Harbours of Byzantium

The Archaeology of Coastal Infrastructures

Edited by

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Cover: Southwestern harbour of Byzantine Kassandreia in Chalkidiki, Greece (A. Ginalis)

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Editor's Preface

Christianity, Roman tradition and ideology, as well as Greek cultural heritage, have been labelled as the pillars of the Byzantine Empire. In fact, the real crux and enabler of power in an empire that combined the Occident with the Orient was its control over the seas. As such, seafaring constituted the formula of success for dominance of the Mediterranean, playing a key role in communication, military activities, and, especially, economic exchange. But how does one get from land to water? The linking gates are coastal installations, i.e. ports, harbours, and other infrastructures. These function as economic hubs, cultural and social meeting points, as well as gateways for communication and connection.

Even though the study of harbour sites and port networks of the Byzantine Empire constitutes a relatively new research field, it has nevertheless received significant attention over the last few years, as we can see from the instigation of various projects and the staging of conferences. However, attention is rarely paid to analyses of physical harbour remains and their impact on the general development of Late Antique and Medieval architecture, economy, or trade networks.

As such, in 2018, an international conference on the *Harbours of Byzantium* was organised at the Institute for Advanced Study of the Hanse-Wissenschaftskolleg in Delmenhorst, Germany. This event was intended to focus particularly on the archaeology of Byzantine coastal sites, including both harbour infrastructures *per se*, as well as associated facilities and affected landscapes. Leading scholars in the field from twelve different countries presented new material and data with which to understand the development of harbour architecture and coastal activities from Late Antiquity to the Middle Ages. The papers set out to cover sites from all provinces of the Byzantine Empire, stretching from Italy in the West to the Levantine coast in the East, and the Black Sea in the North to Egypt in the South. This allowed a general overview for comparative analyses and discussions on various aspects of Byzantine harbour networks and maritime connectivity.

Accordingly, the current volume provides a series of scientific papers deriving from presentations given at the conference. Beyond general approaches to the study of Byzantine harbour archaeology, the contributions offer a representative picture of harbour activities across the historical and geographical boundaries of the Byzantine Empire. Although it is impossible to reflect a comprehensive picture of the entire sweep of coastal landscapes, this work hopefully provides a basis for future comparative research in Byzantine harbour studies – on a local, regional, and supra-regional level.

The conference programme is included in the Appendices. The differences between the conference programme and the final version of this volume are explained by the fact that some scholars who submitted abstracts were ultimately unable to attend, and some who did attend and gave their papers did not submit them for publication. Fortunately, other colleagues agreed to contribute to this volume and I am most grateful to them for so doing.

I would like to express my deepest gratitude to all participants in the Delmenhorst Conference for presenting papers that provided unique insights, not just into ongoing excavations and investigations related to harbour installations, but also into hitherto understudied aspects of coastal infrastructures. It has been a considerable challenge to assemble this volume, and I am therefore particularly indebted to all authors who contributed and enriched this publication. Bearing in mind the time-consuming work of editing and unifying the papers, etc., as well as the difficulties brought on by the COVID pandemic, I have done my best to ensure as prompt a publication as possible.

Thanks must go here to Dr Susanne Fuchs and her team from the Institute for Advanced Study of the Hanse-Wissenschaftskolleg for their support in organising the conference in Delmenhorst. I am also sincerely grateful to David Davison and Mike Schurer from Archaeopress for agreeing to publish this volume and for guiding this work through to publication, their technical help, and the quick production of the printed version.

Alkiviadis Ginalis

7. An Interdisciplinary Approach to the Study of the Ancient Harbour Site of 'Karon Limen' or 'Portus Caria/Carea', Bulgaria

Preslav Peev, Alkiviadis Ginalis, Bogdan Prodanov, Grigori Simeonov

Introduction

The port city of Karon limen (also referred to as Portus Caria/Carea) at modern Cape Shabla is located in north-eastern Bulgaria (Fig. 7.1). Expanding the maritime network along the western Black Sea towards the north, the site was probably established as one of numerous colonies during the Greek colonisation along the Bulgarian coast between the 8th and 6th centuries BC; however, due to its important strategic position, settlement activities go back to the Neolithic. Accordingly, the area reveals multiple historical sites of great geomorphological and archaeological importance, such as its submerged Prehistoric necropolis, and the Ancient to Late Antique fortress and harbour of the port city (Figs 7.2, 7.4). Since the end of the 19th century, a significant amount of information has been accumulated on the port system of the western Black Sea coast in association with Karon limen. However, it still lacks a comprehensive interdisciplinary approach, which should contribute significantly to the full and qualitative clarification of the complex historiographical development along the Bulgarian coasts and their immediate hinterland.

Since the entire area forms a critically endangered zone, due to various hazards, all archaeological sites, including the case-study of port Karon limen/Portus Caria/Carea are highly threatened with destruction. Not only natural hazards (sea-level rise, coastal erosion, storms, earthquakes, floods), but even more so anthropogenic activities, including constant

