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Helping the *H.L. Hunley* "Complete the Journey"

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Figure 1. Conrad Wise Chapman's contemporary painting of the *H.L. Hunley*.

*In 1864, the Confederate submarine **H.L. Hunley** was the first submersible boat to successfully attack and sink an enemy ship under water with the use of a torpedo. For reasons still unknown, the Hunley disappeared after the attack until it was found in 1995. USGS scientists were asked to provide **H.L. Hunley** archeologists with geological information which was needed to reveal the stratigraphic structure around the wreck site and to better understand the submarine's burial sequence. Side-scan sonar, Chirp and 3.5-kHz seismic data, and 20' sediment cores were collected to map the stratigraphic structure. This information was necessary for planning and engineering purposes, which ultimately led to a successful raising of the **H.L. Hunley** on August 8, 2000.*

Introduction

In May 1999, the United States Geological Survey (USGS) Center for Coastal and Regional Marine Studies assisted the National Park Service (NPS), South Carolina Institute of Archeology and Anthropology (SCIAA) and the Naval Historical Center (NHC) in their quest to raise the Civil War submarine, *H.L. Hunley* (Figure 1) for conservation. Additionally, there was an archeological interest in the *Hunley's* fateful victim, the Federal blockade ship, the *USS Housatonic*.

USGS scientists have been involved in coastal studies for several years in South Carolina as part of the Coastal and Marine Geology Program's South Carolina Coastal Erosion Study. This study focused primarily on mapping the shallow coastal geologic framework and developing a sediment inventory in the Charleston area. Unknowingly, this study acquired seismic, side-scan sonar, and sediment cores within one-half mile of the *H.L. Hunley* wreck site. It was through this study that archeologists at the NHC contacted the USGS for existing geological information in the vicinity of the *H.L. Hunley* and later for additional scientific assistance.

Historical Background

During the Civil War, Confederate inventors James McClintock and Baxter Watson constructed several prototype and operational submersible boats for the purpose of delivering an offensive torpedo. In 1863, an operational submersible was shipped via flat car from Mobile, AL, to Charleston, SC, to take up action against Federal warships blockading Charleston Harbor. The model sent to Charleston had a length of 40 ft, depth of 5 ft, and was powered by a crew of 9 who turned a hand crank attached to a 3.5-ft propeller (Figure 2). Attached to the bow of the submarine was a 17-ft iron spar which held a dagger tipped, 90-lb blackpowder charge torpedo, triggered by a crew member via a trip line. After the first crew of the submersible was lost during a sea trial, Horance L. Hunley, a shareholder and engineer in the Mobile group building submarines, was sent to take command upon its recovery. During another sea trial in Charleston Harbor, Hunley apparently made a fatal ballast mistake which killed him and his crew. Lt. George Dixon, also from the Mobile group, was then sent to Charleston to take command upon its second recovery. On Feb-

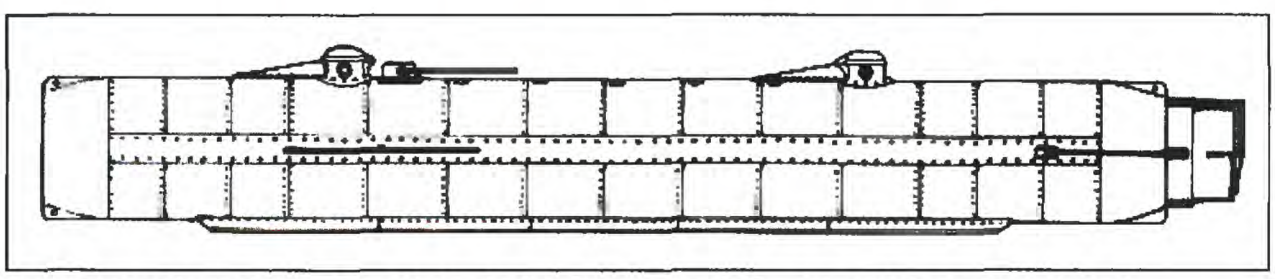

Figure 2. Artist's rendering of the *H.L. Hunley* (longitudinal view). (Courtesy of Friends of the Hunley)

