Figure 22. An older logboat used at the fish market. Note the detached float, and the *banca* and inshore fishing-boat in the water. (author)

war-canoes of the Solomon Islands, they have their niche in the maritime history of the Pacific and are due a more systematic record before they finally disappear.

Michael Stammers
Merseyside Maritime Museum, Albert Dock, Liverpool L3 4AQ, UK

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Data Collection for a Virtual Museum on the Underwater Survey at Kaş, Turkey

The Underwater Archaeological Survey Project at Kaş, on the Lycian coast of Turkey, has emerged from a need to document, research and preserve underwater sites in the area surrounding the town of Kaş. This region has stood out in recent decades as a centre of underwater tourism, enabling countless divers with a wide range of interests and backgrounds to explore the coastal depths of the Mediterranean around this popular town. Rising numbers of recreational divers and increased underwater access to sites of potential historical and archaeological significance has generated an aspiration for their contribution to and participation in a variety of underwater survey projects. Our project has

Figure 1. Possible anchorage-sites and five potential cargo-sites in the vicinity of Kaş. (G. Varinlioglu based on Google Maps)

emerged with the intention of bridging this gap between trained specialists and divers by identifying the underwater cultural heritage for future protection and dissemination.

Introduction

Teke peninsula is located in Lycia on the south-west corner of Asia Minor. This is a long, dangerous rocky coast, blessed by several protected ports such as Patara, Antiphellos, Aperlae, and Andriake (Hohlfelder, 2005). Lycia lay on strategic Eastern Mediterranean maritime trade-routes between the Levant, Egypt, Cyprus, the Greek islands, the Greek mainland and the Anatolian coast (Wachsmann, 1998). Among all the Lycian coasts, Kaş stands out as rich in historical resources, including the remains of ancient Phellos and its harbour, Antiphellos, partially integrated into modern Kaş (Mitchell, 1996; Zimmermann, 2005). Excavations on the Uluburun wreck fundamentally influenced the development of underwater archaeology and our understanding of Late Bronze Age connections around the Mediterranean world (Pulak, 1998; Yalçın *et al*., 2006). Surveys of coastal Turkey have included the region of Kaş (Frey, 1984; Yıldız, 1984; Özdaş, 2007; Özdaş, 2009), but these archaeological surveys carried out in the past decades illustrate how much more information is still neither recognized nor investigated, how much more intensive survey is still needed, and how much more the underwater cultural heritage of Turkey is in need of trained divers (Parker, 1992b).

With the participation of more than 100 divers from a variety of backgrounds, and technical and logistical support from local divers and dive centres, and the Municipality and the Coastal Guard at Kaş, and the assistance of Sualtı Araştırmaları Derneği (Underwater Research Society) (SAD), we have been working on developing a system for recording the underwater cultural heritage in the coastal region of Kaş. What this pilot project intends to create is an online inventory system to be shared by an informed community and to be continually improved by the addition of new discoveries and relevant information.

Objectives and methods

A chief aim of the project is to develop a methodology for collecting data based on trained divers who are not, by education, archaeologists. These divers can then receive a basic background that enables them to participate effectively in the Kaş Project. For sustainability, the Kaş Project intends to rely on simple, standard tools for underwater recording—buoys for marking find-spots, numbers and letters for tagging finds, plastic tapes for taking measurements, a scale and a north sign for photographic recording, and plexiglass slates for underwater sketching and note-taking.

The project has been developed with the objective of building and testing methods of data collection, recording, and analysis. These methods are essential for transporting the data collected in the field to an online database. A substantial portion of the information for the database derives from surveys and training conducted since 2008 from İnceburun, near Kalkan, on the west to Aperlae sunken harbour near Kekova on the east (Fig. 1). Initial steps were taken in 2007 to design the online database of a Virtual Museum.[1] Essentially an online inventory for systematic data collection, description, and analysis, the Virtual Museum currently contains information on 22 sites in the form of sketches, measurements, drawings, and photographs of finds, in addition to descriptions and observations made by divers. Combined with GPS locations of sites and find-spots, the resulting integration of the database with Google Maps illustrates the distribution of significant sites along the Kaş shoreline (Fig. 1).

