Special Session S30
Underwater geoarchaeology: an interdisciplinary field bridging marine geosciences and underwater archaeology

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UNDERWATER GEOARCHAEOLOGICAL SURVEY IN FRONT OF THE DANUBIAN ISLAND "PACUIUL LUI SOARE" (ROMANIA) USING REMOTE SENSING TECHNIQUES – PRELIMINARY RESULTS

Caraivan G.[1], Fulga C.[1], Chera C.[2]

[1] *National Institute of Marine Geology and Geo-ecology (GeoEcoMar), Constanta, Romania: bd. Mamaia no. 304, cod 900581, Constanta, Romania, gcaraivan@geoecomar.ro; cfulga@geoecomar.ro*
[2] *Museum for National History and Archeology Constanta, Place Ovidiu 12, 900745, Constanta, Romania, anroed@hotmail.com*

Abstract: On the Danubian island "Pacuiul lui Soare", between 355 and 357 km, there are the ruins of a Byzantine fortress from the X-XIII centuries, most of which has already been eroded by the Danube river. A seismoacoustic survey which was carried out along the Danube in front of the island, showed the presence of the fortress ruins under the river waters. Further geo-archaeological survey is required in the studied area, aiming to a better understanding of the island evolution and of the fortress history as well.

Keywords: seismo-acoustic survey, underwater geo-archaeology, Byzantine fortress, Danube River.

1. Introduction

On the Danubian island "Pacuiul lui Soare", between the landmarks: NE-44° 8' 05.48"N; 27°28' 14.33"E and SW-44° 7'44.65"N; 27°28' 02.60"E, there are the ruins of a Byzantine fortress from the X-XIII centuries, most of which has already been eroded by the Danube river (Fig. 1; Fig.1a).

In the north-east end of the island, in a dense forest, one can see just a tenth of the ruins of the old Byzantine fortress, the rest being under the river waters. The fortress was built between the years 972–976, by the troops of Emperor John Tzimisces and reflects the strength of Byzantine rule in the Lower Danube and the greatness of the Macedonian dynasty emperors.

Although no Roman archaeological level was identified up to date, it is assumed that the Byzantines built the fortress on the ruins of an older city, reusing building material and also putting into practice a new technique that has demonstrated competence and ability of manufacturers.

Under a non-consolidated alluvial substrate, there were two possibilities to stabilize the walls foundation: (i) a deep foundation, which required a large effort or a woody (oak beams) sub- construction that also requires a large amount of stone (Barnea and Stefanescu, 1971), or (ii) the wall foundation was made of burned oak stakes, than stuck in the ground at some intervals, over which manufacturers had placed oak beams arranged longitudinally and transversely. The vacant spaces were filled with mortar (masonry) - a mixture of lime, gravel and stone grated/shredded tuna (Barnea and Stefanescu, 1971). In the case of "Pacuiul lui Soare" Byzantine fortress the latter approach was used.

Modern underwater remote sensing techniques introduce many advantages to the underwater archaeology, particularly to the detection of submerged man-made structures of archaeological interest (Panin et al., 1977). This work presents the preliminary results of a seismo-acoustic survey in the Danube River for the detection of the ruins of a Byzantine fortress on the river floor.

2. Material and methods

In the fall of 1987, a sedimentological and seismo-acoustic survey was carried out by GeoEcoMar on the Romanian Danube trail. Seismo-acoustic profiling was conducted by ultrasonic survey method with continuous recording (vertical sonar). A high-frequency transmitter generates a sound wave that propagates through the layer of water

Fig. 1. Romania-Danube-“Pacuiul lui Soare” Island and the Byzantine fortress.

