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UNDERWATER ARCHAEOLOGY BY BRAILLE: SURVEY METHODOLOGY AND SITE CHARACTERIZATION MODELING IN A BLACKWATER ENVIRONMENT - A STUDY OF A SCUTTLED CONFEDERATE IRONCLAD, C.S.S. GEORGIA

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Advancement in the science and application of underwater remote-sensing instrumentation has provided the archaeologist with the tools to conduct research in a blackwater environment. This paper discusses the development, application, and methodological approach used to conduct an underwater survey and site characterization of a scuttled Confederate ironclad, the CSS Georgia, in a dynamic tidal and zero-visibility riverine environment. Remote-sensing data collected from this Civil War shipwreck have provided interpretative information to help reconstruct the structural and physical integrity of this important historic shipwreck as she lies in 18 m of water in Savannah Harbor, Georgia. Detailed methodological techniques and a zero-visibility archaeological site characterization model are presented. The model to be presented includes the reconstruction of the site through the use of marine remote-sensing instrumentation and the integration of these data to formulate the interpretative framework.

Introduction

Shipwrecks found in United States riverine and coastal environments are generally in waters that have varying degrees of underwater clarity. Many factors interact to reduce water clarity over these wrecks. These factors include turbidity from sediments from surface runoff; biological activity such as algal blooms fed by nutrients entering streams from agriculture, sewage treatment, dredging activities, and their associated discharges; and freshet transport of resuspended sediments and organic debris, to name but a few of these sources. Suffice to say, the prevailing condition most of the year in major rivers and the coastal littoral is poor-to-zero underwater clarity. Depending upon the particular observer these low visibility conditions are typically termed "blackwater" or "zero visibility."

The conduct of archaeological research using standard survey mapping and excavation procedures is difficult if not next to impossible in the most extreme cases of zero visibility. This is particularly so for the wreck site of the CSS Georgia, a Confederate ironclad sunk in the Savannah River (Georgia) in December 1864 (ORN Series I, Volume XVI:482). Located 11 miles above the river bar off Fort Jackson (Fig. 1), the site is constantly covered by fresh-to-brackish, silty water rich in organics. Mixed by 6-10 foot tides, the suspended particles are constantly entrained by currents in the water column (U. S. Army Corps of Engineers, 1982). In addition to poor visibility, water depth, currents, and shipping traffic make this a difficult site at which to use divers. These conditions have hampered the use of visual recording techniques and fostered the use of instrumental techniques in the survey mapping and characterization of the CSS Georgia site. These techniques in turn have been embedded in a research methodology and organized to provide data and analysis for several levels of inquiry about the vessel and its context.

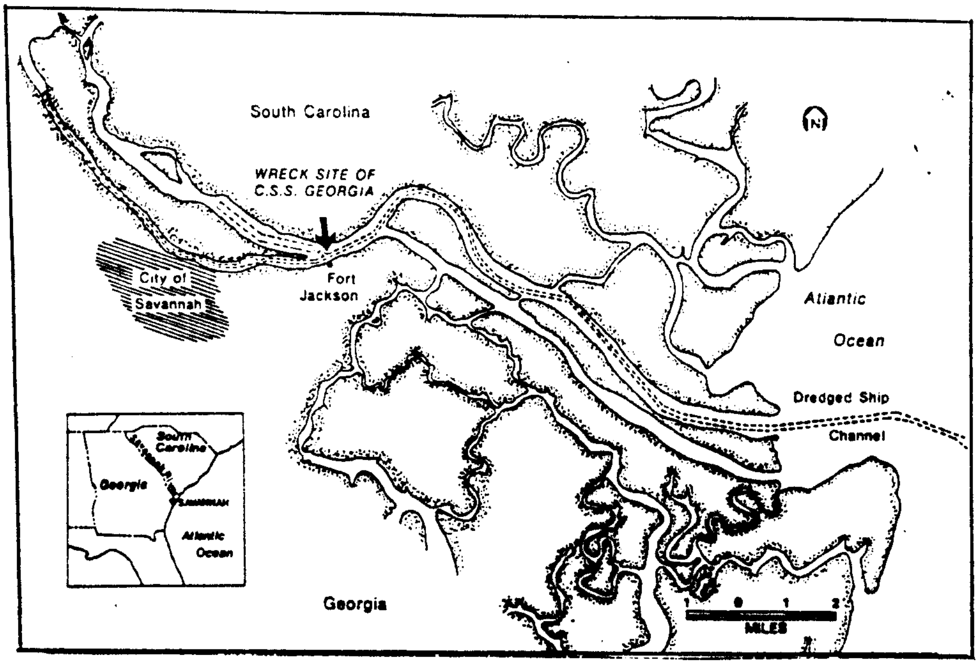

Figure 1. Location map.