This virtual system has particular emphasis on collecting the information digitally without disturbing

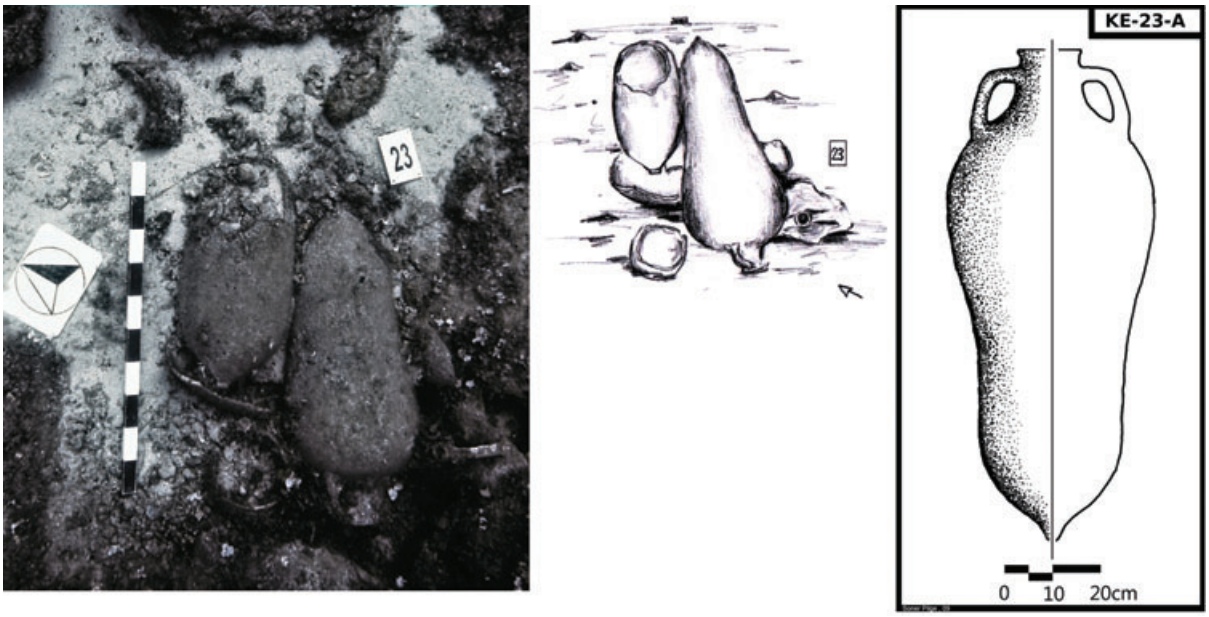

Figure 2. Example of the information collected on an amphora. (sketch and drawing Soner Pilge; photo Güzden Varinlioğlu)

the archaeological remains. Consequently, finds are recorded carefully *in situ*. Other projects which have developed theoretical and methodological approaches to *in situ* analysis of underwater sites and finds include the Ancient Port of Caesarea (Alves, 2008: 83) and Florida's Underwater Archaeological Preserves (Scott-Ireton, 2006: 5). Such an approach also ensures the protection of sites in line with the UNESCO 2001 Convention, one of whose basic principles encourages *in situ* preservation of underwater cultural heritage (UNESCO, 2001).

Particular care to avoid physical intervention in the archaeological record has resulted in recording only what is above the sea-bed. This is a limiting factor in attempts to gather the maximum amount of information at any given site without excavation. At the same time, the information which can be gathered without de-contextualizing the artefacts helps to gain general insight into the nature and the extent of sites and provides a foundation for further and more detailed research. The range of material visible consists mainly of amphoras and other sizeable artefacts such as large ceramic vessels or even *pithoi*, stone and metal anchors, and ballast-stones, millstones and architectural cargoes. Whether or not a site might produce preserved remains of ship-parts is difficult to determine without excavating. Subsequently, sites are categorized as anchorage-sites if there is a wide range finds from different periods, and as cargo-sites if they have groups of finds of similar types and date. 'Cargo-site' is preferred to 'wreck-site', which is only used when hull remains survive. In areas which contain large numbers of sites, the best-preserved examples and unique finds are selected for photography, drawing, and recording of detailed measurements (Fig. 2). Additional measurements are collected to contribute to determining the wider extent of the site using offset and trilateration measurements (Bowens, 2009: 120–22).

Recorded sites

The database for the Kaş Project currently includes records of *c*.600 finds at various locations. Out of 22 archaeological sites, six possible anchorage-sites and five potential cargo-sites have significant characteristics as explained below (Fig. 1).

