shelf are not known, but whether it was created during a marine transgression or has been tectonically uplifted, it was at sea level long before the first human settler came to the site.

On the lee side of this shelf and about 20 m from the present water-line at the south end of the lagoon, the first archaeological excavations of the Hebrew University took place in the 1940's to early 1960's (see above, Sections II.A.2-3; Avi-Yonah 1956a-b; Avi-Yonah & Negev 1963a-b). Although their main goal was to expose and study the ancient synagogue, they also recovered structural remains and quantities of pottery from pre-Herodian times. The bulk of this corpus is of the second century B.C. They also traced a massive wall in the sea close to the synagogue which they suggested had been part of a mole of the harbour of Straton's Tower (Avi-Yonah & Negev 1963a: 148).

These excavations were never fully published, so it is difficult to determine which wall they meant. The most prominent and massive wall in the water is a segment of a concrete structure 4.6 m wide, 8 m long, and rising 1.25 m above MSL. It extends along the southwest side of the lagoon, a few metres off the edge of the uplifted rocky shelf, in 0.4 m of water (figs. III.92-93). Another segment of this wall can be see in the water some 20 m farther east and looks as if it were dragged by the waves 1-2 m north into the lagoon from its original position. This movement is suggested by the fact that it is off the course of the more solid part on the west and lies in deeper water (1.2 m) than that section. In addition, the remains of a wooden beam were traced running parallel to it 1.6 m to the south, apparently part of the formwork in which the wall was poured. A few other fragments of this massive wall are scattered along the line of its original course, but most have been carried north into the lagoon. The entire lagoon is now filled with such debris and has at present at most points a depth of less than 1 m. These fragments, the only structural remains in the water, are certainly of Byzantine date, judging from the type of mortar and the typology of the broken pieces of pottery that were added to it. The staff of CMS surveyed the site during the workshops in 1978 and 1979. The initial survey revealed two or three additional structures along

the water-line to the south, parallel to the Byzantine sea-wall (Section II.B.4; Raban 1981a: 159). The study of these structures was pursued as well during the workshop that followed the 1980 CAHEP season. At this time attempts were made to expose the base of what seemed to be a pre-Herodian quay, and to determine the stratigraphic sequence between it and the overlying course of ashlar blocks bearing matching grooves for dovetail clamps.

During the next two CAHEP seasons, land excavations were carried out on the uplifted shelf in order to look for undisturbed architectural features that might connect this quay with the stratigraphical context of the buildings on the shore excavated by Hebrew University. These efforts were renewed in 1986 and 1987 under the direction of R.R. Stieglitz (Raban & Stieglitz 1987). Results up to the present are summarized here.

The quay is a platform built of slim ashlar headers that pave the base of the uplifted rocky shelf for 18 m on an E-W axis. Its east end is well-defined but probably not the original one. The front of this course follows a shallow S-curve, of which the last preserved block is less than 1 m south of the western segment of the Byzantine wall. Its face is now under 0.18 m of water. The entire structure is either tilted slightly down toward the west or less abraded at its eastern end where the upper surface is now 0.14 m above MSL (figs. III.92-94).

The headers forming the platform are all more or less 1.2 m long, but they vary in width from 0.20 m to 0.45 m. The height of the blocks at the better-preserved east end is 0.42-0.46 m. The face of the platform is incrusted by biogenic growth with some covering debris, so it is hard to follow each of its components. At several points, sections of an additional course are visible behind the front one, and at two places where the incrustation and incorporated rubble have been removed, the platform could be followed back to the base of the rocky shelf, for a maximum breadth of about 4 m (fig. III.95). To judge from their relative positions, it is quite likely that a large part of this earlier platform was removed when the Byzantine roadstead was built, in order to give it a more stable base. For this reason, the quay does not retain its original face, and the entire eastern segment is now missing.

During 1981 the debris and silt were cleared from the sea-bottom in the area next to the eastern part of the platform, at the gap between it and the segment of Byzantine wall. Although the work could not continue below a concreted layer of rubble at a depth of 1.2 m below MSL (which seems to have served as the base level for the Byzantine wall), it did expose two additional courses of headers under the one edging the platform. This additional course makes the structure look more like a real quay rather than a mere platform or a landing stage.

A parallel wall overlies the western part of the quay, about 2 m south of its present north, front edge (fig. III.92). This wall was built of ashlars of varying sizes alternating four to five headers to one stretcher. Judging from their great length, some of the blocks seem to have been extracted from the underlying platform. This wall is preserved for just over 9 m, retaining at its west end underlying stones which look like a corner. The preserved course, now at 0.36 m above MSL, was probably just a base for a still higher structure that faced north. In two cases, matching pairs of grooves for dovetail clamps are still visible on the upper edges

of neighboring blocks. It seems as if this wall was built later than the underlying quay, being adjusted to its already somewhat decaying surface.

A segment of yet a third wall survived farther east on the same axis as the second one, but 1 m to the south on the edge of the rocky shelf (fig. III.96). Six large ashlar blocks of this wall are still more or less *in situ*. They are much broader than those of the quay and considerably larger: 1.6-1.7 x 0.90-1.05 x 0.6 m. All the blocks except the second from the west carry matching grooves for dovetail clamps on their front edges (fig. III.97). The blocks of this course are now tilted to the north, their upper (south) ends 1.3 m above MSL.

Stratigraphically, it is possible to reconstruct these blocks as a second course of the wall to the west, sloping down 0.30-0.35 m after the lower course was carried away by the sea. At present, the facing headers of the quay's platform clearly continue underneath the westernmost of these large blocks with dovetail clamp holes. Considering that dovetailed clamps were never used at Caesarea in structures of the post-Herodian period, the highest of the three structures along the south shore of the lagoon gives an upper date for the various stages of the complex. If Herodian, this course dictates a pre-Herodian date for the underlying quay.

Such a date matches the evidence of similar Phoenician and Hellenistic marine structures in Tyre, Athlit, and Akko (Raban 1985b: 30-40), as well as at nearby Dor (Raban 1981b: 297-305, fig. 24.F; Stern 1982). The typical order of adjacent courses of long, narrow headers is known also from fortifications and sea walls at Dor (Sharon 1987: 25-26), Akko (Dothan 1976: 41), and Samaria (Crowfoot et al. 1942: 118-21, pls. 12, 13, 36).

In 1981, the area above and south of the eastern part of the quay was cleared of some surrounding rubble and wave-dumped gravel. A square 5 x 5 m was excavated down to the rocky shelf and the top of the rear part of the quay (fig. III.92). At least four different building stages were identified. The lowest structure was built directly on the quay platform of small ashlars. It seems to be the northwest corner of a large structure. The surviving corner has two courses (their upper surfaces at 0.69 m and 1.01 m above MSL) that fill in missing bed-rock to the level of the uplifted shelf. On top of this, and farther back on the rocky shelf, there is a complex of rubble, small ashlar blocks, and plastered floors in an extensive cemented matrix of a type that is quite common elsewhere in Caesarea for Byzantine and Early Arab structures. One plastered floor is at 1.75 m above MSL, and above it, at 1.93 m, there is a mosaic floor, now cemented and covered by a later structure. The floors are visible only at the vertical section of the blocks, and the mosaic one is made of medium sized (0.01-0.012 m) white, limestone tesserae.

When the rubble was cleared from the surrounding face of the rocky shelf at about 1 m above MSL, a gap appeared just west of this block of Byzantine structures. The debris and wave-carried silt that filled this gap were cleared in a search for a passage connecting the quay to the adjacent structure on land. All finds in the fill were badly worn by the waves, and although some datable artifacts could be traced back to the late third century B.C., none was associated with intact stratigraphy. A rectangular hollow (1.5 x 1.5 m) was exposed, open toward the water-line at the north, its rocky bottom just below sea level. The bed-rock

walls of the hollow are now badly eroded by wave action, so it is difficult to tell whether they were artificial or natural (figs. III.98-99).

At the west side of the south wall of the hollow there was a gap of irregular form and with a width of 0.5 m. One of the large blocks of the course with dove-tail clamp marks was found tilted down over this passage and had to be removed. The length of the passage is about 1 m, and beyond it there was another rock-cut tank of a very irregular shape (B on the plan). It was cleared of the wave-carried fill from the top of the surrounding bed-rock at 0.9-1.2 m above MSL to about 0.60 m above MSL. At this point, a thin, rock-cut wall was exposed on its south side, about 2 m SW of the passage opposite. This partition wall steps down and tapers from east to west (1.38 m, 1.18 m, 0.66 m above MSL for the steps, and from 0.9 m to only 0.18 m for the thickness of the wall) (fig. III.100).

To the west of the wall, there was a course of blocks edging the west side of a third tank. Its upper surface was at 0.87 m above MSL, just below the adjacent bed-rock farther to the west. The four blocks (W 0.55 m; H 0.50 m) composing the course are cemented to the bed-rock by natural concretions to such a degree that it is hard to distinguish their western ends. Along the eastern side of this course, a 2 x 2 m square was carefully excavated during the remaining days of the 1981 season. The first layer, down to 0.45 m above MSL, was a fill of buff-grey pebbles mixed with broken shells and small, abraded fragments of pottery. The entire fill had the characteristics of secondary wave deposition of nearby debris. There were many coins in this layer, as well as pieces of broken glass vessels, the latest of which are to be dated to the third quarter of the fourth century A.C. Most of the datable finds within the layer belong to the fourth century, and it can be deduced that the deposition was made and sealed (probably by an overlying, no longer extant structure) some time in the later decades of that century.

The underlying fill was clearly undisturbed by any marine agent. It was a brown mixture of silt and clay and was found to be soaked in fresh ground-water. This layer extended down to 0.21 m above MSL, and at that elevation it was based on a thin, white plaster surface (floor?). Two pottery vessels were found on top of this surface: an intact jug and an almost complete hemispheric bowl of Eastern Sigillata A (see Volume II). Other, less complete ceramics, such as two oil lamps, help in dating the stratum (locus 20) to the early first century A.C.

The white level was underlaid by very fine, grey clay soaked in freshwater (locus 21). In that clay there were over two dozen complete clay vessels. First, just below the plaster and in most cases crushed during deposition, there were at least 14 cooking pots of types usually dated to the late second-early first centuries B.C. Just below, there were eight complete and several broken, double hole-mouth jars of various shapes (fig. III.102). For information about all these ceramics see Volume II. These jars resemble drain pipes in having a wide opening on both ends, but the expansion in the walls and variations in dimensions would not have allowed them to be assembled in a single pipe unit. One type has almost symmetrical ends, with well defined hole-mouths and rounded rims which resemble Punic fish containers from Sicily, North Africa, and Spain (Eisman 1973; Bisi 1970, pl. XXII: 14, 15; Pascual-Guasch 1962, fig. 16) and in the Levant (e.g., Duncan 1930: 47T; Reisner et al. 1924, fig. 164: A1). Although these parallels are known to be containers for pickled fish (Eisman 1973; Williams 1979: 116-17), they are not very close in shape to the jars from locus 21. The contents of two of the better-preserved jars were analyzed, but no residues of fish tissue or bones were noted.

Below the clay (at 0.18-0.22 m below MSL) there was a floor of small slabs of kurkar that covered a fill of clean sand above the underlying bed-rock at a maximum depth of 0.6 m below MSL. During the excavation, the water in the dig reached a level of 0.20-0.30 m above MSL and was fresh to slightly brackish (during the high tide). The clay vessels that were recovered from below that level were found to be softened, and their surfaces eroded by salts and the ground-water.

During the 1982 season, excavation was renewed in the area. The area of the 1981 probe was designated as J_1 and that of 1982 as J_1 and J_2. Area J_1 was cleared of the wave-carried silt and rubble that had filled it again during the winter storms. The area around it and to the south was also cleared by removing over 1 m of tumbled blocks, rubble, and silt. The purpose of the probe was to expose what seemed to be another rock-cut tank in the series, in a search for both substantial structures and for better dated finds.

At 1.08 m above MSL, just below the disturbed debris, there were remains of a stone wall running north along the east side of the planned probe. The probe was demarcated by this feature on the east, by the partition wall on the south, and by the line of the ashlar course found during the previous season to the west. The south boundary, toward the area excavated by Avi-Yonah and Negev, was demarcated by a heavy pile of tumbled stones. The square was 2.5 x 2.0 m.

After removal of the scattered blocks, the upper part of the layer was cleared of seaborne gravel, revealing a fill of brown silt mixed with sand and small rubble. This fill (locus 22) continued down to 0.54 m above MSL. In it were found the skeletal remains of a horse and large quantities of broken pottery, including jugs, amphoriskoi, and cooking pots of the late first century B.C., and some Terra Sigillata A. Although no floor was traced below the fill, there was a marked change in its character at 0.54 m above sea level, to a fine grey mud containing a small amount of sand. This fill continued down to 0.12 m below MSL, where the same floor of kurkar slabs was found as at the bottom of locus 21. This fill (locus 23) was packed with potsherds, including two more double hole-mouth jars, cooking pots, typical Hellenistic black-gloss bowls, fish plates, mould-made bowls, Rhodian amphoras, and three Aegean amphoras of unknown provenance. The presence of local Hellenistic red-gloss bowls, amphoriskoi, unguentaria, and four Rhodian stamped handles made a securely dated corpus of the second century B.C.

Summary. The excavation and clearing of the rock-cut features along the 15 m of the uplifted abrasive shelf, from the east end of the Hellenistic quay in the north and the land site in the south, yielded data suggesting the following sequence of events.

1. A series of chambers or tanks was cut in the bed-rock sometime before or during the second century B.C. These tanks increase in size the farther they are inland, starting with the wave-eroded entrance from the quay (A), through a narrow passage and irregular intermediate hollow (B) to a separate semicircular tank

with a radius of 2.5 m, the curved side north. This tank (C) is divided from the neighboring hollows by thin, rock-cut screen walls that were each pierced by two holes, at 0.2 m below and 0.1 m above MSL. The bottom of this tank is at 0.6 m below MSL but might have originally been leveled with sand fill after the quarrying was finished to the elevation of the lower draining holes. The largest tank (D), almost 8 m square, was also dug to the same depth. It is quite possible that these features were designed at first to serve some industrial function, or even as fish tanks, using the perforated drain holes for better circulation of the sea water. This alternative would indicate a sea level at least 0.5 m higher than at present. The first alternative, however, would require a sea level lower than at present by at least 0.20-0.30 m, in order to facilitate a complete drainage of whatever substance was stored in the tanks. It is hard to determine whether the tanks were at one time plastered in order to overcome the porosity of the kurkar bed-rock, but the lime-rich character of the muddy layer and the sand below it might indicate that such plaster was once there and has disintegrated during the centuries.

2. The kurkar slab floor may have been the original base of these tanks, or it may have been laid in a second phase. The coincidence in level with the drain holes favours the first alternative. In that case, the function of a fish tank might be excluded, because a floor would be superfluous for such a purpose. Some scattered sherds that were found in this floor are dated to the third rather than the second century B.C. (Oleson et al. 1984: 302), yet these pieces can be from the earlier stage of the tanks.

3. The cylindrical or cigar-shaped, double hole-mouth jars might just possibly have belonged to a later pipe at the bottom of the tanks, connecting the holes on both sides of tank C. This reconstruction would fit their alleged function as some kind of industrial installation. Yet, they can fit also the hypothesis of fish tanks, or of a fish-packing workshop at the site. A third possibility is that these jars were either stored in the tank or dumped there with other vessels at some later period. It is worth noticing that tank C contained mostly these cigar-shaped jars and cooking pots (that might have been dumped there afterward), while the adjacent tank D contained a much more varied repertory of pottery types, including imported vessels and amphoras. Tank C may have been a storage place, while D was filled with refuse. If this was the case, then tank D went out of its original use by the second half of the second century B.C.

4. Sometime in the second century B.C. the area was replanned and rebuilt. Tank C still functioned (for storage?), but D was covered up by fill and walls were laid upon it. It is tentatively suggested that at that stage, the long, rock-based stone walls were laid in the area. But this issue must be studied further in future seasons at Area J_3.

5. The last stage represented in this complex can be dated to the Herodian period. At that time, it seems the ashlar blocks with dovetail clamps were laid at the new sea-wall, and the entire area within it was rebuilt, with tank C still retaining some function, probably as a plastered basin in the floor of a building.

6. During the Byzantine era, after a period of negligence during which the sea dumped wave-carried deposits, a massive sea-wall was built in the water. This structure might have been installed to stop the rising sea level from eroding the nearby Jewish quarter. After the wall established a retaining base for it, the area above the bed-rock was leveled at 1.8 m above MSL as a base for a new area plan. It is quite possible that this activity took place during the sixth century, contemporary with the later synagogue (Avi-Yonah 1956a: 261).

7. The finds in the rock-cut tanks add supporting data for extensive activites along the shore-line adjacent to the quay during the latter half of the Hellenistic era. These activities might have concerned a fishery or fish-packing factory, but not in a direct context with the quay as such. The elevation of the quay fits a sea level about 0.2 m lower than the present one. These data coordinate with one of the alternatives for sea levels deduced for the rock-cut tanks. It also fits the elevation of Hellenistic floors which were exposed during the 1986-1987 season next to a Byzantine well that was dug to a water-table higher than the present one by at least 0.5 m (the ground-water now rises only 0.15 m above the bottom of the well). This would confirm the restored ancient sea levels at this site as having been lower during the Hellenistic period and higher than at present during the Byzantine era (Raban & Stieglitz 1987; Nir & Eldar 1987).

8. Among the rich corpus of Hellenistic pottery there is nothing that can be dated after 100 B.C. Of the eight stamped Rhodian amphora handles, four are decipherable: one with the eponym *Timokles* (from locus 22) is to be dated to the late second century B.C. and others with the eponyms *Gorgon* and *Timotheos* (found in 1986) are also of the second century (see Grace 1952: 529-30, 1956: 144). Gorgon is dated to period IV (180-146 B.C.), while Timokles and Timotheos are dated to period V (146-108 B.C.) (Grace & Sarvatiannou-Petropoulakou 1970: 286). To the same period is attributed the fabricant Susilas, who made one of the Rhodian amphoras, the handle of which was found in tank C in 1987 (Grace & Sarvatiannou-Petropoulakou 1970: 311), and the Rhodian stamped handle depicting the head of Helios found in 1987 in tank D, dated to the third or fourth quarter of the second century B.C. (Grace 1956: 144). The Rhodian amphora stamps correspond with the rest of the Hellenistic pottery types to make a solid case for late second century B.C. as the latest Hellenistic occupation at this site.

Josephus (*BJ* 1.408; see Appendix I.A) notes that Straton's Tower had already been destroyed at the time Herod selected its site for his city, yet Strabo (16.2.27) states that Straton's Tower had a harbour or anchorage (*prosormon*) during the mid-first century B.C. The archaeological data collected so far by CAHEP and by the team of the Hebrew University (Negev & Avi-Yonah 1963: 148) suggest that this harbour was not the quay at Area J. This area seems to have been abandoned from the time Straton's Tower was taken by Alexander Jannaeus (just after 100 B.C.) until Herod built Caesarea. The anchorage referred to by Strabo might be sought in the Inner Basin of Sebastos (Areas I_1 and T_1; see Sections III.H.1, III.R).

[A.R.]

III.J. Area K: Twin Towers West of Entrance Channel.

Two eroded but massive concrete Towers stand about 50 m outside the Harbour Entrance and 10 m beyond the spill of the Northern Breakwater (figs. III.1, 16) (Raban 1983b: 245-48; Oleson et al. 1984: 293-94). The area where they stand

has been named Area K. Both features are clearly visible in recent aerial photographs (figs. I.13, III.17) and, when sea conditions permit, can be seen from the surface. The pair, roughly square in plan, stand about 6 m apart and protrude from the deep sand fill that now overlies the ancient sea-bottom (figs. III.103-105). The Eastern Tower is the larger of the two, standing 6.10 m high above the sand, and rising to within 1.65 m of MSL (figs. III.104). In plan it measures 5.10 m (N-S) and 6.80 m (E-W). None of the exterior surfaces is finished, and the outer walls, although roughly vertical, are very irregular. The Western Tower is much shorter, standing 3.30 m high and measuring 7.50 m N-S and 7.00 m E-W at the base (figs. 108). The top of the Western Tower rises to within 3.10 m of MSL and has a large slot (W ca. 0.70 m, H ca. 0.90 m) on its south side (fig. III.107).

The Twin Towers were built of concrete and poured in place at the point where they now stand on the ocean floor. A close inspection of the vertical faces reveals roughly horizontal cavities, 0.20-0.30 m square, presumably left by decayed tie beams used to stablize the formwork during the process of construction (fig. III.106). The fabric is a peppery grey-green mortar containing irregular limestone and kurkar rubble aggregate. This material was laid in wooden caissons that were constructed elsewhere and then towed into place, sunk to the sea bed, and stabilized on a previously prepared building site (Oleson 1985a). Airlift excavations in Area K did not uncover any remains of the wooden formwork, but a hollow-walled construction similar to that found in Area G (see Section III.F) might have been used here as well. In that design, cavities between the inner and outer planking were filled with concrete, so that the added weight would help counter the buoyancy of the wooden formwork and aid in sinking it.

Airlift trenches dug during the 1981 season did not locate the ancient sea-floor or the base of either Tower, although air-probe surveys did ascertain that there was no structural connection between the two (Raban 1983b: 245-50). Finds from these trenches were very mixed in character and probably represent secondary deposits brought in by wave action (see Volume II). The ceramics ranged in date from the second to the sixth centuries A.C. and included a wide variety of types of amphoras, utilitarian ware, and red-gloss Egyptian *terra sigillata*. Coins were more uniform in date, yet ranged as early as a badly corroded Roman imperial issue of the second century to a series of eight bronzes of Byzantine date: one of Constantius II (351-354), three folles of Tiberius II (581-2), three folles of Maurice (588-9) and one follis either of Maurice or Tiberius (Hohlfelder 1985). The larger number of sixth-century coins suggests that the repair of the harbour by Anastasius (491-518) may have resulted in a considerable amount of new trade.

There can be no doubt that the Twin Towers in Area K and the single Tower in Area G were part of the harbour entrance described by Josephus (*BJ* 1.413; see Appendix I.A): "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 were supported by two upright blocks of stone yoked together (*sunezeugmenoi*), higher than the tower on the other side." The Twin Towers in the west had probably been faced with ashlar masonry and might easily have been mistaken for upright monoliths of stone, but it is more difficult to understand the meaning of the term *sunezeugmenoi*, "yoked together." Oleson has suggested that Josephus might have

intended that these Towers were "paired", but added that, in that case, it would have been difficult to divide three statues between the two (Oleson et al. 1984: 293-94). However, the span of ca. 6.0 m between the Twin Towers might have been joined by a shallow vault, similar to the one suggested for the reconstruction of the lighthouse of Leptis Magna (Bartoccini 1958: 59-65).

A recent model of the harbour (to be discussed in Volume IV) reconstructs the relationship between the Twin Towers, their columns, and the sculpture they supported, and the Northern Breakwater and harbour Entrance Channel. Although Josephus does not mention a lighthouse in his descriptions of the harbour (see Appendix I.A), the tumble of massive blocks at the northern tip of the Southern Breakwater, close to Area K, has been identified as a likely candidate for such a structure, which was an integral part of any harbour complex.

[R.L.V.]

III.K. Area L: Herodian Quay and Pier.

A unique structure along the coast-line of Caesarea's harbour is an ashlar platform that looks like a pier, projecting from the foot of the present cliff of debris at the shore just north of the modern harbour basin, between the Column Jetty on the south and the modern mole on the north (figs. III.1, 109-110, 113). The structure was first observed and studied during CMS work for the IEC in 1975 (Raban et al. 1976: 33-34, fig. 24). It was then studied briefly by Levine and Netzer in 1976, when they carried out a stratigraphic excavation on the high ground east of it and concluded that the structure was "apparently a pier connected to the port system of Herod's time" (Levine & Netzer 1986: 65; also W 201 on their plan 3, 11c, 11d, pp. 50-52, and ill. 73). It was subsequently excavated by CAHEP in 1986 and 1987. Although these campaigns fall outside the period constituting the main focus of this volume, they are included here because of their importance for the reconstruction of the history of the Intermediate Basin of Herod's harbour. During the CAHEP surveys, the area around the structure was termed Area L, but during the CAHEP excavations, it was lumped in with Area S, as Area S_1. Nevertheless, the Pier will be discussed here under Area L, with cross-reference to the discussion of the contiguous Area S (in Section III.Q).

The structure, preserved to a maximum height of two courses, was framed by two side walls of long blocks arranged as headers (fig. 111). It is 6.4 m wide at its western tip, which is now partly covered by a large chunk of beach-rock that reaches a height of 0.37 m above MSL. This beach-rock indicates that the tip of the pier was covered by beach deposits for a length of time after it went out of use, when the sea level was slightly lower than at present. The north side of the pier is better preserved than the south and still retains all the blocks of its foundation course. There are 38 headers extending in a line for 23.7 m. The better preserved blocks are 2.2 x 0.61-0.63 x 0.42-0.53 m.

On the south side of the pier, only the western 11 headers were preserved more or less in their original configuration. At this point there are remnants of a cross-wall that once lay on top of the pier, on a N-S axis. The western face of this cross-wall was built of alternating headers and stretchers held by the mixed fill of

small rubble and shell-rich cement comprising the core of that wall. The sizes of the building stones, their order, and the incorporating matrix resemble those of the Crusader sea-wall farther south, on the north side of the Harbour Citadel.

During CAHEP's 1986 and 1987 seasons, excavations were carried out in order to expose the base of the pier and the stratigraphic context of its eastern side. The excavation was carried out for three weeks in 1986 in an area designated as Area S_1, directed by Robin Ziek. During these excavations the eastern part of the pier was cleared to bed-rock, the architectural complex on top of the pier's eastern stem was excavated, and the debris covering the water-line to the south was cleared by a mechanical shovel, exposing an ashlar quay perpendicular to the pier (fig. III.114).

The main structure excavated during the 1986 season was a rectangular building. Only the western end was exposed, since the rest of it was incorporated into and buried under later structures. The north wall of this structure was preserved to a height of four courses, the blocks laid in alternating order of one course of headers and one course of stretchers. This wall (designated W 180 by Levine & Netzer 1986) is 1.05 m wide; and the blocks are 1.05 x 0.52 x 0.52 m. The base of the wall is at 0.43 m above MSL, and its highest surviving point at 2.49 m above MSL. The ashlar blocks are bound by a cement of compact red loam (*hamra*), mixed with small rubble. At its west end, the wall forms a corner with a similar wall that runs south (designated W 166 by Levine & Netzer 1986: 52). The external side of this northwest corner is directly on top of the northern edge of the pier, 22.3 m east of its western tip (fig. III.111). Just west of this corner, the excavations exposed the blocks of the pier buried in partly-calcified sand. The top of the pier's course is 0.34 m above MSL, and matching grooves for dovetail clamps were cleared on the edges of two neighbouring blocks, attesting the fact that this technique, characteristic of the Herodian phase at Caesarea, was in use for the eastern segment of the pier (fig. III.112).

Excavations inside the rectangular building behind the western wall (locus 101) went through sand fill with some Late Roman potsherds (second-third centuries), down to a grey cement floor at 0.92 m above MSL. Some vessels found smashed on this floor can be dated to the mid-second century. The wall on the west side of the locus 101 survived for only two courses, but it seems as if its original width was at least 1.52 m, the length of the best preserved block. The western face of the wall and its continuation to the south have been badly affected by the sea. So, the southwest corner of the rectangular structure could be restored only by calculating the interaction between the west wall and the course of the south wall which was studied by Levine and Netzer and designated by them as W 167. The external southwest corner is 7.8 m south of the northwest corner and on top of the southern side wall of the pier (Levine & Netzer 1986: 65). The width of the south wall was 1.05-1.10 m (Levine & Netzer 1986: 52), but during the 1986 excavations only a few fragmented blocks of its foundation course were found still *in situ*. According to Levine and Netzer (1986: 52), at least one floor was found within this rectangular building, at 2.13 m above MSL. This floor, and probably another one some 0.13 m higher, were dated by the excavators to the late second-early third centuries A.C. (1986: 65).

The south wall of the pier was found to extend underneath the south part of the rectangular structure, just inside its south wall. At this point (locus 102) the blocks of the pier were covered by a later floor of compact grey mortar with a base of small pieces of rubble (III.115). This floor is 0.57 m above MSL in locus 102 and 0.54 m in locus 101. In both loci it is clearly beneath and earlier than the western and southern walls of the rectangular structure. The ceramics found on this floor give it a tentative date in the late first century A.C. This is an indication of the latest possible time the pier went out of use for its original function. The baulk at the eastern side of locus 102 (baulk A) indicates quite clearly that there was a period of abandonment at this site between the time the cement floor was laid on top of the pier and the building of the rectangular structure: the foundation trench of this structure was dug into a heavy layer of beach deposits (fig. III.116). The coarse components of these beach deposits and their steep gradient indicate that at this period the beach was formed by waves with considerable energy. This situation might indicate that the main breakwaters of the Herodian harbour had already lost their integrity and the main basin was no longer well protected.

The ashlar quay exposed in 1986 along the water-line south of the pier was completely cleared during 1987. Manual excavation, assisted by water-jet sweeping of the wave-carried sand that covered it, revealed the entire surviving part of this quay, as well as the bed-rock behind it and the ashlar wall which retains the fill to the east (figs. III.117-18). This retaining wall is oriented some 20° W of the axis of the quay (bearing 207°, against 188° for the quay). This orientation resembles that of the rectangular structure, while the orientation of the quay is perpendicular to that of the pier (276° along its south edge).

The segment of the ashlar quay which survived included 11 long blocks embedded in a rock-cut trench in a flattened kurkar platform sloping very gently upward to the east. The edge of the structure is even along its outer edge, but the length of the blocks varies between 2.2 and 2.7 m, so the inside edge is uneven. The extant segment is only 6.6 m long, with its northern end 5.6 m away from the southern edge of the pier. The hollowed cuttings in the bed-rock along this gap indicate that the two structures were originally one unit and the missing blocks were removed by human agency or by the sea.

Another segment of the same quay wall is visible just above sea level farther to the south. This segment is about 14 m south of the south end of the first one, on the other side of tumbled sections of the Crusader fortification walls, but on the same line (figs. III.109, 119). It is composed of 11 header blocks over 6.6 m. Here too, as at the other segment, the western face is a straight line while the back side contains some additional paving slabs that are laid as stretchers. The maximum extant width of the platform is 2.8 m, but it seems as if the original width was greater.

There can be little doubt that this long pavement is not the base for a wall but some kind of waterfront quay or platform. The sea next to it is silted up at present, and it is impossible to determine the original depth of water along the quay without further excavation. Nor is it possible to distinguish the original function of this structure: whether it was a true quay against which vessels could moor

or just a paved road leading to the adjacent pier. If one projects the line of this quay about 14 m farther south of its existing southernmost segment, it meets at a right angle the projected western continuation of the massive sea-wall (W 1) in Area S_2. These missing sections lay in an area now covered by 1.2 m of water, exposed to the surge and not protected by later Byzantine and Crusader structures, and seem to have been totally lost to erosion.

The retaining wall behind the northern segment of the quay exposed in 1987 seems to show at least two different stages of construction and to be missing the facing blocks above the second and the third courses (fig. III.118). Two foundation courses were inserted into a trench that was dug down to the bed-rock through 1 m of beach deposits. After the insertion and construction of these two courses of blocks (the lower is 0.37-0.42 m high; the upper 0.6 m high), the foundation trench was filled with rubble and *hamra* similar to that which was used in the construction of the nearby rectangular structure. The same red loam was used as a binding cement within the higher courses of the wall, which is preserved to a height of seven courses on its south side. It seems as if the original width of the wall above its base was about 1.3 m. The total height of the preserved wall is 3.1 m (including 1.0 m of the foundation courses), with its base on the bed-rock at 0.62 m above MSL.

The fact that this retaining wall was built into a beach formed of gravel, shells, and other components typical of wave deposits indicates that prior to its construction the area was exposed to the surge to much the same extant as at present. Judging from the similarity in orientation, foundation elevation, and construction technique, this wall most likely has the same date as the nearby rectangular structure. There is no floor adjacent to the west side of this wall, so it seems as if it was an external wall retaining a filled-in area along the sea.

One might claim, on the basis of these data, that by the late second or early third century this part of Caesarea was a beach exposed to the surge of the open sea and had no apparent harbour function. This might be used as evidence for the early submergence of the breakwaters of the Herodian harbour.

[A.R.]

III.L. Area M: Crusader Citadel.

Area M consists of the central portion of the modern southern breakwater, including structures such as the Crusader Citadel, its moat, and the associated defensive towers (figs. III.120, 122). Other features on the breakwater, including the sluice gate and a small probe dug against the northern (inside) edge of the quay wall in 1983 (Area Q), will be discussed elsewhere below (Section III.O).

The modern southern breakwater is all that remains above sea level of the main structures of the original Herodian harbour. The selection of this position for an anchorage might have been due to the presence of a kurkar promontory still visible at various points along this breakwater. Even if this headland was small, it appears to have been the only substantial relief along an otherwise straight shoreline and must have been an important factor in determining the site of both the

southern harbour of Straton's Tower and Herodian Sebastos. Because of its central location and elevated position within the harbour, this site must have always been important for the control of merchandise coming into and out of the port. The ruins seen there today date from the Crusader period, when this strategic position was selected for the citadel and was separated from the remainder of the city by a water-filled moat.

The remains of the Crusader Citadel consist of the central *donjon*, portions of the northeast and southeast towers, stretches of the sea-walls, the wet moat, and towers on the eastern, or landward side of the moat (Benvenisti 1970: 135-45). The *donjon* was one of the most conspicuous ruins on the site and was often sketched by early visitors including Forbin (1817), Bartlett (1842), and Fenn (1888). The earliest known photographs of the site were taken in the third quarter of the nineteenth century by the Bonfils family of Beirut.

According to Conder and Kitchner, the structure was "still maintained" and appears to have been occupied by the local village headman (Conder & Kitchner 1882: 26). According to the surveyors, these walls were 14.5 ft. (4.42 m) thick and stood to a height of 70 ft. (21.34 m) to the second storey level.[1] The structure was built of small kurkar blocks set in a hard white mortar, characteristic of Crusader construction, with interior rooms covered by ribbed vaulting of traditional European design, portions of which can still be seen among the fallen masses of masonry (fig. III.121). One of the interior ribs was still in place in 1873, supported by a corbel carved in the form of a human head. In addition, there were two windows in their original positions on the south side, one spanned with a flat lintel and the other by a pointed arch. The plan of the building remains uncertain, but a large moulded pier base (H 18 ft. 3 in., 5.56 m; D 5 ft. 3 in., 1.60 m) recorded in the late nineteenth century indicated a monumental interior hall with ribbed, vaulted bays carried on bearing walls and freestanding interior supports (Schumacher 1888: 136).

Several examples of tesselated floors were still to be seen at the same time the pier base was discovered. The fabric consisted of a layer of good mortar, 0.04 m thick and filled with chips of flint and other hard stone, as well as fragments of brick and tile. On the north side of the *donjon*, steps leading to the first floor from the anchorage below could still be seen in the late nineteenth century (Schumacher 1888: 136). The flight was 4 ft (1.22 m) wide and built of marble blocks with risers 9 3/4 to 10 1/2 in. (0.25-0.27 m) high and surmounted a terrace wall of bossed ashlar masonry. Nothing is to be seen today of this northern approach.

On the western tip of the breakwater, Conder and Kitchner recorded a second building identified as a tower (1882: 26). The structure no longer exists and was described at the end of the nineteenth century as almost totally destroyed. It measured 43 ft. (13.11 m) N-S by 66 ft (20.12 m) E-W, with exterior walls 2.0 m thick. The accompanying plan showed a pair of parallel walls in a position very near the sluice gate. The tower was 50 m west of the *donjon* and connected by a vaulted passage of uncertain date.

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1 Where the original surveys used English units of measurement they are reproduced here, but with the metric conversion in parentheses.

The *donjon* was surrounded by sea-walls best preserved on the north side where courses of small ashlar blocks (avg. 0.4-1.2 x 0.35-0.6 x 0.35-0.6 m) stand 3.9 m high (fig. III.128). Another stretch of sea-wall on the south side was described in the *Survey of Western Palestine* as including a small postern gate with a curious triangular vault at the junction of sea-wall and *donjon* wall. This stretch has also disappeared. The masonry of the citadel sea-walls is similar to that of the first stage of the Crusader city walls.

The sea-walls were strengthened at several critical points by massive towers built in traditional Crusader style of alternating courses of large bossed ashlars with rows of columns set into the thickness of the walls (figs. III.125, 129). The length of these columns provided a very broad base for the tower walls, protecting them from collapse due to undercutting by sappers or, for that matter, by wave action. The southeast tower is the best preserved, with exterior dimensions of 13.65 m (N-S) and 12.80 m (E-W) and an interior room 6.5 m (N-S) x 8.4 m (E-W) (figs. III.123-25). The south wall stands 5.25 m high with an interior staircase leading up from east to west. Another interior landing is found on the east side which led to a similar interior passage.

A small excavation in 1983 uncovered portions of the northeast tower and a section of the western curtain wall between it and the southeast tower. Six courses of masonry from the south face of the tower were laid bare between 0.9-3.95 m above MSL, revealing a battered wall with an inclination of eleven degrees. Portions of the north and east sides of the tower are still visible beneath modern terrace walls overlooking the modern inner harbour where seven courses of ashlars and columns stand 3.40 m high (figs. III.126-27).

The moat separating the citadel from the Crusader city is now completely filled but can be identified. Its western edge was defined by the curtain wall between the northeast and southeast towers (no. A in fig. III.126) and the east side by another wall fragment uncovered in 1981 when a new power line was being buried along the southern facade of the existing row of shops. The eastern moat wall, built of a heavily-mortared rubble 2.10 m thick, has subsequently been reburied. A hypothetical restoration of the moat for modern use (not its original state) has been prepared (fig. III.131).

The citadel of Crusader Caesarea dates from the early thirteenth century when King Jean de Brienne refortified the city with the assistance of the Hospitallers and Duke Leopold of Austria. Known as *al-Khedra*, "The Green," the citadel was often the object of attack, and its role is described in some detail in accounts of the attack of Beybars in the final seige of the city. The caliph surprised the town's inhabitants, entered the city, and took as his command post the roof of the nearby church opposite the citadel. After scaling the walls and burning the gates, the Egyptian army entered the citadel in victory. According to Arab sources, the prince came down from his position to assist personally in the demolition of the fortifications. The citadel ruins are now occupied by an artist's studio and gallery on the lower level and a restaurant above.

[R.L.V.]

III.M. Area N: Inner Edge of Southern Breakwater.

Two excavations were carried out during the 1983 CAHEP season along the resent inner face of the Southern Breakwater, at points termed Areas N_1 and N_2 (fig. III.1, 38, 132). The purpose was to search for the quay along the inside of the Southern Breakwater mentioned by Josephus (Appendix I.A). Its presence was also suggested by features farther west and NW along the inner face of the same breakwater, yet it had not been traced during the visual survey or the more systematic survey lines (Section IV.C). Unlike the central portion of the Southern breakwater, which has many courses of blocks along its inner part, the southern section has no remnants of either horizontal paving or a vertical wall that might once have faced its inner edge. Although the Northern Breakwater also lacks any visible remnants of this type, in this case later attempts of renovation may have covered the original features. No such later interference can be determined for the Southern Breakwater, and the data from the casual surveys and Survey Lines nos. 1-3 indicate that components considered to be of the original construction appear all over the upper portion of the sunken structure: for example, the concrete blocks with formwork impressions. There are also heaps of ballast blocks on the surface of this area, left by shipwrecks of the Byzantine period. In addition to the issue of the Inner Quay, there is another special feature of the inner face of the Southern Breakwater that caught our attention. It is a rectangular projection that is easily distinguished in aerial photographs on the inner edge of the breakwater, about 50 m wide and extending about 30-35 m into the basin (fig. I.13). The surface is an elevated platform of debris somewhat less prominent and of different components than the breakwater itself. Our working hypothesis was that this submerged feature might be the remains of an inner platform or a landing stage that was added to the Southern Breakwater in order to increase its docking capacity (Oleson et al. 1984: 289-90). The underwater excavations of the 1983 season, which were devoted to studying the architectural features along the Southern Breakwater, therefore included these two trenches in an effort to recover more information about the issues described above.

III.M.1: Area N_1. The first trench (Area N_1) was cut for about 12 m along the southeast edge of the rectangular feature, toward the edge of the breakwater itself, then for an additional few metres to the west along its inner face (figs. III.132-33). It was dug within an area marked by two parallel ropes fixed to the sea-bottom 2.5 m apart, extending from the assumed inner face of the breakwater for 10 m to the northeast, inside the edge of the rectangular structure. The excavation started at the northeast end of the marked area and extended toward the main breakwater.

The platform was found to fall into two sections. The section closer to the breakwater was about 1 m higher than the other and composed of larger pieces of rubble. The portion extending into the basin of the harbour rises about 0.8 m above the surrounding sand and is composed of a spill of kurkar rubble (avg. D 0.3-0.9 m). The top of the rubble is at a depth of 6.3 m below MSL. The surface of the rubble was incrusted by marine fauna and contained some badly worn sherds. Excavation revealed that this layer was 1.0 m thick and lay on a layer of clear sand with no pottery, about 0.8-1.0 m thick. At a depth of 8.1-8.3 m a thin but well-defined layer of grey clay was encountered, overlying coarser sand and shingle. The top of

the clay was cleared for approximately 1 m^2 (fig. III.134), exposing some well-preserved pottery incorporated in its upper surface. The sherds included a few pieces of Terra Sigillata A and a lamp of Herodian type. The character of this clay and the chronology of the pottery on it suggest a deposition during the reign of Herod and at a stage when this area was covered by calm water. The same stratigraphy was found along the lower part of the entire trench as far as the edge of the breakwater itself. Along the last 8 m before the breakwater, the thickness of the layer of rubble increased to almost 2 m, with its crest rising to a depth of only 5.2-5.3 m below MSL. On top of that spill and next to the trench on the west, there were five scattered clusters of ballast stones some 5-10 m apart, composed of basalt, schist, or similar igneous rock. In two cases the ballast included stone blocks; one of these groups was composed of large blocks with concave sides (0.68 x 0.36 x 0.26 m) (see Volume II). At least two dozen such blocks were traced in the area, undoubtedly indicating a wreck site. The wave-worn potsherds that were found concreted to the face of the rubble near the ballast stones can be dated to the Late Roman and Early Byzantine period (late third to fifth centuries).

At the base of the main structure the trench revealed a steep spill of larger rubble (avg. D 1.0-1.5 m), mixed with crumbling pieces of concrete and some tumbled kurkar blocks. At this point, the trench was extended west for 8 m (figs. III.132-33, section A-A_1) along the steep sloping mass, the crest of which stands at a depth of 3.8-4.2 m below MSL. The base rested on clear sand at a depth of 7.3-7.8 m. No clay layer was found below that level and no man-made structures.

Although no coherent structural features were revealed, the excavations did expose some regular blocks (3 x 1 x 1 m) tilted down so their lower edges are now at a depth of over 7 m. There were five still in approximately their original relationship, but turned counterclockwise (westward) by 30-40 degrees from their original orientation in a course of headers. It is very probable that these blocks are remnants of the face of the Inner Quay and that the slabs that paved the top of it are to be sought under the overlying spill of rubble. Their present tilt might have resulted from either the submergence of the breakwater or the fluidation of the sand underneath (or both).

The wreck sites on top of the rectangular projection indicate that it already existed in much its present form by the fourth century. But the presence beneath it of the stratum of clay indicates that it does not date from the harbour's first construction period. This clay seems to have been deposited when the breakwaters still protected the basin and it indicates the floor of the Roman harbour basin. The stratigraphy resembles that of the sunken floor in Area F (Section III.E), although its form is totally different.

The data available fall short of allowing reconstruction or dating of the platform. At present, the more likely alternatives are: (1) The projection represents an additional landing stage that was built either in the final stage of the construction of the original Sebastos, or somewhat later, in the early part of the first century A.C., when the harbour was still functioning to its full capacity. (2) The projection is actually a spill of building materials from the upper structures on the Southern Breakwater that were thrown into the water by wave action during the early stages of the harbour's decay. This possibly occurred when the harbour had

fallen into a state of disrepair, at a time when there were no longer the resources or economic justification to keep such a complicated, expensive, and probably already subsiding complex intact. This might have happened some time during the second or early third century. Nevertheless, the rectangular shape of the platform and the two separate units of different thickness composing it call for more explanation than just accident. Further excavation is needed over a more extended area before secure answers can be presented.

III.M.2: Area N_2. The second trench excavated in this area in 1983 was called Area N_2. It was located 60 m SE of Area N_1, along the inner face of the Southern Breakwater, 90 m west of the modern mole (figs. III.1, 38). A 5 x 5 m square was designated with a line on the sea-bottom toward the steeply-sloping rubble at the edge of the submerged structure, just east of Survey Line no. 1 (Section II.C) at metre marks 15-20 (pl. I). The sea-floor in the area was covered by a layer of scattered rubble, partially overlaid by wave-carried sand. The depth of the sea-floor on the north side of the square was 6.83 m below MSL, and at its south side, half-way up the slope of the edge of the breakwater, was 5.75 m.

The trench penetrated a layer of kurkar rubble approximately 1.0 m thick (D 0.3-0.6 m), including three or four scattered blocks (avg. 1.5 x 0.6 x 0.5 m). Below a depth of 7.6 m, there was only clear sand with some shells and badly-worn potsherds. At 8.05-8.12 m below MSL the compact grey clay layer was encountered. It was found to be similar to the stratum in N_1, about 0.04-0.05 m thick, containing fine pieces of broken shells. This layer overlaid coarser sand with a higher percentage of shells. Here, as in N_1, there were potsherds of Herodian and early first century A.C. date. The layer of clay could be followed all around the bottom of the northern part of the trench. On the southern side, however, just at the foot of the sloping debris of the breakwater, there was a hollow where the stratum was missing altogether, and the sand underneath the rubble, mixed with some small stones and wave-worn potsherds, continued down to over 9.6 m of water (the bottom of the pit). The sloping debris was cleared away and about 1.5 m of tumbled rubble was removed, including some large pieces of concrete and a few blocks similar in size to those found below. Not a single block of the type found at Area N_1 could be traced in Area N_2. The heap of rubble was found to continue down to a depth of about 7.9 m and to be underlaid by clear sand with no man-made artifacts.

The sandy hollow that now divides the existing inner face of the breakwater debris from the clay layer might very likely be a robber's trench from which the original ashlar blocks were salvaged after the harbour went out of use, to be reused for structures on land, such as the Crusader Harbour Citadel. This plundering seems also to have affected Areas A-C.

The data acquired from Area N_2, like that from the trench in Area N_1, fell short of giving definite answers for the original layout of the inner side of the main breakwater. Several hypothesis may be proposed, nevertheless, but they are tentative in character. (1) Assuming that the clay layer represents the original floor of the functioning Harbour Basin, its absence here and there might be due either to later salvage activities (as in Area N_2) or to a current that was flowing around the basin from the flushing channels in Area Q (Section III.O). Such circula-

tion might have gained velocity when flowing in a curved course dictated by the topography near the bottom of the harbour. In such a case, the flow might have had enough energy to carry silt along, to dump it only when losing velocity again, at sites such as the outer portion of the Entrance Channel. (2) The inner face of the Southern Breakwater either lacked the features of a quay altogether, or its characteristic components -- such as ashlar paving slabs and courses of headers -- were totally robbed out some time in the past. (3) The quay was built of easily lost materials such as wood or badly mixed concrete. Although both techniques are known from Roman harbours in the West, there is no architectural or textual evidence for their use at Caesarea or any other ancient harbour in the Levant.

[A.R.]

III.N. Area P: Piscina.

Introduction. The South Bay at Caesarea is framed on the north by the kurkar projection on which the Southern Breakwater of Sebastos was founded and on the south by a second low kurkar peninsula ca. 50 m wide that projects ca. 80 m into the sea (cf. Section IV.B) (figs. I.40, IV.2). Several low kurkar islets and *Vermetus* platforms project just above sea level around the peninsula, which is fringed by submerged slopes of kurkar bed-rock and rubble that descend gradually to the white sand of the present sea bottom, at a depth varying from 2 m below MSL close to shore to 10 m at the westernmost point.

This peninsula, termed Area P (figs. III.1, 135), now presents a complicated appearance. The upper surface originally sloped unevenly downward from approximately 6 m above MSL where it joins the shore to sea level at its western extremity. The irregular natural surface has been largely quarried away, with the exception of occasional low outcroppings left at several points along the north and south margins of the peninsula. At the base of the peninsula an area approximately 30 x 10 m was levelled and built over in the Herodian period, perhaps for part of Herod's palace. The mosaic covered floor in this structure is now at 1.49 m above MSL. This area of the peninsula was not covered by the permit granted to CAHEP but has been probed and partly excavated. Probes were carried out here by Alexander Flinder, E. Netzer, and L.I. Levine in 1964 (Flinder 1976a: 77; 1981-82, 1985a: 174), and by E. Netzer in 1976 (Levine & Netzer 1986: 149-77). Several E-W and N-S channels cut in the rock cross the southern end of this platform. The rock between the south end of the platform and the sea still rises to its original height.

The central portion of the remainder of the kurkar peninsula has been cut down to a level now about 0.3 m to 0.4 m above MSL in order to accommodate a large, elaborate fish tank and its associated circulation channels and reservoirs (figs. III.136-41). The Roman term for this type of installation is *piscina*. At some later period, long foundation trenches were cut into the broad platform of rock (ca. 30 x 30 m) to the west of the Piscina basin to accommodate bedding courses of blocks for several N-S and E-W walls (fig. III.151). The southern margin of the peninsula adjacent to these foundations carries the bulky remains of the Byzantine city wall (fig. III.141), possibly occupied as a strong point in the Crusader period as

well. This lower portion of the peninsula was covered by the CAHEP permit. In 1964 and 1973 Alexander Flinder carried out a preliminary survey of the whole Piscina area, but without any real excavation (Flinder 1985a-b). Portions of the central area of the basin were cleared of rubble and sand in 1976 by Avner Raban and Yossi Tur-Kaspa, and in 1983-84 the entire peninsula was carefully surveyed and drawn by CAHEP staff, and that portion of the basin floor still encumbered with sand charted by means of metal probes.

Judging from the history of Caesarea and the arrangement of the rock-cut and built remains on the peninsula, the Piscina was the first major structure located at this point. The chronology, function, and technological context of this feature will be discussed in Volume IV, and only a description of the surviving physical remains and their archaeological investigation is provided here, with a brief, preliminary analysis at the end. The main feature of the Piscina complex is a rectangular central basin connected to the sea by channels on the north and south, towards its west end (fig. III.136). An elevated rock-cut channel enters the basin towards its southeast corner, and another channel at the centre of the west wall connects it with three long reservoirs cut in the rock at the western extremity of the peninsula. At present the basin is partially filled with kurkar rubble, cut blocks and columns, and sand. The eastern quarter is occupied by a mobile, but more or less permanent, sand and gravel beach carried there and shaped by the water that flows in and out of the central basin with the tide and by winter storm waves that break well over the flattened area of the peninsula, almost as far as the basin itself. Some of the photographs illustrating this section were taken during a few hours of very low water level brought about by a combination of tidal and wind action.

Central Tank and Associated Channels. The central basin of the Piscina is a shallow, rectangular, rock-cut tank, the long axis of which is oriented to the long axis of the peninsula, more or less due E-W (the long axis is on a bearing of 83 degrees; the eastern end is 7 degrees west of north) (figs. III.136, 138, 140-41). The dimensions are slightly irregular: north edge L 35.15 m; south edge L 35.26 m; east edge L 18.20 m; west edge L 17.87 m. The floor of the basin is smooth and seems more or less level to the eye, although slight irregularities appeared in surveys and are reflected in the section drawings (fig. III.137). It apparently is unmarked by any intentional rock-cut depressions or protrusions. The floor stands approximately 0.80 m below present MSL, but the actual level of water in the basin fluctuates markedly, depending on the tides, the direction of the wind, and sea conditions. The maximum variation is approximately 0.50 m in either direction. Since the upper surface of the kurkar bed-rock around the tank has not been cut to a completely uniform level, the height of the vertical tank walls above the floor varies from one point to another: at the southwest corner the floor is 1.20 m below the upper edge of the wall, at the northwest corner 1.42 m below, at the northwest sluice 1.35 m below, and at a point 2.0 m west of the south end of the internal divider wall, 1.40 m below. On the whole, the surface of the kurkar peninsula is rougher and closer to its original profile along the north than along the south edge of the basin. A series of shallow depressions (1.40 x 0.60 x 0.10 m deep) for bases or some other architectural element have been cut into the rock in a row 2.2 m north of the north basin wall, towards its east end (fig. III.140).

The only rock-cut feature visible within the tank are two steps 1.45 m wide that descend into the basin near its northeast corner, connecting the mosaic pavement to the east with the basin floor. The lower step is 0.23 m high, the upper 0.10 m high. The other intact features are built of concrete, mortar, and cut stone blocks: a central pier or base (fig. III.149), and a curved divider wall towards the east end of the basin (fig. III.139). The numerous column drums that now lie scattered around the basin probably constitute the debris of the structures that originally surrounded the Piscina (fig. III.148).

The pier, 1.68 m wide (N-S) and 2.70 m long (E-W), is located almost exactly at the centre of the basin. The distance between its north edge and the north margin of the basin is 8.4 m. The mortar forming this feature is similar to that of the Herodian concrete blocks in the harbour: it is fine-grained and hard and contains specks of a green volcanic material and small nodules of lime. The rounded upper surface of the pier stands almost exactly at present MSL: ca. 0.80 m above the rock-cut floor of the tank. The upper surface clearly has not preserved its original form, but the general coincidence with sea level may not be an accident. The present sea level is approximately the same as that in the time of Herod, and this pier of hydraulic concrete may have originally served as the foundation for a statue base built of stone blocks less resistant to the sea-water. It may also have served to support a walk-way built of wooden planks, associated with the maintenance of the fish-tank. A low margin of short, wide kurkar blocks set in mortar surrounds it, extending out 1.03 m to the north, 0.75 m to the east, 0.60 m to the south, and 0.80 m to the west (fig. III.149). It is possible, but can no longer be proven, that these mortared blocks originally extended upward to form a casing for the concrete core.

A low, wide, concrete partition wall curving markedly to the east separates the eastern third of the Piscina from the rest of the basin and its water channels (fig. III.139). It is approximately 1.35 m wide and 1.20 m high, the irregular but roughly level upper surface rising to within 0.05 m of the upper edges of the rock-cut basin wall at its north and south ends. The west face of the wall abuts the basin walls 10.5 m west of the east basin wall. The heavily eroded upper portion, built of large, irregular pieces of kurkar rubble set in a thick matrix of a sandy white mortar, was founded for at least part of its course on a curving base of well-cut kurkar blocks. These blocks are exposed where the upper part has fallen away, in particular for a 1.5 m stretch at its southern end and a gap of 4.0 m at the centre. This central gap has the appearance of an intentional opening, since it occurs at the centre of the partition wall and has a regular lower surface formed by the kurkar foundation blocks. Furthermore, it constitutes the only possible connection between the main body of water in the tank and the portion isolated to the east by the wall. Originally, however, the opening may have been much smaller and been enlarged subsequently by erosion: there is now no evidence for sluice-gate slots at either end. It is difficult to say whether this wall belongs to the original construction period of the Piscina, was added soon afterward, or is considerably later in date. Internal partition walls are certainly characteristic of Roman *piscinae* (see below), but if it were part of the original plan, one might expect it to have been cut in the bed-rock. This was not the case with the central pier, but this latter feature is less prominent and has the appearance of an afterthought added to allow some embellishment of the complex. The architect of the original phase would have known where his partition walls were to go from the start, if they formed part of his plan for the tank. Furthermore, the mortar used for the partition wall does not have the characteristic green colour and fine texture found in most Herodian concrete at Sebastos. It certainly is different in character than the mortar found in the central base.

One metre east of the east edge of the northwest sluice, a single course of finely-cut kurkar blocks 0.75 m long projects 2.0 m into the main basin, perpendicular to the north basin wall. It no longer is clear whether this feature is intentional and connected with the original phase of construction, or later. It serves no obvious function in its present form and is not balanced by similar walls in symmetrical positions elsewhere in the Piscina. The column drums that lie scattered or stand upright around the basin were not originally intended for this area. A cluster of upright columns midway between the two rock-cut channels superficially has the appearance of the remains of a *monopteros*, but the columns do not stand on bases, and their placement is in fact irregular (fig. III.148). The upper ends of several of the columns have been eroded into shapes that resemble weathered Corinthian capitals, reinforcing the false image of a structure.

At present there is a gap of 6.7 m at approximately the midpoint of the south wall of the central basin, where the bed-rock either was lacking at the time of construction or has since been eroded away by the action of the sea. This gap now is occupied by a heap of irregular kurkar rubble that the action of the waves has pushed northward to occupy the adjacent part of the basin (fig. III.141). Although the spill of rubble seems to be restricted to this area, there are no visible traces of mortar or cut blocks to suggest that this rubble constitutes the remains of a filler wall built across the gap at the original time of construction or later. It may simply have been generated by the decay of the bed-rock forming the wall at this point. Certainly the edge of the reef is deeply indented here, and great plates of kurkar lie tipped at various angles.

There are three rock-cut conduits or sluices designed to control the circulation of water in the main Piscina basin: two main channels with medial holding tanks running directly into the sea from the north and south walls of the basin 4.5 m from its west end, a smaller channel connecting the high ground SE of the Piscina with its south wall, just west of the interior divider, and a second small channel that guided water from the complicated series of cuttings west of the basin to the middle of the west basin wall (fig. III.136).

The southeast channel still is partially covered with sand and rubble, but its general course and design are clear. It cuts through the south wall of the basin 11.8 m west of the southeast corner, 0.8 m west of the south end of the curved partition wall. At this point it is 0.47 m wide and 0.60 m deep, with a smooth, sloping floor that terminates 0.80 m above the floor of the basin, more or less at present MSL (fig. III.142). There are two pairs of grooves for sluice-gates 0.40 m and 2.20 m south of the intersection with the basin wall. These grooves, like the channel itself, are damaged by erosion, but they seem to have been 0.10 m wide and deep, and to have been cut from the surface of the bed-rock to a point 0.20 m above the channel floor. For its first 3.8 m the channel is oriented more or less

perpendicular to the south basin wall, but it then makes an approximately 90 degree turn to the east and slopes upward gradually until its course is lost in the sand. Where it disappears in the fill, the bottom of the channel is 0.85 m above the basin floor. Although it was not possible to excavate the entire course of the channel, it is clear from visible cuttings in the bed-rock further to the east that, at a point 14 m east of the first bend, the channel made a second 90 degree turn and carried on to the south margin of the peninsula in a deep cutting excavated through the high (3.0 m) wall of bed-rock that survives at this point (III.143). Judging from the photographs in his report (1986: ill. 132), Netzer did not excavate this channel either, but his plan (1986: 151) shows the same arrangment. The width of the channel is approximately the same here as at its intersection with the basin (0.52 m), and its floor is approximately 1.10 m above the level of the basin floor, 0.30 m above MSL. The deep cutting opens out to the sea with smooth, spreading walls, funneling major waves into the water channel. The kurkar bed-rock here has been deeply undermined by the waves, and at one point 2.0 m in from the termination of the channel a smooth rounded hole (D 0.50 m) has been eroded through its floor from below. This opening now functions as a blowhole, and the often spectacular sucking and blowing effects caused by the waves seem to have misled Flinder (1985a: 174) into believing that the hole was cut here intentionally in order to extract water from the Piscina basin. There are several reasons the channel could not have served such a function, not least of all that it slopes downward from the hole to the basin. This conduit most likely was designed to assist circulation of water in the rear of the basin by funneling into it water from the waves that break very hard against this point of the promontory. Netzer assumes that it carried fresh water into the basin from an aqueduct to the east (see discussion below).

The main entrances and exits for the water in the basin, however, were the two channels cut down into the bed-rock well below sea level near the west end of the basin, providing direct connections between the basin and the sea to the north and south of the peninsula (figs. III.144-48). The northwest channel is 10.0 m long from its intersection with the basin to the rough, untrimmed edge of the visible kurkar bed-rock, the southwest is 18.0 m. The west edge of each channel is 4.5 m east of the west basin wall, and their arrangement appears symmetrical to the eye. The northwest sluice, however, is slightly wider than the southwest, being 1.15 m as opposed to 1.0 m. Although the surface of the rock has only been roughly trimmed, both channels are 1.20 m deep, their smooth, roughly level floors approximately 0.80 m below present MSL. Seaward of their intersections with the basin, both channels have suffered from erosion and fracturing of the bed-rock and are partly encumbered with fallen kurkar blocks and rubble. The debris in the northwest channel has been frozen in position by the formation of beach-rock around it. Nevertheless, the general arrangement can be determined.

Each channel was interrupted 3.75 m seaward from the basin by a large rectangular tank (2.0 x 5.7 m) positioned symmetrically across the long axis of the channels. The blocking walls built of long kurkar blocks that are still in position in the northern tank, in line with the channel walls, apparently were designed to separate the east and west terminations of this intermediate tank from the channel proper (figs. III.144-45). Only traces of such walls remain inside the tank in the

southern channel (figs. III.146-47), probably because of the greater exposure to wave action and the absence of beach-rock. It seems unlikely that these blocking walls were part of the original design, since they seem to negate the function of the tanks. They may have something to do with the removal of sand from the incoming water. Seaward of the tanks the long axis of each channel shifts 0.25 m to the west. There may have been a second rock-cut tank approximately 4.0 m square in the southwest channel, extending east of the channel wall, 6.0 m south of the first tank, but there has been so much damage at this point through erosion and fracturing that it is difficult to be certain. Although both channels are obstructed with debris, they seem to have consistently horizontal floors along their entire length, level with the floor of the Piscina.

As a result of the erosion or collapse of the channel walls, it is now difficult to determine the location of all the sluice-gates that once interrupted them. Because of its location, sheltered from the prevailing southwest seas, the northernwest channel is better preserved. Here, however, only three pairs of sluice-gate slots can be seen: all of them seaward of the intermediate tank (figs. III.144-45). They are 0.20 m wide and disappear in the erosion notch at present sea level or in the concreted debris of the channel. Unfortunately, the condition of the channel walls between the central basin and the intermediate basin is too degraded to have preserved traces of sluice-gate slots. Traces of what may have been two pairs of such slots can, however, be seen along the course of the southwest channel, between its intermediate tank and intersection with the central basin. No clear traces remain seaward of the tank. It seems likely that the intermediate tank in each of the main channels was bracketed by sluice-gates.

The cuttings and structural remains in the large levelled area west of the main Piscina basin are very complicated and disturbed (figs. III.136, 151). In summary, there are three long, narrow, and deep rock-cut tanks connected to each other at their eastern ends by a shallow channel that leads in turn to the west end of the central basin. The three tanks or reservoirs, oriented in an E-W direction, are parallel, more or less the same size, and terminate 14 m west of the main Piscina basin. The northern tank is 12.10 x 1.85 m, the central tank 12.95 x 1.49 m, and the southern tank 12.50 x 1.85 m. All three tanks are to a greater or lesser degree filled with beach-rock that has solidified around tumbled kurkar blocks and rubble and occasionally incorporates fragments of pottery (all of which appear to be undifferentiated amphora body sherds). The southern tank (fig. III.152), which is the least encumbered, is presently 1.30 m deep along its northern edge, holding water to a depth of 1.15 m. If this is in fact the original floor, it is at approximately the same level as the floor of the main Piscina basin.

Although the situation at the eastern end of the three tanks is confused as a result of the deposition of beach-rock and the cutting of bedding trenches for courses of kurkar blocks, it can be seen that a shallow N-S rock-cut channel connected all three (fig. III.153). The east end of the northern tank narrows at one point to take on a cruciform shape. A long, shallow conduit (W ca. 0.35 m, ca. 0.40 m deep) connects the centre of this transverse channel with the centre of the west wall of the main Piscina basin, 14 m to the east. Some parts of this conduit have been quarried away and others filled intentionally with kurkar blocks, but it seems to have been interrupted at its midpoint by a shallow tank ca. 2.0 m square.

There are two pairs of sluice-gate slots 0.05 m wide between the west end of the conduit and this central tank, and two further pairs in the last 1.5 m before it enters the main Piscina basin. At its intersection with the west Piscina wall, the floor of the channel is 0.86 m above the basin floor, more or less at present MSL. A branch of the same dimensions as the main channel leaves it 1.5 m west of the basin wall and curves around to the south to enter the basin 3.0 m south of the other channel (fig. III.150). There is another pair of sluice-gate slots in this subsidiary channel, just after its deviation from the main channel.

West of the three reservoirs, a shallow N-S cutting 2.0 m wide runs for 18 m south from a point more or less even with the centre line of the central reservoir. It does not appear to be connected with any of the reservoirs and may in fact have served as the bedding trench for a masonry wall. A number of short E-W and N-S stretches of such walls still survive in this area, particularly the section SW of the main Piscina basin. These foundation trenches and the walls they supported bear no obvious relation to the function of the Piscina, and for the most part they seem to ignore or interfere with its channels, conduits, and reservoirs. They also bear no relation in materials or structure to what is probably a fragment of the Byzantine city wall, the tall, irregular mass of mortared rubble along the south edge of the promontory (fig. III.141). Another feature apparently unrelated to the Piscina is a small tank (3 x 3 m, 1.9 m deep) cut in the rock at the very northwest corner of the peninsula. A very shallow, irregular channel extends for 4.0 m to the south, but the present profile of the bed-rock makes it unlikely that it ever connected with the rest of the complex. This tank resembles the simple, shallow rock-cut tanks that can be found all along the coast of the Levant, including several just to the south of Sebastos in the kurkar reefs in front of Kibbutz Sedot Yam (Section IV.D). Since they do not have any mechanism for controlling the flow of seawater, they may have served as temporary holding tanks for live fish, or for some industrial process such as the production of purple dye or the finishing of cloth.

The westernmost man-made feature of the Piscina promontory is a long, shallow cutting -- perhaps again a bedding trench for a now-vanished wall -- that forms a gentle westward arc between the south end of the bedding trench west of the three reservoirs and the north side of the peninsula (fig. III.154). The northern end of this feature has been lost to erosion. Seaward of this cutting the kurkar bed-rock is fractured and pitted with potholes and terminates in an irregular fringe of *Vermetus* colonies before falling off steeply to the sandy sea-bottom.

Preliminary Analysis. Netzer, who excavated the fill to the east of the Piscina, proposes that the structures found there, along with the central tank, were all part of the palace of Herod described by Josephus (*AJ* 15.331) (Levine & Netzer 1986: 176-82). East of the Piscina he found a large, mosaic-paved chamber oriented around its central axis, flanked on either side by two symmetrically disposed chambers. From an examination of the traces of cuttings and walls around the central Piscina tank, he reconstructs a paved court at an elevation of 1.4 m above MSL, a colonnade of 18 by 11 columns surrounding the tank, and possibly flower boxes placed above the series of rectangular cuttings between the columns. There was a small, shallow pool (1.3 m on a side) at the open, front edge of the central chamber on the east, on the central line of the Piscina tank, but, strangely, Netzer makes no mention of the pier at the centre of the pool. Because of the presence of traces of grey ash-and-lime plaster on the wall of the Piscina tank at its northeast corner (not observed by the CAHEP survey), Netzer believes that the pool was designed to be filled with fresh water for bathing. According to his interpretation, the water would have been supplied by an aqueduct though the conduit in the southeast corner of the complex. He regards the steps, curved wall, and north and south channels as additions of the late sixth or early seventh century.

The suggestion that the Piscina complex was part of the palace of Herod is quite reasonable, and in my opinion correct. It does, however, seem much more likely that the pool itself was from the start intended to be a *piscina* in the Roman sense of the word: a salt-water tank intended for the raising or holding of commercially valuable or exotic varieties of fish, both for ostentation and for consumption in the palace. The north and south channels are not so different from the rest of the structure that they must be later, and there is no reason to assume that the southeast conduit must have carried fresh water. In any case, it is difficult to imagine why a swimming pool would have been limited to a water depth of less than 1 m. The presence of a plaster lining over the porous kurkar bed-rock can have been intended as much for appearance as for segregation of salt and fresh water, and it may have been necessary to keep the porous kurkar tank filled during times of abnormally low tides. In any case, the stucco lining would have helped the cleaning and maintenance of a salt-water tank and allowed better control of circulation by channeling all intake and outflow through the north and south channels. Finally, fish tanks of this type in splendid sea-side palaces are very much a part of the Late Republican tradition of *villae maritimae* in Italy. They are alluded to by numerous Roman authors and described in some detail by Varro (*R* 3.17.2-9; for collections of ancient sources, see Lafaye 1916, Schneider 1950, Ooteghem 1968). The owners who were so devoted to them and lavished so much money on their preparation and maintenance came to be called *piscinarii*, and were the subject of innumerable jibes and anecdotes (see Cicero, *Att* 1.19.6, 20.3; and Varro *loc.cit.*). The design and function of the Piscina, and its place in Italian and eastern Mediterranean villa architecture will be discussed in Volume IV.

[J.P.O.]

III.O. Area Q: Promontory and South Side of Intermediate Basin.

Area Q was the term used by CAHEP to designate the western half of the promontory that served in antiquity as the base of the Herodian Southern Breakwater, just west of the site of the Crusader Harbour Citadel (Section III.L) (figs. III.1, 120).

At present, the promontory protrudes from the general line of the shore for over 200 m toward the WNW. It is about 30 m wide on the average. Later structures and the pavements which now cover most of its surface disguise the original bed-rock and make it difficult to determine whether it continues along the entire length of the promontory. At this moment, the bed-rock is exposed only as far east as the west side of the tumbling remains of the central structure of the Crusader Citadel (fig. III.120), some 90 m east of the present tip. At this point some

rocky outcrops project well above the modern pavement. Most of the bed-rock was removed by the Crusaders, then by Israelis in 1949-1961.

Clearing in 1987 west of the Citadel exposed the highest leveled surface of the bed-rock at about 1.6 m above MSL along most of the northern edge of the modern breakwater, between the Citadel and the tip of the promontory. This surface is set back 3-4 m from the present northern edge of the promontory, where it is outlined by Crusader and modern stone walls (fig. III.158). To the south, there is now a wide platform of concrete laid in 1951 that covers all earlier features. The plan of this area made by the surveyors of the British Palestine Exploration Fund in 1872 shows a configuration much like that of today, with presumed bed-rock covered by Crusader floors and sea-walls (see Conder & Kitchener 1882: 16; Schumacher 1888: 132; Schiler 1981, cover fig., figs. on pp. 3, 47, 55, 57, 71). It is possible that the base of the promontory was formed not by bed-rock but by a kind of *tombolo*. Recent trenches that were made by the Caesarea Development Co. along the eastern half of the promontory to lay drains and electric cables did not reach bed-rock above present MSL. CAHEP's excavation in 1982 showed that the Crusader moat separating the harbour Citadel from the rest of the town was not cut in bed-rock -- at least as far down as present MSL (Oleson et al. 1984: 302-4; Section III.L).

Although extensive Crusader and modern building activities have not left much of the earlier man-made or even natural features, two locations on the westernmost part of the promontory seem still to bear some traces of older structures. Both were observed and surveyed during the CMS 1976 session (see Section II.B.3; Raban et al. 1976: 30-31, 34-35). During the 1982 season the architects of CAHEP carried out a systematic survey of the promontory and prepared a detailed map and series of plans of all the Crusader and other early structures (fig. III.122). In the course of that survey the rock-cut flushing channel was redrawn and studied. The western side of this channel has been partially destroyed, probably during preparation for the construction of the new mole in 1949. During that activity, a modern stone wall was built across its northern section and cement paving laid over the earlier features beyond it.

At present, only the southern 4 m of the channel are visible (figs. III.155-56). It has a width of about 1 m and was cut down into a bed-rock projection, the upper surface of which stands at 3.2 m above MSL. The present floor of the channel lies just below the abrasive shelf, but considering the extensive biogenic incrustation on such a shelf, it is hard to determine precisely the original elevation. There are pairs of vertical grooves cut into the sides of the channel. The first pair, which occurs about 2 m north of its seaward opening, is preserved on both sides; the second is farther along the eastern side 1.4 m north (the west side is missing). All the grooves are preserved to a height just short of 2 m above the base of the channel, and, although partially filled in by marine incrustation at their base, they seem to continue down to the floor of the channel at about 0.05 m below present MSL (fig. III.157). These grooves were undoubtedly designed for the insertion of sluice-gates designed to control the flow of water into the channel. Such a device is well known all over the Mediterranean from at least the early Roman period, and it was very common whenever a controlled inflow was needed for the circulation of water in *piscinae* (see Schmiedt 1972) or harbour installations (Blackman 1973:

177; 1982: 199-202; Poidebard & Lauffray 1951: 31-32). In order to determine which of these two functions this channel might have been built for, the waterline along the other side of the promontory was examined for an opening into the harbour basin. Unfortunately, this side is now covered by late structures, including the continuous base of a Crusader sea-wall. In one place, however, there is a gap in the platform underlying this wall that seems more or less in line with the general course of the channel.

If in fact there existed a channel with an overall length of about 40 m across the stem of the breakwater, it would most likely have been fashioned as a flushing device for keeping the harbour free of silt. The other known alternative -- that of a *piscina* -- is less likely for several reasons. First, if such a *piscina* had been built while the Herodian harbour was still even partially functioning, its siting would have hampered the movement of goods along the Inner Quay. Second, for a later stage of the Roman and Byzantine era, there is a large *piscina* elsewhere, on the next promontory to the south (see Section III.N). Finally, no rock-cut tank is indicated on the promontory in early illustrations, and nothing was found during the 1987 excavations in Area M_4. Consequently, the most likely function of this cross channel is for flushing the harbour of wave-carried sand and silt by trapping enough surplus water within it to permit a continuously outflowing current through its entrance. In this arrangement, the sluice-gates would have to have been operated to keep out wave-carried sand, yet allow a continuous flow even during calm sea conditions at low tide. For such an operation the base of the channel should have been just above the low-tide level. Following this logic, the sea at the time the channel was made had to be about 0.10-0.15 m above present MSL. Such a figure fits the elevation of the faunal remains and the abrasive notch on the face of the quay in Area I_1 (see Section III.H.1).

This circumstantial evidence advocates giving the channel the same date as the Inner Quay at its later phase of use. Since this channel alone would have been far from sufficient to supply the quantities of water needed to keep such a vast basin free of silt, more channels must have existed. The siting of the surviving channel is suitable for the capture of silt-free waves. Since it faces a part of the coast which is on the lee of the line of breakers during stormy seas and with a shallow rocky bottom, the waves reaching the channel inlet would already have dropped most of their burden of solid particles. For that reason other channels might have been located on this part of the Southern Breakwater.

One such channel might have existed at the southwest corner of the main building of the Crusader Citadel, just east of the high rocky outcrop. There a "tunnel" was found during a survey made by the Israeli Navy in 1949, leading from the sea underneath the Crusader walls. A third flushing channel might have pre-dated the Crusader moat on the eastern side of the Citadel. These proposed additional channels might have been even wider than the one at the western tip of the promontory. Being farther to the lee of the breakers, it would have been easier to control their intake and to keep sand from entering with the water.

The northern edge of the promontory retains better-preserved features, the most prominent of which is a segment of abrasive shelf with a straight edge that runs for about 20 m along the base of the modern paved road, but 2 m farther

north (fig. III.158). The regular shape of this shelf indicates its man-made origin, a character that becomes apparent when viewing its surface carefully. Under the coating of marine incrustations the lines separating individual ashlar blocks of kurkar are clearly visible (fig. III.159). These are usually long, slim headers (1.3-1.5 x 0.4-0.5 x 0.55-0.60 m). Toward the eastern side of this platform the headers become shorter, and a second course is visible behind them. On top of this second course are remnants of a wall which faced north, toward the harbour Basin.

This wall was built of reused Roman columns interlaid with small ashlar blocks bound in heavy mortar. The mortar seems to cover the lee of the platform beneath, and it can be distinguished from it and from the coating of marine incrustation by the small pieces of rubble incorporated into it. About 5 m from the eastern end of the platform, the capping wall seems to be held up by an outcropping of bed-rock which was leveled in antiquity to about 1.2 m above the present MSL. On top of the remnants of this wall there is modern fill, a retaining wall, and the cement pavement of the quay that was built in 1961. The construction technique of the wall which is above the abrasive platform and below the modern paving matches the north wall of the Crusader Citadel. The combination of reused Roman columns alternating with ashlar blocks is characteristic of all the basement courses of walls and towers all over the complex of the Crusader Citadel (e.g. fig. III.125). This wall seems to have been laid in a shallow foundation trench that was quarried or prepared by clearing some of the slabs off the earlier, underlying platform.

During the 1976 survey, the CMS surveyors made an underwater probe at the base of this platform, 12 m east of its western end (Raban et al. 1976: 34-35). During the CMS workshop in 1980, a new trench was dug in the sea-bottom at the same site with a dredge. This excavation exposed the features at the base of the platform down to a depth of 2.3 m below MSL (fig. III.160). Three courses of headers were observed. The top one constitutes the platform's present surface and looks as if some 0.05-0.10 m of its original height has been worn off over the centuries. The second one is less worn on its vertical face, which now protrudes 0.2-0.3 m beyond the top one. This course is just over 0.6 m high. The third course was found to be exceedingly worn at its base, leaving a recess about 1.3 m deep. This recess was filled with wave-carried pebbles, small pieces of rubble, sand, badly-worn potsherds, and some fragments of modern bottles. The vertical surface at the deep end of the hollow seemed to the surveyors to be composed of concrete rather than kurkar.

During the 1983 CAHEP season, the platform in Area Q was studied again in an attempt to find out how this platform was built, and whether it might be considered part of the Inner Quay of the Southern Breakwater of the Herodian harbour.

The site selected for the trial trench was next to the west end of the platform, where the present water depth suggested that it would be easier to expose the foundation of the structure. It soon became apparent that the sea-bottom was covered by a heavy deposition of gravel that had been dumped when the new quay was built in 1954. The excavation was slowed by the need to remove the gravel manually a sufficient distance from the trench. In addition, the rough sea stirred

up a heavy surge and reduced visibility almost to zero, even at this sheltered point.

The trench reached a maximum depth of 3.8 m below MSL without exposing the actual base of the structure (fig. III.160). Below the paving course of the platform a second one, made of large ashlar header blocks, was exposed. Beneath this course, at a depth of 1.3 m of water, was the upper surface of a third one. This lower course was found to be both exceedingly worn and cemented by marine incrustation. Following its concave face, the excavation entered the same type of overhanging hollow as in the 1980 probe. Yet this hollow seemed to be higher, as if most of the bottom course of headers was missing. Two blocks that were found in the fill at a greater depth might have fallen from that course.

The inner face of the recess is composed of a substance that resembles the concrete of which the Towers in Areas G and K are made (Sections III.F, J). The sediments below the modern dump of gravel consisted of clean sand with some wave-carried ancient and modern artifacts and sea-shells, down to a depth of 3.2 m below MSL. Still deeper, the recessed hollow was found to be filled with small pieces of rubble, dark grey sand mixed with clay, and various particles of volcanic ash and tufa, possibly the decomposed remains of a concrete block. At the bottom of the trench, the recess became shallower, as if below that depth the concrete block is less worn and better preserved. Although the data from both the 1980 and 1983 trenches correspond rather well, it is still not clear if these were the same three courses of headers in both sites, or what is the exact elevation of the top of the concrete block, or where the bed-rock begins, or what the depth is of the sea-floor at the time the structure was built.

There are several other issues to which the data so far extracted from Area Q have contributed. The rectangular abrasive platform along the western 20 m of the north edge of the promontory is part of a man-made marine structure that pre-dates the Crusader period. This structure might be a remnant of the Inner Quay of the Herodian Southern Breakwater. If this is the case, it explains the fact that its continuation could not be traced farther west, in Area N (Section III.M). As far as can be learned from the Area Q data, this quay was built of two to three ashlar headers topping a substructure made of concrete blocks. Preservation of these topping ashlars by the Crusaders for use as a base for their sea-wall partially preserved the Herodian foundation beneath them, while in Area N robbing of these topping blocks may have caused the loss of the rest of the wall.

Although the bed-rock is visible only at one point next to the platform, it is possible that it served as the foundation for much of this section of the Southern Breakwater. The man-made features would have functioned only as additional fill to build an even platform with the breadth and elevation necessary to match the demands of the general layout of the Southern Breakwater. This eastern base built on bed-rock would have confined the Intermediate Basin of the harbour, and its continuation beyond the alleged additional pier (Area F) would have confined the external, Main Harbour Basin. If this is a correct reconstruction, some architectural and technical differences might be anticipated in regard to the construction of the two units.

Although it is possible that the artificial platform in Area Q was added in some later stage, after the completion of the Herodian harbour, and although there are no means for dating it directly, there are no other reasonable periods for its construction. It is highly improbable that volcanic ash and tufa were imported for use in concrete in the post-Herodian period. Both the delineation of the platform's edge and its building style fit in with Herodian structures elsewhere within the harbour complex.

It is obvious that the present surface of the platform is not the original one. Since wave action and later salvage efforts contributed to reduce the original platform more or less to MSL, it is no wonder that no mooring stones or access staircases were found along the preserved segment of the quay. A staircase was observed along this line about 30 m farther to the east before the main structure of the Harbour Citadel was blown up at the turn of our century, but it is now completely lost (Schumacher 1888: 136).

Next to the flushing channel, on the east side of the rocky outcrop into which it was cut, there is a remnant of an ashlar course of headers (fig. III.161). These blocks are 12 m east of the channel, parallel to the course of the platform on the other side of the promontory. It consists at present of four closely-laid blocks, about 2.0 x 0.5 x 0.5 m. Although these blocks might be remnants of a later structure, like the Byzantine pavement made of reused Herodian slabs at the nearby area M_4 (see Raban & Stieglitz 1988), they might also be the *in situ* remains of the external paving of the Herodian Southern Breakwater. Their general alignment with the inlet of the flushing channel is an additional fact in favour of such an assumption.

[A.R.]

III.P. Area R: Rubble Projection Inside Harbour Entrance.

The site of the trial probe marked as Area R was selected and excavated during the 1984 season. It is located about 30 m south of H_1 (on the south side of the Northern Breakwater, next to its western tip), and about 50 m SSE of Area D_2 in the harbour Entrance Channel (Section III.C.2) (fig. III.1). The probe was made along the steep slope of rubble that creates a dog-leg projection on the southeast side of the tip of the Southern Breakwater, inside the harbour Entrance Channel (cf. fig. I.13). Since this projection gives the inner part of the Entrance Channel a funnel shape, it was considered possibly to be an intentional feature designed to speed up the outflowing current for more flushing of the narrow part of the entrance (see Raban 1988: 192-96). The probe was made in order to determine the character of the spill, to look for more substantial structures in it, and to expose its base and the stratigraphy below it. The location was selected on the north slope of the spill, next to its eastern tip (fig. III.163), just east of m 31 of Survey Line no. 16 (Section IV.C). The top of the rubble spill is at a depth of 5.4 m below MSL and slopes down to 8.5 m at the sandy bottom of the Entrance Channel, about 10 m farther NNE.

The probe was made with a 5-inch airlift, creating a semicircular hollow into and below the slope of the spill, with a radius of about 4 m. At the centre of this

area, on the sandy floor, a single block of stone 2.2 x 1.1 x 1.2 m was found, extensively eroded by the sea and not associated with any structures.

The spill was composed of two layers: the upper one, down to 7.1-7.3 m below MSL, is composed of small to medium sized flattened pieces of rubble (D 0.3 m to 0.6 m). Some badly-eroded potsherds of Byzantine date were found incorporated within this rubble layer. The lower layer contained much larger and more angular chunks of rubble up to 1 m in length. No potsherds were traced in this layer, which was exposed to its base at a depth of 9.2 m.

Below the rubble at that level, the fill was composed of a mixed layer 0.5 m thick of small rubble, large quantities of shells, and sand (fig. III.162). Within this layer there were many amphora fragments of the second to third centuries and other artifacts such as lead weights, pieces of lead sheathing, and ballast stones. This layer was underlaid by poorly-sorted sand with shells but lacking any artifacts, all the way to the bottom of the probe at approximately 10.5 m below MSL.

No clay layer was detected, and the mixed sand at a depth greater than the base of the rubble spill indicates the former presence of strong currents. The pottery and other artifacts found below the base of the spill might have been dumped there either before the rubble feature developed, or during a period when the submarine topography was such as to initiate a rapid undertrenching current. If the artifacts were deposited before the rubble and not inserted by erosive currents, this feature was laid on the sea-floor long after the completion of the Herodian harbour, and very probably only after it went out of use. In that case, one might suggest that the spill belongs to Anastasius' attempt to restore the harbour around A.D. 500 (Oleson et al. 1984: 294, n. 20). The fact that the base of the rubble spill in both Areas R and Area D (Section III.C.2) is at the same depth might back the alternative explanation, that the pottery was carried in by the sea.

[A.R.]

III.Q. Area S: Sea-Wall to Northeast of Intermediate Basin.

The excavation area along the northeast shore of the Intermediate Basin, at the north edge of the present public beach, was designated Area S (figs. I.37, III.1, 109-110, 164-66). During CMS research for the IEC at this point in 1975, an ashlar wall preserved to a height of 1.2 m above MSL was observed running along the water-line in an E-W direction (Raban et al. 1976: 35, figs. 38-41). This wall had been noticed before, and Bloch claimed that the presence of bore holes of *Lithophagae* on its upper surface might indicate that it had been covered by a MSL at least 1.3 m higher than at present (Bloch 1965: 15-16) (fig. III.171). The wall was partly cleared during 1976 and was found to have been reused in the Crusader period, when its western end was rebuilt with the use of iron clamps and an additional stretch was added to it at a somewhat different orientation, on a level indicating a sea level lower than at present (fig. III.170).

This wall was studied again during the 1986 CAHEP season as Wall W 1, and an extensive area behind it was excavated in an attempt to determine its original date of construction and the character of the structures that were adjacent to it

then and at later phases. Although this campaign strictly falls outside the period with which this volume is concerned, a summary of the results is presented here because of their importance for our understanding of the harbour. The area that was studied is composed of two adjacent units: an eastern one along both sides of the wall mentioned above, and a northwest unit composed of two large chambers fronting the water to the south (fig. III.165). As noted above in Section II.K, for the purpose of the 1986-87 excavations, former CAHEP Area L was re-named Area S_1. The area to the south, discussed in this section, was subsequently referred to as Area S_2.

The wall W 1 in Area S_2 has survived to a total length of well over 20 m, but it was exposed along its external south face for only its western 18.9 m (figs. III.170, 172). In its present form this wall shows many phases of reconstruction. In addition to the latest, Crusader phase, there is evidence that it was part of a habitation level in the Early Islamic period. At that stage two cisterns were inserted into it -- one just inside its western part, and the second 15 m east of its western end, on its edge. The blocks of the walls were removed from a 1.05 m stretch of the wall at that point, down to a level of 0.46 m above MSL. This recess was extended behind the south face of the wall for an additional 0.6 m, and the fill was retained by reused blocks in order to create a rectangular cistern (1.05 x 1.72 m) descending from ground level at 1.58 m above MSL. The bottom of the cistern might have been located at the interface between sea-water and the overlying fresh water, implying a sea level about 0.5 m higher than at present. A similar sea level can be deduced from the other cistern and from at least half a dozen more that were excavated in the area. In that Early Islamic phase the entire area along the lee side of the wall was leveled to about 1.6-1.5 m above MSL, either by additional paving slabs (as at the eastern segment) or by additional fill of small rubble and large quantities of potsherds. These sherds are all of Middle and Late Byzantine types.

An even higher sea level was attested for the latest Byzantine phase. Removal of Early Islamic fill from a chamber on the north side of the western part of W 1 (locus 219) exposed a floor of flattened pebbles at a level 0.59 m above MSL (locus 224). This floor extended along the north face of W 1 and under the wall (W 17) that forms the west side of the chamber. On the floor and the north face of W 1 there was a substantial coating of marine incrustation, to a height of 0.72 m above MSL. This coating was absent on the eastern face of W 17, indicating that this wall was added in a later period, when this pavement was no longer flooded by the sea. The northern segment of W 17 was then removed in the northwest corner of locus 219, and a pit was cleared there (locus 226), all the way to the eastern face of W 12. Although no floor was apparent in that probe, the exposed face of W 12 turned out to be coated with the same marine fauna as W 1.

Two probes were made along the south face of W 1. The eastern one followed the hollow of the Early Arab cistern and continued down below it (fig. III.173). Altogether, five courses were exposed (the cistern went down almost to the bottom of the third). The two lower courses were found to be bonded by L-shaped blocks. At about the middle of the lower course, at 0.43 m below MSL, there was a horizontal line of *Ostrea* that might indicate an ancient sea level. A similar line was found at 0.42 m below MSL in the western probe 10 m away. The western probe went down along the north face of W 1 to a depth of 2.0 m below MSL (locus 225). Excavation in both probes was made possible only by constant pumping.

The south side of W 1 in locus 225 was found to be composed of seven courses of blocks. The upper course seems to have been relaid by the Crusaders, judging by the unmatched grooves for dovetail clamps and the use of iron C-clamps (fig. III.170). A line of *Vermetus* incrustation along the lower part of the second course, at 0.65 m above MSL, resembles the marine fauna coating the other side of the wall at that point (locus 224) and proves that it was there by the Byzantine era. The fourth and fifth courses are below MSL and are incorporated in a most uneven manner, much like those in the eastern probe. Two additional courses (the sixth and the seventh) were found to be made of ashlars almost 0.7 m high. A horizontal line of *Ostrea* incrustation was found at about half the height of the bottom course, at 1.77 m below MSL. This course was laid on a layer of fine compact grey clay. The top of the clay is at 1.87 m below MSL and there is bed-rock some 0.4-0.6 m underneath (reached with an air-jet probe). The potsherds that were recovered from the top of the clay were from the first century A.C.

Wall W 1 seems to have been built at an early stage in the history of Caesarea, yet there are no clear indications for the date of this structure. On the one hand, parallels with other early structures in the Inner Basin, such as the Round Tower (Section III.R.1) or the nearby platform W 220 (see below) might suggest a pre-Herodian date. On the other hand, the uneven quality of the building is typical of post-Herodian structures, in contrast to Herodian structures such as the Pier and Quay in Area L, nearby (Section III.K). Nevertheless, the orientation of W 1 is the same as that of the pier at Area L and its adjacent quay, and not the same as that of the Late Roman structures, maintained throughout the Byzantine and Early Arab periods.

Of the structures on the western part of Area S, the earliest is undoubtedly W 220 (figs. III.166, 169). This is not actually a wall, but a platform or paved road leading SSW toward the water of the Inner Basin. This pavement went through many stages of reuse and partial dismantling. In its original form it was probably a line of long, narrow ashlar blocks 1.6 m wide, inserted into the surface of the flattened bed-rock, with its upper surface 0.23-0.37 m above MSL (the higher elevation on the north side). This course was bordered on both sides by long, narrow stretchers of uniform measurements: 1.6 x 0.5 x 0.27-0.32 m (figs. III.166, 169). This pavement runs through the centre of a later chamber, 5.2 m wide (E-W) and 11.1 m long (N-S). The last 3 m of the pavement toward the south part of the chamber seem to have been rebuilt at some later stage, in order to be adjusted to a passage through the south wall, which is offset about 0.5 m east of the original course of the pavement. The passage through the south wall is 1.5 m wide and leads to the water through two descending stairs. The wall itself (W 13) was originally 1.8 m wide, but at a later phase an additional course of blocks was added on its western, seaward side, making a foundation for a new wall 2.7 m wide. The original pavement can be seen under the rubble fill of the later stage, just below MSL.

While clearing the northern, better-preserved part of the pavement, some Late Hellenistic potsherds were recovered. Although the chamber retains no stra-

tigraphy of any significance, since it is washed by the sea during stormy weather, the presence of pre-Herodian pottery within it hints that the earliest architectural remains in this area may also related to this early date.

The chamber within which this early pavement lies is one of three parallel spaces of more or less similar width that, according to Levine and Netzer, are of the same date as the rectangular structure in Area L, while the earlier cross-wall along the water-line is of the same date as the Herodian pier there (Levine & Netzer 1986: 60-63, W 150). The side walls between these three chambers are built of ashlar blocks in an uneven order of headers and stretchers. The westernmost (Levine & Netzer 1986: 60, plan 14, W 160) is poorly preserved and mostly covered by a later Crusader fortification wall. The next one to the east, W 10 (Levine & Netzer 1986, W 154) is 1.35 m wide and has been preserved for seven courses from its base at 0.61 above MSL to 3.98 m. The two upper courses seem to belong to a later stage (fig. III.167). On top of the wall there is a narrower one (W 0.6 m) which was dated by Levine and Netzer to their Stratum 4, the Final Byzantine period (1986: 60-65, plan 14, ill. 87). Similar features exist at the next wall to the east, on the other side of the early pavement. That wall (W 11) is only 1.75 m wide and has survived to a height of eight courses, with its top at 4.45 m above MSL (fig. III.168). The eastern face of this wall is incorporated into the west face of W 12, adjacent to it on the east, by a coating of small rubble and a grey cement, once faced with thin stone slabs. This space was divided in the Early Islamic period into six adjacent chambers or bins by partition walls of cemented rubble and faced by paving slabs. Most of these slabs were removed in antiquity, and at present only the base courses survive, to a height of about 0.18 m above the mosaic floors of the bins (fig. III.165).

This bin complex was partly excavated by Levine and Netzer (1986: 61, ill. 90-91) who dated it to the Early Arab period. The bins were cleared completely during CAHEP's 1986 season. They resembled four other groups of rectangular bins with mosaic floors that were exposed by Negev at the foot of the Herodian Temple Podium east of the Inner Basin (Negev 1967: 67-68). The semi-circular recesses in the mosaic floors of these bins indicate that liquid was stored in them, probably olive oil, to judge from the black, greasy substance which impregnated the cement under the mosaic floors.

Summary. In summing up the main features of Area S, one may argue the following chronological order:

(1) The pavement in the central chamber in the northwest part of the area (locus 220), in its original form, might be of pre-Herodian date. In any case, its orientation does not fit those of Herodian structures in the area, or in the adjacent Area L. The original function of this pavement is not clear and cannot be defined without further excavations toward the north.