ruary 17, 1864, Dixon and his crew fatefully launched the *H.L. Hunley* from Sullivan's Island to attack the Federal blockade ship *USS Housatonic*, which laid at anchor 4 miles offshore. Observers aboard the *USS Housatonic* reported the *H.L. Hunley* rammed the stern quarter amidst small arms fire, planted its torpedo and remotely activated it with such a large explosion that the *USS Housatonic* sank within minutes. The *H.L. Hunley* never returned to Sullivan's Island for reasons that are still unknown. Upon its discovery by the novelist Clive Custler in 1995, it was determined that the *H.L. Hunley* sank 1000 ft from the final resting place of the *USS Housatonic*.

Figure 3. R/V *Gilbert* retrieving a sediment core near the *H.L Hunley*, and closeup of coring rig.

Geological Investigations

The USGS provided geological expertise to *Hunley* archeologists to help reveal the nature of the sediment layers around the *Hunley* and the *Housatonic*, and to understand the submarine burial sequence. This information was crucial for planning purposes which would ultimately lead to a successful recovery and preservation of these historical entities.

In May 1999, USGS scientists onboard the R/V *Gilbert* collected chirp (upper strata, high-resolution) and 3.5-kHz (deeper strata, lower resolution) seismic sub-bottom profile data, and 500-kHz sidescan sonar seafloor images near and over the *Hunley* and *Housatonic* wreck sites (Figure 3). The Chirp sub-bottom profile sonar sensor is a high-resolution system, which can resolve very thin layers of buried sediment. Five 20-ft-long sediment cores were collected 25 ft from the *Hunley*, and three cores were taken near the site. The sedimentary layers contained in the cores were used for ground truthing seismic data, and additionally, they were analyzed for their geotechnical properties (Figure 4). Geotechnical properties of the surrounding sediments were needed to assess the bearing capacity of the underlying sediments during the excavation and raising process.

Sidescan-sonar images revealed surficial expressions of the submarine's two hatches (Figure 5). It is assumed that slight topographic depressions over the hatch covers were detected by the sonar. Diver observations by the *Hunley's* archeologist during partial excavations in 1996 revealed the submarine was resting horizontally on a firm sedimentary layer buried in fine to medium size sand approximately 2 ft below the sea

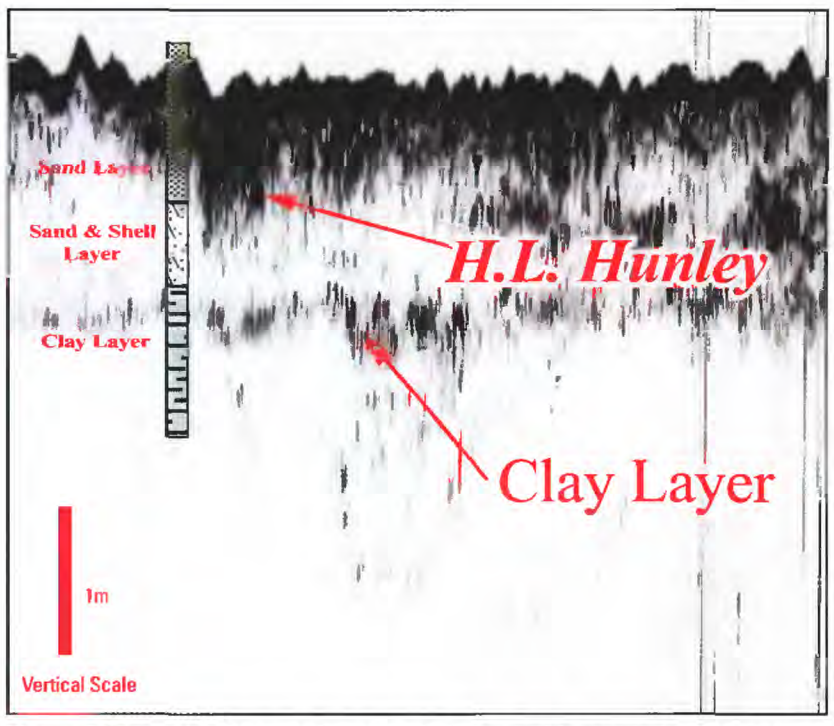

Figure 4. Example of one chirp seismic image and corresponding core log over center section of submarine.