Anchorage-sites

The anchorage sites at Kovanlı, Körmen-Çılpacık, Kalkan-Heybeli, Gürmenli Islands and İnceburun, Çapabanko Inlets, are described as probable mooring-sites along ancient maritime routes. These sites have produced remains of a variety of anchors and a wide range of amphoras and other types of pottery scattered on the surface of the sea-bed. Furthermore, these sites are often located on the east of the adjacent landmass, so protected from the harsh westerly winds prominent in this region. Such observations bring to mind discussions on the suggestion that ancient mariners often tried to hug the shoreline for safety and attempted to take shelter behind protective landmasses at night, at rising conditions of danger or in harsh weather (Parker, 1992a: 4–7; Wachsmann, 1998: 297). In addition, the diversity of amphora and anchor types recognized at these six sites potentially indicates different chronological periods and illustrates the long-lasting use of these sheltered areas by seafarers during their voyages across the Lycian coast of Turkey (Foss, 1994).

Cargo-sites

Scattered ceramic and anchor remains clustered at five areas in the vicinity of Kaş, at Bucak, Üçkaya, Kepez Inlets, Kaş-Heybeli and Besmi Islands, have been interpreted as possible cargo sites. Situated not far away from notorious reefs and rocks above water, these cargo-sites are often open to harsh weather. Of the five, three seem to have been considerably damaged, most probably through deliberate looting. These sites at Bucak Bay, Cape Üçkaya, and Kaş-Heybeli Islands are all located in relatively shallow waters. The remains at Bucak Bay are near notorious rocks above water named as Köfte Island, exposed to westerly winds at Cape Çukurbağ, on the west of the sheltered inlet of Port Vathi. The completely disturbed site covers an area of over 50 m at a depth ranging from 6 to 10 m. Also very damaged, the second cargo-site is recognized at depths ranging from 10 to 24 m and near a hidden reef exposed to westerly winds at Cape Üçkaya on the south of Kaş. Presumably including more than one wreck, this partially disturbed site covers an area over 100 m. The third of these disturbed sites is located further south, at a depth of between *c*.12 and 24 m, on the west of a group of five small rocky outcrops, commonly called the Kaş-Heybeli Islands. Remains at this site include various amphoras of similar types, ballast-stones and a T-shaped anchor.

Two apparently undisturbed cargo-sites were discovered in deeper waters, with maximum depths of *c*.30 and 45 m. The first is located to the north of the rocky island of Besmi, located 1.2 nautical miles west of Kastellorizon and 3.1 nautical miles south of Kaş. Although the area of Besmi is regularly visited by recreational divers, the fact that the remains cover a wide area 34–46 m deep might explain the lack of disturbance; most of this site appears to be relatively well preserved. Remains at Kepez, the second undisturbed cargo-site, are found on the west coast of the mainland *c*.2.5 nautical miles east of the Greek island, Kastellorizon, and *c*.2.4 nautical miles south east of the modern town of Kaş. Finds are scattered in an area of 50 m, between 16 and 43 m deep. Observations include one T-shaped anchor and 115 undisturbed and 146 broken amphoras of 11 different types. Although survey done by Cemal Pulak in 1983 mentions relatively fewer amphora types, Kepez cargo-site might possibly be the Roman Wreck (Wreck #7) dated to the 4th century AD, discovered by a team from INA and Bodrum Underwater Archaeology Museum in 1983 (Yıldız, 1984: 23).

