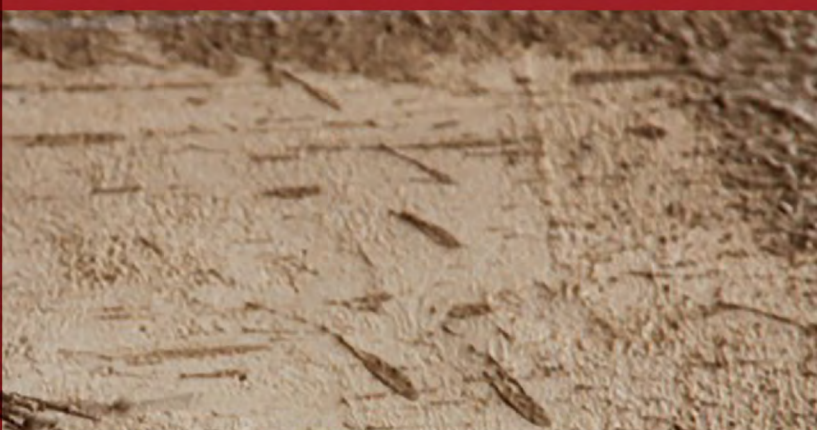


LiMeS Project

Life between Mediterranean and Sahara



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P A D O V A U N I V E R S I T Y P R E S S

Il Progetto “**LI.ME.S.** Life between **M**editerranean and **S**ahara. Living along the *limes*: the borders of Roman Numidia”,
è stato finanziato dalla Fondazione CaRiPaRo nell’ambito del Visiting Programme, bando 2018

Il Progetto è stato possibile grazie all’attiva collaborazione
con le Università algerine di Biskra, Batna1, Costantine2 e Algeri2,
con il CNRS di Algeri e l’École Nationale d’Architecture et d’Urbanisme di Tunisi

Comitato Scientifico
Paola Zanovello
Giuseppe Salemi
Armando De Guio
Andrea Meleri
Giovanni Cagnoni
Azeddine Belakehal
Ahecine Zineddine Saouli
Aomar Dali
Rachida Aboudil
Rachid Djebnoun
Sabah Ferdi
Yacine Rabah Hadji
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Università degli Studi di Padova
Dipartimento dei Beni Culturali: Archeologia, Storia dell’Arte del Cinema e della Musica
Piazza Capitaniano, 7 – 35139 Padova

ISBN 978-88-6938-442-4
© Padova 2024, Padova University Press
Università degli Studi di Padova
via 8 febbraio 1848, 2 - 35122 Padova
tel. 049 8273748, fax 049 8273095
e-mail: padovauniversitypress@unipd.it
www.padovauniversitypress.it

Layout: Matteo Annibaletto

On the cover (from right to left, top to bottom):
pseudo-morphology extrapolation of an area from historic B/W aerial photos;
Roman aqueduct shaft found north of Thaboudeos;
present-day community use of the Roman basins in Gafsa;
ancient cultivation area viewed from ground level,
lights and shadows on the vault of the Pantheon in Rome;
traditional wall plastering on a restored mosque in Biskra;
plan of the Roman city of Tingad;
reconstructive hypothesis of the Roman library of Tingad;
M’cid mosque of Biskra during the colonial period.

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a cura di

Paola Zanovello, Andrea Meleri

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FIRST PART

Archaeology and Territory

Over the past few years, acting within the framework of the European community's Erasmus+ cultural exchange programs, archaeologists from the Department of Cultural Heritage of the University of Padua have been fortunate to be able to collaborate with Algerian archaeologists and colleagues from the Department of Architecture of the University of Biskra.

The pre-Saharan territory of Les Zibans around the city of Biskra, the Roman *Vescera*, preserves the memory of a profound stratification of human experiences along the desert threshold, before and after the Roman phase. A long path that has left traces in a territory that has continuously evolved, sometimes taking elements from the past reinventing them, often inserting new concepts and methods, always adapting these, at least in some part, from what was present before. This continuous dialogue between past and present inherent in this area has prompted a fruitful discussion between archaeologists and architects since, as said in the introduction to the second part, archaeology ultimately has to deal with architectures that are no longer functional, and the architectures of the past, evoking human histories and building techniques often forgotten, might be a relevant factor in shaping the future of local communities.

In its own respect, archaeology is also intimately intertwined with the broader territory it studies, which is often an intricate web of connections between historical landscapes, ancient settlements, and the people who inhabited and continue to inhabit these spaces. In this section, we navigate through diverse archaeological landscapes, delving into various aspects of the region's history, and shedding light on economic structures, military fortifications, agricultural management, and the role of water resources. From the rediscovery of archaeological sites using modern geospatial technology to the uncovering of ancient coins that reveal economic histories, from the Roman *limes* to remote fortifications, from economic hubs to hydraulic infrastructures, these articles collectively paint a comprehensive picture of the intricate interplay between archaeology and the vast Algerian territory. Together, they remind us that archaeology is not just about uncovering the past; it's about understanding how the past continues to shape our present and future within the broader tapestry of our environment, highlighting also the delicate balance between preserving cultural heritage and fostering community engagement, emphasizing the need for sustainable practices that safeguard the past while benefiting the present.

A final note: this publication, relating to the proceedings of the workshop held in December 2019, has fallen victim to delays resulting from the unfortunate situation of the COVID pandemic in 2020-2022, many of the topics presented have evolved in the meantime, we apologise to colleagues and would like to update the publication of our experiences and research activities in the near future.

Paola Zanovello, Andrea Meleri
(editorial team) *Università di Padova - dBC*

LIVING ALONG THE *LIMES* IN ROMAN NUMIDIA: CIVIL AND MILITARY SETTLEMENTS AND AGRICULTURAL MANAGEMENT IN THE AREA BETWEEN THE ZIBANS AND THE AURÈS

Paola Zanovello

Università di Padova / dBC

This paper explores the historical landscape along the border in Roman Numidia, shedding light on various aspects of this region's economy, agriculture, trade, communication networks and military settlements. Delving into archaeological evidence and epigraphic records, the text highlights the coexistence of settled farmers and nomadic shepherds-breeders, revealing how Roman authorities managed and regulated these competing interests. It also examines the presence of praedia (rural properties) and saltus (wooded or hilly areas) and their roles in the local economy, often owned by elite families and passed down through generations. Additionally, the text discusses the organization of marketplaces and commercial transactions, emphasizing the pivotal role of communication hubs like Zairi in connecting agrarian and nomadic populations. These insights provide a nuanced understanding of Roman Numidia's economy and social dynamics.

KEYWORDS: *limes, Roman Numidia, economy, trade, agriculture, pastoralism, nomadism, marketplaces.*

LES ZIBANS AND THE AURÈS MOUNTAINS

The area known today as Les Zibans is located between the Sahara and the Saharan Atlas range including the Zab mountains and Aurès massif, having as its capital the present-day city of Biskra¹, *Vēscera*, an ancient military settlement located along the southern border line of the Empire. The name derives from the location of a series of oases; in Berber *zab* (plural *ziban*) means oasis, but the root *zaba* seems to refer to flowing water and in reality the area is located at a point of contact between two different morpho-structural areas, Atlas and Sahara, where a rich basin of groundwater emerges as the Oued Djedi, one of the best known oued (wadi) since ancient times, characterized by perennial water². In the description of the Arab traveler Ibn Khaldoun, who lived in the fourteenth century, the area was populated with numerous villages, each belonging to a *zab* and among these Biskra was the most

important³; the settlement is located at the mouth of a wide valley between two mountain ranges: the Zab mountains to the west and the more isolated Aurès massif to the east. These are composite reliefs, probably for this reason defined in the plural in contemporary literature⁴. Their geographical disposition is very particular, since they are distributed with a clear oblique orientation, from north-east to south-west, with the valley in the center where Biskra opens; in the Aurès the highest peaks exceed 2000 m (Djebel Chelia 2328 m), in the Zab they reach 1313 (Djebel Mimouna).

The area also has two other important geographical references: to the south the vast expanse of the Sahara and to the north the Hodna basin: a large depression between the Tellian Atlas (the Hodna mountains) and

¹ During the medieval period it defined a much larger area, between Tebessa and M'Sila, later limited to the area of Biskra.

² What J. Baradez (1949, pp.171-180) called "petit Nil fertilisateur".

³ "Le Zab est un pays étendu, renfermant de nombreux villages, assez rapprochés les uns des autres et dont chacun s'appelle un zab. Le premier est le Zab de Doucen; ensuite on trouve le Zab de Tolga, le Zab de Melili, et ceux de Biskera, de Tehouda et de Badis. Biskera est la métropole de tous les villages zabiens" (text by Ibn Khaldoun translated by Mac Guckin de Slane 1934, p. 125).

⁴ Three main mountains are distinguished in the Aurès (Ballaïs 2012), just as in the Zab mountains (Côte 1996; 2005) there are three well-defined areas. See Procopius' *Aurasios mons* (*Bellum Vandalicum*, III, XIII, 5; III, XIII, 21-29).

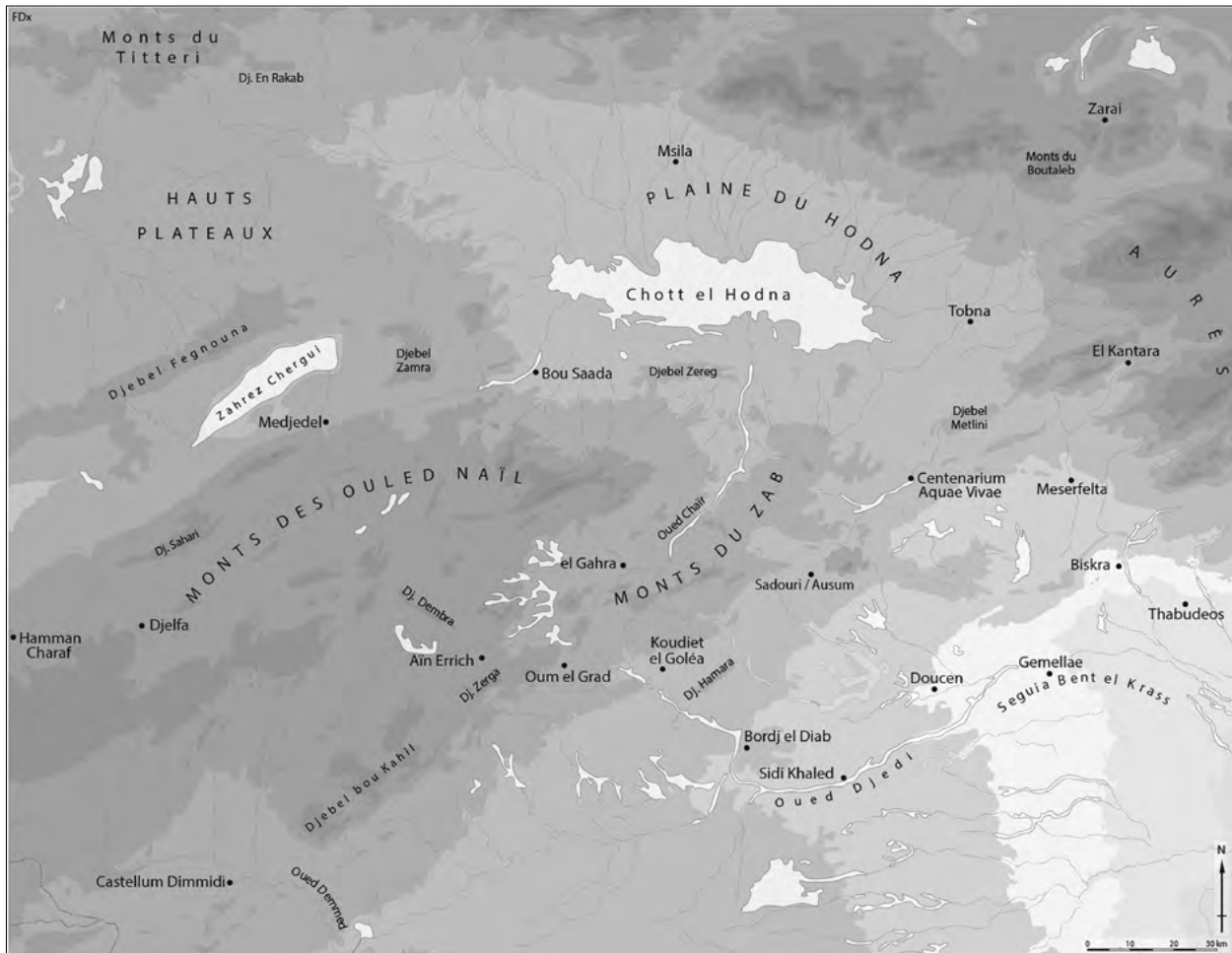


Fig. 1 – Area between Sahara, Zab mountains, Aurès massif and Chott el Hodna (Faure, Leveau 2015)

the Saharan Atlas (the mountains of Zab), occupied in the lower part by one of the great salt lakes of North Africa, the Chott el Hodna, known in antiquity as *salinae Tubonenses* or *Nubonenses*, as also stated in the *Tabula Peutingeriana*⁵ (fig. 1).

TERRITORY AND RESOURCES

This pre-desert territory, particularly articulated from an orographic point of view⁶ and apparently devoid of resources, was frequented and inhabited since pre-historic times. Life was therefore possible, even in conditions of high temperatures and low rainfall; however, there was no shortage of water, especially at the level of underground aquifers, which in some points,

particularly in the oases but also in numerous springs distributed almost everywhere, especially in the mountainous areas, flowed in sufficient quantities to meet the needs of the population. These last offshoots of the Saharan Atlas, crossed transversely by a network of oueds, have a morphological structure where the mountainous areas, characterized by numerous djebels and mainly inhabited by shepherds who practiced seasonal transhumance, are clearly distinguished from the valleys, more suitable for permanent settlements, which naturally had to provide careful management of the water supply in order to put the land to good use. The Zab Rharbi area, in the western sector, was traditionally a forage region, irrigated by the waters that flowed abundantly at the foot of the Zab mountains⁷.

⁵ *Tab. Peut., Segm. II.*

⁶ On the geoclimatic and agricultural organization of the territory, see a summary in Leveau 2018, pp. 21-30, fig. 1 (from CÔTE 1988, p.337). A general overview of the hydrographic conditions of the area is given in DESPOIS 1942 (fig. 1 p. 196), later taken up by WHITTAKER 1978 and TROUSSET 1986, p. 93, fig. 1.

Agriculture, breeding and pastoralism were therefore the main resources, to which, since ancient times, the trans-Saharan trade should be added, practiced in

⁷ CÔTE 2005, fig. 5.

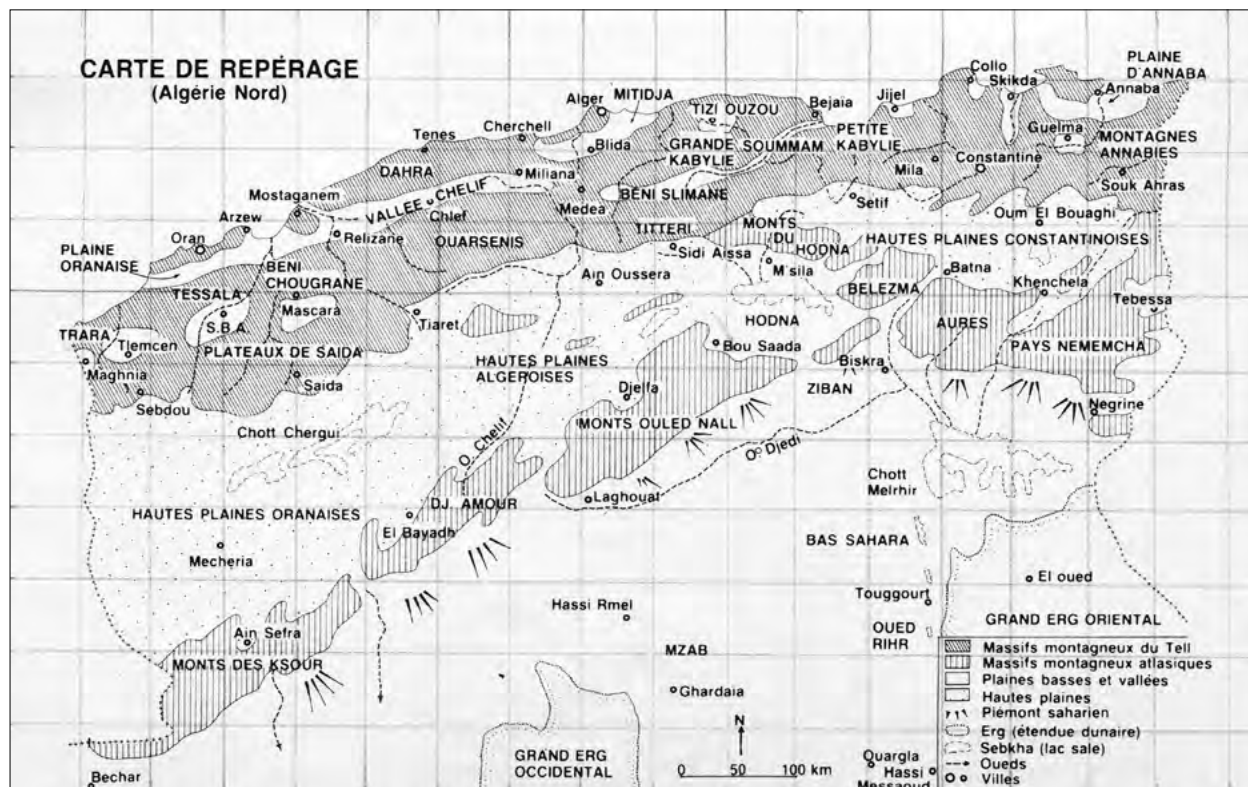


Fig. 2 – Mountain ranges, high and low plains, Saharan piedmonts and salt lakes (chott) in North Africa (Leveau 2018, fig. 1)

a constant flow of relationships and exchanges, above all the trade of precious materials between the central African countries and ports in the Mediterranean. In Roman times cereals and olive trees in particular were cultivated and livestock farming and pastoralism were practiced. It is sufficient to scroll through S. Gsell’s *Atlas Archéologique de l’Algérie*⁸ to realize the amount of data recorded at the beginning of the 20th century on the presence of springs, rural settlements and related production activities, documented by the numerous presses and millstones found over time. Evident traces of the assiduous commercial activities remain in the rich epigraphic documentation: consider for example the texts attributable to real tariffs applied in merchandise transactions attested in Zarai and Lambesi⁹. There were also other resources, such as thermal springs, everywhere considered healthy, such as the *Aquae Herculis*, located between Biskra and Batna; rock salt was present in the same area, in the site known today as Djebel Melh, “the mountain of salt”, while not far away, in the Bou Taleb area¹⁰ and just north-east of the chott el Hodna, there were some lead mines exploited in antiquity (figs. 2,3).

⁸ GSELL 1911, f. 26.

⁹ The inscriptions are dealt with in the following paragraphs.

¹⁰ GSELL 1911, f. 26, n. 34.

POPULATION AND MILITARY SETTLEMENTS IN THE CENTRAL SECTOR OF LIMITED NUMIDIA

According to the ancients, the term *Numidae* derives from the Greek *nomâdes*¹¹, as if to indicate the origin of the population of this territory, an interface between the mountains and the pre-desert, an area frequented seasonally to transfer the flock to the hills during the hot African summer, which offered milder temperatures and above all water and food. Transhumance, *achaba* in the Arabic language, is a practice still common throughout the North African belt between the northernmost sector of the Sahara and the mountainous base which from the Atlas mountains continues almost uninterruptedly eastwards up to the Libyan heights; this activity has remained in use in the Algerian territory even in recent decades, keeping the ancient routes active¹² (fig. 4).

The territory between Les Zibans and the Aurès was certainly one of the most important areas in ancient times, with penetration routes to the north that had *Vescera* - Biskra as reference points, along the line of the African *limes*, and further north the valleys of El Kantara, *Calceum Herculis*, and Menaa, the ancient *Tfil-*

¹¹ IBBA, MASTINO 2012a, p. 80.

¹² LAPORTE 2011-12, pp. 545-547, fig. 4.

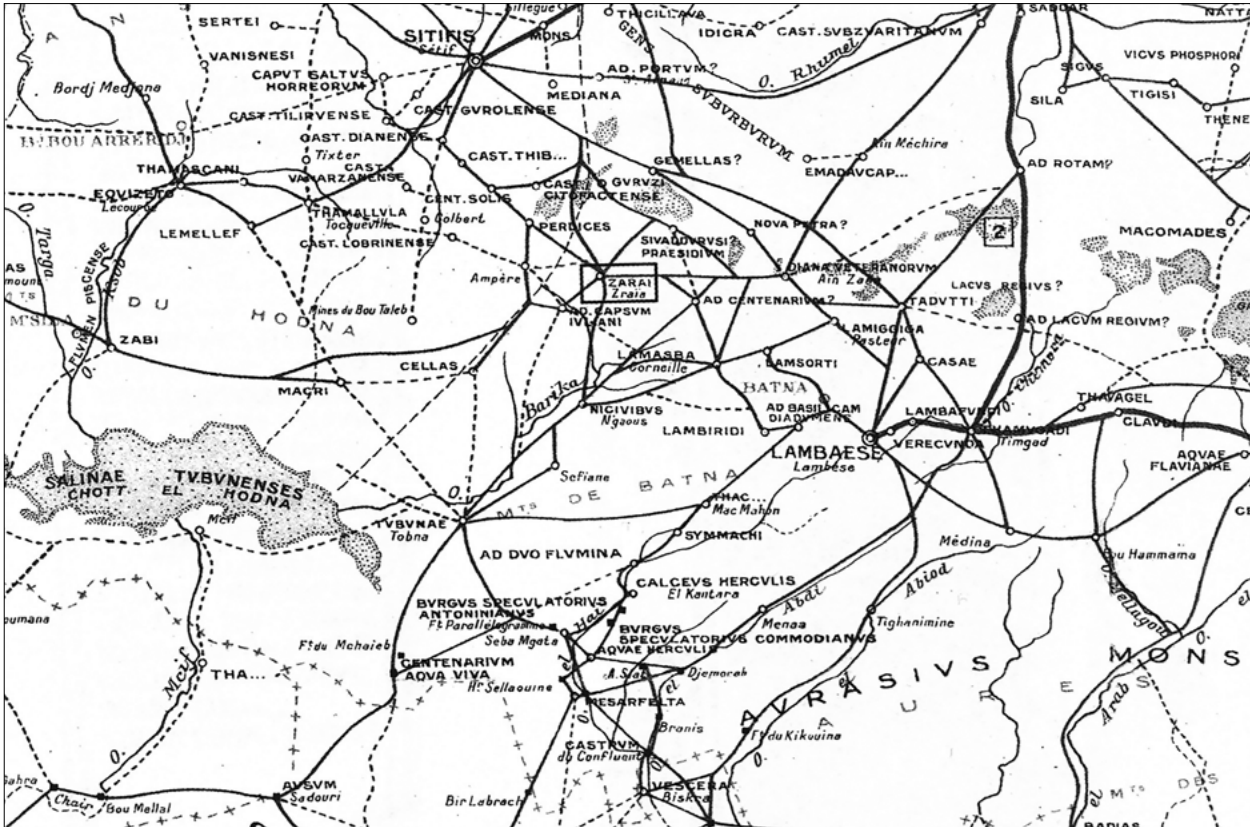


Fig. 3 – Roman viability and toponyms in the Zarai area between the Zab and Aurès mountains (France 2014a, fig. 2)

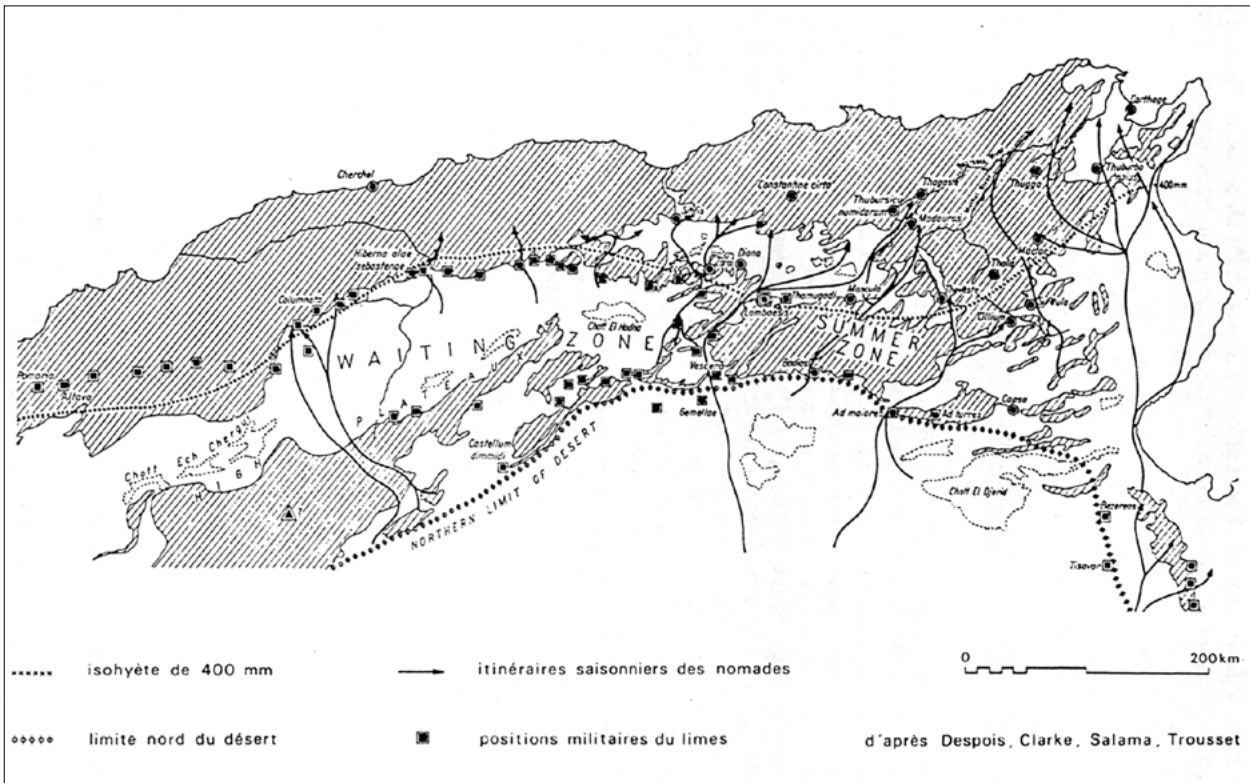


Fig. 4 – Transhumance routes in North Africa (Trouset 1986)

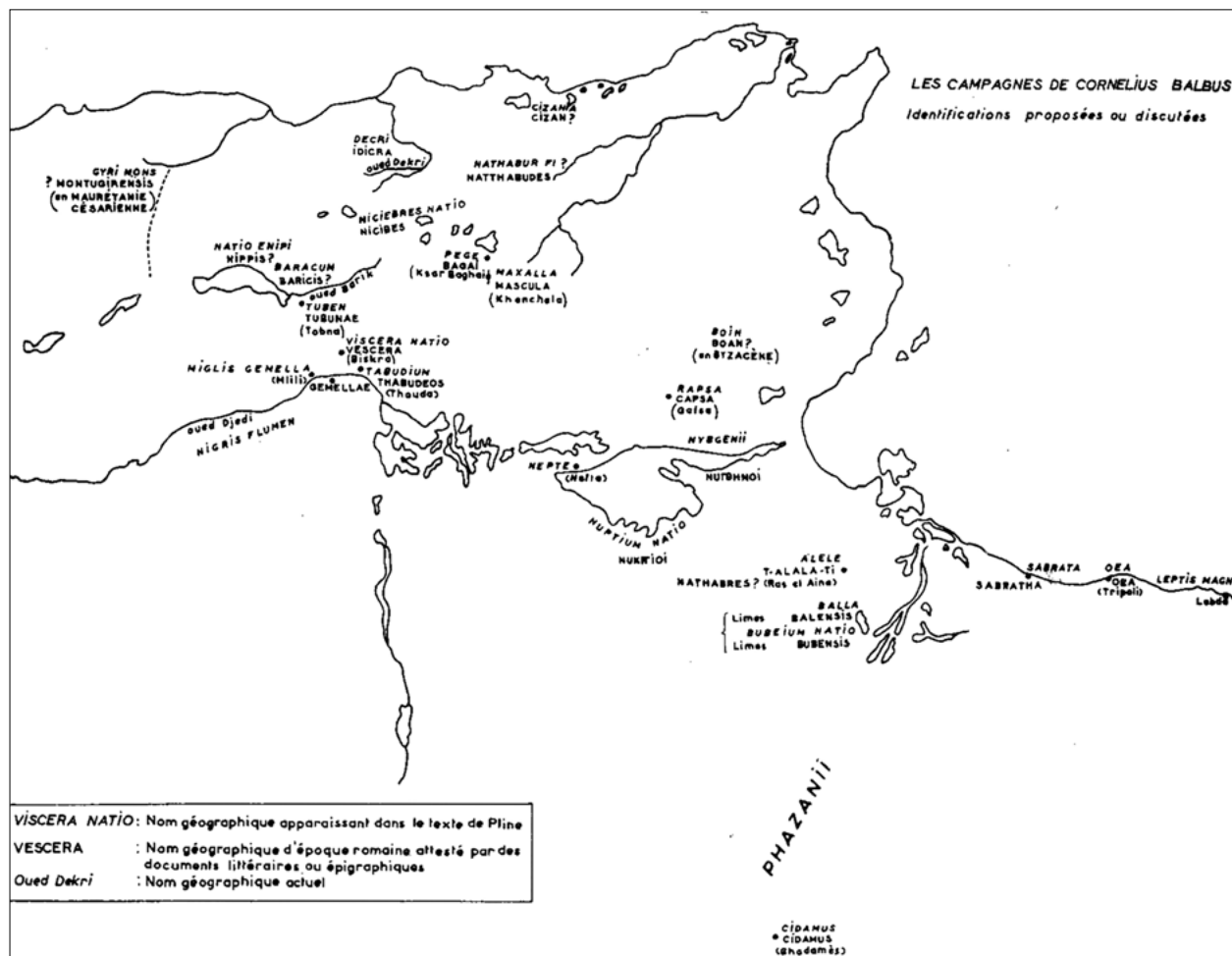


Fig. 5 – Identification of places visited during the expeditions of *Lucius Cornelius Balbus* in 20-19 BC (Desanges 1957)

zi, towards Lambesi and *Thamugadi*; it also extended towards the Hodna basin, passing through N’Gaous, the ancient *Lamasba*, known for the discovery of the long inscription relating to the procedures for community water management¹³. The territory is particularly rich in epigraphic and archaeological documentation, which testifies to an intense human presence, also detailed through the prevalent activities.

Of course, the first point of reference for the Roman age is the military occupation, which took place slowly and gradually, with a dynamic process that unfolded over the course of several centuries. The first exploratory expeditions, mentioned in ancient literary sources, refer to the early Augustan age, 20-19 BC, when the Gaditan *Lucius Cornelius Balbus* pushed with his soldiers along two routes which generally correspond to the lines of Roman expansion¹⁴: to the east towards

the lands of the Garamantes, moving from Sabratha in Libya towards the south, along well-known caravan routes, to the west towards the *Tubonenses* salt pans, the area of Hodna, the Oued Djedi, perhaps the one mentioned by Pliny as *Niger flumen*¹⁵, and the Aurès massif, later called *Aurasios mons* (fig. 5).

This territory was mainly inhabited by *Gaetuli* and Numidians¹⁶ and the resources found here prompted the Romans to gradually occupy the area: in the Flavian era, even if there was probably not a real borderline here yet, the main headquarters of the *III Legio Augusta* were moved from *Ammaedara* in Africa Proconsular to *Theveste* in Numidia. It was against this slow westward movement of occupation of lands that, in the

¹³ For an updated bibliography on the Tables of Lamasba see MAGANZANI 2012, pp. 195-213: among others see in particular DE PACTÈRE 1908; SHAW 1982; SHAW 1984; MEURET 1996.

¹⁴ LAPORTE 2011-2012, pp. 547-549.

¹⁵ It is considered the southern limit of the Maghreb (DESANGES 1957, p. 40).

¹⁶ Sallust (*Jug.*, XIX): *Super Numidiam Gaetulos accepimus partim in tuguriis, alios incultius vagos agitare; post eos Aethiops esse, dehinc loca exusta solis ardoribus*. According to Apuleius (*Apol.*, 24) Madaura, his hometown, was half Getulian and half Numidian.

Tiberian era, the Berber *Tacfarinas* had rebelled¹⁷. In the second half of the first century AD the first traces of a permanent occupation are recorded, which was further accentuated during the reign of Trajan, when the headquarters of the *III Legio* was moved even further west to Lambesi, and numerous farms and agricultural plants were established in the area, as well as structures related to water management. In the early years of the second century AD several sites south of the Aurès were permanently occupied, in particular at the mouth of the river courses in the plain, and an advanced defensive line was organized in order to directly protect the Aurès complex, rich in water and arable land, despite its southern latitude¹⁸.

As in many other parts of the Empire, the Hadrianic age brought in this area a consolidation of the defensive works, which constituted for the first time an organized and stable system of the southern border. This task was accomplished with the construction of important military settlements such as at *Gemellae*, just north of the Djedi course, and the network of forts located immediately south of the Aurès, testify to the full Romanization of this whole area, intensely inhabited and exploited in its agricultural and commercial resources. After a pause of a few decades, the advance towards the south-west resumed in the Severan age, in particular in the lands of the neighboring *Mauretania Caesariensis*; the third century AD represents a period of great settlement flourishing, with the monumentalization of the most important inhabited centres, such as Lambesi and *Thamugadi*¹⁹. However, for the *III Legio* this was a very complex period, having to deal not only with the defense of the borders but above all with the heavy rebellions that led to the war of Carthage. In fact, in January 238 a revolt had broken out in North Africa against the emperor *Maximinus the Thrax*, considered a cruel tyrant²⁰; in particular the behavior of an imperial procurator against the population of Proconsular Africa, governed at the time by the proconsul *Gordianus*, had aroused great rancor in the population: the official was killed and one of the rioters, including many soldiers, held a speech to acclaim Gordian himself as emperor, a request later accepted by the Senate of Rome. Gordian associated his son to power, remembered as Gordian II, but the governor of nearby Numidia, *Capellianus*, faithful to *Maximinus* and above all always opposed to the work of Gordian, opposed by sending the *III Legio Augusta* against the Gordians, along with a contingent of Mauri; a single battle took place near Carthage

on 22 April 238 and saw the heavy defeat of the new emperors: Gordian II was killed on the field and on the same day the elderly Gordian I hanged himself, ending a reign that lasted only 20 days²¹. *Legio III* was dissolved by his nephew Gordian III, who after the defeat of *Maximinus the Thrax* and the killing by the praetorians of the new emperors elected by the Senate, *Pupienus* and *Balbinus*, was in turn proclaimed emperor in July of the same year 238 despite his very young age.

The legion was reconstituted in 252 by the emperor Valerian, with soldiers from the Danube provinces, remaining active in Africa until the end of the empire²². In this phase the reorganization of the military defense in the southern strip of the Roman territory was fundamental; from the first years of the fourth century, the word *limes* acquired a meaning more precisely linked to the geographical-administrative context: in fact, in this period the border control responded to a military organization closely connected to the administrative management of the territory, where the commander or *dux* assumed in his jurisdiction not only the task of military defense but above all the control of all economic and political activities²³.

THE AREA BETWEEN THE ZAB, HODNA AND AURÈS MOUNTAINS IN ROMAN TIMES

The epigraphic and archaeological attestations relating to this area are rich and significant, in particular for the Severan era; extensive and well-known documentation concerns the important settlements of *Thamugadi* and Lambesi, with clear references to the military component.

At the south-western edge of the territory, in the Saharan Atlas south-west of the Hodna plain, there is a rock inscription, dated to the beginning of the 3rd century AD²⁴, and connected to the *III Legio Augusta: C(aius) Iulius / Hospes / legionis III Aug(ustae) / sacrum / fecit*. The epigraphic text was carved by a legionary inside a gorge in the Djebel Bou Khalil, a limestone block about 1400 m high, which is part of the Ouled Nail hills. The southern edge was therefore controlled by the army, which organized a series of military settlements in this area. The southernmost outpost²⁵ was built in the last years of the second century AD at *Castellum Dimmidi* and connected to the north-east, following in part the route of the Oued Djedi, to a solid

¹⁷ Tacit, *Annales*, II, 52.

¹⁸ LAPORTE 2011-12, pp. 550-551.

¹⁹ GSELL 1901, GSELL 1913-1928

²⁰ *Hist.Aug* (Julius Capitolinus), XX, *Gordiani Tres*, 5-16.

²¹ HERODIAN, VII, 4-9.

²² LE BOHEC 1989.

²³ ISAAC 1988, MORIZOT 1991, WHITTAKER 1989.

²⁴ CIL VIII, 8794; cfr. FAURE, LEVEAU 2015.

²⁵ TROUSSET 2010.

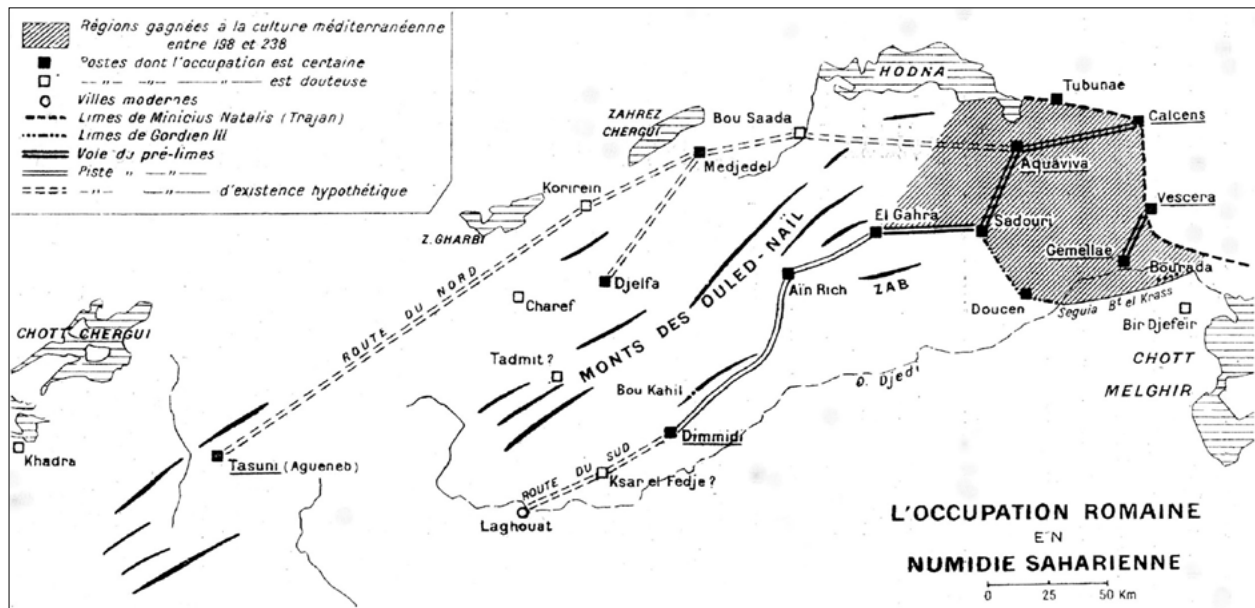


Fig. 6 – Roman occupation in Numidia (Faure, Leveau 2015, fig. 3)

network of fortresses including Sidi Khaled, Doucen, *Gemellae*, *Thabudeos* (fig. 6).

The main feature of this sector of the *limes* should be underlined: its permeability, which allowed the controlled passage of everything that could be useful to the economy of the area and of Rome. As Jean-Pierre Laporte observed, the creation of the *limes* is, in addition to a defensive apparatus, an economic mechanism that gravitates around the garrison, the available resources and the local population. A fundamental element was the surveillance of the passages, as indicated in a letter from *Publicola* to Saint Augustin, but the construction of defensive structures, from camps to towers and linear works, always appears to be in close connection with the presence of arable land or other exploitable resources²⁶. In the analysis conducted by Maurice Lenoir²⁷ in 2011 on the Roman camps in the Near East and North Africa, the distribution of the military structures in the Numidian territory is very well understood: located to the south in order to mark the southern limit of the Empire, along a line that connects the easternmost *Ad Maiores* to the far outpost of *Castellum Dimmidi*.

If therefore the southern border line is well defined, the concentration of military structures further north is even more evident: located in the heart of the territory between Aurès and Zab, strategically along the courses of the main oueds, its function is to protect the penetration routes to the north, that in this mountainous area

they had to use a few obligatory passages, but above all to safeguard the vast expanses of irrigated and cultivated land. The traces of the numerous runways used for daily traffic have been identified several times, along with the routes used for the patrol duties that the army had to carry out systematically in order to control the various activities present in the territory²⁸.

On the south-western edge, for example, there is a well-preserved fort, mentioned in the sources as *Centenarium Aqua Viva*, built at the beginning of the 4th century AD, placed in control of a region of great economic value²⁹. Similarly at the southeastern edge of the Hodna basin there is a fort, located a short distance from the Mdoukal oasis, near a very busy track that connected Tolga to Barika, towards N'Gaous and then *Sitifis*³⁰. An inscription from 303 AD was found here, which recalls the name of the fort and the presence of springs; a *praepositus limitis* directed the organization of the settlement³¹. At the northern edge of this area, south of the Hodna basin, we find another rock inscription, found on the northern slope of Djebel Zireg (fig. 1, as Djebel Zereg), carved also in this case on the wall of an isolated block of rock³².

The text is particularly interesting due to the direct reference to the presence in this area of soldiers, but also

²⁸ LENOIR 2011, pp. 367-374.

²⁹ LESCHI 1947. Visual inspection radius of 100 km around Biskra.

³⁰ LESCHI 1941.

³¹ LESCHI 1941, pp. 165-170, fig. 1 p. 166.

³² AE 1946, 38; LESCHI 1948; LESCHI 1957, pp. 75-79; FAURE, LEVEAU 2015, p. 137.

²⁶ LAPORTE 2011-12, p. 536. The main passages of the letter are reported in French translation in App. 1, p. 559.

²⁷ LENOIR 2011.

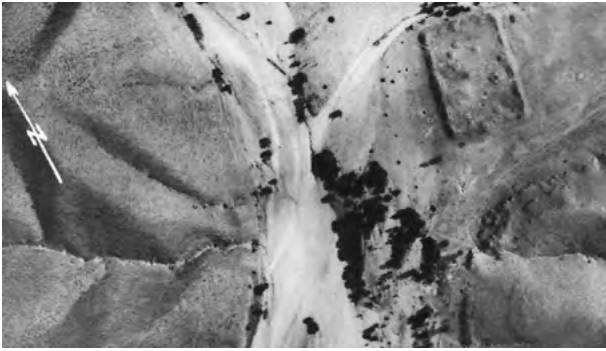


Fig. 7 – Ausum (detail of Baradex 1949, p. 125)

of settlers, shepherds and breeders: *Ex auctoritate Imperatorum trium / Caes(arum) L(uci) Septimi Severi et / M(arci) Aurelii Antonini et P(ubli) Sep(timi) Getae Aug(ustorum) trium agri et / pascua et fontes adsi/gnata [[sunt --- ma]]/[---] curantibus Epag/atho et Manilio Caeci /liano corniculario / praef(ecti) iussu Anici Fa/usti leg(ati) co(n)s(ularis) per M(arcum) Gennium / Felicem evocatum / leg(ionis) III Aug(ustae).*

The inscription allows a fairly precise dating between 198 and 201, the period of maximum expansion of the borders, which led to the foundation of *Castellum Dimidi* by *Anicius Faustus*, also mentioned here. The executors are mentioned: *Epagathus*, probably a freedman, *ensor* by profession, *Manilius Caecilianus cornicularius* of the prefect of the field, an official to whom land surveying tasks were generally delegated, and *Marcus Gennius Felix, evocatus* of the *III Legio Augusta*, the officer in charge of the final deed of assignment. The land was therefore measured, defined in the boundaries and then assigned by what appears to be a military commission in charge of the management and distribution of *agri*, *pascua* and *fontes*, therefore arable land, pastures and water resources. The assignees of the former were probably individual settlers, as some epigraphic sources³³ seem to demonstrate, mentioning in this territory settlers and *conductores* also of imperial property³⁴, while the case concerning the *pascua* is a little different, with shepherds-breeders probably being present only sea-

³³ CARCOPINO 1925, pp. 146-7. Inscriptions found in Mena in the south-western Aurès (CIL VIII, 2469=17958; 166 AD); near Bou Saada (CIL VIII, 8781=18017; Severian period); El Gahra (CIL VIII, 18026; Severian period). The generalized concession of lands was part of Alessandro Severo's policy, with the sole task of protecting the territory from barbarian invasions. Many inscriptions also make it possible to detect the presence here of Syrian soldiers, considered particularly suited to the climatic and topographical conditions of this pre-desert territory (CARCOPINO 1925); see also BADARACCO 2015 on the presence of a *numerus Palmyrenorum* already in the Antoninian period and a *numerus Hemesenorum* in the Severian period.

³⁴ About *coloni* e *conductores* KEHOE 1982; KEHOE 1988, pp. 20-96; KEHOE 2007.

sonally. Here perhaps the tribes came into play, as the continuity of use of these lands over time by specific tribal groupings seems to demonstrate³⁵.

As it has rightly been pointed out³⁶, this also establishes rules of peaceful coexistence between two categories in constant competition: farmers and shepherds-breeders, the former sedentary, the latter nomadic, but in both cases fundamental components of the local economy. In fact, farmers have always resented the occupation, although periodic, of the land by transhumant animals, which naturally trample and cause damage to the crops, even if at the same time they fertilize and enrich the land. Their stay therefore had to be controlled and regulated, taking into account a peaceful coexistence that could benefit the entire community. The exchange and sale of goods, animals or agricultural products, were useful to both breeders and farmers, fueling an economy that brought its beneficial effects not only locally, but also to a wider range.

Nodal points are located south of the Zab mountains³⁷: in Sadouri, the ancient *Ausum*, in an elevated position at an altitude of 450 m there was a fort, built between the Hadrian and Severian periods at the confluence of two oueds; from here three routes branched NW, towards Bou Saada and western Hodna, but also NE, in the direction of *Aqua Viva* and *Thubunae*, and south in the direction of Doucen and Oued Djellal. In the area there were springs and cultivated land; there are still remains of the walls, the baths and a burial mound of the Libyan type, as well as a series of inscriptions, including one to the *Genius* of *Ausum*. The inscriptions, which mainly belong to the 3rd century AD, show that it was an indigenous Roman settlement³⁸ (fig. 7).

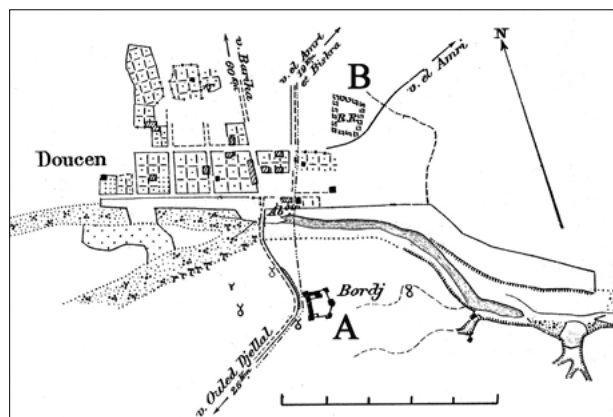


Fig. 8 – Area of Doucen in 1909 (Laporte 2014, fig. 10)

³⁵ LESCHI 1957.

³⁶ IBBA, MASTINO 2012a, pp. 90-95. Cfr. LEVEAU 2018, pp. 67-76.

³⁷ LAPORTE 2014.

³⁸ LAPORTE 2014, pp. 295-306; cfr. GSELL 1911, F. 48, 1; BARADEZ 1949, p. 119.

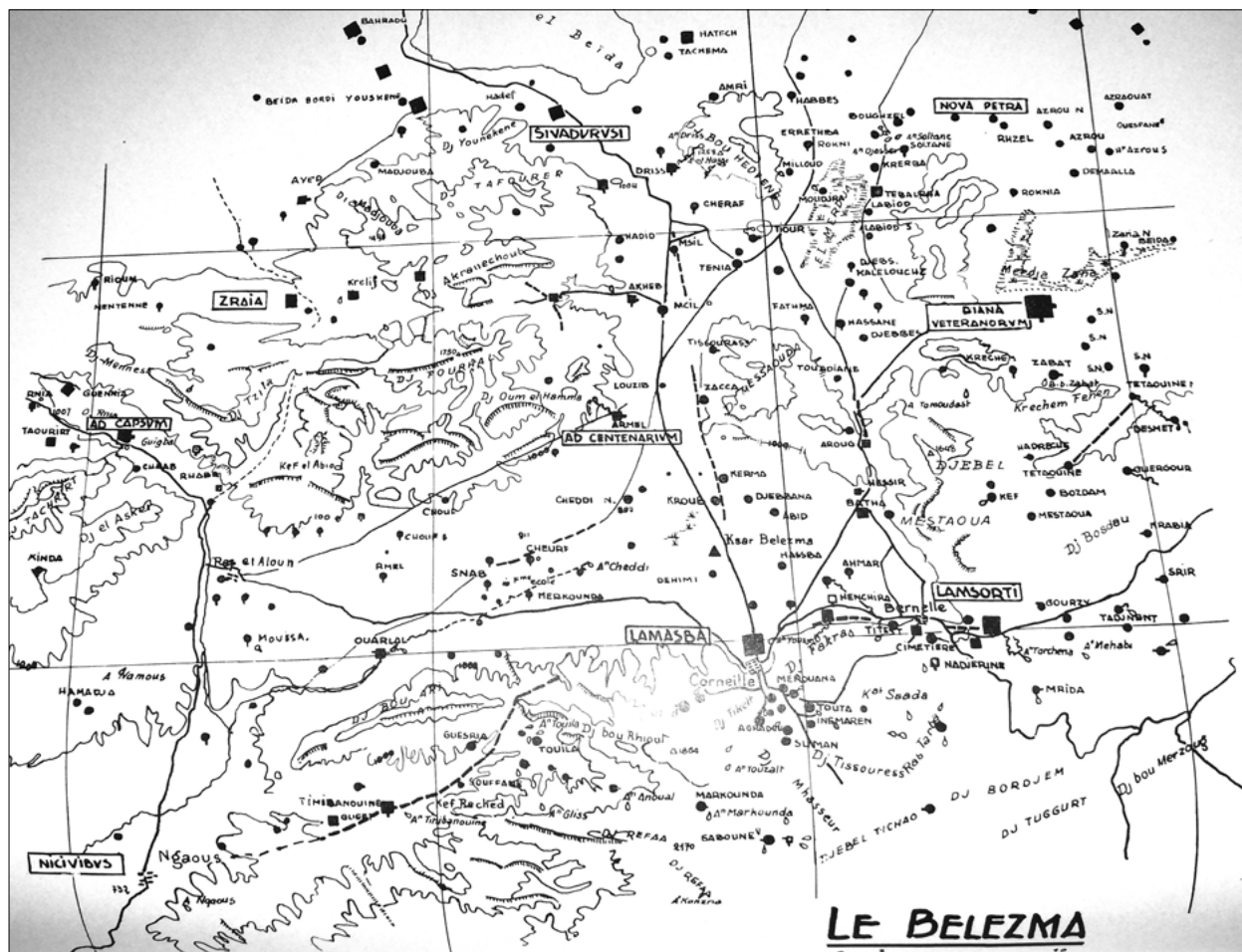


Fig. 9 – Plain of Belezma (Birebent 1962, fig.p. 340)

The site of Doucen is certainly better known since until the middle of the last century there was an oasis here; a fort from the mid-3rd century remains visible, but the traces found refer to at least 5 walls from different periods³⁹. The site was also frequented in the Middle Ages and was visited by *Leo Africanus* in the 16th century: the abundant underground water certainly made it a privileged place (fig. 8).