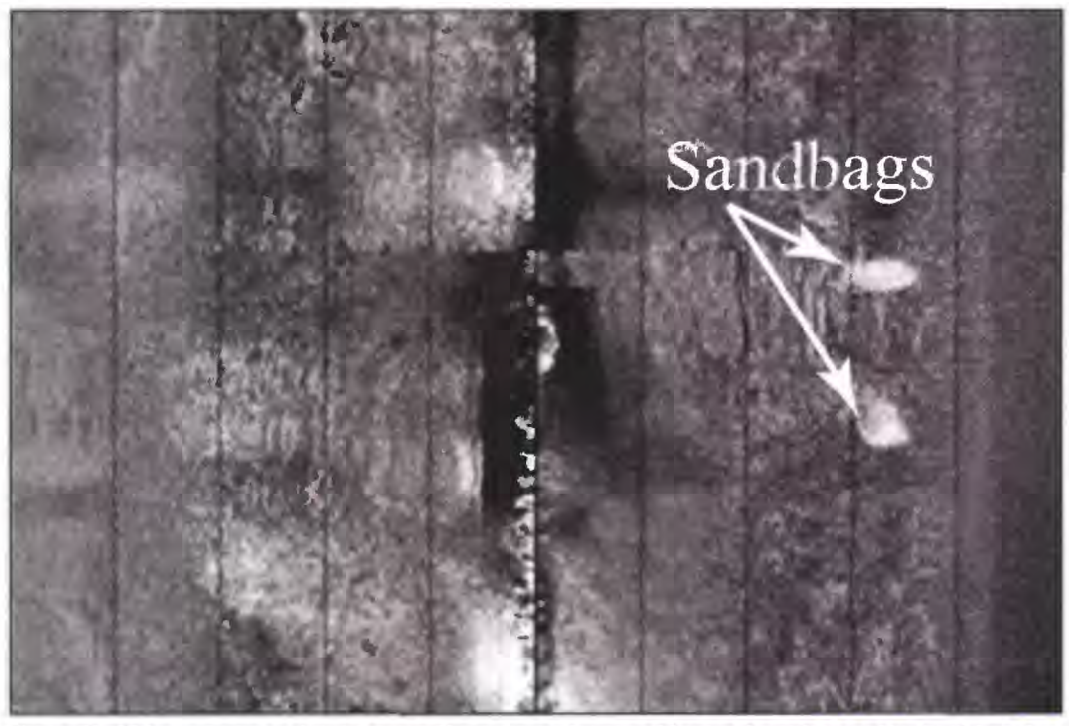

Figure 5. Sidescan sonar image revealing protective sand bags placed near *Hunley's* hatch covers during the 1996 exploratory effort.

floor. Interpretations of the seismic and core data confirmed diver observations. The general outline of the *Hunley* is evident in several of the chirp profile lines that run perpendicular over the center section of the submarine (Figure 5). Interpretations of the chirp data suggest the sediments above the keel of the *Hunley* appear to be rather homogeneous. Core interpretations confirmed the Chirp data interpretations in that sediments above the keel were depositional/erosional sequences of ebb-tidal delta sands. Ebb-tidal deltas are sand bodies which form at the entrance of inlets, in this case Charleston Harbor inlet. Thin layers of mud and shelly sand were interspersed in this top layer. At 9 ft below the sea floor, the *Hunley* was resting on a Holocene (less than 10,000 years old) dense clay layer, which has a consistency of modeling clay. It is this layer that probably kept the submarine from sinking deeper into tidal sediments over the past 130 years.

