

tions of broken pottery, including vestiges of Hellenistic through Late Roman maritime trade mixed with early modern pottery and modern debris. Among the more important finds was a concentration of eastern Aegean amphoras, probably of Early Hellenistic date, as well as several bifid handles and other Late Hellenistic and Early Roman jars. The range of finds merits closer investigation of this area, which appears to have been in use from the Early Hellenistic period as an anchorage for occasional protection from less prevalent northerly and easterly winds.

Akrotiri-Dreamer's Bay Ancient Port Project

The summer of 2006 was the first field season of this combined terrestrial and underwater investigation of the remains of a Roman (and probably earlier) maritime facility by a team from Lake Forest College, the University at Buffalo, SUNY, and Brock University. The expansive site—likely the same port attested in Strabo and other ancient literary sources—extends along the cliffs of the south coast of the Akrotiri peninsula and includes the remains of multiple warehouses and possibly maritime villas, two necropoleis, a large quarrying operation, and a submerged harbor complex.

In addition to establishing the site grid and map, this initial season focused on recording several warehouses and other structures in danger of erosion along the cliffs. The team identified a large, steep earthen ramp with rope points for lowering stone from the cliff above to the harbor below, where the large ashlar-built breakwater—constructed of header and stretcher blocks in the same tradition at the harbor at Paphos—was recorded. Analysis of the pottery points to a likely establishment for the port during the Early Hellenistic period, when the island was a strategically important Ptolemaic possession. A variety of local and regional cabotage is evident, along with long-distance trade, apparently indicating the lively maritime connections of this emporium, especially at the height of its activity during late antiquity.

Kyrenia Ship Project

In their work toward final publication of the investigation of the Kyrenia ship, eight specialists returned to study such items as amphoras, iron billets, nails, rigging, and species identifications of woods from the hull and equipment. New insights into the keel shape and a probable heightening of the hull in antiquity to convert it to an amphora carrier have come to light, enlarging the story of the ship's trading life.

Mazotos Shipwreck

In the fall of 2006, the Department of Antiquities undertook the preliminary investigation of a Helle-



Fig. 11. Stalo Eleftheriou (Department of Antiquities, Cyprus) records stone anchor KSA018 at the Kouklia anchorage (D. Howitt-Marshall).

nistic shipwreck of amphoras reported near Mazotos, west of Larnaca. The site, discovered by divers and described by the department for the press, will see intensive future recording as a cooperative investigation between the department and the University of Cyprus.

RPM EASTERN MEDITERRANEAN DEEPWATER SURVEY

Jeffrey G. Royal, RPM Nautical Foundation, reports:

During the summer of 2006, the RPM Nautical Foundation carried out extensive surveys along the coasts of Turkey, Sicily, and Malta; work continued in Sicily during the 2007 field season. The goal was to document all submerged cultural resources from as near shore as feasible to the 100 m contour. Documentation for each site included mapping its precise location, an estimation of the site's size and composition, a preliminary cultural resources identification, a determination of the date range, and a preliminary assessment of its historical context and potential for further study. The surveys were conducted with RPM's research vessels, equipped with multibeam echosounder sonar systems and subsequently verified with an ROV.

Multibeam echosounder imagery has proven more effective for locating submerged cultural sites than either sidescan sonar or other remote sensing systems at these depths when properly analyzed. In conjunction, each site was thoroughly and extensively documented with video and digital photographic coverage, and when possible, diagnostic artifacts were collected for further analysis with the ROV.

Turkey

The 2006 field season in Turkey continued previous work conducted with the Turkish Ministry of Culture and Tourism. During the 2005 season, survey of the southeastern Bozburun peninsula identified 105 anomalies, verifying 34 that season (fig. 12). With five historic-period and two modern wreck sites discovered in the 2005 expedition, continuation of the verification process in 2006 was critical. The historic wreck sites include two from the Renaissance period and one each from the Medieval period, late antiquity, and the Roman Imperial era.²⁸ In 2006, the remaining 71 anomalies were verified: three historic-period wrecks, a modern wreck, and a wreck site consisting of a ballast pile from an undetermined era.²⁹

One of the historic-period sites consists of a 21 x 10 m sand mound with a height of about 0.5 m at a depth of 83 m and featuring several stacks of exposed ceramic tiles. With no other artifacts visible, the tiles suggest a broad Graeco-Roman or Byzantine date range. Numerous amphoras from this date range lie in the area, perhaps redistributed by trawls.