Methodology is most correctly defined as the "study of method." It is not the simple explication of a technique or techniques used in the study of an archaeological problem (Pelto, 1970). It is "logic-in-use" involved in selecting particular observational techniques, assessing their yield of data, and relating these data to theoretical propositions. In the case of the archaeological study of the CSS Georgia we have attempted to gain, through a wide range of primary observations, data for a series of generalizations about the vessel and its historical period. To make these observations required the use of instrumental techniques and a subsequent enhancement of their data by graphic and digital means.

Objectives

Our first objective was to characterize the wrecksite of the CSS Georgia in as much physical detail as possible (Fig. 2) within the restrictions placed on us by its zero visibility environment. Other objectives were to:

a) relate these instrumental data on the wreck to historical data on the dimensions and general form of the vessel when in service during the War Between the States;

b) assess the current distribution and orientation of the wreckage; and

c) develop alternate models for the visual display and analysis of instrumental data so as to accomplish best the preceding objectives and improve the rigor and specificity of our methodology for zero visibility archaeological research.

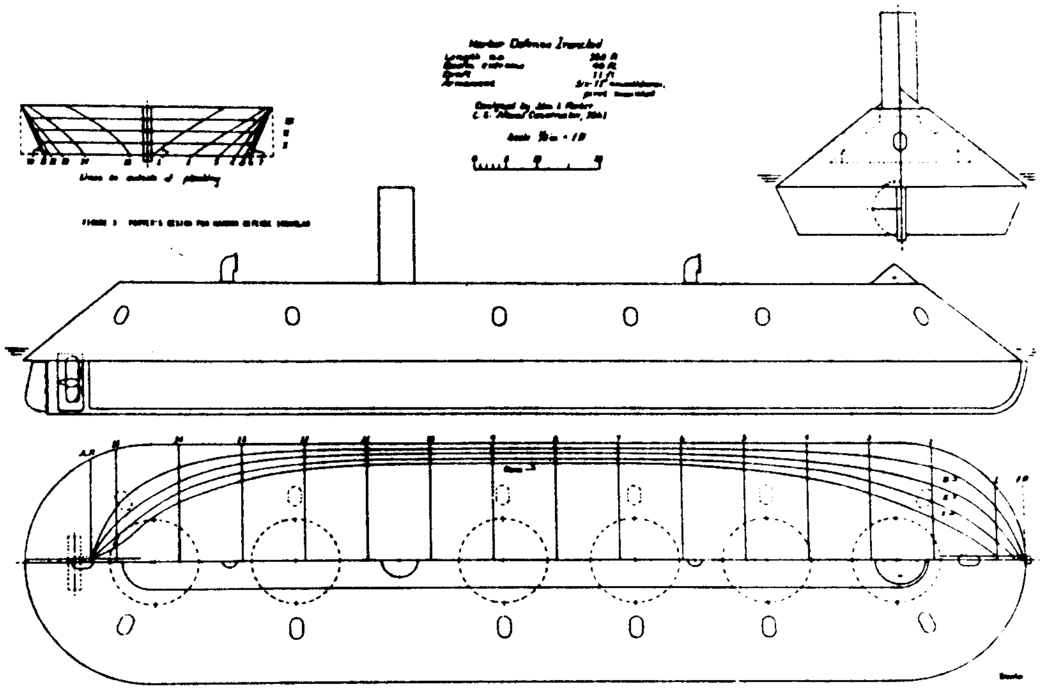

Figure 2. Harbor Defense Ironclad (after Porter, 1861)

<u>Background of the vessel</u>

In November 1864, General William T. Sherman began his "infamous" march to the sea from Atlanta to Savannah. Soon after Fort McAllister was captured by Union troops on December 13, the city of Savannah was pressed on two sides by Sherman and on another by a Union naval blockade. At this time, the Savannah Harbor Defense Squadron consisted of eleven armed vessels--seven gunboats and four ironclads. One of these was the <u>CSS Georgia</u> (Fig. 3). During the final hours of the siege of Savannah, the <u>CSS Georgia</u> was towed to a defensive position across from Fort Jackson to defend the river channel below the city. She trained her batteries against the Union naval advance. Her broadside, facing east, was fitted with two 9-inch Dahlgren smoothbores and two 32-pounder rifles. She also had one 32-pounder mounted in the extremity of the vessel. On her spardeck was a 24-pound howitzer.