The wreck of *USS Housatonic* became a navigational hazard and in the early 1900s it was reportedly dynamited several times to eliminate the hazard. The archeological interest in the *USS Housatonic* was primarily to assess the amount of damage inflicted by the *H.L. Hunley*. Seismic data over the *USS Housatonic* site did not reveal any anomalies. Sidescan images detected several large objects near the wreck site that may have been part of the *Housatonic's* coal-fired boilers. Gravel-size coal pieces were found in the upper 6 ft of two of the sediment cores taken near the wreck site. It is speculated the coal came from the *Housatonic's* coal bunkers.

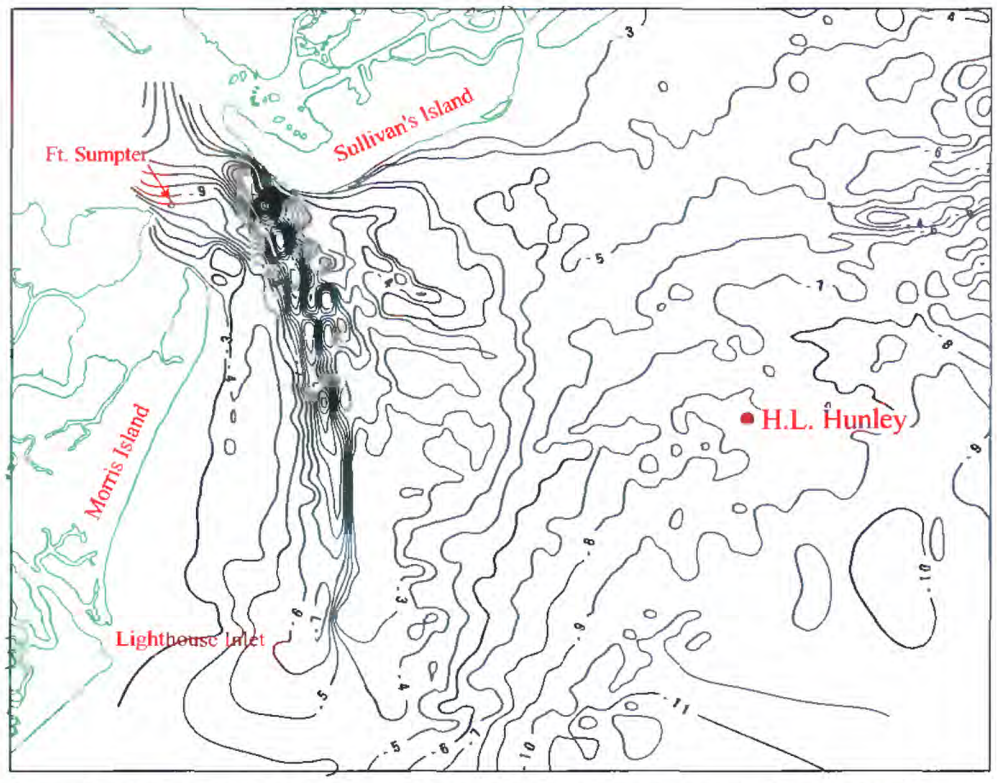

Figure 6. Bathymetric contour map of the 1880s showing location of the main ebb channel along Morris Island and the location of the *Hunley* wreck site.