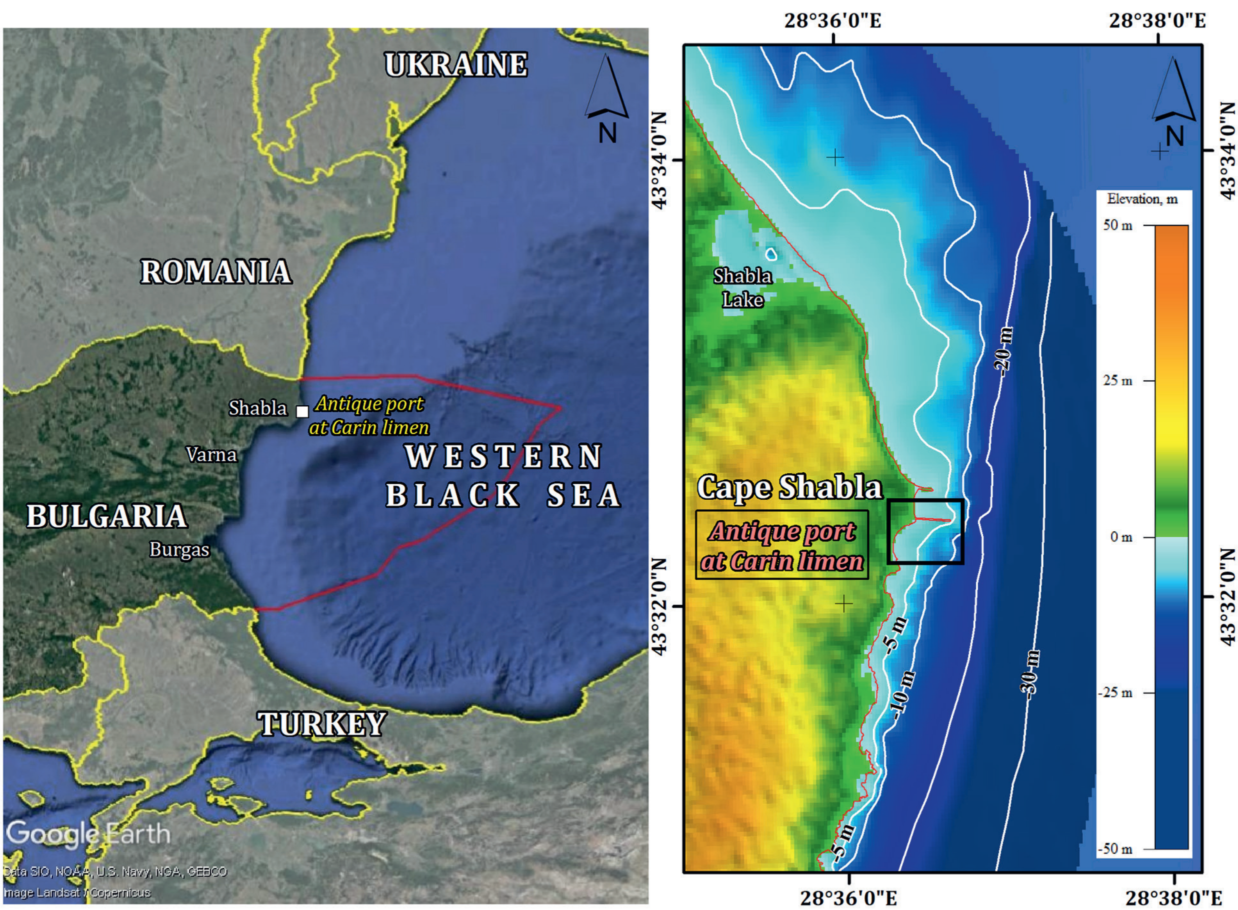

Figure 7.1: Location of Cape Shabla, Bulgaria (Institute of Oceanology – BAS).

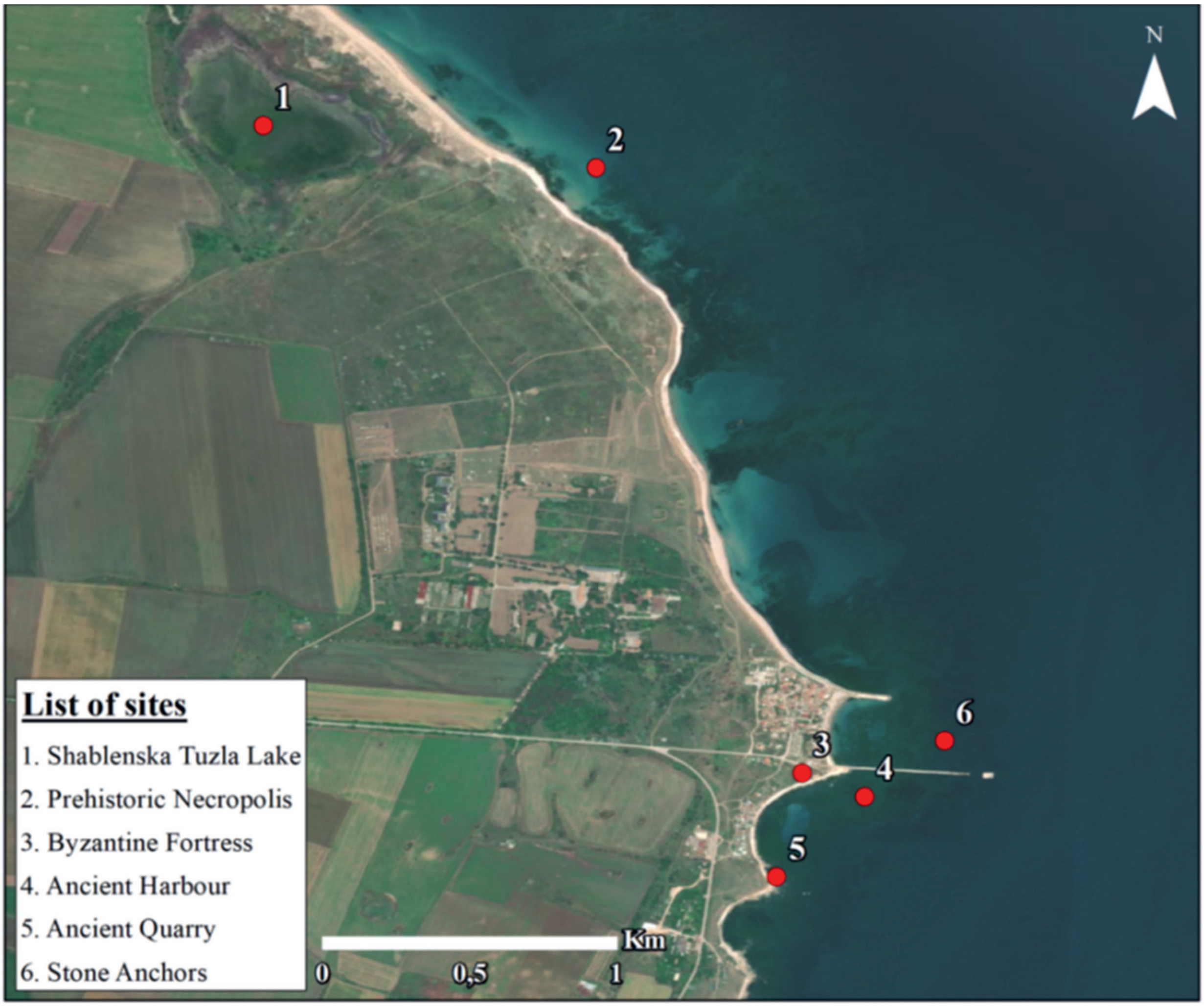

Figure 7.2: Detailed map of archaeological sites (based on Google Earth).

construction works and the impact of tourism, pose huge threats to the historical landscape of Cape Shabla. So as not to further impair the area, modern archaeological research methods, e.g. aerial remote sensing and photogrammetry, need to be applied; accordingly, the Institute of Oceanology of the Bulgarian Academy of Sciences uses UAV surveying technology. Although a significant change in the archaeological approach from direct fieldwork and excavation to non-intrusive remote sensing has generally taken place over the last two decades (Skrypitsyna *et al.* 2019), this field is relatively new and therefore still in its infancy in Bulgaria. Nonetheless, coastal geomorphological and landscape mapping have improved, with much new data being collected in relation to the Bulgarian coastline (Prodanov *et al.* 2020a).