Nearby, the whole plain of Mahisser, crossed by three oueds, was fertile and cultivated; in Kef el Guemaa there was a fortified farm⁴⁰ and along the Oued Djedi valley many rural settlements are reported, interpreted by Baradez⁴¹ as *mansiones* with associated oil production activities.

The valley between Aurès and Belezma, west of Batna, is characterized by a network of oueds coming from both sides, which allow the land to be fertile, both for agriculture and livestock⁴². The plain of Belezma, with a width of over 100 km, was in the past very fertile, as attested by the abundance of remains from the Roman era, both relating to residential and productive structures and to water collection and management systems⁴³. Aqueducts, dams, canalizations, cisterns and hydraulic works are well documented in the analysis of the territory conducted by Jean Birebent⁴⁴ in the early 1960s, evidence of an intense occupation of cultivable areas (fig. 9).

As evidenced by the inscription of Lamasba, near N'Gaous, at least 400 settlers must have settled here, as they were assignees of the hourly distribution of water, in land located on sloping terraces and in relation to

³⁹ LAPORTE 2014, pp. 309-314; cf. GSELL 1911, F. 48, 73; BARADEZ 1949, p. 116.

⁴⁰ LAPORTE 2014, pp. 319-322; cf. BARADEZ 1949, p. 119.

⁴¹ See Leschi 1949: based on some unpublished explorations conducted by Baradez in the Djedi valley. See also LAPORTE 2014, p. 322.

⁴² MORIZOT, DUPUIS 2001, pp. 893-894.

⁴³ BIREBENT 1962, pp. 340-351.

⁴⁴ BIREBENT 1962.

the types of cultivation practiced, such as arable land, orchards and olive groves⁴⁵.

THE AGRICULTURAL ORGANIZATION: *PRAEDIA* AND *SALTUS*

In Numidia there was no lack of important extensions of land, *praedia* and *saltus*, often imperial properties but managed by *conductores* with settlers and local manpower⁴⁶. Epigraphy documents its existence, especially in the area between Batna, Lambesi and Timgad⁴⁷, but also in the valley between Aurès and Belezma.

The site of *Lambiridi* appears to be interesting, not far from Ras el Ma (which can be translated as “Head of water”), about 25 km from Lambesi (see center of fig. 3); the settlement, documented by inscriptions, became a *municipium* in the 3rd century AD. At Ras el Ma in 1875 traces of buildings⁴⁸ from the Roman age were identified, taken over by the French military, some inscriptions and bricks with the stamp of the *III Legio Augusta*. The site was then the destination of an inspection in 2000 by Pierre Morizot⁴⁹, who found the area strewn with ancient materials including the inscriptions, already seen by Héron de Villefosse at the end of the 19th century, which attracted the scholar’s attention. It was a series of 4 blocks with inscriptions on both opposing faces, certainly belonging to the same epigraphic set. It was already published in the *CIL* and recognized as a poetic text in verses, which however remained completely obscure in their meaning. Pierre Morizot and Xavier Dupuis, connecting the blocks together, proposed a new interpretation; on one face they read the following text:

*Moenia quisque [f]acit famae et[ernae studet ille]
Qui maiora tenent ponant de m[ontibus altis]
Ad nobis satis est paruo de cul[mine parua]
Et tamen aequ[a]t amor paruas re[s grandibus ardens]*

They provided this translation:

« Quiconque édifie un monument aspire à une gloire éternelle,

Ceux qui ont de plus grands moyens l’érigent sur de hauts sommets,

⁴⁵ CIL, VIII, 4440 (p. 956) = 18587 = ILS, 5793 (p. 185) = AE, 1982, 955 = 1983, 978 = 1996, 1801. SHAW 1982, pp. 61-103; TROUSSET 1986, pp. 175-178, 192-193; MEURET 1996, pp. 87-112; IBBA, MASTINO 2012b, pp. 66-69.

⁴⁶ It is also worth remembering the legislation prepared between the second and third centuries AD against uncultivated lands, also applied in African land (BIUNDO 2019), such as the *lex Manciana* and the *lex Hadriana*. See KEHOE 2007, pp. 56-62.

⁴⁷ About ten *praedia* are recorded in Numidia (Lengrand 1996, table on pp. 113-114).

⁴⁸ The site was known as Henchir Fegousia: HÉRON DE VILLEFOSSE 1875, pp. 51-54; see GSELL 1911, f. 27, 115.

⁴⁹ MORIZOT, DUPUIS 2001, p. 894.

Mais il nous suffit de construire petit sur une petite éminence,

Et un amour ardent rend les petites choses pourtant égales aux grandes ».

The other face, more mutilated and difficult to reassemble, however lent itself to a comparison with similar inscriptions, such as the one relating to the *praedia* of *Rufius Volusianus*, found at *Thibursicu Bure*⁵⁰; the proposed lecture is as follows:

*In h[is praediis]
[---A]mpeli c[larissimi] [u[ri] et ---Ma]ximillae c[larissimae]
f[eminae] eius,
[--- in ho]c praetorio [--- c]um his omnibus
[---]fecerunt ac si[mul] dedicaerunt.*

The inscription would refer to an estate, owned by the *clarissimi Ampelius* and *Maximilla*, therefore owned by the *Ampelii* family, who built and dedicated a building in this “*praetorium*”, a term used in a public context, but often also in reference to residential parts of private villas. The poetic part almost seems to underline a particular context: “it is enough for us to build a small thing on a small summit: an ardent love makes small things equal to great ones”. In the interpretation of Morizot and Dupuis, the part that mentions the *praedia* and their owners appears to be directed towards the outside, towards those arriving on the estate, while the part composed in delicate verses would look towards the inside of the property and therefore the private dimension⁵¹. Both the paleographic characters and the comparisons with other epigraphic texts, also relating to the *Ampelii*, seem to lead back to the 4th century AD⁵².

These considerations fully fall within the lines present in Denis Lengrand’s study regarding the *praedia* in the Roman world, in particular as regards the use of the formula *in his praediis*, generally preferred in epigraphic texts to the definition of *saltus* or *fundus* to indicate a rural property. Among the 60 examples collected, often also with the determination of the owners’ name in the genitive, numerically the most represented areas are Italy with 21 attestations⁵³ and North Africa with

⁵⁰ CIL VIII, 25990; see MORIZOT, DUPUIS 2001, p. 907 note 9. The formula *in his praediis* is found in many other African inscriptions, such as CIL VIII, 20873, 20934, 24019; see LENG-RAND 1996, tables pp. 112-116.

⁵¹ Other fragments of inscription found in the surroundings (CIL VIII, 2517 and 2524) actually represent the citation of an epigram by Martial (I, 40): this is well suited to the socio-cultural context of the owners of the *praedia* (MORIZOT, DUPUIS 2001, p. 910).

⁵² A *Publius Ampelius*, originally from Antioch and known (Sidonius Apollinaris, *Carmina*, IX, 304) as a scholar and poet, was *proconsul* in Africa in 364 AD, but other *Ampelii* are known in Africa at least from the first century AD; cfr. MORIZOT, DUPUIS 2001, pp. 911-912.

⁵³ 15 in Rome and surroundings, 3 in Pompeii and 1 in Bologna, Narni, *Ficulea* in Lazio (LENG-RAND 1996, tables pp. 110-112).

34 attestations⁵⁴; other 4 attestations are documented in Syria, Illyria, Gaul, Britannia⁵⁵.

The formula is almost always recorded in the first line of the text and in most cases in the plural⁵⁶; in this way it is almost a proud affirmation of the owner's wealth and rights.

A concentration of *praedia* in the heart of North Africa, between Proconsular and Numidia, but also in the rich neighboring *Mauretania Caesariensis*, therefore in territories suited to agriculture, livestock and pastoralism, appears evident, with confirmation also in the archaeological documentation. In Numidia the attestations are located not so much around the coastal cities, but rather in the rich hinterland of the western sector of ancient *Cirta*, today Constantine, in two sites characterized by the presence of water: Ain Tin and Ain Djemil, both west of the great city. The Ain Tin inscription refers to the making of *turres* and *salus saltus*; therefore the defensive security necessary for the well-being of the hillside property seems to be evoked⁵⁷.

From *Thamalla*, north of the Hodna, already in *Mauretania Sitifensis*, comes a text which recalls the presence of a *balneum* on the probably imperial property⁵⁸. Three other inscriptions are found between Batna and Lambesi⁵⁹, while one comes from the Guergaoun valley on the western side of the Aurès⁶⁰; this clearly indicates the systematic occupation of this vast territory for agricultural purposes.

Particularly interesting is the text of Tamagra⁶¹, near Kenchela, the ancient *Mascula*, on the north-eastern

edge of the Aurès: here the senator *P. Iulius Iunianus Martialianus*, governor of Numidia between 227 and 230, owned a vast estate, which emphasizes being private (*in his praediis privatis*), certainly in a context where imperial properties were not lacking⁶²; his estates were managed by settlers, from whom he made a profit. The text also recalls how in that place spaces were rented in order to be able to make further profit (*vectigalia locantur*), as also happened in the city: in *Thamugadi*, for example, two inscriptions⁶³, coming from the western quarter, recall that *Q. Antonius Maximus Acutianus* and *M. Rutilius Castrensis* made spaces available for commercial activities (*meritoria praestantur*) for a fee.

In general, the *praedia*, at least as far as the best documented ones are concerned, can have very vast extensions and can include different types of land⁶⁴, such as *fundi* and *saltus*, but also buildings, from villas, with urban and rustic pars, to thermal facilities; the coexistence of complementary production plants, for example for ceramics and bricks, allows us to understand the complexity of the economic system underlying these large properties. They were also a family appanage and therefore passed on from generation to generation and generally belonged to local elites, often represented by senatorial figures⁶⁵.

In the case of the *praedia* attested at Ain Khalfoune near *Sitifis*, which belonged to a family of *Iulii*, of the senatorial order, a mosaic from a thermal environment confirms that the bathing facility was open to outsiders, for a fee, and therefore exploited as an additional economic resource⁶⁶.

Two inscriptions found in Ain Djemil between Milev and Constantine offer another element of reflection⁶⁷: they are in fact funerary texts of two members of the same family, father and son, who appear to be settlers and not owners. *Q. Staius Caecilius Butra* died aged 70, having spent 25 working on this property; his son *Profuturus* died at 57 and was buried next to him, having lived 30 years on the same estate with his father *Butra* and another 22 after his death. The role of the farmer within a property was therefore very important, as

⁵⁴ 2 in Tripolitania, 11 in Proconsolare, 10 in Numidia, 2 nella *Mauretania Sitifensis*, 10 in *Caesariensis* (LENGRAND 1996, tables pp. 112-116).

⁵⁵ LENGRAND 1996, tables p. 110.

⁵⁶ LENGRAND 1996, p. 109. The author has also collected the attestations of the word *praedium* on stamps of ceramic and clay material, considered indicative of production activities that took place within the properties; in some cases there are references to thermal baths, *horrea*, sacred buildings and burials, always built within the *praedia* (tables on pp. 110-116).

⁵⁷ CIL VIII, 19328; LENGRAND 1996, pp. 119-120; cfr. GSELL 1895, p. 56.

⁵⁸ LENGRAND 1996, p. 128. Near Setif too, in nearby *Mauretania Sitifensis*, two inscriptions are recorded with reference to the construction of a bath and a *villa*. In 8 cases Lengrand records the presence of *balnea* within private properties (p. 126); important among these was the site of Hammam Saiala, near Beja, ancient *Vaga*, in *Caesariensis*.

⁵⁹ The inscription from Lambesi (CIL VIII, 2841) actually refers to a very particular case: the dedication to *Tiberius Claudius Firmus, princeps* of the *III Legio Augusta*, for whom an altar was erected in Lambesi by his freedmen and heirs, while in Rome, on his properties, a mausoleum was built for the sum of 50,000 sesterces (LENGRAND 1996, p. 124).

⁶⁰ DUPUIS, MORIZOT 1992, n.8 p. 373, tav. III, 1.

⁶¹ ILS 6022; LENGRAND 1996, p. 118.

⁶² GSELL, GRAILLOT 1893, p. 470. Cfr. KEHOE 1988, p. 204.

⁶³ LESCHI 1943-1945, pp. 342-346; Leschi 1957, p. 233. Spaces for commercial activities were very often rented out in the urban *praedia*, as is well documented in Pompeii and in the Vesuvian area (LENGRAND 1996, p. 126).

⁶⁴ LENGRAND 1996, pp. 116-117.

⁶⁵ LENGRAND 1996, pp. 124-125. It is curious what Saint Augustine relates in a sermon discovered in recent times (DOLBEAU 1993, p. 413) about the fact that many owners posted signs, *tituli*, at the entrance to the estates, thus affirming their rights and their wealth.

⁶⁶ GSELL 1911, F. 16, 322, 323; CIL VIII 8424; LENGRAND 1996, p. 117.

⁶⁷ LENGRAND 1996, p. 118. CIL VIII, 20084-20085.

demonstrated in this case by the duration of the relationship and the bond established with the owner⁶⁸, which allowed for their burial *in his praediis*.

Owners may also include women, as in the case of the property at Ain Tin, near Mila⁶⁹: *in his praediis / Caeliae Maximae C(larissimae) F(eminae) / turres salutem saltus / eiusdem dominae meae / constituit / Numidius servus actor*. In this case it is the slave *Numidius* who builds for his mistress *Caelia Maxima* what is necessary to make the property safe and enjoyable and in particular the *saltus*, a hilly and wooded area.

MARKET PLACES AND COMMERCIAL TRANSACTION MANAGEMENT

From this same region come some of the most important epigraphic documents relating to the commercial activities that took place in precise market places, which were held periodically throughout the Roman world⁷⁰ (fig. 10).

An inscription⁷¹ from the first half of the 2nd century AD comes from Lambesi, in which reference is made to different types of goods and the corresponding tax levies, but which highlights the importance of the military component in this place: in fact, the *signiferi* were in charge of customs controls but also of the *cura macellii*, as shown by another Lambesitan epigraph⁷². In El Kantara (*Calceus Herculis*), an important obligatory passage in the network of roads in the area, the commander of the *numerus Palmyrenorum*, as reported in another inscription from the Antoninian era, had the delicate task of checking weights and measures⁷³. In Zarai⁷⁴, west of Lambesi, along the road that connected the ancient *Salinae Tubonenses* to Lambesi and *Thamugadi*, a well known inscription⁷⁵, the “Tariff of Zarai”, was found: datable 202 AD, its text defines the place as a customs office, through which various goods had to pass and then be placed on the market, and not only the goods destined to the local one.

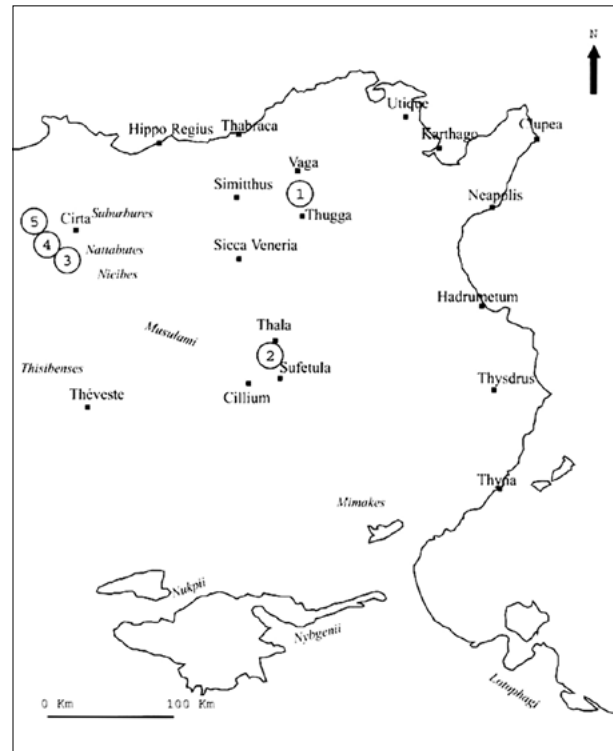


Fig. 10 – Location of *nundinae* (Chaouali 2002, fig. 1)

Here we find references to the laws in force on taxation deriving from trade⁷⁶, but also to the quality and quantity of goods in transit. As Pol Troussset⁷⁷ reminds us, “La position de Zarai à la Limite des deux grandes entités naturelles d’économies complémentaires que sont le Tell et le Sahara” makes this place an important point of contact between the populations of the North, more Romanized and close to Roman culture, and those nomads and semi-nomads who inhabited the South and had always managed the caravan trade routes⁷⁸: a sort of “boulevard présaharien”⁷⁹.

Morizot⁸⁰ also recalls the strategic importance of the place, an obligatory passage between the high plains of Constantine, the ancient *Cirta*, and the semi-arid steppes of Hodna, an essential stage along the transhumance routes, mentioned in sources such as Herodotus (12, 4, 198) and Strabo (20, 17, 3, 7; 23, 17, 3,

⁶⁸ In all likelihood *Butra*, of servile origin, later becomes a freedman and can therefore acquire the right to the *tria nomina*, which however the other members of his family do not have. GSELL 1933, pp. 413-414; LENGAND 1996, p. 118.

⁶⁹ CIL VIII, 19328. LENGAND 1996, pp. 119-120.

⁷⁰ DE LIGT 1993.

⁷¹ Reassembled from two fragments AE, 1914, 234 (fragment A); CIL, VIII, 18352 (fragment B). See De LAËT 1949, pp. 264-271; FRANCE 2014b, p. 94-101.

⁷² CIL, VIII, 18224 (ILS, 2415); cfr. FRANCE 2014b, p. 101.

⁷³ AE, 1941, 156; AE, 1980, 954; FRANCE 2014b, p. 101. The inscription is dated to 167-169 AD.

⁷⁴ In Ptolemy (Geogr., IV, 2) it is called *Zaratha*.

⁷⁵ C.I.L., VIII, 4508=18643. Cfr. De Laët 1949, pp. 264-265; TROUSSET 2002; FRANCE 2014a; ZANOVELLO 2020, p. 349.

⁷⁶ FRANCE 2014a.

⁷⁷ TROUSSET 2002, p. 368.

⁷⁸ TROUSSET 2002, p. 368: “Le tarif de Zarai est ainsi un document de premier ordre car il permet de saisir le monde nomade dans sa double fonction d’éleveur transhumant et de transporteur caravanier”.

⁷⁹ TROUSSET 2002, p. 368. On the network and the importance of these market places in this type of Saharan society, in constant movement and interface between nomadic and sedentary populations, see also SHAW 1981.

⁸⁰ MORIZOT 2009, pp. 162-163.

15); the same denomination of Zarai, of Berber origin, is “transparent” in its meaning of “transit”⁸¹. The site has yielded about sixty inscriptions, which make extensive reference to the military presence, the existence of a *praetorium*, an *ordo Zairitanorum* and the presence of many veterans, recipients of land assignments⁸². According to France, the “Tariff of Zarai” had the fundamental purpose of clarifying the new procedures, put in place after the reorganization of the border and the departure of the military cohort previously stationed in this place: a sort of “reminder” between old and new provisions, placed to avoid disputes and misunderstandings. The reference authority is now the legate of the new province of Numidia, created between 197 and 201, and qualifies the post of Zarai as an imperial *portorium*⁸³. The change that has taken place is therefore evident: with the departure of the cohort, the rules change and the products destined for the army and veterans (who often become *conductores*) are exempt from tax levies; this probably aims to facilitate transactions between civilians and military.

The area was therefore the point of contact and exchange between the agro-pastoral economy and the merchants, according to a guideline that basically follows the paths of transhumance; the same geographical orientation can be seen in the *Tabula Peutingeriana* where the *via Tubunae-Sitifis* is represented, probably passing through *Zarai*. Furthermore, the large number of milestones found between Tobna and N’Gaous, the territory of the *Nicives*, being similar to what is found along main routes such as *Carthago-Theveste*, demonstrates that also this route must have been very busy⁸⁴. Even if it refers to a delimited circumscription, above all the document of *Zarai* testifies to the existence of a wide network of communications between the Saharan area inhabited by those mixed populations, well known to the ancients, such as *Gaetuli*, *Mauri*, *Garamantes*, and the mainly mountainous territories of the North, more open to the Mediterranean and its international trade routes. Furthermore, *Zarai* was located a very short distance from the border between Numidia and *Mauretania Caesariensis* and it is therefore probable that commercial traffic also took place in an east-west direction, along the axis traced by the progress of Romanization in North Africa⁸⁵ (fig. 11).

Other epigraphic texts, found in the same topographical context where *Zarai* is located, allow us to under-

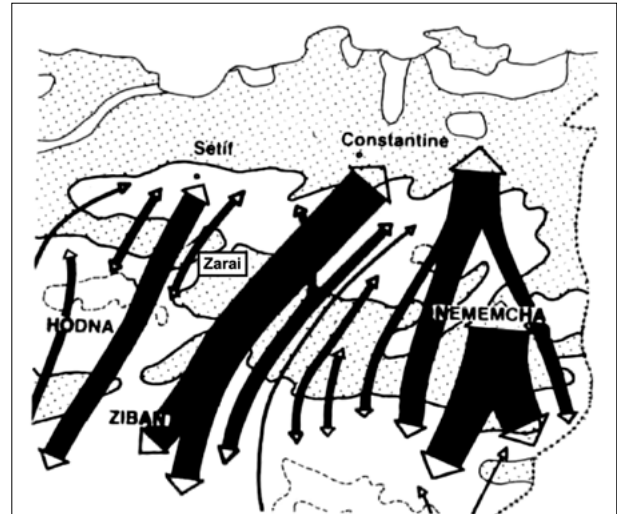


Fig. 11 – Location of Zarai along the traffic routes (Achaba da Cote 1988, p. 69)

stand that in some localities, usually where there were water points and therefore privileged rest areas along the road or caravan routes, rural markets or *nundinae* were organized: this is the case of Ain Kerma and Ain Mechira⁸⁶, whose toponyms significantly report the word “ain”, source.

“Le tarif de Zarai et les inscriptions d’Ain Kerma et d’Ain Mechira prouvent que le but n’était pas seulement de regulariser le va-et-vient des troupeaux afin de prévenir son cortège de désordres, mais bien d’occuper les points nodaux où s’effectuaient périodiquement les déplacements et les contacts entre semi-nomades et sédentaires”⁸⁷. Pol Troussset rightly underlines the importance and role of nomadism and semi-nomadism in the Roman-African context and in particular in the border areas, contradicting the old formulation of Gsell or Gautier who saw the nomads as populations expelled under the Roman impulse from the mountainous areas of the Tell towards the desert expanses⁸⁸. Water was essential for the birth of these rest and commercial exchange centers that arose along the transit routes: the presence of a spring was sufficient to guarantee the usability of the place for these purposes.

⁸¹ FRANCE 2014b, p. 94.

⁸² FRANCE 2014b, p. 94; cfr. GSELL 1893, p. 143; GSELL 1911, pl. 26, 69.

⁸³ About *portoria* cfr. DE LAËT 1949.

⁸⁴ MORIZOT 2009, p. 162.

⁸⁵ MORIZOT 2009, p. 163.

⁸⁶ TROUSSET 2002, pp. 369-370. Cfr. CHARBONNEL, DEMOUGIN 1976; MELONI 2008.

⁸⁷ MORIZOT 2002, p. 370. Cfr. SALAMA 1973; SHAW 1981, pp. 59-61.

⁸⁸ TROUSSET 2002, p. 371. Both Stéphane Gsell, archaeologist, and Émile-Félix Gautier, geographer, who lived between the late nineteenth and early twentieth centuries, dedicated numerous studies and research to the North African, Saharan and Algerian territories in particular: GSELL 1902; GSELL 1911; on Gautier, lesser known, see LARNAUDE 1940 and LEVEAU 2018, pp. 48-55.

It should also be emphasized that the commercial activity is directly connected to the productive activities: very often the epigraphy and the literary sources document rich landowners requesting the state authority to be able to set up periodical markets inside of their funds, generally in peripheral areas and closer to the road layouts. In this way the landowners had the possibility to increase their earnings through trade, but at the same time they offered the state authority a guarantee to control over the transactions that took place on their own lands: these markets could then become the necessary points of reference for the collection of tax levies to be allocated to the Treasury. Several examples of this are attested in the area between Numidia and nearby Proconsular Africa, on this subject an overall study⁸⁹ demonstrates the importance and fundamental role that these places assumed in the economy, not only local and linked to the large landed families, but above all in its relations with Rome, especially between the 2nd and 3rd centuries AD.

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⁸⁹ CHAOUALI 2002. See also MELONI 2008.

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THREE UNUSUAL FORTIFICATIONS IN WESTERN HODNA (ALGERIA): HENCHIR MEÏREBIÂ – LOUGMANE – BOULSANE

Souad Slimani

Faculty of Humanities and Social Sciences, Department of Archeology, University of Constantine 2 Abdelhamid Mehri

In this article, we present a non-exhaustive study about the condition of three sites, probably military in origin, found during surveys carried out in the western part of Hodna (west of M'sila) in Algeria, in the area located between west of Aras (currently known as «Tarmount») and east of Zabi-Justiniana (Antique Bechilga). In this paper we will provide a summary of the information available about these places, confronting the field data with old information mentioned in a few of the archives we have consulted, then we will add new data. Two of these sites are reported on the map 25 (M'sila) of Gsell's Archaeological Atlas of Algeria: Henchir Meïrebiâ and Fort Lougmane. The third is called Boulsane by residents, and was recently discovered.

KEYWORDS: Hodna; Henchir Meïrebiâ; Lougmane; Boulsane; fortified farm.

INTRODUCTION

The three sites under the study were found throughout the surveys carried out in western Hodna (on the west side of M'sila) in Algeria, in an area located between west of Aras fort (currently known as «Tarmount») and east of the ancient Zabi-Justiniana city (Antique Bechilga). Two of these sites were reported on map 25 (M'sila) of the Archeological Atlas of Algeria (Gsell, 1911). The first, *Henchir Meïrebiâ*, was mentioned as number 7 of this map, but not having found the latter at the place indicated, in order to indicate the different place we propose to use “7bis” for our new emplacement of *Henchir Meïrebiâ*. The second fort, present on the same map as number 20, is reported in the Atlas as “roman ruins”, but we will call it *Lougmane*. The third and last one was recently discovered and it is called *Boulsane* fort, since this is the toponym attributed by the local residents (see fig. 1).

HENCHIR MEÏREBIÂ (7)
(35°50'34.64"N - 4°12'11.61"E)

At number 7 of map 25, Gsell places a roman camp called «*Henchir Meïrebiâ*», and partly quoting a report by M. de Kermabons, describes it as having a large rectangular enclosure with a length of 300 m (west-east) and a width of about 200 m (north-south); the remains discovered on the spot were rocks, enormous in size, that were used for its construction, fragments of columns, pottery fragments and few roman coins. Gsell also inferred the existence of square cornered bastions and, at about 50 meters to the south, the existence of ancient wells, but was unable to indicate the era of this

fort; he assumed that it was monitoring the immense plain which extends to the west and to the south and also had to maintain the road from Zabi-Justiniana to *Auzia* by Aras and *Tatilti* (Gsell, 1911, map 25, n°7).

Furthermore Massiéra, basing his deduction on an aerial view, thought that the dispositions of the three corners of Aras camp would be similar to that of the south-southeast corner of *Ain Meïrebiâ*, a camp which was reported close to Aras (Christoffe, 1935, p. 279), but he did not provide any further details about this camp used for comparison.

Currently the *Henchir Meïrebiâ* toponym is unknown to the residents of the region and it is not even mentioned on the topographic maps. It can be found only in an overall schematic map of the *Tarmount* region, created by Paul Massiéra and found in the archives of M'sila (Bastion 23) located in Algiers.

The prospection of this location certainly allowed us to confirm an antique occupation, although the remains have nothing to do with what had been reported by the two authors briefly mentioned. Indeed, the number 7 is exactly at an altitude of 600 m and at a distance of 7km northwest of the ancient site of Aras. It has an almost square shape (21×22m²) in ruins and the structure is barely visible. However, we were able to distinguish the remains of an 11m wall with an average thickness of 0,7 m. It appears to be constructed in *opus africanum* with rubble fillings. Elsewhere, a few remarkable stones were still in place, intercalating rubble structures. (fig. 2). In addition to a column base we found remains of tile, mixed with a layer of mortar made of whitewash and clay. Outside this area we saw the upper part of a manual mill (*catillus*) and some shards of common ceramic.

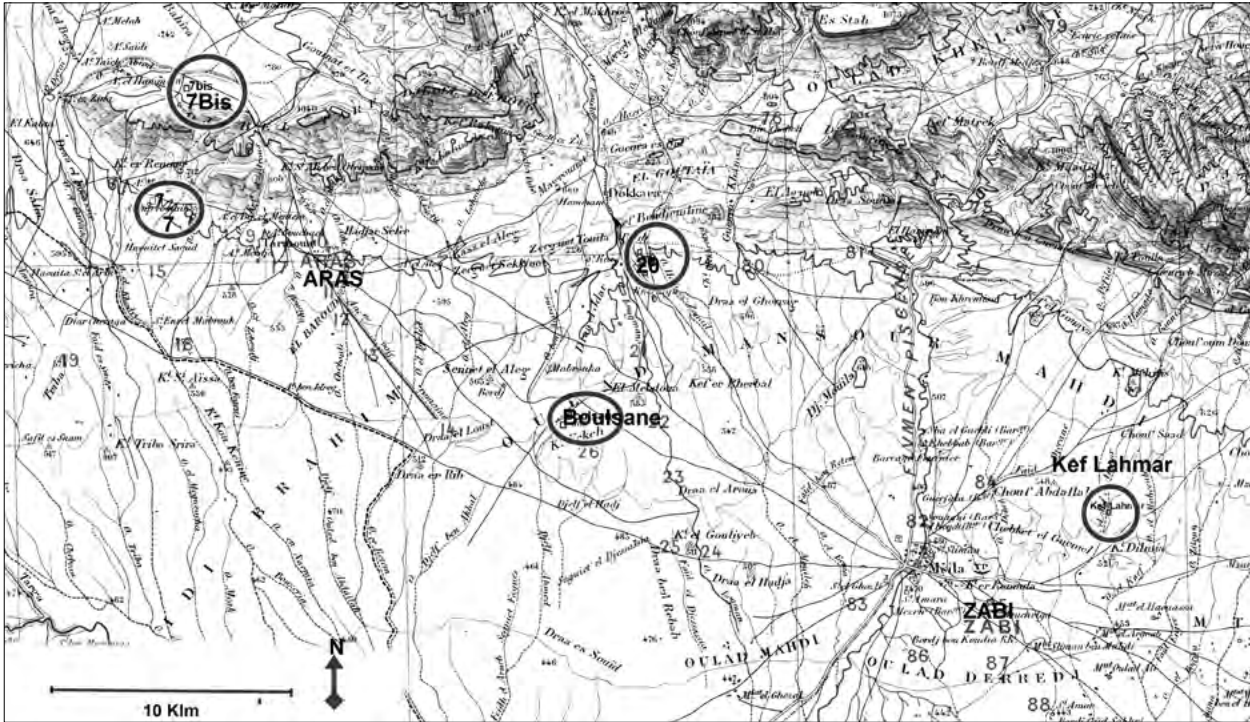


Fig. 1 (above) - The location of the three forts over Gsell Atlas (GSELL 1911).

Fig. 2 (beside) - Remains found at number 7 of Gsell map.

Fig.3 (below) - A reproduction of the Baradez Plan (BARADEZ 1939/ 1961)



Note that the site is covered with a runoff coming from *Djbel Tarf* at an altitude of 962m. We thus speculate that it seems more like a farm rather than a military establishment.

POSSIBLE REAL LOCATION OF HENCHIR MEÏREBIÀ'S (7BIS)
(35°52'57.71"N- 4°12'50.43"E)

Looking at the Jean Baradez fund, kept in the *Outre-mer* archives (Baradez, 1939/1961), we came across an unpublished manuscript, it's a note of two pages (back-to-back) but without any date. Apparently, Baradez described the *Henchir Meïrebià* camps, seen from above, with a very schematic and unscaled plan. (fig. 3)

At the top of the first page, Baradez locates the roman camp 9 km west-northwest of *Tarmount*, saying also that it refers to number 7 of map 25 (Gsell 1911). We are then facing a difference of 2 km compared to the position mapped on this map.

Using the available description and schematic plan we were then at the mercy of Baradez, but a virtual prospecting (via Google Earth) eventually allowed us to identify the real location of the so-called roman

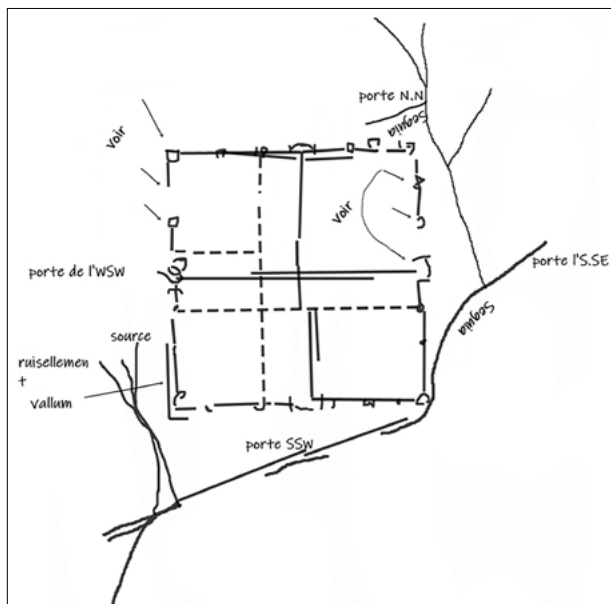




Fig. 4 - A view of 7bis (Google Earth).

camp. (fig. 4), to which we attribute the number 7bis that will be used in the figures of this article. Still, this did not prevent us from questioning the description of Baradez, either after examining the satellite images from Google Earth or even after a survey performed in these places.

From an aerial view the structure seems effectively a square in shape ($\approx 500 \times 500$), with a northeast-southwest orientation. At the northern corner, we clearly distinguished a projecting rectangular structure ($\approx 95 \times 115$), it's the highest point of the slope, at an altitude of 880m. Compare this with Baradez note: «it seems similarly squared. Orientation northeast-southwest, conditioned presumably by the slope of the terrain. [...] Corner towers, the northern one is the best preserved».

The so-called «roman camp» is exactly at 9km northwest of *Tarmount*, on *Djbel Tarf*'s northern slope, between *Hamam Etarf* village in the west and *Djaraa el Haouas* vil-

lage in the East. In other words, it is also on the way from *Tatilti* to *Zabi-Justiniana*, passing by *Aras* (Salama, 1951). On the ground, the rocky land makes it difficult to identify the site as well it's internal layout. However Baradez thought it could locate the other towers, four gates and the internal grid, he wrote: «It seems that the fort had four gates, the one in the north-northeast, apparently the least erased on the surface along with that of the southwest, on the contrary it is likely that the east-southeast door is covered by a thicker layer of alluvia. Between each door and each corner there were 2 towers splitting the corner-door distance in three equal segments. The two towers which seem least obliterated were those located between the north-northwest corner and the western gate (through which passes a runoff channels or a spring) [...] The construction's grid is easily found».

In reality we found ourselves facing a rather large and irregularly shaped enclosure (fig. 5). With diameters varying between 6 and 13 m, the site is dotted with nu-



Fig. 5 - A structure inside 7bis.

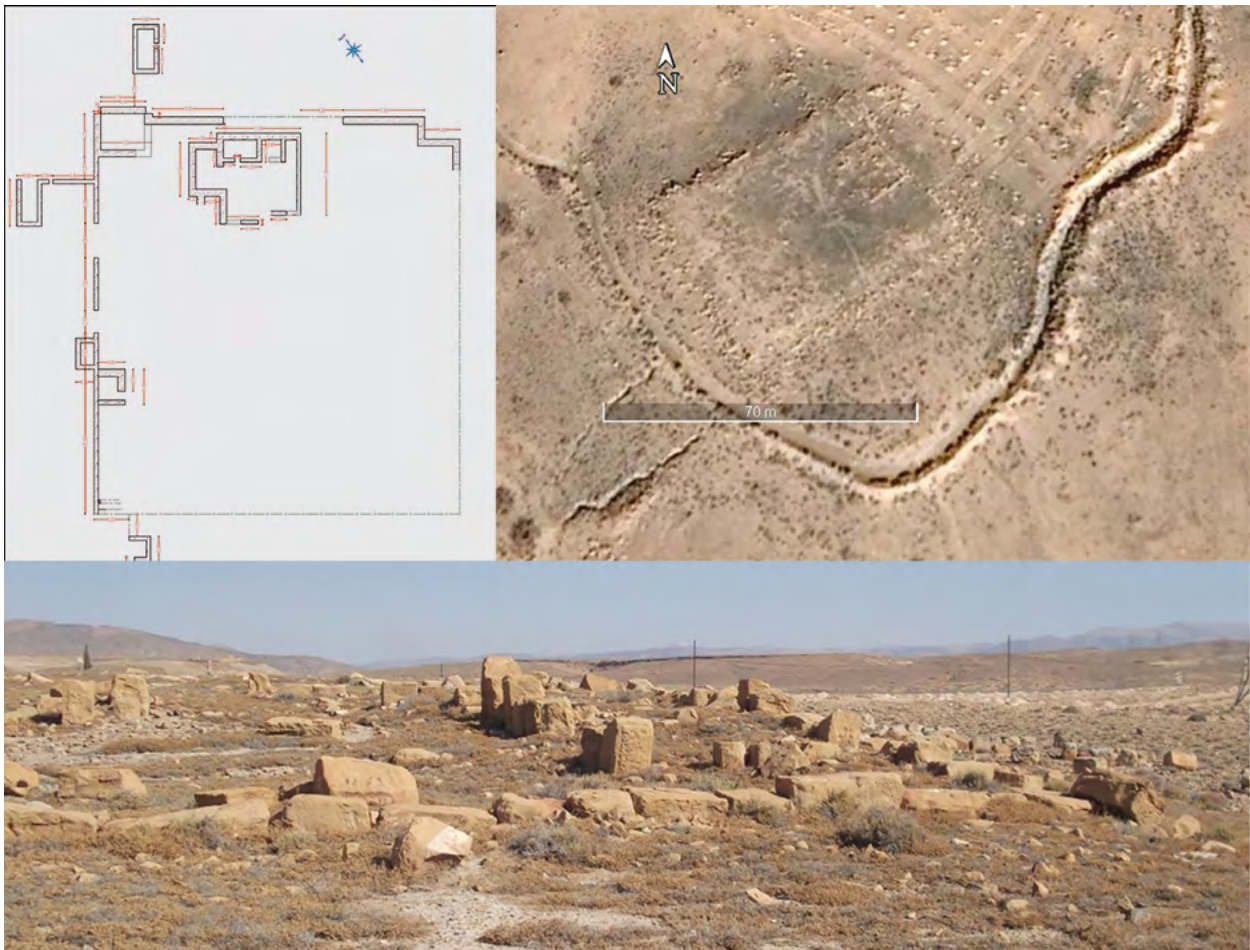


Fig. 6 - Lougmane Fort.

merous *bazinas*. These frustoconical tombs, which would have been still there after the abandonment of the site, are part of a necropolis extending over almost the entire expanse of *Djbel Tarf*, reaching in part the northern region of *Tarmount* (Gsell 1911, map 25 n°19). This landscape immediately reminded us of the *Ausum* fort (*Bir Sadoun*) site, a third century military camp on the *limes* (Carcopino 1925, pp. 30-57) located in the extreme southeast of *Hodna*, where eleven *bazinas* were recently found inside the perimeter, as firstly reported by Gsell (Gsell 1911, map 48 n°1) and then identified by Morizot in an aerial photo (Morizot 1997, p. 156).

Regarding the interior part of *Henchir Meïrebiâ*, we had to use rocky reliefs in order to fill in the constructions of several spaces, just like the layout sometimes carried out in the city of *Tiddis* in Numidia. In general the deteriorated condition of the site makes it hard to determine the shapes, especially, with no trace found of the carved stones or other architectural elements: everything seems to have been returned to its natural state. Wall aisles are leadind to different directions,

only a precise survey would enable to read the details closely. Even the ceramics materials are very rare, a few common fragments, mostly modeled.

Regarding the protruding part in the south corner, called by the residents *Elkherba*, it has seen posterior development, transforming it into a dwelling.

In conclusion Baradez, looking from above, thought he had seen a tetrarchic camp «*in summary, this camp has the appearance of tetrarchia*». On the ground however everything seems different and more complicated: no clear trace of roman occupation was found and we were wondering if it was a refuge or even a habitat established in a natural reserve and was subsequently abandoned. This would explain the presence of the *bazinas*. A similar site, with a different desing, was found in the Ouenougha area. It is known locally as Bouglada (Slimani & Kherbouche, 2019, pp. 10-12). The latter is located at a distance of 12 km as the crow flies, north-northwest of *Henchir Meïrebiâ*.

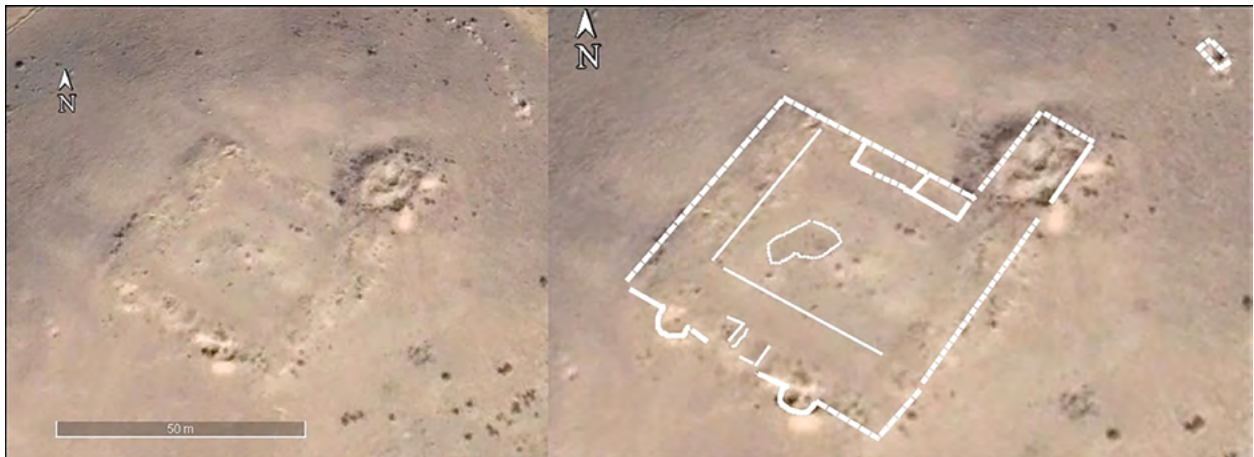


Fig. 7 - Lougmane Fort (Google Earth).

LOUGMANE FORT

(35°48'46.43"N- 4°25'41.02"E)

A roman village ruins (Gsell 1911, map 25 n°20), occupying an area of 500m²; we named it *Lougmane*, because it is built on a fertile land dominating the left bank of *oued Lougmane*, it is also surrounded by a runoff coming from this *oued* (fig. 6). On this *oued*, we can still see the remains of an old hydraulic system: four dams at successive intervals of 3500m (the last of which must have been a settling basin), supply pipes and a few reservoirs (Payen 1864, pp. 7-9).

A rectangular enclosure (≈80,5 x 62 m²), whose two courses are still visible, is oriented northeast-southwest. Inside and in the middle of the north east face, a central rectangular recess (≈16 x 12 m), facing large courtyard, barely rises from the ground.

Traces of towers appear outside the enclosure on the north west side; the one on the north west side, at the west corner, has a rectangular shape (4 x 9 m) and seems the most intact. The whole place is built with large blocks made from poorly cut stones.

The schematic plan of this installation recalls the architecture of *Benia Guedah Ceder*, a *castellum* on the *limes tripolitanus*, near the *El-Djérid chott* on the Tunisian-Libyan border (Troussset 1974, pp. 67- 68): this place dates back to the early fourth century and Maurice Lenoir preferred to classify it as a large farm, rather than a military installation (Lenoir, 2011, p. 280). This is the case of several sites in Africa (Février, 1990, pp. 82- 85) and it is possible this is also true for *Lougmane*.

BOULSANE FORT

(35°45'29.94"N- 4°23'20.77"E)

The fort of *Boulsane* is similarly located at the top of a mound in the middle of a fertile land and on the right bank of *Oued Fagues*, an affluent of *oued Lougmane*, located southwest of the previous location at a distance of 7km as the crow flies (fig. 6). It was probably monitoring the ancient route which connected *Auzia* to *Zabi* (Slimani- Kherbouche 2019, p. 202). A milestone is still resting in place nearby (Kasdi & Slimani, 2019, pp. 280-286). The fort structures are barely visible on the ground, it has an almost square shape (≈48x49 m). The average thickness of the exterior walls is 0,80 m, while the interior walls have a mean thickness of 0,60 m (fig. 7).

We were able to find only one entrance on the southwest side, with an opening is of 2,80 m. On either side of this entrance the remains of two semi-circular towers are visible: the one on the left (looking at the entrance) is located 10 m from the south corner, whereas the other is 7 m from the southwest corner. It should be noted that Pol Troussset thought that enclosures with bastions and a single door were very common in Numidia and they should be dated to the fourth century. In addition, towards the outside of the eastern corner of the north face, a rectangular (≈8x13 m) extension is protruding from the ruins. Inside two rectangular spaces adjacent to the enclosure are facing the courtyard. Similarly, about 80 m down the slope of the mound and with the same orientation of the fort, we registered a rectangular structure (13,85 x 9,92 m) that also had an opening of 0,9 m on the southeast side.

All that remains of the site are basements in large irregular stones and cobblestones, sometimes bound with mortar, covering the entire surface and the slopes; probably the structures were built in *opus africanum*.

The structure of Boulsane is reminiscent of fort Ksaren-Kabouch (Mercier 1901), one of the strategic military posts which ensured the connection with *Saldae* (now *Bejaia*) and *Tubusuptu* (now *Tiklat*) (Gagnat 1913, pp. 642-644).

Little ceramic was collected on the surface: remains of tiles, *dolia*, shards of common ceramic and even African *sigillata*, belonging to kitchen utensils, bearing stamped decorations of guilloches, crosses and other frequent motifs of the late period (Ben Moussa 2007, pp. 198-213).

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FOLLOWING BARADEZ'S TRACKS: THE GIS APPROACH USING PHOTOGRAPHIC AND SATELLITE SOURCES WITH TWO EXAMPLES AROUND THE AREA OF FONTAINE DES GAZELLES (BISKRA, ALGERIA)

Andrea Meleri

Università degli Studi di Padova / dBC

*The aero-photographical and ground surveys conducted by Jean Baradez in the 1940s, later published in his *Fossatum Africae*, are an often overlooked source of information about the rich and complex network of archeological sites around the roman *limes* area of Biskra (*Vescera*) in Algeria. An effort was made to georeference in GIS most of the published Baradez aerial photos against modern satellite imagery and other sources, leading to the potential (re)discovery of many archeological sites. Some of these sites were found and surveyed during two short archeological campaigns conducted in 2018 and 2019. This contribution presents some preliminary findings, along with specific examples highlighting both the quality and the conservation risks of these sites, often located in the vicinity of recently developing peri-Saharan areas.*

KEYWORDS: Algeria, archaeology, Baradez, aerial photography, satellite imagery, GIS

THE NUMIDIAN *LIMES* AND THE *FOSSATUM AFRICAE*

Although the *limes* segments in the Rhine-Danube region and in the north of Britain are more researched and bibliographically known, the African *limes* was probably the first to be traced on the ground, already in the aftermath of the fall of Carthage in 146 BCE.

Since its genesis in the African landscape, the roman *limes* was certainly not intended in its modern and uni-dimensional paradigm of a line drawn on the ground, but rather as a large border area, infrastructured with military works (ditches, observation towers, *castra*) but also civil works (roads, water pipes, agricultural divisions and the related production centres, *villae*): not so much, or in any case not only, a border line to be defended but rather a wide swath of territory, peripheral but actively productive and osmotically open to controlled commercial and socio-cultural exchanges with the external areas¹.

At the end of the XIX century a significant stretch of the African *limes* was identified by the French historian and cartographer Gsell with a ditch called by the locals *seguia*²; the area is located south of Biskra and nearby the already known remains of the roman fort of *Gemellae*³;

¹ FORNI 1987, BIREBENT 1964, FERCHIOU 1998, ZANOVELLO 2017, 2019 and 2020.

² BASSET 1905: these are the remains of what the locals had always believed to be an ancient irrigation canal.

³ GSELL 1911 and 1929, BARADEZ 1949b, TROUSSET 1998: GEMELLAE is present in the *Tabula Peutingeriana*, as is probably the

this is the first discovered segment of what is now commonly known as the Numidian roman *limes* of Africa.

The investigation continued in the aftermath of WWII, thanks to the pioneering work conducted remotely and on the ground by Jean Baradez, a french army aviator who was familiar with Gsell's work in Algeria thanks to his personal interests in antiquities and his personal friendship and collaboration with the coetaneous archaeologist and epigraphist Louis Leschi⁴.

During and after the war Baradez was stationed in the french colonial department of Algeria. In his role as reviewer of territorial infrastructure projects, Baradez found himself examining hundreds of aerial photos taken for prospecting purposes, thus identifying in the aerial photos not only the traces of the *seguia* of Gsell, but also many other stretches of the roman *limes*. These traces were located in a much larger area that, consistently with the toponyms and itineraries present in the ancient sources, must have been the southern perimeter of the roman territorialization in this area.

Thanks to new and specific aerial photography campaigns promoted by Baradez himself, the length of known segments of the roman *limes* was thus extended from 60 km to 240 km (fig. 1). Moreover, the complexity of the network of military, civil and produc-

centre of Biskra itself which appears with the name of *Ad Piscinam* (perhaps at the origin of the latin toponym *Vescera*, see TABBERT 2010, 3C2).

⁴ LESCHI 1928, EUZENNAT 1971.

