# Coastal geoarchaeology of Apollonia Pontica (Bulgaria)

## *Géoarchéologie de la côte de l'ancienne colonie grecque d'Apollonia Pontica*

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*Multidisciplinary geoarchaeological investigation of the ancient Greek colony of Apollonia Pontica (Sozopol, Bulgaria) has been a key research field for the French-Bulgarian archaeological collaboration started in 2002 by the Centre Camille Jullian with the Archaeological Institute and Museum of Sofia and the Archaeological Museum of Sozopol. The main objective of this project was to reconstruct the geomorphological evolution of this coastal area of Apollonia and the palaeoenvironmental context of the necropolis at Kalfata. Particular attention was paid to the location of the ancient harbours of the city, a question directly linked with the chronology of the sandy isthmus between the historical peninsula and the continent.*

*These studies clearly demonstrate that the region of Apollonia, like the entire Bulgarian coast, does not attest to sea-level oscillations. On the contrary, the important coastal regularisation by infilling of the bays and the formation of a tombolo, such as at Sozopol, reflect the modest role of sea level and the high sedimentary inputs at base level.*

*Keywords: Black Sea, Apollonia Pontica, Sozopol, coast, sea level, tombolo, harbour, Greek colony, geoarchaeology*

La mise en place d'un programme de recherche pluridisciplinaire sur la géoarchéologie de l'ancienne colonie grecque d'Apollonia (Sozopol, Bulgarie) constitue un des principaux volets de la collaboration franco-bulgare lancée en 2002 par le Centre Camille Jullian.

La compréhension de l'évolution géomorphologique de la zone littorale constitue le principal objectif de ce programme. Cette démarche s'appuie sur la reconstitution de la topographie d'Apollonia du Pont et sur celle du cadre paléoenvironnemental de la nécropole de Kalfata. La localisation des ports de la colonie a fait l'objet d'une attention particulière en relation directe avec la chronologie de la connexion sableuse entre la péninsule historique et le continent.

Les observations démontrent que la région d'Apollonia, à l'image de l'ensemble du littoral bulgare, n'atteste pas d'oscillations du niveau marin. L'importante régularisation de la côte par le comblement des baies et la formation d'un tombolo à Sozopol reflète une montée du niveau marin modeste.

Mots-clefs : Mer Noire, Apollonia du Pont, Sozopol, littoral, niveau marin, tombolo, port, colonie grecque, géoarchéologie


**Fig. 1** - Location map of Apollonia Pontica (Sozopol, Bulgaria)
*Source: Baralis, 2011*

The ancient city state of Apollonia Pontica was founded towards the end of 7th c. BC by colonists from Miletus (Strabo, 7, 6, 1 ; Ps. Skymnos, Periegesis, 730) or during the first decades of the 6th c. BC according to a tradition related to the philosopher Anaximander (Aelianus, *Varia historia*, III, 17 ; Baralis and Hermary, 2010). The Greek colony benefited from an exceptional situation, located at the mouth of a deep gulf opening onto the upper plain of Thrace. This position served as a base to gradually extend its influence over a vast region, between the Rhodope and the Balkan mountain range. Apollonia rapidly became an economic and cultural interface with the Thracian hinterland and maintained this role throughout the medieval period.

Our knowledge with regards to the evolution of the historical topography of Apollonia, as well as the main features of the ancient environment of the city and its territory, are very limited. As a result, our understanding was based until recently on a few studies which present controversial methods and conclusions. To shed new light on these questions, a multidisciplinary project was started up by the French archaeological team at Apollonia (headed by A. Hermary), leading to two field campaigns in 2005 and 2006. This work has been complemented by additional analyses financed by the French National Research Agency ("Pont-Euxin", headed by A. Baralis).

The preliminary results shed new light on the coastal evolution of the Sozopol area by recontructing the evolution of the topography of the ancient city and the paleoenvironmental context of the Classical and Hellenistic necropolis at Kalfata (PANAYOTOVA *et al.*, 2006; BARALIS and RIAPOV, 2006). In addition, we investigated the location of the ancient harbours, a question directly linked to the chronology of the sandy isthmus between the historical peninsula and the continent (MORHANGE *et al.*, 2010).

