2012

Coastal Exploration of the Southern Black Sea Off Ereğli and Sinop, Turkey

Michael L. Brennan
University of Rhode Island

Dan Davis

See next page for additional authors

Citation/Publisher Attribution

Brennan, M. L., Davis, D., Roman, C., Buynevich, I. V., Catsambis, A., Kofahl, M., Merrigan, M., Tuzun, S., Duman, M., Urkmez, D., Vaughn, J. I., & Turanli, T. (2012). Coastal exploration of the southern Black Sea off Ereğli and Sinop, Turkey. In K. L. C. Bell, K. Elliot, C. Martinez, and S. A. Fuller (eds.), New Frontiers in Ocean Exploration: The E/V *Nautilus* and NOAA Ship *Okeanos Explorer* 2011 Field Season. *Oceanography* 25(1), supplement, pp. 26-27.
doi: 10.5670/oceanog.2011.supplement.01

Oceanography
VOL. 25, NO. 1, SUPPLEMENT | MARCH 2012

New Frontiers in Ocean Exploration

The E/V *Nautilus* and NOAA Ship *Okeanos Explorer* 2011 Field Season

GUEST EDITORS | KATHERINE L.C. BELL, KELLEY ELLIOTT, CATALINA MARTINEZ, AND SARAH A. FULLER

Coastal Exploration of the Southern Black Sea Off Ereğli and Sinop, Turkey

By Michael L. Brennan, Dan Davis, Chris Roman, Ilya V. Buynevich, Alexis Catsambis, Meko Kofahl, Maureen Merrigan, Suna Tuzun, Muhammet Duman, Derya Urkmez, J. Ian Vaughn, and Tufan Turanli

The Black Sea is the largest anoxic basin on Earth. Below approximately 155 m depth, its waters become depleted in oxygen, and hydrogen sulfide is present in the water column. We returned to the Turkish Black Sea coast at the beginning of this year's expedition for the first time since 2007. Expeditions in 1999, 2000, 2003, and 2007 mapped and explored the area off Sinop between the 100 and 400 m isobaths to document the possible paleoshoreline that predated Black Sea flooding following the last ice age. During these surveys, four Byzantine-era amphora wrecks were found: three at 100 m depth, and one well-preserved wooden wreck with its mast still standing upright at 325 m depth (Ward and Ballard, 2004). In 2011, we returned to continue exploring the seabed across the oxic/anoxic interface where internal wave motion between these water layers affects sediment dynamics along the shelf. This internal wave action increases the preservation potential for shipwrecks that lie in water depths shallower than 155 m.

While conducting the side-scan sonar survey of the shelf along the Turkish coast, we observed a variety of seafloor features, including large sediment slumps along the steeper slope off Ereğli and waveforms below ~ 200 m depth off Sinop (Figure 1). We explored these bedform areas with the ROV *Hercules* (Figure 2) during a dive into the anoxic water layer to collect sediment cores. Push cores were collected in oxic and suboxic layers for comparisons between these environments (Figure 3). We collected a total of 12 cores, processed them on board, and then sent them to various institutions in Turkey and the United States for geological and biological analyses, including microbiology, grain size, porewater chemistry, and meiofauna. The resulting database will help us learn more about the biogeochemical processes occurring in these water layers.

Figure 1. Side-scan sonar image of bedforms off Sinop, Turkey.

Using the dissolved oxygen (O_2) sensor on *Hercules* to locate coring sites in the suboxic zone (the interval at which O_2 is < 5 μM), we found that this layer began at 120 m depth. In a study done in the same area northwest of Sinop, Duman et al. (2006) reported the oxic/anoxic halocline to be between 100 and 110 m, with the suboxic transitional zone extending from 100 m down to ~ 200 m, which is

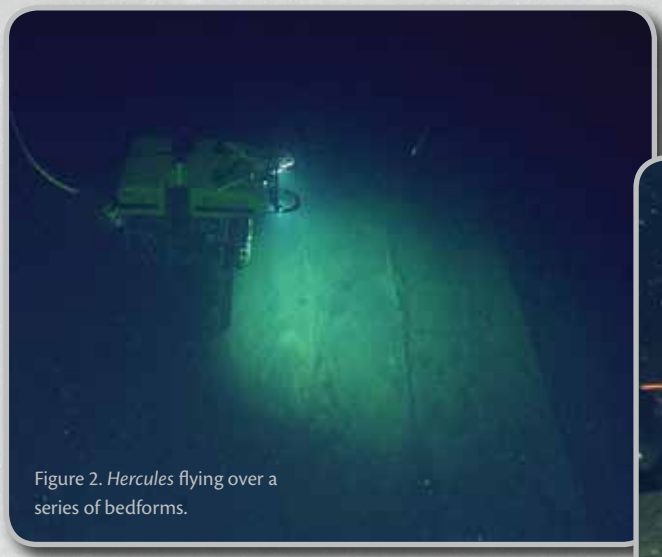

Figure 2. *Hercules* flying over a series of bedforms.