Figure 3. Engraving of <u>CSS GEORGIA</u> published in Harpers Monthly, 1863.

Early on December 20, 1864, Sherman's troops captured Fort Jackson (Baker *et al.*, 1981), and the Confederates, to avoid its capture, quickly scuttled the CSS Georgia by opening all of the seacocks. Today, she rests in about 55 feet of black, silty water--remarkably preserved, but broken in her superstructure by harbor dredging activities performed since her sinking. She has proven as formidable in her resistance to destruction by these modern foes as she was in the past.

Built in 1862, her construction, interestingly, was accomplished through funds raised by members of the Ladies' Gunboat Association. These women of Savannah, Augusta, and other Georgia communities contributed over $115,000 for her construction. The need for such a vessel was intensified during the height of the women's solicitation of funds when, in March 1862, the news reached Savannah of the engagement of the USS Monitor and the CSS Virginia (better known as the USS Merrimac). This battle proved to be the turning point in the development of naval warfare in Savannah, just as the battle and the war, in general, proved a turning point in the history of naval warfare all over the world. It pointed out that the most effective defense was the ironclad ship, and the most effective offense was the rifled gun. In this atmosphere of excitement and expectation over ironclads, the CSS Georgia was born (Garrison and Anuskiewicz, 1988:74).

The CSS Georgia was essentially a steam-powered floating battery--a barge-type structure roofed over with wood at an inclined angle and then covered with railroad iron cladding. Such ironclads were, according to various historical accounts, also described as "floating forts." One observer of the CSS Georgia called it "an ironplated monster a la Merrimac" (ORN Series I, Volume XVI).

The CSS Georgia is an enigma because of the discrepancies in her construction details. These discrepancies are directly related to the condition in which she was built during the war. The CSS Georgia remains an enigma and a major source of historical and archaeological data on the "War between the States." As detailed architectural knowledge does not exist for the CSS Georgia, her reconstruction necessarily proceeds on thin ground. The vessel had no keel, was unstable in the water, was too heavy and cumbersome to float without the aid of her engines or to maneuver under her own power (Kollack, 1950), first planned as an ironclad "gunboat," but she was actually used as a floating battery. These criteria present a number of possibilities for consideration in a realistic reconstruction. The CSS Georgia floated for 20 months on the Savannah River, moored near Elba Island where, if the situation required, she could bring her broadside to bear on either channel of the river (Nordoff, 1863). In December 1864, when General Sherman was approaching the city of Savannah on his famous march, the CSS Georgia's fate was decided: as per orders from Commander Hunter, because of her lack of sufficient motive power, she was to be scuttled if Union forces reached Savannah (ORN Series I, Volume XVI:482). On December 20, 1864, the city of Savannah was evacuated and the CSS Georgia was scuttled, making her resting spot for the next century and more on the bed of the Savannah River.

She was considered a "failure" by some contributors and termed a "mud tub" and a "marine abortion" by others (Lawrence, 1961; Still, 1971; Kollack, 1950; Scharf, 1887). Although imperfect and oft times disappointing vessels, such ironclads by their simple presence prevented many a Union thrust at Southern ports (Johnson and Buel, 1962).

Instrumental imaging and enhancement techniques as used on the CSS GEORGIA

Because of the difficulty of mapping the site with conventional underwater archaeology techniques, a variety of remote-sensing methods was applied. These included video, magnetometer survey, tight-beam bathymetric survey, and side-scan sonar surveys. The video proved unable to see through the thick sediment load of the river and was abandoned. The side-scan sonar produced informative images and will be discussed later. The magnetometer and fathometer produced large amounts of data; ten thousand bits of data per run were typical. To image and process such quantities, Amdahl and Prime computers at Texas A&M University were employed, and the final images were plotted on Versatec and Printronix plotters. We looked at three ways of displaying the instrumental database. The magnetometric data were plotted as a curved line contour map only. The bathymetric data were plotted as 1) curved line contour maps, 2) color contour maps, and 3) three-dimensional grid element contour displays, which could also be used to produce stereoscopic views.