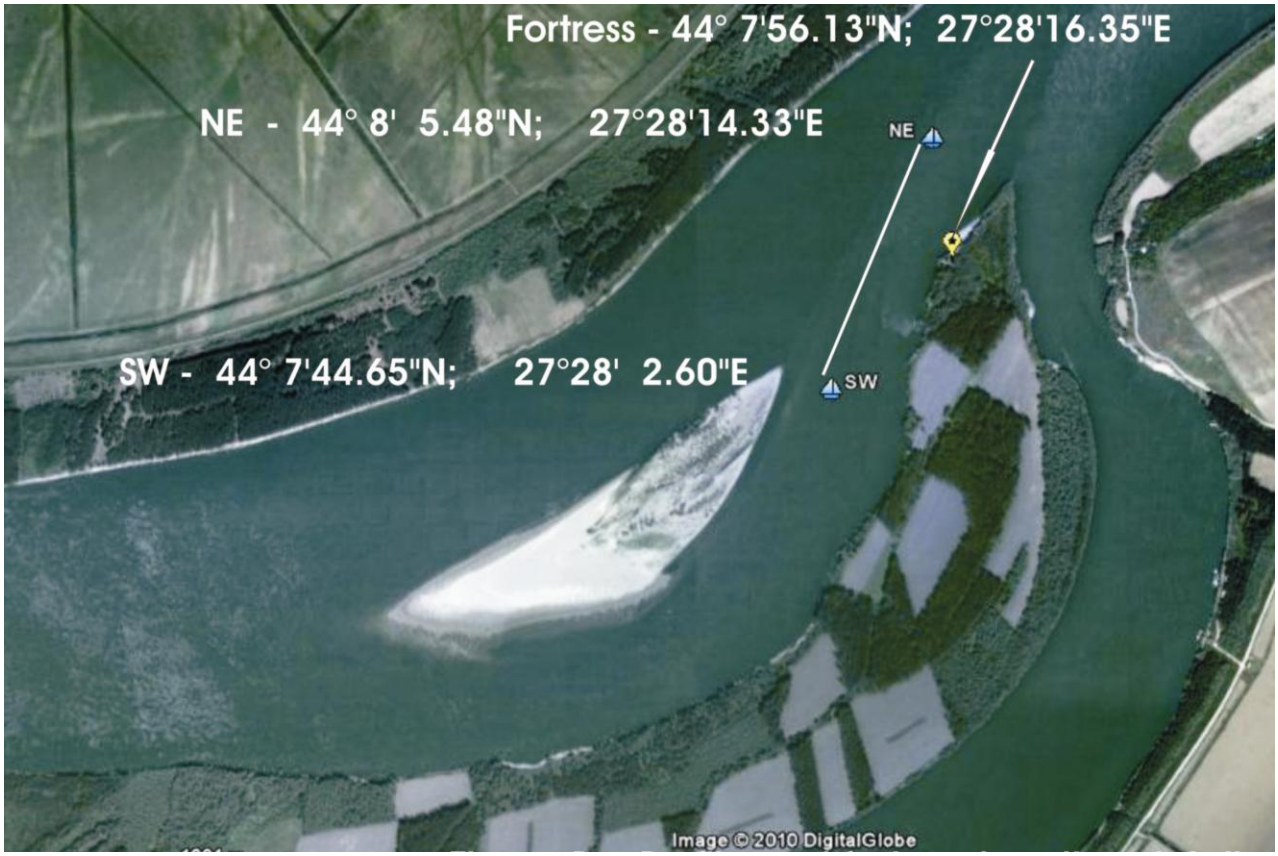

Fig. 1a. Profile and fortress location details.

with a speed of about 1500 m / sec, then reflected on the interface water / sediment, being received by a transducer (hydrophone), located in the same place with the transmitter. The pulse length, generated by the transmitter, was milliseconds order of magnitude, and the issue rate of 1 second. The bottom reflected signal was recorded on electro-sensitive paper, obtaining a continuous profiling during the vessel trackline. An Ocean Sonics vertical sonar ORS-219, with dry recording paper and working emission frequency of 8 KHz, was used. The equipment was mounted on a tug of 600 hp, with maximum draft of 1.80 m. The speed of research vessel considered optimal, was about 13 km/h. The vessel route followed river sailing line at the proximity of the "Pacuiul lui Soare" (Fig. 2). The position and the navigation of the vessel were carried out using a DGPS system with an accuracy of less than 1 m.