Another wreck site is an ovoid mound consisting of amphoras, sand, and rock. It measures about 10 x 8 m and rises approximately 0.75 m off the seafloor at a depth of 91 m. Rhodian amphoras indicate a date in the second half of the second century B.C.E. (fig. 13). Examples of Forlimpololi form C/D amphoras from northern Italy also appear to be part of this cargo. A small number of intrusive amphoras dragged onto this site by trawls include Koan and Late Roman 1 varieties. Although most of the amphoras are damaged, numerous examples are situated upright with their necks protruding from the sand. This suggests that the lowest level of cargo and hull remains are undisturbed. As the survey area is opposite the island of Rhodes, this wreck site, along with the slightly later Rhodian wreck discovered nearby in 2005, provide good data for Roman-era trade in this region.

An extraordinary find was an Ottoman-period wreck site at a depth of 87 m. This well-preserved site was about 25 x 8 m, with armament, tableware, ship materials, and a substantial amount of hull timber present. The vessel was outfitted with at least eight cast-iron cannons, four on each side of the site. Several crossbows were grouped amidships, and plates, bowls, pitchers, jars, pots, and a brazier lie in concentrated deposits throughout the site, the majority on the wreck's port side. Numerous concreted iron fastenings, rigging el-

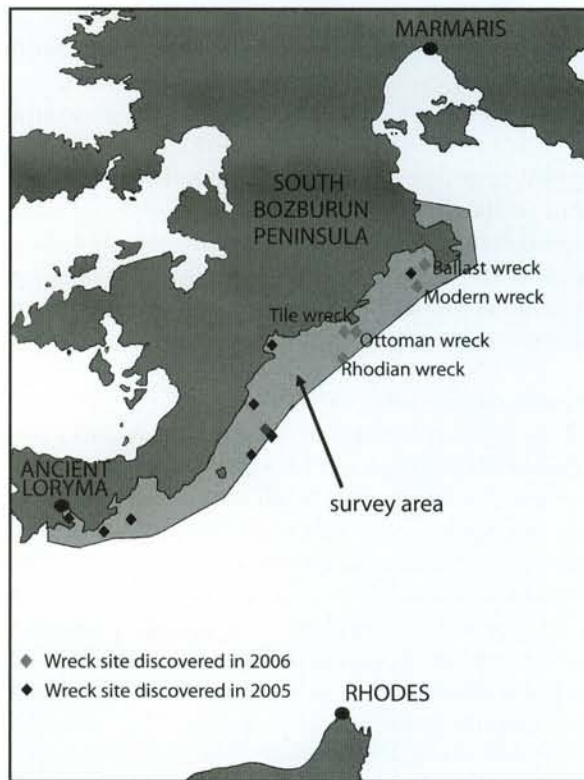


Fig. 12. Survey area along the southeastern Bozburun peninsula, Turkey (courtesy RPM Nautical Foundation).

ements, and one large anchor are also present. The cannons and large metal artifacts helped protect the exposed and substantial hull remains of the ship.

Based on the shape and style of the cannons, the presence of crossbows, features of the anchor, and the style of tableware, the preliminary date of the vessel falls in the late 16th/early 17th century C.E. Stylistically, the artifacts suggest this was an Ottoman vessel. Two wrecks from roughly the same period were located nearby during the 2005 campaign. One of these is a small, armed merchantman; the other is a small war galley. Full analysis of all three Renaissance-period wrecks and their historical context will form a forthcoming publication.³⁰

Sicily

A project, begun in 2005 in partnership with Sebastiano Tusa, Superintendent of Underwater Archaeology in Sicily, consisted of surveying an area around

rously contested by the Ottomans, Knights Hospitaller, and Italian city-states during the Renaissance.

²⁸Royal 2006.

²⁹Royal 2008.

