

# TECHNIQUES IN EXPLORATION OF MARINE ARCHAEOLOGICAL SITES – A CASE HISTORY FROM TAMILNADU COAST

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## INTRODUCTION

Marine archaeology may be defined as the study of ancient shipwrecks, ports, harbours, submerged towns and other offshore sites marked by scattered potteries, anchors etc. (Dumas, 1962).

There are many wide ranging aspects of marine archaeology and each one is as existing as other. In the earlier days the scope of marine archaeology was confined to very shallow water depths. Consequently for long time, primary method for the search was limited to diving and the main equipment was underwater camera. However, recent developments in instrumentation - a by product of offshore oil industry - have opened up new vistas in marine archaeology. The search for locations known only by saga, folklore or history can now be attempted with the help of these instruments which can help in minimising diver's efforts by suggesting probable sites.

The present paper deals with site evaluation, equipment selection and planning for such surveys. Results of surveys off Tamilnadu coast are discussed in brief at the end.

## SITE EVALUATION

Surveys for marine archaeological studies may be requisitioned for searching either an ancient shipwreck or any other submerged site. Surrounding environment play dominant role in preserving or destroying it. Muckleroy (1977) has carried out detailed studies of historic wreck sites with respect to their environment. Following parameters should be considered before undertaking any such surveys.

### 1. Accuracy of Site Position and its Authenticity

These aspects largely determine the quantum of surveys. At times accurate position of a

known shipwreck may be available so that the detail investigations can be initiated. In cases, where the existence of the wreck is known only from the archives and no precise position is available, then preliminary surveys are required to select the locations for detailed surveys and confirmation.

The informations on ancient ports are gathered by archaeologists from literature (Rabban, 1980; Bacon, 1978). They are also derived in some cases from epics or even from mythology and so the actual existence itself may be doubtful. Dwaraka, Lakhpat etc, on west coast and Kaveripattinam (Poompuhar), Tranquebar and others on east coast of India are such ports which are believed to be most active once upon a time, however, presently they are as good as ruined.

### 2. Chances of Survival of Wreck or Structure

Factors like type of wreck expected, material and technology available for its construction, cause of wreckage if known, water depth, current speed in the area, surrounding geology etc. determine the fate of the object. Dumas (1962) has discussed some of these factors, analyses of these factors help not only in assessing the conditions of wreck after given lapse of time but also in determining the equipments required in the surveys. For example, if the ship was built of iron then it is sure to survive and magnetometer along with side-scan sonar are best suited equipment for survey. In other type of search, for example, ancient port etc, remnants of some structure may still exist, either on the surface or buried, and therefore, side-scan sonar subbottom profiler and magnetometer will be appropriate equipment for the search.

### 3. Siltation

The greatest single suppliers of sediments to the coastline are undoubtedly rivers. Consider-

able quantities of sediments may also be supplied to the coastline from the erosion and reworking of the immediately adjacent seafloor. Evans (1973) has stressed the complexity of the problem. There are many well known evidences of siltation causing the closure of the harbour. The study of the rate of siltation in the area will help in deciding if site is expected to be burried and therefore, in selecting equipment accordingly.

#### 4. Changes in Sea Level

The variations in sea level in past is a well known phenomenon. Coastal archaeological sites provide an excellent sea level indicator in time span of 1-5000 years with an accuracy varying from 1 m to as little as 0.1 m (Flemming *et al.*, 1973). According to them it is unlikely that the total amplitude of eustatic sea level change ever exceeded  $\pm 1$  m relative to present sea level in last 3000 years. If the relative changes at a site is higher, then there is certainly a contributory factor of earth movement. The tectonic history of the area, therefore, will provide important clue in this matter.

### EQUIPMENT

#### 1. Position Fixing

In any survey, position fixing plays vital role. In case, where shore markers are easily available and area is very close to the shore, visual position fixing system may serve the purpose with required accuracy. However, some other position fixing system with better accuracy is required in different situation. Further more, the need for repeatability, i.e. occupying the same position again is also to be considered. Shore-based electronic radio position fixing system can provide both accuracy and repeatability.

