Using archaeological data to infer past relative sea-level positions along the Bulgarian coast of the Black Sea

Variations relatives du niveau de la mer à partir des indicateurs archéologiques le long des côtes bulgares (mer Noire)

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Abstract - Here we present a review of the present position of ancient harbours along the Bulgarian coast of the Black Sea. This study provides new insights into the relative sea-level evolution of this area since antiquity. Archeological data show that relative sea level (RSL) was around -4 m below present in the 6th century BC, rising to the present mean sea level around the 6th century AD. All ancient harbour facilities on the Bulgarian coast ceased functioning at the end of the 6th and the beginning of the 7th centuries AD.

Keywords: sea level, harbour system, sunken structures Bulgaria, Black Sea

Résumé – Prenant en compte la localisation actuelle des ports anciens le long du littoral bulgare de la mer Noire, cette étude propose un nouvel aperçu sur l'évolution relative du niveau marin dans ce secteur depuis l'Antiquité. Les données archéologiques démontrent que ce niveau était inférieur de 4 m au VIe s. av. J.-C. avant d'atteindre le niveau actuel au VIe s. ap. J.-C. Toutes les structures portuaires antiques sur la côte bulgare cessent de fonctionner à la fin du VIe s. av. J.-C. et au début du VIIe s. av. J.-C.

Mots-clefs : niveau marin, système portuaire, structure submergée, Bulgarie, mer Noire

In Antiquity, especially during the Hellenistic period, the port systems of the West Pontic coast expanded. During this period, the first harbour facilities began to be built along the Western Black Sea coast, which brought new architectural forms to the coastal cities (DIMITROV, POROZHANOV, ORACHEV, 1982). On the Bulgarian Black Sea coast a series of sunken harbour facilities (Karantinata, Galata, Apollonia Pontica) (DIMITROV and ORACHEV, 1982) and parts of residential quarters of the Hellenic *poleis* are known (Bizone, Mesambria) (OGNENOVA-MARINOVA, 1975 and 1980; PRESHLENOV, 2008). In some places, such port facilities used natural reefs (Shabla, Cherni nos, Sveti Atanas, etc.) (LAZAROV, 1988; PEEV, 2008; PEEV, 2014) (Fig. 1).

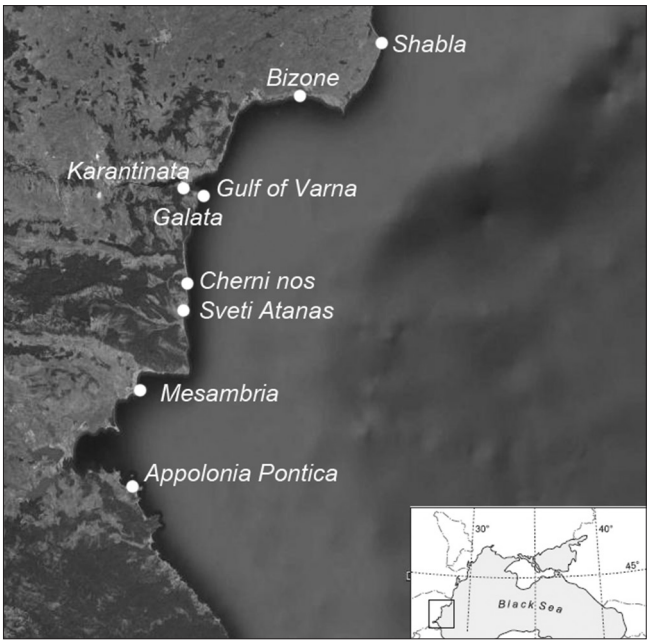

Fig. 1 – Map of mentioned archaeological sites along the Bulgarian Black Sea coast

Artificial ports (SIMOSSI, 1994; RABAN, 1994) with jetties and quays started to be built in the Mediterranean in the Geometric Period, beginning in the 9th-8th centuries BC. Initially, this only comprised protecting dikes and quays made from assembled stones in fixed places. Later, the leaders of the flourishing Hellenistic settlements improved their harbours, adding jetties and docks. These facilities protected the ports from sea gales and the coastline from wave erosion. Some Bulgarian archaeologists think that similar artificial structures along the Western Black Sea coast (DIMITROV and ORACHEV, 1982) were built during the Classical Period (5th–4th c. BC) around Apollonia Pontica. During the Hellenistic Period, quays were constructed from stones specially prepared for this purpose. During the Roman Period, when hydraulic concrete came into use, the biggest artificial harbours in the Mediterranean were built (BLACKMAN, 1982a and 1982b). They were very similar to modern ports. They often became blocked with silt and were eventually abandoned. Therefore rich archaeological material has accumulated in their basins.