The research was undertaken at various temporal and spatial scales. At a regional scale, the main aim was to reconstruct the mobility of the coastal landscapes around the city of Sozopol during the past 6 000 years, including:

– sea-level changes;
– shoreline modifications and the evolution of settlement patterns;
– environmental potentiality (ancient harbours and the tombolo of Apollonia, peripheral lagoons, sand bars);
– the characterisation of human impacts on the environment (sediment erosion crises etc.).

At a more local scale, we looked to elucidate the relationships between the settlement pattern and the physical landscape, in tandem with the archaeological excavations carried out in the coastal necropolis of Kalfata. The latter allowed the ancient environments to be reconstructed in this coastal area. More precisely, we wanted to answer the following questions:

- What was the physical environment of the Classical and Hellenistic necropolis of Apollonia?
- Where were the ancient harbours of the Greek colony located?

Research relating to sea-level changes at Sozopol is abundant, particularly with regards to the "flooding" of the Black Sea around 7000 years BP (MAJOR *et al.*, 2002; KEREY *et al.*, 2004). This chronology, however, does not take into account the data provided by the sites belonging to the Harmangia culture in the Northern Dobroudga, which already occupied a coastal position at this time as attested by the palaeozoological remains (HAŞOTTI, 1997). An earlier date must not be excluded at this stage. Regardless of this question, several researchers have underlined the existence of recent sea-level oscillations, whilst other scholars propose a more gradual rise during the Holocene. In this sense, SHILIK (1997) has published a composite curve of the sea-level oscillations since 6 000 years. For example, Sozopol and Kiten are characterised by Early Bronze Age layers, 5 to 6 m beneath current sea level (DRAGANOV, 1995). Shilik has called this low sea level (-9.5 m around 4500 years BP) the "Varnian regression" (SHILIK, 1997). He has also identified higher sea levels above present. The first is the "Flandrian" level, about +2 m around 1800-1700 BC. The latter was followed by a "Phanagorian regression", with a range of 10 m, and afterwards by a "Nymphaean transgression" attaining 1 m above present around the 7$^{th}$ or the 8$^{th}$ c. AD. Finally, a "Korsunian regression", 3 m beneath current sea level, characterises the sea-level history of the Black Sea. This reconstruction appears speculative, and is dependent upon many unreliable palaeobathymetric indicators from diverse geological contexts (GERGOV, 2001 and CHEPALYGA, 1984). Several recent studies have shown that sea level was already stable in Bulgaria around 5 000 years ago (PREISINGER and ASLANIAN, 2003 and 2004 ; BRÜCKNER *et al.,* 2010).

Therefore, in a "stable" sea-level context, the most important variable to explain coastal mobility is sedimentary inputs during the past 5 000 years (MARRINER and MORHANGE, 2007). A number of papers have dealt with the study of shoreline variations at Sozopol. These prevent a synthesis of the relationships in this region between the settlement patterns, since the foundation of Apollonia around 610 BC, and the ancient geomorphological dynamics of the coastline. Preisinger and Aslanian (PREISINGER *et al.*, 2001; PREISINGER and ASLANIAN, 2003 and 2004) published maps showing the evolution of the shorelines during the last 7 500 years. Around 3 000 years BP, these authors proposed a shoreline 5 m below present sea level, erasing the depression between the Skamni promontory, which accomodates the Greek port, and the island of St. Cyriaque. They also reconstruct a Thracian breakwater (the Early Iron Age) based on the discovery of stone anchors in this area, and Greek infrastructure off St. Cyriaque (Fig. 2).

