UNDERWATER SURVEY AND EXCAVATION AT THE ANCIENT
PORT OF GRAVISCA, ITALY

A Thesis
by
ELIZABETH BOSTWICK SHUEY

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Approved as to style and content by:

Dr. George F. Bass
(Chairman of Committee)

Dr. Vaughn M. Bryant, Jr.
(Head of Department)

Mr. J. Richard Stetley
(Member)

Dr. Campbell W. Pennington
(Member)

May 1978
ABSTRACT

Underwater Survey and Excavation at the Ancient Port of Gravisca, Italy. (May 1978)

Elizabeth Bostwick Shuey, B.A., University of California, Berkeley

Chairman of Advisory Committee: Dr. George F. Bass

The first extensive survey and excavation of the underwater remains at the port of Gravisca, now called Porto Clementino, was conducted in the summer of 1977, yielding new information on the design and construction of the ancient breakwater. The possible location of the ancient port of Etruscan Tarquinia and the Roman colony of Gravisca, long disputed by scholars, was focused on this site as a result of recent land excavations and earlier reports of breakwater remains in the harbor. Land excavations in progress since 1969 have revealed traces of both the Roman colony of Gravisca and earlier Etruscan occupation from the 6th to 3rd centuries B.C., along with large quantities of imported Greek pottery, indicating that this was an important center for overseas commerce in the 6th and 5th centuries B.C. Declining in the Late Roman period, the harbor was apparently abandoned, reviving partially from the 11th century A.D. on when it was known as the Medieval and Papal port of Corneto, the name given Tarquinia in the Middle Ages.

Underwater investigation of the site was necessary to verify the location and dating of the ancient port and to define the form of the presumed breakwater and overall design of the harbor. As a result of
the survey, part of a breakwater that appears to date from the Roman period was discovered, comprising a large mound of rocks located circa 125 meters northwest of the harbor promontory and another smaller rubble mound only 20 meters from shore. This type of breakwater, which is similar to that at the nearby Roman ports of Cosa and Pyrgi and the Etruscan port of Populonia, appears to have been a simple but effective means used by the Romans to break the force of the waves and thereby create a sheltered port.

The fact that the rubble piles are separated from one another rather than formed in one continuous breakwater extending out from shore is also indicative of Early Roman design; the wave action could be kept to a minimum, but currents could pass freely between the rock barriers providing a natural means of cleansing the silt from the harbor. The local currents observed in the harbor during the survey follow precisely this pattern, although the harbor itself has silted-in considerably since it was bombed in World War II. Sherds dating primarily from the Imperial Roman period were found buried in the large rubble mound, while one Etruscan handle and a Medieval rim fragment found on the harbor floor help to affirm the temporal spread of harbor use.
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Note: All photographs and illustrations are by the author unless otherwise indicated.
INTRODUCTION

For the study of ancient harbor development, the Tuscan coast of Italy (FIG. 1) presents as much of a challenge today to archaeologists interpreting port remains as it did to the earliest seafarers who sought shelter for their ships. In contrast to the bay-studded Aegean so conducive to early development of seafaring, the geographical configuration of the Tuscan coastline offered little in the way of naturally protected anchorages, and must therefore have stood as an obstacle to early seafaring growth. Yet evidence for a well developed seafaring culture was reflected in the written record beginning in the earliest period of Etruscan history (circa 7th century B.C.), and the intense degree of Etruscan commercial activity suggested from the archaeological record lent credence to the Etruscan's seafaring reputation.

The style and format of this thesis are those followed by the Journal of Field Archaeology.


For historical references to Etruscan maritime activity and naval achievements see Diodorus Siculus v.40; v.19; Dionysus i.25; Strabo vi. 2.10; v.2.2; v.3.5; Herodotus i.166-167; vi.17. Based on these and other references, hypotheses of an Etruscan "thalassocracy" or mastery of the seas have been forwarded by M. Pallottino, The Etruscans (Indiana 1975) 82; S. Paglieri, "Origin e diffusione delle navi etrusco-italiche," StEtr (1960) 209-223; L. Stella, Italica antica sul mare (Milan 1930) 107-196.

Pallottino, op. cit. (in note 2) 83. The seafarers responsible for the vast number of foreign objects and motifs (Greek, Phoenician, Sardinian) found in Etruscan tombs have been presumed to be Greeks and
Figure 1. Map of Tuscan coast with inset of Gravisca. This region is bordered by the Arno River to the north and the Tiber River to the south.
Little is known about Etruscan ships as no Etruscan hull remains have yet been excavated, and the artistic depictions from that period are unclear with respect to hull construction. But the hull design of Etruscan ships known from the representations is distinctive from contemporary Greek and Phoenician ships in its rounded shape and downward curving prow, perhaps indicating some form of independent seafaring technology in the Etruscan culture. The degree to which this technology developed independently or was influenced by Greek and Phoenician seafarers is difficult to discern without concrete evidence for hull construction, and thus the question of Etruscan seafaring development must be evaluated from a different source.

For this reason scholars have turned recently to the study of Etruscan ports in hopes of providing a firmer foundation for the Etruscan reputation as a sea power and exploring the level of technology geared toward Etruscan port design. Just as early Aegean seafarers took advantage of high rocky promontories or natural reefs in designing their ports, the Etruscans, it has been assumed, turned to the few semi-protected sites along their shoreline and utilized the shallow

Phoenicians as well as Etruscans; see A. Masso, The World of the Etruscans, (Geneva 1973) 62. However, the wide distribution of Etruscan products (bucchero vases, bronzes) found abroad from Spain and N. Africa to Asia Minor favors active Etruscan participation in seafaring trade.

4The cargo of a ship believed to be Etruscan has been excavated, but no hull remains were found. C. Livadie, "L'Epave étrusque du Cap d'Antibes," RStLig 38,1-3 (1967) 300-326.

coastal lagoons or low broad reefs for harbor sites.\textsuperscript{6} But unlike the Aegean, only one of the Etruscan centers known from historical records, Talamone, enjoyed the geographical protection of a high mountain promontory,\textsuperscript{7} and most Etruscan cities were forced to accommodate their ships to unfavorable coastal conditions. In fact, of all the cities known from the Etruscan period, only Populonia was founded directly on the sea coast,\textsuperscript{8} while the rest of the great cities were built some distance inland on isolated summits protected by steep cliffs.\textsuperscript{9} Ports to serve the commercial interests of these cities, then, had to be established as separate settlements near low coastal promontories, shallow lagoon areas, and reef outcrops.

Only one port associated with these separate settlements, Pyrgi, the port of Caere, has been surveyed and excavated underwater; but no distinctive Etruscan features have been positively identified yet.\textsuperscript{10} The remains of the rest have been inundated by a slight rise in sea


\textsuperscript{7}"Talamone," \textit{FAA} VII (1965) 583-584. Pliny \textit{nat. hist.} v. 51 records the site near Monte Argentario. For a general discussion of the importance of Talamone see Bruno, op. cit. (in note 6) 198.

\textsuperscript{8}Strabo v. 2.6.; Pliny \textit{nat. hist.} iii. 8.


\textsuperscript{10}Oleson, op. cit. (in note 6) \textit{passim}
level and gradual coastal silting making them difficult to locate.\textsuperscript{11} The port associated with the coastal Etruscan city of Populonia has also been the focus of recent archaeological research, but the remains there have been obscured by later breakwater construction, and details of its earliest design are now well buried.\textsuperscript{12} It is therefore still unclear to archaeologists exactly what features characterize an Etruscan port, and the number of questions which naturally arise concerning their design and construction renders the study of Etruscan ports one of the more challenging topics in the history of seafaring.

If the Etruscans were indeed active seafarers as the historical record indicates, one would expect their involvement with the sea to be reflected in the level of Etruscan port engineering technology. That Etruscan engineers must have been capable of designing and constructing artificial harbor installations is implied by such advanced practices as the engineering of underground channels or \textit{cuniculi}\textsuperscript{13} and elaborate tombs like the corbelled cistern,\textsuperscript{14} both of which were later adopted for use by the Romans. The question has thus been raised not only how

\textsuperscript{11}For discussion of gradual silting and inundation see Bruno, op. cit. (in note 6) 208-211 and G. Schmiedt, \textit{Il Livello Antica del Mar Tirreno. Testimonianze dei resti archeologiche} (Florence 1972) 274-275.


\textsuperscript{13}D. Strong, \textit{The Early Etruscans} (London 1968) 14. \textit{Cuniculi} were tunnels cut into rock which may have served as outlets carrying streams from one valley to another or as underground drainage channels. \textit{Cuniculi} found underground in Etruscan Rome may also have been used as sewers, A. Boethius and J. B. Ward-Perkins, \textit{Etruscan and Roman Architecture} (Baltimore 1970) 91.

\textsuperscript{14}Boethius and Ward-Perkins, op. cit. (in note 13) 80.
Etruscan ports were designed, but also to what extent Etruscan technology may have been utilized by the Romans.

This is not an unlikely possibility, considering that the Romans are scarcely noted for their seafaring abilities; in fact, it appears they may have adopted much of their ship construction techniques from the Phoenicians. Roman engineering, on the other hand, was famous for its innovativeness, and land engineering achievements such as Roman aqueducts were complemented by equally advanced practices in building artificial harbor installations. For example, studies of the Roman ports at Cosa, Pyrgi, Civitavecchia, and Ostia on the Tuscan coast, and the ports of Pozzuoli and Baiae to the south, have revealed extensive evidence for Roman awareness of the need for silt control in harbor design, and the Roman discovery and use of pozzuolana in making hydraulic cement has long been considered one of the more innovative

15 The theory that the Romans copied Phoenician warships stems from a passage by Polybius (1. 20) referring to the First Punic War and Pliny's reference (xvi. 192) to Roman duplication of a captured Phoenician quinquereme in 261 B.C. See H. Frost, "First Season of Excavation on the Punic Wreck in Sicily," IJNA 2.1 (1973) 33; P. Throckmorton, "Romans on the Sea" in A History of Seafaring, op. cit. (in note 5) 67. According to Pliny (vii. 209), the "rostrum" type ram on Roman warship depictions may also be attributed to the Etruscans.

steps in the development of breakwater construction. Did all these advancements appear suddenly, or were they the result of a gradual development in port engineering beginning long before the Roman period?

While the earliest seafarers in Italy faced a difficult situation for their ports, during the Roman period the harsh coastal conditions which confronted the Etruscans were intensified as rivers began to be subjected to a rapid accumulation of alluvial deposits and the few sheltered coastal lagoons began to silt-up and become malarial swamps. The causes of this change are still debated, but one factor which appears to have been partly responsible was the careless deforestation which began in the Roman period and subjected river banks to erosion. Similar practices extending into historical times that heightened silt deposition, combined with a slight change in sea level since antiquity, have resulted in the formation of a coastline considerably different from that in the Etruscan and Roman periods. Traces of ancient ports have thus been well buried beneath the sea and silt.

17 Vitruvius ii. 6.1, 2-6, 12. For the importance of this 3rd century B.C. discovery along with the Roman introduction of the arch, cofferdam, and pile driving in deep water see Saville, op. cit. (in note 16) 226.

18 According to Bruno, op. cit. (in note 6) 207, this change must have begun sometime before the Roman period, for in Strabo's description of the coast (circa 64 B.C.—A.D. 21), the lagoons were already being referred to as marshes.

19 Strabo (v. 5) wrote of mass deforestation along the rivers of Etruria to supply the Romans with timber for ship construction and buildings for the expanding city of Rome.
Literature Review

In order to investigate the early development of Tuscan ports and to evaluate the effects Etruscan port engineering may or may not have had upon the Romans, it has been necessary to rely upon underwater archaeology to obtain essential data. Studies beginning in the early 1900's have been concerned with defining and dating ancient port structures along the Italian coast. These, however, were either conducted entirely from shore or were geologically oriented with respect to sea-level studies and therefore did not involve comprehensive underwater survey or excavation. But a long-term archaeological project called the Tuscan Port Survey, combining sea-level studies with intensive underwater survey and excavation, has at last enabled comprehensive evaluation of submerged harbor installations, and underwater investigations at Populonia, Fyrgi, and Cosa have already uncovered traces of both Roman and Etruscan ports.

At Populonia, evidence of what is believed to be an Etruscan breakwater was found at a depth of 2.3 meters below the present ocean floor, extending out directly north from the modern breakwater. The design

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20 Gunther, op. cit. (in note 16); K. Lehmann-Hartleben, antiken Hafenanlagen des Mittelmeeres; Beiträge zur Geschichte des Stadtebaues im Altertum, Klio, Beiheft 14 (1923); Testaguzza, op. cit. (in note 16).

21 Schmiedt, op. cit. (in note 11); N. C. Flemming, "Archaeological Evidence for Eustatic Change of Sea Level and Earth Movements in the Western Mediterranean during the Last 2,000 Years," GeolSocAmSpecPap 109 (1969) 1-125.

22 Begun in 1965, this project is directed by Dr. A. K. McCann under the auspices of the American Academy in Rome.
of the breakwater, with its low broad platform designed to break waves gradually, differs distinctly from the narrow Creek jetties designed to break the force of the seas all at once.\textsuperscript{23} Excavations at Pyrgi, though not yet complete, have suggested the possibility that a series of previously unknown volcanic shoals which supported the Roman rubble-mound jetties may have been the principal attraction to original Etruscan settlers at the site.\textsuperscript{24} And at the Early Roman port of Cosa, a breakwater has been found consisting of a large rubble mound with a series of extensions out into the harbor serving as protection from the waves, at the same time allowing the currents to flow through the harbor keeping it free of silt.\textsuperscript{25}

Each port had its own significance to the study of ancient trade, with Populonia existing as an early base for foreign trade and the working of iron ore brought by ships from Elba,\textsuperscript{26} Pyrgi being the port of the famous Etruscan city of Caere, and Cosa representing the earliest known Roman port, with a commercial span from the 2nd century B.C. to the 2nd century A.D.

Other Etruscan ports have been located only tentatively, one of the most archaeologically promising being the port of Gravisca, located

\textsuperscript{23} McCann, et al., op. cit. (in note 12) 282.


\textsuperscript{25} McCann and Lewis, op. cit. (in note 16) 204.

approximately 40 miles northwest of Rome (see inset FIG. 1). Gravisca has long been associated with the Etruscan city of Tarquinia and the Roman colony of Gravisca. But while the archaeological evidence from Tarquinia attests to its importance as a powerful city actively engaged in commercial exchanges with Greece beginning in the Archaic period, little was known about either the port or the colony apart from its name and approximate location on the coast near Tarquinia. Only a few scattered references, mostly vague or inconsistent, have been handed down from Roman geographers and historians in which Gravisca was either placed relatively between the coastal stations of Cosa and Castrum Novum, or its location was given in absolute distances which rarely agreed. Nevertheless, combining the contradictory evidence from the ancient sources with occasional observations of questionable archaeological remains, scholars attempted to locate Gravisca beginning in the 1830's. No less than four different sites have been proposed over the years; but until recently there was no conclusive evidence to substantiate any of these theories.

27 Gravisca's existence as an Etruscan settlement was acknowledged by the Roman writers Silius Italicus and Virgil. Silius Italicus viii. 475 referred to "veteres" Gravisca, and Virgil Aeneid x. 184 mentioned Gravisca with the Etruscan cities in the time of Aeneas.

28 Even the spelling was not settled upon, as Gravisca's ending varied in the ancient sources between Graviscæ (5 references), Gravisca (4), Graviscas (1), and Gravisci (1). Gravisca has been chosen here as it is used in the most recent publication of the site by M. Torelli et al., "Gravisca - Scavi nello sito etrusco e romano. Campagne 1969 e 1970," NSc Series 8 25,1 (1971) 195-299.