³⁰This particular area between Turkey and Rhodes was vig-

the island of Levanzo, one of the Egadi Islands off the northwest coast, to the 100 m contour (fig. 14). This area was selected because Polybius mentions it as the final naval battle site of the First Punic War in 241 B.C.E. It also lies along a well-established overseas trade route connecting North Africa, Sicily, and the Italian mainland. Artifacts retrieved from fishing nets in the area include a ship's bronze ram and a helmet from the Roman Republican era.

Multibeam survey in 2005 generated 214 anomalies in the 17.5 km² survey area. The 2006 season was devoted to verification by ROV. The majority of the anomalies were small rock outcrops extending 20–30 cm out of the seafloor. One shipwreck and many isolated finds were located. During the subsequent multibeam survey early in the 2007 field season, more than 118 km² was surveyed. Another 586 anomalies were identified, and verification began during the 2007 season.

Situated to the north of Levanzo, a shipwreck site at a depth of 92 m comprises a mound about 14 x 4 m, surrounded by a scatter of artifacts and an exposed concentration of artifacts at each end. The concentration on the eastern end includes a large number of *tubi fittili* (vaulting tubes), tableware, amphora fragments, and concretions (fig. 15). Artifacts on the western end of the site are primarily large amphora sherds and what may be exposed timbers. Most of the amphoras from this site are types commonly manufactured in North Africa during the later Imperial period, including Africana II and Agora M254 varieties. A few examples of Spanish amphoras also appear in the cargo. Based on the amphoras, the preliminary date for the vessel is the fourth century C.E.

Some artifacts, including tableware and *tubi fittili*, were recovered for further analysis. Additional artifacts and material samples will be subjected to a CAT scan for object shape and Inductively Coupled Plasma (ICP) analysis for material composition. All artifacts will be conserved by the superintendent's office and will be featured in the forthcoming publication of the wreck site.³¹

Malta

Two survey areas were completed during the field season with the Maltese Ministry of Culture: one just south of Valetta harbor, the other within a small bay on the northern island of Gozo. The former was part of a cultural resources impact assessment for the Maltese government that resulted in the survey of 33 km² outside Marsascalea Bay, on the southeastern coast of



Fig. 13. Broken Rhodian amphoras atop and partially buried in the mound, near the Bozburun peninsula, Turkey (courtesy RPM Nautical Foundation).

the large island. Subsequent analysis of the multibeam data produced 24 anomalies; each was verified with the ROV. The survey along Gozo located a large scatter (ca. 50 x 100 m) of mostly broken amphoras that included Etruscan, Samian, Graeco-Italic, Late Roman, and Arab-period examples. This broad time span suggests discarded material from ships anchoring in the bay.

THE ROMAN MARITIME CONCRETE STUDY (ROMACONS): ACTIVITIES TO 2007

John Peter Oleson, University of Victoria, and Christopher Brandon and Robert L. Hohlfelder, University of Colorado at Boulder, report:

Concrete and the Infrastructure of the Roman Empire

From ca. 200 B.C.E. to 300 C.E., the Mediterranean Sea was thronged with merchant ships engaged in long-distance trade. Of about 1,200 documented pre-modern shipwrecks in the Mediterranean, 761 (63%) belong to this period. Maritime trade on a large scale was the main factor allowing the rise and survival of the Roman empire. Although not all ships and cargoes required extensive harbor installations for loading and unloading, such facilities were essential for most port cities and for the enormous trade in bulk foodstuffs and construction materials that sustained the great cities around the Mediterranean. This period of active maritime trade and widespread harbor construction coincides almost exactly with the florescence of Roman

³¹ Tusa and Royal (forthcoming). This publication will include a historical context for the vessel, particularly in relation to Late Imperial architectural developments and the *annona* system.