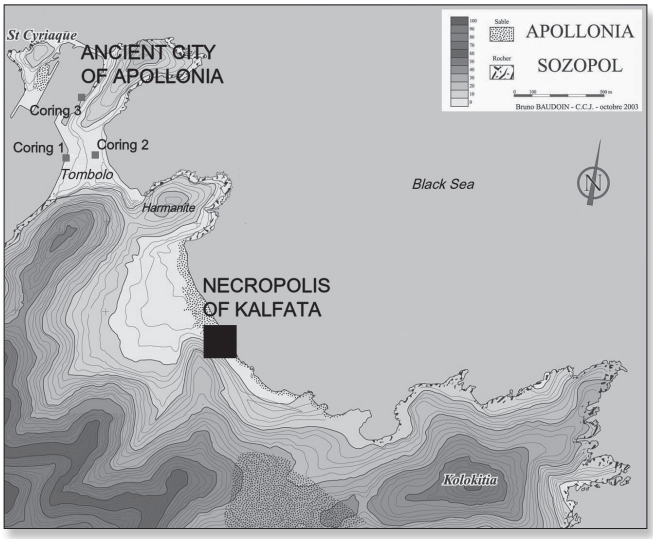


**Fig. 2** - Topography of Apollonia Pontica and the necropolis of Kalfata
*Source: B. Baudoin, CCJ, 2003*

Another aim of this collaboration was to relocate the ancient harbours of Apollonia during the Ionian colonisation. According to the Anonymous Periplus of the Black Sea, the city had two very suitable harbours during antiquity (*Periplus Ponti-Euxini* (§ 85). Thanks to this particularity, Apollonia became an important centre on the maritime trade routes between the Aegean world and the Greek settlements of the northern Black Sea. Several hypotheses have been published, one of them locating the most ancient harbour along the reef in the basin between the island of St. Ivan and the peninsula of Skamni. The latter suggested that the harbour lay at the south-western extremity of the island of St. Cyriaque, in an area open to the swell (Fig. 2). These two hypotheses are not well explained (DIMITROV *et al.*, 1982).

## 1 - Regional setting

Modern Sozopol is built on ancient Apollonia and Byzantine and Ottoman Sozopolis (Fig. 2). The city is located on a peninsula with a N/S orientation. It was an ancient island, nowadays linked to the continent by a sandy isthmus, a tombolo. It is on this tombolo that the inhabitants of Apollonia developed, during the late Hellenistic and Roman periods, the main necropolis of the city. On each part of this peninsula, the south-eastern coast is open to the dominant swell, although the north-western area is better protected by the island of St. Cyriaque. This area appears more suitable for the ancient harbours of Apollonia.

Further south, on the continent, the coastline shows a regular succession of rocky capes and ancient bays, infilled during the Holocene. The latter are isolated by sandy bars, sometimes consolidated by important dune systems.

The site of Kalfata, on the coastline, is located beneath the present sandy bar. The archaeological and geomorphological data show the development during the second half of the 5th c. BC and the first quarter of the 4th c. BC of a landscape similar to the present geography.

## 2 - Methods

Several corings were carried out in the neighbouring bays of Alepou, south of Sozopol, close to the mouth of the Ropotamo River, and of Gerena, further north, between the peninsulas of Skamni and Chernomorets. Our objective was to reconstruct the coastal changes.

Concerning the location of the ancient harbours, corings were carried out in two areas, each a candidate for a protected harbour: (1) on the north-western coast of the promontory of Skamni (Fig. 2, coring 3) in an area well protected from the dominant NE and E winds (POPOV and MICHEV, 1974); and (2) along the western shore of the tombolo, between the centre of Sozopol and its suburb (Fig. 2, coring 2).

At Kalfata, the archaeological excavations provided a whole section of necropolis layers with two very different sedimentary features (GERGOV, 2001), well dated by the pottery and the archaeological structures.

## 3 - Results

Concerning sea-level changes at Sozopol, field surveys show that no visible sign exists for a coastal level higher than present during the Holocene. Indeed, from the Turkish to the Romanian border, no geomorphological (platforms or raised notches) or biological evidence (bioconstruction, biodeposition) has been found above present. Present sea level is therefore the highest of the Holocene. On the other hand, submarine archaeological studies at Sozopol have revealed a layer of wooden posts and fragments, belonging to a settlement of the Early Bronze Age (3000-2800 BC), at about 6 m beneath present sea level (LAZAROV, 1993; ANGELOVA and DRAGANOV, 2003; DRAGANOV, 1995), according to a situation also found at the neighbouring sites of Atya (LAZAROV, 1974), in the mouth of the Ropotamo river (KARAYOTOV, 1990, 1992 and 2002) where the Bronze Age settlement expanded 5.5/5.6 m below the present sea level, and further south at Kiten where the last cultural layer was found at 6.4 m, radiocarbon dated to 2850-2600 BC (ANGELOVA and DRAGANOV, 2003; DRAGANOV, 1995). The Black Sea has logically transgressed these archaeological layers during the past 3000 years.