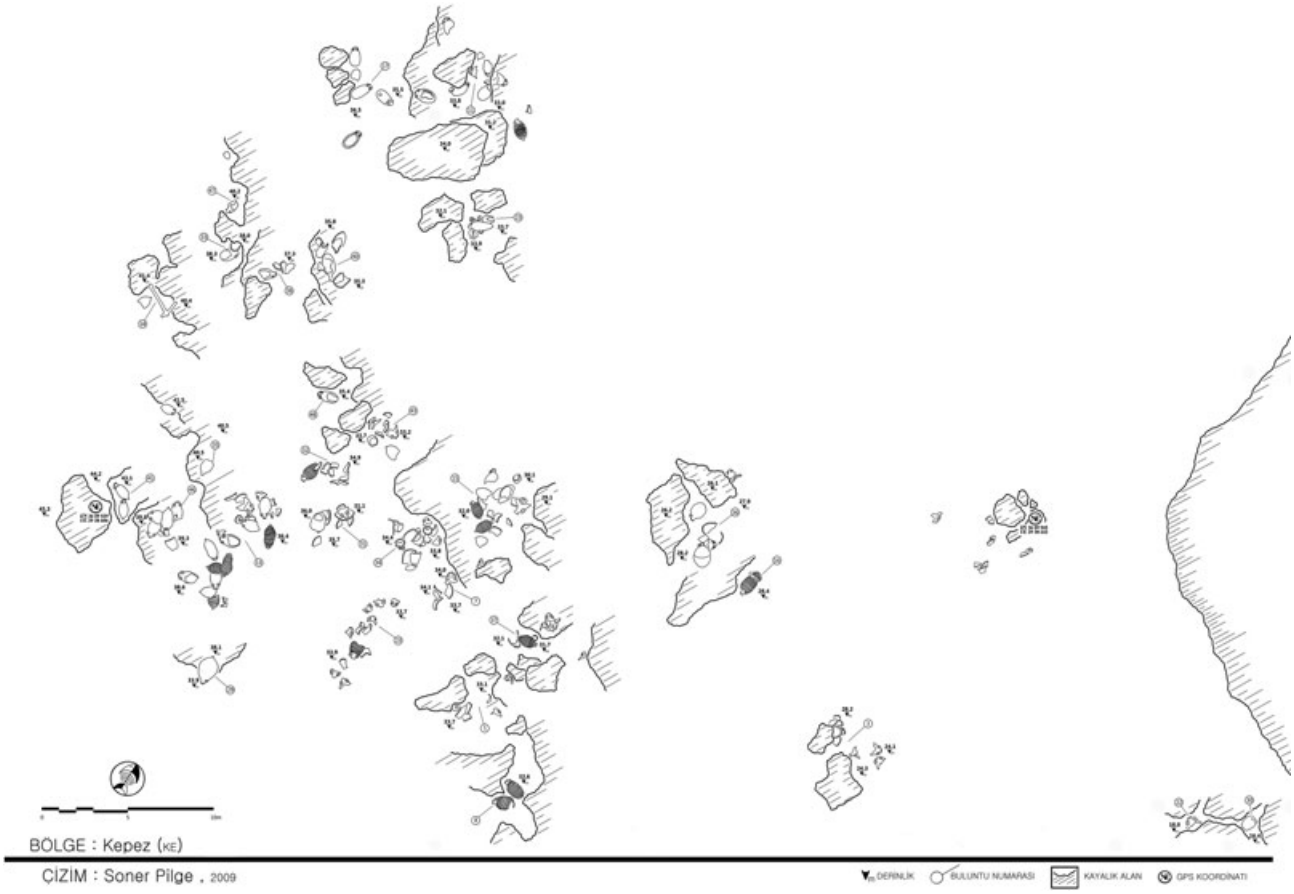

Figure 3. Plan of remains at the Kepez cargo-site. (Soner Pilge)

Figure 4. Online database entry for the find KE_23.

Recording methodology

During the survey, the divers tested various recording techniques throughout different stages of the Kaş Project. Work carried out at Cape Kepez best illustrates the current stage in the development of the project's survey and recording methods. The site was investigated during a total of 221 dives covering an area of *c*.50 x 75 m (Fig. 3). Divers marked each pile of finds with a number and each individual find with a letter marked on a small plexiglass slate. These numbers enabled find-spots to be investigated during multiple dives and by different groups of divers. These tags also provide a link between types of recorded data within the structural design of the database when the finds are entered into the system, enabling connections to be made between multiple sketch drawings, measurements made by different teams and multiple photographic and video recordings, each of which could be made on different dives (Fig. 4).

At Kepez, divers counted 115 undisturbed amphoras and a T-shaped anchor in small sandy niches on the rocky sea-bed. All the measurements, sketches of finds, observations, and photographic records were entered into the database after the completion of each dive in the following manner: in the case of ceramics, descriptions of rim, neck, handle, shoulder, base, and body types were separately documented in addition to height, width, rim, neck, base diameters,