29 Mela de chorographia, ii. 72; Ptolem. iii. 1.4; Pliny nat.hist. iii. 51. Castrum Novum was located just south of Civitavecchia.
The Maritime Itinerary of Antoninus placed Gravisca 27 miles from Pyrgi, a distance which prompted E. Westphal to position it on the right bank of the Marta River. G. Dennis endorsed this conclusion, using the additional figure given in the Itinerary of Gravisca 12 1/2 miles from Centocellae (Civitavecchia). However, his theory moved it two miles upstream in accordance with what he believed to be the remains of an ancient quay, sewer, and causeway. L. Dasti incorporated into this view the description by Rutilius Namatianus of Gravisca's scattered house tops appearing on the coastline north of the Mignone, and placed it back at the mouth of the Marta, this time on the north bank.

On the other hand, Strabo's conflicting figure of "somewhat less than 180 stadia" (22 1/2 miles) for the distance from Gravisca to Pyrgi was also taken literally to cite its location. Canina used it to suggest that the site lay at the mouth of the Mignone River,

31 G. Dennis, The Cities and Cemeteries of Etruria, vol. I (London 1848) 393. But none of his reported remains have been confirmed, and it is doubtful the river would have been navigable that far upstream.
32 de re dita suo i. 281-284.
34 Strabo v. 218. Also listed here was Gravisca 300 stadia (37 1/2 miles) from Cosa.
35 L. Canina, L'Antica Etruria Marittima, Compresa nella Dizione Pontificia vol. II (Rome 1846) 46; see also L. Canina, "Adunanze dell' Instituto de' 18 Decembre, e degli 8 Gennaio", Annist (1847) 92, note 1. This is countered both by the description of Rutilius Namatianus and by the fact that it lies only 8 mi. from Centocellae rather than the 12 1/2 mi. given in the Maritime Itinerary.
while others utilized it to place it in line with the salt marsh slightly to the north of the Mignone. But Pallottino, who trusted the Maritime Itinerary with its relative distances more than Strabo with his absolute figures, used the same figure listing Pyrgi 27 1/2 miles from Gravisca, which had been argued for the Marta location, to place the colony instead at the modern-day harbor of Porto Clementino, also called Marina di Tarquinia (FIG. 2). Unlike others, Pallottino believed that the port of Gravisca was actually located at a different site than the Roman colony, and placed it instead at the mouth of the Marta, which he believed would have been the site mentioned in the Itinerary as Maltanum.

Later scholars followed Pallottino in using the Itinerary to place the Roman colony at Porto Clementino in view of the fact that this harbor was known in historic times as the Medieval and Papal port of Corneto, the name given Tarquinia in the Middle Ages. Geographical support for a harbor at this location could also be found on

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36 Cited by Dennis, op. cit. (in note 31) 393; specific names not mentioned. The salt marsh theory was still considered a possibility in 1971. See A. Fioravanti, Elementi di tecnica archeologica subacquea (Rome 1971) 20.

37 M. Pallottino, "Tarquinia," MonAnt 36,1 (Milan 1937) 579. The alternate sites of Maltanum (at the mouth of the Marta) and Rapinum (at the mouth of the Mignone) mentioned in the Itinerary have been explained by other scholars as landing places in the belief that Tarquinia had 2 minor ports to serve it in addition to Gravisca. See G. Fòtì, "The Principal Cities of Southern Etruria and their Special Characteristics," CTBA Foundation Symposium on Medical Biology and Etruscan Origins (1959) 14; Dasti, op. cit. (in note 33) 29.

38 G. Uggeri, "La Terminologia portuale Romana e la documentazione dell'Itinerarium Antonini," StItal 40 (1968) 244.
Early Renaissance maps. Although these, too, were of questionable accuracy, they were at least consistent in placing Gravisca away from the Marta and Mignone Rivers. On the 13th century *Peutingeriana Tabula*, 39 Gravisca was shown well south of the Marta River, while a later 17th century map drawn on the wall of the Vatican placed Gravisca clearly between the two rivers. 40 On the map of Ptolemaeus (1490), 41 Gravisca was placed on a slight peninsula between Cosa and Castrum Novum, but the coastline may have been too generalized on this map to be taken literally. On the 1275 map of Pisana 42 and another unpublished 17th century map on the wall of the Vatican Museum (FIG. 3), a well-defined bay was represented in place of the small promontory at present-day Porto Clementino. One might wonder whether this was merely an exaggeration of the fact that there was a port there, or whether it represented the true ancient shoreline.

A. Pasqui, who visited the harbor at Porto Clementino in 1885, noted what he believed were the remains of a solid mole extending directly out from the harbor promontory to the northwest in the form of a 700-meter-radius semicircle. 43 According to Pasqui, this structure lay

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39 *Peutingeriana Tabula Itineraria* (1753 edition). This is a 3rd or 4th century A.D. map copied from a lost original in 1265.

40 Painted by Luca Holstenio in 1632, this map can be seen today in the Vatican Museum. It is also published in A. P. Frutaz, *Le Carte del Lazio* II (Rome 1972) table 63.


42 *Carta dette Pisana del circa 1275: Foldout appended to K. Kretshmer, Die Italienischen portolane des Mittelalters* (Berlin 1909).

43 A. Pasqui, NSc (1885) 519, note 3.
Figure 2. View of Porto Clementino facing southward.

Figure 3. Map of coastline near Tarquinia (Corneto) on 17th century wall painting in the Vatican Museum.
1 m. below sea level, measured 1.5 m. wide and was built in cement masonry on a foundation of limestone blocks. Recent investigations from land by G. Schmiedt and L. Quilici could not confirm the existence of a mole fitting this description, but geographically Porto Clementino appeared to them the most suitable location for the port and colony compared with the alternate sites at the Marta, the Mignone, or salt marsh.

Final proof settling the question as to the location of the Roman colony was brought to light at Porto Clementino in 1969 by Professor Mario Torelli. In the process of exploring ruins which were accidently discovered 500 m. east of the promontory during the laying of modern building foundations, remains of the Roman colony were found along with evidence for earlier Etruscan occupation.

At first structures from the Roman colony were identified in phases of continuous occupation from its founding in 181 B.C. up to the 5th century A.D. in the Late Roman period. These consisted of tile-built tombs and a rectangular mausoleum from the 2nd-4th century A.D., three insulae, and a luxurious private residence from the 3rd-5th century A.D. levels. Trial trenches below these strata then

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44 G. Schmiedt, "I Porti Etruschi," Atlante Aereofotografico delle sedi umane in Italia (Florence 1970) 121-122. The aerial photographs shown in table CXXX, fig. 3 did not reveal any traces of underwater structures.


revealed traces of an earlier Etruscan town (6th-3rd century B.C.), larger and richer than the Roman colony and with a somewhat different street plan.⁴⁷ Short stretches of streets and remains of private houses from the Etruscan period were found well preserved, built with foundations of large limestone blocks.

One of the most enlightening aspects of the site with respect to early sea trade was the discovery of a large sanctuary located circa 500 m. to the southeast of the Roman section of the colony, but in close context with the Etruscan settlement⁴⁸ (FIG. 4). Three rectangular buildings containing altars and large quantities of imported Greek pottery from the 6th and 5th centuries B.C. were found, with the latest phase dated to circa 250 B.C.⁴⁹ One of the rectangular buildings appeared to be an Archaic shrine (590-480 B.C.) belonging to the goddess Hera; dedications to Hera in the Greek alphabet and Ionian dialect, along with Greek graffiti on sherds, a high proportion of Ionian pottery, and circa 1000 terracotta lamps of a type frequently found in East Greek sanctuaries (Samos and Rhodes), all suggest it was frequented almost exclusively by Eastern Greeks.⁵⁰ In addition, a stone cippus found in the sanctuary dated from circa 500 B.C, and inscribed in the dialect and alphabet of Aegina with the words "I belong to Apollo of

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⁴⁹ Torelli, op. cit. (in note 48) 48.

Figure 4. Aerial photograph showing sanctuary at Gravisca. Remains of Archaic Greek sanctuary are immediately to left of white balloon tether. North is to right. Photo: J. Whittlesey 1974, kindness of A. M. McCann.
Aegina; Sostratos had made" may refer to the renowned Greek merchant mentioned by Herodotus (IV. 152), which lends further strength to the theory that Gravisca was tied commercially with Ionia. 51

Thus, the first archaeological evidence of Greek settlement on Etruscan soil in the 6th and early 5th centuries B.C. can be attributed to the site of Gravisca at Porto Clementino, along with testimony to the importance of this coastal site as a commercial center for Etruscan and Archaic Greek trade. 52 With such strong evidence, the four locations previously suggested for the site of the Etruscan port could be reduced to two: Porto Clementino and the salt marsh extending circa 3 km. to the south.

While the latter area may perhaps have been navigable in the Etruscan period, it had no doubt begun to silt-up by Roman times, along with the other shallow lagoon areas, and the question arises as to whether this lagoon would have ever been deep enough to accommodate sea-going ships. The exposed shore in front of the salt marsh would hardly have been suitable for anchorage outside, and, contrary to at least one scholarly hypothesis, there is no evidence that the present channel from the sea into the salt marsh was built in antiquity to facilitate a harbor entrance. 53


52 Torelli, op. cit. (in note 47) 216.

53 Pallottino, op. cit. (in note 37) 580 wrote of great blocks of limestone lying underneath the jetty there which he believed were part of a Etrusco-Roman "cloaca" or sewer drain; "certainly the remains of an inner port dug in imitation of a Greco-Punic cothon, probably in the 1st half of the 2nd century B.C." We found no sign of such construction,
The low promontory at Porto Clementino, which extends 75 m. out from shore, offers little protection from the predominant westerly and northwesterly winds and frequent southeasterly storms. But it does form a relatively large basin which would presumably have been larger and deeper in antiquity before the shoreline began to silt-up. It could well have served as a reasonably large anchorage area for sea-going ships, provided there was some form of protection from the corresponding wave fronts to which it was directly exposed. Furthermore, it was well known from the historical record that Porto Clementino was used as a Medieval and Papal port, and quite logical to suppose that it might have been built over an earlier Etruscan or Roman port. However, no descriptions have survived of the breakwater which reportedly existed there, and consequently nothing was known about either the construction or the design of the port at any period in history.

Research Objectives

In order to establish where and how a breakwater would have been constructed and at what period in the development of the harbor this might have taken place, a full-scale underwater survey and excavation was necessary. With an interest focused primarily on Etruscan use of the harbor stemming from the abundant evidence for Etruscan sea trade, however, and the jetty itself is most likely the remains of the 19th century construction by Pope Pius VII to drain the marsh for salt production. See A. Zeri, "I Porti del litorale Romano," Monographia storica dei porti dell'antichita nella penisola Italiana (Rome 1905) 238.

54 Forelli, op. cit. (in note 28) 197.
the director of the Gravisca excavations, Professor Torelli, invited the writer to examine the site under water. It was hoped that the survey would be able to substantiate the theory that this was without doubt the Etruscan port, as well as provide some evidence for the design of the port and possible construction of a breakwater. Furthermore, since nothing was known about the design of the port from any period, this kind of study was potentially valuable with respect to whatever period existing breakwater remains were found to represent.

With these objectives in mind, an underwater survey and excavation was carried out at Porto Clementino over a six-week period from August 1st through September 15th, 1977. The project was conducted as an extension of the Tuscan Port Survey under sponsorship from the American Academy in Rome, with funding provided by a grant from Texas A&M University. Equipment was acquired through in-kind contributions from the American Academy in Rome, and additional support was given by the American Institute of Nautical Archaeology. The project was directed by the writer and assisted by a team of four divers.55

The area of submerged remains extending circa 300 square meters to the north and west of the harbor promontory and ranging in depth from 0.5 to 5.0 m. was mapped and partially excavated, and studies of the currents were conducted to help evaluate the overall harbor design. Combining the results of this work with research into the history of

55 Team members were graduate students Richard Swete (nautical archaeology, Texas A&M University); Cynthia Orr (classical archaeology, University of Pennsylvania); Nan Bray (physical oceanography, Woods Hole Institute of Oceanography); and Tom Gross (engineer, University of California, Berkeley).
the port, it has been possible to reconstruct partially what may be
the original design and construction of the breakwater, and to hypothe-
size the nature of seafaring activity at Gravisca from Etruscan times
up until the 19th century, when historical records indicate the port
was finally abandoned.
HISTORICAL BACKGROUND

Gravisca's history is inherently bound with that of Tarquinia, as it no doubt arose as a port to serve the needs of that town. From its earliest period Gravisca served as a center for trade and communication, but it was politically and administratively dependent upon Tarquinia. Gravisca was used also to some degree for naval defense, at least when a Roman colony, but to what extent the Etruscans used it for defense remains an open question.

Like all major Etruscan cities with the exception of Populonia, Tarquinia was founded upon an inland rise overlooking the coastal plain (FIG. 5). Situated 8 km. inland on a spur-shaped hill naturally protected by steep limestone cliffs on three sides, it was strategically located from a trading point of view, as it lay beside the Marta River valley and was connected to the neighboring regions by a well developed network of roads.

Tarquinia grew from a Villanovan village to one of the principal

56 Torelli, op. cit. (in note 9) 13.


58 No Etruscan fleets at Gravisca were ever mentioned in the sources.

Figure 5. View from modern Tarquinia looking seaward. Porto Clementino slightly to right out of picture.
cities in the Etruscan League (9th-7th centuries B.C.), and there is some evidence to suggest involvement with the sea starting in the earliest period. That it was a center of political and cultural importance is known archaeologically from its rich necropolis, where some of the richest tombs in Etruria have been excavated. Tarquinia's greatest period of splendor is reflected in tombs dated from the close of the first half of the 6th century to the beginning of the 5th century B.C., and it is from these tombs that two of the most important Etruscan ship representations have come to light. The seagoing ship in the "Tomba della Nave" stands out for its distinctive Etruscan character and its two-masted rig which is a unique feature for that period (FIG. 6).

The ship represented in the "Tomba della Caccia e Pesca", on the other hand, appears to be a small shallow-water craft, and it has been suggested that this represents the type of fishing boats used in coastal lagoon areas such as the salt marsh at Gravisca (FIG. 7).

Tarquinia's first contacts with Greek and Phoenician seafarers appear to have begun in the 8th century B.C. when Tarquinia first

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61 H. Henken, Tarquinia, Villanovans and Early Etruscans, vol. I (Cambridge 1968) 410. This evidence consists of six Villanovan boat models found dating from the 10th to 7th century B.C.

62 Coarelli, op. cit. (in note 9) 183.


64 Bruno, op. cit. (in note 6) 206.
Figure 6. Etruscan merchant ship painted in the "Tomba della Nave", Tarquinia. Early 5th century B.C.

Figure 7. Etruscan fishing craft painted in the "Tomba della Caccia e Pesca", Tarquinia. Late 5th century B.C.
acquired the function of an important center for unworked metals. Between the early 7th and early 6th centuries B.C., Tarquinia's cultural development was closely tied with the Orientalizing movement in Etruria, and this contact appears to have peaked at the close of the first half of the 6th century B.C.