The side-scan sonar data were converted to gray scale by film recording and image enhancement. The combination of these techniques with diver verification of salient features allowed a definition of the nature and extent of the wreck site. This information will serve as an essential part of the planning process for the future evaluation and disposition of the vessel. Plans to enlarge the Savannah River navigational channel will eventually necessitate the removal of the vessel.

A number of features in the aerial view of the river and the city of Savannah to orient successive images should be noted. The river flows from right to left, the main channels being the south or lower one on the left and the north or upper one on the right. The northern shore is South Carolina and the southern shore is Georgia. The wreck is located off Fort Jackson in the middle of the river at the limits of the juncture of the main dredged channel and the channel dredged for the Back River. The angle of intersection of the lines of the back and main channels can be used to orient the other graphics.

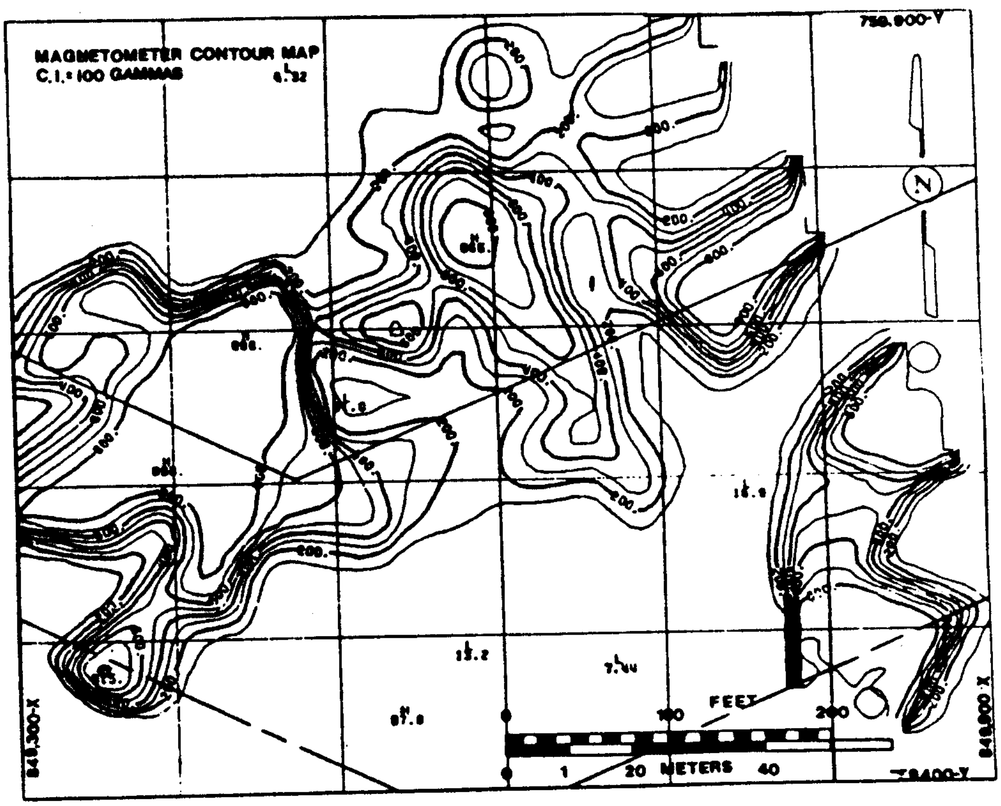

Figure 4. CSS GEORGIA wreck site magnetometer contour map.