## 4 - Relative sea-level stability and sedimentary budget since antiquity

The tide-level records at Varna, Nesebar or Burgas, do not show any significant changes since 1948 (BELIASHKI, 1985; BECKER *et al.*, 2002; CAZENAVE *et al.*, 2002). On Kalfata beach, at Sozopol, layers of present-day supratidal sediments seal, for example, graves of the 5th c. BC suggesting the close proximity of the shoreline at this time, as well as a very modest rise in sea level during the past 2500 years. In this context, the sedimentary budget, has contributed to the progradation and regularisation of the coastline. Old photographs clearly show the isthmus between the promontory-island of Skamni and the continent (Fig. 3). It constitutes a tombolo linking Skamni island to the continent, due to wave diffraction and a greater accumulation of sediments in this sheltered area. This accumulation is earlier than the Hellenistic period, because 4th c. BC graves have been discovered on the top of the tombolo, in an area close to the city (TSANEVA and STOYANOV, 1981).

**Fig. 3** - The peninsula of Skamni at the beginning of the 20th century
*Source: Laskaridis edition*

DIMITROV (2004) concludes that the tombolo was built up after the 5th c. BC, when the construction of a pavement road increased the sedimentation in this area. A coring taken next to the church of St. Zosim shows two very different sedimentary features (Fig. 2, coring 1). The volcanic substratum outcrops 8 m beneath the present ground level. This is sealed up with a layer of biodetritic sand and then by 2 m of embankment. In the absence of dates and in comparison with other tombolos, such as Pharos of Alexandria (GOIRAN *et al.*, 2005) or Tyre (MARRINER *et al.*, 2007 and 2008), we can conclude that the short tombolo of Apollonia pre-dates the Greek colonisation and can be linked to the beginning of sea-level stabilisation, around 6000 years BP.