Tarquinia suffered the severe economic crisis which hit Etruria towards the end of the 6th century B.C. Weakening considerably after the downfall of nearby Veii and Caere, it slowly declined until it was absorbed into the Roman sphere as a federal state in the late 4th century B.C. Gravisca fell into this sphere along with Tarquinia, although it was still associated with the Etruscans in the 2nd century B.C., according to at least one ancient historian. By the end of the 1st century B.C., Tarquinia had become a municipium and regained its

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65 Torelli, op. cit. (in note 9) 17. This is reflected by the sudden change in social structure to include a rich upper class.
66 Coarelli, op. cit. (in note 9) 185.
67 Moretti, op. cit. (in note 59) 4.
68 Torelli, op. cit. (in note 9) 30-31. This crisis began with the decrease in Greek trade following the collapse of Ionis, and was heightened by internal political conflict and social unrest. Another factor contributing to this decline may have been a general depopulation caused by the spread of malaria from the nearby swamp. For general discussion of this theory see Bruno, op. cit. (in note 6) 211.
69 Moretti, op. cit. (in note 59) 4. The final surrender came about only after a three-year war with the Romans (311-307), after which the Romans imposed harsh conditions upon Tarquinia.
70 Silius Italicus viii. 475 described the army manned by Etruscan warriors under the famous leader Galba in the second Punic War (218-201 B.C.) and noted that the choicest men were sent by Caere, Cortona and Gravisca.
former prestige, apparently reaching moments of great splendor under the Antonine emperors.

From the archaeological record, it appears that Tarquinia's role in the international sphere during the Roman period was relatively insignificant, and the resulting effect on its port is undoubtedly reflected by the decrease in imported material found in the Roman settlement at Gravisca. While Pliny's reference to Gravisca's excellent wine and coral furnishes some historical evidence for commercial activity at Gravisca in the 1st century A.D., there is little else in the historical record to help reconstruct the scope of this trade. Indeed, all that is known about Roman Gravisca from historical sources, where it ranked as hardly more than a place-name, can be reduced to a few uninspiring facts.

Gravisca's foundation as a Roman colony in 131 B.C. was related by Livy (XL. 29,1). In addition to the names of the three leaders who founded it — G. Calpurnius Piso, P. Claudius Pulcher, and G. Terentius

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71 Moretti, op. cit. (in note 59) 3.

72 Torelli, op. cit. (in note 46) 366.

73 Pliny nat.hist. xxxii. 21 referred to the excellent red coral at Gravisca and ranked Gravisca's wine "next to the top of the Adriatic wines" nat.hist. xiv. 67-68. Paget, op. cit. (in note 60) 122 wrote that the famous wines of Gravisca were being exported to Greece about 350 B.C., but he cited no references.

74 Paget, op. cit. (in note 60) 122 noted that sheep were apparently bred for milk, and their wool was a source of wealth, however no mention was given for Roman export of these products.

75 A different date for its founding (237 B.C.) was given by Velleius Paterculus i. 15.3, but was probably confused with another event as its validity has not been accepted.
Istra — Livy noted that five jugera of land were given each colonist and that drought and crop failures plagued the first year. A new ded-uction of colonists under Augustus was also recorded, and from the inscriptions it is known that the clan of the city was the same as that of Tarquinia, and that Gravisca was a "free collegium". Evidence for Gravisca's existence in the reign of Trajan (A.D. 98-117) and in the time of Justinian (6th century A.D.) is also found in inscriptions.

To supplement these references, one finds only a few judgements about Gravisca on the part of the ancient authors, most of which dwell upon its unhealthy pestilent atmosphere due to the nearby marsh. This apparently plagued the Romans starting in Republican times, when the shallow coastal lagoons began to silt-up and turn into marshy, malarial-prone swamps.

Following this fragmented glimpse of Gravisca's early history gathered from historical sources, one finds a period of further decline sparse in source material until the Middle Ages. Sometime in the 6th

76 Lib. Col. 220.

77 The "Stellatina" CIL vi. 2928.

78 CIL 1x. 511; xl. 3378; Lib. Col. 220; Geogr. Rav. v. 2.

79 For Trajan see Dennis, op. cit. (in note 31) 389 in reference to an unnamed inscription published in the AnnInst (1832) 152. For Justinian see Digest xxxi. 30: "rei publicae Graviscanorum."

80 Virgil Aeneid x. 184 referred to Intempestaque ("fever-stricken") Gravisca; Rutulius Namantianus i. 281-284 on his voyage north along the Tuscan coast in A.D. 416 noted the desolate ruins of the town "plagued by bad-smelling air from the marshes in the summertime". See also Cato, frag. 46 and discussions in Dennis, op. cit. (in note 31) 393 and Canina, op. cit. (in note 35) 46.
century A.D., the city was moved to another site nearby which was better defended by the steep surrounding rocky face. The name was changed to Corneto and is mentioned in the papal chronicles relating to the Councils of A.D. 504 and 649. Another gap in the historical evidence then appears between that period and the rise of Corneto as an agricultural and trading town in the 13th century, during the economic peak of the Middle Ages. A brief review of the economic history in the intervening period can partially explain this vacuum.

In the 9th century the economic development of western Europe was at its lowest ebb, plagued by social disorganization and foreign invasions. At the beginning of the 9th century, Italian ports outside the Byzantine sphere of influence were still sunk in the poverty and obscurity that had closed over them at the time of the Lombard conquest. But it was also an era of stabilization and relative peace, and by the end of the 11th century the early Medieval cities of Venice,

81 Zeri, op. cit. (in note 53) 237.
82 Morelli, op. cit. (in note 50) 360.
84 H. Pirenne, Medieval Cities (Princeton 1925) 55.
86 Pirenne, op. cit. (in note 84) 55. For discussion of Pirenne’s theories, several of which have been disputed, see A. F. Havighurst, The Pirenne Thesis: Analysis, Criticism, and Revision (Boston 1958) 43ff.
Genoa, and Pisa had grown sufficiently to challenge the long-distance sea routes hitherto monopolized by Saracen and Greek traders.  

The first opportunity for expansion came to the Venetians in 1082 when, during a moment of weakness, the Byzantine Empire was forced to appeal for help in its struggle to maintain control over the eastern Mediterranean under threat from the Turks and Normans. In return for the services of their fleet, the Venetians obtained complete freedom from all Imperial customs in the Aegean and Mediterranean. Thus, the western trade of the empire fell completely into their hands. Pisa and Genoa then followed suit (1097 and 1099, respectively), offering the services of their fleets in the First Crusade against the Turks. Soon these three Italian cities were competing for every chance the Crusades offered, as they were rewarded with streets and quarters or thirds of captured ports in which they could establish trading stations. By the end of the 12th century, the Italians dominated the profitable silk, spice, and dyestuff trade routes from Constantinople and the Levant to the west. And as Italian merchants were the first to master new techniques of Medieval business in the 13th century, foreign trade in western Europe became a virtual Italian monopoly.

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87 Hyde, op. cit. (in note 85) 29.
88 Ibid. 32.
89 Ibid. 31.
90 Ibid. 31. In time this commercial rivalry came to include attacks on each other's ships. Pirenne, op. cit. (in note 84) 65.
from the 13th through the 16th centuries.\footnote{Hyde, op. cit. (in note 85) 31-32. This included control of trade in the Levant, S. Europe, France, Flanders and England.}

Although Corneto's role as a trading center in this period of economic growth was subordinate to that of flourishing coastal cities like Pisa and Genoa,\footnote{D. P. Waley, The Papal State in the Thirteenth Century (London 1961) 15. In 1165 Rome reportedly granted Genoa the right to trade freely with the coastal area between Corneto and Terracina in terms suggesting a claim to control the entire Tuscan Patrimony.} a certain involvement does seem to be reflected from the historical sources. The first reports of a port at Corneto have been said to appear in the 11th century when Corneto was still a feudal possession,\footnote{C. de Cesaris, "Il Porto di Corneto," Bollettino delle attivita nell'anno 1976 (1977) 50.} but their actual substance was mentioned nowhere. In the 12th century Corneto became a free commune, and special alliance treaties with the more important ports of the Tyrrhenian were recorded for this period.\footnote{Commercial alliances with Pisa, Venice, and Genoa are mentioned by Zeri, op. cit. (in note 53) 238 and de Cesaris, op. cit. (in note 93) 53.}

It has been suggested that Medieval trade was not built exclusively on high quality merchandise such as gold, silver, or Eastern luxuries so much as it was on wool, cotton, silk, dyestuffs, salt, wheat, sugar, wine, timber, iron, copper, and aluminum.\footnote{G. Luzzatto, An Economic History of Italy from the Fall of the Roman Empire to the Beginning of the Sixteenth Century (New York 1961) 114.} In this respect,
Corneto had two important products to contribute: wheat and wine. But the extent to which the port of Corneto at old Gravisca was used for commercial trade at this time is not entirely clear.

While some scholars assume it was a large port, improved upon from earlier periods to accommodate larger ships, there is no evidence of expansion in the historical records until 1449, when it was "rearranged" by Pope Nicholas V, and 1461 when it was "enlarged" by Pope Pius II. However, one report of "a great number of ships," including 18 galleys wintering at the port from October to March of 1190, does imply that there must have been some form of artificial protection at that time, particularly since they originally pulled into port as a result of a sirocco storm.

A. Zeri speculated that Corneto's port would have been quite small, providing only the use of a jetty for unloading and an anchorage.

96 Waley, op. cit. (in note 92) 83, note 2, gives reference to the exportation of grain through Corneto to Genoa and the consequent presence of traders from Corneto, Orvieto, and Toscanella at Genoa; however it was not mentioned if this trade was overland or by sea. I was unable to consult V. Vitale, Il Comune del Podesta a Genova 87, 331, 397-399.

97 Dasti, op. cit. (in note 33) 98, for example, denies the existence of a Medieval port at Porto Clementino altogether, theorizing instead Corneto's use of the 2 landing places at the mouth of the Marta and Mignone.

98 de Cesaris, op. cit. (in note 38) 51.

99 "Porto Clementino," Guida d'Italia del Touring Club Italiano Lazio (Milan 1964) 125. See also de Cesaris, op. cit. (in note 93) 52.

100 From a document reported by Calisse in his history of Civitavecchia as noted by de Cesaris, op. cit. (in note 93) 52 (title not cited). Without some form of artificial protection, the southeasterly sirocco winds would have rendered the harbor useless.
deep enough for small boats. This was based primarily upon his belief that Corneto was commercially insignificant in this period in that it was associated more with the favorite landing place of Papal officials on their voyages north from Rome than with trade. Such a hypothesis is in fact supported by the following contemporary and later geographical reports.

In a manual written for navigators circa 1250-1265, Corneto was mentioned only with respect to its distance from the port at Monte Alto further north, whereas the next port south, Civitavecchia, was described in detail as a good port which had two entrances, one for small and one for large ships. In 1502 it was reported that the ships carrying Pope Borgia back to Corneto after his voyage to Piombino could not land due to a sudden storm and therefore had to sail back to the more protected port of Porto Ercole. The 16th-century Portolan of Rizo described the marina at Corneto equipped with

101 Zerl, op. cit. (in note 53) 238.

102 Ibid. 237. See also de Cesaris, op. cit. (in note 38) 51, 54 for description of Pope Urbano V's famous visit in 1367 and Pope Borgia's embarkation from Corneto to Piombino in 1502. F. Cincari, Sic Roma Portus (Civitavecchia 1977) also stated the belief that the port had only modest importance.


104 This may explain why Corneto, during its period of greatest expansion in the 1220's took over the port of Civitavecchia. See Waley op. cit. (in note 92) 84.

105 de Cesaris, op. cit. (in note 93) 51. The lack of protection at Porto Clementino at this time, however, may have been due to destruction of the port by Napoleon's fleet in 1486. On destruction see Quilici op. cit. (in note 45) 107, note 1.
mole and lighthouse, but went on to state that the port was only suitable for small boats. 106 And finally, in a 1560-1570 description of Corneto's port facilities, it was noted that the harbor was nothing more than an anchorage. 107

After what was described as another long period of decadence, 108 the harbor was reconstructed under Pope Clementine XII in 1738 and renamed Porto Clementino, with later improvements added in 1752 by Pope Benedict XIV. 109 In 1805 Pope Pius VII converted the pestilent marsh area into a salt works, 110 which by 1840 was yielding a sizable profit. 111 The last historical mention of ships using the port was in 1870, when an Italian fleet of nine warships and smaller ships laid anchor for two days before sailing on to Rome. 112

The sum total of these relatively unenlightening historical reports can probably be taken to represent alternate periods of

106 Kretschmer, op. cit. (in note 42) 486, 597. No description of the mole or lighthouse was given.


108 de Cesaris, op. cit. (in note 93) 56.

109 Ibid. and Guida d'Italia, op. cit. (in note 99) 125.

110 Zeri, op. cit. (in note 93) 238. See also Torelli, op. cit. (in note 28) 197.

111 de Cesaris, op. cit. (in note 93) 56. Profit was listed as "10 million per year", however no specific currency was given.

112 Ibid. 57.
prosperity and decline during the Middle Ages and into the Renaissance. But little can be gained with respect to separating features in the harbor constructed in these years from those built in the earlier Etruscan or Roman periods because no actual description of the breakwater itself can be found. One is left to wonder, then, not only how and where the breakwater was constructed in antiquity, but how and where it might have been improved in later years.

One last historical fact about Porto Clementino renders the answer to this question even more difficult; namely, that the harbor and the bastion were both bombed by the Germans in World War II (1944). The results from this bombing can be seen today in the form of large sections of the bastion remains lying on the beach approximately 75 m. away from their original position (FIG. 8). According to local residents, the anchorage basin has silted-in approximately 2 to 3 m. since 1944, due in part to displacement of the breakwater remains. Thus, it is evident that the harbor one sees today is considerably different from that seen in antiquity.

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113 Guida d'Italia op. cit. (in note 99) 125. Local Italians report that this was done to prevent the Allies from landing at Porto Clementino and using it as a marine base.
Figure 8. Porto Clementino showing displaced ruins of bastion in foreground.
GEOGRAPHIC AND GEOLOGIC SETTING

Today the harbor at Porto Clementino consists of a small shallow bay 0.5 to 1.5 m. deep, open to the predominant west and southwest swell and exposed to winds from all directions. It is formed by a low sandy promontory extending west from the shoreline, upon which the ruins of a Medieval bastion stand out as the prominent feature of the harbor 114 (FIG. 9). Although Porto Clementino is a popular seaside resort in the summertime, there are no modern facilities for anchoring or docking boats, and all aquatic activities are restricted to small craft launched from the beach.

Geologically, the coastline in the vicinity of Porto Clementino is dominated by a series of dunes consisting of sand and volcanic minerals. 115 Much of the material was swept north along the coast after explosions of the volcanoes north of Rome. Behind the dunes is a large lagunal area filled with relatively recent clays, and behind the lagoon is a series of older dunes. The highlands are made up primarily of a bedrock formation of Triassic and Jurassic age limestones (calcare calvornoso). Overlying and intruding the limestones

114 A description of this bastion from the 16th century was given by Guglielmotti, op. cit. (in note 107) 507 in terms of its function as "hotel, barracks, stable, customs house, hospital, prison, and warehouse" with mention of its terrace as "the fortress of armament to guard the port." No references were found for the date of its original founding.

115 The following geological description is based upon the Carta Geologica di Italia; Tuscania, Folio 136; Civitavecchia Folio, 142 (1970), and personal communication with Dr. Jelle de Boer, Dept. of Earth and Environmental Sciences, Wesleyan University.
Figure 9. View of survey area looking northwest from bastion.
are an immense complex of Quaternary volcanic rocks and sediments: tuffs, welded tuffs, tuff lavas, rhyolite, trachyte, phonolite, pozzolana, etc. Additional minerals in the volcanic sequence include magnetite, olivine, apatite, rutile, zircon, and sodalite. Pleistocene littoral outcrops have also been described for the region of Tarquinia, with sediments of these outcrops made up by the pre-Pleistocene "arenaceo-argilloscistosa" formation as well as by Lower Pleistocene blue clay. 116

The marine geology of the harbor area has not yet been scientifically studied. However, the sandy littoral which forms the coastline between the Marta and the Mignone Rivers has been described by Schmiedt as "morphologically simple and monotonous... with sand rich in tufa, small pebbles, and white pumice". 117 The calcareous deposits which constitute the geological makeup of the local highland bedrock may well extend out from shore; however, this could not be determined without geological core sampling.