3. Results and Discussion

The interpretation of the seismo-acoustic profile, obtained when passing along the underwater continuation of the fortress, showed an informative vertical picture of the Danube bed. Perpendicular to the northern wall of the fortress a mound-like feature is obtained on the seismo-acoustic profile. This feature appears a sharp rise of the Danube bottom having a length of about 40 m and a height of 9 m compared to the surrounding river bottom. The minimum water depth of the river at the area was only 4.5 m. This feature is developed on a bathymetric background of 14-15 m. The acoustic character on the seismo-acoustic profile suggests the hard nature of the raised feature, compared with the usual "anti-dune" morpho-dynamic structure of the sedimentary bed (Fig. 3). The presence of well shaped depressions on the Danube bottom bed, downstream and upstream of the underwater raised feature illustrates the hydrodynamic conditions, induced by undermining and flooding of the fortress walls (Fig. 3). Upstream of the main bed lifting, small positive ruin shaped irregularities are found on the Danube bottom, with a height ranging from 1.00 to 1.50 m (see Fig. 3, and Fig. 3a, in the right half of the seismo-acoustic profile, see the scale of the depth, below the sketch of profile lines. Seismo-acoustic profile also showed 2-3 subbottom discontinuous reflectors from 3 to 5 m below the river bottom, indicating the existence of lenses of different lithological characteristics. The Byzantine fortress walls which are located on the

