Application of geophysical prospecting methods for the purposes of underwater archaeological research in the Black Sea

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Key words: marine, geophysical prospecting methods, archaeological research

Abstract

The application of geophysical prospecting methods for the purposes of underwater archaeological research allows for the delineation of areas of potential archaeological interest.

The present paper focuses on the results achieved during several research projects carried out by the Centre for Underwater Archaeology in 2014 in the aquatoria of Varna (Pasha dere), Pomorie, Chernomorets and Sozopol in relation to the implementation of several investments projects, and in the southern bay of Kiten in relation to the survey and underwater archaeological excavation of an Early Bronze Age settlement funded by the Ministry of Culture.

Our gratitude goes to the Centre for Underwater Archaeology for the generous permit to use the results of the underwater archaeological research for the purposes of this presentation.

The archaeological research conducted on the sites mentioned above was designed to provide accurate location and reliable identification of potentially significant targets, as well as assessment and documentation of submerged cultural resources in the study areas. The methodology developed by the Centre for Underwater Archaeology was based on a systematic remote-sensing survey combining different geophysical prospecting methods that can provide reliable information for both – sites of potential archaeological interest exposed on the sea bottom, and information on the geological and geomorphological characteristics of the study areas that can be used for the reconstruction of submerged palaeolandscapes.

Considering the limitations of each single geophysical prospecting method, a set of magnetic, acoustic and electric remote-sensing equipment was employed for the purposes of the surveys.

Equipment used:

1. Side scan sonar as an imaging system for obtaining information about the character of the sea bottom and the location of sites/objects of potential cultural value;
2. Single-beam echo sounder – as a back-up control system for bathymetric measurements;
3. Multi beam echo sounder – for bathymetric measurements and development of Digital Terrain Models;
4. Sub-bottom profiler – for obtaining vertical sections of sediment layers;
5. DGPS systems – for heading and positioning;
6. Marine acquisition 10 channels resistivity-meter of a “dipole-dipole array” type – for electrical measurements and vertical sections of the sea bottom;
7. Magnetometer/gradiometer survey - for detecting magnetic anomalies;
8. Supporting computer systems with the relevant software for data acquisition and post-processing;
9. Metal detector with different coils;
10. Video and camera equipment (tow & drop camera, ROV, still camera);
11. Diving equipment – surface supply and scuba.

The sensors were mounted on both sides of two vessels, on specially designed stands.

Due to the great quantity and variety of data acquired during the surveys, different methods and post-

processing software were used for the different sites.

The main aim of data processing was to acquire enough information about the character of the seabed and to determine the presence or absence of cultural resources in the study areas.

In order to assess the archaeological potential of the research areas the data were carefully examined in real time during their acquisition since all the systems used provided real-time viewing of the data.

A second desk-based data review followed the field survey.

A Multi-beam echo sounder and a Single beam echo sounder were used to create detailed bathymetric charts of the study areas and digital terrain models to instruct archaeological research and observation.

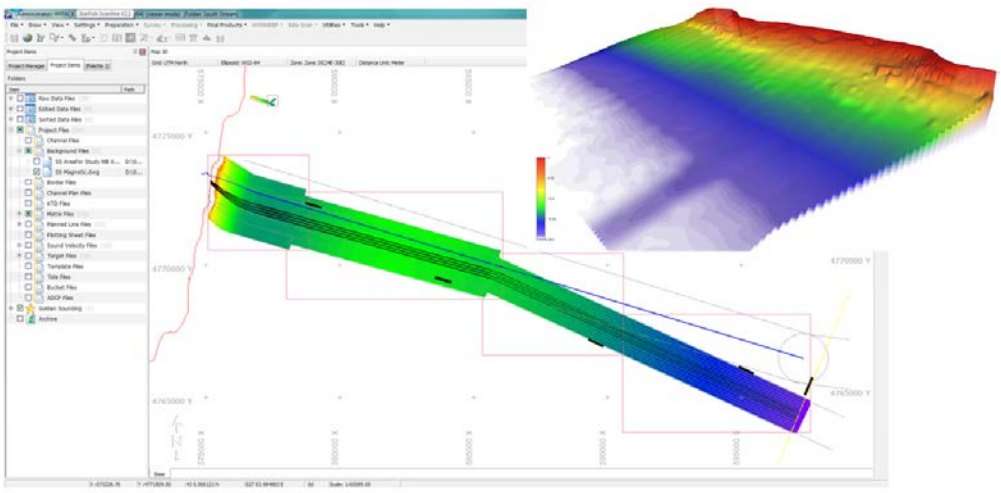

Figure 1. Pasha dere – Varna. Digital terrain model of a part of the nearshore area based on MB data.