Cape Shabla and its surroundings: the geological context

The investigated area includes the easternmost part of one of the main morphotectonic units in Bulgaria – the North Bulgarian Arch (Fig. 7.3). This ancient platform, the so-called 'Moesian Epiplatform Plain', forms the eastern part of the Dobrudzha Plateau, one of the major geological structures of the Carpathian and Balkan foreland – the Moesian (Danubian) Platform (Stanciu and Ioane 2019-2020: 3; Kotzev *et al.* 2017; Zagorchev *et al.* 2009). The Moesian (Danubian) Platform occupies the northern part of the Bulgarian Black Sea coast. The evolution of the geological formations occurring along the shoreline, which constitute the eastern slope of the North Bulgarian Arch, is determined by extremely complex processes and factors, including fluctuations in relative sea level, fluvial inputs, marine dynamics, tectonics, as well as the varied morphology. Its lithostratigraphic composition is dominated by Miocene sedimentary strata, such as sandy limestones,

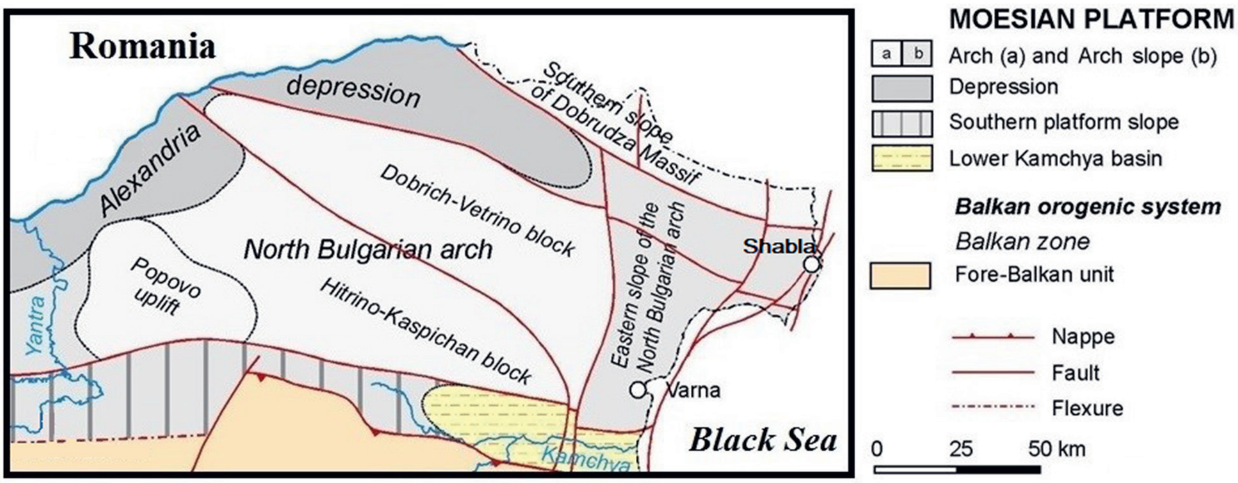

Figure 7.3: Morphotectonic Map of Bulgaria (after Zagorchev *et al.* 2009).

sandstones, marls, clays, etc. A distinctive lithological feature of the shore, 9-19 m thick in this area, is the Quaternary loess (Stanciu and Ioane 2019-2020: 5; Kotzev *et al.* 2017; Peychev and Peev 2006).

The erosion of the shoreline, which comprises Sarmatian limestone (the Karvuna Formation) and loess type deposits, is common in the northern extremity between Cape Sivriburun and Cape Shabla. At Cape Shabla, the cliff has a generally eastern exposure, causing an increased recession rate of *c.* 0.30 m/year (Peychev and Peev 2006; Peychev *et al.* 2005).

Figure 7.4: The Byzantine fortress of Kreas and its harbour bay (A. Ginalis).

Cape Shabla and its surroundings: the archaeological and historical backgrounds

The archaeological sites in the area of Cape Shabla are partly located on the seashore, built on a coastal cliff, and underwater. The ancient site of Caria is partly preserved beyond two submerged graves, which most likely belonged to a prehistoric necropolis related to the Late Neolithic settlement of Shabla I/II (Peev 2008: 303; Peychev and Peev 2006; Todorova 1984). The features include the northern city wall, a tower, and a quarter of the southern part. However, the most significant archaeological and architectural finds belong to the Late Antique period (Peev 2008: 303; Torbatov 2002). These comprise the remains of an Early Byzantine fortress of the 4th-6th century AD (Fig, 7.4) which seems to have protected a large harbour area and its associated industrial hinterland (Minchev 2013: 248-249).

The harbour site at Cape Shabla finds its very first references during the 1st-2nd century AD by the Roman geographer Pomponius Mela (Pomp. Mela II. 20, Parroni (ed.) 1984: 137) and the Greek historian Lucius Flavius Arrianus – also known as Arrian of Nikomedia (Arr. PPE 24. 3, ed. Silberman 1995). After these accounts, the toponym *Karon limen* or *Portus Caria* is only mentioned again in a 6th-century AD dated anonymous *Periplus of the Euxine Sea* (An. PPE V. 75, Diller 1952: 136).[1] By situating it between Kalatis (modern Mangalia, Romania) and Cape Kaliakra (also referred to as *Akra, Tetrisias*, or *Tirizanakros*), the Periplus explicitly refers to it as the port (*limen* or *limena*) of the Carians. Taking the existence of the aforementioned Early Byzantine fortress into account, the provided pronunciation *Karai* or *Kareai* can possibly be associated with the so-called fortress of *Kreas*,[2] mentioned by the likewise 6th-century historian Procopius (Procopius, *De Aedificiis*, IV 11. 18-20, ed. Haury and Wirth 1963: 149).

As for the archaeological investigations of the harbour itself, the site was identified and allocated as Karon limen as early as the late 19th to early 20th century by

[1] In contrast, the edition by Müller suggests a 5th-century date (*Geographi Graeci Minores*, Müller (ed.) 1855).
[2] Another equivalence might be Creas for C(a)reas (Beševliev 1970: 148).