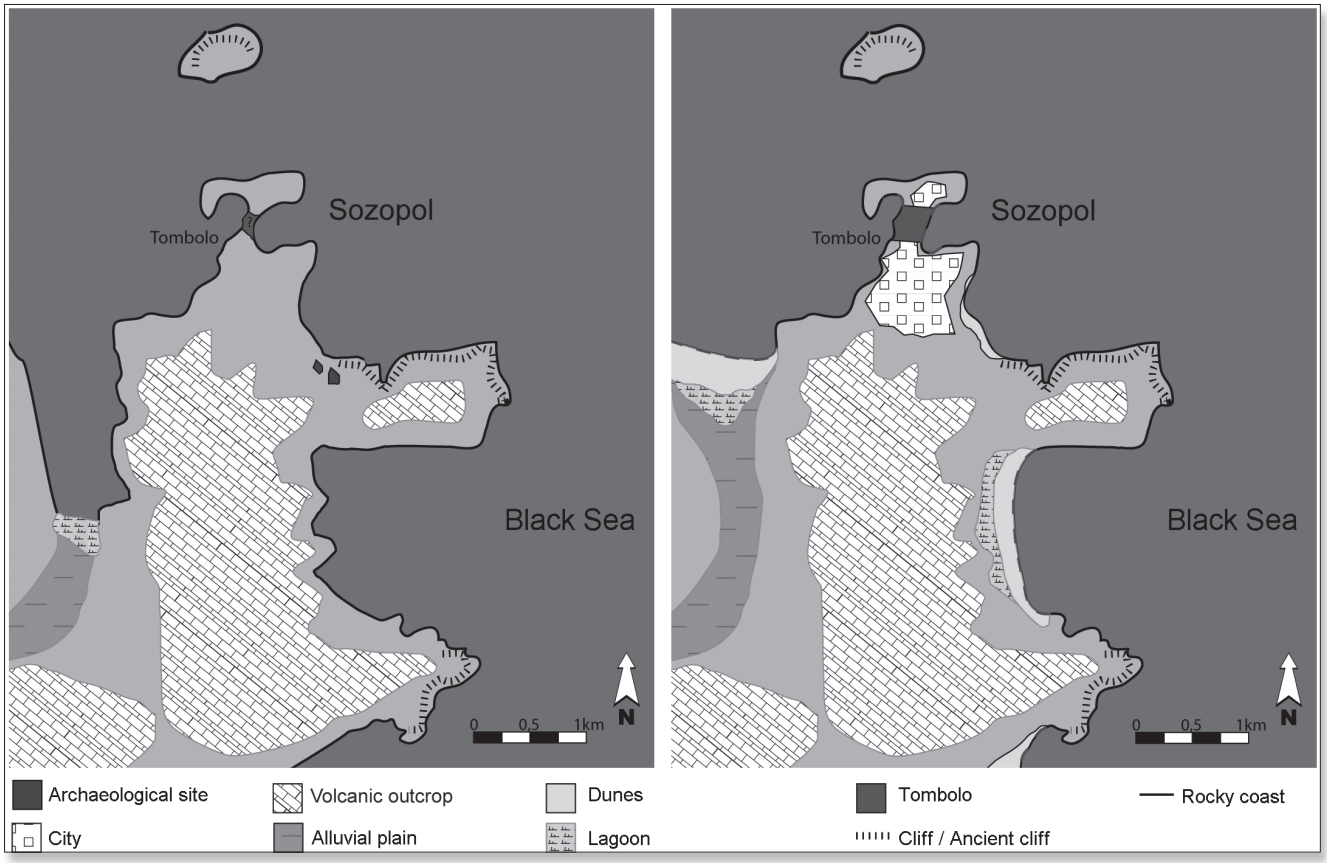


**Fig. 4** - Geomorphological context of the Sozopol region. A: current situation, B: situation around 6000 BP - *Source: Devillers*

