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SESSION

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Technology, Theory, and Analysis

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Using Remote-Sensing as a Tool for Middle-Range Theory Building in Maritime and Nautical Archaeology

Introduction

This paper is presented to provide some guidance to the archaeologists working underwater contemplating using geophysical-prospecting data as a tool for middle-range theory building in maritime and nautical archaeology. The methodology and data presented herein are based on archaeological research conducted on and around St. Catherines Island, Georgia, and focus on the use of magnetometer remote-sensing. The research objectives were basically three-fold: first, to develop an historic maritime model for St. Catherines Island; second, to test this model by conducting comprehensive maritime and nautical archaeological studies of the waterways adjacent to and contiguous to the island; and third, to develop a correlation between remote-sensing signatures and the archaeological context for middle-range theory building. This presentation will specifically discuss the methodological approach used to develop a maritime model and how the model used nautical archaeology in middle-range theory building for St. Catherines Island.

Middle-Range Theory and How it Works

An example of how middle-range theory building works in historical archaeology can be drawn from a brief discussion of David Hurst Thomas' recent work (1987:67) at the Mission Santa Catalina de Guale on St. Catherines Is-

land. Thomas was able to define linkages between the traditional archaeological concepts of walls, structures, and features and the way they are perceived remotely by sensors of geophysical prospecting, such as magnetometers (Anuskiewicz 1989:6).

Further, Thomas defines archaeological concepts as typically abstract categories employed by the archaeologist. In his research Thomas explored the archaeological context of 16th and 17th-century Spanish Florida, such as buildings, pits, graves, palisades, bastions, wells, etc., on St. Catherines Island. Therefore, effective middle-range theory relates these concepts to an unambiguously defined *class of empirically observed phenomena*; in remote-sensing these phenomena are the battery of signals and signatures that derive from nondestructive geophysical prospecting (Thomas 1987:66; Anuskiewicz 1989:7).

Constructing a correlation of remote-sensing signatures and the archaeological context *must* be viewed as middle-range theory building in archaeology. This is simply another way of assigning meaning to our empirical observations (Schiffer 1976; Garrison and Bray 1976; Binford 1977; Thomas et al. 1979; Hayden and Cannon 1984; Thomas 1986:238; Anuskiewicz 1989:7). Middle-range theory is how we *perceive* the past and is quite different from how we *explain* the past (Binford 1981:29; Thomas 1983a, 1983b).

Maritime Archaeology

The study of sunken watercraft on St. Catherines Island and their associated economic and cultural activities were subsumed under the general headings of historical and maritime archaeology. Muckelroy specifically defines *maritime archaeology* as:

The scientific study, through the surviving material evidence, of all aspects of seafaring: ships, boats, and their equipment; cargoes, or passengers carried on them, and the economic systems within which they were operating; their officers and crew, especially utensils and other possessions reflecting their specialized lifestyles

Chronological Periods - Spanish, British, Early American and Modern

Maritime Site Typology	Cultural Periods	Expected Site Factor Locational Indices	Expected Site Formation Processes	Expected Archaeological Indices	Expected Instrumental Indices
3.a.) SHIPWRECK Wooden hull, (continuous)	3.) Spanish, British, Early American	3.) "Loss traps", harbors, shoals, ocean-side beaches, shallows of navigable river and creeks.	3.) Poor navigation, natural-foundering, storms or hurricane, accidental-fire, economic-abandonment, warfare-scuttling or battle damage.	3.) Wooden debris and some metal fittings, nautical and personal implements, marine hardware, ship's cannons, sheathing and ballast stones.	3.a.) <u>Bouyant hull pattern</u> . A linear distribution of multiple anomaly peaks. A dipolar signature pattern oriented along the same heading as the long axis of the hull. Low to medium gamma intensity(10-80 gamma).
3.b. and c.) SHIPWRECK Wooden hull (discontinuous).					3.b.) <u>Bouyant hull fracture pattern</u> . Multiple dipolar anomalies radiating upslope and downcruent from a more tightly clustered, high-intensity anomalies. Low gamma intensity(5-65 gamma). 3.c.) <u>Bouyant structure pattern</u> . Non-clustered dipolar anomalies of varying intensities, scattered unevenly across the beach. Low gamma intensity(5-45 gamma).

TABLE 1. The St. Catherines Island Maritime Model

(Muckelroy 1978:6).