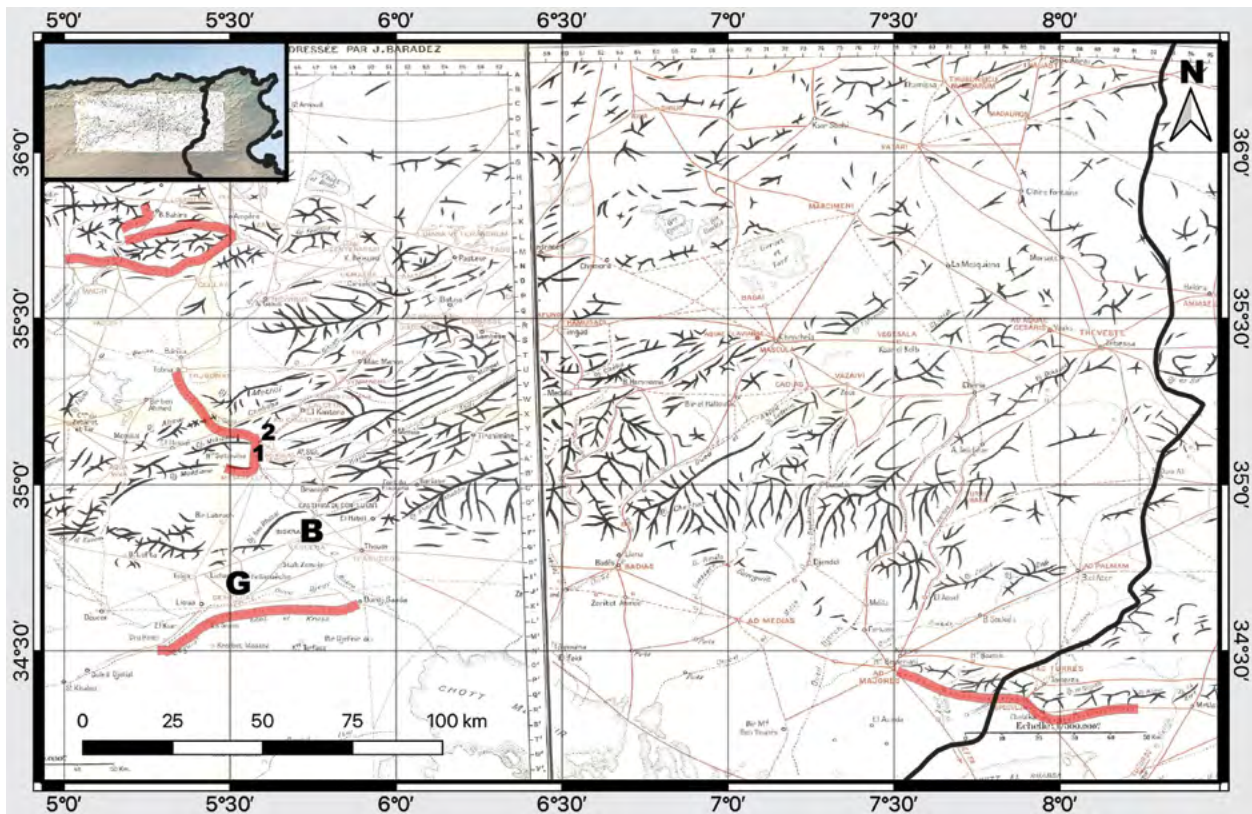


Fig. 1 - Segments of the numidian *limes* identified by Baradez (shown as thick red lines): B = Biskra, G = fort Gemellae (with the below the *segua* identified by Gsell), 1 marks the surveyed segment of the *limes* and 2 the nearby area of *Fontaine des Gazelles* (maps from BARADEZ 1949a, georeferenced and edited).

tion infrastructures that populated these border areas clearly emerged from the aerial photos, augmented by Baradez's interpretation and survey campaigns on the ground (fig. 2). All the findings were collected and published in his seminal work *Fossatum Africae*⁵ in which the author implements the textual description of the findings with the use of interpretative transparencies that can be superimposed on the printed aerial photos.

The use of aerial and zenithal photos in archaeology was innovative, in a time when lateral pictures were preferred⁶, and in this case it was particularly crucial. The author himself recounts how often the traces of the structures evident in the photos revealed to be evanescent when seen from the ground, moreover if this survey was uninformed and not expected to find something. The morphology of the places, mainly peri-desert areas that have experienced a moderate erosion due to atmospheric agents⁷, helped to disguise on the

ground those same traces that were so evident in the aerial photos. At the same time these regions had not seen too much continuity of frequentation and consequently the remains that had been naturally hidden had also remained largely undisturbed, ready to be found during an informed and guided ground survey.

GEOREFERENCING BARADEZ

The number of archaeological sites identified and volume of information published by Baradez is considerable, but after the 1950s very little has been investigated regarding the new sites identified in *Fossatum Africae*. The Algerian independence in the early 1960s, the construction of an autonomous nation and a *de-facto* civil war in the 1990s evidently imposed other priorities on the country. The generation of archaeologists that was formed at the turn of the new century is the one that in the last two decades has begun to take up again the investigations that were somehow put on hold with the end of the French colonial phase.

In this context of renewed interest in the archaeological past of Algeria, a rich and recent source of information as *Fossatum Africae* should play a pivotal role, but its use to

⁵ BARADEZ 1949a

⁶ For the beginnings of archaeological aerial reconnaissance see GESTER 2005.

⁷ Wind erosion is the most constantly active agent, but the areas are also affected by water erosion events, which in the peri-desert regions can be occasional but of considerable magnitude.

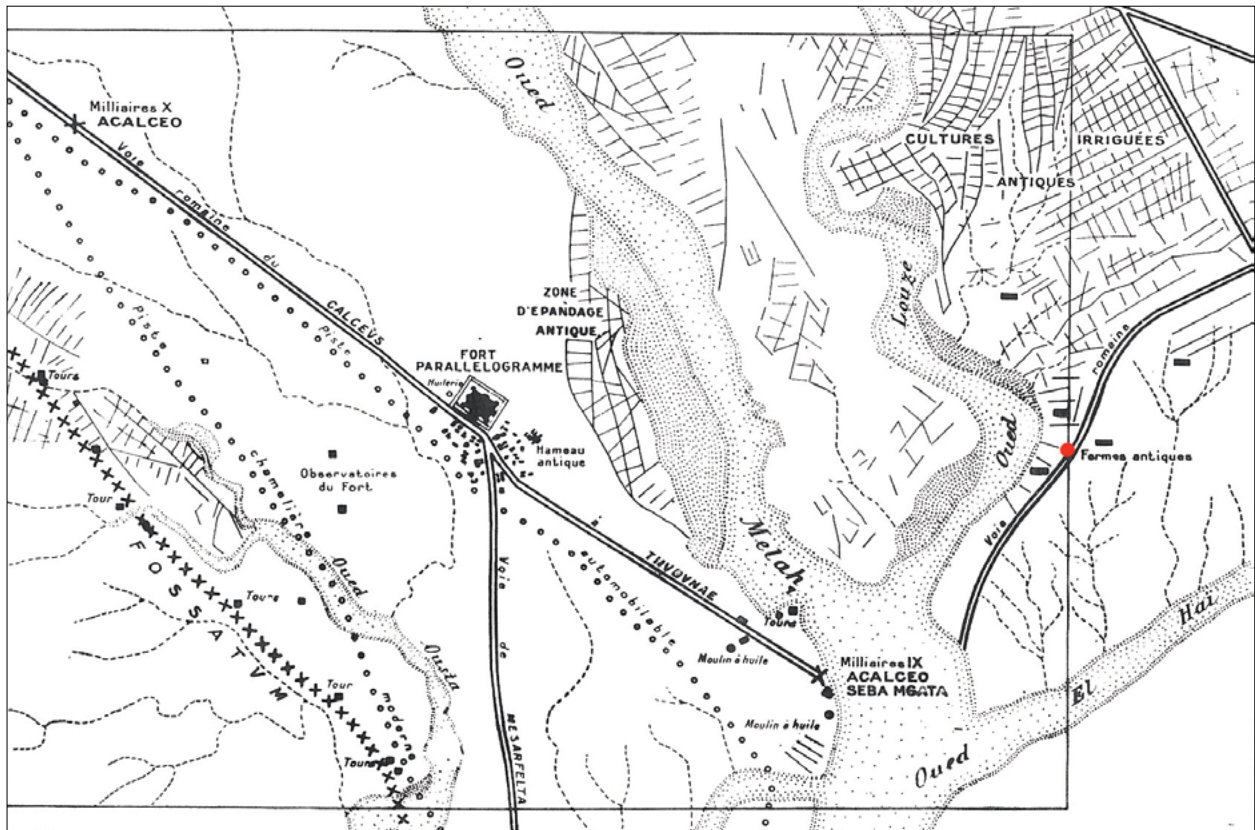


Fig. 2 - Example of a Baradez's annotated archeological map, derived from aerial photo imagery and analysis on the ground; the area shown is the one surveyed around *Fort Parallelogramme* (near 2 in fig.1), the *limes* passage is visible on the lower left, on the right the area of ancient cultivation and *fermes antiques* (the red dot is the set destination target for the survey), note the absence of geographical grid or distance scale (BARADEZ 1949a p.12).

guide new ground-based exploration is far from straightforward. The aerial photos are printed at different and sometimes unknown scales, the geographic north is not always indicated, the reference of a geographic grid is missing. The geographical location of a given photo present in the book is still possible but would be approximate, being frequently based on toponyms no longer in use. In its published form Baradez's work is not always able to guide an archaeological survey aimed at (re)discovering the sites described by the author, especially for the vast majority of less known sites that, for these same reasons, were left untouched and unexplored since the 1950s.

The most natural arrangement of all the archeological and geographical information present in *Fossatum Africae* in a modern medium seems to be a geographic information systems (GIS) project. This is a choice that seems also faithful to some intuitions of the author: his idea to publish interpretative transparencies that could be superimposed on the printed aerial photos somehow foreshadows the common GIS method of drawing informative vector layers over georeferenced photos.

To this purpose the majority of the photographic and cartographic contents present in Baradez's work were

digitised, georeferenced and collected inside a GIS project, specifically using the free and open source QGIS platform⁸. Thus, using mostly free satellite photos as a reference (Google Maps and NASA missions), almost all Baradez aerial photos⁹ placed within a radius of 50 km from Biskra have been georeferenced (fig. 3), exclusively using geo-morphological and anthropic control points that could be safely assumed to have remained unchanged in the intervening years¹⁰. Baradez interpre-

⁸ See <https://www.qgis.org> - the use of free and open source software seems preferable in an international collaborative context.

⁹ Along with and some other aerial photos that were made in the 1970s were provided by the university of Biskra.

¹⁰ Mountain or hill ridges and other geo-morphological features, but also ancient anthropic features still visible in recent satellite images (forts, trenches, grids of ancient cultivated areas). A specific *genus* of bush, resilient and endemic of these peri-desertic areas, was sometimes used, since its dotted arrangements of individuals frequently maintained the same recognisable geometric shapes from the 1940s up to the current day. An in-depth study of this specific botanical aspect could be valuable in the context of a future valorisation of the passage of the numidian *limes* in these areas (for example as an eco-friendly and resilient marker of the passage of the *limes*).

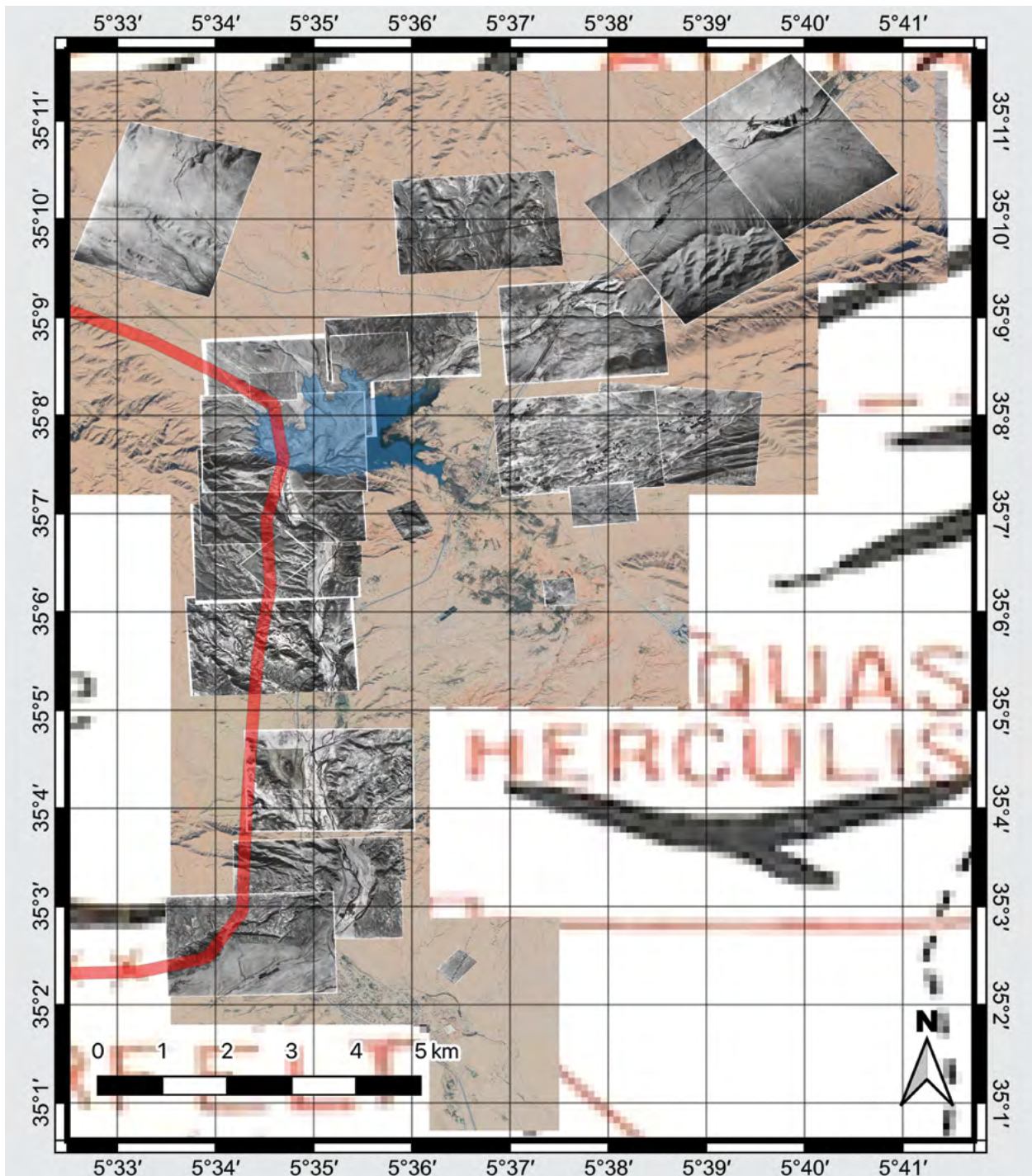


Fig. 3 - A subset of georeferenced Baradez aerial photos around the area of *Fontaine des Gazelles* artificial basin (1 and 2 in fig.1), shown above satellite imagery and the same Baradez maps visible in fig. 1; the *limes* trace is enhanced as a thick red line, and the extent of the artificial water basin is shown outlined in blue.

tative transparencies were then georeferenced over the photos. These layouts really contained the most relevant information, since they had already been controlled on the ground by the author. All the features and structures discovered and outlined by Baradez eventually acquired precise geographical coordinates.

Already in the first phase of the analysis, which was conducted only remotely, the consistency of this operation emerged: even in areas distant from the control points the visible features were matching traces still identifiable in recent satellite photos, with a maximum drift of about 10-20 meters: a precision sufficient to ef-

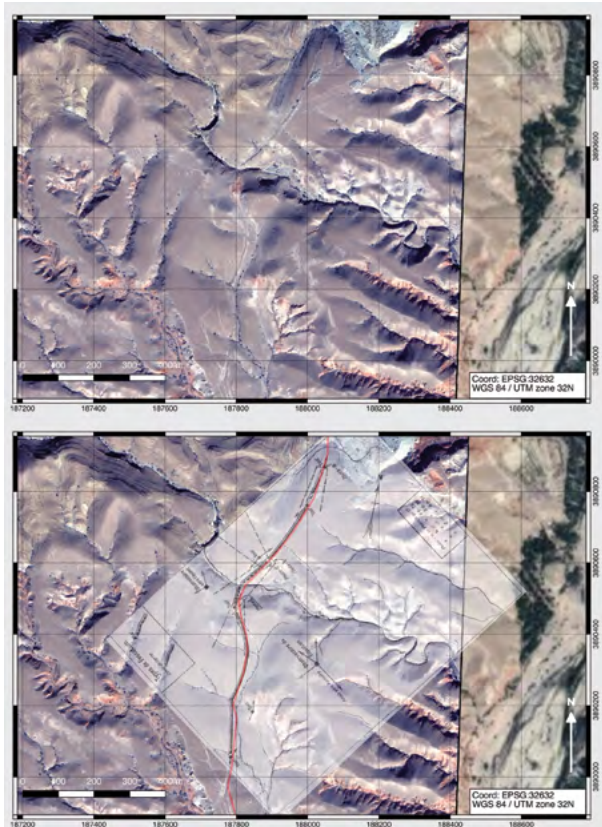


Fig. 4 - Example of remote analysis of a 1 km segment of the *limes* (area around 1 in fig.1); the first image shows the satellite imagery without annotations: many similar traces are visible in this peri-desertic area; the second image shows the reconstructed route of the *limes* falling within few meters of one of the satellite traces. Note how the shown Baradez transparency used to reconstruct the route of the *limes* is lacking a coordinate grid and a distance scale, but when georeferenced the terrain morphology is matched very closely.

fectively guide the survey of evidences in the following phase (fig. 4).

FOLLOWING BARADEZ'S TRACKS

The second phase of the analysis was conducted on the ground during two short archaeological survey campaigns (about two weeks in march of 2018 and 2019), using the cartographic information reconstructed in the first phase and with the indispensable support of the colleagues from the University of Biskra.

Two specific cases will be presented, both related to the same segments of the *limes* that run north-west¹¹ of Bisk-

¹¹ Before Baradez, the roman *limes* was mainly expected to pass south of Biskra, as in the case of Gemellae fort and the nearby *seguia/fossatum*. In BARADEZ 1949a the author argues that the nature of the roman *limes* was very discontinuous, depending on strategic necessity and terrain morphology (see the numidian *limes* general layout in fig. 1).

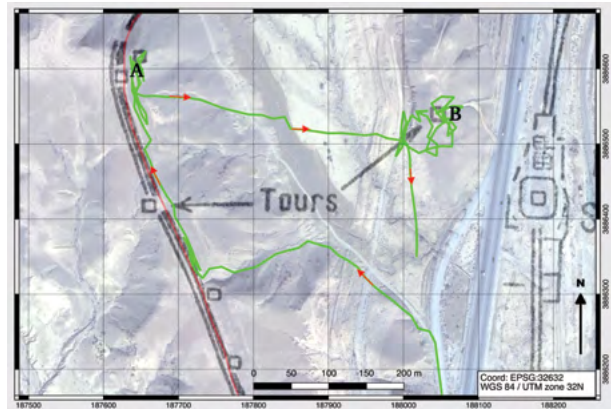


Fig. 5 - One of the surveyed areas of the *limes* (1 in fig.1), shown against satellite imagery and the relative Baradez interpretative transparency (whose derived GPS points are guiding the survey); the green line is the recorded GPS track during the survey; stopping nearby the expected position of the observation towers; around B this track wanders searching a missing tower (see fig. 6).

ra, in and around the perimeter of the artificial water basin of *Fontaine des Gazelles*¹². This is also the general location of the *Aquae Herculis* station (with *vignette*) in *Tabula Peutingeriana*¹³, an indication that this area was already quite significant in terms of water presence.

The first case regards a specific segment of the *limes*: the remote analysis phase had precisely georeferenced a 13 km north-south stretch of *limes* discovered by Baradez about 30 km north-west of Biskra, in a barren and peri-desert area, located at a certain distance from a regional road. This is one of the most investigated segment of the *limes* in Baradez's account in terms of photo coverage and transparencies annotations detailing the *fossatum* shape and the position of its many observation towers.

With the help of a GPS device set on the coordinates obtained from the remote survey, it was immediately possible to identify the remains of the passage of the *limes* on the ground: a wide and levelled-down *fossatum*¹⁴ with a corollary of square shaped foundation ruins, the latter found in the same points where Baradez had hypothesised the presence of observation towers (fig. 5). Ceramic materials (*sigillata*) and roman coins have been found nearby the position of the towers, the results are present-

¹² The basin was made in the 1990s, but similar projects regarding this same area are dating back to Baradez time, and this may also be the explanation why this area is one of the most covered in terms of Baradez aerial pictures and ground surveys.

¹³ TABERT 2010, 3C5 ; the actual position of the *Aquae Herculis* station can be determined from Baradez maps and photos, but it will not be discussed here.

¹⁴ Seen from the ground, the *fossatum* has indeed an evanescent and mimetic appearance, at least if seen traversing the area uniformed of its presence. Without the aid of the GPS coordinates derived from the GIS project, its identification would have been much more difficult and time consuming.

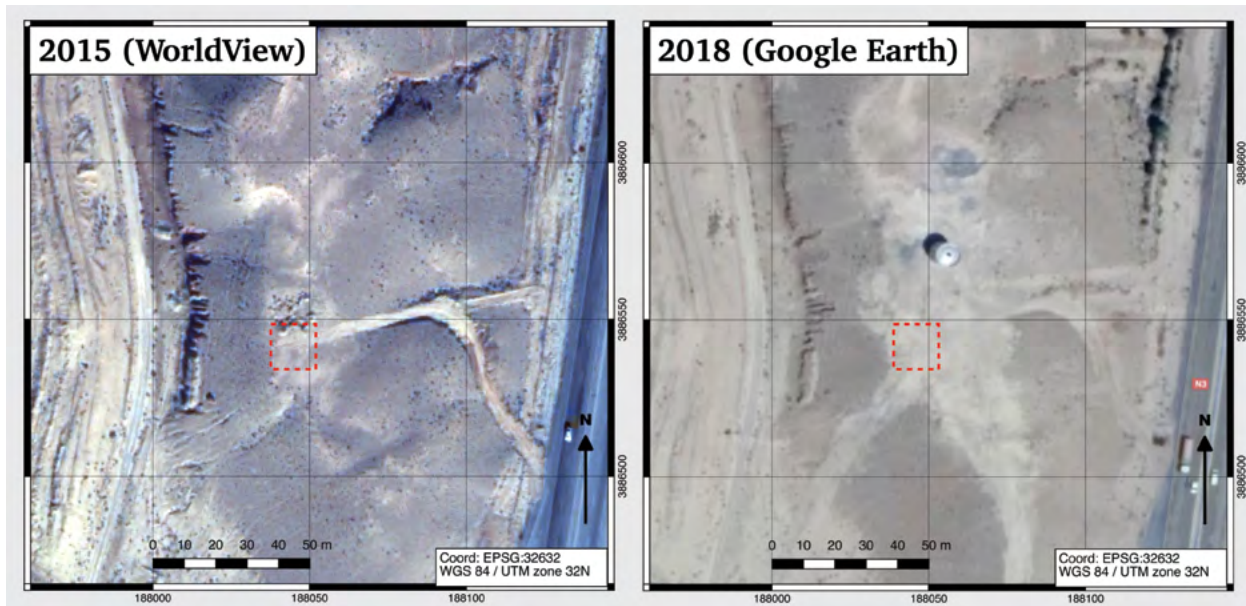


Fig. 6 - The missing tower: the red square marks the expected position of the tower (from Baradez, see fig. 5), which falls within 20 meters from the foundation traces visible in satellite images dated 2015; unfortunately more recent images clearly show how this area was levelled down to allow for the construction of a tower silo.

ed in separate contributions of this same volume, but the general timeframe of these materials (IV-VI CE) corresponds the roman (and vandal) presence in these areas. One of the most prominent towers identified by Baradez in a elevated position, the remains of which were still easily identifiable from satellite photos dated few years earlier, had been completely “negativized” by the very recent construction of a tower silo (fig. 5 and 6) and the area around the structure had been completely levelled and probably emptied of all the archaeological materials it contained. This event recalls the theme of the protection and conservation of cultural heritage in a country that is experiencing a constant demographic growth.

The second example presented here relates to an investigated area located just north of the previous one, beyond the artificial water basin of Fontaine-des-Gazelles. The GPS coordinates derived from the same GIS project directed the survey to a precise position on the northern shores of this lake, where it was possible to (re)discover one of the sites best described in Baradez’s work: the so-called *Fort Parallelogramme*.

This 65x65m parallelogram-shaped roman fort guarded a critical point where the *limes* changed direction (east-west to north-south) nearby the general area of a water source (as it is still today, even if artificially augmented) that probably fed a grid of cultivated field to the east¹⁵

¹⁵ The dating of these cultivated areas has not been determined yet, the traces visible today could be more recent or perhaps reaffirm areas already cultivated in roman times.

(fig. 2), whose traces are still visible both in Baradez’s aerial photos and in recent satellite images. The nearby water source and the cultivated fields are probably the reason for the presence of the fort in this location.

On the ground the site of the fort appears as a slightly raised (0,5 m) quadrangular *tell*, dotted with numerous clandestine excavation holes that reveal the presence of still standing vertical structures and a footfall level located at least one meter below than the current one (fig. 7). The ceramic and coinage materials that were found in a simple surface survey are abundant and fall into the same aforementioned time frame (IV-VI CE), for detailed information see the specific contributions present in this same volume.

The presence of clandestine excavation holes in this site and the fact that the site is partially used as a landfill (fig. 7) raises again the issue of conservation of cultural heritage sites and materials in this rapid developing country. Looking at the time series of the satellite images, the number and size of the holes seems to have significantly increased from 2018 to the present day, especially in last years during which no further survey missions have been possible due to the COVID-19 travel restrictions. There is therefore the possibility that the resumed interest of the scientific community toward this site has encouraged further clandestine excavation activities: any future interventions on this or other archeological sites should be evaluated accordingly and should in any case start from an involvement of the local communities, stressing the impor-

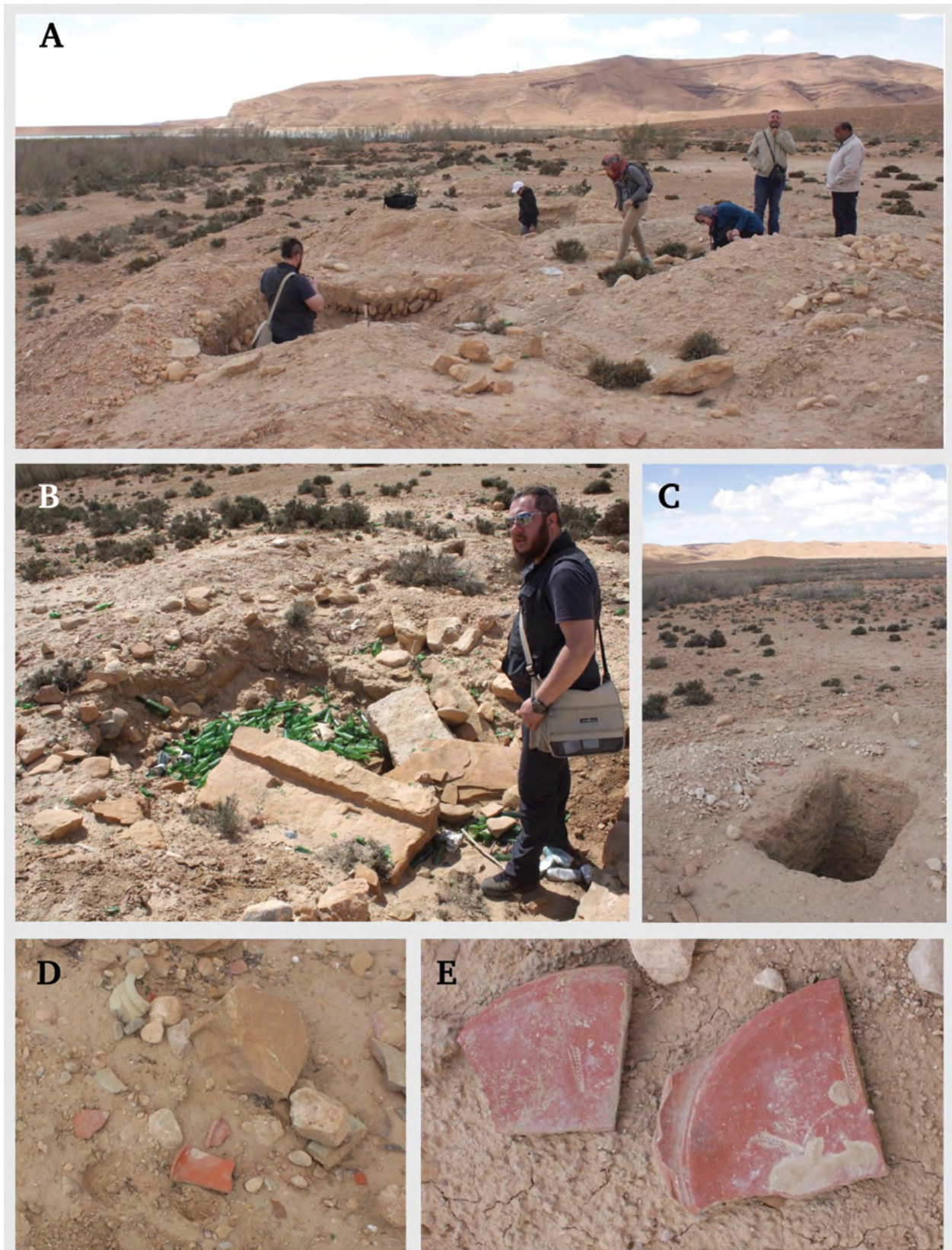


Fig. 7 - Fort Parallelogramme area (see fig. 2). A: from the ground the site appears as a slightly raised quadrangular *tell*, dotted with numerous clandestine excavation holes. B: architectural elements of considerable size laid down in an area partly used as a landfill. C: some clandestine holes have a regular shape, perhaps an undocumented archeological sample dig? D, E: various ceramic materials present on the surface with considerable presence of *sigillata*.

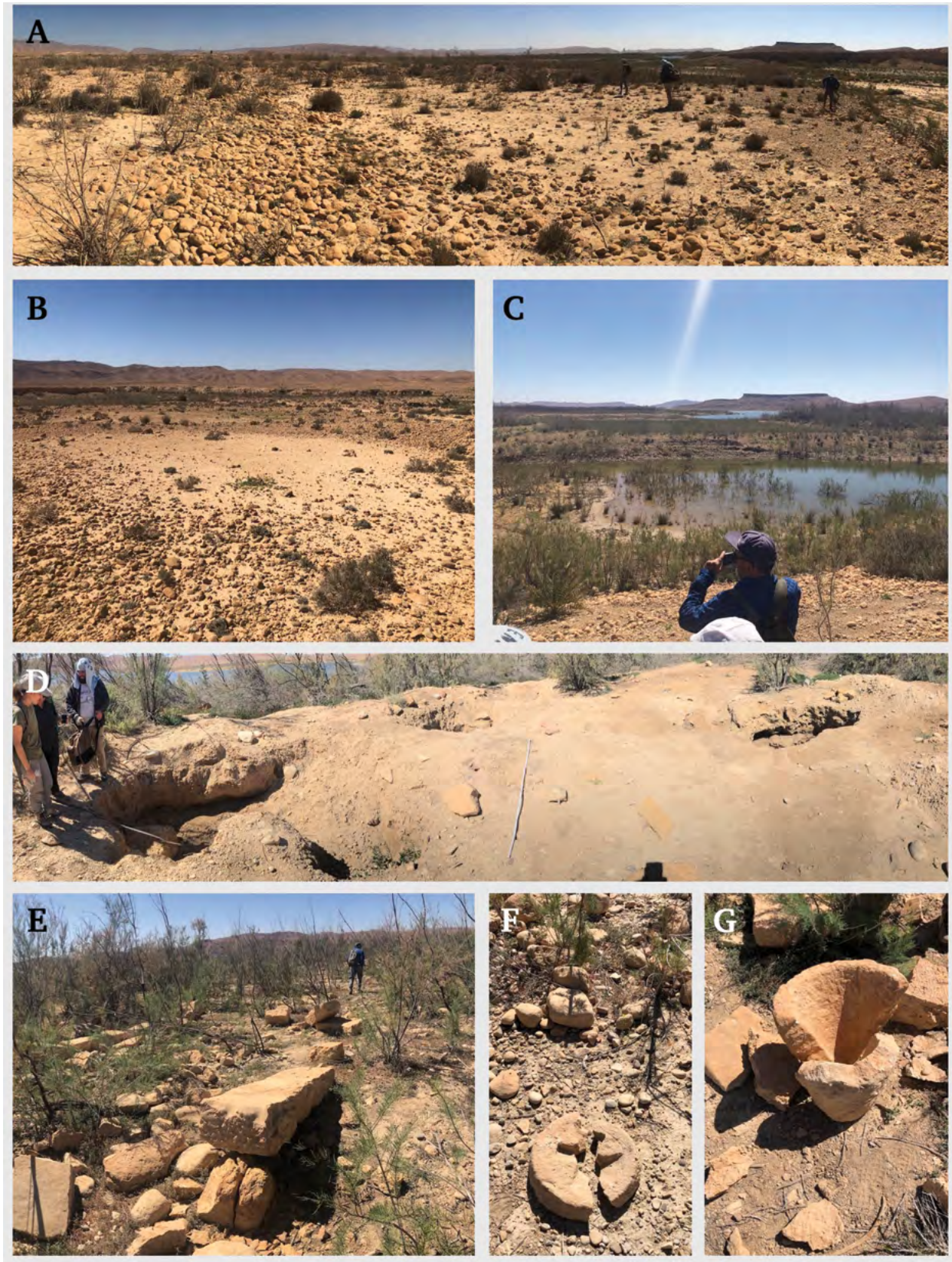


Fig. 8 - *Farms antiquas* area (see fig. 2). A, B: appearance of the ancient cultivation grid seen from the ground, where areas of finer sediment are framed in geometric shapes by linear creases of boulders and pebbles. C: the area is surrounded and infiltrated by water coming from the nearby artificial basin. D: evidence of clandestine excavations similar to the ones found in the nearby fort (fig. 7). E: collapsed architectural elements. F, G: probable remains of a millstone and parts of an oil mill.



Fig. 9 - Roman epigraph (milestone?) found in *farmes antiques* area, the small inset (photo by A. Dali) shows the same subject after a probable flooding episode. The dedication is to *[I]mp(eratori) Caes(ari) M(arco) Aureli[o] / [S]evero Antonin(o) / [P]io Felici Aug(usto)*, the reign title of Caracalla, in the year of his third *imperium* and fourth consulate (*IMP III COS IIIII*) which corresponds to 213 CE (MASTINO 1982).

tance of preservation of an historical cultural heritage that should be primarily felt as their own.

This specific area is also threatened by the variable water level of the reservoir, which in specific periods of the year can come very close to the fort area. This specific risk is even more evident in an adjacent area to the east, nearby the traces of ancient cultivations, an area with evidence of productive structures that Baradez outlines in details and refers to as *farmes antiques*. This area was also selected to be surveyed on the ground because of its information potential.

This nearby “ancient farms” area is currently dominated by a widespread shrub vegetation, with areas periodically flooded by the variable geometry of the lake shore: especially in this case the identification of the remains was possible only thanks to the precise coordinates derived from the GIS project. In addition to a fair abundance presence of *sigillata* ceramic on the surface (compatible to the one found in the fort), remains of a trilithic system, a millstone and other stone blocks were found, probable remains of one or more oil mills buildings (fig. 8).

The most relevant find was an exposed roman epigraph laying in (secondary) horizontal position, a heavy stone element that clandestine operators had probably already prepared for transport but had not

been able to remove. The dedicatory inscription of the epigraph can be dated to the Emperor Caracalla, in the years 213 CE of his reign (see fig. 9 caption for more details), so this is the earliest dating artifact found during the recent surveys around the *Fontaine des Gazelles* area. A subsequent analysis of the time series of satellite images has revealed that the epigraph was surely periodically submerged during periods high water levels (also confirmed by a recent photo by A. Dali visible in fig. 9), adding further concerns regarding the conservation of cultural heritage in these areas.

Significantly, the epigraph and the other findings cited above were found within a radius of 50 meters from the GPS destination set by the remote analysis, a destination target which was purposely placed along a line that Baradez identified as a roman road (the epigraph is therefore perhaps a milestone¹⁶) in a position that was also the barycentre of the infrastructured area (red dot in fig. 2).

¹⁶ Baradez accounted for many epigraphs and inscriptions, but the one that was found during this survey is not among them. Some findings similar to the one recently found were photographed by Baradez along a nearby road, distanced by about one mile (BARADEZ 1949a). Moreover, there seems to a *X(X)* numeral on the lower right corner.

CONCLUSIONS

A subset of Baradez aerial photos and interpretative layouts, when georeferenced in a modern GIS project, have shown the true potential of all the data collected and analysis performed by this author in the 1940s. In this digital format such a treasure trove of information is more readily accessible for remote analysis and has proven capable to guide targeted survey campaigns in specific areas, with an empirical precision of a few tens of meters.

Applying the same method to the whole material, and integrating with different sources (such as Gsell and Barrington atlases, *Tabula Peutingeriana* and more) could lead to the creation of a new and updated digital atlas for the numidian *limes* archeological sites, a reference for future investigations and studies.

Some selected control sites around the area of *Fontaine des Gazelles* were actually (re)discovered and have returned ceramic, monetary and epigraphic material dating to a wide spectrum of roman (and vandal) phases in these areas (213 - VI century CE).

The theme of the conservation and protection of cultural heritage has emerged clearly several times during these surveys: all future projects should take into serious consideration this aspect, both at the state and local community level.

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INSIGHTS FROM RADAR AND MULTISPECTRAL SATELLITE ANALYSIS IN THE AREA OF FORT PARALLÉLOGRAMME

Armando De Guio

Università degli Studi di Padova / dBC

A note from the editors

The following is a brief editorial summary of the talk that Prof. Armando De Guio held during the December 2019 Workshop in Padova, a short bibliography and list of reference websites can be found in the notes; the author is currently working on a more extensive and updated contribution that will be published at a later date, updates can be requested by sending an email to andrea.meleri@gmail.com or paola.zanovello.1@unipd.it.

ASTER DIGITAL ELEVATION MODELS

Leaving aside the introduction to the general study area and research topic that can be found in the previous contributions to this volume, the focus area of this brief report is the region around the *Fontaine de Gazelle* artificial water basin, north of Biskra. In the following we will be detailing some remote analysis sources and methods that have been tested and can be later fully developed in this area.

Firstly, we were able to use a digital terrain model of the research area with a 30 m ground resolution, the data were acquired by the ASTER sensor present on the NASA Terra satellite¹. It's important to underline that this level of resolution is suitable only for very preliminary investigations, such as the general morphology of the area and its main hydrographic and orographic features. Examples can be seen in fig. 1, where the third coordinate is used to increase the readability of the landscape morphology on satellite images and large-scale cartographies found in Baradez².

A more refined resolution would be crucial to identify archaeological features on a smaller scale and a suitable method would employ a drone equipped with a digital camera (and possibly an IR sensor) to reconstruct a 3D digital model whose resolution can reach the precision of centimetres. A micro-morphological resolution is very important and would also allow to

model the hydraulics of the site, for which purpose we can use very specific and sophisticated computer programs and simulations.

This specific source of information is presented first, since the digital elevation model is frequently used to enhance the morphological readability of the other 2-dimensional data sources used during remote analysis.

FREELY AVAILABLE SATELLITE IMAGES AND WORLDVIEW MULTISPECTRAL RASTERS

When examining a more local and detailed scale, high resolution 2-dimensional satellite images can be obtained from freely available sources such as Maxar Technologies³, the main provider of satellite imagery for online GISs such as Google Maps and Google Earth. These images have usually a resolution of about 0.5 m, sufficient to identify archaeological structures; see for example in fig. 2 the area around *Fort Parallelogramme* and the nearby agricultural and productive areas.

Regarding satellite images, the most important source for our remote analysis is the multispectral data sold by DigitalGlobe and acquired with their Worldview satellites⁴. The WorldView-2 and WorldView-3 satellites represent a technological leap in the realm of Earth observation and remote sensing. Launched by DigitalGlobe in 2009-2014, these advanced satellites can gather high-resolution multispectral imagery.

¹ See <https://terra.nasa.gov/about/terra-instruments/aster> ; <https://asterweb.jpl.nasa.gov/gdem.asp> .

² Fossatum Africae. *Recherches aériennes sur l'organisation des confins sahariens à l'époque romaine*, Baradez, J., Paris 1949

³ See <https://www.maxar.com> .

⁴ See <https://worldview3.digitalglobe.com/> and <https://www.satimagingcorp.com/satellite-sensors/worldview-2/> .

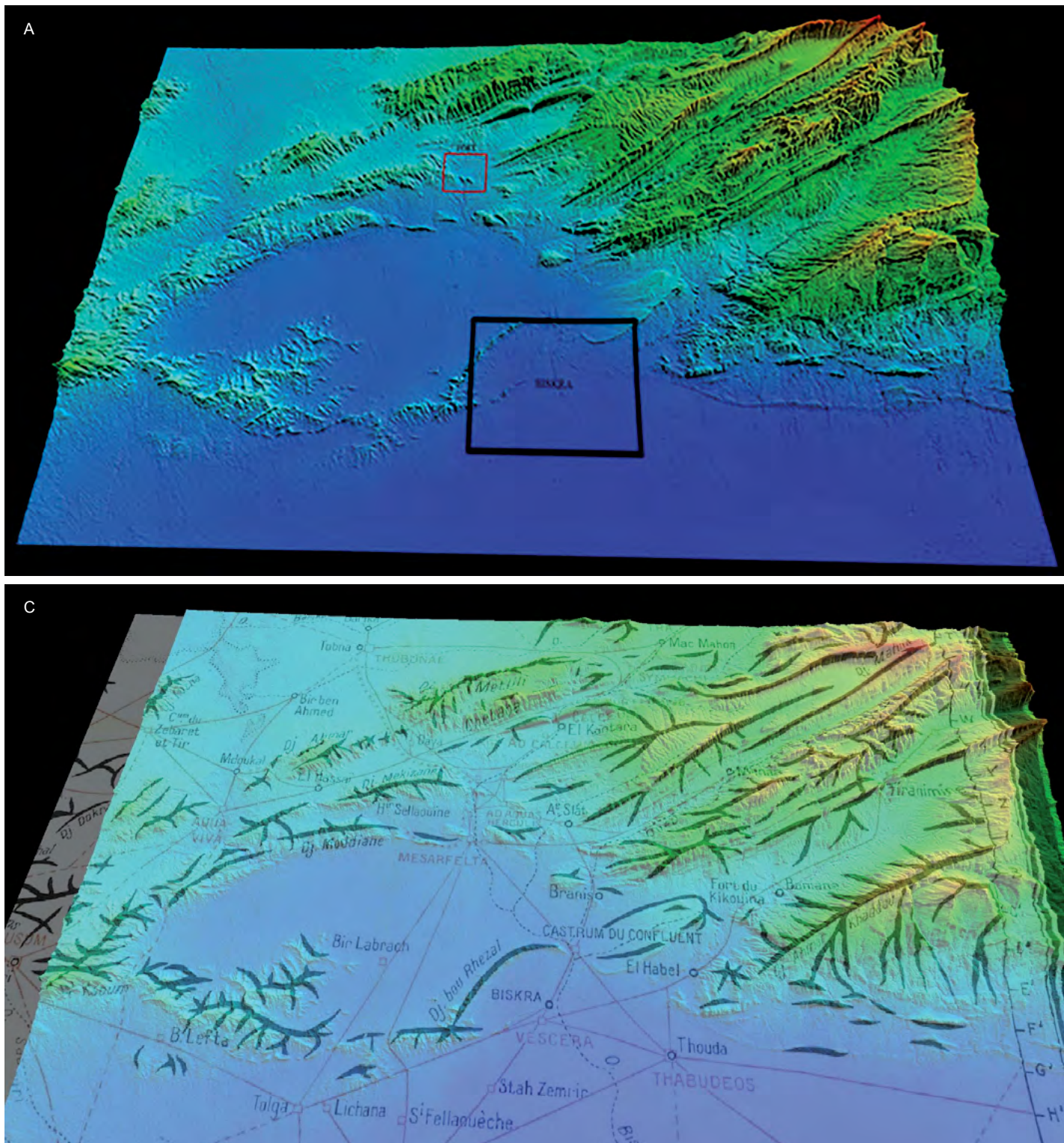


Fig 1 - Example of ASTER elevation model (A) used to increase the morphological readability of the focus area, overlays of satellite images (B,D) and Baradez's large-scale cartographies (C,D).

Equipped with cutting-edge multispectral sensors, they can capture a stunning array of information across the electromagnetic spectrum, including visible and near-infrared bands.

The images have a resolution comparable to the aforementioned freely available sources, but the images are acquired in 8 bands. Starting from the lowest and in-



Fig. 2 - Satellite imagery (Google, Maxtar Technologies 2019) of the area around *Fort Parallelogramme* including the nearby agricultural and productive area, rendered as flat (A) or enhanced in 3D using ASTER elevation model (B).

bands, (even as an algebraic combination) seeking to enhance specific details. For example, in order to obtain an image in the visible range similar to the ones shown in fig. 2, the bands red, green and blue (bands 5,3,2) would be selected. For a near-infrared false colour image, the bands NIR1, red and green (bands 7,5,3) are usually selected, producing images as in fig. 3. This specific selection of bands is useful to enhance details related to vegetation growth and soil reflectance⁵, as shown in the figure.

The use of the coastal band is very important in areas like *Fort Parallelogramme*, where significant portions of the archaeological site are submerged and not easily accessible: the use of a combination of bands like

⁵ For a more detailed treatise, listing also the main vegetation indexes used in remote analysis, see *Cropping for a better future, vegetation Indices in archaeology*, De Guio A., in *Detecting and understanding historic landscapes*, PCA studies, SAP Mantova, p. 109-152

green, blue and coastal (bands 3,2,1) permit to push the visibility partially below the water level, allowing to conduct a form of remote underwater archaeology in remote, see fig. 4. It will be interesting to compare the traces made visible with this process to the archaeological traces recorded in areas of Baradez's aerial photos that were later flooded with water.

The traces enhanced with any selection or algebraic combination of bands offer us great prospects in the future for experimenting with automatic interpretation and recognition of archaeological remains, using for example processes involving artificial intelligence.

COMSAT 5 RADAR IMAGES

Another source of information that we have not yet begun to exploit to its full potential, but which is very important, is the radar images collected by the South

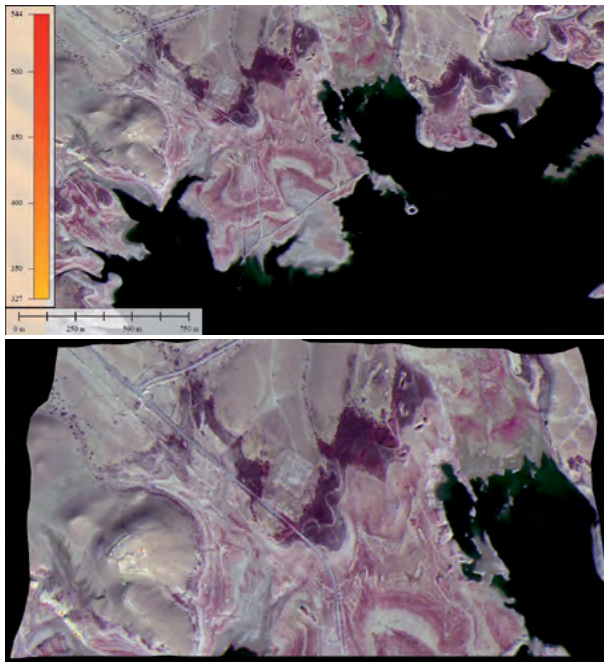


Fig. 3 – Worldview multispectral imagery nearby *Fort Parallelogramme*: selection of bands NIR1, red and green (7,5,3) in order to enhance vegetation growth and soil reflectance, rendered flat or 3D as in fig. 2.

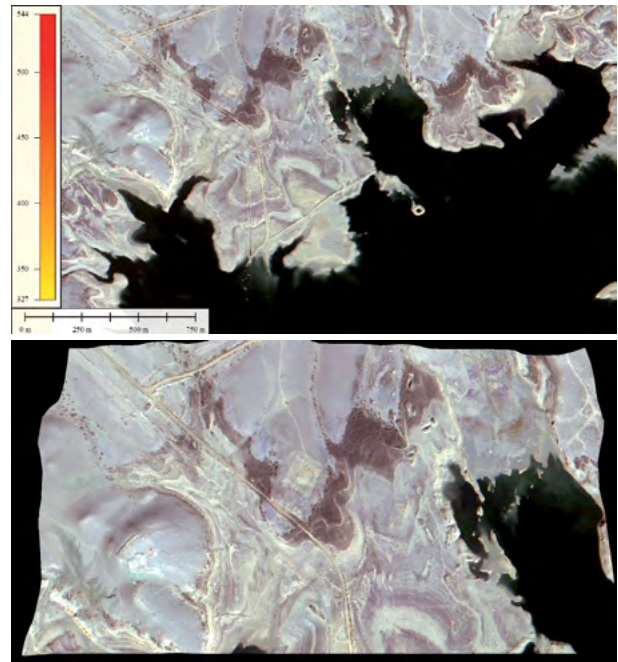


Fig. 4 – Worldview multispectral imagery nearby *Fort Parallelogramme*: selection of bands green, blue and coastal (3,2,1) in order to enhance visibility just below the water level, rendered flat or 3D as in fig. 2.

Korean COMSAT 5 satellite: this might be the first time that this data is taken into consideration for archaeological remote analysis in the Maghreb.

The images are taken at a relatively low resolution, 1.5 m and a lot of “salt and pepper” noise is present, see fig. 5 for two examples around the area of *Fort Parallelogramme* employing two different data processing filters.

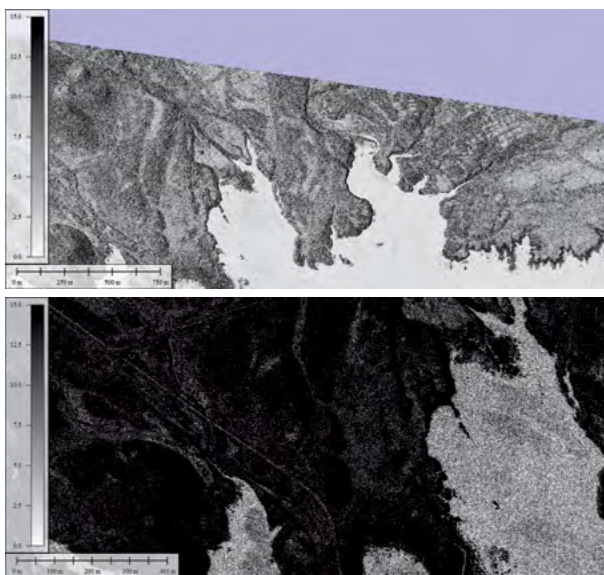


Fig. 5 – COMSAT radar data nearby *Fort Parallelogramme* rendered using two different and preliminary data filters: compare (B) with figs. 3B, 4B.

The low resolution and high noise levels make the elaboration phase very difficult, but the outlook is very promising because of the radar’s extraordinary and unique capabilities, which are basically two. First of all, radar is weatherproof: it is able to capture images in all possible atmospheric conditions, also night-time conditions are not a problem. The second factor is that it is the only remote sensing tool really able to penetrate the ground. All the other sensors really use what is present on the surface as a mediator: micro-morphology, vegetation, soil colour or spectral reflectance; whereas radar pulses actually penetrate the ground, measuring the difference in electrical conductance of the soil⁶.