To better understand how and when these harbour systems functioned it is important to have good relative sea-level data for the Black Sea area.

1 - Relative sea level in the Black Sea during Antiquity

The presence of numerous submerged archeological sites (walls, quarters, harbour structures) along the Bulgarian coast led to the interpretation that they were built during a regressive phase. The eustatic theory of the evolution of the Western Black Sea was related to the idea of the Phanagorian regression first proposed by FEDOROV (1977). Since then, most of the studies looking at Late Holocene RSL

evolution of the Black Sea presumed a high-stand at the beginning of the 2nd millennium BC, followed by a major decrease during the first half of the 1st millennium between 5 to 10 m below present (FEDOROV, 1977; SHILIK, 1997; CHEPALYGA, 1984; BALABANOV, 2009). This concept was mainly advocated by Russian investigators but was also accepted by Bulgarian scientists (FILIPOVA-MARINOVA, HRISTOVA, 2001). These studies on the Bulgarian coast, as well as those around the Black Sea, have sought to explain the Late Holocene coastal changes, including ancient settlements, as result of important shifts in relative sea level (FEDOROV, 1977; SHILIK, 1997; CHEPALYGA, 1984; BALABANOV, 2009). Although a number of ancient Greek *poleis* around the Black Sea coasts are partially submerged, recent geoarchaeological studies (BRÜCKNER *et al*., 2010; FOUACHE *et al.,* 2012; VESPREMEANU-STROE *et al*., 2013) do not support eustatic oscillations, but rather widespread hydro-isostatic and neotectonic effects.

The Black Sea level was affected by a rapid increase of 50-90 m during its reconnection to the Mediterranean (RYAN *et al*., 1997; MAJOR *et al*., 2002; GIOSAN *et al*., 2006).

In the middle of the 2nd millennium BC, the so-called "Phanagorian regression" began and lasted until Late Antiquity. This hypothetical fall in the relative sea level of the West Black Sea has been assigned to the 5th to 3rd c. BC. According to different authors and interpretations, the maximum ranges were between 2/3 to 11 m below modern mean sea level (FEDOROV, 1977; SHILIK, 1997; CHEPALYGA, 1984; BALABANOV, 2009).

The Black Sea relative sea level during the Late Bronze Age was approximately about 1.6 to 5 m below present. This is confirmed by data from the Bay of Yarulgach where pottery from the middle of the 2nd millennium BC was found at a depth of 1 m b.m.s.l. (SHTEGLOV *et al*., 1976), from Olbia (3420±60 BP at a depth 1.6 m b.m.s.l.; SHILIK, 1972), from Bug firth (3210±50 BP at a depth of 3 m b.m.s.l.; KRYZHITSKYI and SHILIK, 1974; SHILIK, 1997-1999).

From the Bulgarian Black Sea coast, a series of sunken ancient harbour facilities (Karantinata, at cape Galata, Apollonia Pontica-Sozopol) and parts of residential quarters of Hellenic *poleis* are known (Bizone, Mesambria, Apollonia Pontica).

According to Xanthi (*Lydiaca, 3*) at the time of the Persian king Artaxerxes III (465–425 BC) there was a drought. From the period 8th-4th centuries BC, sunken walls are known from Halieis, as well as two temples and a water gate (JAMESON, 1974). In Nympheion, layers from the 4th-3rd century BC were excavated at –3.2 m (BLAVATSKYI, 1961), -4 m (GRACH, 1974) and -4.5 m (SHILIK, 1987). In the Rhodian colony Phaselis, D. BLACKMAN (1973) mentions a breakwater going back no earlier than the 4th century BC. On the French Mediterranean coast, a Hellenistic necropolis is known in Fos Bay (3rd–2nd c. BC) (LIOU, 1987). Sunken Roman remains are known from the Rhone delta (walls and warehouse) (VELLA and PROVANSAL, 2000), from the French and Italian Mediterranean (MORHANGE *et al*., 1993), defensive walls from Chersonesos (ANTONOVA, 1971; SHILIK, 1997-1999), Late Roman artifacts along the southern coast of the Argolida peninsula (VAN ANDEL and LIANOS, 1983), an ancient quarry at Andriake, Turkey (FOUACHE, SIBELLA, DALONGEVILLE, 1999), and an early Byzantine wall from Mesambria (OGNENOVA-MARINOVA, 1975 and 1980).