Of greater geological significance to the study of the ancient harbor works is the relative change in sea level along this area of the coastline. Unlike some areas of the Tuscan coast, such as Populonia, where a rise in sea level as great as 2.0 to 2.5 m. since Etruscan times has been proposed, 118 at Porto Clementino it appears


117 Schmiedt, op. cit. (in note 11) 252.

118 McCanna, op. cit. (in note 12) 293.
that the sea level has risen only about 0.5 m. since the Roman period. Recent sea level data obtained from the Marta River, 2.5 km. north, the Mignone River and Point Mattonara, both approximately 0.5 km. south, and Point Augustino and Torre Valdaliga, 8.5 and 12 km. south, respectively, show a rise of 0.40 to 0.65 m. from Early Roman times to the present. For the Tyrrhenian coast of Italy in general, a sea level rise of about 1 m. has been suggested for the same period by Schmiedt. According to this study, archaeological remains indicate an average sea level rise of 7.5 cm. per 100 years from 300 B.C. to A.D. 150. E. Pongratz proposed the same change for the Latium coasts. N. Flemming, comparing the archaeological and geological evidence for sea level changes in the entire western Mediterranean basin, concluded that there has been no sea level change in the last 2,000 years. But, according to his calculations, sea level stability does not preclude variations of ± 50 cm. Thus, it seems reasonable to accept a sea level rise of 0.5 m. at Gravisca.

There has been no synthesis of agreement as to the nature of this change in sea level, e.g. whether it was a smooth and steady or


120 Schmiedt, op. cit. (in note 11) 316.


122 Flemming, op. cit. (in note 21) 85.
fluctuating rise, but it may have been caused by some combination of the eustatic rise in sea level brought about by melting glaciers, and tectonic subsidence (local earth movements).

Although this slight rise in sea level may be partially responsible for the present submergence of the breakwater remains 0.5 to 0.8 m. below the surface, the deposit of silt and sand in the harbor has resulted in an extension of the shoreline approximately 20 to 25 m. out from the ancient coastline. One indication of this may be found by examining the berm line which shows up on the aerial photograph in figure 10. This line, visible as the sand/dune-grass interface circa 1 to 2 m. high which can be seen inshore of the beach line, is often used by geologists to determine ancient coastlines as it tends to represent the boundary of the ancient foreshore. If this is in fact the case at Porto Clementino, it would appear that the harbor may well have been larger and more protected in antiquity; perhaps as much as 20 m. farther inshore behind the promontory. Given that this area would have been substantially deeper before the shoreline silted

123 For a summary of these arguments see J. Gifford, "Sea Levels and Ancient Seafaring," ATNA Newsletter 3,2 (1976) 1-3; and section by J. Bourgeois in McCann, et al., op. cit. (in note 12) 290-292.

124 Pirazzoli, op. cit. (in note 119) 519 notes that eustatic fluctuations in the northwestern Mediterranean have not exceeded 0.15 m.

125 Flemming, op. cit. (in note 21) 85 concludes that there has been no change in sea level since the year 0 due to eustasy, only changes due to tectonism.

126 F. P. Shepard, Submarine Geology, (New York 1963) 169 and personal communication Captain T. K. Treadwell, Jr., Department of Oceanography, Texas A&M University.
Figure 10. Aerial view of Porto Clementino and salt marsh, 1939. North is to left. Photo released by Stato Maggiore Aeronautica, kindness of Ammiraglio F. Gnetti, Sub Sea Oil Services, Piumincino.
in, it must be supposed that Porto Clementino would have offered a sizable anchorage area for sea-going ships.
THE SURVEY

Objectives

Aside from the few limited investigations of Porto Clementino conducted from shore by Pasqui, Schmiedt, and Quilici and one brief series of dives on the site by A. M. McCann's Etruscan Port Survey team in 1968, no surveys or underwater investigations had been attempted at Porto Clementino before 1977. Aerial photographs taken in 1974 by Julian Whittlesey (FIG. 11) served as the initial guide in planning our survey, and based upon the underwater features visible on these photographs, I decided to concentrate upon the area approximately 300 square meters to the north and west of the harbor promontory.

With the overall goal of determining the design and dating of the ancient port, the objectives of the survey were: 1) to examine and define the presumed area of the ancient breakwater; 2) to map the underwater remains and reconstruct a contour map of the breakwater area; 3) to excavate trial trenches to help determine the type of breakwater construction and overall design of the harbor; and 4) to obtain datable material from the breakwater area to document the harbor's use and period of construction.

Procedures

The work was conducted in phases corresponding to these objectives. The first phase consisted of diver reconnaissance over the entire area of submerged remains visible on the aerial photographs and extending approximately 300 m. to the north, south, and west of the harbor.
Figure 11. Aerial photomosaic of Porto Clementino. North is to left. Photo J. Whittlesey 1974; kindness of A. M. McCann.
promontory. Until the numbered stakes had been laid out to serve as survey points and orientation markers, divers could keep their bearings only by surfacing constantly in the 1-to 3-m. deep water and sighting to shore with compasses.

The main purpose at this point was to determine the extent of the breakwater remains in order to decide in which areas mapping should be concentrated. The remains were found to consist primarily of mud, coral, and *poseidonia* weed, and were arranged in a completely irregular pattern extending in all directions. The *poseidonia*, more commonly referred to as *poseidon grass*, presented the greatest problem for mapping in that it grows in dense clusters of tangled roots or *motte*, and is virtually impossible to penetrate with knives or airlifts¹²⁷ (FIG. 12). It immediately became apparent, then, that the major problem of the survey would be to distinguish which of these mounds covered natural features and which covered man-made breakwater structures. Only a large mound of rubble circa 100 m. across found 125 m. northwest of the bastion stood out at first as a likely portion of an ancient breakwater.

There was one area visible on the aerial photographs which could be eliminated from consideration as a breakwater, however, this being

¹²⁷ *Poseidonia oceanica* overruns all the rocky or sandy substrata along the Italian coast and southern France, growing in depths from the surface to about 40 m. Because it can cover pure sandy areas as well as rocks, it was difficult to tell which areas were relative to the interpretation of the ancient breakwater. For discussion of this and other marine features see W. D. Nesteroff, *Geological Aspects of Marine Sites,* *Underwater Archaeology – A Nascent Discipline* (Paris 1972) 176.
Figure 12. High-relief mound of poseidon grass 100 m. west of bastion promontory.

Figure 13. Rectangular "bastion blocks" resembling blocks used on bastion. Scale in 50 cm. increments.
a low coral outcrop located approximately 20 m. to the west of the promontory and extending approximately 200 m. to the south. The predominance of coral in this area, with little sign of concentrated rubble, differed substantially from the remains to the northwest of the promontory.

Aside from the relatively large amount of rubble scattered on and under the poseidon grass in the latter area, several squared limestone and tufa blocks resembling those used in the construction of the bastion were noted lying on top of the poseidon-grass mounds from 25 to 225 m. northwest of the promontory (FIG. 13). The blocks averaged 30 x 30 x 20 cm. in size and were covered with encrustation. Numerous amphora sherds consisting primarily of unidentifiable belly fragments were also seen mixed between the sea bed and the rocks or scattered in the sand beside the mounds. All of the above factors suggested the region northwest of the promontory to be the most important area for mapping.

After several days in the initial reconnaissance phase, we set out numbered stakes marking all the visible remains in the survey area in preparation for the mapping phase. The markers were 0.5 m. long stakes of metal reinforcing rod labeled with yellow plastic tags 8 cm. square. Approximately 200 of these were set out over the course of three weeks. We began phase two, mapping the points using shore-based theodolites, before all the stakes had been placed, due to our discovery that several of them were being removed each day by the many snorkelers in that area. Of the original 200 stakes, only 170 were
eventually located for plotting.  

With the help of a four-man Italian survey team, we plotted the points using a "Galileo" theodolite and "Geodimetro 12" electronic distance calculator.  

Sightings were made to a 5-meter long adjustable range pole on which the prism of the electronic distance calculator was mounted (FIG. 14). The pole was held by a diver positioned beside a numbered stake (FIG. 15), and the depths were simultaneously recorded by another diver reading the increments directly off the calibrated range pole. Diver-to-shore communication was provided by two-way radio, with one person manning the radio from the support boat and another from the bastion station. In this way the boat crew could notify the transit operator exactly when the pole was in position, and could relay the depths as they were recorded. With the theodolite providing the angle, the electronic distance calculator giving the exact distance, and the range pole itself showing the depth, all points throughout the 250-square-meter area could be plotted to an accuracy of ± 0.02 m.

With survey points placed around the perimeter of each poseidon-grass and rubble mound, divers could then measure and sketch the area between the points on sheets of polyester drafting film mounted

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128 One attempt to deal with this problem was to post a sign in Italian explaining our work and asking people not to remove the stakes. This lasted several days before it too was removed.

129 At first two theodolites were used, one placed at the bastion station and the other moved between two secondary locations along the beach to the north. After plotting a series of triangulations to double check the accuracy of the electronic distance calculator, only the bastion station was used for sighting.
Figure 14. Diver steadying range pole from surface. Support boat to right.

Figure 15. Diver holding range pole beside numbered stake.
on plastic slates, noting the density and size of rubble concentrations, square blocks, or coral, and recording the locations of sherd concentrations and other distinguishing features. Measurements immediately around the numbered stakes were first taken using the Peterson compass-rose method, but this proved to be both difficult and time-consuming in the shallow waters heavily affected by surge. We then resorted to the standard method of triangulation using 50-meter plastic tapes. However, this also presented difficulties because the divers easily lost their bearings swimming over the vast distances of identical terrain.

Thus, in order to provide accurate coverage over the broad, confusing expanses on top of the grass and rubble mounds, a system of radial mapping was devised, enabling divers to plot their positions and sketch bottom features simultaneously. The mapping technique used was adapted from civil defense search and rescue procedures, and consisted of a 25-meter-radius radial search pattern oriented according to the directions of the compass. Equipment consisted of a central stake, a 25-meter line marked in 5-meter intervals, a clip attaching the line to the stake, and a combination compass board and slate marked with a polar graph (FIG. 16). The compass was mounted on one corner

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130 M. Peterson, *History Under the Sea. A Handbook for Underwater Exploration* (Washington D. C. 1965) 42 and pls. 1-3. This method consists of an azimuth ring mounted on a central stake, with bearings and distances to each feature recorded using a plastic measuring tape. Two divers are necessary for this procedure; one to read the distance and one to record the bearing.

131 This system was developed and perfected by team members Tom Gross and Nan Bray.
Figure 16. Radial mapping board with polar graph drawn on slate and radial map sketched on drafting film.

Figure 17. Diver swimming circular pattern using radial mapping board.
of the slate, with the zero arrow of the compass on a line with the
cord and pointing away from the center of the circle to be mapped.

The diver swam along the bottom holding onto the 25-meter line,
which was tied to one of the plotted survey points (FIG. 17). As
bottom features and numbered stakes were spotted, they could be entered
onto the slate according to the compass reading and distance out
from the center. When a full circle had been completed, the diver
moved out 5 m. to the next knot and made another run. A 25-meter
radius could be accurately charted in this way in approximately one
hour of diving time. As all the radial maps were drawn to the same
scale, they could be fitted together each night and reduced to the
smaller-scale final plan.

In addition to the above surveying and mapping activities,
numerous dives were also spent geologically sampling, measuring, and
drawing the rubble remains (FIGS. 18 and 19). In places of high
relief where rocks protruded from the poseidon grass, the ledges were
measured and probed for underlying rubble and the general morphology
of the mound was recorded (FIG. 20).

Mapping Results

Within approximately three weeks of diving time, all the survey
points had been plotted and the remains mapped according to bottom
topography and feature characterization. The bathymetric map (FIG. 21),
drawn according to the depths recorded for each point, shows the
contour of the harbor floor and should be read in reverse from a
normal topographic map (e.g. the numbers represent measurements in
Figure 18. Diver sampling and measuring scattered rubble beside poseidon-grass mound.

Figure 19. Diver sketching rubble concentration on poseidon-grass mound directly west of bastion promontory.

Figure 20. Diver probing poseidon-grass mound.
Figure 21. Bathymetric map of survey area.
Map: S. Smith.
centimeters below sea level, rather than height off the bottom).

On this map the areas of high relief to the northwest of the bastion promontory stand out as separated, oddly-shaped mounds. The largest mound farthest away from the promontory was also the highest in relief, approximately 3 m. off the sea bottom as shown in the profile in figure 21, while other areas to the south and east were in relatively low relief in shallower depths. A channel approximately 3 to 4 m. deep lay between the largest mound, and the other lower relief areas which spread to the south and east. There was also a small channel between the bastion promontory and the first small mound of rubble covered with coral, and another directly to the northwest of the largest mound; the northwest slope of this mound constituted the farthest extent of possible breakwater remains in the harbor. Both of the latter two channels are used today for the majority of boat traffic in the harbor.

The characterization map shown in figure 22 outlines the major differentiations between areas with and without poseidon grass mentioned above, and shows also the distribution of rubble in terms of size and quantity.132 Studying this map in conjunction with the bathymetric map, the underwater features can be read according to their morphology and present height off the sea bottom. Although each of these areas will be discussed in the final analysis of the survey, a brief description of each general area is given here to provide a basic

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132 Specifications as to rubble size and type were noted on the initial map, but are generalized here due to the limitations of graphic reduction.
Figure 22. Detailed characterization map of survey area. Letters indicate trench locations. Map: S. Matthews and L. Shuey.
orientation to the site.

The most prominent underwater feature was the main rubble mound 125 m. northwest of the promontory which was roughly 100 m. x 100 m. and stood approximately 3 m. above the bottom 0.5 m. below sea level at the highest point. The mound resembled a rubble pile composed primarily of large unshaped boulders 50 to 75 cm. in diameter (FIG. 23) mixed with medium-sized rocks 30 to 40 cm. in diameter (FIG. 24) and a few squared "bastion blocks". The rocks were packed in a solid mass, cemented together by natural concretion, and in many areas concentrations of amphora sherds were visible scattered among the rubble (FIG. 25). Poseidon grass and a few low coral heads bordered the rubble pile and in some places overlay the top of the mound. Several large shallow depressions resembling craters were visible in these poseidon-grass patches averaging 3 to 6 m. in diameter and 0.5 m. in depth. The edges of these craters looked as though they had been cut away rather than formed naturally, and it is possible that these may be connected in some way with the 1944 bombing of the harbor. Of all the underwater remains at Porto Clementino, the largest mound presented the greatest resistance to the waves and therefore seemed to be the most likely remnant of an ancient breakwater.

Focusing next on the small mound directly northwest of the bastion promontory (FIG. 22; e/2), we found a pile of large-and medium-sized limestone rubble 25 to 40 cm. in diameter covered by large coral heads. The mound measured 8 x 12 m. across and stood approximately 0.5 to 1.2 m. above the sandy bottom. The channel, 1.8 m. deep and 20 m. wide, which runs between this mound and the bastion promontory was of
Figure 23. Large, unshaped boulders covered with grass and concretion on main rubble mound.

Figure 24. Medium-sized rocks on main rubble mound. Scale in 10 cm. increments.

Figure 25. Amphora sherds imbedded among rubble on top of main rubble mound. Scale in 20 cm. increments.
special interest, for the question arose as to whether this channel formed the original design of the port or whether there existed some kind of connecting structure between the bastion and the small rubble mound as suggested by Pasqui's observations in the late 19th century. 133

The two oddly-shaped mounds of poseidon grass directly out to the northwest of the small rubble mound (FIG. 22; e-f/3) were slightly higher in relief than the grass areas immediately to the north and southwest (1 to 1.5 m. versus 0.5 to 1 m.). While the size of the rubble scattered on, and in some places under, the poseidon grass in these two areas was somewhat smaller than that on the solid rubble mounds. The density of these rubble concentrations was noticeably greater in this area than in the other lower relief grass beds.