Škorpil, Tsitsov, and Bozhkov (Torbatov 2002; Bozhkov 1925; Tsitsov 1909). However, the first systematic archaeological excavations did not take place before the 1960s - 1980s, which also included underwater survey campaigns in 1962, 1974, 1979, and 1980 (Lazarov 2009; 1988; Torbatov 2002: 197-215). The latest significant study of the harbour site prior to the current investigation was done by Totev *et al.* (2022), Minchev (2013: 248-249), Peev (2008), and Torbatov (2002), who compiled and summarised almost all the available information on the archaeology and historiographic development.

These data reveal that the oldest archaeological material, and thus the earliest harbour activities in the area, date back to the Late Neolithic. The prehistoric phase is attested by five stone anchors, each with three holes, discovered during underwater archaeological investigations north of the reef (see below) at a depth of 1.5 m - 3.5 m. Additionally, four lead stocks (type IV) of iron anchors were found further to the east at a depth of 10 m - 11 m (Peev 2008: 303; Orachev and Oracheva 1988).

The earliest import goods that can be associated with maritime contacts, and thus with harbour activities, constitute amphorae from the Aegean island of Chios, from the second and third quarter of the 5th century BC (Totev *et al.* 2022: 305; Lazarov 1988). The supply of the wider area with imported goods lasted until the Early Byzantine period (Minchev 2013: 249; Torbatov 2002), with the harbour basin apparently remaining active until a sudden, rapid rise in sea level seems to have gradually put the harbour out of operation during the 6th century AD (see below). Finally, extensive quarry activities have been documented along the shoreline south of the harbour basin and further to its south (Figs 7.5a-d); these indicate extensive industrial exploitation, which can likewise be associated with harbour activities.

Figure 7.5a: The harbour bay with the quarry area from the south (A. Ginalis).

Figure 7.5b: Quarrying activities (A. Ginalis).

Figure 7.5c: Quarrying traces (A. Ginalis).

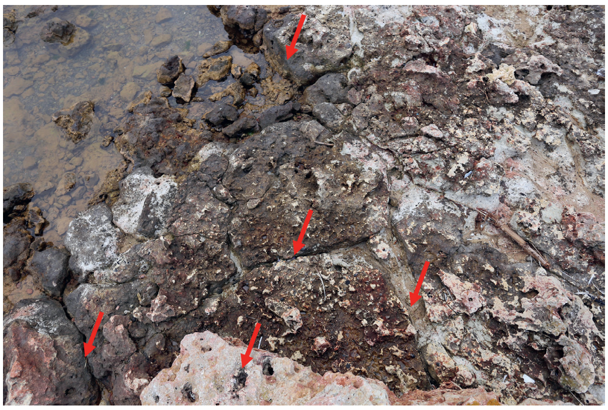

Figure 7.5d: Quarrying traces (A. Ginalis).

Interestingly, archaeological remains were not only found in the harbour bay immediately east and southeast of Cape Shabla, but also further north at Lake Shablenska Tuzla. During underwater archaeological surveys a large amount of material remains, e.g. pottery sherds, a lead trademark of the 2nd-3rd century AD, and a millstone, have been recorded south of a further submerged reef at a depth of *c.* 5 m - 7 m (Peev 2008: 303-304; Rokov 2007). The latter support a further link between the agricultural exploitation of the surrounding hinterland and the wider maritime trade network.

Methods

For a better understanding of the function of the wider coastal area of Cape Shabla, and its interconnection with the Bulgarian Black Sea port network of the Ancient to Late Antique and Medieval periods (Peev and Ginalis 2020: 385-388; Ginalis *et al.* 2019: 51), a profound knowledge of the coastal and marine environment, as well as the relative sea-level change for the Black Sea basin, is of fundamental importance. In the Late Holocene the coastal morphology is controlled by sea transgressions and regressions, which find clear evidence in underwater archaeological finds. (Peev 2016; Flemming 1978). However, due to lack of data on the operation of harbour basins along the western Black Sea coast, in addition to documenting the submerged architectural remains and archaeological material it is extremely important to determine sea fluctuations when restoring the ancient coastline.

Unfortunately, there is no common consensus concerning the problem of relative sea level in the Black Sea between the 2nd millennium BC and the Late Antique to Early Medieval periods. Looking at the relative sea level evolution of the Black Sea in the Late Holocene, most Soviet and post-Soviet studies presume a high level at the beginning of the 2nd millennium BC, followed by a major decrease of 5 m - 10 m below present sea level during the first half of the 1st millennium BC (Balabanov 2009; Filipova-Marinova and Hristova 2001; Shilik 1997; 1997-1999; Chepalyga 1984). While this assumption is supported mainly by Russian scientists, but also widely accepted among Ukrainian and Bulgarian scholars, Fedorov rather presents a eustatic theory on the evolution of the Black Sea related to the so-called ‘Phanagorian’ regression that began in the middle of the 2nd millennium BC and lasted until Late Antiquity (Federov 1977). Recent geoarchaeological studies of a number of Ancient Greek *poleis* around the Black Sea coasts, however, do not support eustatic oscillations, but rather widespread hydro-isostatic and neotectonic effects (Vespremeanu-Stroe *et al.* 2013; Fouache *et al.* 2012; Brückner *et al.* 2010). Accordingly, the relative sea level along the Bulgarian coast can be set at least 7 m below today’s level. This is also roughly reflected by new data obtained from the Late Neolithic necropolis of Cape Shabla, where two burial sites have been documented at a depth of 3.5 m and 6.5 m (Peychev and Peev 2006).

Between the 6th and 3rd centuries BC the average regression eventually rose to a relative sea level of *c.* 4 m - 5 m below what we find today. This relative sea level lasted until *c.* the 6th century AD, when a sudden rapid rise can be observed, resulting from low global temperatures and decreased river outflows. Such factors led to today’s sea levels after the 6th/7th century AD, which is supported by the absence of pottery after the 6th century AD (Peev 2016: 17-18; Peev 2008: 303; Peychev and Peev 2006).

To quantify shoreline and sea level changes along the coastline of Cape Shabla we used multi-temporal data for the period 1985-2020. All the field observations and existing information from coastal surveys were undertaken by the Institute of Oceanology at the Bulgarian Academy of Sciences.[3]

In October 2019, an initial aerial survey campaign was conducted under appropriate meteorological conditions. By using a DJI Phantom 4 Pro Quadcopter, aerial photographs of the wider harbour bay, with its archaeological sites, were taken to reconstruct the topography of the area. 29 ground control points (GCPs) were systematically placed, and geodetic control measurements were made with a GPS (HiTarget V90Plus). While the ground control points are within 2 cm horizontal and 3 cm vertical accuracy, the geodetic control measurements provide millimetre accuracy. The flight altitude was 50 m at 1.45 cm ground sampling distance (GSD). For better details, some elements were captured at 25 m altitude with 0.75 cm GSD (Fig. 7.6). UAV data processing of the imagery was made by Agisoft Photoscan Professional and Pix4Dmapper.