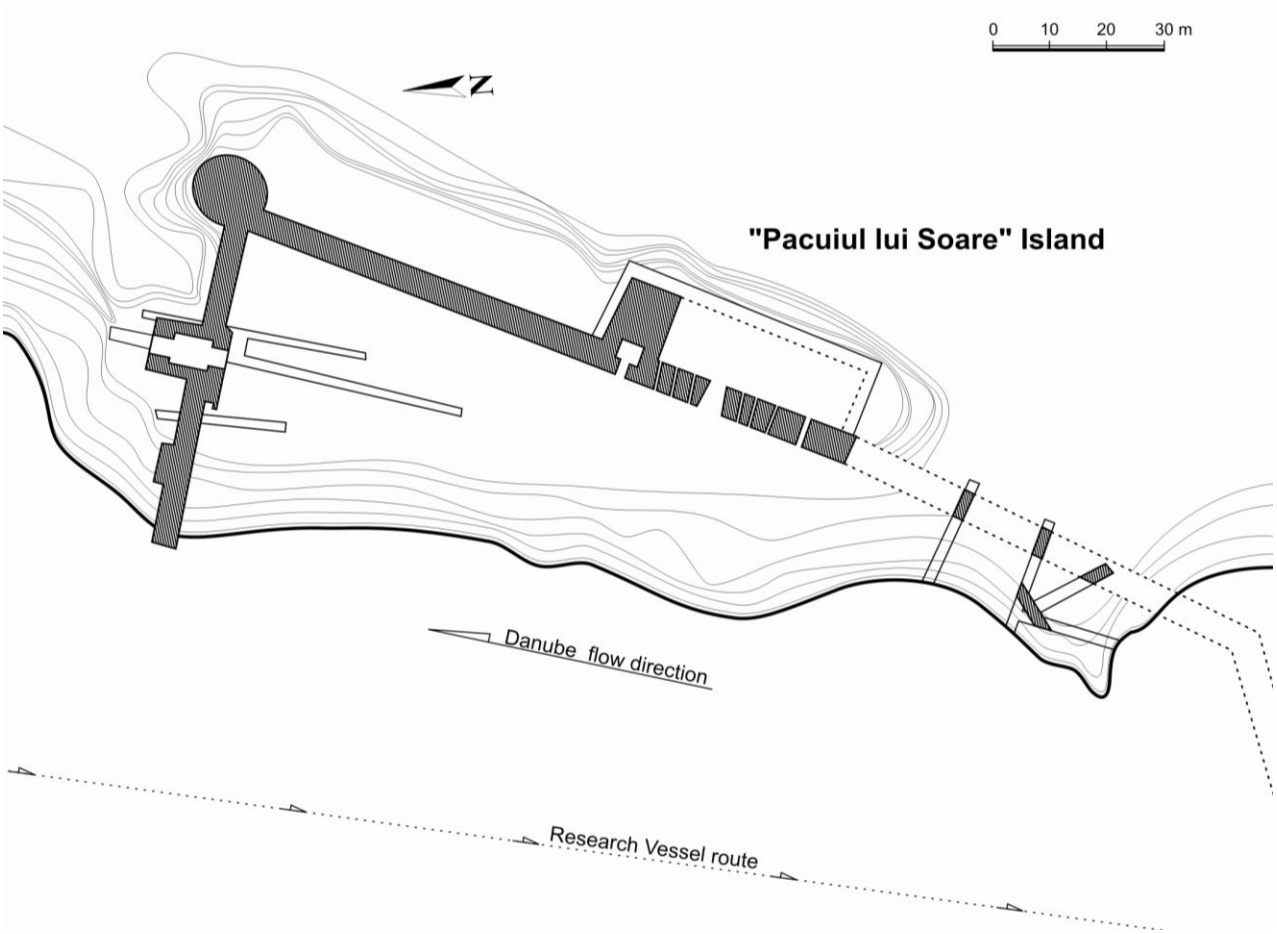

Fig. 2. “Pacuiul lui Soare” Fortress GPS position - 44° 7'56.13"N; 27°28'16.35"E.

island of “Pacuiul lui Soare” end abruptly at the bank of the Danube,

suggesting the underwater continuation of the ruins under the Danube River waters. Seismo-acoustic survey conducted on the Danube River near the “Pacuiul lui Soare” island brings an important geophysical argument supporting this hypothesis.

The sub bottom discontinuous reflectors identified on the seismo-acoustic profile could represent the woody bed foundation, on which the fortress walls