In this area, too (FIG. 22; f/3), a piece of rough rectangular limestone similar to the "bastion blocks" noted above was seen protruding from the edge of the poseidon grass on the western edge of the mound circa 1 m. below the top. While in this case the limestone appeared to have been artificially shaped, in one other area nearby (FIG. 22; g/3), a similar but flatter and more irregular protrusion of limestone was noted beneath the poseidon grass level with the sea bottom (FIG. 26). Although the latter rock was more natural in appearance, without the expertise of a geologist we were unable to determine whether or not this may have been an indication of a natural limestone reef beneath the poseidon grass.

While the eastern edge of the poseidon grass to the southwest of

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133 Pasqui, op. cit. (in note 43) 519, note 3.
Figure 26. Limestone protrusion out from base of poseidon-grass extension 100 m. west of bastion promontory.

Figure 27. Small scattered rubble on sand beside poseidon-grass extension northeast of main rubble mound.
the promontory was relatively low in relief (0.2 to 0.3 m.), the north-west edge was considerably steeper (0.5 to 1.0 m.), and the drop-off between this area and the large rubble mound to the north (approximately 3 m. high) formed a channel-like depression 2 to 4 m. deep. Bordering the rubble mound to the east was another low extension of poseidon grass, with small scattered rocks visible on the sand along the eastern edge (FIG. 27) The western side of this extension (FIG. 22; a-d/4) was an obscure mixture of low poseidon-grass islands and fingers which did not appear to be related to the rubble remains and was also extremely difficult to chart under water. This area, then, along with the southern extension of poseidon grass (FIG. 22; 1/2-6), has been drawn as a dotted line on the map, representing also the boundaries of the survey.
THE EXCAVATION

With the mapping stage carried far enough to give some perspective on the extent and general contour of visible underwater remains, test trenches were excavated in selected areas with the objective of answering some of the questions about the site raised from the initial mapping: Were the solid rubble mounds all that remained of the presumed breakwater? Or were some areas buried beneath the sand, perhaps connecting the mounds already mapped? What kind of foundation would have been used under the rubble mounds? Which of the features were natural and which were man-made? How deep was the ancient sea bottom?

Ideally, test trenches into the rubble and through to the ancient floor would have allowed one to determine how the breakwater was constructed, and to identify its foundation. However, attempts to move the heavy rocks on the larger mound were thwarted due both to their size and to the fact that they were concreted naturally together, while on the smaller mound they were solidly buried by coral. It was possible to measure the thickness of the rock piles, and some excavation was possible on the main rubble mound. However, for the most part excavation was carried out in the sand beside the mounds with the objective of defining their boundaries.

This was done using a lightweight hydraulic suction dredge.\textsuperscript{134}

\textsuperscript{134} Also called a shallow-water airlift, this tool was first perfected by J. Shaw at Kenchreai. (See J. Shaw, "Shallow-water Excavation at Kenchreai," \textit{AJA} 71 (1967) 230; pl. 64 and Shaw, "Shallow-water Excavation at Kenchreai: II," \textit{AJA} 74 (1970) 179-180; pl. 49). The dredge used at Gravisca was similar in design, except that the rigid end of the
mounted on an inner tube or on the support boat for protection from sea water and for ease of transportation around the site (FIGS. 28 and 29).

It should be noted here, before evaluating the results from each trench, that vertical penetration through the sand was limited due to one major problem. Unless a retaining wall supported the sand on the side of the trench, the sides tended to slide down as fast as they were excavated. This problem was solved at Cosa and Populonia by using one-meter-high steel caissons 1.3 m. in diameter, inside of which a diver could excavate in a controlled manner. However, more manpower and a larger support boat than was available to us at Gravisca would have been needed to make use of this device. Several attempts were made to construct a more portable retaining wall in the form of a 1 by 3 m. sheet of thin metal bent into a semicircle and held in position with cross bars of steel reinforcing rod. In a calmer area this might have worked, but for our purposes it was unsuccessful as it was constantly knocked out of place by the surge. Our "trenches" were necessarily then shallow round holes, and vertical penetration was restricted to 0.5 to 0.8 m. at the deepest. Probes were made at the bottoms of the trenches when it became impossible to dig deeper, and thus 1 to 1.5 m. of penetration could at least be obtained.

suction hose was used for intake rather than exhaust, and the motor (3 1/2 h.p. Briggs & Stratton), mounted on the boat or inner tube, enabled operations to be moved out from shore rather than be restricted to a given length of hose extending out from the beach as at Kenchreai.

135 McCann and Lewis, op. cit. (in note 16) 204-206.

136 McCann et al., op. cit. (in note 12) 283.
Figure 28. Stand-by diver starting airlift mounted on support boat.

Figure 29. Airlift mounted on inner tube during excavation of channel trenches beside bastion promontory.
The first series of trenches was directed toward exploring the small channel between the bastion promontory and the first small, coral-covered rubble mound. We hoped to determine, first, how deep the rubble actually extended beneath the sand and, second, if it extended outward to the south, possibly bridging the gap between it and the bastion. Trench A (FIG. 30) shows the profile beside the mound to a depth of 0.5 m., while trenches B and C (FIG. 31) extend out into the channel to the same depth. Trench locations are noted by corresponding letters on the characterization map in figure 22.

Trench A revealed limestone rubble extending down at least 0.3 m. below the rubble mound. A layer of fine black silt with decayed vegetation was encountered 0.15 m. below sterile coarse sand, a layer which was found uniformly at approximately the same depth throughout the channel excavations. Below this, only a scattering of medium-and small-sized limestone and tuff fragments was found along with other small igneous pebbles of various compositions. One unidentifiable amphora sherd was found at a depth of 0.2 m.

Trenches B and C were excavated extending southeast across the channel perpendicular to the bastion promontory. Again, only a scattering of small and medium rubble was found, spaced on the average 0.2 to 0.5 m. apart, along with another unidentifiable sherd. Probes made at the bottom of all three trenches did not hit solid material, suggesting that the smaller rubble was a result of natural deposition from either the bastion or the small mound, and negating the idea of a connecting structure between these two features. It is possible that extensive silting has occurred in this channel, covering what might
Figure 30. Section of Trench A excavated in channel beside bastion promontory.

Figure 31. Section of Trenches A, B, and C excavated in channel beside bastion promontory.
have been Pasqui's observation of a continuous mole; but local accounts
from fishermen indicate that the channel has been there at least since
1917 and, as mentioned above, most of the silting appears to have taken
place after World War II.

Trenches D and E (FIGS. 32 and 33) on the northwest side of the
small mound were excavated in the same fashion described above, here
somewhat more successfully to a depth of 0.75 m., with the same objec-
tive of checking for buried connecting rubble. Again, only scattered
limestone and tuff fragments were discovered from .20 to .65 m. deep,
along with two bricks, small pieces of natural concretion, and a small
piece of hematite.¹³⁷ A glazed rim fragment, probably Medieval, was
found in Trench D, the only non-ancient sherd found during the survey.

Another effort to locate extensions of the breakwater mounds took
place in the form of a trench system G (FIG. 34): a series of five
holes circa .80 m. deep and 1 to 3 m. in diameter which extended circa
15 m. across the channel to the west of the main rubble mound. The
same assortment of pebbles and medium-sized rocks including red lime-
stone, igneous rocks, and natural concretions, was recorded beginning
0.2 to 0.4 m. beneath the sand and continuing interspersed with sand to
a depth of 0.8 m. One sherd, sandstone, quartz, red tuff and marble

¹³⁷ This sample, tentatively identified for us by Gianfranco
Ciurliuini and Dr. John Oleson as having possible origins in the nearby
island of Elba, is of interest in that early exploitation and ship-
ment of iron ore from Elba is associated with the Etruscans. See
McCann, op. cit. (in note 26) 20.
Figure 32. Section of Trench D excavated 35 meters northwest of bastion promontory.

Figure 33. Section of Trench E excavated 40 meters northwest of bastion promontory.
Figure 34. Cross-section of Trench System G excavated across channel south of main rubble mound.
fragments were also uncovered. The trench system ended approximately mid-channel, where it ran into a low-relief area of poseidon grass and a large number of sherds. Two large amphora bases, one within the other, were found to the west of this grass outcrop, but they were removed by local snorkelers before we could return on the next dive to retrieve them.

After it was determined that underlying rubble did not appear to connect either the small rubble mound with the bastion or the main rubble mound with the area directly across the channel, an attempt was made to examine the morphology of both the poseidon-grass and pure rubble mounds.

Trench F was excavated directly into the southeast side of the main rubble mound through a section of poseidon grass which bordered the south and west sides (FIG. 35). This location was chosen because the rubble-studded poseidon grass was typical of the rest of the site, and at the same time was associated with probable breakwater remains. It was therefore hoped that this section would reveal the foundation of the rubble mound, as well as the kind of sub stratum the poseidon grass might be covering. Choosing this route was, in fact, the lesser of two evils because, while it was impossible to remove the concreted large rubble, vertical penetration through the poseidon grass was also limited due to the density of the thick matted

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138 Professor Jelle de Boer kindly identified several of these samples from color slides. He noted that the red sandstone, red limestone, and one volcanic tuff fragment were most likely collected from gravel banks in one or more major streams, possibly picked up as ballast for ships.
and its virtually impenetrable nature. 

Though time-consuming, it was feasible to excavate one section through the sea grass and down below the sand to a depth of 1 m. Below 0.6 m. of poseidon grass matte and approximately 0.05 m. of black organic material, a medium-sized piece of natural concretion (0.1 x 0.2 x 0.5 m.) appeared, along with a few large limestone rocks approximately 0.1 m. apart. Four other small concretions were mixed with a heavy concentration of pebbles and limestone rubble to a depth of 0.55 m. below sand level. The remaining 0.4 m. was mostly coarse sand with a definite decrease in rubble concentration. A small ceramic sherd was found 0.35 m. below the sand and 0.7 m. out from the embankment.

One other attempt at finding some indication of constructional features for a breakwater was made near the southwest corner of the main rubble mound in the area with the highest concentration of squared limestone blocks (FIG. 22; g/5-6). Although both their similarity to the blocks used on the bastion and the sparsity of their distribution over a broad area suggests that their existence in the harbor may be the result of the World War II bombing of the bastion rather than part of the original breakwater, it was possible that other blocks might be uncovered in a more intact position. The results were negative, both in a section excavated 0.4 m. down into the grass beside the #33 marker

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139 This problem has also been encountered on previous surveys along the Italian coast, most notably at Pyrgi and Populonia, where poseidon grass completely covered a large part of the underwater remains. It was not solved there either, as the only solution is a more powerful dredge than has been available to any of these surveys.
Figure 35. Section of Trench F excavated through poseidon grass on southeastern border of main rubble mound.

Figure 36. Section of Trench H excavated through poseidon grass on western border of main rubble mound.
and in Trench H, excavated in the sand directly beside the mound (FIG. 36). Probes were made to an additional 1 m. in depth, again with negative results.

By far the most revealing phase of the excavation came from the trench located on top of the main rubble mound in one of the poseidon grass crater-like depressions mentioned earlier (location f/6). In addition to the extremely high concentration of sherds embedded among the medium and large unshaped boulders around this area, hundreds of sherds were visible protruding out from under the poseidon-grass ledges surrounding each hole (FIG. 39). Sampling one 25-cm.-thick layer in this sherd deposit directly beneath stake #95, (Section Ia, FIG. 37), one amphora neck and a lip fragment were found among approximately 50 sherds of similar material. Because this type of sherd deposit, in situ beneath approximately 0.4 m. of grass overlying the rubble, could be useful in dating the rubble deposit itself, a trench was begun five meters around to the northwest of the stake through an identical section of the exposed crater ledge (Trench Ia; FIGS. 37 and 38). At 0.42 m. below the poseidon grass, a number of light red-ware amphora necks with thin walls were found, again embedded among hundreds of smaller, unidentifiable sherds (FIG. 40). Due to the limitations of time here, only necks, bases, lips, or handle fragments were saved for cataloging; however, it was noted that they were predominantly of the same red-ware composition. Beneath this level, a layer of poseidon grass, gravel, concretions, and mud was mixed with a few sherds of coarse gray texture, thicker than those noted above. These extended approximately 0.3 m. down, whereupon another sherd layer of coarse gray
Figure 37. Section of crater-like depression in poseidon grass on top of main rubble mound showing locations of Section Ia and Trench Ib.

Figure 38. Section of Trench Ib.
Figure 39. Sherds protruding from edge of crater-like depression in poseidon grass on top of main rubble mound.

Figure 40. View of sherds underlying poseidon grass in upper half of Trench Ib.
amphora sherds was intermingled with medium and large limestone rocks and mud (FIG. 41). Below the 1.40 m. mark the mound was solid rubble. Analyses of these finds will be presented in the next section.

A cylindrical piece of wood 20 cm. in diameter was found 15 cm. below the rubble bottom of the crater (FIG. 42). This was notched with a kind of lip 5 cm. thick, and two straight grooves 5 cm. wide by 2 cm. thick were notched on either side of the cylinder directly below this lip on the outside. A hole 8 cm. across at the top revealed another smaller hole several centimeters below. It was impossible to determine the full shape of this wooden piece, as it was tightly wedged between two rocks and buried well below the narrow trench bottom, but its size and shape seemed to indicate that it was probably not part of the original breakwater construction. 140

In the process of exploring the sandy areas around the main rubble mound for potential excavation sites, the remains of two ships were found partially buried in the sand; one lay in a narrow sand depression in the poseidon grass 5 m. east of the main rubble mound, and the other in the sand beside the low sea-grass extension 175 m. northwest of the same mound. 141 As these hull remains might have served to indicate the type of ships used in the harbor and, if datable, the time in which

140 Several suggestions as to its possible identification have been offered by Mr. J. Richard Steffy. These include a capstan and the revolving drum from a lifting crane.

141 We learned of two others from a local fisherman who pointed out the clandestine operations of a group of Italian divers working near the easternmost one we located and also circa 250 m. north of the main rubble mound. As we were warned by the locals against interfering in any way with this group, we did not attempt to dive on the wrecks.
Figure 41. View looking down into Trench Ib directly below section visible in figure 40.

Figure 42. Conceptual sketch of unidentified cylindrical wood piece found in Trench Ib.
the harbor was in use, they were partially excavated by hand fanning and air-lifting and recorded as finds of potential interest for further study.

The ship located closest to the rubble mound lay oriented in a north-south direction in 3 m. of water, and appeared to have come to rest in an upright position on the sea bed. Most of it had been destroyed by a combination of wave action, teredo worms, and local salvage operations. However, a large enough section of the keelson, adjoining frames, and planking survived to enable limited interpretation of the ship. A total length of 5.5 m. of hull remains buried beneath approximately 20 cm. of sand was excavated by hand fanning and partial use of the dredge pump. These were photographed, drawn and measured for the plan in figure 43.

A 2.50-meter stretch of broad, flat keelson, with an average siding of circa 37 cm. and moulded to an average of 16 cm. was found overlying fragments of 7 floor timbers. This was locked over the frames with sawed, square notches to help keep them in place. One additional floor timber lay in situ beyond the broken end of the keelson, and another displaced frame was uncovered one meter to the west.

