

Discovery and study of “S.S. Egypte” shipwreck using remote sensing techniques, off north harbour of Patras city, Greece

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Abstract – A very interesting historical shipwreck has been discovered close to the entrance of the old (north) harbour of Patras during a systematic remote sensing survey of the wider area. Multibeam echo sounder (MBES), side-scan sonar (SSS) and subbottom profiling system (SBP) were used for the study of the shipwreck and the seabed around the wreck site. The shipwreck has been identified as “SS Egypte” based on historical archive research. The ship was a Belgian cargo ship which sank in 1909 after a collision with Greek steamer “Andreas”. The marine remote sensing survey located and identified the “SS Egypte” shipwreck, delineated the shipwreck “scene” and determined the horizontal extent and the origin of the wreck debris field and shipwreck’s condition based solely on acoustic data.

I. INTRODUCTION

Marine remote sensing methods (MBES-multibeam echosounder, SSS-side scan sonars, SBP-subbottom profilers, MM-marine magnetometers) have emerged in recent decades as the most effective means for the detection, identification and study of ancient and historical shipwrecks as well as submerged coastal archaeological sites. Their widespread application in underwater cultural heritage (UCH) sites has led to the emergence of a new scientific discipline described under the title “Marine Geoarchaeology” [1]. This new emerging discipline uses cutting-edge marine remote sensing methods and ground truthing techniques on board research platforms ranging from conventional research vessels to autonomous vehicles (USV, AUV). The detection of historical and ancient shipwrecks is achieved by mapping large areas of the seabed at a rapid pace which is one of the main advantages of marine remote sensing techniques. The initial identification of a shipwreck then leads to the design of highly accurate remote sensing surveys which yield important information about the condition of the shipwreck itself (degree of deterioration) but also the modifications (site formation processes) that the surrounding seabed environment has undergone precisely due to the presence of the shipwreck [2,3].

Historical and modern shipwrecks are easy targets for remote sensing due to the strong bathymetric difference with the surrounding seabed, which results in the formation of an extensive acoustic shadow, as well as their sharp geometric shape. The detailed study using ultra—high resolution systems allow documentation of the wreck structure and damages. On the contrary, the detection and identification of an ancient shipwreck, of which only the cargo is preserved (assemblage of amphorae) is a demanding process, as natural formations such as coralligenous formations present similar acoustic pattern to that of an ancient shipwreck. A combined use of ultra-high resolution SSS and SSB in conjunction with automatic detection software is needed for the best possible distinction of ancient shipwrecks from natural seabed formations [2,3].

Submerged and buried archaeological resource recorded in the inshore coastal waters of Northern Ireland using a suite of remote sensing (geophysical) equipment including SSS, SBP and MM [4]. The geophysical research successfully imaged 80 19th- and 20th-century wrecks, and 20 targets of further archaeological potential. The HMHS Britannic studied, the sister ship of Titanic, was studied using a dual frequency SSS [5]. Sonographs show that the original superstructure of the ship, including deckhouses, mast, cargo cranes, giant lifeboat davits and Wellin type davits, remains in remarkably good condition, while a limited debris field (mainly the funnels) has been formed around the main wreck. A total of 11 out of 36 known shipwrecks in the Ionian Sea (Greece) was systematically studied using marine remote sensing and ground truthing techniques [6]. At each wreck site, the condition of the wreck, the debris field and man-made activities were determined based mainly on acoustic data. The process of identification of a newly discovered wreck and of the wreckage area based on acoustic data, without involving a team of divers and/or ground truthing survey was demonstrated in Baltic Sea (Poland)[7]. The acoustic findings, in conjunction with the collected archival documentation, allowed for the identification of the wreck.

The objectives of this short paper are: (i) to detect and/or locate/relocate the “SS Egypte” shipwreck and to delineate

the shipwreck “scene”, (ii) to determine the horizontal extent and the origin of the wreck debris field, (iii) to determine shipwreck’s condition based mainly on acoustic data and (iv) to provide information regarding the environmental setting of the wreck site.

II. SURVEY AREA

A. Physiography

The old (north) harbour of Patras is part of the coastal urban fabric of the city and its facilities have been greatly expanded over the last two centuries. It was the main port of the city until 2011, when the new (south) harbour was put into operation, at the southern end of the city. The old harbour has four main piers and wharves of approximately 3 km in total length, with fourteen mooring waterfronts and a total of eight docks. The breakwater has a length of 1565 m.