In general, the Black Sea level at the beginning of this period (6th c. BC) was around -4 m and reached the present level during the 6th century AD. The archaeological data are supported by geophysical observations, such as those from Franhti cave (VAN ANDEL and LIANOS, 1983). After the 6th century AD, there apparently was a relatively rapid rise in sea level. The foundations of the tower in Chersonesos (6th – beginning of 7th c.) were at a depth of -1 m b.m.s.l. (ANTONOVA, 1971).

2 - Archaeological sites along the Bulgarian coast

2.1 - Shabla

Around cape Shabla (Fig. 2) three important geoarchaeological sites are known: the sunken prehistoric necropolis situated to the north of cape Shabla, the reef at Caron Limen and the reef at lake Shablenska Tuzla (PEEV, 2008). Both reefs lie 4 m below present mean sea level and had protected bays that do not exist today.

Cape Shabla's underwater reef is known, which was the quay of the ancient settlement Caron Limen at the time of a lower Black Sea level (Fig. 3). Underwater archaeological surveys have demonstrated that the site is about 400 m long and up to 4 m deep (LAZAROV, 1988). If we picture the situation before 3,500 years ago, when the Black Sea level was about 3-5 m below present, we will see that the reef was above the water and that it was protected by the ancient bay. This explains the presence of a settlement and a port in the area, which is unsuitable for mooring nowadays.

Near Lake Shablenska Tuzla, there is a reef with a length of 1 km and a depth of up to 5-7 m. The known archaeological material from this area attests to the existence of a harbour that is not mentioned in written sources. During diving surveys at the site, a lead trade mark was found (dated 2nd-3rd c. AD), as well as ceramic material (PEEV, 2008). The artefacts were found to the south of the reef. It is obvious that these natural conditions were exploited by ancient mariners and that the ancient gulf was sometimes used as a harbour.

New data was obtained from the prehistoric necropolis of Cape Shabla. Two burial sites are present, the first is at a depth of 6.5 m, while the other is at a depth 3.5 m. These could be dated to the Late Neolithic or to the Chalcolithic.

Fig. 2 – Aerial view of Cape Shabla

Fig. 3 – The Early Byzantine ruins of Caron Limen at Cape Shabla

The relative sea level along the Bulgarian coast was at least 7 m b.m.s.l. (PEYCHEV and PEEV, 2006). Without doubt the necropolis is related to the settlements Shabla I and/or Shabla II (TODOROVA, 1984).

2.2 - Bizone

Until now, unequivocal evidence for an artificial harbour at Bizone has not been found (TONCHEVA, 1970). B. DIMITROV and A. ORACHEV (1982) have described the harbour as being natural. There is evidence for the existence of an artificial structure in the eastern part of the Gulf of Kavarna at a depth of 3 m (Fig. 4). During an underwater archaeological expedition in 2005, traces of buildings were found at depths of up to 3.5 m.

Fig. 4 – View of the present Kavarna bay

The earliest pottery from Bizone is dated to the Hellenistic Period (4th c. BC). It is very likely that shortly before or shortly after the beginning of the new era, the city suffered from an extremely severe earthquake which destroyed not only a part of the settlement but also modified the geography of the coast. This event is mentioned by a number ancient authors such as Strabo, Pomponius Mela, Plinius the Elder, Anonimus Periplus Ponti Euxini. Flavius Arianus in 131 called Bizone "desert place". For clarification of the dating of this catastrophic earthquake, Pseudo-Scymnos (760) mentioned Bizone but does not mention a natural disaster.

In the modern port of Kavarna, a stone anchor, amphorae from the 1st c. AD and a coin from Hadrian's reign have been found (SALKIN, 2009). According to the findings, the harbour complex operated from the 1st–2nd c. AD until the end of the 6th c. AD.

2.3 - The Gulf of Varna

The Gulf of Varna is situated between Cape St. George to the north and Cape Galata to the south. This is the second largest gulf along the Bulgarian Black Sea coast, after the Gulf of Bourgas. The length of the coastal zone is 14 km, the maximum depth -18 m and the approximate area of the bay is around 20 km^2. The exposure of the coast is east – south-east, which means that this is perilous for shipping, coastal and port facilities. Its northern and southern shores are high and steep, while the west coastal strand is low, shaped by accumulation processes. At the bottom of the gulf there are sand deposits separating the Varna – Beloslav Lake from the sea.