The sub-bottom profiling system (SBP) was used with the aim to distinguish between layers of the sea bottom of different densities (and hence, of different acoustic impedance).

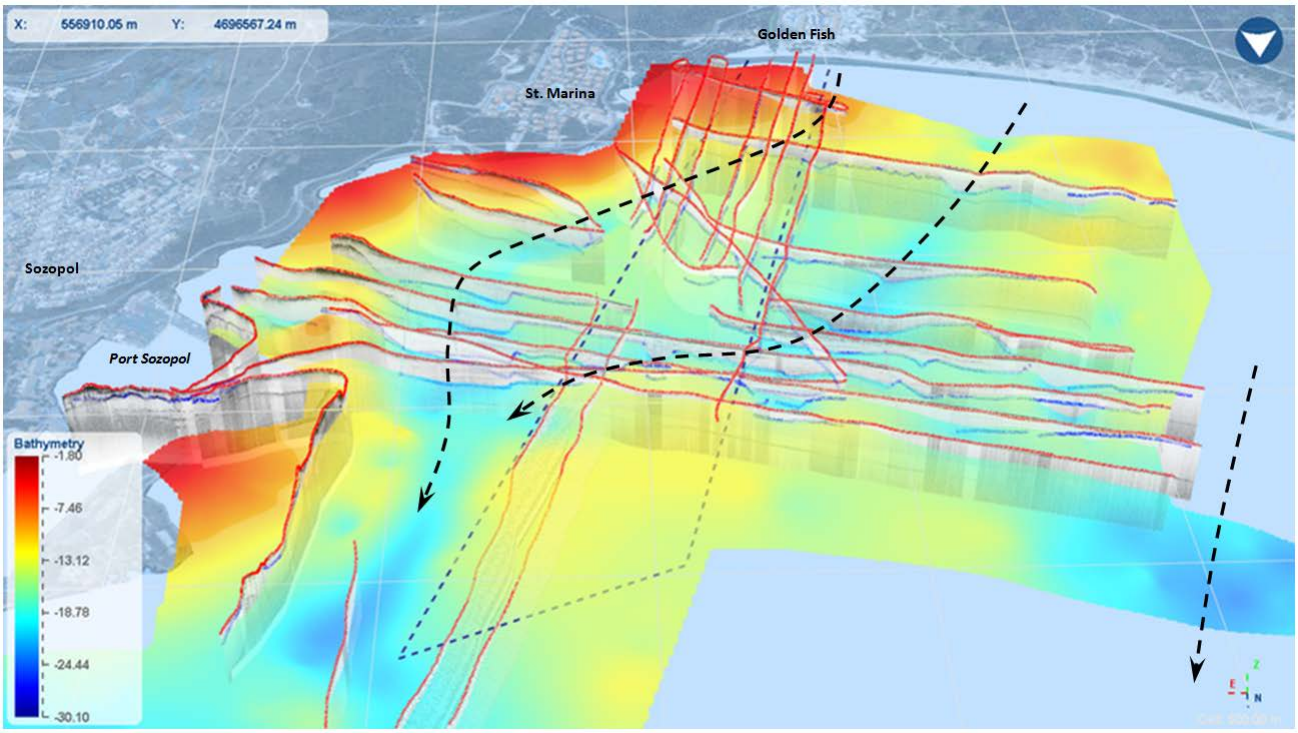

Figure 2. Sozopol - Bedrock and 3D model based on Sub-bottom Profiler data.

The side scan sonar (SSS) data was instrumental in selecting a number of targets within the survey areas exposed on the sea bottom.