Maritime activity sites and sunken watercraft are a part of the archaeological resources. They were part of an active cultural landscape wherein maritime activities, processes, and the people who participated in them were part of a larger historical cultural context.

In my research, the use of nautical archaeology remote-sensing technology to evaluate the St. Catherines Island maritime landscape and waterways made it possible to discover and examine specific types of archaeological sites and materials of the historic period. By examining the physical characteristics and recent geological history of the island's landscape and waterways, this study was able to specify which waterways were navigable and to what size of vessel, and therefore predict the archaeological record for shipwrecks (Anuskiewicz 1989:11).

The St. Catherines Island Maritime Model

The maritime model for St. Catherines Island was developed to conceptualize archaeological expectations and to formulate and test a set of verifiable hypotheses. The model is represented by six major descriptive and analytical categories for data input, interpretation, and analysis (Table 1). The categories described in this model were developed from archaeological information initially derived by Thomas (1987, 1988) from the discovery and issuing studies of the Mission Santa Catalina de Guale.

Descriptive, Analytical Model Categories, and Expectations

Maritime Site Typology

This category identifies the types of specific maritime sites expected to occur on St. Catherines Island. These included a Spanish mission, a careening site associated with the mission complex, shipwrecks, and a ballast pile or marine dump site associated with the Spanish, British, early American, and modern periods of occupation.

Cultural Periods

This category is pretty much straight forward and represents individual cultural periods considered in this model. Each cultural period is matched with a maritime site type to provide specific site-type correlates for each period of the island's maritime history.

Site Factor Locational Indices

This category describes the expected geographic locations of maritime sites within the physiographic landscape of the island. These indices are specifically correlated with the *Maritime Site* and *Cultural Periods* categories to determine the most probable geographic location at which to search for a specific maritime site type.

The expected Site Locational Indices for shipwrecks on the island consist of the specific concept of "loss traps" as described by Schiffer (1976). These are specific areas where vessels are lost due to natural phenomena of storms, currents, and shoals. These loss traps are expected to be concentrated along open and unprotected areas of the eastern Atlantic coast and beaches of St. Catherines Island. Heavy shoaling areas located near the northeastern tip of the island and an inlet near the center of the island are also expected to be additional high probability areas for loss traps.

It is also expected that there is a direct correlation between the size of the vessel lost and the size of the loss trap or waterway in which it was lost. For example, the smaller, meandering creeks found on the island have historically been navigable only to smaller type vessels such as canoes, launches, sloops, skiffs, and smaller motor-powered recreational and sport fishing watercraft.

Site Formation Processes

This category describes how each type of maritime site was formed. For example, Thomas' recent work (1987) suggests the remains of

the Mission Santa Catalina de Guale were formed as the result of the construction, destruction, and reconstruction sequence of the mission during the Spanish occupation of the island.

Site formations for shipwrecks are expected to be caused by poor navigation, natural foundering, accidental fire, economic abandonment, or mutiny, warfare, scuttling, or battle damage. The subsequent examination of the archaeological indices of individual wreck sites is expected to substantiate the site-specific shipwreck formation process. If a wreck is located in a "loss trap" and shows evidence of burning, one can assume that the vessel caught fire and ran aground.

Expected Archaeological Indices

This category represents specific archaeological features and material culture remains expected to be found in association with a particular maritime site type (Anuskiewicz 1982) identified in this model.

Wooden-hulled shipwreck sites associated with the Spanish, British, and early American period are expected to have the following archaeological indices: wooden debris, some metal fittings and fasteners, ballast rock, cannons, nautical implements, marine hardware, and personal items of the crew.

Wrecks of the later American and modern periods are assumed to contain more metal components associated with later construction techniques and the presence of the debris from these motor-powered vessels. Modern wrecks are expected to be constructed of materials such as steel, aluminum, and fiberglass and to be powered by diesel or gasoline engines (Garrison 1989).

Expected Instrumental Indices

This category is expected to produce correlative remote-sensing signatures for specific maritime features located during this study. These signatures and their verified archaeological correlates will form the foundation of middle-range

theory building for maritime sites associated with the island.

The Expected Instrumental Indices for a shipwreck associated with the island should vary with the particular historic period. For example, sailing vessels of the 16th, 17th, and 18th centuries were constructed mainly of wood and had relatively few associated ferrous metal fasteners and fittings. Some of these vessels are expected to have associated cannon, and all vessels should have associated anchor, ground tackle, and the crew's personal items as part of the ship's archaeological context. It is expected that historic period shipwrecks reflect specific wreck patterning and correlative magnetic signatures. In general, the magnetometer signature should reflect the lack of large quantities of ferrous components and produce low to medium amplitude dipolar anomalies.