(2) The main sea-wall, W 1, was laid in the water, perhaps in order to serve as a retaining wall or a base for a vertical quay wall that continued farther west, perhaps far enough to make a right angle with the southernmost tip of the quay in Area L. If the original stage of this wall can be assigned a pre-Herodian date, it provides a reasonable function for the pavement W 220 which might have led to it. The main importance of W 1 is in the abundant data it provides to document various sea levels. These can be securely dated to the Roman, Byzantine, Early Arab,

and Crusader periods. These sea levels were at about the present MSL in the first century A.C., 0.6-0.7 m higher during the later Byzantine period, about 0.4 m higher in the ninth to tenth centuries, and at least 0.4 m lower in the mid-thirteenth century.

(3) The three rectangular chambers NW of W 1 are clearly post-Herodian in date and probably even post-date the original phase of the cross-wall and the passage to the water at W 13. It seems possible there was a series of storehouses here, *horrea* of the later Roman era (see Levine & Netzer 1986: 65), but later uses of these structural components have removed any artifacts that could document such a proposal.

(4) During the Early Arab period much of the area was leveled at about 1.5 m above MSL, at a working surface provided with many freshwater cisterns. One chamber was built up to a height of over 4.5 m above MSL, containing storage bins or rectangular silos for large quantities of olive oil or some other liquid commodity for export.

(5) During the Crusader period, the course of the fortification line along the water-front covered the westernmost part of Area S and was extended outside the former W 13 to the south. At that time the sea must have been farther away, as can be deduced from the western addition to W 1 and the now submerged wall that stems from this addition, leading south across the bay (Area T_2; Section III.R.2).

[A.R.]

III.R. Area T: Walls and Towers in Intermediate Basin.

III.R.1. Area T_1: Round Tower. The Round Tower that was discovered and studied during the 1978 CMS workshop (Section II.B.4; Raban & Linder 1978: 243) was re-studied during the CAHEP 1984 season (Raban 1985c: 163-65). The second survey was an attempt to collect additional data for the date of the tower's construction, the architectural design of its base, and its interrelationship with the promontory to the south.

The tower is a round structure formed by a single row of radial external blocks, which at present lies some 10-20 m west of the modern bathing beach (figs. III.1, 174). This area was designated Area T_1. The south edge of the tower is 32 m north of the inner edge of the base of the promontory. At present, the tower is often at least partly covered by sand, except for its west and northwest quarter, which is adjacent to a pile of blocks and large pieces of rubble. The 60 slim headers that define its circumference are generally uniform in size: 1.6-2.0 x 0.4-0.5 x 0.5-0.6 m (figs. III.174, 177). The highest surviving course was extensively abraded by the wave-carried sand and pebbles, and some of its blocks had lost more than half their original height. On the tower's north to northeastern section, the course of headers is replaced by what seems to be a connecting wall built of slightly smaller ashlars. It had a probable original width of 4.6 m. Only its western face can now be discerned, built of alternating headers and stretchers. This order continues for a few metres along the circumference of the tower at the lee side of the wall. Inside the tower, there is another concentric course of slim blocks (0.8-1.3 x 0.35-0.50 x 0.7-0.8 m). There are 12 such blocks encircling a central cir-

cular hollow 4.5 m in diameter, filled by a paving of flat kurkar slabs. The face of this paving is at a depth of 1.3 m below MSL, 0.5 m lower than the tops of the blocks. Another floor of broader and larger slabs paves the 2 m space between the two concentric circles; its face is under 1.1 m of water on the west side and just less than 1 m on the east side. There is a westward slope of about 0.15-0.20 m for the floor and the top of the external course of headers.

In 1984 a probe 1 m wide was made along a 4 m stretch of the external face of the south side of the tower (figs. III.175-76). The probe tapered to only 0.8 x 0.8 m at its bottom, under 2.7 m of water and 1.5 m below the present sea-floor. Three additional courses of kurkar headers were exposed below the top one. Since the courses are not properly leveled, the blocks in each of them differ somewhat in height so that they interlock. There are still traces of smooth plaster on the adjoining longer sides of two of the blocks, as if they had previously been used as stretchers in another wall (fig. III.176). Other plastered blocks were found during the probe made in 1978 along the west face of the tower.

From the sandy sea-floor at 1.2 m below MSL, the trench descended through a disturbed top layer about 0.9 m thick of tumbled ashlar blocks and large rubble blocks, mixed with sea-worn potsherds of various periods, including broken Coca Cola bottles. At a depth of 2.1 m the sediment turned grey and consisted of coarse sand with some pebbles and carbon particles. Large quantities of sea-worn potsherds, including big pieces of amphoras of Late Roman and Byzantine dates, composed almost half the volume of that fill, down to a depth of 2.5 m. Beneath lay about 0.15 m of sticky grey clay interbedded with flat fragments of kurkar. Only a few sherds were found in this layer, and they are of Late Hellenistic-Early Roman date. At the base of this layer there was a gradual change in texture, the clay and artifacts disappearing and the kurkar chunks becoming more compacted (fig. III.178). At a depth of 2.7 m below MSL, poorly-cemented kurkar bed-rock appeared.

Three additional probes were made with the dredge at the sea-floor along a line from the tower to the promontory, at a bearing of 230°. The probes were made every 12 m, down to bed-rock. In all three cases the stratigraphy was much the same as in the trench along the south side of the Round Tower. The bed-rock was reached at 2.8 m below MSL in the first probe, at 2.65 m in the second, and at 2.5 m in the third, only 10 m north of the present north side of the promontory. Some additional air-jet probes that were made around this area between the tower and the promontory to the south and southwest did not encounter any buried structures below the sandy sea-floor. It is quite clear that this area was not blocked and that no man-made structures had ever been laid for either closing or narrowing the gap between the tower and the promontory south of it.

Stylistically, this Round Tower with overlying courses of headers has parallels dating from the fifth to second centuries B.C. (e.g., Crowfoot 1942-58: 27, n. 2; Levine 1975a: 11, no. 56; Winter 1971: 194; Adam 1982: 62). The closest parallels date from the Late Hellenistic period (e.g. Jameson 1969: 333-35, pl. II; 1973; Reisner et al. 1924, plan 10), and the best of these are the two round towers that were excavated by the Italian Mission near the beach north of the Crusader city walls of Caesarea (Frova et al. 1965: 247-92) (Sections II.A.5, III.H.3; figs. I.8, no.

16, I.35-36, II.1). Since the structure and date of these towers have a bearing on the tower in Area T_1, the data will be summarized here. The Joint Expedition tried to verify the stratigraphic data of the Italians by excavating a probe farther east along that wall (Blakely 1984; cf. Raban 1987). Of the two towers investigated by the Italian Mission, only the eastern one was found to be almost intact (fig. II.2).

This structure survived to a height of seven courses, almost 4 m. It consisted of a circular wall about 2 m wide to which an external semicircular facing was added around the southern part of the tower. The upper course of the original structure was arranged in an alternating order of header and stretcher on both its sides, with the infacing header against an outfacing stretcher and vice versa (Frova et al. 1965: 269-71). This order was not kept all around the circumference of the tower and was adjusted by additional headers or stretchers when necessary for a tighter fit between the two sides of the course. Lower courses seem to have been built in a different order, but still using the same principle, with more headers facing the external circumference of the tower. The bottom course was built of headers only (fig. II.3). The kurkar blocks of which the tower was built are so badly weathered that it is hard to determine whether they all had drafted edges. On the lower, less weathered courses, there are some headers and stretchers that are clearly fashioned this way.

The eastern tower and adjacent structures clearly belong to three different building stages (Frova et al. 1965: 266-78). The wall east of the tower seems to have been built at the same time as the original tower, being structurally incorporated into it (fig. II.2). The additional width of the south side of the tower is of later date and was even of a different building technique, with mortar and inserted slates between the ashlar blocks. A third feature, probably built even later than the other two, is the broad wall adjacent to the west of the tower. It closes the passage between it and the western tower, some 12 m away (fig. II.3). The suggested date for this wall, according to the excavators, is Herodian, so there was no functioning gate at that time between the two towers (Frova et al. 1965: 280-86).

Clearly, there are many problems in relating the original structure of the gate towers (at least of the eastern one) to the Herodian phase. The fact that the High-Level Aqueduct cut through the fortification wall to the east creates still more problems. For these reasons, and for others that are discussed above (see Section III.H.3), the fortification should be pre-Herodian. The wall probably was the northern boundary of Hellenistic Straton's Tower, the stronghold of the tyrant Zoilus (Raban 1987). Although the eastern of these northern towers has the same diameter as the one in Area T_1, and the size of the blocks and height of the courses is much the same, the arrangement of the blocks is different, along with the internal structure. The four lower courses of the eastern tower are the most similar, but that level is exposed only from the outside, so there are no comparative data available for its inner construction. The carefully finished inner face of the circular wall of the eastern tower at the level of the sixth and seventh courses indicates that the structure was hollow at that level. The tower in Area T_1 had its floor at the level of the top of the fourth course. This is also the level of the opening through the circular wall at the south side of the eastern tower of the northern fortification.

If we consider the paved space that fills the circle between the two concentric walls of the tower in Area T_1 to be a pavement or a base for an ascending flight of stairs, its present submerged level is difficult to understand. One would expect such a platform to be at about the same level as the rampart on top of the adjacent fortification wall, or at least well above the water. The present level of about 1 m below MSL suggests a vertical displacement of about 2 m. This is perplexing in comparison with the stability of nearby features on either side of the Intermediate Basin. The later submerged walls and tower in the same area, somewhat farther toward the west and northwestern side of the basin, are not based on natural bed-rock, as the T_1 tower was found to be.

These data are even more perplexing when we consider the fact that bed-rock was found at much the same level all across the bottom of the bay, between the tower and the southern promontory. Reconstructing the elevation of this rocky bed at 2 m above its present level destroys any possibility of a navigable channel into the Inner Basin in Area I_1, some 100 m farther east. The absence of a wall adjacent to the Round Tower on the promontory side makes sense only if there was an inlet for such an Inner Basin at this point.

One tentative hypothesis is that the Round Tower was built at much the same depth at which it now stands, and that the paving within its walls was merely part of the building process. The interior would then have been filled with packing to a level which suited the operational demands of such a fortification. This assumption would fit in with the differences in the construction techniques of this tower and the two towers of the north shore. In the case of the northern towers, the thin inner wall was just a means of retaining fill. The header-faced courses over the existing part of the submerged tower matched the bottom course of the eastern tower excavated by the Italians.

These towers at two distant locations in Caesarea, may be related to the same fortification system that incorporated the southern and the eastern walls of the Herodian Podium Vault in Area I_3 (Section III.H.3). Projecting the continuation of the south wall of this vault westward, it leads to the promontory on the south side of the bay in which the submerged tower is found. Such a course for the southern part of the wall would fit an enceinte designed to protect Straton's Tower. From the topographic point of view, it encompasses the Intermediate and Inner Basins. In a similar way, the western segment of the north wall with twin round towers can be projected toward the sea at a point appropriate for protecting the north entrance into the lagoon, with the Hellenistic quay at its inner end (Section III.I).

In the absence of datable, stratified ceramics, the exact date of the tower can be deduced only by stylistic and historical arguments. As was noted above, the best parallels outside of Caesarea for the architectural style of the tower are found at Samaria (Reisner et al. 1924, II, plan 10; Crowfoot 1942-58: 40). At that site they were dated to the Late Hellenistic period, prior to 88 B.C. (Crowfoot 1942-58: 118-21). Such a date would fit the testimony of ancient sources that Straton's Tower was at that time a fortified stronghold and the capital of Zoilus, with Dor a secondary town within his territory (*AJ* 13: 324-35). The idea that Dor is a "lesser city" is repeated explicitly when Josephus compares Dor and Joppa (Jaffa) to Straton's Tower (*AJ* 15.333; Appendix I.A). Considerable data relevant

to the Hellenistic phase at Dor and its fortifications, have been recovered during recent excavation (e.g., Sharon 1987; Stern 1982). Although the actual fortification walls at Dor are dated to an earlier stage of the Hellenistic era, and its towers are not round, one can compare the size of the area encompassed by those walls with the suggested fortified confinement of Straton's Tower (about 12 ha for Dor and 20-25 ha for Straton's Tower). Given this information, it is possible that the round towers and the fortification walls were built by Zoilus some time toward the end of the second century B.C. and were sufficient to repel Jannaeus. The survival of these walls in later Caesarea is suggested by the Rabbinic sources, which refer to them as landmarks for the boundaries of Eretz Israel on the seacoast (Sussmann 1976: 228-29, 256, III). It is quite possible that the fortification walls Zoilus built for his stronghold and which had never been stormed in war, were used three generations later as a boundary delineating the harbour district of Sebastos from the rest of the city.

III.R.2. Area T_2: Crusader Wall and Square Tower. The area designated as Area T_2 is at the east side of the present anchorage at Caesarea, northwest of T_1 (figs. I.10, III.1, pl. I, no. 50). A submerged wall was traced and studied in this area in 1976, during CMS research for IEC (Section II.B.3). During the CMS field workshop in 1979 the wall was surveyed again, the southern continuation partly cleared, and some trial trenches were dug with a dredge along both sides (Section II.B.4).

During the CAHEP 1983-1984 seasons the entire area was surveyed by a group of diving architects from the University of Maryland, and the previous plans and sections were checked and corrected. During this survey the rectangular tower at the south end of the wall was drawn in detail.

The submerged wall is composed of two sections at somewhat different orientations. The base of the north section is a segmented ashlar wall running along the north shore of the bay on a bearing of 292° (figs. III.109, 166). It was built of large ashlar blocks with typically Herodian dovetail clamps reused from some earlier structure. Some of these grooves were re-set with iron C-clamps set in lead. In cases where the clamp holes were absent or in the wrong position, a small hole was cut at the face of the block and the iron clamp was inserted into it. This wall is probably a western segment of W 1 in Area S_2 (Section III.Q), at the latest phase of that wall. This segment can be traced for about 5 m, being completely covered by marine-cemented debris farther east and west along its projected course. The visible segment consists of only two courses of ashlars of various sizes: 0.6-1.2 x 0.4-0.6 x 0.45 m. The top of the higher course is just below MSL, and the base of the lower one rests on rubble at a depth of 0.93 m below MSL.

The north end of the submerged wall meets this segment at right angles, its upper surface just below that of the lower course of the wall on shore, at a depth of 0.56 m. This section of the submerged wall has a bearing of 203°. Its eastern face is the only one that can be followed at present for almost its entire extent (figs. III.179, 181). The uppermost course of this face (the fourth from the bottom) can be traced for 58 m. It is composed of medium to small kurkar ashlars, most of which are laid as headers (0.5-0.9 x 0.2-0.4 x 0.28-0.31 m). The blocks were laid carelessly and the gaps filled with small rubble and cement, most of

which has been washed out. In some places there is more than one row of facing blocks: at points 6-7 m and 13-14 m south of the wall's base. At these points the total width of the wall is about 1.5 m, but it is only 1.3 m wide at the southern tip of the north section, at 55 m south of its stem. The entire upper part of the structure is tilted westward. Two trenches were dug against the eastern face of the wall: the first was made 26-27 m south of its north end (fig. III.180). At this point the wall is preserved to a total height of 1.78 m and consists of six courses. It is based on a non-consolidated layer of gravel, small rubble and sand, which includes quantities of sea-worn potsherds from various periods, but mostly Byzantine and Early Arab.

The lower three courses are tipped backward 5° from the vertical, while the upper three are tipped as much as 13° off their original vertical position (fig. III.181). The base of the wall is now at a depth of 2.06 m and its surviving upper surface at 0.27 m. The height of the course is 0.30 m, except for the fifth one from the base, which is only 0.22 m high.

The second probe was made near the south end of the wall, 52-53 m from its north end (fig. III.180). At that point there are also six courses, but the bottom one was found to be partially lost through undertrenching. The same westward tilt was found as in the first trench. Yet at this point the entire last 8 m was displaced, so that the south tip is now 1 m west of the general course of the wall. The base of the wall is at 2.24 m below MSL and its upper surface at 0.68 m below. The sediments under the wall's base are a wave-disturbed mixture of sand, gravel, small rubble and potsherds, extending to kurkar bed-rock at 2.8 m below MSL. It seems as if the unconsolidated sediments on which the wall was built allowed extensive undertrenching that eventually caused dislocation, partial destruction, and general submergence of the wall. This process might explain the undulating elevation of the wall's line. The upper surface of the fourth course along the line of wall is at 0.6 m below MSL at 1 m south of the north end; 0.8 m below at 5 m; 0.73 m below at 8 m; 1.0 m below at 12 m; 0.7 m below at 21 m; 0.6 m below at 27 m; 1.1 m below at 38 m; 0.9 m below at 45 m; and 1.2 m below at 55 m, next to its south end.

The west side of the wall is covered by a layer of heavy building stones, rubble, and scattered column drums, some of which seems to make sense as displaced components of the wall itself: for example, two concreted masses of building stones and parallel columns laid perpendicular to the wall, one 9 m west of m 13, and the other 8 m west of m 22. A third group of four parallel columns lies on the bottom, at 1.9 m of water 6 m west of m 38. Plotting these columns and others scattered nearby gives a general layout that suggests a western edge of the wall about 8 m west of its eastern face. This possible western face was built in much the same way as the sea-walls of the Crusader Harbour Citadel, with courses of columns at its base and other columns incorporated as reinforcing beams into the upper courses of the structure. A Crusader date for the wall can be deduced also from its joint with a segment of wall set with iron clamps in a typical Crusader technique known also from Akko (Linder & Raban 1966: 23-27) and elsewhere in Caesarea (Raban et al. 1976: 35). As a result, this wall might be a continuation of the Crusader sea-wall, the remnants of which are clearly visible at the headland north of the bay and along its north shore in Area S (Section III.Q; cf. discussion of the Column Jetty in Section II.B.3).

The southern section of the wall is preserved only to the level of the surrounding sea-floor, and its eastern edge can be followed only with difficulty among the mass of scattered debris. The north end of this segment is offset about 2 m east of the south end of the longer segment and the connection between the two is now totally lost. The course of this southern section is 185°, 18° different from that of the northern one. It is composed of the same type of blocks as the other section and was preserved to a maximum height of three courses at a point 5 m away from its northern tip. At that point its upper surface is now at 1.5 m below MSL and its base at 2.38 m. At many points the wall is preserved to a width of three or four blocks, and in two places massive columns are incorporated within it. At the north end, the original width of the structure seems to be indicated by the tip of a west-facing edge 5.1 m away from the eastern one. If the line of this face is projected parallel to the eastern edge for its 38 m length, it terminates just beyond a column bridging most of the width of the structure, and at the line of the south edge of the remnants of a rectangular tower 3.1 m to the west.

Only the inner core of the base of this tower has survived, as a mass of rubble and small stones bound by heavy mortar. At the east side of this rectangular pile there are two columns. One marks the southeast corner and has a diameter of 1.3 m. Its preserved shaft is 3.2 m long. The second column is only 0.62 m in diameter and is laid near the northeast corner of the tower, pointing northward, with its 6 m long shaft lining up with the eastern side of the rectangle.

It seems as if this column was a binding component of the tower wall. Two parallel column shafts similar to the one at the southeast corner of the tower are laid as a southern continuation of the structure and might represent remains of the south wall of the tower and the tip of the structure. On the basis of the measurements and structural components of the towers and walls at the eastern side of the Harbour Citadel, some 50 m SW on the promontory (Section III.O; plans, figs. III.125-26, 128), one can reconstruct a tower with a chamber 9 x 6 m surrounded by walls 3.2-3.8 m thick.

The south wall of the tower continued along the south edge of the structure east of it. This structure was very probably a platform or a quay, 5.1 m wide at its southern section and backed by a sea-wall that ran along its western edge. This sea-wall continued also along the west side of the north section, and the columns there might indicate its course. If projected northward, it would line up with the remains of the Crusader structures at the base of the Column Jetty and with the base course of a wall that runs across the Roman Pier in Area L (Section III.K).

The problem remains of why the remains of the quay, tower, and sea-wall are now so far below MSL. Fluidization and undertrenching might be the cause for some subsidence, but the general integrity of the surviving portions of the wall suggests that their combined effect did not exceed by very much the present irregularity in the level of the courses, which is less than 0.7 m. Another cause for the submergence might be the fact that at the time this complex was built the sea level was eustatically lower by 0.5-0.8 m than at present.

An abrasive notch at the eastern face of the wall that can be traced at various places along the better preserved parts of the northern section is now at a depth of 1.1-0.8 m, along the top of the fourth course. This notch represents the

sea level at the time this structure was intact and still functioning. It would leave 1.2 m of water depth along the inner face of the quay, or somewhat less, considering the base of the structure must have been covered by silt to a certain extent. These data correspond to the fact that the fourth course is the uppermost to survive for most of the northern section, maybe as some kind of an abrasive platform. The advanced destruction of the adjacent sea-wall might have been caused by its being a tall, narrow structure rather than a broad, low one like the quay. Once undertrenched, such a wall would tumble in large units, with a devastating impact on its components, which would soon be carried away and scattered by the surge. The energetic efforts of the Mamelukes to demolish as much as possible of the Crusader fortifications at Caesarea and to fill up their anchorage with debris (Hazard 1975: 88-89) might also explain the almost total disappearance of this sea-wall and the side walls of the rectangular tower.

[A.R.]

III.S. Area Y: Roman Shipwreck.

History of Survey and Excavation. Although the full publication of the hull and associated finds will appear in Volume II, Area Y was an integral part of the CAHEP excavation for several seasons, and a preliminary report must be given here. The wreck was first discovered in the summer of 1976, during a casual survey carried out by A. Raban and a group of IUES divers. The ends of 25 frames spaced 0.25 m apart centre-to-centre were observed sticking out the sand for a distance of ca. 6 m (figs. III.185-86). The wooden remains lay in less than 2.5 m of water about 60 m west of the current shore-line, inside the partially protected bay about 200 m NW of the Hellenistic Quay in Area J, and about 80 m north of the two round towers discovered by the Italian Mission in 1960 (Raban 1985c: 173, fig. 20) (figs. I.8, III.90, pl. I, no. 61.

Heavy surge and poor visibility made it impossible to carry out an extensive reconnaissance, and during later visits the area was found always to be completely covered with a thick layer of sand. The site is partially protected by rocky shallows to the west that cause primary breaking at this point of waves over a certain magnitude. As a result, there are breakers above the wreck most of the time, which makes the sand bar covering the area virtually a permanent feature (see Peregrine 1983). In consequence, it seemed likely that, because the wreck was almost constantly covered by sand through the centuries, a large part of the wooden hull might have survived, despite the very dynamic environment. It is probable that this complete and permanent coverage was altered for the first time only in recent years, due to the interruption of longshore sand movement caused by the construction of the breakwaters for the cooling water basin of the new electric power plant at nearby Hadera (see e.g. Gitai 1982, and Section I.A.4).

Early in 1980, a rip current exposed a few wooden planks between and under some scattered stone blocks several metres south of the frames discovered in 1976. The presence of mortise-and-tenon joints indicated the ship had been built in the ancient shell-first technique. Further, carbon-14 analyses performed on samples from two planks, one frame, and one tenon at the Weizmann Institute of Science (Rehovot, Israel) dated the wood to 1900 ± 140 BP and 1900 ± 220 BP (133 B.C.-A.D. 307), calculated at an uncorrected half-life decay rate of 5570 years. Dendrochronological correction based on the bristlecone pine provides a date of approximately 200 B.C. ± 240 years, or a span of from 440 B.C. to A.D. 40 (see Appendix III.B, below). These data suggested the wreck might be that of a ship from the Early Roman period, perhaps even from the time of Herod.

By early April of 1980, winter storms had cleared the sand away from the south end and southeast edge of the surviving portion of the hull. During a few days between two storms, the site was surveyed and photographed and the first plan of the hull was made. This survey revealed that the sea-bottom on which the hull's remains lay consisted of a very compact orange to greyish-brown loam, which was covered by scattered rubble, sea-worn potsherds, and some heavy artifacts that had been carried by the waves from the nearby shore (fig. III.187).

The wreck was found to consist of a segment of the lower part of the wooden hull of a heavy merchantman. The south end comprised an intact segment of 14 planking strakes just under 0.09 m thick, and two strakes extended an additional 6.2 m southward. Forty-three frames were counted above the sand along the eastern edge, consisting of half-frames alternating with floor timbers and their futtocks (fig. III.185). These frames were moulded (high) ca. 0.25-0.28 m, sided (wide) about 0.16 m, and set some 0.09 m apart. A coiled rope was found near the planks extending southward, and other scattered finds included numerous large fragments of dolia, one leg from a folding bronze table (two more legs were recovered in 1980 by S. Wachsmann, the marine supervisor of the Israel Department of Antiquities), a badly worn plate, a bronze rod of a balance scale, a few lead brailing rings, and some fragments of lead sheathing (see Volume II).

The first attempt to excavate the wreck was made in the 1983 CAHEP season. Excavation was carried out with a 5-inch dredge connected by a 3-inch firehose to a pump located on shore (fig. III.182). The pump delivered 1500 litres of water per minute at a pressure of 4 atm. A smaller pump was mounted on an inflatable boat moored over the wreck site. This pump developed 3 atm. of pressure and supplied 500 litres/minute through a 2-inch firehose that terminated in a Galiazzi nozzle. This produced an easily-regulated stream that was used to help clear off the heavy overburden of sand.

A base-line was extended due north from the known southwest corner of the wreck, and a metal grid was installed lengthwise along the eastern side of the base-line at its southern limit. The grid consisted of four adjacent squares measuring 2 m on a side that could be levelled independently of one another. A grid of 0.20 x 0.20 m squares was superimposed on each square after the hull was completely exposed within it, to provide a base level from which vertical measurements could be taken (fig. III.184).

A series of probes with air-jets was made along the N-S base-line in order to locate and delineate additional remains. The probes suggested that wooden hull members extended as far as 28 m north of the southwest corner of the known portion of the hull, and up to 4 m west of the base-line, for a distance of 26 m from the south end of the hull (Raban 1985c: 176, fig. 23).

Over the course of the 12 days of seas calm enough to allow work on this shallow site, an area 14 x 5 m was cleared, starting at the southern, less deeply-buried part of the hull. A free-hand plan with a preliminary set of measurements was made immediately, to acquire some tentative data for the entire excavated area. Unfortunately, only six squares were more closely surveyed and drawn by architects before waves severely restricted work at the site. In fact, for most of the season the excavation was a Sisyphian effort, as each day began with the removal of the constantly inflowing sand. An attempt to build a retaining bank of sand bags around the wreck reduced the flow, but it was inadequate whenever the surge increased (fig. III.182).

In October of 1984, during the making of a documentary film on Caesarea's harbour, an additional session of excavation was carried out, and the site was surveyed with a metal detector (fig. III.183). The purpose of this survey was to locate artifacts that might have been carried away from their original context in the sunken ship. Although the sea-bottom west and south of the wreck was littered with building stones, broken amphoras, scattered coins and other metal objects, most of these items seemed to have been dragged out from the shore-line by the rip currents.

Excavations over 11 days of calm seas in 1986 revealed that a section of frames and planking 3 m long had disappeared from the south end of the wreck since 1983. Moreover, air-jet probe data indicated most of the hull thought to have been located north of the 1983 excavation area had been shifted or destroyed by storms during the intervening years.

Two areas located at opposite ends of the preserved hull, which was then ca. 9.75 m in length, were uncovered and partly recorded. Frames 8, 9, 10, and 13 at the north end were recorded in plan view. Sections across the hull were taken at frames 8 and 13. Elevations of the east and west edges of the hull between frames 8 and 13 were also drawn. At the southern extremity of the wreck, which was only 2 m wide, a small area was cleared consisting of 1.5 m of planking south of frame 33. This area was drawn only in plan view.

Relatively few artifacts were found in 1986. A beautifully preserved ivory gaming die was retrieved from the east edge, and a lead token, unfortunately illegible, was recovered from the fill between two frames. Between the frames on the southwest side of the hull was found mud mixed with straw, twigs, and some pine needles; a pine cone of the species *Pinus pinea* was discovered in a concretion lodged between frames 12 and 13.[2] Numerous concreted iron nails of various sizes and configurations were found (discussion in Volume II).

Destruction of the wreck by the sea continued in 1986 and 1987. Exposure by a storm in early spring of 1987 disclosed that another 2 m of planking and 3 m of frames had been lost from the southern extremity. At that time the timbers were covered with more than 200 sandbags in an effort to prevent further damage.

Description of the Ship. A summary description of some of the hull's features is given here. A more detailed discussion with citation of parallels and a complete corpus of the finds will be published in Volume II.

2 Identification confirmed by Dr. M.E. Kislev, Department of Life Sciences, Bar-Ilan University, Ramat Gan, Israel.

Wood samples taken from three planks and four frames all proved to be pine of the Red and White pine groups, at least half of which are not local varieties. Two tenons are of poplar, and three treenails belong to the live oak group (see Appendix III.A, below).[3]

The ship was built in standard Graeco-Roman fashion: hull planks were fastened edge-to-edge with mortise-and-tenon joints, and frames consist of floor timbers and futtocks that alternate regularly with half-frames (figs. III.188-89) The keel was originally located west of the existing portion of the hull, as indicated by the heavy damage to the floor timbers and planking, and by the presence of finished half-frame extremities, along the west edge of the remains. Furthermore, at the eastern edge, the eroded ends of the frames usually begin to make the turn of the bilge (fig. III.186).

A single layer of strakes reaches a maximum breadth of approximately 3.2 m near the north end of the wreck at frame 13. Planks are a maximum of 0.32 m wide (avg. 0.285 m) and 0.09-0.094 m thick between frames 8 and 13, and 33 and 39. The mortise-and-tenon joints are staggered across the thickness of the planks and spaced a mere 0.05-0.06 m apart (figs. III.188-89). Dimensions of the mortises measured vary, but they average 0.09 m in width, 0.01 m in thickness, and the tenons fit tightly within them. The pegs holding the tenons in place are spaced consistently at intervals of 0.13-0.14 m centre-to-centre, and are set 0.03-0.04 m from the planking seams.

Frames examined so far are naturally-grown shapes. The half-frames are of one piece, and the floor timbers and their futtocks are separated by gaps of 0.02-0.10 m (figs. III.185-86). Frames 8 through 13 span breadths of up to 3.5 m and are set 0.05-0.10 m apart, with an average spacing of 0.07 m. At the west or keel side of the hull remains, these frames are moulded (thick) 0.15-0.20 m, but average 0.167 m. They are sided (wide) an average 0.18 m, ranging from 0.16 to 0.22 m. Along the eastern edge of the wreck, near the turn of the bilge, the same frames are sided 0.18-0.19 m and moulded 0.18-0.24 m, averaging 0.18 m. With average sided dimensions of about 0.18 m and an average spacing of some 0.07 m, room and space (distance centre-to-centre) averages 0.25 m.

The frames are fastened to the hull planks with treenails driven from the outside and staggered to prevent splitting. Treenail diameters are ca. 0.015 m on the interior frame surfaces and ca. 0.02-0.025 m at the outer planking faces. Occasionally, bronze nails (D of head 0.035 m, D of shaft 0.0065 m) were driven through the treenails, but they did not protrude above the interior frame faces. In the absence of an opportunity to examine the exterior of the hull, no pattern for such usage has yet been ascertained.

A unique feature of the Caesarea ship lies in the use of bolts inserted through the planking and frames from the outside. In some places their concreted shafts protrude above the upper frame surfaces. Two such bolts were noted in 1986 (fig. III.192), and in 1987, when the surviving portions of the hull were almost completely exposed, four more were recorded. Within the concretions the bolts are

3 Wood analyses performed by Donna J. Christensen of the Center for Wood Anatomy Research, U.S. Forest Products Laboratory, Madison, Wisconsin, and by the staff of the Archaeometric Laboratory at Tel Aviv University.

ca. 0.013 m in diameter at the frames, but taper slightly to 0.011 m at their upper extremities, which are 0.08 m from the frame surfaces. A concretion was recovered that yielded a perfect cast of what had been a copper alloy washer. Its inner diameter matches perfectly the diameters of the upper extremities of the bolts. From this evidence it may be cautiously proposed that such bolts were used to fasten heavy stringers ca. 0.08 m thick to the planks and frames. The distances between the four bolts found in 1987 suggest such stringers could have been ca. 0.18-0.25 m wide, and that they might have been fastened with the bolts about every 2 m (that is, at every eighth frame). In any case, the practice of bolting stringers to planks and frames, if this is indeed true for the Caesarea ship, is unparalleled in the archaeological literature. It would also be unique if the bolts were used simply to fasten planks to the frames, apart from the presence of stringers.

Yet another unusual feature of this ship is the alignment of the gaps between all floor timbers and their respective futtocks down the length of the hull (fig. III.186); the limber holes in the half-frames align with these gaps. It was interesting to discover that within those limber holes, and thus able to pass through the gaps, is a rope 0.015 m in diameter (fig. III.191). Its function clearly was to help keep the limber holes open to assure free passage of bilge water to a bilge pump. We have found only one other example in the archaeological literature of rope within limber holes: the late fourth- or early fifth-century Port-Vendres wreck (Liou 1974: 423).

On frame 21, at the inboard extremities of the futtock and floor timber, a group of Greek letters has been scratched into the wood twice (fig. III.190). One possible reading is XIAIAIΨN, which might translate as "one thousand, 750" or "1750," possibly some indication of the capacity of the ship. Lionel Casson (oral communication) has suggested that they might have been carved by a stevedore involved in loading the ship.

The wooden hull of the Caesarea ship was protected from marine borers and its watertightness improved by a thin sheathing of lead. Such sheathing was commonly fastened with copper tacks over a layer of fabric impregnated with pitch or a similar substance. Traces of pitch were observed, but no fabric, and the pieces of sheathing recovered from the site are pierced with nail holes 0.005 m in diameter, spaced 0.055-0.065 m apart in a quincunx pattern (fig. III.193).

Equipment, Fittings, and Cargo. A few items of equipment associated with the operation of the ship have also been found on the site. A lead box with one pipe still attached and holes for two others was discovered in the winter of 1985. The box is rectangular with an open top, and no soldered seams are evident in the lead, which is 0.0017-0.002 m thick. Original dimensions can be reconstructed as 0.29 x 0.15 x 0.21 m, suggesting a capacity of about 9 litres. The pipe is made of lead sheeting 0.003 m thick and has an outer diameter of about 0.05 m. A number of similar boxes have been found on shipwrecks of the Roman period and are thought to be components of bilge pump systems (Oleson 1984c: 197, 213, 218).

In 1983, eight lead rings with inner diameters of 0.02-0.032 m were recovered, and another two were found in 1987 that are 0.026-0.041 m in diameter. Cross-section shapes range from circular to rectangular. No holes or lugs are present on

these rings, and none is split open. These probably are brailing rings from the sails of the ship, but they could have served equally for the disentanglement of fishing lines (discussion in Volume II).

Three ropes were discovered about 0.15 m west of the west extremity of frame 13 in 1986. Two large ones were positioned at the level of the frame/plank interface (fig. III.191), while a third lay approximately 0.20 m beneath them. It measured ca. 0.01-0.015 m in diameter. Both large ropes consist of three strands laid left, and one is round with a diameter of 0.05 m. The other is flattened in section, with dimensions of 0.045 x 0.02 m. Botanical analysis indicates this latter rope was made of rolled leaves of *Stipa tenacissima*, or Esparto grass (Appendix III.A).[4]

Fragments of three different sizes and shapes of dolia were found in the immediate vicinity of the wreck in 1983. The first type has no distinct rim and no handles. Maximum internal diameter is ca. 1 m, with a height much greater, and the diameter of the mouth exceeds 0.60 m. The closest parallels to this type come from the Cap Bénot 2 wreck, which probably dates to early in the first century A.C. (L'Hour, Long, Pomey 1985: 81). More parallels are provided by the cargo of dolia on the Diano Marina wreck, off the Ligurian coast of Italy (Pallarés 1975-81: 92-97). On both sites the dolia are somewhat larger than those at Caesarea, and seem to have contained wine. The second dolium type has a short neck with a broad folded rim, and vertical semi-circular handles. It measures about 1.1-1.2 m high, and has a maximum diameter of just under 1 m. The diameter of the base varies from 0.24-0.32 m, while the mouth diameter ranges from 0.32-0.39 m. The third type has a neck and rim much like those of the second type, but the diameter of the mouth is somewhat greater, at 0.36-0.42 m. The diameter of the base is 0.23-0.36 m.

Preliminary Analysis. From the information at hand it is difficult to draw many firm conclusions about the ship. We cannot determine where the ship was constructed, because we only know that at least half of the pine used for the planks and frames are not local varieties. At most, we might venture that the ship was not built in the Levant.

The remains excavated and probed in 1983 extended some 34 m, and frames from part of one side of the ship spanned 3.5 m, indicating that the ship was of significant size. This conclusion is further supported by the heavy planks fastened with staggered mortise-and-tenon joints, and by the large dimensions of the closely set frames, which are larger than those in the ship that sank near La Madrague de Giens. That vessel, dated to 70-60 B.C., is reconstructed to ca. 40 m x 9 m (Pomey 1982: 145, 147, fig. 8). The Caesarea ship was quite likely of similar size, and perhaps a bit larger.

The carbon-14 data (Appendix III.B) imply a construction date earlier than the first century A.C., as does the presence of lead sheathing on the hull, a feature that is quite rare on Roman craft from the first century on. However, the wreck's close proximity to Herod's harbour, which was built between 23 B.C. and 10 B.C., might suggest a date late in the first century B.C. or later for the ship's sinking.

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4 Botanical analysis performed by Professor Doctor Udelgard Körber-Grohne of the Institut für Botanik, Universität Hohenheim, Stuttgart, West Germany.

Moreover, the use of dolia as cargo containers is considered to be an innovation of the Late Augustan era, early in the first century A.C. (L'Hour, Long, and Pomey 1985: 79). In consequence, a construction date of the first century B.C., and a wreck date of sometime in the first century A.C. seem likely for the Caesarea ship.

Our historical understanding of the types of goods that were transhipped at Sebastos suggest that the bulk cargo contained in the dolia of the Caesarea ship might have been either salt from the Dead Sea or spices from the Indian Ocean that came over caravan routes partially controlled by Herod (cf. Sidebotham 1986: 76-77).

The issue of why King Herod built such a magnificent and oversized harbour in the poor vassal kingdom of Judea will be discussed in Volumes III and IV of this report. Here, within the context of a primarily factual description of the excavations, it can be suggested only that the wreck in Area Y might be relevant to the question. Its large dimensions, heavy structure, and presumed bulk cargo seem consistent with the notion that this marine engineering endeavor was not intended simply for show, but that it was a well-calculated economic project designed to attract international seaborne trade with its considerable revenues. An alternative hypothesis is that the ship was a bulk carrier wrecked while moored at the semi-protected lagoon of the pre-Herodian anchorage during the time Sebastos was under construction. It may have been carrying building materials such as the pozzolana and tuff added to the concrete used in the harbour, which were loaded at Puteoli in the Bay of Naples.

[M.F., A.R.]

APPENDIX III.A: ANALYSIS OF WOOD AND ROPE

Appendix III.A.1: Wood and Rope from Areas D and G.

The following results have been translated from the Hebrew reports received by CAHEP from the Laboratory for Archaeometric Studies at Tel Aviv University, reports prepared by Dr. Liphschitz and S. Lev-Yadun. Dr. Liphschitz frequently visited Caesarea during the field seasons and instructed our staff in proper sampling techniques, in order to insure the quality of the specimen and the proper treatment on the way from recovery to the laboratory in Tel Aviv. Twenty-eight pieces of wood and one piece of rope were selected during the 1982 season. They were kept in sterile water in plastic bags and brought to the laboratory in Tel Aviv, along with a detailed description of each piece, including the location, depth, archaeological context, and probable date. Some of the samples turned out to be in such a state of decay that the identification of the species was not possible. Such samples were left out of this report.

All the samples were from Areas D and G. The first group is composed of fragments of wood found on or in the lowest clay stratum that represents the actual floor of the Herodian harbour basin at the time it was still functioning. The latest datable archaeological context is no later than early third century A.C. The other group was collected from the remnants of the wooden forms of the concrete block at the northwest tip of the Northern Breakwater and from part of the sleeper beam and other wooden pieces that were recovered at the base of the Tower just to the north, both in Area G (fig. III.196) (Section III.F). The loci in Table 1 are scattered around the trench in Area D_1. The loci in Table 2 are as follows: a and b, west side of south block; c, northwest corner of south block; d, north face of south block; e and f, east face of south block; g, southeast corner of south block; h, south face of south block; i and j, south face of north block; k, west face of north block.

Table 1. Wood and Rope Samples from Area D.

No.	Locus	Depth	Description	Species
1.	D1-a	9.2m	rope fragment	*Phoenix dactylifera* (Palm)
2.	D1-a	9.1m	plank	unidentified
3.	D1-a	9.6m	twigs	unidentified
4.	D1-a	9.3m	sheave block	(see Table 3, below)
5.	D1-a	10.1m	plank (from ship?)	*Pinus* sp. (Pine)
6.	D1-2	8.7m	twigs	*Quercus calliprinos* (Oak)
7.	D1-2	8.7m	twigs	*Quercus calliprinos* (Oak)
8.	D1-b	10.6m	treenail	*Quercus calliprinos* (Oak)
9.	D1-b	10.4m	treenail	*Quercus* sp. (Oak)

10.	D1-a	9.7m	broken tenon (?)	*Buxus* sp. (Boxwood)
11.	D1-b	9.7m	plank (from ship?)	*Populus* sp. (Poplar)
12.	D1-a	9.9m	beam (ship's frame?)	*Pinus* sp. (European Pine)
13.	D1-a	10.1m	plank	unidentified conifer

Table 2. Wood Samples from Area G.

No.	Locus	Depth	Description	Species
1.	G-a	5.8m	formwork plank	*Pinus* sp. (European Pine)
2.	G-a	5.8m	formwork upright	unidentified conifer
3.	G-a	6.1m	formwork sleeper beam	*Abies* sp. (Silver Fir)
4.	G-b	5.7m	cross beam within form	unidentified conifer
5.	G-c	6.2m	joint at NW corner	(see Table 3)
6.	G-d	6.2m	formwork upright	*Pinus* sp. (European Pine)
7.	G-f	5.9m	formwork sleeper	*Abies* sp. (Silver Fir)
8.	G-g	5.9m	part of joint at SE corner	*Abies* sp. (Fir)
9.	G-h	6.3m	sleeper beam (?)	*Pinus* sp. (European Pine)
10.	G-i	5.7m	sleeper beam (?)	*Pinus* sp. (European Pine)
11.	G-i	5.8m	treenail from formwork	*Populus* sp. (Poplar)
12.	G-k	6.5m	sleeper beam tenon	*Quercus* sp. (Oak)
13.	G-k	7.2m	formwork sleeper beam	*Abies* sp. (Silver Fir)

Some of the samples were actually combined units of what might be more than one type of wood. These were studied separately, and the results summarized in Table 3. Specimens 4a-c are cited from Table 1, specimens 7a-b from Table 2.

Table 3. Composite Wood Samples.

No.	Locus	Description	Species
4a.	D1-a	sheave block	*Buxus* sp. (Boxwood)
4b.	D1-a	sheave block wheel	*Quercus* sp.(European Oak)
4c.	D1-a	sheave block pole	*Fagus* sp. (Beech)
7a.	G-c	joint of beams	*Pinus* sp. (European Pine)
7b.	G-c	joint of beams	*Picea* sp. (Spruce)

[N.L., S.L-Y., Y.W.]

Appendix III.A.2: Wood from Area Y.

In 1983, 12 wood fragments from selected members of the hull of the Roman Wreck in Area Y were brought to the lab at Tel Aviv University. The following information, dated 1 November 1984, was sent to CAHEP (Report no. 114,1.11.84).

The samples were treated, sliced and dyed in the regular freezing process (see below) and the identification was made the same way. It was possible to identify only the general species, both due to the poor state of the wood and the difficulty of identifying European trees more precisely. In species like oak and pine, the

European standard is to identify the level of the general species only, due to the close resemblance among the various sub-species.

The hull of the wreck from Caesarea was made of three types of wood. The long timbers (planks and frames) are all made of some kind of European pine. The two tenons are of poplar, and all the treenails of some kind of foreign evergreen oak (also European). Based on these data it is very likely that the ship was built in Europe, probably in Italy or Southern France.

Table 4. Wood Samples from Area Y.

1. Frame no. 31: *Pinus* sp. (European pine).
2. Frame no. 31: *Pinus* sp. (European pine).
3. Frame no. 26 (half frame): *Pinus* sp. (European pine).
4. Frame no. 26 (half frame): *Pinus* sp. (European pine).
5. Plank a (below second wall): *Pinus* sp. (European pine).
6. Plank d: *Pinus* sp. (European pine).
7. Plank k (the westernmost): *Pinus* sp. (European pine).
8. Treenail from plank d: *Quercus* sp. (evergreen oak).
9. Treenail from tenon of k: *Quercus* sp. (evergreen oak).
10. Treenail from tenon of j: *Quercus* sp. (evergreen oak).
11. Tenon from plank j: *Populus* sp. (poplar).
12. Tenon from plank k: *Populus* sp. (poplar).

[N.L., S.L-Y., Y.W.]

Appendix III.A.3: Rope from Area Y.

Four fragments of a piece of rope associated with the shipwreck in Area Y were submitted for analysis (fig. III.191). Under the stereo-microscope (10X to 40X), it can be seen that the raw material consists of relatively thick and strong plant material with a diameter of 1 mm and more. It therefore cannot belong to the fully processed fibres of flax or hemp. Under the microscope (100X to 400X), three types of cellular tissue can be seen:

1) Epidermis cells alternating with long cells and short cells. The long cells have undulating walls and are relatively broad (16-18 millimicrons).

2) Bundles of fibre sclereids lying directly under the epidermis. The bundles are separated from each other only by a narrow part with other cells.

3) One layer with cells which are rich in broad papils (short hairs). The papils are ca. 26-34 millimicrons long and at the base are ca. 10 millimicrons broad. This layer is situated at the inner side of the fibre bundles.

This type of cellular tissue belongs to the leaves of *Stipa tenacissima*, (Esparto grass). This useful plant grows today in North Africa and Southern Spain. In Roman times it was commonly used for wickerwork and rope-making.

[U.K-G.]

Appendix III.A.4: Dendroarchaeological Analysis (Report no. 99, 3.11.1982).

The samples that were brought by CAHEP were sliced to cubes of 1.0-0.5 cm each. Due to the decayed state of the waterlogged wood, it was frozen before slicing. Freezing minimizes the internal distortion of the cells and tissues and shortens the long period of time needed to prepare marine samples for slicing (Liphschitz, Lev-Yadun, Waisel 1981: 231).

The slicing was executed with a sliding microtome in three directions: across, tangential longitude, and radial longitude. The thickness of the slices varied between 20-150 μ, depending upon the state of preservation of each sample. The slices were dyed with two separative fresh pigments: ClZnI and Reactif Genevois. Such colouring enables visual distinction of various cell-walls. The identification of the tree species was made by visual comparisons with photographs of parallel specimens from the lab's catalogue, made of contemporary trees, and with photographs of parallel sections published in standard botanic textbooks on European trees (Greguss 1959; Schweingruber 1978). The data in Tables 1-3 above present eight species of trees, some of which could be identified to the level of sub-species, such as in the case of the oak, of which all but one sample (G-14) is of the local sub-species, *Quercus calliprinos*. Yet all other samples of oak are of some European sub-species that could not be defined from the present samples, due to their decaying state. It is, however, quite clear that none of these oak samples can originate in the types of oak which grow in the Levant. Three samples are of unspecified conifers (D-13, Table 1 no. 13; G-2 and G-4, Table 2 nos. 2, 4). The state of the wooden samples enable us to say only that they are all conifers, not cypress, not pine, and very probably not other local species.

Only two of the eight species are clearly local: the common oak (*Quercus calliprinos*) and the common palm (*Phoenix dactylifera*). The other six are typical to Europe or the northern part of Turkey. Three of them are conifers: Pine (*Pinus*), spruce (*Picea*), and fir (*Abies*). The other four (including the unspecified oak) are deciduous: beech (*Fagus*), boxwood (*Buxus*), and poplar (*Populus*). The relatively high proportion of foreign wood species is not surprising for the site of a trading harbour such as Sebastos. It is also quite likely that the extensive building activities during Herod's regime, deforestation through burning for charcoal and foraging by the black goat, and the expansion of agricultural cultivation might have caused severe deficits in forest areas in the country, necessitating importation of timber from abroad for the harbour's extensive construction works.

The wooden remains that are dated to the Herodian period all come from the forms used during the harbour's construction. Of these, all the long beams, the upright poles, and the planks were made of imported conifers. Treenails and tenons were made of other types of imported wood, such as poplar and oak. The wooden samples from Area D, which are dated to the two centuries that followed Herod's time, are either parts of ship hulls or rigging, such as the palm-made rope or the oak component of the sheave block. The planks and the piece from a ship's frame were made of European wood: boxwood, beech, pine, and poplar. The two samples D-6 and D-7 (Table 1) are probably two pieces of a branch from local oak. Some of the bark is still visible.

[N.L., S.L-Y., Y.W.]

Appendix III.A.5: Dendrochronological Analysis.

In 1984, a large section of the sleeper beam along the north face of the south block in Area G was recovered for dendrochronological analysis (fig. III.195) and sent to Prof. P.I. Kuniholm of Cornell University. His laboratory was able to isolate a sequence of 151 years of growth on the beam (sample name C-IS-CSM-1l; ID no. 198601), but unfortunately it has not as yet matched up with any other dated or undated sequence in his large databank. Future discoveries may verify the date of felling of ca. 15 B.C. that we assign to the wood of this formwork on the basis of historical probability.

[J.P.O.]

APPENDIX III.B: RADIOCARBON DATING

Several samples were sent from CAHEP's excavation to various laboratories in Israel, the United States and South Africa for carbon-14 dating. Although results were sent back for all the samples, only one written report was properly summarized in publication (Carmi 1987: 101). These samples were treated at the Department of Isotope Research, in the Weizmann Institute of Science (Rehovot, Israel) by Dr. Israel Carmi and his assistants. Two proportional counters were used: (1) 0.5 litre volume, 0.865 ± 0.023 cpm background, 12.830 ± 0.134 cpm NBS oxalic acid standard. (2) 0.25 litre volume, 0.484 ± 0.023 cpm background, 6.185 ± 0.123 cpm NBS oxalic acid standard. A passive shield was increased by 2 cm of mercury next to the counters. For anti-coincidence, a modular gas counter was used. Data acquisition and processing was carried out with a scaler/buffer built at the Institute and an IBM PC computer. Samples were filled into the counters and counted for ca. 1000 min. at least twice. For other details of the processing of the samples, see Carmi, Noter, and Schlesinger 1971: 412.

Results:

1. RT-609 (CAHEP, 1981): Beam from possible lifting frame found under large kurkar block in Area D at a depth of 8.7 m in a grey sand mixed with gravel, shells, and Byzantine sherds and coins.
   1470 BP ± 50.
2. RT-631A (CAHEP, 1983): Timber of white wood from the harbour Entrance Channel, at a depth of 10.1 m (see above Appendix A, Table 1: no. 13). The archaeological context is of first or early second century A.C. $\check{S}^{13}C$ = 26.4%.
   2210 BP ± 190.
3. RT-631B (CAHEP, 1983): Sleeper beam (Silver fir) of the formwork in Area G, at a depth of 6.1 m (see above, Appendix A, Table 2: no. 3). $\check{S}^{13}C$ = 25.8%.
   1970 BP ± 70.
4. RT-645 (CAHEP, 1983): Piece of Pine strake (plank a) from the Roman Wreck in Area Y, at a depth of 2.1 m (see Appendix A, Table 4: no. 5). Exposed to the water for considerable time, on several occasions.
   1870 ± 60.
5. RT-653B (CAHEP, 1983): Piece from frame no. 31 from the Roman Wreck in Area Y, at a depth of 2.2 m (see Appendix A, Table 4: nos. 1-2). Exposed to the open water for a considerable period, on several occasions. $\check{S}^{13}C$ = 28%.
   1990 BP ± 140.
6. RT-653C (CAHEP, 1983): Fragment of frame no. 26 (half frame) from the Roman Wreck in Area Y, at a depth of 2.3 m (see Appendix A, Table 4: nos. 3-4). Exposed to the open water a few times before the excavations. $\check{S}^{13}C$ = 26.6%.
   1990 BP ± 140.

7. RT-680B (CAHEP, 1983): Tenon from strake (plank k) from the Roman Wreck in Area Y, from the deeper part of the preserved hull, at a depth of 2.7 m (see Appendix A, Table 4: no. 12).
   1990 BP ± 100.
8. RT-680A (CAHEP, 1983): Tenon from strake (plank j) found far south of the rest of the hull of the Roman Wreck in Area Y, from a depth of 2.4 m (see Appendix A, Table 4: no. 11). Exposed to the open water at least in recent years. $\check{S}^{13}C = 27.1\%$.
   1930 BP ± 220.

All the dates are based on a half-life of 5568 years. Calibration factors were not calculated, although several might be considered. The first is the alternate half-life of 5732 years, and then there are the various suggestions for calibration based on tree rings of bristlecone pine and other means (see Stuiver & Pearson 1986). There are also some new theories about marine specimens in the Mediterranean being older than the radiocarbon dating by as much as 135 ± 85 years (Stuiver, Pearson, and Braziumas 1986, fig. 10B). As a result, the dates shown above may be far from accurate. The calculated calibrations would possibly add as much as 5-10% to their date, or at least this will be the trend.

[A.R.]

APPENDIX IIIC: CHEMICAL ANALYSIS OF MORTAR

Appendix III.C.1: Gross Chemical Analysis.

Three of the samples that were brought to the archaeometric labs of Tel Aviv University were non-organic fragments of mortar. Two were extracted from the concrete block in Area G. No. 1 is typical of the fill between the double walls of the form. No. 2 was extracted from the matrix that cemented the rubble fill within the form itself. No. 3 was collected in Area D_2, where an attempt was made to expose the original western face of the harbour Entrance Channel. This piece of concrete was extracted from what looked like a decomposed concrete block, similar to others that might have made up the bulk of the breakwater's volume. Eventually, it became clear that these chunks had been carried away by waves from their original location, perhaps already in antiquity. Unfortunately, the lab at Tel Aviv gave the data with no interpretation and with no credit for the people who did the analysis. The samples were dried in the lab at a temperature of 150° C before the process. The analysis was made in a spectrographic technique (see Richards & Hartley 1960).

Table 1. Gross Chemical Analysis of Mortar, CAHEP 1982.

Sample	Lab.no.	SiO_2%	CaO%	MgO%	F_2O_3%	SO_4%	Al_2O_3%
1.	23658	13.98	33.24	9.30	1.30	n.d.	4.40
					H 150° 23.5 Lo 600° 18.2 900° 36.0		
2.	23657	37.48	6.30	21.13	2.07	n.d.	9.80
					H 150° 23.1 Lo 600° 16.2 900° 20.0		
3.	23659	42.30	15.44	4.80	4.15	n.d.	7.73
					H 150° 16.8 Lo 600° 14.4 900° 20.2		

[n.d.= not detected]

[N.L., S.L-Y., Y.W.]

Appendix III.C.2: Major Element Analysis.

Major element and trace element analysis was performed on several samples of mortar and tuff collected in the harbour basin in 1982 and 1983, as part of the attempt to find the source of the volcanic material used in the mortar. G. Branton of the Department of Chemistry, University of Victoria, and J.P. Oleson will report in Volume IV on the results of the trace element analysis of the pure volcanic materials. One of the mortar samples, collected from the large block north of the Subsidiary Breakwater in Area E_2, was subjected to Plasma Emission Spectroscopy at Quanta Trace Laboratories in Burnaby B.C. (Lab. reference #4739-016). The method used was alkaline fusion of 0.100 g of sample material. The sample was prepared by grinding approximately 75 g of mortar, isolated from any large coarse aggregate.

Table 2. Major Element Analysis of Mortar, CAHEP 1983.

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O
48.3%	12.2%	2.20%	4.89%	9.24%	2.84%	3.50%
BaO	MnO	P_2O_5	SrO	TiO_2	ZrO_2	
0.013%	0.096%	<0.09%	0.031%	0.36%	0.02%	

Loss on ignition: 16.49%.

[J.P.O.]

APPENDIX III.D: PHYSICAL ANALYSIS OF MORTAR

The following information is for the most part adapted from reports submitted in February and April, 1987 by Gordon E. Brown, Concrete Consultant (R.R. #3, Caledon East, Ontario L0N 1E0). Sample no. 1 analyzed here was taken from the same fragment for which major element analysis is given in Appendix III.C: the concrete block in Area E_2, north of the Subsidiary Breakwater. Sample no. 2 was taken from the mortar filling of the hollow wall of the formwork in Area G.

Sample no. 1: Mortar from Concrete Block in Area E_2.

The mortar is classified here as concrete. It is grey, with dark brown, porous coarse aggregate up to 25 mm D. The fine aggregate is brown and contains particles of pumice. The material has some porosity, typical of what would be expected from undercompacted concrete placed underwater. Unit weight was calculated from the measured bulk specific gravity in a saturated, surface dry condition. Absorption was measured after 24 hour immersion in 20°C water. This sample did not contain any large coarse aggregate and consequently was lighter than most Roman concrete. A small cube (28 mm x 29 mm) was cut and prepared for a compression test. The Moh hardness of the interior of the sample was measured and the estimated compressive strength taken from a graph produced from the testing of 38 samples from other ancient sites, and their subjection to linear regression analysis. These data can be used to estimate compressive strength in the field.

Unit weight: 1574 kg/m^3.
Absorption: 33.3%.
Moh hardness: 2.5.
Estimated compressive strength: 10 MPa.
Actual cube compressive strength: 6.6 MPa.

A modified version of the ASTM 457 Modified Point Count was used to estimate the paste and aggregate content. The test excluded counting any coarse aggregate and was confined to the mortar fraction only. Calculations were made considering the specific gravity of the materials to give an estimate of the lime content, by bulk volume. The weight of the materials was calculated as follows: lime, 40 lb./cu.ft.; fine aggregate, 64 lb./cu.ft.

Ratio of lime to fine aggregate: 1:2.0.

Since this calculation is only an estimate, it may be coincidental that the ratio is the same as that specified by Vitruvius (5.12.5) for hydraulic mortar. Samples of ancient concrete are normally carbonated throughout, so no reaction with phenolphthalein occurs.

Carbonation: complete.

The fine aggregate consisted of an acid-insoluble material containing a brown pumice, probably the imported pozzolana. The coarse aggregate was dark brown, somewhat porous, and the specific gravity test suggested it was a coarse fraction of the imported pozzolana (fine aggregate). The specific gravity of the natural coarse aggregate at Caesarea is in the range of 2.60-2.70. This figure is supported by a specific gravity of 2.70 found in the coarse aggregate used in the concrete for the aqueduct at Caesarea. Although the sample submitted for analysis contained only a fine aggregate and some coarse particles of similar material, large, boulder-size coarse aggregate was used to complete the matrix of the concrete. The specific gravity and absorption of the fine and coarse aggregate were calculated, in so far as it was possible.

Apparent specific gravity: coarse aggregate, 2.26; fine aggregate, 1.58.
Absorption: coarse aggregate, 6.9%; fine aggregate, undetermined.

X-Ray Diffraction analysis of the samples was carried out by Dr. R. Hooton, University of Toronto.

Major: Calcite ($CaCO_3$) and α Quartz (SiO_2).
Minor: Feldspars, such as Albite ($NaAlSi_4O_{12}$), Zeolite ($K_2Al_2Si_4O_{12}NH_{20}$).

The detection of CSH (hydrates formed by hydraulic cements or pozzolanic mortars) by X-Ray Diffraction is difficult, since CSH is a very poor diffractor. The minor constituent, Zeolite, is known to be pozzolanic.

Sample no. 2: Mortar Filling from Formwork Wall, Area G.

The material was classified as mortar. It was a light grey, fine-grained mortar containing very little fine aggregate. The test methods described above produced the following results:

Unit weight: 1425 kg/m^3.
Absorption: 66.7%.
Moh hardness: 2.
Estimated compressive strength: 7 MPa.
Carbonation: complete.

The sample was subjected to X-Ray Diffraction by Dr. R.D. Hooton of the University of Toronto.

Major: Calcium Carbonate ($CaCO_3$), Calcite ($CaCO_3$).
Medium: α Quartz (SiO_2).

There was a significant amorphous halo, possibly caused by CSH (Calcium Silicate Hydrates).

The unit weight of the sample was of particular interest. The standard test calls for immersion in water for 24 hours. The sample absorbed 66.7% moisture, and the unit weight was recorded at 1425 kg/m^3. When dry, however, the sample had a unit weight of 855 kg/m^3. In other words, when dry, this mortar would float in water for a short time, until it absorbed sufficient water to sink. Microscopic examination indicated that the sample may have contained the same pozzolana as the concrete of Sample no. 1, but that the lime and pozzolana were ground to a

fineness that promoted rapid hardening. The Calcium Silicate Hydrates possibly revealed in the X-Ray Diffraction analysis are products typical of a finely-ground, superior hydraulic mortar, supporting the microscopic examination. The possible reasons for the employment of this special type of mortar will be examined in Volume IV.

[J.P.O.]

CHAPTER IV: CAHEP SURVEYS

IV.A: Architectural Survey on Land.

The survey of all recognizable antiquities on land included the mapping of partially submerged features along the coast, as well as documentation of standing remains and structures excavated by the different teams that have worked at the site in the past. The final product of the survey will be a Master Urban Plan which will ultimately include all significant remains of Caesarea and its environs. A preliminary version of that plan is published here (pl. I), and the final series will follow in Volume IV.

The first map of major architectural features of the city was that of Conder and Kitchner, produced at the end of a brief visit in the spring of 1873 (Conder & Kitchner 1882: 13-29). Several other sketch plans of the site were published in the early twentieth century, but no substantial new surveying was carried out until Edward Russell of Cornell University prepared an urban plan for JECM, an abbreviated version of which was published in 1986 (Bull, Krentz, Storvick 1986: 33, fig. 2). The plan was drawn at a scale of 1:2500 and was based on the British Ordinance Survey, the same one used by CAHEP.

The recording of ancient and medieval structural features along the shore-line was included in the CMS report to the IES in 1976 and has been combined with the contemporary work published by the JECM. Among the major features from north to south are the Sea-Walls and associated Quay in Area J, the Pavement in Area L, the massive line of column shafts (tentatively identified as a Crusader Jetty), a Quay Wall of reused ashlars in Area S, the submerged walls and Rectangular and Round Towers in Area T, the fortifications of the Crusader Citadel in Areas M and Q, and the submerged pavement just north of the Piscina. Each of these has been surveyed and measured stone by stone, placed on the Master Urban Plan, and drawn separately in plan and elevation. In some instances, such as in Areas J, L, S, M, and Q, additional data have been gathered through excavation since 1985.

Not all our objectives have been realized. Documentation of the relationship between the South Bay and Field C of the Joint Expedition, south of the Crusader city, would have been most instructive for a complete understanding of the way in which the Herodian warehouses and the quay walls or streets were organized. The possibility of excavating in this area not only depends upon the cooperation of CAHEP and the Joint Expedition, each holding separate permits for different parts of the site, but also is complicated by the presence of a beach road leading to parking facilities used by both local fishermen and the large crowds attending evening performances in the restored Herodian theater.

The complete Master Plan will also include the locations of all excavations at the site since organized exploration started during the 1940s. No map to date has included the locations of the early British and Israeli excavations before and after independence. Likewise, the work by Avi-Yonah within the Crusader fortifications has never been properly recorded, although its general location is now surveyed and included on the plan. In fact, a plan of this type is never complete and must continually be augmented with additional structures.

[R.L.V.]

IV.B: Survey of the South Bay.

The South Bay today is a slight bight in the coast to the south of the Southern Breakwater (figs. I.11, IV.2). It extends ca. 500 m south of the Outer Basin to the kurkar promontory into which the Piscina has been cut. It stands completely open to the sea, affording no protection from even the afternoon waves of a typical summer's day, but in antiquity the configuration may have been different. Submerged bed-rock and rubble spill mark the entire coast and hint at ancient structures on the shore destroyed long ago by the sea. In addition, the presence of beach-rock along the entire length of shore suggests that it is currently eroding (fig. IV.3). The ancient shore-line may well have been 10-15 m farther west (Oleson et al. 1984: 268, n. 16). Divers from the University of Haifa also discovered a submerged section of floor near the promontory that also speaks to a changing coast-line (see Section II.B.4).

Most scholars agree that the South Bay played some role in the maritime life of Caesarea (e.g. Raban & Hohlfelder 1981: 63). As recently as 1950, before the advent of underwater explorations at the site, Reifenberg incorrectly placed the main harbour described by Josephus (Appendix I.A) in this location (Reifenberg 1950-51). In fact, the South Bay may be intended by this ancient author in his oblique reference to the secondary anchorages that existed at Caesarea (*BJ* 1.410).

Although clearly an auxiliary facility to the great artificial Outer Basin described in detail by Josephus in the same text, it appears the South Bay could, and did, handle a great many commercial activites when sea conditions permitted. One archaeologist has estimated that over 100 *horrea* (warehouses) dating back to the Herodian era existed along its shores (Bull 1982: 36). Recent land excavations conducted by the JECM have uncovered evidence suggesting that the one vaulted storage facility it has excavated completely was in service from Caesarea's foundation (fig. I.8, no. 27, pl. I, no. 31). It was used into the Roman era in a variety of ways, such as a Mithraeum, and remodeled accordingly (Bull et al. 1986). Diagnostic sherds from the earliest stratum in this building included numerous transport amphoras from around the Mediterranean basin (Blakely 1987, 1988; Holum et al. 1988: 137). In particular, a number of *garum* amphoras from the Iberian peninsula were discovered here. The other warehouses still awaiting excavation nearby most likely were constructed at the same time and followed the same longevity and diversity of use until the buildings fell out of service following the Arab occupation in the mid-seventh century.

If so, the South Bay had a huge storage capacity for incoming and outgoing cargo during the period Caesarea functioned as an international emporium. While commodities from and for merchantmen moored in the Outer Basin could have been transported by carts to and from these warehouses, it would have been much simpler and more efficient if these transport containers could have been loaded on and off ships moored adjacent to the warehouses themselves. Thus, the very existence of these shore-line storage magazines argues for a major commercial role for this anchorage in the life of the port and suggests that the South Bay may have been a more protected anchorage in antiquity. Perhaps the slight natural protection afforded by the breakwaters and the southern promontory were augmented in some way by Herod's engineers as part of the original design of Sebastos.

CAHEP's 1983 survey was not the first one to attempt to define the role of the South Bay in the port's life. The Link Expedition did not systematically examine this ancient feature during its one season in 1960 (Section II.B.1). Later on in the 1960's, Elisha Linder of the University of Haifa, who had organized a group of Israeli navy divers as the Israel Undersea Exploration Society (IUES), conducted various surveys of the whole harbour area with this group and various foreign collaborators (Section II.B.2; Linder & Leenhardt 1964). His efforts included an examination of the South Bay.

In 1976, an extensive survey was undertaken by Raban and Flemming as part of a comprehensive examination of the Caesarea coast-line conducted by the CMS for the Israel Electric Company (Section II.B.3). Subsequently, the students and staff of CMS also explored this area during workshops conducted in the summers of 1978-1980 and discovered a section of pavement near the base of the Piscina promontory (Section II.B.4). Hohlfelder and Oleson also briefly reconnoitered this section of submerged coast-line in 1978 (Hohlfelder & Oleson 1980; Section II.B.5).

After the results of all these efforts were collated by CAHEP, some inconsistencies and unanswered questions remained in the archaeological record. In 1983, a systematic survey of all visible underwater features in the bay was carried out by teams of divers. This detailed investigation, intended to expand and reconcile previous searches, was undertaken in an attempt to define the original configuration of the South Bay in antiquity and to see if any man-made structures had existed there. In particular, exploration was focused on three different locations.

At the north side of the bay, a long arm of rock protrudes from the base of the Southern Breakwater to the SW for a distance of ca. 75 m before disappearing beneath the sand (fig. I.11). In appearance, it looks like a purposeful appendage to the main anchorage in the lee of the larger installation. This impression is reinforced by a large rubble concentration ca. 200 m SE of the terminus of this arm. It too looks like the badly damaged remains of a breakwater built out from shore to create and enclose a small basin. The third area of concern was the Piscina promontory itself (Section III.N; figs. I.11, III.135, pl. I, no. 41). Its actual configuration is now obscured both by the sandy bottom and by rubble that has toppled from what may have been a Byzantine fortification wall. Did it extend farther west or even NW in antiquity to serve as an enclosing arm for the South Bay? The CAHEP survey was designed to answer these questions.

The primary method of exploration was placement of two 40-metre long probe lines along the main axes of the northern and central features to see if they continued beneath the present sandy sea-bottom, and if so, to trace their dimensions and orientation (see fig. I.11, Lines A-B and K-L). In addition, 20-metre long probe lines were marked out at the visible end of the promontory to the south (Lines H-I) and at other locations on the northern arm (Lines C-D, E-F, A'-B', and A"-B").

The jet-probing was carried out by a team of two divers (see Section IV.E). One diver, wearing twin 80 cu.ft. tanks, carried an air-jet probe made from 2 m lengths of narrow pipe (0.02 m in diameter) attached by screw joints (fig. IV.17). This was fed air from the SCUBA tanks through a yoke and flexible plastic hose (Oleson et al. 1984: 286). The other diver recorded data on a plastic slate. A probe line marked in metre increments or an underwater tape measure was placed on the ocean floor in the desired location, its position checked by compass readings. At every metre mark along the lines, the diver with the jet-probe engaged a trigger mechanism to release a jet of air from the end of the pipe, enabling him to penetrate the sand until reaching solid rock or to the limit of the pipe sections in use. The second diver recorded data: the metre mark, the depth of penetration before a blockage was reached, and the depth of water over the probe point. In the shallow water of the South Bay (ca. 5-8 m average over the probe lines), this team could conduct 15-20 probes before exhausting the air supply in the twin 80 tanks. The team would then surface for full tanks, verify their assignments, and continue the investigation. This jet-probing device, designed by Stephen Breitstein of CMS, is more mobile and better suited for underwater explorations conducted over a large area than the prototype model, which employed a water-jet and was created by John Lewis for use in the Cosa excavations (Lewis 1973: 247).

Using this system, it is relatively easy to trace submerged structures that are at present covered with bottom sand and to recover an accurate reading of their original dimensions and orientation. In the case of CAHEP's probes in the South Bay, however, all were negative. None of the three major submerged features explored was substantially larger in antiquity than it appears today, nor did they exhibit any changes in direction. In all instances, the probes also recorded a gradual seaward slope similar to that of the visible portion of the rock and rubble concentrations investigated. It also appeared that none of these projections was man-made, although rubble may have been consciously dumped on the northern arm at some point.

Given the improper orientation and insufficient size of the northern, central, and southern features, and the absence of any sub-bottom continuation of any of these projections, it is very unlikely that any of these submerged features were important components of a harbour in the South Bay. Their submarine profile probably has not changed significantly over the centuries and may well closely resemble their configuration in antiquity.

If there were no man-made or natural enclosing arms creating a harbour in the South Bay, how can one explain the presence of the numerous shore-line *horrea*? It seems most likely that this bay was always a secondary anchorage, more specifically a fair-weather haven. It was too exposed to the volatile sea conditions along this section of the Levantine coast, and to the storms that come from the SW ever

to have served as Caesarea's main harbour. But when the seas were calm, usually from the dawn to mid-morning during the normal sailing months in antiquity (April to October; Casson 1971: 270), ships could have been drawn by hawsers to a quay fronting the entire line of warehouses for easy loading and unloading. When conditions deteriorated, the ships would have been pulled or sailed back to a safer offshore anchorage.

In this way, the South Bay could have served the port's needs. It was never an all-weather roadstead, but would not have been needed as one, since the Outer Basin served that purpose. It did function nicely, however, as a secondary facility for Caesarea. In fact, long before Herod's city rose from the sand dunes, the bay had attracted ancient mariners when weather conditions permitted. A stone anchor discovered adjacent to the northern arm suggests such use as early as the Late Bronze Age (see Volume II).

Professor Bull has mentioned uncovering the remains of a road along the sea front west of the warehouses. Presumably, it topped a quay, but details of his excavation have not yet been published (Bull 1982: 36). The recovery of extensive evidence for either of these proposed features is unlikely at present, for a modern road now extends the length of the South Bay's shore-line in front of the *horrea*. It was constructed of fill from the Italian Mission's excavation of the theatre (Section II.A.5) and conceals whatever survives of earlier structures. The receding coast has destroyed any remains seaward of the present road, although the submerged rubble spill paralleling the coast may derive in part from its ancient counterpart.

[R.L.H.]

IV.C: Survey Lines and Section Drawings.

Procedures. In 1980, a few marked survey lines (abbreviation: SL) were laid out from Area A (near the south end of the Inner Quay along the inside face of the Southern Breakwater) across the adjacent breakwater mass. The resulting data allowed preparation of rough reconstruction sketches of the breakwater's cross section. The 1980 survey lines were executed by Dr. William Murray, University of South Florida, who assisted with field direction of the 1983 season as well. In 1983 eight such survey lines (nos. 1-8) were laid down across the Southern Breakwater by Oleson and Sherwood as part of a project to prepare a comprehensive set of detailed sectional elevation drawings for both breakwaters. In 1984, Oleson and Sherwood laid out four more survey lines (nos. 9-11 and 16) on the Southern Breakwater and four on the Northern Breakwater (nos. 12-15) (fig. IV.5). Finally, in 1986 Avner Raban laid out and surveyed SL no. 17 from south to north along the spine of the Southern Breakwater. In such a vast harbour site, only scale drawings of this nature can give a precise idea of the present configuration of the structural remains of the breakwater and the arrangement of the materials used in building it. The ultimate purpose of the survey lines was to provide information allowing reconstruction of the original mass of these structures, their design, and the process of their construction. The results of the survey for the most part appear in Volume IV, and only the raw data are presented here, accompanied by a brief summation of their significance.

The lines themselves were plastic-covered, steel airplane cables marked with coloured tape every metre and numbered distance tags every 5.0 m. The base or zero points for the survey lines were chosen and their bearings calculated so that their courses would extend over selected architectural features and (except for nos. 6, 12, and 16) run more or less perpendicular to the axis of the adjacent portion of the breakwater face. Each survey line was measured from a zero mark attached to a stake pounded into the sand at a point 5 to 10 m inside the inner face of the structure. The line then was played out along the selected bearing from a portable reel carried by two divers and anchored ca. 10 m beyond the visible outer edge of the breakwater (fig. IV.6). The survey lines varied in length from 40 m (no. 16) to 345 m (no. 12), with an average length of approximately 144 m. The total length of 2.465 km of surveyed lines represents a remarkable accomplishment for three seasons of underwater work.

Line Number	Bearing	Length
1	180°	100 m
2	235°	95 m
3	240°	130 m
4	240°	115 m
5	270°	135 m
6	330°	110 m
7	280°	160 m
8	290°	190 m
9	300°	200 m
10	310°	180 m
11	320°	190 m
12	100°	345 m
13	10°	85 m
14	10°	80 m
15	10°	75 m
16	30°	40 m
17	6°	235 m

It proved necessary to anchor the lines only at either end, since the cable is heavier than water and lay on the bottom, and the irregular surface of the breakwater prevented significant lateral movement even in heavy seas. Teams of three divers gathered data for sectional elevation drawings by working along the line with two 2.0-m long poles marked in centimeters, connected by a 10-m line marked in metres. Two divers set the poles on the survey line 10 m apart and drew the 10-m line tight, allowing the third diver to level it with a bubble-level by sliding the extremities of the line up or down the marked poles (fig. IV.7). This last diver then noted the elevation of the temporary base-line at either end and its location on the survey line, and recorded elevations along the breakwater mass beneath it at 1.0-m intervals. For each 10-m unit the diver recorded 10 elevations, prepared a sectional elevation sketch with a graphite pencil on sheets of mylar, and made notes concerning building materials. An air-jet probe was used to provide data on those portions of the breakwater covered by sand. A more detailed check of materials and structural features was carried out later by separate teams of divers using hammers to remove surface concretions and take samples, and all

the data were entered on a preliminary drawing. This drawing then was checked against the survey line itself by the architects, who later prepared the final sectional elevation drawings. Reduced copies of these drawings appear here as plates II-V. The most significant data from each survey line have been incorporated in these drawings, and further details are provided in written form in the descriptions below. In the tabulation of the data, reference is made to points along the survey lines as "metre mark 'x'," abbreviated to "m 'x'", to avoid confusion with the depth readings and measurements of features in which the "m" follows the number. All depths are below MSL; for features still buried below the sand, depths are given both to the sand and to the top of the buried feature. For the most part, the description of the breakwater given for each survey line is based on the structural remains observed for approximately 1 m to either side of the actual line. Note was made, however, of significant features up to 10 m on either side of the line, and many of these are commented upon here. The depth readings are given for all significant features, and regularly at 10-m intervals along the lines. The great size of the features noted along the Survey Lines, combined with the presence of very thick incrustation and generally poor visibility have meant that photographs are of very little use for illustration of the following discussion. Many photographs were taken for the record, but -- with a few prominent exceptions -- they are of little use in illustrating the shape or material of the features on the breakwater. Figure IV.4 gives a good impression of the general appearance of the breakwater surface. As a result of these difficulties, the reader will have to depend on the sectional elevation drawings for details.

Survey Line no. 1. Survey Line no. 1 was laid out across the base of the Southern Breakwater to clarify the connection between the main breakwater mass and the Subsidiary Breakwater to the south (pl. II). Some of the results are presented above, in the discussion of Area E_2. The base point, approximately 70 m from the west end of Area F at a bearing of 265°, was selected so that a line laid from it for 100 m at a bearing of 180° would pass over the visible east end of the Subsidiary Breakwater, where it joins the main breakwater mass. The line was tangent to the east edge of Area E_2.

Description of Features, SL no. 1:

m 0-5: rubble covered by a layer of sand decreasing gradually in thickness from 0.75 to 0.1 m. Depth at m 0: 7.45 (to sand, 6.7 m).

m 5-20: gentle slope of tumbled kurkar rubble and occasional kurkar blocks 1.5 x 0.6 x 0.4 m. Kurkar block at m 18.5: 2.0 x 1.3 x 1.3 m. Depth at m 10: 6.75 m; at m 20: 5.9 m.

m 20-40: breakwater core, composed of a tumbled heap of broken and eroded kurkar blocks up to 3 m in length. Depth at m 30: 5.4 m. The heap crests between m 26 and m 32, then slopes downward to the south at about 45 degrees to a depth of 8.3 m at the m 40 mark. The foot of the slope is revetted with large, irregular masses of concrete (D ca. 1.0 m), beyond which extends an apron of small, smooth pieces of kurkar and limestone rubble (D ca. 0.1-0.2 m) 6 m wide.

m 40-44: rubble apron.

m 44-57: sand. At present a layer of sand covers the space between the Southern and Subsidiary Breakwaters, concealing all structural remains except for some large kurkar blocks with maximum dimensions of 1.5 to 2.5 m. Sub-bottom probes revealed a layer of rubble 0.8 to 1.2 m below the sand. Depth at m 50: 10.4 m (to sand, 9.2 m).

m 57-70: a low ridge of small kurkar rubble interspersed with large kurkar masses rises 1.0 m above the sand, probably similar in character to the section hidden below the sand at m 38 to m 44. Depth at m 60: 9.1 m; at m 70: 8.7 m.

m 70-100: the line in this area skirts the east edge of Area E_2 and crosses the main body of the Subsidiary Breakwater and its footings to the north and south. For a full description of the structure see the discussion of Area E (Section III.D). Collapse of the Subsidiary Breakwater has produced sloping berms of kurkar rubble to the north and south, interspersed occasionally on the north with the remains of eroded concrete blocks (max. D 1.5 m). The slope rises from a depth of 8.7 m at m 70 to 7.5 m at the crest (m 78). The roughly horizontal rubble crest extends from m 77 to m 85, then slopes rapidly to the south beneath the sandy sea bottom. Depth at m 80: 7.9 m; at m 90: 8.6 m (to sand, 7.7 m); at m 100: 8.8 m (to sand, 7.8 m).

Summary. Survey Line no. 1 showed that (at its point of intersection) the remains of the main breakwater mass are ca. 25 m wide. The structure is composed largely of tumbled and broken kurkar blocks and masses and rises to a height of 3.5 m above the sea-floor along its outer face. A few tumbled concrete masses revetted the outer face, above a bedding of small kurkar rubble. The remains of the Subsidiary Breakwater are now ca. 15 m wide but only 8 m across the crest, which rises ca. 1.5 m above the present sea-bottom, 2.5 m above its southern footings. The construction was carried out with kurkar rubble and blocks, with the occasional use of large masses of concrete to stabilize certain sections.

Survey Line no. 2. Survey Line no. 2 was laid out across an apparently narrow portion of the Southern Breakwater to the tip of the Subsidiary Breakwater (pl. II). It was designed to clarify the character and relationship of both structures. The base point was located midway between the base point of SL no. 1 and the edge of Area N_1. The line was laid out for 95 m at a bearing of 235°.

Description of Features, SL no. 2:

m 0-5: rubble covered by a layer of sand decreasing in thickness from 0.9 to 0.1 m. Depth at m 0: 7.7 m (to sand, 6.8 m).

m 5-10: small kurkar rubble (D ca. 0.15-0.25 m). Depth at m 10: 6.4 m.

m 10-35: main core of breakwater. At m 10 the average diameter of the kurkar rubble increases to ca. 0.5-0.7 m, and a few tumbled kurkar blocks appear scattered across the surface: avg. size 2.0 x 1.5 x 1.0 m. These materials rise along an even slope to the crest of the breakwater at m 24: depth 4.9 m. From m 20 to m 30, the crest is formed of tumbled kurkar rubble with an avg. D of 0.8-1.5 m. The rubble is naturally concreted, but marked with deep fissures caused by settling. Depth at m 20: 5.5 m; at m 30: 5.3 m.

m 35-40: south face of breakwater. Sloping field of irregular kurkar rubble (max. D 0.2-1.0 m). Depth at m 40: 7.9 m.

m 40-82: sand, through which projects an irregular kurkar mass 2 m in diameter at m 48. Probing of the sand revealed the presence of an irregular but more or less horizontal layer of rubble from 1.2 to 1.8 m below the sand, and occasional lenses of grey clay at 0.40 m below the surface. Depth at m 50: 9.4 m (to sand, 7.9 m); at m 60: 9.1 m (to sand, 7.7 m); at m 70: 9.5 m (to sand, 7.7 m); at m 80: 8.2 m (to sand, 7.6 m).

m 82-85: visible portion of Subsidiary Breakwater, consisting of irregular kurkar rubble (max. D 0.15-0.5 m). The structural remains slope down gently toward the north and south beneath the sand. Depth at m 83 (crest): 7.2 m.

m 85-95: sand. For the profile across the Subsidiary Breakwater see the discussion in Section III.D. Depth at m 95: 8.6 m (to sand, 7.6 m).

Summary. Survey Line no. 2, like SL no. 1, showed that the remains of the main breakwater are approximately 25 m across at the point of intersection. On this line, however, no remains of concrete blocks were found along the outer face. The main breakwater here has begun to curve to the north, away from the Subsidiary Breakwater, which is separated from it by a sand-covered depression 47 m across. The Subsidiary Breakwater is slightly narrower at SL no. 2 than at SL no. 1 but rests at approximately the same depth.

Survey Line no. 3. Survey Line no. 3 was positioned to cross several large, well-preserved concrete blocks and clarify their relationship to the rest of the breakwater (pl. II). From the base point 5 m inside the visible inner edge of the remains of the Southern Breakwater, the line was laid out for 130 m at a bearing of 240°, extending 10 m beyond the visible outer edge.

Description of Features, SL no. 3:

m 0-5: rubble covered by a layer of sand decreasing gradually in thickness from 0.75 to 0.1 m. Depth at m 0: 8.25 m (to sand, 7.5 m).

m 5-11: tumbled kurkar rubble (max. D 0.15-0.60 m). Depth at m 10: 7.5 m. A probe through the rubble revealed that it is a thin layer of spill overlying at least 2 m of clear sand.

m 11-21: edge of main breakwater structure, marked by larger kurkar rubble (max. D 0.7-1.0 m), a kurkar block (4.4 x 2.3 x 1.5 m), and an amorphous mass of concrete at m 19 (max. D 3.0 m). Depth at m 20: 5.8 m.

m 21-39: sloping heap of tumbled kurkar rubble varying in max. D from 0.2 to 1.5 m. Depth at m 30: 6.2 m.

m 39-55: core of breakwater, composed of large concrete blocks set in kurkar rubble, cresting at m 51 at a depth of 3.9 m. At the crest the line passes over a tipped concrete block. Its upper surface is marked with a cross from the wooden tie beams that held together the formwork into which the concrete was poured: block 4.7 x 3.4 x 1.7 m; beam casts ca. 0.3 m square (figs. IV.8-13). There are similar blocks adjacent to this one on the east and west, and many enormous, eroded concrete masses (max. D 1.7 to 4 m) along the north slope of the core, from m 39 to 50. Depth at m 40: 5.2 m; at m 50: 5.0 m.

m 55-70: outer face of breakwater core, composed of kurkar rubble sloping down markedly from a depth of 5.0 to 8.5 m. Depth at m 60: 6.5 m; at m 70: 8.5 m.

m 70-97: scattered concrete and kurkar blocks and masses overlying sand and kurkar rubble. The concrete block at m 71 is one of the largest concrete masses in the harbour: ca. 7 x 8 x 4 m (fig. IV.14). There are numerous other concrete masses along this stretch of the survey line, varying in maximum diameter from 2 to 4 m, and several worn kurkar blocks (4 x 2 x 2 m). The blocks are surrounded by sand which conceals a layer of kurkar rubble varying in thickness from 0.1 to 2.0 m. Depth at m 80: 9.8 m (to sand, 9.5 m); at m 90: 10 m (to sand, 9.5 m).

m 97-130: continuation of sand-covered layer of rubble, interspersed with a few eroded kurkar masses at m 105 (max. D 2.6 m) and m 121 (max. D 2.0 m). The layer of sand averages 0.5 m in thickness. Depth at m 100: 10 m (to sand, 9.2 m); at m 110: 9.8 m (to sand, 9.1 m); at m 120: 9.3 m (to sand, 9.1 m); at m 130: 10.45 m (to sand, 9.4 m).

Summary. Survey Line no. 3 crossed a better-preserved area of the breakwater than SL nos. 1 and 2. The structural remains here are ca. 70 m wide and at their crest stand 5.5 m above the sea-floor outside. Again, the bulk of the structure is kurkar rubble, but scattered concrete masses appear on the inner face, and the crest is occupied by well-preserved concrete blocks. Some enormous concrete and kurkar masses lie in apparently random clusters for a distance of 25 m seaward of the main breakwater slope. Blocks of this size, which also appear elsewhere along the west and southwest portion of the breakwater, may have been part of a massive revetment designed to protect the structure from the winter storms that approached from this direction. No concrete or kurkar masses of this size are found inside the breakwaters.

Survey Line no. 4. Survey Line no. 4 was positioned to cross a well-preserved section of the Inner Quay along the inside face of the Southern Breakwater at Area B (Section III.B), and to touch the south edge of what appeared in aerial photographs to be a recess in the outer face of the breakwater ca. 60 m on a side (pl. II). This line, which crossed the breakwater at a bearing of 240° and extended 115 m, was designed to provide information on the relationships between the quay, the core of the breakwater, and the recess.

Description of Features, SL no. 4:

m 0-10: rubble covered by sand through which project several kurkar masses (D 1.0-1.6 m). The sand is 0.8 to 1.0 m thick. Depth at m 0: 8.1 m (to sand, 7.3 m); at m 10: 7.5 m.

m 10-20: Area B. Eroded kurkar blocks of quay (2-2.5 x 1 x 1 m), bedded partly on sand, partly on small kurkar rubble. Depth at m 15 (centre of wall section): 7.3 m. Depth at m 20: 7.6 m.

m 20-45: core of breakwater, composed mainly of irregular kurkar rubble (max. D 0.15-1.0 m). The inner face of the structure rises steeply to a crest at m 24 (depth: 5.8 m), then slopes gradually downward to a depth of 8.2 m at m 45. There are several eroded kurkar blocks (L 2.3-3.0 m) embedded in the surface of the rubble at m 27, and two large concrete blocks halfway down the outside slope, from m 30 to m 33: 3 x 2 x 1 m and 4.5 x 4 x 1.5 m. Depth at m 30: 6 m; at m 40: 7.6 m.

m 45-75: broad field of large, badly broken and eroded kurkar and concrete blocks, sloping gradually down to a depth of 8.5 m at m 59, then up to a depth of 7.5 m at m 75. The blocks rest on small kurkar rubble. Large kurkar masses, the eroded remains of blocks, appear at m 46 (max. D 2.5 m), m 50 (max. D 6 m), and m 55 (max. D 5 m). An irregular concrete mass at m 65, with maximum diameter of 6 m, is surrounded by smaller fragments. Another concrete mass 2.5 m in diameter appears at m 74. The zero point of SL no. 6 is located at m 70 on this line. Depth at m 50: 6.8 m; at m 60: 8 m; at m 70: 7.5 m.

m 75-103: sloping field of kurkar rubble interspersed with a few scattered kurkar masses (max. D 1.5 to 2 m). A kurkar block rests on the rubble at m 84: 6.0 x 2.4 x 1.3 m. Depth at m 80: 8 m; at m 90: 8.6 m; at m 100: 10.2 m.

m 103-115: sand, covering a layer of rubble that slopes gradually seaward. Depth at m 110: 11 m (to sand, 9.8 m); at m 115: 11.5 m (to sand, 9.8 m).

Summary. Survey Line no. 4 crossed a poorly-preserved portion of the Southern Breakwater approximately 70 m wide. At this point, the kurkar blocks of the N-S Inner Quay skirt it on the interior, resting on a cushion of kurkar rubble. The crest, which stands 4 m above the sandy sea-bottom, is composed of kurkar rubble with a concentration of large concrete and kurkar blocks 4 to 5 m long and ca. 2 m square along the outer slope. The field of large isolated kurkar and concrete blocks seaward of the breakwater crest may represent the remains of a portion of the breakwater core scattered by the action of the sea.

Survey Line no. 5. Survey Line no. 5 was oriented to pass across the line of the Inner Quay at Area A (Section III.B) and to touch the northern edge of the apparent recess in the outer face of the Southern Breakwater (pl. III). It extended for 135 m at a bearing of 270°. Like SL no. 4, no. 5 was designed to clarify the relationship between the quay wall, breakwater core, and recess.

Description of Features, SL no. 5:

m 0-21: undulating stratum of kurkar rubble, covered by a layer of sand 0.5 to 1.8 m thick through which project occasional masses of kurkar 0.5 to 1 m long. At m 7, the line crossed the blocks of the N-S Inner Quay, which are oriented more or less E-W: avg. 2.4 x 1 x 1 m. Depth at m 0: 9.4 m (to sand, 7.5 m); at m 10: 8.9 m (to sand, 8.3 m); at m 20: 9.2 m (to sand, 8.3 m).

m 21-60: scattered remnants of the breakwater core, composed of large concrete and kurkar masses and blocks in a field of kurkar rubble. There are heaps of rubble between m 21 and m 30 and between m 34 and 39, cresting at m 25 (depth, 6.8 m) and at m 36 (depth, 6.5 m). Several large kurkar blocks (avg. 3.7 x 1.7 x 0.6 m) rest against the west face of the first heap, at m 31. Elsewhere, enormous eroded masses of concrete 2 to 4.5 m square and up to 3 m high rise out of the field of kurkar rubble. The largest are at m 42 (depth at crest 5.6 m) and m 59 (depth at crest 6.5 m). Depth at m 30: 8 m; at m 40: 8.8 m; at m 50: 8.5 m; at m 60: 8.7 m (to crest of block, 6.5 m).

m 60-93: northeast corner of possible recess in outer face of breakwater. The remains of the breakwater at this point are at a slightly lower depth than the surrounding areas. They are composed of an irregular stratum of kurkar rubble covered by a layer of sand 0.2 to 1.0 m thick through which project kurkar masses and blocks (max. D 1.0 to 2.5 m). Depth at m 70: 9.0 m; at m 80: 9.5 m (to sand, 9.1 m), at m 90: 9.6 m (to sand, 9.1 m).

m 93-127: mound of kurkar rubble varying in diameter from 0.2 to 1.5 m, interspersed with occasional kurkar blocks and masses. The inner edge is faced with two large kurkar blocks (5.5 x 2.3 x 2.2 m), the upper surfaces of which are at a depth of 8 m. At m 95, SL no. 5 crosses the 105 m mark of SL no. 6. The mound of small rubble slopes down gradually from this level to a cluster of slightly larger kurkar rubble masses (max. D 1.5-2.0 m) at m 117-125. Depth at m 100: 8.5 m; at m 110: 8.3 m; at m 120: 9.3 m.

m 127-135: sand, beneath which a layer of rubble slopes gradually seaward. Depth at m 130: 9.7 m; at m 135: 11 m (to sand, 9.5 m).

Summary. Survey Line no. 5 provides much the same information as SL no. 4. It shows the Inner Quay wall resting on a layer of rubble and sand just inside and below the low rise of the breakwater core. The remains of the main breakwater, presently ca. 80-100 m wide, clearly have been scattered by the action of the waves, which may have shifted even some of the larger blocks. See also the summary of SL no. 6.

Survey Line no. 6. The structural remains in the area of SL nos. 4, 5, and 6 are more complex than those elsewhere along the Southern Breakwater (pl. III). Aerial photographs and our plan show an immense, roughly square recess in the outer face of the breakwater at this point, approximately halfway along its length. The apparent recess is ca. 60 m long from north to south, and about the same in width. In 1982 and 1983, a few isolated, large kurkar and concrete blocks protruded from the otherwise featureless sand within it. In 1984 much of this sand disappeared temporarily as a result of changes in currents and wave action, revealing a bed of tumbled, irregular kurkar rubble. The absence of contrast rendered the feature less distinct. Nevertheless, there is a distinct depression in the area. In view of the amount of material that has disappeared, it seems only remotely possible that the feature is the result of accidental erosion of a breakwater core of rubble at this point. The recess may, however, have a bearing on the theory that significant portions of the breakwater core was composed of cells of sand held in by surrounding heaps or walls of rubble (Raban 1985c, 1988: 189-93). In order to gain information about the character of the recess, SL no. 4 was laid out across the breakwater along the south edge of the feature and SL no. 5 just to its north. SL no. 6 was laid across it from south to north, from the m 70 mark of SL no. 4 to the m 95 mark of SL no. 5, for a distance of 110 m at a bearing of 330°.