The harbours and Patras city are located at the south-eastern coast of the Gulf of Patras. The Gulf is a semi-closed embayment with a maximum depth of 135m, which is open into the Ionian Sea on its western side and is linked through the Rio-Antirio narrows to the Gulf of Corinth on its western side. Sandy sediments dominates near-shore substrate types and thick sedimentary sequences have been deposited at the southeastern margin of the Gulf. A very well-formed pockmark field has been systematically surveyed the last three decades, in the new harbour, while gas charged sediments have been also detected in the old harbour. The gas emission and the formation small-scale pockmarks due to the weight of metallic shipwrecks on the fine-grained, gas-charged sediments have been well documented in the north margin of the Gulf [8].

B. Cultural environment

The Patras Gulf has a rich Maritime and Cultural Heritage spanning over centuries and constitutes an important transport route and a battleground from ancient times to WWII. Many Naval Battles took place in its waters but, there is no doubt, that Naval Battle of Lepanto (1571) between Holy League and the Ottoman fleets is the most important and crucial as change the course of history by stopping the territorial expansion of Ottomans in Europe [9]. Furthermore, clusters of cannons (16-17th century ?) and shipwrecks of WWI and WWII have been found and studied using remote sensing and photogrammetric techniques [6].

C. Sinking of the SS Egypte

“SS Egypte” a Belgian general cargo ship sank after it collided with a Greek steamer cargo (“Andreas”) off the old (north) harbour of Patras, on February 7, 1909. The crew for both ships were reportedly safe. At early 70’s, a contracting company undertook to dismantle the wreck to recycle its iron parts as scrap, which was valuable at the

time. Most of the ship's superstructures were cut away and lifted. After this technical work, the wreck “sank” into oblivion, without even its exact location being known.

III. MATERIALS AND METHODS

A. Instrumentation and Survey design

The marine remote sensing survey conducted using: (i) a Multibeam (MBES) Elak Nautik Seabeam 1185 with 300m maximum operational depth, (ii) a “Chirp” Kongsberg Geoacoustics Geopulse Plus subbottom profiler system with a Universal transceiver, an acquisition display, and a Pinger over-the-side Transducer Mounting (array of 2 transducers) with a hydrophone, (iii) an Edgetech dual Frequency (100 and 400 kHz) digital towfish 4200SP with an Edgetech 4200-P topside Processor and (iv) a Hemisphere Vector VS101 Compass GPS with two multipath resistant antennas with <0.5m accuracy. The HYPACK software was used for the navigation of the research vessel. The survey lines were tactically planned to ensure total coverage of the seabed in the survey area.

B. Data processing

The processing scheme for MBES data comprised five (5) stages: data review, swath-by-swath editing, area-based editing, cube and contouring. A detailed bathymetric of the shipwreck and the surrounding area was designed. The 100 and 400 kHz SSS data were imported in SeaView software where:

- bottom-track was corrected automatically and manually when needed,
- both end-start and port-starboard extents were cropped to reduce errors,
- acoustic gain, de-stripping, and slant-range corrections were applied, to enhance seabed contrasts and features,
- the backscatter intensity mosaic was then correlated with the bathymetric data to adjust navigation if needed.

The SB-Interpreter (Triton Imaging Inc) software has been used for post-processing the subbottom profiling (seismic) data. Swell, Band-Pass, Automatic Gain Control, and Time Varied Gain filters were considered for signal enhancement and radiometric corrections on the recorded data. Interpretation of the seismic data was done based on characteristics of surface (seabed) and internal seismic reflectors (continuity, sharpness, frequency, amplitude), the overall geometry of reflectors, and other seismic stratigraphic relationships.

IV. RESULTS AND DISCUSSION

Systematic mapping of the area off the breakwater of the old (north) harbour of patras showed the site of the shipwreck as indicated by the elevated seabed and the certain geometric shape of the hull. Bathymetric data acquired have shown that the shipwreck remnants are

located at a water depth of about 40 m and 700 m western-northwestern off the southern entrance of the old harbour of Patras (Fig. 1).