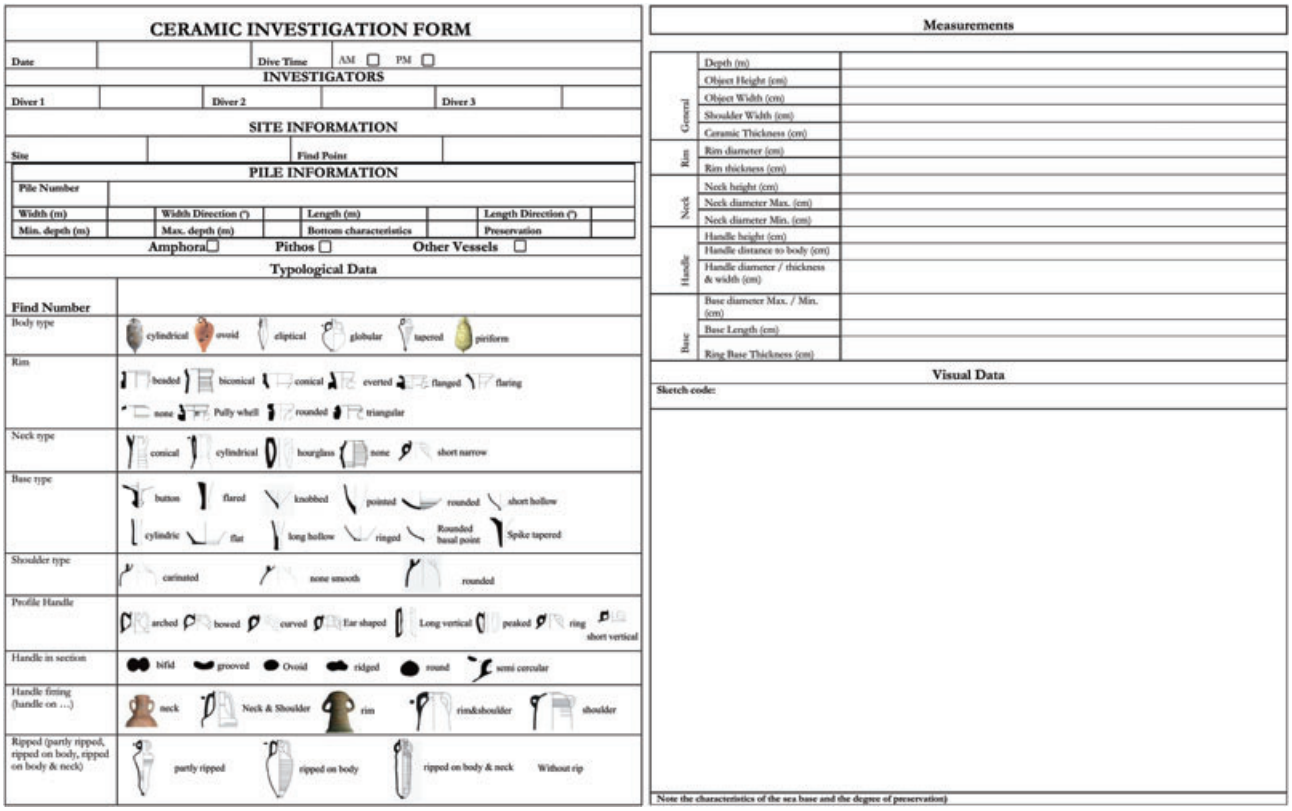

Figure 5. Data-sheet example of ceramic investigation form.

and shoulder and handle heights. In certain cases, details such as handle sections or observations made on body decoration such as rips, were also included in the database (Fig. 5). Similarly, anchor descriptions and measurements of various details were collected and noted. These will eventually provide suggestions for the origins and dating of distinct types of discoveries.

Conclusion

After the process of updating the data collected during the last season of work at Kaş, the project will be resumed with studies of amphora and anchor-types in order to investigate implications of interconnections and chronological frameworks of the finds. As the project was started because of an evident need to inform interested parties on the underwater cultural heritage of Kaş, particular care is placed on the development of survey and training methods. A series of training programmes was created for the participants (Varinlioğlu, *et al*., 2007). Within the framework of this programme, survey techniques were developed, tested and practised at a modern 'wreck'-site, Archaeopark, created in 2006 at Hidayet Bay, *c*.1.5 nautical miles west of the modern town of Kaş. This project had come to life under the guidance of a collaboration between SAD and 360 TAD (360 Degree Research Group), which have both supported the Kaş Project since its preliminary stages. In addition to archaeological prospecting, the project intends to advance much-needed training and educational public programmes on the underwater cultural heritage of Kaş and its surrounding area.

Güzden Varinlioğlu
Faculty of Art, Design and Architecture, Department of Interior Architecture and Environmental Design, Bilkent University, Turkey, and Underwater Research Society (SAD), Turkey

Note

1. Data collection for an online database forms the author's dissertation project in the Faculty of Art, Design and Architecture at Bilkent University, one of the goals of which is to contribute to the management of underwater cultural heritage in Turkey. The database in the dissertation builds on what was designed during The Virtual Museum of Turkish Underwater Cultural Heritage: Kaş Archaeopark Pilot Project during summer 2007 under the sponsorship of TÜBİTAK, through collaboration between the Culture and Art Research Center of Başkent University and SAD. Serkan Girgin of the Middle East Technical University designed the database, while Altay Özaygen, of the same university, worked on its internet application.