Colleagues at Boston University, such as Farouk El-Baz, have demonstrated that in arid zones, such as different regions of Egypt and South Sudan, the radar has the ability to penetrate up to 8 meters, operating ideally in arid and contrasting conditions⁷. Farouk El-Baz is a rel-

⁶ *Image processing and analysis of radar and lidar data: new discoveries in Verona southern lowland (Italy)*, Burigana L., Magnini L., STAR: Science & Technology of Archaeological Research 3:2 2017, p. 490-509

⁷ *Near-Surface Imaging of a Buried Foundation in the Western Desert, Egypt, Using Space-borne and Ground Penetrating Radar*, Farouk El-Baz et al., Journal of Archaeological Science 40(4) 2013, p. 1946-1955; *Remote Sensing of the Earth: Implications for Groundwater in Darfur*, Farouk El-Baz, The Bridge - technologies for clean water, National Academy of sciences, p. 5-13

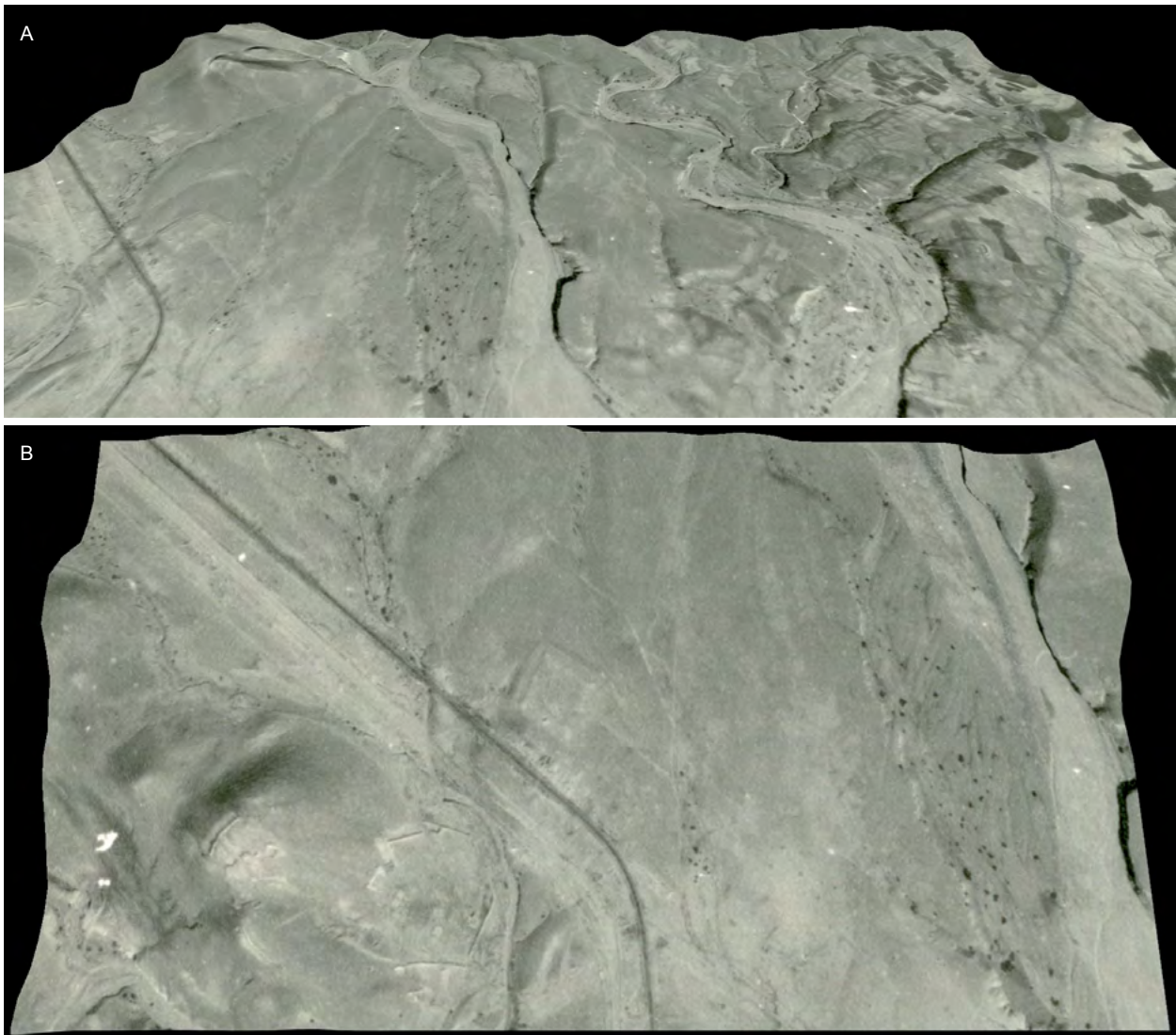


Fig. 6 – The readability of old black and white aerial photos is enhanced in 3D using using ASTER elevation model: compare (A) with fig. 2B and (B) with figs. 3B, 4B, 5B.

evant figure in this field, an Egyptian engineer who became famous in his youth selecting for NASA the specific places on the moon where the first APOLLO missions would be sent: an exceptional scientific figure with whom we would have the opportunity to collaborate.

Regarding below-the-surface remote sensing, we are thus opening two really promising windows for the future: underwater exploration with Worldview multispectral rasters and underground exploration with radar data sources.

MODERN ELABORATION ON THE AERIAL PHOTOS AND INTEGRATION OF ALL THE SOURCES (PREVIEW)

Despite the excellent quality and potential of the sources cited, we should not overlook the high quality information content present in the aerial photos collected by Baradez in the late 1940s and other aerial photos of the 1970s that the University of Biskra has shared with us. These aerial photos contain a wealth of information that is impossible to retrieve from more modern satellite sources because of the significant transformations this area has undergone.

Modern processing methods can also be applied to these historic sources, such as increasing the readability of these old black and white landscapes by integrat-

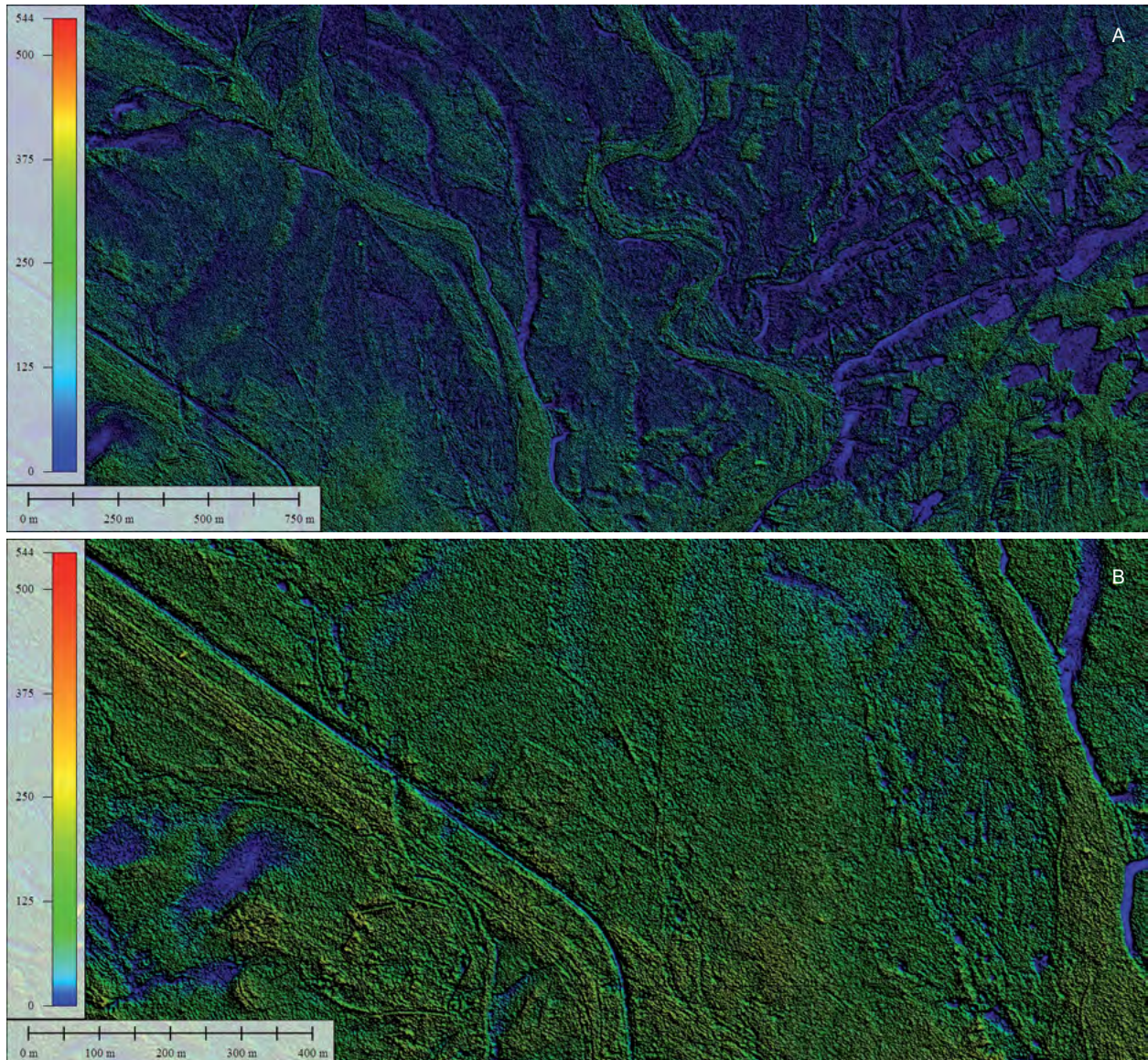


Fig. 7 – Experimenting pseudo-morphology extrapolarations on the old black and white aerial photos: compare (A) with fig. 6A and (B) with fig. 6B (or fig. 2A for the most recent satellite imagery).

ing the ASTER digital terrain model into the data, see for example fig. 6, showing in 3D the area around *Fort Parallelogramme* as it was in the past.

On the digitised format of these old aerial photos we can also employ modern algebraic transformation maps, for example we can use the grey levels of every pixel to work as a pseudo-morphology of the landscape: black pixels (level 0) are made to represent the lowest places and white pixels (level 255) correspond to the most elevated areas. This does not necessarily correlate to the real morphology of course, but this process can greatly enhance the readability of surface traces and features, see for example fig. 7, where this pseudo-elevation information is represented with a colour range, adding also

a visual “hillshade” effect in order to increase the result. Then, for example, successive elaboration runs could be performed trying to match this pseudo-morphology with the real digital elevation model of the area, or maybe to enhance the real digital elevation model with the information coming from the pseudo-morphology.

The most information can be extracted by integrating together all the aforementioned sources, an example is shown in fig. 8, where we are integrating the pseudo-morphology derived from the aerial photos, Worldview multispectral data and Baradez interpretation layouts; experimental algebraic mapping operations, not detailed here, are also performed between the different sources.

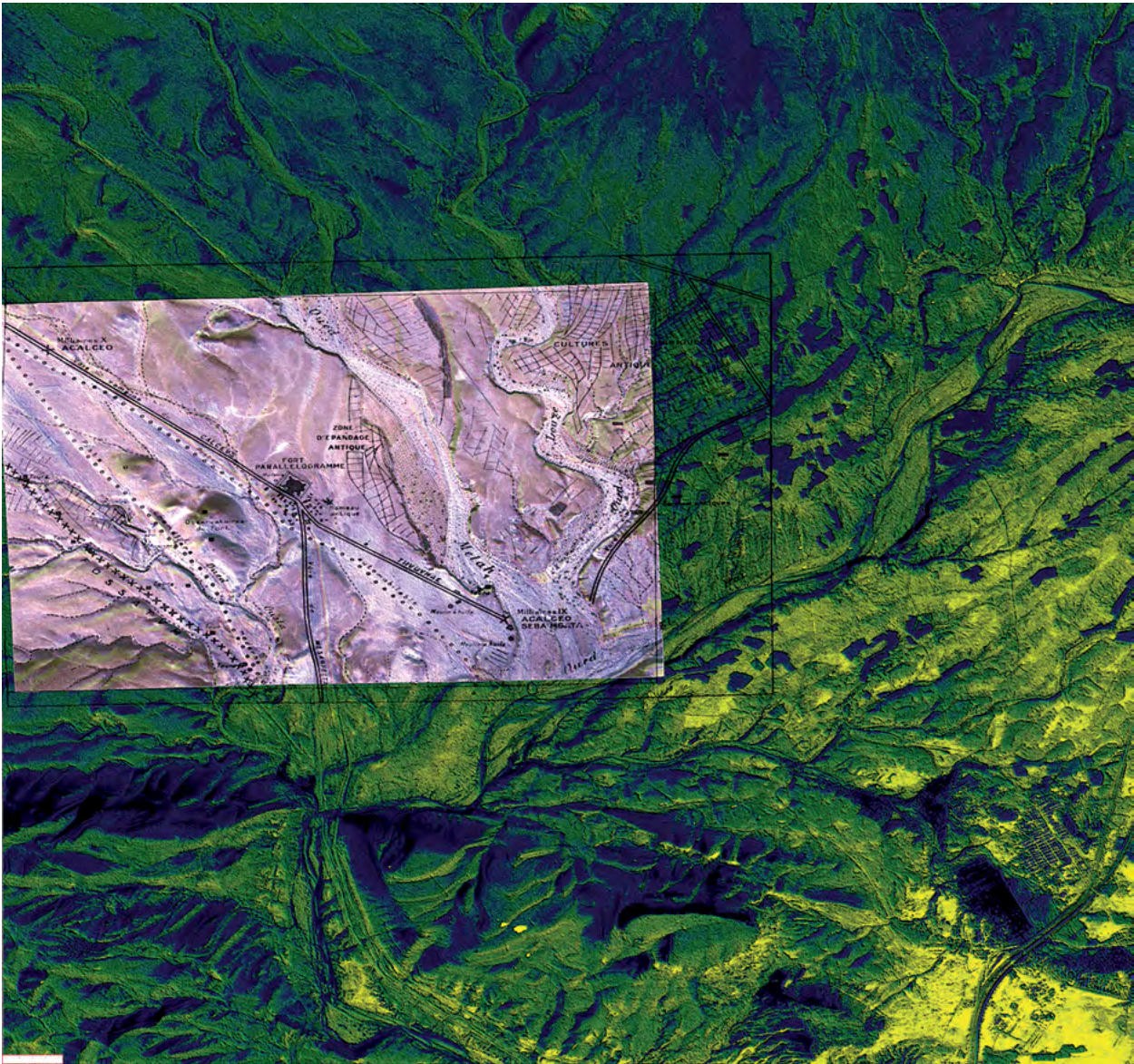


Fig. 8 – Experimental integration of different photographic and cartographic sources, the enhanced area (with Baradez annotations) is centered around *Fort Parallelogramme*.

In fig. 9 the pseudo-morphology derived from the aerial photos of the 1970s is used to increase the readability of a recent satellite image, thus allowing to read the satellite imagery backwards, into the past, and below, under the water. A further step would be to integrate in this analysis also Baradez's interpretative cartographies (as in fig. 8A): the author had the capacity to detect thousands of tracks, the potential to re-discover what still remains on or below the ground (such as building structures, hydraulic infrastructures, network of different kinds) is enormous, as we were able to verify during our surveys.

Finally, it is worth mentioning that in recent years the region around Biskra has seen a growing interest of

various researchers, not only us from the University of Padova but also from the University of Sassari and also academic institutions from Tunisia, as attested by a recent monographic publication⁸. The main interest seems to lay in the classification, by means of automatic processing of satellite photos, of different land uses: bare soil, vegetated soil with shrubs, steppes, and different levels of saline areas. To achieve these classifications, it is necessary to follow very detailed analysis paths employing boolean choices (yes/no) that build a

⁸ *Recent Advances in Environmental Science from the Euro-Mediterranean and Surrounding Regions*, Proceedings of Euro-Mediterranean Conference for Environmental Integration (EMCEI-1), ed. Springer, Tunisia 2017

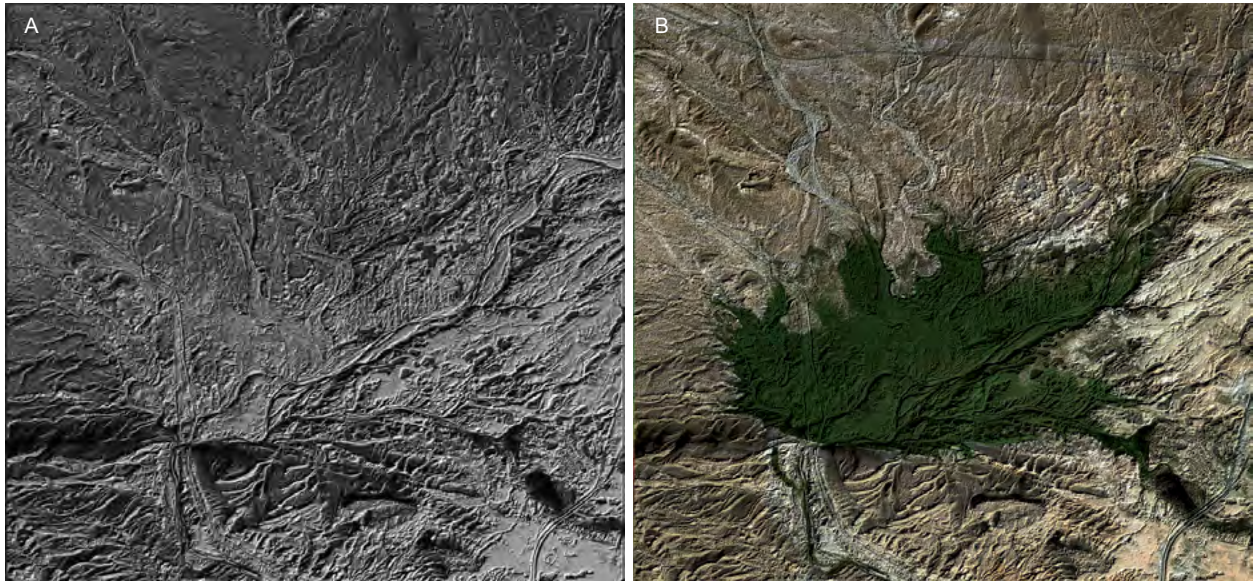


Fig. 9 – Experimental integration the pseudo-morphology derived from the old aerial photos (A) with recent satellite imagery (B); the area represented is the same of fig. 8.

“decision tree”. In the end, it is possible to have a truly detailed and meaningful classification that could also be used in an archaeological context, moreover if we succeed in automatically integrating this information with the extraordinary number of traces recorded by

Baradez, maybe developing methods involving the use of artificial intelligence.

The approaches and examples presented here are the product of ideas we have just begun to test, the results are very preliminary but very promising indeed.

ARCHAEOLOGICAL SURVEY AND ROMAN POTTERY AT THE EDGE OF THE EMPIRE: FIRST RESULTS FROM THE 2018-2019 CAMPAIGNS IN THE AREA OF FORT PARALLÉLOGRAMME AND ALONG THE ALGERIAN *LIMES*

Luigi Magnini¹, Ilaria Barensi², Anna Michielin³, Elena Griggio⁴

¹ Department of History, Human Sciences and Education – University of Sassari

² Department of Cultural Heritage: Archaeology and History of Art, Cinema and Music – University of Padova

³ Department of History and Cultures – Alma Mater Studiorum University of Bologna

⁴ Department of Cultural Heritage: Archaeology and History of Art, Cinema and Music – University of Padova

During the spring of 2018 and 2019, joint teams from the University of Padova and Biskra conducted a series of archaeological surveys along the Roman Limes in the province of Biskra (Algeria). The aim of this archaeological work was to identify spatially and chronologically the Roman occupation of the territory in one of the most remote (but also very important) areas of the Empire. Fort Parallélogramme, the main case study of this research, is a Roman castrum located about 35 km north of Biskra and identified by Baradez during his aerial surveys in the late 1940s. A systematic ground survey was carried out on the area with a partial collection of the finds, which allowed the acquisition of ceramic materials, the main focus of this paper.

KEYWORDS: Algeria, Roman Limes, archaeological survey, sigillata ceramic

1. INTRODUCTION: SURVEYING, COLLECTING AND CATALOGUING

During the spring of 2018 and 2019, joint teams from the University of Padova and Biskra conducted a series of archaeological surveys along the Roman *Limes* in the province of Biskra (Algeria). The aim of this archaeological work was to identify spatially and chronologically the Roman occupation of the territory in one of the most remote (but also very important) areas of the Empire. Fort Parallélogramme, the main case study of this research, is a Roman *castrum* located about 35 km north from Biskra and identified by Baradez during his aerial surveys in the late 1940s¹. A systematic ground survey was carried out on the area with partial collection of the finds, which allowed the acquisition of the ceramic materials, main focus of this paper. The investigated area had previously been delimited into a regular grid to provide even indicative location of the remains. Two grids were settled down, the first one of 81 squares of 10x10 m to cover all the extension of the site and to register the presence/absence of structures. The second one, made of 16 squares each 20x20 m, was used for the systematic survey and to define the distribution of the archaeological remains (fig. 1). Each column was

taken over by an archaeologist who carried out the survey operations by filling in a pre-defined form. During the ground survey were collected, for each square, information regarding geography and topography (absolute coordinate and relative position), presence/absence, materials and typology of single archaeological artefacts and clusters. Seven classes of remains were selected to be recorded in the survey form: metals, lithics, bones, glasses, diagnostic pottery, pottery clusters and structures. Other biological remains except bones were not found as well as clusters of other classes of materials. The diagnostic pottery class was also divided into subcategories according to the portion of vessel found and the ceramic body.

The number of artefacts per class within the grid was the basic data for calculating the point density distribution of the archaeological remains in the area of Fort Parallélogramme. This analysis allows to estimate the incidence of a class of artefacts within a single square, thus providing density maps based on the distribution within the predefined grid. A density map for each remains class and a cumulative map with the overall incidence was derived (figs. 2 and 3).

The second area of interest for the research was the *Limes* that runs in a North-South direction from Fort Parallélogramme itself towards Biskra (ancient *Vescera*). Along this “line”, clearly visible by remote sensing and

¹ BARADEZ 1949.



Fig. 1 - Fort Parallélogramme WorldView 3 Multispectral Image with the 20x20 m grid used for the archaeological survey.

already identified to a large extent by Baradez, several turrets have been identified on the ground from three of which the pottery came. Other less systematic surveys were carried out on the sites of *Gemellae* and *Bades*. The main production of pottery collected and studied was the “African red slip ware” but also some examples of local coarse ware were found during the surveys. For the study of the remains, it was helpful the creation of a catalogue in which every finding has been inserted. In a first moment was given an identification letter to every bag containing pottery sherds (from A to Z), followed by cataloguing and numbering of every piece present in each bag (numbered from 1 to 94). At the same time all the information were inserted in a digital database. Into this catalogue are reported in columns, following the alphabet order and, consequentially, the number order, bags and ceramic fragments. To the tab were also added other columns to be filled with the date of the finding, the location, the square, the operator, the measures of the fragment, the ceramic body and a brief description for each one of them. Furthermore as some of the elements had a match, a column was added with the annotation of the number of the matching fragment Those fragments that, instead, were found broken but with all

their pieces in the same place, have been catalogued with the same number, followed by a letter (ex. 1a, 1b, 1c, ...). Beside the help given to the study for the management of all the ceramic fragments, from the creation of this catalogue it was possible to quantify, at first, how many pieces were found during these surveys, for a total amount of 94 ceramic fragments (72 from 2018 and 22 from 2019). Of this total, most of them (58) come from the area of Fort Parallélogramme, as it was the zone of major interest during the survey campaigns. On a general analysis it was also noticed that the pieces could be divided into different composition types: coarse ware, fine ware and African Red Slipped Ware. Referred to the shapes to which all these ceramic fragments belong, it was possible to identify some type of potteries as *lucernae*, plates or *amphorae*, as a number of them was found almost intact (as it happened for 3 *lucernae*), or because some elements found, as handles or fragments of decorated ceramic, were easily recognised as part of them. The majority of this findings shows a huge number of fragments that can be reconducted to the rims' category. Of the 45 elements collected, in some cases it was even possible to define the class of artefacts to which they belong as plates or *amphorae*. The

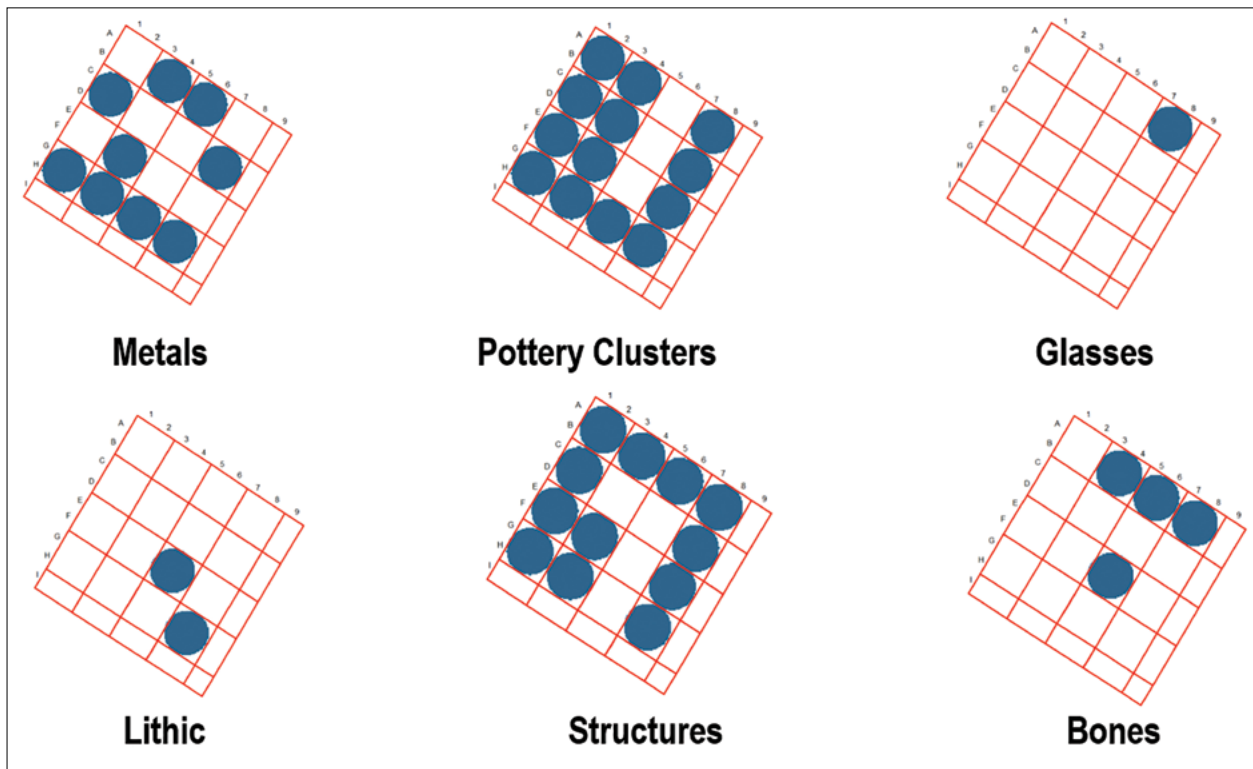


Fig. 2 - Results of the point density analysis for each class of materials.

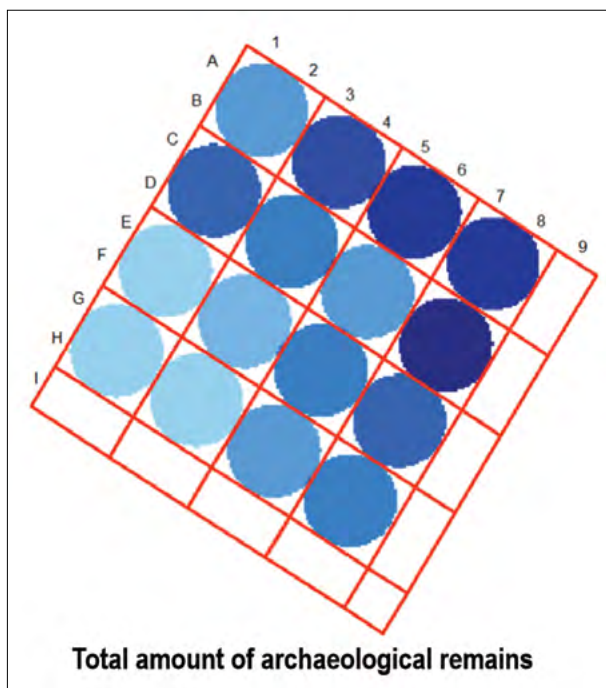


Fig. 3 - Overall result of the point density analysis including the total amount of archaeological remains.

second bigger group of findings is related to bases, for a total amount of 26 pieces. Of those fragments, a number of them decorated, 16 pieces were defined as bas-

es of plates and 6 were identified as bases of *lucernae* (of which two fragments have a match). 5 *lucernae* were found almost intact, showing decorations even referred to the Christian tradition (as palms or XP). The other findings were identified as handles (6 pieces) or fragments of amphorae' walls or plates' rims (10) and one fragment has been identified as neck of an *olpe*.

2. AFRICAN RED SLIP WARE: PRELIMINARY NOTES

The term "African red slip ware" (from now on shortened as ARS) refers to a typology of fine tableware produced in various regions of the *provinciae* of *Africa Proconsularis*, *Mauretania Caesariensis* and *Tripolitania*. The epicentre of this production can be found within modern Tunisia; however, many local and regional productions existed as well, belonging to a craft tradition which developed between the end of the 1st century A.D. and the 7th century A.D. At first, this tableware was produced for a more internal and regional demand (focusing on the African regional markets), but it quickly expanded to the Mediterranean markets. Such large diffusion and the longevity of this production are the main elements that brought this pottery class to be considered as a "guide fossil" for contexts related to the late-antiquity age².

² GANDOLFI 1994, p. 127; GANDOLFI 2005b, p. 195.

Two main features characterise this pottery class: a more or less depurated and slightly granular fabrics, whose colours vary from pinkish orange to brick-orange, and a more or less smooth and shiny slip whose colour matches the fabric, and it can either entirely or partially cover the artefact. The quality differences in slips and fabrics distinguish the known different productions spreading across North Africa. Sometimes, the artefacts can be decorated with different methods, for example appliqué motifs, stamped motifs, *barbotine* motifs and rouletting. The morphological repertoire related to this class comprises open forms as cups, bowls, plates of various dimensions, and *missoria*; close forms like drinking vessels and jugs are included as well³.

Among the materials found in the context of the Fort Parallélogramme, 56 findings⁴ can be attributed to this pottery class. While the majority (55 fragments) of this ensemble belong to the Algerian productions, more known ARS productions are attested as well, for example the ARS E (1 fragment).

The Algerian productions are characterised by finer fabrics and a really depurated and well-cooked clay, a thin and shiny slip which covers the artefact internally and sometimes externally (especially the rim); the typical vessel forms manufactured are plates and flanged bowls imitating the classical Tunisian products⁵.

The ARS E production is distinguished by a finer, brick-orange clay and fabric, and by a matt, brick-orange slip: what really characterises this production is the presence on the external surface of the vessel of traces of vegetal elements such as straw or palm leaves which provided a resting place as the artefacts were left to dry. This production started in southern Byzacena during the mid-4th century A.D. and developed through the 5th century A.D., but it never reached a large diffusion, focusing on a more regional scale⁶.

2.1. Typological study

This typological study is divided in productions and provides a description and chronology of the different types that has been recognised: as all the artefacts have been found as fragments, descriptions and chronolo-

gies are based especially on the works of J. W. Hayes⁷, S. Tortorella⁸ and M. Bonifay⁹.

As already stated, quite documented is the presence of fragments belonging to the Algerian production. Among the 55 artefacts considered, 25 of them (4 fragments or rims, 4 fragments of walls, 17 fragments of floors) are not determined from a typological point of view. Five types have been recognised: they mirror some of the commonest typologies that can be found in Algerian contexts.

Six individuals, all found in Fort Parallélogramme, are attributed to the type Hayes 91/"Février" 1963, fig. 5¹⁰ (tab. I, nn. 1-2), a local variant of the more known type produced in ARS D, found especially in Sétif. This flanged bowl has a rounded rim and the typical broad and curved flange on the external surface, below the rim, generally hooked at edge. The walls can be more or less steep, while in general the body of this vase can be almost hemispherical and not particularly deep. The floor rests on a low ring foot. From a chronological point of view, the Hayes 91 type can generally be traced from the mid-4th century A.D. until the 7th century A.D.: considering its morphological characteristics, this specific type can be dated to the 5th century A.D.¹¹.

Type Hayes 68/Sétif 1970 fig. 28 nn. 44-46¹² is attested as well (tab. I, nn. 3-4), by two individuals found in Fort Parallélogramme; in this case too they both belong to a regional variant which imitates the better-known artefact produced in Tunisian ARS. This large bowl is distinguished by its characteristic rim, which is articulated in two parts: the inner part of the rim connects with a v-shaped hollow moulding to a broad flat member rising obliquely to a hooked and thickened lip characterised by a triangular profile. Its walls can be more or less curved, and the vase may rest a slight foot. As it is connected to the Algerian productions, it can be dated between the second half of the 4th century A.D. and the mid-5th century A.D.¹³.

A group of nine individuals has been attributed to the type Sétif 1970, fig. 33, n. 106¹⁴ (tab. I, nn. 5-7), similar to the more known type Hayes 62 produced in Tu-

⁷ HAYES 1972.

⁸ ATLANTE I.

⁹ BONIFAY 2004.

¹⁰ For comparisons, see: FÉVRIER 1963, p. 130, fig. 5, 1965, fig. 32, n. 1; *Atlante* I, t. LXIX, n. 2; BONIFAY 2004, p. 203.

¹¹ A more detailed description of this type can be found in: HAYES 1972, pp. 140-144; *Atlante* I, pp. 105-106, 141; BONIFAY 2004, pp. 177-181.

¹² For comparisons, see: SÉTIF 1970, p. 140, fig. 35, n. 139; *Atlante* I, t. LXVIII, n. 7.

¹³ HAYES 1972, pp. 116-117; *Atlante* I, pp. 121, 141.

¹⁴ This type can be compared to: SÉTIF 1970, p. 135, fig. 33, n. 106. See also: *Atlante* I, t. LXVIII, n. 2; FENTRESS 1991, f. 51, n. 3.

³ For an overall overview on the African red slip ware productions: HAYES 1972, *Atlante* I, pp. 9-183; GANDOLFI 1994, pp. 127-156; BONIFAY 2004, pp. 45-66, 155-210; GANDOLFI 2005b pp. 195-232.

⁴ Numbers referring to fragments are always to be considered as MNI (minimum number of individuals): see ARCELIN, TUFFREAU-LIBRE 1998.

⁵ While studies on this production are still an on-going process, more detailed descriptions and in-sights about the ARS produced in central and oriental Algeria can be found in: HAYES 1972, pp. 300-304; *Atlante* I, pp. 140-141; MALFITANA, BONIFAY 2016, p. 528.

⁶ GANDOLFI 2005b, p. 213; MALFITANA, BONIFAY 2016, p. 524.

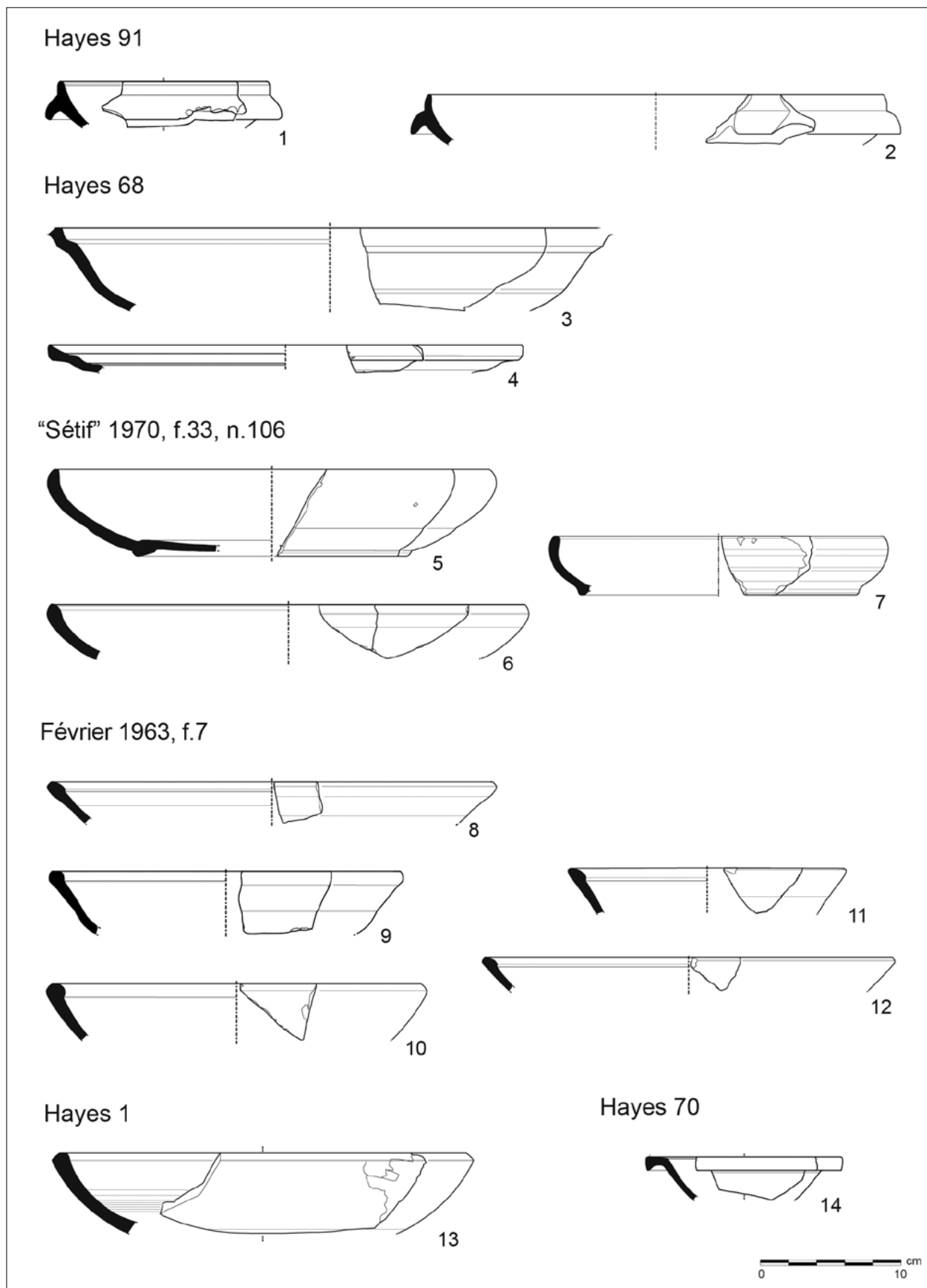


Table. I - Algerian ARS (1-13); ARS E (14). Scale 1:4, drawing and graphic rendering by Elena Griggio.

nisian ARS. This plate is characterised by an indistinct and rounded rim and curved walls. The ring-foot has predominantly a triangular-shaped section¹⁵. Five of these individuals have been found in Fort Parallélogramme, while two individuals have been found in *Gemellae* and another pair has been found in *Bades*.

Another ensemble of ten individuals has been attributed to the type “Février” 1963, fig. 7¹⁶ (tab. I, nn. 8-12). This plate can be distinguished by its rounded rim, internally thickened. The walls can be more or less steep and curved, while the body is generally quite deep. The floor is generally flat¹⁷. In particular, eight of these individuals have been found in Fort Parallélogramme, while one has been found in the so-called “Tower 2”, nearby the Roman *limes*.

One fragment of rim found in Fort Parallélogramme has been attributed to the type Février 1965, fig. 32 GM 6-7, c.2, nn. 6-13¹⁸, similar to the more known type Hayes 61 produced in ARS D. This plate is characterised by a slightly incurved rim flattened on the external surface, thus giving a typical triangular section. Walls can be more or less steep, and the base is flat, without a ring-foot¹⁹.

These types have been described by P. A. Février as common tableware, especially in contexts as Sétif as well as in Djemila, Mila, Tamedfoust and Tiddis. Their diffusion took place between the 4th century A.D. and the 5th century A.D.²⁰.

Peculiar is the presence of a local imitation of type belonging to the so-called Cypriot red slip ware (or Late Roman D ware), attested by one rim, found in Fort Parallélogramme, recognised as type Hayes 1²¹ (tab. I, n. 13). This plate is characterised by a plain and thickened rim (which could be round or bevelled on the outer surface), sloping walls and a low foot²². An interesting characteristic is the blackened rim, an imitation of the style of the Cypriot/Levantine products as well. As this type is dated between the late 4th century A.D. and the second half of the 5th century A.D., this imitation could belong to this chronological range as well. Artefacts attributed to the ARS E have been found as well during this survey in the Fort Parallélogramme area, although sporadic, compared to the dominance of local and regional products.

¹⁵ *Atlante I*, p. 140.

¹⁶ Comparisons: FÉVRIER 1963, p. 131, fig. 7. See also: *Atlante I*, t. LXVIII, n. 3; FENTRESS 1991, p. 185, fig. 51, n. 4.

¹⁷ HAYES 1972, pp. 300-303; *Atlante I*, p. 141.

¹⁸ To be compared to: FÉVRIER 1965, fig. 32, GM 6-7, c.2, nn. 6-13; *Atlante I*, t. LXVIII, n. 4; FENTRESS 1991, pp. 184-185, fig. 51, n. 6.

¹⁹ About this type: *Atlante I*, pp. 141.

²⁰ HAYES 1972, p. 303; *Atlante I*, p. 140.

²¹ Comparisons: HAYES 1972, f. 80, n. 2; *Atlante I*, t. CXXI, n. 2.

²² For a description of this type: HAYES 1972, pp. 372-373

One individual found in Fort Parallélogramme can be attributed to the type Hayes 70 nn. 1, 7 (tab. I, n. 14)²³. This small bowl has a characteristic broad and flat rim that may be decorated with one or two grooves, and it ends with a hanging lip, bevelled on the outside. Walls are generally steep and with a light ridge externally. This vessel ends with a flat base and a small ring foot with a generally square section. This type is dated between the end of the 4th century A.D. and the beginning of the 5th century A.D.²⁴. This type has been documented in Sétif in a context dated from the late-4th century A.D. to the beginning of the 5th century A.D., associated with coins of Constantius II²⁵.

2.2. Decorative system

Four floor fragments show a simple decoration made of thick and short bands, with a slight S-shape, radiating from the centre obtained by rouletting. One of the floors is decorated with a rather simple stamped motif too, which consists of a three concentric circles motif and can be attributed to the Hayes type 26²⁶, fairly common and used in many decorative styles, especially with palm-motifs²⁷. Due to its fragmented state, it is not possible to deduce whether another stamped motif was present on the artefact as well or not (tab. II, nn. 15-16). Five more floor fragments show a more peculiar stamped decoration: these motifs became a characteristic feature of the ware from the 4th to the 6th century A.D. As the artefacts document, it is normally found on the floors of dishes and bowls, especially of the large variety. Really helpful is the tendency to change motifs, the rendering and the arrangements of these stamps, which permits to distinguish several styles each with a limited duration, thus connecting it to a more or less specific chronology²⁸.

Two main motifs have been found in these artefacts, which represent some of the commonest decorative styles recognised in the ARS productions.

The first motif is characterised by palm branches. Two slightly different types have been recognised: the Hayes type 9 and the Hayes type 10 (tab. II, nn. 17-19), recognised at first at Djemila and similar to the

²³ Comparisons: HAYES 1972, p. 118, fig. 20, 70, n.1; *Atlante I*, t. LV, n. 9.

²⁴ And in-depth description of this type can be found in: HAYES 1972, p. 119; *Atlante I*, p. 122.

²⁵ HAYES 1972, p. 119 and cited bibliography.

²⁶ Comparison: HAYES 1972, pp. 234-235, fig. 26.f.

²⁷ About stamped decorative motifs and the different styles that have been recognised: HAYES 1972, pp. 217-281.

²⁸ A more in-depth analysis on decorative motifs and their descriptions can be found in: HAYES 1972, pp. 217.

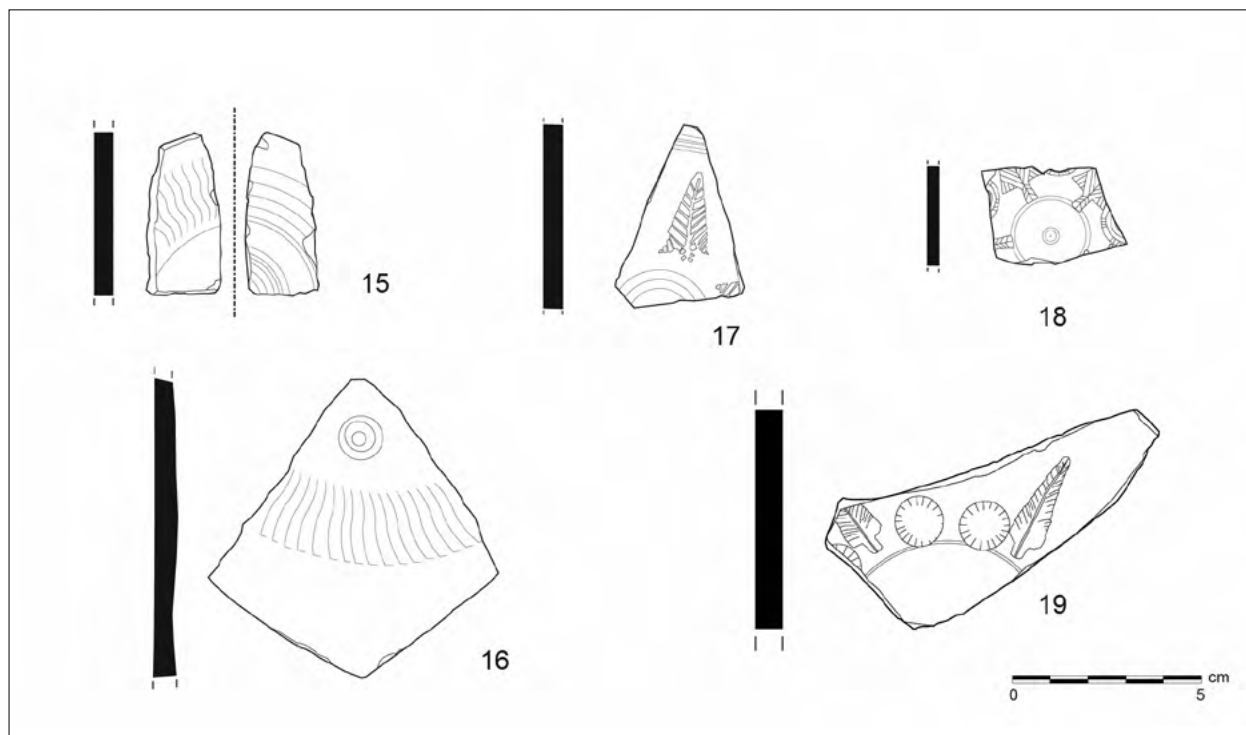


Table II - Decorative motifs. Scale 1:2, drawing and graphic rendering by Elena Griggio.

Tunisian productions²⁹. Both motifs are fairly common and consist on branches with a triangular shape and a short stalk; they tend to be used both alone and together with circle or rosette motifs.

More precisely, type 9 has a triangular/dart shape, with a short stem below; all ribs are turn upwards, with herringbone pattern on the stem (mostly going on opposite directions). It is attributed to the so-called style B³⁰, at dates to the mid-late 4th century; findings with these motifs are mainly located in the Algerian area.

Type 10 is similar to type 9 but it has two or three short vertical ribs on each side at bottom. It too belongs to the so-called style B, and it is dated to the second half of the 4th century.

The second motif that has been recognised is connoted by rosettes, and it appears on one of the floor fragments together with the palm branches motif. The

²⁹ Comparisons for Hayes type 9: ALLAIS 1957, t. after p. 42, n. 8; HAYES 1972, pp. 232, fig. 39.9, 231; *Atlante I*, p. 140, t. LXIX, n. 9. Comparisons for Hayes type 10: ALLAIS 1957, t. after p. 42, n. 4; HAYES 1972, pp. 232, fig. 39.10, 231; *Atlante I*, p. 140, t. LXIX, n. 12.

³⁰ Style B is characterised by compositions of palm branches and concentric circles: the common scheme consists of five palm branches radiating from a groove around the centre, with circles in-between, but rosettes may appear too as fillers. Chronologically, this style can be found between the second half of the 4th century A.D. and the first decades of the 5th century A.D. (for a detailed description: HAYES 1972, pp. 219-220).

closer comparison is with the type Hayes type 44/ Tamedfoust n. 184 (tab. II, n. 19), documented in the Algerian region as well³¹. This type is composed of incuse wedges representing petals. It refers to the so-called style A³², and it's a fairly common motif, that is dated mainly to the second-third quarter of the 4th century A.D.: two stages are distinguished, considering how large the rosette is.

As it is documented, these two motifs are used together in one artefact: despite being attributed to two different styles, it is not uncommon for these to be used together as well.

3. CONCLUSIONS AND FINAL REMARKS: SOME CONSIDERATIONS

Though the number of findings is limited, interesting data can still be deduced. First, the number of vessels attributed to the regional productions mirrors its dominance in well-known contexts such as Sétif. Despite this fact, other productions (such as ARS E) are

³¹ Comparisons: GUÉRY 1970, p. 280, t. I, n. 12; HAYES 1972, p. 238, fig. 41.44 A-B; *Atlante I*, p. 129, t. LVII, nn. 65-66.

³² Style A consists of quite a wide range of geometric and floral motifs stamped around the centre or radiating from it. Three phases are distinguished by J. W. Hayes, and it is dated from the first half of the 4th century A.D. to the second half of the 5th century A.D. A detailed description: HAYES 1972, pp 218-219.

documented as well, mainly from an internal region of Tunisia: contacts between the Algerian *limes* and centres from Tunisia could happen, perhaps mirroring movements of groups of people such as the military, or movements of goods for supplies. In particular, southern Byzacena products were probably manufactured to satisfy the demand of inland regions, especially during the 4th-5th centuries A.D. It must be noted, anyway, that these connections seem rather weak, focusing more on an Algerian inland connection³³.

The typological study also shows how these findings also mirror the commonest type that were produced and used regionally. From a chronological point of view, a certain homogeneity can be noted as well, as all the findings are dated to the late-antiquity age, specifically between the 4th century A.D. and the 5th century A.D. It cannot be ignored the context, the *limes africanus*: the data gathered in this preliminary study confirm, in fact, the Roman presence in the area during the Late Antiquity age, connected to the military that would occupy this area, especially the Fort Parallélogramme, as the majority of the findings belong to this context.

A further consideration on the chronology of the remains can be made with regard to the context in which they were found: ground survey, although systematic, highlights more the last phase of occupation of a site. In the absence of accurate stratigraphic excavations, the chronological expression of the site as a whole cannot be determined, especially in places where anthropic impact (with the exception of looting) is limited. On the contrary, density analyses of the artefacts distribution carried out on the site of Fort Parallélogramme have made it possible to hypothesise different uses for the areas inside the *castrum*. With the exception of the pottery class, which finds a rather homogeneous distribution within the site, the presence of animal bones in association with carbonaceous traces and ash discharges in the northern part of the camp, highlights how the area was used, at least in the final phases of the site, as a dumping area for the remains of meals and hearths. The distribution of the metal elements (almost all of them being coins) also indicates a probable commercial use of the area in front of the *castrum*, along the southern side (fig. 2). In conclusion, the general distribution of the materials (fig. 3) is considerably influenced by the presence of clandestine excavations that have altered the quantitative aspects of the data; the comparison between the orthophotos of the area with the density maps shows that the areas most affected by looting are also those with the greatest presence of remains on the surface.

³³ On this issue, see also: FENTRESS 1990; BONIFAY 2017.