Description of Features, SL no. 6:

m 0: m 70 mark of SL no. 4. Depth at m 0: 7.5 m.

m 0-43: rough field of irregular, tumbled kurkar rubble from which project occasional eroded masses of kurkar and concrete. Irregular concrete masses 2.5 to 3 m in diameter appear at m 6 and m 12, and a kurkar mass 2.5 m in diameter at m 27. The depth of the upper surface fluctuates between 8.6 and 7.2 m. The field of kurkar rubble slopes down markedly from a depth of 8.2 m at m 40 to 9 m at m 43, marking the the edge of the recess. Depth at m 10: 8.6 m; at m 20: 7.6 m; at m 30: 7.9 m; at m 40: 8.2 m.

m 43-58: cluster of large, eroded kurkar masses (D 2-3 m) surrounded by kurkar rubble. Depth at m 50: 8.9 m.

m 58-74: sand-covered depression. The rubble surrounding the kurkar masses of the previous section slopes down from a depth of 10 m at m 58.5 to 11.7 m at m 61. Depth at m 60: 11.5 m. Air-jet probes through the sand every metre revealed a more or less level stratum of rubble across this entire portion of the line, sloping upward at the north end from a depth of 11.1 m at m 70 to 9.6 m at m 74.

m 74-110: area of large kurkar blocks standing on a level stratum of small kurkar rubble (D 0.3-0.5 m), covered with a thin layer of sand. There is an irregular kurkar block (L 4 m) at m 80, a shapeless kurkar mass (D 1.5 m) at m 90, and a smaller block (2 x 0.7 x 0.7 m) at m 100. At m 105 the line crosses two enormous blocks of kurkar (see SL no. 5 m 95). Depth at m 80: 8.6 m (on block; to rubble, 10.1 m); at m 90: 10 m; at m 100: 9.6 m; at m 110: 8.3 m (on block).

Summary. The recess occurs between m 40 and m 103 of SL no. 6. It appears as a deep, sand-filled central depression 4.5 to 5 m deeper than the surrounding breakwater remains. Few large blocks project from the sand in this central depression (none at all in the area of the survey line), but blocks and masses of kurkar and concrete do appear on level platforms of rubble to the north and south. These are 2 m higher than the central depression but still 2.5-3 m below the surrounding level of rubble.

Survey Line no. 7. The base point of Survey Line no. 7 was placed 20 m north of the zero point of SL no. 5, 7 m inside the visible inner edge of the breakwater remains. It was played out for 160 m at a bearing of 280° in order to provide a section perpendicular to the crest of the breakwater (pl. III).

Description of Features, SL no. 7:

m 0-7: sand, covering a gently sloping layer of small kurkar rubble (avg. D 0.15-0.3 m). Depth at m 0: 8.3 m (to sand, 7.4 m).

m 7-30: small kurkar rubble, sloping gradually upward towards the Inner Quay wall (at m 28). Occasional irregular masses of concrete (1 x 2 m) lie scattered on the rubble, and a few limestone boulders (ballast?) around m 20. At the point of intersection, the blocks of the Inner Quay measure approximately 3.0 x 1.4 x 0.7 m. Depth at m 10: 7.8 m; at m 20: 7.4 m; at m 30: 6.8 m.

m 30-72: an area of larger kurkar rubble slopes upward gradually to a concentration of large concrete blocks at the crest of this portion of the breakwater. There are irregular masses of concrete (2.5 x 1.0 x 1.0 m) at m 33 and m 48, and numerous large concrete blocks between m 50 and m 70 that still retain much of their original shape: 2.1 x 1.1 x >1.2 m; 6 x 5 x 1.4 m; 5 x 3.9 x 1.2 m. The marks of formwork, however, have either been lost through erosion or are concealed beneath marine concretions. There are numerous other large fragments of blocks in this area, from 2 to 3.5 m in maximum diameter. Depth at m 40: 6.9 m; at m 50: 6.0 m; at m 60: 5.0 m (on block); at m 70: 5.3 (on block).

m 72-100: outer slope of breakwater, composed of irregular fragments of kurkar surrounding larger blocks, fragments of blocks, and masses of the same material. At m 84 the line crossed a block 4.5 x 1.0 x 1.0 m in an area of irregular kurkar masses 2 to 5 m long. Adjacent to a large sand pocket 5 m north of the block, there is a cluster of tumbled kurkar blocks (avg. 1 x 0.5 x 0.5 m). This and several other pockets in the area are sand-filled depressions

rather than holes in the breakwater. At m 97 there are three large kurkar blocks more or less in line with one another and approximately the same size: 4.5 x 1 x 1 m. Depth at m 80: 6.8 m; at m 90: 7 m; at m 100: 7.4 m.

m 100-118: rubble-filled depression in the breakwater. This area is approximately 1 m lower than the surrounding remains, and composed of small kurkar rubble (D 0.2-0.4 m). One kurkar block was encountered in the area of the line: 4.4 x 1.5 x 1.3 m. Depth at 110: 7.4 m.

m 118-139: mound of large, irregular kurkar rubble and blocks. The irregular kurkar masses average 1-1.5 m in maximum diameter. A block 5 x 2.5 x 1 m rests on the rubble at m 121, and there is a slightly larger block 15 m north: 6 x 2.5 x 1.5 m. The outer edge of the mound is marked by a kurkar block 4 x 2 x 2 m. Depth at m 120: 6.4 m; at m 130: 6.8 m.

m 139-160: gentle slope of small kurkar rubble (max. D 0.15-0.3 m) with occasional pieces of limestone (ballast?). Depth at m 140: 8.2 m; at m 150: 10 m (to sand, 9.4 m); at m 160: 10.9 m (to sand, 9.4 m).

Summary. Survey Line 7 crossed a portion of the breakwater that has been badly damaged and scattered by action of the waves. The crest still stands ca. 4 m above the level of the sea-bottom outside, but the slopes are very gradual both inside and out. The bulk of the visible structure is composed of small kurkar rubble, although there are numerous concrete masses along the central portion of the line, and the outer slope is characterized by large kurkar blocks surrounded by rubble.

Survey Line no. 8. Survey Line no. 8 was laid out across a broad, low, eroded portion of the Southern Breakwater (pl. III). The zero point was placed 50 m NE of the zero point of SL no. 7, and the line was played out for 190 m at a bearing of 290°. The line crossed Area C at the north end of the Inner Quay on the inside of the breakwater (Section III.B). Its purpose was clarification of the relationship between this structure and the rest of the breakwater and of the arrangement of materials in the eroded breakwater core.

Description of Features, SL no. 8:

m 0-5: sand, gradually diminishing in depth from 1 to 0.1 m. Depth at m 0: 8.5 m (to sand, 7.5 m).

m 5-60: low, slightly sloping mound of kurkar rubble (max. D 0.15-0.40 m) on which sit occasional small blocks or eroded masses of kurkar or concrete. There are a few rounded boulders of limestone in the area of m 10 to 20, possibly from ships' ballast, and kurkar blocks (max. D 2 m) at m 30 and m 35. At m 38, the line crosses the N-S Inner Quay at a point where the blocks are well-preserved (3.0 x 0.75 x 0.75 m). Depth on wall block: 6.3 m. At m 52 an eroded mass of concrete (2 x 2 x 1 m) rests on the surface of the rubble. Depth at m 10: 7.5 m; at m 20: 7.3 m; at m 30: 7.2 m; at m 40: 6.7 m; at m 50: 6.7 m; at m 60: 6.8 m.

m 60-70: the line crosses several piles of tumbled kurkar blocks and rubble just before the main breakwater core. The blocks at m 60 to 62 measure 1.7 x 0.7 x 0.3 m. Just to the north of these blocks there is an isolated area ca. 10 m on a side composed of flat kurkar slabs, similar to paving slabs. There is a heap of kurkar masses (D 1-2 m) at m 70, just before the inside slope of the breakwater core. Depth at m 70: 6.0 m (on heap).

m 70-100: mound of kurkar and concrete rubble and large concrete masses marking the breakwater core. The inner edge of the mound, at m 71, rises steeply from a depth of 7.0 m to 5.5 m. The mound, composed of tumbled rubble ranging from 0.5 to 1.5 m in diameter, crests at m 82 on an eroded concrete block (ca. 3.5 x 3.0 x 1.0 m): depth, 5.0 m. There are several smaller concrete masses (D 1-1.5 m) just seaward of the large block, and a second large block (3 x 3 x 1.5 m) down the slope at m 94. The outside slope of the mound is very gradual. Depth at m 80: 5.5 m; at m 90: 6 m; at m 100: 6.7 m.

m 100-150: level field of concrete and kurkar rubble punctuated by kurkar blocks and an enormous mass of concrete. The concrete mass, which extends from m 105 to m 112, is surrounded by a level area of small kurkar rubble (avg. D ca. 0.3 m). The lower surface seems to extend to a depth of 8.0 m, and the crest rises to 3 m. The block is approximately 4 m wide, and, although the shape is very irregular, the present volume can be calculated at approximately 75 m^3. Between m 120 and m 148, there is a heap of enormous kurkar blocks. The only well-preserved example measures 7.2 x 1.7 x 1.5 m. The maximum diameter of the remaining irregular masses ranges from 1.0 to 3.5 m. Depth at m 110: 5.1 m (on block); at m 120: 7.8 m; at m 130: 7.3 m; at m 140: 6.5 m; at m 150: 8.2 m.

m 150-190: low mound of small kurkar rubble (avg. D 0.15-0.3 m). A depression in the rubble spoil from the breakwater between m 150 and m 164 has filled with 0.6 m of sand. Between m 160 and m 175, the rubble rises gently 1.6 m, from a depth of 8.9 to 7.3 m. The outer slope then descends gradually to the sandy sea-bottom at m 184. Depth at m 170: 7.8 m; at m 180: 7.5 m; at m 190: 9.4 m (to sand, 7.5 m).

Summary. Survey Line no. 8 covers an even more badly damaged section of the Southern Breakwater than SL no. 7. The crest of the highest rubble mound rises only 2.5 m above the level of the sea-bottom on the exterior, although the crest of the concrete block between m 105 and m 112 is 2 m higher. Because of the enormous area over which the rubble fill of the breakwater core has been scattered, it is now difficult to determine the original width of the structure at this point. The largest fragments of building materials occur between m 60 and m 150, which may indicate an original width of ca. 90 m.

Survey Line no. 9. Survey Line no. 9, the zero point of which was located ca. 20 m NE of the zero point of SL no. 8, was designed to clarify the construction of the Southern Breakwater in an area where the preservation was somewhat better than on SL nos. 7 and 8. It was laid out across the structure for 200 m at a bearing of 300°, calculated to take it across a field of concrete and kurkar blocks (pl. IV).

Description of Features, SL no. 9:

m 0-75: gently sloping field of small kurkar rubble punctuated by occasional irregular kurkar masses. At m 30 there are 3 such masses (D 1-2 m). Depth at m 0: 8.1 m (to sand, 7.3 m); at m 10: 7.0 m; at m 20: 6.8 m; at m 30: 6.0 m; at m 40: 6.0 m; at m 50: 6.0 m; at m 60: 6.2 m; at m 70: 5.8 m.

m 75-85: inner slope of breakwater core. The kurkar rubble increases in avg. D to 0.75-1.0 m and slopes upward steeply from a depth of 5.5 m at m 75 to 4.0 m at m 85. Depth at m 80: 5.0 m.

m 85-160: core of breakwater, a confused field of very large concrete and kurkar blocks and masses on a base of smaller kurkar rubble. Although the depth at individual points varies greatly, the overall average relief slopes upward gradually from a depth of 4.0 m at m 85 to 2.5 m at m 139. From m 85 to m 100 the surface is composed of naturally concreted kurkar rubble of widely varying dimensions. Irregular masses of concrete 2.5 to 4 m in maximum diameter appear on this base at m 102, m 109, and m 132, and an enormous block at the crest (m 139; ca. 5 x 5 x 1.5 m). Kurkar masses of similar dimensions appear at m 113, m 120, m 147, m 152, and m 158. Depth at m 90: 3.8 m; at m 100: 4.0 m; at m 110: 4.0 m; at m 120: 3.5 m; at m 130: 4.0 m; at m 140: 2.8 m; at m 150: 4.5 m; at m 160: 5.2 m.

m 160-200: a sloping field of concreted kurkar rubble marked with deep fissures. Depth at m 170: 4.8 m; at m 180: 5.5 m; at m 190: 7.3 m (to sand, 6.6 m); at m 200: 8.0 m (to sand, 7.5 m).

Summary. Survey Line no. 9 crosses a section of the breakwater where the massive character of the construction materials, and possibly the oblique orientation to the prevailing waves, has preserved it from total destruction. Although inside the breakwater there is a broad, level field 70 m wide of rubble pushed off it by the waves, it is still possible to discern the 80 m width of the original structure. Both concrete and kurkar masses were used in the construction of the core, but there is a concentration of large concrete blocks at the present crest, and of kurkar blocks along the outer slope. These patterns may reflect the original design.

Survey Line no. 10. Survey Line no. 10 was designed to gather information on the configuration of the large concrete blocks at the northern tip of the Southern Breakwater (pl. IV). The zero point was placed 10 m inside the present inner edge of the structure, ca. 25 m NE of the zero point of SL no. 9. The line was played out for 180 m at a bearing of 310°.

Description of Features, SL no. 10:

m 0-80: very gently sloping, smooth field of small kurkar rubble. There is only one marked irregularity in the area, a slightly elevated platform of naturally concreted rubble 1 m high, between m 32 and m 48. An irregular mass of concrete (D 1 m) sits on the inner edge of the platform at m 33. Depth at m 0: 9.0 m (to sand, 7.1 m); at m 10: 7.2 m; at m 20: 7.0 m; at m 30: 6.7 m; at m 40: 5.9 m; at m 50: 6.0 m; at m 60: 6.6 m; at m 70: 6.6 m; at m 80: 6.2 m.

m 80-118: series of large kurkar blocks and eroded masses resting on a bed of irregular kurkar rubble. The roughly rectangular masses, varying in maximum dimensions from 1.5 to 3.5 m, are concentrated in the area from m 91 to m 109, at the inner end of a mound rising 1 m above the first part of the line. Area D_3 (Section III.C.3) is 15 m E of m 105. Depth at m 90: 5.5 m; at m 100: 5.3 m; at m 110: 5.4 m.

m 118-144: concentration of large concrete masses, probably representing the core of the breakwater. The first eroded mass, at m 120, is approximately 4 m square and lies on a bed of small kurkar rubble (avg. D 0.2 m). It is separated from the other, larger concrete masses by 6 m of this rubble (from m 123 to m 129). The core of the breakwater in this section now survives as an

area of tumbled concrete blocks, eroded, but with occasional surviving planar faces. Because of the damage and subsequent growth of natural concretions it is difficult to determine the original dimensions or arrangement of the blocks, but the present maximum lengths and heights range from 4 to 6 m and 2 to 3 m, respectively. Depth at m 120: 5.5 m (on block); at m 130: 5.0 m (on block); at m 140: 5.0 m (on block).

m 144-159: compact area of large kurkar blocks. The blocks seem to have tumbled from their original positions, but they now are bedded close to one another and have in some cases been joined by naturally deposited concretions. The blocks that could be measured are 3-3.5 x 1.5 x 1-1.5 m. Depth at m 150: 5.0 m.

m 159-180: outer face of breakwater, composed of kurkar rubble sloping down steeply to the NW. Depth at m 160: 4.8 m; at m 170: 6.5 m; at m 180: 8.6 m (to sand, 6.9 m).

Summary. The data produced by SL no. 10 are similar to those produced by SL no. 9. Much of the mass of the breakwater at this point has been broken and scattered by the waves, some of it forming a level stratum of small kurkar rubble 80 m wide on the interior of the structure. Nevertheless, the core of the breakwater has survived as an area of immense concrete and kurkar blocks tumbled over a low mound of kurkar rubble 80 to 90 m wide. The crest now is composed of concrete blocks, faced along the outer slope by very large kurkar blocks.

Survey Line no. 11. The zero point of Survey Line no. 11 was placed 20 m east of the zero point of SL no. 10. The line was oriented to pass over the large concrete and kurkar blocks forming the head of the Southern Breakwater and the east tower of Area K (Section III.J) (pl. IV). It was laid out for 190 m at a bearing of 320°.

Description of Features, SL no. 11:

m 0-26: sloping field of small kurkar rubble (avg. D 0.25 m). Depth at m 0: 9.6 m (to sand, 7.6 m); at m 10: 7.8 m; at m 20: 6.8 m.

m 26-132: a level platform of kurkar rubble, featureless except for occasional kurkar and concrete blocks. There is a low vertical face 1.2 m high at m 126, formed of naturally concreted kurkar rubble. The scarp may be a natural feature, but there is a large kurkar mass 2.5 m wide visible in the rubble just beyond it, from m 32 to m 35. The profile rises from a depth of 6.7 m at m 25 to 5.0 m at m 30 (on the mass of rubble). The upper surface of this portion of the breakwater is essentially level, with only minor depressions and elevations as far as m 132. Between m 63 and m 75 there is a heap of irregular masses of kurkar (D ca. 1-1.5 m). At m 101, there is an eroded concrete block 3.5 m square, embedded in the kurkar rubble. At m 120, there is a second concrete mass (1.5 m long) adjacent to a disturbed but recognizable line of 8 kurkar blocks. The best preserved block is 2.2 x 0.8 x 0.5 m. There are more small masses of concrete scattered in the area between m 122 and m 132. Depth at m 40: 5.5 m; at m 50: 5.5 m; at m 60: 5.6 m; at m 70: 5.2 m; at m 80: 5.5 m; at m 90: 5.4 m; at m 100: 5.5 m; at m 110: 5.5 m; at m 120: 5.2 m (on wall); at m 130: 5.5 m.

m 132-165: core of breakwater, composed of enormous blocks of concrete and kurkar. Several concrete blocks (2 x 2 x 1 m) lie on the rubble between m 132 and m 136, and irregular masses of kurkar (2-3 x 1.5 x 1.5 m) lie scattered around the surrounding area on the kurkar rubble. There are two concrete blocks side by side at m 144 to m 151 (7 x 5 x 2.5 m). Blocks of similar dimensions are tumbled in a great heap 4 to 5 m high, just west of the line from m 148 to m 168. These lie on some even larger concrete foundation blocks, one of which the line passes over at m 156 to m 165 (8.5 x 3 x >2 m). The crest of the pile of concrete blocks rises to within 2.0 m of sea level. The concrete masses terminate abruptly in a rough vertical face at m 168, and the rubble base or buried blocks slope down steeply beneath the sandy sea-bottom. Depth at m 140: 5.5 m; at m 150: 5.0 m (on block); at m 160: 4.2 m (on block); at m 165: 5.0 m (on block).

m 165-190: Area K (Section III.J). The east tower of Area K is separated from the present visible face of the breakwater by 6 m of sandy sea-bottom. It rises 5 m from the present bottom to within 2.0 m of sea level. Probes along the line of both sides of the tower show that the sand is more than 2 m deep over any buried structures. Depth at m 170: undetermined, >8.5 m (to sand, 6.5 m); at m 180: undetermined, >9.3 m (to sand, 7.3 m); at m 190: undetermined, >9.2 m (to sand, 7.2 m).

Summary. Survey Line no. 11 crosses the head of the Southern Breakwater. At present, major structural features appear only along the last 50 m of the line, and the core of the breakwater itself is apparently only 30 m wide. The smooth field of rubble 132 m wide on the inner face of the breakwater at least in part is rubble spill from the decay of the structure, but it may conceal the foundations for quays or other features.

Survey Line no. 12. Survey Line no. 12, by far the longest in the series, was oriented almost due E-W to provide a profile across the Entrance Channel (Area D_1; Section III.C.2) and along the length of the Northern Breakwater (pl. IV). The zero point was located 20 m north of the trench in Area D_2, 15 m from the end of the Southern Breakwater. The line was laid out on a bearing of 100° for 345 m, up to the present beach at the base of the Northern Breakwater. Because of the relatively uninformative character of the last 170 m of this line, and because of space restrictions on the plates in this volume, only the first 170 m of this line are reproduced on plate IV.

Description of Features, SL no. 12:

m 0-15: tip of Southern Breakwater. Excavation in area D_2 has shown that the gently sloping rubble forming the present tip of the Southern Breakwater is spill that has been pushed off the structure by waves during its decay. This spill extends all the way across the Entrance Channel to the tip of the Northern Breakwater (Section III.C.2). Depth at m 0: 5.9 m; at m 10: 6.5 m.

m 15-24: harbour Entrance Channel. The rubble-filled remains of the Entrance Channel are now covered by a shifting layer of sand. Since the slope of the tip of the Southern Breakwater is gentle, the apparent profile of the channel changes dramatically from year to year with only minor variations in the depth of sand. In 1984 the sand was approximately 2.5 to 3 m thick over the layer of spilled rubble. Depth at m 20: 7.0 m (to sand).

m 24-42: head of Northern Breakwater. At this point the breakwater head was built of large kurkar blocks 5-6 m long that were interlocked with lap-joints and fastened with large iron clamps set in lead (see Section III.C.1). The blocks are tumbled in a steep pile rising from the original channel floor at a depth of 11.0 m at m 24 to 2.6 m at m 33. The heap then slopes down to a depth of 5.0 m at m 42. Depth at m 30: 4.0 m; at m 40: 3.9 m.

m 42-110: core of breakwater. Virtually the entire length of the preserved portion of the Northern Breakwater is composed of irregular, heavily eroded masses of kurkar and concrete resting on, or surrounded by, kurkar rubble of markedly varying dimensions. There are irregular pockets where the rubble has been lost, or where the breakwater core was constructed in part of sand held in rubble-built cells, along with amorphous heaps composed of rubble cemented together fortuitously by natural concretions. There are isolated kurkar blocks 3-4 m long at m 45, m 49, m 84, and m 100, and a heap of irregular kurkar rubble possibly derived from blocks at m 91 (avg. D 1.5 m). At m 63 the line crosses m 25 of SL no. 13; at m 98 it crosses m 22 of SL no. 14. Depth at m 50: 5.5 m; at m 60: 4.5 m; at m 70: 4.5 m; at m 80: 4.6 m; at m 90: 5.7 m; at m 100: 5.7 m; at m 110: 5.0 m.

m 110-156: sloping field of kurkar rubble. For the most part the rubble is small in size (avg. D 0.2-0.3 m), but there are isolated kurkar masses (L 2-4 m), at m 130 and m 144. At m 148 the line crosses m 22 of SL no. 15. Depth at m 120: 5.0m; at m 130: 5.0 m; at m 140: 5.0 m; at m 150: 4.6 m.

m 156-318: sloping, highly irregular field of kurkar bed-rock. From m 156 to m 171 a level stratum of bed-rock is visible beneath the kurkar rubble. Between m 171 and m 230 the relief is very marked, and at one point -- between m 192 and m 208 -- two very large projections reach present sea level. At m 210 the level descends again to a depth of 5.8 m and subsequently rises gradually to sea level at the beach. Where it is exposed, the surface of the soft kurkar has been eroded by the sea into level surfaces or streamlined forms. Depth at m 160: 3.4 m; at m 170: 3.3 m; at m 180: 5.0 m; at m 190: 2.0 m; at m 200: 1.5 m (on reef); at m 210: 5.8 m; at m 220: 3.3 m; at m 230: 2.5 m; at m 240: 2.3 m; at m 250: 1.7 m; at m 260: 1.6 m; at m 270: 0.6 m; at m 280: 0.5 m; at m 290: 0.7 m; at m 300: 0.7 m; at m 310: 0.7 m.

m 318-345: sand, pebbles, and occasional kurkar rubble cover the bed-rock, rising to form the beach at m 341. Depth at m 320: 0.8 m; at m 330: 0.5 m; at m 340: 0.1 m; at m 345: +0.4 m.

Summary. Survey Line no. 12 reveals that the Northern Breakwater was founded on a kurkar bed-rock reef extending out at least 180 m from the present shore-line. In places this reef is still very prominent, and in its original form it would have formed a stable core for the rubble and blocks of the artificial structure. Although the central part of the seaward portion of the breakwater has been seriously damaged since antiquity, it can still be seen that there has been no major tectonic faulting across it. Instead, there is a more or less uniform, gradual slope from its base at present sea level to the outer end. This slope may be the result of tectonic activity along a fault running through the harbour Entrance Channel, or from slumping across the whole harbour area. The presence of a tall heap of blocks in Area D at the end of the structure reflects the careful attention paid to

the placement of materials at the crucial breakwater head. Elsewhere, loss of the original structural facing has allowed the core of concrete and kurkar blocks and kurkar rubble to be scattered and destroyed by the waves.

Survey Line no. 13. Survey Lines nos. 13, 14, and 15 were laid out across the Northern Breakwater from south to north to provide information on the profile of the structure. Since the outline of the breakwater is quite regular in aerial photographs, it was hoped that some portions of the original casing or inside quays might have been preserved. See the discussion of Area H_1 (Section III.G). The zero point of SL no. 13 was placed across Area H_1, 40 m east of the west end of the breakwater (pl. V). The line was laid out perpendicular to the long axis of the breakwater, at a bearing of 10°, for 85 m.

Description of Features, SL no. 13:

m 0-14: south face of breakwater, Area H_1. The mass of the structure is formed of small kurkar rubble (avg. D 0.3 m) that slopes upward steeply from 7.7 m at m 8 to 4.7 m at m 13. This rubble face plunges steeply below the sandy seabottom at m 8 but levels off at a depth of 8.0 m and slopes downward gradually to the south. There are several kurkar blocks and irregular masses (ca. 2 x 1.5 x 1.5 m) at the foot and crest of the slope. Depth at m 0: 8.3 m; at m 10: 6.0 m.

m 14-32: southern edge of breakwater core. The whole southern margin of the structure is marked by a low E-W ridge of large but heavily-eroded kurkar and concrete masses, surrounded by loose and naturally-concreted kurkar rubble. There are kurkar masses 2-2.5 m in length at m 15 and m 30, framing a shapeless concrete mass (D 4 m) at m 23. The mound crests at a depth of 2.1 m at m 25. At this point it crosses m 63 of SL no. 12. Depth at m 20: 3.2 m; at m 30: 2.8 m.

m 32-85: the remainder of the breakwater is a generally level platform of small kurkar rubble on which rest occasional heaps of badly-eroded masses of kurkar or concrete. The bulk of the breakwater is composed of small kurkar rubble (D 0.3-0.4 m). A pile of large concrete masses (ca. 3.5 x 3.5 x 1 m) appears at m 43 to m 46; a heap of kurkar masses (D 2 m) at m 52 to m 59. At m 70 the rubble surface begins to slope very gently down and disappears beneath the sand at m 77. Depth at m 40: 3.3 m; at m 50: 3.2 m; at m 60: 3.5 m; at m 70: 3.8 m; at m 80: 5.4 m (to sand, 4.5 m); at m 85: 5.9 m (to sand, 4.5 m). Air-jet probes later revealed that the slope remains gentle for at least 10 m beyond the end of SL no. 13.

Summary. Survey Line no. 13 shows that the core of the breakwater is approximately 60 m wide at this point, with a well-defined southern edge but an indefinite northern margin. At present no remains of any masonry shell can be identified, and in general the building materials are much smaller in dimensions than those used on the Southern Breakwater. There is a concentration of large masses towards the southern edge of the structure.

Survey Line no. 14. Survey Line no. 14 was laid out across the Northern Breakwater 35 m E of SL no. 13 to provide data for a sectional elevation at this point (pl. V). It was laid out for 80 m at a bearing of 10°.

Description of Features, SL no. 14:

m 0-14: south face of breakwater. The rubble forming the bulk of the structure slopes upward steeply from a depth of 6.4 m at m 7 (its intersection with the sand) to 3.6 m at m 13 (the crest). Below the sand, the rubble footings slope gradually to the south to a depth of 7.6 m at m 0 (6.4 m to sand). The sloping face is composed of irregular kurkar rubble (D 0.2-0.4 m), while a large kurkar mass (D 3.5 m) occupies the crest, surrounded by a few eroded blocks (2 x 1 x 1 m). Depth at m 10: 4.8 m.

m 14-58: breakwater core. North of its southern edge, the breakwater remains are composed of a very irregular field of broken kurkar blocks, kurkar rubble of all sizes, and large irregular kurkar and concrete masses. The level varies from depths of 3.6 to 6.0 m. Between m 18 and m 23 there are numerous tumbled kurkar blocks (avg. 2.5 x 0.7 x 0.7 m). At m 22 the line crosses the m 98 mark of SL no. 12. At m 30 there is a large, irregular kurkar mass (D ca. 5 m) projecting from the rubble, and a smaller mass (D ca. 2 m) at m 45. An eroded mass of concrete (D ca. 3 m) stands in a pocket of small kurkar rubble at m 40, and a flat block ca. 7 m square projects slightly from the rubble between m 51 and m 58, its upper surface at a depth of 3.6 m. Depth at m 20: 5.9 m; at m 30: 5.1 m (on kurkar mass); at m 40: 4.6 m (on concrete mass); at m 50: 5.0 m.

m 58-80: north face of breakwater. Beyond the concrete block at m 51 to m 58, the breakwater is composed of small kurkar rubble coated and joined by a thick layer of natural concretion. It slopes off very gently from a depth of 4.4 m at m 60 to 6.3 m at m 70 (to sand, 5.6 m). The rubble seems to virtually level off at this depth and stands at a depth of 7 m at m 80.

Summary. Survey Line no. 14 provides much the same information as SL no. 13, but the concavity of the central portion of the breakwater is more pronounced. As a result, the crests occupied by kurkar masses on the south and north edges are more distinct. The remains of the breakwater proper are approximately 60 m across.

Survey Line no. 15. Survey Line no. 15 was laid out across the Northern Breakwater 50 m east of SL no. 14 to provide data for a sectional elevation (pl. V). The line was laid out for 75 m at a bearing of 10°.

Description of Features, SL no. 15:

m 0-17: south face of breakwater. The kurkar rubble constituting the mass of the structure slopes up gradually from a depth of 6.4 m at m 0 (to sand, 5.4 m) to a depth of 5.6 m at m 10. Between m 11 and m 16 there is a low crest formed by heavily-eroded kurkar masses (D 1.5-2 m), surrounded by numerous small kurkar blocks (1 x 0.5 x 0.5 m). The crest (at m 16) stands at a depth of 4.6 m.

m 17-59: breakwater core. The central portion of the breakwater now has the appearance of an irregular field of eroded kurkar blocks and rubble surrounding occasional large masses of kurkar or concrete. The average depth is approximately 5 m. At m 22 the line crosses the 150 m mark of SL no. 12. Between m 20 and m 30 the line crosses numerous broken kurkar blocks of approximately identical dimensions: 1.2 x 0.4 x 0.6 m. At m 32 a kurkar block (2 x 2 x 1 m) rests on a pile of kurkar rubble. There is a smaller block (2.2 x

0.7 x 0.4 m) at m 43, next to a concrete block 1.5 m square. Between m 51 and m 57 the line crosses a pile of eroded kurkar masses (L 5-6 m) that may originally have formed a row of blocks ca. 10 m long laid side by side in a N-S orientation. The upper surface stands at a depth of 4.1 m. Depth at m 20: 5.0 m; at m 30: 4.7 m; at m 40: 5.2 m; at m 50: 5.2 m.

m 59-75: north face of breakwater. This portion of the breakwater, composed of small, heavily-concreted kurkar rubble, slopes down gently from a depth of 5.0 m at m 60 to 6.0 m at m 70 (to sand, 5.4 m). Depth at m 75: 6.7 m.

Summary. Survey Line no. 15 provides much the same information as SL no. 14, but the relief of the south slope and the concavity of the central portion of the breakwater are less pronounced. Here again, there are distinct crests on the south and north edges, but both are occupied by kurkar masses. The remains of the breakwater proper are approximately 55 m across.

Survey Line no. 16. Survey Line no. 16 was laid across a narrow projection angling out from the southeast tip of the Southern Breakwater to determine its profile, structural character, and relationship to the Entrance Channel (pl. V). It was laid out from south to north for 40 m at a bearing of 30°.

Description of Features, SL no. 16:

m 0-18: gently sloping field of small kurkar rubble (avg. D 0.25 m). The rubble rises very gradually from a depth of 8.4 m (to sand, 7.4 m) at m 0 to 7.4 m at m 18. Depth at m 10: 8.0 m.

m 18-35: core of breakwater spill. Between m 18 and m 34 the feature is composed of small kurkar rubble concreted together in a steep-sided mass marked by several deep fissures. No kurkar or concrete blocks are visible at present. Depth at m 20: 6.3 m; at m 30: 6.0 m; at m 35: 8.0 m.

m 35-40: harbour Entrance Channel. The steep profile of the rubble along the channel continues under the sand, again without any apparent structural features. Depth at m 40: 9.5 m (to sand, 7.8 m).

Summary. In view of the absence of any blocks or other structural features, it seems likely that the projecting line of rubble crossed by SL no. 16 is simply rubble spill pushed off the terminal portion of the Southern Breakwater during its decay. The low slope of small kurkar rubble is found all along the inner face of the northern portion of the Southern Breakwater, just the area to which rubble would be pushed by the force of the prevailing southwest storms. The steep northeast face of the rubble projection is governed by the greater depth of the Entrance Channel, while the southwest face has the gentle slope typical of the sediment-choked harbour basin.

Preliminary Analysis of Survey Lines nos. 1-16. In summary, the lines surveyed in 1983-84 provided an excellent review of the nature and arrangement of the materials used in the construction of the harbour. They showed that the Southern Breakwater was built of large pieces of kurkar rubble or roughly-shaped blocks placed on a cushion or apron of smaller kurkar rubble and sand. This core of rubble was revetted and protected by immense blocks of kurkar and concrete along its crest and outer face, and by smaller blocks of kurkar along the inner face. The

core of the northern portion of the breakwater was composed of enormous masses of concrete designed to reinforce the breakwater head, to protect an important docking area, and possibly also to serve as the foundations for a lighthouse. The Subsidiary Breakwater was built simultaneously to protect the south flank. The recess built into the west face of this breakwater probably represents the remains of another subsidiary breakwater or wave-breaking arrangement in this area. This feature cannot be explained simply as an accidental result of the erosion of the breakwater and scattering of the rubble core at this point. Too much construction material seems to have vanished. A long quay was also built along the inside face of the main breakwater mass.

The Northern Breakwater was constructed of much the same materials: a core of kurkar rubble founded on bed-rock for half of its length, on a cushion of smaller rubble for the rest. Much of this rubble core seems to have been lost from the central portion of the breakwater. Its disappearance left a depression along its length framed on the north and south sides by the remains of the original protective cladding of large kurkar and concrete blocks. The interior face is steeper and deeper than the outside face, probably because the outside face had to be designed to absorb the force of the open sea. The breakwater head was built of carefully interlocked blocks of kurkar, a response to its critical importance. This section was the key to the stability of the whole breakwater and of the adjacent harbour Entrance Channel.

There is evidence for placing the level of the ancient sea-floor around the two breakwaters at a depth of ca. 8 m below present MSL: it can be discerned in the sterile sand beneath the rubble bedding in Area E, in the viscous clay in Areas N_2 and H_1, and in the erosion notch on a tower in Area K. In the Entrance Channel the clay level occurs at a depth of ca. 10.5 m. If we restore an original depth of 2.5 m for the Outer Basin, it appears that the whole area has slumped 5.5 m. But lowering present sea level 5.5 m would still leave most of the two breakwaters at or slightly below sea level. Some of the better preserved sections would stand ca. 1.5 m above the water. Obviously, a great deal of the breakwater superstructure has been destroyed, scattered, or carried away. The tip of the Southern Breakwater and the entire Northern Breakwater are better preserved. They seem to be more solidly built, perhaps because they bracketed the crucial harbour entrance and were designed to support towers and possibly a lighthouse. In addition, they were shielded from the full force of most storms even after the decay of the Southern Breakwater. Preliminary calculation of the total original volume of the breakwaters on the basis of the present configuration of the remains is presented in Section II.B.3. Final calculations based on the survey lines recorded here will appear in Volume IV.

It should be noted that the concrete blocks which originally reinforced the two breakwaters, particularly on their outer faces, are more susceptible to total loss than the kurkar blocks and rubble. Once a concrete block broke up, because of settlement of the foundation or other stresses, the soft fragments of mortar, or of mortar and aggregrate, were much less likely to survive the abrasion of rolling around on the surface of the crumbling breakwater than kurkar fragments. Only a few mortar fragments were found in the course of the excavation and survey, usually in deep strata (e.g. Area D_2, Area E_2). Part of the reduction in the mass of

the breakwaters can be attributed to this phenomenon. It is also possible that much of the Southern Breakwater was not solid, but consisted either of wave-breaking basins such as the Subsidiary Breakwater, or of rubble-built cells or compartments built of rubble and concrete or kurkar blocks and filled with sand dredged from the Outer Basin as the breakwaters were constructed. The decay of the breakwater core and scattering of its rubble may have partially obscured some of these wave-breakers and sand cells. Raban in particular supports this last solution, and he laid out a seventeenth survey line in 1986 to collect the relevant data. The results of this survey are presented below.

[J.P.O., A.N.S.]

Survey Line no. 17. During the 1985 study season, the issue of how the main breakwaters were built was discussed at length by the co-directors of CAHEP. The data collected by the survey lines leave room for various interpretations of the original components of the the breakwaters, their layout, and the cross-sections. The preliminary report published by Raban was questioned, particularly regarding the suggestion that Herod's engineers made use of compartments filled by wave-carried sand to form a significant portion of the breakwater cores (Raban 1985c: 155-58; 1988). The other co-directors felt that this procedure, which is not documented in any ancient authors, would have been both hazardous and impractical. They felt that, while rubble-built compartments filled with sand dredged from the Outer Basin and sea-bottom might have functioned as an effective foundation, there was not as yet sufficient evidence to postulate their existence. As a result, Raban arranged to lay out one more survey line in 1986 (SL no. 17) along the crest of the Southern Breakwater. The line was laid out from south to north, extending from m 26 of SL no. 6 for 235 m at a bearing of 6° (pl. V). At m 62 this line crossed SL no. 5 m 71; at m 85 it crossed SL no. 7 m 73; at m 131 it crossed SL no. 8 m 95; at m 162 it crossed SL no. 9 m 108; and at m 129 it crossed SL no. 10 m 138. The northern termination was on the sandy sea-floor just outside the northwestern tip of the debris of the Southern Breakwater.

Description of Features, SL no. 17:

m 0-49: eastern edge of recess at the west side of the breakwater. Depth at m 0: 7.1 m (on top of a concrete block), drops to a sandy bottom at a depth of 8.3 m. Thin layer of rubble (D 0.2-0.4 m). Large block at m 7 (4.2 x 3.6 x 2.2 m). Depth on block 6.8 m. Two broken blocks at m 15, at a depth of 7.3 m. Kurkar block at m 30 (4.9 x 2.3 x 1.7 m), at a depth of 7.0 m.

m 49-60: two large concrete blocks, possibly two sections of a single broken block. The south side of one sits on sand at a depth of 8.2 m (base at a depth of 9.1 m) and extends upward to 3.9 m. The top of the other mass is at a depth of 5.8 m.

m 60-83: level area of broken and eroded kurkar blocks, some over 2 m long, laid in and on top of smaller rubble, at depths of 6.2-6.5 m. At m 76, blocks at a level of 6.5 m lie on rubble at 7.5 m.

m 83-92: group of concrete blocks at a depth of up to 4.9 m (9.1 x 7.2 x 4.2 m). There is a cluster of concreted roof tiles to the west of these blocks, possibly a wreck site.

m 92-105: an almost horizontal surface of eroded ashlar blocks of kurkar, sloping gradually to the east and north; depth at m 95: 5.4 m, at m 105: 6.0 m. Some rubble and a few large kurkar blocks (2.1 x 1.2 x 0.7 m) lay on this surface.

m 105-121: two concrete blocks, adjacent on a SW-NE axis. Although badly eroded, the total diameter is now 14 m. The upper surface is at a depth of 4.1-4.3 m. The rubble to the west is at a depth of 6.1 m and is over 0.8 m thick.

m 121-129: flat-surfaced kurkar blocks sloping toward the north from a depth of 4.8 to 5.6 m.

m 129-146: five masses of concrete. The upper surface of the first is at a depth of 3.4 m, sloping northward to a depth of 7.8 m. The last two in the series stand about 2 m above the surrounding rubble surface (at a depth of 6.2 m). Dimensions of the blocks: 4.2 x 3.4 x 2.2; 4.1 x 3.8 x 1.4 m; 3.1 x 2.7 x 1.6 m; 3.2 x 2.4 x 2.1 m; 3.2 x 2.3 x 2.2 m.

m 146-158: rubble surface, partially covered with sand, sloping from a depth of 6.1 to 5.2 m. To the west the rubble drops to a depth of 7.1 m, where there is a large patch of sand, with rubble underneath, at a depth of 9.3 m. Probing showed that the rubble was missing at several points at the west and east of this segment, toward the north end. The rubble layer at a depth of 5 m is only 0.7 m thick, with clear sand underneath, probed to a depth of 12 m. Several kurkar blocks are scattered around. West of the line 6 or 7 m there is a huge concrete block (8 x 6 m) tipped westward, its upper surface at a depth of 2.6 m. There is the impression of a wooden beam on its eastern face.

m 158-170: two concrete blocks at a depth of 5.5 m. The first (3.7 x 3.1 x 2.4 m) is at a depth of 3.4 m. The second (6.8 x 4.1 x 1.8 m) is tilted toward the SE, its upper surface at a depth of 4.0 m.

m 170-204: an area of rubble sloping northward from a depth of 5.5 to 7.1 m, with some sandy patches at the lower points. There are three large blocks on this segment: one at m 178-180, its upper point at a depth of 4.5 m; a second at m 182-186 (4.2 x 3.3 x 1.4 m); and a third at m 190-195 with its upper point at a depth of 5.5 m (5.6 x 3.9 x 1.8 m).

m 204-228: an area of huge rectangular blocks of kurkar tumbled and tilted in different directions. The first three lie about 1 m apart on a NW-SE axis, tilted downward to the east toward a sandy hollow at a depth of 6.7 m (5 x 2.5-3 x 2 m). Their upper ends are at depths of 3.5 m, 4.7 m, and 4.5 m. The other blocks average around 2 x 3 x 2 m and slope to the north from a depth of 4.5 to 7.3 m. This group may have formed part of the breakwater head.

m 228-235: the sandy sea-floor at the foot of the breakwater is at a depth of 7.3-7.6 m. A thin, buried layer of rubble at a depth of 10.8-11.6 m was noted by means of water-jet probing. Several large kurkar blocks are scattered on the bottom in this area.

Summary. Except for the single huge block west of m 160, the entire area west of Survey Line no. 17 is lower, and in general made up of much less consolidated rubble than the area to the east. Some of the debris piled up to the east of the line is shallower, but on the whole the blocks and masses here are smaller than those on the line itself. Although the cause or function of the recess on the west face of the breakwater at m 0-49 is still obscure, the rubble base at a depth of 9.2

m does seem lower than the footings for the breakwater elsewhere. The scattered fragments of blocks in it seem to have fallen there before the hollow was later partially filled up with small rubble and quantities of sand. The fact that so many blocks are tilted down away from the crest on which the line lay indicates that this central feature was built on better substructures. Nowhere along the line could probes penetrate the rubble to underlying sand. Since the eastern edge of the recess is on the same line as the central ridge of the breakwater remains, it may be an intentional feature. It may have served as the basin for a wave-breaker functioning in the same manner as the recess behind the Subsidiary Breakwater to the SE, but has now lost its outer wall. There may have been several more of these compartments along the outer edge of the breakwater to the north.

Survey Line 17 also seems to have detected a pattern of segments of rubble alternating with areas of concrete blocks. The stretch from m 50 to m 220 contains seven units of concrete blocks separated by six intervals of rubble and smaller blocks. These intervals are approximately 15-20 m long each. This pattern may indicate the spacing of the towers Josephus mentions along the Southern Breakwater (*AJ* 15.336; *BJ* 1.412; Appendix I.A): solid foundations beneath the towers alternating with rubble or sand-filled compartments. Although the data gathered in Survey Line no. 17 do not provide proof of the theory of sand-filled cells as part of the construction technique for the breakwaters, it is still possible that this procedure was used.

[A.R.]

IV.D: Miscellaneous Underwater Surveys.

During and between the CAHEP field seasons, various opportunities arose for carrying out random underwater surveys at Caesarea. The relative proximity of the site to Haifa and the presence there of the permanent base and diving workshop of CMS made it possible to visit Caesarea and search the sea-floor after almost every winter storm, in order to check for any new exposures of unknown features, artifacts, or additional data for studying the cyclical variation in deposit of wave-carried sand at various sites. The current year-round activities of the Caesarea Diving Center at the site, which is concerned mainly with training new sport divers, are in informal collaboration with CAHEP's studies. The owner of the centre, Itzhak Asher, and his diving instructors at our request keep a record of observations made during training dives. This information is reported to us, and any promising reports are followed up by CMS divers with the full co-operation of the Diving Center.

Other random surveys were carried out prior to each season, usually in late April and early May, in order to assess the situation at various sites that were scheduled for intensive study the same year. During the actual field seasons there were often opportunities for members of CAHEP's staff to use spare time and idle gear for casual searches of the enormous expanse of sea-bottom in the vicinity of the sunken harbour, looking for relevant new information.

Much of the information gathered through these surveys became a factor in selecting specific sites for further investigation and full-scale excavation (such as

Area G). In most cases such surveys were directed toward the environs of the known submerged features such as the breakwaters, walls, paved areas, and other features that might contribute to the reconstruction of the harbour. This was always the case when surveys were carried out looking for wreck sites on top of the breakwaters, or the search for segments of intact building courses of ashlar. Most of the information gathered is presented here, and the more significant finds from these random surveys are described and discussed in Volume II. The sites and features discovered through these surveys that are relevant to the history of Caesarea's harbours, are described below rather than incorporated directly in one of the designated areas discussed above. These sites are described in order from north to south, and those which are partially above the water are at the end.

Aqueduct Beach. This is the area just northwest of the walled area of ancient Caesarea, between it and the southernmost tip of the intact part of the High-Level Aqueduct (figs. I.34, pl. I, between nos. 1 and 10). It is the northern half of a semi-protected body of water separated from the open sea by a series of flattened reefs. These are more prominent in the southwest portion of this unit, just west of Area J (figs. III.90-91). This badly abraded and mostly submerged kurkar ridge is the northern continuation of the same rocky formation constituting the promontories of the Harbour Citadel and Piscina. It seems as if this ridge was originally not fully continuous and that there was some hollow or a fault line leading NNW through which the sea came and carried away the less consolidated sediments in the lee of the ridge.

This structural weakness, possibly triggered by the alteration of coastal processes through construction of the Herodian harbour, caused massive erosion of the shore-line, and the eventual destruction of a long stretch of the High-Level Aqueduct and some 50-70 m of the built-up urban area (Nir 1985). The scattered foundations of the aqueduct's arches are easily traced in shallow water just off the present beach, but there are quantities of building stones and debris up to 100 m farther out.

Most of the sea-floor up to a distance of about 300 m off shore, where the submerged ridge is at a depth of 3-4 m, is covered by sand deposits of varying thickness. Here and there, exposures of sandstone bed-rock can be seen, either as intact flattened units, or as already decomposed chunks incrusted with marine growth. In rare instances, after a spell of winter storms some patches of hard loam are exposed on the sea-floor. These exposures usually are the richest in artifacts. Several anchors were found in these sites, indicating that small to medium-sized vessels used to moor at this place.

The recorded anchors include five of the Byzantine era, two of the Medieval period, and two of either the Mameluke era or later. The casual observation of amphora fragments presents more or less the same variety of historical periods, with the addition of a few Early Roman types and at least one basket-handled jar of the Phoenician type characteristic of the late fifth-early fourth century B.C.

Sea-Floor West of Area Y. This area is actually the southern half of the topographic unit described above (fig. III.90). Being closer to the built-up shore-line and better protected from the open sea, the sea-floor of this area is littered with much heavier spills of building debris and other relics eroded from fill along the

shore. Nevertheless, under these sometimes quite massive coverings, there are many remnants of ancient maritime activities. It seems as if the Roman merchant ship found in Area Y (Section III.S) was not the only case of shipwreck in this area in antiquity. Beside a rich repertory of broken pottery of all periods from the second century B.C. to the Late Byzantine era, and a variety of building components, architectural members, marble column drums, and other items carried away from the eroded shore-line, there are metal objects such as bronze and iron nails, lead rings, and many pieces of lead sheathing representing other ill-fated vessels that were swept ashore just south of the wreck in Area Y.

This area south and SW of Area Y has a sub-bottom of grey-to-orange compact loam at a depth of about 3.0 m. Of the extremely rich and varied finds, one might point out at least five large *mortaria* of typical Late Roman-Early Byzantine shape, their rims bearing stamps recording the name of the fabricant in Greek or Latin.

Another interesting discovery was a group of three lead bar-ingots of trapezoidal section (0.52 x 0.27 x 0.18 m). They were cast around a core of small pebbles, possibly to increase volume without increasing the weight. It is possible that these bars were a core fill in a sandwich type of composite lead-wood Roman anchor.

More complete anchors were found farther west, about 200 m off shore. The first is a Byzantine iron anchor found at the northern edge of a rocky exposure, some 130 m due west of Area Y, in 3.2 m of water. The other is a three-hole stone anchor of a rectangular shape typical of the Phoenician tradition of the seventh to fifth century B.C. that was found about 50 m farther west, on a rocky bottom under 4.6 m of water, just on the lee side of a passage between two reefs.

Cove West of Area J. The sea-bottom near Area J attracted our attention from the first season. It is a narrow, sand-filled hollow which is confined by shallow, rocky reefs on the north, east, and south. It is about 50 m across and separated by a rather narrow shelf from the inner lagoon next to the landing stage of Area J (figs. I.36, III.90).

Badly worn, sporadic fragments of amphoras dating to various periods were collected from the eastern edges of this hollow. Yet, on three occasions when the sand fill in the hollow was low, a more uniform corpus of sherds in a better state of preservation was traced in deeper water. Among this corpus were the upper parts of about half a dozen Rhodian wine amphoras, three of Coan type and two of Cnidian type. All three types are variants typical of the late second-early first century B.C. and might mark the wreck site of a merchant ship that was making its way to the nearby haven, but missed the entrance at the head of the reefs, 200 m farther north.

Interior of the Harbour Basin. The sea-floor within the confinement of the submerged Herodian breakwaters was surveyed more than any other section, both by CAHEP's divers and by other visitors to this underwater site. Many of the finds recovered in this area by the public found their way to private collections and antiquities dealers; others are described and discussed elsewhere in this report within their proper contexts. At least four units are worth mentioning here.

A long, narrow spill of small rubble runs parallel to the Northern Breakwater, some 50 m south of it and east of Area R, at a depth of 6.8-7.2 m. On the west end of this spill a group of rectangular, brick-shaped basalt blocks were found during the 1987 CAHEP season, piled like remnants of ballast. Manual probes and a survey with a metal detector have yielded some well-preserved bronze coins of Philip the Arab (244-49), many pieces of lead sheathing, various bolts and nails, and two sets of lead brailing rings still lined up on the sea-floor as they might have been originally set on the sail's canvas (Section III.P). It is probable that this is a wreck site to be dated to the mid-third century.

Another pile of ballast stones is located at the eastern edge of that spill, some 80 m farther east. Within this pile there were various iron bars that, although found in an advanced stage of decay and heavily corroded, can still be identified as components of ship's railing, lifting devices (capstans) and other members of the operational gear of a still undated wreck.

A rather restricted spill of ashlar blocks with no apparent nearby context was traced just east of the very centre of the harbour's Outer Basin, some 30 m west of the edge of the rocky outcrops, at a depth of 4.8 m. This area is almost constantly covered by more than 1 m of sand, so it will take a unique opportunity of natural exposure, or a large-scale excavation, to attempt a better understanding and a more comprehensive study of this site.

About 50 m south of Area R, and even closer to the first site mentioned above, during a unique exposure of the sandy floor in August 1968, a diving instructor (H. Rosenstein) equipped with a metal detector discovered and salvaged over 300 gold coins from just over 8 m of water. Rosenstein allowed Dr. A. Kindler, the director of the Kadman Numismatic Museum in Tel Aviv, to check 230 of these coins. Of these, 39 were described and discussed in print (Kindler 1969), another 193 were recorded during 1971-1972 and found to be from the imperial Roman series minted in Rome over a period of almost 120 years. Of the 232 recorded coins, 4 were of Augustus, 14 of Tiberius, 7 of Claudius, 38 of Nero, 2 of Nero-Drusus, 2 of Galba, 3 of Otho, one of Vitellius, 34 of Vespasian, 11 of Titus, 25 of Domitian, one of Nerva, and 90 of Trajan, from a series dated 112-117 A.C. No further details were ever made public about this hoard. It seems as if the spot was revisited for several years in the early seventies in a search for additional coins, but there is no available information about any additional discoveries.

South Bay. The area between the Herodian harbour of Sebastos and the promontory west of the theatre, the site of the Piscina (Section III.N) was probably an additional harbour that operated contemporaneously with Sebastos as an open anchorage for the local needs of the city. It was probably even more important in that respect when Sebastos fell into disrepair sometime during the Roman era. The data gathered through the various surveys of this bay are discussed above (Section IV.B).

Sedot Yam. The sea in front of Kibbutz Sedot Yam is dissected by a series of abrasive platforms (fig. II.12). Until the 1940's these features were well anchored in the sandy beach (Dalman 1925: 74, pl. 65), but ever since, it seems that the balance of the sand supply to the beach has been repeatedly interrupted by human intervention. In particular, the recent establishment of large breakwaters for the

IEC station at Hadera added a significant factor. So much so that during the exceptionally stormy winters of 1980/1, 1986/7 and 1987/8 there were weeks when the entire shore-line was stripped of all sand.

Many man-made structures and artifacts have been exposed during these periods, both on land and under the water. The people of the kibbutz are fully aware of the phenomenon and many are well trained for salvaging any newly-exposed artifacts. Among the members of the kibbutz there is a student of the Department of History of Maritime Civilizations at the University of Haifa, Mr. A. Engart, who keeps records of these recovered artifacts and temporarily exposed structures. From his files we have now plans and documentation for as many as 18 different structures, mainly of the Byzantine period, and drawings and photographs of dozens of coins, bronze statues, and other small finds, from the Herodian to the Crusader eras.

E. Galili is currently helping A. Engart conduct an underwater survey. His reports indicate a possible wreck site of a Byzantine merchantman that carried cigar-shaped Gaza type amphoras, the remnants of which they traced just south of the V-shaped reef, opposite to the southern Kibbutz beach, some 40 m off the shore at a depth of 2.3 m.

The other site is farther south, just off the boat-house of the Hapo'el Sport Centre. There, just at the border between the centre and the kibbutz, there is a series of regular blocks (4 x 1 x 1 m), each carrying a circular hollow on its upper surface, arranged in two parallel lines that lead from the beach into the water. They could be followed for some 35 m off shore to a depth of about 1.6 m of water. Not all the blocks survived *in situ*, so it is hard to determine the original interval between them. It is quite likely that these stones represent bases for a wooden jetty that was carried on poles and might have been built in the Byzantine or the Early Arab period. Such a jetty could have been used for exporting the products of the adjacent agricultural fields.

Just south of this possible jetty, a group of three bun-shaped lead ingots was found in 2.7 m of water, inscribed with some syllabic writing possibly of Iron Age date. They are currently being studied by Dr. M. Artzy of CMS. Next to these ingots there were about 300 kg of coiled fragments of lead sheathing and other metal artifacts, including a large bronze statuette of a standing nude female (Aphrodite?) leaning on a small image of Priapus that stands on top of a small column.

The above list of information is by no means final. The data were gathered through random surveys, and none of the sites has yet been the subject of intensive study. For these reasons, the information here can serve only as extra background, rather than a coherent chapter in the story of Caesarea's ancient harbours. To the same category one would add the coast-line survey of features which are not directly connected to either of the major architectural complexes (Appendix II.A), but rather more isolated units--though still clearly within the maritime context. Of several such structures that have been traced and documented through the years, two are presented here as an example.

Column Jetty on the North Shore. This structure is to be found at the breaker zone, just off the outlet of the Herodian sewer tunnel (fig. I.35, bottom of picture,

pl. I, no. 5). It was first noticed by the surveying team of the Survey of Western Palestine in 1873. The fact that a hundred years ago it was as exposed as it is now might be used as a good argument for the present relative stability of this stretch of the beach that otherwise is considered to be extensively eroded (Nir 1985; Roller 1983: 63, 65). The structure seems to be some kind of a landing stage or a loading platform that was laid on the beach and into the water to a distance of over 20 m. Unlike the Column Jetty in the present anchorage at Caesarea, this one was laid roughly, with no binding cement or solid leveled base. The best parallels are the column jetties at both ends of Tel Ashkelon, where such structures seem to be laid by the Crusaders as a base for their sea-walls. Here on the north shore of Caesarea, however, there is no coastal structure nearby identified as Crusader that can be associated with the structure in the water.

Another interpretation might be that the jetty was built as a loading platform by Ahmed Jazzar, the ruler of Akko during the late eighteenth century to enable his men to load plundered building materials from the nearby site, to be carried on barges to Akko (Schiler 1981). If the structure was built at such a relatively late date, its preservation on the beach is less intriguing.

Quay near the Theatre. This structure was traced several times, but finally documented and measured only during the early spring of 1986 (fig. IV.15). It is a platform, possibly a landing stage, which is built of ashlar slabs (1.2 x 0.6 x 0.6 m). Due to erosion, the dimensions are hard to determine. The segment that was measured in the last survey is at the water-line, on the south side of the Piscina promontory, 16 m due east of the corner of the main structure excavated by Netzer in 1976 (his W 224 and W 228) (Levine & Netzer 1986: 155, plan 16). At the time of the survey, a stretch of 16 blocks was exposed, to a total distance of 9.8 m on an east-west axis, and three rows of slabs, with a total width of 3.6 m, sloping down to the south into the water.

Although there is almost no doubt that this platform had some maritime function, no data were found to suggest a date for its construction. The nearby structures on the west, north and east are not directly connected to this platform, and they have never been properly studied.

[A.R.]

IV.E: Jet-Probes.

Both Israeli coast-lines are rich with archaeological and historical sites dating from the Pre-Pottery Neolithic to late antiquity and the modern period. Artifacts retrieved from these sites document an extensive trade both with the hinterland and overseas. This sea-borne trade necessitated safe havens for the merchantmen and quays for safe trans-shipment of goods. The search for these harbour installations confronts the archaeologist with a basic problem: what was the relationship of the shore-line to a known coastal site in antiquity, and did it have the present configuration at the time that site was functioning as a port? There are many indications for all sorts of changes in land-sea relations during the Holocene period. Eustatic sea level fluctuations, local and regional tectonic displacements, marine erosion, coastal deposition, and other natural processes constantly

affected the stability of the shore-line. The earth sciences have shown that the odds for the delicate equilibrium between the land and water masses at any point along the coast to be maintained over many decades are meagre. Disturbance of this equilibrium is a constant menace to a properly functioning harbour and might be devastating for the people who make their living from it. For that reason any long-lasting harbour must have been repeatedly rebuilt and adjusted to the changing land-sea relations. Determination of its site at any stage of the harbour's history may be possible only if one knows where the water-line was and what the sea level was at each period. The answer to this question may be sought by the geomorphologist, because the line of battle between the land and the sea is of a particular character. When rocky, a special type of abrasive table is created; when sandy, sloping plates of beach-rock are formed and pebbles and sea-shells deposited.

These features may be covered later by all kinds of sediments whenever a change in the sea level takes place and may now be well buried below the water and the sand. Although a careful and systematic visual survey of the coastal strip, both above and below the water-line, might trace some of these characteristic "benchmarks," in many cases they are at present either worn away or buried. In order to help the archaeologists in their search, a simple technique has been developed for tracing these buried features. This is a jet probe, a rigid pipe through which water or air is pumped, allowing it to be manually driven through the various non-consolidated sediments, both on land and on the sea-bottom. The probing pipe goes through soft strata until it hits bed-rock, a cemented stratum, or compacted clay. At the same time data can be collected for the archaeologists concerning the whereabouts and the elevation of buried ancient water-line features, and additional geomorphological data gathered for the vertical rate and the stratigraphic characteristics of the overlying sediments. These data enable reconstruction of a geomorphological sequence of events, dated and calibrated by archaeological finds within the sedimentary context.

During the recent growing search for new off-shore oil-fields, very sophisticated techniques and remote sensing devices have been developed for seismic survey of the sea-floor. Those tools, usually working on the principle of recording echoes reflected from buried strata, might be of some help to the marine archaeologist, but in most cases it is not accurate enough for their needs. Repeated surveys with our manually-operated jet probes at sites that were previously surveyed with seismic remote sensing instruments have proved that the simple tools that we have developed can give much more reliable and precise data, and they are often the only way to properly interpret the results of a seismic survey. For this reason CMS has been asked in recent years to carry out all sorts of applied surveys for various companies and agencies, such as the IEC, Port Authorities, Marine Engineering Projects, etc.

There are two simple ways of probing: with air-jet and with water-jet. Air-jet probes are effective only on the sea-floor when there is a relatively shallow layer of soft sediments. The best results obtained are in penetrating through layers of wave-carried sand, so typical of the near shore sea-floor of the Mediterranean coast of Israel. The probe is performed by a diver who carries, in addition to his standard SCUBA gear, a flexihose attached at one end to the first stage of the

regulator and at the other to a rigid pipe marked with a scale (fig. IV.17). This pipe might be of Niarrosta steel, copper, or any other non-rusting material, about 2 m long and of a minimal inner diameter (1/4-1/8 inch). Opening the outflow from the regulator provides a constant supply of pressured air through the rigid pipe at 8-9 atm. The outflow at the tip of the pipe dilutes the sand and permits easy penetration through it. The effectiveness of this system is radically reduced when over 2 m of sediment are attempted. So, though simple, fast (one diver can carry out a probe in 20-30 seconds), and handy, it is limited to beds of fine-grain sands of less than 2 μ thickness.

The other system is much the same, but the compressed air is replaced by water. A water pump with an output of 500 litres/minute at 4-8 atm is operated from a boat (when working on the sea-floor), sucking in sea-water and pushing it through a 3-inch or 4-inch fire hose into a rigid 3/4-inch metal pipe (fig. IV.16). The liquifaction of the sediments at the tip of the pipe enables it to penetrate to an almost unlimited depth, although there are some technical limitations for manually-operated probes.

In Caesarea we have used coupled units of 2 m pipes to penetrate as far as 10 m into the sediments on the sea-floor. Using pipes marked with scales, it was possible to take records of the relative depths of various strata through which each probe went. The probing device was operated by a team of four: boat operator, pump tender (on the boat), and two divers -- one tending the pipe and the other recording the data on a PVC board. The exact position of each probe was recorded by a team of surveyers on the shore, using theodolites or transits and having radio communication with the boat team. In some cases, the desired points for probing were pre-marked with numbered buoys.

Through years of training, the diving technicians of CMS have acquired much experience on operating the jet probes, and they have learned to feel the characteristics of the layers through the vibration of the penetrating pipe as it goes through them. Some finer sediments can be observed as they come to the surface of the drilling hole along with the compressed water. The pipe tender can shake or even hammer the pipe to penetrate layers of rubble, gravel, and even thin sheets of kurkar. The probing pipe, however, is stopped by layers of compact clay, beach-rock, or well-cemented sandstone.

During the CAHEP seasons at Caesarea, the accumulated experience made it possible for the diving technicians of CMS to determine not only the total vertical deposit of soft sediments, but to define interstrata of soft clay, pure sand, beach sand with shells, shingle, gravels, and pebbles. Traditional sub-bottom cores extracted with heavy duty drilling gear from working platforms and drilling towers have verified the accuracy of our interpreted data (e.g., Neev et al. 1977).

Selecting a probing site or a line for a series of probes was done after consultation among the archaeologists, geomorphologists, geologists, and technical staff of CAHEP, considering carefully the potential contribution of the data to answering specific questions. Although in most cases the sites were selected to add sedimentological and geomorphological data, or to find buried man-made structures, in some cases the jet probes were used in "reverse." It became apparent that oblique probes can reveal how far a certain structure extends under the sand, or

what type of bedding is beneath the base of a course of building blocks. Both air- and water-jet probes became one of the most valuable and frequently-used systems during the years of field work at Caesarea. They proved to be an essential means for three-dimensional preliminary survey of areas prior to excavation, and in many cases they saved the trouble of exposing features buried deep in the sea-floor.

[Y.T-K.]

Rapoport, A. Ron, A. Rothledge, Y. Schneider, U. Sela, Y. Shapira, S. Shap-
karo, N. Tur-Kaspa, N. Yogev.

1985 (Study Season): June 3-29.

Director: A. Raban.
Co-Directors: R.L. Hohlfelder, J.P. Oleson, R.L. Vann.
Assistant Directors: S. Sidebotham (Pottery and Small Finds), A. Sherwood (Pot-
tery), M. Fitzgerald (Wreck in Area Y), Y. Tur-Kaspa and S. Breitstein
(Underwater Survey, Probes, and Section Lines).
Photographer: M. Little.
Pottery Draughtsmen: K. Sherwood, Z. Friedmann.
Pottery Restorer: N. Columbus.

CHAPTER VI: SUMMARY DISCUSSION

The following summary is intended to be a concise, provisional analysis of the facts presented in detail in the previous chapers. It is provisional in the sense that it does not attempt a complete reconstruction of the various features of Caesarea's harbours, their original function, and the manner and sequence of its construction. Such a reconstruction will be presented, together with a comparative and historical study, in Volumes III-IV of the CAHEP report. The following pages are intended to draw together in a summary way deductions concerning the main harbours of Caesarea through the ages, based on the data collected in the field to date by CAHEP and other projects. The conclusions suggested should be considered tentative, but for the most part they are based on research and analysis carried out by all four CAHEP co-directors and by some of the other contributors to this volume. In some instances they represent the personal opinion of the author rather than the collective opinion of the CAHEP co-directors. These differences in interpretation will be discussed in detail in Volume IV. We hope to be able both to better substantiate some of these suppositions and to bring forward alternatives as additional data are recovered and studied in future CAHEP field-work. We also hope that the additional studies of Caesarea and other harbours of the early Roman Empire will help the scholars of future generations to correct our shortcomings and any possible misinterpretation of the facts we have before us at the present time.

VI.A. Straton's Tower.

The historical documents are explicit about the existence of a Hellenistic town called Straton's Tower *(Stratonos Pyrgos)* at the later site of Caesarea since at least the mid-third century B.C. (Roller 1983; Raban 1987). There are no historical or archaeological data to directly substantiate the common notion that it was founded by Phoenicians from Sidon in the fifth century. This town had an anchorage in which the Ptolemaic official Zenon landed around 258 B.C. (Abel 1923), and toward the end of the second century B.C. the town had become a true stronghold for the local tyrant Zoilos. Later Jewish tradition recalled it at this period as a "peg, stocked amid Israel" (Levine 1974). Alexander Jannaeus failed in his attempts to conquer the city by force, but eventually Straton's Tower was given to the Hasmonean king by Ptolemy Lathyros around 100 B.C. The city was subsequently given back to its original "Greek" inhabitants by Pompey in 63 B.C., and thirty years later Strabo mentions that it had an anchorage. About this time, Herod regained most of the coast-line for Judaea, including the site of Straton's Tower, which Josephus referred to not only as "much decayed" (*pólin kámnousan*)

(*BJ* 1.408), but also as "suitable for the foundation of a city" (*AJ* 15.331).[4] Th name of Straton's Tower remained in use long after the establishment of sarea, down to the Medieval period (Ringel 1975: 83-84). In Jewish tradition city walls of the former town were referred to as the boundary of the Holy for practical *halachic* purposes.

The bulk of the pre-Herodian finds at Caesarea come from the excava near the shore north of the Crusader city, just south and SE of CAHEP's Ar and from Field G of the JECM (Negev 1967: 9-13; Roller 1983). In both sites in Area J, most of the datable pottery is of the second half of the second cen B.C. Being well within the urban area of Herodian Caesarea, about half between the ancient sewer outlet to the north and the Northern Breakwate Sebastos to the south, the general location of these finds fits the histor account of the location of Straton's Tower. Within this area there are five str tural units that are considered to be pre-Herodian:

1. A rectangular courtyard-house of ashlar walls, mainly headers, in Yonah's Area A, just west of the synagogue and next to CAHEP's Area J. Its fo dation, at 2.8 m above MSL, rested on sterile soil (Avi-Yonah 1956a: Avi-Yonah & Negev 1963a: 146-47).

2. A quay, built of long ashlar headers, observed at the edge of the wate CAHEP's Area J (Section III.I). The curved line of this 4.0 m wide platfo excludes the possibility that it was the lower part of a building, and the lo courses on its sea side show that it was not a street. The overlying ashlar w with its grooves for dovetail clamps is Herodian in date. This date assigns the q itself to an even earlier phase.

Stylistically this quay has its best parallels at Tyre and at Akko, in Phoenici harbour works of the Persian and Hellenistic periods. The phenomenon of in dated structures being preserved only up to present sea level is common in Mediterranean, but the overlying ashlar wall was laid directly on top of this lev so the extant surface may be the original one.

A segment of this quay ca. 18 m long has survived. It might originally ha been longer, for the shore-line east of its entrance end is markedly eroded. The are no intact traces at this point of even the later, more massive Byzantine se wall. The erosion of the coast at the inner, southeastern part of the bay is w attested by the regression of the coastal cliff, tumbled structures, the missi western end of the northern city wall, and the fact that a paved Byzantine stre that once ran along the shore is now cut off by the retreating cliff (see also N 1985 for the destruction of the High-Level Aqueduct along this segment of t coast).

3. A series of three basins cut down into the bed-rock of an older, uplifte abrasive platform were found to be filled with second-century B.C. pottery. Th fill was dumped there sometime in the latter part of the second century B.C., y it is not the latest pre-Herodian phase in that site. On top of the fill in the south ernmost basin of the three, an ashlar wall was laid (W 32 in Area J_3) with an adj cent floor on which Late Hellenistic sherds were found.

[4] For the text of Josephus' descriptions of the city and harbour of Caesare referred to throughout this chapter, see Appendix I.A.

The rock-cut basins were connected to each other by holes through the partition walls, indicating that the basins were fashioned to contain water and to drain into the nearby sea. Remnants of plaster on the floors of these chambers may indicate that their floors and side walls (a very porous sandstone) were sealed to make them waterproof. Whether these basins were associated with a fishery or fish-packing shop cannot be determined. The corpus of double hole-mouth jars and of cooking pots tend to support the assumption that their original function was some industrial process that included soaking, cooking and packing. The elevation of the basin's floors and the draining holes suggest that, at the time this unit was functioning, the sea level was at least 0.3 m lower than the present MSL.

4. A corner of an ashlar building, of which only two courses have survived, was exposed at the eastern end of Negev's trench D, about 50 m east of the synagogue. It was found to be covered by a heap of sherds of the third or second centuries B.C. (Avi-Yonah & Negev 1963a: 148). This corner was built of ashlars in an alternating order of two stretchers and a header, and the rest of the structure might have been plundered by Herod's workers, to be used as building materials in his new city (Negev 1967: 12-13).

5. One of the most controversial issues of Caesarea's ancient topography is that of the date of the north wall and its towers, which were excavated by the Italian Mission (Frova et al. 1965: 247-92). This complex was dated by its excavators to the Herodian period, although the evidence is far from being generally accepted (Levine 1975b: 9-13; Negev 1966b: 343-44; Ringel 1975: 76-77; Raban 1987). In order to test the theory held by many Israeli scholars that this complex dates to the Hellenistic era, the JECM carried out a probe (G 8) on the external side of that wall, at its southeastern extension. From the data recovered from that probe, they deduced that the wall was built sometime between 120 B.C. and the end of the pre-Christian era (Blakely 1984; Holum et al. 1988: 82; and in a paper presented at a symposium held in Washington, 27.3.88).

It has been argued elsewhere in this volume (Sections III.H.3, R.1) that the data recovered from the probes and the architectural survey of the Podium Vault (Area I_3) are substantial enough to attest a pre-Herodian date for the southern and eastern walls of that structure. The resemblance between these walls and the inner face of the north city wall in the order of the blocks within each course, their dimensions, and the drafting of the edges, suggest a Late Hellenistic date for it as well. In fact, the north wall had a long life, and it was fixed, rebuilt, and in some phases, altered more than once.

In summary, CAHEP's field-work and other data gathered in the field suggest that the north wall and the southern and eastern walls of the Podium Vault are two segments of the same original unit: the city wall of Straton's Tower (Holum et al. 1988: 43-53). On the basis of historical and archaeological data, we suggest that this city wall was built late in the second century B.C., probably at the time Zollos made Straton's Tower his stronghold and capital. This wall may have been incorporated within the master plan of the Herodian city, possibly with the function of a dividing line between the municipality of Caesarea outside the wall and of the Royal Emporium Sebastos within. Such an administrative division is known from other cities, especially those with royal harbours, where the taxation, cus-

toms, and other administrative requirements called for a division between the urban unit and the adjacent royal enterprise, the Free Port or Emporium (see Blackman 1982: 194-96).

The next element that might have formed part of the Hellenistic complex of Straton's Tower is farther south. It is the Round Tower that was found submerged under less than 1 m of water at the back of the Intermediate Basin (Section III.H.1). This tower is similar in dimensions and structural details to the round towers of the north wall (especially to the lower four courses of the eastern and better-preserved tower). The data produced by the CAHEP excavations indicate that the submerged tower was the southwestern terminus of a fortification line, with an opening on its south side between it and the natural promontory of the later Harbour Citadel. This 50 m wide opening has at present a water depth of 2.2-2.5 m, down to bed-rock. Estimating the Hellenistic sea level to have been about 0.3 m lower than the present one, this channel probably still had about 2 m of water at that time. It is logical to assume that the western continuation of the south wall in the Podium Vault (Area I_3) would have been on the promontory, embracing the Inner Basin within its confinement. In that case, the opening would have led into the lee of the bay, to the presently silted area on the east. About 120 m away in that direction were found the quay and mooring stone of Area I_1 (Section III.H.1). In fact, no items found there date earlier than the second half of the first century A.C., but the deepest probe in Area I_1 was very small, and at a point where the base, the quarried bed-rock, slopes steeply westward. One would expect to find the earliest remains deeper and farther to the west. Although we have no data for dating the presently landlocked quay, we still have its orientation and topographic layout to suggest a connection with the south wall and with the Round Tower to the west.

In summary, at the time of Zoilos, the opening between the Round Tower and the promontory may have been the entrance to a rock-cut Inner Harbour Basin that measured about 120 m on an ESE-WNW axis and about 45 m on a NNE-SSW axis. This basin would have been lined on the outside by the inner face of the city walls of the southern part of Straton's Tower. Another basin, in the north, was defined at its southern, innermost part by the quay in Area J, having the built-up area of Straton's Tower along its southern and eastern shores. The north wall that originally continued farther west into the now inundated area might have protected the eastern flank of its northern entrance, while the series of reefs off shore functioned as a natural breakwater on its west side. These reefs, which even now provide good shelter on their lee, were less fragmentary in ancient times and would have given much better protection to this natural anchorage of Straton's Tower. It is possible that this natural haven was the topographic feature that attracted the original settlement. At present, this basin has a minimal water depth and is almost filled with building materials eroded from the nearby shoreline. The reefs on its seaward side have trapped the debris in the basin.

[A.R.]

VI.B: The Inner Basin.

It was suggested above that the Inner Basin of Sebastos was probably the artificial, rock-cut inner harbour of the Hellenistic town, yet the archaeological data indicate that it was in use as such at least to the time of Vespasian. As a component in the Herodian harbour, Sebastos, this protected basin might be intended by Josephus in his mention of deep anchorages (*batheis hormous*) in the inner part of the harbour (*BJ* 1.410). Only about 12 m of the eastern quay of this Inner Basin were exposed during CAHEP field-work. This segment is now about 100 m inland from the public beach and very probably represents the northern end of a quay that was originally 45-47 m long on a NNE-SSW axis. It seems likely that during the Herodian period an additional pavement of rectangular stone slabs was laid along its edge, raising the surface of the quay to an elevation of about 1.4 m above present sea level during the latest stage at which it was in use. The uppermost line of marine incrustation was ca. 0.3 m higher than the present MSL. Given these circumstances, the hole in the mooring stone would have been only ca. 0.5 m above the water and would have been fit for mooring only small boats rather than sea-going vessels. The water depth at the face of the quay during the Herodian period was ca. 1.4 m, too shallow for large sea-going ships. Nevertheless, the rocky bottom slopes down quite steeply away from the quay, westward. At a distance of 2 m from the wall, the depth is almost 1.8 m, and it is possible that ships of considerable size could have been moored with their prows over the top of the quay, in the manner depicted in numerous Roman bas-reliefs (Blackman 1982: 80, 92, fig. 2). In any case, we do know that the depth of the water at the entrance to this basin was about 2 m at the same period, deep enough for a medium-sized merchantman. If such vessels ever moored in the Inner Basin, they would have been towed to their berths by towing boats. The absence of additional mooring stones along the exposed stretch of the quay is puzzling. If boats or ships were moored against the quay with their prows or sterns toward it, one would expect mooring devices to be only 3-4 m apart (although in the Trajanic basin at Ostia, they were placed at regular intervals of 14-15 m; Blackman 1982: 203 and n. 100). If ships were moored broadside, the depth would have been sufficient for only flat-bottomed barges or small boats.

It is possible that either the Inner Basin was used for lighters and harbour barges that moved cargos to and from sea-going vessels at anchor outside the harbour or in the centre of its great Outer Basin, or the other mooring stones were removed. They may have been trimmed off when the area was refurbished as a fresh water basin in the Late Byzantine era. The surviving mooring stone may have escaped such a fate because it was used to anchor a water pipe in that Byzantine installation.

From the data presently available, it is impossible to reconstruct the architectural arrangement linking the quay with the nearby structures. Negev's suggestion that the massive structure to the east was once a staircase that led up to the top of the artificial podium (Negev 1967: 27-30) is intriguing, but in its present state this structure is the product of repeated remodeling down to the Early Arab period. If indeed it was once a staircase, it was later reshaped in a manner that looks like a fountain house or a Nymphaeum. It may have formed part of the public complex which a sixth-century inscription refers to as the Hadrianeum (Levine

1975b: 21, n. 146; Avi-Yonah 1970).

[A.

VI.C: The Intermediate Basin.

The Intermediate Basin of Sebastos is more or less the area of the prese anchorage at Caesarea. On the east side it was separated from the smaller Inne Basin by a sea-wall (possibly of Hellenistic date) which terminated at its south with the Round Tower. The 50 m gap between this presently submerged tower a the south promontory was the entrance from the Intermediate to the Inner Bas Only the lower courses of this sea-wall have survived, in less than 1 m of wate and in an area which is at present extensively covered by debris heavily incrust by marine fauna. As a result, the details of its structure have not yet been stu ied. The western section of this proposed Intermediate Basin is west of the fau line that caused submergence of the major part of the harbour. If the Sunke Pavement in Area F is the remnant of a pier that projected into the harbour fro the Southern Breakwater, the western edge of the Intermediate Basin might b reconstructed some 50 m west of the modern mole, just on the N-S line of th original tip of the rocky promontory prior to the subsidence of its westernmo segment. No remains have been found to indicate that there was a similar pie projecting south from the Northern Breakwater. The entire northern half of th Intermediate Basin is now filled in with carbonate-cemented debris, and there ar some geomorphological indications that the process had begun already in the La Roman period (see below). The area to the south of the base of the Northe Breakwater is dissected by fragmented, rocky reefs. Having been subjected t extensive wave erosion, nothing can be traced that might indicate where th water-line was during the Herodian period, and what structures were there at th time.

Just to the south, about 250 m north of the southern promontory, and north o the present anchorage, there is a rocky projection with its northern edge at wate level. This rocky platform is connected to the land by a modern pier built in 196 The pier is now in a bad state of disrepair, but it seems to have altered the cu rents created by the winter storms in such a way that the shore north of it retreating, while a protective sandy beach has formed on the south (fig. I.3 There are indications that this rocky tongue has existed since at least the La Roman era, and that at that time it diverted the current much as it does a present. This hypothesis is supported by the presence of a crescent-shaped forma tion of beach-rock on its south side which covered the Herodian Pier and Quay CAHEP's Area L (Section III.K) and coarse beach deposits into which a wall wa inserted in the fourth century. Such a beach could not have formed while the sub merged area of the harbour was protected by the intact breakwaters of Sebasto and if the rocky projection had predated Sebastos, Herod would have built th Quay on it and the beach. This circumstantial evidence suggests that this rock projection appeared in the post-Herodian period, either as a concreted mass o debris, or as the remains of a larger platform of bed-rock that was fragmented b movement of the fault line just to the west.

The Pier in Area L must have been a component of a larger complex, part of which is still buried below later structures to the east, and part of which to the south has been carried away by the waves. The Pier was over 7 m wide, and almost 30 m of its length have been exposed. It was built in a typical Phoenician style of courses of long headers, much like the moles at Athlit and Akko (Raban 1985a: 30-40), but the blocks were more uniform in shape and dimensions than those of the quay in Area J. The Quay perpendicular to the Pier on its south side was built of the same type of headers. Only two segments of this Quay have survived *in situ*, but its continuation southward for about 43 m can be projected from the corner with the Pier. At that point it might have formed a right angle with the westward continuation of W 1 in Area S (Section III.Q).

Unsolved issues are the original function of the Pier and Quay and the water depth next to them. The surviving northern segment of the Quay consists of a single course of blocks and looks more like a paved margin added to the water side of a rocky platform than a quay with sufficient depth for even small boats. The same is true for at least the eastern half of the Pier. Nevertheless, the concreted debris that covers the surrounding sea-bed disguises and conceals the original base of both the western tip of the Pier and the southern segment of the Quay. The tip of the Pier is also concealed at its surface by a large piece of beach-rock. This beach-rock, which indicates the location of the Late Roman beach, may have preserved the remains of the Pier shoreward. As a result, one cannot tell how far west the Pier originally reached.

The similarity in size of the ashlar blocks in this Pier to those found along the inner side of the Southern Breakwater might indicate that it was constructed to form part of the Intermediate Basin of Sebastos. Nevertheless, the header blocks in the Round Tower in Area T_1 and in the round tower of the north city wall are also of much the same dimensions. As a result, it could be argued that the Pier and the Quay in Area L are of pre-Herodian date and may have been built by Zoilos. The different style of building on the Quay in Area J in this case might reflect an earlier building phase, possibly of the third century B.C. The exact date of the Pier and the Quay in Area L is not yet known, but the stratigraphic evidence and the presence of dovetail clamps suggest they were built no later than the Herodian period.

Farther SE, around the (missing) corner, is the Area S complex (Section III.Q). This complex includes three parallel, walled spaces facing SSW, toward the water and the Intermediate Basin. There, and farther WNW, the original waterfront from the time of Sebastos is now missing altogether. It seems that the damage occurred at least by the Late Roman period, when the cross-wall (W 220), the entrance, and the staircase leading to the water were built (for an even earlier date, Levine & Netzer 1986: 60-65). The eastern segment of Area S contains a complicated series of rebuilt features, of which the main one is wall W 1. This broad ashlar structure, the base of which is now 2 m below MSL, was built as a sea-wall. If there was in fact a quay on top of it in that phase, nothing remains of it at present. Marine incrustations on the south face of this wall indicate that at one time after its construction the sea level was at least 0.4 m lower than the present MSL.

Fragmented as they are, the remains of the marine installations at the northern part of the Intermediate Basin must be studied further. One would expect to find there, below and behind the retaining wall on the south side of Area L, the *Neorion* (Arsenal), of Sebastos, where ships underwent repairs. This site is the only one that was proved to be out of use for a considerable time during the Roman period, when the earlier, Herodian structures were covered by a sandy beach. Such a unique situation may have kept these remains from being radically altered, as was commonly the case for Herodian buildings elsewhere in Caesarea.

The south side of the Intermediate Basin is delineated by the South Promontory (Section III.O). The extensive later constructions on top of this rocky feature, especially those of the Crusader and the modern eras, have left only a few fragmented remnants of the earlier man-made features -- all of which are to be found at the westernmost part of the promontory.

At the southwestern end of the rocky outcrop there is a flushing channel with sluice gates. This type of rock-cut feature is known from many other marine installations of the Roman world, both from Italy and the Levant. The best parallels are either feeder channels for *piscinae* or the flushing channels of harbours (such as the one in Sidon). The measurements and the location of the channel in Area Q make the second function much more probable. Although there is no way of dating rock-cut structures by direct evidence, the behavior of sediments along this coast and arrangements made for flushing out other ancient Levantine harbours suggest the presence of such a feature here. Such a system for de-silting the harbour requires arrangements for an incoming flow of silt-free water through its moles. This fact might as well be used for determining the function and the date of the channel in Area Q.

A small segment of a course of ashlar headers with matching dovetail grooves located on the south side of the promontory just east of the rock-cut channel, might also be dated to the Herodian period. It might be a base course of the longitudinal wall which, according to Josephus (*AJ* 15.335), was the most prominent feature on the mole, or just a remnant of one of the vaults that were located there. More substantial remains of a wall have been preserved at water-level along the edge of the north side of the promontory. This structure, of which a stretch of ca. 20 m is still *in situ*, is built of long, slim headers adjacent to the rocky outcrop, laid most likely on blocks of hydraulic concrete. There should be a segment of the quay wall of the Intermediate Basin of Sebastos. Although the blocks are somewhat smaller in size than those elsewhere in the harbour (possibly due to the sheltered location of this particular feature), the fact that they seem to form an architectural unit with cement blocks underneath makes other dating or functional interpretation most improbable. CAHEP's underwater probes in Area Q were too limited and the site too disturbed by modern building activities to allow assured reconstruction of the building technique. However, it seems likely that the water depth next to this segment of the quay was well over 3 m and that blocks of concrete were cast at the site in order to widen and consolidate the bedrock foundation for the quay, to allow the proper construction of its north side.

[A.R.]

VI.C: The Submerged Breakwaters.

The research of CAHEP, CMS and other groups has shown that a major fault line crossed Sebastos just inside its Intermediate Basin (Neev et al. 1978). For that reason, the man-made features which were laid there or in close proximity to the active fault underwent such a complicated set of destructive processes that in most cases they are incomprehensible or have been lost entirely. This is clearly the case with the two main breakwaters. It seems as if both were based on the tips of rocky promontories, or actually on the rocky western extension of such natural features. But whether these rocky bases were at the time above the water or already in a process of submergence, we cannot tell. We have studied the submerged Southern Breakwater, its subsidiary feature in Area F, and the way in which the artificial substructures were incorporated into the western tip of the southern promontory. The area west of the modern mole, however, was littered with huge masses of rock, structural debris, and concrete blocks left over from modern harbour works.

There is less natural disturbance at the base of the Northern Breakwater, but a spill of small rubble, possibly representing the Byzantine attempt to reconstruct the mole, covers the remains of the earlier structure. West of these areas, the debris of both breakwaters lies on a sandy bottom far above any bed-rock base. No bed-rock was traced west of the fault line at least to a depth of 11 m below the present MSL. This profile proves that the parts of the breakwaters which enclosed the main harbour basin were built on a sandy floor in the first place. Such a foundation is prone to decay from both fluidation and undertrenching of the sand.

CAHEP research on the submerged portions of Sebastos has from the beginning depended on Josephus' description of the harbour as it was in the first century, on the data from the earlier surveys by Link and the CMS (Sections II.B.1 and 3), and on our own set of working hypotheses. The sites studied were selected for their potential value for better understanding the way the harbour was built and functioned, or in a search for additional unknown and unmentioned components of the harbour complex. This is still our motive for studying Sebastos. The sites in the submerged part of the harbour which have been studied so far include the Entrance Channel (Areas D, D_1, D_2, D_3), the Towers mentioned by Josephus as standing just outside the entrance (Areas K and G), the ashlar courses and segmented pavements along the inner side of the Southern Breakwater (Areas A, B, C), the Subsidiary Breakwater outside the Southern Breakwater (Area E), the inner edges of the Southern Breakwater (Area N) and the northern one (Area H), the Sunken Pavement at the southeast side of the main basin (Area F), and the rubble spill inside the inner face of the Southern Breakwater, within the northwest part of the main basin (Area R). Moreover, all data was gathered from numerous visual surveys and mostly from the 17 survey lines (Section IV.C). The data recovered during these studies are summarized here.

Northern Breakwater. The debris of the Northern Breakwater has a regular, rectangular outline, about 60-65 m wide (N/S), and over 200 m long (E/W). The tip is clearly defined by a conspicuous spill of huge kurkar blocks piled on top of the actual structure of the mole to a minimum depth of 1.4 m. The tumbled pile spills down in front of the original tip of the breakwater to a depth of over 9.0 m. This

tumbled structure (Section III.C.1) was undoubtedly massive and very conspicu when intact.

The unique half-lap joint at the termination of some of the huge ashlars a the use of iron clamps set in lead for fastening them to each other are not to b found elsewhere in the harbour. They probably indicate a special function whi imposed exceptional physical stress on the structure. The location would not us ally have been exposed to the full force of storms, so the stress might have be caused by another force. One possibility is that these unique components we parts of the anchoring device for capstans used for pulling heavy iron chai across the harbour entrance, either overnight or during periods of external sea borne threat (for such a practice in the Roman era, see Blackman 1982: 194). An alternative function might have been for mooring ships alongside the edge of th entrance, before they entered the basin for the administrative procedures o checking credentials, bills of lading, and harbour fees before they were towed to their berths.

This magnificent structure may have disintegrated prior to the early sixth century, when Anastasius made his attempt to renovate the harbour. A wooden cradle carrying a block, found in the Entrance Channel was dated to this period by carbon-14 analysis (Appendix III.B, sample 1). The rubble spill over the inner third of the Northern Breakwater may date to the same period. It seems to extend from the base of the structure on the east all the way to the high pile of huge ashlar blocks at the northernmost tip of the Southern Breakwater, and probably also over the triangular rampart of rubble east of CAHEP's Area C. The rubble spill on top of the inner edge of the Northern Breakwater rises to about 3.5-3.8 m below MSL, while the rest of the breakwater's surface is at present at an average depth of ca. 5.0 m. Over this area there are three large hollows of generally rectangular shape which might indicate the manner in which the breakwater was built (see below). The rubble spill slopes steeply down along the inner face of the breakwater. The trenches in Area H exposed some Late Roman pottery below this spill, but no evidence was found for an inner quay. It is unlikely that there was no such feature along such a wide mole. The present width of the debris fits Josephus' figures ("200 feet;" 61 m), and the superstructure and other components that Josephus described should be there. The external side of the Northern Breakwater has a gentle slope and lacks the external features of the other breakwater, such as the Subsidiary Breakwater and the large concrete blocks.

A unique feature was studied by CAHEP at the western end of the external side of the Northern Breakwater. This is the largest and the best preserved concrete block located so far. The 12 x 15 m block survived to a height of over 2 m and was originally topped by an ashlar pavement of which a few slabs remain in place. A large portion of the sleeper beam of the original wooden formwork within which the concrete was laid survived in place, resting directly on the sandy sea floor with no rubble cushioning. The design of the wooden form is described above (Section III.F), and the way in which the block was laid has already been discussed in several places (Oleson et al. 1984: 297-99; Oleson 1985a; Hohlfelder 1987a; Raban 1988b: 187-89).

The sleeper beams were found at a depth of just under 6.0 m below MSL and tilted somewhat westward. Considering the original height of the feature to be about 3.0 m from its base to the topping pavement, and the tectonic subsidence to be over 5.0 m since the Herodian era in this part of the harbour, it is possible that the wooden form was laid at an original water depth of just over 1 m and that the pavement on top of the block was at about 2 m above sea level. These data, and the fact that this block projected outside the regular outline of the breakwater to the north and is adjacent to a vertical ashlar wall of headers on its southern side, may suggest that it was a feature that was added some time after the completion of the two main breakwaters. It may be argued that soon after the flushing current within the harbour basin was functioning, sand-bars began to accumulate outside the entrance on both sides. If this was the case, the flanking towers here and in Area K may have been located at the sand-bars in order to serve as a navigational aid for incoming vessels. The southern concrete block in Area G may have been placed on such a shallow sand-bar as a bridging device to the other block, 5.0 m to the north, which must be interpreted as the tower on the port side of ships entering the harbour, mentioned by Josephus (*AJ* 15.338). The base of the northern block is about 0.5 m deeper than the base of the southern one, and it tilts more toward the west. Assuming that both were laid on a sand-bar, these facts are easily comprehended as the outcome of under-trenching. It is worth noting that even at present the sandy sea-floor in Area G is at least 2.0 m shallower than that of the nearby Harbour Entrance Channel or of the sea floor 20-30 m farther to the north. Alternatively, the difference in elevation might be explained by the presence of what may be bed-rock beneath the southern side of the southern block and the three courses of blocks at the edge of the breakwater proper. A third possible explanation of this topographic discrepancy is the presence of another fault line (F_2, according to Neev et al. 1978) that crosses the harbour at its entrance, on the NNE-SSW axis. But such a fault would not explain the relatively high elevation of the bases of both blocks.

Harbour Entrance Channel. The Harbour Entrance Channel is clearly visible between the western tip of the Northern Breakwater and the eastern side of the spill of the Southern Breakwater. It is the only gap in the entire circumference of the sunken harbour and it was the only site at which Link's expedition carried out underwater excavation (Fritsch & Ben-Dor 1961). The area was studied and excavated by CAHEP during several seasons (Sections III.C). At present, the channel is a funnel-shaped sandy hollow that narrows toward the north. Just inside and SW of CAHEP Area D_2, the channel is blocked at its base by a spill of several large blocks and rubble. The base of this spill is at 8.3 m below MSL, and it was found to be underlaid by a stratum of grey sand, gravel, mud and many artifacts (coins, jars, lamps, etc.) of the Byzantine period. This stratum continued westward underneath the 3.0 m thick spill of rubble on the west flank of the channel, where the D_2 trench was dug. At the base of these layers, under one that included many fragments of wood, there was a layer of coarse sand with no datable finds, and at a depth of 10.5-11.0 m below MSL there is another layer of fine clay, littered with artifacts of the first and early second centuries. This lowest layer is more prominent just outside the part of the channel narrowest at the present, although we do not know where the narrowest point was in antiquity. It must represent the har-

bour floor at the time the Outer Basin was intact and protecting a still body of water.

The fact that this thin, compact layer of clay was traced at various sites within the Outer Basin (Sections III.C, D, E, G) and never outside or beneath the debris of the Herodian structure (except for the enigmatic case of the Sunken Pavement in Area F, Section III.E) supports this deduction. It seems as if the clay layer which was exposed at the bottom of the excavated trench in Area D represents the area where the flushing outflow current met the wave-driven water outside the harbour. At such a site, which was still within the confinement of the channel, at least some of the silt and debris carried by the flushing current from within the harbour basin would have been deposited.