A. Magnetometric Survey Data

The first computer graphic is a planimetric presentation of magnetic anomalies at the wreck site (Fig. 4). The contour interval is 100 gammas; each square of the superimposed grid is equal to 100 feet. The anomaly on the lower right is due to a modern anchor that was later recovered; the anomaly on the lower left is the chain and anchor to the wreck buoy marking the site. The other contours record an intense magnetic concentration to the north of the main channel at the point of intersection with the back channel and to the east of that intersection. This information does serve to approximate the location of the wreck; but because the CSS Georgia was an ironclad and thus an object of intense magnetism, it is difficult to obtain detail using this technique. Data for this image were obtained by passing over the site, and taking magnetometer readings in coordination with navigational fixes to locate positions where the readings were made. These data were then run through a program that performed trigonometry and positioning of readings. Contour maps were produced using a "Conrec" program subroutine (Reid, 1980). This magnetic contouring technique has been used for some years (Breiner and MacNaughton, 1965), and more complex graphics of magnetometric data have been produced (Arnold and Clausen, 1975a; Breiner, 1973, 1975; Upham, 1979; Anuskiewicz, 1985, 1989).

B. Bathymetric Survey Data

1. Curved Line Contour Maps

Fig. 5 illustrates the development of our knowledge as the computer-processed database was expanded. For these maps the same bathymetrically generated database was imaged as a regular smooth line contour map (Fig. 5), with a contour interval of one foot. However, to the uninitiated, contour maps are often difficult to read; even to the experienced, subtle features may escape notice. We also felt an even more dynamic presentation was needed to image features for analysis and use as an orientation model for divers working on the site.

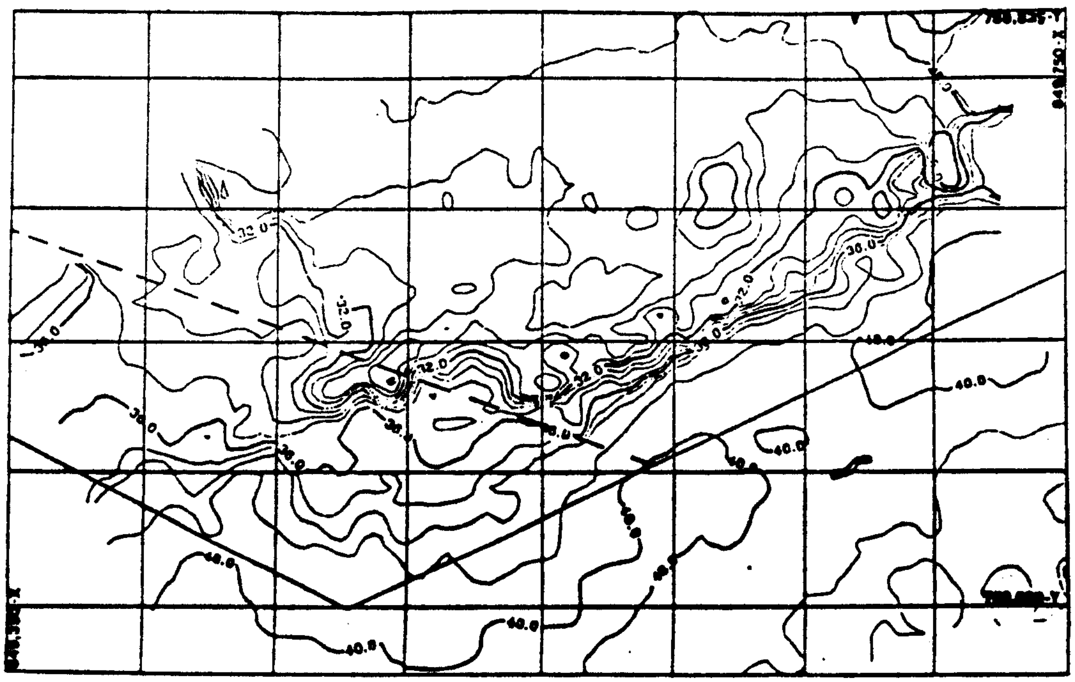

Figure 5. Computer generated bathymetric contour map of the CSS GEORGIA. Contour interval = 1 ft.; grid spacing = 50 ft.

2. Color Contour Maps

The use of color in graphics imaging has the advantages of being visually appealing as well as adding contrast to specific features or areas of interest. By manipulation of a color palette available with many CAD-CAM (computer-aided design-camera) systems, one can assign various hues to a specific parameter, which in our example was relief elevation in feet. In Fig. 5 we can highlight the major area of wreckage and debris scatter down on or onto the adjacent channel slope.

C. 3-d Grid Element Contour Display

Three-dimensional graphics (Fig. 6) translate the data into images that approximate a perspective or isometric view of the actual terrain. In Fig. 6, the CSS Georgia wreck is in the center of the image, looking downstream, with the dredged channel on the right and the undredged river bottom on the left. A second dredged channel comes into the main channel from the left foreground of the image.