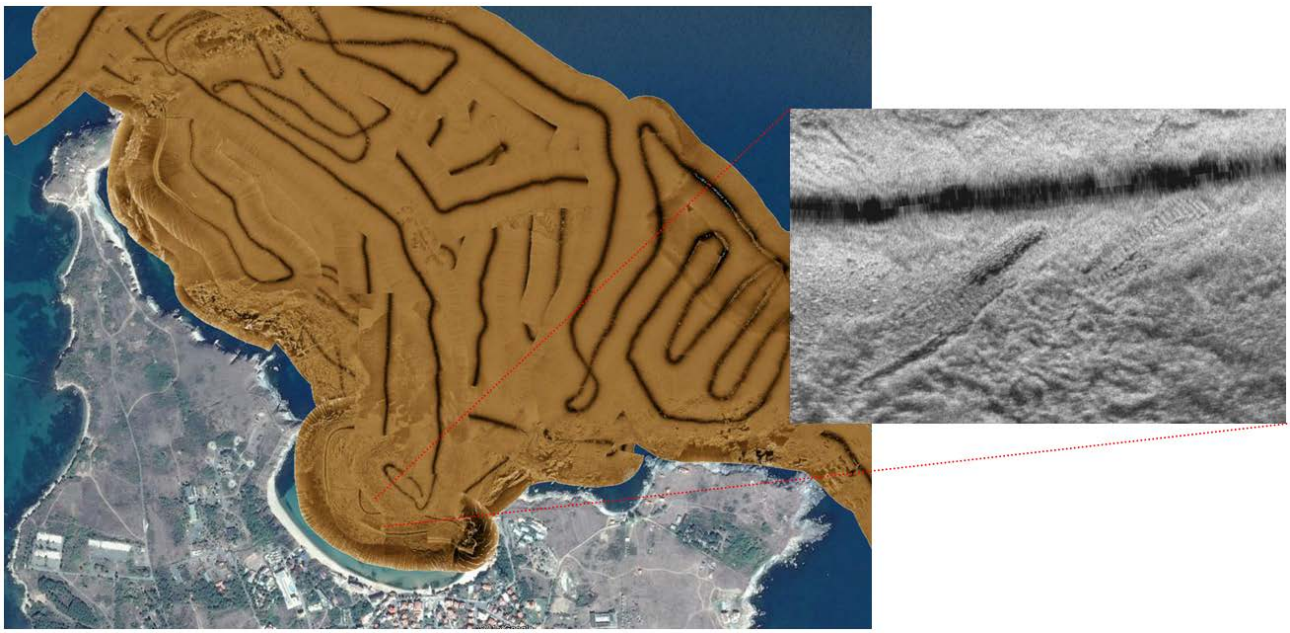

Figure 3. Chernomorets - Mosaic of the sea bottom based on SSS data.

Magnetometer/gradiometer survey along pre-defined track lines with the aim to identify the presence/absence of metal objects.