Although the tumbled structure at the tip of the Northern Breakwater marks quite clearly the location of the original eastern edge of the harbour Entrance Channel, the later spill of rubble disguises completely the location of the western edge. In an attempt to locate this western edge (Area D_2), a trench was cut through the heavy spill for about 12 m west of the present channel, but no structural features were detected that might indicate the location of the original western flank of the entrance. So far we do not know the width of the opening or whether it was narrow enough to make blocking with a chain possible. The wider the entrance was, the more difficult it would have been to keep the harbour free of silt. Considering the awareness of Herod's engineers to the problem of siltation by wave-carried sand, as is demonstrated both by its mention by Josephus (*AJ* 15.333) and by the way the harbour was built, one would expect the entrance to have been of a minimum width. The current estimation of 20-30 m for the width of the entrance, as suggested by CAHEP's co-directors (Oleson et al. 1984: 297), is still just a working hypothesis, based on some comparative data from other Roman ports (Blackman 1982: 194).

The western towers, outside the harbour basin, just off the northernmost tip of the Southern Breakwater, were first traced by IUES divers in the late 1960's but were studied for the first time by CAHEP in 1981. Their location, some 80 m NW of the entrance, is much farther from the Entrance Channel than the eastern tower and could suggest that the original width of the channel was much greater than 20-30 m. But, if they served as a navigational aid, as suggested above, or as a wave breaker serving also to scour silt, their location at the very tip of the great breakwater and at a site that might have had accumulated sand-bars is logical. In fact, they may not have been located immediately beside the channel opening.

Only the lower parts of the two towers have survived 20 centuries of erosion. These bases were made of concrete laid within wooden formwork, as can be attested by the horizontal impressions and hollows on the surviving masses (Section III.J). In one case, fragments of the wooden beam were found still inside. The eastern of the two towers has survived to a total height of over 6.0 m above the present sea-floor, with its crest at 1.6 below MSL. CAHEP's probe along its eastern side went down as deep as 9.3 m below MSL and exposed a horizontal notch at a depth of 8.2 m. Although it has been suggested (Oleson et al. 1984: 293) that this may be a solution notch indicating sea level, there is no evidence elsewhere in Caesarea for such a degree of submergence of the sea-bottom since the Herodian

era. The present vertical position of the huge block suggests that it has not slumped further than the surrounding sea-floor through fluidation or undertrenching of the sand underneath its base. In consequence, the horizontal notch more likely represents an extensively eroded recess that formed around a beam from the original wooden form, now missing. The uneven measurements of the surviving block indicate that it lost much of its original volume all around its vertical surface, and it is hard to reconstruct how broad it was when it was cast.

The western tower has retained a wide groove at its crest. The groove is about 1 m wide and seems to be too large to have formed around a cross-beam of the wooden form (though the erosion might have widened it considerably). The extensive excavations and probes around and between the two towers failed to trace any remains of a bridging device between the towers or from the towers to the edge of the Southern Breakwater, which is only 6.0 m south of the eastern one. Interestingly, this is also the distance between the two concrete blocks on the other side of the Harbour Entrance Channel. No remains of what might be considered as components of the upper structures of the towers or their statues could be traced.

There is a tumbled area of huge kurkar and concrete blocks on the section of the Southern Breakwater next to the Towers. The scattered debris covers a large area on top of the breakwater and on the sea-floor below. The top of the spill is under just 2.0 m of water, and the bottom was traced below the sand to 9.0 m below MSL. The largest of the measured blocks is 7 x 5 x 2.5 m (see Survey Line 11 in Section IV.C). It is quite probable that a conspicuous tower originally stood there, perhaps the Drusion that Josephus referred to as the most magnificent of the towers which decorated the medial wall of the Herodian breakwater (*AJ* 15.336). Such a tower might have been used as a lighthouse, such as the Pharos in Alexandria, or that at Leptis Magna. The later parallel was also located at the tip of the greater mole, at the closest possible point toward the open sea, and at a distance from the harbour entrance (Bartoccini 1958: 59-65, pl. III).

Southern Breakwater. This feature is a single architectural unit in the form of a great arc over 500 m long. The width of the spill varies from less than 50 m at its southwestern section (between Survey Lines 3 and 5) to almost 200 m at its northern part (between Survey Lines 8 and 10). The general layout of this breakwater was described above (Section III.B, M, IV.C) and in some early field-reports (Oleson et al. 1984: 290-93). Despite the marked differences in the breadth of the spill of debris, the basic cross-section is quite regular, at least in the portion between Survey Lines 3 and 9.

On the inner side there was a quay, now a course of ashlar headers, with its base at about 5.0 m below MSL at the north end and as deep as 8.0 m on the south. About 10 m west of the eastern edge of this Inner Quay there is a spill of large blocks, most of which are fragments of larger concrete blocks bearing the impressions of the long-decayed tie-beams of the wooden formwork within which the blocks were cast. In many cases these chunks are tilted, and the tie-beam impressions are found on the now almost vertical faces.

The area between the spill and the quay is covered by a thin layer of rubble, nowhere over 0.5 m thick, with a sterile (i.e., lacking artifacts) sand underneath.

In the sections where the ashlar course of the quay is at a higher elevation (Areas B and C) there are additional courses, either adjacent to it, in a perpendicular orientation, or in a random scatter west of the main course. Other offset, segmented courses are located in the deeper area on the south part of the quay (see BL m 125-65 in fig. III.3). The spill west of this line is less regular. In one place there is a rectangular hollow (SL no. 6) and in others the scattered debris includes large rock-cut blocks. In some instances these blocks are piled up with their ends facing the open sea.

The probes and the excavated trenches made by CAHEP in Areas A, B, and C indicated that in some places the quay is now well below its original relative level and that segments of it had subsided further than others. In most cases these segments are associated with lesser layers of rubble, or are even laid directly on sand (Areas A, C_3, C_4). Other segments seem to have been projected over into the harbour basin, as the layer of compact clay was found to be underlying their present position. Nowhere were more than two superimposed courses of ashlars to be found, and even these double courses were found only in very short segments (Area B). As summarized at the end of Section III.B, it is possible that the long course of headers represents not the base course of a vertical Inner Quay, but rather its top courses, or the first course for the part which was originally above the water-level. This suggestion fits the fact that in places the base of this course is now in less than 5.2 m of water. Since this figure represents the best estimate of the amount of tectonic subsidence since the Roman era, it implies that their original level was just above the waves.

While the location and configuration of the inner edge of the Southern Breakwater is reasonably secure, there is still some ambiguity about the method of construction and final appearance. It is clear that the edge of the breakwater directly behind the quay was sand-filled up to the ancient sea level. This fill was then covered by a layer of rubble on which a pavement of ashlar slabs was laid. The pavement most likely formed the promenade described by Josephus (*AJ* 15.337). The portion of the Southern Breakwater which is just east of BL m 17 might have been the location of the longitudinal wall along the breakwater. If this is the case, one could reconstruct the wall as furnished with towers of about 10 m square spaced about 20 m apart (see Section IV.C, SL 17). The debris on either side of this proposed line could be attributed to the wall, the towers, and the "great number of vaults" that lined the quay (Josephus, *AJ* 15.337). In this case the debris of enormous concrete and rock-cut blocks and piles of rubble on the west side probably represent the *prokumatia* (or *prokumia*, *AJ* 15.335), the external breakwater. This structure probably took the form of a segmented line set a short distance outside the line of the main body of the breakwater, with openings for the outflow of water from the waves that broke across it. The large recesses in its lee would have served to absorb the energy of the waves. One such hollow might be preserved in the present recess on the southwest side of the breakwater. The best preserved section, however, is that of the Subsidiary Breakwater along its south face (Section III.D). This wall has sloping faces on both sides. It is parallel to the main breakwater, and their combined width (from the external side of the Subsidiary Breakwater to the inner edge of the main one) is ca. 65 m -- resembling the figure of 200 feet which was attested by Josephus for the overall breadth

of Herod's mole. Several air-jet probes and sub-bottom profiling with the "Mud Penetrator" failed to trace any man-made feature bridging the present gap between the two structures. The present elevation of the crest of the Subsidiary Breakwater (4.8-5.8 m below MSL) seems to indicate that originally it was not much higher than the ancient sea level, just the right level to cause waves to break without undergoing excessive stress. The trenches in CAHEP's Area E_1 and E_2 proved that it was built on a sea-bottom that had at the time a depth of 3-4 m, and was laid on an artificial cushion of small rubble, probably in order to avoid undertrenching and fluidization of the sand below. Like the subsidiary breakwaters farther north along this breakwater, the southern portion too was probably fashioned with gaps as outlets for the rip-current set up by waves breaking over the outer barrier. Its westernmost continuation is at present in a final stage of decay, leaving a wide and deep opening toward the open sea. This gap might have facilitated the evacuation of the tumbled building materials from the hollow and therefore maintained its original characteristics, unlike the situation elsewhere along the breakwater.

The debris of the southwestern portion of the Southern Breakwater is more coherent than that of the western and northwestern sections. It has the same components as the other sections, although the area on the external side of the central body of the breakwater has better preserved the original configuration of the Subsidiary Breakwater. The main body of the breakwater consists of a fairly level platform of debris, about 3-4 m above the adjacent sea-bottom, with a width of 30-35 m. The course of ashlar blocks typical of the Inner Quay, however, is absent on the inside. The absence of this feature was studied by CAHEP in 1983 in Area N_1, where some of these ashlar slabs were found to be buried below the northern edge of the spill and tilted westward. The underlying sand and the layer of compact clay 1.0 m below the base of these blocks suggest that they were pushed from their original position into the harbour basin by wave action or tectonic subsidence some time after Sebastos went out of use (Section III.M). These offset blocks were not found in the eastern trench (Area N_2), and there are indications that most of the better building material in that area was salvaged from the breakwaters by later settlers, probably the Crusaders, who may have used the blocks for the foundations of their Harbour Citadel.

An enigmatic feature of this portion of the Southern Breakwater is the rectangular spill of rubble on its inner side by Area N. Survey Line 3 (Section IV.C) and the probing trench in N_1 did not yield conclusive data for establishing either the date or the exact function of this feature. At present, the best assumption is that this spill was projected from the decaying upper parts of the breakwater during the winter storms in the later part of the Roman era. The corners on its eastern side might have been created by the Crusaders' plundering activities, which were more extensive closer to the shore-line. The date of the spill might be attested by the lumps of sherds, ballast stones and other remnants of Late Roman wreck sites on top of it.

The Sunken Pavement in Area F (Section III.E) was already used by CMS scholars in 1976 to make a case for the submergence of the Outer Basin of Sebastos. The fact that a pavement with such a poor foundation has retained its horizontal surface and that a large portion has survived suggests that its subsidence resulted

from an even, gradual submergence of the sea-floor over the entire surrounding area. Yet the feature itself remains enigmatic. Like other stretches of paving slabs along the inner side of the Southern Breakwater, it lacks any substantial foundation. Otherwise, its location, orientation and elevation might suggest that it was the remnant of a pier that projected from the Southern Breakwater and was used as a partition between the main harbour basin and the Intermediate Basin. The fact that the northern edge of the floor consists of large ashlar blocks in a uniform order of headers seems to indicate that it is the original tip of the structure. Yet this single course is laid on only a thin layer of small rubble with nothing but loose sand underneath. It is true that some remnants of a course of more substantial blocks in a lower elevation on the east side of the floor might belong to the original side wall that supported it and held in the underlying sand fill, but the wall that would have supported the pavement on its northern side has disappeared, as has the pavement itself to the south.

CAHEP excavation and survey did not find such remains, and while the absence of the southern part of the floor may be due to Crusader plundering (with the remaining portion escaping salvage because it was well below the sand at the time), the absence of any remains from the north wall is still an unsolved problem. The presence of a clay layer beneath the sandy fill under the pavement was noted above as an indication that the structure may be a later addition to the Herodian harbour.

[A.R.]

VI.E: Tentative Reconstruction of the Herodian Harbour.

The following is a very tentative reconstruction of how Sebastos was built, its general plan, and the functional components it contained. It is based on ideas contributed by all the CAHEP directors in the course of the excavations and surveys. Since this tentative reconstruction is merely a preliminary summation of the more detailed analysis that will be included in Volume IV, not all the arguments and comparative material are presented here.

When Herod had called in his engineers to survey the coastal site of Straton's Tower and to prepare a master plan for his harbour and the city that was to be adjacent to it, they found a stretch of coast typical of this part of the Mediterranean coast-line of Palestine. The site chosen is close to the south end of a coastal unit extending for about 40 km from Athlit in the north to Hadera in the south, and it represents the only site with a hinterland providing easy access to the Mount Carmel range. The shore-line was characterized by low and broken longshore kurkar ridges, the westernmost one partly inundated by the sea, and its western half already abraded as a wide rocky platform at sea level. Occasionally, the sea had penetrated the ridge, creating small sandy bays or reef-protected lagoons on its lee (fig. I.12, pl. I). At Straton's Tower they knew that two of these coves had been used by the Phoenicians and had been artificially improved to serve as anchorages. Although both these basins were incorporated within a single city wall, Herod's engineers ignored the northern one, since it was probably already half-filled with debris, too shallow, and too detached from the nearby

open water by an extensive series of rocky reefs. It is quite likely that this haven was still in use at that time by the local Jewish people as a fishing harbour, and left to be used in its decaying state throughout the building of Sebastos, as an alternative mooring place for the bulk carriers of imported building materials.

The other Hellenistic haven was a rectangular, artificial, rock-cut basin with a water depth of over 2.0 m, lining up with the southeast corner of the city walls. This basin was protected by two rocky promontories that protruded westward into the sea from the generally straight line of the shore, over 300 m apart, framing a small bay. The promontory to the north was the southern end of the reef that enclosed the northern haven and was wide and flat. The one to the south was more conspicuous and narrow, connected to the land by a sandy *tombolo* and the southwest section of the Hellenistic wall. Both were selected as bases for free-standing moles to be built westward into the open waters. The sea-floor in that area was mostly sandy, constantly shifted by the surge and by the longshore currents.

While planning was taking place and the sea-floor surveyed, shipments of building materials started coming in from Italy, carrying softwood lumber and large quantities of volcanic ash and tufa from the bay of Naples, possibly using the north haven for unloading -- either directly or by means of lighters. The wreck of the merchantman in CAHEP's Area Y might have been one of these freighters.

The longitudinal core of the breakwater was probably the first section to be built. A series of wooden forms was prepared on shore or in shallow water (see Oleson 1985b). Each form was based on a rectangular frame built up on heavy sleeper beams, with vertical uprights inserted into them. The uprights were then braced by a series of horizontal cross-beams and planked over on both their sides. A bottomless form was created, with double walls all around, divided into narrow compartments by the uprights. These compartments within the double walls were then filled with a liquid mixture of a special mortar -- with a high proportion of volcanic ash mixed with lime. According to one possible interpretation (Raban), the poured cement was left to dry on the shore, so it became light enough (with a specific gravity of only 0.6; Appendix III.D) to float. Each form was then launched in its turn and towed afloat to its designated site. Reaching that point, divers fixed its four lower corners with iron chains to anchors on the sea-floor 2-3 m below. The mortar within the double walls was soon soaked by the sea-water, gaining extra weight and causing the form to sink gradually to the sea-floor, which had been cleared and levelled previously. A rubble berm was then built up against the edges of the form in order to protect the base of the block against undertrenching and fluidization. According to an alternate explanation (Oleson 1985b, 1988), the forms were built in shallow water, towed into position, and sunk by adding liquid mortar to the wall compartments. Once the forms securely rested on the sea-floor, they were filled with a mixture of small rubble and hydraulic mortar that cured even in contact with the sea-water.

In this way, the core of the breakwaters was constructed of a series of concrete blocks with rubble fill between. The retaining wall on the external side may then have been secured by setting long kurkar blocks at the edge of the rubble spill with their short ends facing out. The work continued with a second, parallel wall built within the circumference of the spinal wall, as the base for the inner

quay. These two parallel structures may possibly have been connected by spaced cross-walls, creating a series of large walled compartments rising to about water level. These compartments were then filled with sand either naturally deposited by the surge or dredged from the floor of the harbour basin, or from the sea-floor outside the harbour. A third wall was then built parallel to the main body of the breakwater, but some 30 m outside it. The third, external wall was built in the same manner as the rest of the structure, but not as a continuous line. Gaps were left at intervals for the outflow of rip-currents. This external wall was probably what Josephus referred to as the *prokumatia* ("wave-breaker") (*BJ* 1.411; *AJ* 15.335 has *prokumia*).

The sand-filled hollows between the spinal and the inner walls may then have been covered with a layer of rubble on which the pavement and superstructure were built. Along the central line of the breakwater, a sea-wall was built with towers, tipped at the end of each breakwater arm with an exceptionally large structure. The terminal tower on the Northern Breakwater may have been the headquarters of the harbour pilot, the customs house, or a Royal administrative centre; that on the tip of the Southern Breakwater was most likely a lighthouse and a watchtower, possibly called Drusion. Inside the sea-wall, along the Inner Quay with its mooring facilities, storage vaults were erected, with a paved promenade in front of them.

Nothing was added outside the spinal wall, except for some rubble facing at the base of the sea-wall. The space between this wall and the external *prokumatia* was left hollow, in order to serve as a wave-catcher, absorbing wave energy and minimizing structural damage and the passage of spray over the sea-wall to the storage vaults and promenade.

The Outer Basin encompassed about 200,000 m^2 of protected water, with berthing space of about 600 m along the inner quay of both moles. Ships probably were towed to their berths by harbour boats after they had checked in at the entrance. The Intermediate Basin probably had a series of flushing channels across the mole on its south side and docking facilities and shipyards on its north part. The water area in it was about half the size of the Outer Basin and probably a proportionate figure for the total berthing space at its various quays and piers. The Inner Basin had a water area of just less than 5000 m^2, with about 250 m of quay (fig. VI.1).

In addition to the storage vaults on the two main moles, there were six larger vaults on land east of the Inner Basin. These vaults were built against the south-east corner of what is probably a surviving section of the older city wall of Straton's Tower and were incorporated within the podium of the temple that Herod dedicated to Rome and Augustus. The city walls of Straton's Tower may have delineated the boundaries of the terrestrial portion of Sebastos, which may have enjoyed some special status. Along with the great new harbour, with all its facilities, the wall may have encompassed as well as the old fishing anchorage in the north and most of the Jewish quarter.

[A.R.]

VI.F: The South Bay.

An additional series of vaults was built outside Sebastos' territory, along the shore-line to the south, toward the theatre. This South Bay was flanked on its south side by a broad and low promontory carrying the *piscina* associated with Herod's palace. This bay may have been used during the sailing seasons in early summer and fall as an anchorage for local traders who preferred to avoid royal customs, taxes and harbour fees. It may have constituted a sort of municipal harbour for the city of Caesarea, while Sebastos functioned as the Royal one. The spill of rubble on the northwest side of this bay, although not properly dated, indicates that some effort may have been made in antiquity to add further protection to this body of water. The northwestern feature consists of a spill of rubble that may have been added to a natural rocky outcrop projecting ca. 75 m southwest from the south edge of the later Harbour Citadel. If properly finished, such a mole would have diminished the force of the northwest waves stirred up by summer winds. The longshore fault line that runs across the western side of the bay has caused that area to sink over 5 m below its level at Herod's time, and most of its original features are now covered by the sandy sea-floor.

The merchantmen who used the South Bay most likely did not attempt berthing at its shore-line but lay at anchor within the bay, probably in the northwest quadrant, in the shelter of the Southern Breakwater. Lighters and other harbour boats could have been used for transhipments of people and goods from the moored vessels to the shore. Such a practice has been common at Levantine ports throughout the ages, and it was the only possible procedure at harbour cities such as Gaza, Ashkelon, Jaffa, and Apollonia. The vaulted horrea along the shore of the South Bay show that it was important for the seaborne trade of the city. Later on, in the Byzantine period, the northwest mole may have decayed, and ship captains preferred the submerged basin of Sebastos as a better anchorage. At that time the horrea were no longer functioning.

[A.R.]

VI.G: Later Man-Made Features.

The great breakwaters of Herodian Sebastos fell into disrepair and the Outer Basin eventually went out of use, possibly as early as the third century. There are several possible explanations for such a fate. In the first place, Sebastos was built on a grand scale with extraordinary sophistication. It may have been an attempt by Herod to take advantage of the political situation in the late 30's of the last century B.C. and attract the overland transit trade from the Indian Ocean to the Mediterranean (adding to it his own royal exportation of salt, asphalt and myrrh from the Dead Sea). Alternatively, it may represent the megalomania of a king whose ambitions surpassed those of King Solomon.

In any case, the harbour he built may have ultimately turned out to be too big for the needs of local seaborne trade, or for the provincial authority of the post-Hadrianic era of peace. If, as was suggested above, Sebastos was not the municipal harbour of Caesarea, the citizens of the city would not have paid the costs of its maintenance. This task had to be taken care of by the Roman officials of the

province. After subduing the Bar Kochba revolt in Judaea, the Roman procurators who resided in Caesarea had no real need to maintain such a costly harbour and may even have lacked the technology and the financial resources to counteract the ever-growing rate of decay of the harbour due to the natural processes.

The most devastating of these natural processes was the gradual tectonic submergence of the two great breakweaters framing the Outer Basin. We do not know when this process started; it may already have been underway when the harbour was under construction and the added burden of the moles hastened the subsidence of the sea-floor, or they may have triggered it. Once the *prokumatia* (the essential device to regulate wave energy) fell into disrepair, the ever increasing effect of the waves would quickly have inflicted serious damage. It is understandable that sometime during the Late Roman period portions of the Southern Breakwater and its superstructure had disappeared below the waves.

Although Caesarea continued to thrive and to be the main port of entry to the country, maritime activities must have been affected. Nevertheless, the prosperity of the city does not seem to have suffered unduely from the decay of Sebastos. Archaeological excavations on land do not document any crisis in the urban life that might be attributed to the fact that Sebastos went out of use as a safe, year-round haven. If it had not been for a single historical document, no one would have considered the possibility that "the harbour of the city named after Caesar had disintegrated through age, and lay open to every threat of the sea. Its structure no longer measured up to the category of the harbour, but of its former condition it kept the name alone. You did not ignore her as she asked for help, continually bewailing the merchant vessels that after escaping the open sea, often wrecked in the harbour." This did take place within the thriving Byzantine era of Caesarea. This entry is from a panegyric of Procopius, the Bishop of Gaza, to Anastasius (491-518), who renovated Sebastos (Panegyricus 19, translated by Oleson; Oleson et al. 1984: 294, n. 20).

Evidence gathered by CAHEP not only validates this historic text, but suggests that the state of the harbour as described by Procopius was the result of a long process of decay. In the first place, geomorphic, sedimentary, and stratigraphic data from Area L within the Intermediate Basin of Sebastos, indicate that this site was exposed to the sea to much the same extent as at present. A crescent-shaped beach with a steep gradient and depositions of coarse sand, shingles, and wave-worn sherds was found to cover the Pier, Quay, and a plaster floor that was laid above the back of the Pier in the late second century. These open beach deposits predate ashlar walls of Late Roman buildings that were cut into them in the third or early fourth century (Section III.K).

Secondly, numerous wreck sites were found on top of the submerged breakwaters. These sites contain heaps of ballast stones and piles of concreted sherds of amphoras and other vessels. The earliest datable sherds from these contexts belong to the second half of the third century, indicating that by that time merchantmen were attempting to sail across the already submerged breakwater.

Thirdly, the spill of rubble along the inner side of the Northern Breakwater and farther to the west, across the harbour Entrance Channel and on top of the northern part of the Southern Breakwater, may have been laid there by Anasta-

sius early in the sixth century. Sherds that were found in Area H underneath this spill are from the Late Roman and Early Byzantine eras, predating the spill. No later attempts to renovate the submerged part of Sebastos were ever documented by either historical texts or archaeological data.

On the north side of the Intermediate Basin only the eastern, innermost side of the harbour was still functioning in the fourth through tenth centuries. Farther west, in Area L, the buildings of that period were seemingly built with their backs to the sea, with no maritime function. In Area S there was a series of warehouses facing south toward the water, just west of the sea-wall W 1 (Section III.K). These structures were studied also by Levine and Netzer (1986: 58-65) who find evidence to date them from the late third century up to the tenth. At the first stage, the central one had an opening with two stairs leading to the waterfront. These warehouses were rebuilt several times during the Byzantine period, and eventually, in the Early Arab period, the third from the west was remodeled as a vat with six compartments, most probably for the storage of olive oil. Similar bins (of six and four chambers) were excavated by Negev at the foot of the Temple Podium, east of the Inner Basin.

Also of Byzantine date is the ashlar paving in the rock-cut basin that served earlier as the Inner Basin. By that time the already land-locked basin was inundated by the rising ground-water, due to the rising sea level. At this time, a segment of the basin at its northeast side was selected for refurbishment as a freshwater tank, perhaps as part of a nymphaeum. The original base of the hollow was then leveled and raised by a series of loosely-laid ashlar slabs. The surface of this paving was built just above the interface in the water-table between seawater and the fresh water floating above it. Some partition walls were set on top of this floor dividing the area into a series of smaller basins. The date of this structure is attested by the post-Byzantine beach deposit that covers it. During the Medieval era this site was high and dry, as can be deduced from the remnants of a private house at the site.

Also of the Byzantine era is the massive sea-wall in Area J (Section III.I). Over 30 m of this 4.6 m wide wall survive, although in a damaged condition. Its highest surviving surface is about 1.4 m above MSL, and it was built within a wooden form of which some remains are still visible in the southwest corner of the eastern segment, under 0.5 m of water. This wall may have been built to retain the land structures and to protect them from the rising sea level.

At about the same time, on the south side of the southern promontory, next to the Piscina, the westernmost section of the southern Byzantine city wall was built, probably as part of the fortress that was built around the site of the theatre. East of this wall, on the southern edge of the promontory's lee, there is a quay or landing stage built of ashlar slabs, possibly the remnant of a small Byzantine fishermen's haven (Section IV.D).

Many structures were built at the site of Sebastos during the Crusader period (Section III.O, R.2). Of these, the better candidates for a maritime function are those now inundated, or the walls which were built on a base course of reused columns. Bases of this type can be seen on the towers around the Harbour Citadel, at the moat that separated the Citadel from the rest of the Crusader town, on the

wall that overlaid the Herodian quay in CAHEP's Area Q, and the arched st tures that projected southwest of the Harbour Citadel, into the South Bay. architectural remains of this last structure were dismantled in 1949, includin tunnel which led at water-level toward the south. A similar passage led from western courtyard of the Citadel toward the site of the present harbour. This sage may indicate that the Intermediate Basin of Sebastos became the anchorage of the Crusaders. Farther east along the northern edge of the promo tory, just inside the northeast tower of the Citadel, there was a marble staircase leading to the water.

Further to the east, on the landward side of the moat, there were two rectangular towers. About 50 m north of the North Tower, in ca. 2 m of water, there are the remains of another, heavily ruined tower that has been stripped of most of its ashlar facing, probably early in the nineteenth century, or later on by the Bosnians, searching for building materials for their new houses or clearing a landing for their fishing boats. This tower stood at the end of the Crusader sea-wall that confined the town on the west. Some kind of quay was adjacent to the east side of this wall at the presently submerged section in the back of the Inner Basin, all the way from the square tower to the site of W 220 in Area S (Section III.Q).

It seems as if the Crusaders had some kind of shallow inner basin within the sea-wall, and a quay next to it in which the water was less than 1.2 m deep. This quay was about 80 m long and just over 5 m wide from its outer edge to the east face of the sea-wall. The quay had its base at its north end, on the other side of the bay in Area S, where it was incorporated into a paved rampart on the west side of W 220, which itself had been renovated by the Crusaders. The platform of cemented rubble covered the waterfront portion of the former warehouses. They might have been reused for their original purpose, except for the western one which was incorporated into a bastion or a corner tower of the Crusader sea wall. Behind that corner, the sea-wall continues its course northward, and its remnants can still be traced across the Herodian pier in Area L. At that time the sea level was lower than the present one and the shore-line in Area L was at about the line of the mass of beach-rock that covers the tip of the Herodian pier. About 15 m due south there is the stem of a long jetty that was built of reused Roman columns. This Column Jetty started off from the Medieval beach just outside an alleged sea-gate that was adjacent to the north flank of the corner tower of the Crusader sea-wall. The base of the jetty was some 30 m west of the projected course of the sea-wall. It was 5.5 m wide (probably dictated by the length of the Roman column drums that were plundered from the colonnaded streets of the earlier city) and proceeded due west for about 75 m, with the bases of the columns at present in about 0.5 m of water. It was laid on an abrasive platform of marine cemented debris all the way to its western tip. There, the jetty's course diverged toward the southwest, in the direction of the tip of the promontory on the other side of the bay. This stretch of the jetty is now well below the water, and it seems as if the underlying platform has crumbled since it was built. The columns of this part of the jetty are now tilted eastward and some are tumbled off the line of the structure. These columns can be traced for an additional distance of ca. 50 m, giving the jetty a total length of 125-130 m.

This jetty encompasses the north and northwest sides of the present basin, confining a water area for the Crusader harbour of about the same as the modern one. The water depth on the west part of this basin, and maybe next to the tip of the Column Jetty, was great enough for berthing the sea-going ships of the time, probably for no more than two or three of them at once, in only a partly protected haven, safe enough for short-period mooring only. Farther north, the remnants of the base course of the Crusader sea-wall are to be seen in the water a few metres off the present shore-line, behind the stem of the modern north pier, on a line that led to the tip of the northern city wall and in a position more easterly than the south section of that sea-wall. This recessed line indicates that the extensive wave erosion at the northeast corner of the Intermediate Basin of Sebastos took place already before the Medieval era.

[A.R.]

VI.H: Land-Sea Relations.

During the archaeological work by CAHEP, CMS, and other groups, data has been gathered concerning evidence for land-sea relations during historical periods. Such changes include rising, subsiding, tilting, slumping, etc. Some major work has been carried out by Israeli geologists since the 1960's in Caesarea and the vicinity, on land and in the sea, studies of tectonic and other changes that radically affected the land-sea relations (see Neev et al. 1978, 1987, and the extensive bibliography there). These dealt with geologically-late phenomena which cannot be calibrated with the same precision as historical ones. The full critical discussion of the issue will be included in Volume IV, with an attempt to settle the discrepencies between various interpretations and sets of data. A summarized list of the archaeologically attested evidence for such changes is presented here, for the time the site of Caesarea was settled. The effect of such changes on the people of Caesarea would have been major, most of all for their maritime installations, but also for their near-shore buildings, water-table, quality and availability of freshwater supply, and agriculture.

This list is presented with a minimum of annotation and in two sections: vertical changes and horizontal changes.

Relative Changes of Mean Sea Level. There is a considerable amount of evidence in the harbour for relative changes of MSL (see Flemming et al. 1978).

a. A raised abrasive platform in Area J indicates a sea level higher by about 1.2-1.3 m for some period prior to the third century B.C. The relative integrity of that platform in the sections that were built upon in the Hellenistic era suggests that this platform was created not long before that period. The same type of elevated platform was found on the south promontory of the Piscina, over 1 km farther south, and at Krokodeilonpolis, some 3.5 km to the north. So, it might be considered either the result of a tectonic uplift of a segment of the coast at least 5-8 km long, or as an indication of a eustatically higher sea level in an earlier historical period.

b. The level of the slab floor at the Hellenistic rock-cut tanks in Area J, and the elevation of the drain holes through the partition walls between them and the sea, might indicate a sea level lower than the present MSL by 0.3-0.4 m, or more. The same type of indication can be deduced from the elevation of the foundation of the southern wall of the Podium Vault in Area I_3 (probe 1) and from the line of *Ostrea* on W 1 in Area S. These data fit in with information from other sites along the coast of Israel and might be eustatic in character (Nir & Eldar 1987, fig. 3; Raban & Galili 1985, fig. 26).

c. The base of the rock-cut flushing channel with sluice gate in Area Q on the southwest tip of the promontory of the Harbour Citadel was related to a sea level much like the present one. Similar conclusions are indicated by the elevation of the Herodian level in Area J (both in the rock-cut chambers and the course of blocks with dovetail clamp marks on top of the Hellenistic quay).

d. Structures on the water-line that were in use during the latter part of the first century and in the second century indicate that the sea level was gradually rising, very probably for eustatic reasons (see also Bloch 1981; Raban & Galili 1985: 339-49). This can be tested by the elevation of the Piscina and its feeding channels in Area P, the solution notch on the face of the Inner Quay in I_1, and the cement floor on top of the eastern part of the pier in Area L. The sea-level at that time was 0.2-0.3 m above the present one.

e. The eustatic rise in sea level continued through the later Roman period and all through the Byzantine era. The late Roman beach in Area L, with the beach-rock on top of the pier attest such a trend, as well as the relatively high elevation of the foundation trenches of the nearby ashlar walls. The elevation of the marine fauna on the lee side of the walls in locus 219 in Area S indicates a sea level 0.7 m higher than the present in the Byzantine period. The same figure might fit the massive sea-wall and well in Area J (Raban & Stieglitz 1987).

f. The numerous cisterns that were built during the Early Arab period are related to a water-table higher than the present one by at least 0.4-0.6 m. Such are the cisterns in CAHEP's Areas S and M_4 (1987), and those excavated by Negev at the foot of the temple podium. Some of these cisterns bear evidence of having been deepened in a second phase, suggesting that the water-level subsided during the time period between the eighth and the eleventh centuries. But the MSL was higher than the present one through most of this period.

g. During the first half of the thirteenth century, the Crusaders in Caesarea built structures that seem to relate to a sea level lower than the present one. The binding ashlar floor within the column jetty, which is now under 0.3-0.4 m of water, indicates a sea level lower by at least 0.6-0.7 m than the present MSL. The same figure fits the elevation of the iron-clamped course of blocks W 220 in Area S. A similar conclusion comes from the present elevation of the base course of reused columns in the South Moat Tower and the southeast tower of the Harbour Citadel in Area M and that of the passage that was surveyed in 1949 on the south-west side of the Citadel.

h. The present elevation of the submerged quay, the sea-wall and the rectangular tower in Area T_2 indicates the same trend of a lower sea level at the time of the Crusaders. Yet, as has been suggested above, there are indications of other

for the subsidence of these structures beside eustatic change in sea level. causes might have been slumping, fluidization, and maybe even some tec- drop within a very confined area at the centre part of the Intermediate

Movement of Shore-Line. Horizontal changes are archaeologically by either terrestrial man-made structures which are now inundated off the shore-line, or by maritime installations which are landlocked at present time. The causes for horizontal changes might be either vertical changes in land-sea relations of natural character, or a by-product of such changes represented by fur- wave erosion, or additional beach deposits. Such interrupted equilibrium of coastal processes might be triggered also by human activities which change the configuration of the coast-line (see Nir 1982a, 1985). In Caesarea several such changes were observed and are summarized below (from north to south).

a. About 300 m of the High-Level Aqueduct was washed away by the sea north of the outlet of the Herodian sewer tunnel, some 700 m NE of Sebastos (figs. I.17, a; I.34). The extent of coastal retreat is at least 50 m and seems to be continuing at present. The historical and archaeological evidence that this aqueduct was functioning until the end of the Byzantine era may indicate that negligence plus a rising sea level have caused the destruction, possibly triggered by the construction of Herod's harbour (Nir 1985).

b. The present water-line on the east side of Area J is clearly post-Byzantine. Both the Hellenistic quay and the Byzantine sea-wall ended 30 m west of the southeast corner of the bay, and it seems as if at a later time (maybe only in the post-Crusader era) this 30 m of land was washed away by the waves. The steep cleft above the present narrow, seasonal beach in that corner contains dissected floors, walls, various other man-made installations, and a small segment of ashlar paved street, dating to periods up to the Byzantine. Farther to the north, the western end of the north city wall is missing, also washed away by the waves (fig. I.17, b).

c. The shore-line along the northwest section of the Crusader town, between its north wall and the modern north pier, is retreating continuously. It seems as if the Crusaders managed to stop this process temporarily by installing their sea-wall across the stretch of shore, but at present the remains of this wall are in the water, about 10-15 m west of the steep slope of tumbling land structures (fig. I.17, f). On the other side of this modern pier, there is a small sandy beach which has formed there since the construction of this feature in 1961. The pier is now in an advanced state of decay, with its base undertrenched by the surge on its north side. This modern beach is on the site of a larger ancient one, that lasted at least from the time the main Herodian breakwater had lost its integrity until the post-Crusader period. Judging from the location of the base of their column jetty, this beach was about 30 m wide and the sea front that same distance farther west than at present (figs. I.17, g, I.37).

d. We do not have clear data for dry land that has submerged due to the active longshore fault line that caused the submergence of the Herodian breakwaters. Nevertheless, one might argue that prior to Herod's time, the tips of the rocky

promontories on which these breakwaters were based were above the water ther to the west.

e. The offset plates of beach-rock at the south side of the Southern Bay cate that the coast-line there is retreating quite rapidly at present. This ca attested by the chunks of recently tumbled bed-rock on the northeast side o promontory of the Piscina in Area P. Yet there is no evidence for any real ch in the location of the shore-line along the rest of that bay since the Roman Some undated beach-rock on the floor of that bay and its rocky topography co be used to suggest that there once were two smaller bays here, with their beach 20-30 m farther to the west. But so far this tentative reconstruction cannot dated (figs. I.17, e, IV.2-3).

f. South of the Piscina and all along the shore of Kibbutz Sedot Yam, th are remnants of Byzantine structures on the water and just off shore (Sectio IV.D), but these remnants have not yet been studied and one cannot tell how and how deep into the sea they extend, or what the reasons are for their subme gence. In the present stage one can only argue that this stretch of coast retreated somewhat since the Byzantine era.

The above survey of archaeological evidence for changing land-sea relation excluded such man-made features that might be argued as having been offset d to tumbling of the base on which they were laid. Such are the sunken pavement near the Piscina, or the Column Jetty at the northern sewer outlet. There is ge morphological evidence for an ancient coastal basin at the site of the present nea shore water, as it is attested by the sub-bottom of clay in Area Y and off an under the beach of Kibbutz Sedot Yam. Yet the date of this terrestial basin much older than the earliest suggested date for the foundations of Strato Tower, so it is irrelevant to the present survey.

We did not mention in the above survey the case of so-called "uplifted natura beach deposits" of shingles and sea shells that were found on top of the sand dune that cover the Byzantine structures along the south bay, or in the trenches of th Joint Expedition in their Field C. These post-Byzantine, or even post-Crusade "High Beaches" as it has been alleged by Neev and his colleagues (Neev et a 1987; Section I.A.2), are not archaeologically documented and might be explained in other ways, such as being natural deposits of decomposed man-made structures. Sea shells were common components in floor fills and in binding cement, at leas since the Byzantine era, and were to be found in such structures all over Cae sarea.

[A.R.]

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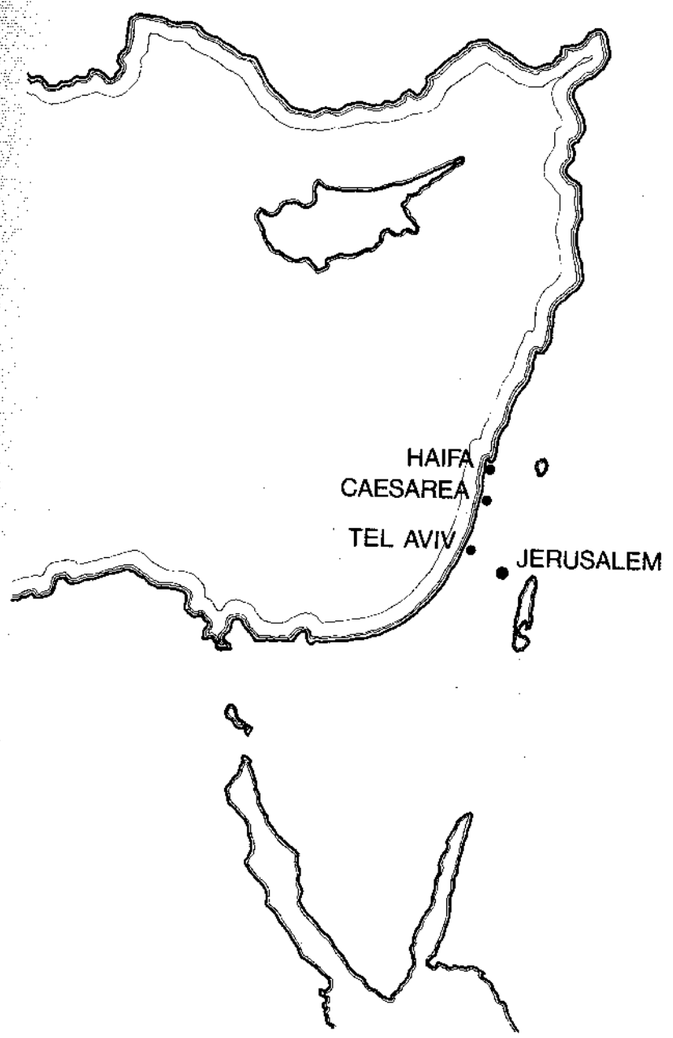
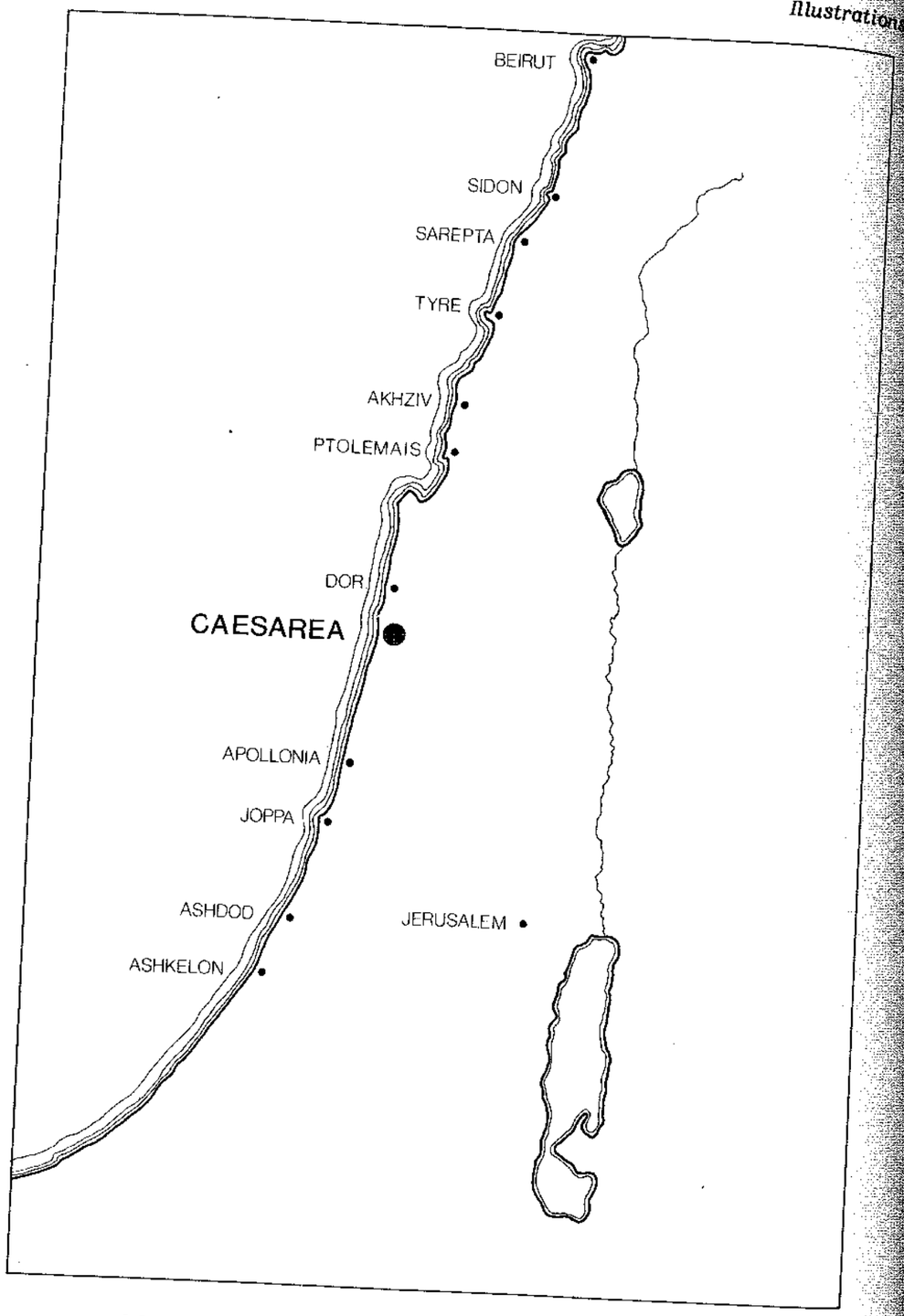
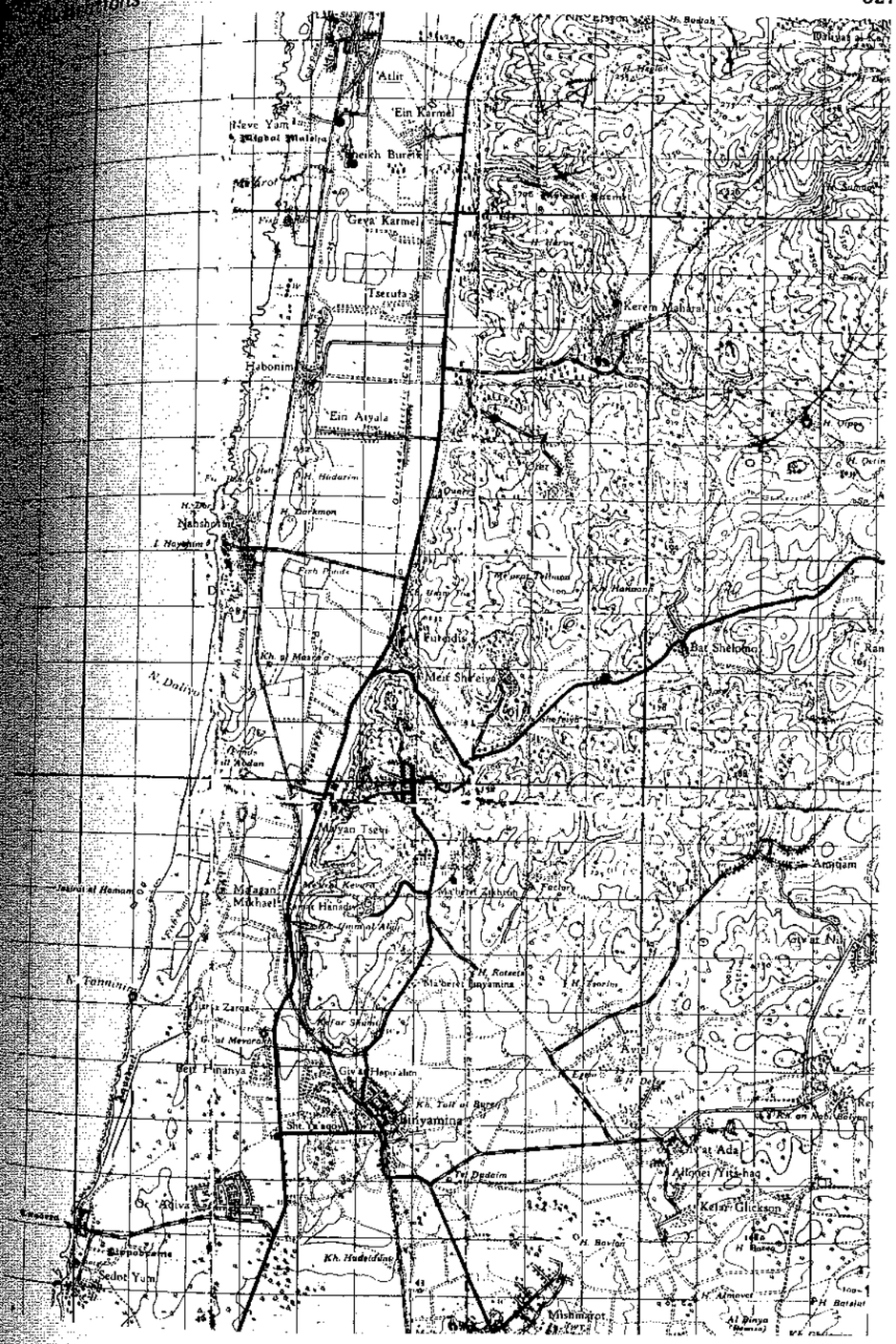
ILLUSTRATIONS



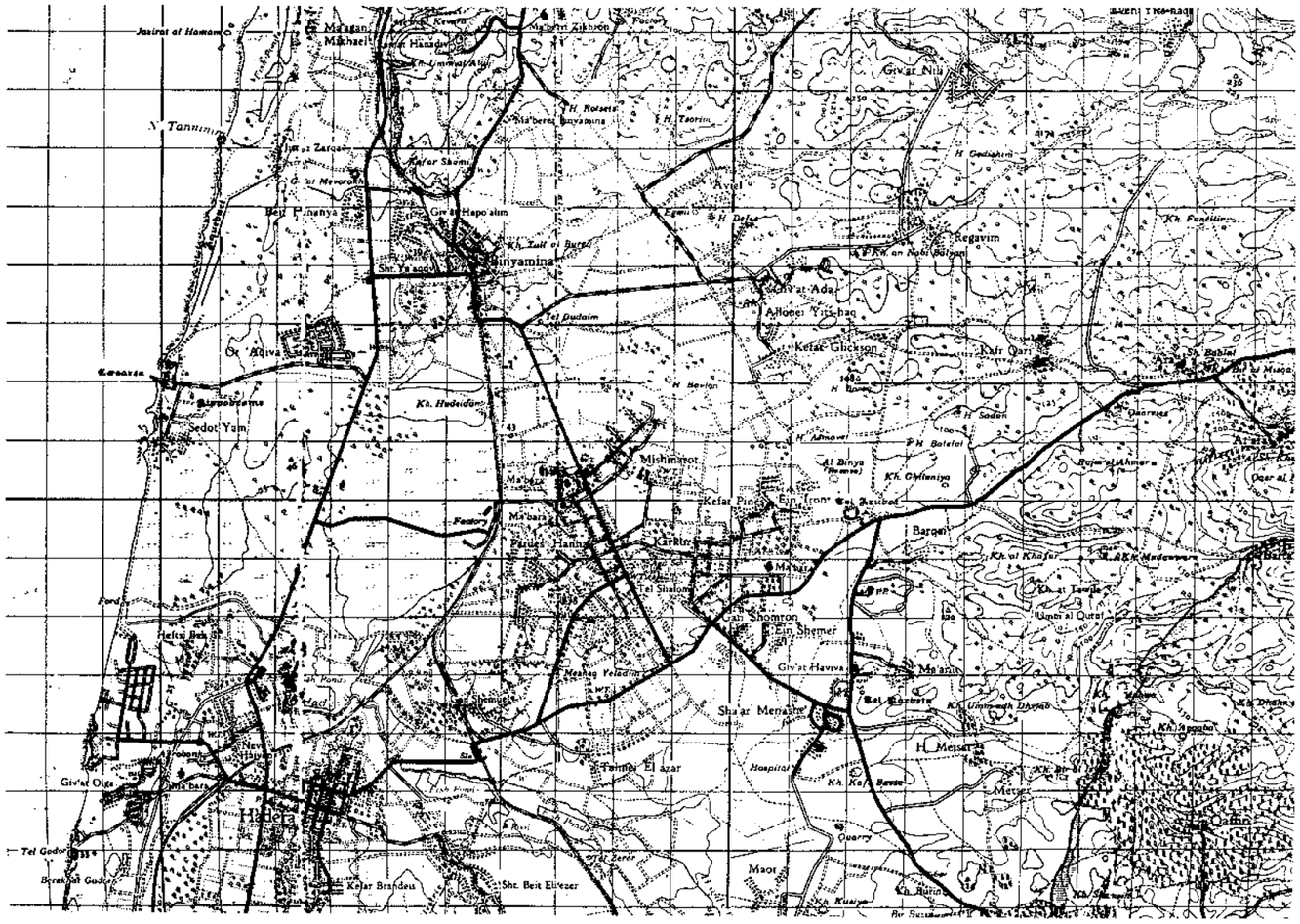
I.1 Location map of Caesarea in the Eastern Mediterranean.



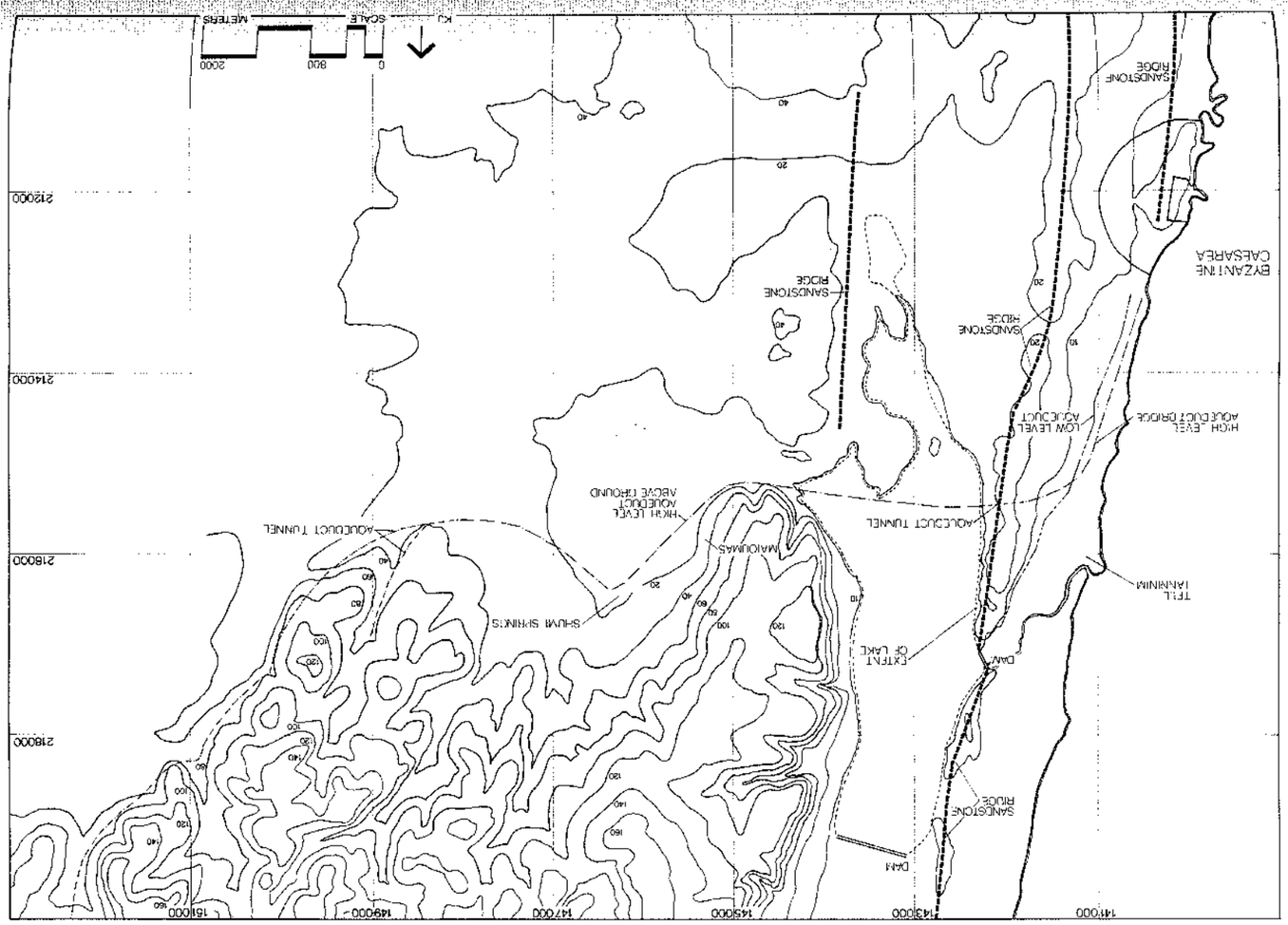
I.2 Location map of ancient harbours in the Levant.



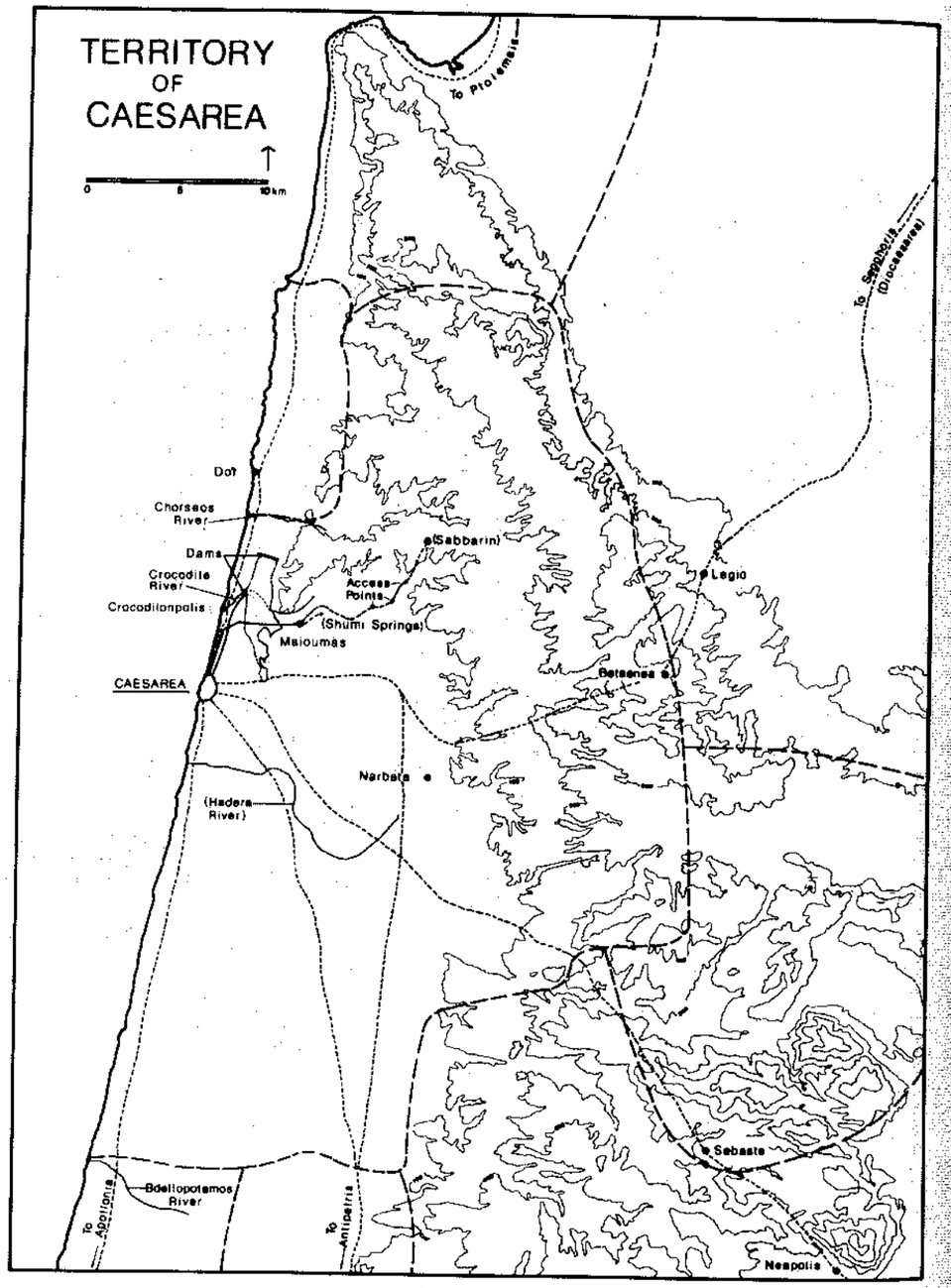
I.3 Topographic map: coast-line north of Caesarea (1 km grid) [Topographic Survey of Israel].



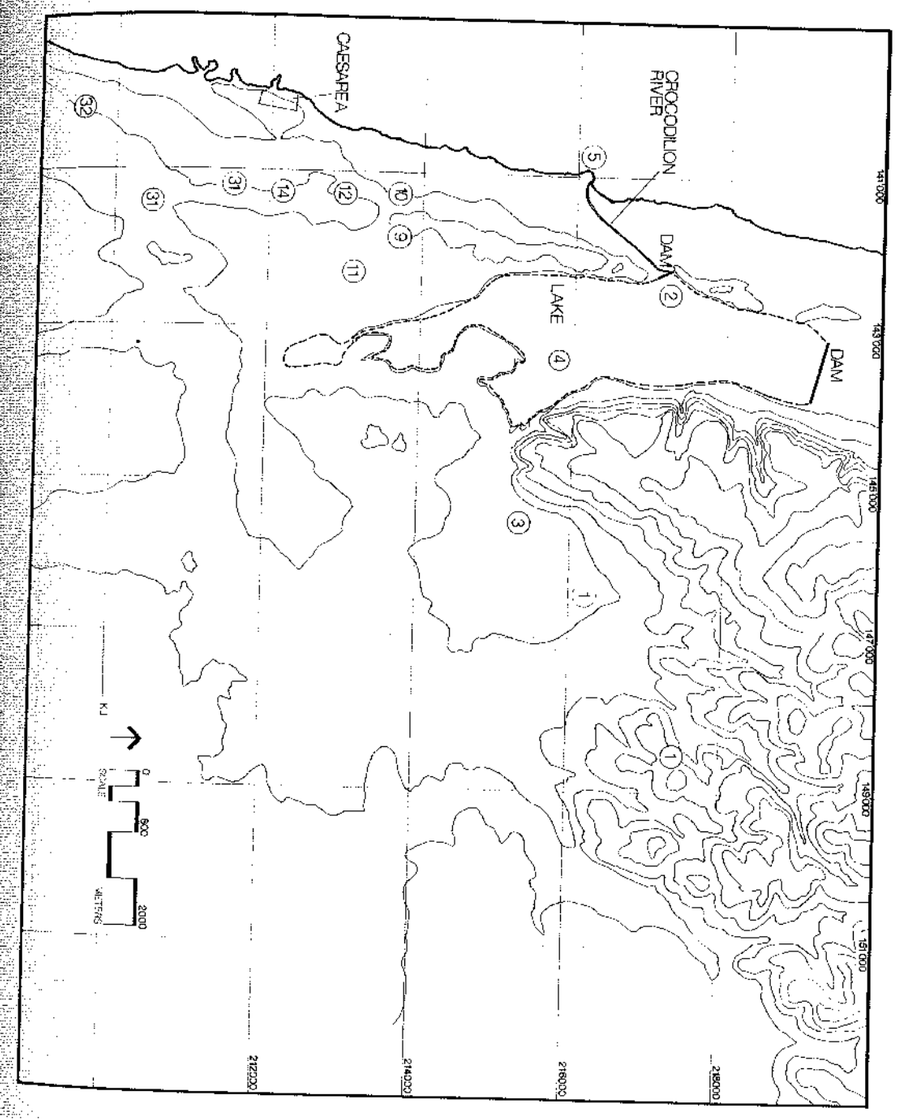
1.5 Topographic map: area east of Caesarea (1 km grid) [Topographic Survey of Israel].



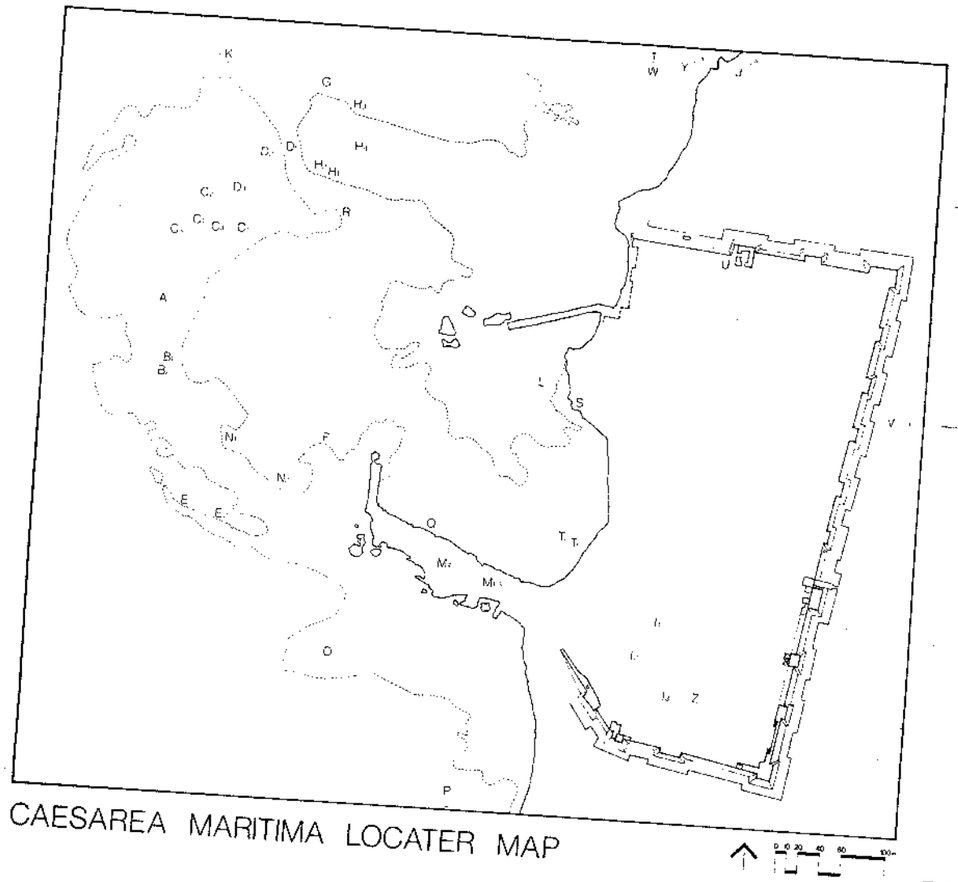
1.4 Topographic and geological features north and east of Caesarea.



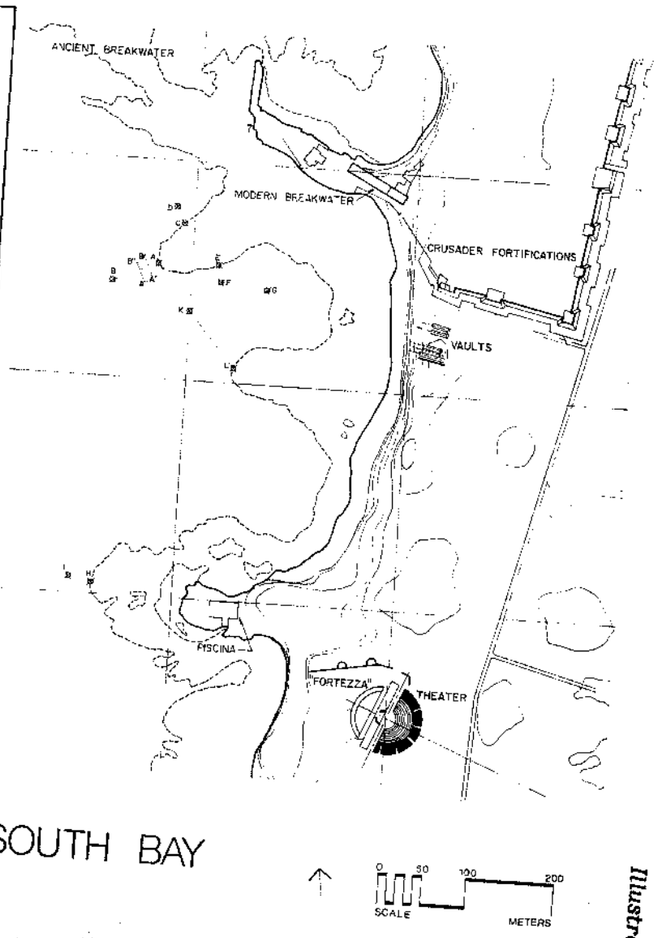
1.6 Ancient territory of Caesarea, with road system.



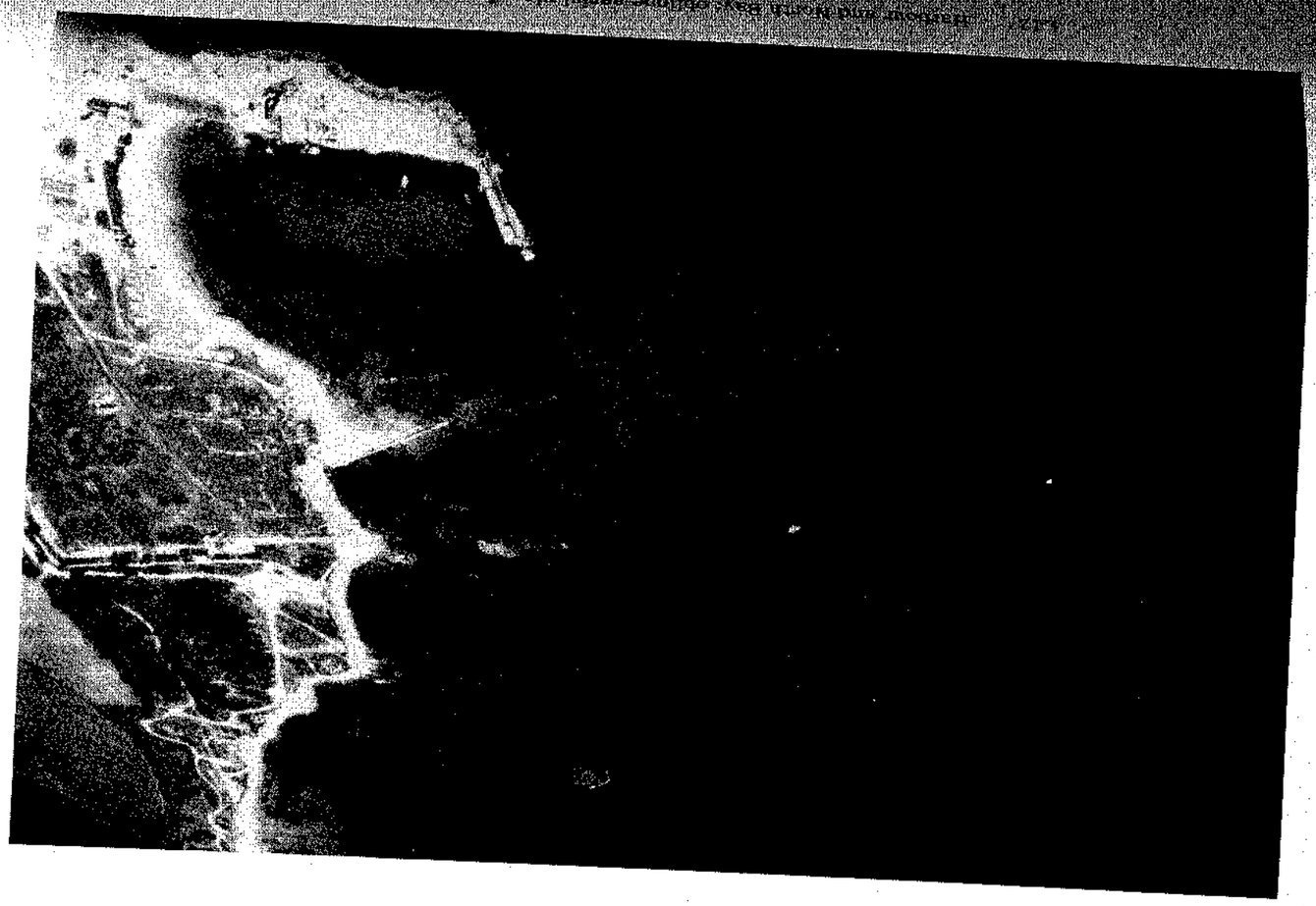
I.7 Location map: suburban features of Caesarea (for key, see Appendix II.A).



I.10 Harbour: location map of excavation areas.

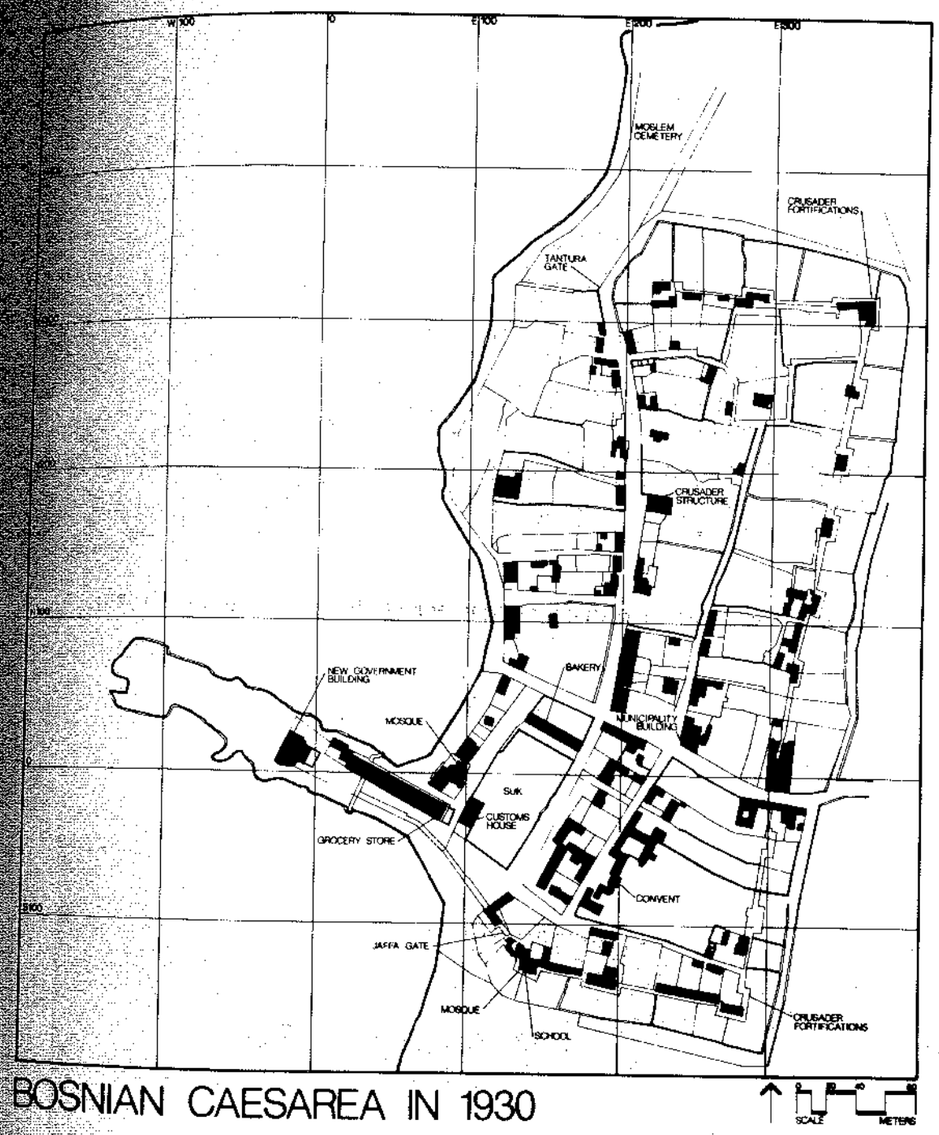


I.11 South Bay: ancient features and excavation areas.

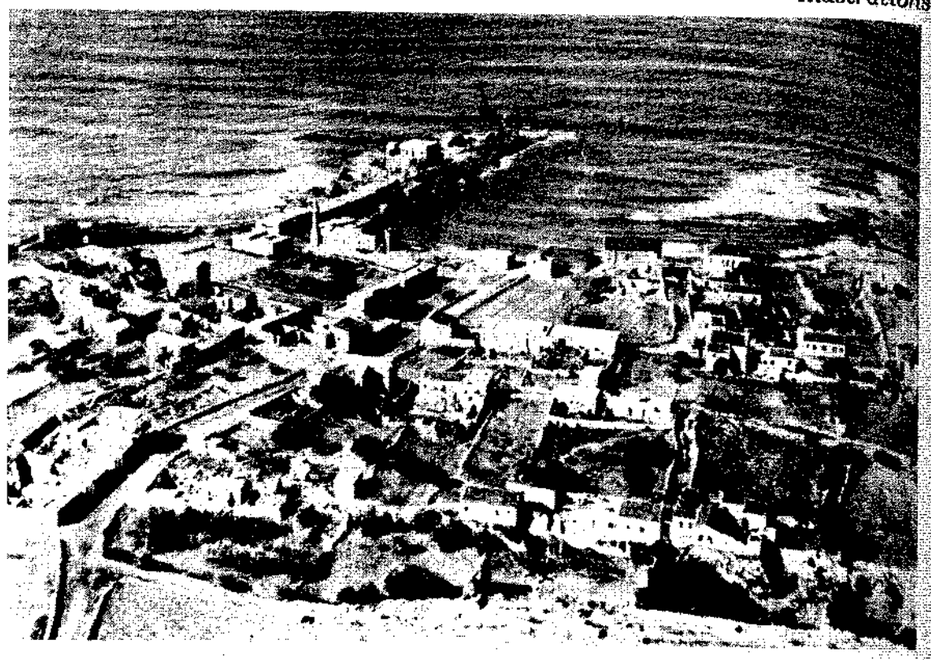


I.12 Herodian and Roman port: general view from south (1984).

I.13 Bosnian soldiers guarding Ottoman prisoners, 1878.

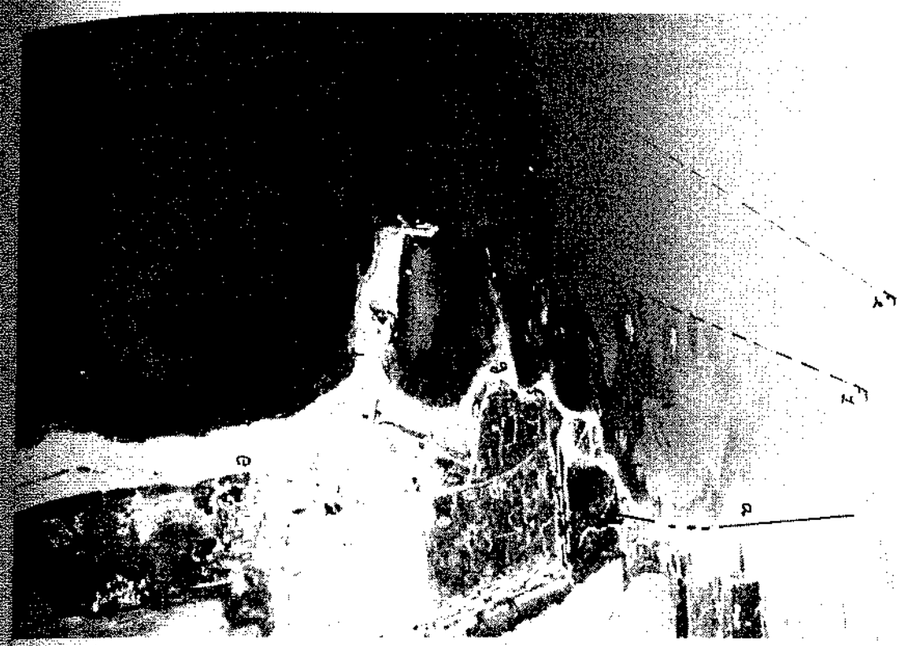


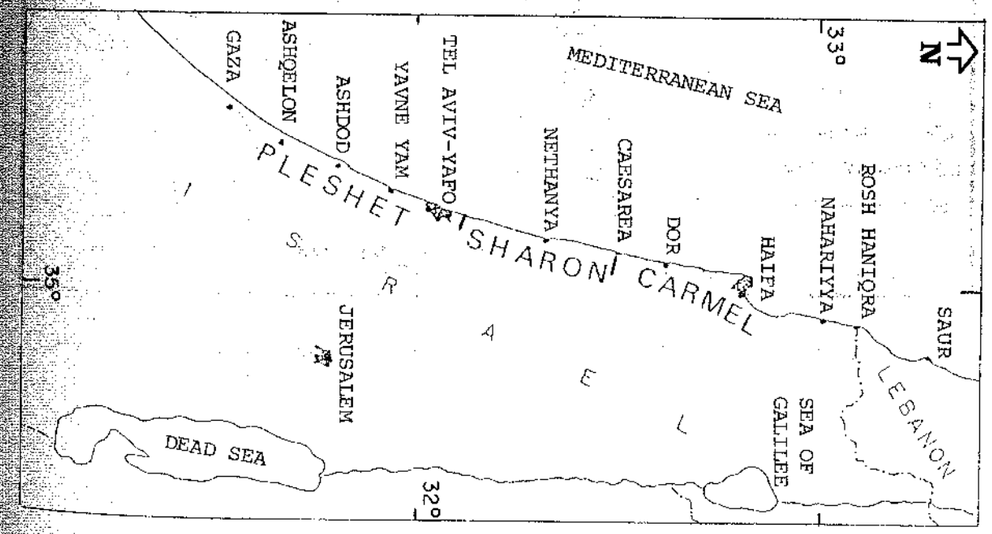
I.14 Map: Bosnian Caesarea in 1930.

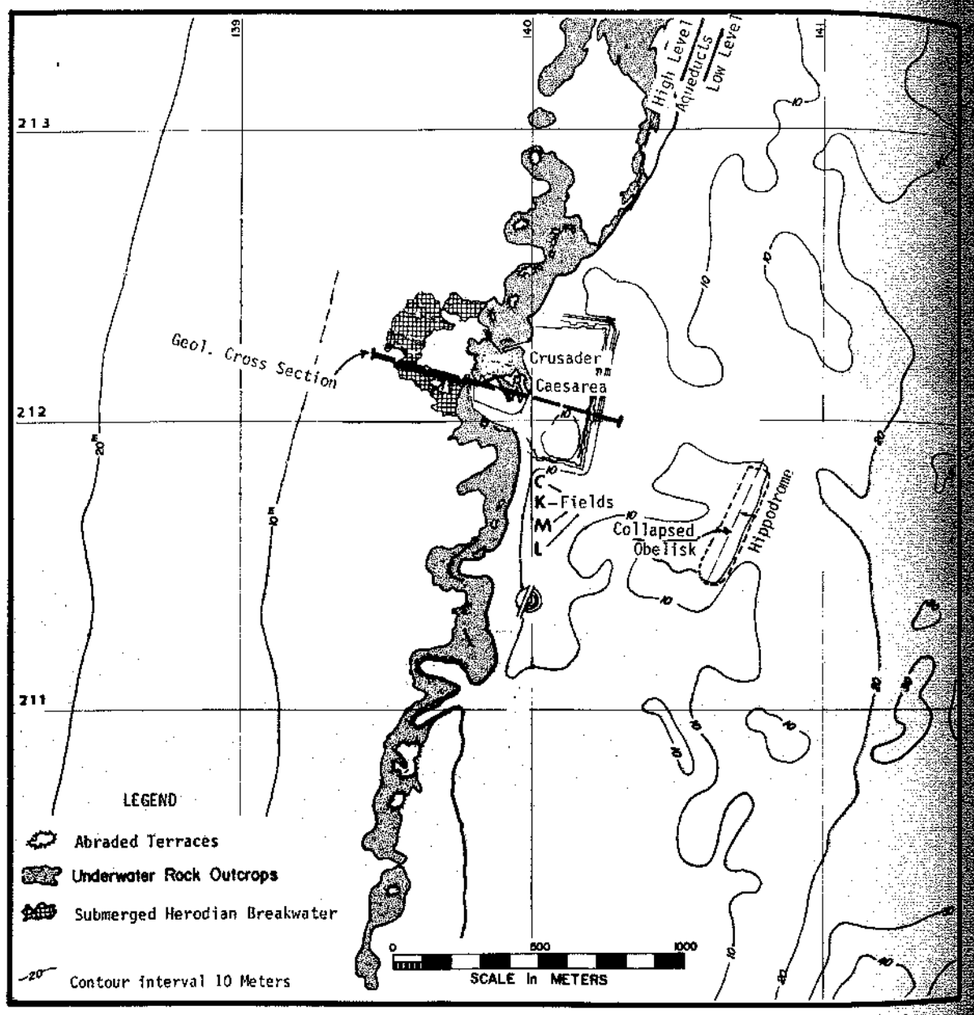


I.15 Harbour and Bosnian village: oblique aerial view from east (ca. 1925).

I.16 Harbour: oblique aerial view from east (1984).

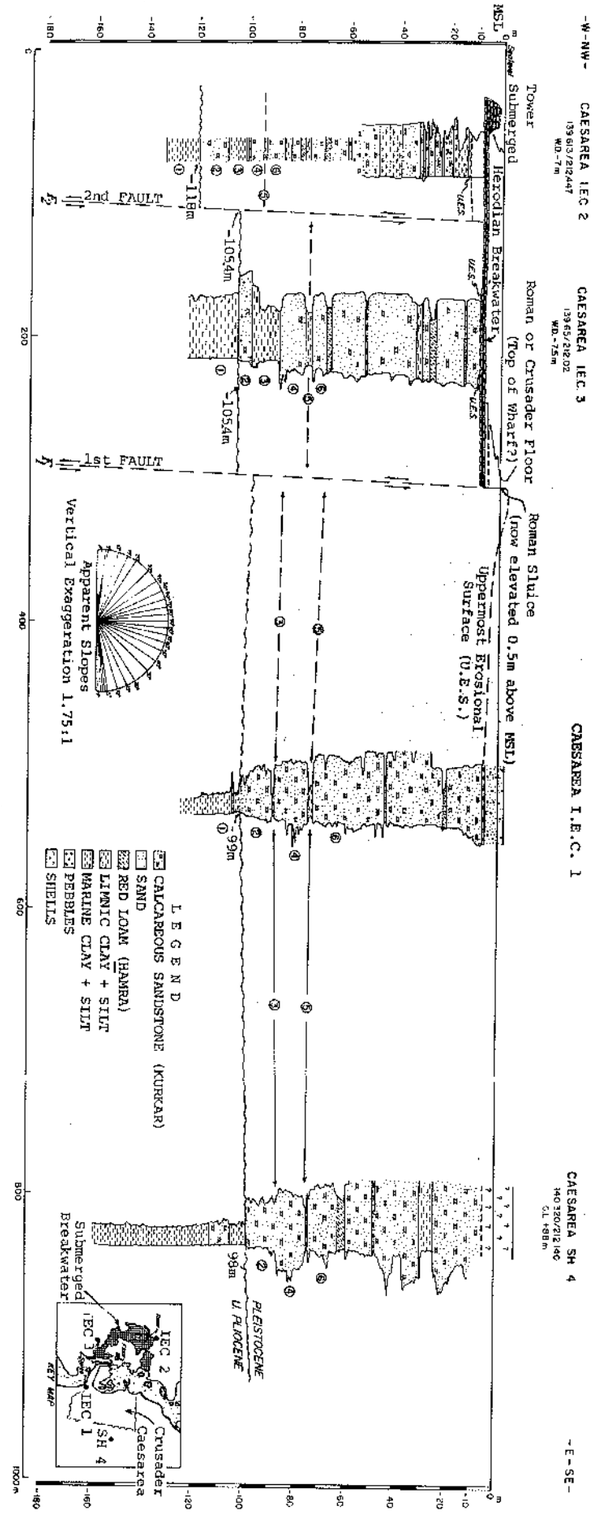


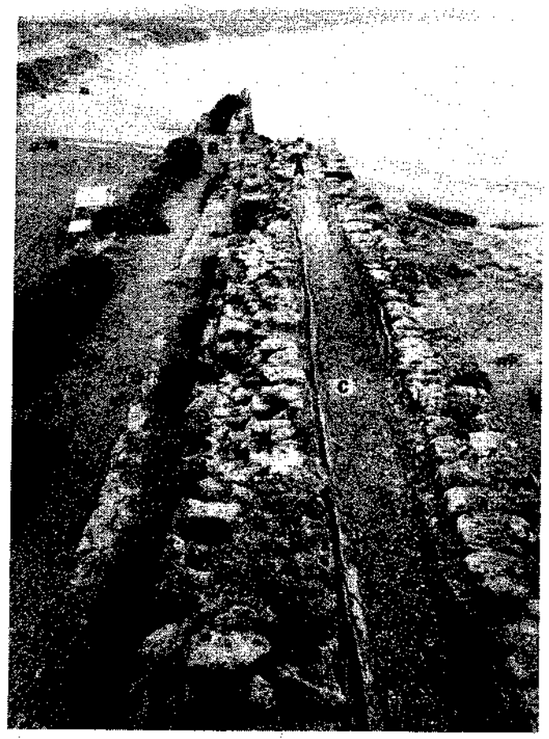




I.19 Caesarea: map indicating JECM excavation fields, geological features, and location of geological cross-section [D.N., K.O.E.].

I.20 East-West geological cross-section through late Pliocene to Recent sedimentary sequence at Caesarea [D.N., K.O.E.].



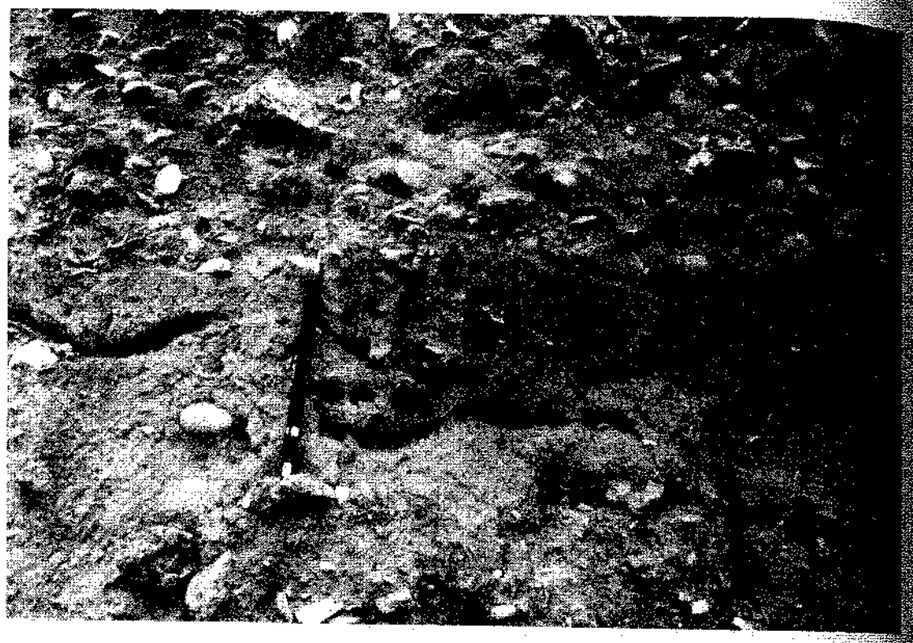


I.21 Channels of High-Level Aqueduct, looking south to break [D.N., K.O.E.].

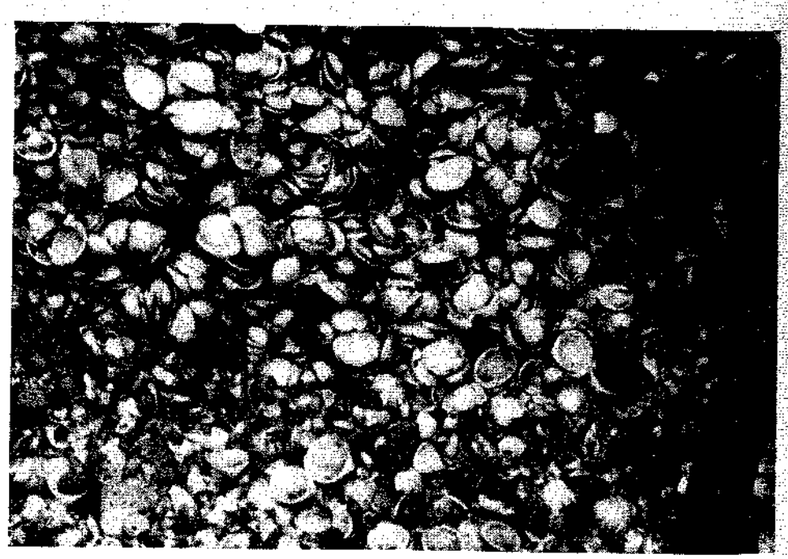
I.22 Channel of Low-Level Aqueduct, looking north [D.N., K.O.E.].

I.23 Sedimentary sequence over Byzantine and early Moslem structures south of Crusader walls [D.N., K.O.E.].

I.24 Detail of I.23: horizontal lamination in swamp sediments [D.N., K.O.E].



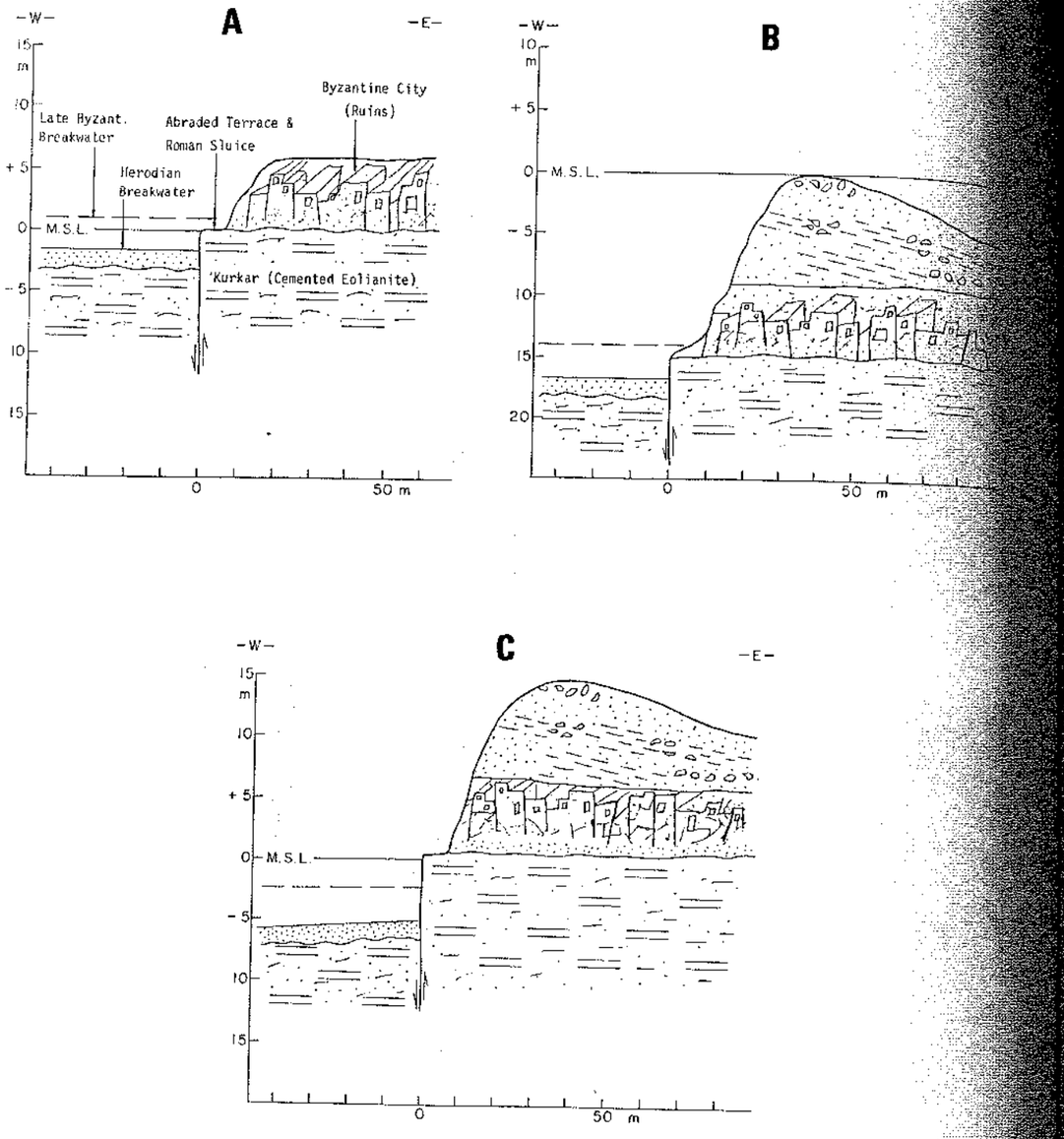
I.25 Detail of I.23: burrows suggesting bioturbation or aerobic condition [D.N., K.O.E.].