The underwater coastal slope of the Gulf of Varna is almost completely covered by modern sediments. In some places there are submerged shoreline cliffs with niches, abrasion terraces, etc., which are characteristic of paleocoastlines (PEYCHEV and PEEV, 2006).

The sea currents were well known and skillfully used by seafarers during antiquity and Medieval times. On the coast of the Gulf of Varna, between the capes of St. George and Galata, there are two coastal currents: the Euxinograd and the Asparouhovo. The Euxinograd stream-current flows to the northeast – southeast close to the bottom of the bay and all the alluvium follow this direction. Similar processes are attested along the southern coast of the gulf, shaped by the Asparouhovo current (DACHEV and CHERNEVA, 1979). There the current flows from cape Galata to the west part of the bay following an east-west direction.

In the Gulf of Varna, four ancient ports are known (Kastritsi, Odessos, Karantinata and Galata), and two of them have harbour structures – Karantinata and Galata (TONCHEVA, 1964).

2.4 - Karantinata (or Lazuren briyag)

During underwater archaeological investigations in the early 1960s, the existence of a submerged ancient harbour construction was ascertained. It comprises a perpendicular coastal jetty and is 250 m long. It was built of medium size broken stones without mortar which are paneled with larger oval stones. The highest parts of the construction are at a depth of 2.5 m b.m.s.l. The lowest part of the site is at a depth of 4.5 m (Fig. 5). The jetty protected the marine area.

West of this pier and east of the old iron bridge around Karantinata represents the basin of this ancient port. In the 1960s, during underwater archaeological excavations, fragments of amphorae, bowls and anchors were found. To this day, there are still regular archaeological finds.

In addition to the many and varied ceramic artefacts in the area of Karantinata, three iron anchors were also found and excavated. Two of them are grapnels and the last one is T-shaped. Chronologically, the T-shaped anchor is earlier, as sailors used this type of iron anchor during the 6th–8th centuries, while grapnels are much later and came into use during the late Middle Ages.

During the archaeological investigations, pottery was found dating from the Hellenistic period (3rd c. BC) to Late Medieval times, together with millstones and anchors.