The satellite and orthophotographic database had to be implemented by using UAV-based photogrammetry. As such, UAV-based surveys were conducted in February and May 2020. The Shabla coastal sector was photo-mapped at very high resolution (VHR), under 7cm/pix GSD. The post-processing of the UAV imagery data generated VHR digital surface and terrain models and orthophotographic mosaics (Prodanov *et al.* 2020a, b).[4]

In March and April 2020, the aquatory front of Cape Shabla was investigated for the purpose of preliminary archaeological and geomorphological studies. The data

[3] As part of the joint project ‘Inventory of Late Antique and Medieval ports along the Western Black Sea’, funded by the National Science Fund of the Ministry of Education and Sciences of the Republic of Bulgaria, and the Centre for International Cooperation & Mobility (ICM) of the Austrian Agency for International Cooperation in Education and Research (OeAD) of the Federal Ministry of Education, Science and Research (BMBWF).

[4] The workflow requires up to eight main steps: (1) masking of the images (in case any of the photographs include sky or other unwanted elements); (2) image alignment; (3) generation of the initial dense point cloud; (4) geo-referencing of the model; (5) optimising the image alignment using the ground control points; (6) assessment of the model uncertainty (optional but recommended if change detection is required); (7) generation of a dense high-resolution point cloud; (8) generation of the digital surface model, orthophotomosaic and tiled model.

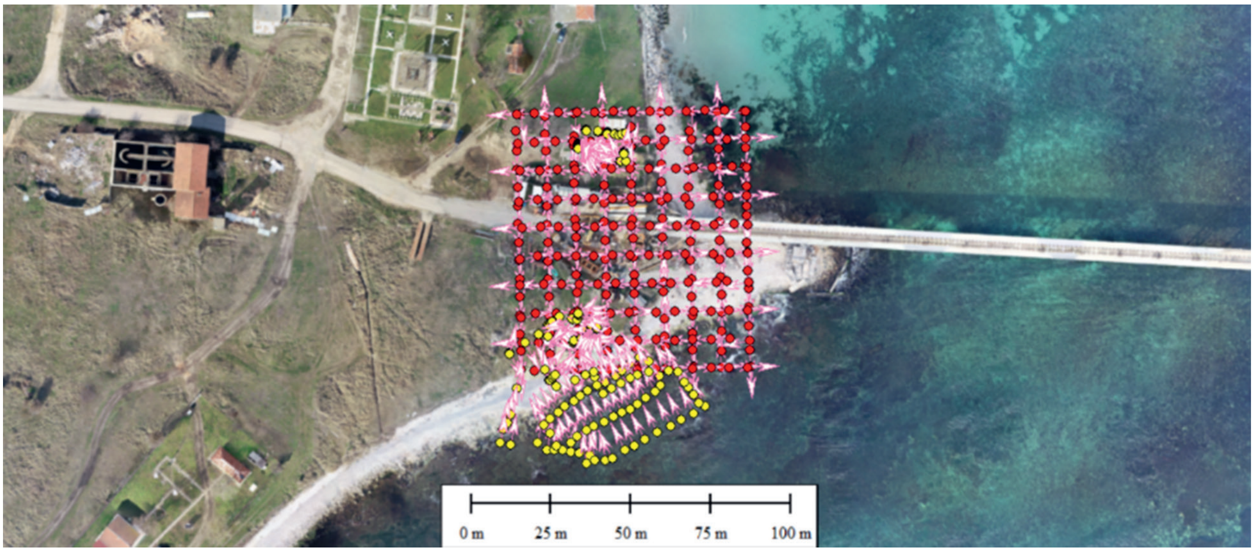

Figure 7.6: UAV imagery: red points flight altitude 50m and yellow points manual mode (Institute of Oceanology – BAS).