Nineteenth- and 20th-century ships were, and modern ships are, constructed of more ferrous and steel components. These wrecks, and their specific wreck patterning, are expected to produce multi-point source, dipolar anomalies that are larger, sharper, and broader at a medium to high amplitude. These signatures would reflect the amount of iron or steel in the vessel's construction and the associated metal in the steam, diesel, or gasoline power train components.

It must be noted that the Expected Instrumental Indices represent only a general range of magnetometer readings for the periods identified in the St. Catherines Island maritime model. There are multiple variations of these instrumental indices for shipwrecks, variations caused by the wreck distribution pattern and the amount of ferrous material associated with the wreck.

The Archaeological and Material Cultural Expectations of Shipwreck Sites

Muckelroy wrote extensively on the expectations for shipwreck distributions and the preservation of specific elements of these sites (1978:157-225). His fundamental taxonomy divided shipwrecks into *continuous* and *discontinuous* types.

The continuous sites represent shipwrecks that, while undergoing varying levels of wrecking processes, are still relatively localized in their remains of the hull and any cargo or ship's fittings. The artifact distributions associated with these wreck have not been interrupted by sterile areas which do not have to be taken into account during the interpretation (Muckelroy 1978:182).

Discontinuous sites are those with elements of the ship widely scattered, with no single specific locus of the wreck site. These sites have been disturbed by the wrecking process. There is a total absence of any defining framework, making the reconstruction of such sites extremely difficult (Muckelroy 1978:196).

Clausen (1966) and Clausen and Arnold (1975) further discuss the discontinuous shipwreck patterns for shallow coastal wrecks:

In the majority of cases, vessels of wooden construction lost on active, exposed coasts tend to break up and disintegrate under the influence of storm-generated waves and currents. Later, they may also be destroyed by intense attacks of various marine organisms and the effects of succeeding storms, scattering their components, ballast, and cargo over an area much larger than the dimensions of the original ship (Clausen and Arnold 1975:80).

Recent research in maritime and nautical archaeology has classified shipwreck patterning and developed Expected Instrumental Indices for specific wreck patterns, indices based on studies of the wreck's physical remains. Delgado et al. (1984) and Gearhart (1988a, 1988b) have further refined shipwreck patterning by developing distinctive site patterns using correlative magnetic signatures. They have designated these specific site patterns as buoyant hull, buoyant hull fracture, and buoyant structure. These wreck-type patterns and their correlative magnetic signatures were used as a basis to predict and develop shipwreck instrumental indices in this maritime model.

Development of Shipwreck Instrumental Indices Expectations

The *Buoyant Hull Site* is defined as a continuous wreck site in which the vessel comes ashore and settles in the sand relatively intact. Gearhart (1988b:40-43) reports that buoyant hull wrecks may differ from one wreck to the next because of materials used in their construction (e.g., wooden versus steel hulls). His expectations for this site type are characterized by two important magnetic patterns. First is a linear distribution of multiple anomaly peaks within the overall pattern produced by the remains of the intact hull. For a wooden-hulled vessel, one expects the anomaly patterns to exhibit a complex, elongated anomaly containing areas of high and low magnetic intensity within its boundaries. Further, the expectation is that the long axis of the anomaly pattern will be oriented along the same heading as the long axis of the hull. Finally, Gearhart suggests that the long axis of the anomaly pattern should be oriented parallel to the surf line because of the tendency of a drifting hull to turn broadside to the waves.

Buoyant Hull Fracture Sites are discontinuous wreck sites that occur when the hull of the ship comes ashore intact but breaks up on the beach and is dispersed by the surf. Therefore, the expected anomaly pattern for this wreck type would consist of multiple anomalies (i.e., wreck scatter) radiating upslope and downcurrent from an area of more tightly clustered, high-intensity anomalies (i.e., the area of hull breakup). This magnetic signature is produced as a result of the distribution of wreck parts (e.g., iron fittings or magnetic ballast material) that become scattered away from the main body of the wreck due to storms and wave action.