The top of the keelson appeared to be rounded (FIG. 44), and the lack of splitting and wear marks along its edges indicated that it was probably rounded originally. There was no evidence for bolts or nails through the keelson; however, treenail fastening could well have been

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142 The following analysis is based upon the interpretation of the plan and photographs made possible by the invaluable aid of Mr. J. Richard Steffy.
Figure 43. Plan of hull remains excavated in sand depression on eastern border of main rubble mound. Letters indicate hull timbers referred to in text.
overlooked. A possible treenail was found lying under the keelson next to frame FH (3.5 cm. in diameter, with an extant length of 19.2 cm.).

All the frames appeared to be floor timbers, with the exception of one possible futtock, FY, pressed into a floor timber on the west side of the keelson. Two other pieces, UM\textsubscript{1} and UM\textsubscript{2}, lying beside this one, were approximately the same shape and thickness and may be frames as well. The floors averaged 11 cm. square in cross-section and were spaced approximately 22 cm. apart (Fig. 45). Two frames spaced only 8 cm. apart were located directly below the only surviving piece of ceiling planking (CP). No explanation could be found for this change in spacing. The wood for the frames has been tentatively identified from the photographs as hardwood.\textsuperscript{143} Limber holes were recorded under frames FH and FX, approximately 25 cm. from the keel centerline.

A timber believed to be a piece of the keel lay skewed over to the east side of the keelson, apparently broken off and displaced from its original position (K\textsubscript{1}). A profile of this piece showed a 1 cm. rabbet 4 cm. from the top and 7 cm. up from the slightly curved bottom. Although the piece was buried too deeply to record its width, the shape of the profile left little doubt that it was a keel. At the southern extremity of the keelson, directly beneath it and frame FH, a similar cross-sectional dimension was recorded, sided 13.75 cm. and moulded 12.0 cm. At least three pieces of outer planking, two of which

\textsuperscript{143}J. R. Steffy, Personal communication; type unknown.
Figure 44. West side of keelson showing rounded upper edge and notches over floor frames. Section of garboard visible between frames. Scale in 20 cm. increments.

Figure 45. West side of southernmost extremity of keelson. Frames FE (left) and FG (right) overlie fragments of outer planking. Scale in 20 cm. increments.

Figure 46. View from southernmost extremity of keelson. Keel and garboards visible beneath frame FG. Displaced frame FZ visible at bottom. Frame FH lying to right of keelson was removed from original position. Scale in 20 cm. increments.
are garboards, were recorded\textsuperscript{144} (FIG. 46).

The garboards were fastened with 1-cm.-square nails, three of which were found on the east side of the keelson. Two similar square nails were recorded fastening the ceiling planking to the floor timber. A countersunk nail hole with signs of ferrous concretion was found on an unidentified piece of wood (UM\textsubscript{4}) (75 \times 32 \times 5.8 cm.) lying to the west of the keelson. A notched piece of wood (UM\textsubscript{3}) lying approximately 40 cm. south of the keelson was also unidentifiable.

The form and size of the timbers at hand indicates that this was not a particularly strong or big ship. What appear to be an undersized keel and a light framing pattern support this assumption. Comparable framing size and spacing can be found on the Kyrenia ship,\textsuperscript{145} Brown's Ferry,\textsuperscript{146} and the Serge Liman ship,\textsuperscript{147} all of which have an estimated length of 15 to 20 m. The floors indicate a medium dead rise. No traces of cargo were found to help date the ship, but the lack of mortise-and-tenon joint pegs in the outer hull planking would place it after the 4th century A.D.\textsuperscript{148}

\textsuperscript{144} While all the planking thicknesses were not determined, the garboard thickness appeared to match that of the keel at their junction, while the outboard edges had a thickness of 5 cm. thick. However this may be an erroneous measurement.

\textsuperscript{145} Casson, op. cit. (in note 5) 214.

\textsuperscript{146} Wright, "Notes and News", \textit{IJNA} 6.1 (1977) 75-77.

\textsuperscript{147} F. H. van Doorninck, Jr., personal communication.

\textsuperscript{148} All Mediterranean ships so far excavated dating between the 5th century B.C. and the 4th century A.D. have had their hull planks edge-joined with pegs locking mortise and tenon joints. See F. H. van Doorninck, Jr., "The 4th century wreck at Yassi Ada. An interim report on the hull", \textit{IJNA} 5.2 (1976) 122-123.
The hull remains of the second ship located farther to the north-east consisted of two broken pieces of keel, 8 frame timbers, 4 pieces of planking, a possible knee, and an unidentified broad, rectangular piece of wood with square nail holes. Although the wood was well preserved, the exposed and fragmented state of this hull left little room for interpretation of the ship. However, approximate measurements and sketches of the wood were made.

The two sections of the keel lay several meters apart, but appeared to be from the same ship. They were approximately 2.13 m. long and were sided 12.70 cm. and moulded 20.32 cm. The keel was rabbeted, with notches in the top of varying sizes, averaging 21 cm. wide by 2.54 cm. high, and spaced 17.78 cm. apart. One piece of the keel had no extant frames, while on the other, remains of 8 floor timbers were found in situ on top of the keel extending to the east side. Measurements recorded for the frames were 5 m. long, sided circa 45 cm., and moulded 33 cm. Although these pieces were observed on the bottom as 8 individual pieces, it is possible that they actually represented 4 frames, each consisting of an adjoining frame and futtock. In either case, the size and spacing of the framing indicates heavy construction and contradicts the lightness of the keel, which is relatively small. Perhaps a heavy keelson made up for the minimal structural contribution of this keel, but unfortunately no evidence for a keelson was found. No cargo was found from this ship either, but we were told by local Italians that Venetian pottery has been brought up from the ship in the past.
THE FINDS

The following catalogue lists the complete sampling of artifacts raised from the survey area. They consisted entirely of potsherds with the exception of a few roof tile fragments. Roughly half the finds were unidentifiable amphora sherds found in the sand trenches; the remainder were datable neck, handle, and toe fragments recovered loose from the bottom and from beneath the rubble on top of the main rubble mound. The finds were rinsed in fresh water upon recovery and are now in storage at the Museo Nazionale di Tarquinia.

The catalogue is arranged according to fragment type, with proveniences listed and identifications given where possible. Field catalogue "numbers" assigned alphabetically as letters appear in parentheses; numbers to the right of letters indicate individual items in a lot number, e.g. A1_2. Proveniences are listed with respect to the map in figure 22.

Catalogue of Artifacts

1. (AC; FIG. 47a) Amphora neck fragment preserving rim, piece of one handle, and stump of other handle. Preserved ht. 0.14 m. Rim diam. 0.128 m. Rim ht. 0.017 m. Mouth diam. 0.12 m. Clay is micaceous; gray to yellow-buff. Rolled rim has chip in one side. Marine deposit on surface.

Upflying double handle is similar to Dressel types 2-4, CIL xv, pl. 2; (2nd to 3rd century A.D.), and profile is comparable to neck fragment in M. Capitanio, "La Necropoli Romana di Portorecanati," NSc. Series 8, 28 (1976) 240. n.54, (1st half 2nd century A.D.). Also corresponds to Type 12b in E. L. Will's typology for Roman amphoras to be published in the Athenian Agora series.149 E. L. Will suggests possible

149 E. L. Will, personal communication. All comments by Dr. Will incorporated into this catalogue are based upon her kind examination of the drawings and photographs.
imitation of Roman type.

Provenience: Surface find; h/4-5.

2. (AQ; FIG. 47b) Amphora with outflaring rim; both handles preserved. Pres. ht. 0.20 m. Rim diam. 0.123 m. Rim ht. 0.018 m. Mouth diam. 0.105 m. Clay is slightly micaceous; dark brown. Slight marine deposit on surface.

Neck is similar to Dressel types 7, 9, 10, and 11, CIL xv, pl. 2. E. L. Will suggests jar was manufactured in Spain and used to import garum (fish sauce). Estimated date 2nd to 3rd century A.D.

Provenience: Section Ia on top of main rubble mound.

3. (AS; FIG. 47c) Amphora neck with shoulder fragment and one double-ribbed handle preserved. Pres. ht. 0.155 m. Rim diam. 0.088 m. Mouth diam. 0.08 m. Rim ht. 0.014 m. Clay is fine with slight traces of silver mica; light brown to red-buff. Rolled rim has chip in one side. Slight marine deposit on surface.

Profile and fabric similar to "Gallic" type amphora in C. Panella, "Ostia III," Studi Miscellanei 21 (1973) 628 n.19, 20; probably imitation of "Mauretanian" type amphora. Dated circa 2nd to 3rd century A.D.

Provenience: Trench Ib.

4. (AT; FIG. 47d) Amphora neck with pieces of shoulder and two double-ribbed handles preserved. Pres. ht. 0.249 m. Rim ht. 0.015 m. Rim diam. 0.095 m. Mouth diam. 0.075 m. Clay is slightly micaceous; orange to red-buff. Everted rim has chip in one side. Heavy marine deposit on one handle and shoulder.

Neck is similar to "Gallic" type amphora with same parallels as above example. Dated circa 2nd to 3rd century A.D.

Provenience: Trench Ib.

5. (AH; FIG. 48a) Amphora handle with fragment of belly preserved. Pres. ht. frag. 0.253 m. Diam. handle 0.036 m. Clay is extremely coarse with abundance of black mica; beige to yellow-buff. Handle appears to be attached to upper portion of belly, as top edge curves up slightly suggesting beginning of extremely short neck. Thick marine deposit on surface.

Rounded shape and fabric type suggest handle is Etruscan with similarities to 6th century B.C. Etruscan form 3 from Bon-Porte I; cf. B. Liou, "Note provisoire sur deux gisements Greco-Etrusques (Bon-Porte a et pointe du dattier)," Cahiers d'archéologie subaquatique 3 (1974) 10-11, pl. 1, fig. 3. Also similar to Etruscan amphora in P. Fiori, "Le Mouillage antique du Cap Gros," Ibid. 97, pl. 1, figs. 1 and 2.

Provenience: Surface find; g/4.

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150 This identification is based upon Prof. M. Torelli's inspection of the handle at the site. A parallel with Punic amphora types was suggested by E. L. Will, cf. P. Cintas, Ceramique Punique (Tunis 1950) pls. 16 and 17, however these differ slightly in shape and are of a different texture and color.
Figure 47. Amphora neck fragments dated circa 2nd-3rd century A.D.
6. (AP; FIG. 48b) Double-ribbed amphora handle. Pres. ht. 0.18 m. Clay is extremely micaceous with white inclusions; orange to red-buff. Slight marine deposit on surface.

Handle resembles "Tarracconensis" type amphora in F. Zevi, A. Tchernia, and C. Panella, et al., "Recherches sur les amphores Romaines," Collection de l'école Francaise de Rome Supplément 10 (1972) 56, fig. 1. E. L. Will suggests Spanish imitation of Campanian Dressel types 2-4 in Panella, "Ostia III" 625 n.5; probably used to carry wine. Also similar to Dressel types 44 and 45. Corresponds with E. L. Will's type 12b. Dated 1st to 3rd century A.D.

Provenience: Surface find; g/3.

7. (AW; FIGS. 48c-d) Amphora handle with stamp. Pres. ht. 0.20 m. Width 0.045 m. Ht. of stamp 0.012 m. Width of stamp 0.06 m. Clay is micaceous; gray-buff.

Handle shape is similar to Dressel type 20 I in Panella, "Ostia III," 627 n.15. Also corresponds to E. L. Will's type 20. Dated circa 2nd century A.D.

E. L. Will offers the following interpretation of the stamp: The apparent letters C · F V A C should be read C · F UL A C, with the ligature UL barely discernible. Two parallels for this stamp are Q · F UL N C; CIL xv. 2897 and Q · F UL N G; CIL xiii. 10002.234, both of which Dr. Will believes are misreadings of the original stamp where the letter N was mistaken for the letter A. The stamp is dated late 1st to 3rd century A.D.

Provenience: Trench Ib.

8. (AX; FIG. 48e) Amphora handle with small fragment of shoulder preserved. Pres. ht. 0.253 m. Width 0.049 m. Clay is micaceous; gray-buff identical to above handle.


Provenience: Trench Ib.

9. (AZ; FIG. 48f) Amphora handle. Pres. ht. 0.197 m. Diam. 0.045 m. Clay is micaceous; gray-buff.

Handle is similar to Dressel type 20 in Panella, "Ostia III," 627 n. 17 and E. L. Will's type 20. Dated circa 2nd century A.D.

Provenience: Trench Ib.

10. (AB; FIG. 49a) Amphora fragment with pieces of lower belly and toe preserved. Pres. ht. 0.21 m. Diam. at base of toe 0.037 m. Clay is slightly micaceous; orange to red. Marine deposit on surface.


Provenience: Surface find; d/3.
Figure 48. Amphora handles and stamp.
  a) Handle dated ca. 6th century B.C.
  b-c) Handles dated ca. 1st-2nd century A.D.
  d) Stamp of handle in c).
  e-f) Handles dated ca. 2nd century A.D.
11. (AM; FIG. 49b) Flat-bottomed amphora fragment with one side of lower belly preserved. Pres. ht. 0.15 m. Diam. at base of toe 0.05 m. Clay is slightly micaceous (silver mica); red to brown-buff. Partly covered with marine deposit.

Fragment is similar to African "Mauretanian" type 18 amphora in Panella, "Ostia III" 629 n.25-32 and 630 n.33. Dated late 1st to 2nd century A.D.

Provenience: Surface find; f/3.

12. (AN; FIG. 49c) Flat-bottomed amphora with fragment of lower belly preserved. Pres. ht. 0.155 m. Diam. at base of toe 0.05 m. Clay is micaceous; brown-buff. Slight marine deposit on surface.

Fragment is similar to African "Mauretanian" type 18 with same parallels as above example. Dated late 1st to 2nd century A.D.

Provenience: Surface find lying directly under above amphora toe; f/3.

13. (AU; FIG. 49d) Amphora toe with fragment of one side lower belly preserved. Pres. ht. 0.104 m. Diam. at base of toe 0.016 m. Clay is smooth with few traces of mica; beige to red-buff. Wheel ridges slightly visible on exterior surface. Marine deposit on interior surface.

Fragment is similar in shape to unpublished "Africano grande" type amphoras from Cosa, circa 3rd century A.D., however no exact parallels could be found.

Provenience: Trench Ic.

14. (AV; FIGS. 50a-c) The following 5 fragments were found together in Trench IB. As all appeared to be of the same type in size, shape, and fabric they were catalogued under one lot number. The presence of 2 toe fragments indicates at least 2 amphoras are represented. The fabric of each piece was micaceous; dark gray with light gray mottling on surface probably due to submersion.

Two pieces not illustrated were belly fragments; one with the handle stub preserved (Pres. ht. 0.224 m. Pres. width 0.12 m.) and one broad in curvatura with wheel ridges visible on the interior surface (Pres. ht. 0.23 m. Pres. width 0.195 m.

FIG. 50a: Toe fragment. Pres. ht. 0.047 m. Diam. at base of toe 0.015 m. Slight ridge at juncture of toe and base of amphora.

FIG. 50b: Toe fragment. Pres. ht. 0.046 m. Diam. at base of toe 0.019 m.

FIG. 50c: Rim fragment. Pres. ht. 0.055 m. Pres. width 0.13 m. Slight indentation visible on lower portion of interior rim face.


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151 E. L. Will, personal communication.
Figure 49. Amphora toes with fragments of lower belly.

a) Fragment dated ca. 3rd-1st century B.C.
b-c) Fragments dated ca. 1st-2nd century A.D.
d) Fragment dated ca. 3rd century A.D.
15. (AG; FIG. 50d) Rim fragment, probably from bowl. Pres. ht. 0.10 m. Pres. width 0.14 m. Clay is slightly micaceous; gray to pink-buff; thin yellow-green glaze with dark gray-green mottling visible on interior and exterior surfaces.