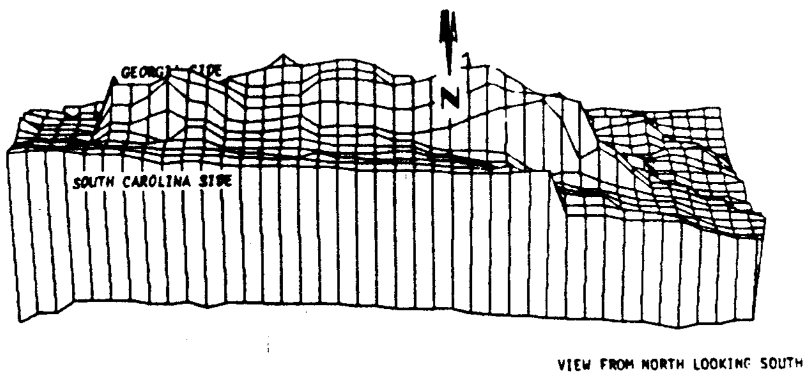

Figure 6. 3-D view of the wreck site looking south.

Three-dimensional graphics programs often allow the user to select the viewing angle, offering the opportunity to "swim" around the site and to study the terrain from any position. Fig. 7 represents the same data base used in Fig. 6, rotated over 90 degrees. In graphics, we speak in terms of x, y, and z axes, with x and y often being directional, such as meters north or east of an origin. The z axis may represent height, as in bathymetric surveys, or some other variable such as magnetism. Both contour and isometric views comprise lines having either constant x values or constant y values, but the isometric view has had contour lines added, lines of constant z value. These contour lines follow two-foot intervals and were generated by a single change to the program used to create Fig. 6.

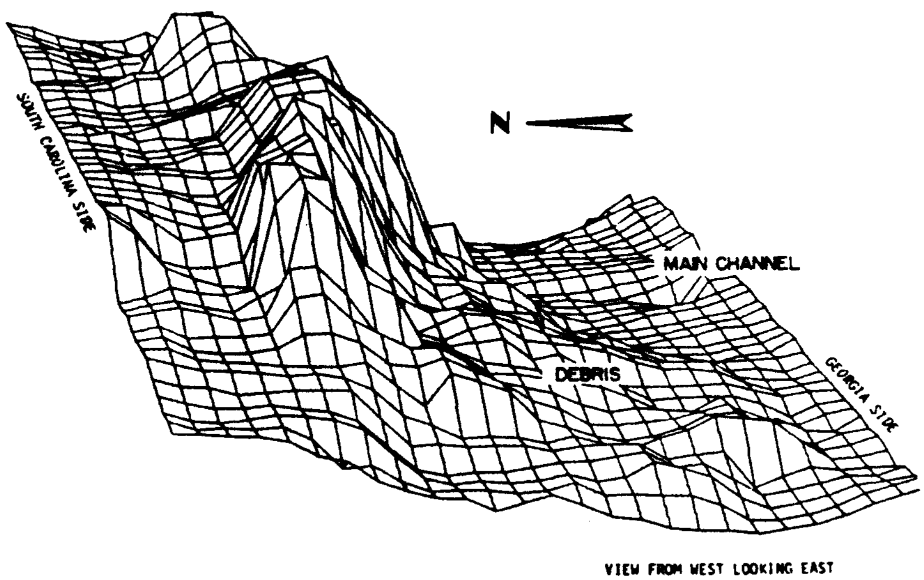

Figure 7. 3-D view of the wreck site looking east.

D. Side Scan Sonar Survey Data

Figs. 8, 9, and 10 are sonographs taken with two different instruments. The difference in the instruments was the frequency of the transmitted pulse, which was 100 or 500 kHz (kiloHertz). Resolution in sonar images is related to the pulse length and frequency. The higher the frequency (hence shorter pulse length), the smaller the object that can be resolved.

The first image (Fig. 8) is an unenhanced 100-kHz sonograph of the wrecksite. The track of the vessel is shown and can be related to previous graphics. Two large pieces of wreckage can be seen with a gap between them. To examine this view further, a photographic enlargement was made and printed as a positive to reverse the light and dark gray tones. This next view (Fig. 9) shows the enhanced sonograph with areas of no signal return shown as shadow or dark features. This treatment of the sonar image clearly improves the amount and the conceptualization of the detail seen.