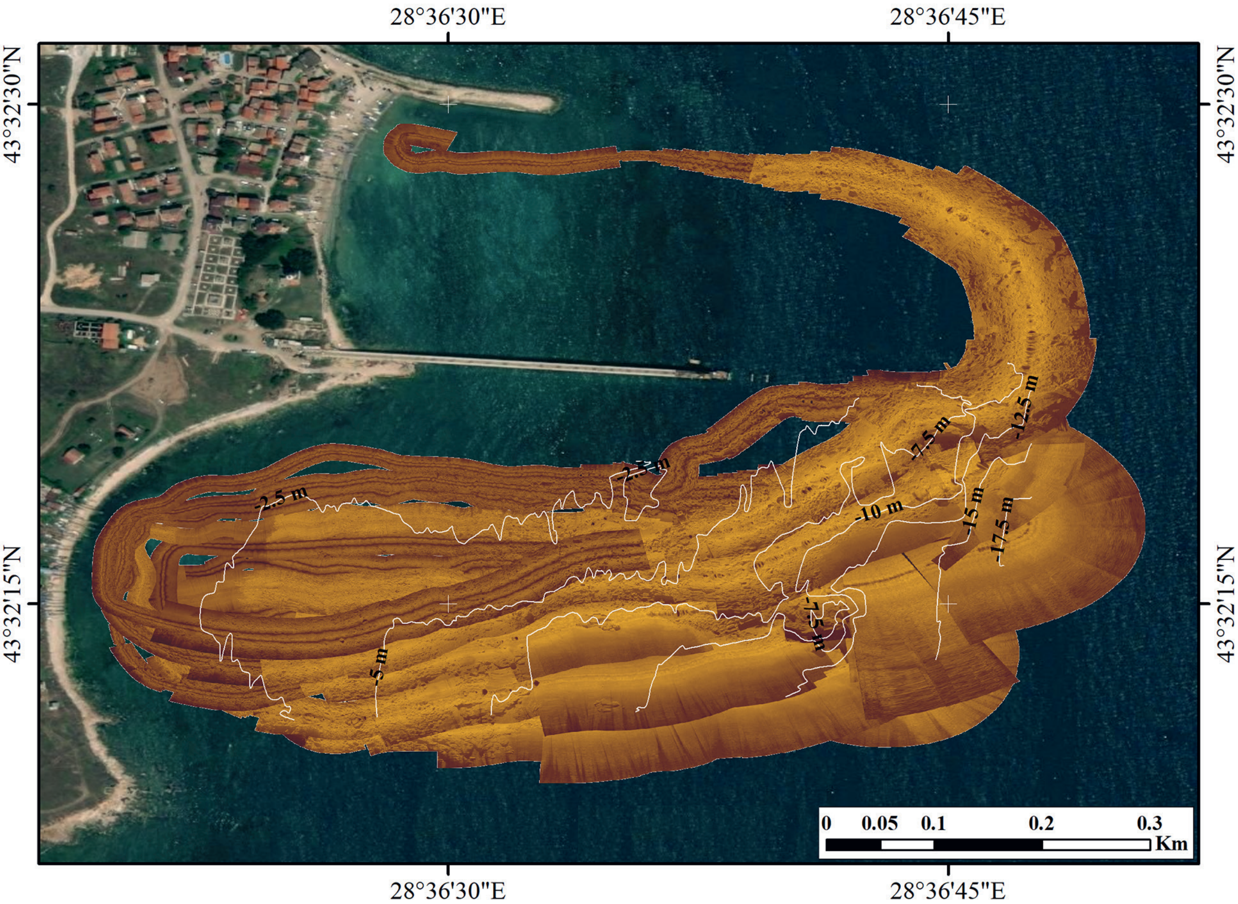

Figure 7.7: Side scan sonar mosaic of hydrographic survey (Institute of Oceanology – BAS).

was acquired during hydrographic surveys performed by HDS-7 LIVE, with Active Imaging 3-in-1, as well as single-beam echo sounder Ohmex SonarMite BTX. The terrain model was generated using data from the single-beam and sonar system (Fig 7.7), and post-processed with ReefMaster 2.0, following the methodology for hydrographic surveys (Prodanov 2017).

In May 2021, a final non-intrusive survey campaign was conducted as part of the project 'Inventory of

Late Antique and Medieval ports along the Western Black Sea', funded by the National Science Fund of the Ministry of Education and Sciences of the Republic of Bulgaria and the Centre for International Cooperation & Mobility (ICM) of the Austrian Agency for International Cooperation in Education and Research (OeAD-GmbH). Apart from extended orthophotography by using UAV-based photogrammetry, the entire shoreline was studied for remains of coastal facilities and quarry activities.

Results and discussion

The detailed mapping of the sea bottom led to the documentation of underwater reefs. Apart from the reef of Lake Shablenska Tuzla, with its archaeological remains, the hydrographic and underwater archaeological surveys finally also revealed and localised the underwater reef at Cape Shabla (Fig. 7.8a), known as the reef of *Karon Limen* (Peev 2008: 303; Lazarov 1988; Lazarov 1975).[5] It has a length of *c.* 400 m and stretches in an east-west orientation from the coastal cliff of the fortress into the sea. It is situated 2.5 m below present water level, and after a narrow depression, that reaches a depth of up to 4 m, at its eastern end, it abruptly falls to a depth of 7.5 m - 10 m (Lazarov 1988). At a distance of *c.* 220 m from the present coastline, the reef also turns north, where after *c.* 250 m it meets the breakwater of the modern harbour (Fig. 7.8b). Considering the given depth and the sea level changes discussed above, at the time of low sea level the reef must have been above the water surface. In contrast to the present coastline, with its unfavourable environment and unsuitable for mooring, Cape Shabla, therefore, certainly provided a large harbour basin (*c.* 5 ha), with a sheltered bay to its south, that functioned as roadstead between the 2nd millennium BC and Late Antiquity.[6] As such, Torbatov correctly assumes that it not only must have functioned as a natural breakwater for the ancient coastal settlement, but most likely also offered ideal preconditions for the erection of various harbour installations, e.g. quay, mole constructions, etc. (Peev 2016: 18; Peev 2008: 303, Torbatov 2002). In fact, the existence of artificial structures of some kind along the shoreline and on the reef is not just indicated by written accounts. Traces of harbour installations have indeed been observed by the early investigators of the area, who revealed that the reef once functioned as substructure for architectural features that enclosed the large rectangular harbour basin (Torbatov 2002, 199, fn. 166-167; Tsitsov 1909) (Fig. 7.8c). Despite the high degree of destruction caused by modern building activities, remains of the quay-line can still be traced east of the fortress today (Figs 7.9a-b).

In this regard, it should be noted that the written sources – Pomponius Mela (Pomp. Mela II. 20, Parroni (ed.) 1984: 137), or the *Peripli of the Euxine Sea* – explicitly use the term *limen* (λιμήν) or *portus* instead of *hormos* (όρμος) for the site's toponym *Karon limen* (Καρῶν λιμήν or λιμένα), or *Portus Caria* (Angelova 1985). While *hormos* can generally be translated as anchorage or roadstead, which often form sheltered natural harbours without any man-made installations, a *limen* or *portus* implies the existence of artificial mooring infrastructures, if not also additional installations and surrounding facilities. Therefore, it can be understood as harbour, or even port.

Beyond traces of coastal quarries, during our non-intrusive survey campaign in 2021 further architectural remains were documented, such as mooring stones and walking levels along the shoreline south of the harbour basin, which most likely belonged to further harbour-related facilities linked to the extensive industrial exploitation (Figs 7.10a-b-7.12).

As such, it can be concluded that between the Late Neolithic and the Late Antique periods there indeed once existed a sheltered bay south of the harbour basin that was used as a roadstead and open anchorage for the area of Cape Shabla. Although both sides of the reef seem to have been used and frequented by ships, as evidenced by the stone anchors and lead stocks, the ancient harbour included not just the basin inside the reef but the entire area south of the natural reef formation, which was well protected from the northern and eastern winds. The current investigation revealed that the harbour area not only provided a transhipment centre for the import of goods to the wider region west of Cape Shabla as well as a safe haven for the shipping lanes. Vice versa, it offered the agricultural and mainly industrial exploitation of the area direct access to the maritime trade routes along the western Black Sea. Confronting the anchor finds north of the reef with the earliest notable ceramic imports from Chios, it can be assumed that beyond the use of the wider bay as anchorage, only after the 5th century BC did the coastal settlement acquire a harbour basin of rectangular shape *per se* by constructing artificial infrastructures.