Presence of glaze places this fragment sometime after the 7th or 8th century A.D. according to D. Whitehouse, "The Medieval Glazed Pottery of Lazio," BSR 35 (1967) 45, 46. Glaze may correspond to Whitehouse's "green-glazed" type (p. 55) described as follows: A bright green finish applied to smooth pink or reddish fabric; principal forms bowls and jugs; open forms glazed on the outside and inside." This parallel would narrow the date to circa mid 12th to 14th century A.D.

Provenience: Trench D.

16. (AL₁; FIG. 50e) Rim fragment. Pres. ht. 0.05 m. Pres. width 0.042 m. Slight traces of silver mica; brown-buff.

Provenience: Found between frames of hull remains closest to main rubble mound; e/4-5.

17. (AL₂; FIG. 50f) Rim fragment. Pres. ht. 0.032 m. Pres. width 0.06 m. Slight traces of silver mica; dark beige.

Provenience: Excavated with above hull remains; e/4-5.

18. (AR) Rim fragment. Pres. ht. 0.03 m. Pres. width 0.095 m. Rim ht. 0.018 m. Slightly micaceous; red to brown-buff.

Provenience: Section Ia.

19. (AY; FIG. 50g) Rim fragment. Pres. ht. 0.06 m. Pres. width 0.08 m. Rim ht. 0.041 m. Slight traces of black and silver mica; gray-brown to pink.

Provenience: Section Ib.

20. (AI) Fragment lower belly of amphora, base broken. Pres. ht. 0.22 m. Pres. width 0.30 m. Micaceous; yellow-buff. Wheel ridges visible on interior surface. Heavily encrusted with concretion.

Provenience: Surface find; g/4.


Provenience: Surface find; f/3.

22. (AL₃; FIG. 51) Shoulder fragment. Pres. ht. 0.08 m. Pres. width 0.045 m. Micaceous; dark red to brown.

Provenience: Excavated with hull remains closest to main rubble mound; e/4-5.

23. (AK₇) Shoulder fragment. Pres. ht. 0.11 m. Pres. width 0.09 m. Micaceous; beige to yellow-buff. Wheel ridges visible on interior surface.

Provenience: Trench H.
Figure 50. Amphora toe and rim fragments. a-b) Toe fragments dated ca. 3rd century A.D. c) Rim fragment dated ca. 3rd century A.D. d) Medieval rim fragment dated ca. 12th-14th century A.D. e-g) Unidentified rim fragments.
24. (AK) Belly fragment. Pres. ht. 0.15 m. Pres. width 0.10 m. Slightly micaceous; gray-buff.
   Provenience: Trench H.

25. (AD) Belly fragment. Pres. ht. 0.052 m. Pres. width 0.09 m. Slightly micaceous; orange-buff.
   Provenience: Trench A.

26. (AF) Belly fragment. Pres. ht. 0.16 m. Pres. width 0.15 m. Slightly micaceous; orange-red. Wheel ridges visible on interior.
   Provenience: Trench B.

27. (AJ) Belly fragment. Pres. ht. 0.17 m. Pres. width 0.105 m. Slightly micaceous; brown to red-buff.
   Provenience: Trench H.

28. (AR) Belly fragment. Pres. ht. 0.10 m. Pres. width 0.08 m. Micaceous; orange-brown.
   Provenience: Excavated with hull remains closest to main rubble mound; e/4-5.
   Twenty-two other unidentifiable potsherds were excavated in context with the hull remains and were catalogued as Lot AL. All were micaceous; brown to red-buff. Average preserved dimensions were 0.05 x 0.03 m.

29. (AO; FIG. 52) Roof tile fragment. Flat with 0.02 m. overhang on top edge. Pres. ht. 0.212 m. Pres. width 0.19 m. Slightly micaceous; buff.
   Provenience: Found along with 15-20 similar roof tiles in sand beside poseidon-grass mound in vicinity of g/4.

30. (AK) Potsherd; possible roof tile fragment. Pres. ht. 0.10 m. Pres. width 0.08 m. Slightly micaceous; exterior surface beige, interior surface light brown.
   Provenience: Trench H.

31. (AK) Potsherd; possible roof tile fragment. Pres. ht. 0.20 m. Pres. width 0.12 m. Slightly micaceous; exterior surface beige, interior surface light brown.
   Provenience: Trench H.

32. (AK) Potsherd; possible roof tile fragment. Pres. ht. 0.18 m. Pres. width 0.11 m. Slightly micaceous; red-buff.
   Provenience: Trench H.

Analysis of the Finds

In evaluating the finds it should be noted that the above sampling is only a small percentage of the overall number of sherds sighted
Figure 51. Unidentified shoulder fragment of amphora.

Figure 52. Roof tile fragment.
during the survey. As most were unidentifiable belly fragments of little datable value, it was not considered worthwhile to expand the surface collection beyond those fragments which could be dated. Unidentifiable sherds found in the sand trenches were catalogued primarily because of their buried context. However in the last two excavations on top of the main rubble mound more sherds were uncovered than were catalogued; in this case due to lack of time. An additional consideration for the incomplete nature of the sampling is the fact that most of the sherds originally deposited in the shallower areas of the site had no doubt already been picked up over the years; few were visible within a 100-meter radius of the promontory.

While the time span represented by the sherd sampling clusters in the Roman period from the late 1st to the 3rd century A.D., two earlier pieces dating from the 6th century B.C. and 3rd to 1st centuries B.C., along with one Medieval fragment, demonstrate the harbor was in use over a much greater period. This temporal spread reflects only slightly the archaeological record of the 5th to 5th century B.C. material from the Etruscan settlement at Gravisca or the archaeological and historical record of the 2nd century B.C. Roman colony; however there does exist the possibility that deeper penetrations through the sand to the ancient sea bottom or into the main rubble mound might have yielded more material from these earlier periods.

The finds do at least shed some light on Gravisca's 2nd to 3rd century A.D. history; a period when the harbor apparently received more use than has generally been recognized from the historical accounts of a declining malarial-ridden trading station. Ships bringing garum
and wine in jars from Spain and perhaps wheat in the large jars from
Africa were at least calling at Gravisca, as shown from items 2, 6, and
14 respectively. The level of this trading activity, however, is
impossible to gauge at the present time.
SURVEY AND EXCAVATION ANALYSIS

The interpretation and dating of extant breakwater remains at Gravisca is complicated by the strange configuration of visible underwater features and by the intense degree of silting which has inevitably altered the original design of the harbor. However, by comparing the construction and design of the two most prominent breakwater-like features, namely the small and large rubble mounds 20 m. and 150 m. off the promontory, with the breakwater remains found at the Roman ports of Cosa and Pyrgi and the Etruscan port of Populonia, several parallels do appear which seem to suggest a port at Gravisca of Roman construction and design. By further study of the local wind, wave, and current patterns and comparison with the geographical situation at Cosa, one may conclude that the design proposed below for the port at Gravisca offers a logical solution to the natural problems of the site.

The large rubble mound at Gravisca is comparable in form with the rubble breakwaters at Cosa, Populonia, and Pyrgi (FIG. 53), in that both consist simply of large, unshaped limestone rocks tumbled into piles to form broad jetties. As at Gravisca, the rubble on the main breakwater at Cosa varied in size, with medium and small limestone

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152 McCann and Lewis, op. cit. (in note 16) 204.
154 Oleson, op. cit. (in note 6) 301.
Figure 53. Tumbled rocks of Roman breakwater at Pyrgi. Eastern jetty; east end near structure B. Photo: kindness of A. M. McCann.
rocks wedged among larger boulders.\(^{155}\) Interspersed among the rocks at both ports were large concentrations of amphora sherds, and the entire masses were cemented together by a natural concretion of sand and shell.\(^{156}\) This type of simple construction was, in fact, an extremely effective combination of naturally-shaped rocks locked in place and held together by a naturally-formed sand-shell conglomerate with the bonding strength of hydraulic cement.\(^{157}\)

The broad, semi-rounded shape and the overall size of the large rubble mound at Gravisca (100 m. x 100 m. across and approximately 3 m. high) corresponds also to the main breakwater at Cosa (80 m. x 100 m. across and 4 to 5 m. high)\(^{158}\) and at Pyrgi (200 m. x 100 m. across).\(^{159}\) In addition, the size of the small rubble mound directly off the bastion promontory at Gravisca (12 m. x 8 m. across) is roughly the size of the small breakwater extensions at Cosa averaging 10 m. x 10 m. across.\(^{160}\)

Based upon the large number of Roman amphora sherds found in the

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\(^{155}\) See description of Cosa breakwater in Lewis, op. cit. (in note 16) 240.

\(^{156}\) Ibid. 235. Lewis forwarded the hypothesis that the top layer at Cosa may have been added to repair the breakwater in the later years of the Early Roman period.


\(^{158}\) McCann, op. cit. (in note 16) 204. Lewis, op. cit. (in note 16) 242 gives height.

\(^{159}\) McCann and Oleson, op. cit. (in note 24) 400. No height given.

\(^{160}\) McCann, op. cit. (in note 16) 204.
underwater trenches dug alongside the large breakwater at Cosa, the
construction of the breakwater has been dated to the Roman period.161
The deposit of Roman sherds found embedded up to 1.5 m. deep in the
large mound at Gravisca, then, would also seem to be indicative of
Roman construction. Although other sherds were occasionally noted in
the sand near the small rubble mound as well, any sherds on the mound
itself which might have helped to indicate its antiquity have long since
been removed by the many swimmers frequenting the area directly off
the promontory.

A brief additional comment on this type of rubble breakwater con-
struction can be made with reference to Vitruvius who, at the end of
the 1st century B.C., wrote a short chapter on Roman harbor construction
in his treatise on architecture and civil engineering (De Architectura,
v. 12). Vitruvius wrote that jetties were built either on a mass of
rocks or on masonry foundations, although he only indicated the first
process rather than described it. While this omission on the part of
Vitruvius was once believed to be due to the simplicity of rubble
mound construction and the fact that it was used only rarely by the
Romans,162 the findings discussed for Cosa and Pyrgi, as well as
discoveries at Syracuse,163 suggest that it may not have been so un-
common. Gravisca is perhaps another example.

161McCann, op. cit. (in note 16) 204.
162G. Dubois, "Observations sur un passage de Vitruve," MéMOrome 22
(1902) 442.
Furthermore, there are a number of decided factors in favor of rubble mound construction, of which Roman engineers must have been at least partially aware. Modern engineers have noted that the most lasting form of breakwater construction is composed of randomly-shaped natural rocks which are locked together because of their shapes and sizes.\textsuperscript{164} Also important is the fact that in areas where there is little or no tide, as in the Mediterranean, a rubble breakwater needs only one-fourth the amount of stone as does an area of deep tidal fluctuation.\textsuperscript{165} No doubt of equal importance to the ancient engineers at Gravisca would have been the availability in the near neighborhood of large amounts of ideally-suited limestone.\textsuperscript{166}

Just as the sizes and shapes of both the rocks and the mounds at Gravisca are comparable with those of other ancient ports, so is the nature of their strategic positioning in the harbor with respect to local winds and currents. As in most areas along the Italian coast, light morning winds, called \textit{Tramontana}, blowing off the hills, are normally replaced in the afternoon by a strong sea breeze, \textit{ponente}, coming predominantly from the west. Frequent \textit{sirocco} storms blow also from the south-southeast in summertime, lasting for weeks at a time, while in winter the \textit{maestrale} winds from the northwest blow for as long as

\begin{itemize}
\item \textsuperscript{164} \textit{Shore Protection, Planning and Design}, op. cit. (in note 155) 345.
\item \textsuperscript{165} R. R. Minikin, \textit{Winds, Waves, and Maritime Structures} (London 1950) 117.
\item \textsuperscript{166} For advantages of limestone see Lewis, op. cit. (in note 16) 240. F. e. the specific density of limestone compares favorably with that of granite.
\end{itemize}
three months.\textsuperscript{167} The harbor at Gravisca lay open to all these winds and to their corresponding wave fronts. Protection for ships in the harbor was thus totally dependent upon the breakwater's proper orientation and size. Furthermore, not only was it necessary to protect the ships, but also design the breakwater in a manner which would keep the harbor free of silt.

In Lewis' discussion of the engineering aspects in the breakwater design at Cosa, it is pointed out that the most effective orientation of a breakwater is at an angle toward or away from the wave front in order to prevent the force of the waves from striking along the full length of the structure at the same moment.\textsuperscript{168} As shown in figure 54, the main line of the breakwater extensions at Cosa was built at a 45-degree angle to the prevailing wave front, and at Gravisca it appears that conditions might have been similar. At Cosa the breakwater was built in the form of separate rubble mounds extending directly out from the cliff and angling northward to form a semicircle. These extensions were designed so that the waves breaking over and through the rocks from the southwest would provide some current or flow into and

\textsuperscript{167} These facts are based upon observations during the survey and are supplemented by information from local fishermen. A similar wind pattern is thought to have existed along the Italian coast in antiquity. See J. Rougé, Recherches sur l'organisation du commerce maritime en Méditerranée sous l'empire Romain (Paris 1966) 34-35.

\textsuperscript{168} Lewis, op. cit. (in note 16) 240.
Figure 54. Schematic plans comparing port designs at Cosa and Gravisca. Cosa plan adopted from Lewis (1973) 241, fig. 6.
out of the harbor, thus reducing the effects of silting. At Gravisca the same system appears to be present in a slightly different arrangement.

While the largest rubble mound at Cosa was built as an extension from the natural promontory with the smaller mounds acting as breakwater extensions, at Gravisca the largest mound was placed approximately 100 m. out from shore with the smallest mound placed close by but not attached to the promontory. This discrepancy makes sense, however, when one considers the differences in topographical conditions between the two sites and the additional feature at Cosa of a system of what may have been sluice channels to help control silting.

At Cosa the longshore current flowing northward along the Italian coast hugs the shoreline south of Cosa and flows directly into the promontory as it curves around to the west. This current almost certainly would have deposited large amounts of silt in the harbor had it not been for one important factor. A series of channels made from natural clefts in the limestone cliff appear to have been used as sluices to provide an outlet for the longshore current entering the harbor from

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169. McCann, op. cit. (in note 16) 204. A scouring channel was also evident between the shoreline and the two jetties found at Pyrgi; Oleson, op. cit. (in note 6) 307, although this cannot be used as a parallel with Gravisca.

170. McCann and Lewis, op. cit. (in note 16) 202-203. Interpretation of these channels as sluices is problematical. Counter explanations of drainage canals or a means of providing the proper mixture of fresh and salt water for fish tanks in the inner lagoon have also been proposed by E. Rodenwaldt and H. Lehman, "Die antiken Emissare von Cosa-Ansedonia, ein Beitrag zur Frage der Entwässerung der Marenmen in etruskischer Zeit," Heidelberger Akad. Wiss. Math-natur. Klass, Sitzbert (1962) 1-31. Full treatment of the problem will appear in the forthcoming publication on Cosa by A. M. McCann.
the northeast. Although three channels are visible today, it has not been possible to determine if all three were in use at one time; but sluice gates found at either end of the easternmost channel or "Tagliata" suggest that at least one of these channels might have been in use with the harbor in the Early Roman period. Such a sluice system, then, would have allowed the large breakwater at Cosa to have been built directly out from the natural promontory with no danger of obstructing the current flow through the harbor.

While the high limestone cliff at Cosa with its natural clefts may have been conducive to such a sluice system, enabling the largest mound to extend directly out from shore, the low flat promontory at Gravisca presented a more difficult situation which could only be remedied by allowing the longshore current to pass between the promontory and the first breakwater mound. For if the same type of breakwater extension was built directly off the promontory at Gravisca as it was at Cosa, the current would have eddied around the northern edge of the mound and there would have been no way for the silt deposited there to leave the harbor again. But with a channel off the promontory and the large mound placed farthest out, the combined action of the waves passing between the mounds and the natural longshore current flowing through the channel would have provided the necessary means of cleansing the harbor.