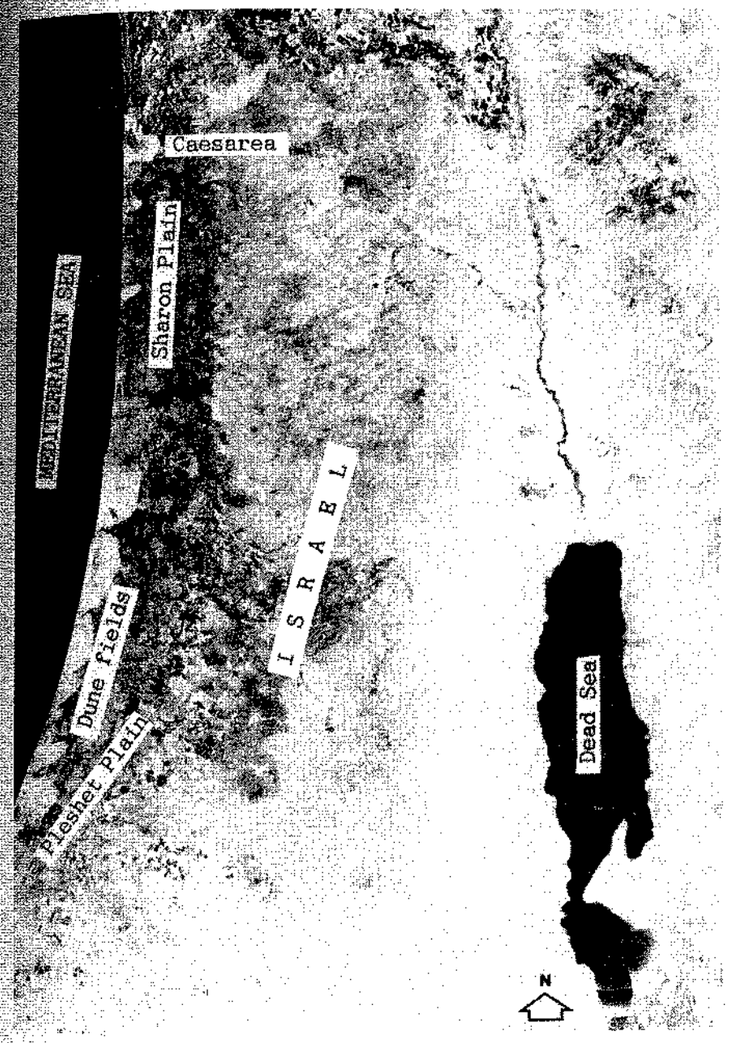
I.26 Detail of I.23: shell lenses within post-Byzantine sequence [D.N., K.O.E.]

I.27 Detail of I.23: shell lenses within post-Byzantine sequence; dominant concave-downward orientation [D.N., K.O.E.].

I.28 Detail of I.23: shell lenses within post-Byzantine sequence; lenticular layer of imbricated fragmented shells and pebbles [D.N., K.O.E.].

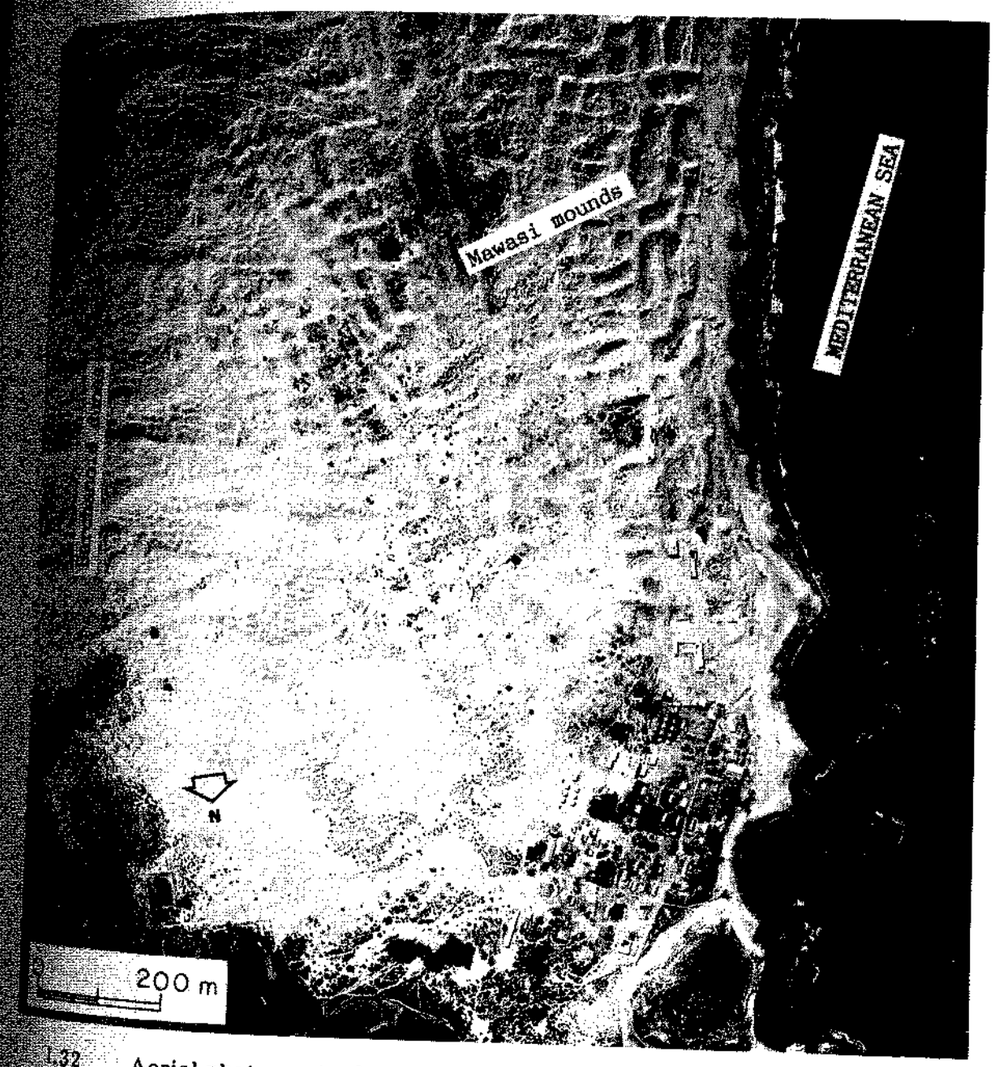


I.29 Three stages of post-Byzantine tectonic movement across coast-line at Caesarea: A. Pre-movement. B. Post-subsidence. C. Post-rebound [D.N., K.O.E.].

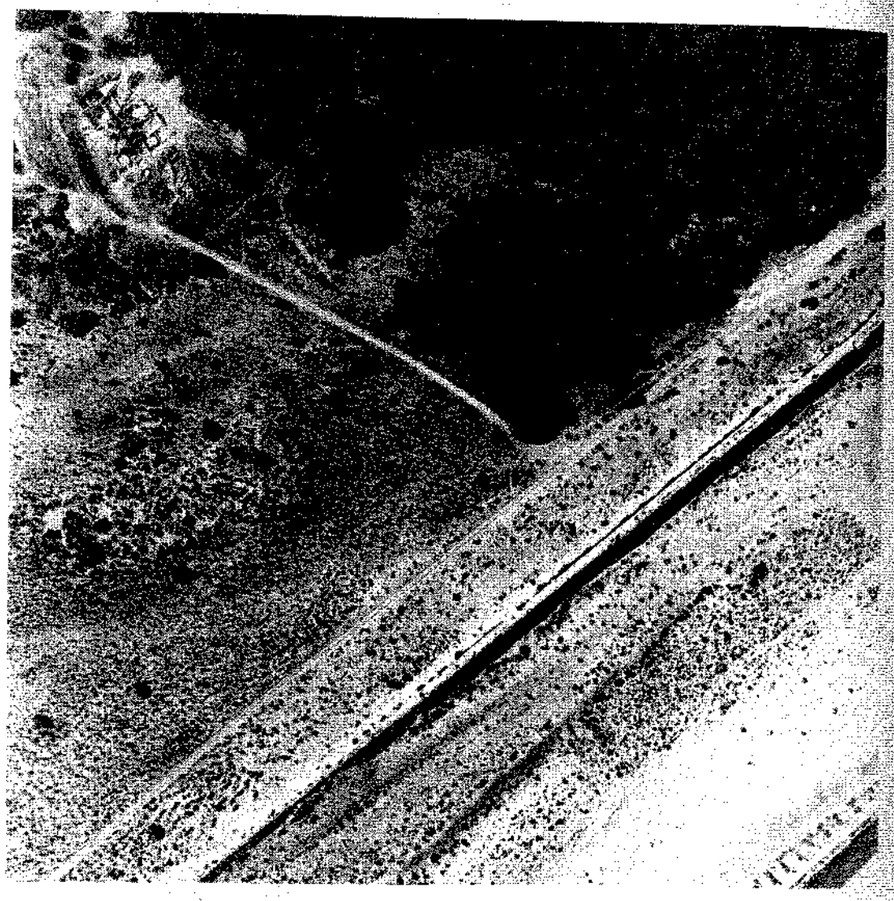


I.30 Satellite image of dune fields south of Caesarea [NASA].

I.31 Aerial photograph of dune fields around Caesarea [Survey of Israel].



I.32 Aerial photograph of dune fields south of Sedot Yam [Survey of Israel].



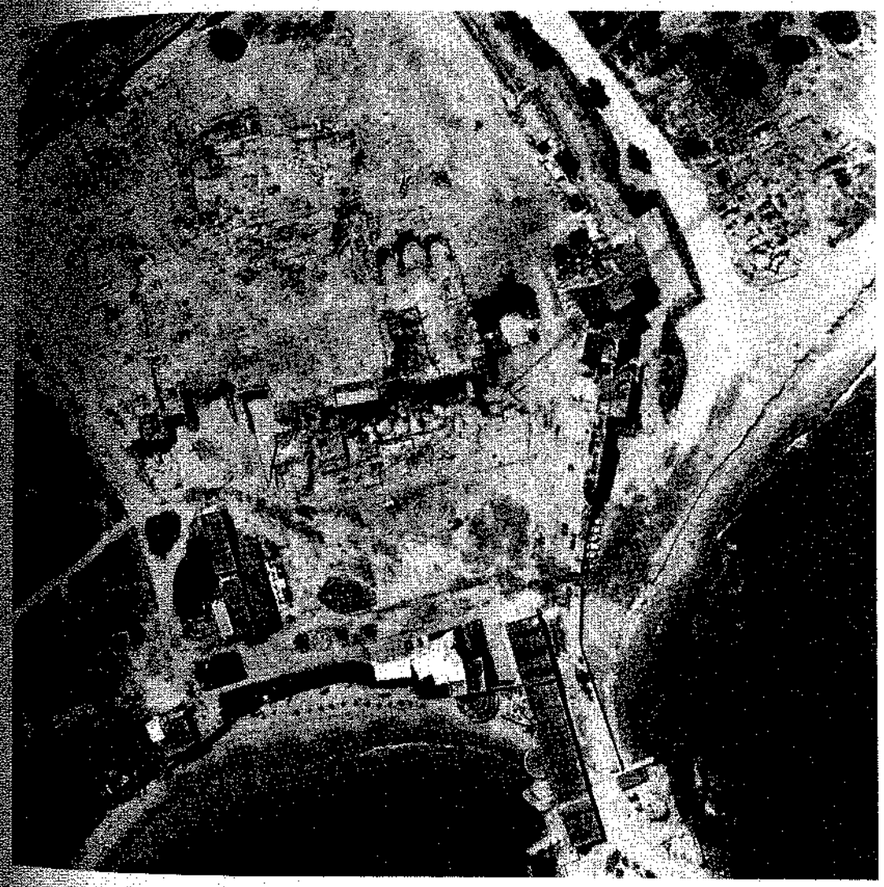
I.33 Aerial photograph: Byzantine bath building (JECM E-Field), and Low-Level and High-Level Aqueducts [J.W. Myers].

I.34 Aerial photograph: termination of aqueducts north of Crusader walls [J.W. Myers].

I.35 Aerial photograph: north gate with twin round towers [J.W. Myers].

I.36 Aerial photograph: north gate to Area J [J.W. Myers].

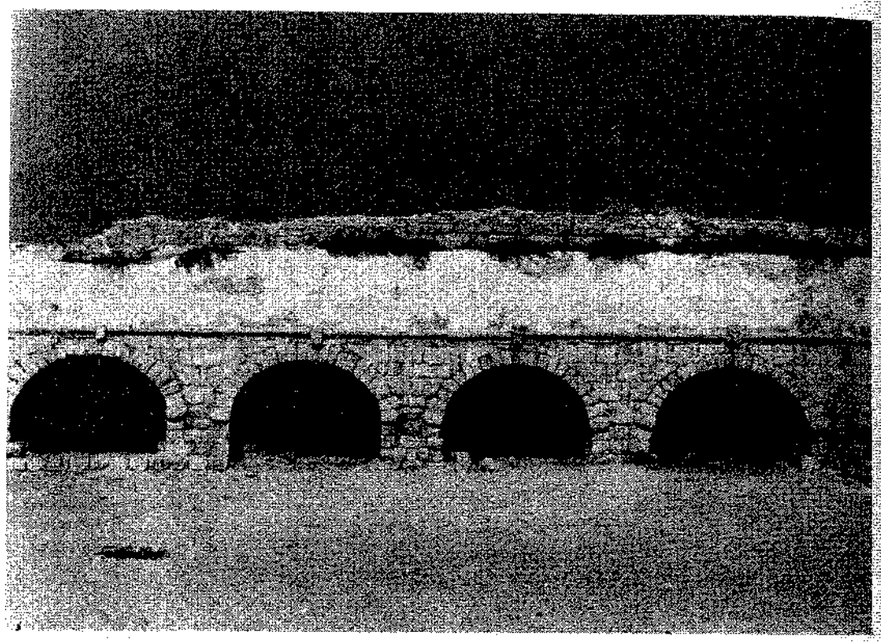
I.37 Aerial photograph: north Crusader wall, Column Jetty, Area L, Area S [J.W. Myers].



I.38 Aerial photograph: Inner Basin (Area I), modern beach, south Crusader wall, JECM C-Field [J.W. Myers].

I.39 Aerial photograph: JEOM C. Field, dunes, coast of South Bay [J.W. Myers].

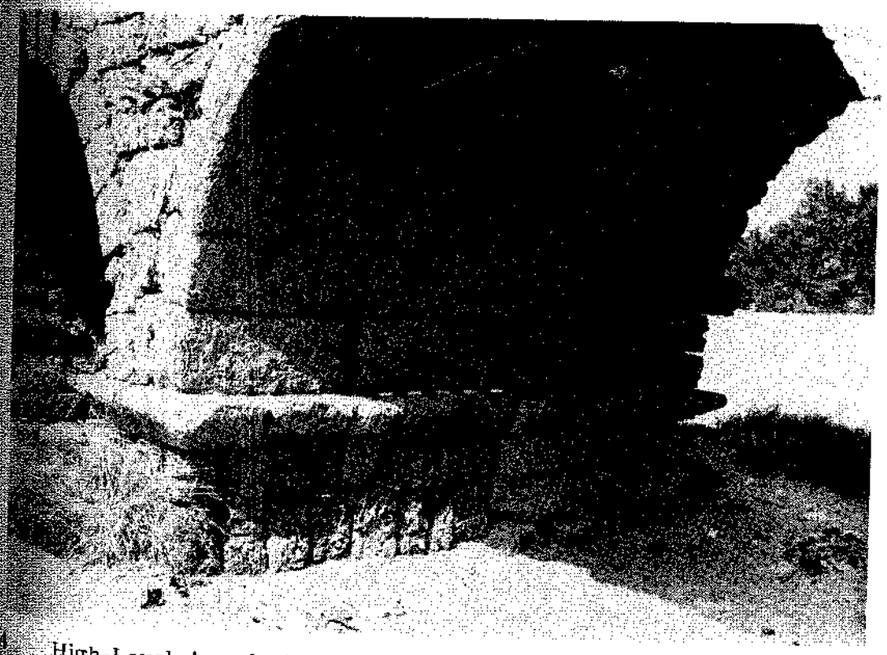
I.40 Aerial photograph: coast of South Bay, Piscina, Byzantine wall, Theatre [J.W. Myers].



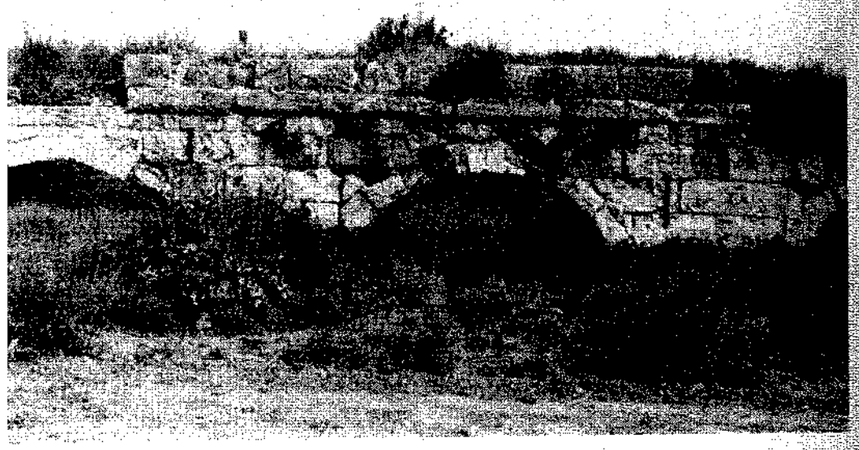
I.41 High-Level Aqueduct: east face [Y.P.].

I.42 High-Level Aqueduct: west face [Y.P.].

I.43 High-Level Aqueduct: broken south end showing two construction stages [Y.P.].



I.44 High-Level Aqueduct: detail of arches showing two construction stages [Y.P.].

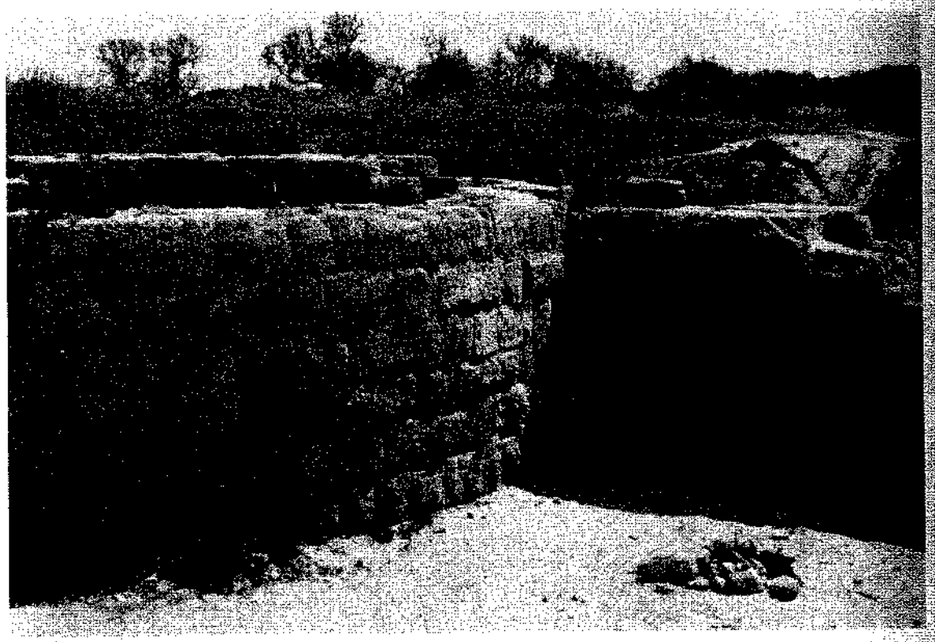


I.45 High-Level Aqueduct: Kabbara marsh by-pass [Y.P.].

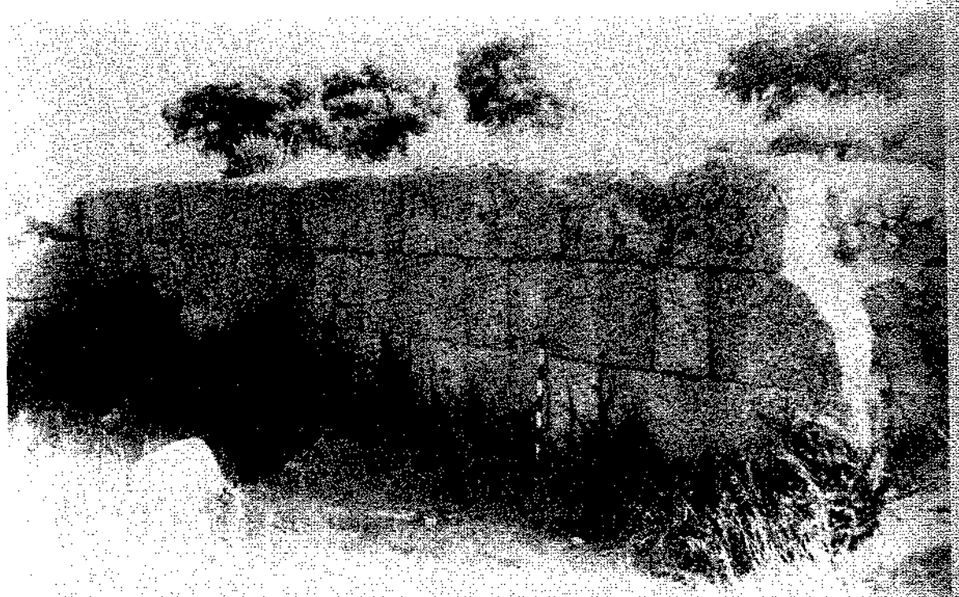
I.46 High-Level Aqueduct: triple pipeline in Kabbara marsh section [Y.P.]

II.1 North gate with twin round towers: oblique aerial.

II.2 North gate: east tower, from east.

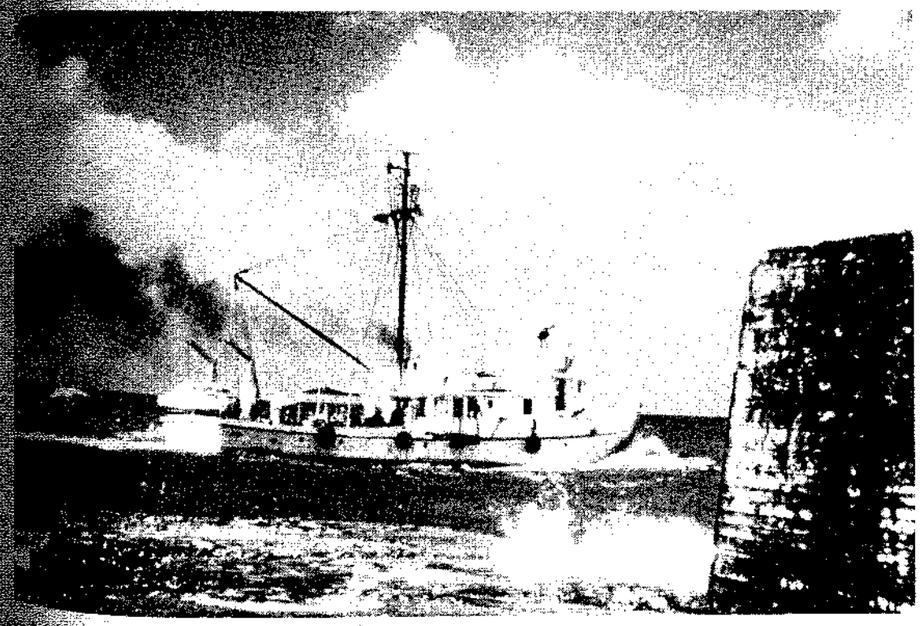


II.3 North gate: blocking wall between towers.

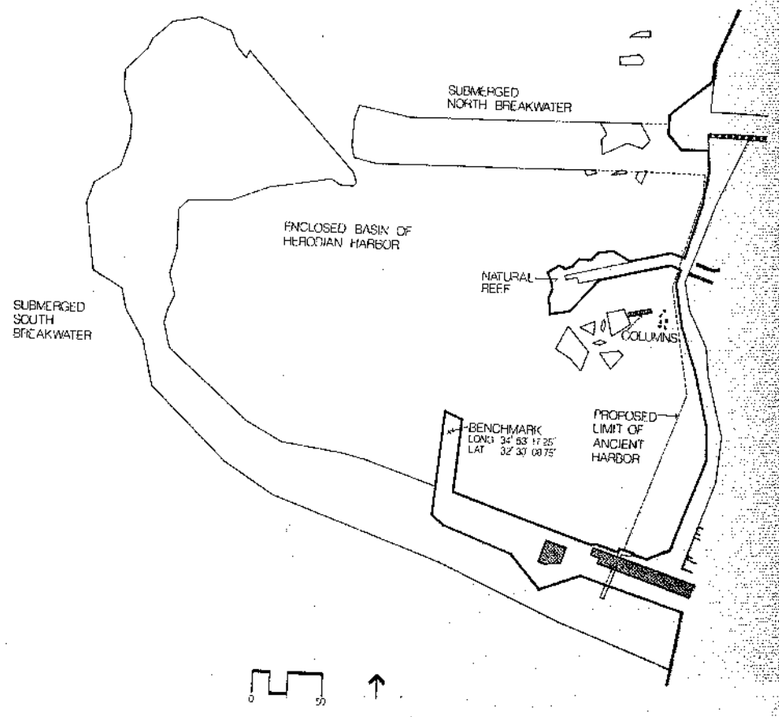


II.4 North gate: city wall east of east tower, outer face.

II.5 North gate: city wall east of east tower, inner face.

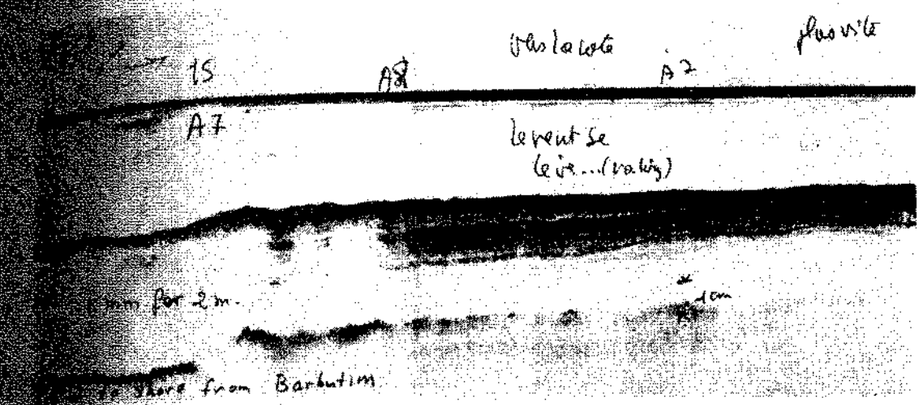


II.6 Link's ship *Sea Diver* at the harbour of Caesarea [C.T. Fritsch].



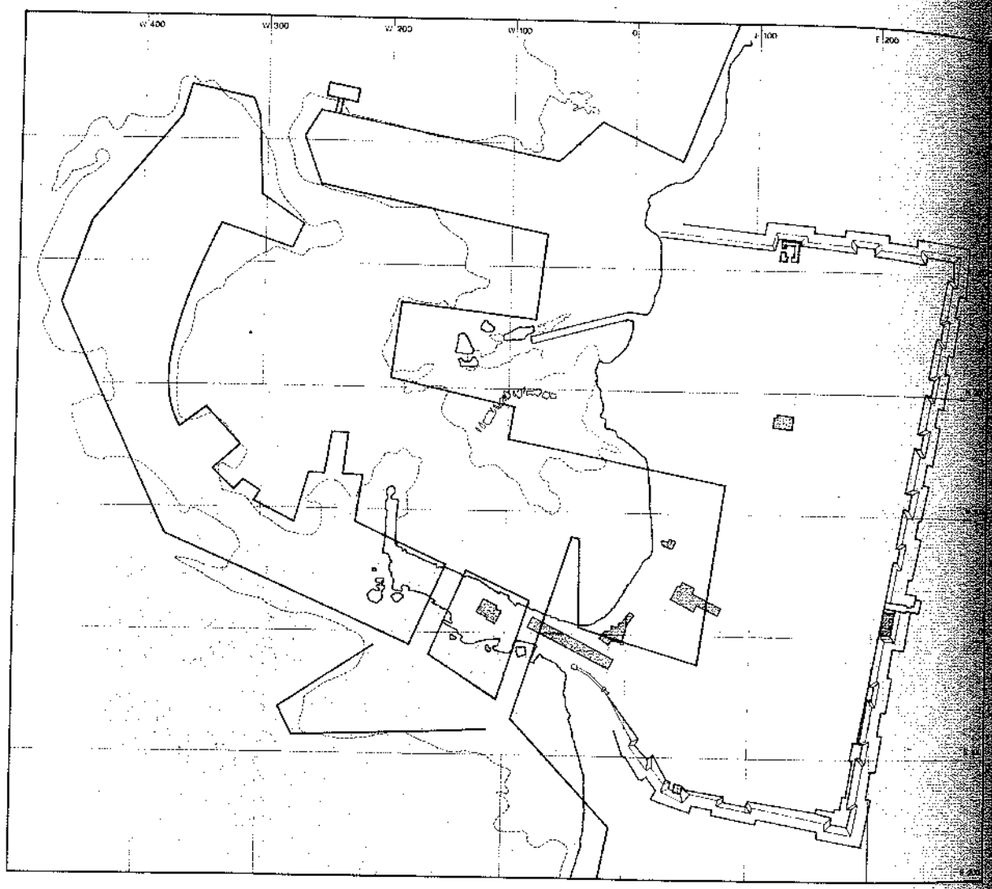
II.7 Link's plan of the Herodian harbour (redrawn by CAHEP).

II.8 Harold Edgerton at Caesarea in 1963. To the right, E. Linder, O. Leenhardt.



II.9 Sub-bottom profile print-out, seaward from shore of South Bay.

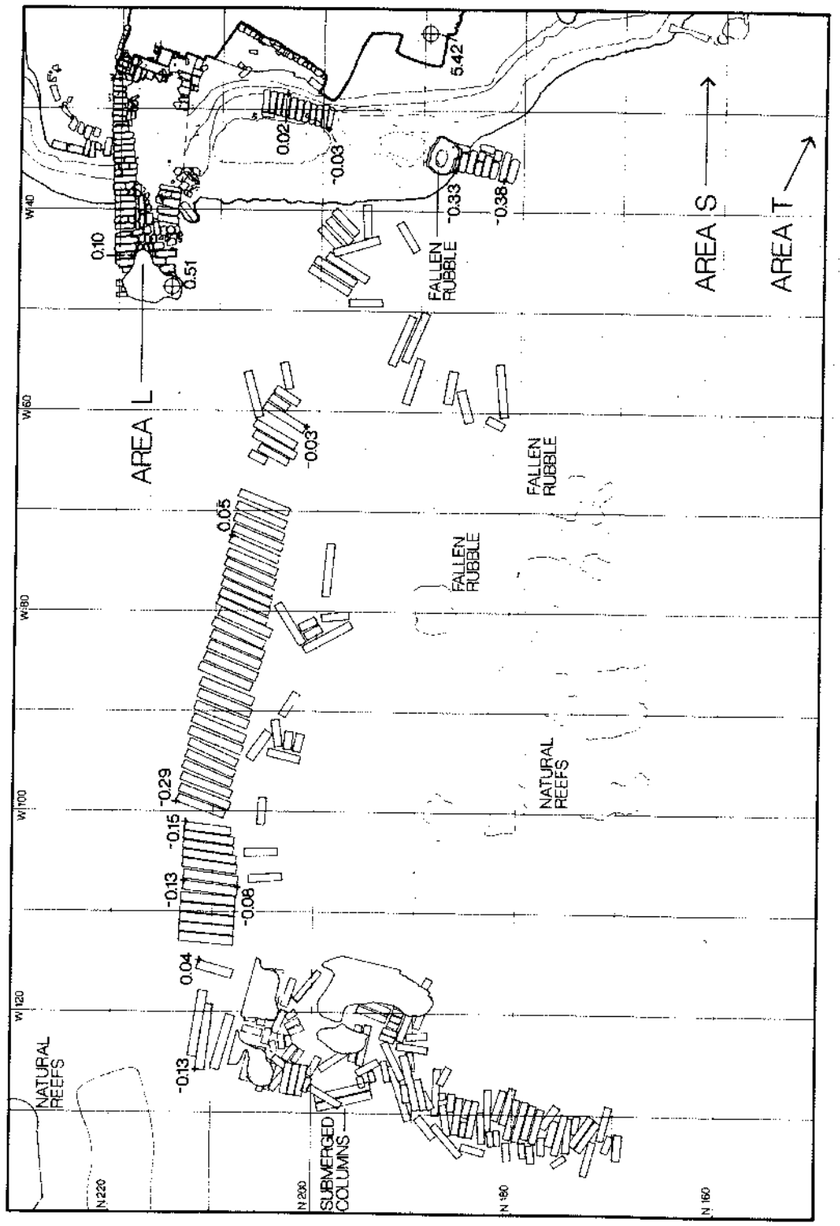
II.10 Southern Breakwater: dendritic pattern of melted lead found at depth of 8 m near later CAHEP Area K, 1967.



II.11 Map of ancient harbour produced by CMS for IEC Survey.

II.12 Reefs off Sedot Yam: arrows indicate rock-cut tanks.

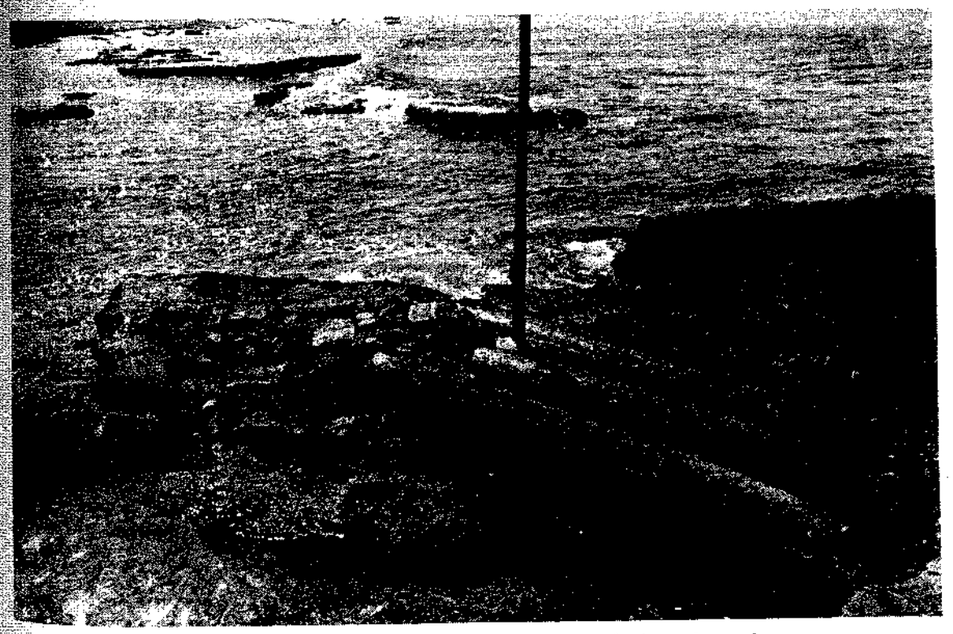
II.13 Rock-cut tank in reef off Sedot Yam.



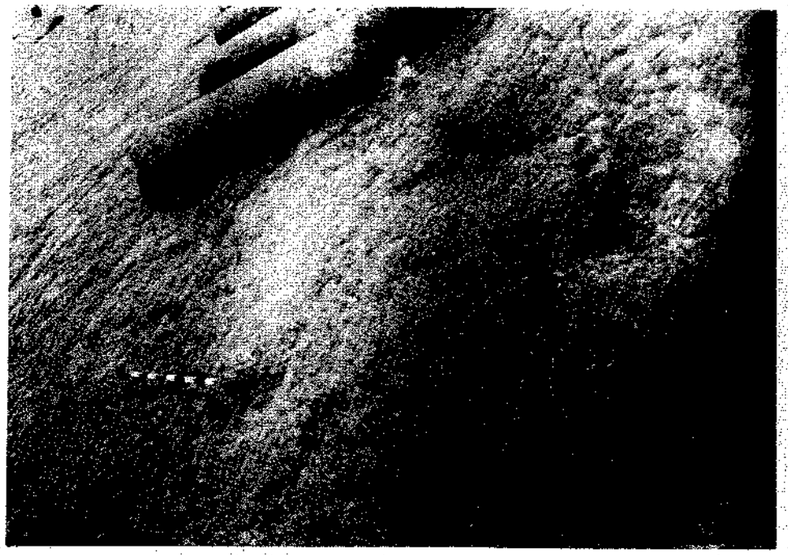
II.14 Column Jetty: plan.

COLUMN JETTY

II.15 Column Jetty: aerial view of central section from north. Arrow indicates ashlar platform.

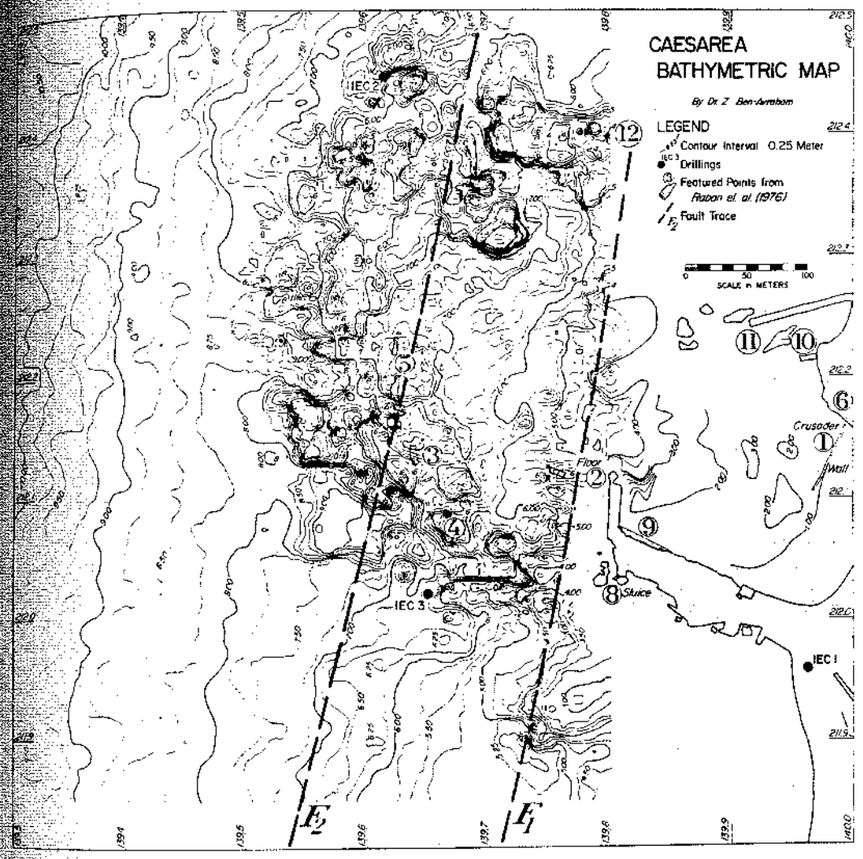


II.16 Column Jetty: columns embedded in beach-rock.



II.17 Column Jetty: ashlar platform beneath columns.

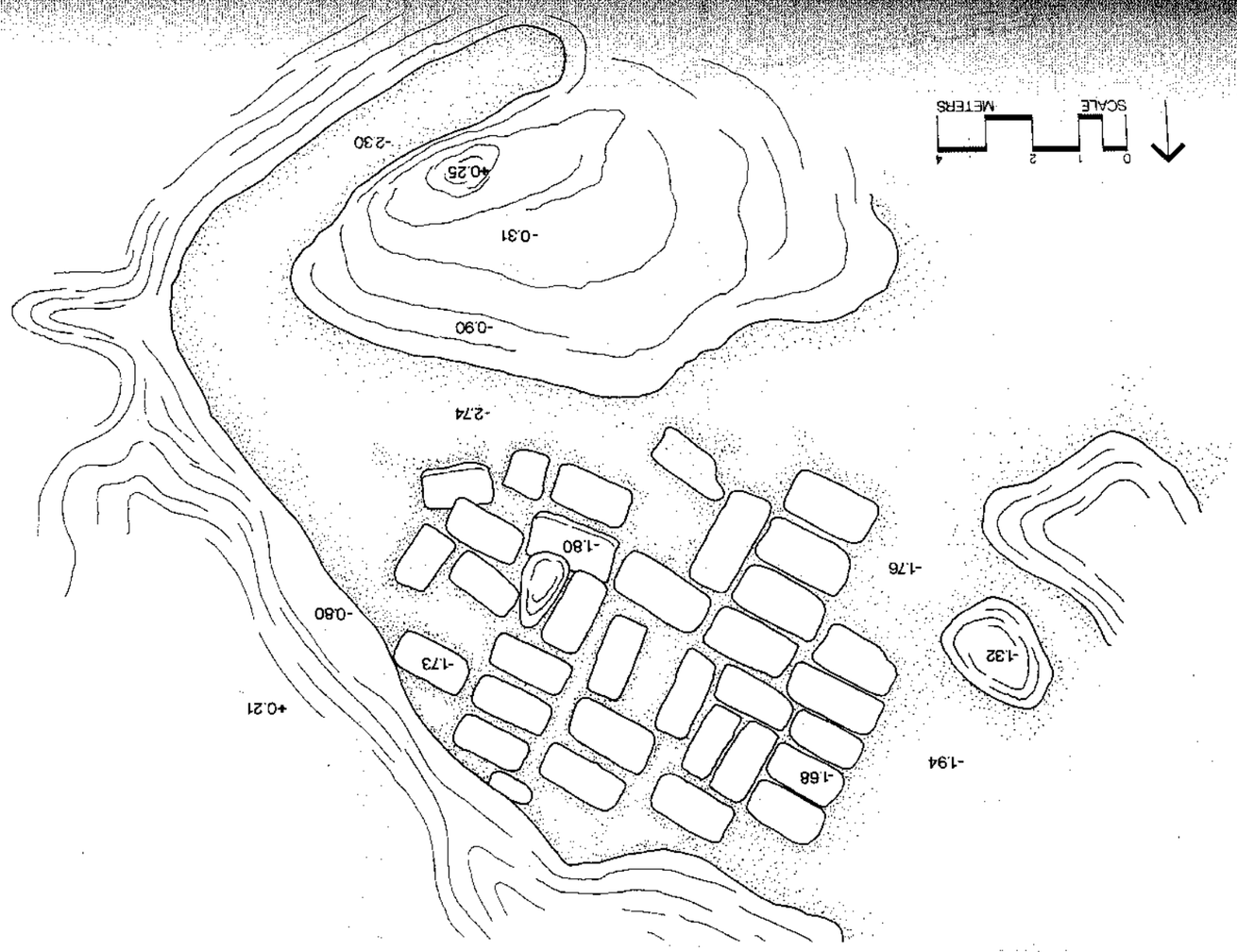
II.18 Area I_1: CMS probe against quay wall (1976).



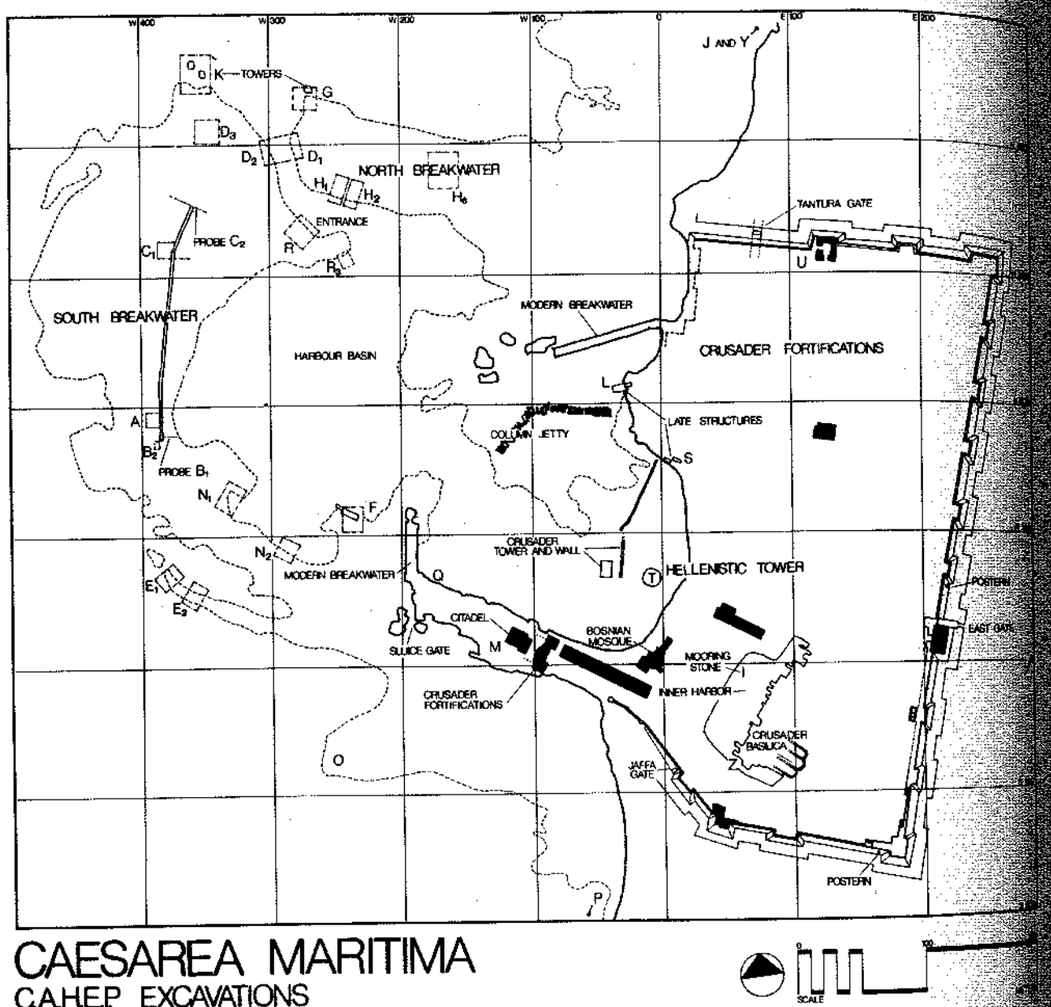
II.19 CMS bathymetric map of ancient harbour area, with indication of fault lines 1 and 2 (1976).

II.20 Crusader wall showing high proportion of *Glycymeris violacescens* shells in mortar.

II.21 Byzantine ceramics at site of possible shipwreck on southwest edge of Southern Breakwater.

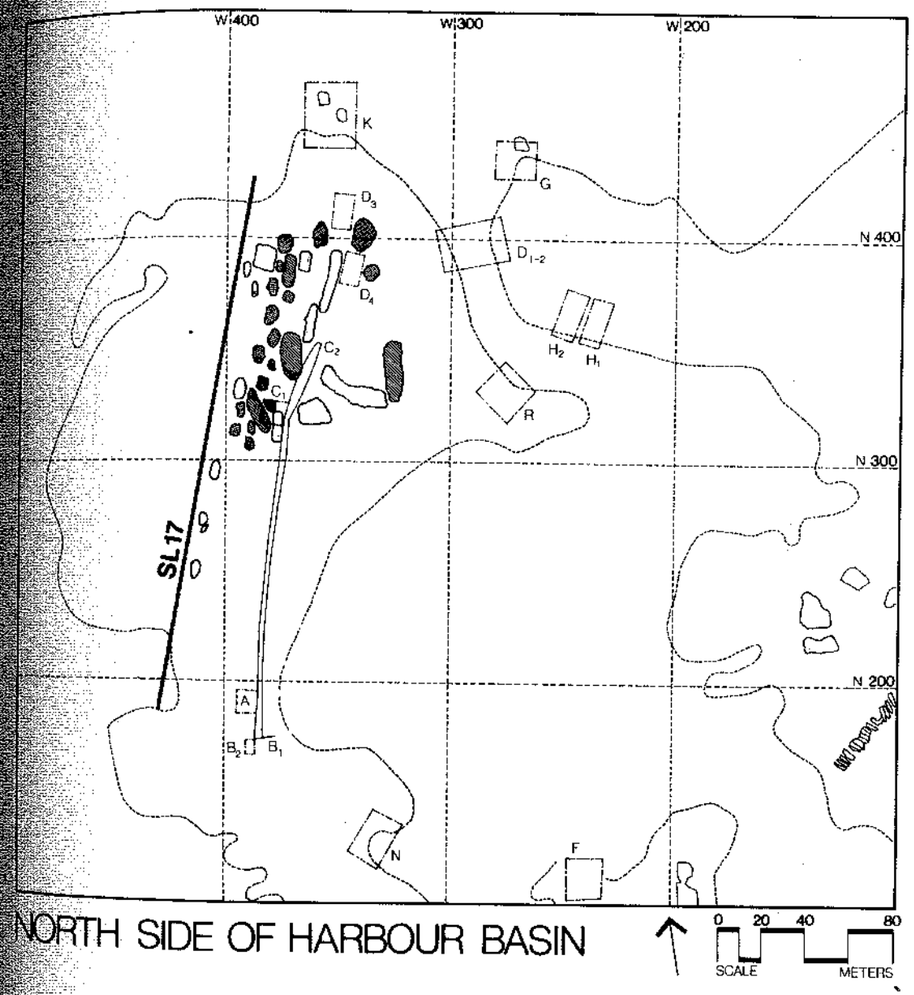


II.22 Underwater survey plan of Byzantine shipwreck at Pisa(?).



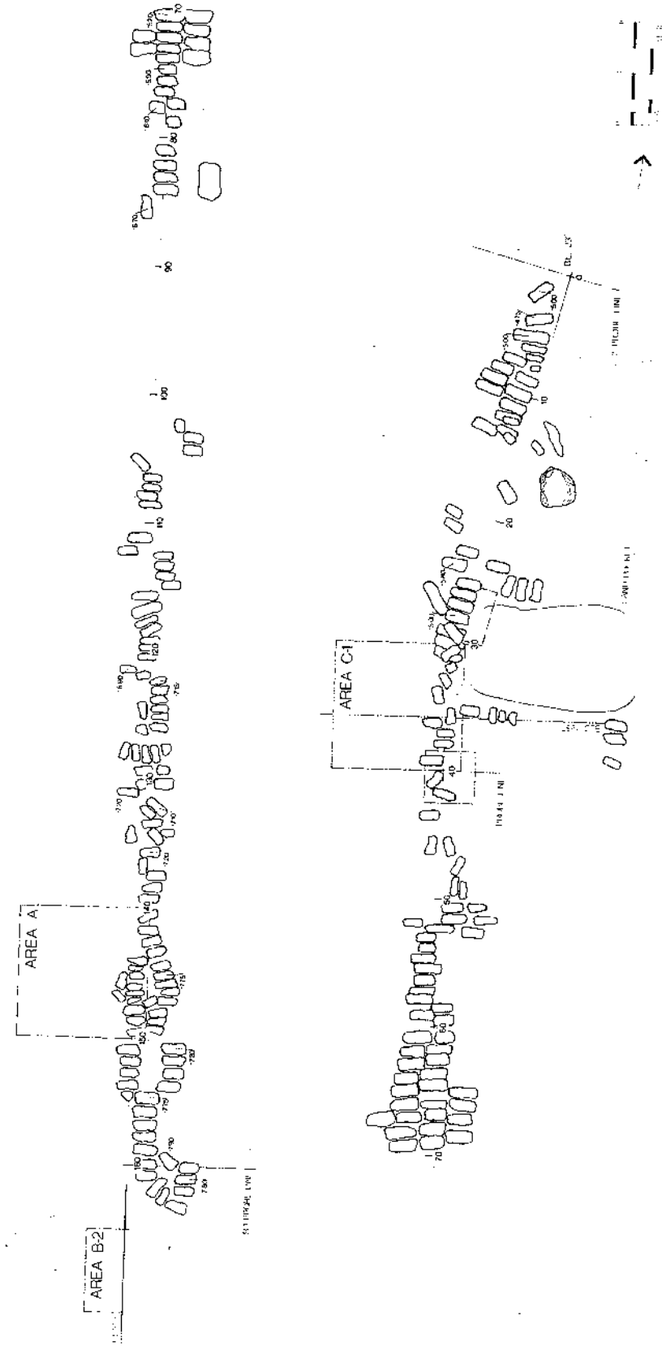
CAESAREA MARITIMA
C.A.H.E.P. EXCAVATIONS
COMPOSITE PLAN 1:1000 RLV

III.1 Location map: CAHEP excavation areas, 1977-87.

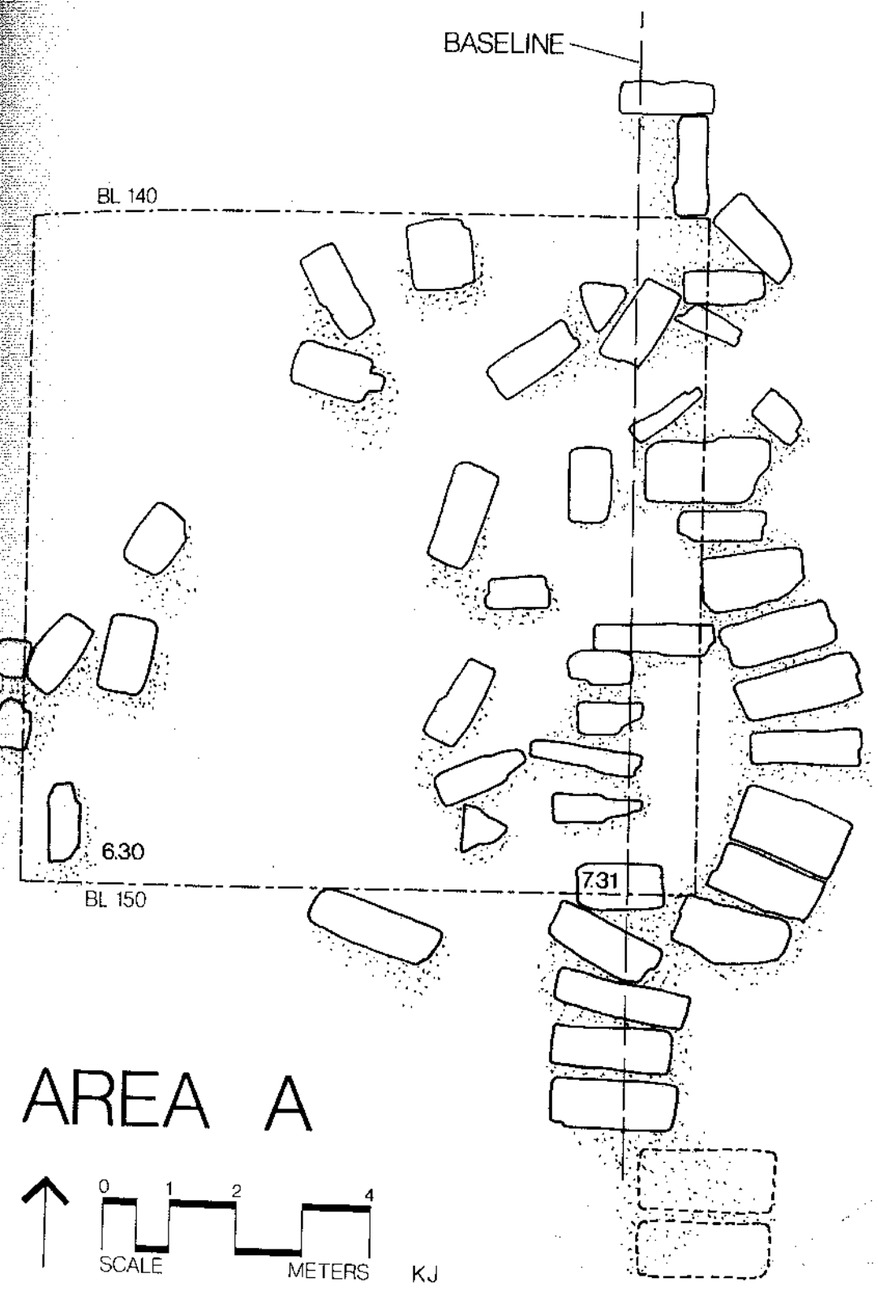


NORTH SIDE OF HARBOUR BASIN

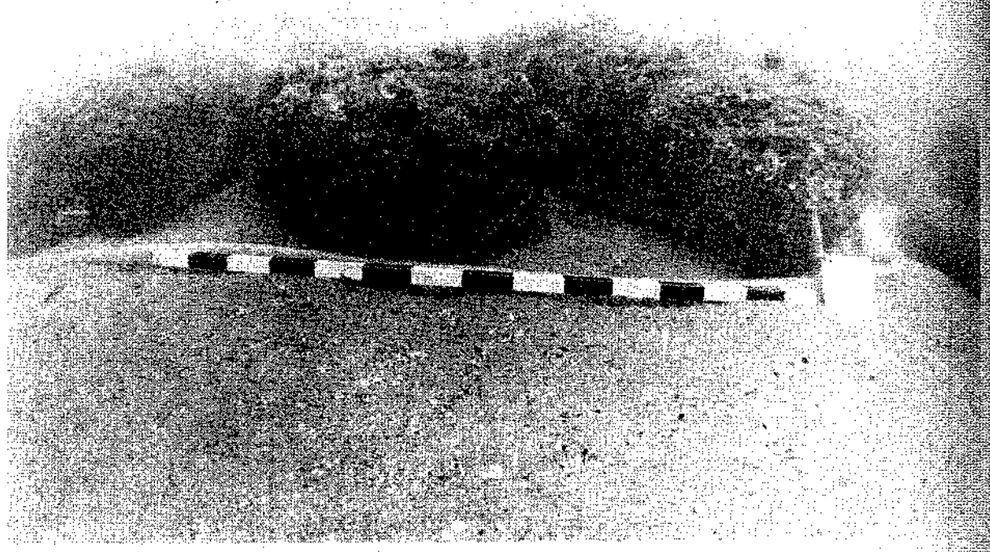
III.2 Excavation areas in north and west portion of harbour, and Survey Line 17.



III.3 Areas A, B, C: plan.

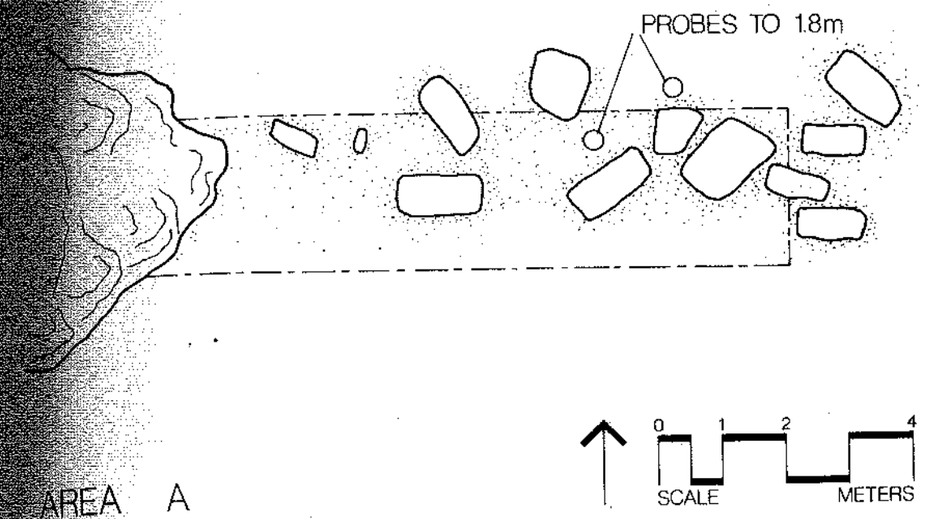


III.4 Area A: plan.

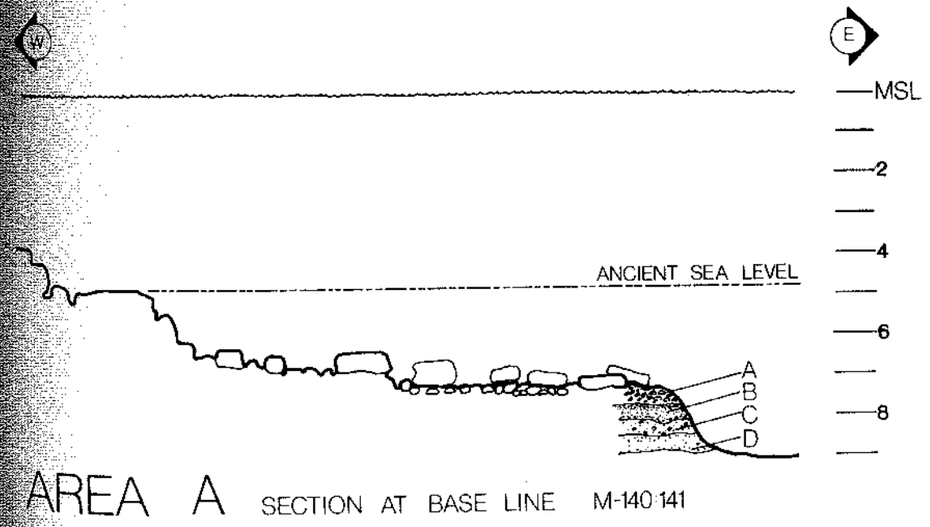


III.5 Area A: line of blocks arranged as headers.

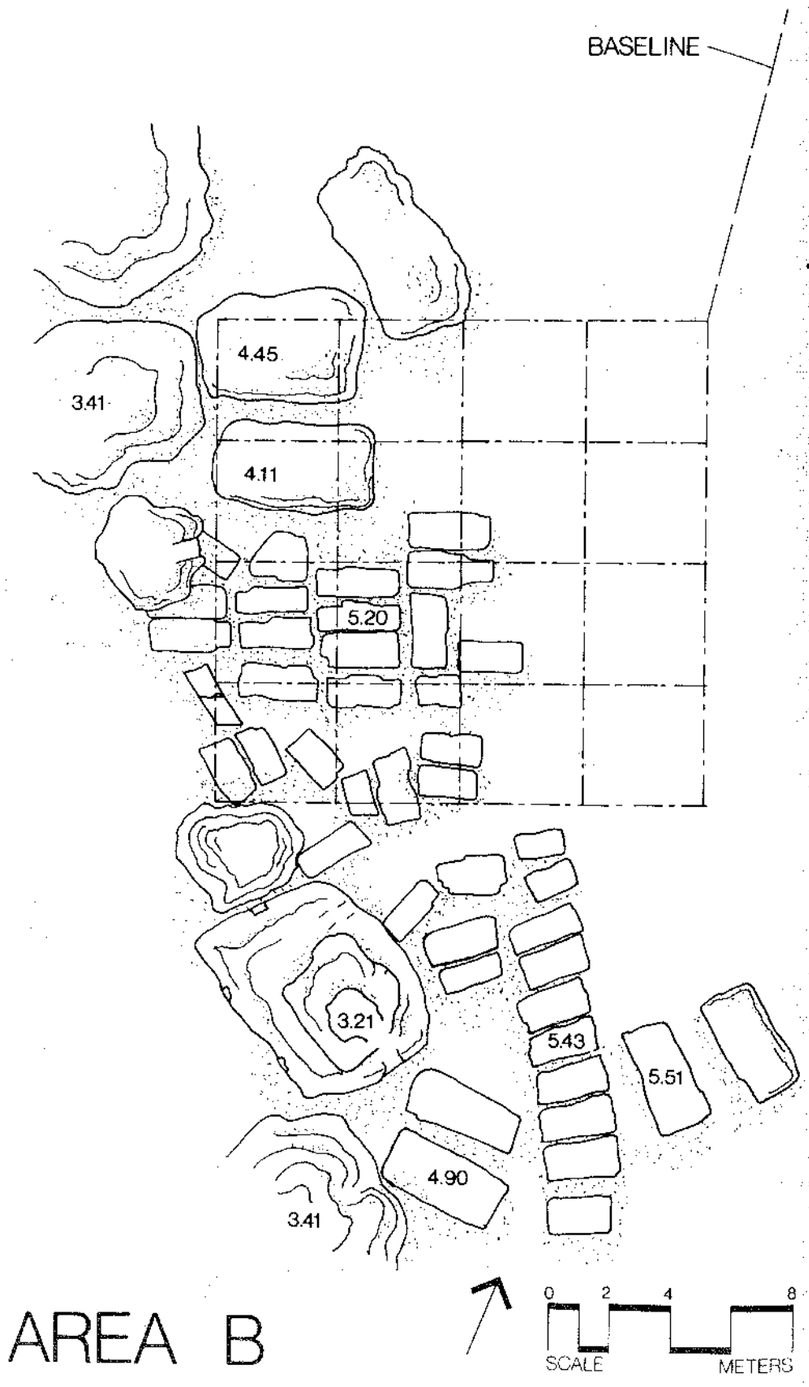
III.6 Area A: header blocks, detail.



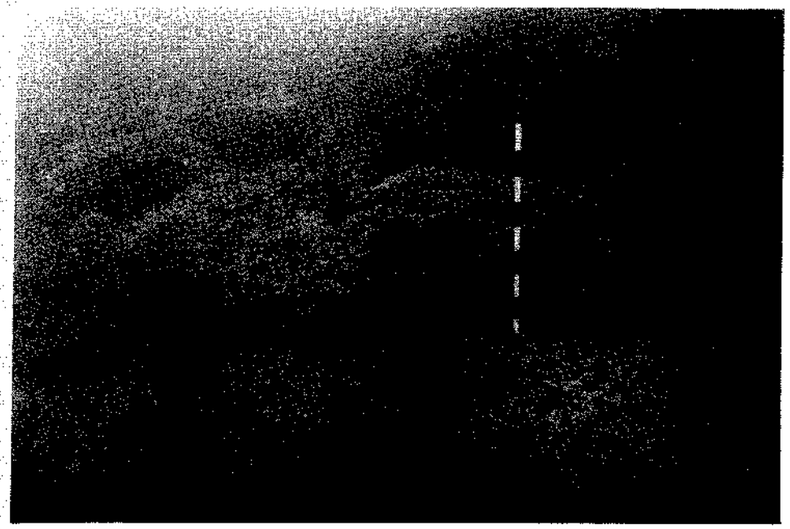
III.7 Area A: plan of probes.



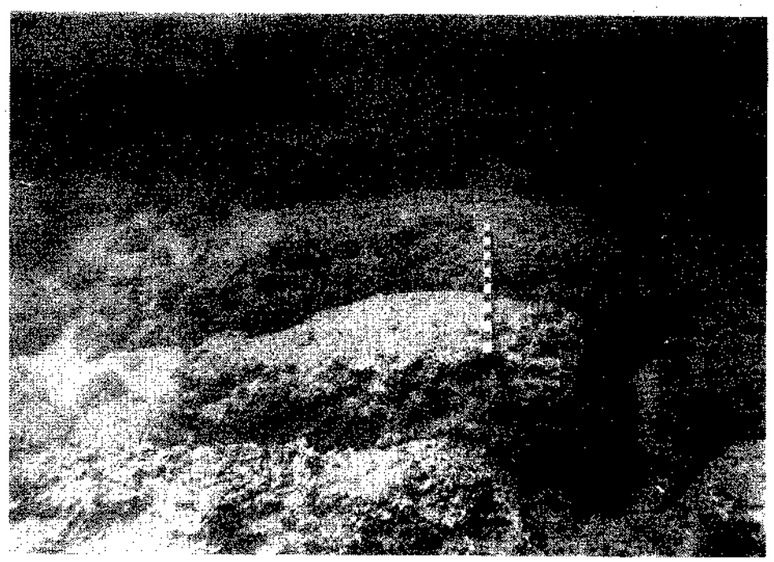
III.8 Area A: section across probes, showing stratigraphy.



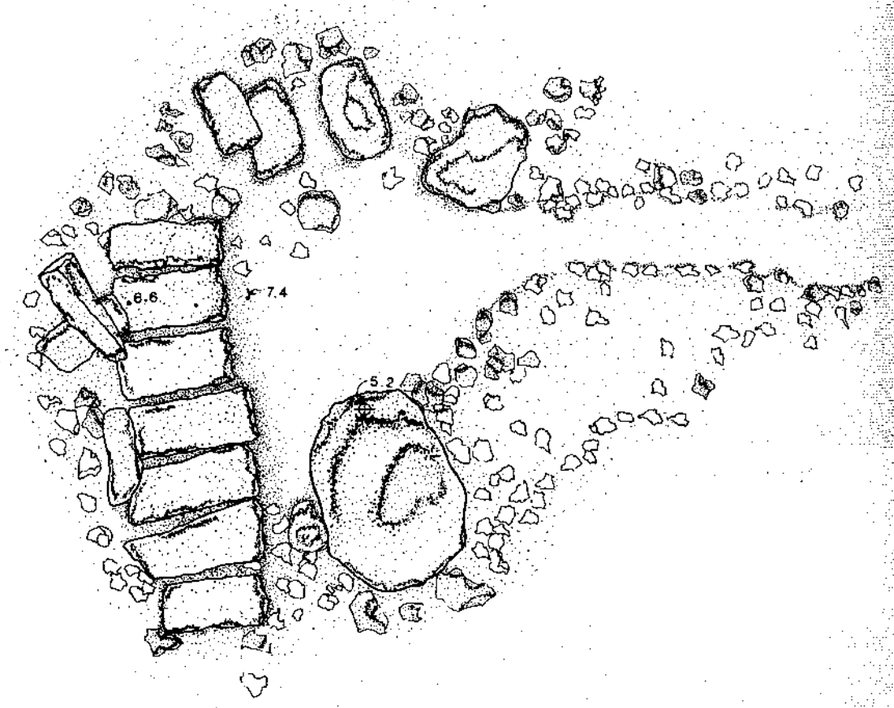
III.9 Area B: plan.



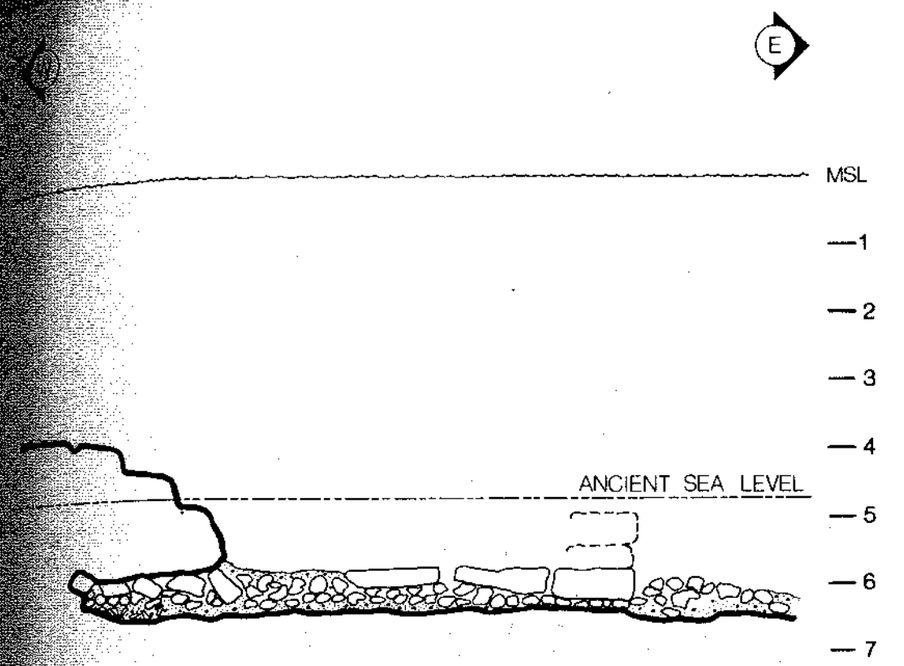
III.10 Area B: stacked blocks at edge of breakwater.



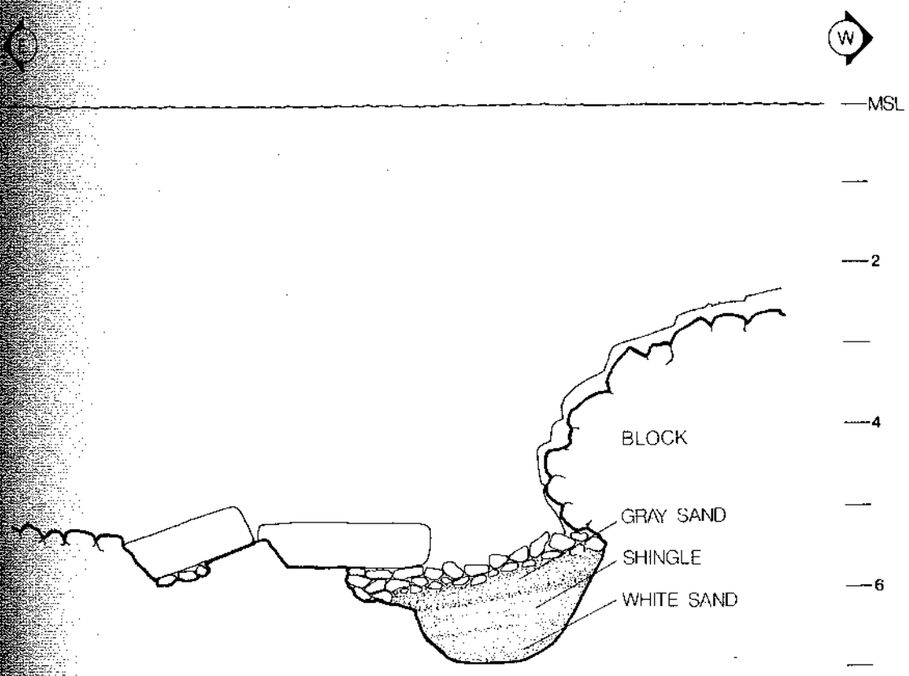
III.11 Area B: platform of blocks.



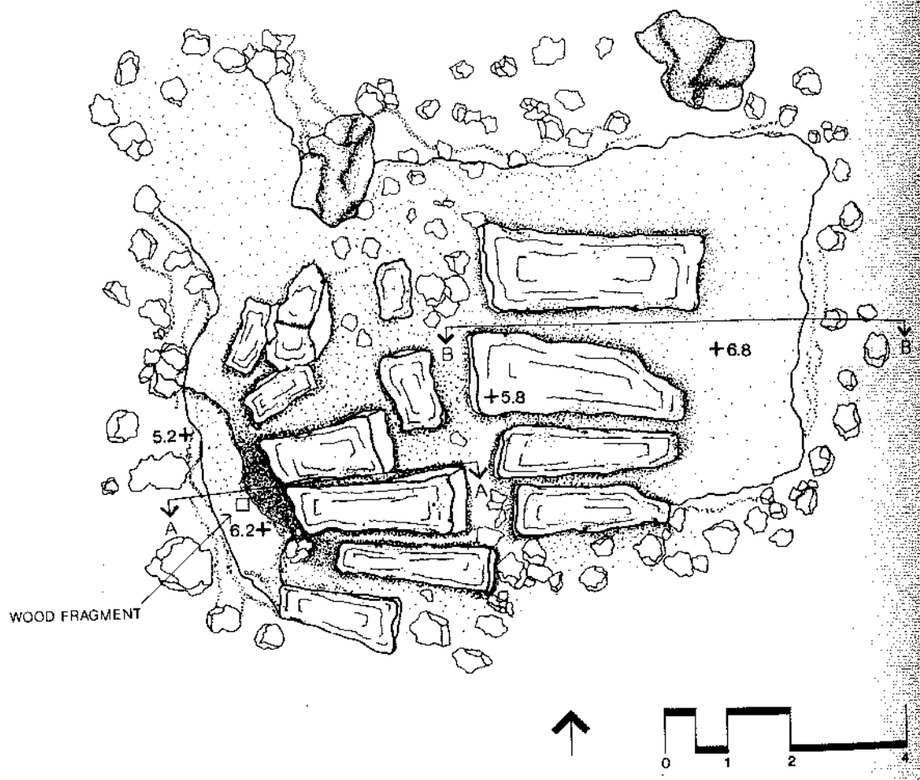
III.12 Area C_1: plan of excavation area.



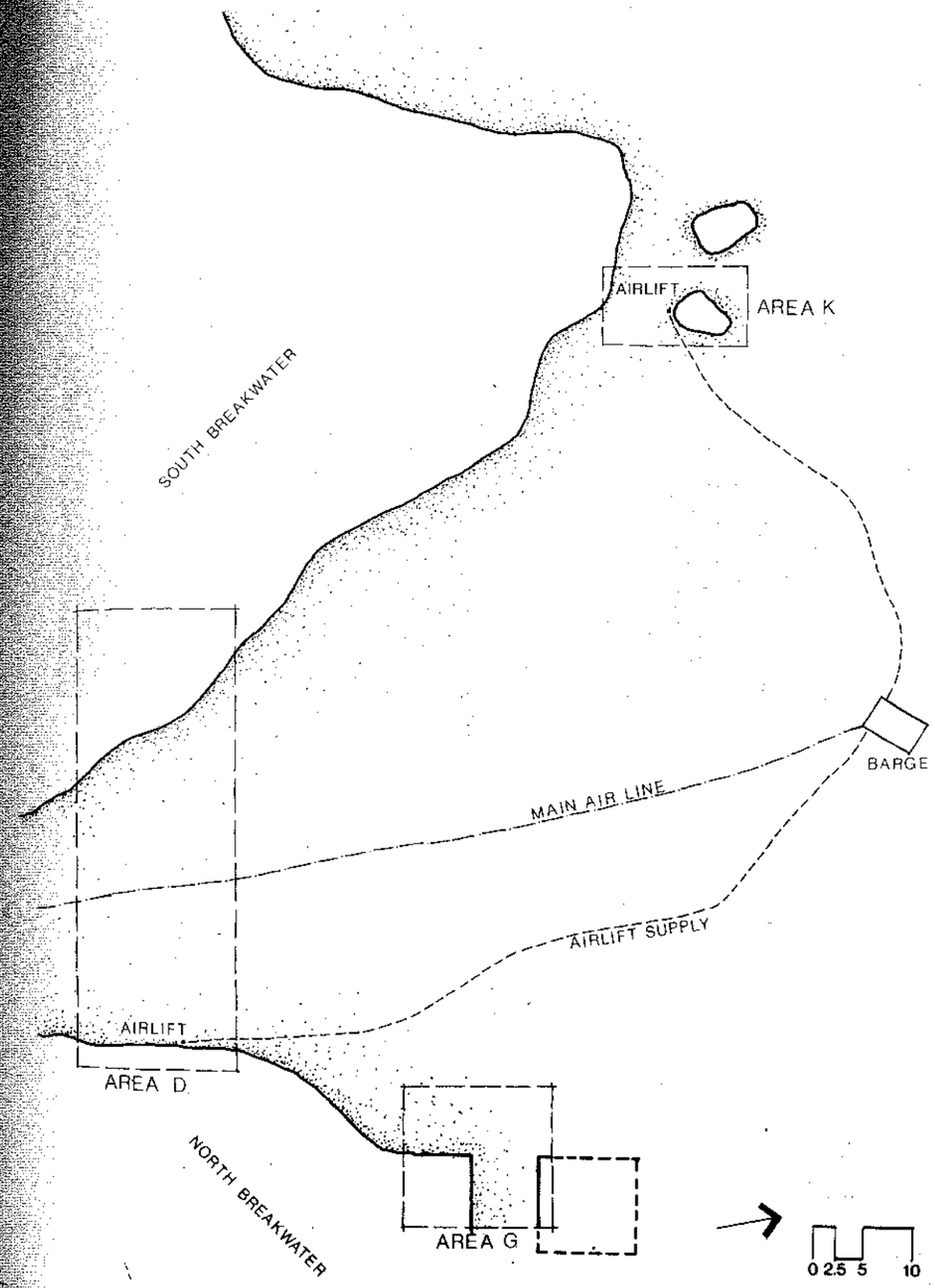
III.13 Area C_1: section across south end (BL m 40).



III.14 Area C_2: section A-A.

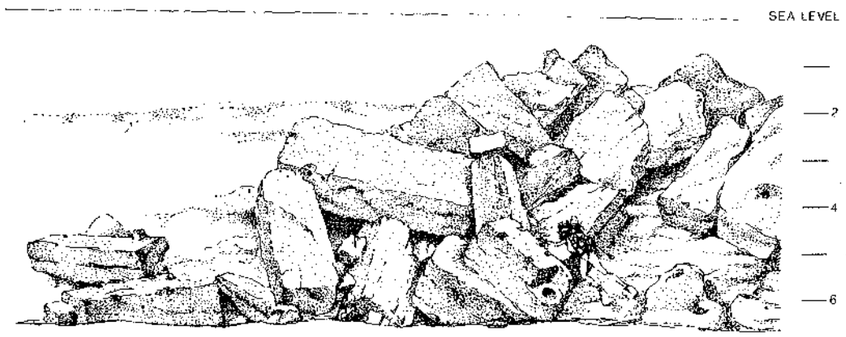


III.15 Area C_2: plan of excavation area.

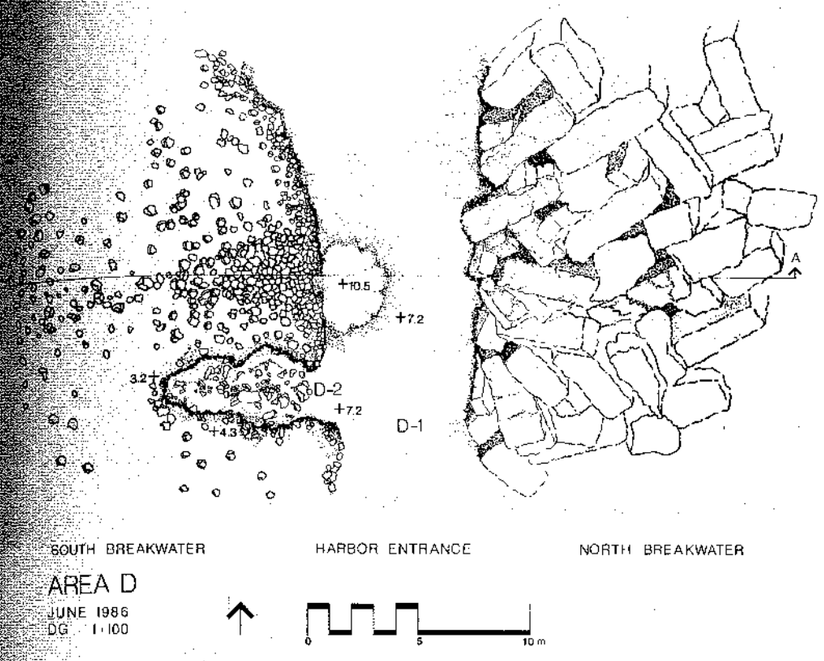


III.16 Harbour Entrance Channel: location plan showing Areas D, G, K.

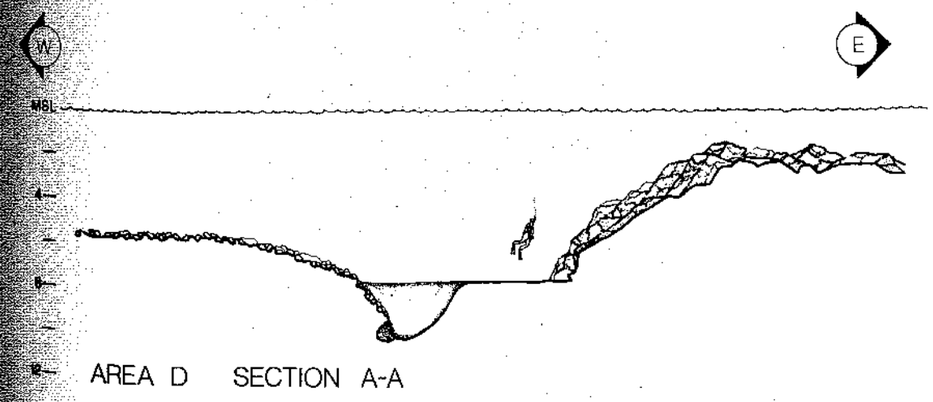
III.17 Harbour Entrance Channel: oblique aerial view from SE (1984).



III.18 Area D: drawing of west end of Northern Breakwater.

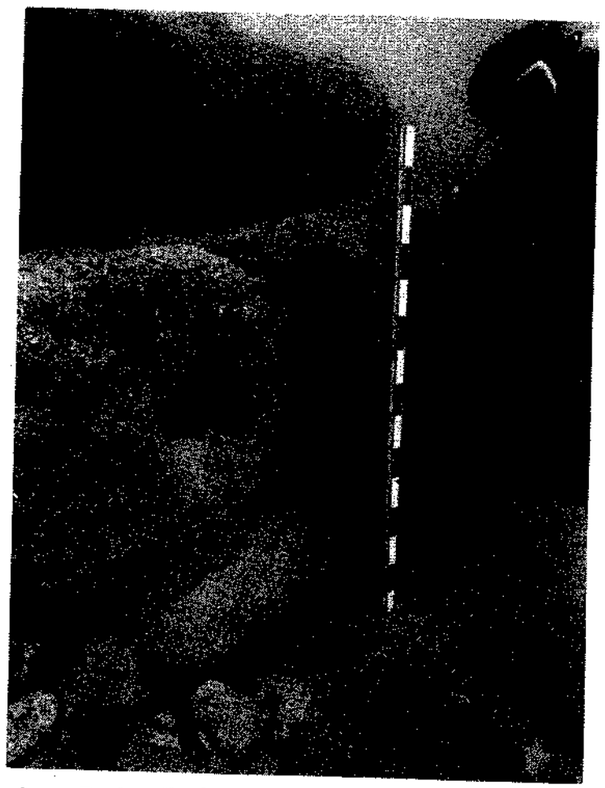


III.19 Area D_1-D_2: general plan (1986).

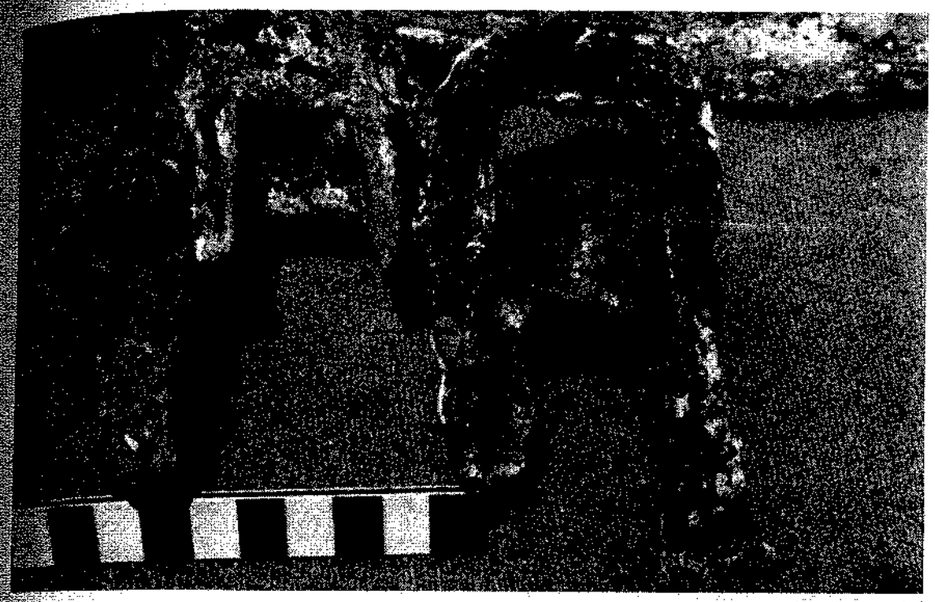


III.20 Area D: east-west section across channel.

III.21 Area D: block with lap-joint and clamp settings.

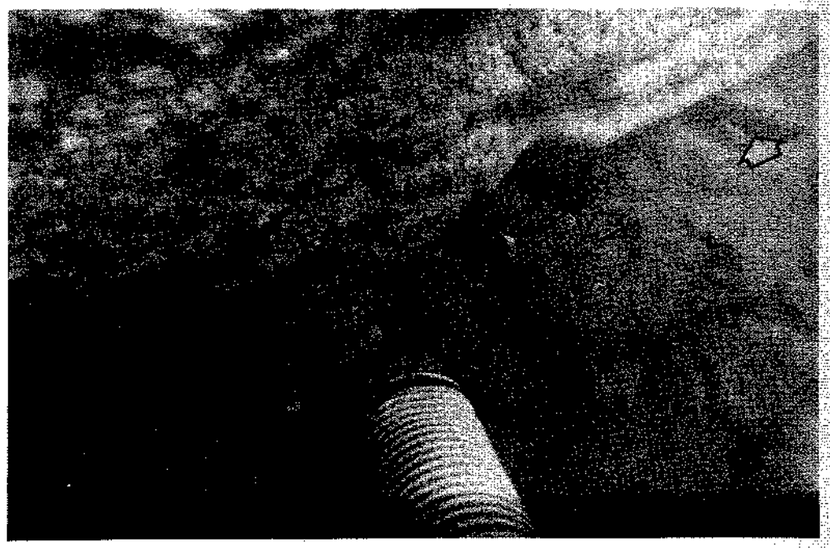


III.22 Area D: detail of block with lap-joint and clamp settings.



III.23 Area D: lead clamp settings from Entrance Channel fill.

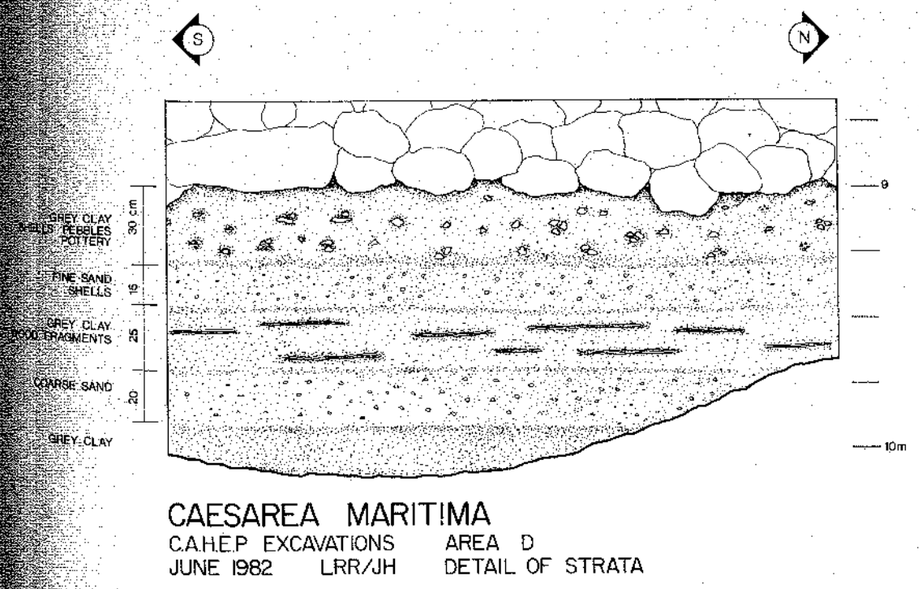
III.24 Area D_1: excavation of sand fill in Entrance Channel.



III.25 Area D_1: remains of wooden pallet beneath kurkar block in Entrance Channel (arrows).

III.26 Area D_1: eroded Byzantine ceramics below rubble fill in Entrance Channel.

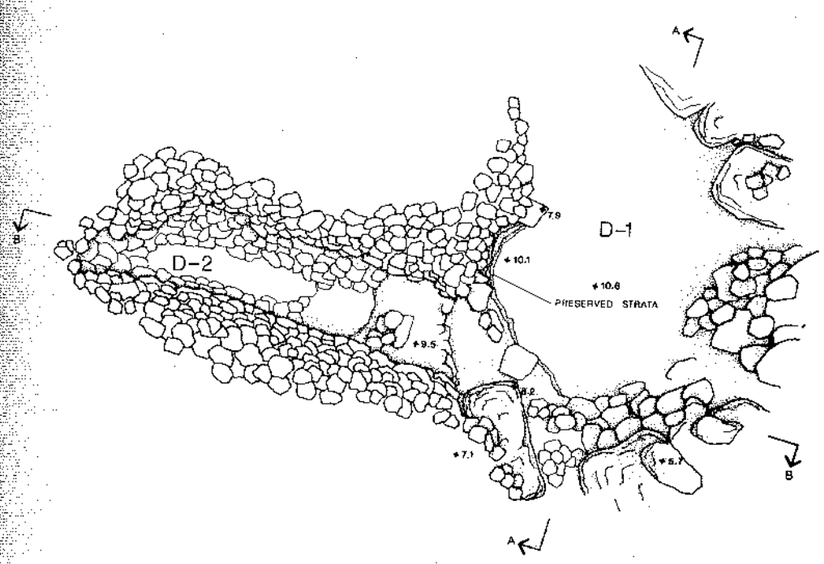
III.27 Area D_1: west baulk of probe at tip of Southern Breakwater.