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COINS AT THE END OF THE ROMAN WORLD

Elisabetta Montaguti, Michele Asolati

Department of Cultural Heritage: Archaeology and History of Art, Cinema and Music – University of Padova

In March 2019, an Italian-Algerian team carried out archaeological surveys in the Biskra area, along the Roman limes that is part of the Algerian territory. About sixty bronze coins were found, some of them completely isolated, others grouped in clusters. The coins belong mainly to a period ranging from the 3rd to the 5th century AD, with a few exceptions.

KEYWORDS: Coin finds, Northern-African Limes, Late Roman Bronze Coins

1. FINDS OF THE 2019 CAMPAIGN (Elisabetta Montaguti)

In 2019, the survey campaign led to the discovery of ancient coins in the areas of Fort Parallelogram, fort *Gemellae* and Oumache-Mlili. In addition, a further specimen was found in the tower 3, along surveyed section of the *limes* south of Fort Parallelogram.

When possible, the GPS coordinates of the finds have been recorded and will be presented here in the metric format WGS84/UTM31N (EPSG:32631). In particular, in the *Gemellae* area, the coordinates of each find have been considered, while in the area of the Fort Parallelogram only the clusters of coins, including at least two pieces found together, have been recorded.

64 coins have been found during the campaigns and they cover a chronological span from the 1st century AD to the beginning of the 6th century AD, with the only exception of a coin possibly dating to the 2nd-1st century BC or to 1st-2nd century AD (Cat. no. 17). Most of the finds are concentrated between the second half of the 4th and the beginning of the 5th century. Among all the coins discovered, the Italian-Algerian team was able to clean and to collect the related technical details (weight, diameter, die axes) of 37 of them. The remaining coins have been only photographed and, for this reason, their identification could only be hypothetical according to their morphological features. Since their diameters match the AE3 and AE4 standards, they probably belong to the same chronological period of the coins that have been cleaned and recorded. Some of these coins are shown in fig. 1, while the graph on fig. 2 shows the chronological distribution of all the coin findings, with the indication of the different find spots.

1.1 Fort Parallelogram

In the Fort Parallelogram area, the survey was carried out, as shown in fig. 3, dividing the site into 20x20 m squares, identified with letters from A to H and numbers from 1 to 8¹, and in an additional band 10 m wide in the sides S-E and S-W of the site. During the survey, attention was paid to all the materials of numismatic relevance. With respect to the isolated finds, the square in which they were found have been recorded, while in the case of the multiple discoveries a cluster has been named, and the spatial coordinates have been registered through the GPS of a mobile phone.

Looking at the 3, we can see a greater concentration of finds in the N-E portion of the fort². This pattern of distribution is possibly due to the presence, in this part of the site, of some pre-existing pits, detected during the survey, made in modern times with the purpose of stealing archaeological material. This led to greater dispersion of the archaeological material, especially eliminate of small size.

Three white dots identify the precise location of the coin clusters: CB01 consists of six coins³, while clusters CB02 and CB03 include three⁴ and seven⁵ specimens respectively.

Overall, 34 coins were found at this site. The earliest monetary evidence dates from the 2nd century BC to the 2nd century AD, although the minting authority is

¹ For more details on the criteria for reconnaissance applied on site, see the contribution of Luigi Magnini in this volume.

² In particular, three coins were found in each of the following squares: AB34, AB56 and CD34; one in AB78; and seven in CD9.

³ It was detected in CD9: the coordinates of the discovery are 734869,601 N 3891388,178 E.

⁴ Located in CD34, it is defined by coordinates 734834,562 N 3891429,453 E.

⁵ It was found in the square GH56, at coordinates 734820,699 N 3891383,469 E.

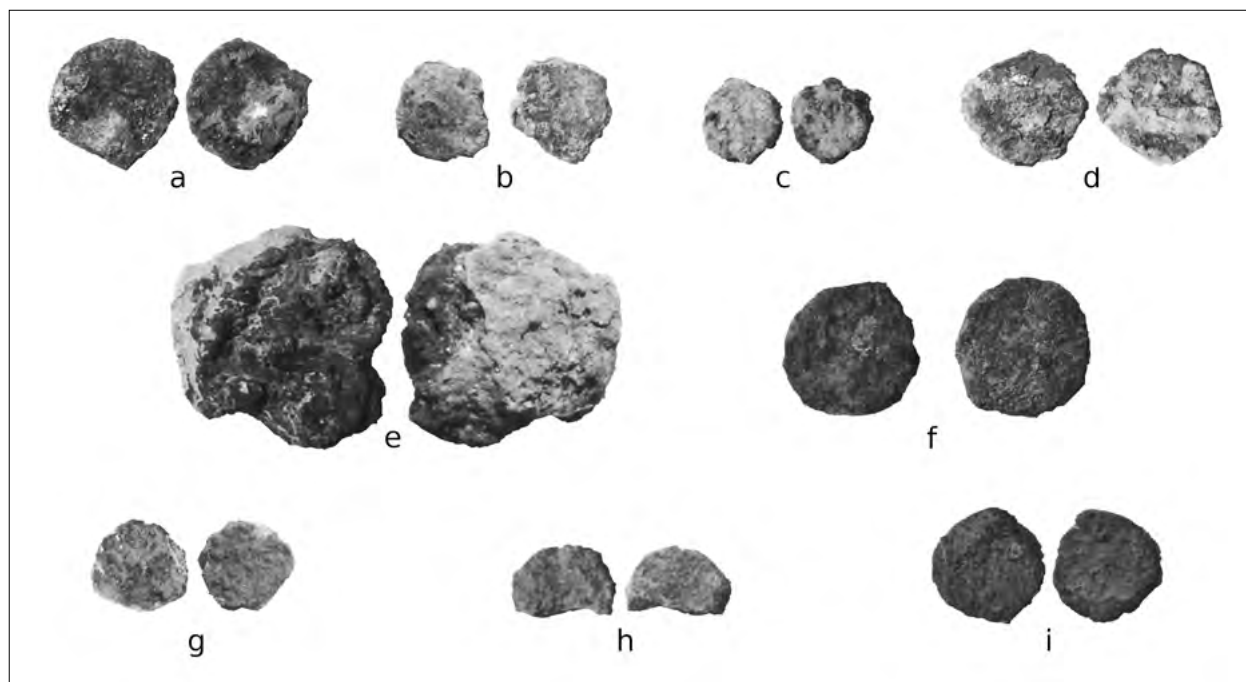


Fig. 1 - Some of the coins which were only photographed and not catalogued (see below nos. 38-46): (a), (b), and (c) were found in square AB34, (d) in AB56, and (e) in AB78; (f), (g), and (h) were discovered respectively in GH12, GH34, and GH78; coin (i) was found out of square.

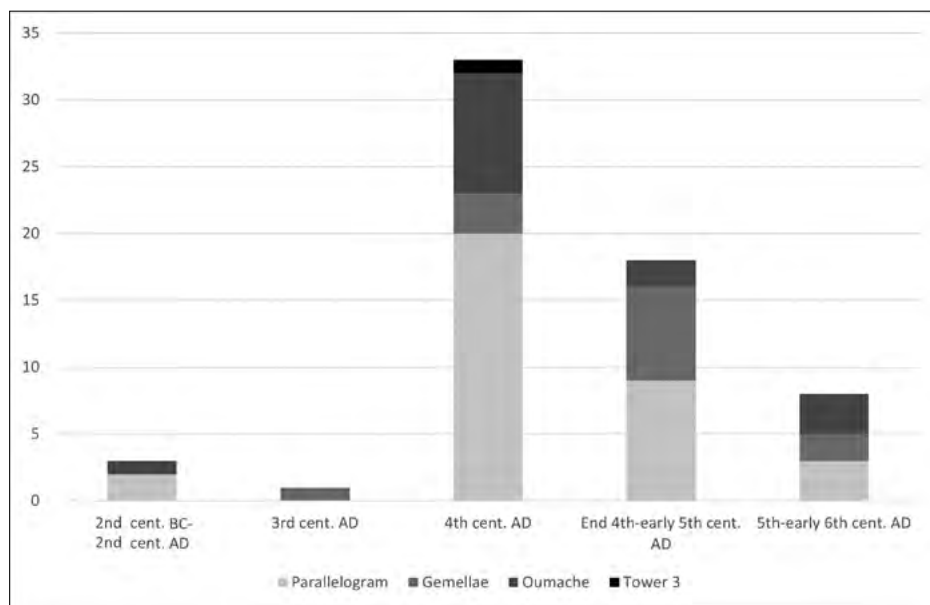


Fig. 2 - Chronological and site-specific distribution of the coins under study.

not recognisable. However, the coin could be ascribed either to a North African, Egyptian or Cyrenaican mint because of the thin flan, completely illegible, showing a truncated cone cross-section and a short part of a sprue, that make it very similar to some bronze issues produced in Alexandria⁶ and/or Cyrene⁷ during the 2nd-1st century BC, or in Alexandria in the 1st-2nd century AD⁸.

⁶ Cf. PICARD, FAUCHER 2012, nos. 874-982.

⁷ Cf. *NAeCy*², nos. 105-108, 111-114.

⁸ Cf. for example *RPC*, I, nos. 5077-5078, 5083-5085, 5178-5180, 5191; *RPC*, II, nos. 2741, 2743-2756, 2768-2770; *RPC*, III, nos. 6248, 6261.

After this period, there is a gap in the documentation, until the 4th century, to which twenty coins can be attributed, 59% of the total finds from this site. All these coins belong to the second half of the century, except for four pieces (Cat. nos. 20, 21, 41, 43) generically dating to the 4th century. The remaining examples are poorly legible due to metal corrosion; in particular, nine of them date between the late 4th and the early 5th century (Cat. nos. 6, 10, 11, 22, 38-40, 44-45), while three between the 5th and the beginning of the 6th century (Cat. nos. 12, 13, 16). In most cases the mint can't be determined, except for four coins: one belongs to Cyzicus (Cat. no. 2), one to an orien-

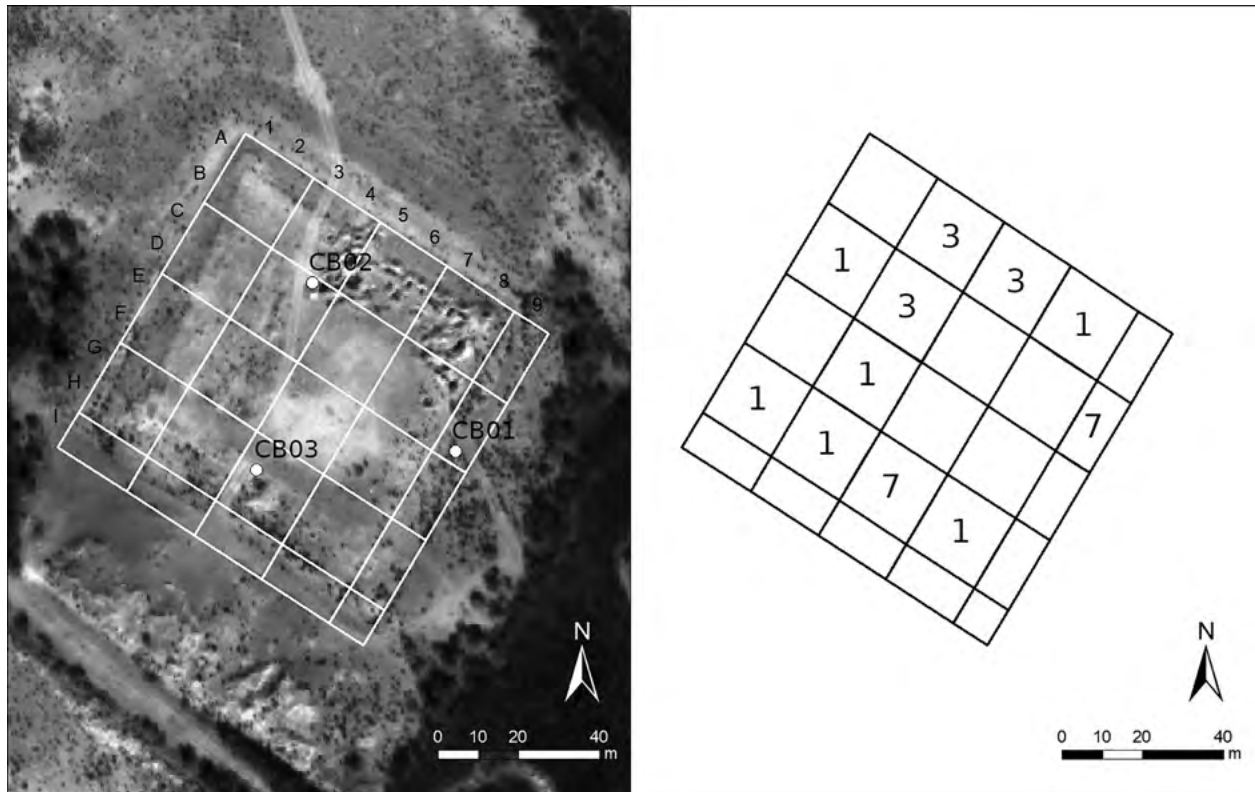


Fig. 3 - A) Aerial photo of the site of Fort Parallelogram with representation of the grid employed during the survey and cluster localization; B) quantity of coins found within each square.

tal mint (Cat. no. 7, Thessalonica or Nicomedia), and two coins to three possible mints respectively (Cat. nos. 8 and 15).

About 18% of the coins coming from this site had been manipulated by removing part of the flan or by clipping (Cat. nos. 1, 2, 15, 18, 20, 21), with the aim to adapt the older coins to the new standards⁹.

1.2 Gemellae

The survey at fort *Gemellae* was conducted in the eastern and north-eastern area outside the fort itself. Unfortunately, it was not possible to investigate the entire off-site due to the short time available¹⁰. Also in this case all the numismatic material found during the survey activities was collected. The geographical coordinates of each find were detected and registered, while the clusters of coins have been marked with a single point. The fig. 4 illustrates the location of the discoveries, identified by white symbols and progres-



Fig. 4 - Distribution of the coin finds in the area of fort *Gemellae*.

sive numbers¹¹. According to the data obtained during the survey, there is a higher concentration of coins and bronze fragments in the eastern part of the off-site, in correspondence with the main access route and its exit

⁹ For more information on this phenomenon see ASOLATI 2005, pp. 25, 51; ASOLATI 2006a, pp. 109-110; ASOLATI 2010, pp. 311-312; ASOLATI in press; ASOLATI, STELLA 2018, pp. 122-124. .

¹⁰ For the survey methodology, see the contribution of Luigi Magnini in this volume.

¹¹ The coordinates of the finds are as follows: B01 731463,701 N 3835635,036 E; B02 731460,486 N 3835656,825 E; B03 731475,486 N 3835688,277 E; B04 731367,011 N 3835751,935 E; B05 731405,918 N 3835725,938 E; B06 731325,628 N 3835741,242 E; B07 731410,656 N 3835756,58 E.

from the fort: in this area the team was able to find two coins in B01, two coins and a bronze fragment in B02 and four coins and bronze fragments in B03. In the portion of the land investigated to the N-E of the fort, fewer coins were discovered. In particular, only two finds came from B04, while B05, B06 and B07 gave a single find each.

A total amount of 14 coins have been found, covering a chronological time frame starting from the first half of the 3rd to the 6th century AD. The oldest coin discovered is dated between 200 and 250 AD, while all the others were minted between the middle of the 3rd century and the beginning of the 6th. The coins from this site are largely corroded and their identification is so limited, that only one of them could be dated with some accuracy to the period between 350-361 AD, although it is not possible to determine with certainty the mint (Cat. no. 27). Three coins are severely corroded in a way that generates a split of the flan along the entire edge (cf. fig. 6)¹². For all these reasons, the mint attribution was not possible for all the finds. In addition, at least two coins are cut or clipped (Cat. nos. 26 and 30).

1.3 Oumache-Mlili

The survey on the site of Oumache was carried out focusing on the detection of the structures *in situ*. Due to the purpose of the visit and the lack of time available to the team, it was not possible to geo-reference the coin finds. The area of the entire site was densely covered with ceramic fragments and bronze coins of which 15 have been chosen as sample. The oldest one is an *As* probably of the Domitian's period (Cat. no. 32). All other coins are dated between the 4th and the beginning of the 6th century. For none of them the identification of the mint was possible.

1.4 Tower 3

During the survey of the structures of tower no. 3 along the limes, a single well-preserved coin has been found¹³. It was minted in Siscia during the reign of Constantius II (Cat. no. 37).

2. THE COIN FINDS IN THE REGIONAL CONTEXT (Michele Asolati)

The features of the ancient monetary presence in the central-western part of Northern Africa are outlined in a wide literature based on the contribution of two

very active scholars, Pierre Salama¹⁴ and Saïd Deloum¹⁵, which was the starting point of further studies edited by others. The result is an analysis that focuses primarily on the pre-Roman coinage, especially the Numidian one¹⁶, as well as on the central and final phases of the Roman Empire and on the transition to the Vandal domination up to the Byzantine reconquest. The analysis is often based on the edition of specific hoards¹⁷, but research summaries have been published as well¹⁸. Nevertheless, the analysis of single finds, from both excavations and stray finds, appears to be less common. Apart from the particular and significant case of Carthage¹⁹, whose numismatic materials found during international excavations have been precisely published, data are available for the sites of *Bulla Regia*²⁰, *Sétif*²¹, *Lambaesis*²², *Tipasa*²³, *Nador*²⁴, *Cherchel*²⁵, *Zilil*²⁶, *Thamusida*²⁷, *Volubilis*²⁸, *Banasa*²⁹ and for few others³⁰, while further significant informa-

¹⁴ Valuable information about the bibliography of Pierre Salama are available in SALAMA, LAPORTE, DECHEZELLES 2008; many of his texts, also on numismatic topics, have been subsequently re-edited with updates in SALAMA 2005.

¹⁵ A useful summary of Saïd Deloum's numismatic bibliography is available in DELOUM 2015a, pp. 364-366, note 1.

¹⁶ Cfr. DELOUM 2015a.

¹⁷ With regard to the Late Roman and Vandal periods see TURCAN 1961, 1984; MORRISSON 1980; BRENOT, MORRISSON 1983, BOURGEOIS, BRENOT 1995; BRENOT 2002; MOSTECKY 1994, 1997; DELOUM 1989, 2006, 2008a, 2015b; BALDUS 2014; BALDUS, KHANOUSSI 2014. The contributions dealing with the presence of 3rd century radiated coins should be considered as well, above all CALLU, SALAMA 1974 and CHAMEROY 2008, 2010.

¹⁸ SALAMA 1979, 1985, 2004; MORRISSON 1980, 1988a, 1988b, 1996, 1999, 2001, 2003a, 2003b, 2016; DELOUM 1990; SALAMA, CALLU 1990. See also HOYER 2018.

¹⁹ This is not the place for a survey of the wide bibliography edited since the 70s of the 20th century on the coin finds coming from the excavations on the site of Carthage; refer to MORRISSON 1988a, 1988b, 2016, part. pp. 177-178; VISONÀ 2009, p. 128, nos. 38, 47; ASOLATI 2012, pp. 167-170, Tables B and C.

²⁰ BALDUS 1993, part. pp. 224-238.

²¹ FEVRIER *et alii* 1970, part. pp. 129, 138, 141-142; DELOUM 1991.

²² CAGNAT 1909, pp. 203-204; SALAMA 2004, p. 27.

²³ Cf. SALAMA 1979, inv. 72-73, 75-79, 82-85, 87, with further bibliography.

²⁴ BAISTROCCHI 1984; SALAMA 1989.

²⁵ Cf. SALAMA 1979, cat. 39, 46-47, 55, 57, 60-61, 63-65, 68, with further bibliography.

²⁶ DEPEYROT 1999.

²⁷ CALLU *et alii* 1965, *passim*, part. pp. 72-77, 133, 202-218, 266-273; MARION 1967, *passim*; REBUFFAT, MARION 1977, part. pp. 94-140

²⁸ MARION 1967, *passim*.

²⁹ MARION 1967, *passim*.

³⁰ Cf. above all SALAMA 1979, with previous bibliography, on: *Iconium*, inv. 94, 96-98, 102-103; *Portus Magnus*, inv. 13-17, 19; *Dellys (Rusucurium)*, inv. 117-120; *Dijnet (Cissi)*, inv. 115; *el Guelta (Arsenaria)*, inv. 28; *Kherbet Ramoul*, inv. 26-27; *Les Andalouses*, inv. 7-8; *Mazafran*, inv. 90; *Sidi bel Atar*, inv. 21-24; *Sidi*

¹² Cf. below, note 36.

¹³ The coordinates are 735145 E, 3884218 N.

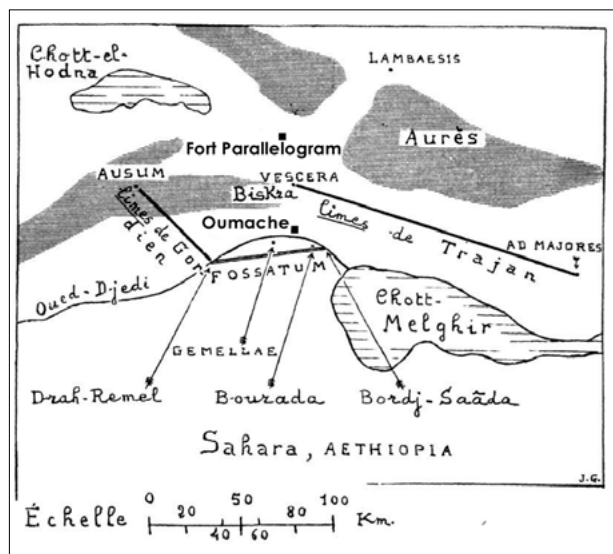


Fig. 5 - Location of the “castellum” of Bourada in the map edited in GUEY 1939, modified in order to present also the location of the sites of Oumache and Fort Parallelogram, surveyed in 2019.

tion can be found among museum collections based on local finds³¹. However, in terms of coin finds, literature focuses primarily on the sites of the coastal areas as opposed to those of the inner part of the Roman *limes*, resulting in an uneven picture of the find pattern, with special regards to the single ones.

For this reason, the coin finds yielded by the joint surveys of the University of Padua and the University of Biskra, are of some interest despite their small number. The highest share in this sample concerns the coins of the 4th century struck under the house of Constantine the Great and the Valentinianic dynasty. The same feature emerges from the analysis of the finds coming from areas close to those investigated by the Italian-Algerian team. For example, at both *Lambaesis*³², located north west of *Vescera*-Biskra, and the “castellum” of Bourada, located south of the former one, along the *limes* established by Gordian III³³ (fig. 5). In the first case 4th century is represented by 59 coins of the house of Constantine the Great, 10 specimens of the Valentinianic period and 35 pieces of the Theodosian dynasty³⁴; for Bourada, instead, among the 180 coins found in the site, “dont la plupart, fort détériorées par le terrain salé, sont restées illisibles après nettoyage”, there are 31 copper

Brahim (Gunugus), inv. 37; Sidi Fredj, inv. 91-92; Siga, inv. 1-5; Taksebt, inv. 125-126; Tamentfoust, inv. 112; Ténès (*Cartennas*), inv. 31-35. See also MARION 1967, *passim*.

³¹ ARGUEL 1878, 1881; DEMAECHT 1895-1898; SALAMA 1979, inv. 39; DELOUM 2008b, 2013, 2015c.

³² Cf. above, note 22.

³³ GUEY 1939, pp. 207 and part. 245-247.

³⁴ SALAMA 2004, p. 27.

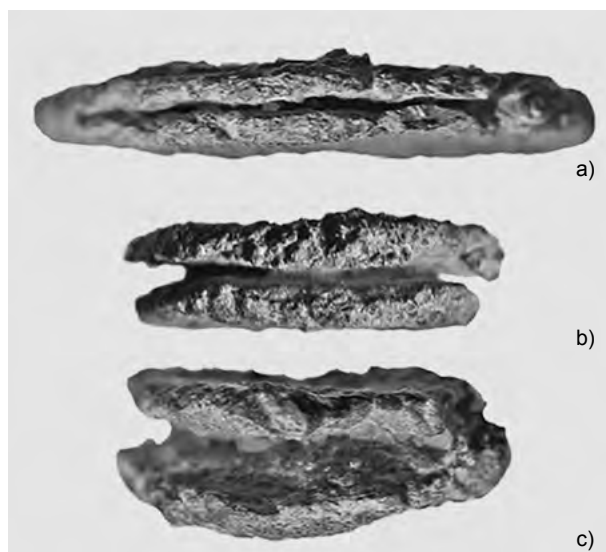


Fig. 6 - Examples of coins corroded along the edge (scale 4:1): a-b) *Gemellae*, survey point B02 (Cat. nos. 27, 29); c) Oumache recognition (Cat. no 36).

specimens which cover a time span between the issue for *Divus Claudius* and the age of Gratian, which is the last identifiable minting authority³⁵.

A common pattern can be seen, even if a different behaviour is noted at *Lambaesis* towards the end of the century. The lack of finds after Gratian at the fortresses of Bourada and “Parallelogram” could depend on the quality of the samples considered (resulting from surface surveys and not from systematic excavations) and the morphometric characteristics of bronze coins of the end of 4th century (substantially AE4), which are more affected by corrosion and more difficult to detect even in systematic surveys than larger coins minted in previous periods. Nevertheless, among the specimens collected near *Gemellae* and at the “Fort Parallelogram”, some apparently illegible flans of small size (11-12 millimetres or even smaller), comparable to those of the Roman imperial bronze issues of late 4th-first decades of 5th century, or even later, have been noted. Some of them show a peculiar pattern of corrosion which implies the split of the flan along the entire edge (fig. 6). This feature enables to identify minting as production technique, instead of casting, proper to imitations³⁶. Thus, the possibility to extend the time span of the evidence collected during the Italian-Algerian surveys to the end of 4th and the first half of 5th is rather than unrealistic, as comparable to the site of *Lambaesis*.

In the light of this, it seems plausible that the region was open to the circulation of the imperial Roman

³⁵ GUEY 1939, pp. 207 and part. 245-247.

³⁶ ASOLATI *et alii* 2019, pp. 1-3; ASOLATI *et alii* 2023.



Fig. 7 - Finds of late Roman gold coins in Vandal Africa (graphic elaboration by C. Morriçon e F. Tessier 2013; from MORRISSON 2016, p. 176, fig. 9.1). Legend: ■ hoard; △ single finds.

currency until the end of the Roman domination, but most likely even beyond. As it was authoritatively observed, “*despite their historical reputation for universal devastation, the Vandals had no interest in destroying the riches of the ‘peaceful and quiet province... the land everywhere flourishing’ of which they had taken control. In fact, the conquest in 429 has left few archaeological traces of destruction. The sacking of Carthage in 439 was limited to the Antonine Baths, the Odeon and theatre, all located near the rich villas to the northwest of the city, the most tempting area for plunder, and the one where military resistance. The thriving African economy relied on a multi-tier coinage widely distributed over the province. On the Vandals’ arrival, the circulating medium was composed of the usual pluri-metallic Roman denominations: gold was mostly represented by solidi, silver must have been rather scarce since there are no datable finds of it, and small bronze pieces were the most common*”³⁷.

This continuity in the Biskra area is confirmed by some finds that fit into a very well documented regional framework regarding both the circulation of imperial gold coins and the presence of bronze Vandal issues. In this regard, it should be noted the discovery in 1952 of a hoard of *solidi*, containing 45 coins in the name of Honorius minted in Ravenna, and two of Theodosius II struck in *Constantinopolis*³⁸. Furthermore, in 1958, during the construction of the military airport, a hoard of *minimi* was unearthed, about which Pierre Salama states: “*Parallèlement, la composition du lot d’Aïn Mérane équivaut à celles de Mouzaïa, Nador, Msila, Biskra-Korra, et Hamma, c’est-à-dire que l’on couvre par une circulation monétaire de même nature une distance de 600 km*”³⁹.

So, the closing date of the hoard can be placed in the late Vandal period, between the end of 5th and the mid 30s of the 6th century⁴⁰. This numismatic evidence is supported by numerous other finds gathered in the maps recently published by Cécile Morriçon, reproduced in figs. 7 and 8⁴¹.

Moreover, the persistence of connections between this part of Northern Africa and the Italian mints during 5th century can be ascertained thanks to a particular feature that links the Italian and African bronze coin hoards at the turn of the half of the century⁴². Even in the absence of such indications in the Biskra and in the neighbouring areas, the presence of monetary evidence before (4th century AD) and after (second half 5th-first half 6th century AD) these phases, makes it reasonable to assume that the gap is due to a lack of documentation, rather than to a real absence of currency in antiquity, which is entirely plausible in the light of what mentioned before.

Basically, the coins discovered during the Italian-Algerian surveys near the Algerian *limes* shed new light on the Roman presence in the area, especially in the late imperial phases, although in a rather well-known context that seems to include the entire central-western part of Northern Africa, namely the *Proconsularis* and the eastern *Mauretania Tingitana* at least until the end of the Roman rule⁴³, and the *Proconsularis*, the *Numidia*, as

⁴⁰ Cf. MORRISSON 1980; DELOUM 1990; DELOUM 2015b, part. pp. 672-673.

⁴¹ About the presence of late Roman and later *solidi* cf. also SALAMA 2001 and LOUM 2023.

⁴² ASOLATI 2005, pp. 21, 50-51, 2006b, *passim*; ASOLATI, STELLA 2018, pp. 129-130.

⁴³ Cf. SALAMA, CALLU 1990; SALAMA 1979, 1985; MORRISSON 2016. The situation observable in the part of the *Tingitana* fac-

³⁷ MORRISSON 2016, pp. 174-175.

³⁸ SALAMA 2001, p. 263, no. 26.1.

³⁹ SALAMA 1985, p. 195, note 48: Cf. also SALAMA 2001, p. 263, no. 26.2.

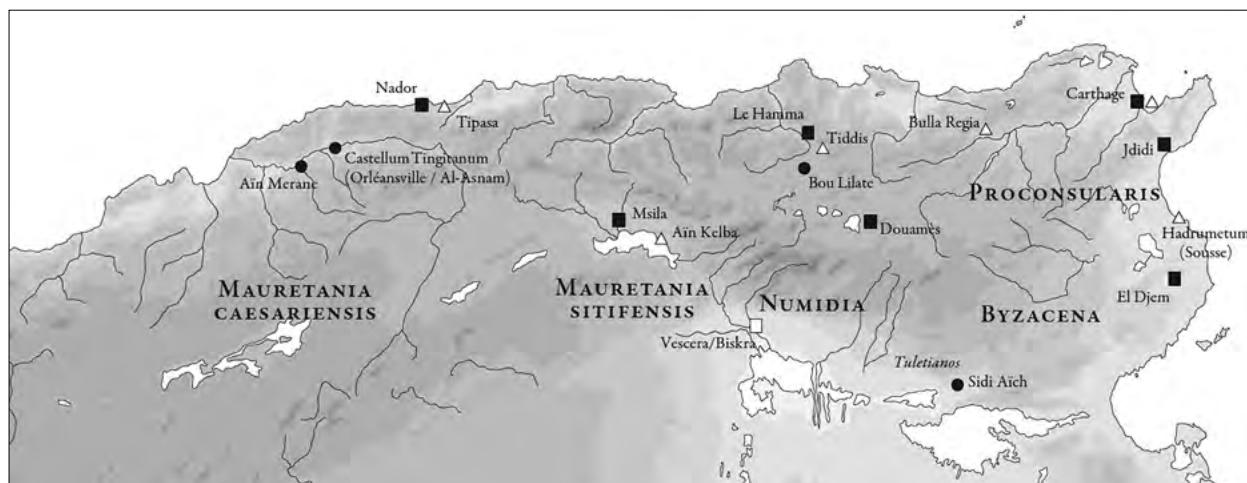


Fig. 8 - Finds of Vandal bronze coins in Africa (graphic elaboration by C. Morriçon e F. Tessier 2013; from MORRISSON 2016, p. 178, fig. 9.3). Legend: Δ finds including signed Vandal coins; \bullet finds including imitations of Vandal coins; \blacksquare finds including Proto-vandal bronze coins; \square unspecified metal.

well as a part of the *Caesariensis* in the Vandalic period. In the light of this, new and systematic archaeological investigations conducted in those contexts could lead to new significant acquisitions.

3. CATALOGUE OF THE FINDS AND ITS ARRANGEMENT (Elisabetta Montaguti)

Due to a lack of time during the mission of the University of Padua, in collaboration with the University of Biskra, it was not possible to clean all the coins found. For this reason, 60% of the coins were selected to be cleaned and recorded. The identification of the remaining coins is based only on pictures and they are listed in the final section.

The coins have been arranged according to their provenance: “Fort Parallelogram”, *Gemellae*, Oumache, and “Tower 3”. The numismatic evidence from “Fort Parallelogram” is further classified following the order of the grid, while those from *Gemellae* are listed following the progressive number of the find.

For each coin we have specified: minting authority, date, mint, denomination, legend and description of the obverse, legend and description of the reverse, item identification number, technical details (metal, weight expressed in grams, diameter in millimeters,

ing the Atlantic seems to be different. Here the presence of imperial coinage decreases already during the 4th century AD: MARION 1967. Nevertheless, the case of Zilil (site located just beyond the Strait of Gibraltar, south of Tangier) should not be neglected: DEPEYROT 1999, part. pp. 32-43. There, the chronological distribution of the coin finds is comparable with those of the most important sites of the Mediterranean, at least until the beginning of the 5th century AD.

die-axis in terms of hours on a clock), and bibliographical reference.

Illustrative tables are provided at the end, arranged according to the catalogue numbers, where coins are represented in full scale, both on the obverse and on the reverse.

4. COINS CLEANED AND RECORDED

FORT PARALLELOGRAM

SQUARE A6

Constantius II / Constantius Gallus/ Julian III, 350-361 AD, unidentifiable mint, $\text{AE}3$.

O: Bust, right.

R: [FEL TEMP REPARATIO] Soldier advancing left, spearing fallen horseman with right hand.

1: [AE ; 1,26 g; 15 mm; h 12]

Cf. *LRBC*, pl. II, no. 2295.

SQUARE AB56

Constantius II / Julian III, 355-363 AD, Cyzicus, $\text{AE}3$.

O: Bust, pearl-diademed, draped, cuirassed, right.

R: [SPES REI-PVB]LICE Emperor standing right, holding globe in right hand and spear in left hand, in exergue SMK.

2: [AE ; 1,47 g; 15,5 mm; h 12]

RIC, VIII, pp. 499-500, nos. 117, 123.

SQUARE CD12

Constantius II, 350-361 AD, unidentifiable mint, $\text{AE}3$.

O: [DN CONSTAN] -TIVS PF A[VG] Head, pearl-diademed, right.

R: [FEL TEMP REPARATIO] Soldier advancing left, spearing fallen horseman with right hand.
3: [Æ; 1,52 g; 15 mm; h 12]
Cf. *LRBC*, pl. II, no. 2295 ?

SQUARE CD34

CLUSTER CB02

Valentinian/ Valens/ Gratian, 364-383 AD, unidentifiable mint, Æ3.
O: Bust, right.
R: [SECVRITAS REIPUBLICAE] Victory walking left.
4: [Æ; 1,96 g; 14 mm; h 6]
Cf. *LRBC*, pl. III, no. 527.

Valentinian II / Theodosius, 378-388 AD, unidentifiable mint, Æ4.
O: Head right.
R: Type *Vota*.
5: [Æ; 1,64 g; 11 mm; h 6]
Cf. *LRBC*, no. 377.

Unidentifiable emperor, end 4th-beginning 5th century AD, unidentifiable mint, Æ4.
O: Illegible.
R: Illegible.
6: [Æ; 0,74 g; 10,5 mm; h 6?]
RIC, IX, X ?.

SQUARE CD9

CLUSTER CB01

Constantius II, 350-361 AD, Thessalonica / Nicomedia, Æ3.
O: [DN CONSTAN-TIVS PF AVG] Bust, pearl-diademed, right.
R: [FEL TEMP REPARATIO] A in left field. Soldier advancing left, spearing fallen horseman with right hand.
7: [Æ; 1,83 g; 18 mm; h 12]
RIC, VIII, p. 419, no. 189, p. 482, no. 107.

Valentinian II / Theodosius / Arcadius, 383-388 AD, Rome/ Aquileia/ Thessalonica, Æ4.
O: Bust, diademed, right.
R: [VICTORIA AVGGG] Two Victories facing holding wreaths.
8: [Æ; 1,19 g; 12 mm; h 6]
Cf. *LRBC*, no. 140.

Valentinian II / Theodosius / Arcadius / Honorius, 383-403 AD, unidentifiable mint, Æ4.
O: Head, right.
R: [SALVS REIPUBLICAE] Victory walking left, dragging captive and carrying trophy.
9: [Æ; 1,08 g; 13,5 mm; h 12]
Cf. *LRBC*, no. 1105 ?.

Unidentifiable emperor, end 4th-beginning 5th century AD, unidentifiable mint, Æ4.
O: Illegible.

R: Illegible.
10: [Æ; 0,99 g; 12 mm; h ?]
RIC, IX, X ?.

Unidentifiable emperor, end 4th-5th century AD, unidentifiable mint, fragment of coin.

O: Illegible.
R: Illegible.
11: [Æ; 0,34 g; 9 mm; h ?]
RIC, IX, X ?.

Unidentifiable emperor, 5th-early 6th century AD, undefined mint, Æ4.
O: Illegible.
R: Illegible.
12: [Æ; 0,59 g; 8 mm; h ?]
RIC, X ?.

Unidentifiable emperor, 5th-early 6th century AD, unidentifiable mint, Æ4.
O: Illegible.
R: Illegible.
13: [Æ; 0,37 g; 8 mm; h ?]
RIC, X ?.

SQUARE EF34

Constantius II, 350-361 AD, unidentifiable mint, Æ3.
O: DN CONSTAN-TIVS [PF AVG] Bust, pearl-diademed, draped, cuirassed, right. Part of dotted circle.
R: [FEL TEMP REPARATIO] Soldier advancing left, spearing fallen horseman with right hand.
14: [Æ; 2,87 g; 17,5 mm; h 6]
Cf. *LRBC*, pl. II, no. 2295.

SQUARE GH56

Constantius II for Julian III, 355-361 AD, Arles / Siscia / Thessalonica, Æ3.
O: [---]IAN-[---] Bust, bare-headed, draped, cuirassed, right.
R: [FEL TEMP REPARATIO] Soldier advancing left, spearing fallen horseman with right hand.
15: [Æ; 2,02 g; 17 mm; h 12]
Cf. *LRBC*, pl. II, no. 2295.

Unidentifiable emperor, 5th-early 6th century AD, unidentifiable mint, fragment of coin.
O: Illegible.
R: Illegible.
16: [Æ; 0,28 g; 9 mm; h ?]
RIC, X ?.

SQUARE GH56

CLUSTER CB03

Unidentifiable emperor, 2nd-1st century BC or 1st-2nd century AD, Egyptian or Cyrenaican mint, Greek planchet, truncated cone shape, with shank.
O: Illegible.

R: Illegible.
17: [Æ; 1,02 g; 12 mm; h ?]
SNG ?

Constantius II, 350-361 AD, unidentifiable mint, Æ3.
O: [DN CONSTAN-TIVS PF AVG] Head, diademed, right.
R: [FEL TEMP REPARATIO] Soldier advancing left, spearing fallen horseman with right hand.
18: [Æ; 1,27 g; 16 mm; h 12]
Cf. *LRBC*, pl. II, no. 2295.

Gratian, 367-383 AD, unidentifiable mint, Æ3.
O: [DN GRATIA]-NV[S PF AVG] Bust, right.
R: [SECVRI]TAS-REI PVBLICAE Traces of letters in exergue. Victory walking left, holding wreath and trophy.
19: [Æ; 2,26 g; 18 mm; h 6]
Cf. *LRBC*, pl. III, no. 527.

Unidentifiable emperor, 4th century AD, unidentifiable mint, follis / Æ3 (fragment of coin, flaked off).
O: Illegible.
R: Illegible.
20: [Æ; 0,40 g; 10 mm; h ?]
RIC, VIII, IX ?.

Unidentifiable emperor, 4th century AD, unidentifiable mint, Æ3.
O: Illegible.
R: Illegible.
21: [Æ; 1,53 g; 16,5 mm; h ?]
RIC, VIII, IX.

Unidentifiable emperor, second half 4th - early 5th century AD, unidentifiable mint, Æ4 (fragment of coin).
O: Illegible.
R: Illegible.
22: [Æ; 0,57 g; 13 mm; h ?]
RIC, IX, X ?.

OFF-SITE SOUTH-EAST

Constantius II / Constans / Valentinian / Valens / Gratian / Valentinian II, Second half of 4th century AD, unidentifiable mint, Æ3 (fragment of coin).
O: Head, diademed, right.
R: Lower part of standing figure, traces of letters in exergue and on the right.
23: [Æ; 0,70 g; 13,5 mm; h 6]
RIC, VIII, IX.

Unidentifiable emperor, 364-383 AD (?), unidentifiable mint, Æ3 (fragment of coin).
O: Illegible.
R: Victory walking left ?
24: [Æ; 0,73 g; 13 mm; h ?]
Cf. *LRBC*, pl. III, no. 527 ?

Unidentifiable emperor, second half of 4th century AD, unidentifiable mint, Æ3 (fragment of coin).
O: Head, diademed, right.
R: Illegible.

25: [Æ; 0,53 g; 13 mm; h ?]
RIC, IX ?.

GEMELLAE

B01

Unidentifiable emperor, first half of 3rd century AD, unidentifiable mint, As ?
Probably cut to reduce size.
O: Part of head with laurel wreath and laces of wreath, part of neck, right.
R: Two figures facing ?
26: [Æ; 1,89 g; 16 mm; h 12]
RIC, IV.

B02

Constantius II, 350-361 AD, unidentifiable mint, Æ3 (flan flaked off).
O: Bust, pearl diademed, draped, cuirassed, right.
R: [FEL TEMP REPARATIO] Soldier advancing left, spearing fallen horseman with right hand.
27: [Æ; 2,03 g; 18 mm; h 12]
Cf. *LRBC*, pl. II, no. 2295 ?

Unidentifiable emperor, second half 4th-early 5th century AD, unidentifiable mint, Æ4 (fragment of coin, flan flaked off).
O: Illegible.
R: Illegible.
28: [Æ; 0,59 g; 12 mm; h ?]
RIC, IX, X ?.

Unidentifiable emperor, end 4th-early 5th century AD, unidentifiable mint, Æ4 (flan flaked off and corroded).
O: Illegible.
R: Illegible.
29: [Æ; 1,46 g; 13 mm; h ?]
RIC, IX, X ?.

18 fragments of bronze coins, some are cut.
Total weight: 3,12 g.

B04

Unidentifiable emperor, 4th century AD, unidentifiable mint, Æ3.
O: Bust, diademed, right.
R: Illegible.
30: [Æ; 2,31 g; 17 mm; h 12]
RIC, VIII, IX ?.

Unidentifiable emperor, end 4th-early 5th century AD, unidentifiable mint, Æ4.
O: Illegible.
R: Illegible.
31: [Æ; 0,80 g; 12 mm; h ?]
RIC, IX, X ?.

OUMACHE

Domitian (?), 81-96 AD, Rome, As.
 O: Head, right. Traces of legend.
 R: Virtus standing right, holding spear.
 32: [Æ; 7,81 g; 27 mm; h 6]
 Cf. *RIC*, II, pl. VII, no. 106.

Unidentifiable emperor, 4th century AD, unidentifiable mint, Æ2.
 O: Head, right. Traces of letters. Part of dotted circle.
 R: Illegible.
 33: [Æ; 3,72 g; 22 mm; h ?]
RIC, VIII, IX ?.

Unidentifiable emperor, 4th century AD, unidentifiable mint, Æ2.
 O: Head, right.
 R: Illegible.
 34: [Æ; 2,67 g; 21,5 mm; h 12]
RIC, VIII, IX ?.

Constantius II / Constantius Gallus / Julian II, 355-361 AD, unidentifiable mint, Æ3.
 O: Illegible.
 R: [FEL TEMP REPARATIO] Soldier advancing left, spearing fallen horseman with right hand.
 35: [Æ; 1,12 g; 15 mm; h ?]
 Cf. *LRBC*, pl. II, no. 2295.

Unidentifiable emperor, end 4th-beginning 5th century AD, unidentifiable mint, Æ4 (flan flaked off).
 O: Illegible.
 R: Illegible.
 36: [Æ; 0,92 g; 12 mm; h ?]
RIC, IX, X ?.

LIMES NORTH

TOWER 3

Constantius II, 351-361 AD, Siscia, Æ3.
 O: DN CONSTAN-TIVS PF AVG Bust, pearl-diademed, draped, cuirassed, right.
 R: [FEL TEMP]-REPARATIO Soldier advancing left, spearing fallen horseman with right hand. In exergue ASISZ.
 37: [Æ; 2,45 g; 19,5 mm; h 12]
RIC, VIII, p. 375, no. 352, p. 377, no. 361.

5. COINS NOT CLEANED (ILLEGIBLE COINS)

FORT PARALLELOGRAM

SQUARE AB34

Second half 4th - early 5th century AD
 38: [Æ; g ?; 16,5 mm; h ?]
 39: [Æ; g ?; 13 mm; h ?]
 40: [Æ; g ?; 10,5 mm; h ?]

SQUARE AB56

4th century AD
 41: [Æ; g ?; 15,5 mm; h ?]

SQUARE AB78

1st-2nd century AD (?)
 42: [Æ; g ?; 27 mm; h ?]

SQUARE GH12

4th century AD
 43: [Æ; g ?; 17 mm; h ?]

SQUARE GH34

End 4th-early 5th century AD
 44: [Æ; g ?; 11,8 mm; h ?]

SQUARE GH78

Second half 4th-early 5th century AD
 45: [Æ; g ?; 13 mm; h ?]

OUT OF SQUARE

Second half 4th century AD
 46: [Æ; g ?; 14 mm; h ?]

GEMELLAE

B03

End 4th - early 5th century AD
 47: Fragment of coin. [Æ; g ?; 7,6 mm; h ?]
 48: [Æ; g ?; 10 mm; h ?]
 49: [Æ; g ?; 10,5 mm; h ?]
 50: [Æ; g ?; 10 mm; h ?]

5th - early 6th century AD
 51: [Æ; g ?; 7,3 mm; h ?]

B05

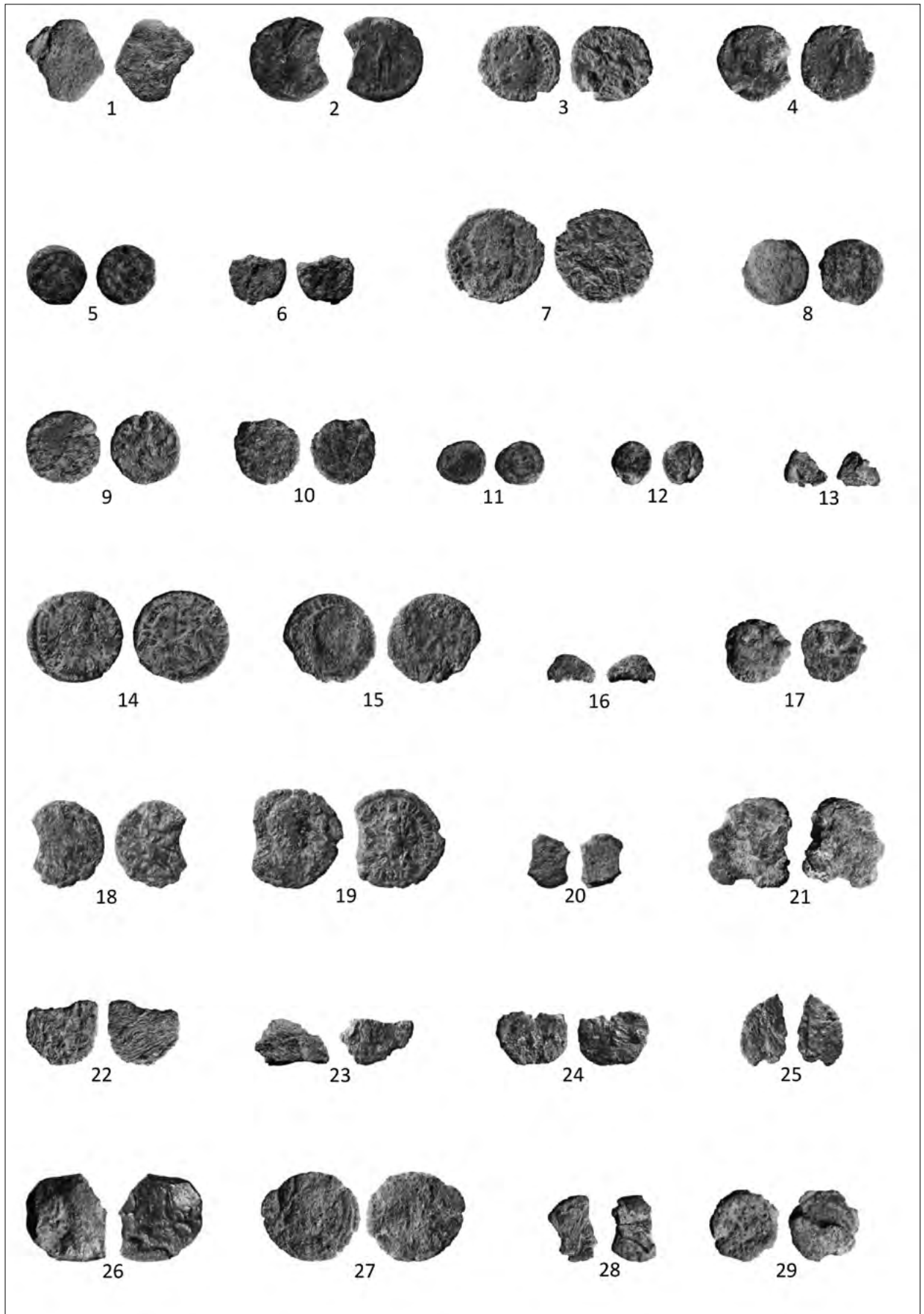
4th century AD
 O: Head, pearl-diademed, right. Traces of legend.
 R: Victory advancing left, holding wreath and palm branch. Traces of legend.
 52: [Æ; g ?; 15,4 mm; h 6]

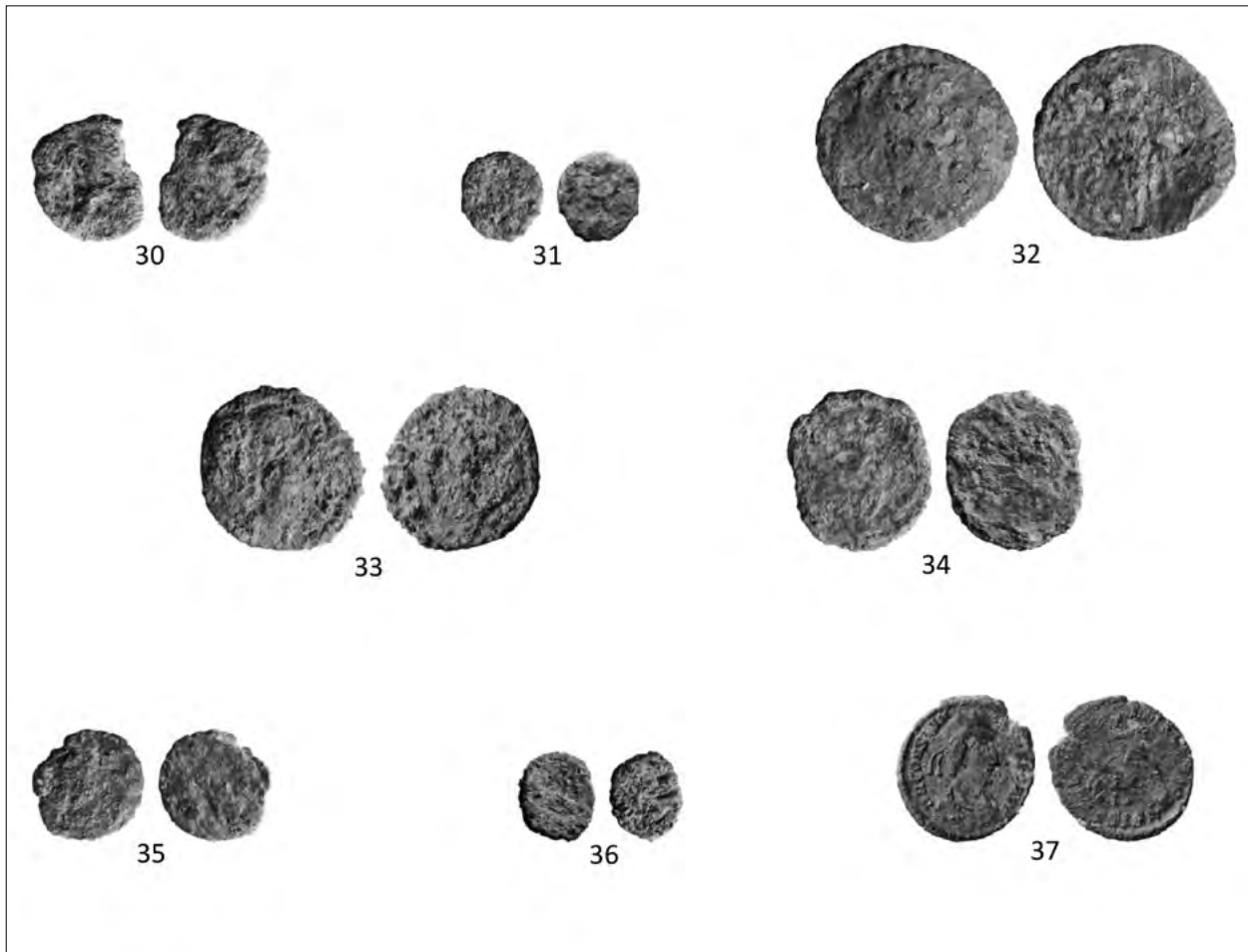
B06

Second half 4th - early 5th century AD
 53: [Æ; g ?; 13,2 mm; h ?]