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Comments Concerning Recent Fieldwork on Roman Maritime Concrete

In recent years the most important advance in underwater archaeology *vis-à-vis* hydraulic concrete structures for Roman maritime installations has been made by the Roman Maritime Concrete Study (ROMACONS) project, directed by Brandon, Hohlfelder, and Oleson, dedicated to analysing the composition and manner of use of the elements making up the concrete mixtures (Oleson *et al*., 2004a; Oleson *et al*., 2004b; Brandon *et al*., 2005; Hohlfelder *et al*., 2007; Gotti *et al*., 2008). In many cases *pulvis puteolanus* was present as an essential element. This, the construction material recommended by Vitruvius and found on the Phlegrean and Neapolitan coastline of Campania, was transported as far as Caesarea Maritima (Branton and Oleson, 1992).

With a view to verifying how widely pozzolana was used (for example, we would expect it to have been used in Mauretania in the port of Jol-Chercell under Juba II), or to analyse and evaluate structures created with other combinations of materials, samples of conglomerate for analysis have been taken by means of drilling. The sites studied so far are: Cosa, Santa Liberata, Portus, Antium, Baiae, and Gnathia. Similar research has also been carried out at Chersonesos in Crete (Oleson *et al*., 2004b: 206; Brandon *et al*., 2005). The results, which have mostly already been published, provide useful information. Among the most obvious, the presence of pozzolana has been confirmed on many sites, and one of the structures of the port of Cosa has been dated by C14 to the mid-1st century (57–33) BC, which is almost a century later than had been previously supposed (McCann, 1987; McCann, 1998: 43; see also Oleson *et al*., 2004b: 217ff.).

The general purpose of this paper, stimulated by the results produced by the ROMACONS project, is to review the chronology for the early use of *opus caementicium* for building structures in the sea. In addition, a review of supposed structures at Carthago Nova indicates that they do not relate to the harbour, but very probably to a temple, while the *pilae* at Tarraco and Ampurias are also not definitely maritime structures.

Identifying the earliest example

The structure at Cosa had been thought to be the oldest identified example of maritime construction using hydraulic concrete. Another potentially early site, roughly contemporary with the *Porticus Aemilia,* which is thought to be the first large-scale use of concrete at Rome (Liv. XL, 51, 4), is the mole built by M. Aemilius Lepidus on his properties at Terracina in 179 BC (D'Arms, 1981: 36). Now, however, the revised date for Cosa perhaps makes such an early instance of the use of pozzolana much less likely.

The application of this technique in the sea, due primarily to the use of *pulvis puteolanus* in the mixture making up the *caementicium*, is indirectly attested only at a later date. The first instance of the creation of *piscinae* for fish-farming, built in the sea by Sergius Orata in the first years of the 1st century BC, occurred in precisely the area which Vitruvius (II, 6, 1 and V, 12, 2–3) notes as having pozzolana of the best quality; all the more effective if, Pliny adds, '*Cumano misceatur caemento*' (*NH* XXXV, 166, see also Strabo V.4.6; Sen., *Nat. Quaest*. 3.20.3). There is, therefore, no reason for doubting that the technique was invented and applied extensively along the whole littoral of the Phlegrean Fields during the construction boom of the late Republic and early Principate. This was a time when other daring experiments were also conducted on land, as can be seen, for example, in the vaults of the Baths of Baiae.

The previous chronology for the mole at Cosa slightly anticipated this scheme, but nevertheless constituted a useful reference-point for the study of other ports. Now, however, some of them must be reconsidered in the light of the new dating. This is the case with Carthago Nova, to which an inscription (*CIL* I, 2:2271 (= I,1477) and 3:1104; *CIL* II, 3434 (suppl. 5927) and p.952; *ILLRP* 778) mentioning the construction of concrete piles refers. Since this inscription is dated to the late-2nd or first half of the 1st century BC (Abascal Palazón and Ramallo Asensio, 1997: 71–7, n.1, pl.1; Gianfrotta, 2008a: 73f.), the associated port would replace Cosa as the oldest known example of construction with hydraulic concrete in the sea. After listing at length the *magistri* who dedicated it, the