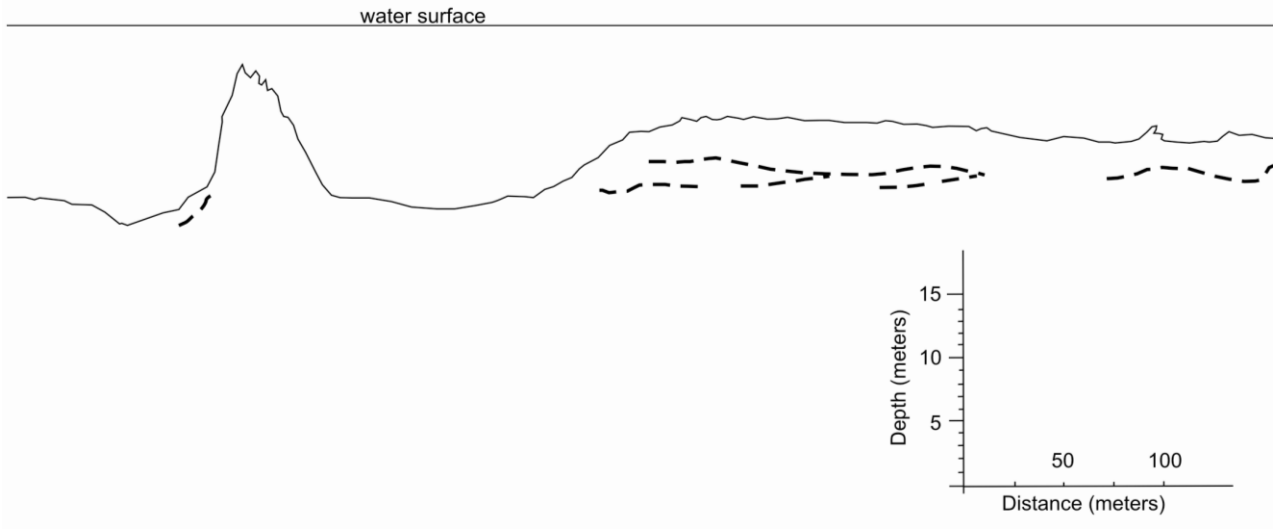

Fig. 3. The profile from NE to SW, between: NE - 44° 8' 05.48"N; 27°28'14.33"E and SW - 44° 7'44.65"N; 27°28' 02.60"E.’

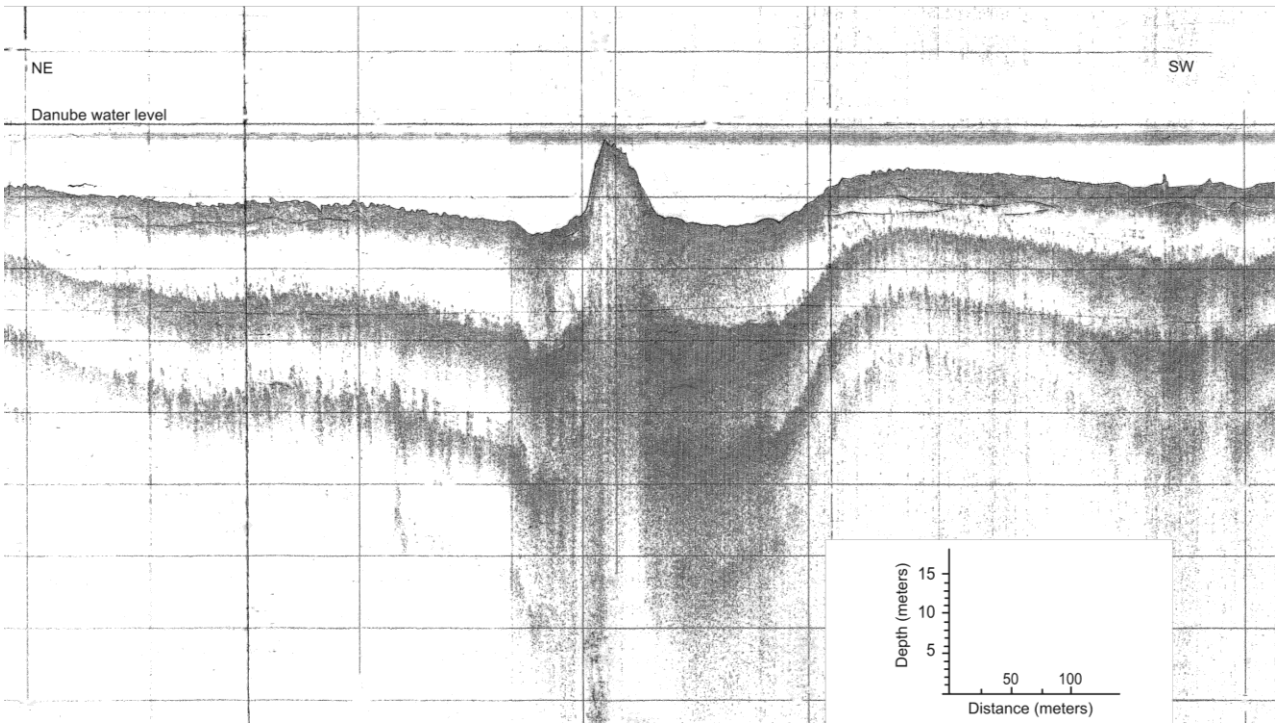

Fig. 3a. "Pacuiul lui Soare" Island and Fortress – Image of the original seismo-acoustic profile.

were built. By changing of the Danube flow regime, the left side of the island was subject to enhanced erosion, causing sub digging of the foundation structure. In 2003, when the Danube water was at very low levels, the network of wood beams was clearly visible.

