

Hermeneutic Cartography for the Restitution of a Lost Antique Seaport: Case of Muslubium Horrea of Bejaia, Algeria

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ABSTRACT

This article deals with the reconstruction of an ancient seaport in the town of Bejaia, known as Muslubium Horrea. This settlement, ignored by the official historiography, would nevertheless have played an important role in wheat exports and trade with the Roman port of Ostia. Moreover, of all the ancient ports known to date, the Algerian coast has only two port warehouses, and Muslubium Horrea is the only granary belonging to the Roman province of Mauretania Sitifensis (400AD). The methodology adopted to locate and reconstruct the topography and the settlement's structures is based on the concept of cartographic hermeneutics. The compilation of existing historical accounts and the interpretation derived from the superimposition of ancient geographical maps and 19th century archaeological and geological maps identified all the natural resources necessary for its construction, in particular the abundance of water sources and deposits of geomaterials for construction (clay, stone, gypse, marble, etc.). These data were confirmed by field and photogrammetric surveys, resulting in a map showing the archaeological context of the Muslubium Horrea port and the remains of structures still visible today. The approach adopted allowed to delineate the size of the port site and scale the structures that make it up, as well as identify the water supply source and its primitive topography prior to its establishment.

JOURNAL OF MEDITERRANEAN CITIES (2024), 4(1), 178-199

https://doi.org/10.38027/mediterranean-cities_vol4no1_11

ARTICLE INFO:

Article history:

Received: July 02 2024

Revised: August 09 2024

Accepted: September 10 2024

Available online: Oct. 12 2024

Keywords:

Antique seaport settlement;
Musbium Horrea;
Cartographic restitution;
Cartographic hermeneutics;
Photogrammetry.

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1. Introduction

Nearly 6,000 ancient coastal settlements have been identified worldwide to date (De Grauw, 2022). The archaeology of Mediterranean ports has changed significantly over the last thirty years, since the discovery of several archaeological excavations (Morhange, 2014:12), including the antique ports of Narbonne, Marseille and Egypt. However, the exact location of some abandoned ports often remains unknown, due to the complete transformation of the environment caused by the large deposits of ancient alluvium and/or the erection of buildings on the sites. However, a great deal of scientific work is still being carried out to date on the location of former ports that have disappeared.

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How to cite this article:

Manel, O. L., & Ahmed, B. (2024). Hermeneutic Cartography for the Restitution of a Lost Antique Seaport: Case of Muslubium Horrea of Bejaia, Algeria. Journal of Mediterranean Cities, 4(1), 178-199. doi: https://doi.org/10.38027/mediterranean-cities_vol4no1_11

A number of authors have attempted to define criteria for locating antique ports (Mauro, 2019). Some authors have applied geomorphological criteria (topography, sediments, bays and coastline). This is the case, for example, of the underwater discoveries and the location of the port of Missua (Sidi Daoud) in Tunisia, which was carried out through geo-archaeological and paleo-environmental research, (Trabelsi, 2019: 2). The combined studies of coring, high-resolution sedimentary studies as well as archaeological prospecting have identified several port basins comprising the port of Missua. Research into the identification of the ancient topography of Narbonne's ports, through which the geomorphological conditions and layout of the ancient settlement were determined using geotechnical drilling, archaeological documents and underwater excavations (Ambert, 2000: 295). Nautical aspects, in particular navigation, ships and the flow of goods, have received little attention in the literature (De Grauw, 2022). With the exception of a cartography locating the antique ports used as relays for the various commercial exchanges in the Mediterranean, based on the analysis of historical documents through which the itineraries as well as the speed of the routes, the flows and the navigation seasons were reconstructed (Arnaud, 2005).

This article relates to the rediscovery of an ancient port in the town of Bejaia in Algeria. This port settlement mentioned as Muslubio Horrea or Muslubium in ancient maps and located on 19th-century archaeological maps. This port was considered a granary that played an important role in trade with the port of Ostia (Rome) during antiquity and was very active during the Severan era (Gallico, 2020:100). The port of Muslubium dates back to a period yet to be defined (antique or earlier).

The rediscovery of this site in 2022 is the fortuitous and fortunate result of research devoted to the reconstruction of Bejaia's port landscapes. An exploration of the entire northern zone of the Babors (study area from Aokas to Melbou) led to the identification of archaeological ruins and the discovery of artefacts on the Andriach plateau (French name). This site is presumed to be the site of the Muslubium settlement, which had not been found since it was published by A. Poulle during his exploration of the area in 1858.

The aim of the research work undergone is to geolocate the port and all its structures, to reconstruct its primitive topography, and also to estimate its approximate size by incorporating evidence of daily life, in particular the artefacts found on site.

A number of hypotheses have been put forward concerning the Muslubium settlement, including that it was made up of several entities (such as the port, the granaries, a village and ceramic manufacturing workshops), and equipped with important hydraulic systems for supplying water to the entire settlement and for irrigating the surrounding land. The potential of the topographical site, in terms of its geographical location, geological nature, and the existence of mineral and plant resources within a radius of less than 10 km, suggest that these vital potentialities contributed to the choice of the Muslubium Horrea facility.

To locate Muslubium and recreate its topography, urban layout and architecture, geo-referenced locators and modern surveying methods (drone) were exploited, in conjunction with in situ archaeological excavations, exhumation of the remains of structures and their constituent materials and artifacts. The results were then analyzed and hermeneutically validated.

1.1. The lost antique seaport of Muslubium Horrea

The site, buried under ancient deposits of alluvium and sand, on which a few modern buildings have been erected, and of which very few structures remain visible today, is unfortunately unknown in the historiography of the town of Bejaia. As a statement, this site is not part of any conservation operation. It is true that for more than 1,500 years, apart from the antique maps showing the granaries of Muslubio (Muslubium, Muslubium Horrea), no document mentioned this site, either in writing or on maps. It was not until the 18th and 19th centuries that archaeologists were able to identify its existence on maps.

However, the site was not covered by the extensive archaeological exploration work carried out as part of the 1911 Archaeological Atlas of Algeria (Stéphane Gsell, 1911). Various results of scientific investigations relating to a few rare sources and revealing the approximate location of the port as well as the identification on a map of its existing structures were published during the French colonial period.

It is important to point out that exploration of this area was very superficial and that no topographical representations or archaeological excavations were undertaken during the French colonial period (De Mannert 1849. Poulle, 1858). To date, this immense port settlement covering more than 800 hectares unfortunately remains Terra incognita and deserves to be rescued from oblivion.

2. Study area and methodology

The study area corresponds to the site of the port establishment from the plateau known as Andriach or Sidi Rehane, and its entire extent as far south as the Kefrida pass, covering an area of 800 ha. The area is located in the commune of Aokas, 25 km east of the capital of the wilaya (department) of Bejaia. The aim of this research is to study all the discoveries made in this area in terms of structures, materials, fragments, etc. The methodology adopted in this research consists of an on-site investigation based on the study of archaeological remains still visible or discovered by exhumation and their photogrammetric recording. This in situ investigation is combined with a hermeneutical approach to support the results obtained by interpreting the contents of ancient maps and accounts. In order to locate and reconstruct the remaining visible architectural structures of the port, as well as to restore its initial topography, two studies were carried out and their results cross-referenced. The first study involved exhuming and surveying the site using aerial photogrammetry (using a drone) (Figure 1).