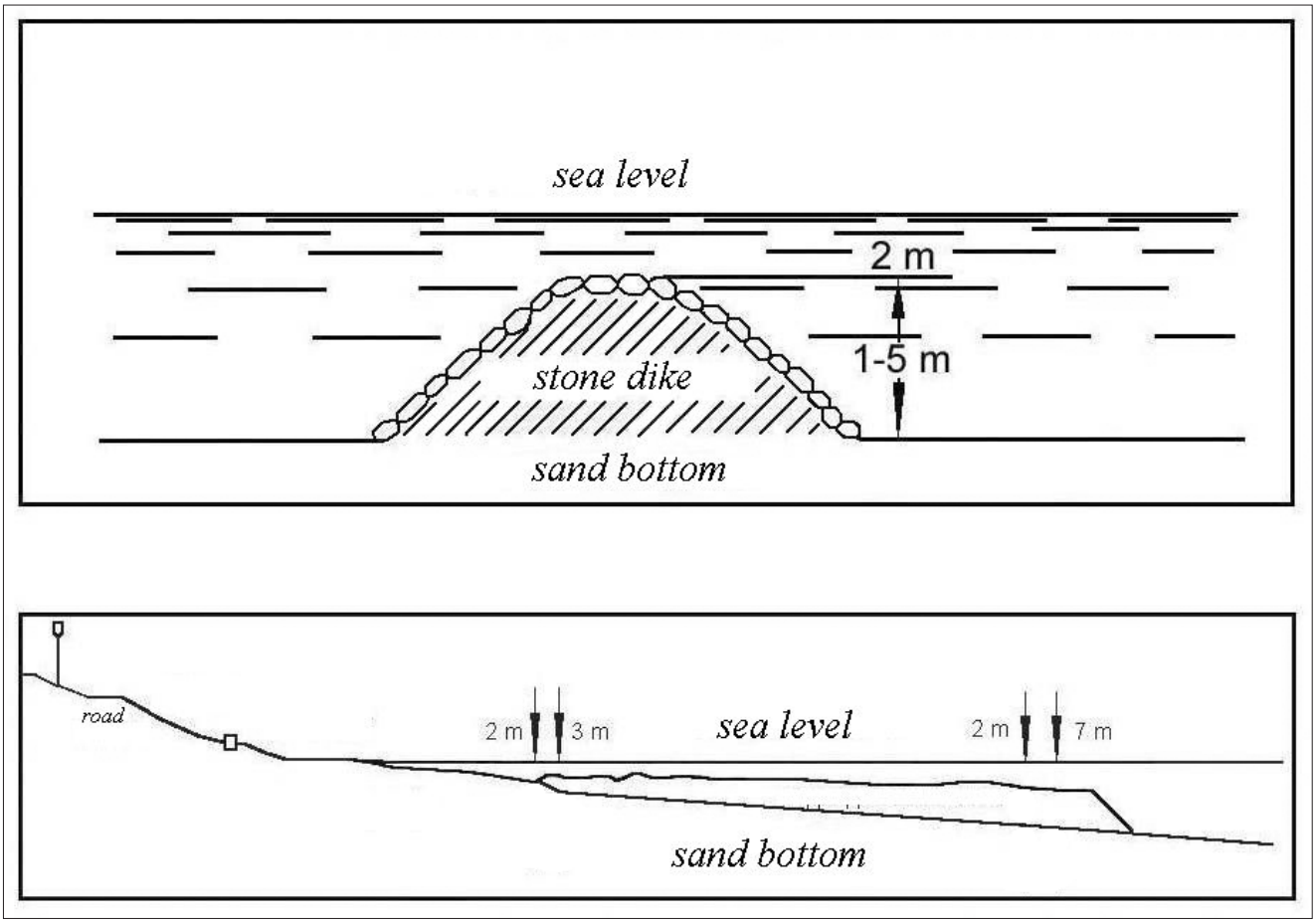

Fig. 5 – Sketch of the ancient breakwater (?) at Karantinata – *After Toncheva, 1964.*

I believe that the Anton Bedzhev cross section, published by G. Toncheva (TONCHEVA, 1964) is only hypothetical. At the time of my underwater archaeological observation of the site, I never observed the cross-section of the underwater wall proposed by G. Toncheva. Moreover, it is highly likely that this is not an artificial structure but a natural reef, which today is 2 or 3 m b.m.s.l.

2.5 - Galata

An underwater quay is known from the lighthouse area at cape Galata. The first archaeological materials from the aquatory (anchors and amphorae) were found in 1962. In the same year, an underwater wall was found close to the modern jetty of the Varna – Galata ferryboat line. Most probably, this construction belonged to the ancient Thracian settlement of Karabizia. The quay contains large broken stones that are the same shape as those from Karantinata. The highest parts of the site are at a depth of 3.5 m b.m.s.l. Various pottery, stone and wooden anchors have been found.

Due to the lack of sufficient bibliographic information (TONCHEVA, 1964) we are not able to provide more specific details with regards to the jetty around cape Galata.

In August 1969, in the area of the jetty at cape Galata, a one-holed stone anchor was found. Three years later, two lead stocks from a wooden anchor were also found.

In this part of the bay there is another underwater site that is interesting for our investigation. It is located west of the modern bridge at the restaurant "Romantika". It probably comes to a natural underwater reef with a length of about 250–300 m and a maximum depth of 2.5–3 m. It begins immediately from the shore with a slightly recessed, but pronounced, cape. This cape is marked on all charts, without exception, as the direction is like the other two: north-south. The general impression is that all three identified breakwaters are perpendicular to the coastline.

2.6 - Cape Cherni nos (Kara burun cape)

In front of cape Cherni nos (or Kara burun), there is a natural extension of land, which is a chain of boulders and rocks. The direction of the reef is east – west and the total length is 400 m. The minimum depths along the reef vary between 1 and 6.6 m. In Antiquity, during the Phanagorian regression when the Black Sea level was 5 m b.m.s.l., the highest parts of the site were above water. Thus, a natural extension of Cherni nos circumscribed a protected aquatic area where small vessels were able to find refuge. In 1967, 1968 and 2010, underwater archaeological investigations were conducted on the reef south of Cherni nos, focusing on the reef and amphora pile. The origin of amphorae is the coast of modern Tunisia and they are dated to the end of the 4th c. AD to the middle of the 5th c. AD.

2.7 - Sveti Atanas

The reef east of cape Sveti Atanas has a length of 400 m and a depth of between 2 and 4.4 m. According to the archaeological material found in the aquatory of ancient Viza (Fig. 6), the bay protected by the reef was used from the Early Iron Age until Medieval times.