B07

5th - early 6th century AD
 54: [Æ; g ?; 8,8 mm; h ?]





OUMACHE

4th century AD - early 5th century AD

- 55: [Æ; g ?; 15 mm; h ?]
 56: [Æ; g ?; 13,5 mm; h ?]
 57: [Æ; g ?; 15 mm; h ?]
 58: [Æ; g ?; 14,2 mm; h ?]
 59: [Æ; g ?; 13 mm; h ?]
 60: [Æ; g ?; 12 mm; h ?]
 61: [Æ; g ?; 13,5 mm; h ?]
 62: Fragment of coin. [Æ; g ?; 7,5 mm; h ?]

5th - early 6th century AD

- 63: [Æ; g ?; 8,5 mm; h ?]
 64: [Æ; g ?; 10 mm; h ?]
 65: [Æ; g ?; 9 mm; h ?]

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TAHOUDA, A NUMIDIAN LIMES' HUMAN SETTLEMENT

Yacine Rabah Hadji

Institut d'archéologie, Université d'Alger2, contact: yacine.rabah.hadji@univ-alger2.dz, hadjiyacinerabah@gmail.com, hadjiyacinerabah@yahoo.com.

This article aims to highlight the importance of antique Tahouda archeological site. Thus, will be described the archaeological data collected in situ by means of prospecting or excavation. Technical and scientific problems and reflections raised during field works will also be presented.

KEYWORDS: water, Limes, fertile land, hydraulic structure, excavation, archaeological survey, tahouda, tehouda, t'houda, thouda, mosaic, fortification, thermal baths, infrastructure.

THE GEOGRAPHICAL LOCATION

Tahouda (also Tehouda or Thouda) is located at the southern edge of the mountain ridge of Aurès, on the left bank of the Oued Biraz. This latter is the natural continuation of *wadi el Abiadh (Abiod)* after passing through the gorges of *Foum el Kherza* or *el Gherza* (fig. 1), which belongs to the eastern *zab*.

Its geographical coordinates are as follows: 34.800983°N, 5.895821°E.

THE SITE CURRENT STATUS

Tahouda archaeological site is classified according to the official journal of the Algerian Republic as n° 52 on 09/11/1996, page 24. This site was originally the center of the village of Tahouda. However, because of its material protection by a fence, the inhabitants gradually lost interest in it, and since 2005 they left the site. Even the mosque of Sidi Sahbi, previously used for prayer, was abandoned. In 2011, a new extramural mosque was built in order to provide the local religious needs and it has become the new center of the village in present time. The village itself saw a full urban extension towards the north, north-west and west slope.

SURVEY IN THE REGION

From 2003 to the present day, the Tahouda region has been visited by our research team¹ from the Institute of Archeology / University of Algiers 2. These surveys revealed a multitude of *koudiat* (mounds, artificial tells) located around the protected archaeological site of Tahouda. They are archaeologically similar to each other

¹ The team was headed by Prof. Dr. Yacine Rabah Hadji.

and consist of structures built in earth and archaeological artifacts: pottery, ceramics, architectural elements, etc. They are arranged almost within the same radius where the center is the protected site of Tahouda. This distribution leads to believe that we are in front of an agglomeration of radio-concentric type (Pinson 2012, pp. 23-48.). This settlement is surrounded by several suburbs districts linked together by an urban fabric made of a network of multiple communication roads (fig. 1). The actual archaeological site of Tahouda is composed of: i) a secular vernacular settlement, locally called Dachra, surmounting a *koudiat*; ii) an ancient fortress located to the south of the latter; iii) an ancient cemetery to the east (the inhabitants continue to bury their deceased there until today); iv) an empty space to the south and south-east of the fortress (fig. 2). The whole site has been recently protected by a mesh fence with a monumental gate on its north side, where the only main road leads to the modest village of Tahouda (Hadji *et alii* 2018, pp. 447-449.). The current village is characterized by a new mosque named Sidi Sahbi, as the old mosque within the archaeological *koudiat*. This old mosque is still standing thanks to many consolidations made by the inhabitants before the site was even protected². Thanks to the research team of the Institute of Archeology / University of Algiers2 supervised by Prof. Yacine Rabah Hadji, the mosque plan was revealed in 2013 after a surface cleaning of the west front (Hadji 2015, p. 55).

TAHOUDA: AGGLOMERATION OF NATURAL RESOURCES

Because of its archaeological site, its strategic location and its natural resources, Tahouda region has allowed

² HADJI 2006, p. 329.; Morizot described the mosque during his visit in 2008: MORIZOT 2010, pp. 818-820.; HADJI 2015, pp. 54-58.

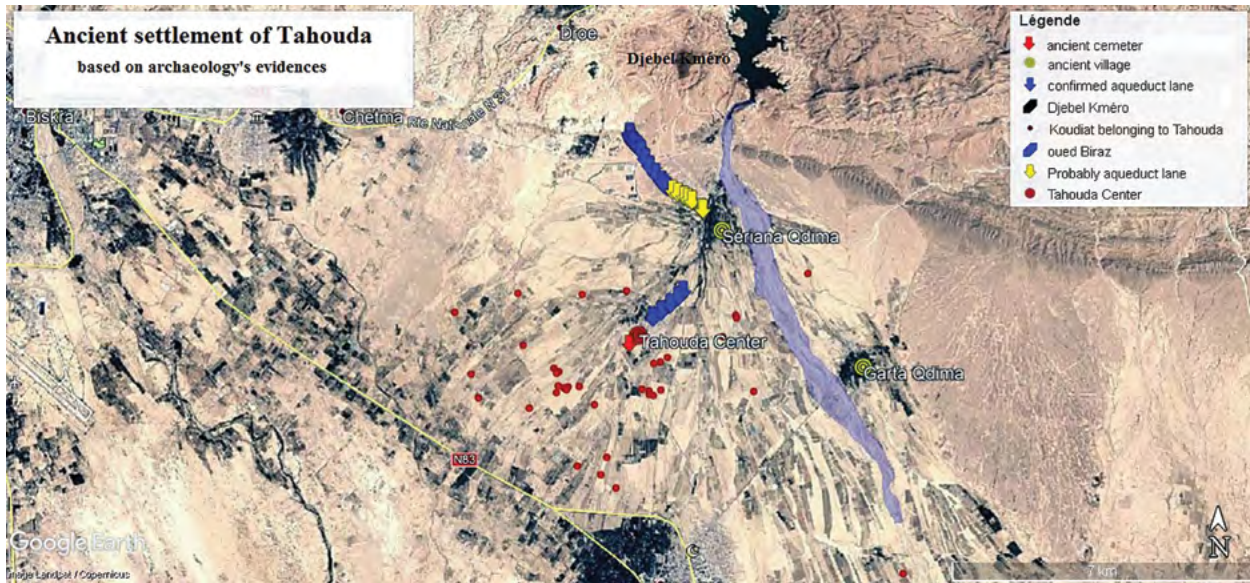


Fig. 1 - Ancient settlement of Tahouda based on archaeological evidences.



Fig. 2 - Aerial view of Tahouda archaeological protected site and surrounding areas.

us to look for material archaeological evidence in the immediate surroundings of the site itself. The researched area is geographically limited to the north by the Ahmar Kheddo (the region of Foum el Kherza dam and its surroundings) to the east by Oued Biraz and the Garta region, to the south by the Sidi Okba palm grove, and to the west by the Chetma region (fig. 1). Tahouda region is located in an open terrain stretching from east to west and it is practically flat, with a slight gradient from north to south. This slope allows for a smooth water flow reaching the Tahouda archaeological site. The region is rich in terms of alluvial deposits

accumulated over time, the plain frequently changing its relief due to seasonal flooding (Hadji 2006, p. 323). This implies an availability of clay as building materials in various forms including adobe, cob and brick. The stone material is variously present in the archaeological site as ashlar, rubble stone and pebble. These construction materials, in particular the first two, exist in their raw state 6 km north of the Tahouda site, where the multi-storey quarries of the Jebel de Kméro are located (Foum el Kherza dam region, see Hadji 2006, p. 336.), while the pebbles are abundant in nearby river beds.

TAHOUDA ANCIENT AGGLOMERATION INFRASTRUCTURES

Local natural resources exist in abundance and were within the reach of the ancient dwellers who, in order to develop this territory, exploited the resources for their own benefit and promote efficient processes for their survival. Archaeological evidences recorded *in situ* attest Tahouda ancient agglomeration specific infrastructures such as the aqueduct, construction materials, and fertile soil.

a. Aqueduct

Tahouda aqueduct is of the canal type, built low to the ground and buried underground, following the relief along its trajectory. It was well executed and designed to provide water to the agglomeration of Tahouda, either to supply the inhabitants, or to irrigate lands of different cultures with an average flow of 32270,5 m³/day (Ammari, Remini 2019, pp. 45-46.).

Building materials and techniques³ are local and simple: an ashlar foundation made in *opus quadratum*, a channel built with pebbles and rubble stone, the whole capped and covered with brick slabs.

This aqueduct is important for its singularity. It was used at least two or more times during the ancient period. At first sight, we notice two occupation soils separated by a layer of construction with rubble stone embedded in mortar. This phenomenon is interpreted as follows: i) the first occupation soil is the first bed of the canal; ii) over time, the initially relied upon water flow decreased due to limestone deposits; iii) thus, in order to regain the desired flow it was necessary to fill / backfill the canal and iv) build a second canal above, using the same technique and materials (fig. 3).



Fig. 3 - Construction phases of the aqueduct.

³ For more details, see Tamburrino article in this same publication.

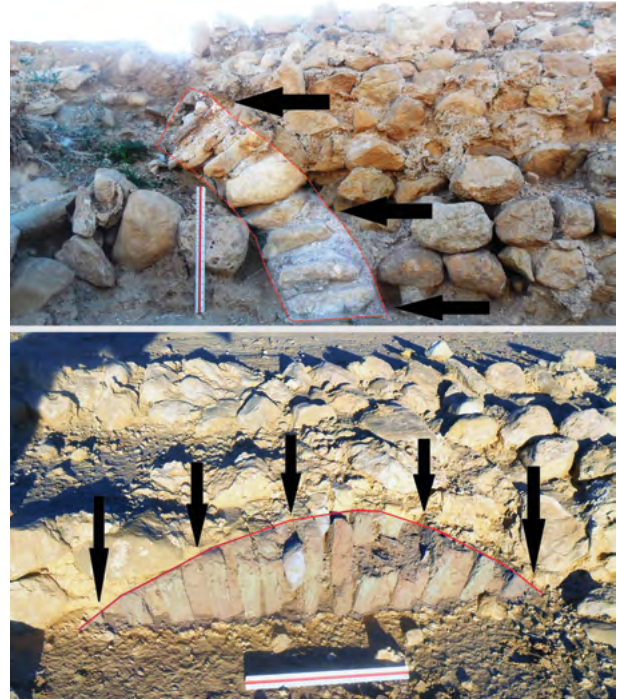


Fig. 4 - Presence of bridge-shaped structures found at the foundations level of the aqueduct.

Another characteristic of this aqueduct is the presence of bridge-shaped structures found at the foundations level (fig. 4) (Ammari, Remini 2019, p. 46.; Hadji 2014, pp. 44-45.).

The aqueduct path is readable for a distance of 550m, up to the road connecting the Foul el Kherza dam to the village of Sidi Khelil; then it cuts across the wadi bed near the road and resumes its path on the opposite side roadway over a distance of 1000m; eventually the path is hidden under the cover of plant crops. Using virtual prospection on Google Earth Pro, it is possible to follow it until the wilaya road (CW36A) connecting Sérïana Qdima (the ancient village) to Tahouda and Sidi Okba. Here, it disappears completely under the gardens of the old village of Sérïana (Sérïana Qdima), reappearing again after them, as we were able to confirm during our prospections in 2006 and 2012 (recorded GPS coordinates: 34°48'5.24 "N , 5°54'3.30"E; see fig. 1 and Hadji 2006, pp. 334-336.; Hadji 2014, pp. 41-42).

b. Building materials

The region is rich in quarries providing, singularly, different building materials such as ashlar, rubble stone and rolled pebbles from the wadis.

Ashlar is omnipresent throughout the site and it is used for the saharan-type vernacular dwellings bases, built according to the saharan technique (Hadji 2006, pp.

327-329). These centuries-old earthen houses are still visible on the *koudiat* but are gradually beginning to be lost. Likewise, this building material is used as functional supports of a floor or a roof. The ashlar is made from sandstone material coming from the hills surrounding the Foum el Kherza dam, where 13 stepped stone quarries are located (Hadji 2006, pp. 336-337.).

The ashlar quarry is coherent with all the roman period norms in Africa, such as the measurement of the negative of the stone extracted in the wall, the work area and the transport path.

The rubble stone is present in the ancient fortress' thermal baths walls. It is spread on the last northern slopes of Tahouda hills. This material is used in *opus mixtum* with brick, in *opus incertum* for the walls and the roof of the thermal baths, in groin vaults or in barrel vaults.

Rolled pebbles are abundant everywhere on the site. In the *koudiat*, where the vernacular habitats are located, they constitute the base on a foundation made in reused ashlar (Hadji 2006, p. 327; Hadji 2014, pp. 36, 42,46). Besides, in the fortress they are present in the walls, towers, the south gate and the thermal baths.

As the most used material since antiquity, brick is locally found in the thermal baths, the walls and the towers of the fortress. Different sizes and various shapes (square, triangular, rectangular) do exist (Hadji 2006, p. 327; Hadji 2014, pp. 36, 42,46).

The adobe (*toube*) is present in two types depending on its location: as construction material in the vernacular dwellings of the Dachra (Hadji 2006, p. 327; Hadji 2014, pp. 36, 42,46) and as layers in the ancient fortress (Hadji 2018, p. 464.).

c. Fertile soil

All current research on the soil of the Zibans, and especially the eastern Zab, has shown the importance of this region from an agronomic and water-related point of view. In fact, this territory is penetrated by a dense and rich hydrographic network that has fed it since antiquity. The fortuitous discovery of agricultural artifacts (Hadji 2006, p. 336; Hadji 2014, pp. 36, 42,46) during our exploration in Tahouda region, testify to the expansion of crops, mainly cereals and olive groves.

THE URBAN FABRIC

The infrastructures give us a fairly clear picture of the human settlement in the Tahouda region, even in the archaeological site. The *koudiat*s distribution around the fortress has probably become the urban center of the agglomeration of the radio-concentric type, similar to the various ksours present today. Another type

of plan is the checkerboard one. The strongest square is at the center of the urban fabric, around it the residential districts and the market are located. The whole is surrounded by an enclosure. By means of the virtual aerial prospecting on Google Earth Pro, cases similar to the Tahouda site were detected, visibly buried underground, an example is the site of Henchir Besseriani (*Ad Majores*, Laporte, Dupuis 2009, pp. 51-102). Also, the use of the aerial photo provided by Baradez similarly revealed the site of el Kasbat (*Gemellae*).

From this analysis it could be deduced that human activity in the area was dense due to the presence of water, a resource which is really located far from the ancient city, at an approximate distance of 10-15 km towards the north, in the region of Droë. Thus, water was brought by aqueducts (Hadji 2006, pp. 334-336; Hadji 2014, pp. 41-42) and it was also made accessible by drilling wells, as in the case of Tahouda Dachra, at the foot of the *koudiat* on the east side.

On the other hand, the creation of an urban agglomeration and its components, such as military thermal baths, was favored by the abundance of building materials such as ashlar (brought from the north of Jebel Kméro) and availability of local clay and fuel (trunk, palm leaves and date nuts) used produce lime and brick. The presence of the baths in particular demonstrates the importance of personal hygiene among the natives, considering the scarcity of rainfall in the region.

As preliminary synthesis, it could be said that man was attracted to this region due to the abundance of raw materials. In order to settle down he easily found water, building materials and a fertile land, in a geographical setting that stretches from the southern piedmont of the Aures to the saharan horizon: conditions that prompted man to work the land and create wealth. In addition this human settlement required the protection represented by the establishment of a fortification network, able to ensure food security in the region on one hand, on the other allowing the collection of taxes, therefore providing money for the public treasury. The region and the site fit very well into the *limes*⁴ system of the province of Numidia as a support post, economically and then militarily. In conclusion, the ancient algerian inhabitants knew how to exploit and master the locally existing means, despite the harsh nature of this Saharan region. An economic hub was created, able to spur inward and outward trade, leading to an intense influx of population in the region. This scenario was confirmed in the 6th century by the author Corippus the African who boasted that the Afri-

⁴ Made for the economic purpose of collecting taxes and protecting agricultural land.

can *limes* region was one of the most fertile lands, where the grain size of wheat was larger and harvest was possible twice a year, when compared to the northern regions. Moreover according to the 10th century historian el Bekri the region was populated with a dense vegetation cover which extended up to Chott el Hodna. All these achievements are the fruit of technological innovations (Hadji *et alii* 2021) resulting from a cultural heritage transmitted from one historical period to another, across the historical and civilizational transition.

PROBLEMS ENCOUNTERED IN THE FIELD AND REFLECTIONS

In this *limes* region, any work is difficult because of the arid Saharan climate. From the archaeological scientific side, the difficulty is summed up in: i) the lack of knowledge about the real nature of the ruins, due to the lack of continuity of use of the same construction materials and processes over the centuries; ii) the lack of a typical stratigraphic approach as a model.

Archeology of the *limes* is still at the beginning of its discovery. As a matter of fact, the few known archaeological excavations since the advent of archeology in the Saharan region can be counted on the fingers⁵.

The African *limes*, and in particular its Algerian sector, is mostly known due to the J. Baradez studies published in *Fossatum Africae* in 1949. Despite the logical criticisms subsequent to his time (Napoli, Boniface 1998, 613-648.), this book remains the fundamental and main reference document for all those wanting to venture within this kind of research in such a hostile geography.

Most of the sites discovered and presented in Baradez's book are misinterpreted by the author, as it is usually inferred from one or two examples checked in terrestrial prospecting (Napoli, Boniface 1998, pp. 616-618). Additionally it was sufficient for Baradez to see an ashlar to assert that it pertained to the roman period. All things considered, given the historical richness (antiquity, medieval, and precolonial) of the region traversed by Baradez, the researcher should be careful when identifying archaeological sites.

⁵ By this I intend the systematic excavations led by a research team and authorized by the supervisory authority during the colonial period: M. Massie a military who excavated south of Lioua and published his report in *Le recueil des notices et mémoires de la société archéologique du département de Constantine*, 22, 1882, pp. 407-412; J. Guey who settled in the Bordj es Saâda region in 1938 and published his findings in GUEY 1939, pp. 178-248; J. Baradez was in Tahouda at the NE tower and *Gemellae* in 1947; then from algerian independence to the present day Y. R. Hadji in TAHOUA in 2011, 2016, 2018 and 2019.

This specific roman identification of the ruins was indeed promoted by the scientific authorities of the colonial period⁶ in Algeria, with the result that nearly all the sites which were discovered in the country would be identified as roman period sites. This led consequently to the suppression of the medieval period phases, thought difficult to be found, during the clearing of all sites excavated from the colonization until after the Second World War⁷. The earthen buildings *strata*⁸, considered by researchers of this period to be of poor quality and mediocre, were never recognized for their importance. Yet, these transitional eras are very important from the civilizational point of view (Hadji *et alii* 2021).

The *limes* was certainly created in the roman period. However, the *limes* system flourished not only during this period but continued⁹ to exist until the Ottoman period. There have certainly been periods of decline, but this system did not disappear.

DATING OF BUILDINGS IN TAHOUA

Given the limited number of archaeological traces susceptible of absolute dating in Tahouda, the only viable method is relative dating.

In Tahouda there are three places where one could be in contact with the archaeological remnants: i) the *koudiat* where the ancient village is located, which surmounts about twenty meters the anthropic earthen hill (tell); ii) the ancient fortress to the south, cited by Baradez (he excavated the northeastern of its towers); iii) the thermal baths digged by Touchard in 1899. The current state of the buildings presents the last phase of the occupation of the site.

In order to know the detailed stratigraphy of the fortress and investigate its origin, it was necessary to con-

⁶ Since the colonial period, the authorities imposed their vision and ideology in order to better colonize Algeria. One of the methods was "romanizing" the ruins discovered everywhere in the country, to better instill in the minds of algerian intellectuals that Algeria was indeed Roman, of Latin culture and early Christian.

⁷ After that date, the academic researchers willing to study medieval archeology in the country have shown the importance of this phase in the history of Algeria.

⁸ Two written passages attest that the sites with a roman vocation are only sites that were later anyway occupied during the medieval periods in Algeria, one of them is published, the other is still in the archives: the first is from LASSUS 1981 (pp. 28, 43, 48, 89, 227, 241), the second comes from the unpublished excavation report kept in the 1954 archives of Euzennat, preserved in Bastion 23 in Algiers.

⁹ This is attested by several authors during the medieval period, such as El Bekri in the 11th century.

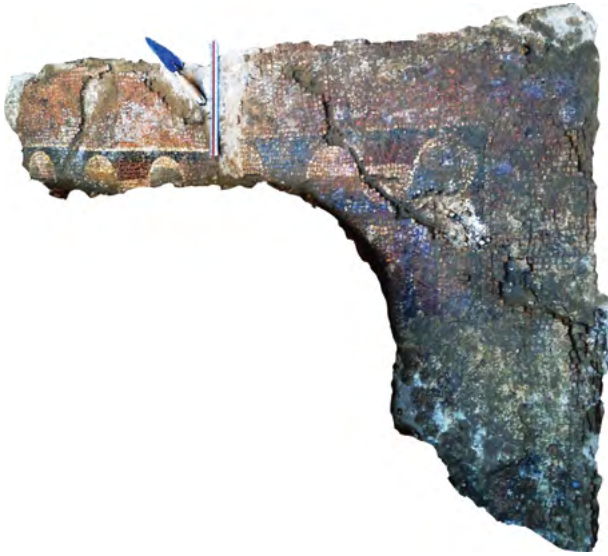


Fig. 5 - The mosaic floor of polychrome geometric type found in room 01.

duct a series of archaeological surveys during the campaigns of 2011, 2016, 2018 and 2019.

Despite a scant discovery of artefacts in 2011, the examination of the last layers of occupation led to a dating to the 11th and 12th century CE (Hadji 2015, p. 51).

In 2016, the field work was focused on clearing four points in the fortress: 1) the west curtain; 2) the SE tower; 3) a small part of the curtain southeast of the south gate; 4) the south gate itself (Hadji *et alii* 2019, p. 201, fig. 1).

In 2018 (Hadji *et alii* 2019, pp. 203-212), archaeological surveys were conducted in room 01 and room 04 of the thermal bath plan (plan of the thermes in Hadji *et alii* 2018 p. 456). The room 01, that Touchard excavated, was surveyed by means of an L-shaped trench at the bottom of the north and east walls. After having cleared the backfill caused by the previous excavation of Touchard, a mosaic floor of polychrome geometric type (fig. 5) was found. Conversely, room 04 had never been excavated before and was surveyed by means of a similar L-shaped trench at the bottom of the north and east walls. Inside, it was found a demolition layer in black ash with a thickness of 0,20 m (Hadji *et alii* 2019, p. 205); then, an adobe built with clayey mortar of the same nature as adobe; the whole is put back down a layer of rolled pebbles and ashlars debris (Hadji *et alii* 2019, p. 205). A third trench was carried out to the north of the two rooms (01 and 04), corresponding probably to the corridor of the thermal bath services; the outcomes were similar to those specific to room 04 (Hadji *et alii* 2019, p. 205).

In 2019 (Hadji 2019 report, pp. 04-06.), the archaeological surveys in the same rooms continued. But this time two other trenches at the bottom of the southern wall of both rooms were opened. The results were important in



Fig. 6 - The presence of an hypocaust in room 01.

room 01 where we reached its foundations and at this level we found the hypocausts (fig. 6), implying that this room is ancient. The room was in communication with room 04 through a door in the common wall forming a brick arch, disappeared nowadays.

Regarding room 04, another floor was discovered: it is lower than the first occupation level revealed in

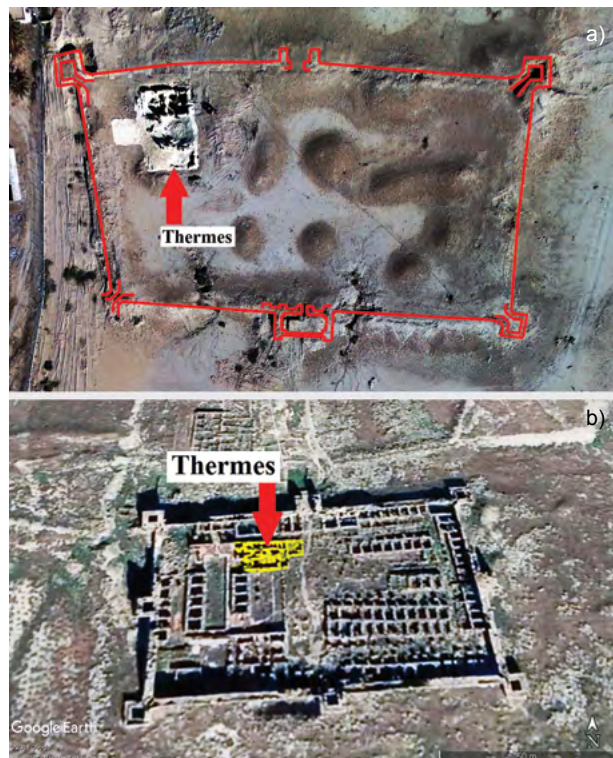


Fig. 7 - Aerial view of the two fortresses: a) Tahouda; b) Timgad [Google Earth]

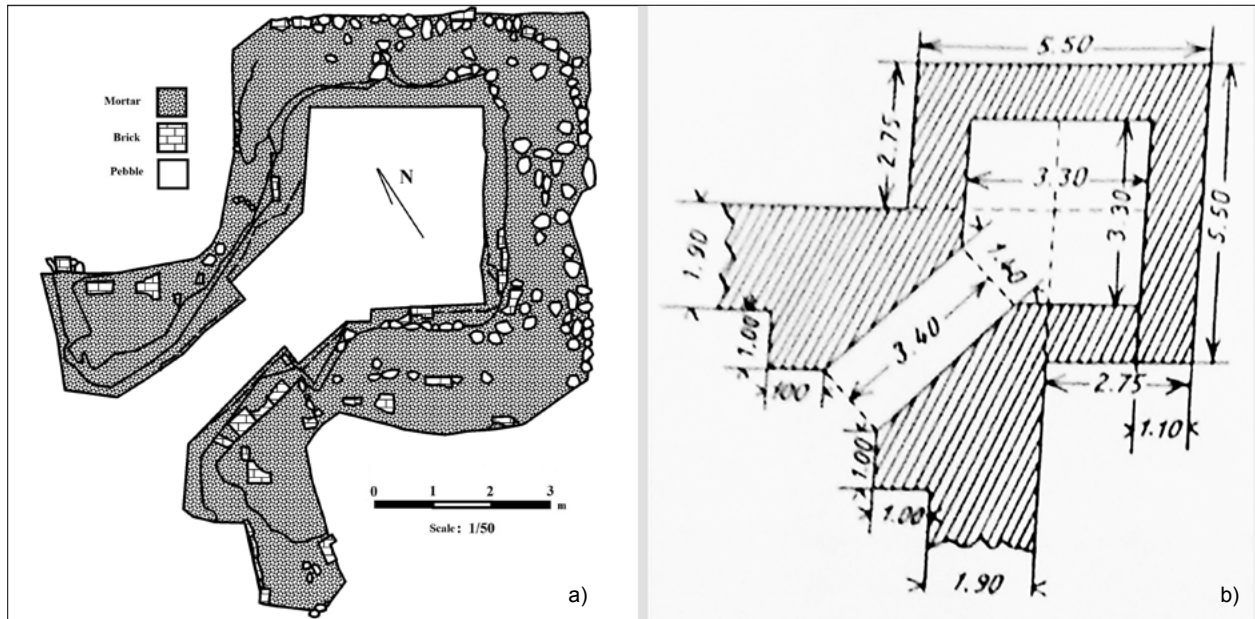


Fig. 8 - Comparison between the N-E tower plans of fortress of Tahouda: a) The plan of the N-E tower according to the archaeological relevé of the fortress of Tahouda [Hadji, December 2015]; b) the plan of the N-E tower according to Baradez relevé of the fortress of Tahouda [BARADEZ 1949, p. 282].

2018. The new floor is built using the same technique, a foundation of stone debris and rolled pebbles above an adobe wall (*toube*) (Hadji 2019 report, pp. 05-06). The archaeological material was scant during the two excavation campaigns of 2018 and 2019, because of the nature of the finds.

To summarize, the findings illustrate a transformation of the mode of occupation of the places. These thermal baths lost their original function (thermal space) during the medieval period and changed towards the new function of habitat, they also have two ground levels of occupation during the same historical period. The baths' walls construction technique of the ancient or even Roman period is as follows: the walls are built with *opus incertum*, coated with *opus mixtum*. The entrances jambs are built in *opus testaceum*. Room 01 follows the norms for a warm room (hypocaust, *tubuli*) and has a well-made polychrome square mosaic (white, black, ocher-red, orange) with a single orange colored connecting strip, framing an outer border with a linear compositions in the form of polychrome waves (black, ocher-red, white). The area of the mosaic is buried under the Touchard embankment.

The layout plan of Tahouda fortress is rectangular, tending slightly towards the trapezoid. Besides, it is similar to the layout plan of Timgad Byzantine fortress (fig. 7) for the following aspects (Hadji *et alii* 2016, pp. 33-47), as follows.

– **The fortress:** the north and south faces of Timgad fortress (Lassus 1981, pp. 59-60) measure 119,5 m

and 118,35 m respectively, the east and west ones are 80,5 m and 76,8 m, including the corner towers. The north and south faces of the Tahouda fortress (Hadji *et alii* 2016, p. 37.) measure 120 m and 112 m respectively the east and west ones are 73 m and 65 m, again including the corner towers (fig. 7a-b).

- **The corner towers:** both fortresses corner towers are square in plan and in the same position (opposite at the top from the angles of the rampart). In each interior corner of the fortress, there is a cut-away wall: the wall thickness is 1,90 m in Tahouda and 1,90 m in Timgad. The corridor is diagonal with a 1,40 m width in Tahouda and 1,42 m in Timgad. The interior measurements of the tower are 3,30 m in Tahouda and 3,20 m in Timgad. The tower outer measure is 5,50 m at Tahouda whilst it is 7 m at Timgad (fig. 8a-b).
- **The main entrance:** (fig. 7a-b): each fortress is provided with a main entrance that opens in the middle of one of the longer sides, either the north or south side. This gate is monumental in Timgad (Lassus 1981, pp. 78-89) and it should have been similar in Tahouda. The surface cleaning of the south gate, revealed a wall in front of the surrounding wall which is inscribed between the interior buttresses; we expect to know the complete and final floor plan of the southern gateway in the next excavation campaigns.
- **The thermal baths:** (fig. 7a-b): the thermal baths location is the same in both fortresses. They are located in the western half towards the north. Tahouda thermal

baths follow the so-called imperial plan, with a perfect symmetry and four similar rooms distributed two on each side. The room 01 is a caldarium. Additionally, the axis of symmetry is from East to West. The total number of identified rooms up to now is six¹⁰. Tingad thermal baths (fig. 7b) are asymmetric in plan. They are also small in size compared to Tahouda ones (fig. 7a), they are located in the part known to be reserved to the staff, on the western half of the fortress towards the north of the roll-call grounds¹¹.

CONCLUSION

Considering the Tahouda fortress and with its towers, this vestige dates probably from the Byzantine period or even older (a search for archaeological clues is needed). About the thermal baths, the bottom of the caldarium room (with the presence of an hypocausts) have been reached, the construction technique and its materials date from the ancient period, until proven otherwise. The transition period will be visible in room 04 of the thermal baths, since this area has not been excavated before and the *strata* are *in situ*.

The evolution of the isolated military camp towards a radio-concentric urban plan with districts, continues to exist until today. This plan is generally dated to medieval times. The ancient urban fabric is often in the form of a checkerboard plan.

The adobe / earthen construction technique with the use of pebbles below the adobe wall, with a ashlar base is called the saharan technique (*koudiat*), and it dates from the medieval period.

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¹⁰ For more details see: HADJI *et alii* 2016, pp. 33-47.

¹¹ For more details see: LASSUS 1981, pp. 123-146.

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MAPPING THE ‘HYDRAULICSCAPE’ IN THE BISKRA REGION, AN INTERIM REPORT FROM THE 2019 SURVEY CAMPAIGN

Eugenio Tamburrino

Università degli Studi di Padova / dBC.

The paper aims to give some first accounts on the wider project devoted to the survey of the hydraulic infrastructures in the territory of Biskra and the neighbouring areas. In particular, the paper will take into account an aqueduct found in the area close to Thabudeos/Thouda, probably dated to the Roman period, and a lithic pipe found in a secondary bed during the restoration works of the Venerable Marabout Sidi Moussa El Akdahari mosque in Biskra, the ancient Vescera.

KEYWORDS: Ancient water management; Roman aqueduct; Thabudeos; Vescera.

INTRODUCTION

The recent picture of increased attention concerning the importance of water by defining an appropriate procurement system, conservation and runoff, as well as the definition of good practices for a correct use of the water resources, has brought the West closer to a sensitivity that the area of North Africa has instead always well developed for obvious reasons. Since the Roman Age in fact a wide diffusion of hydraulic systems or installations, both large and small has made the population and agricultural exploitation of these regions possible.

One of the activities put in place during the 2019 survey campaign “*LiMeS.: Life between the Mediterranean and Sahara - Living along the limes: the Borders of Roman Numidia*” (directed by Paola Zanovello and Azeddine Belakehal), developed by the Department of Cultural Heritage of the University of Padova and the Architecture Department of the University «Mohamed Khider» of Biskra, was the initiation of a more systematic work of mapping and analysis of the hydraulic infrastructures present in Biskra – the Roman *Vescera* – and in its territory. The chronological horizon that the work adopted is deeply diachronic, encompassing examples that go from the antique age up to contemporary uses and technologies, with a specific anthropological attention¹.

In this brief report some preliminary observations are presented relating to two findings attributable to hydraulic systems of Roman Age, one coming from the

city centre of Biskra/*Vescera*² and the other from the countryside of the nearby town of *Thabudeos*.

THE THABUDEOS AQUEDUCT: FIRST DATA³

The *Thabudeos* ancient settlement, today known as Thouda, is positioned about 6 kms to the North of Sidi Okba along the road towards Sidi Khellil. *Thabudeos*, also quoted by Pliny the Elder in *Naturalis Historia*⁴, has always represented a monumental cornerstone in the boundary line of the Roman Empire first and then the Byzantine territories. From the hydraulic point of view the settlement has revealed a thermal facility excavated by Birebent first and later by Hadji⁵; a hydraulic channel was also discovered which, according to Hadji, pertains to an irrigation system already identified by Birebent and located approximately 1 km to the East of Thouda⁶.

The area taken into consideration during the survey is located between Thouda and Biskra and is closed to the North by Djebel Bou Rhezal, the last offshoot of the massive Aures Mountain range, the Roman Mons

¹ Particularly interesting, for example, was the practice of water supply and distribution within the modern palm groves of Biskra, that uses the same technologies and methods already attested by the Roman Tables of Lamasba (ZANOVELLO 2020; ZANOVELLO 2022).

² The urban water cycle most likely had a certain degree of complexity, so much so that it was able to power structures with a high hydraulic requirement such as the urban *thermae*, now partially preserved within the Mohamed Khider University campus.

³ A wider publication concerning this structure is in preparation by the writer, Yacine Rabah Hadji, Giovanni Cagnoni, Luigi Magnini, Andrea Meleri, Michele Secco and Paola Zanovello. I take this opportunity to thank them, the Algerian colleagues and the students who actively collaborated in the mapping and documentation of the artefact: Irene Bettini, Elisabetta Montaguti, Giulia Rovera, Giulio Rondi Totto, Veronica Venco.

⁴ PLIN. SEN., *Nat. Hist.*, V, 5, 31-36.

⁵ BIREBENT 1962, p.296; HADJI 2006, p. 333; HADJI 2014; HADJI 2018.

⁶ HADJI 2006, pp.334-336, fig. 10.

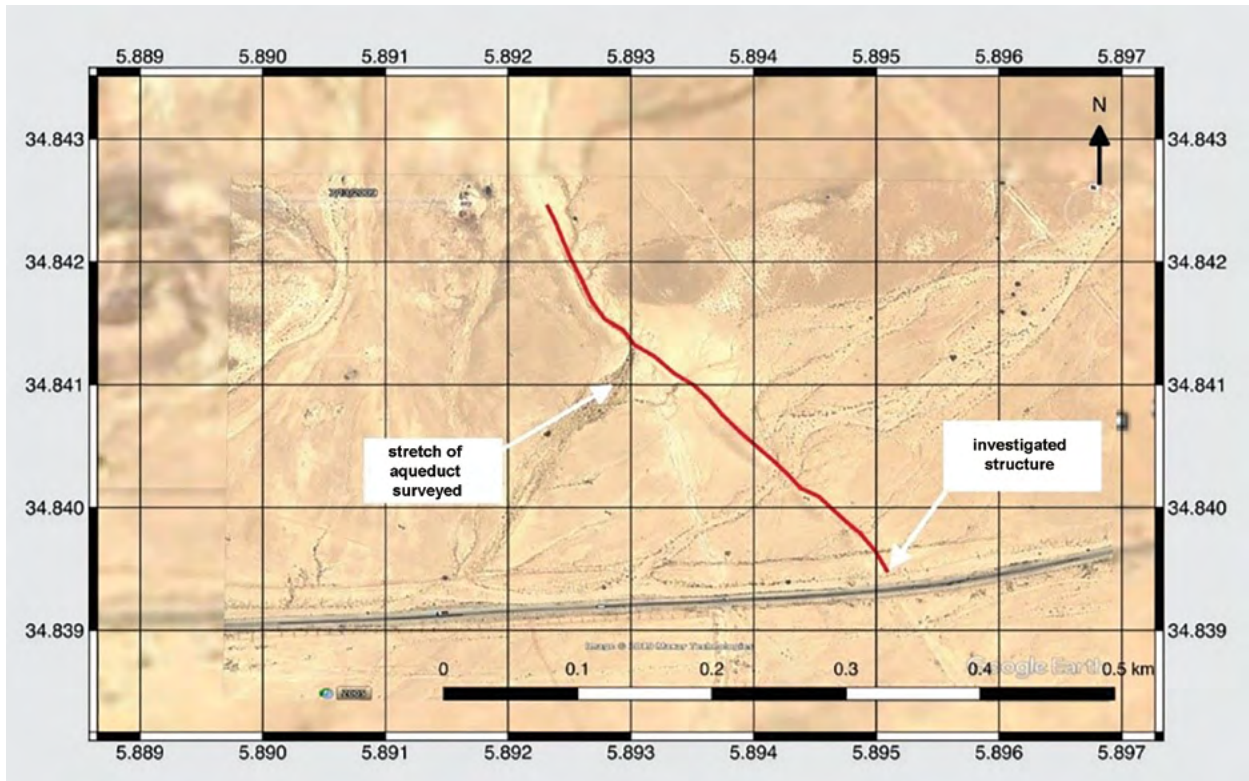


Fig. 1 - Map of the stretch of aqueduct surveyed North of the CW Sidi Khellil provincial road, that splits in two parts the plain around *Thabudeos* (map by courtesy of Luigi Magnini).

Aurasius. The area is crossed by the CW Sidi Khellil provincial road, cutting the plain object of the survey in two and the aqueduct as well (fig. 1).

The structure under consideration was revealed, albeit in part, by Hadji in 2014 in a report of the field activities carried on in 2012. An initial operative phase preliminary to the ground check on site was therefore a tele-observation and analysis using the photographic set of Baradez⁷ and the series of Google Earth satellite images⁸. The verification on the ground has actually greatly enriched the understanding of this area, confirming the clearly visible presence of the duct both upstream and downstream with respect to the provincial road, but also providing important information regarding the design phase of the structure and the construction characteristics of the same.

In particular, three construction methods of the duct have been found.

Proceeding downstream from the mountains towards the valley, the first stretch of the hydraulic channel encountered belongs to the underground type, recognisable by the presence of two inspection and ventilation

wells (*lumina*). As already mentioned, the area on which the survey was conducted was limited, obliging us to postpone the mapping and analysis of the duct in the parts further upstream of these wells to future missions on the ground (which in turn were later postponed due to the 2020 pandemic).

Just downstream of the *lumina* and for the main part of the route mapped so far, the aqueduct is built in a trench, the upper side of which is at the field level.

The last duct typology is represented by a passage of the canal on arches to cross a small water course, a structure

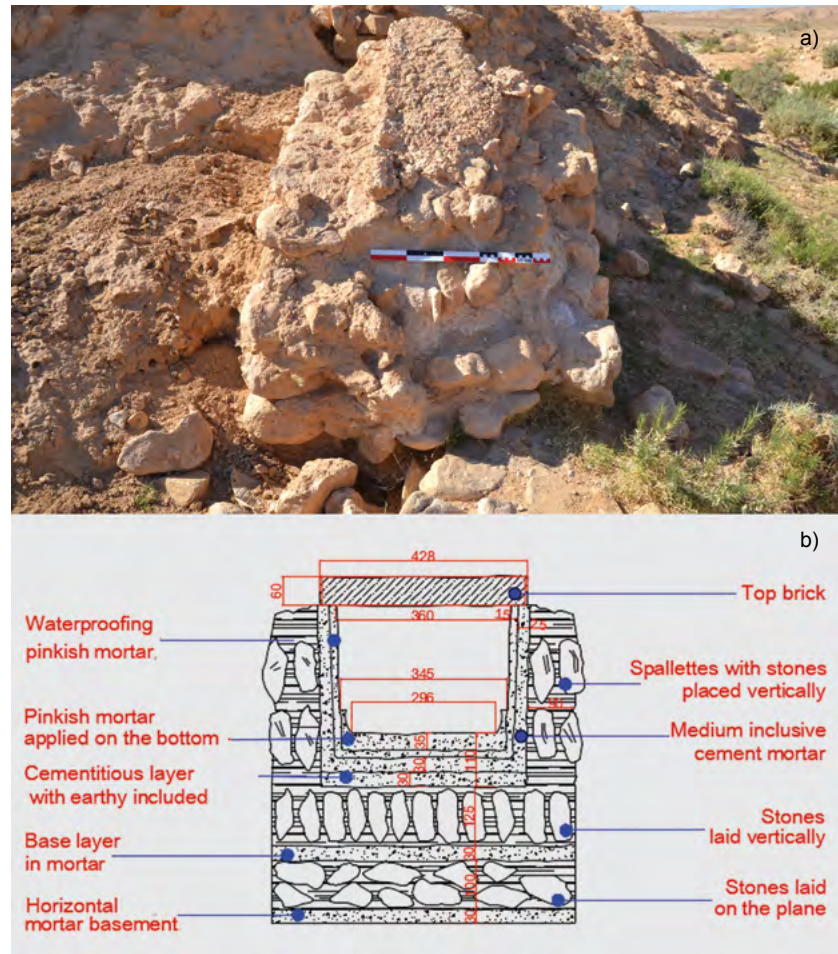


Fig. 2 – One of the two shafts found (photo by the author).

⁷ BARADEZ 1949.

⁸ See the contribution by Luigi Magnini in the aforementioned article.

Fig. 3 - a) shred of the channel, where are well visible the foundation layers; b) reconstruction draw of the duct (courtesy by Giovanni Cagnoni).



now interred due to the accumulation of soil transported from the same river. This water course should probably be identified with the current Oued el Abiod, whose course now is modified both by natural factors and by the presence of the Foug El Gherza dam, built by French Administration and powered by the same Oued⁹. In total, approximately 700 m of the aqueduct route have been mapped on the ground while remotely it has been possible to trace a total of 1,60 km, divided

in two sections by the crossing of the CW Sidi Khellil provincial road.

From a constructive point of view the first type found following the route of the aqueduct from upstream to downstream is represented by two wells, related to the underground section of the structure. The *lumina* discovered have a dimension of 1,20 m (which correspond to four Roman *pedes*¹⁰) on the sides, which are built at an angle of 90° with stone and fine mortar (fig. 2). Unfortunately it wasn't possible to find other wells besides these two, placed at a distance of approximately 20 m from each other.

The main part of the structure found, up to this point, is made up of a duct built in a trench, with side shoulders built in contact with the ground and with a thick, multi-layered foundation. These details were noted

⁹ A geo-archaeological study of the entire area was planned for the 2020 campaign, later canceled due to the pandemic. However, it will be re-proposed as soon as possible and will aim at defining on the one hand the diachronic evolution of the landscape, in order to understand if the trench part of the duct was built on the surface or underground in the Roman period, and also to assess the formative processes of the stratification of the section arranged on *arcuationes*. A first working hypothesis, however, sees the progressive burial of the arches as the consequence of the progressive lack of the maintenance and abandonment of the aqueduct, subsequent to the Roman Age. In this case the bridge on arches, were it already partially obstructed, would have constituted a dam, gradually determining the definitive burial of the structure. On a first look, this scenario seems to be confirmed by the granulometry of the sediments, coarser upstream of the bridge and finer downstream.

¹⁰ We consider here a rough measure of 0,30m, since we acknowledge that there should be considered both a regional variability of the measure of the *pedes*, and a sensible difference among the different types of *pes* elsewhere attested (e.g. the *pes monetalis* [0,296 m] or the *pes drusianus* [0,332 m]) (BOSIO 1967; DUNCAN JONES 1980; CAMPOREALE 2014).

A specific metrological study is to be completed during the following steps of the survey.



Fig. 4 - The channel in a position close to the CW Sidi Khellil provincial road. To be noted the mortar spread in such a way as to cover the upper part of the sidewalls of the duct /photo by the author).

thanks to the possibility to observe the structure in various points, allowing for a cross section analysis and a reconstruction of the characteristics of the aqueduct, represented in the relief made by Giovanni Cagnoni (fig. 3). The shoulders are built with a double row of pebbles arranged in a herringbone pattern to assure a greater solidity of the walls.

There are three layers placed at the foundation composed of pebbles of progressively finer dimensions and mortar for a total thickness of about 10 cm. The base layer is built with large stones and coarse mortar, roughly arranged to derive a first horizontal arrangement as the base of the entire duct. On top of this a second layer of medium sized stones is laid, placed horizontally and partially superimposed on each other. Lastly, a final layer built with minute pebbles, placed vertically side by side probably in order to create a horizontal plane that could assure a uniform application of the hydraulic mortars of the canal. Inside the channeling the waterproofing was made possible thanks to the superimposed spreading of the two layers of hydraulic mortar, about which the petrographic survey conducted by Michele Secco (the results will be included in the already mentioned and forthcoming publication) has confirmed how the preparation follows the most classic canons of *cocciopesto*, with a mixture of mortar, ceramic fragments and a fraction of aggregates made of quartz grains rounded by the erosive action of the wind.

It is of particular interest to observe how the spreading of the layers of mortar appears in the main part of the channeling to cover the bottom, the inner side of the side panels and also the upper side of the same, evidence of a project unity involving the entire structure (fig. 4). In some points of the canal a third layer of hydraulic mortar was noticed and could be explained with operations correcting the slope or repairs affecting the base of the structure, performed in ancient times.



Fig. 5 - The upper part of one of the arches in the stretch built on *arcuationes* (photo by author).

The upper part of the canalisation, the cover itself, must have been object of dispossession in the post-classical age, but the visibility of a specific point of the duct testifies how it was covered with bricks *sesquipedales*, the presence of which could be also a first confirmation of the pertinence of this structure to the Roman phase¹¹.

The third and last construction type identified up to now is the one on arches, made in order to overcome a course of water currently no longer active. In this section of the route, four arches are visible at the moment and are also built in *sesquipedales*. The impossibility to continue with excavations has prevented the verification of the length of the span of the arches, hypothesized to be about four feet (fig. 5).

In conclusion, this preliminary and limited observation of the structure gives us a picture of great complexity and wealth of information, a complete mapping of the structure will allow a clearer understanding of its route, its technical characteristics, as well as its relationship with the city of *Thabudeos*.

A LITHIC PIPE FROM VIEUX BISKRA

The archaeological context of the Roman *Vescera* is unfortunately very limited and incomplete due to the prolonged continuity of life that the city experienced until the current day in the modern city of Biskra. The lively building activity and the only episodic documentation of any archeological findings prevents from having a reliable layout of the city in Roman times. In this context a remarkable fact is the presence of a medium-size thermal building still partially preserved in the campus of the University of Biskra.

In this general framework one of the priorities of any future systematic investigation of the *forma urbis* of

¹¹ The thickness of the bricks is 7 cm.



Fig. 6 - a) the lithic pipe found during the restauration work of the Venerable Marabout Sidi Moussa El Akkdahari, Biskra; b) 3D model of the lithic pipe: view of the two holes on the side (courtesy by Luigi Magnini).

Vescera will certainly have to be the study of the procurement and management of the water in such a challenging environmental context.