In addition to the longshore current, which has an average velocity
of less than 1 knot,\textsuperscript{171} there is also a local counter-current at Porto Clementino which flows southward along the beach when the off-shore winds blow from the west. This wind-driven surface current is a result of the natural 45-degree deflection of the current to the right of the wind direction.\textsuperscript{172} Because this current tends to be a turbidity current carrying sediment down from the mouth of the Marta River, it could be easily observed and its course charted. It was often seen flowing southward along the shore and passing clearly between the bastion promontory and the first small rubble mound (FIG. 55). Current velocity measurements taken at this point using a small drogue showed an average of 0.6 knots.\textsuperscript{173} The area between the small and large rubble mounds did not appear to be as affected by the turbidity current, thus enabling a current caused by wave action to flow into the harbor between the breakwater extensions and be carried out of the harbor by the south-bound current through the small channel off

\textsuperscript{171} Longshore current information was obtained from a hydrographic map titled "Ocean pollution factors. Major currents and shipping routes," U.S. Office of the Geographer, Department of State (1974).

\textsuperscript{172} Called "Ekman flow," this current is caused by the Coriolis effect of the earth's rotation which deflects the currents 45 degrees to the right of the wind in the Northern Hemisphere and 45 degrees to the left in the Southern Hemisphere. J. B. Rucker, "Physics of the Sea," The Science of the Sea: A History of Oceanography, C. P. Idyll, ed., 91-92.

\textsuperscript{173} A series of experiments to determine current direction and velocity throughout the harbor were conducted during the survey using a makeshift drogue made of a 0.5 square meter sheet of nylon weighted at the bottom by a chain fastened lengthwise and attached to a small surface buoy with two lines and a swivel clip.
Figure 55. View of Porto Clementino showing turbidity current (light-colored water) flowing southward through channel between bastion promontory and first small rubble mound.
the bastion.

The placement of the first rubble mound away from the promontory rather than connected to the shore as at Cosa would thus have been a logical solution for the breakwater design at Gravisca, and it does seem evident from the excavations and probes that this channel may well have existed in antiquity. The large rubble mound would no doubt have been intended to break the main force of the waves, perhaps in addition to other rubble mounds set closer to the promontory.

Exploring the possibility of such additional mounds, we examined the branch-shaped poseidon-grass extension which lies between the two rubble mounds (FIG. 22; e-f/3) for signs of a third breakwater mound. Although several rectangular limestone blocks were observed beneath the grass matte, no solid structures were located by probing. Several other factors, however, do at least suggest that some type of breakwater might have existed there.

The noticeable increase in size and density of the rubble concentrations in this area, which in turn overlie grass formations up to 1 m. higher in relief than those directly north (FIG. 22; a-f/3-4) is one consideration. Another is the relatively great distance of 100 m. between the large and small rubble mounds compared with 30 to 40 m. separations at Cosa. It would seem that more than two mounds would have been advantageous at Gravisca to provide maximum protection for the harbor, and a third mound placed in that location would have effectively shortened this gap.

The pre-World War II aerial photographs shown in figure 10 does, in fact give some hint that this area was at one time more solid or higher
in relief. This can be seen by studying the surface disturbance visible in the wave pattern as the southwesterly swell reaches the shallow water directly northwest of the promontory. It appears that the pattern of the waves deflected toward the promontory from the large rubble mound is interrupted by some kind of underwater obstruction between the mound and the promontory in precisely the same location as the high relief grass area noted above. If some kind of structure did exist here, it is possible that it was destroyed during the bombing in World War II resulting in the present-day remains simply of scattered rubble concentrations and a dense growth of grass. A more thorough penetration through the grass bed than was possible with our equipment would, of course, be necessary to substantiate this suggestion.

The most reasonable interpretation of the other poseidon-grass areas shown on the plan, namely the low-relief poseidon grass and small scattered rubble extending to the northeast and south of the large rubble mound, would seem to be that they are unrelated to the original breakwater structure. The northeast section is probably an accumulation of small rocks used as fill on top of the main mound which were washed off by continuous wave action over the centuries, combined with small rocks and sediments deposited as the northern-bound current eddied around the northwest side of the mound. As poseidon grass can grow over pure sandy areas as easily as it roots to a hard substrate, the former would seem to be the case in this area of the harbor.

While it was not possible to determine whether the poseidon grass in the southeast area (FIG. 22; g-j/1-3)overlies sand or bedrock, a few small outcrops of limestone were observed in low areas where sand
depressions revealed the poseidon grass in section. Although their identity is uncertain, the existence of a natural limestone reef underlyng the present growth of poseidon grass should not be ruled out. The question remains, then, as to whether some form of natural reef preceded the original breakwater, such as the natural reef which may have originally attracted the Etruscan settlers at Pyrgi. 174

Similarly, as the ancient sea bottom was never reached in any of the test trenches or probes, it was not possible to determine with certainty whether the large rubble mound was built on bedrock or sand. While the rocks at Pyrgi and the nearby port of Civitavecchia were piled on top of a natural reef, 175 rocks were also simply dumped onto sea beds of sand, clay, or shell as at Cosa. 176 That the latter might have been the case at Gravisca is suggested by the fact that no limestone intrusions comparable to those at Pyrgi were observed around the large rubble mound, and the small obstructions noted infrequently in our trenches and probes out from the breakwater most likely represented scattered stones rather than bedrock.

Turning next to the question of dating, we can surmise that the design of the breakwater at Gravisca belongs to the Roman period based upon above-mentioned parallels with the ports of Cosa and Pyrgi; the late 1st to the 3rd century A.D. material found buried in the top layer

174 McCann and Oleson, op. cit. (in note 24) 402.
175 Pliny, Epistulae, vi. 3.
176 Lewis, op. cit. (in note 16) 241. On sand base foundations for rubble mounds in general see Minikin, op. cit. (in note 165) 90.
of the main rubble mound seems to verify this hypothesis. The exact
date of its construction, however, is more difficult to establish due
to several conflicting factors. The predominance of Imperial Roman
sherds in the breakwater sampling does not correspond with the Early
Roman date established for the port of Cosa (2nd century B.C. to 2nd
century A.D.), nor does it agree with the 2nd century B.C. date when
the first Roman settlers at Gravisca presumably would have used the
harbor. Furthermore, minor evidence of Etruscan and Republican Roman
use of the harbor in the form of one Etruscan amphora handle and a
Craeco-Italic amphora toe fragment suggest an earlier date for the port,
although no evidence was found to relate the breakwater itself to these
earlier periods. On the basis of the data at hand, however, the break-
water can attributed with relative certainty only to the 1st to 3rd
centuries A.D., with the possibility remaining that its original con-
struction took place during an earlier period.

This breakwater, composed of separate mounds rather than a contin-
uous wall of rubble or masonry, is suggested as an alternative to the
hypothesis forwarded by Pasqui and reiterated by Quilici of a mole com-
posed of a large wall circa 1.5 m. wide, semicircular in plan, circa
700 m. in radius, and formed in concrete over a jetty of parallel
blocks of travertine. 177 No evidence for a continuous breakwater or
for this type of construction was found in the underwater areas survey-
ed, and the maximum extent of the breakwater remains appeared to be

177 Pasqui, op. cit. (in note 43) 519, note 3; Quilici, op. cit.
(in note 45) 118.
only 250 m. in an offset line extending west of the promontory.

Although 16th-century historical reports referred to a mole at this port, its description was never given and it is therefore impossible to speculate whether Pasqui's mole, if indeed it did exist, was of a type built during the Middle Ages. The fact that the Medieval port was referred to as one suitable only for small boats (see note 106), along with the relatively unimpressive historical record for extensive use of the port, might suggest that little was done to improve the original breakwater construction. The few historical accounts mentioning reconstructions of the port in 1738 and 1752 may refer simply to additions of rubble to the already existing mounds, and it is possible that towards the end of the Medieval period the harbor had also silted-in sufficiently to limit use of the harbor basin to small ships, thereby restricting its effectiveness as a commercial port. In succeeding periods until World War II, though lacking in specific historical references, it seems logical to conclude that Porto Clementino was used as a shelter for fishing craft. According to local residents, large fishing boats could be accommodated and were often seen in the harbor in the early 1900's. In all probability parts of the ancient breakwater were already in advanced stages of collapse by that period as a result of continuous wave action, and the rapid silting of

178 Portolano Rizo in Kretschmer, op. cit. (in note 42) 486.

179 While historical accounts of Porto Clementino indicate that it was used to some degree up until 1870 (see note 112), no archaeological evidence was found to suggest a design for these periods as distinct from the rubble mound breakwater proposed for the Roman harbor.
the harbor which allegedly occurred after World War II no doubt imposed further changes in the underwater topography of the site, covering completely whatever identifiable features may have remained from the ancient port.
CONCLUSION AND RECOMMENDATIONS

Summary and Conclusion

To summarize the results of the survey, on the basis of our combined shallow excavations and numerous probes, it seems probable that only the solid mass of rubble on the main mound and the small mound directly northwest of the bastion are man-made remains of a breakwater. The rubble-mound construction using unshaped boulders piled circa 3 to 4 m. high is similar to that of the remains found at Pyrgi and Cosa, and the size and shape also has close parallels with Cosa. The design of the breakwater mounds at Gravisca is particularly close to Early Roman engineering design evident at Cosa, both in the individual placement of the mounds and in their overall function of protecting the anchorage basin from wave action while providing passageways for silt-bearing currents in and out of the harbor.

The dating of the most prominent rubble mound at Gravisca to the Roman period based upon the pottery finds in Section Ia and Trench Ib establishes the antiquity of the port at least as early as the 1st century A.D. Other amphora sherds recovered as surface finds ranging in date from approximately the 6th century B.C. to the 14th century A.D., although not pertinent to the breakwater's construction date, do at least give some indication of the time span in which the port was in use and are certainly suggestive of earlier seafaring activity in the harbor as far back as the Etruscan period. Although more conclusive dating for the breakwater's construction is not possible at this time, several
factors have nonetheless been added to what was known previously about the port.

The controversial location for both the Etruscan and Roman port can now almost certainly be assigned to Porto Clementino. Though not outstanding in size, the promontory and harbor basin there offer both a larger anchorage area and more protected shore for unloading than any of the other three sites proposed in past studies, and similar geographical conditions apparently existed in antiquity. The two river sites discussed earlier are less desirably situated due to their shallowness, minimal protection, and distance from the settlement itself, while the salt-marsh area thought to have been a navigable lagoon in Etruscan times has the disadvantaged position of an exposed shore and entranceway with no facilities for anchoring deep-draft ships.

The form of the breakwater at Gravisca, previously unknown, has now been determined, with its design apparently consisting of separated rubble mounds shown to have had roots in the Early Roman period. Analysis of the geographical setting suggests that while the anchorage basin would have been large enough in the earliest Etruscan period to accommodate sea-going vessels, some form of artificial protection would have been needed to provide maximum safety for the ships. Further research is necessary, however, to determine whether this was actually the case.

In view of Etruscan-related seafaring activities already attributed to Gravisca by the evidence for Etruscan merchant ships in the 5th century B.C. "Tomba della Nave" in Tarquinia, and for trade with Greece in the 6th to 5th century B.C. Etruscan settlement, combined with at
least one Etruscan find in the port itself, I believe that sound evidence for Etruscan use of the harbor may be simply buried beneath the silt. With this in mind, several suggestions for future research are proposed below aimed at specific areas of the harbor.

**Recommendations for Future Research**

In analyzing the survey and excavation results, references have been made to limitations in equipment and consequently in the range of data accumulated. Deeper excavations through and beside the main rubble mound, for example, would have undoubtedly yielded more valuable information regarding its dating and construction, and trench penetrations or core samples through the dense poseidon-grass mounds would have provided a means of determining their true composition. Deeper penetrations in particular through the grass area in figure 22; f-h/3 could perhaps also establish whether or not some sort of natural reef ever existed at Gravisca which the ancient engineers could have exploited in constructing the original breakwater. Employment of a more powerful airlift would be necessary to dig through the thick matte in this area; however, useful data could be obtained by geologically sampling the shallow sand depressions mixed with limestone visible in that vicinity.

The main rubble mound is clearly the most promising target area for further excavation. By removing the naturally-concreted rocks with hydraulic jacks, one could expand a trench similar to Trench Ib and penetrate to a depth below 1.5 m. This would enable one to establish the deepest level and earliest dating of sherds buried among the rubble, at the same time affording a more comprehensive sampling of pottery
types. It would also be possible to ascertain the construction of the rubble mound by checking the core to see if it is solid rubble or small rubble fill and determining whether the base is bedrock or sand.

Deeper trenches in the sand beside the rubble and grass mounds using caissons would be useful for searching further into the possibility of buried breakwater remains. Two caissons set upright end-to-end would allow 2.5 m. of penetration with controlled stratification which might be sufficient to attain the level of the ancient sea bottom. Potentially productive areas would be the northeast and southwest edges of the main rubble mound, the sand channel off the promontory, and the sand area beside the poseidon grass and scattered rubble located in the vicinity of e-f/3 in figure 22.

An additional area worthy of investigation which was explored only superficially during the survey is the area 300 m. northwest of the bastion promontory beyond the main rubble mound. This portion of the site was investigated briefly both by diver reconnaissance and by boat, but no distinct features resembling a breakwater were found. Although it is doubtful that the breakwater extended much further out, it is at least possible and therefore worthy of more research. We were told that the remains of at least one ancient ship lies in 6 to 8 m. of water roughly 200 m. further to the northwest, and it is possible that intensive survey there would reveal additional indications of ancient ships.

There does exist one other area proposed as a location for the port which has not yet been explored under water: namely the shallow, rough waters directly west of the modern jetty built at the entrance to
the salt marsh. Although underwater investigations would be difficult here, core samples taken around and in the salt marsh itself would allow one to study the silting process in the lagoon since antiquity and also to investigate its nature as a malarial swamp which is believed to have existed there in the Late Roman period.

If sound evidence for Etruscan use of the harbor were to be found by further investigations in any of the above areas, one might then be able to address some yet unresolved questions, not only about the port but about Etruscan seafaring in general. For example, does the apparent Early Roman design mean that the breakwater was in fact built in the Republican period? If so, were the mounds simply an incorporation of earlier Etruscan attempts to solve the same problem, or did the original seafarers at Gravisca so actively involved with trade simply beach their ships?

No one can yet say with certainty who among the Etruscans, Greeks, and Phoenicians was most responsible for early sea trade along the Tuscan coast. As mentioned above, hypotheses naming the Greeks most active seatraders are countered by theories of Etruscan maritime supremacy in the Tyrrhenian, a mastery of the seas presently supported only by literary and historical references. The potential contribution of archaeological discoveries at Gravisca defining Etruscan port installations is therefore substantial. It is hoped that the material presented in this thesis will stimulate more research in this direction.
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VITA

Elizabeth Bostwick Shuey, daughter of Mr. and Mrs. Hayden Shuey, was born on May 16, 1951 in San Francisco. In 1969, she graduated from Redwood High School and enrolled in the University of California at Berkeley. She received her B.A. in Anthropology from the University of California in 1973, after spending three years at Berkeley and one year as a foreign exchange student at the University of Bergen in Norway. In 1975, she enrolled in a Master's degree program in Classical Archaeology at Florida State University, and transferred one year later to Texas A&M University to specialize in Nautical Archaeology.

Her professional experience has included instruction in scientific diving, teaching and research assistance in Nautical Archaeology at Texas A&M, and archaeological excavations on land in Norway and under water in Turkey, Italy, Kenya, Florida, and the Gulf Coast of Texas.

Her permanent residence is 4 Rock Road; Kentfield, California.