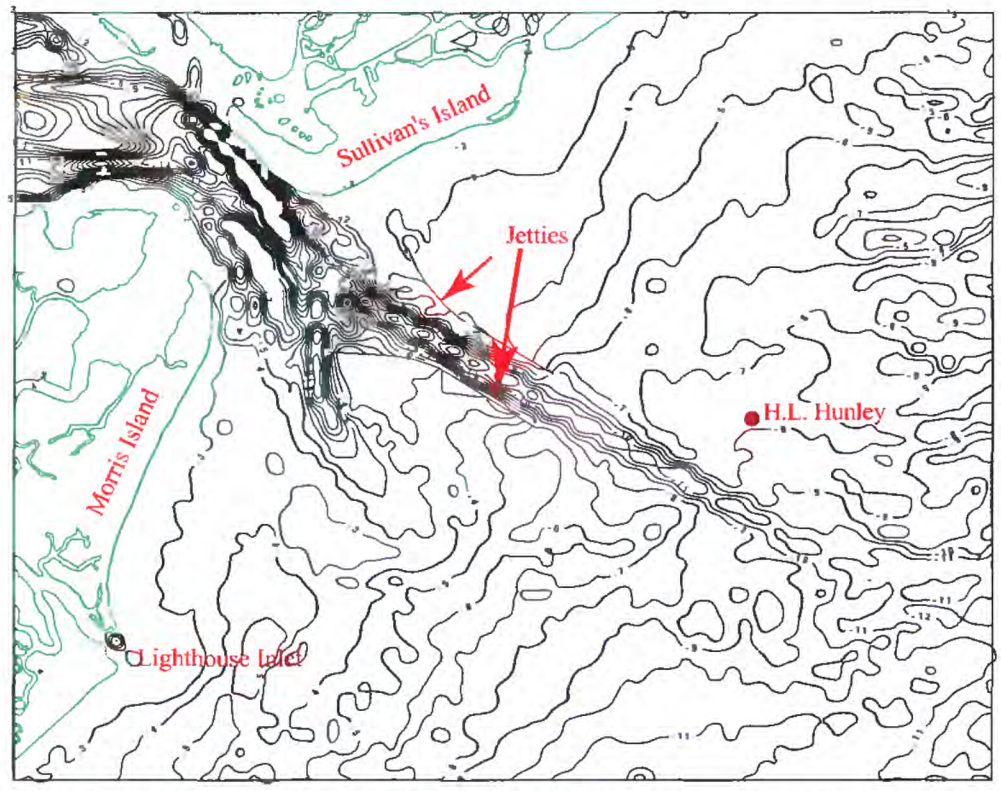

Figure 7. Location of the main ebb channel since jetty construction and proximity to the *Hunley* wreck site.

HUNLEY'S BURIAL SEQUENCE

The historical morphological changes of the Charleston Harbor ebb-tidal delta are important for explanation of the *Hunley's* burial sequence. Tidal-flow patterns and shape of the ebb-tidal delta were radically altered when 19,000-ft jetties were constructed at the mouth of Charleston Harbor in 1890. Prior to jetty construction, the majority of Charleston Harbor's tidal waters flowed through an S-shaped main ebb-channel starting from Fort Sumter, south along Morris Island, then directly eastward at Lighthouse Inlet (Figure 6). During this time, tidal currents near the *Hunley* wreck are estimated to have been low, ~ 1 - 2 knots. Jetty construction dra-

matically changed tidal flow patterns by diverting the main ebb-channel and tidal-flow directly east to a location 300 ft from the *Hunley* wreck site. Measured current flows on the *Hunley* site are 4-5 knots (Figure 7).

The *Hunley* sank on the eastern flank of the then existing ebb-tidal delta, which consisted of fine to medium sands. Tidal currents were relatively low, consequently minimal scouring and subsequent settling occurred, resulting in the submarine being fully exposed on the sea floor. Twenty-five years after the sinking, the jetties induced strong tidal currents over the *Hunley,* resulting in rapid scouring and settling. The scouring/settling processes continued until contact was made with the firm Holocene clay layer, at which point settling ceased. This sequence and time frame are confirmed by biofouling studies, which indicate the submarine was only exposed on the sea surface for 15 to 20 years. We suggest that the *Hunley's* rather rapid burial into anoxic (reduced oxygen) deltaic sediments helped preserve it by slowing the oxidation (rusting) rate.

Scientific information provided by the USGS to *Hunley* archeologists ultimately helped the *H.L. Hunley* "complete the journey."