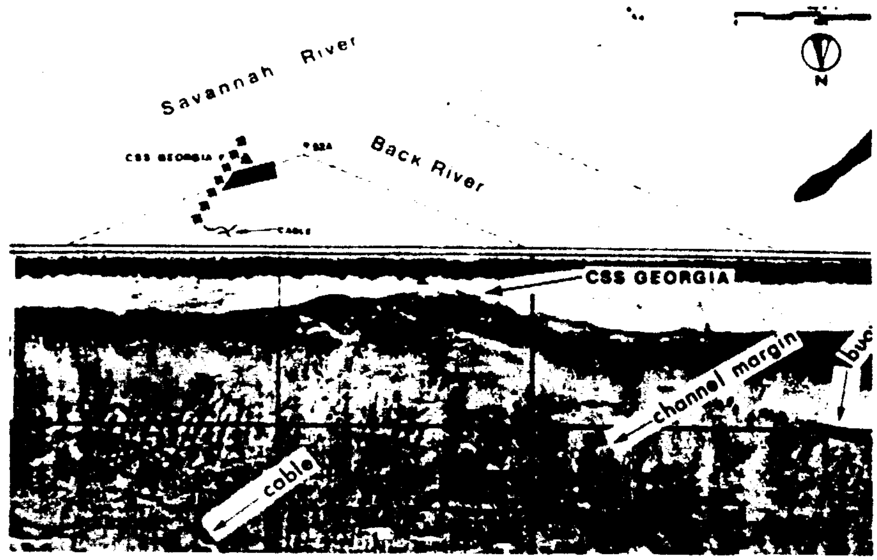

Figure 8. 100 kHz side scan sonar view of the CSS GEORGIA.

Figure 9. Black and white reverse color enhanced sonograph of Figure 8.

The last sonograph (Fig. 10) is a gray-tone enlargement of a 500-kHz image with no reversal of the standard negative presentation. The broken condition of the exposed casemate is dramatically shown in the 500-kHz sonograph of the wreck. Removal attempts in 1866 by blasting reportedly raised 80 tons of armor from the casemate (Reports of the Chief of Engineers, 1872) and probably produced the condition observed in this view.

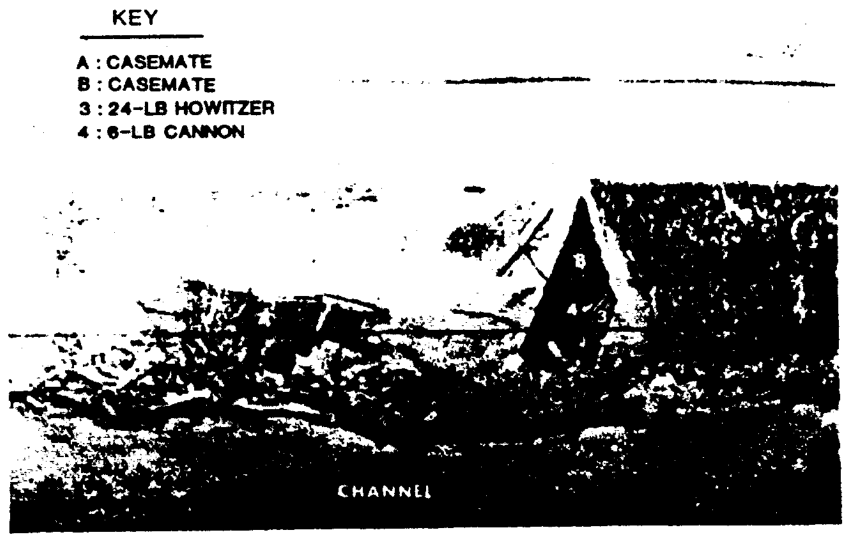

Figure 10. 500 kHz side scan sonar view of the CSS GEORGIA.

Limited diver hands-on correlation of the mapping studies yielded precise locations of major structural features as well as locations of artifacts such as ordnance and ship's gear. All artifacts removed for study were archaeologically mapped prior to recovery. No excavation was done except in the case of ordnance. One hundred shallow-buried Brooks rifled projectiles were excavated by hand to remove them from the main shipping channel of the Savannah River.