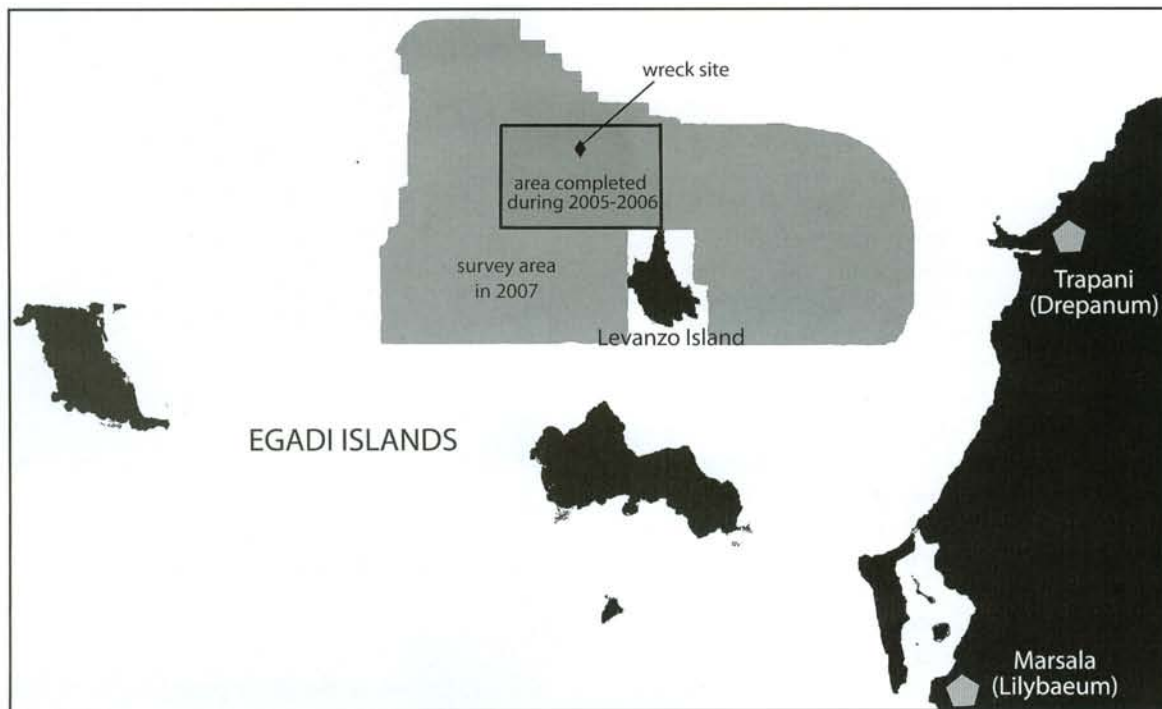


Fig. 14. Survey area in the Egadi Islands, off northwest Sicily, 2007 (courtesy RPM Nautical Foundation).

construction using hydraulic concrete. This material, a Roman innovation developed in Campania ca. 200 B.C.E., made possible the construction of elaborate and durable harbor facilities, as well as bridge footings and coastline fish-raising tanks.³² Hydraulic mortar was also used for many structures on land.

Hydraulic concrete is so called because it can harden while immersed in water; the chemical reaction between slaked lime and a pozzolanic additive supplies the mortar with its own carbon dioxide, allowing it to set and cure out of contact with atmospheric carbon dioxide. For the Romans, the pozzolanic additive was a loose, powdery volcanic ash, first exploited near ancient Puteoli (modern Pozzuoli) on the Bay of Naples and thus called *pulvis puteolanus*, "powder from Puteoli."³³ Around 25 B.C.E., the Roman architect Vitruvius described the materials needed for hydraulic concrete, their proportions, and some of the procedures used for building structures in the sea.³⁴

The Roman Maritime Concrete Survey (ROMACONS)

In 2002, the contributors provided the first proper engineering analysis of samples of Roman hydrau-

lic concrete. A Cordiam Model M60-0 hydraulically powered coring device (a new technology) took intact cores (diam. 0.09 m x max. lgth. 6.0 m) from Roman maritime structures above and below sea level (fig. 16).



Fig. 15. The eastern concentration at the Levanzo wreck site, Sicily (courtesy RPM Nautical Foundation).

³² Oleson et al. 2006.

³³ Plin. *HN* 16.202; Sen. *Q Nat.* 3.20.3; Vitruv. *De arch.* 5.12.2.

³⁴ Vitruv. *De arch.* 2.5.1, 2.6.1-5, 5.12.2; Oleson et al. 2004, 2006.