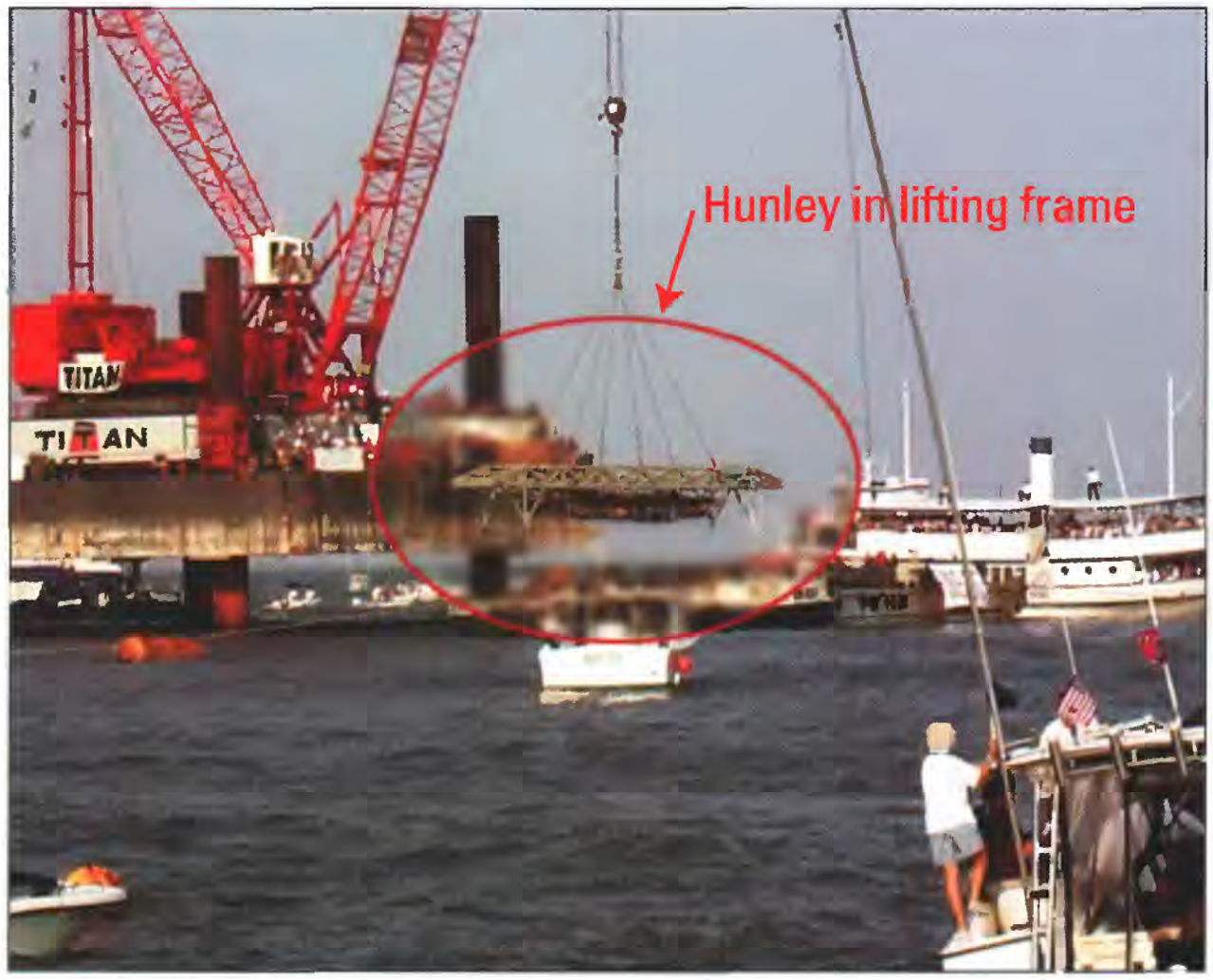

Figure 9. *Hunley* just lifted out of water and about to be set on barge.

Figure 10.. *Hunley* in lifting sling entering restoration laboratory at the US Naval Base in Charleston, SC.

Figure 8. Chief archeologist Dr. Dave Conlin (NPS) describes recovery efforts using miniature models.

REFERENCE

Murphy, Larry
Editor, 1998, H.L Site Assessment, National Park Service, Naval Historical Center, and South Carolina Institute of Archaeology and Anthropology, 198pp.

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