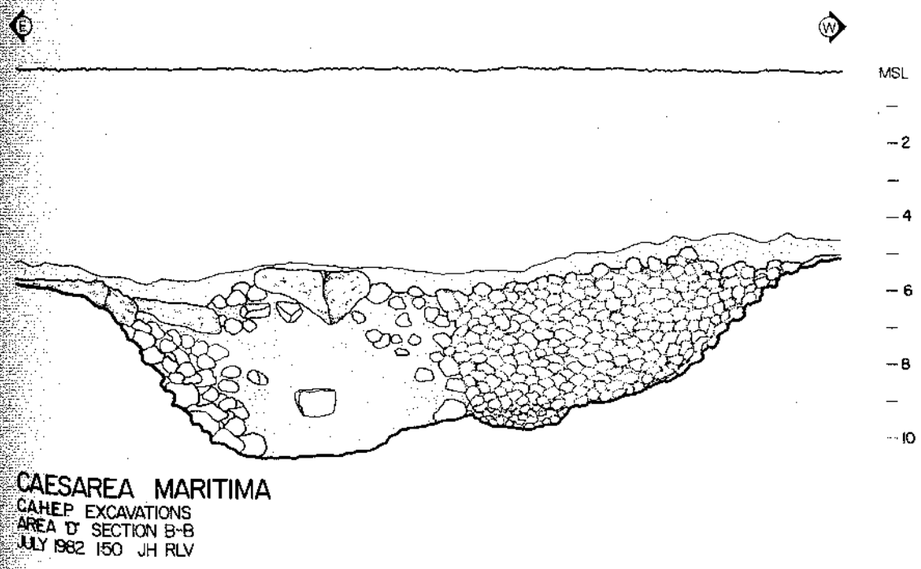
III.28 Area D_1: drawing of west baulk of probe at tip of Southern Breakwater.

III.29 Area D_1: Byzantine amphora resting on stratum of clay.

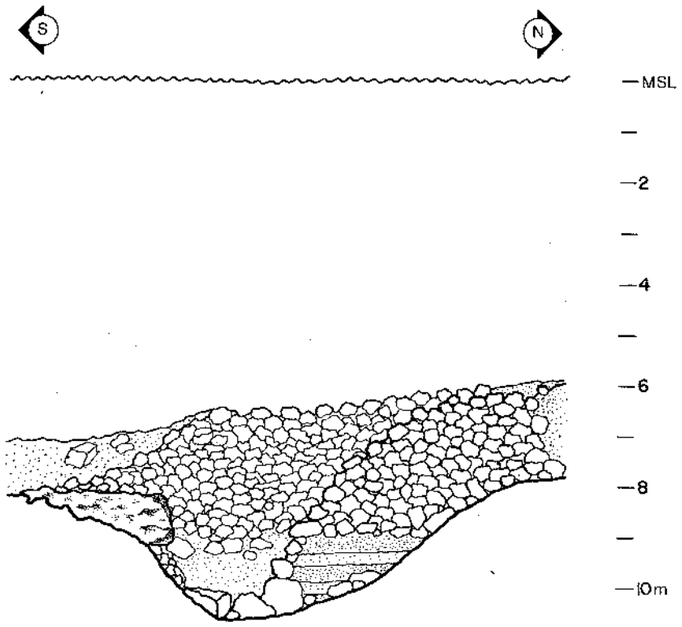
III.30 Area D_1: miscellaneous ceramics resting on or incorporated into stratum of clay.



III.31 Area D_1, D_2: plan.



III.32 Areas D_1, D_2: section B-B.

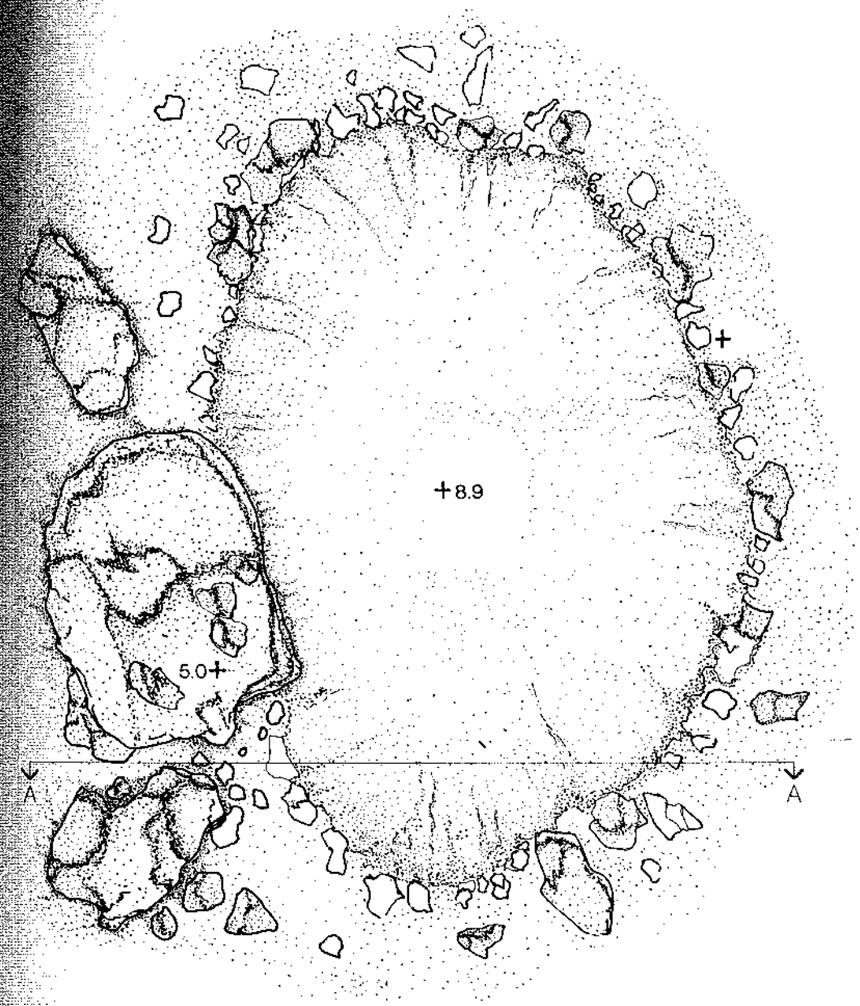


AREA D-1 SECTION A-A

JUNE 1982
JH 1:50

III.33 Area D_1: section A-A.

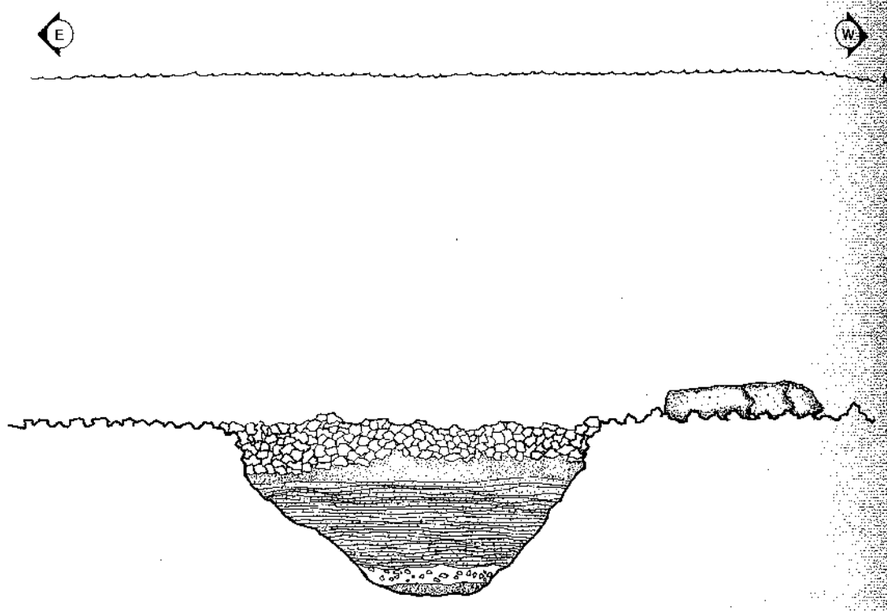
III.34 Area D_2: divers removing rubble.



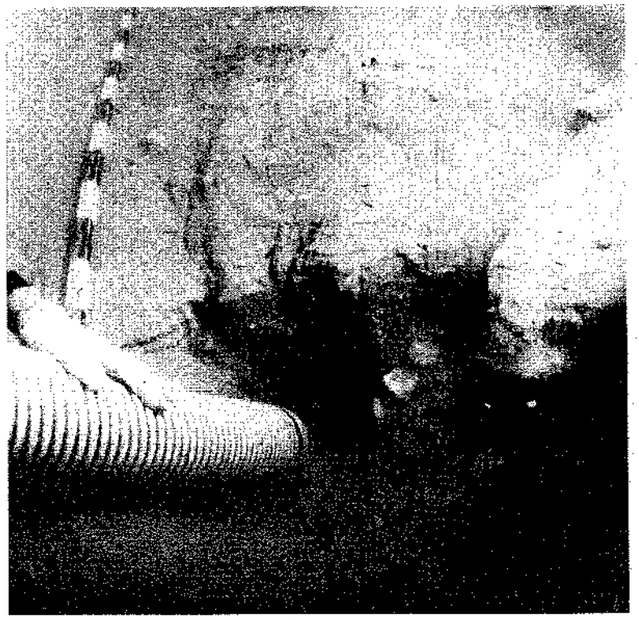
AREA D-3

JUNE 1986
DG 1:50

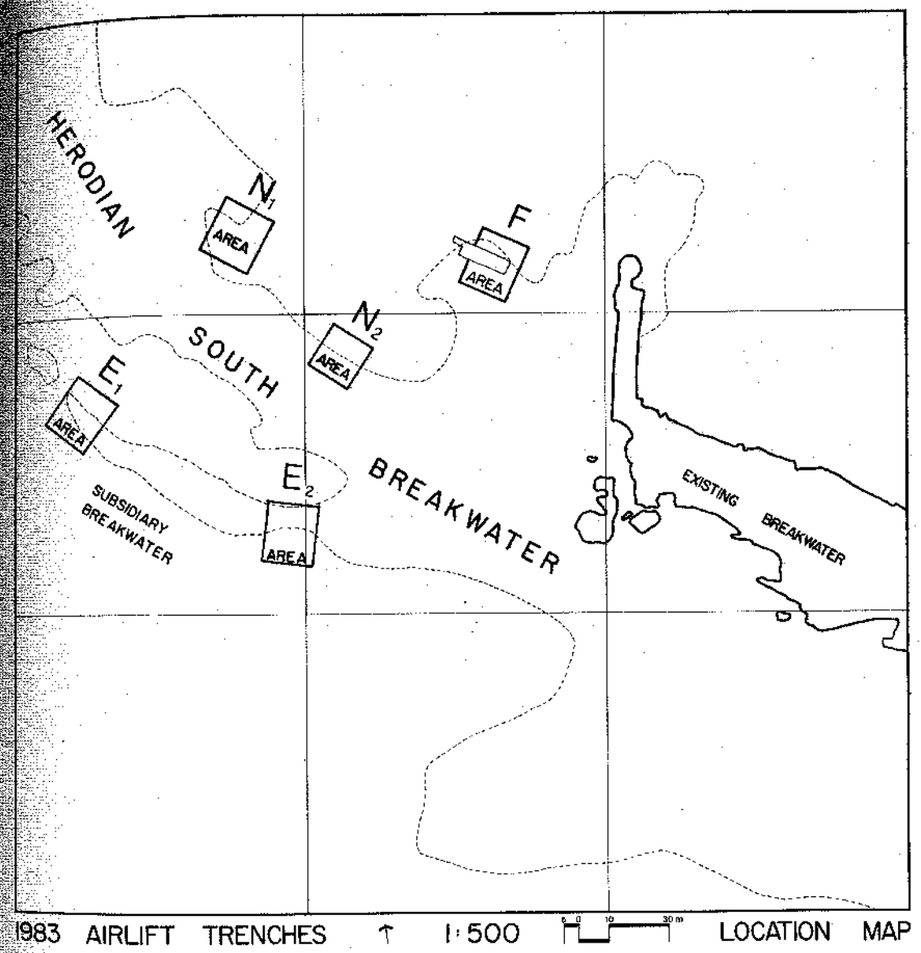
III.35 Area D_3: plan of sounding.



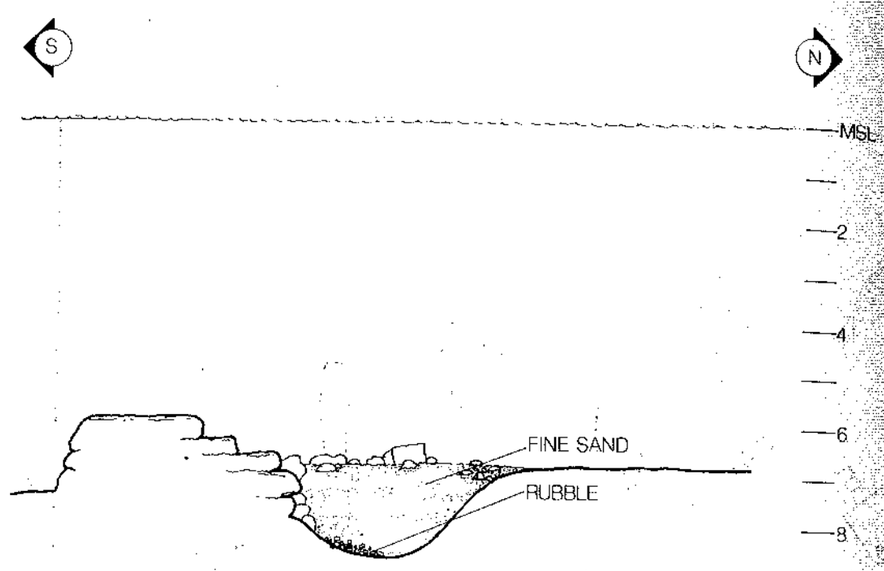
III.36 Area D_3: section A-A across sounding.



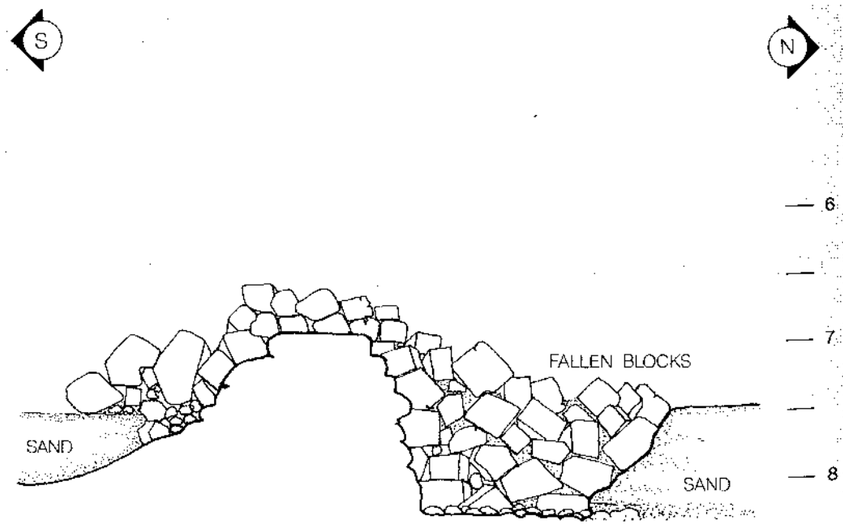
III.37 Area D_3: north face of sounding.



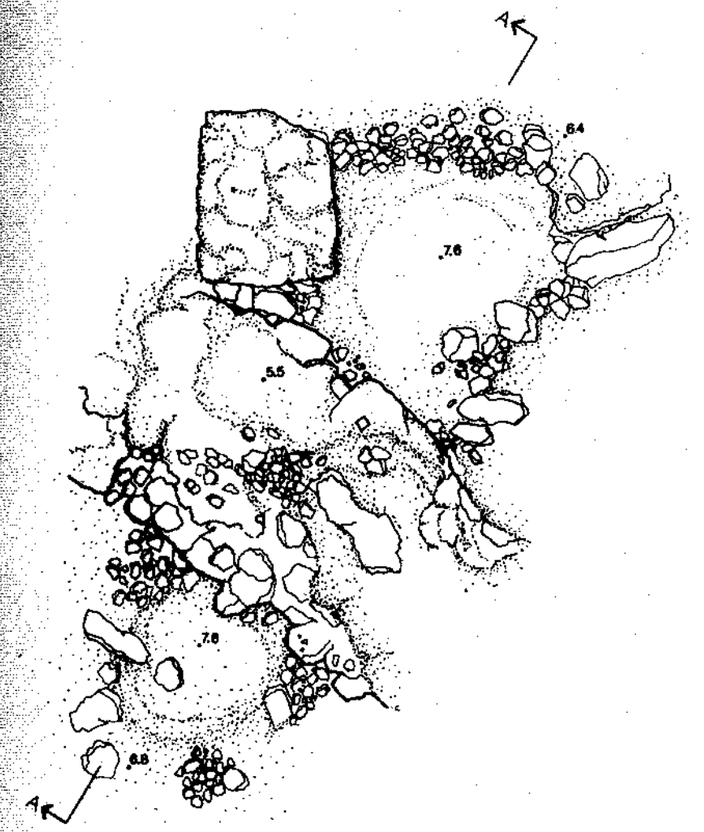
III.38 Southern Breakwater: location plan of Areas E, F, N.



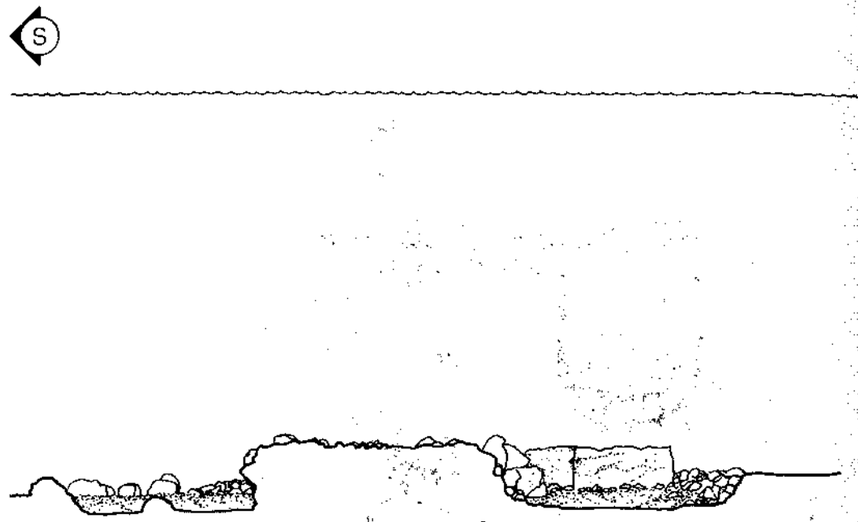
III.39 Area E_1a: north-south section.



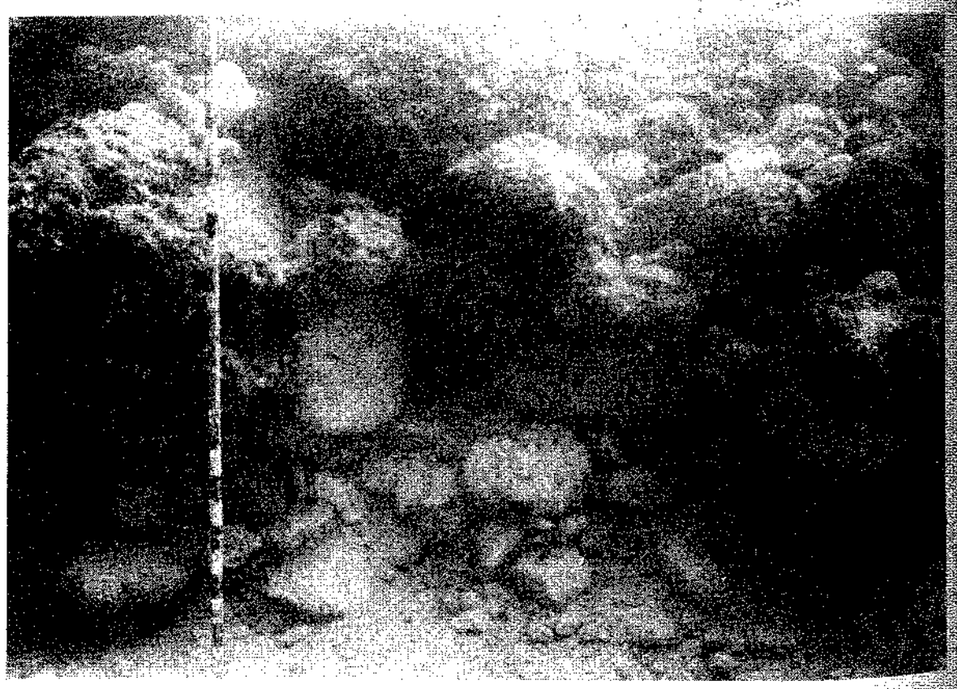
III.40 Area E_1b: north-south section.



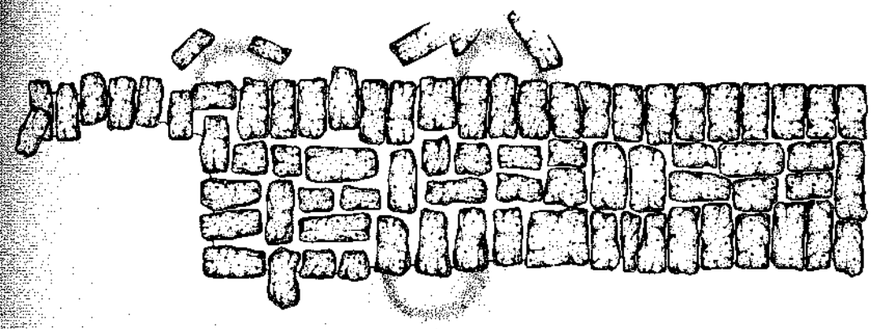
III.41 Area E_2: plan.



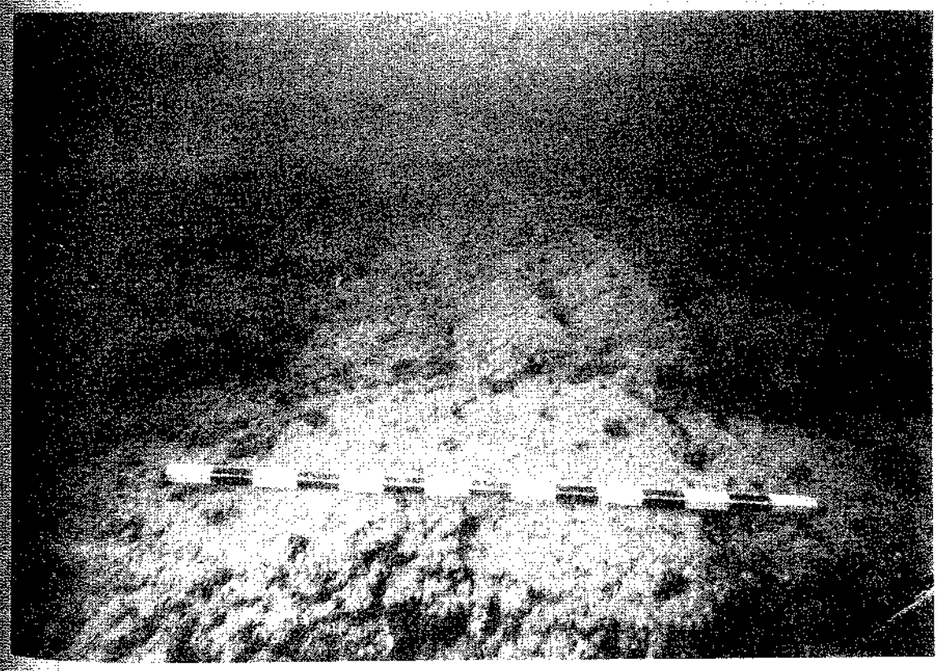
III.42 Area E_2: section A-A.



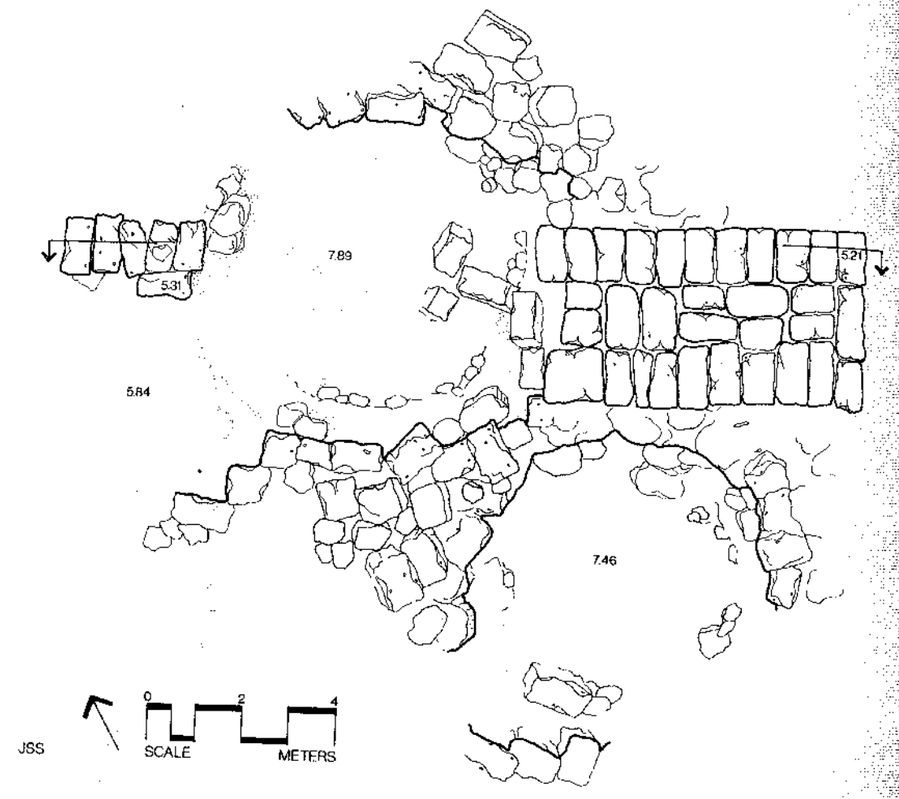
III.43 Area E_2 (south): rubble and gravel foundation below Subsidiary Breakwater.



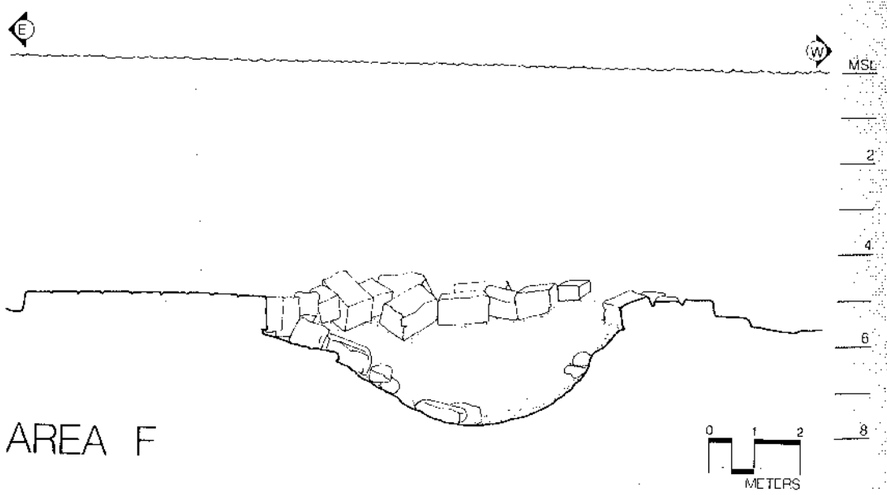
III.44 Area F: plan of pavement before excavation.



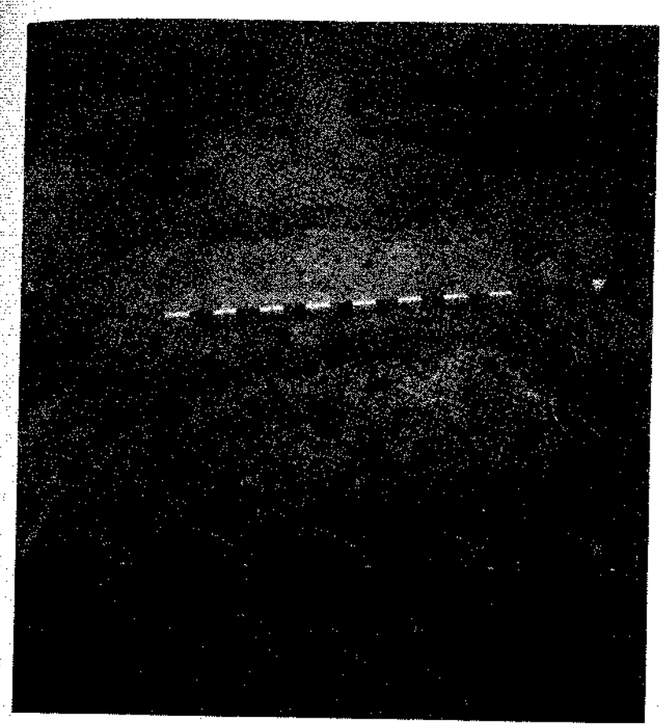
III.45 Area F: surface of pavement.



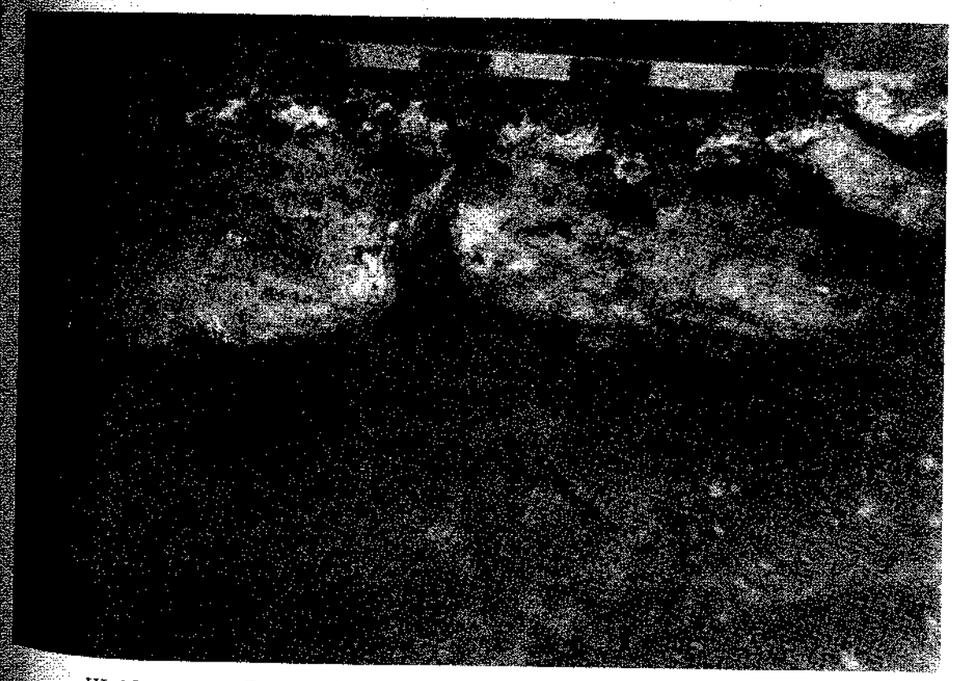
III.46 Area F: plan with soundings.



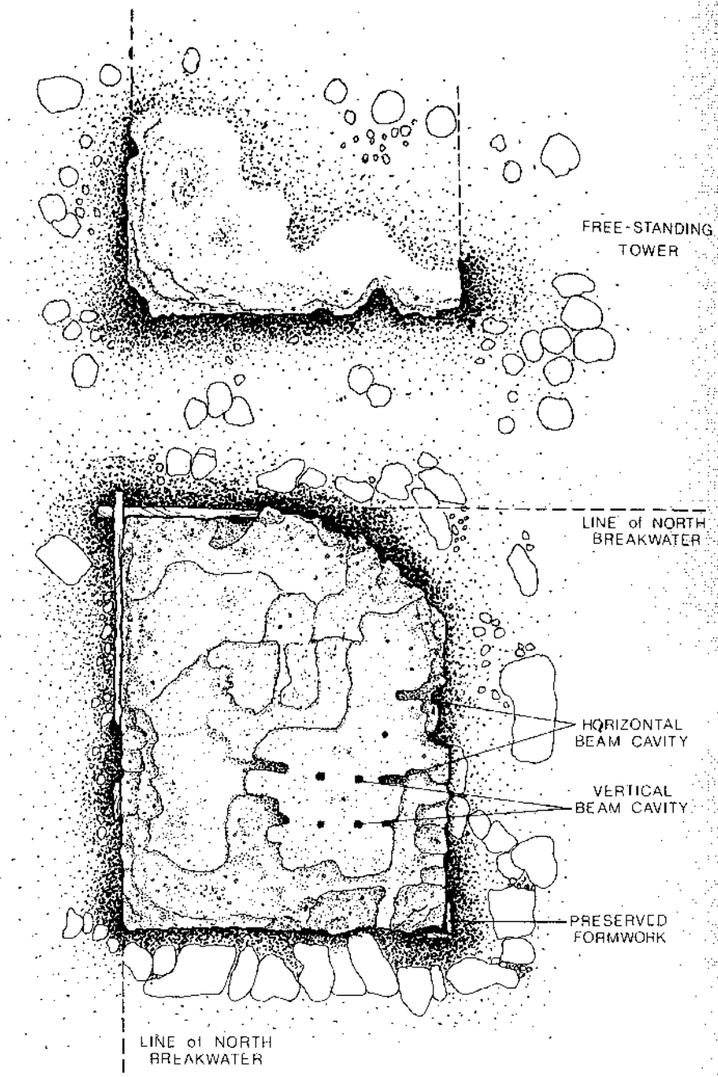
III.47 Area F: section across pavement with sounding.



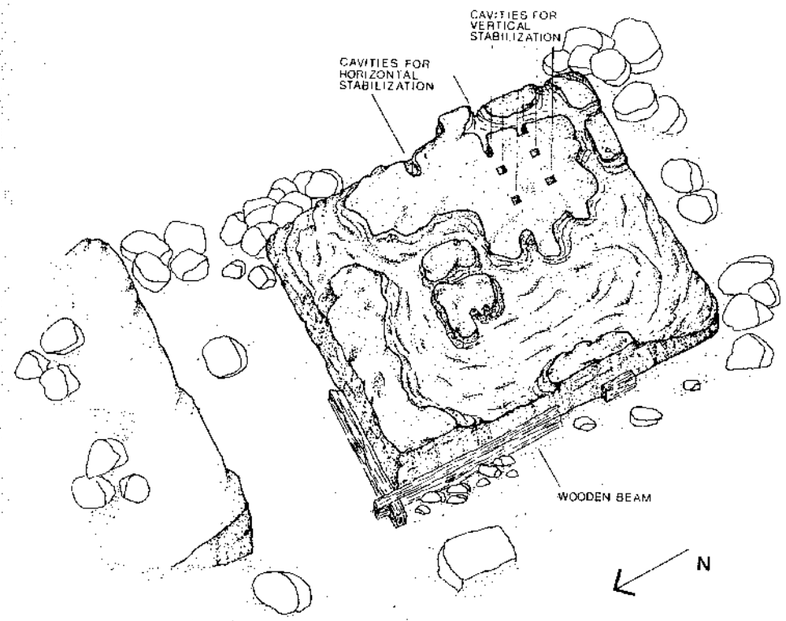
III.48 Area F: north edge of pavement.



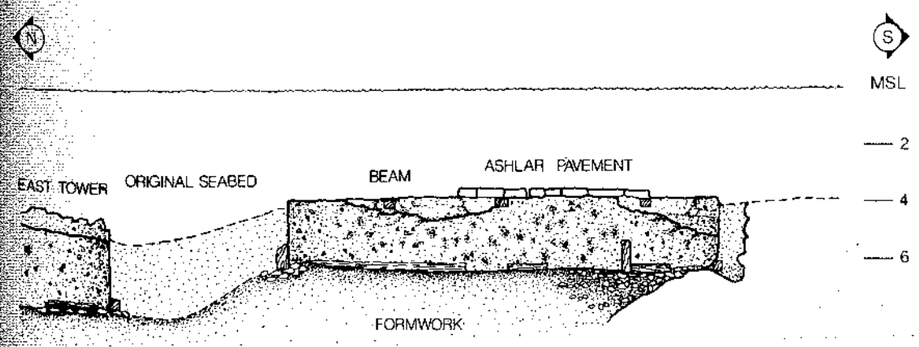
III.49 Area F: sand fill below blocks at north edge of pavement.



III.50 Area G: plan.

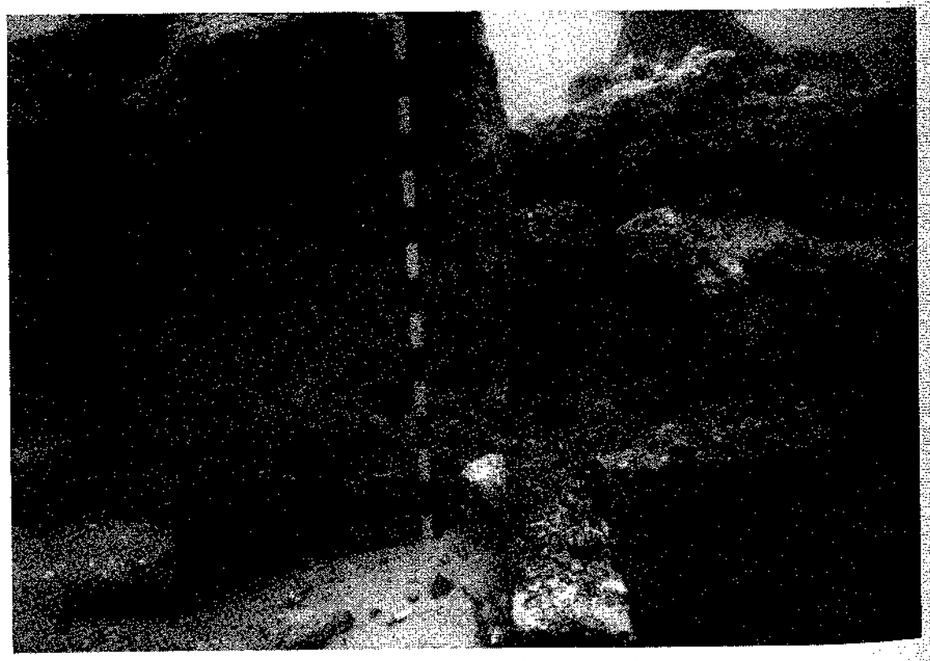


III.51 Area G: isometric actual state drawing.

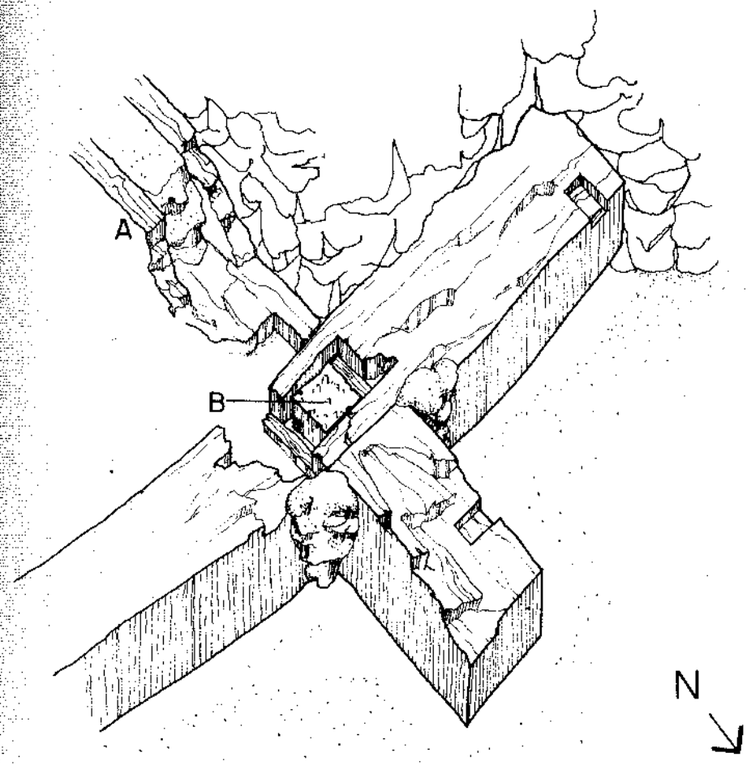


III.52 Area G: north-south section.

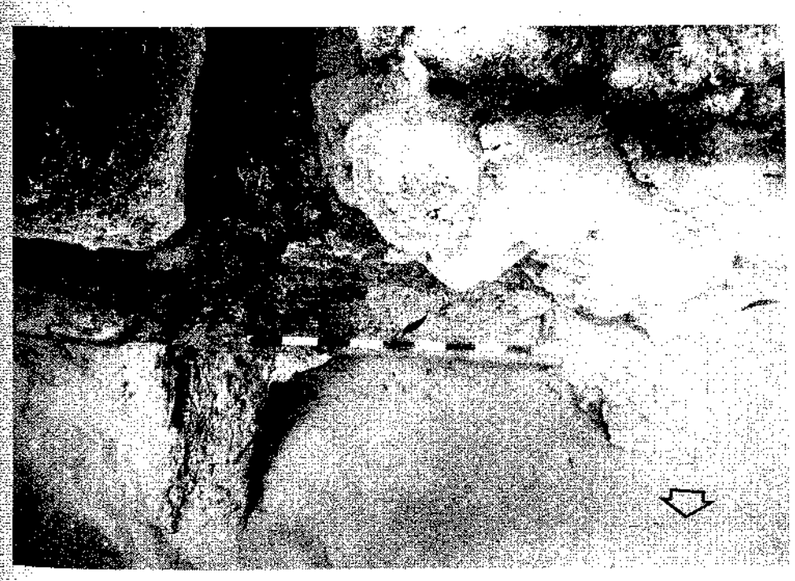
III.53 Area G: northwest corner of formwork, from above.



III.54 Area G: northwest corner of formwork, from north.



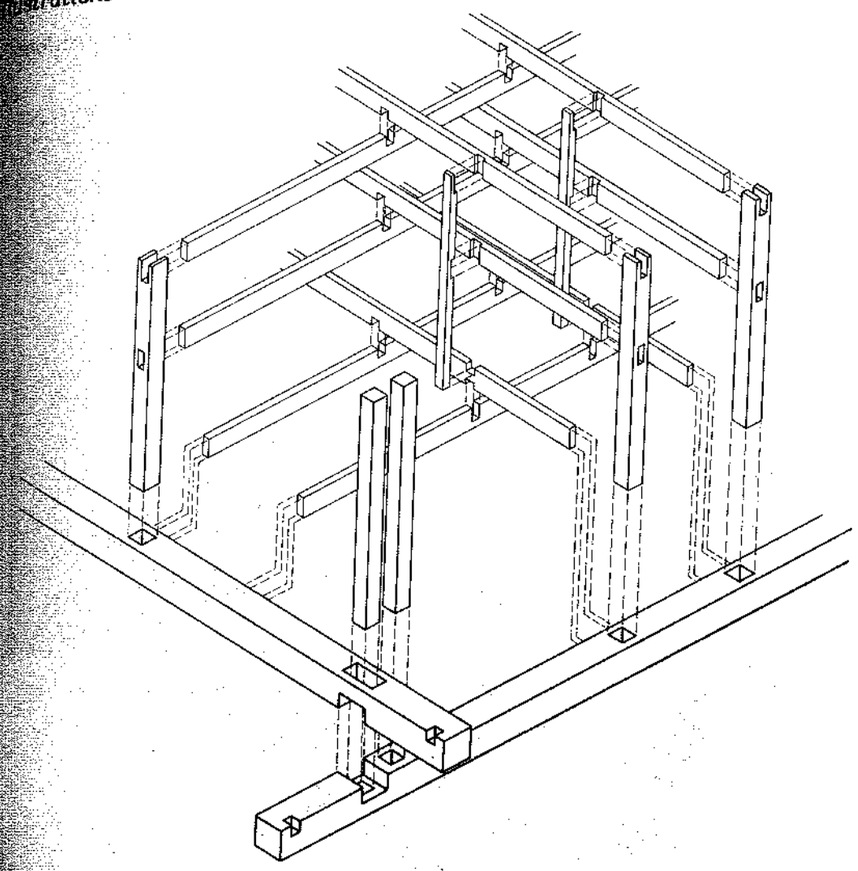
III.55 Area G: northwest corner of formwork, actual state drawing.



III.56 Area G: northwest corner of formwork, from above.

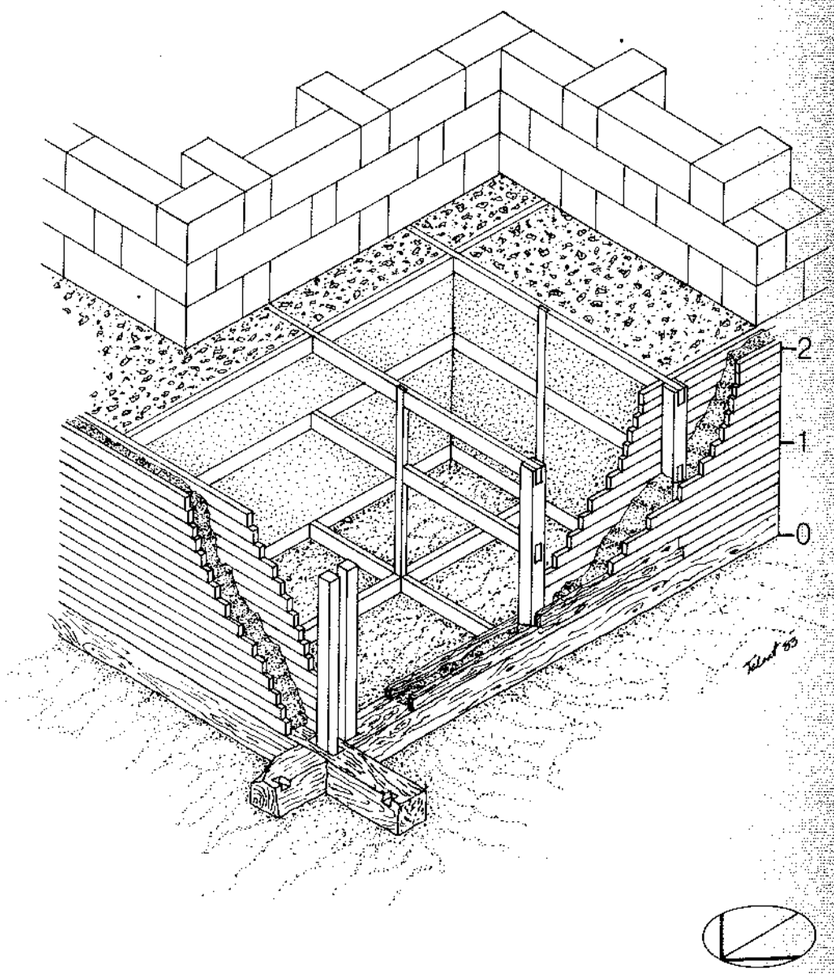
III.58 Area G: formwork along west side of block, from north, filling mortar removed.

III.57 Area G: formwork along west side of block, from north, showing filling mortar.



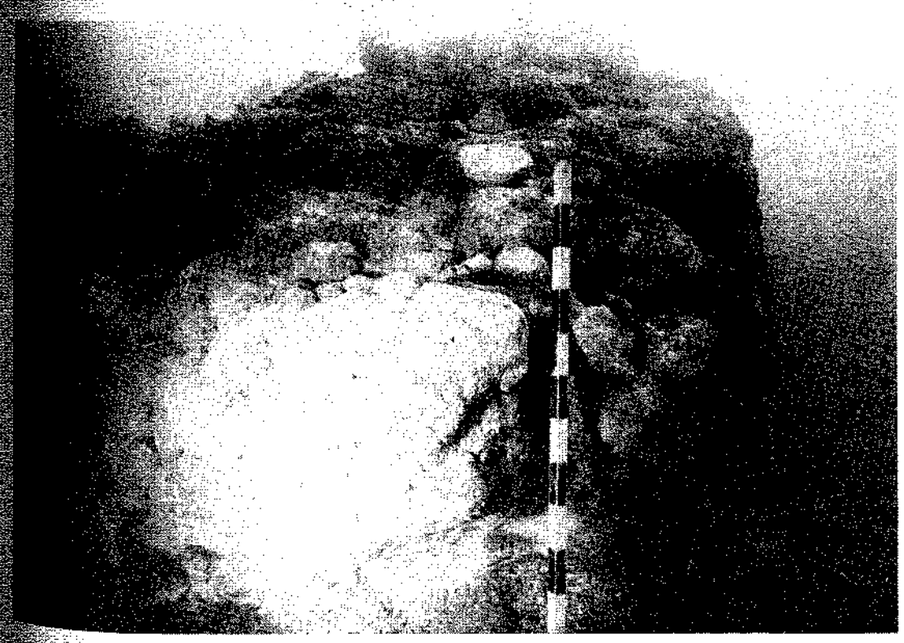
III.59 Area G: hypothetical reconstruction of formwork framing.

III.60 Area G: hole left in concrete by horizontal framing brace.

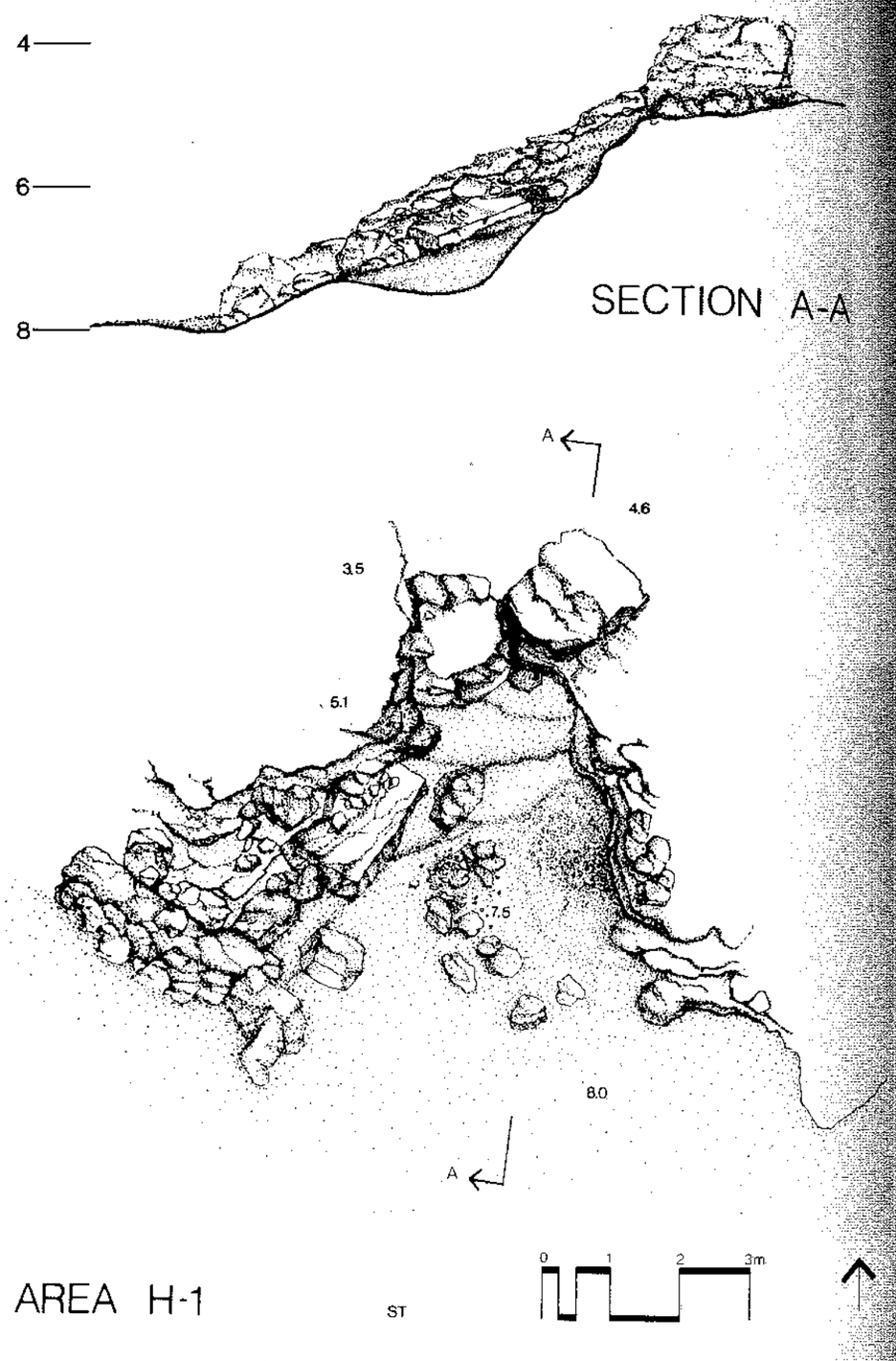


III.61 Area G: reconstruction of formwork and block in place.

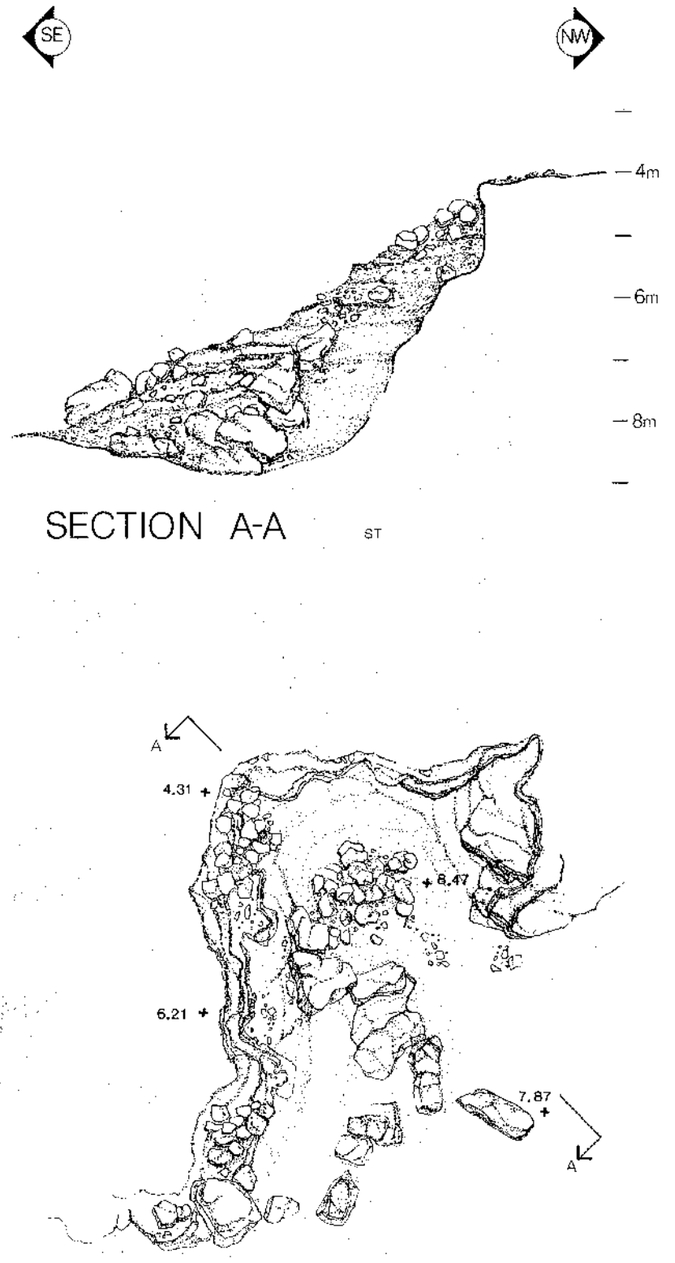
III.62 Area G: south face of north block, from south.



III.63 Area G: southwest corner of north block, from west.

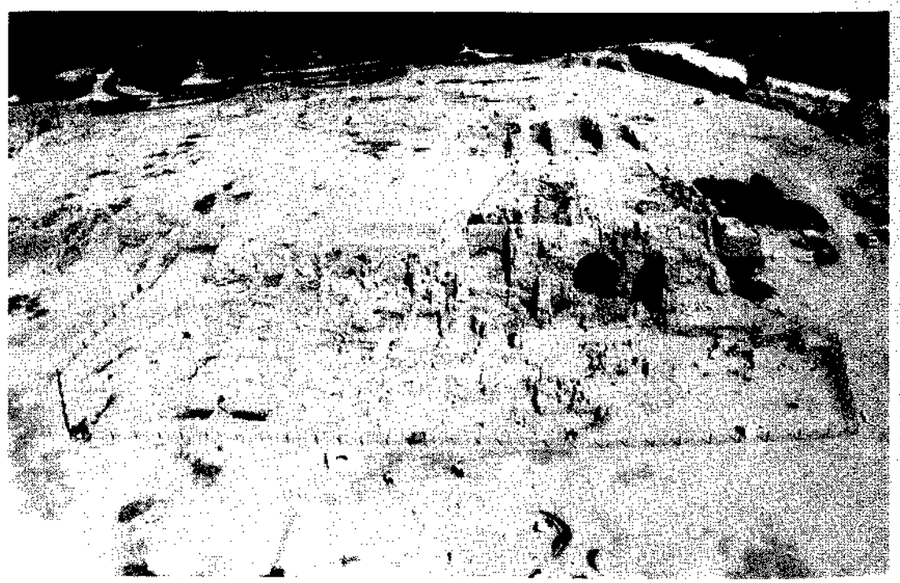


III.64 Area H_1: plan and section.

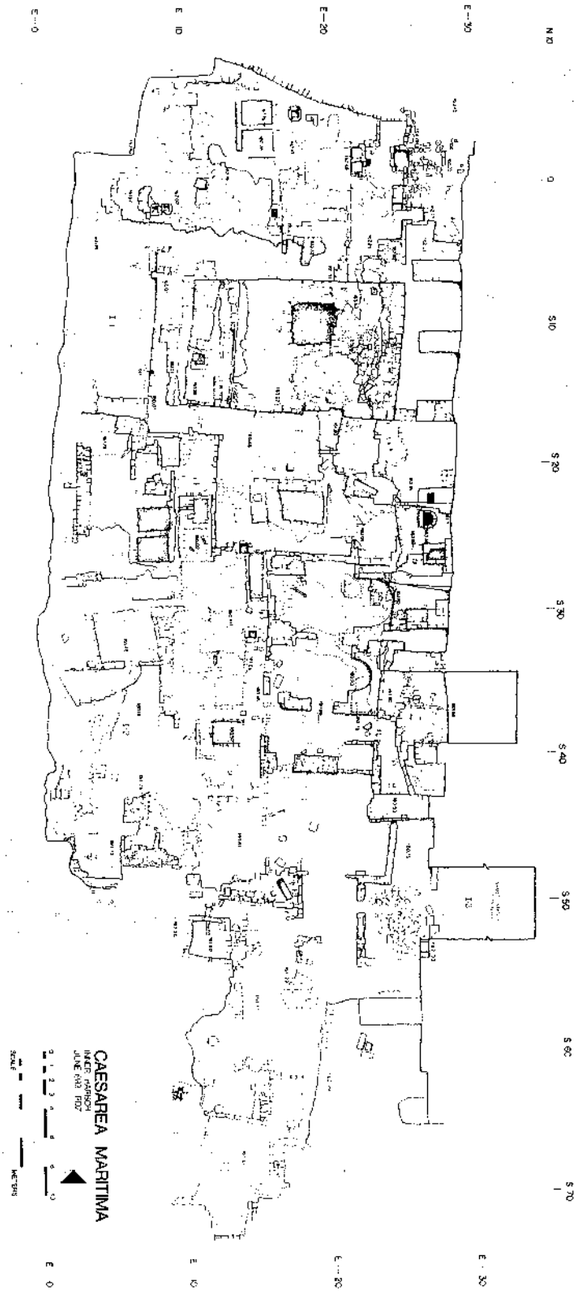


III.65 Area H_2: plan and section.

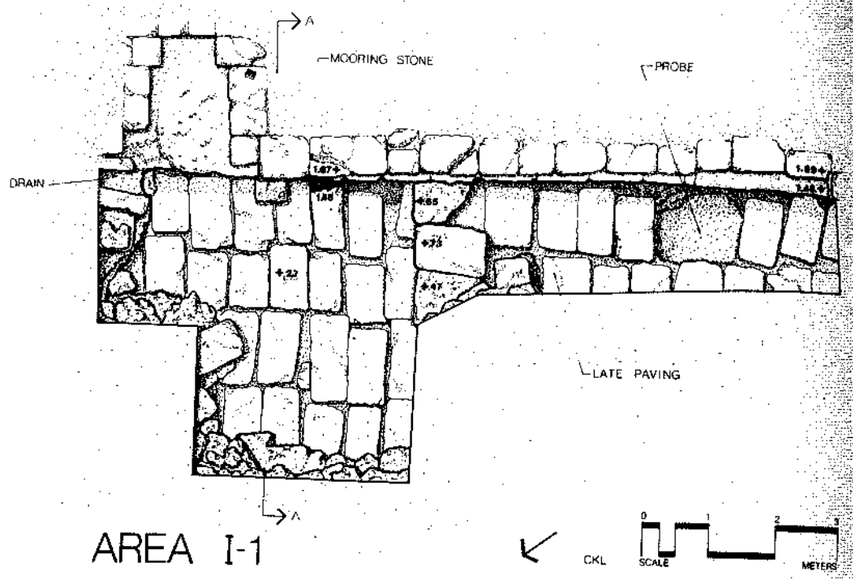
III.66 Area H_1: divers clearing rubble.



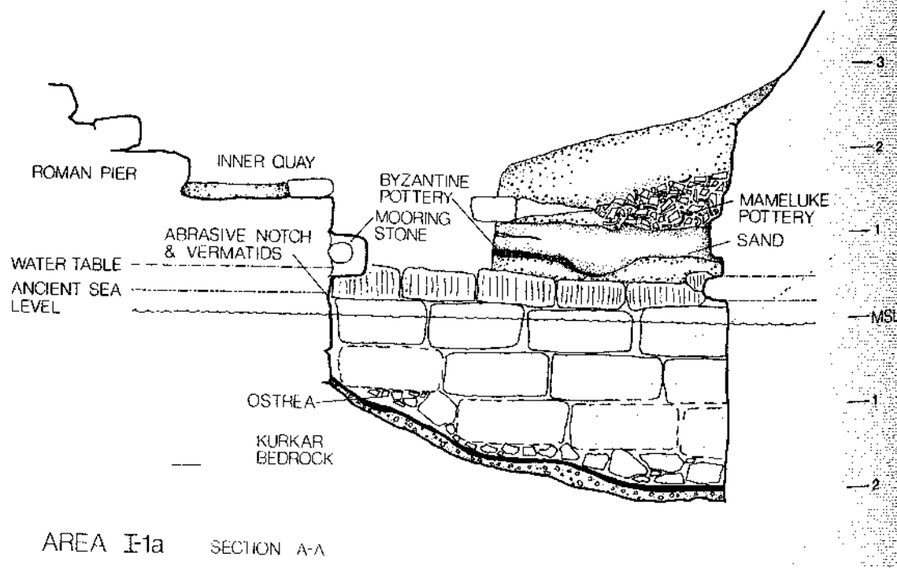
III.67 Areas I_1, I_2, I_3: oblique aerial from west.



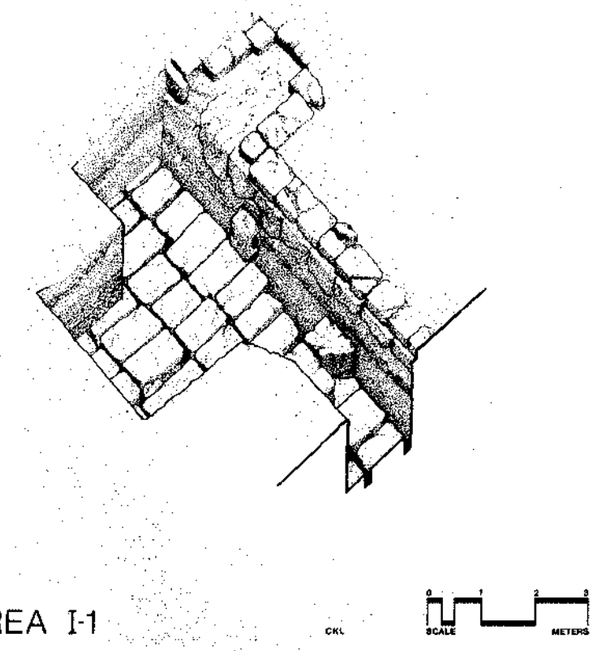
III.68 Areas I_1, I_2, I_3: actual state plan.



III.69 Area I_1: plan.

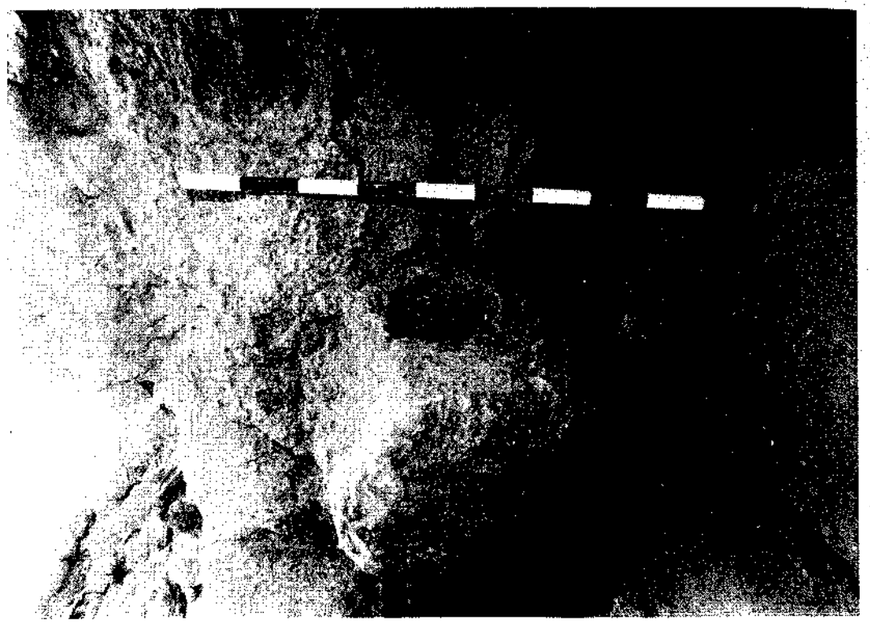


III.70 Area I_1: section A-A.



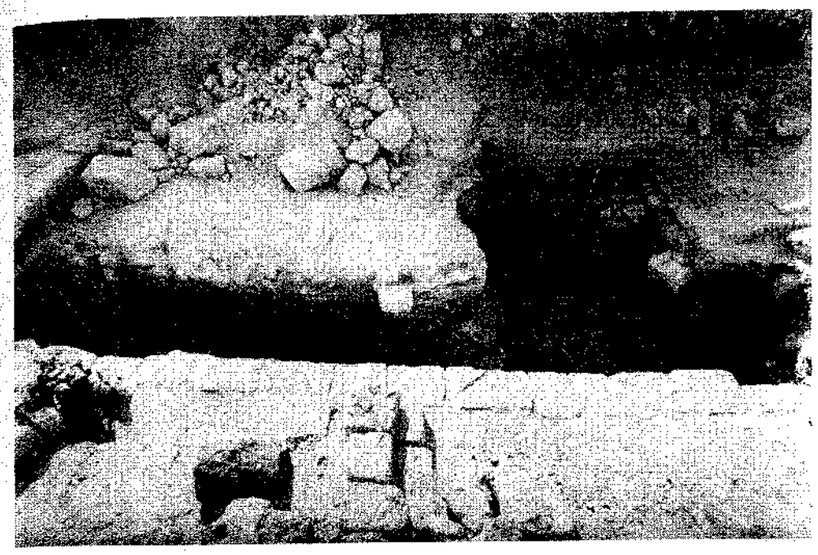
III.71 Area I_1: axonometric drawing from SW.

III.72 Area I_1: quay, mooring block, and pavement.



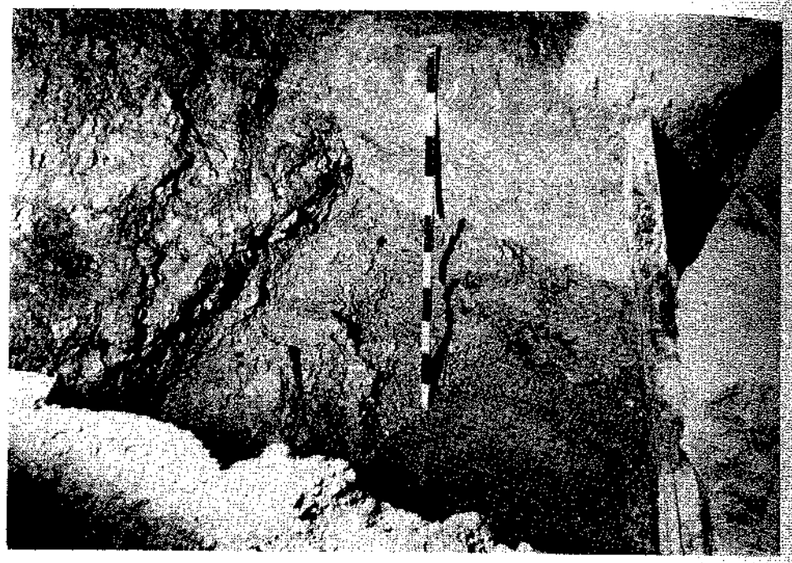
III.74 Area I_1: face of quay with mooring block.

III.73 Area I_1: view from north.



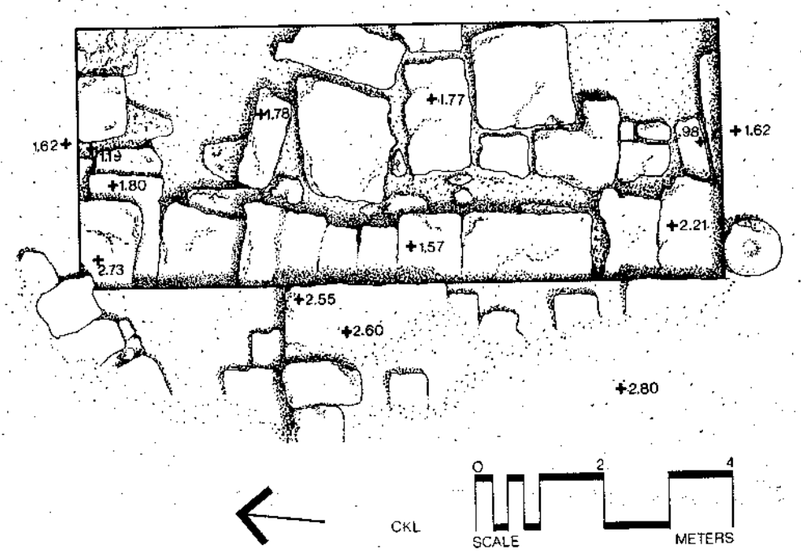
III.75 Area I_1: view from east.

III.76 Area I_1: later wall across pavement, from north.

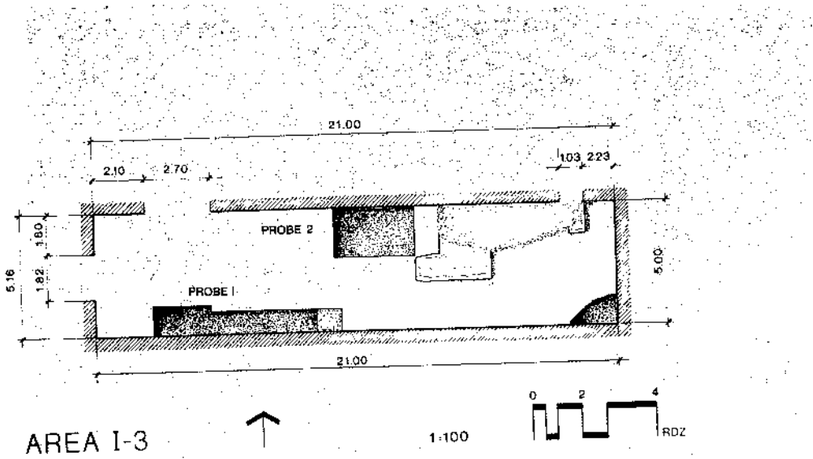


III.77 Area I_1: probe below pavement, from NW.

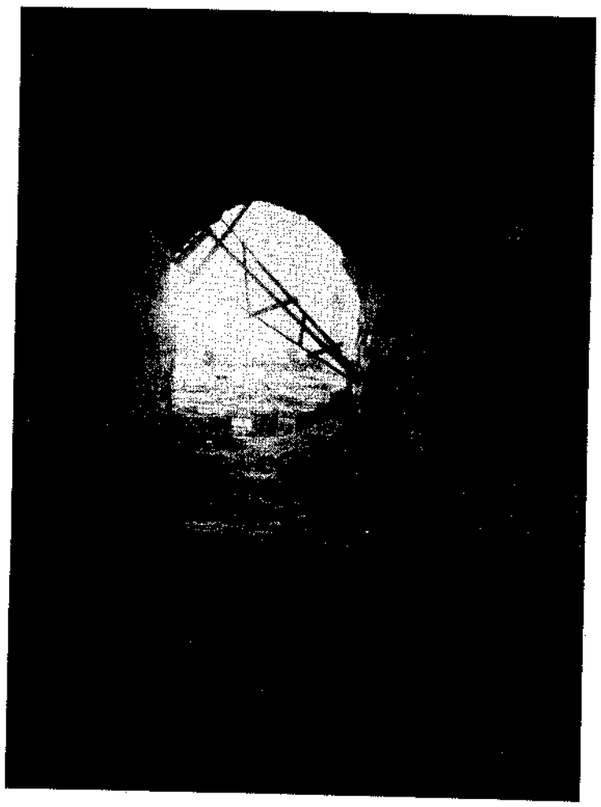
III.78 Area I_1: probe below pavement, *Ostrea* shells on face of quay.



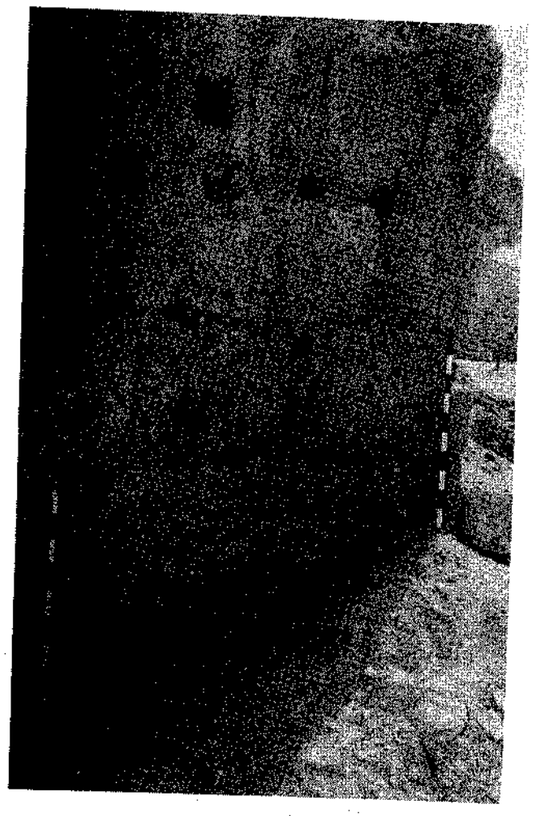
III.79 Area I_2: plan.



III.80 Area I_3: plan.

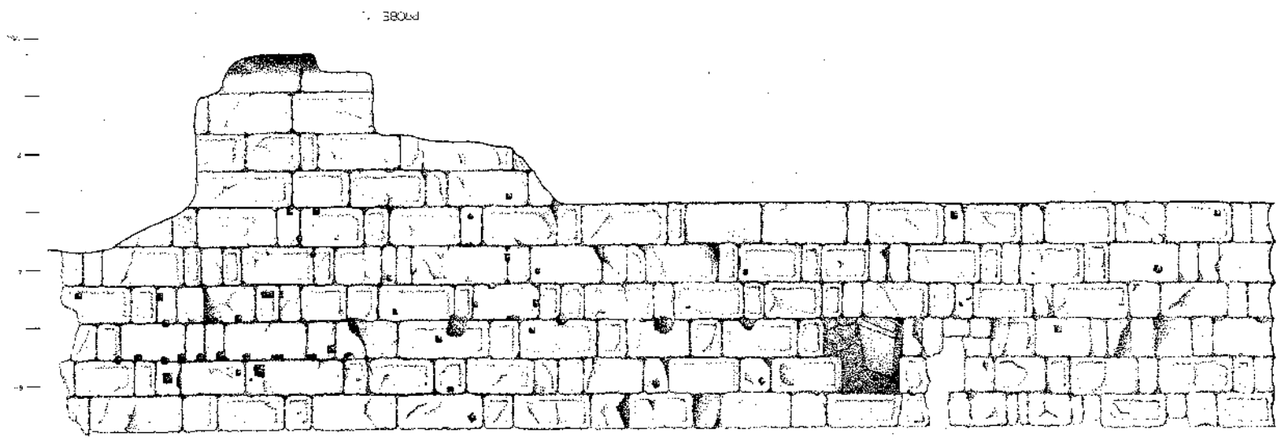


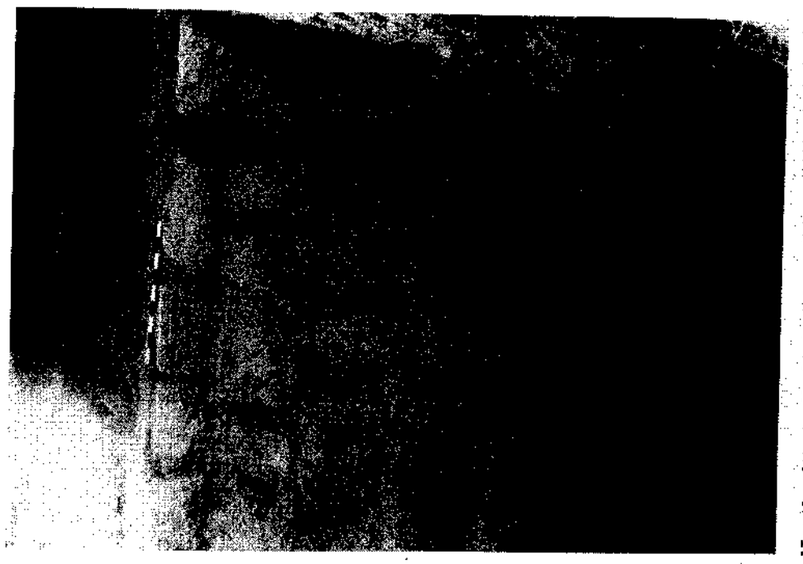
III.81 Area I_3: interior of vault, looking west.



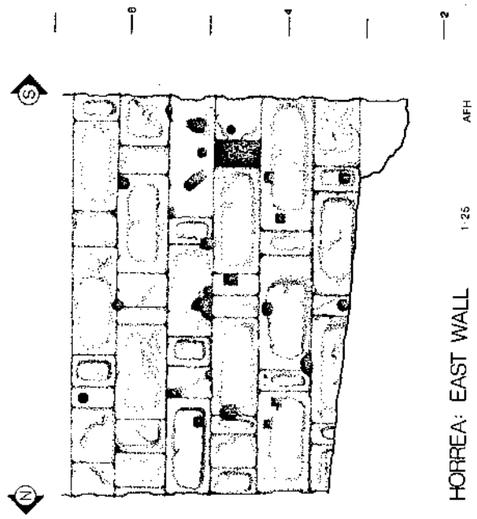
III.82 Area I_3: south wall of vault, west end.

III.83 Area I_3: south wall of vault, actual state drawing.

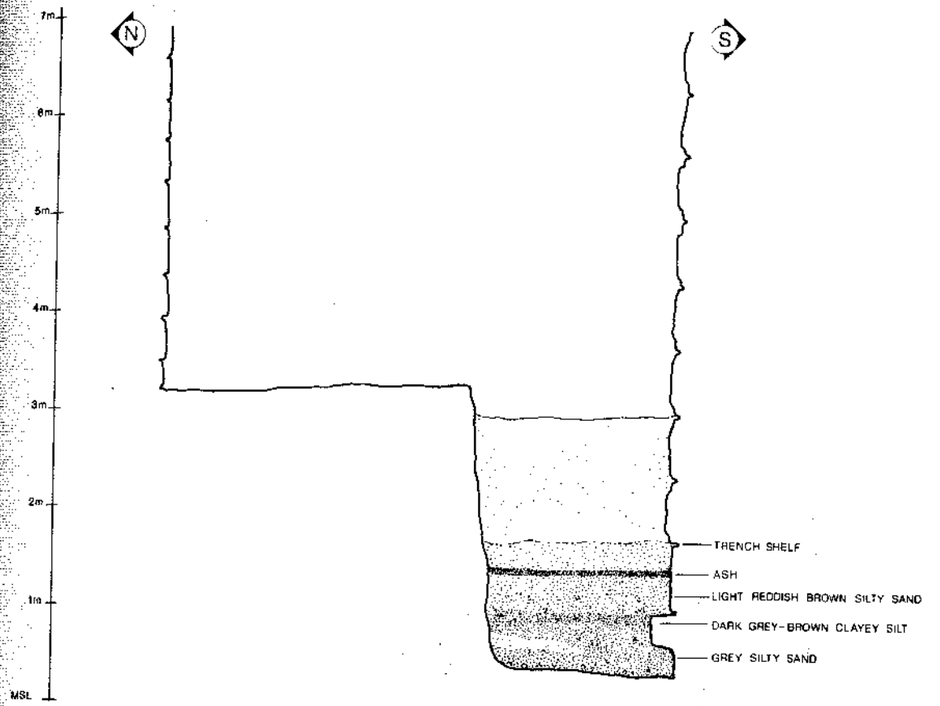


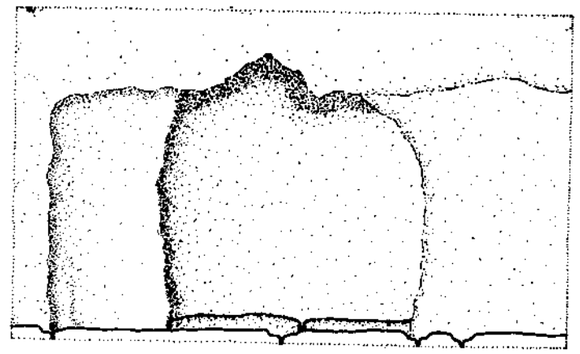


III.85 North city wall, inside face east of eastern round tower.

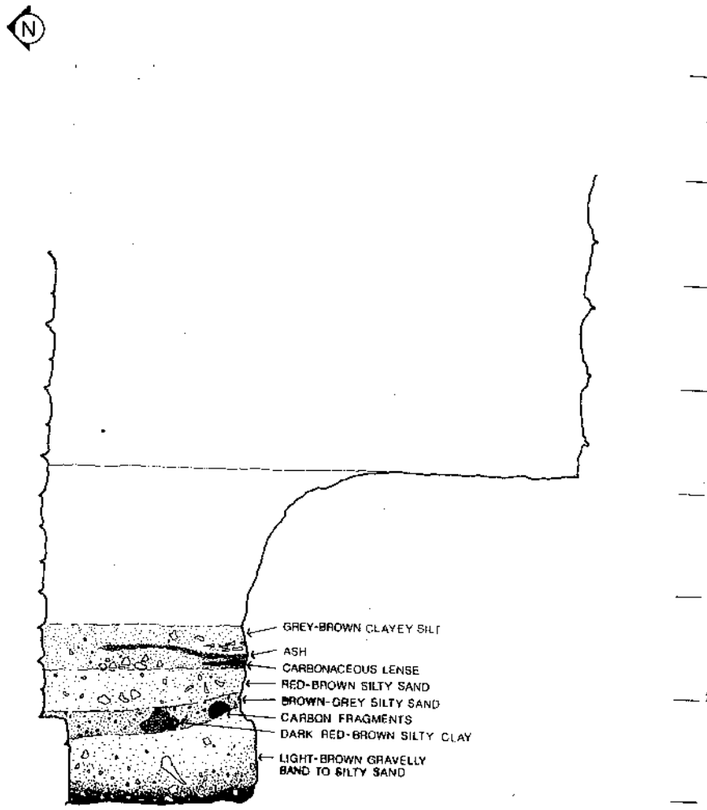


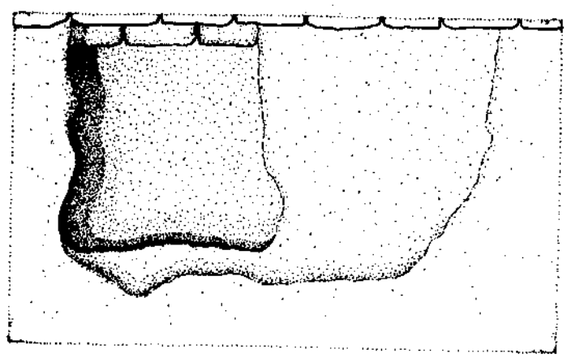
III.84 Area I3: east wall of vault, actual state drawing.





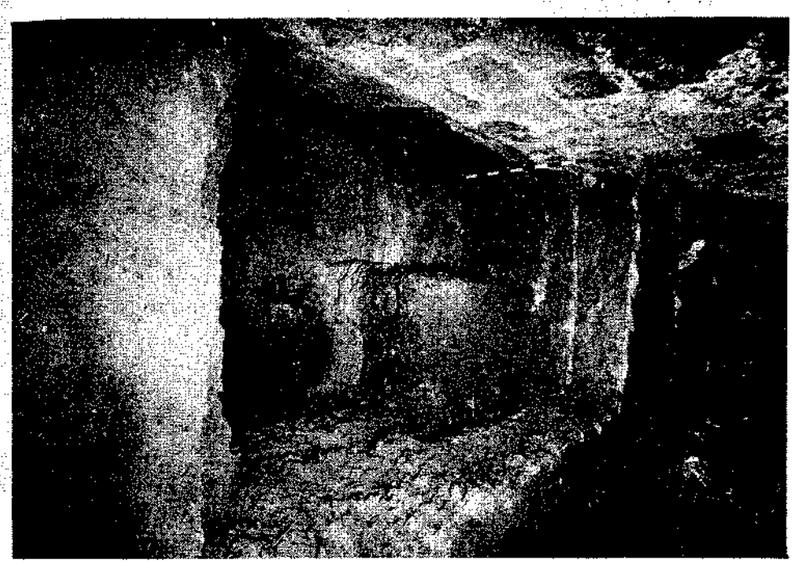
III.86 Area I3: probe I3a (south wall), plan and section.



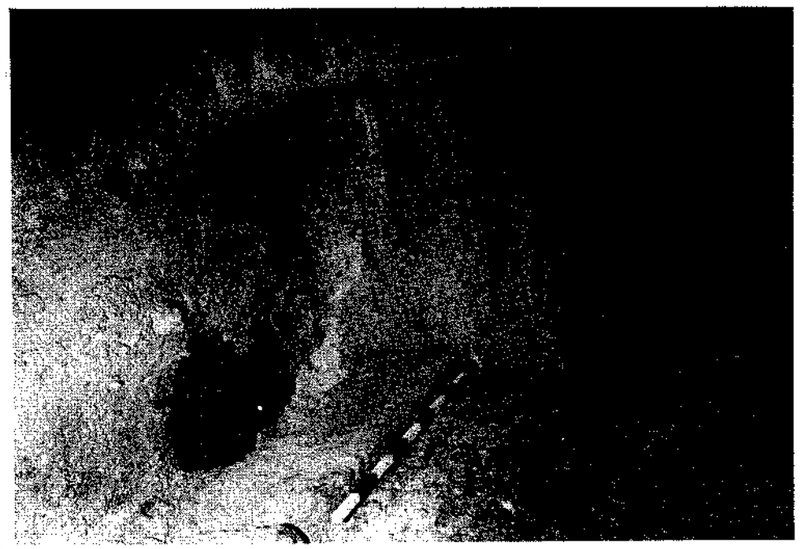


PLAN NORTH PROBE

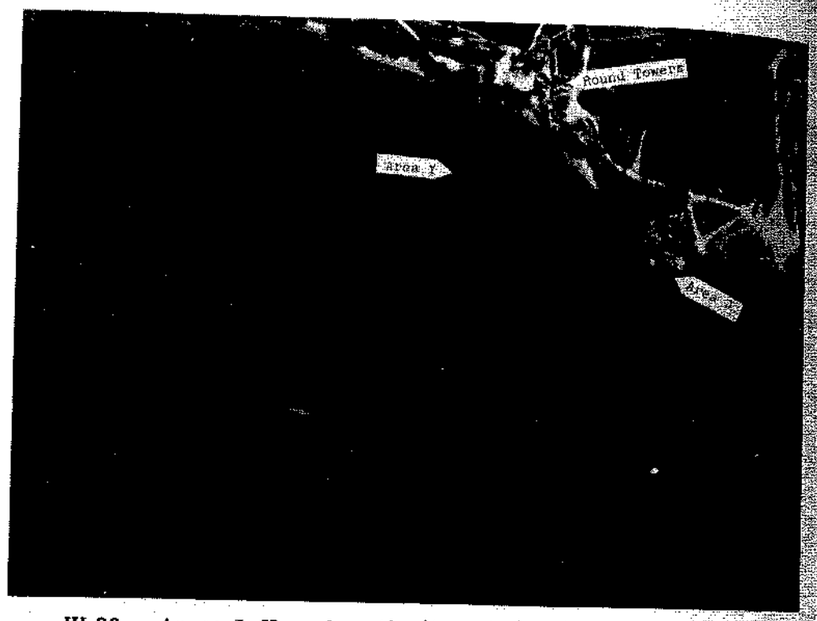
III.87 Area I3: probe I3b (north wall), plan and section.



III.88 Area I3: probe I3b, base of north wall on left.

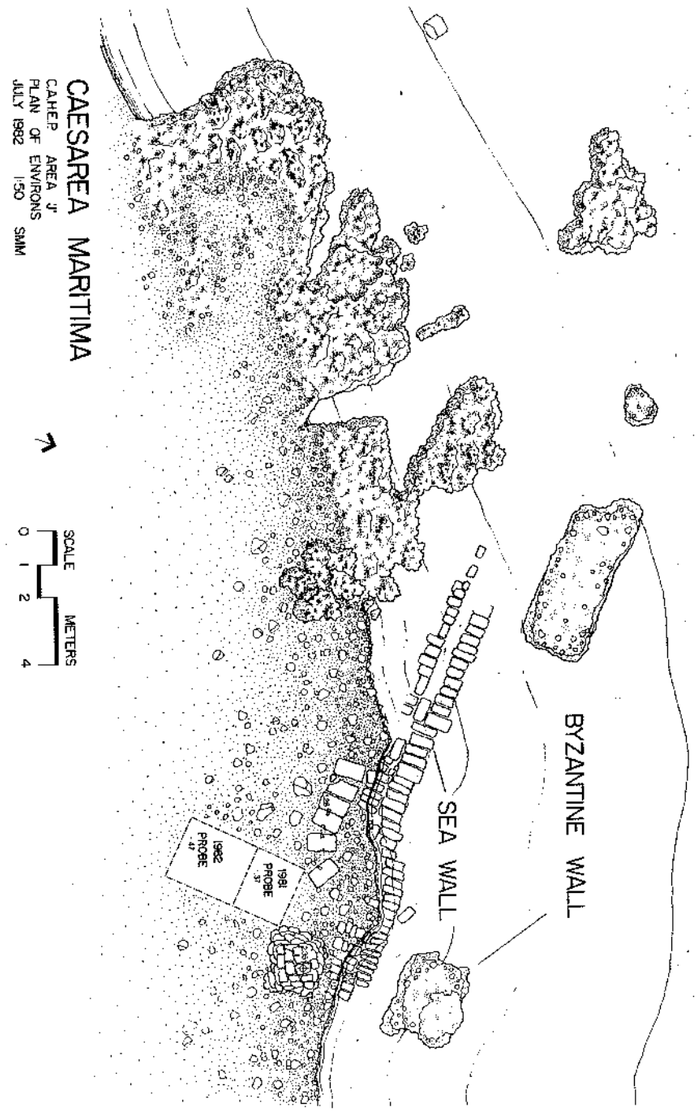


III.89 Area I3: probe I3a, base of south wall on right.



III.90 Areas J, Y, and north city gate: aerial photograph.

III.91 Area J: waves breaking on reefs west of quay (at arrow).

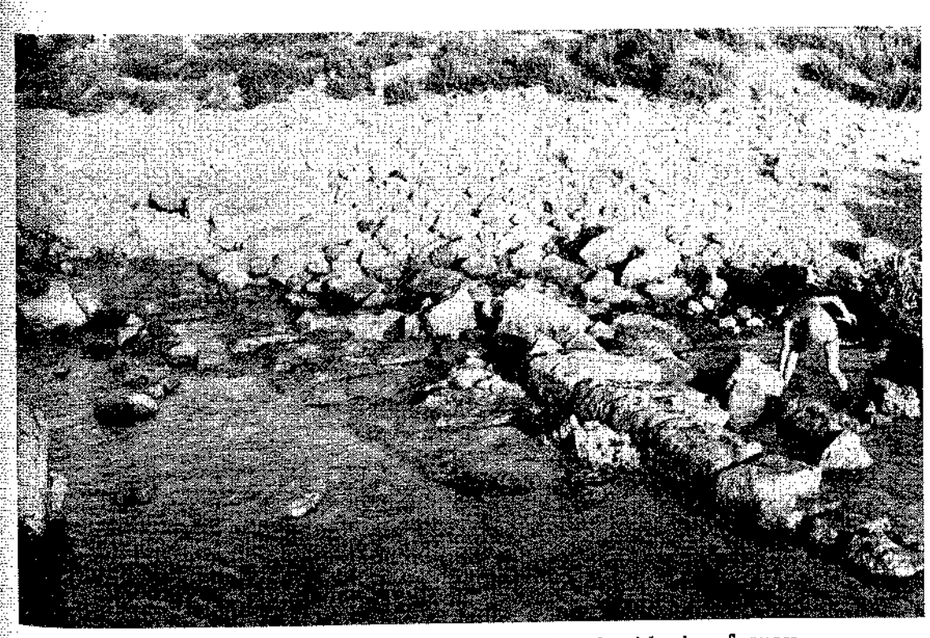


III.92 Area J: general site plan (1982).

III.93 Area J: view of quay and associated walls at low water, from east.

III.94 Area J: view of quay wall, from NE.