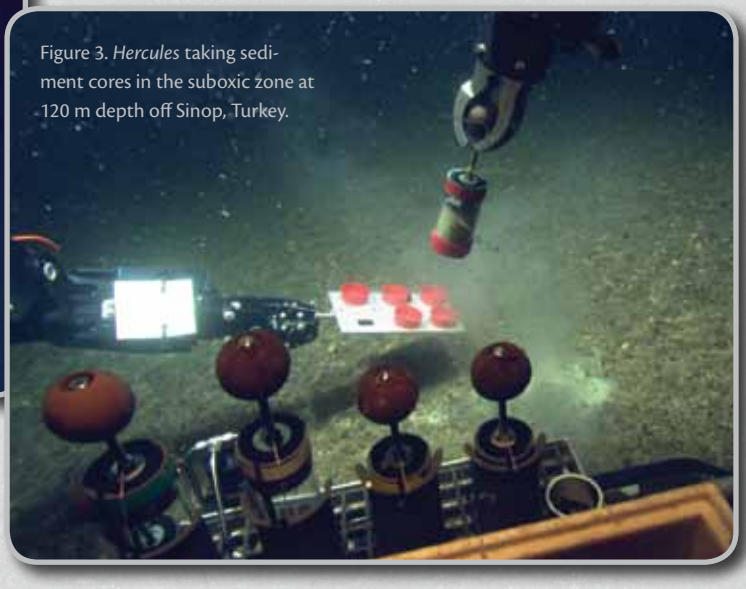

Figure 3. *Hercules* taking sediment cores in the suboxic zone at 120 m depth off Sinop, Turkey.

Figure 4 (above). Photomosaic of the Sinop A wreck site with trawl scars running in multiple directions.

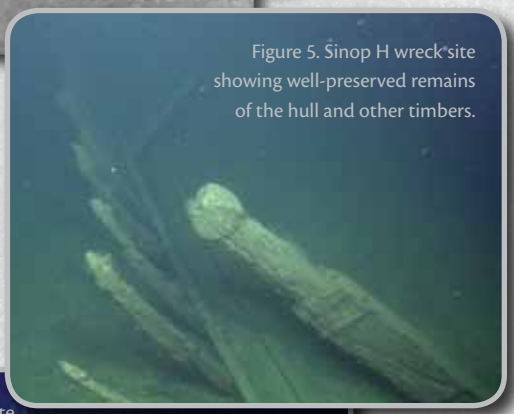

Figure 5. Sinop H wreck site showing well-preserved remains of the hull and other timbers.

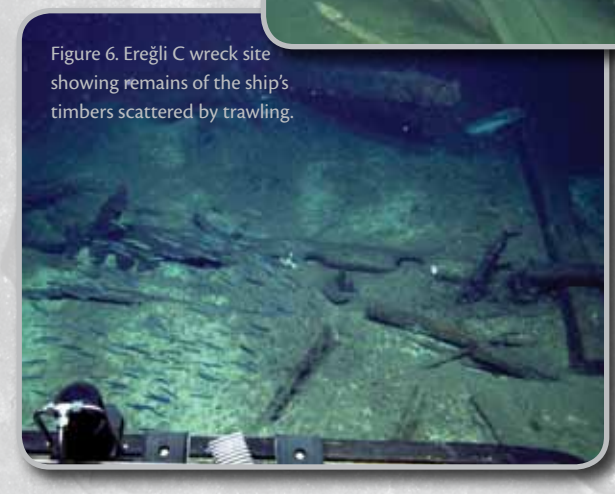

Figure 6. Ereğli C wreck site showing remains of the ship's timbers scattered by trawling.

the depth where we began documenting bedforms (mega-ripples with superimposed ripples). The observed onset of suboxic conditions at 120 m depth correlates well with the ranges cited by Duman et al. (2006), and with the preservation state of shipwreck sites located during this expedition.

During the acoustic surveys of the shelf, we located nine shipwrecks ranging in age from the 4th century BCE to the 19th century CE. These wrecks all lie between 100 and 115 m depth, as do Sinop A, B, and C, discovered in 2000. The wooden components of all of these ships remain preserved to varying extents. Those wrecks from 2000 and 2011 that lie along the 100 m depth contour largely contained cargoes of amphoras. Their timbers, however, are preserved better than expected when compared to ancient shipwrecks found in the Aegean Sea because of the low-oxygen content of the suboxic zone. In addition, internal waves caused by intense storms push suboxic waters up onto the shelf above 120 m depth, preventing wood-boring organisms from consuming the wooden parts of the shipwrecks.

The Black Sea shipwrecks have been damaged by trawl fishing, which we commonly observe at many sites in the Aegean Sea (Brennan, 2010). Sinop A, for example, has trawl scars running through the entire site from multiple directions. These scars are apparent in a photomosaic of the wreck (Figure 4). Many of the wrecks located in 2011 contain large amounts of wood. Some of them, such as Sinop H, still retain a vessel shape (Figure 5), whereas others, such as Ereğli C (Figure 6), have had their timbers ripped away and scattered on the seafloor, presumably by trawl fishing. Therefore, the current preservation state of each wreck site in the Black Sea reflects both human activities in the area and the presence of suboxic waters along the continental shelf. Further work over the next few years will focus on exploring and documenting new sites along this coastal area of northern Turkey to gain a broader understanding of the chemical processes in the water column, as well as the extent and intensity of trawl fishing in order to evaluate the preservation potential of cultural materials.