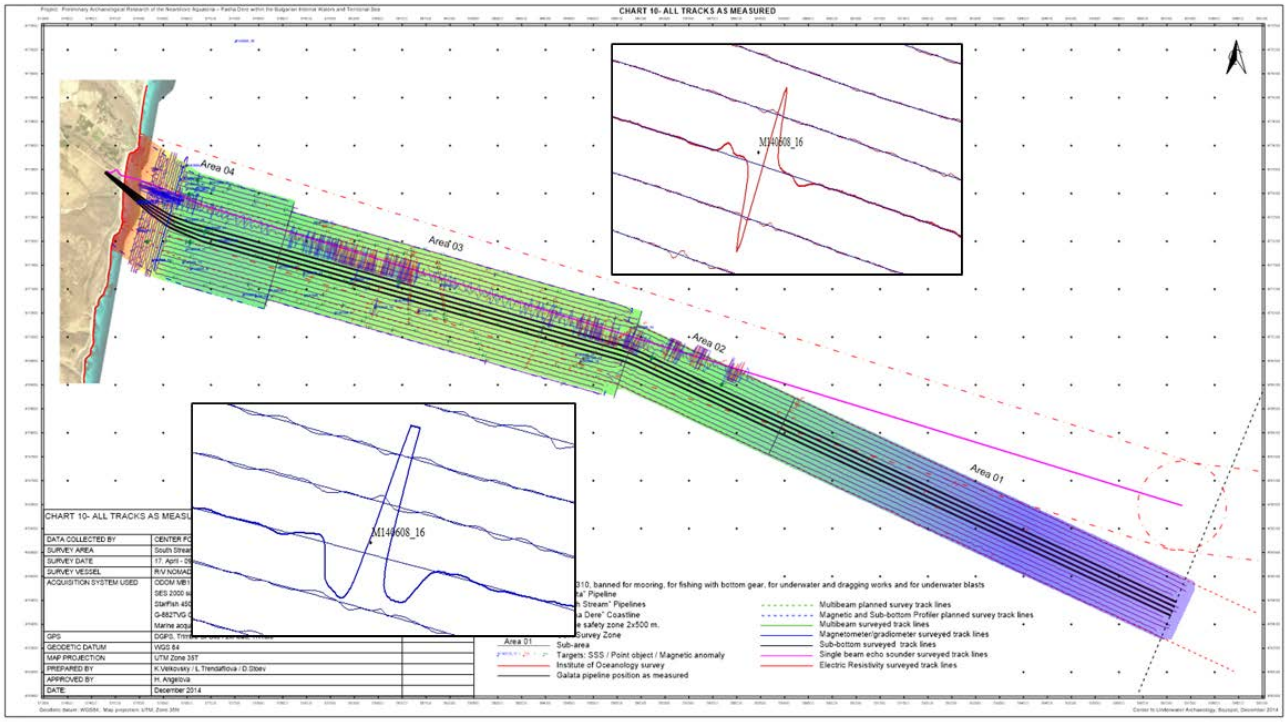

Figure 4. Pasha dere – Varna. Magnetic anomalies registered as a result of a magnetometer/gradiometer survey

The primary goal of the archaeological surveys was the assessment of the archaeological potential of the surveyed Black Sea shallow water areas. For some of them the available archaeological information was either scarce or completely missing (Pasha dere, Varna), for others (Chernomorets) the abundant information for numerous archaeological sites on the adjacent land makes them areas of high archaeological potential, while for others (Sozopol and Kiten) previous underwater archaeological research and excavation of submerged prehistoric settlements makes them very interesting for the reconstruction of the ancient coastline and its development in time. Considering that prehistoric sites had usually been located close to ancient rivers or lakes, one of the main survey tasks was to collect information on buried ancient river beds and outline the areas of highest archaeological potential.

The second main task was to organize detailed survey of that part of the aquatoria that may be affected by construction works and determine its contents regarding cultural heritage environment. In accordance with the results of such research, the type of protection should be defined: there are areas which can be released by archaeological rescue excavations and areas where spatial interventions are not permitted.

Nowadays non-destructive integrated geophysical prospecting methods are increasingly used for archaeological investigation of sites. To achieve the aims of the research and enhance the quantity and quality of information, a combination of non-destructive geophysical methods for detailed remote sensing was applied. Due to the aim of the survey – archaeological prospection, the research was conducted with very high precision and reasonable spacing of survey track lines in order to achieve more detailed and reliable information about the cultural heritage environment of the study areas.

The methodology developed by the Centre for Underwater Archaeology was based on a set of geophysical remote sensing methods and proved to be a valuable tool for the assessment of the cultural heritage potential of different areas in the Black Sea.

Прилагане на комплекс от морски геофизични методи за целите на подводните археологически проучвания в Черно море

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Прилагането на комплекс от акустични, магнитни и електрически геофизични методи за целите на подводните археологически проучвания, както и анализът на придобитите данни и получените резултати, дават възможност да бъдат отличени акватории от потенциален археологически интерес, както и да бъдат детайлно изучени характеристиките на средата, в която са локализирани различни подводни археологически обекти като потънали праисторически селища и корабокрушения.

Комплексът от геофизични методи включва: еднолъчев и многолъчев ехолот, странично сканиращ сонар, поддънен профилограф, магнитометър/градиентометър, апаратура за измерване на електрическо съпротивление. Този комплекс е съществен компонент от методиката за археологическото изследване на обекти под вода, разработена от Центъра за подводна археология.

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