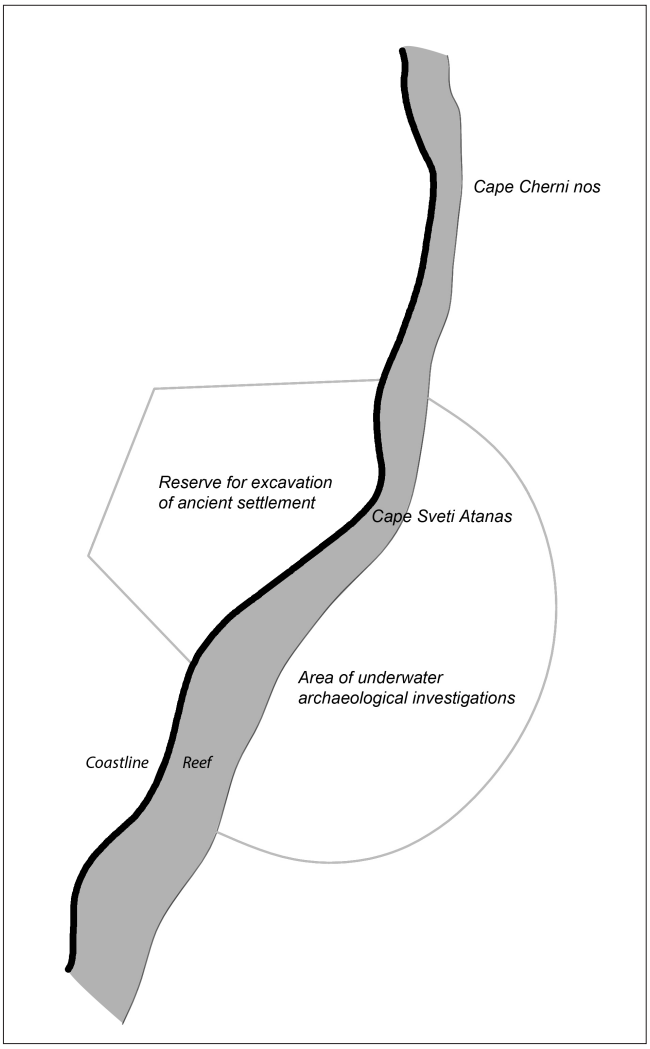

Fig. 6 – Sketch of the investigated surroundings of Cape Sveti Atanas

Fig. 7 – The sunken city wall of Mesambria – *After Preshlenov 2012.*

2.8 - Mesambria

Ruins of the ancient fortifications are located between six isohypse along the southwestern slope of the peninsula and the sea bottom to the fourth isobath along the southeastern slope (PRESHLENOV, 2008). During underwater surveys, sunken parts of the ancient city (up to the 6th c. AD) were recorded at a depth of 5 m (Fig. 7). On the northwestern part of the peninsula, a Late Antiquity wall was traced 80 m in a northerly direction (OGNENOVA-MARINOVA, 1975).

2.9 - Apollonia Pontica

Ancient Apollonia Pontica (present Sozopol) has two artificial quays (Fig. 8). The height of the surface facilities from the bottom to the top of the base is 1.5 to 6.5 m with a depth of 1.5 to 3.5 m (DIMITROV, POROZHANOV, ORACHEV, 1982). They certainly were above water and served as piers because of their width between 10 and 20 m. Suggestions that the stone piles were part of a breakwater have been rejected in a recent publication (HRISTOV, 2013). By contrast, the underwater observations suggest that this structure is probably man-made.

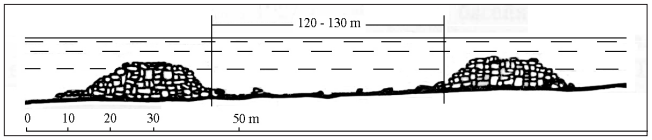

Fig. 8 – Submerged structures at Appolonia Pontica – *After Dimitrov* et al., *1982.*

Conclusion

Archaeological surveys on the Bulgarian Black Sea coast seem to indicate local RSL variations of around 4 to 5 m. Almost all the bays where underwater archaeological remains have been found were not suited for the mooring of vessels. At lower sea level, however, they form beautiful coves protected by underwater reefs. Future underwater archaeological research will inevitably enrich the archaeological map of the west coast with new sites.

All harbor facilities on the Bulgarian coast ceased to function at the end of the 6th and the beginning of the 7th century AD. The conclusion is that a rise in relative sea level occurred from Late Antiquity onwards. This is associated with a recent marine transgression, which is the cause of the flooding of ports and parts of the ancient coastal towns.

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