While the marine and coastal environment of the harbour area, together with the industrial exploitation through the coastal quarries, favoured the development of a thriving port city up to the Roman era, various hydrological and geomorphological changes significantly modified the paleogeographic conditions of the landscape during Late Antiquity, ultimately altering the configuration of the coastline. The changes

[5] A first sketch of the submerged reef was published by Toncheva and Lazarov as early as 1964 (Lazarov 1975; Toncheva 1964).

[6] For definitions of port, harbour, anchorage, and roadstead, see Ginalis 2014: 13-20.

Figure 7.8a: Photomosaic of submerged reef (Institute of Oceanology – BAS, based on Google Earth).

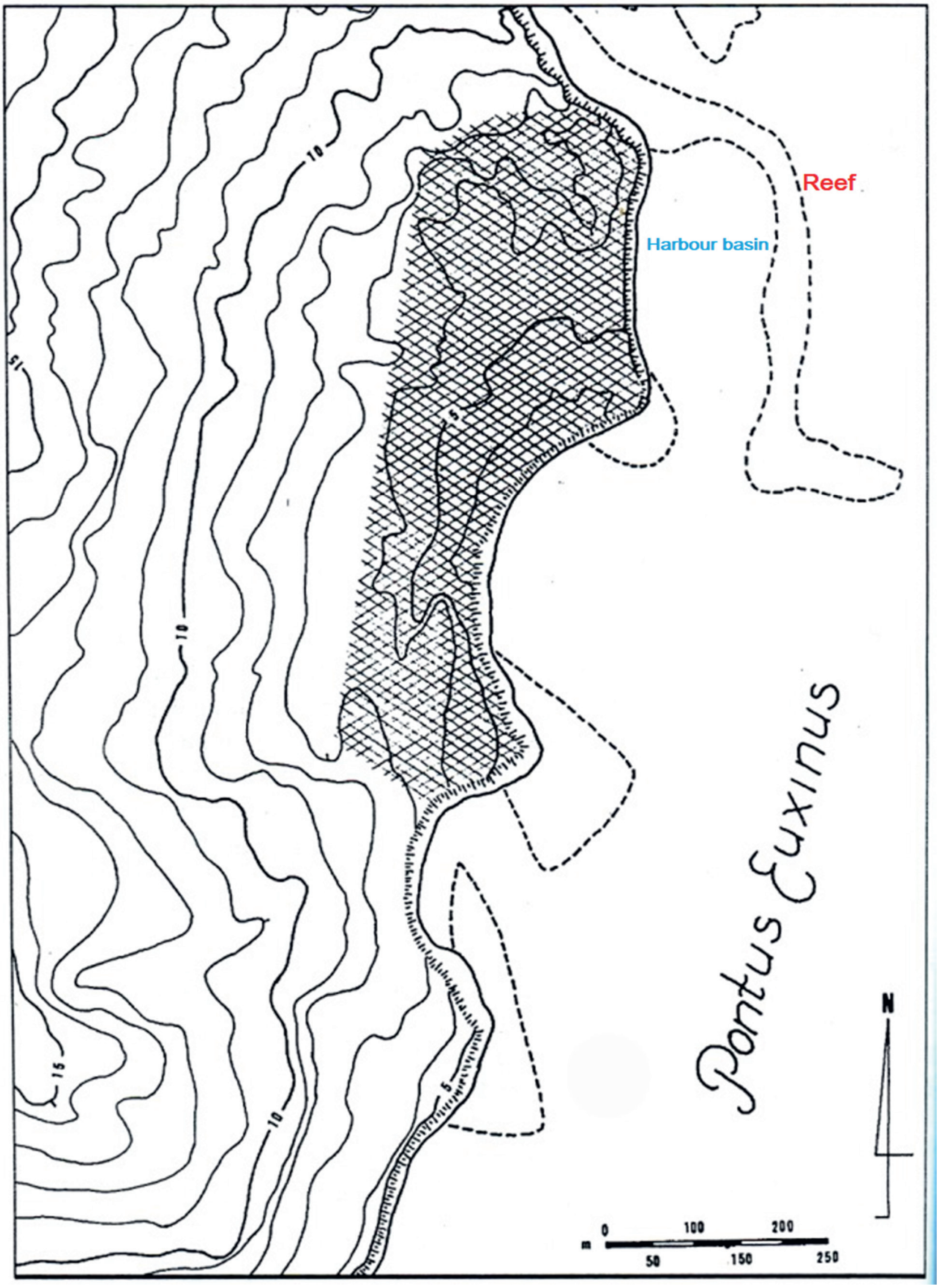

Figure 7.8b: Drawing of the reef and harbour basin (A. Ginalis after Torbatov 2002: 198, Fig. 36).