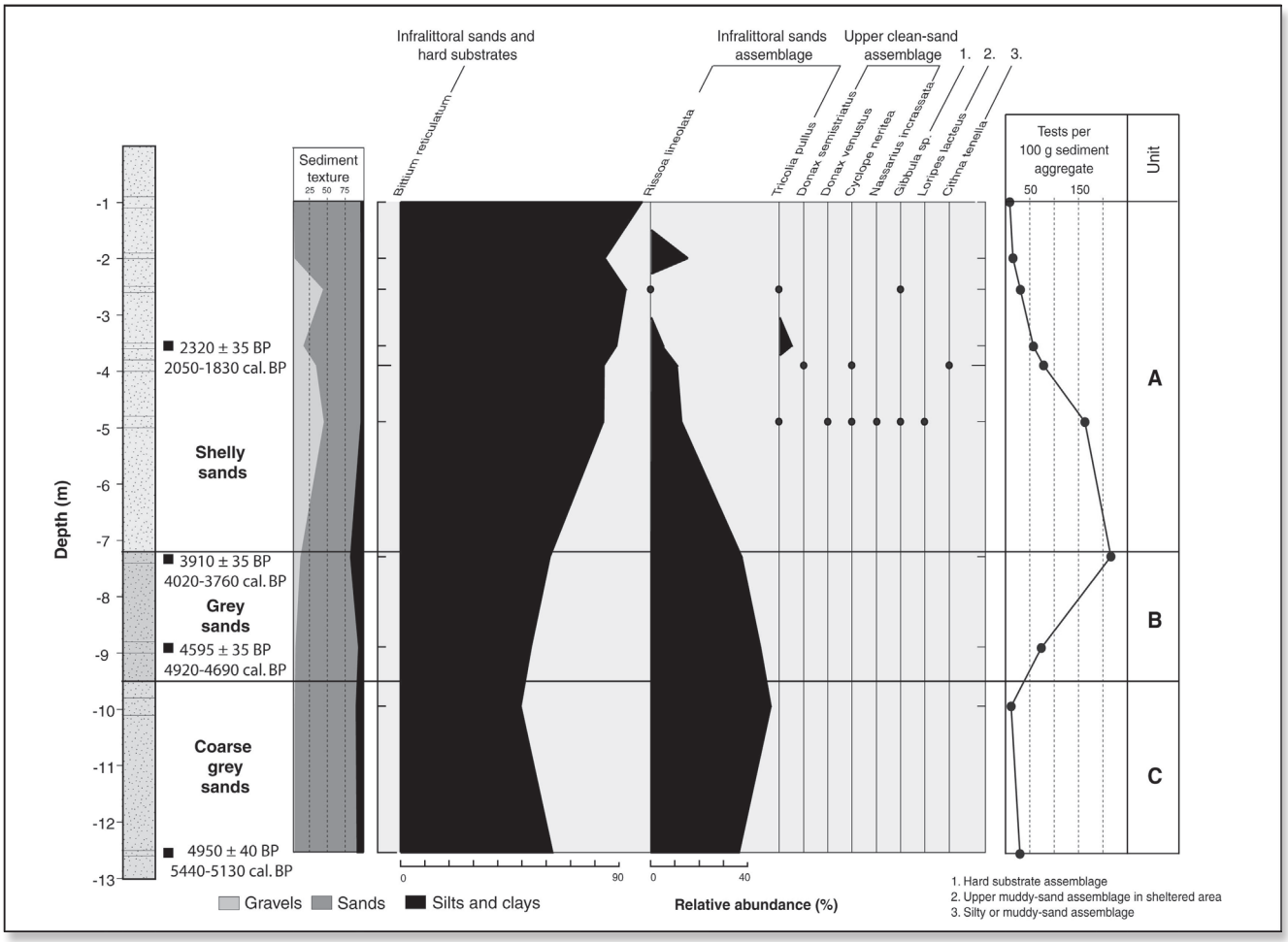


**Fig. 5** - Coring of the N.W. coast of the tombolo, Sozopol, macrofauna- *Source: Marriner*

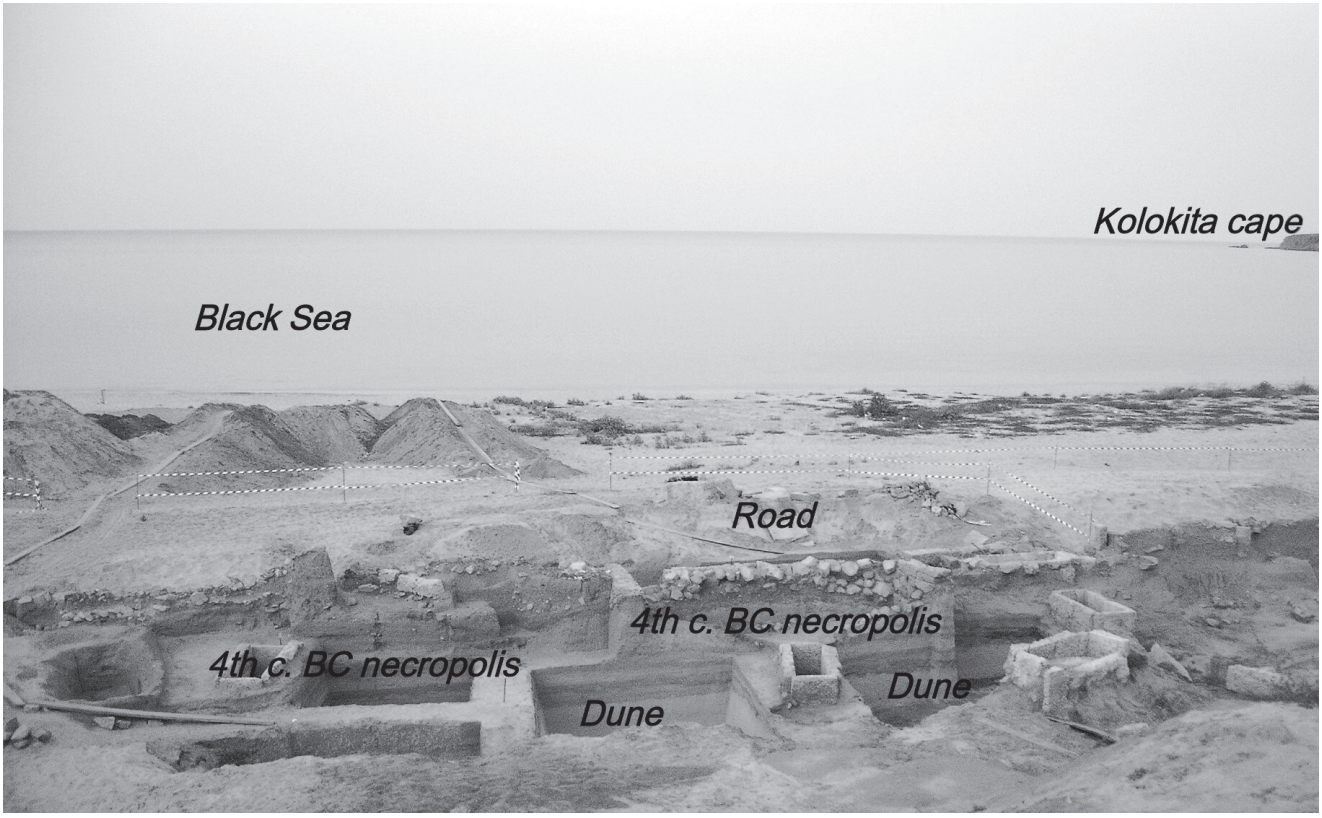


**Fig. 6** - The Classical and Hellenistic necropolis of Kalfata (French area) - *Source: Baralis*

On a more important scale, the city of Sozopol is surrounded by floodplains that correspond to old marine bays. They are consistent with palaeo-lagoons obstructed by coastal bars (Fig. 4). NW of Sozopol, the plain of Gerena-Blatoto corresponds to this type of ancient bay. Further south, the plains of Kalfata and Kavatsite also show a similar morphology which evokes the same process of infilling since around 6000 years BP. Several corings undertaken in the closed lagoon of Arkutino allow us to make comparisons (Bozilova and Beug, 1992). Eleven radiocarbon dates clearly indicate that the sedimentation began around 4000 years BP, suggesting the relatively minor role of sea-level change in forcing coastal change at this time. Evidence for stability is provided by the discovery of a Bronze Age settlement at 5.5/5.6 m beneath the sea at the mouth of the Ropotamo river (Bozilova and Beug, 1992; Karayotov, 2002). Figure 4 shows the transformation of the coastline in the region of Sozopol during the past 5000 years. The important coastal regularisation by infilling of the bays and the formation of Sozopol's tombolo reflects high sedimentary input in the context of relative sea-level stability.

## 5 - The ancient protected harbour of Apollonia

The dominant winds at Sozopol blow from the NE and the E (Popov and Michev, 1974). We undertook a coring on the quay of the present harbour, which is currently protected by the promontory of Skamni. This core was more than 2 m deep and reached the substratum. The top is composed of embankment deposits which grade into coarse sandy marine sediments. These are not associated with low-energy silts, typical of a semi-protected environment. This area comprises an exposed shoreline (e.g. pocket beach), at the bottom of the cliff of Skamni. No causeway appears to have been built between Skamni and the island St. Cyriaque, otherwise the sedimentary context would be confined. In ancient times, the coastline was, like nowadays, particularly limited at the base of the cliff. We hypothesize the existence of a beaching area with vessels hauled onto the shoreline. The ancient protected harbour is therefore not located in this area of the promontory.