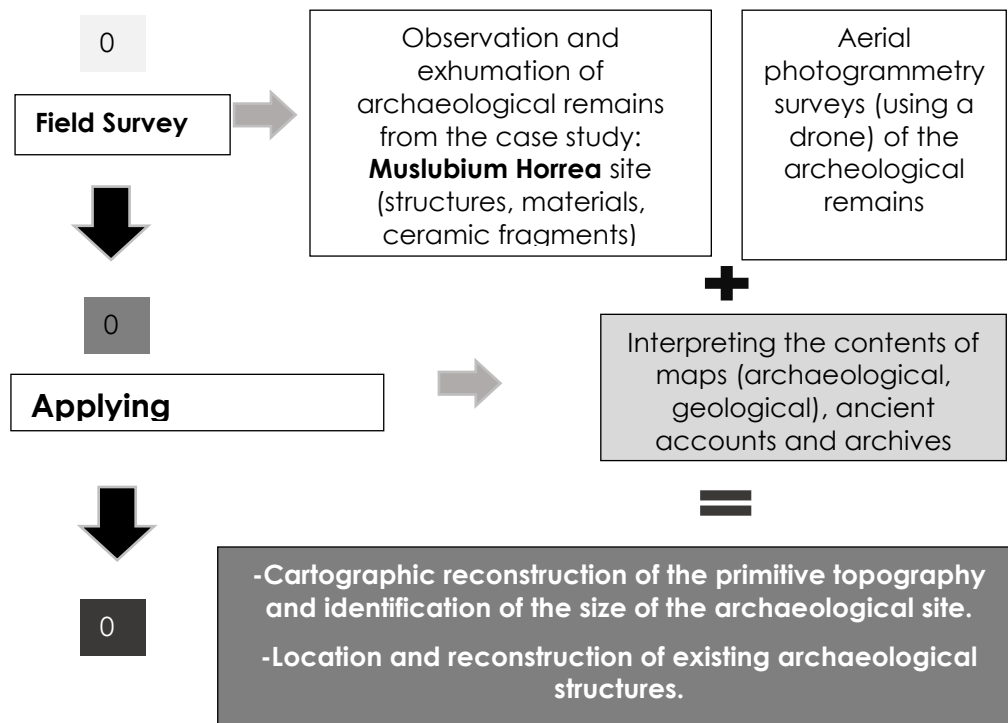


Figure 1. Structure of the study

Photogrammetry is a sophisticated means of safeguarding and transmitting the real and material values of sites of historical importance. It is the art and science of deriving highly accurate metric and descriptive information about three-dimensional objects from a number of analogue and digital images (AL-Ruzouq, 2012: 97).

The aerial photogrammetry was developed from various shots taken in 1960 by a French aircraft equipped with an RMK 30 reference camera at a scale of 1:25,000 (acquisition of ortho-photos by INCT, 2023). More recent images were captured by a drone overflown in May 2024 at two different heights, 64 m and -24 m (measured from my own position, towards the bottom of the pass of Kefrida ravine, giving a level of 667m above sea level.), in full HD 1080/1920. The both old and recent images were employed to analyze the current topography and compare it with the old images, as well as to measure the visible archaeological structures. This method was applied to provide precise metric information for mapping and locating all the archaeological finds.

Verification of the Muslubium's location and determination of the original topography of the natural landscape is achieved by hermeneutics. As a reminder, hermeneutics is the science concerned with the correct explanation of texts, firstly the Bible, then other texts and works of art (Palavestra 2011). It would be the method of understanding the contents of ancient documents such as texts and images and giving them the possibility of speaking and revealing the meanings that would interpret invisible experiences. For Heidegger, this possibility of speaking is given only to the person who advances to meet them, in search not of the thought they contain but of the vital experience they make possible' (Zarader 1990: 23), in other words to the interpreter who undertakes to apply them. Hermeneutics is an approach used to understand the different layers that make up historical landscapes that are bound to evolve, by interpreting the tangible elements visible through time (Redzinska et al., 2022). The desire to understand the different layers of a historic landscape therefore means understanding the imaginary of that landscape, which is already 'discursible' (Corboz, 2009: 74). Interpretation in archaeology is always hermeneutic; in archaeological interpretation, what people thought in the past from the present is assumed to be the appropriate context (Johnsen et al., 1992: 432).

This understanding can be apprehended through three dimensions, which are architectural, scriptural or pictorial [...]. To these three dimensions is added an abstract part, a signifier of sorts (Morisset, 2011: 45), which is what was applied here in the hermeneutic analysis through the interpretation of architectural remains, texts and maps.

Hermeneutics was applied by targeting literary and cartographic sources, as well as French archives whose contents would reveal information of a descriptive or typological nature, with regard to the location of the structures of the Muslubium Horrea settlement, and the topography of the site, which would provide verification in support of the two sources retained in this research, in particular the works of Stephane Gsell (1919) and Jean Pierre Laporte (2017).

It should be noted that, in addition to the two main sources selected for this research, this approach was also based on an exhaustive literary compilation of all the sources relevant to the research problem, and a targeted cartography. A literary corpus was compiled, consisting of nine memoirs and collections by scientific explorers dating from the period between the 18th and 19th centuries. For the cartographic corpus, three antique maps (Table de Peutinger, Anonymous map of Ravenna and antique maps from Samuel Butler's Atlas 1902), a dozen maps drawn up by French explorers, an archaeological map by S. Gsell's archaeological map of Bougie (1919) (Sheet No. 07) at 1:200,000, the geological map of Ziama No. 48 of 1925 at 1:50,000, the fieldwork for which was carried out by Dussert and Brives of Algeria's geology department. And the acquisition of aerial photographs of the Aokas area dating from 1960 from the Institut National de Cartographie et de Télédétection (INCT) of Algiers.

3. Results

3.1. Geographical data

3.1.1. The settlement of Muslubium Horrea on maps

On the Peutinger Table (Tabula Peutingeriana), a 13th-century copy of a Roman map of the entire Roman Empire, Muslubio Horreta (Figure 2) is shown to the right of the colony of Saldas (or Saldas Colonia, the antique name given to Bejaia). On the map of northern Roman Africa in Samuel Butler's 1902 atlas, Muslubium (Horrea) is geographically positioned at latitude 36 50 N and longitude 4 30 E (Butler, 1902), (Figure 3). Between Choba Municipium (now Ziam Mansouria) and Saldas, the ancients also mentioned a station that Antonin's Itinerary calls Muslubio Horreis (Henri Fournel, 1850). The Peutinger Table describes it as Horreta, but it should have read Horrea, a word designating a grain shop, and there was no information on this place (Duesberg, 1842). The location of Andrianch (Musbium Horrea) in relation to Bejaia (formerly Bougie) is at most 30 kilometres and there are 13 or 14 kilometres from the latter point to Ziam (i.e. approximately 44 kilometres from the first of these localities to the last, which represents 29 or 30 miles, i.e. about half the distance marked by the roads) (Pouille, 1858).

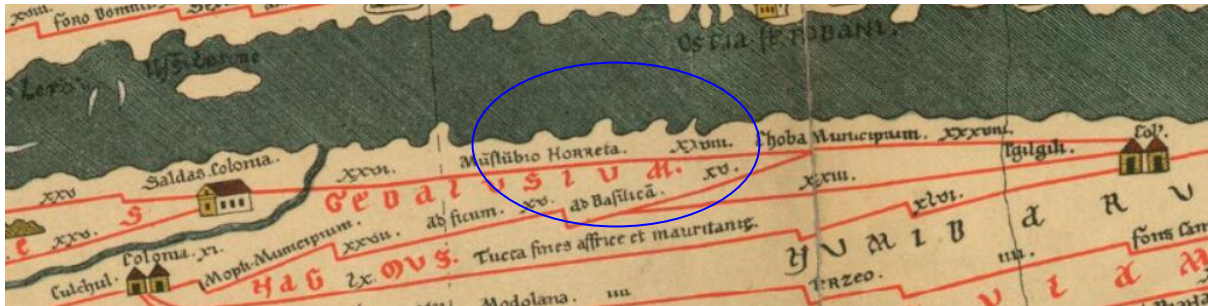


Figure 2. Muslubio Horreta next to Saldas Colonia, inscription on the Peutinger table. Konrad Miller's 1887 facsimile (Otto Maier (Ravensburg, 1888) available online at Gallica:

<http://catalogue.bnf.fr/ark:/12148/cb4>

In a geographical, administrative, postal, statistical and archaeological dictionary published in 1869, the authors place the considerable ruins of Antonin's Muslubium 4 km from Mansouria (J. Adolphe et al., 1869). On the map of the cartographer Guillaume De Lisle in 1726, the Anonymous of Ravenna places Muslubium and Horrea between Choba (Ziam) and Saldas (Bejaia). He places the granary and port of the Roman village Muslubium, which was a Municipium on the same level as Choba, at an equal distance from Choba to Horrea and from Horrea to Muslubium (Figure 4).