The Motorola mini-ranger system is one of such system and has an accuracy within 3 m and range of 70 km. The system consists of a range console and an omni directional antenna which are to be installed on board the survey vessel while reference stations are to be marked at known locations on shore. Peripherals like data processor, track plotter, track indicator, printer etc. can be used with the system. With this system it is possible to reach to the same location again after lapse of time.

#### 2. Echosounder

Echosounders are used to obtain profile of the seabed. The system consists of a recorder and a transducer. Wreck will be recorded on the echogram only if the survey vessel passes directly over it. If the terrain is uneven or rocky than the identification of wreck is difficult. Apart from the depth, information about sub-bottom can also be interpreted from the echogram.

#### 3. Side-Scan Sonar

The system essentially gives plan view of the seafloor. In this system transducers are mounted on either side of a tow fish allowing transmission and receiving the sonar signals from the side. The back scattered signals from the seafloor are recorded in terms of tonal differences. The system scans depending upon the range of operation, 50 to 500 meters on either side of the survey tracks. The resolution of the system is inversely proportional to range operated as also boat speed.

Sonograph (records of side-scan sonar) requires spatial corrections. (1) Slant range correction, as due to geometry of operation the actual area covered will be less than shown on sonograph, depending on height of the tow fish above seabed. (2) Speed corrections to take care of distortion in shape due to vessels speed.

#### 4. High Resolution Subbottom Profiler

There are various equipment available for obtaining cross-section of seabed. They generally operate in 5 KHz frequency band and provide resolution upto 0.1 m or more in some cases. The penetration obtained by these equipment is better in recent fine sediments, mostly clay. It is preferable to operate bottom profiler only when site is expected to be burried and locations are identified by other surveys.

#### 5. Magnetometer

A Barriger Oceanographic Proton Precession Magnetometer is used to detect the magnetic anomalies associated with submerged or exposed magnetic objects/shipwrecks by collecting the total magnetic intensity data of the earth's magnetic field. The sensor of the magnetometer is towed at a distance of about 25 m from the boat to avoid any magnetic effects

of the boat. The total magnetic field is displayed in digital form with an accuracy of  $\pm 1$  nT.

## PLANNING OF SURVEYS

Planning of marine archaeological surveys is quite different than other surveys. For example in the case of offshore construction, the geological and geophysical data from limited area are to be collected and interpreted with reference to the requirement. However, in case of marine archaeological surveys the search for specific objects has to be made in the vast area in which specific location are not known.

Various factors which are to be considered while planning the surveys are discussed below:

### 1. Scale

Scale of the map is primarily related to the accuracy of position fixing system.

### 2. Total Area to Cover and Grid Spacing

When time allotted for survey is limited, these factors become critical in decision making. The problem comes, is it wise to survey more area with wide grid spacing or small area with close grid spacing? The answer generally depends on local conditions and reliability of the expected position of wreck. However, a compromise in some way is the only final answer.

### 3. Range V/S Resolution of Side-Scan Sonar

This aspect is partially connected with selection of grid spacing. In higher range more area can be scanned but resolution decreases. Similarly, at higher speed more area can be surveyed with decrease in resolution. The possibility of identifying any wreck if recorded on sonograph decreases with decrease in resolution.

### 4. Local Geology

The identification of wreck on echogram and sonograph depends to some extent on lithology surrounding it. Typically, at 3 knot speed a wreck of about 25-30 m at base and 5-6 m height will appear as slender-tapering echo. If the echograms reveal uneven topography, in the areas marked by rock outcrops, coral growth, furrows or sandwaves etc, identification of wreck if any, is difficult.

Similarly, on sonograph a wreck will be recorded depending on its shape, ship's speed, range operated and difference in reflectivity. Here also, rock outcrops, sand lenses, gravel beds etc, if present on the seabed, mask the presence of a wreck/structure.