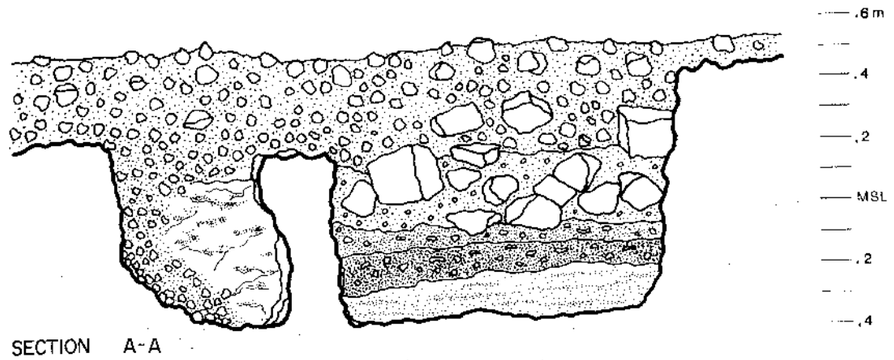
III.95 Area J: detail of central portion of quay wall, from west, showing second row of headers south of the first.



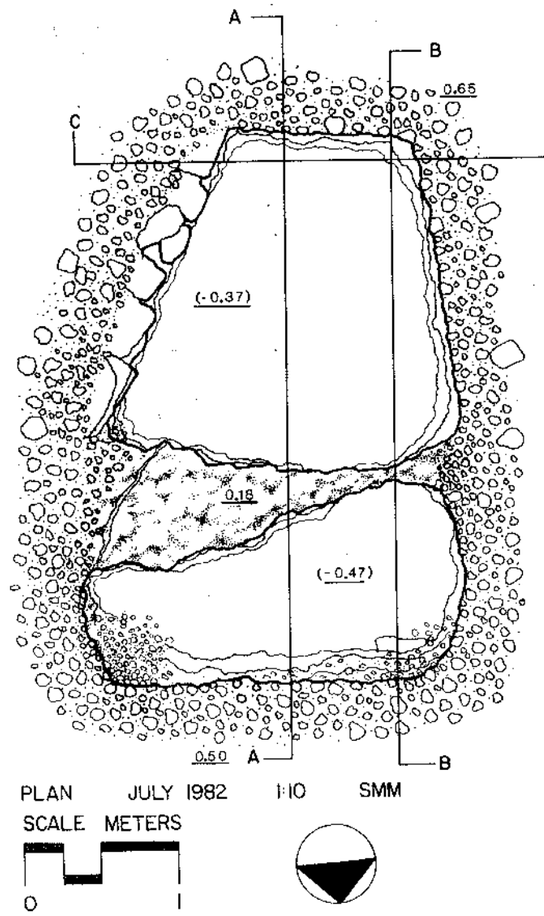
III.96 Area J: ashlar blocks above header blocks of quay.

III.97 Area J: ashlar blocks above header blocks of quay, detail of clamp mark.

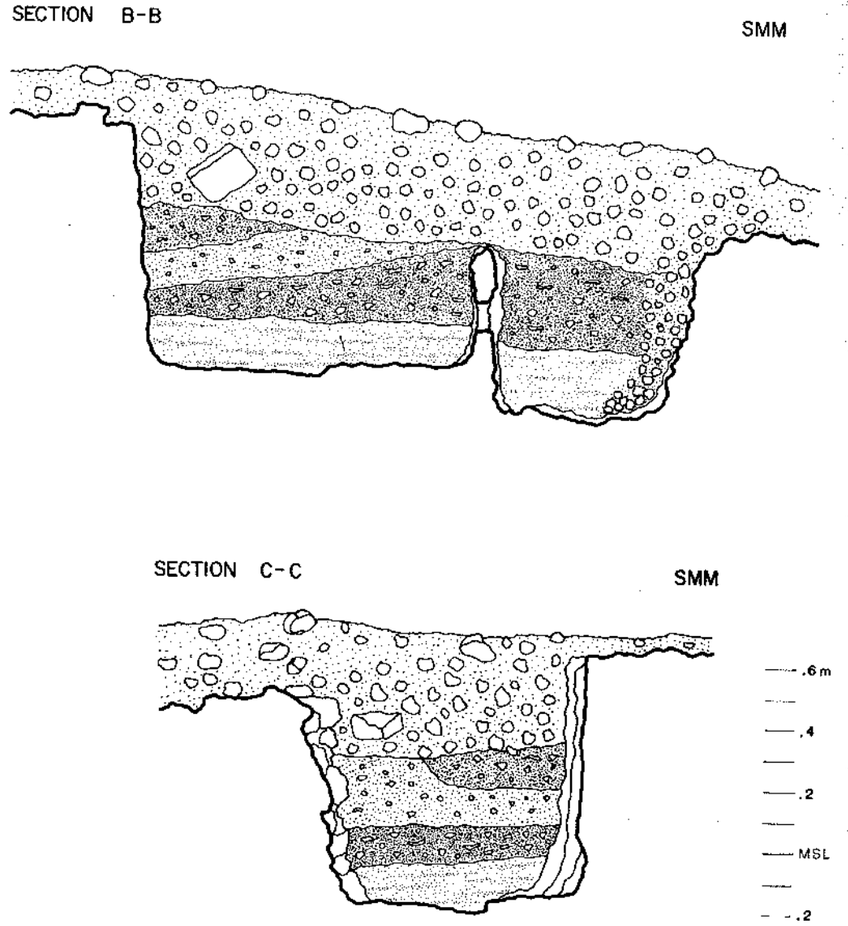
III.98 Area J: rock-cut basin, from north.



SECTION A-A

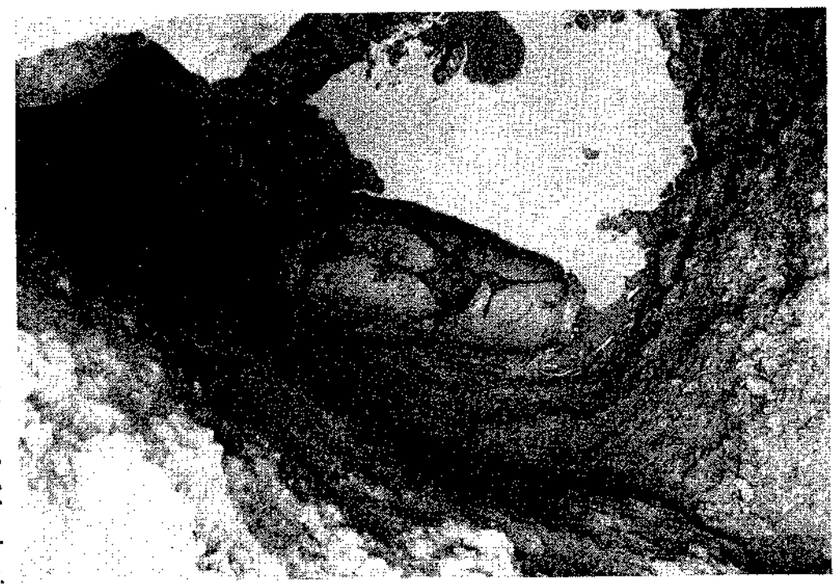


III.99 Area J: rock-cut basins, plan and section A-A.

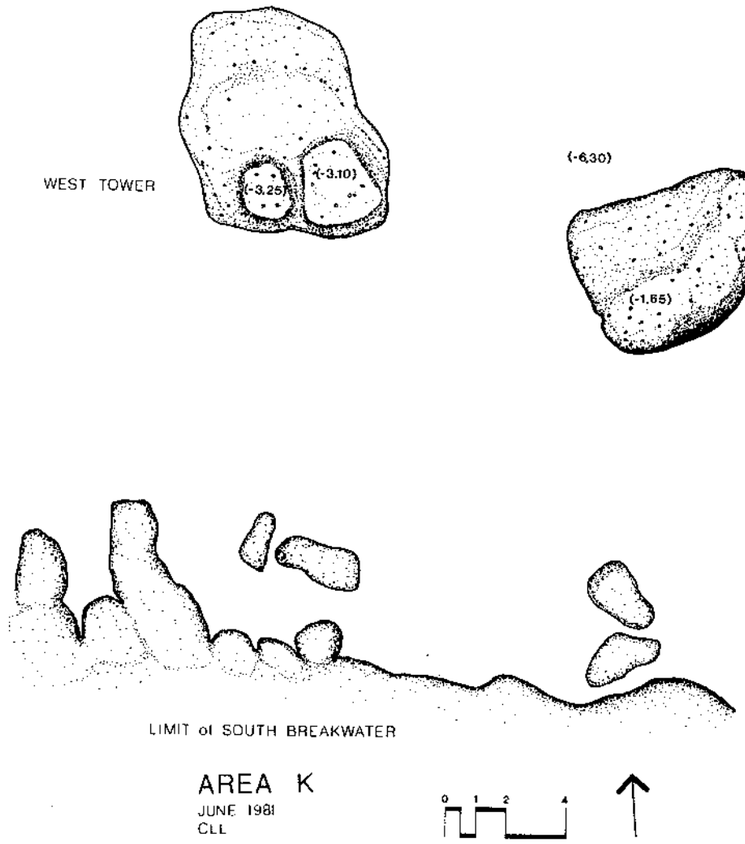


III.100 Area J: rock-cut basins, sections B-B, C-C.

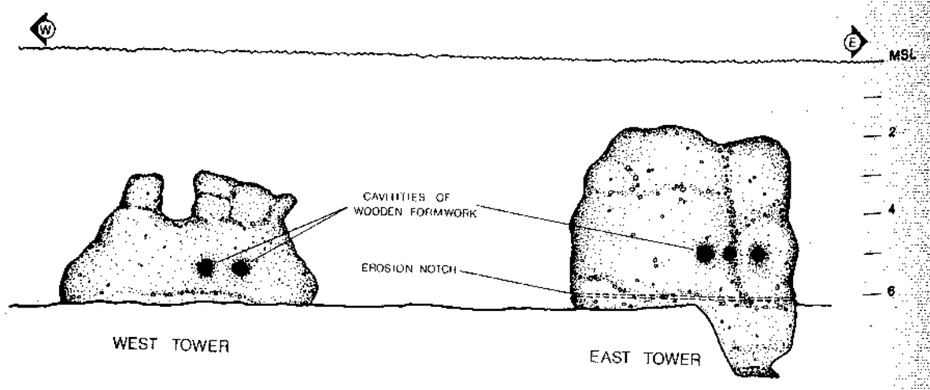
III.101 Area J: rock-cut basin, from south.



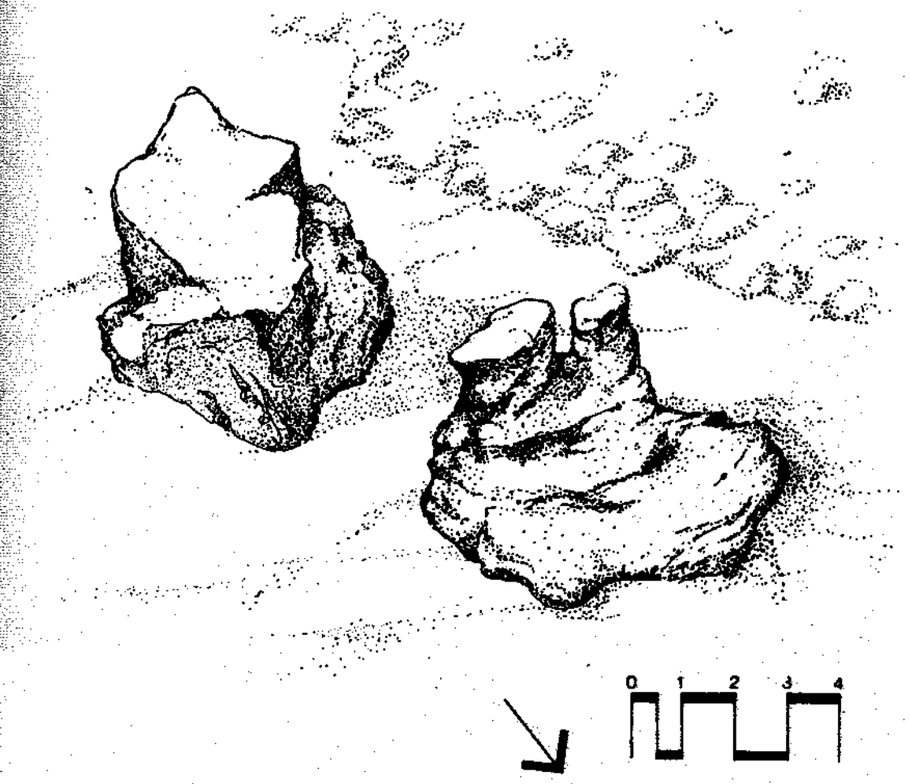
III.102 Area J: rock-cut basin, double ended jar *in situ*.



III.103 Area K: plan.

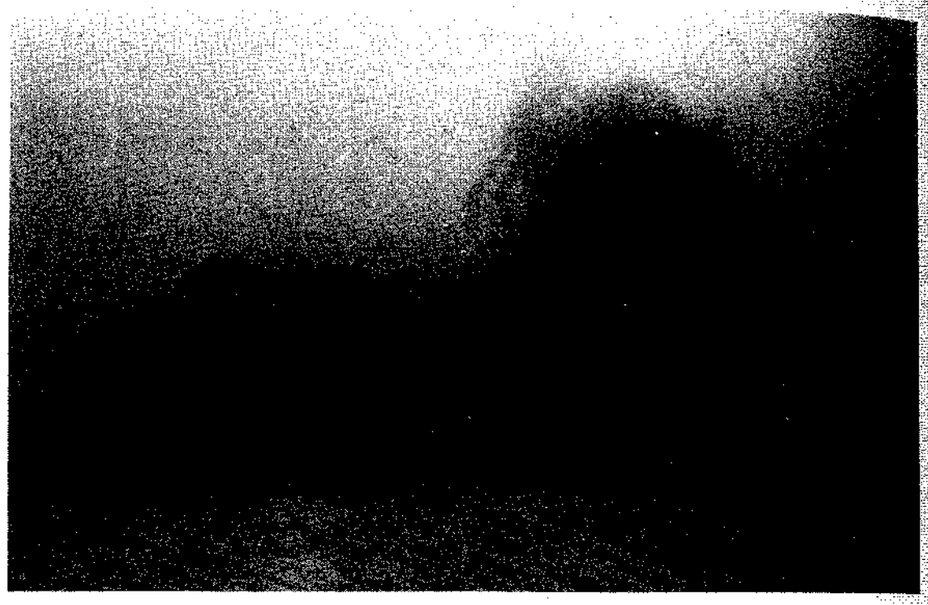


III.104 Area K: East and West Towers, elevation drawing from south.

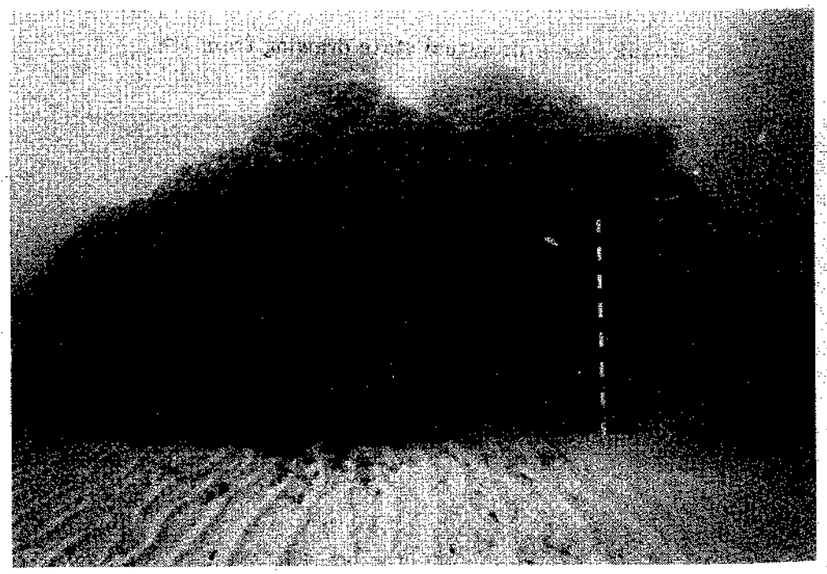


III.105 Area K: actual state drawing from NW.

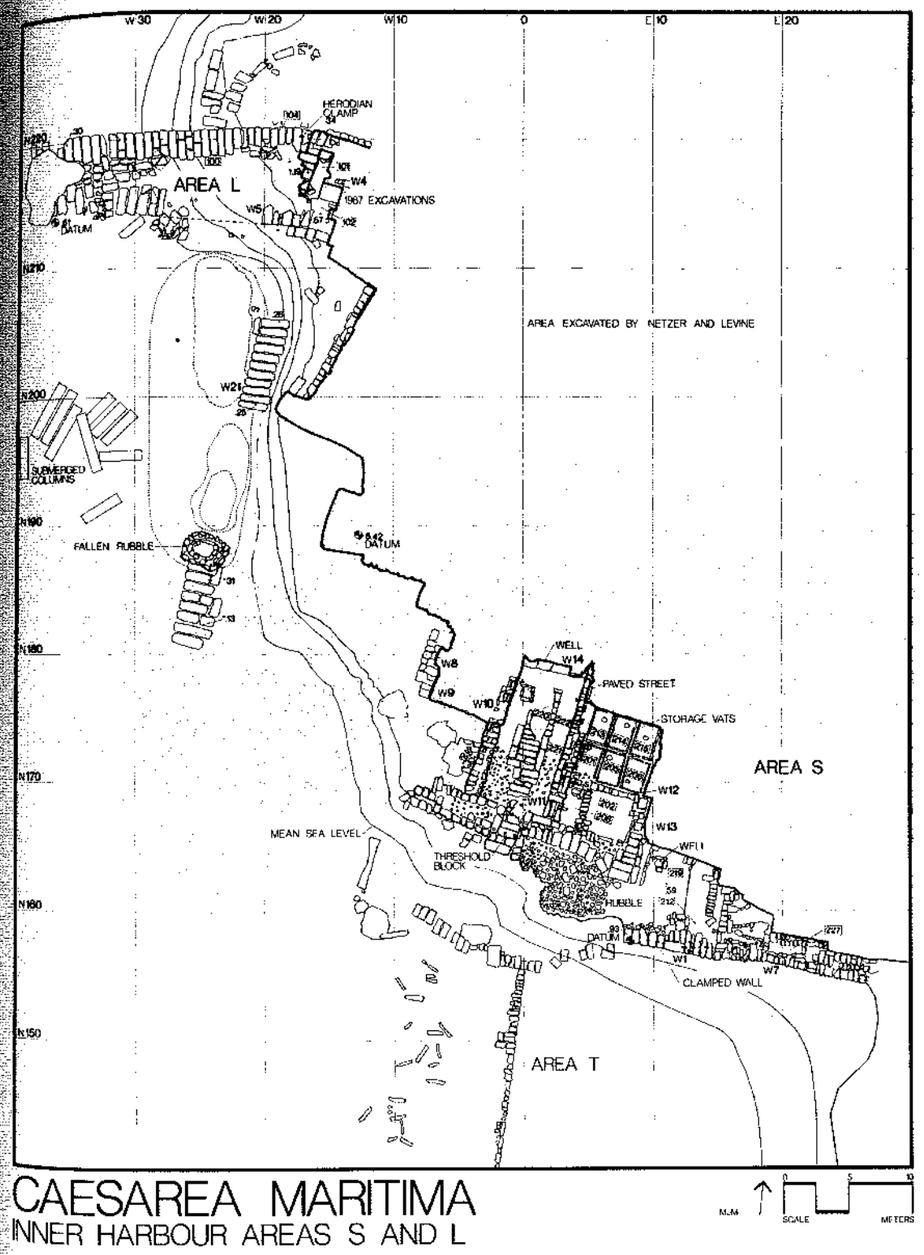
III.106 Area K: groove and hole from formwork tie beams of East Tower.



III.107 Area K: West Tower, from west.

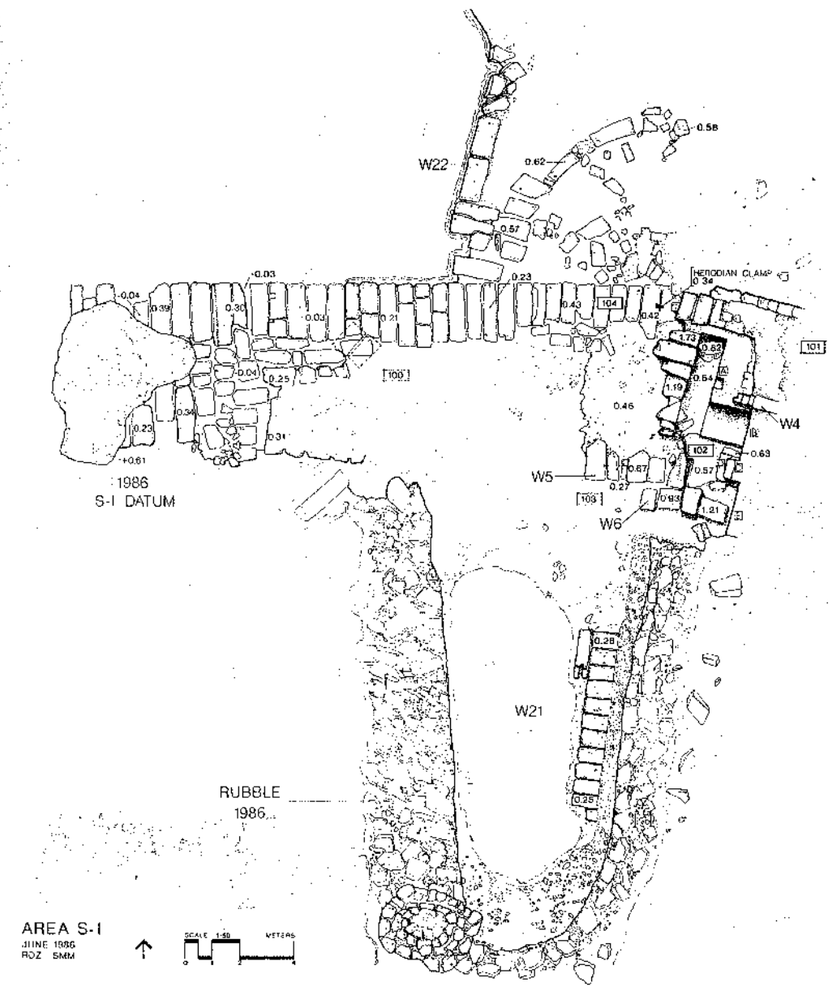


III.108 Area K: southeast face of West Tower.



III.109 Areas L and S: plan.

III.110 Areas L and S: oblique aerial from NW.



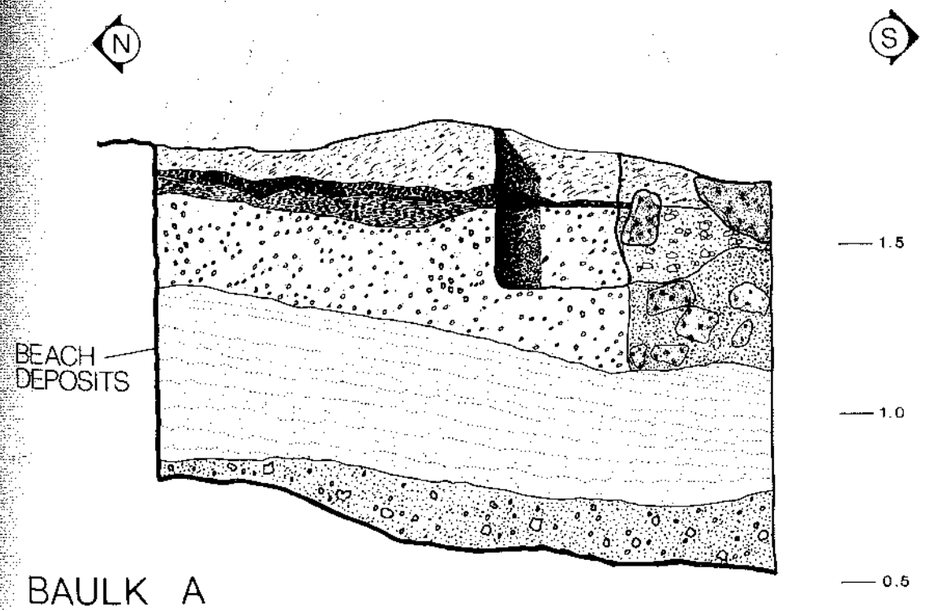
III.111 Area L (later S_1): plan.

III.112 Area L (later S_1): north edge of pier, blocks with dovetail clamp setting.

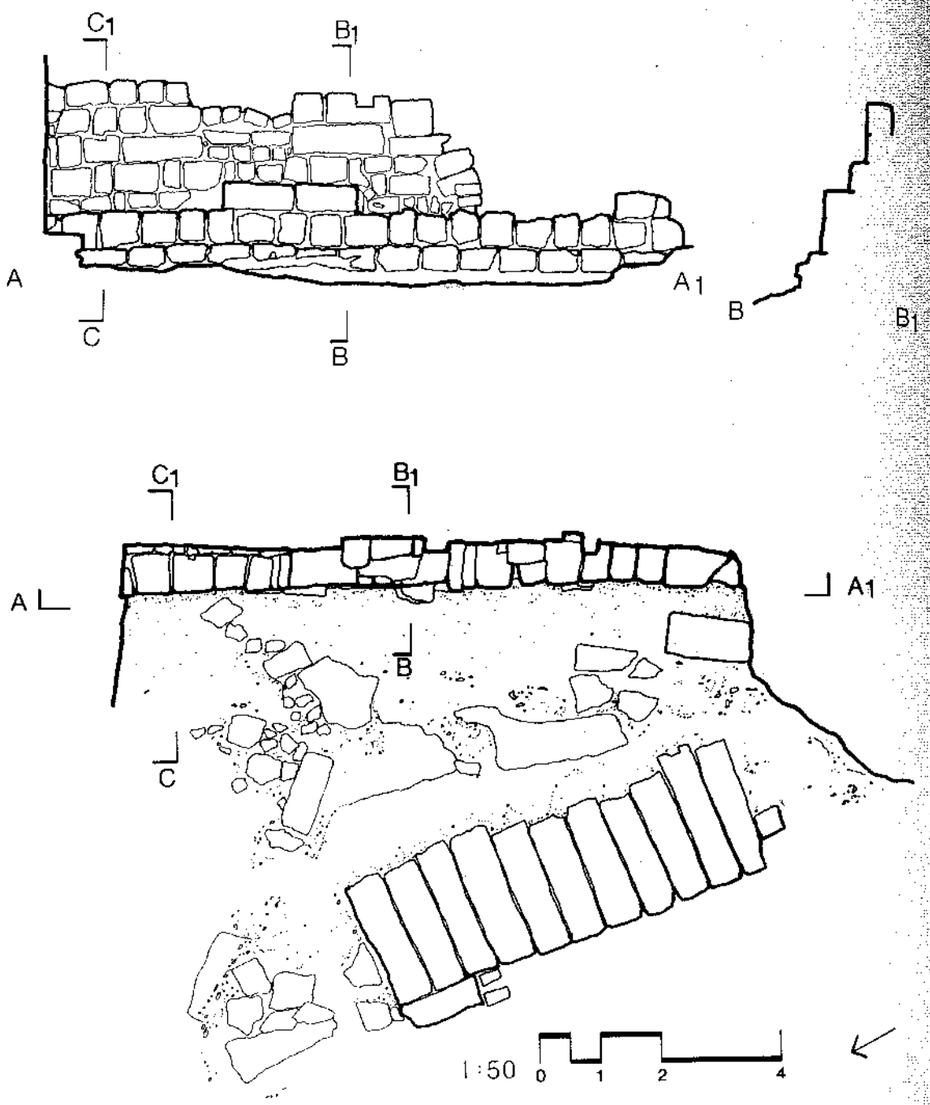
III.113 Area L (later S_1): pier, from east.

III.114 Area L (later S_1): walls at base of pier, from east.

III.115 Area L (later S_1): locus 102.

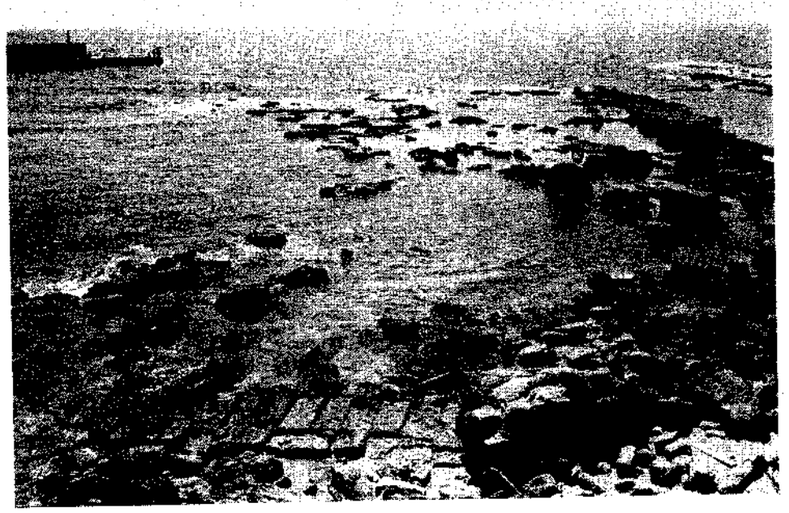


III.116 Area L (later S_1): baulk A, drawing.



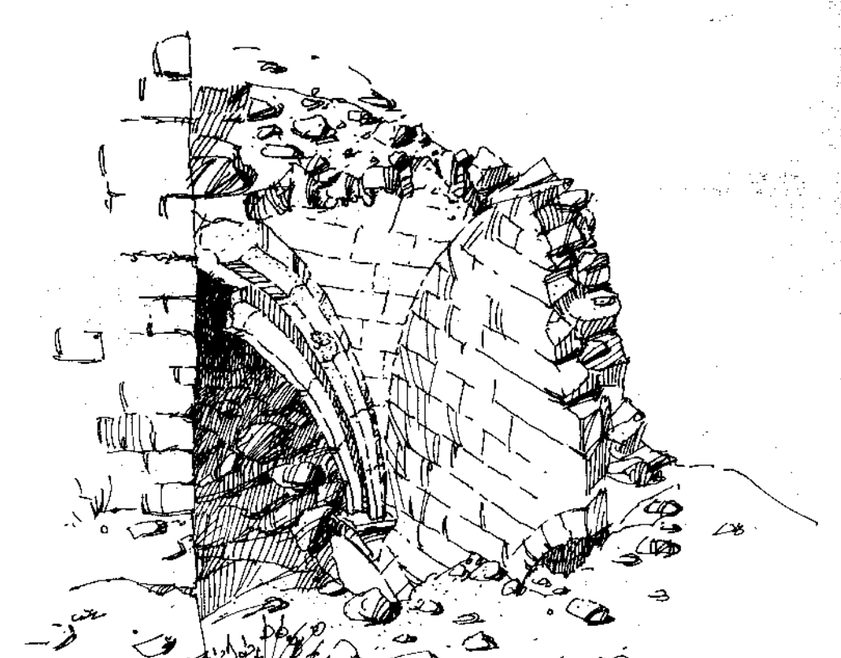
III.117 Area L (later S_1): north-south quay wall (W 21), and later structures to the east; plan, section, and elevation.

III.118 Area L (later S_1): north-south quay wall (W 21), and later structures to the east, view from west.

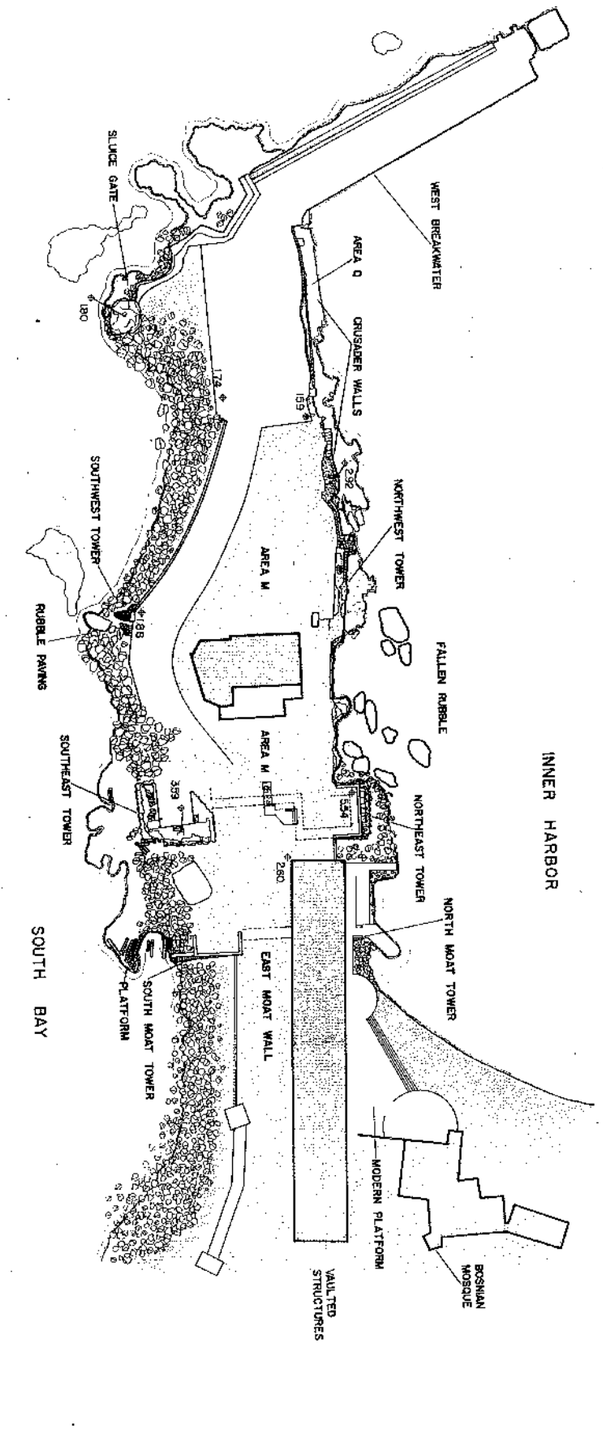


III.119 Area L (later S_1): north-south quay wall, south end, and Column Jetty, from east.

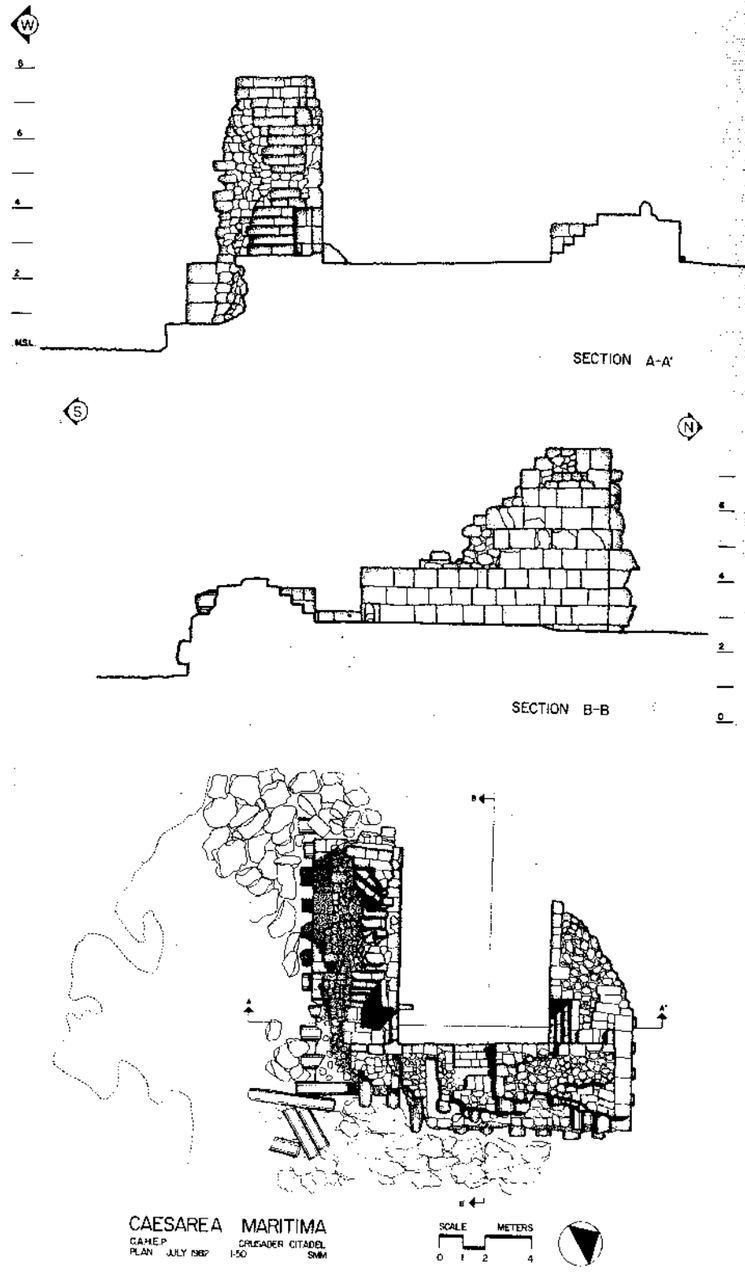
III.120 Areas M and Q: remains of Crusader Citadel and kurkar headland, from SE.



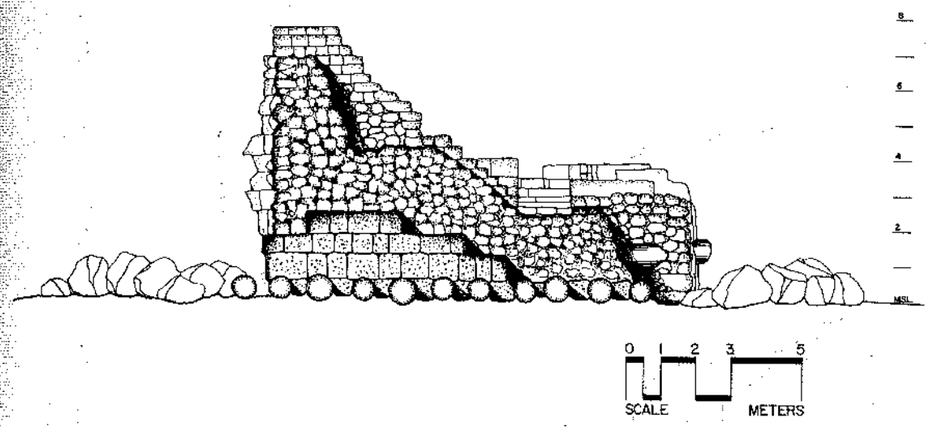
III.121 Area M: detail of Crusader vaulting west of Citadel.



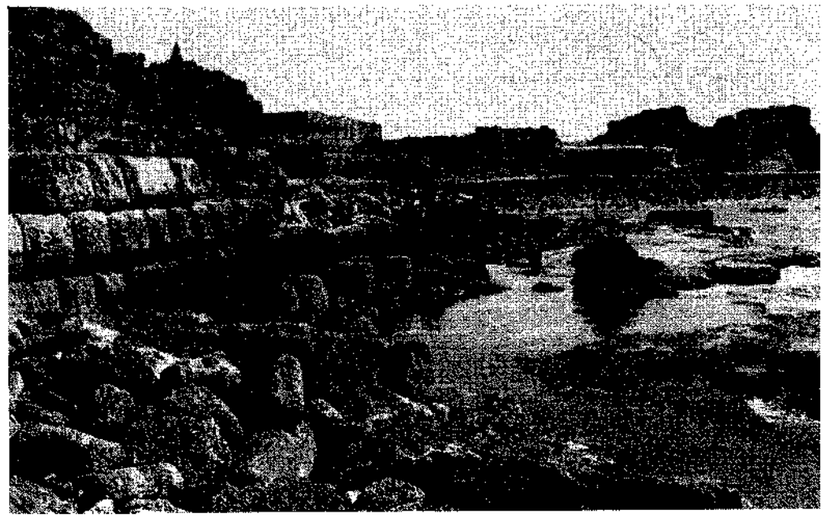
III.122 Plan of modern southern breakwater, with Areas M and Q.



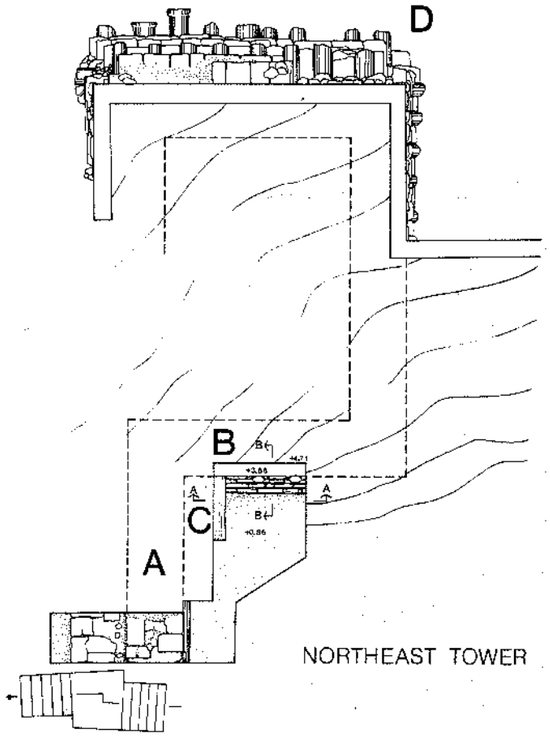
III.123 Area M: Southeast Tower, plan and sections A-A', B-B'.



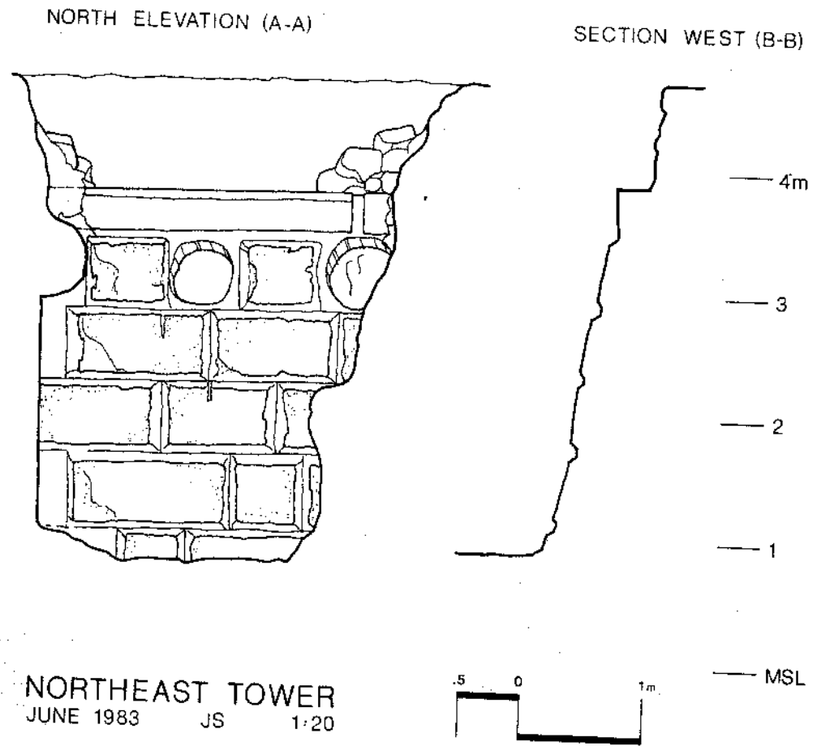
III.124 Area M: Southeast Tower, west elevation.



III.125 Area M: south face of Southeast Tower from west, with tie beam columns.

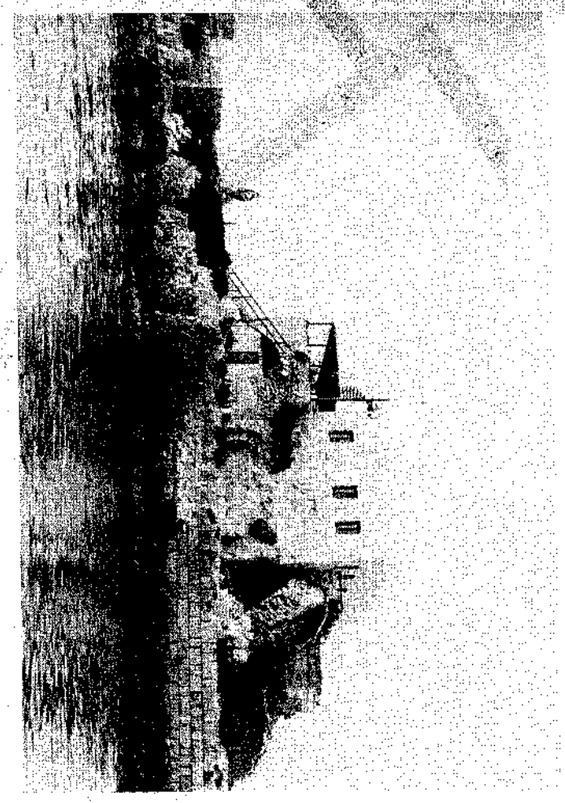


III.126 Area M: Northeast Tower and moat, plan.

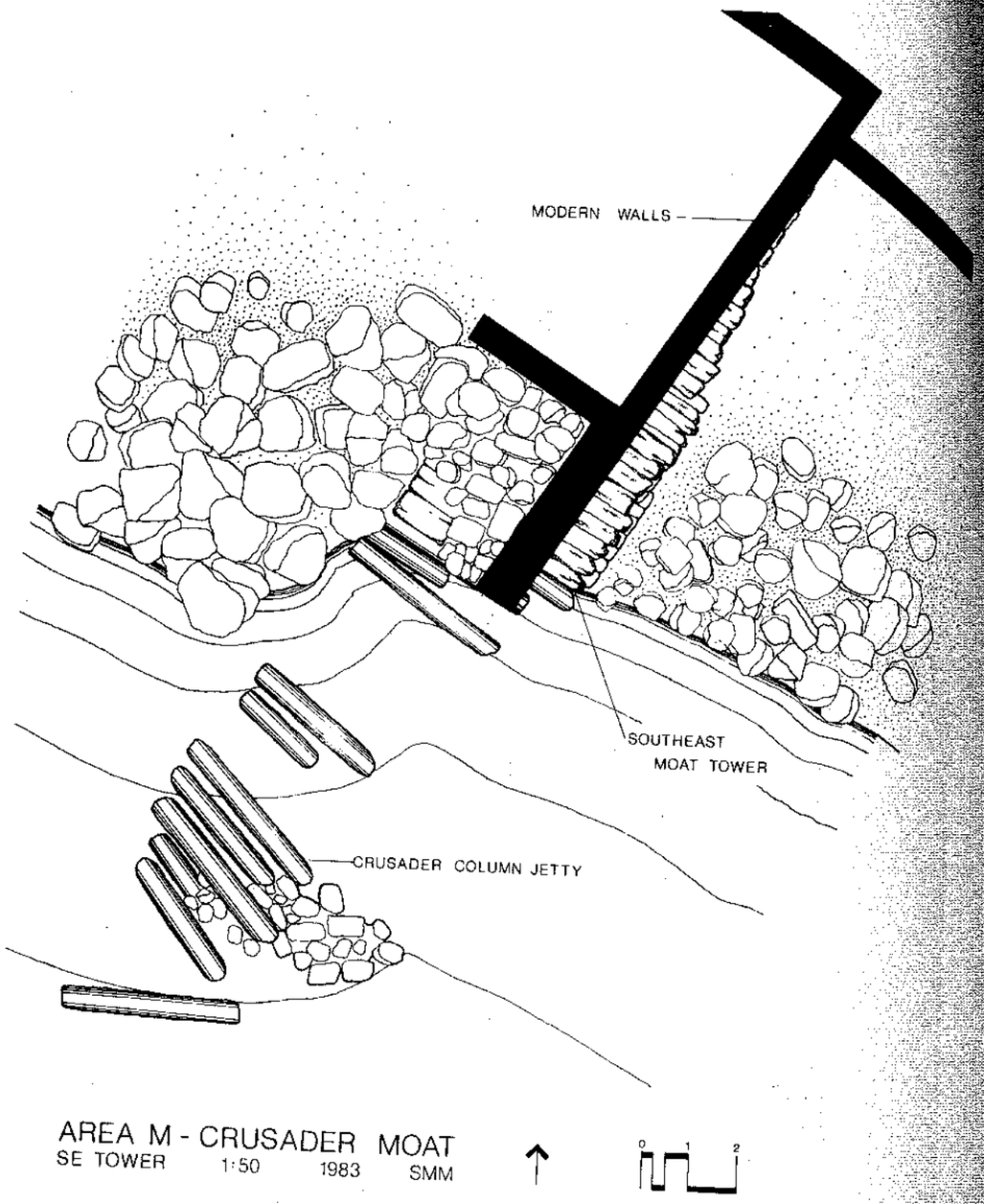


III.127 Area M: Northeast Tower and moat, north elevation and section of south face.

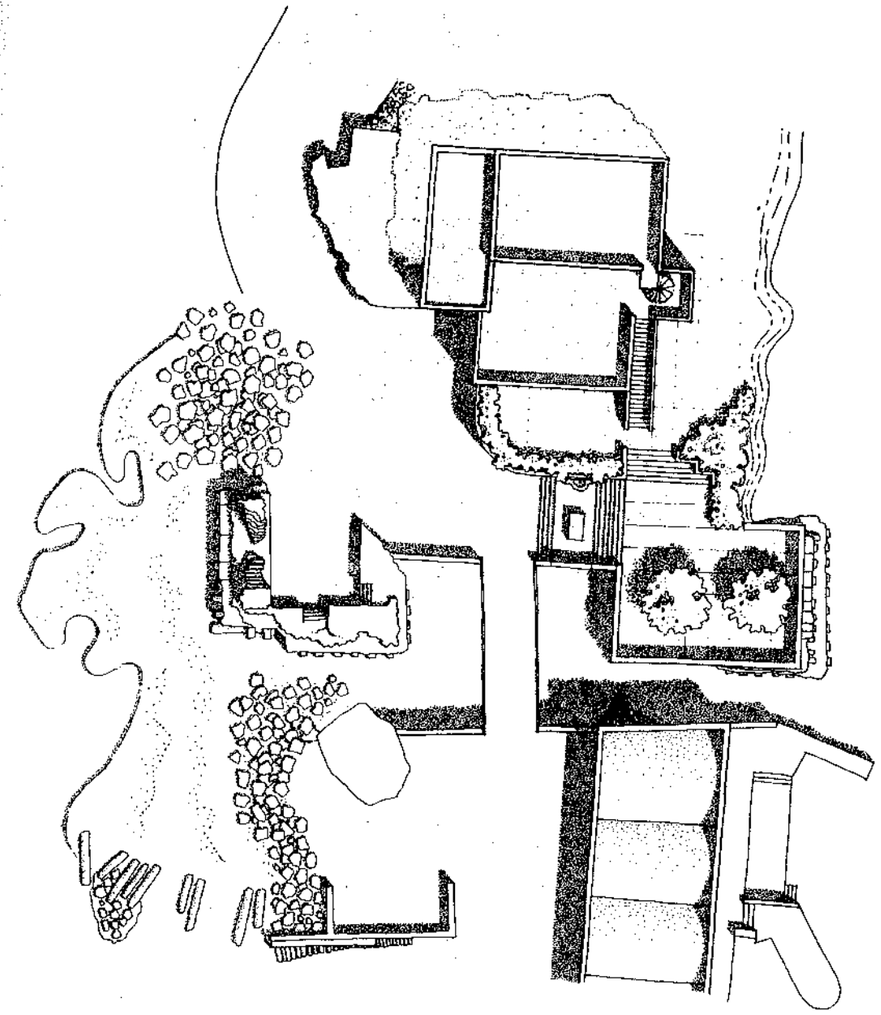
III.129 Area M: Northeast Tower from north.



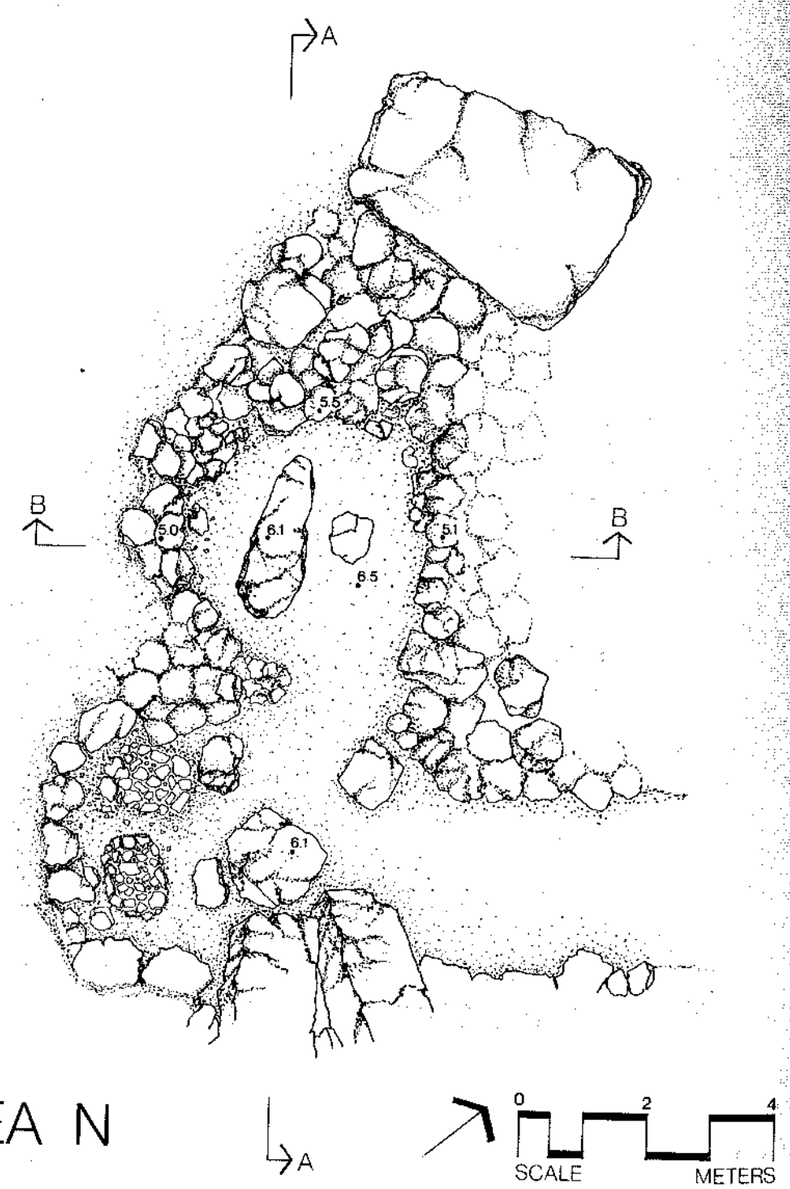
III.128 Area M: Northwest Tower and Citadel, from north.



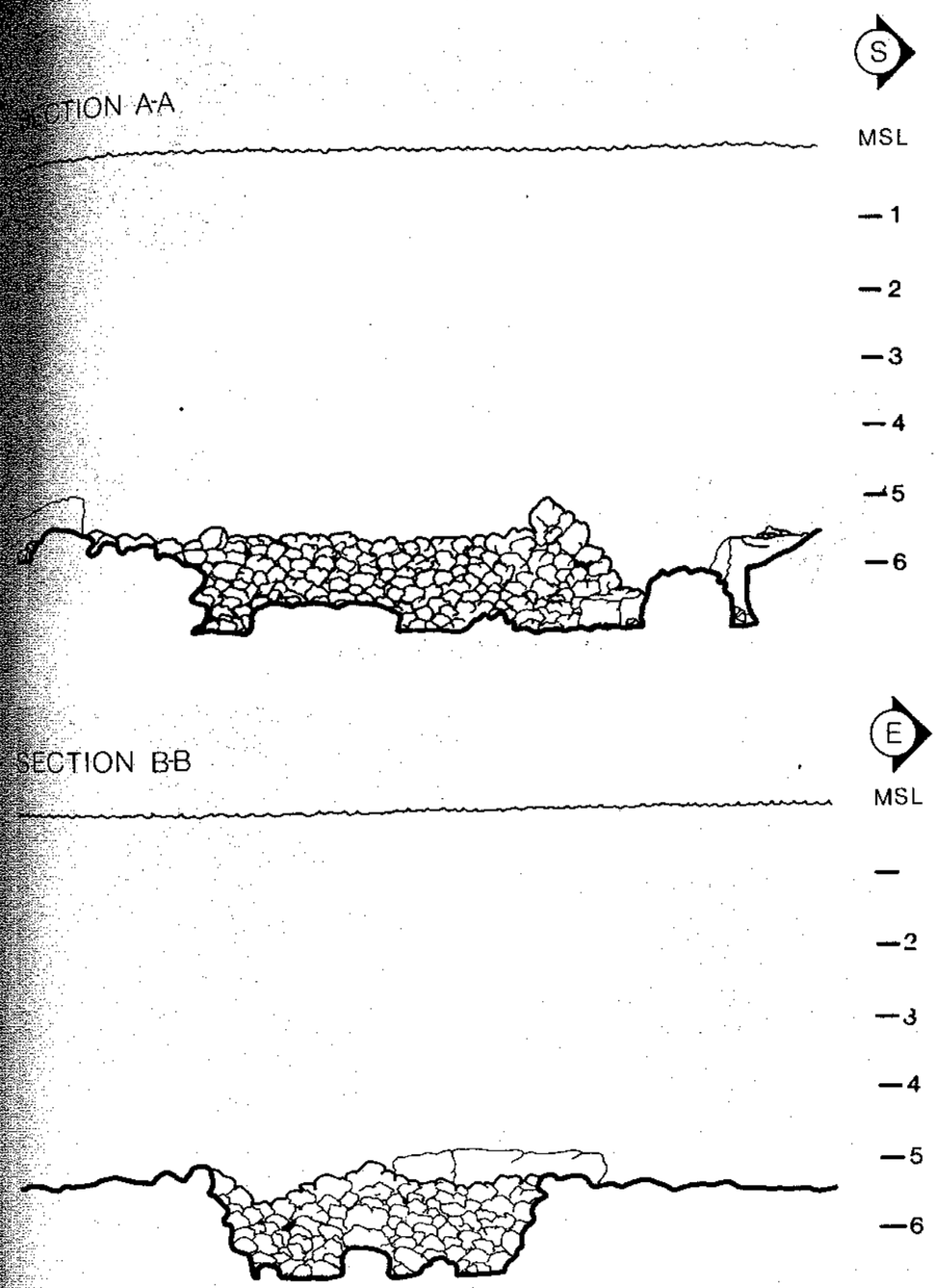
III.130 Area M: Crusader Moat, plan.



III.131 Area M: Crusader Moat, reconstruction proposal, plan.



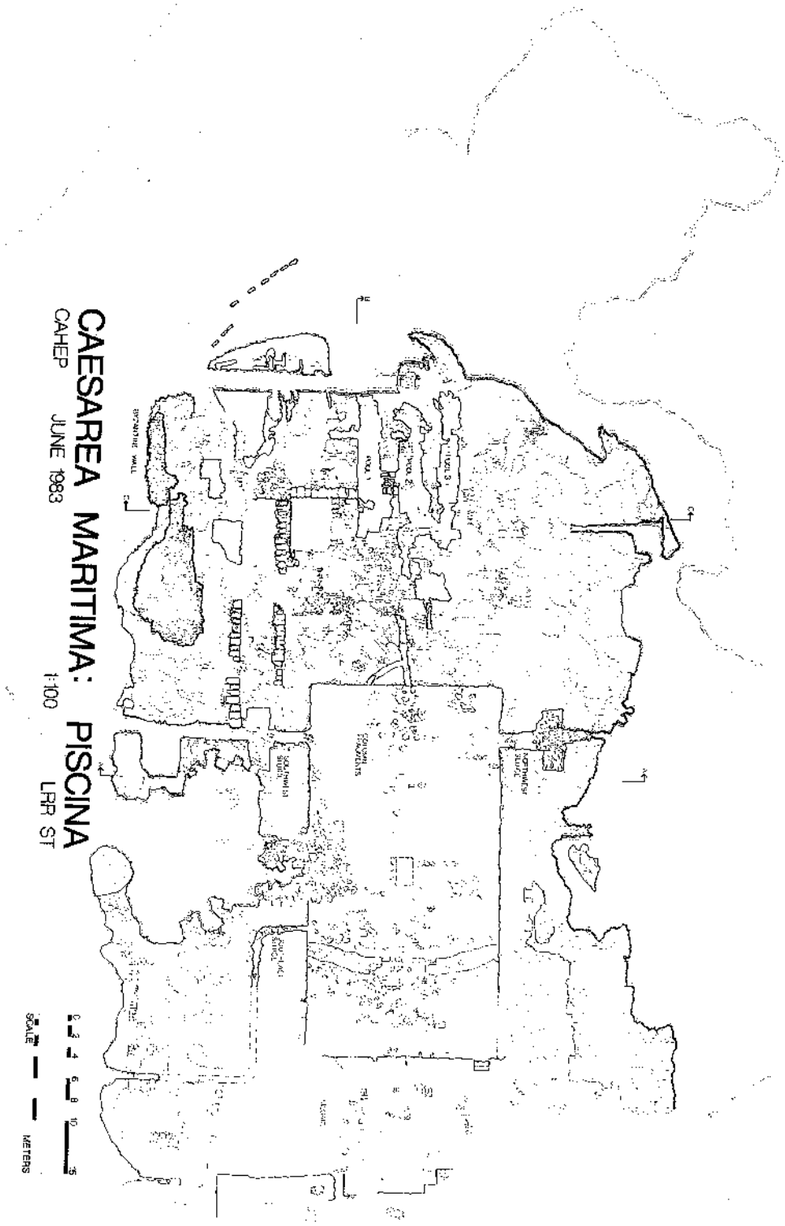
III.132 Area N_1: plan.



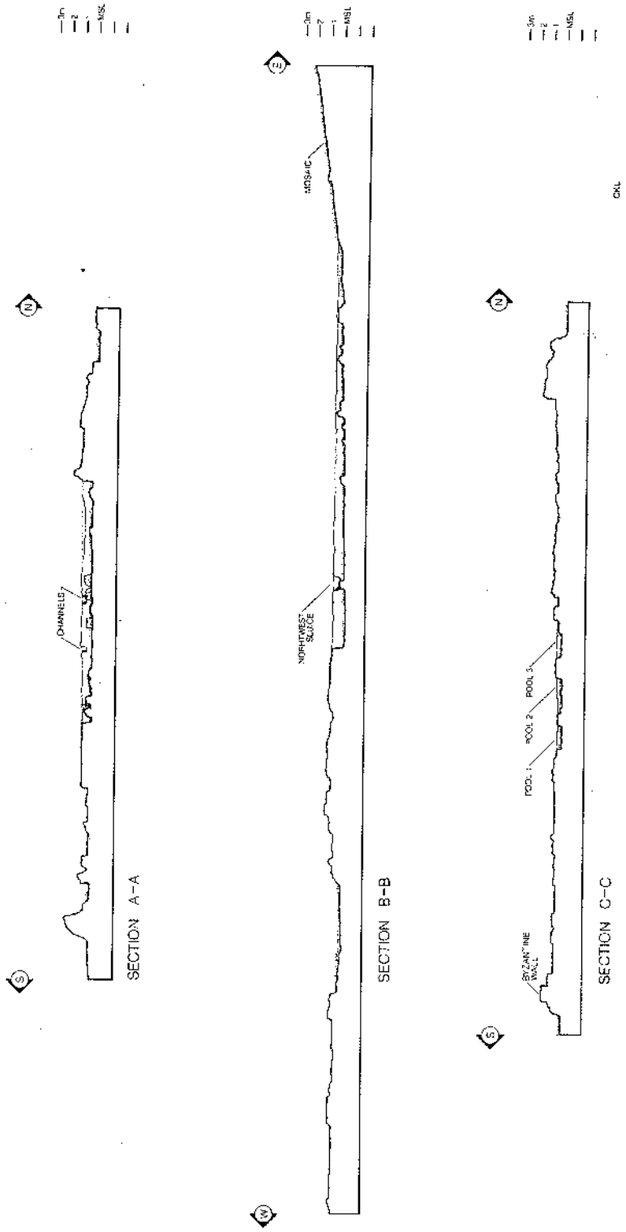
III.133 Area N_1: sections A-A, B-B.

III.134 Area N_1: clay layer.

III.135 Area P: oblique aerial of Piscina, from west.



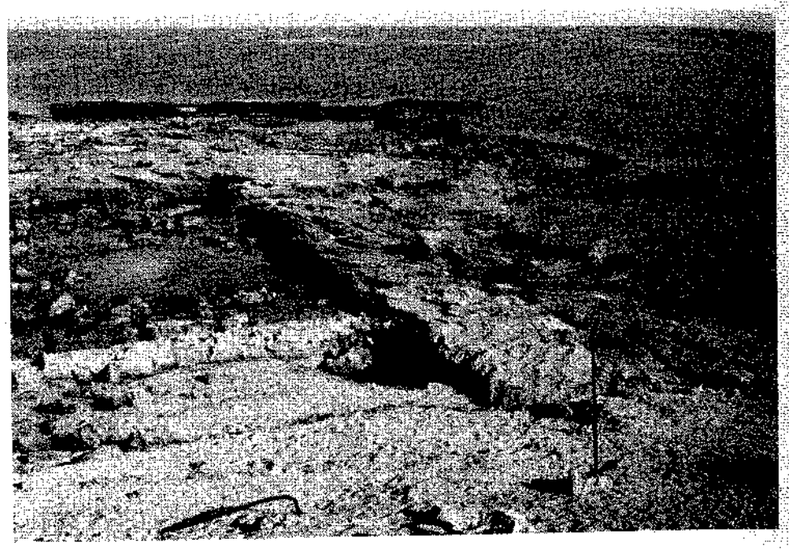
III.136 Area P: plan of Piscina.



III.137 Area P: sections A-A, B-B, C-C across Piscina.

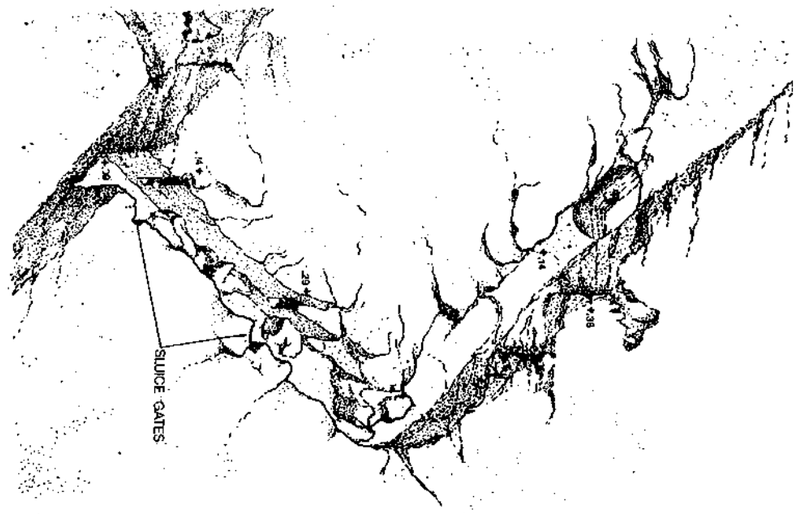
III.138 Area P: Piscina basin, from east.

III.139 Area P: Piscina basin, interior partition wall, from south.

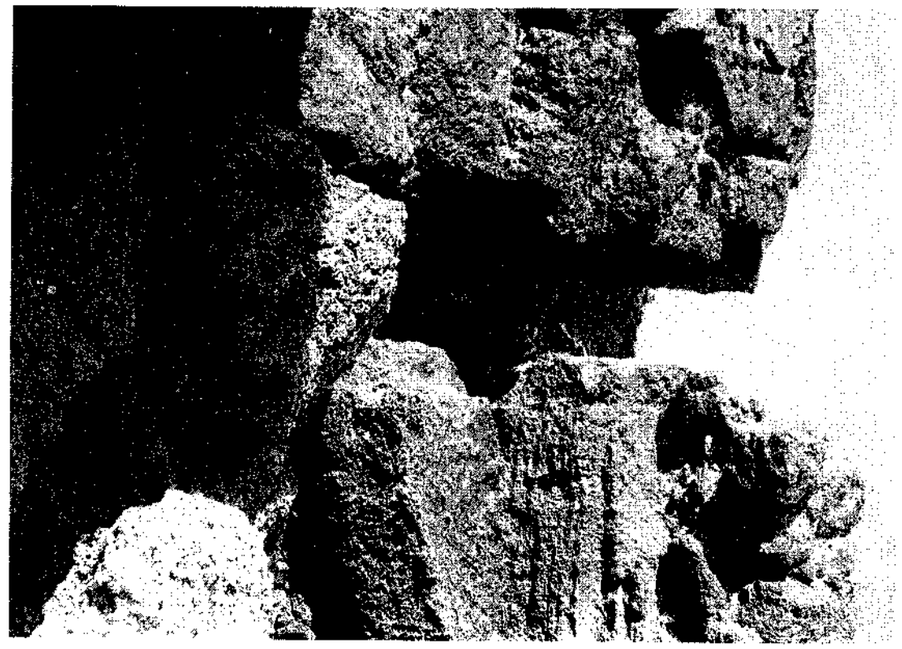


III.140 Area P: Piscina basin, north edge.

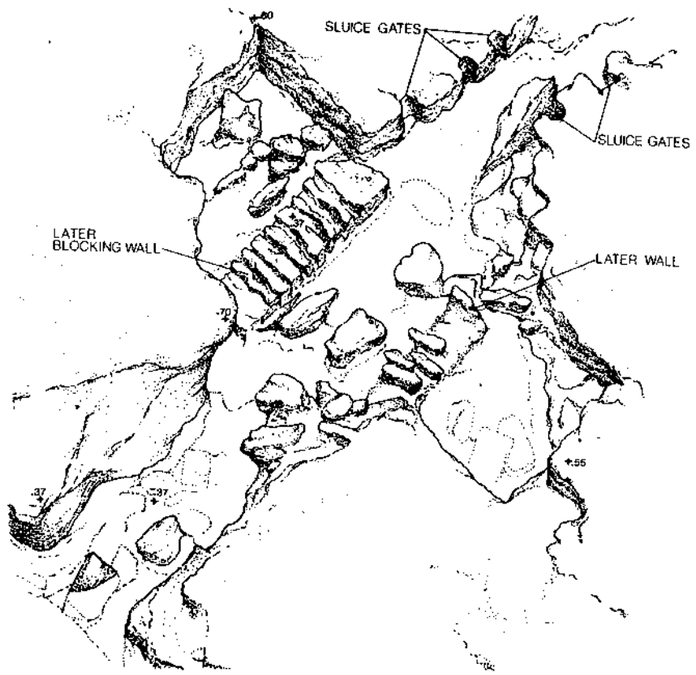
III.141 Area P: Piscina basin, south edge.



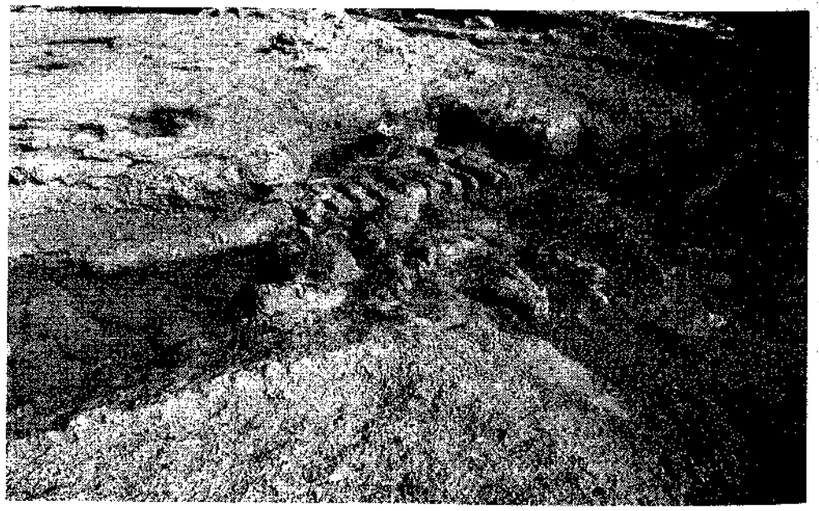
III.142 Area P: southeast sluice, axonometric of intersection with Piscina wall.



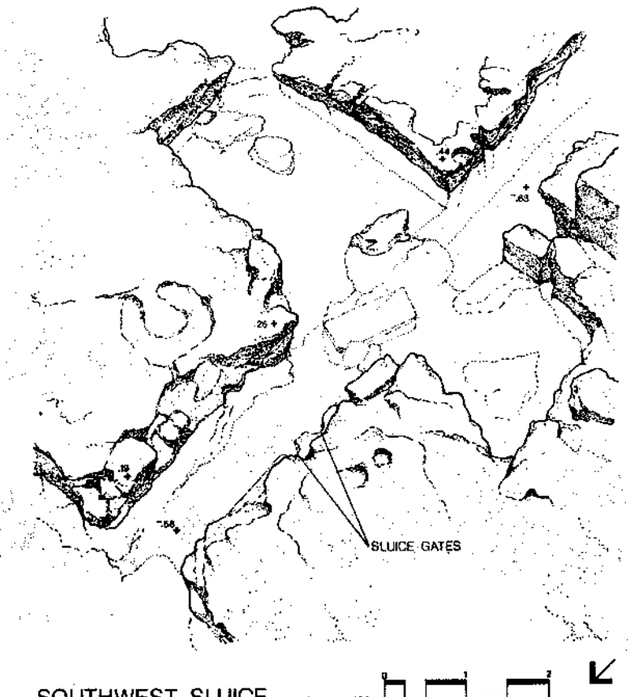
III.143 Area P: southeast sluice, south extension to edge of promontory, from north.



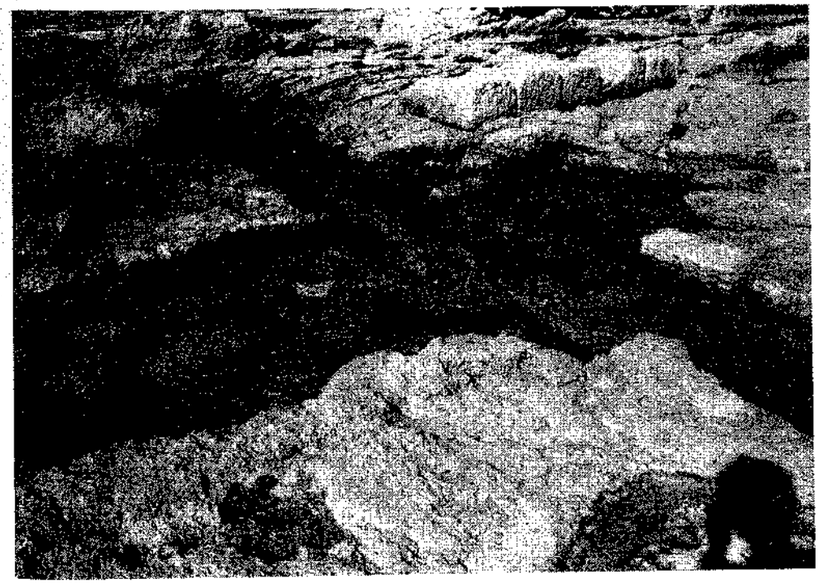
III.144 Area P: northwest sluice, axonometric.



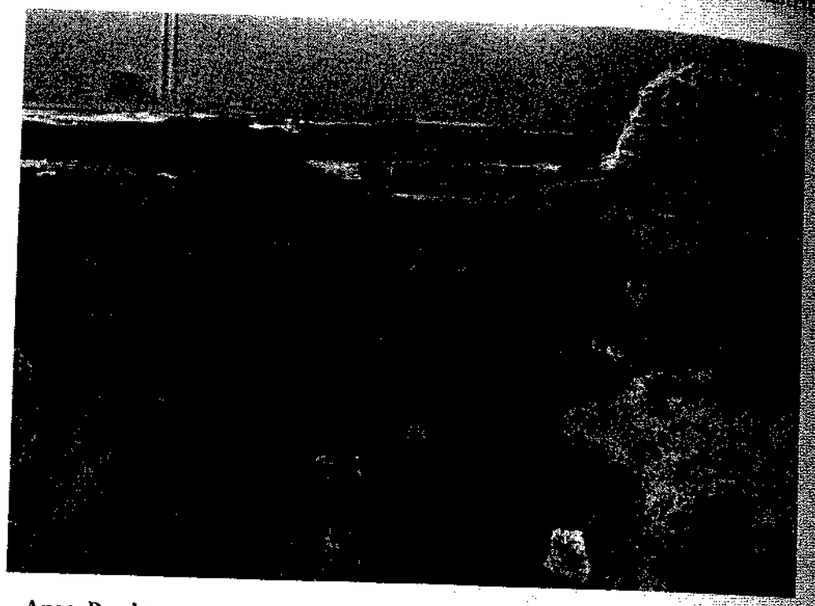
III.145 Area P: northwest sluice, view from SE.



III.146 Area P: southwest sluice, axonometric.



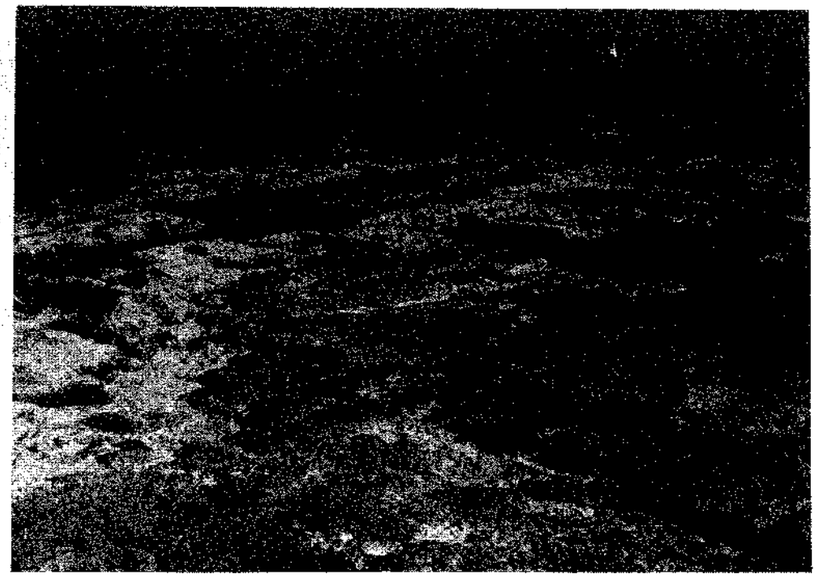
III.147 Area P: southwest sluice, view from NE.



III.148 Area P: view south across central tank from northwest sluice to southwest sluice.

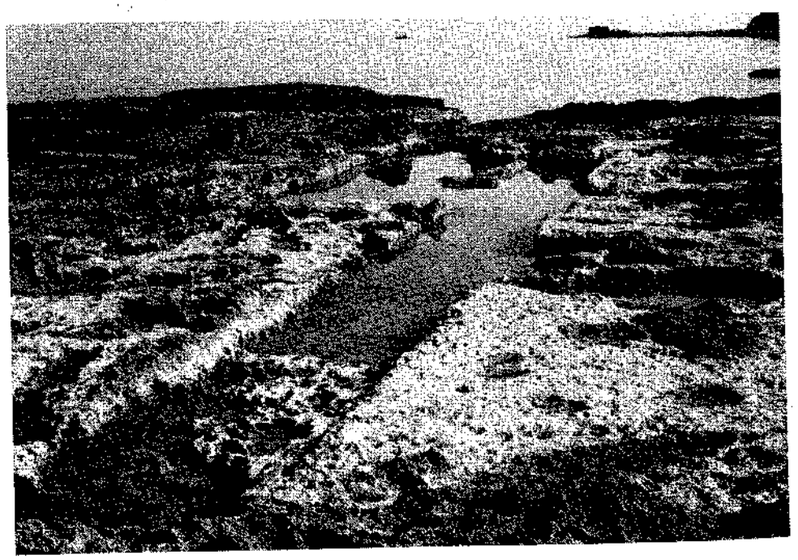
III.149 Area P: Piscina basin, central pier, from south.

III.150 Area P: west sluice and bypass, from west.



III.151 Area P: western termination of promontory, with basins and walls, from SE.

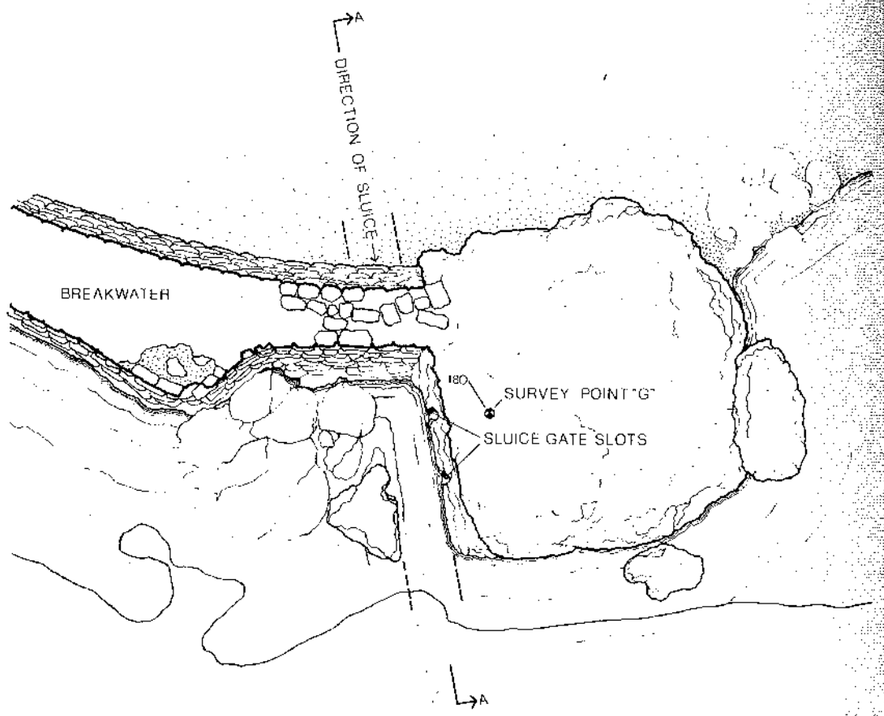
III.152 Area P: western end, southern east-west pool, from east.



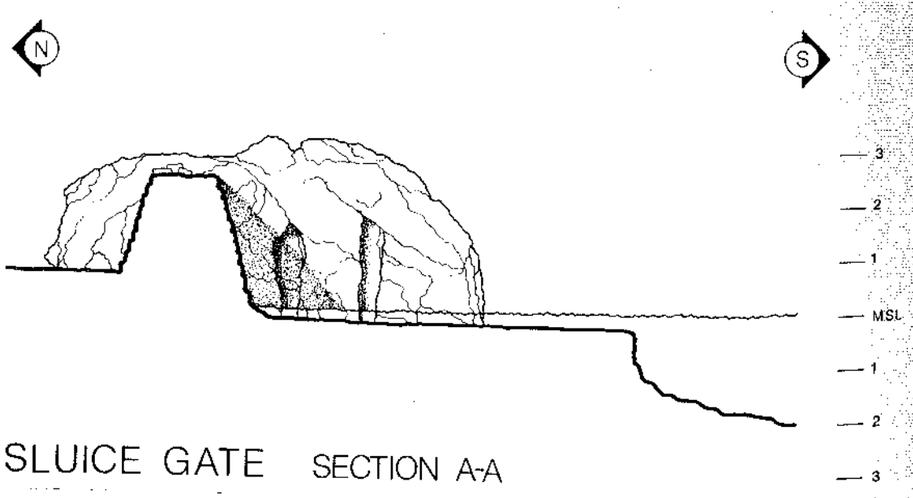
III.153 Area P: western end, north-south pool, from SE.

III.154 Area P: western end, semi-circular rock-cut wall.

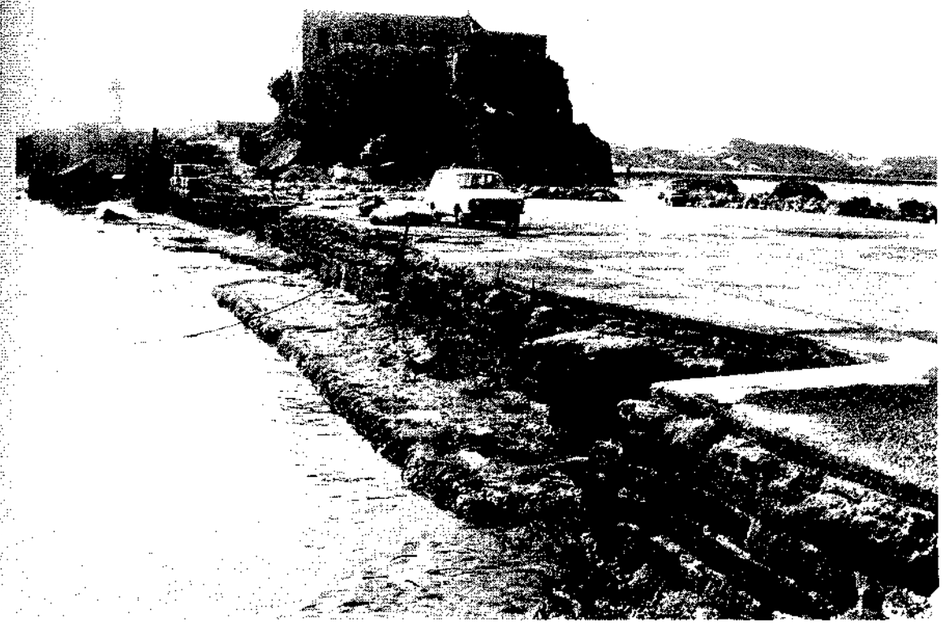
III.155 Area Q: sluice and sluice gates, view.



III.156 Area Q: sluice and sluice gates, plan.

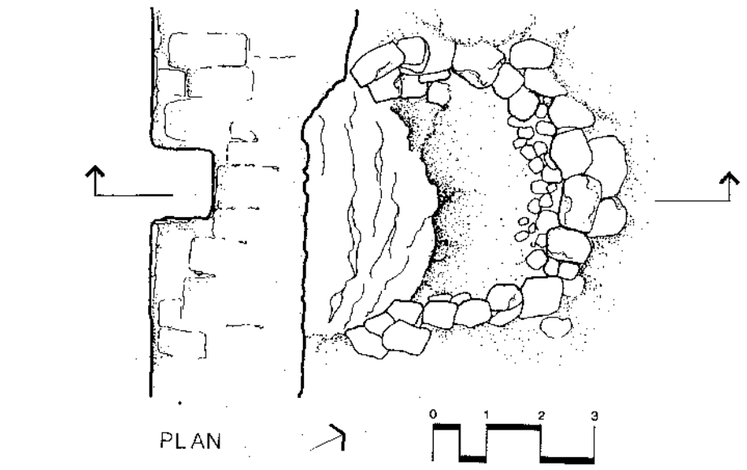


III.157 Area Q: sluice and sluice gates, section A-A.



III.158 Area Q: north face of modern south breakwater, from west.

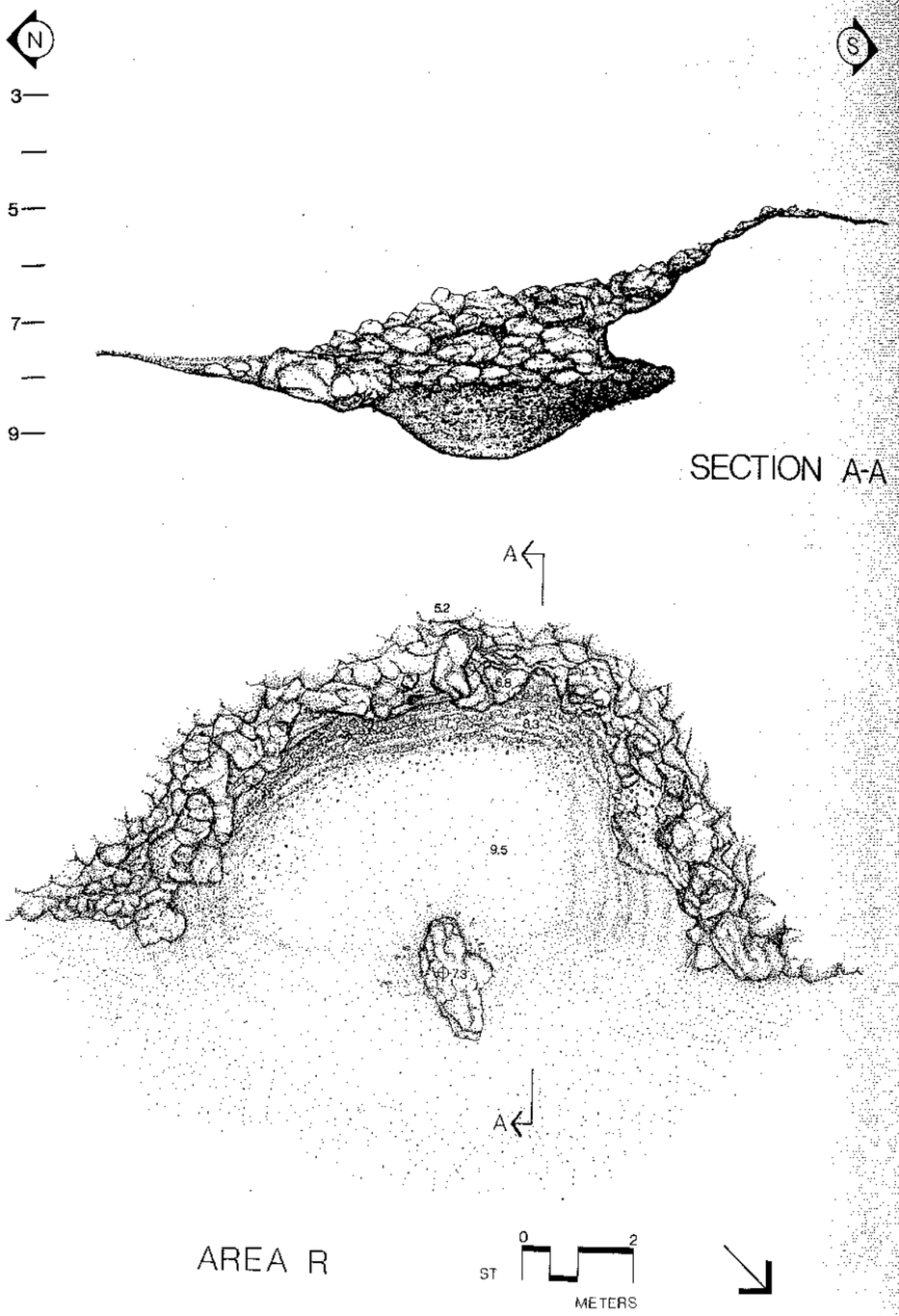
III.159 Area Q: ashlar quay wall, detail from east. Arrows indicate visible joints.



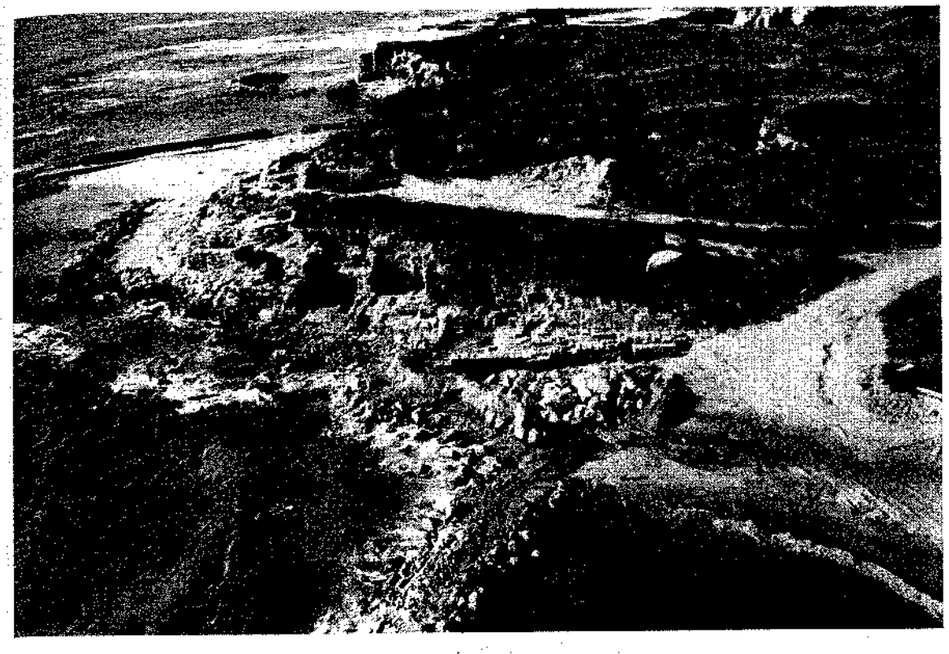
III.160 Area Q: ashlar quay wall, plan and section of probe.

III.161 Area Q: ashlar blocks near sluice.

III.162 Area R: mixed sand and shell fill.

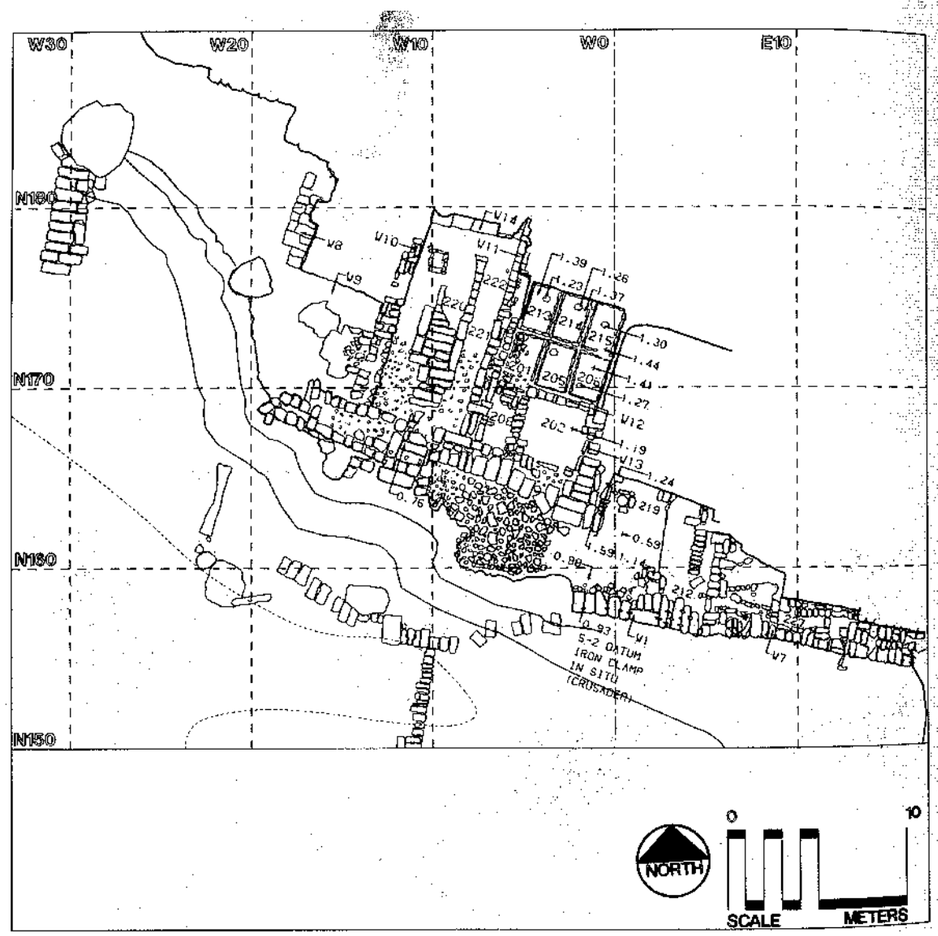


III.163 Area R: plan and section.