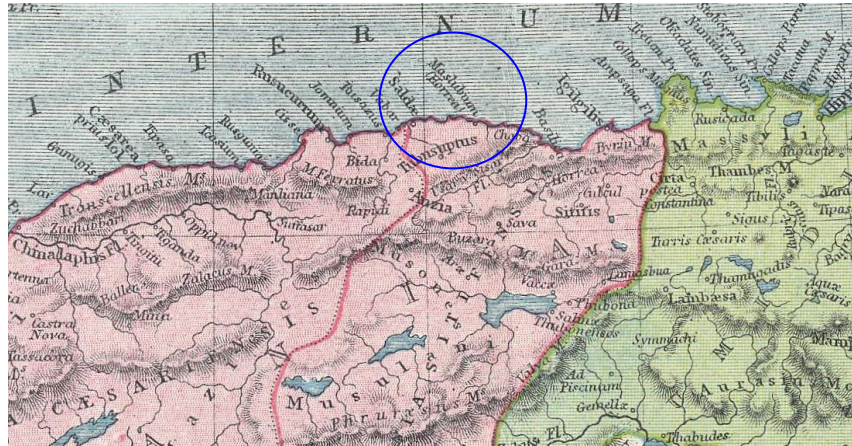


Figure 3. Muslubium Horrea on the map of northern Roman Africa in Samuel Butler's 1908 atlas. Available online at Gallica: <http://catalogue.bnf.fr/ark:/12148>

The main source for locating Muslubium Horrea is the map on sheet 07 of the archaeological atlas by Stéphane Gsell (1911), a French archaeologist and historian specializing in Roman Africa. He explored the entire area and produced a 1:200,000 map (Figure 5) on which numbers indicate antique ruins all along the northern slopes of the Babors near Cap Aokas. The map shows that from number 57 to 63 lies the entire length of the antique port of Muslubium, from the port to the water source tapped by the founders and known as 'Aqua Frigida'. On his map, Gsell indicates the position of Muslubium in an uncertain manner, since it is accompanied by a question mark.



Figure 4. Muslubium Horrea or (Musluviom Orea) on the anonymous map of Ravenna reproduced by cartographer Guillaume De Lisle in 1726. Available online at Gallica: <https://gallica.bnf.fr/ark:/12148/btv1b52519327v/f17>.

In the work of Jean Pierre La Porte in 2017, Muslubium is located 25 km west of Bejaia (Bougie), and 3 km south-east of Cap Aokas. This location supports S. Gsell's hypothesis, as well as the superimposition of the three names given to the site in antiquity, during the colonial era and today: Musluviom, Andriach and Sidi Rehane. The port is thought to have been silted up by alluvial deposits carried by the Agrioune (to the east) and Oued Soummam (to the west) rivers on either side of the site (La Porte, 2017: 25), which have been deposited since ancient times, detaching the promontory from the sea in a tongue of sand 600 m wide and more than 10 km long (Khelifa, 2006: 418).

In Stone's (2014) location of the various ports with man-made harbour structures in North Africa, Muslubium is in 'C' (Figure 6). According to S. Trabelsi, Muslubium could be classified in the group of

medium-sized ports, which does not correspond to the merchant ports Stone (2014) and S. Trabelsi (2019). However, the export function attributed to Muslubium, with reference to the mosaic in Ostia's Piazza di Corporazione, classifies the port of Muslubium as one of the large merchant ports.

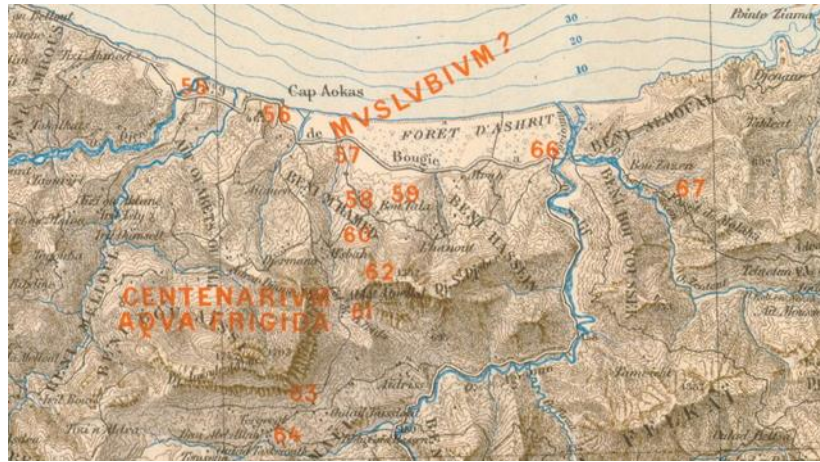


Figure 5. Uncertain location of the Muslubium on S. Gsell's archaeological map (Sheet no. 07. The Archaeological Atlas of Algeria, 1911).

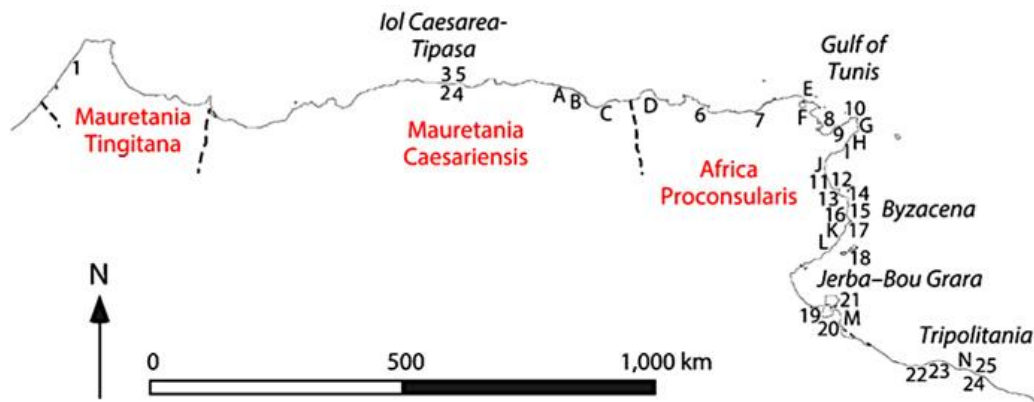


Figure 6. Muslubium from the location of different ports with artificial harbour structures in North Africa (C). (Stone, 2014: 573)

3.1.2. Communication with the port of Ostia

The term *Horrea* refers to a storehouse or granary for storing wheat, and the port, which was very active in antiquity, had to export goods (wheat, wine, oil) from the inland plains, particularly Ain Roua, hence the name 'Horrea' (La Porte, 2017: 26). Some of the foodstuffs brought into the country's granaries and shops in this way was intended for the upkeep of the troops of the occupying corps; another part was distributed to civil servants as remuneration and for the upkeep of their staff in proportion to their rank, and finally the largest part was sent to Rome, to Ostia in particular (Marcus, 1842).