If the study area comprises of only sedimentary formations - identification of the magnetic anomalies due to the magnetic 'objects' is rather easy compared to those of comprising of igneous and metamorphic rocks. Local anomaly due to the source is superimposed on the regional trend of the earth's magnetic field. These local anomalies are considered to be due to the local geology or man-made objects present on or beneath the seabed, if not by any meteorites.

## RESULTS OF SURVEYS OFF KAVERIPATTINAM

National Institute of Oceanography had taken up surveys off Tamilnadu coast in collaboration with Department of Archaeology, Tamilnadu Government. The surveys were carried out off Kaveripattinam with Atlas Deso-10 echosounder, EG & G Side Scan Sonar and Proton Precision Magnetometer using Mini-Ranger as position fixing system. The survey area lies in the Cauvery basin and the Archean basement here has an overall depth of 4000 m. out of which at least 2900 m are Tertiary sediments (Ramakrishna, 1980). The surveys extended from 7 m to about 22 m water depth (Fig. 1).

The analyses of echogram and sonograph clearly show that the gradient of seabed is relatively steeper near shore and the beach sand zone extends upto 7 m water depth. The area in general is even and smooth, probably covered by clay. However, there are interesting anomalies recorded on ediogram, sonograph and magnetics.

Echograms reveal presence of peaks/pinnacles in the water depth range of 18-19 m in some locations. The features at times have broad base or even thin peaks (Fig. 2). About 16 such pinnacles are observed in the study area. Similarly, sonograph from this area show some interesting features. These features are linear, rectangular, circular or oval (Fig. 3). The perfect and near perfect geometrical shapes recorded on sonograph underlines the peculiarities attached to these features as they have diameter of 20 m or more. Vora (1987) has described these features in detail. The mag-

