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# Landscape Imaging of the Southeast Aegean Sea


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New  
**Frontiers** in  
Ocean Exploration

The E/V *Nautilus* 2010 Field Season

GUEST EDITORS |  
KATHERINE L.C. BELL AND  
SARAH A. FULLER



## Landscape Imaging of the Southeast Aegean Sea

By Michael L. Brennan, Tufan Turanli, Bridget Buxton, Katherine L. Croff Bell, Christopher N. Roman, Meko Kofahl, Orkan Koyagasioglu, Daniel Whitesell, Thomas Chamberlain, Richard Sullivan, and Robert Ballard

The waters of the Aegean Sea below depths accessible by recreational scuba divers are largely unexplored. The regions off the Bodrum and Datcha peninsulas, and in Marmaris Bay, have long been hubs of human activity, from ancient shipping to modern fishing. These areas are therefore important for understanding both the ancient and modern submarine landscapes.

Over the past three years, we have begun to document these areas of coastal deep water (50–600 m) with both acoustic and visual imaging systems. In 2008, we conducted a side-scan sonar survey from a small dive boat around the Bodrum peninsula with *Diana*, an EdgeTech 4200 MP towfish, coupled with the small ROV *Hylas* for visual identifications. The following year, *Nautilus* revisited

some of the ancient shipwrecks located during this project with *Hercules* and *Argus*, and also began additional acoustic surveys off the Datcha peninsula to the south. A total of 11 ancient shipwrecks were located in 2008 and 2009, ranging in age from Archaic Greek to late Medieval (Brennan, 2010). In July of 2010, *Nautilus* continued this work south of Knidos and also began exploring the bay south of Marmaris to the east.

During the July 2010 survey, we mapped a total of 59 km<sup>2</sup> with side-scan sonar off Knidos, and 77 km<sup>2</sup> south of Marmaris. We found another nine ancient wrecks—five off of Knidos and four off Marmaris. These sites range in date roughly from Hellenistic to Byzantine (Cemal Pulak, Texas A&M University, *pers. comm.*, 2010). We imaged



Figure 1. Close up image showing the clay pipe artifacts at Yalikavak III and the achievable level of detail in the structured light bathymetry. The bathymetric mesh is gridded at 2.5 mm

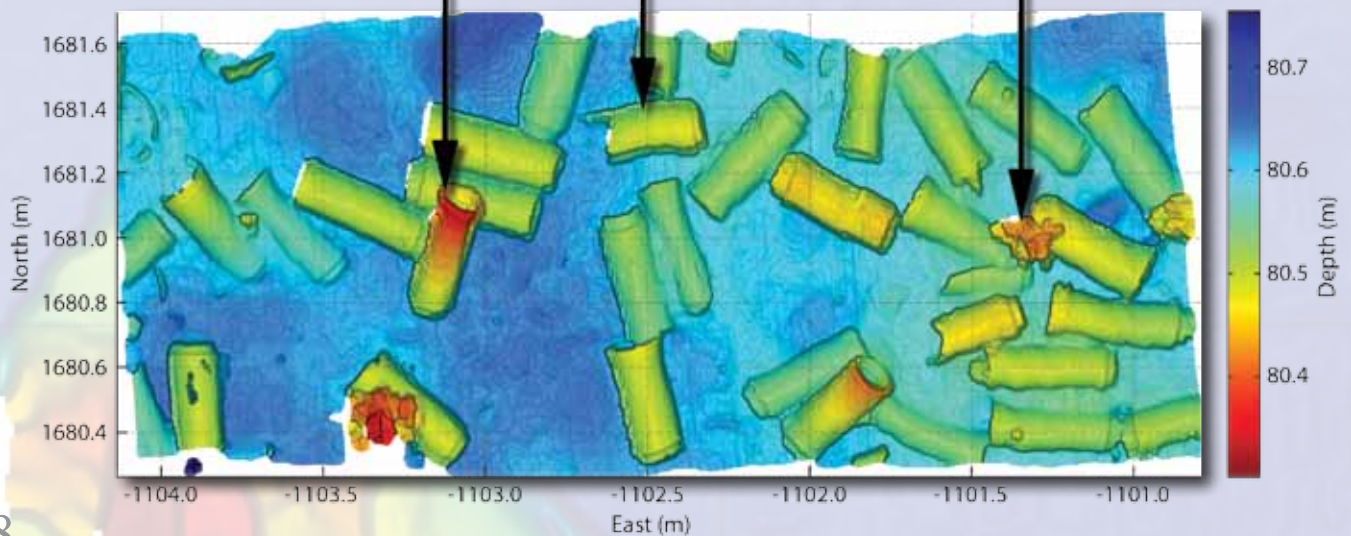


Figure 2. High-definition image captures of shipwreck sites: (a) Knidos F, (b) Knidos H, (c) Knidos I, (d) Knidos J, (e) Marmaris B, and (f) rock outcrop with carbonate crust.

each wreck site with high-definition video and then, time depending, surveyed with a combination of stereo cameras, multibeam sonar, and structured light systems for creating high-resolution maps (Figure 1; see also pages 14–17 and Roman et al., 2010). We also found a series of small rock outcrops with side-scan sonar and visually identified them with the ROVs (Figure 2f). They were found along the slope between 200–300-m depth off both Knidos and Marmaris. These outcrops appear to be carbonate crusts probably formed from methane gas seeps, and further investigations and sampling may be conducted during later expeditions. We also explored the Antalya Basin using *Argus* equipped with the *Diana* side-scan sonar, and documented a series of submarine landslides near the base of the Anaximander Mountains and bedforms in the deeper parts of the basin at 2600 m.

The 20 ancient shipwrecks observed and imaged over the past three years illustrate the damaging effects of trawling and other fishing operations on these sites, further documenting what others have begun drawing attention to in the area (e.g., Royal, 2008; Brennan, 2010). Amphora cargo shipwrecks exhibit this damage best, as the broken artifacts remain visible longer than trawl scars on the seabed. Some of the wrecks are fairly intact amphora piles, such as Knidos F and H (Figure 2a,b). These intact wrecks tend to be in close proximity to areas of prohibited bottom trawling, such as near submarine cables or within 2.5 km of shore (KKGM, 2006). Other wrecks have ceramic cargos that have been heavily damaged and scattered, for example, Marmaris B (Figure 2e). Knidos J shows a trawl scar that ripped through the center of the wreck, and other trawl scars were observed on the seabed near this wreck. Nonamphora cargo wrecks do not exhibit trawl damage as well, due to fewer artifacts (Figure 2c). Side-scan sonar data also show trawl scars, the heaviest of which we observed north of Yalikavak, and parallel to isobaths south of Datcha. Future acoustic imaging in this area will help compile a more comprehensive picture of the extent of trawling on the seabed and its damaging effects on ancient shipwreck sites.