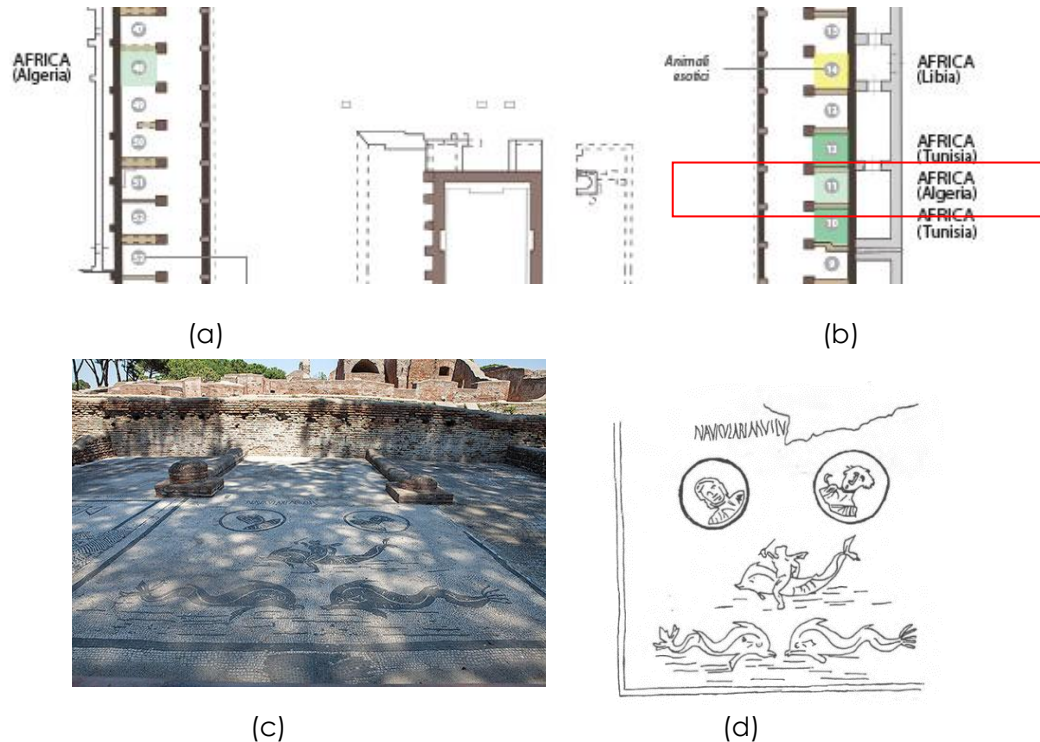


Figure 7. Guild square in the port of Ostia (a), station no. 11 for Muslubium. Mosaic of station no. 11 (c). and drawing by J. P. La Porte (2017) (d) Source: Roman ports, 2016. <https://www.romanports.org/fr/les-ports/298-muslubium-algeria.html>

According to the geographical database of ancient ports compiled by De Graauw in 2014, there are no fewer than 74 ancient ports in northern Algeria, including those modern or identified from a nautical point of view mentioned in ancient writings (De Graauw et al., 2014). Muslubium is identified on the aforementioned database under the number 4219 with geographical coordinates 36.62985° N and 5.26162°E. However, as a warehouse port, there are only two on the Algerian coast, namely Muslubium and M[auretania] C[aesariensis] (Gallico, 2020:100).

In terms of its commercial function, Muslubium was considered as being a real merchant port and a facility with a significant Mediterranean influence compared with other ports, since exports were made to Ostia. In fact, in Ostia, nine out of thirty-one agencies in the guild square were African (Romanelli 1960), and two were Algerian. This is evidenced by a mosaic laid in the Piazza dei Corporatori at no. 11 around 200 AD, the presumed office of the Muslubium shippers in Ostia, on which Muslubium naviculars were depicted, adorned with two medallions, each with a bust of a lover riding a dolphin, and two other dolphins (La Porte, 2017: 26) (Figure 7).

3.1.3. Communication roads

Despite the location of Saldæ (Bejaia), the Romans, in accordance with their traditions, endeavoured to open up the site as much as possible by tracing routes to Roman cities (Comolli, 1997: 98). During the colonial period, five communication routes were recorded linking Saldæ to inland and coastal towns in Setifian and Caesarian Mauritania. However, the two main routes linking the port of Saldæ to two other ports Tubusuptu (river port: Laporte, 2017) and Muslubium (maritime port), both located at a distance of 25 km (Figure 8), Tubusuptu to the south and Muslubium to the east, will be retained.



Figure 8. Commercial route from Muslubium (Andriach, Sidi Rehane) to ad Horrea (Ain Roua, Setif) during Antiquity. On a map of Roman roads ; (Dépôt de la guerre. Function undetermined (France) 1843. Essay on Algeria during the Roman Domination.

These two stations were linked to inland towns for the supply of merchant goods from the starting point called Horrea (Ain Roua) located on the high plateau of present-day Setif and renowned for the quality of its seeds and a fish-based sauce (La Porte, 2017), including:

- Coastal route to the east: linking Saldae and Igilgili (Jijel) via Muslubium,
- Route to the south - east Sitifis (Sétif): Muslubium is linked to the Roman cities to the east by the route that passes through: Centenarium Aqua Frigida- Ad Olivam - Ad Lesbi and Ad horrea (Ain Roua). All these routes were dotted with military posts, which were judiciously placed (Comolli, 1997).

From Muslubium onwards, five posts were recorded on the road to Horrea, stretching as far as the Kefrida pass. Four posts at intervals of 1,000 m but at different altitudes in 58, 60, 61, 62.S. (Gsell, 1919). In addition to these four posts, the 1:50,000 map (Figure 9) identifies an R.R. (Roman Ruins) between 58 and 60 at a distance of 1,000 m from the two points. In terms of altitude, the five points are located at the following altitudes: pt. 58 on 120m, pt. R.R. on 230 m, pt. 60 on 500 m, pt.61 on 787 m, and pt. 62 on 1364 m.

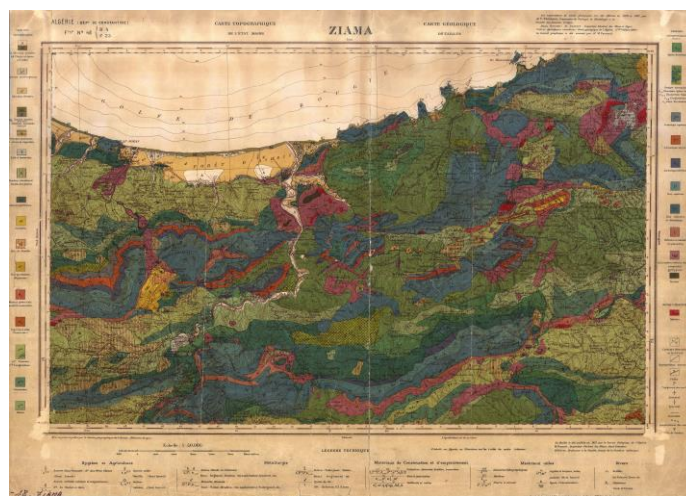


Figure 9. Detailed geological map of Ziama No. 48 of 1925 (1:50,000). Fieldwork carried out by Dussert and Brives of Algeria's geology department. Map acquired from the Bejaia hydraulic services, 2023.

3.2. Ancient geomorphology and topographic reconstruction

The ancient configuration of the coastline is characterised by a crescent-shaped cove facing east and southeast and a high, prominent promontory providing a relatively well-sheltered anchorage from the prevailing northerly winds. As the seawater beat against the rocks at the foot of the promontory, the cove was shallow, less than 7 m deep according to the contour line. On the 1:50000 geological map of 1925, the legend indicates recent alluvial deposits. The mention R.R (Roman ruins) on this map and the mention 59 on the Gsell map indicate a port infrastructure 800 m east north east of Bou Tala, which today indicates the position of 36.622707° N and 5.265324° E, on a height of 6 m above sea level. This structure, described as an antique castle on the plain, represents a port infrastructure given its position. Nearby, there is a 150m long and 70m wide hill reservoir (the result of digging by farmers, who now use the water for watering and irrigation). This reservoir could refer to the existence of a Roman pond or fishpond. Could this antique castle on the quayside be the lighthouse of the port of Muslubium?

According to the 1:50 000 geological map, the Andriach plateau is made up of Valanginian Hauterivian in the north and east, marine deposits in the west and ancient deposits in the south. This spur rises to a height of 50 m in the north, before widening and rising towards the south to an altitude of 57 m above sea level. The rocky spur, which is made up of a single layer of Cretaceous limestone, can be used for construction purposes, according to the data on the 1:50,000 geological map, which is made up of siliceous schist and marl-limestone that are very hard and break up into large slabs, slabs and platelets. Data collected in the field revealed that at the foot of the plateau, evidence of stone extraction, grooves and blocks squared off in tiers are now visible on the northern part of the rock (Table 1).