III.164 Area S (later S_2): oblique aerial from south.

III.165 Area S (later S_2): oblique aerial from south, detail.


W30
W20
W10
W0
E10
N190
N170
N150
V8
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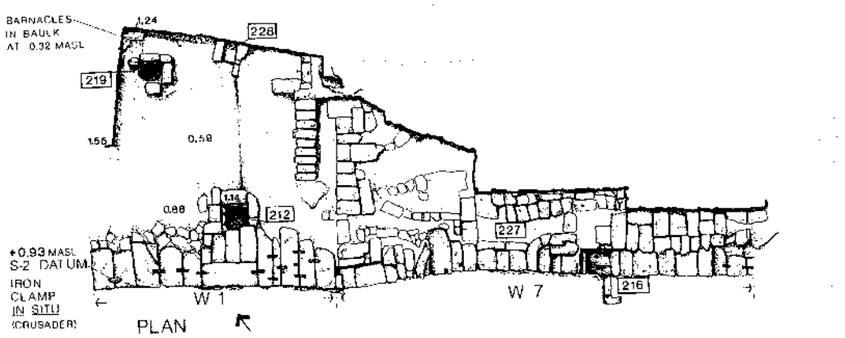
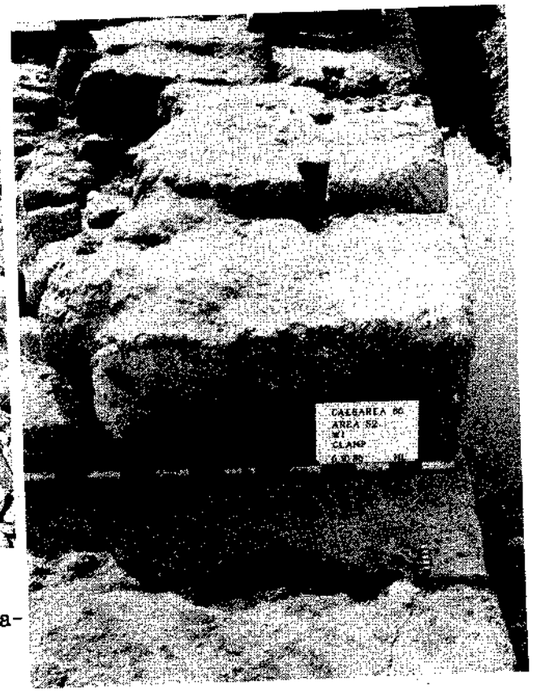
III.169 Area S_2: sea-level platform, from north.

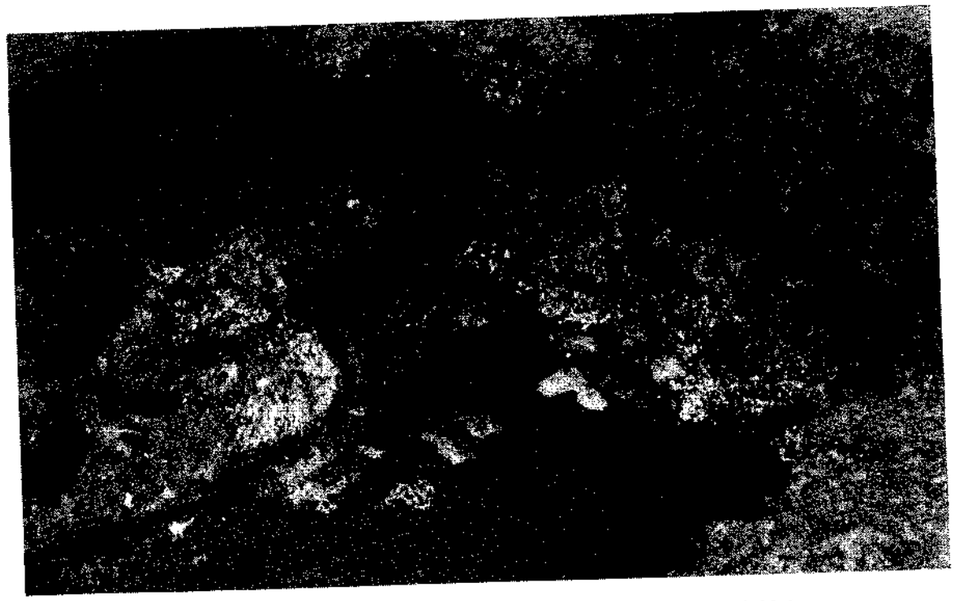


III.170 Area S_2 (east): plan and south elevation.

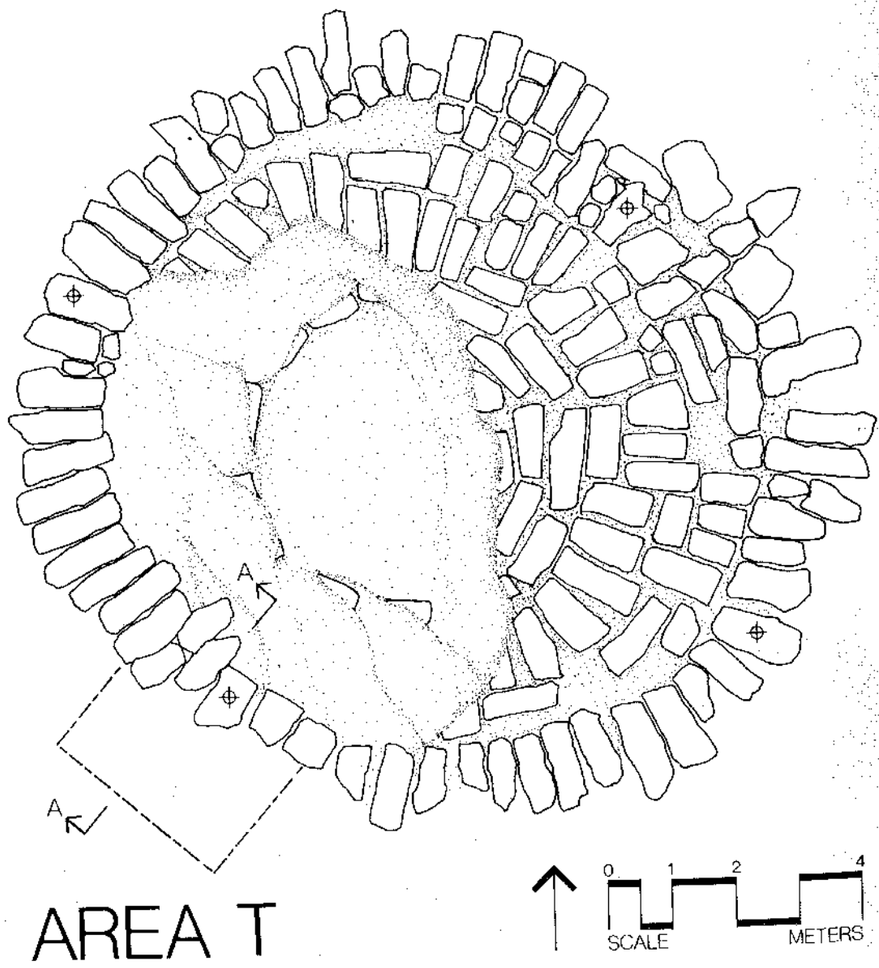
III.171 Area S_2 (east): W 1 before excavation, from east.



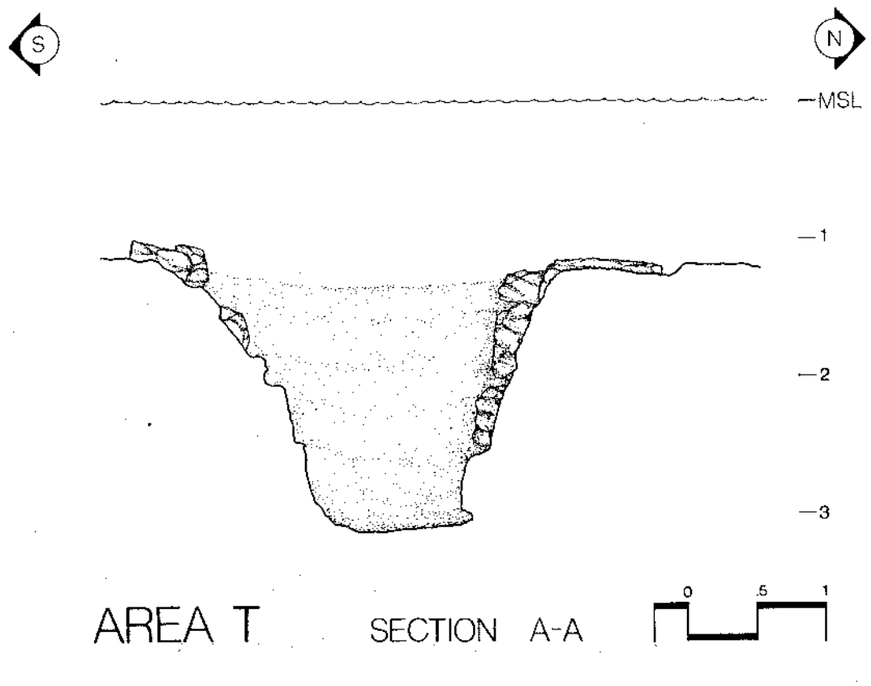
III.172 Area S_2 (east): W 1 after excavation, from west.



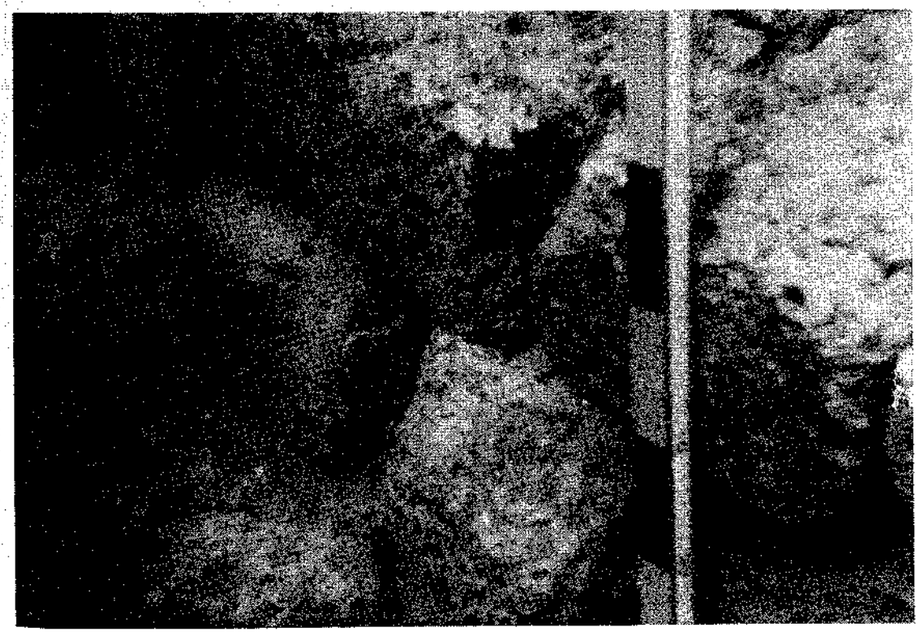
III.173 Area S_2 (east): sounding along south face of W 1.



III.174 Area T_1: Round Tower, plan.

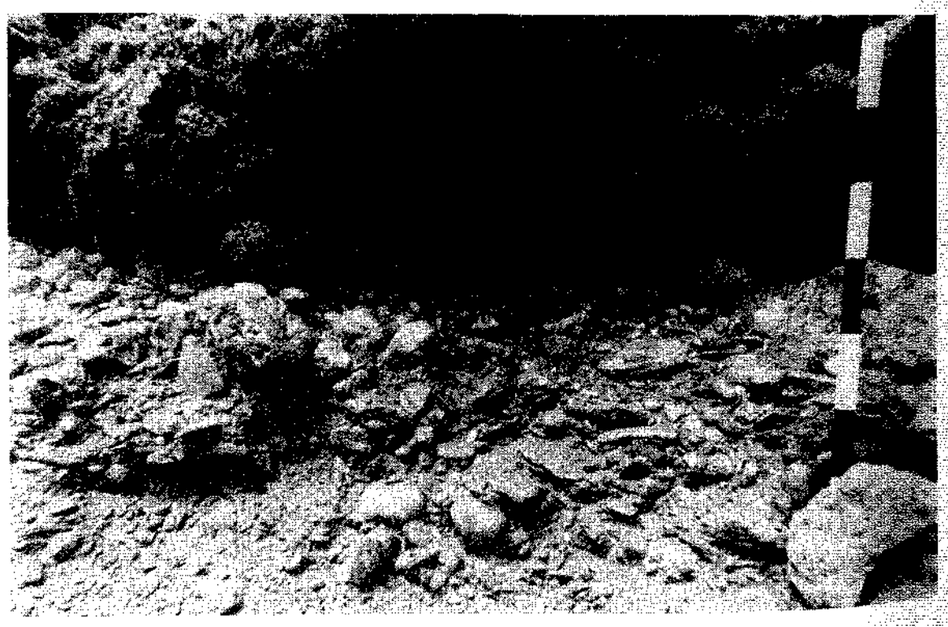


III.175 Area T_1: Round Tower, section A-A across probe.

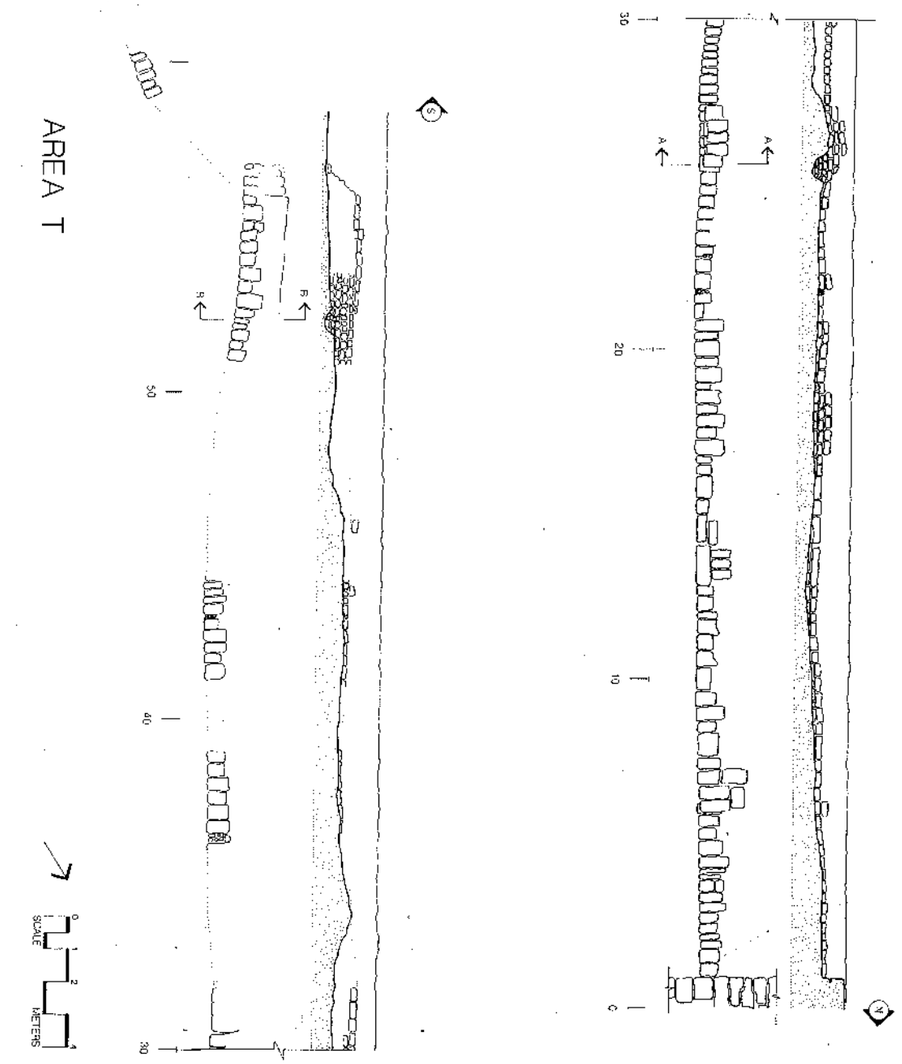


III.176 Area T_1: probe down outer face of tower.

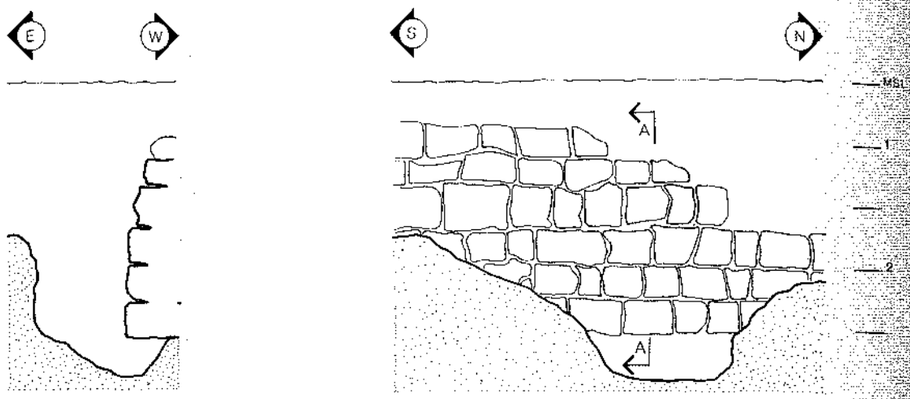
III.177 Area T_1: outer course of headers, view.

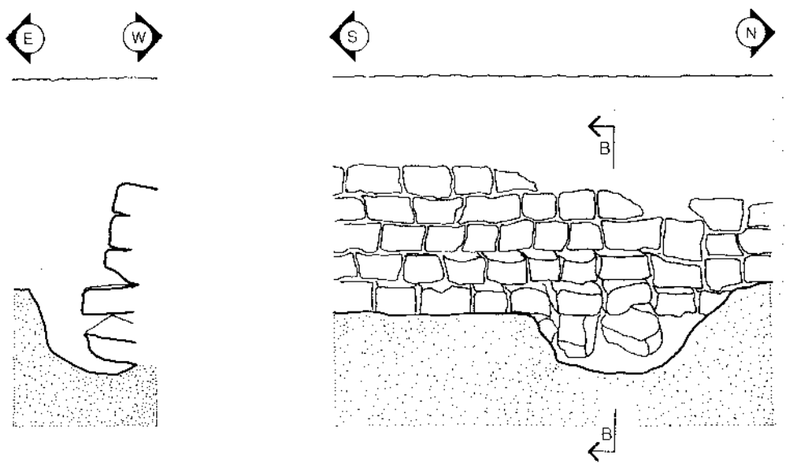


III.178 Area T_1: broken kurkar below foundation.



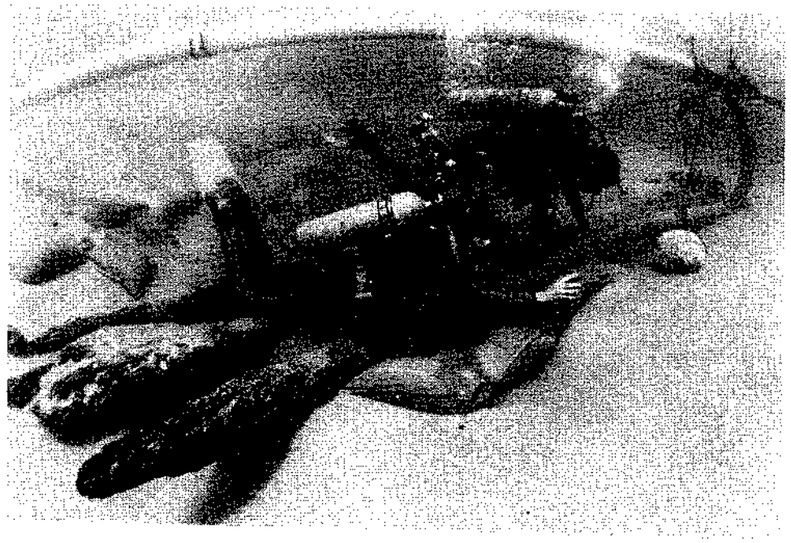
III.179 Area T_2: plan and elevation of wall.



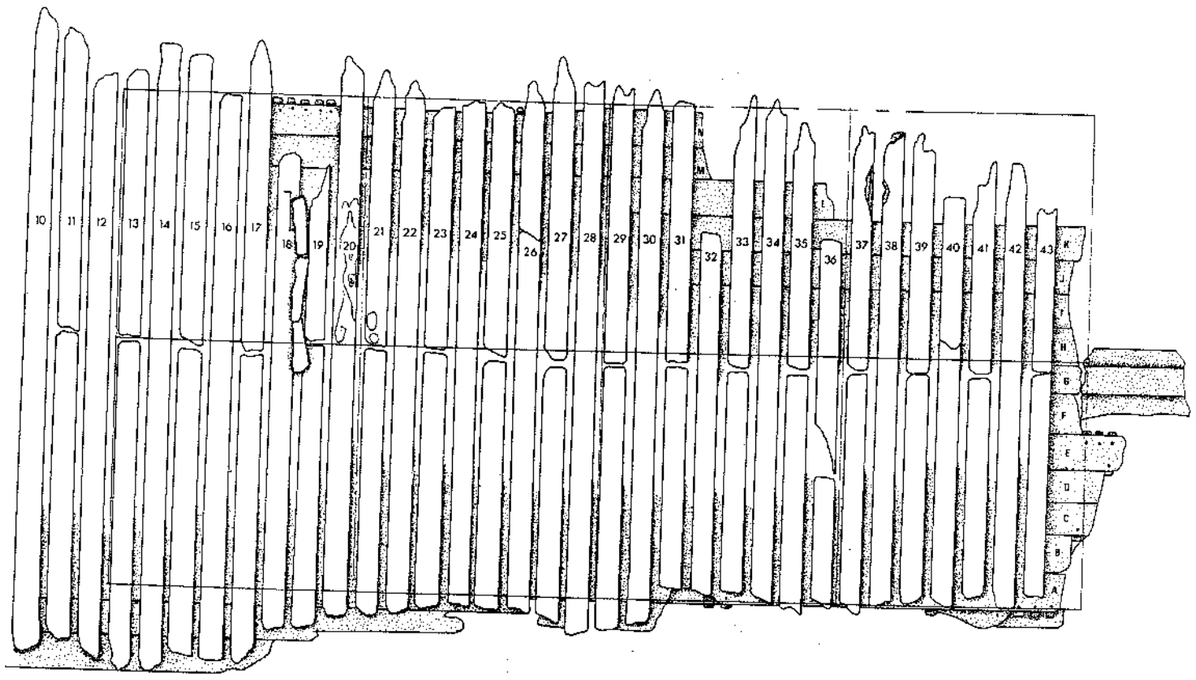


III.180 Area T_2: elevation and sections at metres 26 and 52.

III.181 Area T_2: view of wall from NW.



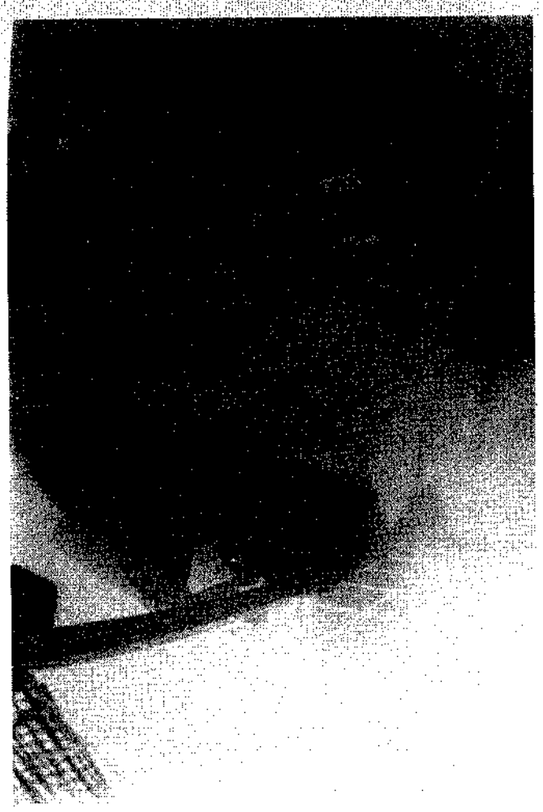
III.182 Area Y: excavation of ship with dredge.

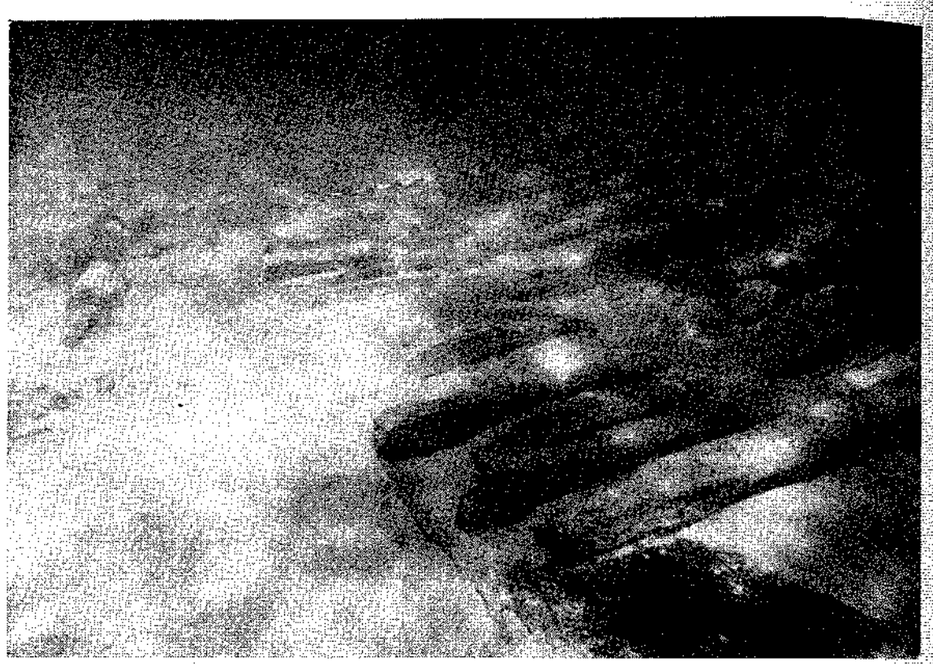


III.185 Area Y: schematic plan.

III.183 Area Y: survey of ship with metal detector.

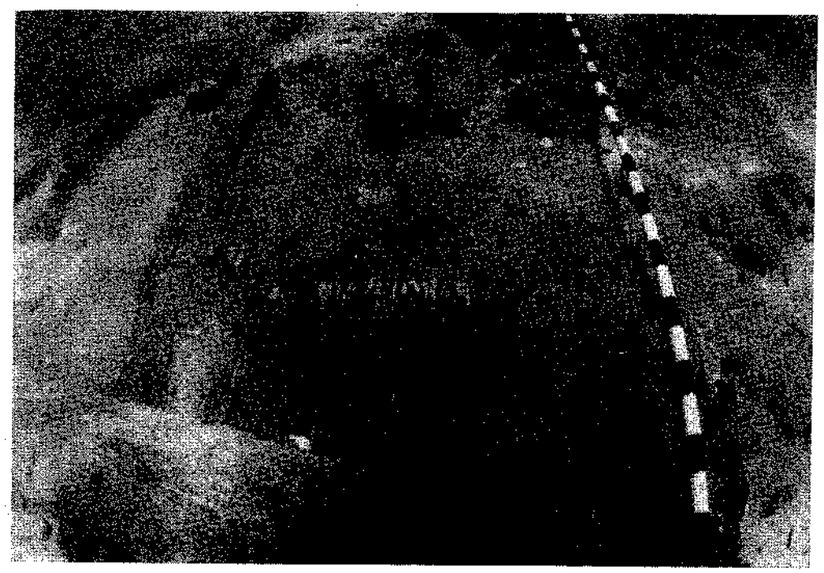
III.184 Area Y: excavation of ship beneath recording grid.



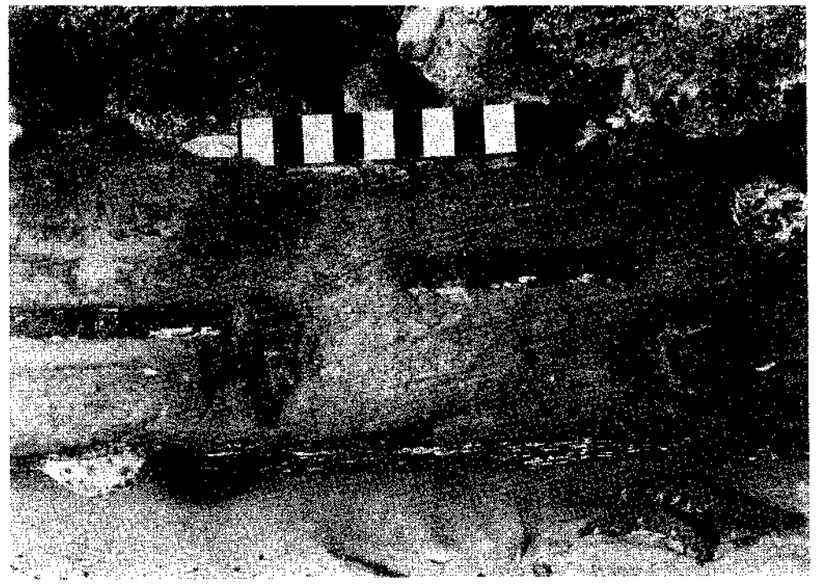


III.186 Area Y: frames and hull exposed.

III.187 Area Y: frames, planking, and fill below.

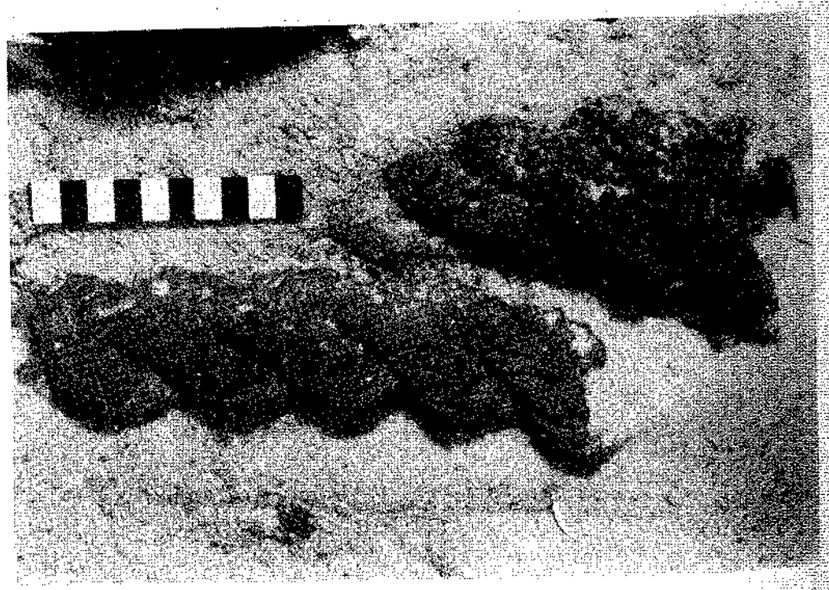


III.188 Area Y: planking, detail from above.



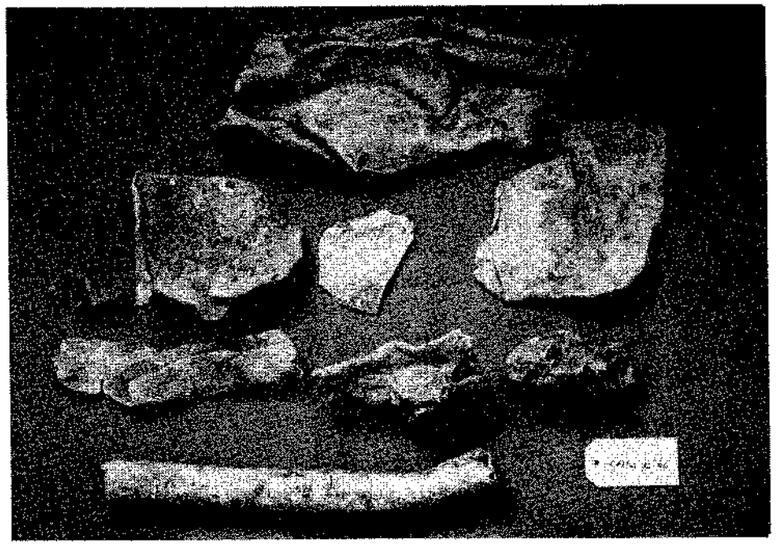
III.189 Area Y: plank edge with mortices.

III.190 Area Y: graffito on frame.

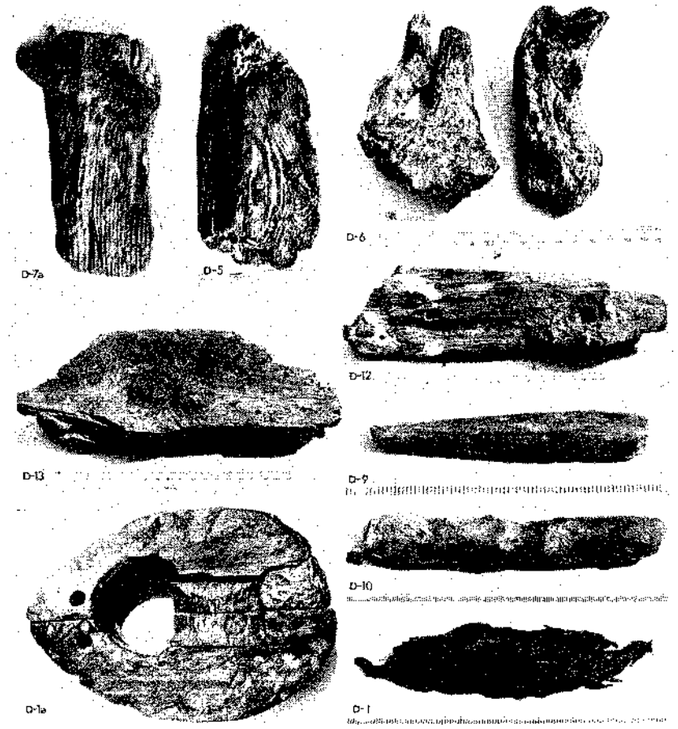


III.191 Area Y: fragment of rope.

III.192 Area Y: remains of bolt through hull.

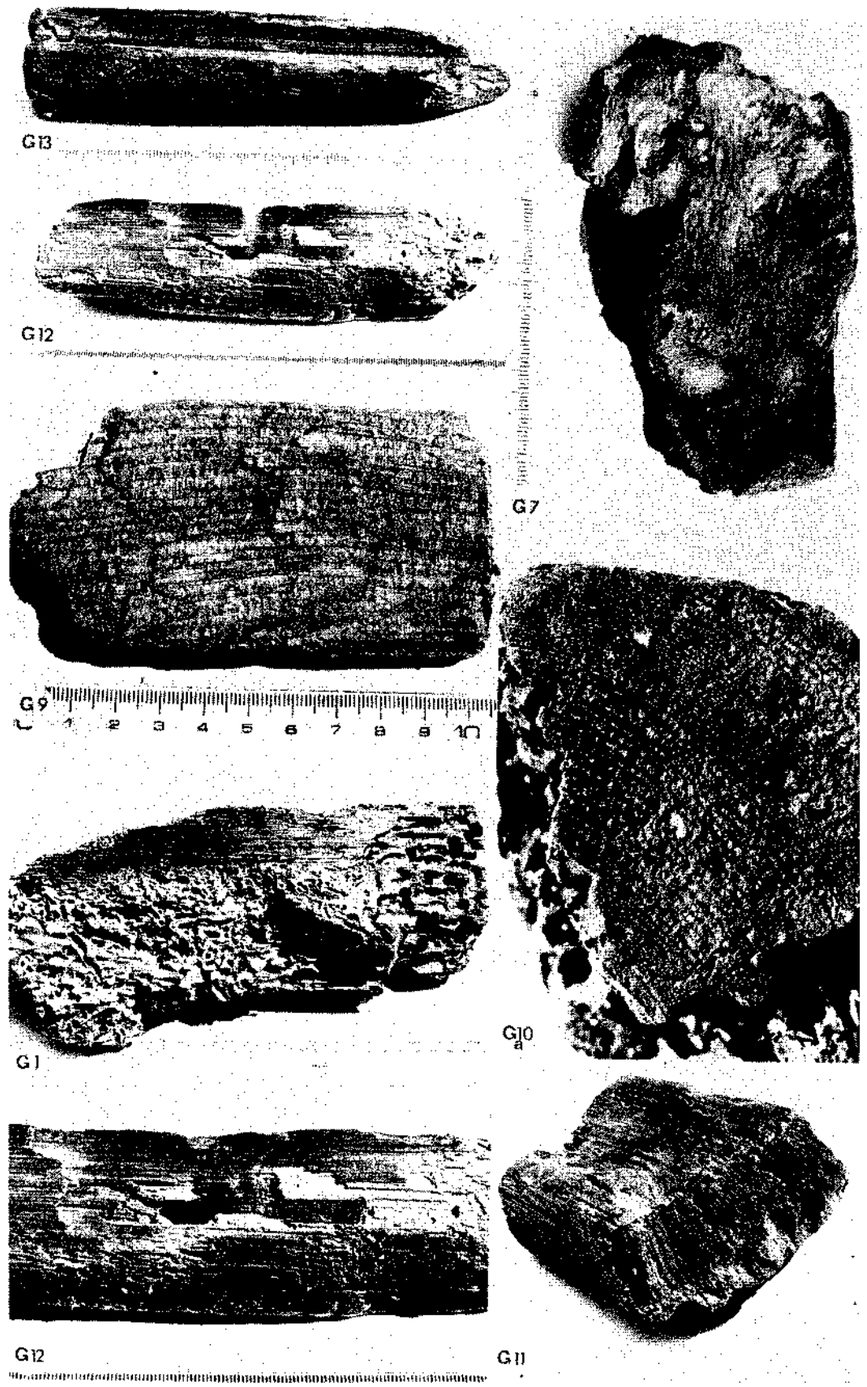


III.193 Area Y: fragments of lead sheeting and pipe.

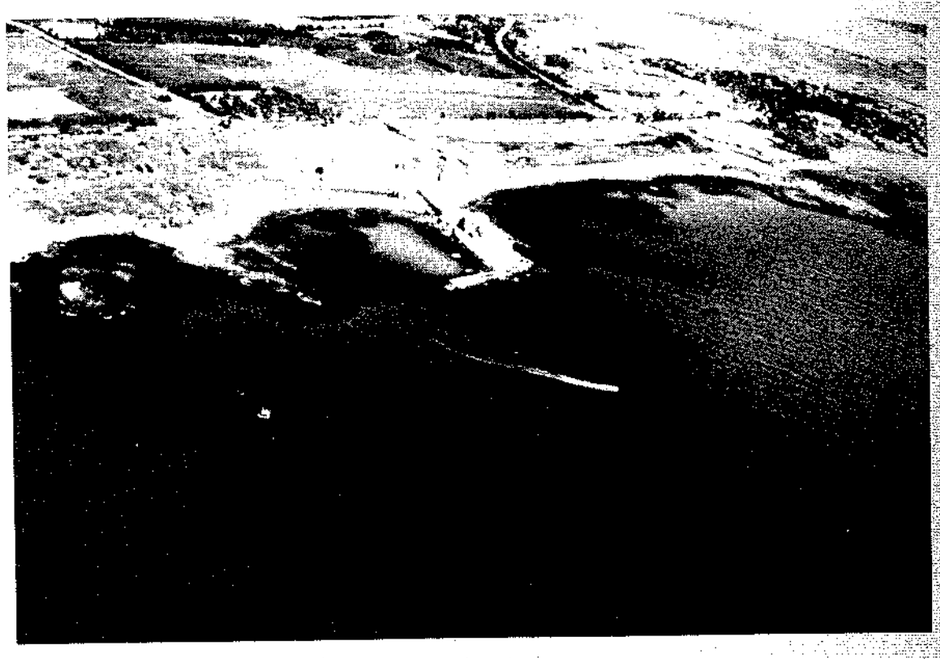


III.194 Wood fragments from Area D.

III.195 Section of north sleeper beam from formwork in Area G.

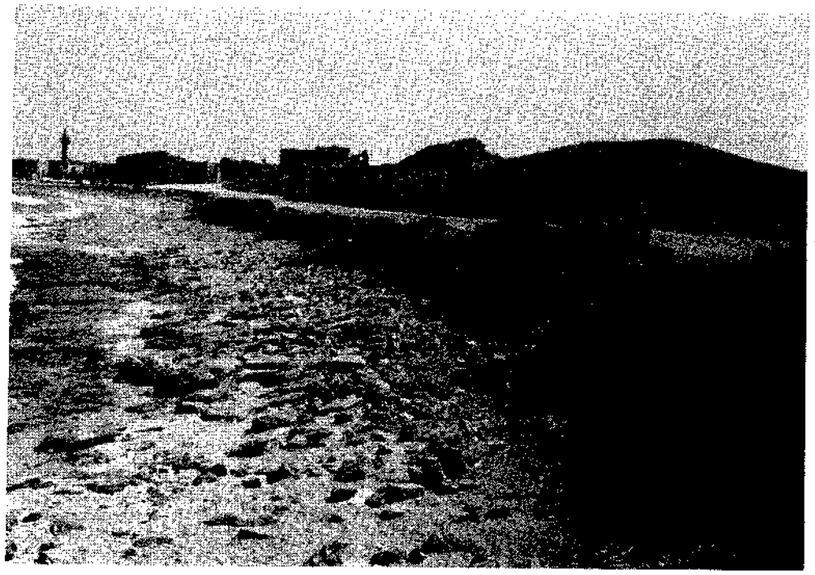


III.196 Wood fragments from Area G.



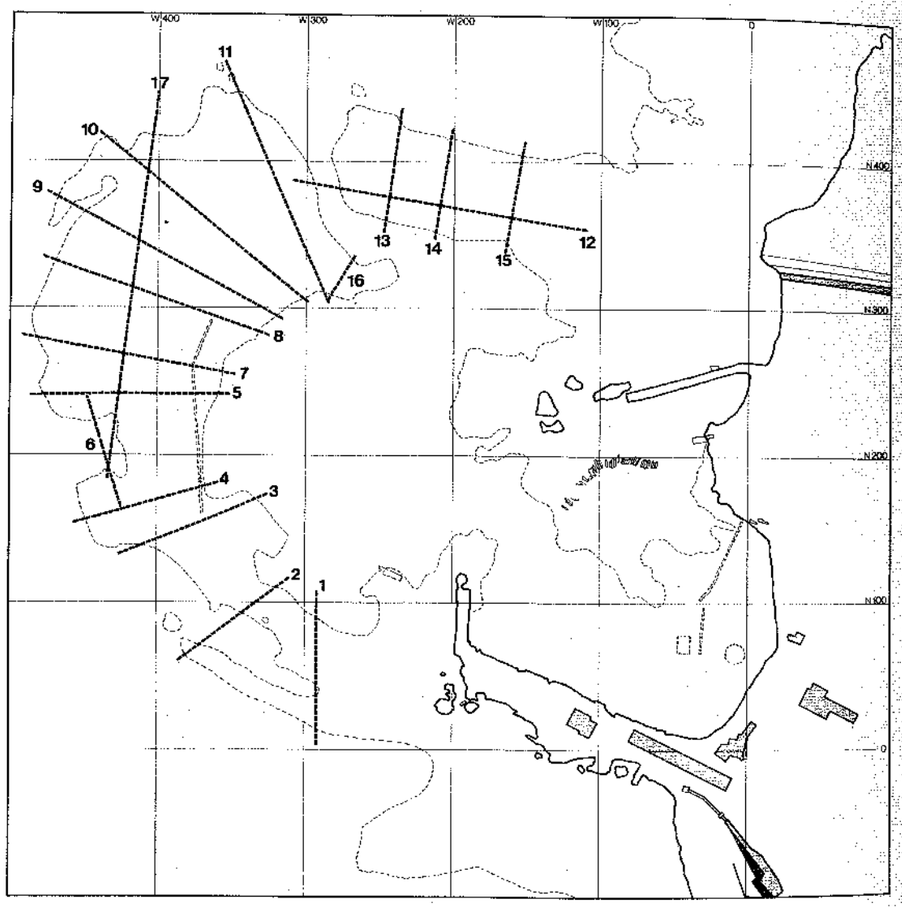
IV.1 Harbour and South Bay: oblique aerial from NW.

IV.2 South Bay: view from Citadel.

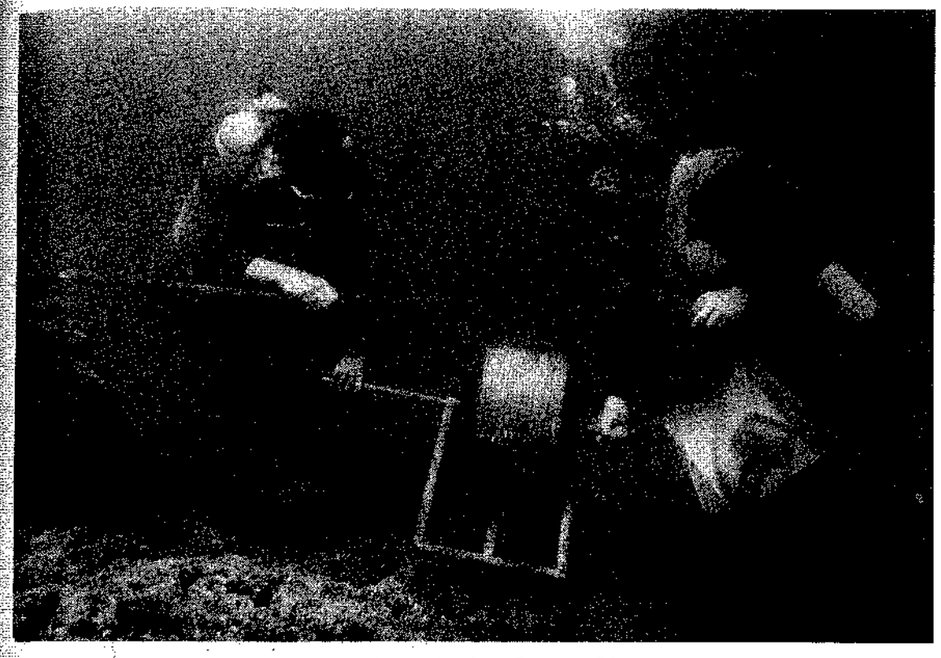


IV.3 South Bay: beach-rock along southeast section of beach, from south.

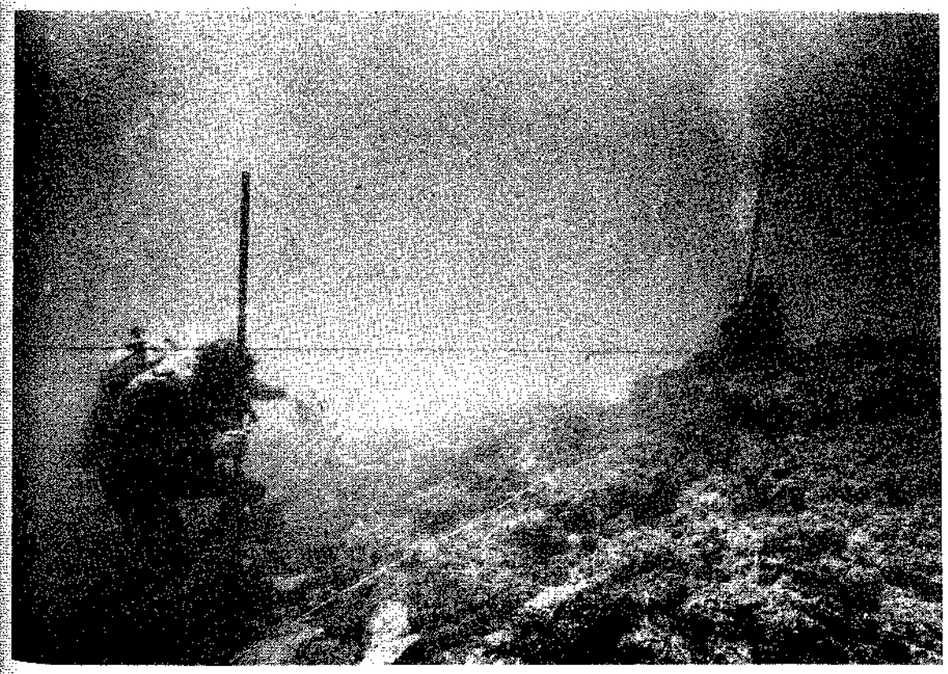
IV.4 Typical example of breakwater surface (near Area D_3).



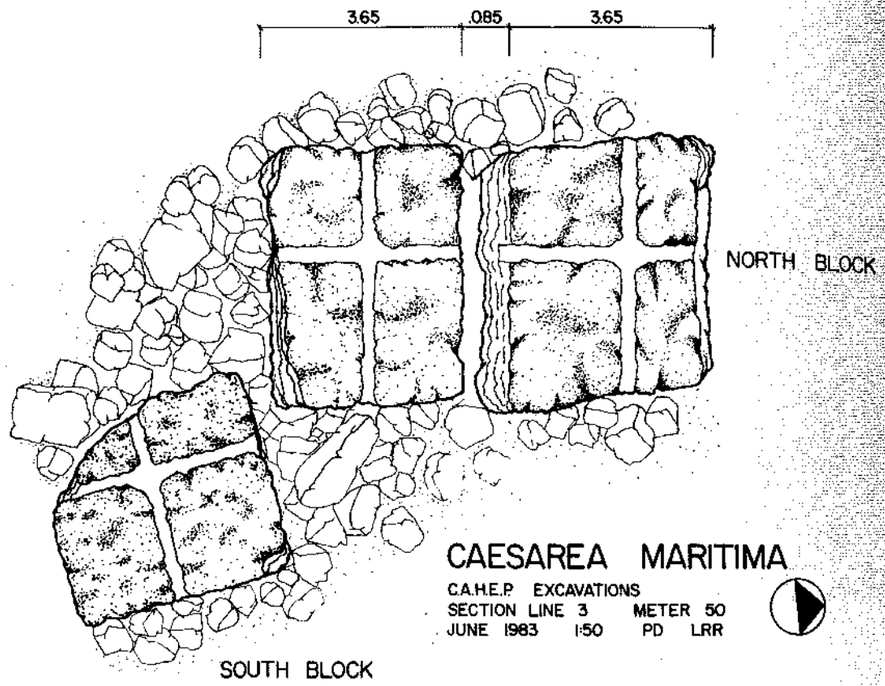
IV.5 Survey Lines: plan.



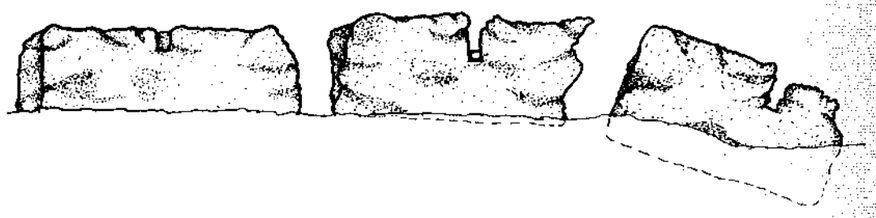
IV.6 Divers laying Survey Line.



IV.7 Divers recording elevations along Survey Line.

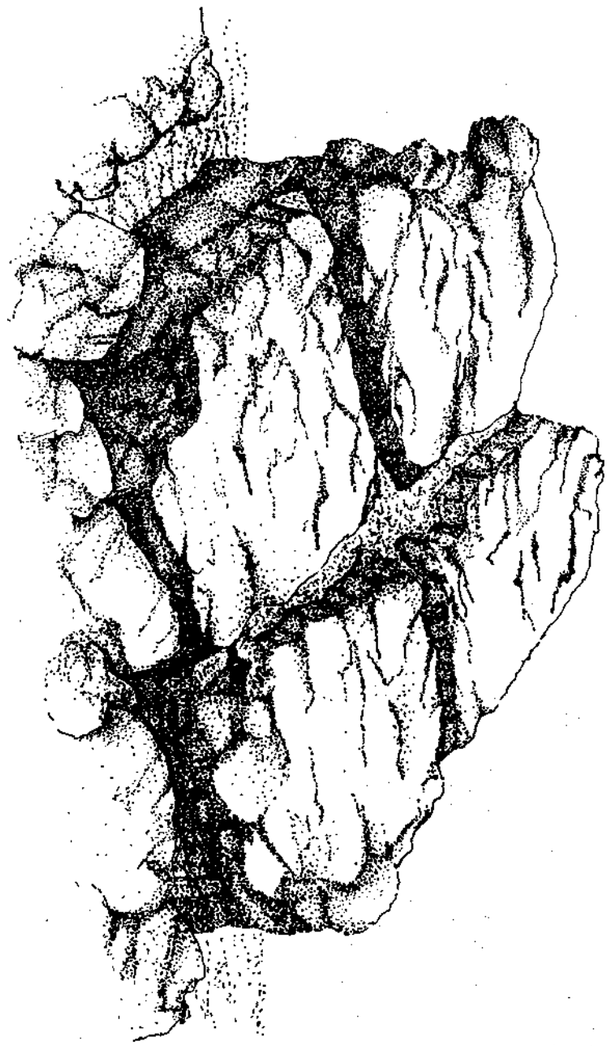


IV.8 Concrete blocks on SL no. 3 (m 50), plan.



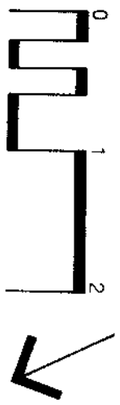
IV.9 Concrete blocks on SL no. 3 (m 50), east elevation.

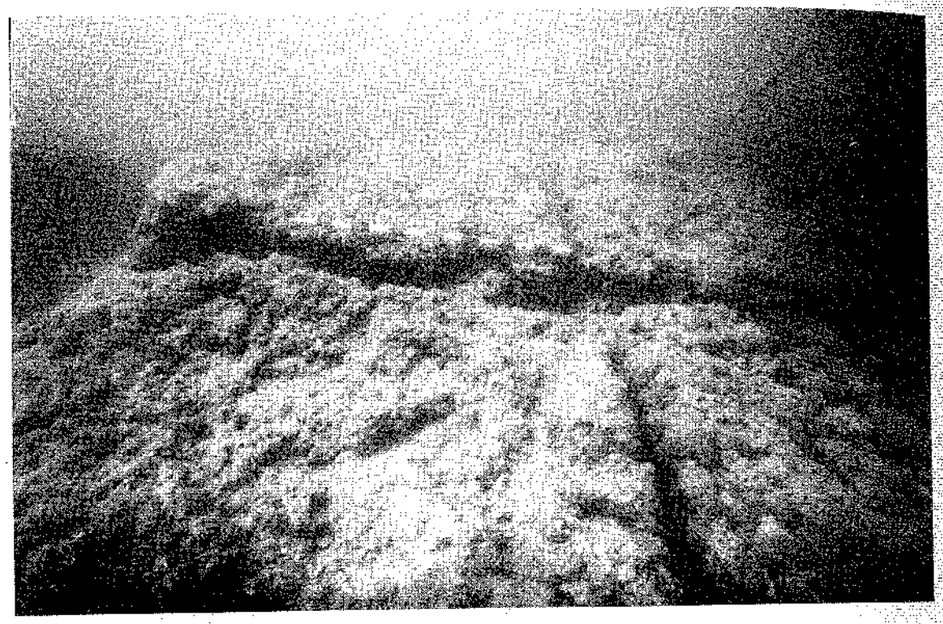
CONCRETE BLOCK



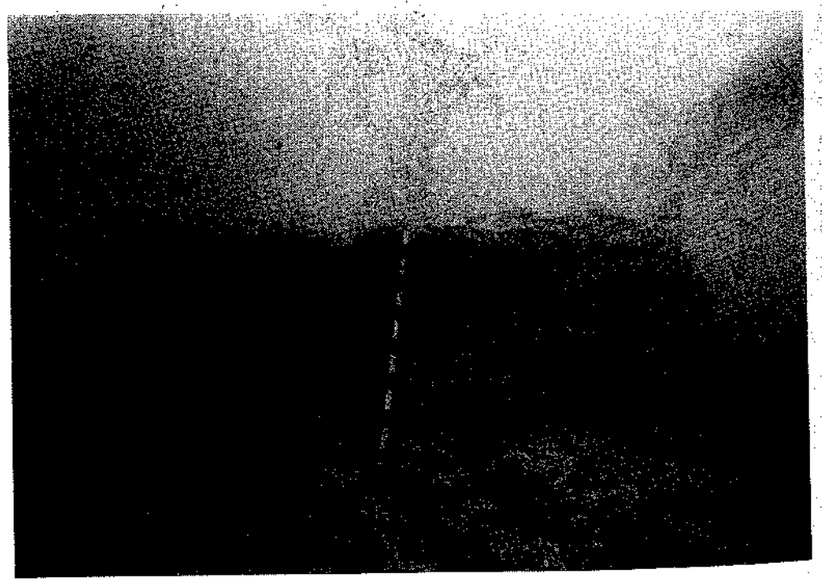
IV.10 Concrete block on SL no. 3 (m 50), actual state drawing.

ST



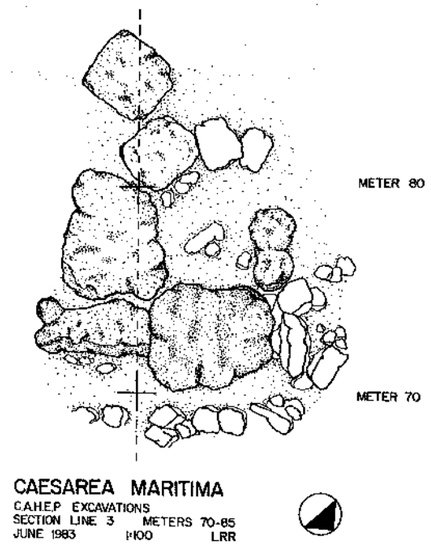


IV.11 Concrete block on SL no. 3 (m 50), view from above.



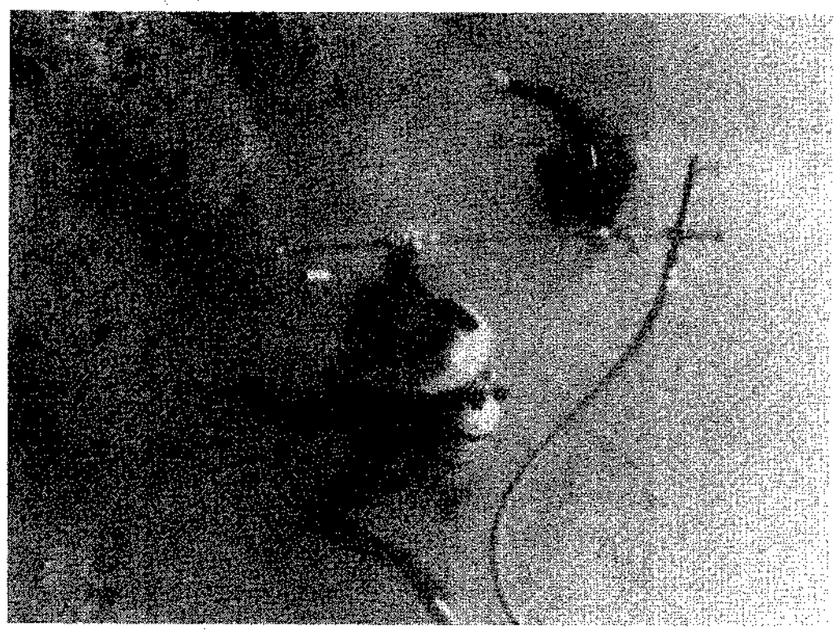
IV.12 Concrete block on SL no. 3 (m 50), view from side.

IV.13 Concrete block on SL no. 3 (m 50), detail of tie beam notch.



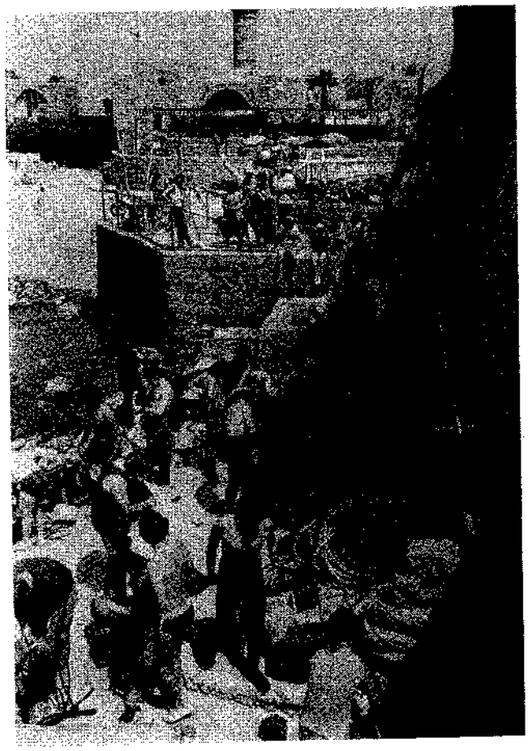
IV.14 Concrete block on SL no. 3 (m 70–85), plan.

IV.15 Platform at sea level, south of Piscina.

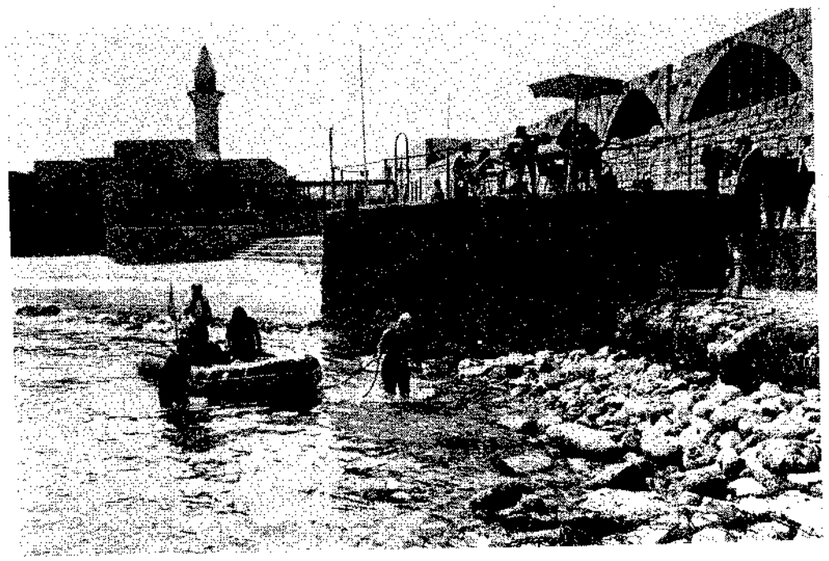


IV.16 Divers using water jet-probe.

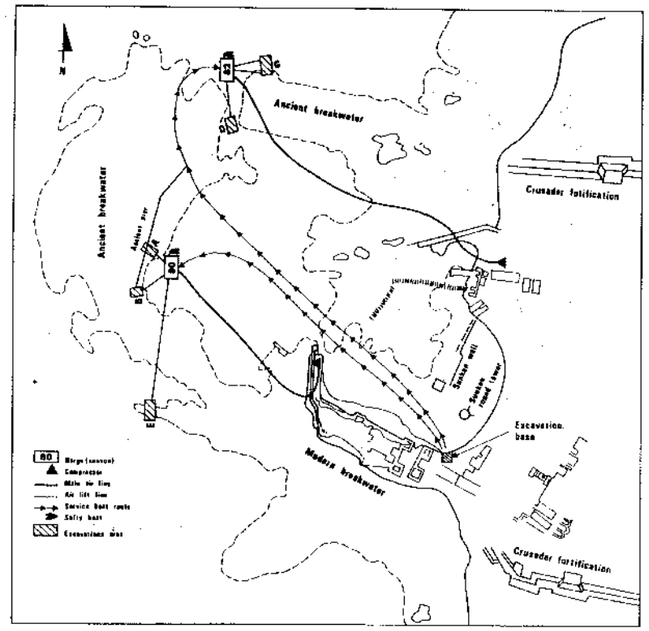
IV.17 Divers using portable air jet-probe.



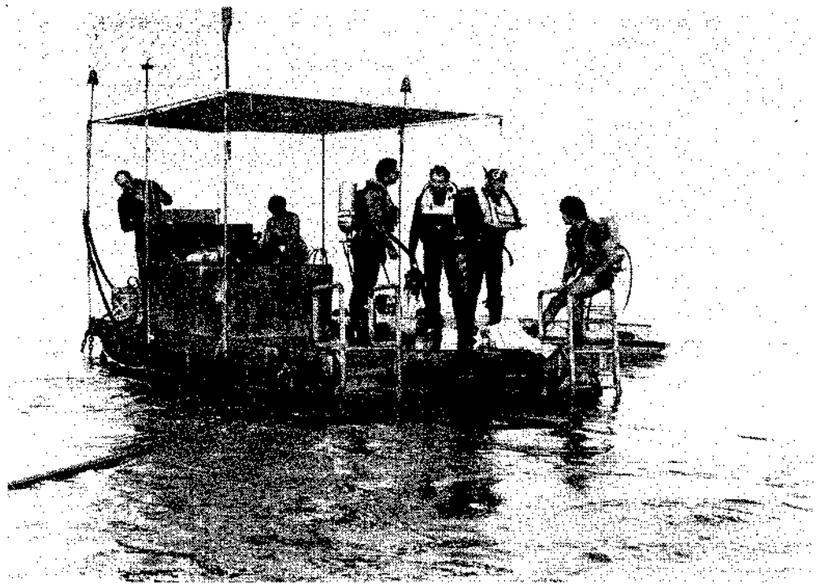
V.1 Diving headquarters, from west.



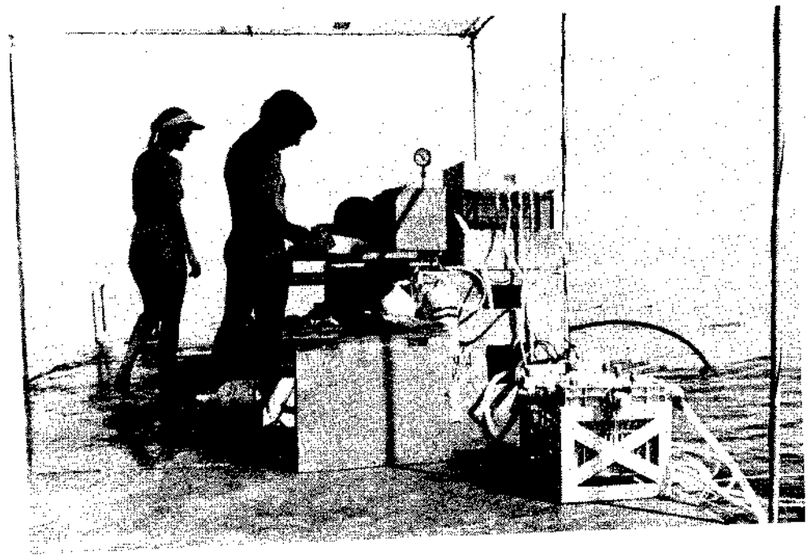
V.2 Diving headquarters and docking area, from NW.



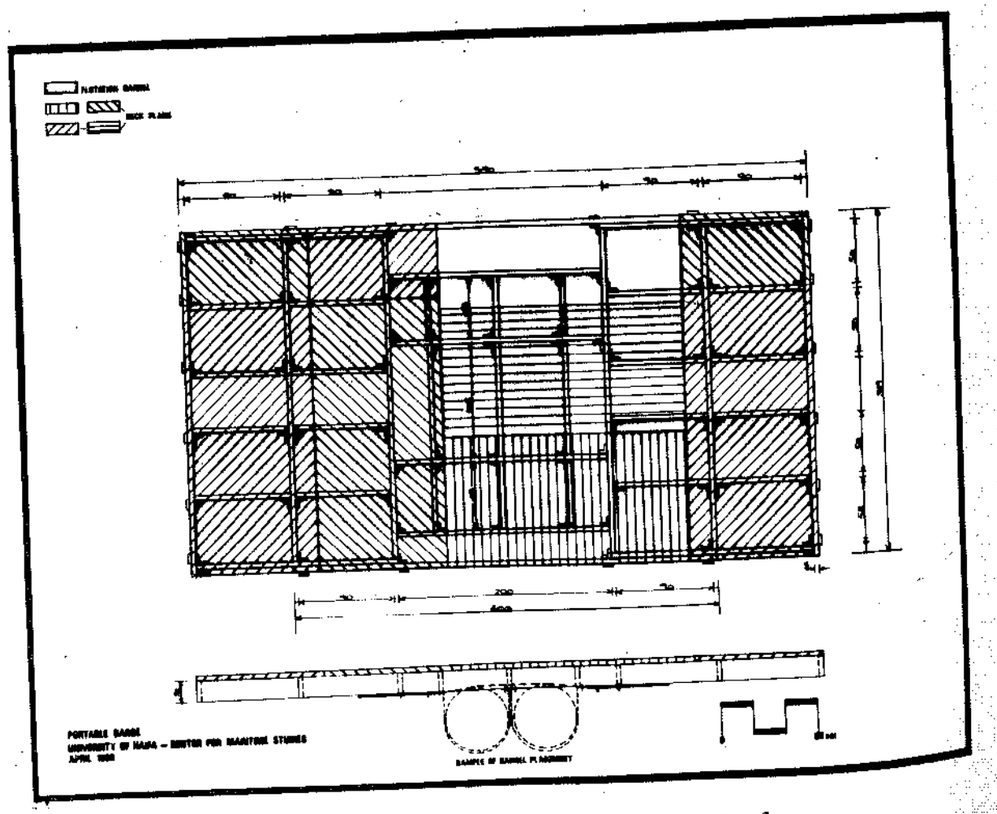
V.3 Diagram of staging barges, excavation areas, air supply, and boat traffic routes [S.B.].



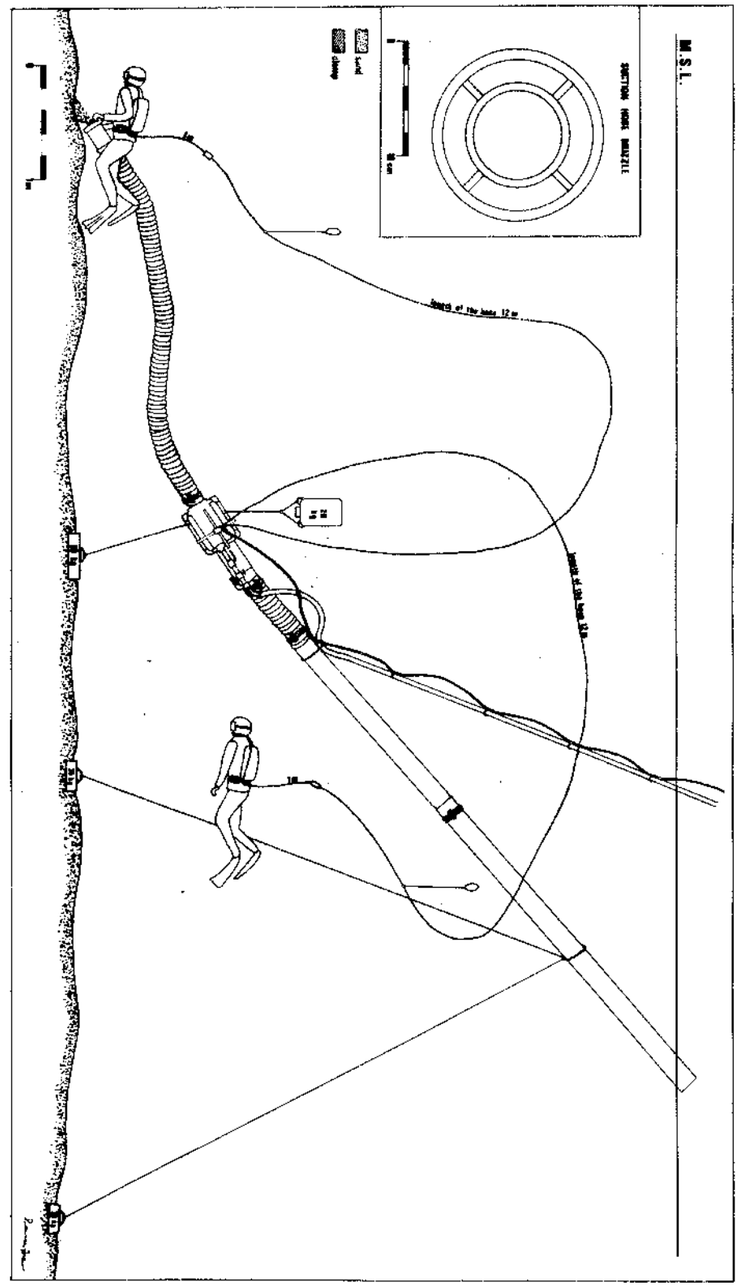
V.4 Staging barge anchored near excavation areas.



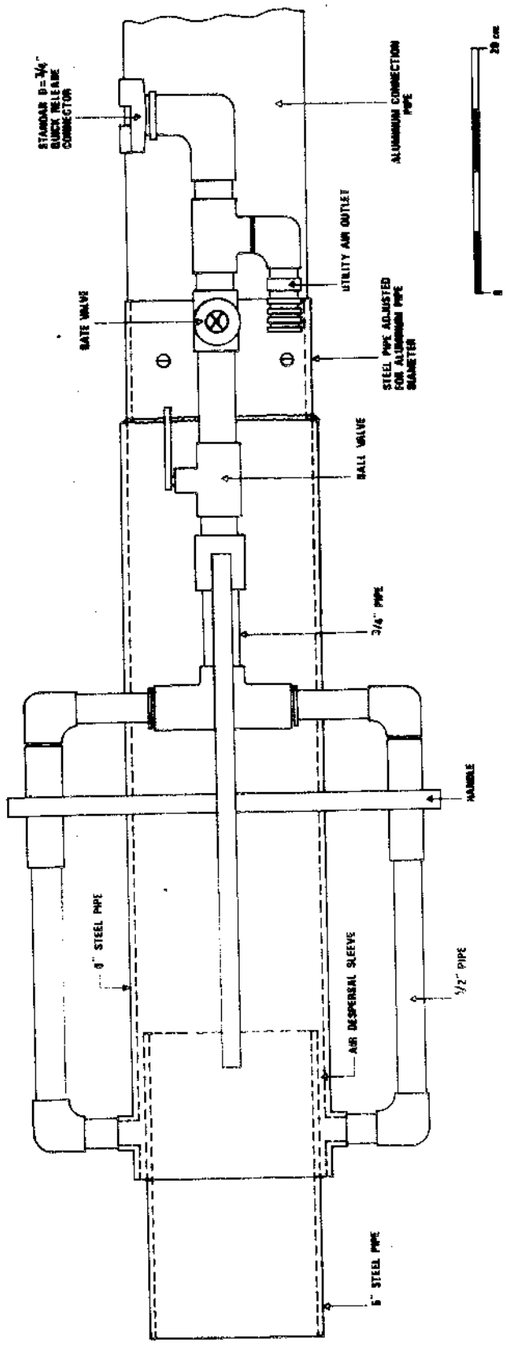
V.5 Air control station on staging barge.



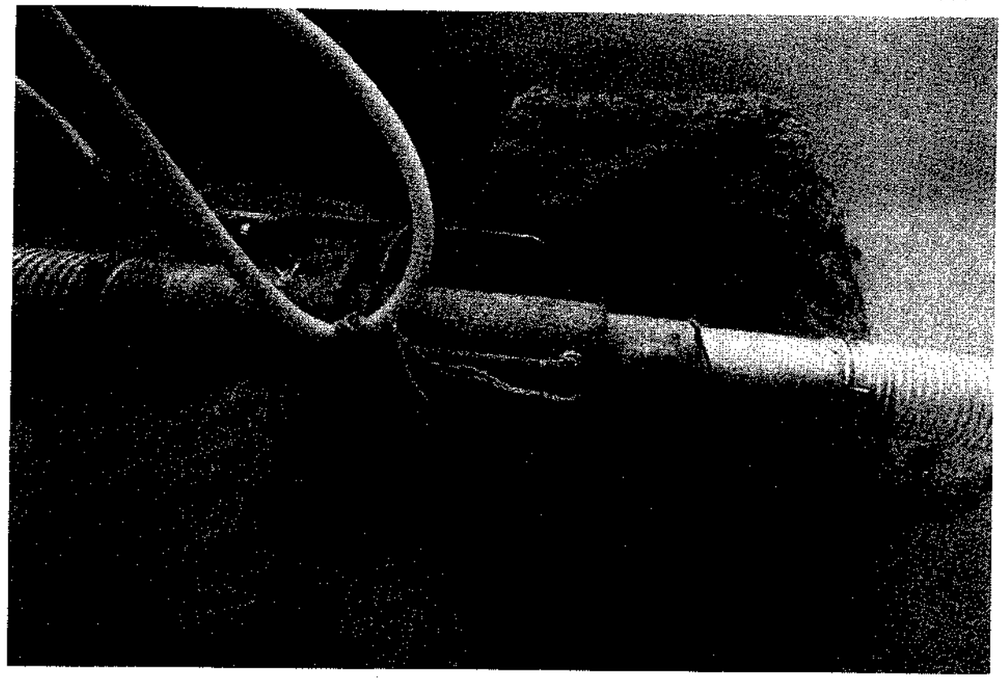
V.6 Portable barge, framing diagram [S.B.].



V.7 Diagram of airlift and associated hookah system in use [S.B.].



V.8 Diagram of airlift yoke [S.B.].

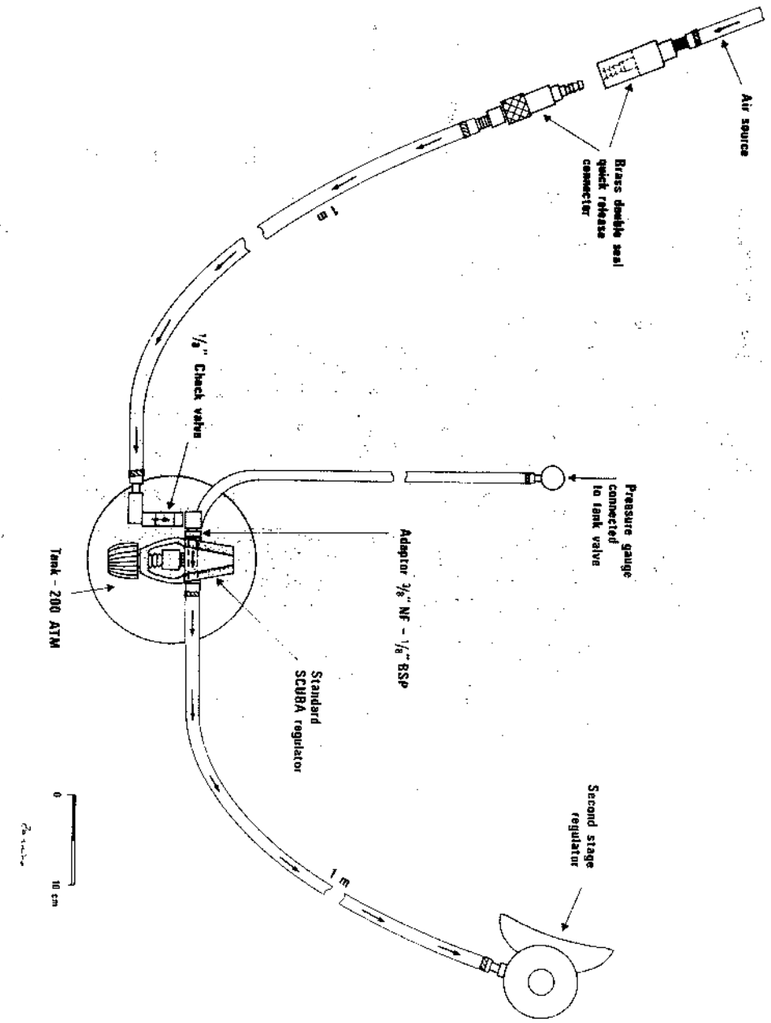


V.9 View of airlift yoke at excavation area.

V.10 Divers using airlift with flexible nozzle, at Area G.

V.11 Divers using combined hookah system and airlift.

V.12 Divers using airlift with flexible nozzle. Note muzzle designed to prevent clogging.

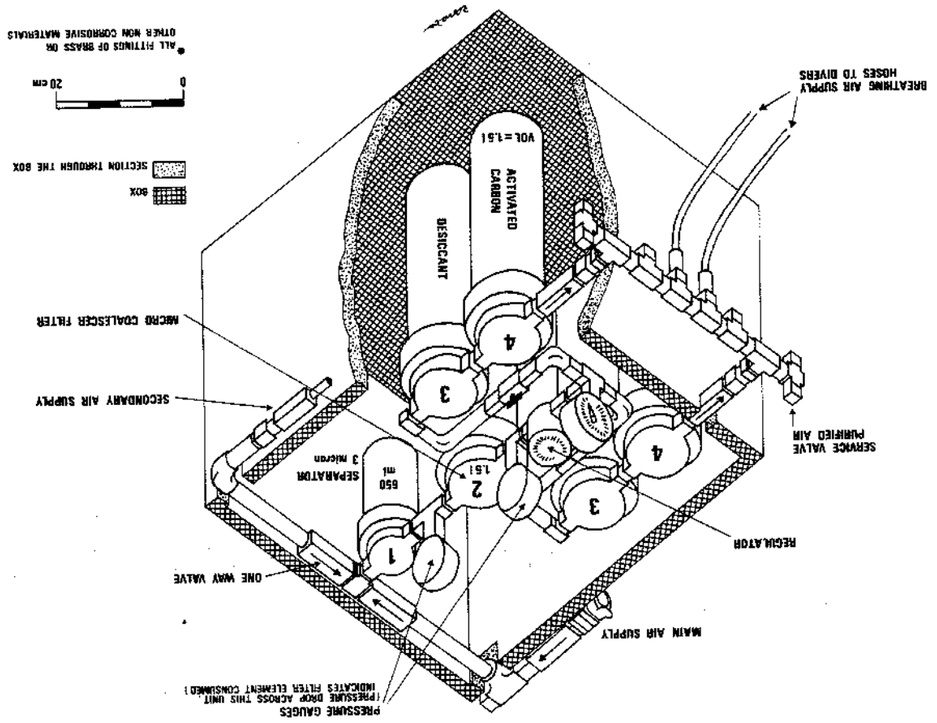


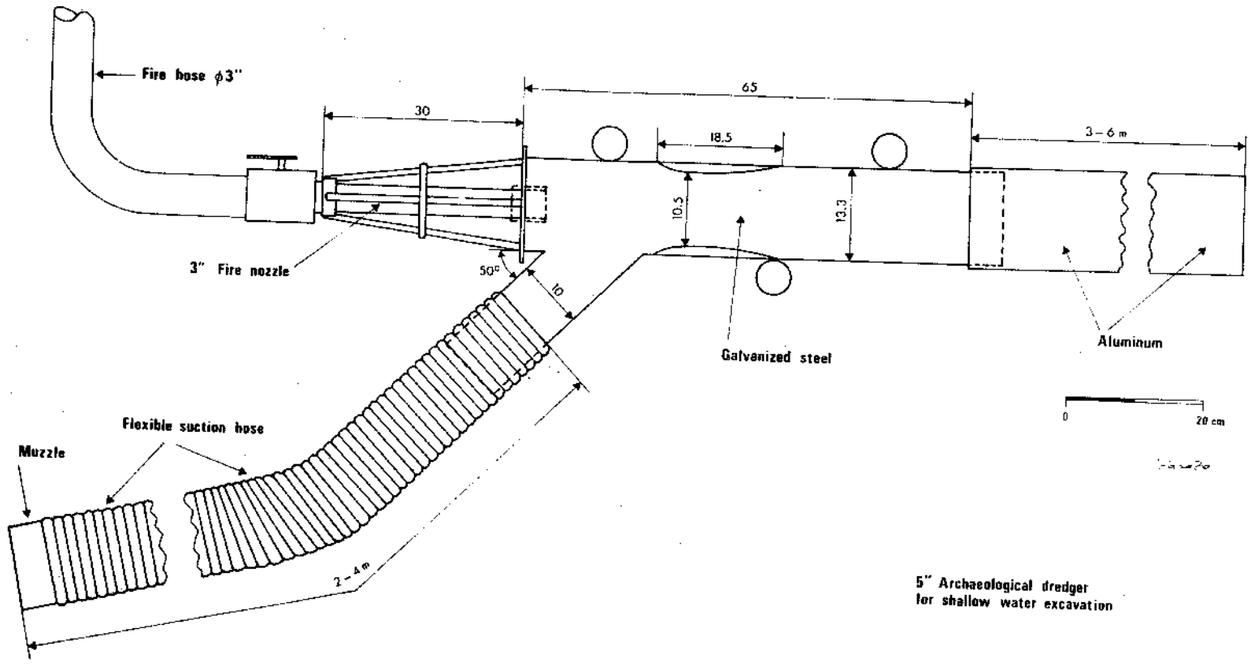
V.13 Diagram of hookah regulator design [S.B.].

V.15 Diver fitting hookah breather hose connection.

V.16 Dredge and pump loaded on boat for transport.

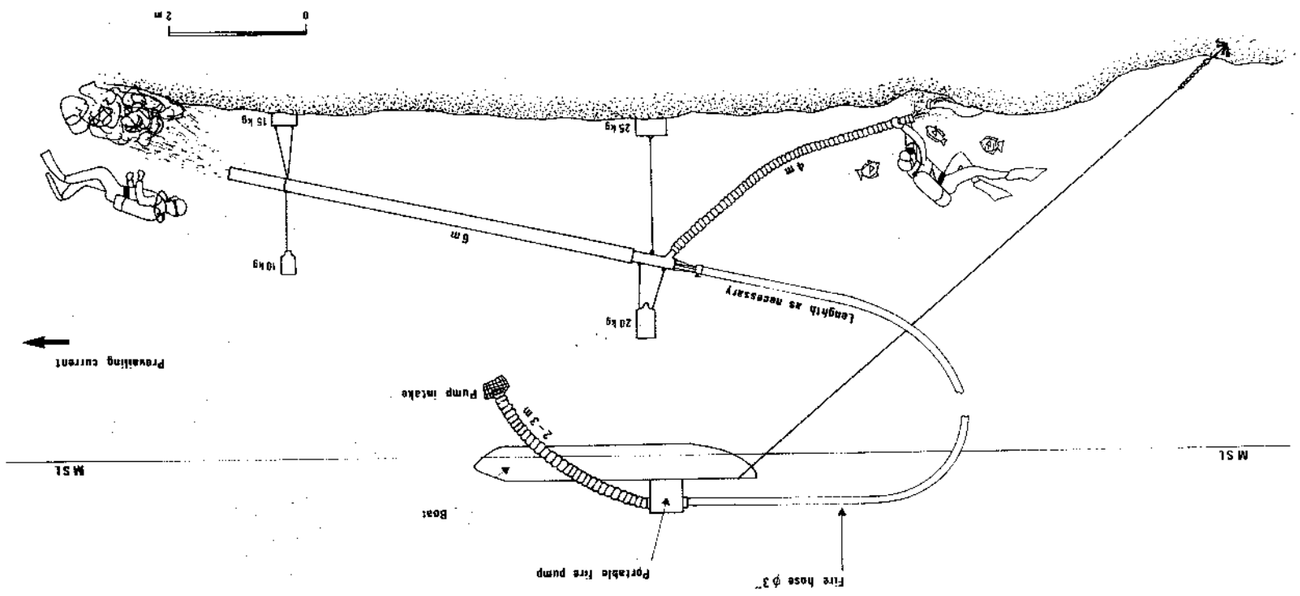
V.14 Diagram of air-supply filtration system [S.B.].





V.18 Diagram of dredge yoke [S.B.].

V.17 Diagram of dredge in use for excavation in shallow water [S.B.].



VI.1 Reconstruction of the Harbour of Caesarea [Robert Teringo. Courtesy of National Geographic Society].

V.19 CAHEP Shore Traffic Log form.

University of Haifa
CAESAREA ANCIENT HARBOR EXCAVATION PROJECT
Shore Traffic Log

Date ____ Page ____ Traffic Supervisor ____

	Name	ID	Time Off Shore	Time On Shore	Object Size	Means	Traffic Sup Signature
1							Off On
2							Off On
3							Off On
4							Off On
5							Off On
6							Off On
7							Off On
8							Off On
9							Off On
10							Off On
11							Off On
12							Off On
13							Off On
14							Off On
15							Off On
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							

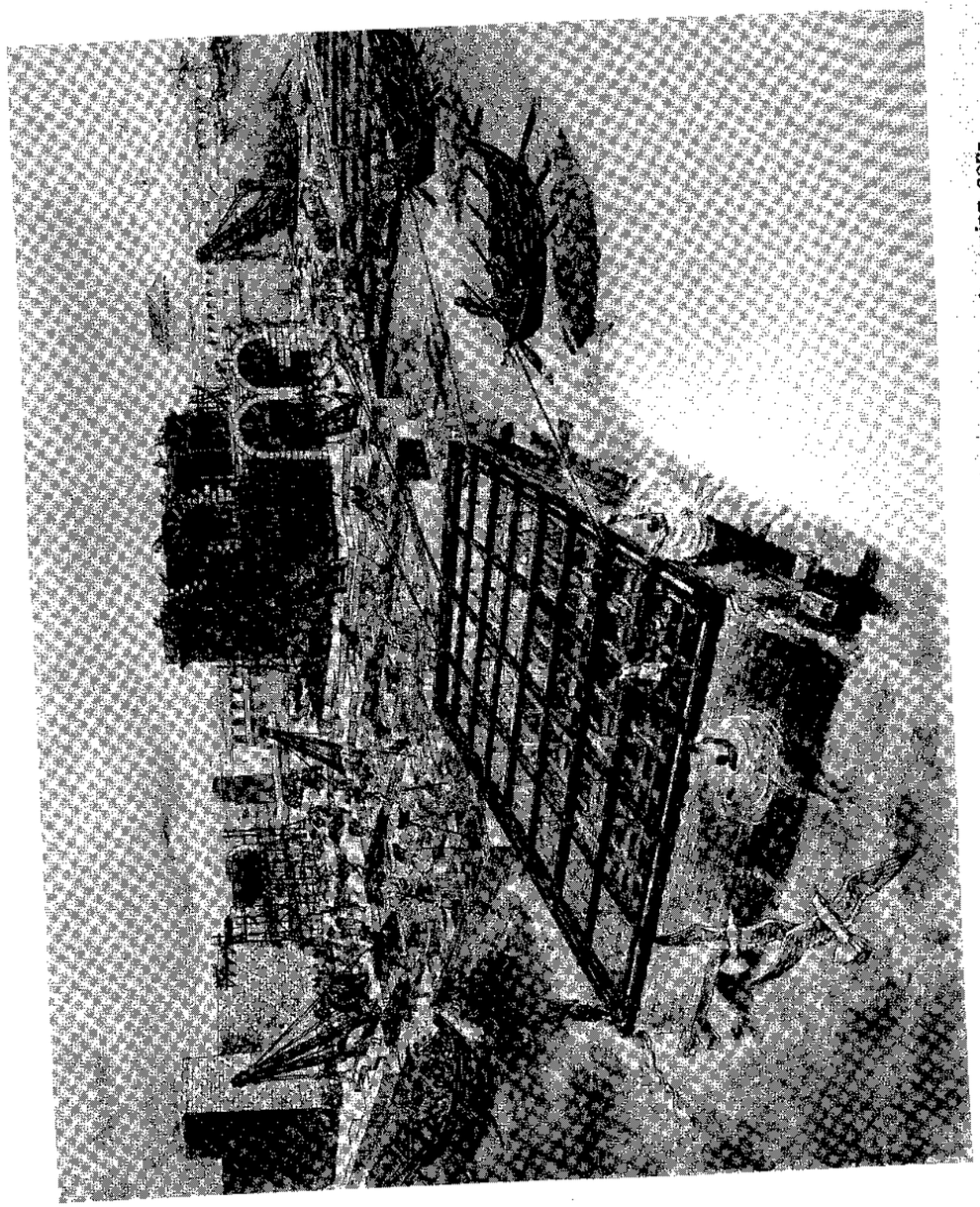
Boat Handler 1 ____ ____ Boat Handler 2 ____ ____ Board Handler 3 ____ ____
T111 T19 T111 T19 T111 T19

V.20 CAHEP Diving Supervisor's Log form.

University of Haifa
CAESAREA ANCIENT HARBOR EXCAVATION PROJECT
Diving Supervisors Log

Date ____ Page ____ Supervisors ____

	Dive Team	Size/ Depth	Objective -equipment	Time In	Time Out	Finds Sect.No.	Supervisor Signature In Out
1							In Out
2							In Out
3							In Out
4							In Out
5							In Out
6							In Out
7							In Out
8							In Out
9							In Out
10							In Out
11							In Out
12							In Out
13							In Out



VI.2 Reconstruction of the method of positioning formwork and pouring concrete in Area G [Robert Teringo. Courtesy of National Geographic Society].

Folding Plates.

I Master Urban Plan of Caesarea and immediate suburbs.

II Survey Lines 1-4: sectional elevation drawings (C = concrete, K = kurkar).

III Survey Lines 5-8: sectional elevation drawings (C = concrete, K = kurkar).

IV Survey Lines 9-12: sectional elevation drawings (C = concrete, K = kurkar).

V Survey Lines 13-17: sectional elevation drawings (C = concrete, K = kurkar).