The western front of the tombolo appears the most suitable place for a coastal shelter, protected from the E and SE swell by the promontory of Skamni and St. Cyriaque. Moreover, the Chernomorets peninsula efficiently protects this area from the NW swell. A coring carried out in this area yielded three different sedimentary features (Fig. 2, coring 2, and Fig. 5). The core is 13 m long, but does not reach the volcanic substratum. The two basal units, dated between 5000 and 4000 BP, comprise coarse marine sand. Two molluscan species dominate (*Bittium reticulatum* and *Rissoa lineolata*), both characteristic of a sandy sublittoral zone. From -7 m to the surface, the sandy sediment becomes coarser with more shell fragments. The latter represents, between 4000 and 2000 years BP, the summit of the sublittoral zone. This coring proves that the formation of the tombolo is clearly earlier than the 7$^{th}$ c. BC. The sandy isthmus provided the city with easy access to the continent, as well as a harbour basin protected on the NW side. This part of the coast is the best protected and corresponds to the ancient harbour of Apollonia. It comprises an "open" harbour, located on the NW side of the tombolo. In the context of our studies, we did

not find a basin artificially protected by a mole. The beach, located on the NW side of the tombolo, and the foothills of the promontory of Skamni seems to be protected enough to accommodate harbour activities from ancient times up until very recently, as suggested by old photographs (Fig. 3).

## 6 - The coastal necropolis of Kalfata

The site of Kalfata is located beneath the present sand bar (Fig. 2). The installation of the first graves began in this area during the mid-5th c. BC, as an important extension to the south of the Archaic and Classical necropolis located in Harmanite along both sides of a coastal road.

The archaeological and geomorphological studies clearly show that during the last quarter of the 5th c. BC a very active infilling has taken place. We excavated a complete section of the necropolis, in two very different sedimentary contexts**.**

At the base, we observe a dark soil. The aggregates are well developed. The texture is silty-clayish, without any evidence of oxidation (US 640). This dark unit, discovered during the excavations, belongs to an important A1 horizon. No A0 horizon was found. The available sections, not as deep, do not allow other horizons to be analysed. It is probable that this soil represents a Chernozem or a Brunizem. The pedology corresponds to a steppe vegetation in relation with low precipitation, close to 400 mm. The first graves discovered at Kalfata, 2-m long pit graves, have been attributed to the second quarter of the 5th c. BC and were cut into this layer. However, the upper part of many of them were already sanded over showing that the infilling had already begun during the final years of this period (Riapov *et al.*, 2010).

The upper part of the stratigraphy is mainly composed of homogeneous litho-clastic sand (US 218/627). This environment is similar to the present dunes, visible in Kalfata (Fig. 6). The sand is very well sorted. We also observe some biodetritic lenses comprising poorly sorted coarse sands, corresponding to the upper part of the beaches, with possible storm deposits.

These elements allow us to describe a continuous accumulation of aeolian sand in the form of dunes. Some graves, belonging to the first and second quarters of the 4th c. BC, are cut into these sandy levels and are also completely covered by this sand.

The stratigraphy of Kalfata only provides a fragmentary overview of the coastal landscape dynamics in the region of Sozopol. It displays the formation of sandy environments just before the 4th c. BC, corresponding to upstream erosion and probably local agricultural development.

## Conclusions

With regards to the harbour, geomorphological results did not yield any dates from the Archaic period. However, the coring carried out close to the church of St. Zosim indicates that the tombolo still existed a long time before the Greek colonisation (Fig. 2, coring 1). Moreover, the coring carried out shows that the basin, on the NW side of the tombolo, constitutes the most suitable place for harbour activities, sheltered by the spit. Therefore, Apollonia probably did not have an artificially protected harbour. Instead, the inhabitants hauled their boats onto a sandy beach.

Concerning the necropolis of Kalfata, the inhabitants of ancient Apollonia decided, as in other Greek cities of the northern Aegean coast, to use the coast for funeral purposes. Moreover, this proximity directly influenced the main development stages of the coastal necropolis. The sand infilling disrupted the maintenance of this site during the last quarter of the 5th c. BC for which we did not find any material during the excavations (Baralis and Riapov, 2006; Panayotova *et al.*, 2006; Riapov *et al.*, 2010). When the inhabitants decided to re-use Kalfata as a necropolis, the topography had changed. On the shallow slope, located below an ancient cliff, stand dunes 2 m high. The inhabitants decided to use the top of these aeolian formations for the new graves. However, the sandy accumulation did not stop, as shown by the existence of sandy lenses over many graves during the 4th c. BC. Afterwards, the dune cover at Kalfata expanded shortly after its abandonment during the mid-3rd c. BC.

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