Table 1. Data collection.

<i>Topography</i>	<i>Ancient geomorphological description as described in texts</i>	<i>Field illustration</i>
<i>The Andriach plateau (Sidi Rehane, Muslubium)</i>	1-The rocky spur widens as it rises, forming a small plateau known as Andriach. 2-A knoll that forms the last ring of foothills descending from the Babors range. 3- A clump of centuries-old aspen trees at the foot of the mound. 4- At the foot of a high cape on the edge of the sea (1869 by J Adolphe). 5- In Antiquity, the sea beat against the foot of the mountain.	 Evidence of stone quarrying on the northern part of the rocky spur.
<i>Port plain</i>	-The bay was covered by the prevailing winds -The waters of the sea beat against the foot of the mountain.	 Freshwater reservoir to the east of the rocky outcrop

Apart from the rocky, ancient part, the ancient marine deposits are thought to be fill brought in by the founders of Muslubium to raise the level of the rock so that they could build on it. for this reason, a remainder of this article, the term retaining wall is used, alternating schistose boulders, instead of enclosure wall. The composition of the wall blocks confirms this hypothesis. The morphology of the

plateau was transformed at the time of the first settlement by the raising of the southern part by around 7 m of marine sand fill (see profile in Figure 10).

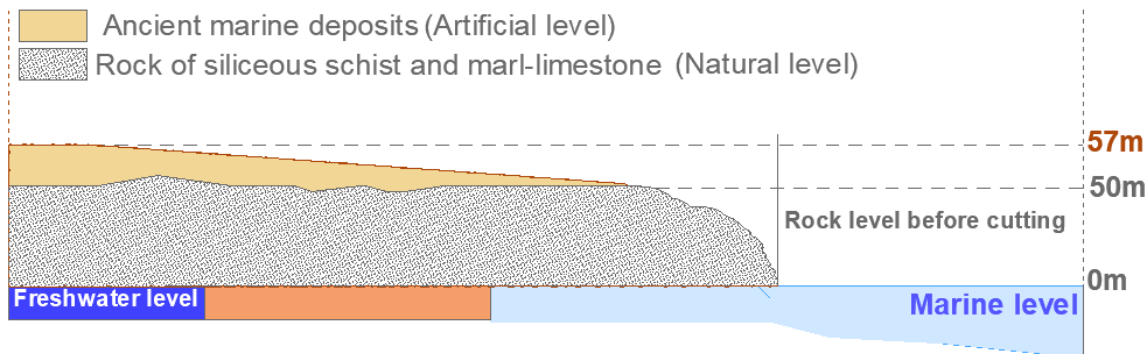


Figure 10. Restitution of the original topography before the Muslubium was built.

3.3. Graphic restitution of the urban extent of the Muslubium port settlement

Given the vast extent of the port settlement, the site has been divided into two areas according to the proximity of the visible structures found on site:

Site 01: this area includes the Andriach plateau, where surviving retaining walls, the ashlar field and fragments of solid brick retaining walls were found. The area is strewn with ceramic debris, amphorae, crockery, tiles, bricks and mosaic shards.

Site 02: checkpoints, aqueducts, Aqua Frigida spring and the Centenarium. This area represents the water supply site from the Aqua Frigida spring, as well as the checkpoints (forts and posts) for the roads leading to Horrea and Sitifis. As well as the aqueduct served to supply Muslubium. Figure 11 shows the profile of the two sites 01 and 02, covering an area of 800ha, with their altitudes.

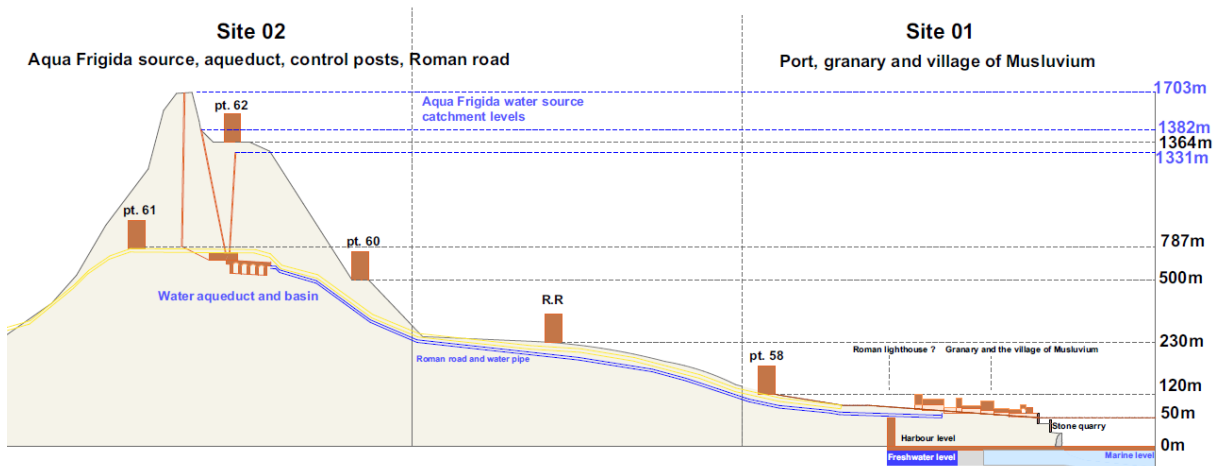


Figure 11. Extent of sites 01 and 02 on longitudinal profile with elevations

3.3.1. Site 01: Infrastructure, land use and activities

From all the texts analysed, the landscape structures making up the port settlement of Muslubium could be identified by recording the different names that could be given to each infrastructure, their function

and their geographical location. The map above shows the extent of the settlement as described in the texts and on the archaeological maps. Figure 12 shows a bird's-eye view of the extent of Site 01.

On a recent nautical map produced by SASPlanet (Geospatial Tool version 2019), a Russian program designed to view and download high-resolution satellite images (downloadable free of charge from the internet), this map shows an underwater bathymetric survey, and in the area of site 01 a submerged structure extending from the port can be seen. Could this be one of the artificial quays in the port of Muslubium?



Figure 12. Site 01, partial view of the Sidi Rehane (Andriach) site (taken from the northeast by drone at an altitude of 100 m).

Table 2 summarises the descriptions of all the architectural and urban structures found on site, as well as their hypothetical functions according to the texts of various authors (Fournel, 1850), (Pouille, 1858), (Bugnot, 1867), (Adolphe, 1869), (Gsell, 1919), (La Porte, 2017).

Table 2. Collected descriptions in texts

<i>Infrastructure</i>	<i>Land use</i>	<i>Activity</i>
-The ruins of an antique population center -The most important antique center between Choba and Saldae -Station - Large enough for a small village and the Administration's granaries -Roman village No. 57 on the map by S. Gsell.	Plateau of Andriach.	Village and attic (living and storage)
Port No. 58 on the S. Gsell map	On the plain below.	Sea transport of wheat to Ostia in Italy.
-Rampart	The perimeter of the	Supporting the