During our stay in Algeria in March 2019, while visiting the Venerable Marabout Sidi Moussa El Akkdahari mosque¹² in the *Vieux Biskra* neighbourhood, we were told that stone pipe was recently found, returning to the surface after being used as the foundation of one of the columns of the prayer room of the Mosque. The pipe belongs to the Vitruvian type of the *lapides perterebrati*, with “cord and glass” or “male and female” joint with a 4,8 cm thick and 16,4 cm high creasing.

The imposing pipe, a parallelepiped of limestone 70 cm long and 31 cm high, has three circular openings. The first, with “male” or “cord” socket (internal diameter 15,4 cm; external diameter 24,2 cm) and is arranged on one of the minor faces of the tube, side by side. The first opening is the one placed furthest away from the hole already mentioned. Equipped with a “female” or “glass” recess (ca 24,5 cm diameter), it was clearly intended for interlocking with another tube, thus deviating 90° of water flow (fig. 6a,b).

Below this opening, placed between this and the one with the “male” socket, the last hole of the pipe, approximately 12 cm in diameter, is placed. It is also circular, but it appears however to be worked with less attention than the previous one and does not show a predisposition for coupling to other pipes. The work-

¹² On the restoration of which see the contribution of Aomar Dali in this same volume.

ing hypothesis proposed here is that it acted whether as an inspection and unclogging hole of the duct, as attested elsewhere, or as a breather for excess pressure¹³. In any case, the discovery clearly leads back its use in an aqueduct¹⁴ and for the archeological framework in *Vescera*, if it is confirmed that it was indeed in a secondary bed, it is an element of innovation, as far as is known at the moment.

CONCLUSIONS

To conclude, it seems more necessary than ever to further intensify the mapping of the structures and hydraulic installations in this area. This, along with a geographical mapping of the different structures, could allow a diachronic analysis able to highlight the changes in the different historical periods and thus tracing the upheavals of the social and administrative entities which controlled these infrastructures.

“*Kulši yeggan, ala tabeneemmet d waman*”

Everything sleeps, except resentment and water
Kabyle proverb, Encyclopedie Berbère,
IV A 179. AMAN, p. 559.

¹³ A cleaning function has been attributed to lithic pipes coming from the siphons of the aqueducts of *Rusazus* (LAPORTE 2009, pp. 92-93, fig. 4) and of Dougga (CARTON 1897).

¹⁴ Remaining in the North African context, a similar example comes from *Rusazus*: LAPORTE 2009.

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SECOND PART

Architectural Heritage and Community

The territories of archaeology and architecture often look at each other from afar, sometimes they brush against each other, and more rarely do they really dialogue. The reason lies in the very nature of the two disciplines; already Vitruvius defined architecture in the form of a triangle, whose vertices must always dialogue with each other in order to obtain a result that simultaneously satisfies its utility, solidity and aesthetic result. Archaeology is the science that deals with contexts that are no longer functional, it analyses the relationships between the parts, and between these and the areas to which they belong. The two disciplines have different contents, but they sometimes find territories of dialogue. One of these is represented by the environment, its values and its relations with the built heritage and the archaeological contents.

The privilege of confronting the territory of Algeria leads to deepening the relationship between environment and the built environment, understood both as a guiding element of a good architectural design and also as a set of elements that has drawn from the environment its peculiar characteristics, its internal relationships and how the archaeological record was created. The risk of not considering the environment as a central design factor is high; as highlighted by some invasive restoration works performed in some mosques, where the balance between the environmental elements that have always characterised the monument was eventually partly lost.

An important environmental factor, which is proving to be central, concerns the relationship that is established between the local heritage and the community to which it belongs; the case of the Roman basins of the Gafsa oasis is an example of how an area can exist suspended between function and memory. The same is true for building materials: the long path of raw earth architecture has not been interrupted, starting from a confrontation in ancient times between Roman builders and resident populations, and arriving to the present day maintaining intact its nature as the protagonist of an architecture willing to establish a virtuous relationship with its environment. Sometimes, however, the less obvious forms of an archaeological system are not themselves a guarantee of the good conservation of a site, especially in an urban context; this is the case of the *foggaras*, an ancient system for acquiring and distributing water using horizontal drainage tunnels, still precious to the present inhabitants of the oases but not considered equally valuable in the cities, even when formally protected by urban planning instruments.

In Algeria, as everywhere, the cultural heritage is often vulnerable, subject to numerous risk factors, especially environmental ones, which are often dynamic over time, it is thus difficult to fix a snapshot of a site or monument. One of the viable avenues might be a systematic cataloguing of sites, characterising them through different risk indices and maintaining over time an updated record of the changes: a process which should, where possible, lead to a conscious and correct archaeological restoration. Information in the site record should also include the actions (or non-actions) of the local community toward its own cultural heritage, a heritage that could also generate a touristic and economic value, provided that the archaeological contents are not only an element of attraction or a background, but are instead at the centre of a correct valorisation developed with the most appropriate didactic tools.

Arch. Giovanni Cagnoni
CH restoration and collaborative archaeology

THE BUILT HERITAGE AMBIENCES, ISSUES, LEGISLATION AND APPROACHES

Azeddine Belakehal

*LACOMOFA Laboratory,
Department of architecture, Faculty of Sciences and Technology,
Université de Biskra, Algeria.*

This paper proposes an environmentally approach towards the built heritage similar to that currently adopted in archeology. In the architectural field, this approach is based on sensory relationships between man and his built environment. Thus, the 'Ambience' is the basic concept for this approach. In situ observations, research outcomes as well as official references are here presented in order to set up the 'Ambient Heritage' as a scientific research field. In addition, a conceptualization and operationalization process are deeply explained in such a way that 'Ambient Heritage' could be investigated in respect of scientific requirements and applied in the architectural practice field.

KEYWORDS: Ambience, Heritage, Patrimonialization, Conceptualization, Legislation, Multidisciplinary approach.

INTRODUCTION

Throughout the history of mankind, architecture has never been reduced to a set of materials assembled in order to create a shape only for aesthetics purposes. Well beyond, the various settlements built by men have to encompass a real life; a life expressing man's own vision of the world and the representations shared with his own social group members. As well, this life illustrates his relationships to the geographical context where he is established and to the physical *milieu* where is inserted the built environment he formed. This know-how constitutes a part of the classical theoretical writings about architecture such as Vitruvius theory (Perrault 1988) and is revealed by our ancestors' marks still noticeable nowadays. However, it seems that this experience is not as highlighted as much as the architectural forms enclosing it.

This contribution is mainly interested in investigating this aspect among the architecture ones, and particularly by the experience-physical context relationships. Primarily, the physical context is targeted through its climatic characteristics because of their strong influences especially in extreme *milieu*. Secondly, there will be a matter of deciphering the experience senses due to other human-created physical parameters such as odors and noises. The experience-physical *milieu* relationships will be examined through the sensorial mode linking man to his environment by means of his five sensorial channels (vision, hearing, smell, touch and taste). This

will be done by distinguishing the 'ambience' as a key notion of the selected approach for this study.

The aim of this article is to highlight two aspects related to the notion of 'ambience' within the urban and architectural heritage field: i) the operationalization of the 'Ambience' as a concept, that is an essential step allowing it to be considered as a scientific research field, and ii) Its enhancement to the rank of heritage by seeking the legislative recommendations emphasizing the 'Ambience' as a rich component of the past, in a latent and/or manifest way.

BUILT HERITAGE AND NATURAL MILIEU

The harmonious relationship between man and his *milieu* has always been expressed by means of urban characteristics and architectural features of his old settlements. These latter were constantly respectful of an ecosystem of which they are an integral part. The traditional villages of the south versant of Aurès mountains, in Algeria, and those of the Al-Hijr city (Mada'in Salah), in Saudi Arabia Kingdom (fig. 1), among others, illustrate such men's fitness for self adaptation and acclimatization to a severe contexts like the hot arid regions. From an intellectual position, this built heritage is, and is still for us, an urban and architectural lesson about the symbiotically environmental adaptation. This point of view allows approaching the built heritage from a sustainability perspective that is being more and more important nowadays (de Souza, Cos-



Fig. 1 - A view of a building encrusted in a rock located in the severe climatic region of Al-Hijr city (Madain Saleh) in Saudi Arabia Kingdom (source: author).



Fig. 2 - An internal view of the Pantheon dome in Rome revealing the illustrious sun movement (source: author).

ta 2018). This built heritage points out the dispositions to take into account and the devices to be created in order to be in harmony with it. Note, in this sense, the pre-ancient temples dedicated to the sun, of Stonehenge (United Kingdom) and Newgrange (Ireland) as well as those ancient, the pharaonic Abu Simbel (Egypt) and the roman Pantheon (Italy) (fig. 2). In addition, this human-environment and/or climate relationship has been the subject of various previous studies which have approached it from the angle of: i) energy performance achieved by these traditional strategies, and/or ii) remarkable conditions of comfort provided by these vernacular architectures. It should, however, be pointed out that these town planning and architectural devices enclose and are associated to specific lifestyles also arising from this symbiosis between man and his natural environment (figs. 3a-b).

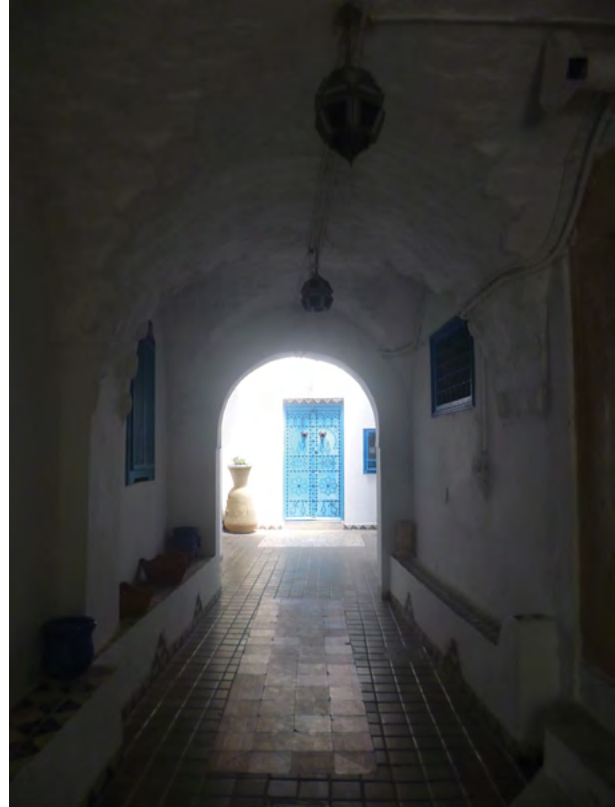


Fig. 3a - Shaded covered alleyways provide a particular urban lifestyle making harmonious the human - built environment relationships (source: author).

Fig. 3b - An underground mosque's prayer hall for early morning prayers in Ha'il region (KSA) where the temperature levels are very low during winter time (source: author).

As a result, it goes without saying that these lifestyles, these spatial practices, these perceptual and behavioral conducts constitute an inherent part of these heritage places as much as the forms and materials which constitute them. It would therefore be insufficient to qualify a place as heritage by limiting oneself to the latter without specifying the experience that took place there. This is an experience that we simply detect in all

kinds of old iconographic documentary sources (fig. 4) and of which the travelers' stories as well as the novels' imaginary provide us with ample information. This related to physical imperatives experience would constitute this environmental and intangible aspect to which attention has been directed for a while and which deserves exploration as well as knowledge and practice constitution. It is in fact the issues relating to this last aspect that would base the *ambient* approach specifically in the fields of urban and architectural heritage.

ATMOSPHERES AND PRESERVATION OF URBAN AND ARCHITECTURAL HERITAGE

The establishment of a disciplinary field about ambiances under the topic of heritage could not be done without the constitution of a scientific knowledge predisposing the various stakeholders to properly preserve this cultural heritage in its tangible and intangible aspects; a situation which would seem to escape a large number of specialists in view of the various situations encountered *in situ*. Indeed and once fully acquired, this knowledge would lead to restoring the environmental specificities constituting the inherent values in these historic places and to skillfully intervene within. The historic places' ambiances profound alterations constitute situations found in the specialized literature as well as observed in the practice field. Among the research works dealing with ambiances in projects carried out in historic places, we will cite, just as examples, those of Mohelnikova *et alii* (2018), and Araujo (2016) respectively focused on case studies in Hluboka (Czech Republic) and Aix-en-Provence (France). More specifically, Mahroug (2016-2017) carried out a doctoral research on the historical reconverted places' atmospheres in the Medina of Tunis (Tunisia) and demonstrated their importance for both designers and users.

Indeed, and from *in situ* observation, it was possible to pick out three situations which strongly alter the heritage places' ambiances that are as follows: i) preservation acts causing degradation; ii) restorations unfaithful to the building ambiances' authenticity; iii) reconversions that alter or even disfigure the place.

The first situation is related to the historic building being still in use but having undergone transformative actions aimed at satisfying certain functional needs, as it is customary in several unclassified buildings. Unfortunately, these needs significantly affect the place ambience and even some of its characteristic features. The Ouled El-Hamra mosque in Casablanca (Morocco) presents the case of the courtyard which was entirely covered in order to enlarge the prayer room; or to make it a protected place in all seasons by means

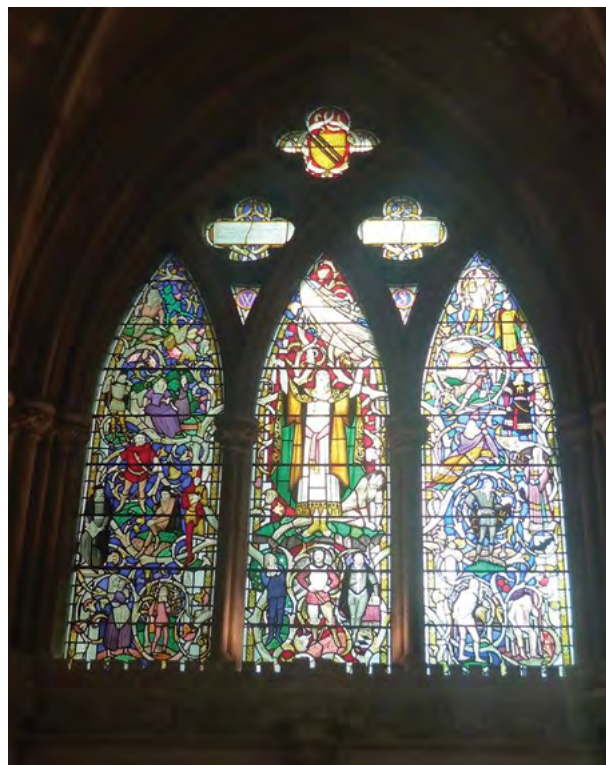


Fig. 4 - Church stained glass constitutes a case of iconographic source informing about human past's experiences (source: author).

of a glass coverage such as was done in the Sabaghin mosque in Tunis (Tunisia). Despite the number of the pierced openings in the raised wall supporting the new roof, it is easy to observe that the mosque has indeed lost this sacred interior-exterior place; a space with multiple specific ambiances including luminous, thermo-aeraulic, acoustic, tactile and olfactory (figs. 5a-b). We note, moreover, the opening of transparent high windows in the Quibla wall replacing and/or added to those of smaller sizes and equipped with plaster trellises as is seen in the mosques of Bab Dzira al-Barani in Tunis (Tunisia), the Ottoman mosque in Mascara (Algeria) and that of the Ouled el-Hamra in Casablanca (Morocco). Thus, this wall loses its luminous character constituting a topological value of the mosque (first row of piers) (Belakehal, 2004) as well as the highly balanced and peaceful luminous environment that it provides. At the convent of la Tourette (France), external metal blinds were applied to the windows in order to recreate a more suitable ambience. This recreation of atmospheres, by the users themselves, has been perfectly illustrated, in the field of domestic architecture, by the houses of Le Corbusier in Pessac (France) (Boudon, 1977; Gharbi, Belakehal, 2020).

The second case is about these restoration projects which do not faithfully reproduce the architectural de-

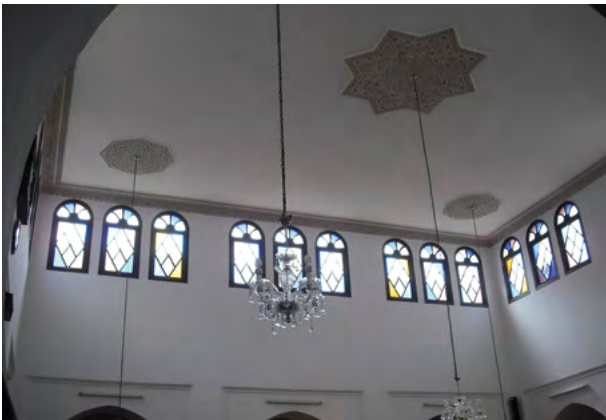


Fig. 5a - The mosque's open-to-sky courtyard is a sacred interior-exterior place enclosing several ambiances (source: author).
Fig. 5b - Covering the mosque's open-to-sky courtyard results in a loss of this plural ambiental character (source: author).



Fig. 6 - The restoration of the Debanne Palace in Sydon (Lebanon) strongly altered the ambiances of this residential place, particularly the well-known thermo-aeraulic and luminous environments of the open-to-sky courtyard (source: author).

vices in their original state and cause changes for the nature of the ambiances. Thus in the Great Mosques of Meknes and Fès EL-Jdid (Morocco), for example, openwork plaster screens and carved bays have been replaced by wooden trivial screens or simply very modest woodwork windows. This resulted in the disappearance of the felted effect of natural light penetrating the place through the Quibla wall, even if the bays' dimensions have been more or less preserved. Moreover, in 1902 the restoration of the Debanne Palace in Sydon (Lebanon) and the addition of a floor strongly altered the ambience of the place. Covering the patio with a raised opaque roof incorporating side windows and changing the floor coverings had their impacts on the thermo-aeraulic and luminous environments of this space (fig. 6). The third situation relates to reconversion as an alternative action on architectural heritage. Indeed, the historical and other conditions often lead to change the functional vocation of the place in question. It therefore follows that its *ambient* nature is also modified consequently to the choices of the experts operating there. This case is strongly illustrated by the Mechouar

mosque in Tlemcen (Algeria). This sacred building lost its luminous ambience due to the inner courtyard coverage aiming to protect the decorative covering of the floor of this courtyard. Being opaque, this cover has entirely eliminated the luminous gradient going from the courtyard to the Quibla wall, a gradient characterizing the mosques with a hypostyle prayer room. The same has occurred for the courtyard itself.

The case of Dar Mnebhi, in Marrakech, is even more alarming given that its patio had been covered with a translucent coverage with a yellowish shade. The effect is strongly felt due to its substitution for the bluish light of the sky characterizing the patios of Moroccan and/or Maghreb' Dar and palaces. Beyond the effect on the light ambience and the aesthetic quality of the place, and despite the safety and protection of the surfaces that they guarantee, these metal frame and glass roof covers have a negative impact on the thermo-aeraulic environments of the different rooms of these buildings. Indeed, the patio is part of a whole natural ventilation system in which a series of openings are well placed to achieve this objective. Also, the choice of the white col-



Fig. 7- The Public National Museum of Modern and Contemporary Art in Algiers, new visual and luminous white clear ambiances different from the ancient dark brown and gloomy ones (source: author).

oring of the wooden frame, initially in dark brown, for the reconversion of Algiers old galleries (Algeria) into a modern art museum affected the luminous environment despite the conservation of the glass roofs (fig. 7). This is caused by the increased intensity of the light's internally reflected component. The new function of the place also introduces a more quiet and calm space, completely transforming the original sound environment of this former commercial building.

In the European context, the reconversion of a house and a church into a maritime museum in Aberdeen (United Kingdom) had retained very little from the original spaces' character. Only a few materials (stone walls and wooden roofs) reflect the ancient tactile environments of these places that were originally domestic and religious (fig. 8). Much less transformative, from a visual point of view, but fundamentally very alarming is the replacement of curtains by blinds in one of the spaces, occupied as an office, in Le Corbusier's Villa Savoye, in Garches (France), which has been converted into a museum. This act would question about the high value accorded by Le Corbusier to large, continuous and horizontal bays (Belakehal, 2019).

Besides, the conversion of historic buildings into museums encourages us to question about the ambiances' traces to be transmitted to current users (especially visitors) and those that could be recreated there. The case of Foundouk El-Attarine in Tunis (Tunisia) reminds us of its original function, a place of accommodation and warehouse for perfumers, through an olfactory signal consisting of a fountain of scented water placed in the building entrance hall. This is also the case for the soap factory, converted into a museum, in Sidon (Lebanon) where the small soaps, making up decorative objects,

tacitly renew the flavors of the soap prevailing there in the past. The case is different, however, in the Villa Savoye (France) which welcomes young girls with Down's syndrome to dance there following a ballerina, thus creating a pleasant musical ambience very different from that acoustic original one characterizing the domestic spaces. This situation would be similar in several dwellings (residences or apartments) when converted into museums as witness of a given era architectural style.

ATMOSPHERE: THE CONSTITUTION OF A SCIENTIFIC KNOWLEDGE

An ambience based scientific knowledge could not be developed without its conceptualization and its operationalization process as any scientific study aiming to measure a given real phenomenon in a real situation (Ghiglione and Richard, 1999; Quivy and Campenhoudt, 1995). Similarly and for the case of the concept of 'Ambience' in architecture, the appropriate approach would be the systemic conceptualization deductively reasoned "from paradigms developed by the great authors and whose effectiveness has already been



Fig. 8 - The converted church into a maritime museum in Aberdeen (United Kingdom) has retained very little from the original spaces' character, especially the stained glass (see fig. 4) (source: author).

empirically tested” (Quivy and Campenhoudt, 1995, p.133). Thus, within a phenomenon to be studied, the conceptualization may target the aspects deemed essential. It is therefore a matter of a ‘construction-selection’ (Quivy and Campenhoudt, 1995, p.120). It will follow that the constructed model describing the structure of the research object is, however, not absolutely complete and perfect (Broadbent, 1988).

The authors agree on the fact that a conceptualization takes place by: i) the definition of the dimensions and their components (sub-dimensions), ii) the selection of indicators allowing the direct and most objective measurement of the dimensions, and possibly iii) the construction of indices associating these indicators (Ghiglione and Richard, 1999; Salvador, 1999; Angers, 1997; Quivy and Campenhoudt, 1995).

Therefore, and at first time, this union between scientific rigor and operational flexibility of the conceptualization and subsequent operationalization responds to this concern, that J. P. Thibaud (2012) emphasizes not to restrict this concept of *ambience* to a univocal or even absolute definition. Undeniably, such a limitation would prevent this concept ‘Ambience’ translating as variable and multiple situations (and experiences) of a phenomenon experienced in time and space. However, and from a methodological point of view, it would be essential to arrive at a very preliminary formalization, as well as scalable, of this concept by: i) defining the phenomenon in its totality but with a selection of what is presumed and/or revealed to be fundamental constitutive factor of this phenomenon; ii) preserving the dynamic, changing and multidirectional status of the relations, links and/or associations between these factors. Differently, the *Ambience* will only be a confused notion cut off from any scientific basis preserving it from inappropriate or even any use. In addition, conceptualization in the fields of scientific research embracing the environment, as a component of the problematic involved, would make it possible to overcome the challenges arising from the complexity of the problem studied and the interdisciplinarity required (Fortuin *et alii*, 2011).

In the case of the *Ambience*, the related literature review enabled the development of a conceptual model that was qualified as ‘basic’ in the sense that it can be enriched as much by dimensions as by the relationships linking them (Belakehal, 2012; Belakehal, 2013). This conceptual model has been applied, and even further enhanced, in the context of research work particularly focused on heritage places (Chtara *et alii* 2016; Mahroug 2016; Zidelmal-Remas, Belakehal 2016; Zineddine *et alii* 2018; Ziani, Belakehal 2018). This conceptual model puts in complex interaction and re-

ciprocal influence four components: i) context of the place where the architectural space is located (climate, culture, society); ii) architectural space (conformation and activities); iii) physical environment related to the stimulus (thermal, light, sound, olfactory, aeraulic, etc.) that is transmitted to the user via the sensory way; iv) user (perceptual and behavioral conducts).

ABOUT THE AMBIENCES AS AN OFFICIALLY RECOGNIZED HERITAGE

If various studies and researches have shown the concern and the heritage issue in terms of atmosphere for the user, the designer and the decision-maker, it is necessary to know how ambiances could be constituted as a heritage. Certainly, the literature review enlightens us about this issue, but it is the examination of heritage related official legislative texts that will allow us to answer this question more effectively.

From the tangible to the intangible in heritage: the contribution of previous research

In the field of the historic built environment associated scientific research, the study of devices linked to the physical environment, and in particular the climate, is not strictly speaking new. Indeed, various institutions have invested, and are still exploring, the climatic potentialities of various architectural elements and urban spatial organizations (Malverti and Picard 1993; Zendagui 2017-2018; Disli 2018; Kim and Park 2010; Belakehal *et alii* 2016). That said, it is much more the consideration of the historical and cultural identity dimension of all these characteristics that grants them their heritage status. The result would thus be the integration of the environment as a component of historical archeology (Hardesty 2009) as well as the recognition of intangible aspects as cultural heritage to be preserved (Vecco 2010).

However, when speaking of heritage ambiances, the issue is fundamentally focused on the sensory characteristic evoked and engaged by these environmental devices. This sensory experience calls out the patrimonialization of this intangible dimension of architecture: i) at the time when it was created and lived such as the Maghreb madrasas’ ones (Ziani 2019-2020); ii) nowadays after so many years of use and evolution like some converted old buildings inside the Medina of Tunis (Mahroug 2016-2017); iii) both yesterday and today ambient experiences as it is the urban acoustic ambience of the Medina of Tunis (Chtara 2018-2019).

Which “official” references for the Patrimonialization of Ambiances?

Among heritage related regulation, it was possible to identify three texts dealing with ambiances and recommending to enhance this intangible heritage. These texts all date from the first decade of the twenty-first century. The 2003 UNESCO convention for the safeguarding of intangible cultural heritage considers perceptual and behavioral conducts as an heritage component. It is also the case of the objects and places related to these conducts and recognized as such by communities, groups or even individuals. In addition, this convention emphasizes the impact of the natural environment on this human-environment relationship and on the consequent specific identity (UNESCO 2003). These perceptual and behavioral conducts linked to the ‘context’ in which a building, a site or a heritage sector is located were valued as intangible cultural heritage by the ICOMOS declaration in Xi’an in 2005. This declaration expands the scope of the concept of context beyond the physical and visual aspects by including this natural environment. The latter is indeed at the origin of this historical, current and future interaction between man and his natural environment (ICOMOS 2005).

In 2008 in Quebec, an ICOMOS declaration highlighted the notion of the ‘Spirit of Place’ and recommended the establishment of a specific charter for the intangible cultural heritage of monuments and classified sites. While listing what could be considered intangible cultural heritage (including smells and any source of emotion for a place), this declaration calls for an enriching debate and endorses a conceptual renewal regarding the intangible cultural heritage of a place (ICOMOS 2008).

In this context of ideas, and also in response to the previously cited official references, the concept of ‘Heritage Ambience’ would prove to be more than appropriate. It is therefore necessary to establish a global, flexible and evolving ambient-based approach in order to build an associated scientific research field functional to the historical and cultural knowledge and to the architectural practice as well.

THE URBAN AND ARCHITECTURAL HERITAGE AMBIENT APPROACH

By adopting a multidisciplinary approach, the heritage ambient approach suggested for the urban and architectural research is based on the previously developed conceptual model. This approach includes various research methods affiliated to different scientific fields and submits the acquired results to objective readings

and interpretations based on the mathematical analysis. Thus, the study of a heritage ambience could not, first of all, be done without its location, both spatial and temporal. The fact of situating it temporally will make possible to study it at its apogee time and/or in its current state; this latter being able to be preserved as faithfully as possible or else entirely transformed. Once both spatial and temporal localizations are defined, it would be possible to describe the state of the studied object and subject it to a systematic characterization of the various components of the conceptual model.

Due to their multiplicity, the object(s) of the characterization must be selected in response to the problem of the planned research. The same applies to the means and methods of characterization referring to various disciplinary fields in addition to architecture and town planning. Four stages of dissimilar characterizations, for each of the components of the conceptual model, will lead to a final global and cross characterization concretizing the heritage ambience itself.

Characterization of the physical environment (signal)

This physical sensorially transmitted signal is part of the natural (i.e. daylight) and/or artificial (i.e. odor) physical environment prevalent in the investigated historical building. Being physical, this signal is characterized by means of an objective measurement allowing its quantification in numerals. This process uses building sciences but also other sciences such as chemistry for the quantitative measurement of odors (Ramalho, 1999).

Context characterization

The spatial-temporal contextualization is carried out by means of a global description, both qualitative and quantitative. Methods from disciplines such as history, literature, sociology, geography and meteorology will be used for the characterization of the daylighting resources (Del Hoyo-Meléndez *et alii* 2010) or the thermo-aer-auleic environment (Maekawa and Toledo, 2001).

Characterization of the urban and/or architectural space

The urban and/or architectural studied object is at the origin of the affiliation of this approach to the field of town planning and architecture. It will therefore be necessary to begin by identifying, describing and submitting it to a fine architectural analysis embracing its formal, functional and constructive characteristics. Thus, various analytical methods are employed. Concerning those belonging to architecture, the architectural typology and morphology research techniques are often used for the

classification and categorization of architectural components (Gharbi, 2016-2017, Belakehal *et alii*, 2016; Ziani and Belakehal, 2015, Belakehal *et alii*, 2004).

Characterization of users and/or experts

The users of a historic building are strongly linked to the temporal localization chosen for the undertaken research work. It could therefore be: i) its first users when it was built; ii) current users if the building has survived the hazards of time. It is also interesting as well as useful to explore the opinion of heritage experts about the old recreated ambiances and/or those newly designed within a heritage place. For former users, content analysis of textual and iconographic sources seems to be the appropriate research technique. For current users as well as experts, surveys are the ones largely used. As a result, literature, fine arts, sociology and environmental psychology remain among the disciplines most associated with the study of the ambient phenomenon from this angle (Zidelmal-Remas, Belakehal 2016; Gharbi, Belakehal 2020; Chtara *et alii*, 2016; Mahroug, Belakehal 2016; Zineddine *et alii*, 2018).

Characterization of the ambience (interactions and associations between the components)

In order to characterize the urban and/or architectural heritage ambience, as a global phenomenon, there will be a need to draw the synthesis associating the different and various characteristics resulting from the separate and distinctive study of every component of the heritage ambience based conceptual model from those previously listed and explained. These characteristics turn out to be of varied natures and their interaction would require a very appropriate technique. To this end, the use of mathematics is interesting in more than one way. Mathematical analysis is first and foremost an objective approach leaving little or no room for haphazard readings and interpretations. Numerical outcomes and their graphic expressions fully provide this advantage. Second, it makes it possible to consider the variety of characters identified by means of both quantitative and qualitative different research techniques.

In the case of urban and architectural environments in general, and those of heritage more specifically, the statistical analysis of multiple correspondences is the technique which has made it possible to provide very clear results. The cloud plots expressing graphically its results allow to identify and define very objectively the characteristics associating the components of the conceptual model.

CONCLUSION

The urban and architectural heritage generally studied aspects have been updated and are thus associated with current topics considering both the environment and the citizen, as user and/or expert. Current and future research is therefore intended to go beyond the classic questions which are still unavoidable, such as the typological classification and construction techniques.

The theme of heritage ambiances is devoted to the sensorial mode as a means of connection between the user and his environment. This one turns out to be, by the scientific knowledge constituted as well as the applications which have been made of it, a field of research in its own right. Conceptualization and operationalization have been established and have shown their contribution in terms of identifying a lost heritage, preserving a legacy in danger and/or recreating a heritage to be revived.

Various urban and architectural heritage objects have been the subject of an application of the developed conceptual model for the heritage ambiances. They have made it possible to obtain very relevant and very promising outcomes. However, these objects are all belonging to islamic, vernacular and even modern urban and architectural culture in Maghreb countries. This would be due to the availability of information and accessibility *in situ* itself. In view of this, and in view of current visualization techniques, it would be useful and beneficial to explore the ambiances of heritage places dating from the ancient Roman period in the Maghreb. In addition to the academic challenges, the economic ones, underlying the tourist activities arising from these ancient places, add more motivation to accomplish it.

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ROMAN ARCHITECTURE / VERNACULAR ARCHITECTURE INFLUENCES AND CONTINUITY

Rachid Djebnoun, Ahecine Zineddine Saouli

Université Mohamed Khider Biskra

Ancient civilizations can be identified only from their architectures and the evolution of their built environment which constitute palpable witnesses to their history. In this identification, building materials occupy a fundamental place and play a vital role in the process of a nation's progress. Building materials and constructive techniques require a decisive know-how in order to guarantee a value and a rank of honor to the ancient civilizations. This objective can only be achieved when a nation opens up to other civilizations, allowing the open exchange of ideas and influence. It will then be possible to discover the artistic or scientific expression that will be the result of the melding of nations in the universal interest and the global well-being.

The Romans in the Ziban region actively contributed to the building of such a civilization and empire. They have succeeded in guaranteeing a living environment for their legions and the indigenous peoples, serving their aspirations beyond their European borders, despite the hot and arid climate of the region. The result can be seen in the ruins of Gemellae, Bordj Saada and others.

Our interest is concentrated in the degree of use of raw earth material in Roman architecture in Ziban and Aures, and the techniques conveyed on both sides between the genius of the Roman builders and the know-how of the natives near the site. The influences on each other are thus evaluated. This exploration is built on the only true testimony of the archaeologist Julien Guey, holder of the prospection and excavations of the so-called Bordj Saada and the first investigator of the discovery of the use of the raw earth brick in the region.

KEYWORDS: *constructive techniques, Ziban, Aures, Roman architecture, mud brick, influences*

INTRODUCTION

Our interest in raw earth brick is generated by the richness and abundance of this material, which is considered as the primary material used in constructions and architectures of the past throughout the Algerian lands. It is present in the depths of Algerian history in terms of building cultures based on raw earth. Indeed, raw earth brick is an integral part of the rural landscapes (vernacular architecture) of Algeria, as well as the Maghreb and all northern Africa. Raw earth brick, formed from clay, was originally, and remains, a primary building material in arid parts of the world, and Algeria is considered as one of these regions.

Our interest also is in the knowledge base of construction and filling the gaps in documentation between the end of prehistory and antiquity in Algeria.

The excavations carried out on several Roman sites as indicated by several researchers (Touatia Amaraoui, 2015) have revealed the existence of mixed-construction systems employing largely raw earth. Moreover, Jean Baradez repeatedly cited the use of raw brick in the construction of the walls of the Fossatum and the towers. This suggests that the use of raw earth in archi-

tecture during the Roman era was frequent. It is further supported by additional research that the molded raw earth brick is an oriental practice that spread all around the Mediterranean basin.

It is also likely that other processes using raw earth had been developed in North Africa long before the arrival of the Romans and had spread to the countries of the western Mediterranean at different periods of history. However, the Romans perfected brick-making during the first century of their Empire and generalized its use in public and private constructions. The Romans always tried to adapt to the surrounding environment by adopting the useful and most adequate and appropriate techniques to the different local contexts.

The first question raised relates to the influence of local architecture materials and techniques; on the constructive choices adopted by the Romans. This question must not in any way underestimate the influences brought by the Romans, which are still visible on the constructions erected during their conquests. Pliny had fully defined the power of the Roman empire «Now is the time to proceed to the wonders of Rome, to examine what we have learned over 800 years and to show that we have conquered the world with our buildings

too». However, as mentioned by Strickland (2010), historian Henry Hodges gives the Romans credit for using ideas from elsewhere to their advantage.

A second question concerns the writings of Vitruvius: When describing Roman architecture, do these writings illustrate a construction technique (materials and processes) used by the Romans, or are they simple scientific and educational statements?

SCOPE AND OBJECTIVES OF THE STUDY

The scope of our study involves the constructive processes and building materials of vernacular architecture of two regions, the *Ziban* and the *Aures*, in order to highlight the possible reciprocal influences of local and Roman techniques conveyed over time. It should be pointed out here that the signs of these influences still persist and are present as markers on the Algerian territory of an invaluable construction heritage. These influences materialized by either the direct continuity of processes, or by the partial reuse of elements and materials.

The interest of this reflection, therefore, lies mainly in the evaluation of this influence observed through examples located near the Roman remains existing along the southern Limes of Algeria near Biskra, including: *Melili (Gemellae)*, *Lichana*, *El kantara*, *Ain Zaatout* and *Mchouneche*. It seems that these border areas were highly developed and had some degree of civility. This is due to the diversity of cultures and exchanges between the two nations. This statement confirms that the Limes were in Roman Africa a place of exchange and military-administrative surveillance. Actually all studies confirm that the Limes was also a place of necessary symbiosis between populations and complementary regions assuring social, cultural and economic exchanges in a region with a dual agricultural and pastoral vocation. It had constituted a bridge of influences between neighboring peoples' constructive techniques.

Particular attention will be paid to the site of *Bordj Saada* and its surroundings for the importance of the archaeological findings concerning the use of the raw earth clay bricks in Roman constructions and the influence of the vernacular on the choices they adopted with the objective to build structures that would last.

The realization of our study requires an analysis and a review of the different approaches, reflections and discoveries in relation to our queries. Therefore, in the interest of elucidating our reflections, the following objectives have been set:

- Review the building materials and products as well as constructive techniques of a specific area related to the ancient Roman presence.

- Search for a relationship of influence (continuity) or rapprochement (reuse and transformation) between Roman materials and techniques used in the region and the vernacular (*Arab - Berber*)
- Compare Vitruvius' writing on the use of raw earth with the specific vernacular techniques used in the *Ziban* and *Aures* regions.

IMPORTANCE OF THE MATERIALS: STONE AND EARTH

It should be remembered that stone and earth/mud bricks (baked or raw) are considered the main and most-used materials of all the ancient architectures. Since ancient times, these two materials contributed to the construction of large cities considered as important heritage of great civilizations today. In Algeria, these cities and buildings are still considered living witnesses of our past and especially of our Roman past.

The protohistoric architecture present in Mesopotamia is known for its vestiges built in raw and baked earth. Greek architecture is especially known by its stone constructions, while the Romans knew how to master several varieties of earth bricks and stone, especially freestone, square stone, and lime. Roman builders employed each of these materials for its qualities: strength, durability, and aesthetics. The use of stone was extensive particularly in Rome, its supply was guaranteed by the presence of local stone mined from fields or quarried. The Romans' initial use of earth brick, either baked or raw, was during the first century in Rome for roof tiles to provide protection for timbers and masonry work. In more recent times, Islamic architecture has left us a precious heritage of earthen architecture.

In examining the *Ziban* and *Aures* region, stone and earth coexisted side by side during the different periods. In particular, the Roman and Medieval eras saw the emergence of a specific architecture that evolved into a local or vernacular architecture.

Regarding the reasons for the use of this material in the area surrounding the southern Limes, Guey (1939) justifies its use by the lack of a stone quarry nearby the construction sites: *«le plateau qui règne entre la séguia et l'Oued-Djedi situé à plus de trente kilomètres des carrières les plus proches, est dépourvu de pierres de taille, on avait dû faire venir à grand' peine les quelques grosses pierres que montrent les ruines»*. These remarks leave one wondering why in the same site and along the *Oued-Djedi*, the Romans built the city of *Gemellae (Melili)* on several hectares, using another local material more solid than earth but possessing the class of stone: a relatively soft limestone (*Deb-dab*). A second argument for the choice of earth as a building material lies, according to the same author, in the scarcity of firewood for the production of bricks,

the second material substituting stone in the case of Romans. «*La région était certainement alors comme aujourd'hui très pauvre en bois, le combustible nécessaire à la cuisson des briques faisait presque défaut; c'est pourquoi les Romains employaient dans la région la brique crue.*»

THE «EARTH» MATERIAL AS QUOTED BY SOME HISTORIANS

Many ancient books evoke the term “earth” to designate the material used in construction and architecture. These writings testify that earth as much as the stone in its various forms had been used in ancient constructions, especially in domestic dwellings; and it had never been omitted from the creative and artistic thought of the builders of that time. We quote, for reference, the writings of Vitruvius in *De Architectura*, as well as those of Pliny and Palladio, and we will focus our interest on the two processes of earthen construction that are very widespread in vernacular architecture in Algeria: *adobe* and *pisé*.

Referring to Claire-Anne De Chazelles (2003), «*Témoignages croisés sur les constructions antiques en terre crue: textes latins et données archéologiques*» we note that Vitruvius and later Pliny intersect in the point concerning the material earth «*adobe*».

On the one hand, De Chazelles (2003) concerning unbaked bricks, states clearly in this context and quoting Vitruvius: «*En effet, il ne faut pas les faire de terre mêlée de sable, ni de gravier, ni de sabulo, car si elles sont faites avec ces matériaux, d'abord les briques sont trop lourdes, ensuite, lorsque la pluie les éclabousse, elles tombent en morceaux et se désagrègent et les pailles n'y adhèrent pas. Au contraire, il faut les faire à l'aide de terre argileuse blanchâtre, ou avec de la terre rouge (ocre?) ou du sabulo mâlé.*»

On the other hand, Pliny as cited by Chazelles (2003) recommends that the material should be: «*Les briques ne doivent pas être faites avec un matériau sableux à gros grains ou à grains fins, encore moins caillouteux, mais d'une terre argileuse blanche ou de terre rouge, ou même de sabulo, si c'est du «sabulo mâlé». [...] il faut que le mélange ait bien macéré avant d'être façonné.* ».

Always referring to Chazelles (2003), Palladius (4th century CE) states that during raw brick construction the following recommendations should be followed: «*Parce que si vous voulez faire des murs de briques dans la maison du propriétaire, vous devez procéder de sorte que sur la partie supérieure des murs achevés, on place sous le toit une maçonnerie en terre cuite, haute d'un pied et demi, avec des corniches saillantes [...]*»

More recently, inspired by Pliny, Anthony Rich (1883) defined the *Pisé* in the dictionary of Roman and Greek Antiquities (1883) : «*Espèces de construction connue sous le nom de pisé ; c'est de la terre que l'on presse*

avec de la paille hachée dans des moules que l'on pose les uns au dessus des autres, à mesure que le mur s'élève ; quand la terre est sèche, on retire les planchers ... Et n'étaient pas moins connues autrefois en Afrique ; en Espagne et dans le Sud de l'Italie»

Finally, to conclude with the writings and quotations evoking the raw earth bricks, we refer to the work of Varron “*Res Rusticae*” concerning fences types and quoted by De Chazelles (2003): «*Il y en a environ quatre espèces, car on en fait en pierres, comme dans le territoire de Tusculum, en briques cuites comme dans le territoire gaulois, en briques crues, comme dans la province de Sabine, en un mélange de terre et de gravier aggloméré dans des moules, comme en Espagne et dans le territoire de Tarente.*»

This source bank of references concerning the use of earth in ancient Roman architecture only favors our impetus to go further in detecting the degree of use of this abundant material in the regions of *Ziban* and *Aures*, a material rarely mentioned in archaeological excavations when they started in Algeria at the dawn of the 19th century.

ARCHAEOLOGICAL EXCAVATIONS OF 1938 IN BORDJ SAADA

Julien Guey, a French archaeologist, discovered the archaeological site of *Bordj Saada* (fig. 1) and its surroundings from aerial photographs in February/March 1938. *Bordj Saada* included four forts, particularly the *Drah Souid* and *Bordj Borada*, as shown in figures 1 and 2 and which contained a Christian Basilica of 28.70 m long and 13.55 m wide according to the dimensions measured on the plan of J. Guey. «*Ces deux monuments étaient construits en briques séchées au soleil, en toub, la seule construction possible en cette région. Mais les dimensions de ces toub sahariens rappellent celles des lateres de Vitruve, des briques crues de la Rome républicaine. L'origine de cette architecture militaire (et religieuse) en briques non cuites serait donc romaine plutôt qu'indigène.*»

In an explicit description, Guey (1939) writes the following concerning the granulometry of the used unbaked mud bricks: «*d'argile brune dont est formée ces toub contient un peu de gravier; elle est néanmoins compacte; comme d'ordinaire, elle renferme de la paille hachée qui donne à la matière une grande cohésion.*» The measurements and dimensions of these bricks from the two archaeological sites (fig. 3) show that they are aligned with the Roman lateres types highlighted by Vitruvius: «*ces toub ne sont pas très soigneusement calibrés ; l'épaisseur en est constante (9.50 à 10 cm environ), la longueur par contre varie entre 46 et 53 cm – moyenne approximative de trente mesures prises : 49.50cm et la largeur entre 32 et 36 cm – moyenne approximative de quarante mesures prises : 33 cm.*» (Julien Guey 1939).

Guey (1939) also notes that the foundations of the walls are not present at the basement level, which is

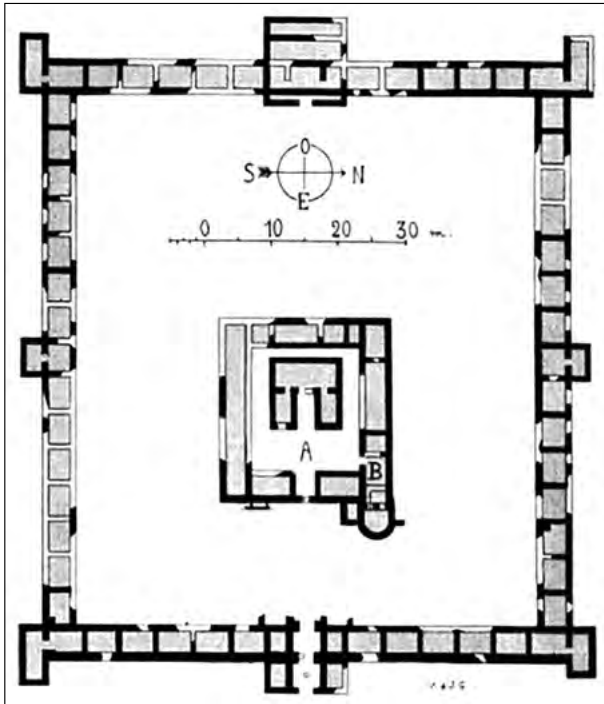


Fig. 1 - Fort Borada [Guey 1939]

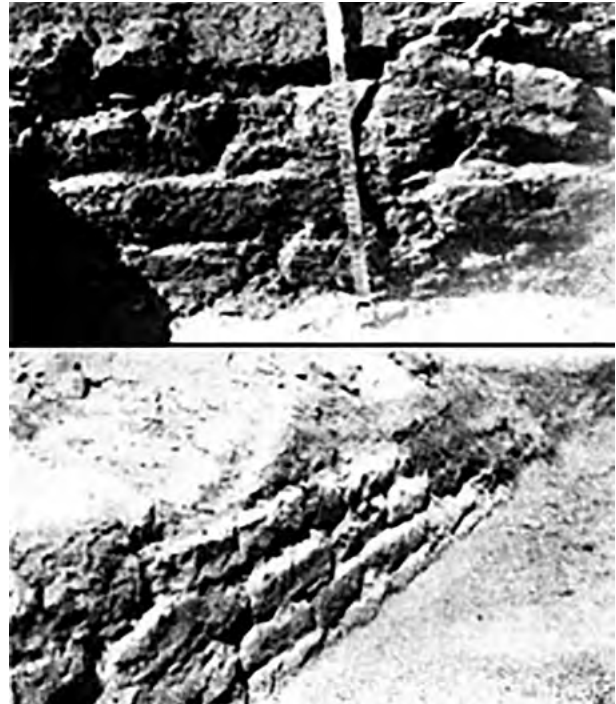


Fig. 3 - Wall built in unbaked mud bricks (toub), Fort Borada [Guey 1939]

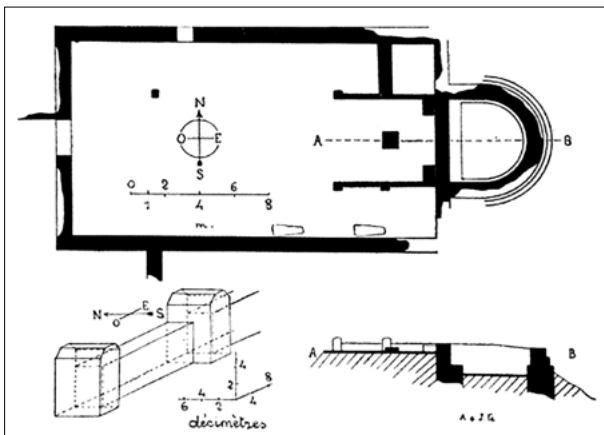


Fig. 2 - Basilique of Draa Souid J. [Guey 1939]

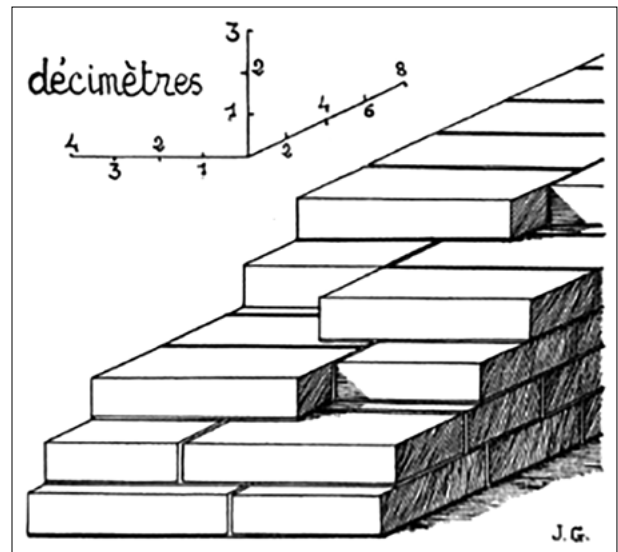


Fig. 4 - Croquis [Guey 1939]

justified by the predominance of the dry climate and the rarity of rainfall in the Sahara region: «quant aux murs, la sécheresse exceptionnelle du climat explique qu'ils reposent à Borada sur les fondations de briques crues et non pas sur des constructions de moellons ou de blocage.»

In terms of construction method, the apparatus or «opus», described in detail by Guey (fig. 4), is accomplished with alternating blocks of bricks, sometimes on the short end and sometimes on the long edge, leading us to suppose, by comparing it with that stated in the writings of Vitruvius, that this laying system is identified with the usual Roman technique: «l'appareil avait

pour principe l'alternance des boutisses et des carreaux» (Julien Guey 1939). This principle of apparatus is clearly evident in the constructions of Lichana (fig. 5).

These survey and excavations, which date back more than 70 years, have unfortunately never been updated. Actually, the site of Draa Souid which encloses the Christian Basilica moans under its rubble and is subjected to the piles of sand. In 2008, Hadji Y. R., an



Fig. 5 - Picture of a building in Lichana [Authors 2015]

Algerian researcher and scholar began a survey and excavations will be undertaken shortly to elucidate certain enigmas concerning this site. Awaiting further scientific discoveries, Guey's testimony remains the only reliable and significant document. It currently represents the only testimony to the presence of the use by the Romans of mud brick in the *Ziban* region.

ROMAN AND VERNACULAR INFLUENCES

In evaluating the reciprocal influences, it is interesting to note the extent of these influences observed in both directions. This allows us to confirm:

- that the vernacular has inherited the Roman influence in relation to constructive techniques and the choice of building materials
- that the Romans had to accept certain changes in their construction methods to modify their choice of materials and even their construction techniques
- that the Romans were not too keen to use raw bricks, since they were looking for lasting buildings. They preferred the use baked bricks instead.