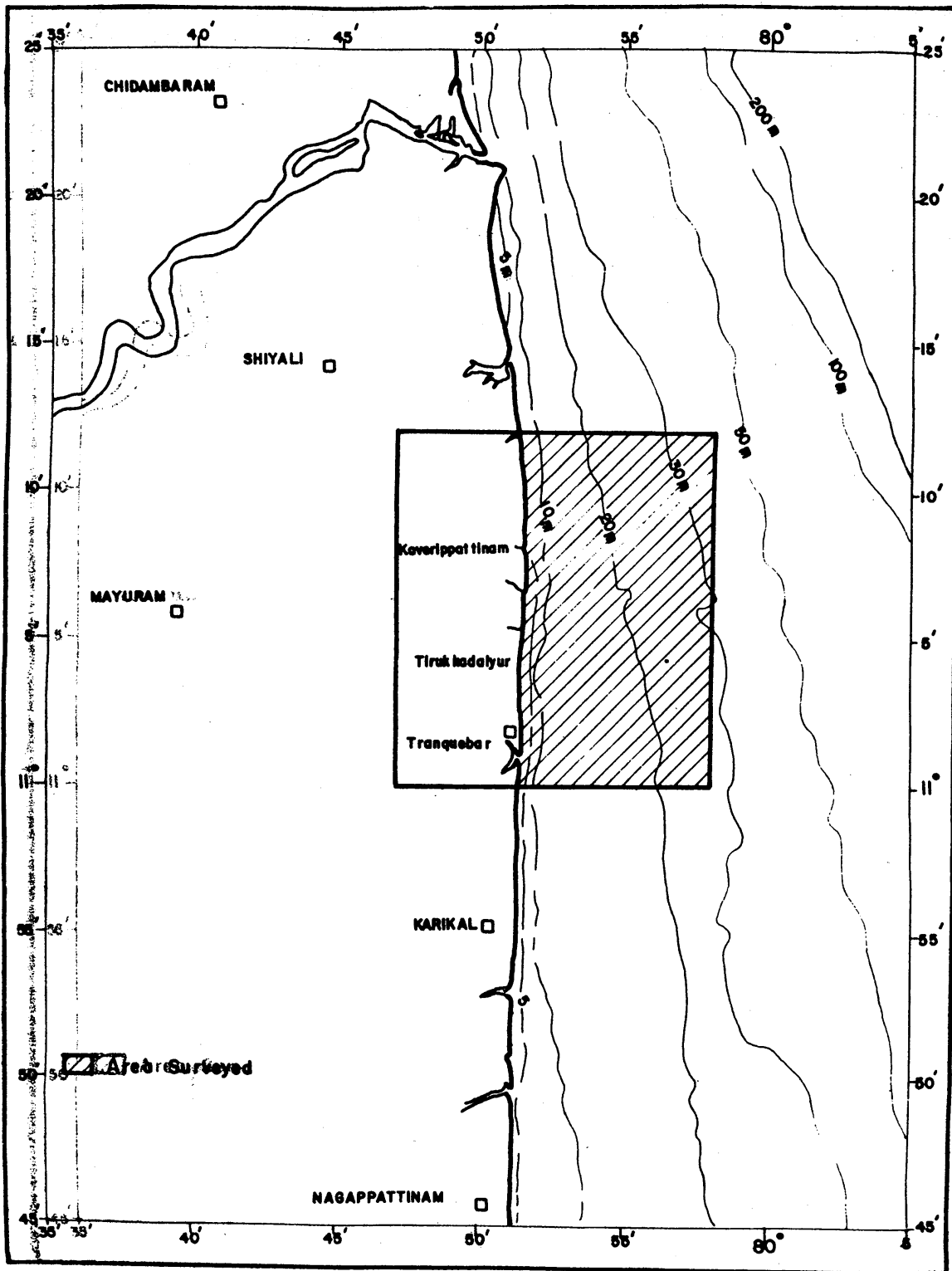


Fig. 1.

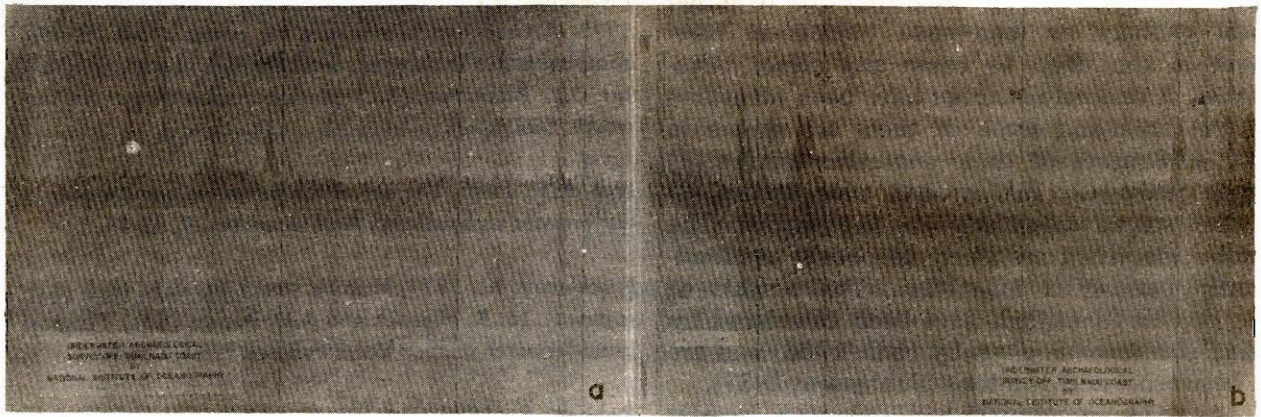


Fig. 2.