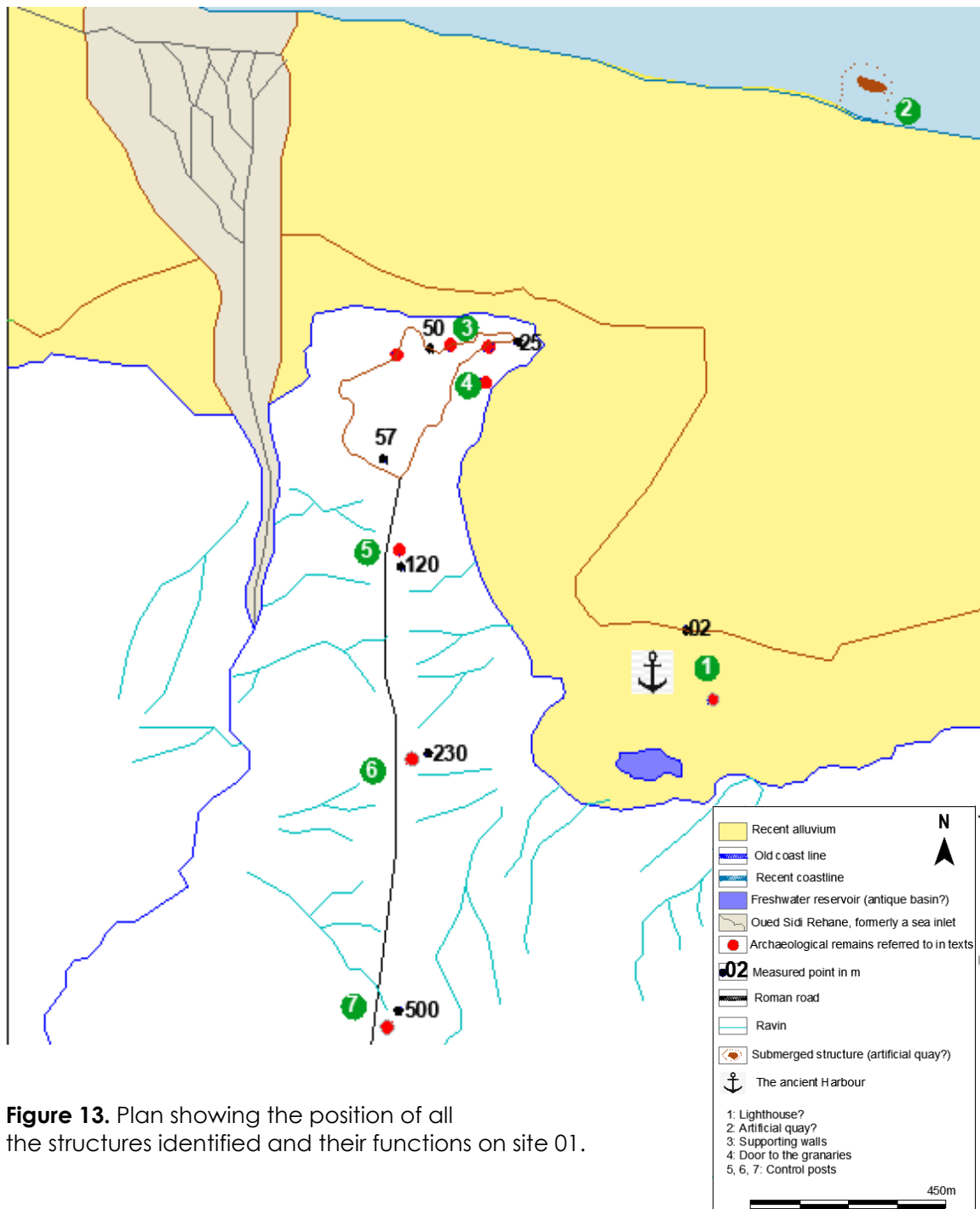
-Enclosure No. 57 on the map by S. Gsell	Andriach plateau follows the sinuosities of the plateau.	embankments of the rocky outcrop.
Antique castles in ruins. N° 58, 59, 60 on the map by S. Gsell	On the eastern plain and in the Kefrida mountains: one on Ablat Amelal at an altitude of 1,364 m, the other below on Mesbah at an altitude of 787 m.	-A lighthouse? Protection posts on the Kefrida pass road.
Horrea, ksar or granary, old fort N° 57 on the map by S. Gsell	High up on the set	Granary for storage
Roman road From 57 to 61 on the map by S. Gsell	From here, an ancient Roman road leads to Setif, which runs along the right bank of the Oued Sidi-Réhane and climbs straight up to the south with this stream, which it crosses at its source at the Col de Kefrida.	Muslubium communicates with Ain Roua (Horrea) and Setif (Sitifis).

As a first result, a map was produced by combining field data with hermeneutic data, showing the position of all the structures identified and their functions on site 01 (Figure 13).

3.3.2. Nature of the ramparts

In the texts compiled, the authors speak of ramparts that follow the sinuosities of the plateau (Figure 14). Surprised by the state of preservation of a large part of the ramparts in 1858 (Fournel, 1850 and Poulle, 1858), they give a brief typological description of the wall, in particular: 'built of blockwork alternating with ashlar chains. Surveys carried out on site 01 in 2023 and 2024 uncovered fragments of walls made of alternating ashlar blockwork that were still homogeneous on the northern slope. This technique, known as Opus Africanum, is made up of vertical or horizontal chains of large blocks joined to the rubble filling, which may have been laid with live joints or clay mortar, (Adam, 1995). This process evolved over the centuries, with the use of lime mortar in the 2nd century BC, and the shape of the rubble stones joined with lime mortar was simplified (Adam, 1995: 130-131).

The drone surveys carried out on May 2024 and the superimposition of 27 old and recent aerial photographs (from 1960 to 2024) revealed the alternating and parallel succession of the same wall at two different heights (see profile, Figure 15). In other words, the hill (the plateau) is made up of three terraces supported by the opus africanum retaining wall, and each terrace has a platform that cannot be detected visually (Ouaret Ladjouze, et al. 2024). Some of the blocks are parallelepipedic (80 x 50 cm) or cubic (50 x 50 cm). Towards the north-west (Figure 16), a fragment of wall still has a brick bond above which a glazed floor tile measuring 25x25cm.