Summary

By using the variety of instrumental techniques discussed in this paper we have been able to characterize the zero-visibility wrecksite in some detail, and we have largely accomplished our research objectives.

Our hope to relate the instrumental data to historical data on the CSS Georgia dimensions and general form has proven successful to the extent that we can evaluate more confidently conflicting reports on her length and breadth (Dictionary of American Naval Fighting Ships, 1963; Reports of the Chief of Engineers, 1872; Schomette, 1973; Scott 1862) that the vessel dimensions varied as much as 110 feet in length (150-260) and 10 feet in breadth (50-60). The shape and size of the casemate sections agree very well with the two published drawings of the vessel and with most contemporaneous reports (cf. Garrison and Anuskiewicz 1988). Other details on the vessel such as hull shape and layout of internal decks must await further study such as trial excavations.

The objective to assess the distribution of wreckage was fully met. The magnetometric, bathymetric, and sonar data all converge to give a reliable estimate, in areal terms, as to the extent of the wreckage. The vessel's orientation still remains somewhat of a mystery, as no key indicators such as funnel, pilot house, rudder, or propeller have been identified. The location of the recovered portside 32-lb rifled gun as seen in the data does support an orientation with bow upstream. This interpretation relies heavily on the original deployment of this gun in the vessel's battery and may not be reflective of the late-1864 placement of the reduced number (6 versus the original 10) of guns known for that time (Garrison and Anuskiewicz, 1988).

Our attempt to model the wrecksite instrumentally has been met with mixed success. Naturally, we would like to determine a realistic and accurate likeness of the vessel as it exists and to retrodict her form as she existed in 1864. This we have not done. Computer graphics and image enhancement have filled in large gaps in our understanding of the site; however, as we have pointed out, equally large gaps in archaeological detail remain.

Computer graphics have been used for some time in archaeology (Breiner and Coe, 1972; Arnold, 1974, 1975, 1976, 1979, 1982; Arnold and Clausen, 1975a and b; Kaplan and Coe, 1976; Weymouth, 1976; Weymouth and Nickel, 1977; Frankel, 1980; Garrison and Anuskiewicz 1988; Anuskiewicz, 1989). Arnold has used computer graphics to good effect, imaging the results of several shipwreck surveys in the Gulf of Mexico. Weymouth has done a series of magnetometer surveys and refined techniques for surveying as well as imaging the results of the surveys. He employs SYMAP (Dougenik and Sheehan, 1979), a program from Harvard's Laboratory for Computer Graphics and Spatial Analysis, which uses alphanumeric symbols to define distinctions between contours as shades of grey, lightness and darkness. Harvard is using a three-dimensional program, ASPEX (Hanson, 1980), which can use the same data used by SYMAP to generate images in three-dimensions. SYMAP and ASPEX are user-friendly programs and require no background in computer science to use. Thanks to such pioneering work, computer graphics have become a frequently used interpretive tool.

Our enthusiasm must be tempered by an awareness of the potential perils posed by computer models. There is a tendency to regard an image as the image. That a representation is computer-generated, on glossy paper, with elaborate fonts, in lovely colors can lead us to suspend our critical faculties and lend the image an air of authority it may not merit. When looking at them we should reserve our judgment and study them carefully.

Baker and Garrison (1983) have pointed out many of the underlying problems arising from less-than-real or inaccurate representations of archaeological features from instrumental data. To discuss them in depth here would diverge too far from the central aim of this paper. Factors such as data density, weighting, windows of influence, and grid size are key considerations in the proper modeling of instrumental data (Baker and Garrison, 1983; Barnes, 1973).

The work on the CSS Georgia has been a laboratory for the evaluation of several of these methods. The results have been positive but not perfect. The present study has demonstrated these techniques to be powerful aids to survey methodology in the blackwater environment. These conclusions have even more weight when one considers the dynamic field of computer graphics today. Coupled with the availability of new graphics software and enhancement algorithms, significant improvement in the imaging of buried and black water archaeology sites is at hand. A recent example of this is the impressive imaging of archaeological magnetic data by Scollar *et al.* (1986). These techniques give the nautical and terrestrial archaeologist alike new conceptual tools for developing interpretative frameworks for instrumental data.

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