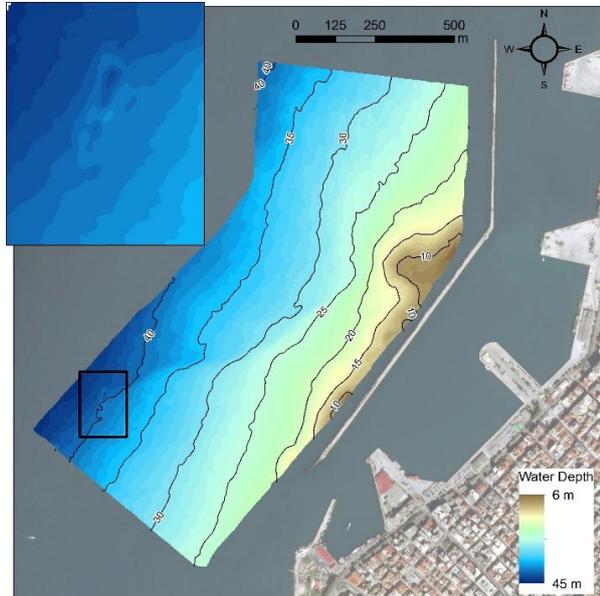


Fig. 1. MBES bathymetric map of the shipwreck's site and the wider area off the old (north) harbour of Patras.

The bathymetry of the area is smooth and featureless except the uneven morphology of the rocky substrate of the breakwater. The shipwreck is resting almost above a step-like morphological feature of the seabed which is running in a N.E to S.W. direction (Fig. 1).

The detailed bathymetric data at the shipwreck site shows that the almost 100m-long shipwreck lies on a heading of 185° (Fig. 2). The shipwreck hull is divided in two elongated depressions which seem to represent structural details of the ship and more specifically the holds. A small seabed depression is also recognised at the astern of the wreck (Fig. 2). An elongated feature, possibly anchor mark, terminates at the wreck (Fig. 2).

The 3D bathymetric representation of shipwreck clearly shows the two holds, the small depression at the astern of the wreck and the anchor mark (Fig. 3).

The SSS sonograph exhibits clearly the remnants of the shipwreck in accordance with bathymetric findings (Fig. 4). The hull of the shipwreck and the scattered debris around its site are characterised by high reflectivity in contrast to the low reflectivity of the fine-grained sediments covering the seafloor (Fig. 4).

The debris field which is more extensive and dense at the port side of the shipwreck, is rather due to the salvage operation that took place 50 years ago.

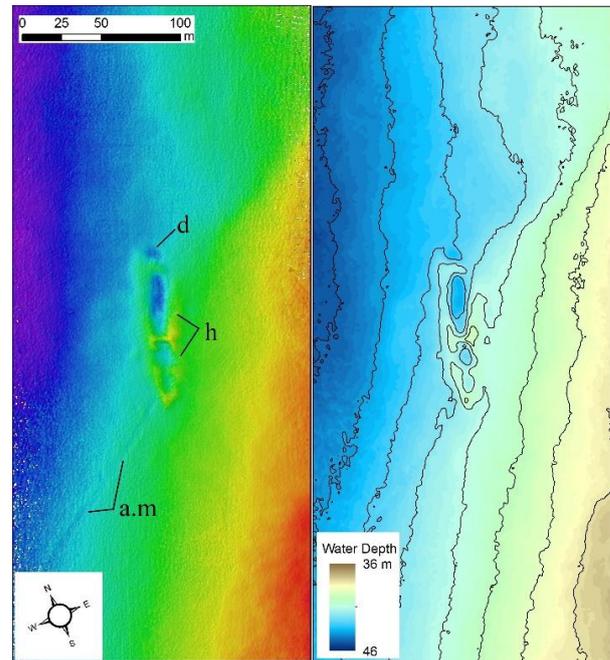


Fig. 2. MBES bathymetric map of the shipwreck and the surrounding seafloor (h:hull, d:depression, a.m: anchor mark).