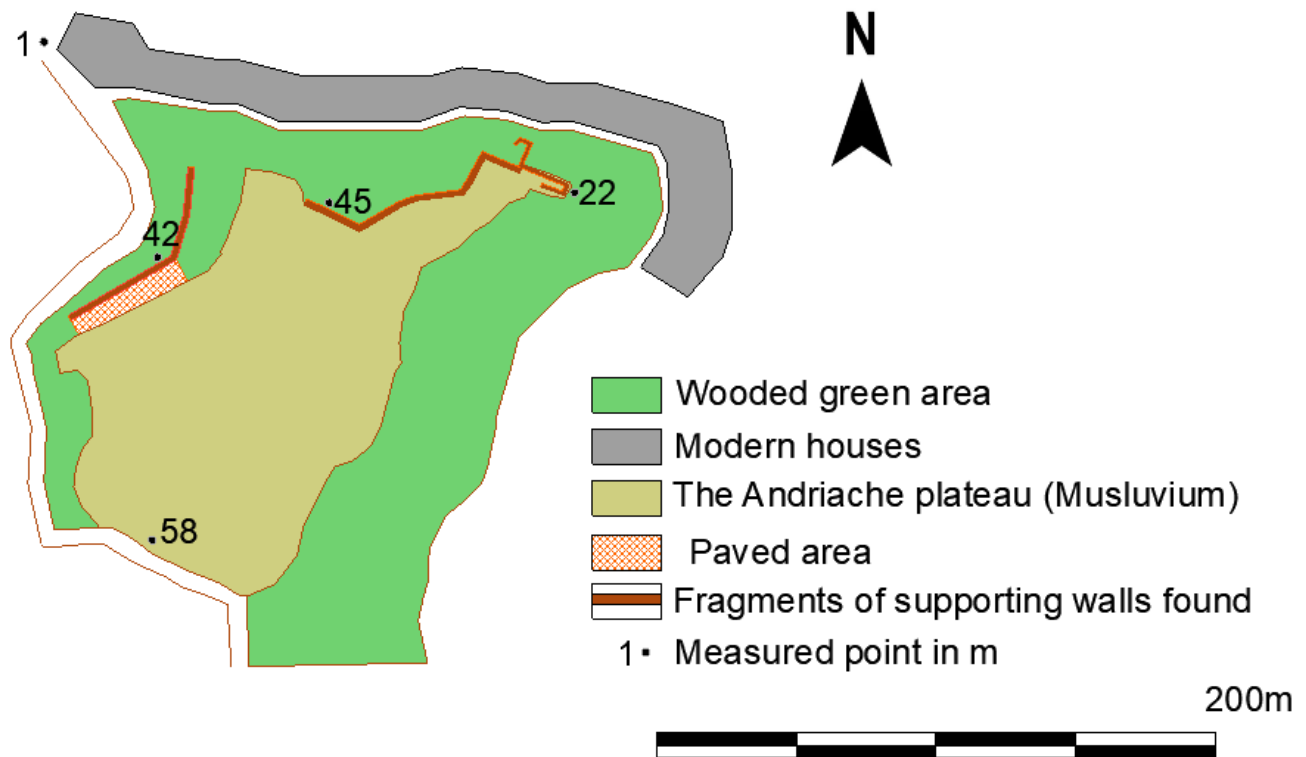


Figure 14. Plan view of the retaining walls visible today

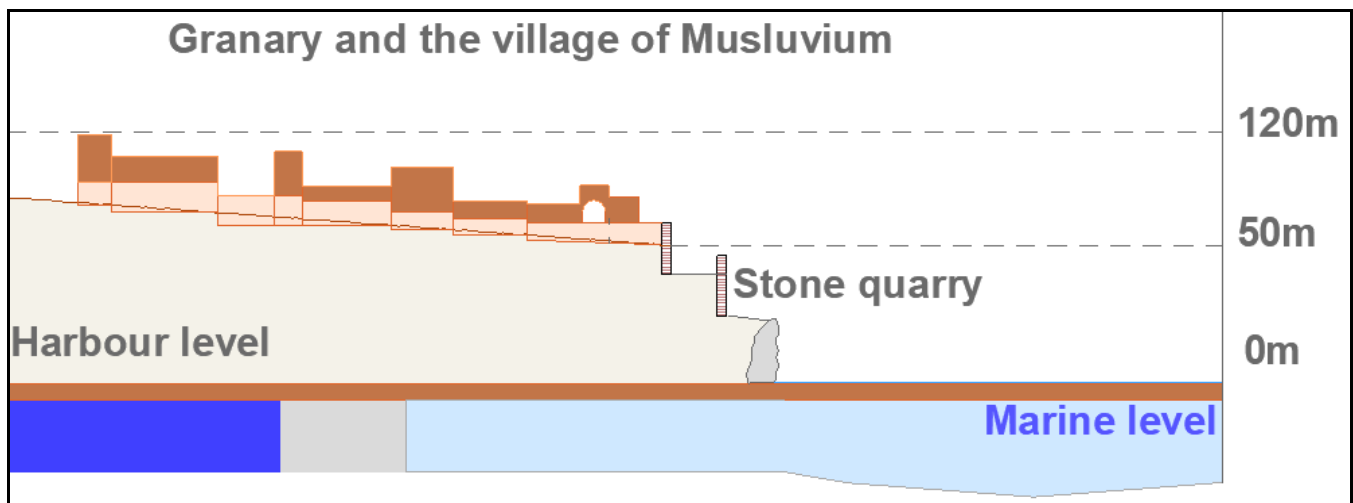


Figure 15. Longitudinal topographic profile and location of retaining walls



Figure 16. Fragments of retaining walls still standing (a). Wall materials scattered over site 01 (cut stone, bricks, floor tiles) (b).

3.3.3. Water source and catchment in site 02

The Kefrida Pass depression, which reaches 900m, is located on the eastern flank of Mount Adrar N'fad (1,756m), part of the Babors massif. This massif has often been described as the most fertile (Ficheur, 1890: 35), watered (around 1m) and forested region of Algeria (Explanatory note to the 1920 1:50,000 geological map). According to nineteenth-century texts (Table 3) and the testimony of the water authorities, there is a spring about 300 meters south-west of the pass, known as Tala Aïzraren, which serve nowadays to supply water to the villages of Aokas.

Table 3. Collected text data.

Infrastructure	Land use	Fonction
- Old aqueduct with a basin below	West-facing slope at the Kefrida pass	Water supply from source to port
-Porte de l'est or two forts or two control posts, Fort or Centenarium de Kefrida or two towers, or a large ruin called Kherbetel- Ksar, close to a small one called Rherbet- Merdj-el-Anasser. Military station.N° 61 on the map by S. Gsell.	On either side of the Kefrida pass and lapidary inscription commemorating the restoration of the Centenarium under Diocletian.	- Controlling the Roman road to Ain Roua (Horrea). - A fortified construction for a garrison of one hundred men.
-Kefrida spring. -Acufida, Aqua Frigida.	-300 S . W of the kefrida pass -Antique catchment at 1703m, 1382m, 1331m in the Triassic sandstone on the Adrar Nfad peaks.	Water supply.
- Necropolis (a sarcophagus at the foot of the slope at the Col de Kefrida).	- Slope (east or west?) of the Kefrida pass.	Old cemetery.

The discovery of the spring was a key factor in the foundation of Muslubium in this location, as it provided an abundant supply of water and was close to the port. Poulle cited a beautiful spring framed by ashlar and known as Tala Aïzraren during his exploration in 1857, around 300 meters south-west of the pass. On one of these stones there is an inscription of which Mr. Faure, an engineer with the Cie des Mines du Djebel Anini, had sent 'an incomplete copy, but sufficient to give an idea of the value of the original'. The lapidary inscription bears witness to the reconstruction of the Centenarium Aqua Frigida by the Cesars in 292-293 AD (Poulle, 1858).

This is ultimately the result of the drop-in altitude of the true source of Kefrida (hence the ancient name Aqua Frigida: fresh water) due to the subsidence resulting from the fault that ran parallel beneath the three true sources of Kefrida in ancient times. These springs were identified by Marcel Billiard (1934), as well as by geologists M. Dussert and M. Brives (1925) on the 1:50,000 geological map. The three source points of Kefrida are located exactly in the lias of Mount Adrar N'Fad on these three summits at 1703m, 1382m and 1331m. According to the work of Marcel Billiard, subsidence due to the fault caused erosion of the slopes, resulting in more abundant water flowing lower down and at an increased rate. Today, the subsidence has revealed the existence of three drains coming from the summits of the mountain, two of which no longer function. The other is connected to the Tala Aizraren spring.

The discovery made in September 2023 of the remains of a stone aqueduct (Figure 17) confirms the information found in the texts about the existence of an aqueduct and a basin beneath it. This aqueduct is now located below the current Tala Aizraren spring, 24 m above the road and just above the spring, which has the following geographical coordinates: 36.5919851-N 5.2535539 E. The subsidence that occurred in 1874 resulted in a 2 m drop in the road and the aqueduct to break in two (as reported in the deliberations minutes of the general council of the Constantine department in 1874), leaving a stone stream visible on the aerial photograph taken in 1960.

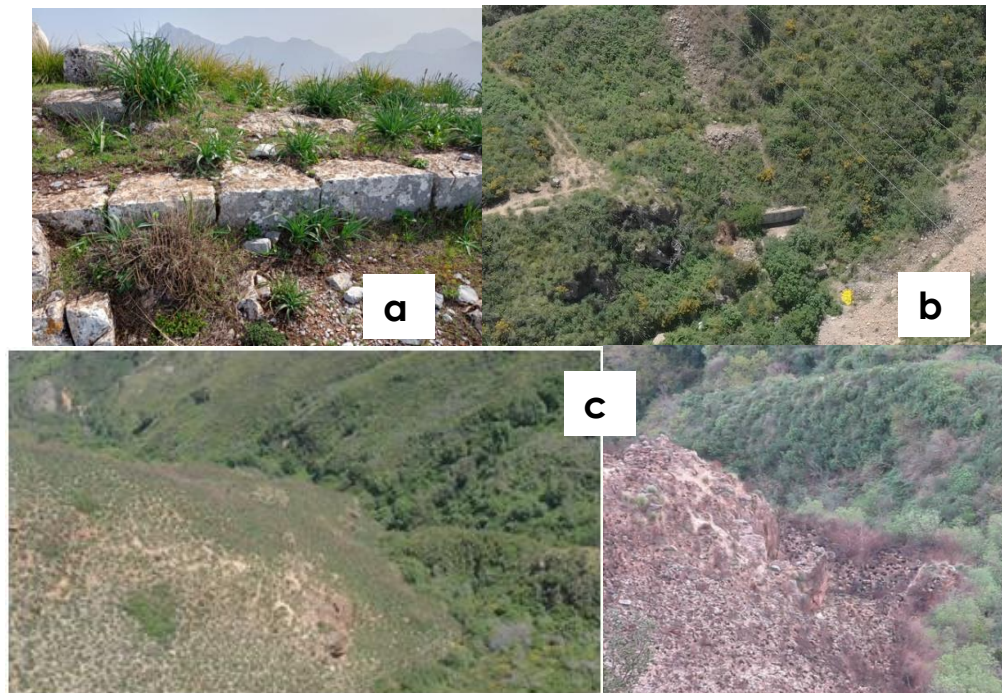


Figure 17. Visible remains of the antique fort located at an altitude of 1364m on the Ablat Amellal ridge (a) photo by Mr. Zidani, president of the Aokas hikers' association (2024). Drone view of the Kefrida spring basin (b). And a left-hand section of the aqueduct, right-hand section of the aqueduct taken by the drone at an altitude of (- 24 m) from road level and towards the bottom of the pass of Kefrida ravine (altitude 476 m) (c).