On the eastern right bank of the "Pacuiul lui Soare"island (or the other name, "Dervent" island), where a narrow branch separates the island from the Dobrogean land, the erosion was much less. Therefore, the constructive structures could maintain in good condition (for example, wharf, see Fig.2 and 4). The underwater seismo-acoustic survey which was carried out in front of the "Pacuiul lui Soare" island fortress, provide a clear argument to support the hypothesis that the remains of city extend in the underwater area. Therefore, further geo-archaeological research is required in the stud-

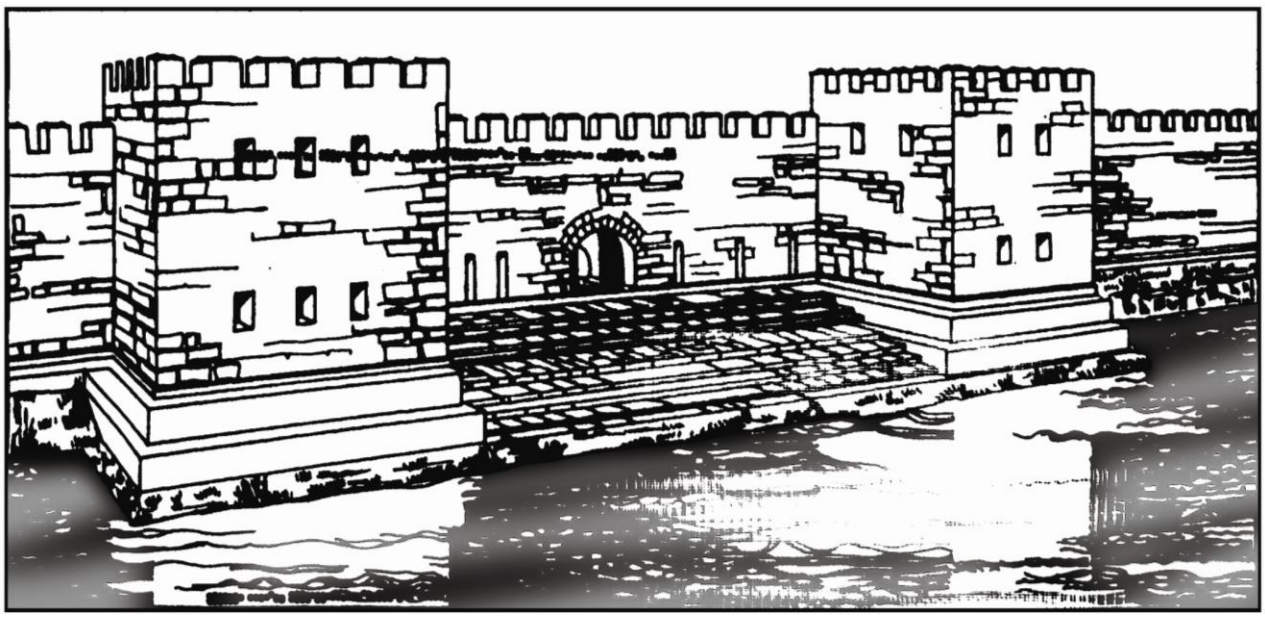

Fig. 4. Wharf reconstruction proposal (arh. Mira Dordea Voitec).

ied area, through a comprehensive interdisciplinary program, involving sedimentological and geophysical studies, in conjunction with direct observations (ground truthing), specific to underwater archaeology. The proposed survey will lead to a better understanding of the history of the city as well as the sedimentary-hydrodynamic evolution of the island.

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