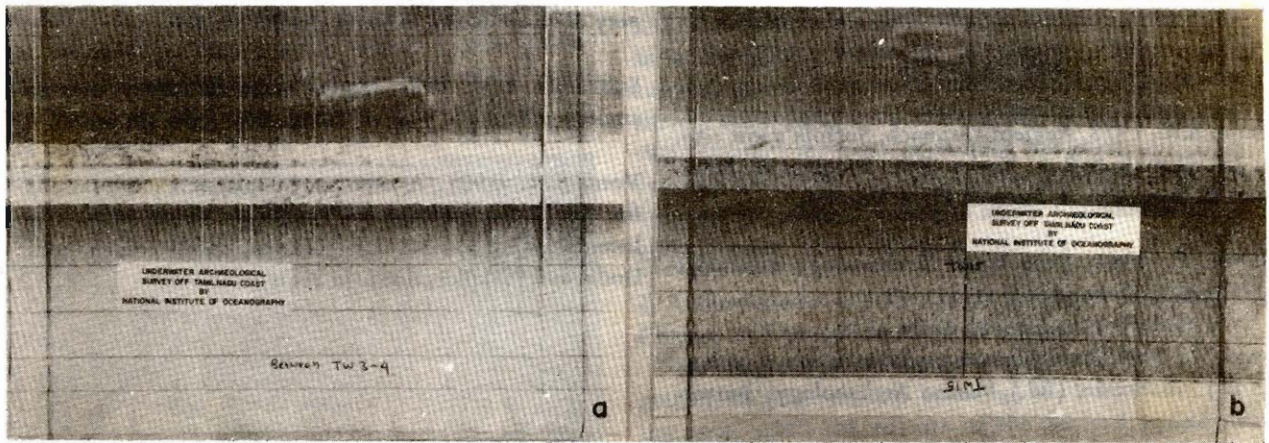


Fig. 3.

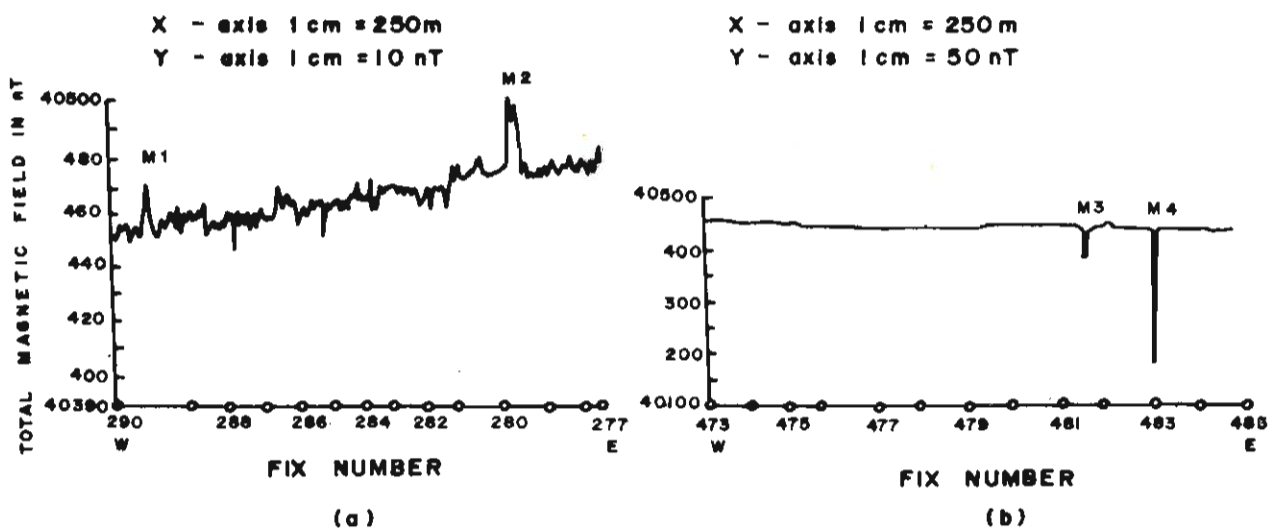


Fig. 4.

netic anomalies in the area may be due to either local geology or man-made objects as basement is too deep to cause any effect. Altogether, 8 anomalous zones have been identified in the area and some of them are shown in Fig. 4. Sources of these anomalies can be (1) single body, (2) shallow and wide bodies (3) bodies spread irregularly on the seabed. The bodies identified are likely to possess predominantly permanent magnetism. The weights of the objects identified, have been calculated by using the formula given by Hall (1966) and are in between 4 and 150 tons (Subbaraju, 1987).

As there are no rocks exposed on the nearby coast and the local geology indicates only sedimentary formations, it is difficult to interpret these features as natural geological ones. Further investigations by diverse are necessary for identification of these features.

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