3.4. Ceramic artefacts found at Site 01

The various surveys also led to the discovery of countless ceramic artefacts (amphorae, crockery, bricks, floor tiles, tesserae) (Figure 18), dotted around the wheat field and its boundaries (Andriach plateau). The timely discovery of amphora bases and handles leads us to believe that this was indeed a granary or warehouse, given the abundance of fragments. After collection and cleaning, a comparison was made with the listed collections of African amphorae. A number of projects were carried out to classify and list the various amphorae of African origin, their contents and their place of manufacture. Classifying the amphora artefacts found at Site 01 is not the subject of this article, but at this stage it is more a question of drawing on the results of previous work in an attempt to find similarities in characteristics. The bases of cone-shaped African amphorae were used as containers for preserving fish-based sauces (Lemaître et al., 2017), while others listed by La Porte belong to Caesarian or Setifian Mauritania and could contain wheat, wine or olive oil (La Porte, 1980).

A strange shallow circular incision (not yet filled in) was found on two amphora fragments (Figure 19). This feature, which was also noted at Fréjus, has been identified as very old, and is in fact a pre-perforation device designed to facilitate the emptying of the contents. These have been identified as 'African amphorae of the Ostia XXIII type' (Excoffon et al., 2015: 156). When this device is not recorked for a second use, it is considered to be of recent manufacture. We could therefore assume that this amphora was made in situ and that there could have been amphora-making workshops at Muslubium. This hypothesis could be further confirmed by the fact that several deposits of clay for making tiles, bricks and pottery have been recorded on the 1:50,000 geological map of 1925, at Beni Ismail, located at the southern end of the Kefrida Pass behind Mount Adrar Nfad.



Figure 18. Some fragments of amphorae found on site 01.

However, the absence of any other explicit evidence calls for caution and circumspection, and the archaeomagnetic studies planned as a continuation of this research will certainly shed new light on the precise dating of the ceramics found on site, as well as on the date of the foundation of Muslubium (Ouaret Ladjouze et al. 2025).

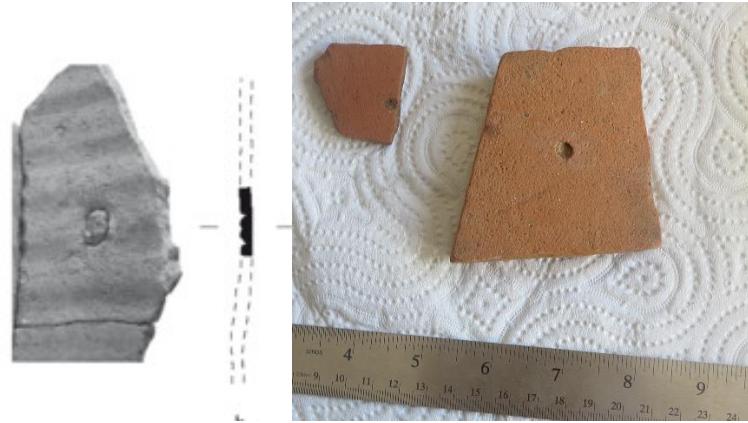


Figure 19. Similarity in the ancient perforation device on ancient amphorae of African origin found at Fréjus of the Ostia XXIII type (P. Excoffon et al. 2015: 159), in comparison with the remains of amphorae found on site (the perforations have not yet been filled in).

4. Discussion

From the foregoing, it is clear that the interpretation resulting from the superimposition of ancient geographical maps and 19th-century archaeological and geological maps has enabled to identify the extent of marine deposits and recent and ancient alluvial deposits that may have modified the ancient levels, burying the port settlement over a 2000-year period. These maps also enabled to record all the natural resources required to build the settlement, in particular the abundance of fresh and salt water springs, deposits of building and paving materials (sand, stone, brick and tile clay, gypsum and marble) and the identification of the various structures that made up the settlement, such as the Roman village, granary, aqueduct, drinking water pipeline, fortifications and checkpoints.

The archaeological discovery of Muslubium was methodologically verified by the interpretation of its preserved past, which still survives in the few texts and maps studied. The geolocalised cartographic restitution of the archaeological structures found, then verified by the interpretation made by hermeneutics, has enabled to highlight a number of new results, notwithstanding a number of hypotheses:

- The Sidi Rehane or Andriach plateau, on which the granary and the village of Muslubium were built, is artificial and of a geological nature that favoured construction, offering the port safe shelter from the northerly winds.
- Today, almost 600 meters wide of alluvial deposits and sand separate the coast from the foot of the Sidi Rehane plateau. This environmental transformation, which took place over more than 2,000 years, buried all the port structures, revealing linear underwater structures visible to the north of the plateau in recent bathymetric surveys. Could these port facilities have been used for mooring?
- A freshwater reservoir on the plain, near a ruin believed to have once been a fortified castle, suggests the existence of ancient basins used as fish ponds. The ruins of an ancient castle, as cited in the texts, suggest the existence of a lighthouse near the freshwater basins.
- The presence and proximity of food resources such as the Kefrida spring, which is abundant and located 4,000 m from the port, an aqueduct and a dock, are fundamental arguments in favour of the founding of the Muslubium settlement. The same applies to the proximity of identified quarries for the extraction of building materials (gypsum (lime), clay, iron, copper, etc.).

It is important to note, however, that both hermeneutics and geoarchology are rather limited in their ability to give a precise date for the founding of Muslubium Horrea, or even to identify the reasons for its disappearance.

Subsequently and as a research perspective, this results needs to be extended by carrying out excavations to establish the link between the granary and the village located on the plateau and the port located below on the plain, to specify the stages in the construction of the village, the layout of the Roman road, as well as the restitution of the structures of the hydraulic network from the Kefrida water source to the aqueduct leading to the port of Muslubium, as well as the possibility of the existence of ceramic manufacturing workshops on the site by dating. Indeed, the exact date of its foundation remains unknown in historical documents. The investigations require future dating studies, which are planned as part of the continuation of this research (Ouaret Ladjouze et al., 2025).

5. Conclusion

The aim of this study was to reconstruct the initial topography prior to the establishment of the Muslubium settlement, and also to pinpoint the precise location of the port, for which there is little archaeological evidence. This was achieved by combining hermeneutics and geoarchaeology applied at different scales from territory to architecture and from architecture to artefact. These investigations brought out the following salient points:

- The settlement has been duly located and its extent clarified,
- The dismantled parts of the site (ramparts, structures, etc.) were identified and objectively located.
- The conditions under which it was founded as a major commercial port have been identified.

The results of this study constitute a significant contribution to current scientific research and the first milestones in the identification of lost ancient Mediterranean ports, and even provide a global understanding of the relationships between different Mediterranean ports in the past. These results obtained need to be backed up by investigations and excavations, as well as laboratory dating tests and other hermeneutical research.

Conflict of Interests

The author declares no conflict of interest.

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