Buoyant Structure Sites are also discontinuous wrecks, formed when a vessel breaks apart offshore and washes onto the beach in pieces (Gearhart 1988b:40). This wreck type could leave a trail of wreckage scattered for miles along the beach. The magnetic signature would depend upon the size and quantity of associated

ferrous debris that remained with the floatable materials that came ashore and the areal extent of their dispersal onto the beach.

This is a very complex wreck type because of the many variables to consider (e.g., distributional length of the wreck site, construction materials of the ship) when deriving expectations as to the magnetic signature pattern. Gearhart (1988b:43) expects such sites to consist of non-clustered anomalies of varying intensities, scattered unevenly across the beach.

Development of Specific Hypotheses

The specific information presented above has provided the necessary archival data and theoretical concepts to formulate working hypotheses to test the maritime, and nautical model for St. Catherines Island. From the maritime model, six working hypotheses were generated with respect to locating maritime sites and shipwrecks associated with the island. The hypotheses concerning shipwreck instrumental indices were easily evaluated using the St. Catherines Island data. The wrecks encountered, and their magnetic signatures, provided exhaustive data on the variety of expected site types discussed above. Certainly the data allow us to broadly classify sites based on the instrumental data. Evaluation of these hypotheses has led to the recognition of ancillary hypotheses. For example, the high correlation of wrecks with the "loss traps" of shoals and bars leads one to pose hypotheses concerning vessel type and size for other areas and to project probabilities for losses in those areas (Ervan G. Garrison 1992, pers. comm.). Even though several of these hypotheses are germane to this discussion, only one is presented below.

Results of Testing the Specific Hypotheses

What must be noted here is that state-of-the-art proton magnetometer instrumentation and underwater and terrestrial search techniques were used to test the specific hypothesis.

Hypothesis: Shipwreck sites will be concentrated at "loss traps"

This statement is true. The six shipwrecks inventoried during this research support the maritime model categories of the Expected Site Factor Locational Indices, Expected Site Formation Processes, Expected Archaeological Indices, and Expected Instrumental Indices developed for St. Catherines Island.

The Expected Site Factor Locational Indices category for shipwrecks in the model projected that wreck sites would be located in loss traps (Schiffer 1976). This study envisioned St. Catherines Island's loss traps at shoals and ocean side beaches. All of the shipwreck sites inventoried during this study were located in these areas. The wrecks exhibited various types of vessel damage prior to, or as a result of, the wrecking process. From the vessel damage, one could postulate the wrecking process and compare it with the Expected Site Formation Processes identified in the model. The debris observed at the wreck sites supported the Expected Archaeological Indices for modern-period shipwrecks. The magnetic signatures recorded for these wrecks also supported the Expected Instrumental Indices for modern wrecks as described in the model.

Middle-Range Theory Building for St. Catherines Island Using the Maritime Model

Maritime model building for St. Catherines Island through the use of archival research has developed sets of perceived archaeological indices for anticipated maritime sites and assigned correlative magnetic signatures to these expected sites. The testing of the maritime model through remote-sensing field work has developed sets of remote-sensing signatures that can be used as baseline reference information. These signatures have produced a framework for middle-range theory building for maritime sites associated with St. Catherines Island.

The shipwrecks studied and analyzed during the maritime study of St. Catherines Island are

certainly specific to the island. The model building and testing by scientific inquiry for this study have provided sets of verifiable magnetic signatures. Therefore, this part of the research has provided the foundation for baseline geophysical signatures and the foundation for middle-range theory building for modern shipwreck sites associated with St. Catherines Island and similar physiographic sites throughout the southeastern United States.

Conclusion

The intent of this paper was to provide some guidance to archaeologists working underwater contemplating using geophysical-prospecting data, in particular from the use of the proton magnetometer, as a tool for middle-range theory building in nautical archaeology. This has been accomplished by presenting the methodological approach to building a maritime model. Further, this paper has shown that the systematic application of the scientific method and state-of-the-art instrumentation, along with a theoretical model, a sound methodological approach, and systematic field techniques, has provided the desired results in locating modern shipwreck sites associated with the island.

Using instrumental survey techniques in the service of well-defined theoretical expectations has eliminated many of the areas where many shipwreck sites could not occur. At a basic level of archaeological inquiry, this study has increased the discovery probability of locating these particular nautical sites with a continued application of this methodology.

This statement is particularly true if the specific theoretical expectations are manifest in discrete, archaeological indices. The archaeological indices are either the features and assemblages themselves or the observable instrumental correlates of these indices established by the application of middle-range theory building (Anuskiewicz 1989:228).

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