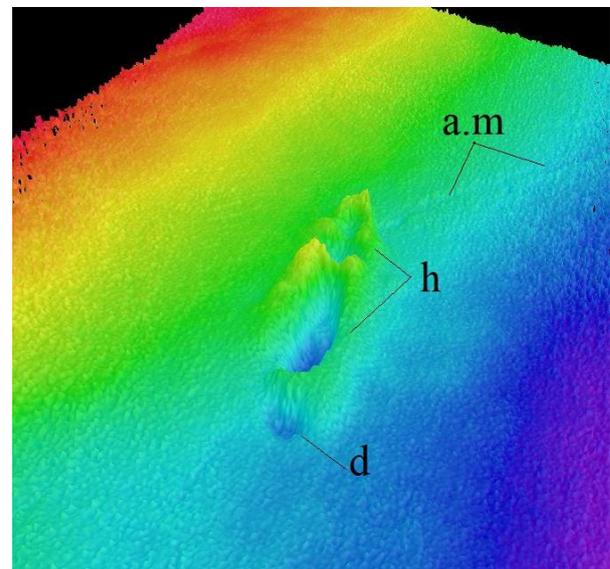


Fig. 3. 3D bathymetric model of the shipwreck (h:hull, d:depression, a.m: anchor mark).

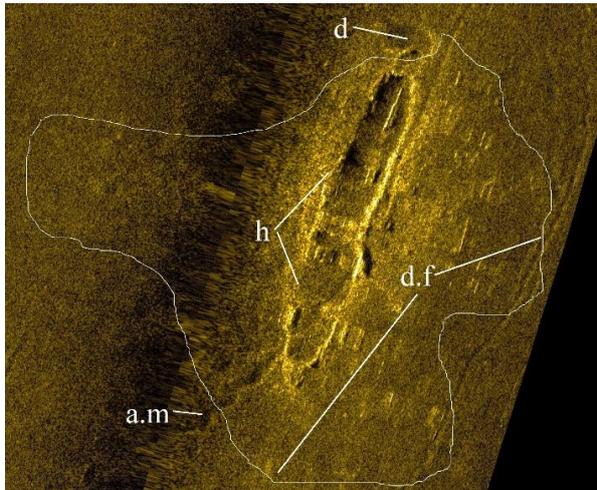


Fig. 4. Side scan sonar sonograph of the shipwreck (h:hull, d:depression, a.m: anchor mark, d.f: debris field).

Subbottom profiling data showed that the seabed at the area of shipwreck consisted of two sediment sequences: (I) an upper one which is characterised by parallel and subparallel seismic reflections indicating fine-grained and soft sediments and (II) a basal one which is characterised by prolonged and semiprolonged seismic reflection indicating coarse-grained sediments (Fig. 5). The shipwreck is lying on soft and fine-grained sediments and part of its hull is expected to have penetrated to the soft sediments. Different acoustic character of the surface sediments at the two sides of the shipwreck's mound possibly indicate the modification of the sedimentation pattern due to the existence of the shipwreck.

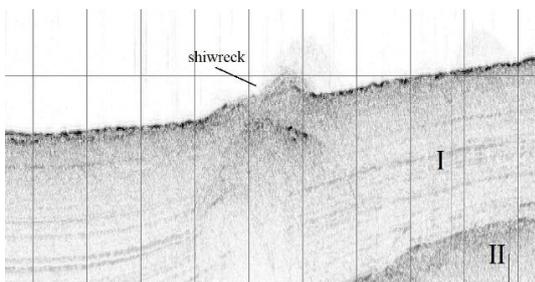


Fig. 5. High resolution seismic profile showing the shipwreck's mound and the two sediment sequences (I and II)

V. CONCLUSIONS

A systematic marine remote sensing survey which carried out off the entrance of the old (north) harbour of Patras, located and studied an important historic shipwreck. The shipwreck has been identified as "SS

Egypte" based on historical archive research. The ship was a Belgian cargo ship which sank in 1909 after a collision with Greek steamer "Andreas". The survey delineated the shipwreck "scene" and determined the horizontal extent and the origin of the wreck debris field and shipwreck's condition based solely on acoustic data using a suite of remote sensing (geophysical) equipment including MBES, SSS and SBP. In order to provide accurate information regarding the environmental setting of the wreck site and to evaluate the surrounding seafloor texture and possible seafloor transformation after the wrecking (site formation processes) more detailed study is needed.

VI. ACKNOWLEDGMENTS

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