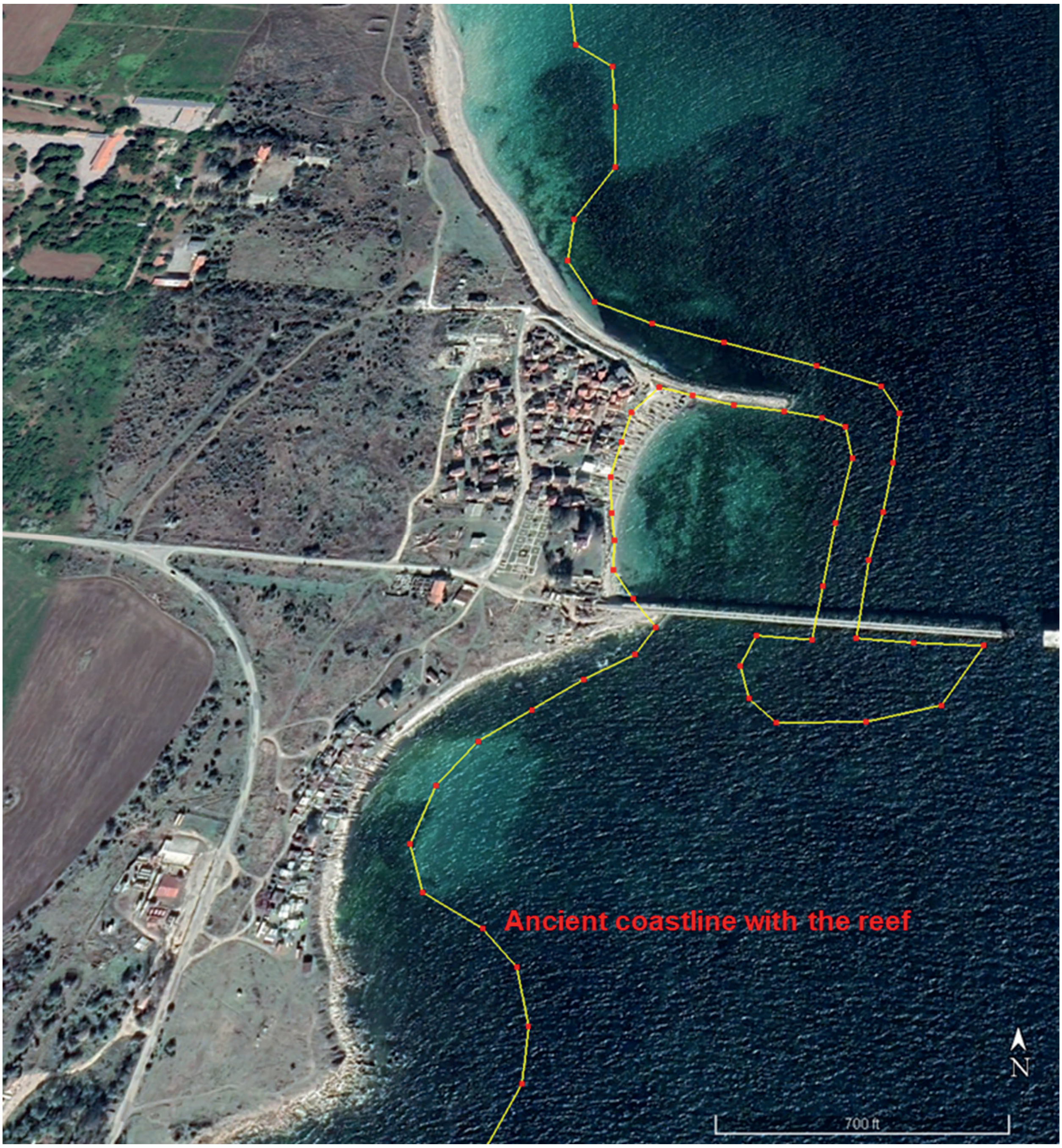

Figure 7.8c: Satellite image of the ancient coastline with the reef (based on Google Earth).

apparently became evident already during the Roman Imperial period, with harbour activities slowly shifting or at least extending towards Lake Shablenska Tuzla to the north. The impact of the geomorphological changes on the harbour basin of Karon limen eventually became particularly noticeable after the 4th century AD, when the rate of sea level rise, together with possible seismic activities in the Black Sea, increased, which eventually resulted in the complete alteration of the coastline (Peychev and Peev 2006).

This, of course, has not gone unnoticed by written sources of the time. Accordingly, the anonymous Periplus author of the 6th-century AD states that the land around (surrounding) the port is (gradually) being flooded.[7] This must have restricted the use of the harbour basin and thus led to an impairment of port activities. Nevertheless, despite the steady process of submerging and the eventual abandonment of the harbour basin,

[7] An. PPE V. 75 (Diller 1952: 136): 'καὶ ἡ γῆ ἐν κύκλῳ τοῦ λιμένος κατακλύζεται.'.

Figure 7.9a: Quay remains east of the fortress (A. Ginalis).

Figure 7.10b: Mooring stone (A. Ginalis).

Figure 7.9b: Posthole on the quay east of the fortress (A. Ginalis).

Figure 7.10a: Mooring stone (A. Ginalis).

the site continued to be of crucial importance, at least for some time after the 6th century AD. This is not just indicated by its strategic position for the control of the maritime trade network along the western Black Sea coast, but also by the extensive industrial exploitation of the coastline and its wider hinterland, such as the quarry activities along the shoreline of the harbour bay and further to its south. The association of the site and its harbour with the importance of quarry activities can be seen by the erection and repair of the Byzantine fortification of Kreas (Creas) and its occupation way into the 7th century AD (Minchev 2013: 249), despite the apparently limited function of the harbour basin by the 6th century AD at the latest.[8] Whether in the course of the 6th century the harbour activities of Karon limen completely shifted towards Lake Shablenska Tuzla, and the former harbour basin and the shoreline to its south were henceforth used exclusively for quarrying, remains to be answered. In any case, only the geopolitical developments of the 7th century AD seem to have made counteraction against the transgression of the Black Sea through potential maintenance works no longer feasible. Thus the important coastal settlement with its industrial zone had to be ultimately abandoned.

Conclusions

Archaeological and geophysical investigations at Cape Shabla show that the northern Black Sea coast of Bulgaria possesses an immensely important historical heritage. Unfortunately, however, a significant part of the Prehistoric, Ancient and Late Antique port city of Karon limen (Portus Caria) has been destroyed irrevocably, with the eastern part of the settlement already being completely lost due to coastal erosion. It should be mentioned that, apart from environmental

[8] This is further supported by the fact that the fortress is located exactly between the harbour basin and the quarries, thus protecting both the harbour entrance and the industrial facilities along the wider harbour bay to the south.

Figure 7.11: Potential walking level (A. Ginalis).

Figure 7.12: Stone block (A. Ginalis).

impact, particularly modern construction works (such as the reuse of building materials from the Byzantine fortress for the construction of the Shabla lighthouse, the disturbance of the cultural layers during the construction of military objects, etc.), as well as oil extraction activities, have all greatly affected and damaged the site of Caria. This makes archaeological studies difficult. As such, the current survey project aims to develop an effective method for monitoring waterfront archaeological sites and coastal changes in order to successfully map and detect coastal archaeological sites using remote sensing technologies. The results of the work carried out at Cape Shabla allowed us to prepare the basis for creating a common geo-information space of the Bulgarian Black Sea region within the archaeological context.

There is an urgent need to design and implement appropriate mitigation strategies to combat the rapid coastal erosion that threatens a site of both national and international importance. In the current context of global change, archaeological sites in coastal zones are particularly vulnerable and at risk from erosion, which is essentially underpinned by three cumulative factors: (1) the dynamic geomorphological character of coastal areas; (2) relative sea level rise; and (3) climate and human-induced reductions in sediment supply to coastal areas (Pourkerman *et al.* 2018; Erlandson 2012). The current results demonstrate that coastal erosion is responsible for significant damage to archaeological sites, with 48% of the studied transects showing erosion during the period 1985-2019. Exploring the timing and drivers of erosion on and around archaeological sites, as well as quantifying the rates of change of coastal areas, is therefore key to developing effective heritage management strategies to ensure the long-term survival of threatened remains. Accordingly, effective conservation of archaeological heritage can be developed by using integrated geographical, geoarchaeological, and geomorphological approaches (Pourkerman *et al.* 2018; Ahmad 2006).

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