In addition to the dimensional influences, our study detected three types of influences:

- A direct influence lies in the direct and total use of materials. It is identifiable at the material level by its texture, dimensions and equipment. This direct influence is also identifiable in construction techniques, by the type of laying of the material, either for the construction of a wall or a vault.
- Partial direct influence by partial reuse of materials for the construction of certain parts of the structure and the transformation of certain building bodies (basement, foundations, etc.).
- An environmental influence: This is the case when environmental requirements forced Roman build-

ers to select the material according to its availability and its mechanical characteristics. This choice is generally not considered to conform to the usual techniques and constructive habits of the Romans. These reciprocal influences between Roman and indigenous constructive techniques have allowed the emergence of an architecture with techniques purely specific to the Saharan region. «*De fait ; l'architecture de briques crues, découvertes indépendamment dans des pays différents, par exemple en Egypte, en Mésopotamie, peut bien être saharienne au Sahara, la population fixée autour des puits d'eau...; avant la conquête romaine semble avoir habité ces oasis et ne vivaient pas sous la tente et, si peu qu'ils construisissent nécessairement en pisé ou en briques crues*» (Julien Guey 1939).

On the other hand, the credit to the Romans in the mastery of earth material is manifested in the testimony of Augustus on Rome: «*Mais les Romains eux-mêmes étaient d'excellents architectes en terres: Auguste appelait la Rome républicaine une ville de briques crues* » (Guey 1939).

Finally, Vitruvius attests that all the means and tools to achieve the objectives of edification and construction are good enough to develop a know-how for a good mastery of the available material: «*There are no rules regarding the choice of materials; he writes about the city walls; because not all sites offer the resources we would like to find there*» (Guey, 1939).

DIMENSIONAL INFLUENCES OF THE VERNACULAR IN RELATION TO ANCIENT DATA.

In this part of our study, we examine the dimensional characteristics of the earth brick and compare those measurements with the bricks found in vernacular construction. Earth brick is considered to be the preferred material of the Romans, produced in mass, standardized and easily assembled. This remark is present in various writings in particular those of Vitruvius, Palladius and Pliny.

In this context Vitruvius clearly mentioned brick preparation techniques in his writings, and these methods are still alive today. They prescribed the following:

1. Mixing the clay with water in a container while ensuring the mixing by stomping by foot.
2. Adding a hardening agent to the mixture. This agent could be straw, dried grass, cereal straw, and sometimes even sand or gravel.
3. Removing excess moisture from the fluid material before placing it in pre-prepared form moulds.
4. Drying the formed bricks to facilitate its handling and structural integrity. Vitruvius specifies the importance of the drying process and states that the drying process should be limited to autumn and spring. It is also essential to fix and establish the

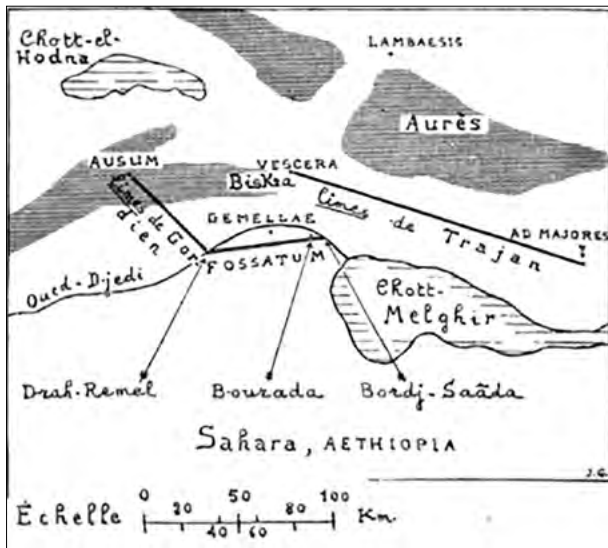


Figure 6 - Localization of Bordj Saada [Guey 1939]

form and dimensions of the brick to facilitate its handling and use in construction.

As far as Vitruvius, Pliny and Palladius are concerned, the baked earth bricks seem to have been standardized upon three certain sizes: *lydium*, 11.65" x 5.8", *tetradoron*, 11.65" x 11.65" (four hands), and *pentadoron*, 14.5" x 14.5" (five hands).

Vitruvius (De Architectura, II, 3) precisely mentions: «We make three types of bricks: one of them which is called *lydium* in Greek, is the one we use, it is one foot and a half long and wide by one foot. The other two types are found in the construction of Greek buildings: one is called *pentadoron*, the other *tetradoron*». The same statement is made by Pliny (*Naturae historiarum*, XXXV), with regard to the dimensions of bricks which reveal themselves to be identical to those of Vitruvius: «[...] There are three kinds: the *Lydium*, which we use, is one foot and a half and wide by one foot [...]», while Palladius (*Opus agriculturae*, VI, 12) proposes dimensions larger than his predecessors: «But that the sides be two feet long, one foot wide, and four inches high».

We should note that the dimensions using the 'foot' do not agree very well compared to the documents on the Roman period, so we prefer to reference the works of Abbé Barthélemy, which seems to be a more reliable and recognized measurement reference. According to Abbé Barthélemy, as quoted by Alfred de Wailly in his *Nouveau Dictionnaire Français-Latin*, the Roman foot is equal to 10 inches, or 29.46116 cm, which means that the brick of Vitruvius and Pliny is (44.19174 cm x 29.46116 cm), while it is of (58.92 cm x 29.46116 cm) x 9.82 cm according to Palladius.

	Length cm	Width cm	Height cm
Vitruvius/ Pliny	44.19174	29.46116	absent
Palladius	58.92	29.46116	9.82
Fort Borada/ Draa Souid	50,00	33,00	9,84
El kantara	35.00	25.00	10.00
Lichana	38.00 - 40.00	18.5 - 20.00	8.00 - 9.50
Tahouda	40.00	20.00	10.00
Ain Zaatout	38.00 - 40.00	18.00 - 20.00	9.00 - 10.00

Table 1 - Dimensions and shapes of the bricks

A comparative table is given (see table 1) to show the differences between some dimensions of unbaked bricks from different regions around the Limes and some areas previously inhabited by the Romans, allowing us to elucidate the influences and similarities. Although we are persuaded that these dimensions have seen a reduction of measurements particularly during periods historically closer to us to reach dimensions more suitable for transport and handling during implementation.

According to the data in Table 01, two remarks can be made:

- The rectangular shape of the bricks is consistent with that of the Romans in all cases chosen, and even elsewhere, because it is rare to find dimensions that tends towards the square, except in the case of *El kantara* where the ratio between length and width is minimal.
- Measurement ratios are consistent with Palladius for *Lichana*, *Tahouda* and *Ain Zaatout* bricks (2 measures x 1 measure) x 4 inches.
- In terms of thickness, all types of bricks are relatively identical in size and conform to the Roman type.

The panneresse apparatus seems to be the most common in the ancient Roman architecture discovered in the excavations of the Gaulish habitat of Saint-Pierres-Martigues (Claire-Anne De Chazelles, 2003) and also mentioned by Vitruvius, while in the vernacular architecture of the *Ziban* and *Aures* regions, different apparatus are observed and each region tends to be characterized by its own specific apparatus.

CONCLUSION

Just as ancient Greek architecture was strongly influenced by North African buildings, the Roman architecture that extended from Morocco to Iran experienced all the influences of these regions. Moreover, the Romans

may have borrowed some of their earliest ideas from the ancient Greeks, Etruscans, Egyptians and Persians.

At the origin of these influences, the vernacular building materials, techniques and methods occupy a privileged place. The collective wisdom of the populations of the *Ziban* and *Aures* regions made these ancient builders able to find solutions to the requirements of the environment in which they built. In our paper we have tried to answer the following question: What is the actual origin of this architecture of raw bricks practiced by the Romans in the regions bordering the southern Limes, specifically in the regions of *Ziban* and *Aures*?

With the advent of Roman conquests, Romans took their brick-making skills everywhere they went. Some technological methods were brought and introduced to the local populations, which created advancements in building methods and techniques. To be more responsive to the environment and to the conditions that prevailed on site, Romans had to refer to the autochthonous people and tap into the rich local traditions to adapt their building methods and techniques. This dialectic relation contributed to the glory of the Romans as well as to the continuity of traditional solutions regarding the built environment.

We have tried to give an architectural assessment and view of the questions raised through this paper. This reflects the growing interest of current researchers who are interested in evaluating the influences of vernacular and Roman architecture in the making of contemporary Algerian architecture. More specifically, our contribution will allow researchers (historians, geographers, archeologists and engineers) concerned with building materials to work on a field of interest and a research track that will open up the prospects of archaeological investigations and excavations in other sites along the Southern Limes so that *Drah Soud* and *Fort Borada* will be no exception in the use of raw earth material.

Last but not least, the perspectives of our work will focus on the archaeology of the southern Limes of the Ziban during the Roman period, particularly on the methods and systems of analysis, including:

- Carrying out historical studies to identify the presence of technical characteristics that have a specific age-typology meaning (*marqueurs chrono-typologiques*). These markers will enable researchers to define and represent the evolution lines of the construction techniques specific to mud brick.
- Enhancement of these studies by the realization of structural analyzes of clay materials, depicting the styles of apparatus and opus and the architectural elements.
- Particularly the carrying out extensive investigations using of the mensiochronological analysis method

(*methodologie mensiochronologique*) to mud bricks remains and found all over the archeological sites during the entire construction cycle (from land extraction to implementation on site).

This necessitates the initiation of the following steps:

- Updating of the research and work undertaken by Julien Guey in 1938 on *Bordj Saada* in particular.
- Resumption of new excavations and prospections in other bordering sites along the southern limes of Ziban to be able to work on reliable and convincing analyzes.
- Initiating the implementation of an inventory of archaeological sites whose Roman architecture had used mud brick techniques as a construction material in this region of Algeria.
- Attempting to develop for every site a detailed technical directory (making of files that help for the classification of historic-archaeological data) on stylistic studies concerning the different apparatus used and the mensiochronology study of mud bricks (Evolution of the size of the bricks: volume, length and height).

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THE TIMGAD FORUM: THE APPLICATION OF A ROMAN URBAN SPACE MODEL IN THE SOUTHERN MEDITERRANEAN CONTEXT

Manal Ghennai, Azeddine Belakehal

*LACOMOFA Laboratory,
Department of architecture, Faculty of Sciences and Technology,
Université de Biskra, Algeria.*

The Forum is the heart of the Roman city, it is the political and religious centre and the theatre where social life takes place. In this work, we will apply a solar study to the Timgad Forum. We will first evaluate the Timgad forum compared to other similar cases in Algeria, then we will create a virtual 3D model by digitizing Albert Ballu's restitution drawings, and finally we will apply a solar simulation. This work provides representative patterns of luminous territoriality on the forum area, depending on the path of the sun and the duration of exposure. These patterns of shadow and light make it possible to infer the way in which the inhabitants were using this public space.

KEYWORDS: Roman forum, Timgad, climate, solar radiation, urban space

1. INTRODUCTION

The climate constitutes a crucial factor in most urban and architectural design theories. In fact, it is imperative to construct the built environment in respect of local climatic factors (Colombert *et alii* 2012). Before designing urban spaces and/or buildings, it is necessary to study the most influential factors such as the sun movement and wind direction. It is more than beneficial to ensure better exploitation of their desirable effects and mitigate their negative effects (Thomas, 2002). What leads us to believe that ancient people took climate data into account when designing cities is the evolution of instruments for measuring time, the solar cycle, and shadows in the ancient era such as gnomons and sundials.

This is confirmed by Vitruvius in his treatise, where he gives recommendations regarding the location of towns and buildings. His recommendations are neither aesthetic, religious nor political, but are climatic based (Bioul 1816, Mandoul 2012).

Hence, this research work aims to explore how Roman urban planners adapted, from the organizational and climatic points of view, the original Roman Forum pattern to Timgad city's geographical context. Firstly, an analogous study compares a study corpus of four well known Algerian cities' forums to the original Roman model. This comparison is undertaken in order to identify the similarities and alterations between those from Algerian city and the theoretical original model. Secondly, Timgad forum is virtually restituted as a study

object. Then we will provide a sun movement simulation followed by a study of shading and shadowing effects within the Timgad forum. These effects are considered as a part of the factors influencing this urban space usage and thus its atmospheres. Eventually it will be possible to highlight at what extent the adapted forum model differs or it is similar to the original one.

2. THE PUBLIC CENTER OF A ROMAN CITY

The apparition of the Roman Forum dates back to 600 BC. Its first version looks very similar to the greek *agorà*. It is a public space that has developed over time. At the first, the forum contained a set of various buildings without a regular and homogenous urban composition. Then, during the imperial era, it became an urban centre expressing the empire's glory (Martin, 1972). It should be emphasized here that Imperial *fora* represent the most illustrative example of multifunctional urban centre in ancient Rome.

This large complex has been built during subsequent historical periods: i) the first forum was built in 53 BC by Caesar; ii) Augustus' forum was built in the year 2 BC; iii) in 75 AD the Peace's forum appeared¹; iv) this urban space was transformed by Domitian, in 98 AD, into a new forum called Nerva; v) in a final phase, Trajan built the last imperial forum in Rome. This last,

¹ This project aimed to connect with the two previous forums and enhance all together the city-centre's urban landscape.

notably luxurious and grandiose project closed the imperial era (Thédenat, 1911).

The Forum constituted the city's functional centre to which converge all the civic and cultural life's components. It consisted of numerous buildings consistently surrounding a rectangular square, mainly: i) the *basilica*; ii) the *curia* and iii) the Temple. In addition, other peripheral buildings were part of it such as: i) the Prison, ii) the City Treasure, and iii) the Archive Room or the *tabularium*. The forum's model was applied in the Roman colonies with some modifications in respect to the context. For instance, Italian cities' oldest forums included a building with several steps called *comitium*. This latter was linked to the *curia* and housed political activities. The *comitium* gradually disappeared thereafter. Besides, in most of the African and Western provinces the typical layout of the Roman forum (*basilica*, Temple, *curia*) was adopted. Sometimes, some simplifications or amplifications were introduced due to the pre-existing urban fabric's constraints. Also, another type of forum called "the provincial forum" existed in some Roman provinces. While expressing the "imperial cult", its functions extended outside the city, even sharing responsibilities with the capital, as in the case of Tarragona (Tarraco) forum (Gros 2002).

From a functional point of view, the main urban square hosts a large number of activities, mostly political. Basically, the Forum is used as a place of controversy, communication and sharing debates. It is a place where all kinds of events take place, sometimes even tragic events linked to civil unrest or moments of public mourning. In addition, it hosts joyful events such as ceremonies, religious festivals, ritual sacrifices, and gladiatorial parades. It is also the place where all classes of society meet: consuls, lawyers, judges, merchants, artists, slaves and so on. Also, the Forum is a multifunctional open urban space for relaxation and entertainment (Thédenat 1911).

3. THE TRIPARTITE SCHEME ADOPTED IN THE WESTERN PROVINCES AND ALONG THE LIMES

Algeria encloses several Roman cities and the presence of forums among these human settlements is well documented. In this study, we take into consideration four Algerian cities forums: Timgad (*Thamugadi*), Hippo (*Hippo Regius*) and the two *fora* of Djemila (*Cuicul*). Firstly this analysis will attempt to identify and define the characteristics of each object of the study. Based on a systematic comparison of these characteristics in comparison to those of the Roman Forum's basic model, this first step of the analysis has been performed by seeking the adaptation modalities, depending on

whether they are an identical reproduction or an alteration from the original model. Thus, at the level of the forum of Timgad and both Djemila's ones, the same urban composition called "forum block" is observed. This name is given to the forum scheme with a rectangular plaza bordered by porticoes as well as dominated on one short side by a temple facing a judicial *basilica* located on the opposite side (Gros 1990).

Balty has explained that this widespread composition scheme goes back well to a model imposed by Rome. Certainly, this type of place where the judicial, religious and administrative components are organized according to a rigorous plan, knew remarkable applications during the two first centuries of the empire within the countries of Gaul, the Germanies and Britain (Balty 2005). In addition Gros notes that Timgad forum represents the Asian version of the *basilica-curia*-temple complex described by Vitruvius in his book *De Architectura* (Gros 1994). The situation is not different for Djemila's old forum where we observe the unity of composition *basilica-curia*-temple. However, this pattern has not been applied in the case of Hippo's forum where the three *basilicae* are located outside the Forum. In a previous study on the Tingitan forums focusing on the tripartite scheme Euzennat, and Hallier (1986) investigated the Banasa, Volubilis and Salé (*Sala*) forums in Morocco that were built according to the tripartite scheme. These authors pointed out that the same forum scheme was applied in the Germanic cities near the Limes. This outcome outlines a certain analogy between the urban organizations and architectural compositions chosen and applied in the cities of the Roman Empire near the northern and southern Limes, since Timgad and Djemila were originally military encampments of the Roman Empire founded to protect the border of the empire (Ghennai, Belakehal 2019). This similarity also suggests that the harsh climatic conditions of both northern and southern Limes contexts might have played a role. This incites investigation into this aspect, discovering the climatic dimension of the Forum design.

4. TIMGAD: AN INTERNATIONALLY EXCEPTIONAL ROMAN SETTLEMENT IN ALGERIA

Gsell considered Timgad as a site so well preserved that it could be studied in all its dimensions (Gsell 1901), an ideal model deserving all the necessary attention by archaeological and architectural field specialists: substantially a reference site.

Timgad is located on the Aures massif piedmont, near Tazoult (*Lambaesis*) and about thirty km east of Batna. This settlement was founded in the first century under emperor Trajan by the Third Augustan Legion. Nev-

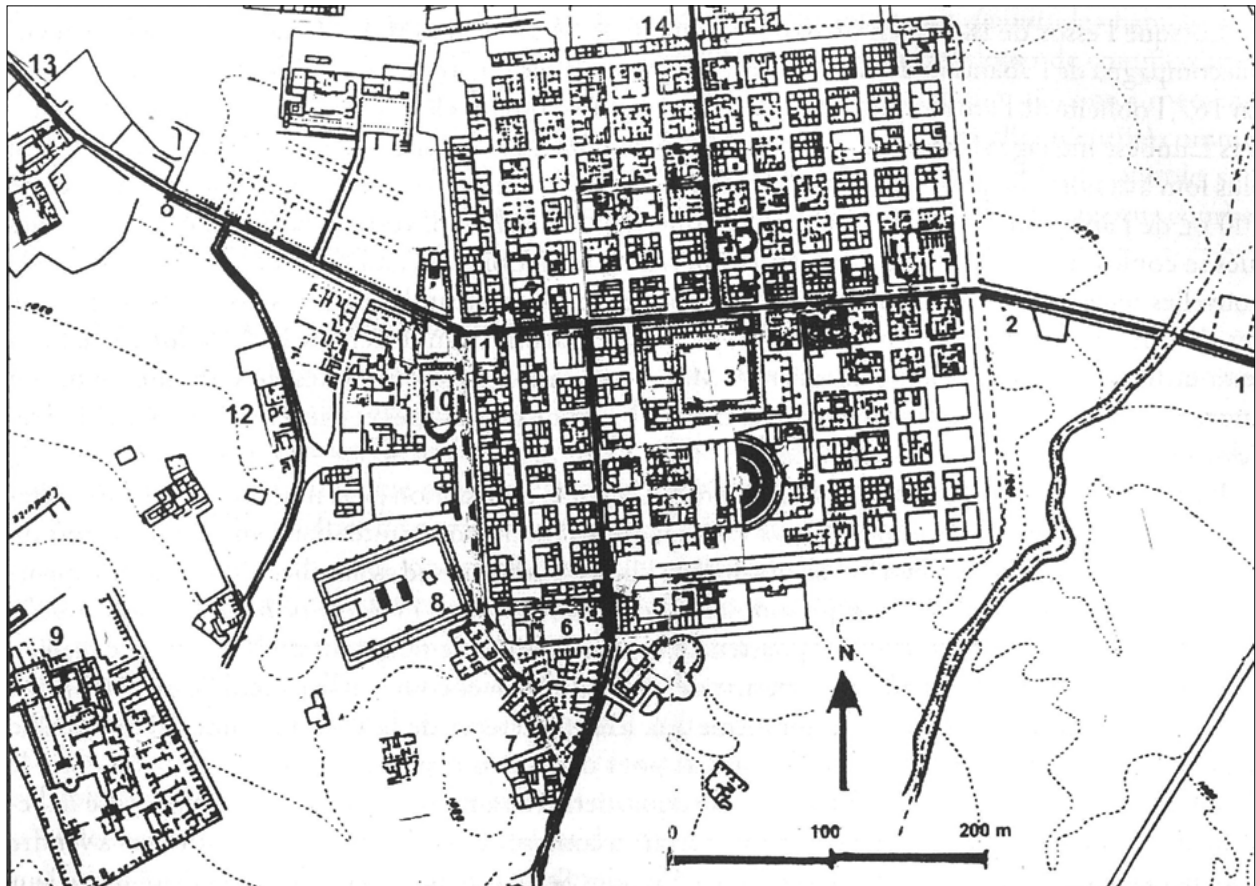


Fig. 1 - Timgad plan indicating the forum location relative to the regional roads (source: LEVEAU 2017, p. 227).

ertheless, there was a chronological spread between its building phases. While the *curia* dates to 250 AD, the construction of the propylon is situated between the second and third century and the capitol was built around the middle of the second century (Gros 1994). The site was discovered by the English traveler James Bruce in 1765 (Courtois 1952) and in 1880 became the first large-scale excavation site in North Africa (Oulebsir 2004).

The city of Timgad perfectly represents the typical model of a Roman city: a division of the available space into four domains by two perpendicular axes, the *Cardo* corresponds to the north-south course (axis of the world) and the *Decumanus* corresponds to the east-west course (path of the sun). The Forum is located at the crossing of these axis (Norberg-Schulz 2007). Similarly to Pompeii and other Roman cities, the Timgad forum constitutes a coordination point with the regional axis. In fact, the city urban network was adapted to the regional traffic. Thus, the urban section took the *Decumanus Maximus* according to a direct route linking Tazoult (*Lambaesis*) and Khenchela (*Mascula*) city gates. Furthermore the starting point of the *Cardo*, which

intersects the *Decumanus* in the Forum area, was a monumental urban gate (fig. 1, Leveau 2017).

The forum (fig. 2) is accessed from the north side throughout a main entrance marked by a propylon. The forum esplanade is filled with almost thirty honorary monuments and equestrian statues and is bordered by porticoes surrounded by buildings. In the right side of the forum we find the *curia*, the colony municipal council and its two essential organizations: the peoples' assembly and the senate. The *curia* is a room of modest dimensions adorned with a platform marked by pilasters. Next to the *curia*, there is a small temple. The *curia* and this temple are linked by rostrum of Victory that dates to the first half of the second century. Beyond the *curia*, the forum's southwest corner is occupied by a complex building that may have hosted the municipal service offices. Along the south wall, there is a series of small shops. Behind the east portico is the *Civil Basilica*. The latter consists of a rectangular space. At its northern end, there are both a semi-circular apse and two small rooms. The west side of the *Basilica* is bordered by a row of offices. Next to the *basilica*, just to the northeast of the forum, is a house with a garden. At the foot of the north

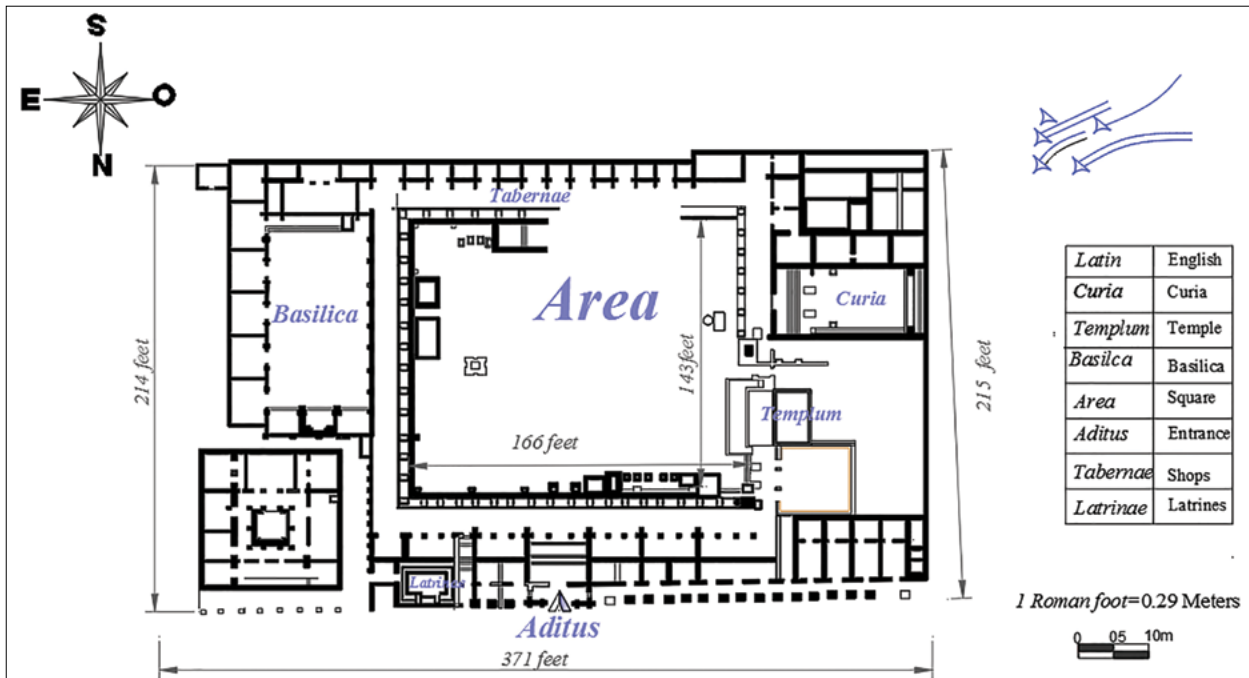


Fig. 2 - Ground floor drawing of the Timgad Forum according to the plan presented in the work of S. Gsell (GSELL 1901 p. 123, annotated by the authors).

portico, an inscription on the ground describes the principles of Roman life: “*venari, lavari, ludere, ridere, hoc est vivere*” (hunting, bathing, playing and laughing, this is living). (Boeswillwald *et alii* 1905; Courtois 1952)

5. TIMGAD FORUM AS A CASE STUDY

Timgad forum is studied in order to highlight the similarities and differences with the original theoretical forum model. For this purpose, Timgad forum’s characteristics have to be firstly compared with those recommended by Vitruvius. In a second step, the forum will be examined and commented regarding its use as a part of its ambient life. This latter aspect is approached as a heritage ambience, so within the relationships connecting: i) users; ii) space; iii) environment and iv) context (Belakehal 2012). The study of Timgad forum’s heritage ambience will be limited, in this article, to the thermal environment and specifically to the effects of sun rays on this important urban space. Such investigation requires firstly: modeling, simulations, processing and tools in addition to field work, literature review and bibliographical research. Thus the following methodological steps are defined: i) carrying out a virtual modeling (restitution) of Timgad Forum; ii) applying a solar movement study within Timgad forum; iii) coming up with a “solar zoning” based on the identification of different solar zones that vary in function of season and daytime.

5.1. Timgad forum Virtual modeling (restitution)

This step consists in digitizing the restitution drawings of Albert Ballu. This well-known orientalist architect marked the Algerian architectural heritage history. At the head of the historical monuments department for more than thirty years during the colonial era, he produced a restitution of the Timgad forum (Koumas, Nafa 2003). Ballu’s restitution work consists of three water-color drawings: i) an urban section crossing the forum square, the main street (*Decumanus Maximus*) and the theater; this section shows the arch of Trajan on the left, and the western elevation of the Forum in the middle (fig. 3); ii) a second urban section crossing longitudinally Timgad city center; this section reveals the theater on the right and the eastern face of the Forum on the left (fig. 4); iii) an elevation view representing the forum main *facade* and the Gardener house and theater side *façade*. The digitalization of these three drawings (fig. 5) allowed the creation of a 3D digital model for the Timgad forum (fig. 6), using Autodesk 3DS Max software.

5.2. Numerical solar simulation

In order to evaluate the impact of the sun on the Timgad Forum complex, digital simulations were carried out using ‘Revit’ multidisciplinary BIM software. The simulation (see table 1) considers the sun movement within the forum from sunrise to sunset for four

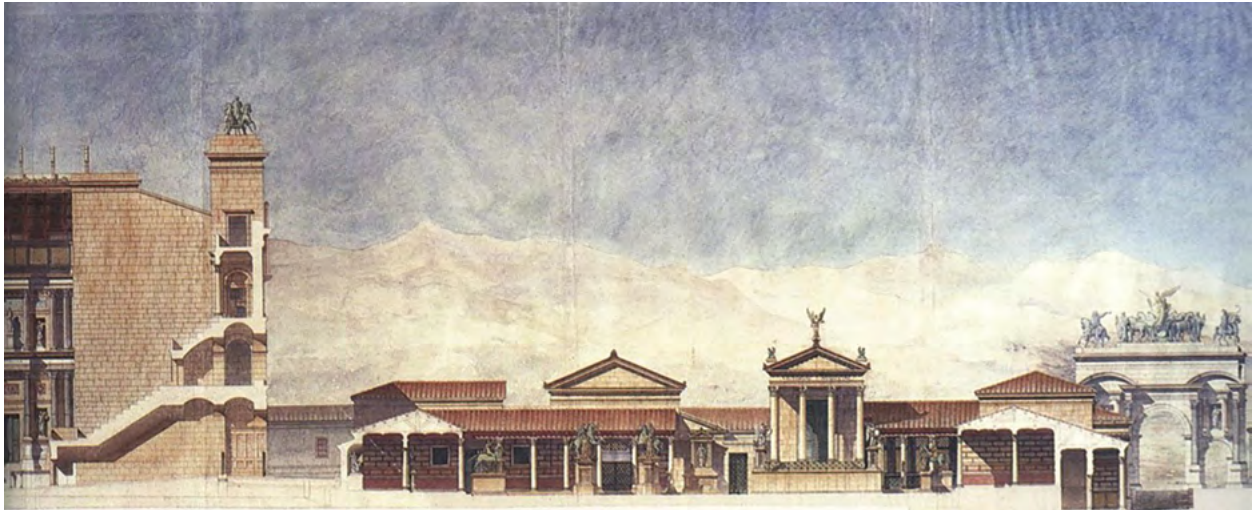


Fig. 3 - Longitudinal section of the Forum (west side) by A. Ballu (source: KOUMAS, NAFA 2003).



Fig. 4 - Longitudinal section of the forum Est side by A. Ballu (source: KOUMAS, NAFA 2003).

days; each one representing a season of the year. The simulation outcomes are constituted by hourly sequences and result in: i) ten photographic sequences for a winter day; ii) thirteen for both autumn and spring days; iii) fifteen ones for summer days.

6. RESULTS INTERPRETATION

The comparison based on Vitruvius' recommendations and the analysis of the simulation outputs allows the following interpretations for Timgad forum case.

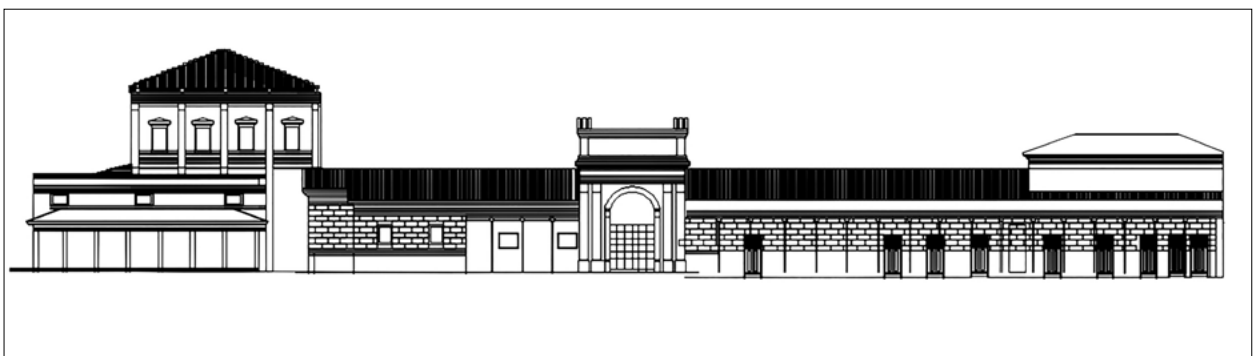


Fig. 5 - Digitization of the main *facade* of the Forum (source: authors).

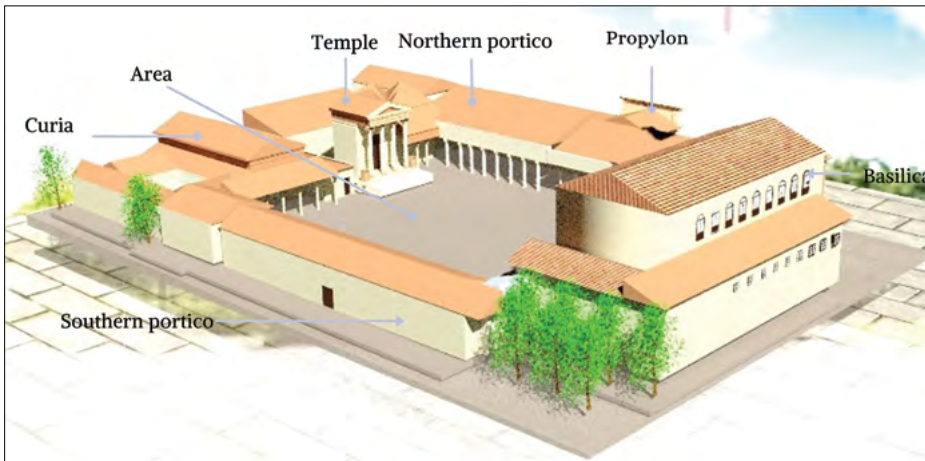


Fig. 6 - View of Timgad's Forum, virtual restitution 3D model (source: authors).

Firstly, the *basilica* is oriented towards the east enjoying good sunshine and lighting. Besides, the *curia* and the temple are exposed to the west benefiting from a maximum sunlight and natural lighting. The least illuminated part in the forum is its main entrance. The south portico is exposed to the south-west. It must be noted here that the *basilica* is oriented towards the east oppositely to the warmer orientation (west, south-west) recommended by Vitruvius.

The forum *area* is an open-air urban square receiving a direct multidirectional sun lighting. The sun movement study is performed by superimposing the solar simulation diagrams of the morning, noon and afternoon. This has been done according to the luminous spatiality (solar spot) in each hour. The outcomes presented in table 2 reveal that the most daylight area during day is that bordering the temple and the *curia* on the other side. The opposite zone receives more light in the afternoon, but for a shorter period. The tribune of the harangues is a plate of debates and controversy between the consuls, the courts and the people. Therefore, it is suggested that it is often used.

Timgad forum platform is, however, very exposed to the sun rays, especially during the morning. Thus it was necessary to employ architectural devices to reduce sun rays impact or to use appropriately this space during the early morning or the afternoon.

Dividing the forum plan into similar units allowed rating them hourly in terms of sun exposure. The results vary obviously for each period of the year: at noon for example, the area is exposed to the sun with a percentage that reaches 90% of its surface in summer, exceeds 80% in autumn and spring, while it is limited to 60% in winter. This great exposure to light suggests that they used solar shading devices during the summer period. In the Roman Forum sails were used to be protected against sun rays (Thédénat 1911) and in Palmyra, in order to adapt to climatic conditions, inhabitants used

glass frames to close the openings in winter and curtains in summer (Legrand, Cassas 1806).

In addition the galleries around the forum area represented intermediate and transitional spaces between the exterior and the interior, playing the role of a climatic regulator. As the highest and most imposing building, the *basilica* offered therefore a large shaded area in the forum, particularly beside the south portico. The part of the area bordering this portico was shaded all year round, except during summer when it was exposed to excessive sunlight and heat. Hence during this hottest season this portico should have served as a comfortable urban space for gatherings and other public activities.

7. CONCLUSION

As an authentic Roman urban space, the forum is a complex place due to its diversified use, the variety of its buildings and its numerous actors. Despite the recommendations related to its organization and spatial composition, it seems that the theoretical original model of this urban space has been adapted to the local severe conditions of the northern and southern Limes environments. The study of the Timgad forum revealed that the contextual adaptation was probably active both at the urban and as well at the architectural scale. Specifically: buildings' orientation, *facade* details as well as movable solar control devices were the means employed to thwart sun rays' effects in function of the season and time of the day. Some space uses' patterns could also constitute another kind of climatic control strategy in such severe climate with cold winters and hot summers. Further research work investigating the forum's uses and the wind's impact on it would provide a more comprehensive view on this topic.

21/03/21019					(6 :37 to18 :45)									
01	02	03	04	05	06	07	08	09	10	11	12	13		
21/06/2019					(5 :20 to 19 :51)									
01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
21/09/2019					(6 :21 to 18 :32)									
01	02	03	04	05	06	07	08	09	10	11	12	13		
21/12/2019					(7 :40 to 17 :23)									
01	02	03	04	05	06	07	08	09	10	11	12	13	14	15

Table 1 - Photographic hourly sequences of solar radiation for the case of Timgad Forum (source: authors).

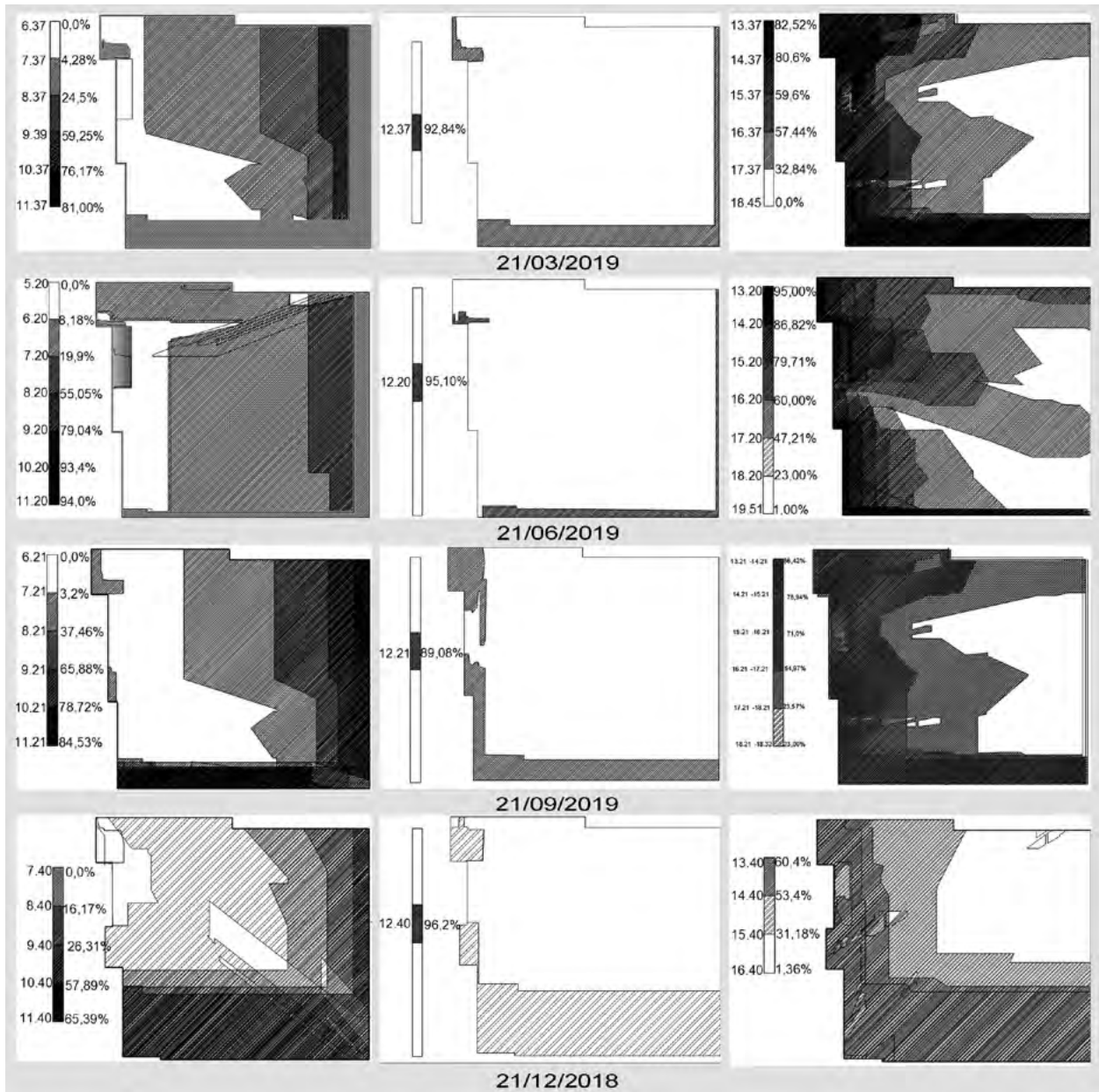


Table 2 - The forum plans showing the movement of sun rays well as the differently lit areas within the forum (source: authors).

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THE ANCIENT ROMAN PUBLIC LIBRARY OF *ROGATIANUS*: AN ARCHITECTURAL STUDY AIMED TO 3D VIRTUAL RESTITUTION

Hana Djouadi¹, Azeddine Belakehal¹ et Paola Zanovello²

¹ LACOMOFA Laboratory, Department of architecture, Faculty of Sciences and Technology, Université de Biskra, Algeria.

² University of Padova, Department of Cultural Heritage: Archaeology and History of Art, Cinema and Music

In these recent years, the interest given to the archaeological heritage has been extended to go beyond the promulgation of laws for the conservation of the existing remains, thus making these latter more known, well presented and visually transmitted to the general public. While not necessarily present at the archeological site itself, public is more immersed and his role is no longer the one of a simple passive visitor of the heritage places. Effectively, people are invited to actively participate in the discovery of presently lost different ambiances (luminous, tactile, visual, acoustic and odorous). The continuous advances in computer sciences and particularly the three-dimensional object modelling allow this new kind of museum route. Nowadays several kinds of built heritage constitute the objects of virtual restitutions.

This investigation follows such aims. It purposes to make people more and deeply informed about an antique Roman North African heritage building: the public library of Rogatianus located in Timgad city (Algeria). A proposal for a three-dimensional restitution of this library is presented. Such virtual restitution will certainly enhance the tourist development of the city of Timgad. Our research is based on an extensive literature review about the Roman libraries. In addition to previous studies focused on Timgad Roman library, in situ visits were undertaken on site. An examination and comparison of both collected data types constitute the basis for the virtual restitution of this Roman antique built heritage.

KEYWORDS: Assessment, restitution 3D, roman public libraries, Thamugadi library.

1. INTRODUCTION

Etymologically, the term library originates from the Latin word “βιβλιοθήκη” designating a place of deposit of books. However, long before Greek Antiquity, real libraries existed in Mesopotamia and Egypt (Masson, Salvane 1961). For the Romans, the word library had three different meanings: i) a collection of books; ii) the building or the wing of the building where this collection was kept; iii) the boxes “*pegmata*” where the volumes were stored (Geraud 1840).

Although greek models inspired the Romans in the construction of their libraries, they developed new ideas for libraries design, particularly for the disposition and manner of storing and organizing books (Aflleck 2012). In this regard, Hendrickson states that «*The form of the “Greek library” is distinguished from the “Roman library,” and these forms are seen as the product of the library’s historical development (from Alexandria’s Lyceum to Rome’s Pergamum)*» (Hendrickson 2014, p.371).

Similarly to Rome, the empire’s provinces had public libraries that were much appreciated by the cultured Romans. Moreover, many provincial libraries featured stately buildings, in some case exceeding in size most of the imperial libraries present in Rome (Staikos

2000). In Roman Africa only two public libraries are known: the library of Carthage in Tunisia and Timgad’s one in Algeria.

The city of Timgad conceals an immense archaeological wealth testifying the Roman civilization settling within the Aures. Several and various public buildings were built in Timgad such as baths, amphitheatres and libraries. In the present research work we consider Timgad’s Rogatianus Roman public library as a case study.

Our main purpose is to allow a large and diversified public to virtually visit the archeological sites using infographics methods. In this context, realizing an architectural representation in 3D of the Roman public library of Timgad and producing the resulting illustrations is the first step in this investigation. The study will then highlight the main ambiances’ related physical environments (luminous, acoustics and thermal). In such a way, this Roman antique built heritage could be virtually lived, thus giving a chance to the public to experiment what was a North African Roman antique public library.

As a first step, a thorough literature review has been carried out. The investigated documents relate to the Roman public libraries in general. However, a focus was given to the works of A. Ballu, R.Cagnat as well as those

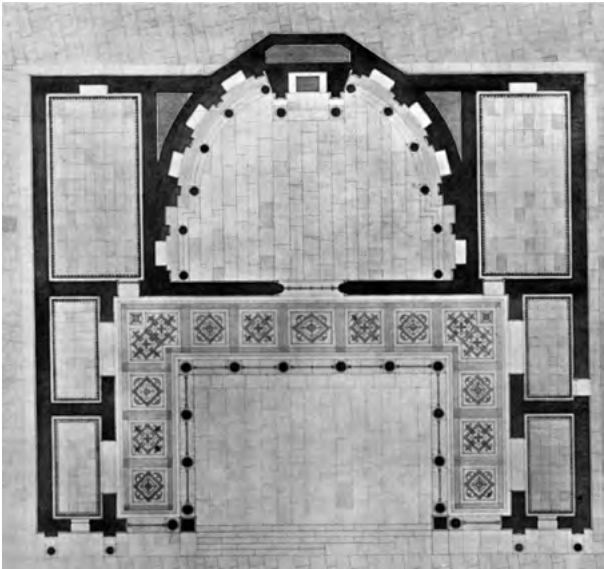


Fig. 1- Plan of the *Rogatianus* library in Timgad. [PFEIFFER 1931].

of Homer F. Pfeiffer. The following step was an *in situ* fieldwork consisting of a meticulous observation of the antique library ruins' spatial layout and constructional details. Finally, a comparative synthesis of the literature review and the fieldwork allowed for the virtual restitution of Timgad's Rogatianus Roman public library.

2. RECONSTRUCTION OF THE ROGATIANUS LIBRARY: STATE OF THE ART KNOWLEDGE

After many years of excavations, bibliographic research and studies of inscriptions found *in situ*, A. Ballu drew in 1903 the first plan of Timgad's library. At that time he did not yet know the precise function of what he named the "semicircular building". Nearly three decades later, Pfeiffer updated the plan of the library that was published in 1931 within the article entitled "The Roman Library at Timgad" (as plate 16-19). This contribution includes more details and consists of several data corrections coming from the previous studies of A. Ballu (1903) and R. Cagnat (1909) (fig. 1). More recently in 2013, the plan of Timgad library drawn by H. F. Pfeiffer (1931), served as a basis for a three-dimensional restitution. This latter has been carried out by M. Nickolls (2013), author of the research work entitled "Roman libraries as public buildings in the cities of the Empire" (fig. 2).

In 2014, M. Mamoli defended a doctoral thesis about ancient libraries entitled "Towards a theory of reconstructing ancient libraries". In this research she reviews the libraries floor plans and conducts a historical analysis. The study suggests employing a shape grammar in order to define the morphological specification of ancient Greek and Roman libraries. Timgad's Roga-



Fig. 2- Reconstruction of the Timgad Library by M. Nickolls. [NICKOLLS 2013].

Figs. 3.a and 3.b: derivations of the Rogatianus Library: a) derivation of the actual design with steps in the entrance; b) hypothetical derivation with door openings in the walls. [MAMOLI 2014].

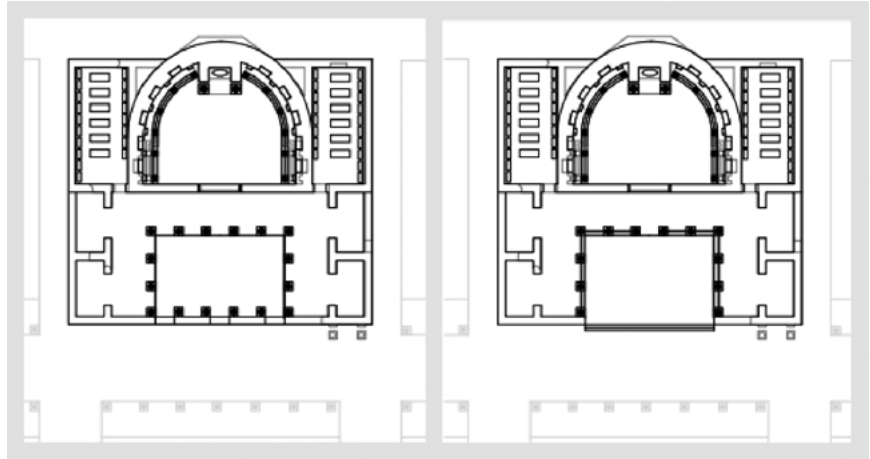
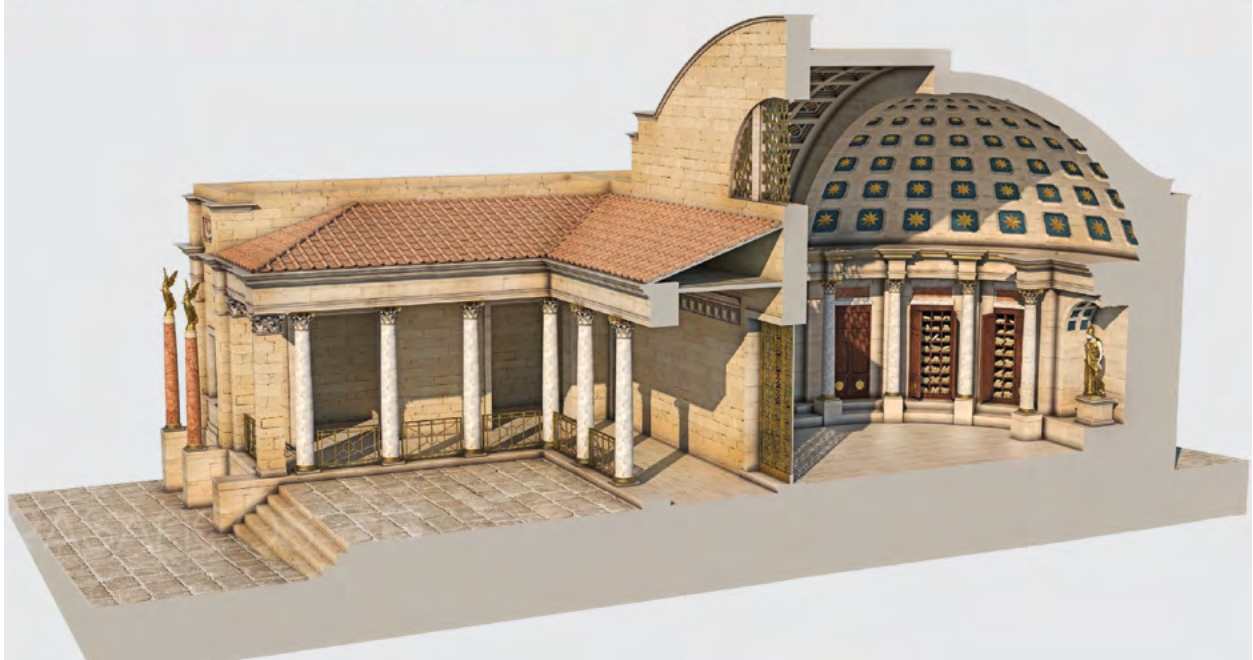


Fig. 4.a - Restitution of the Timgad library in collaboration with Dingo Blanco. [ARMESTO *et alii* 2020]

Fig. 4.b - Section of the Timgad library in collaboration with Dingo Blanco.



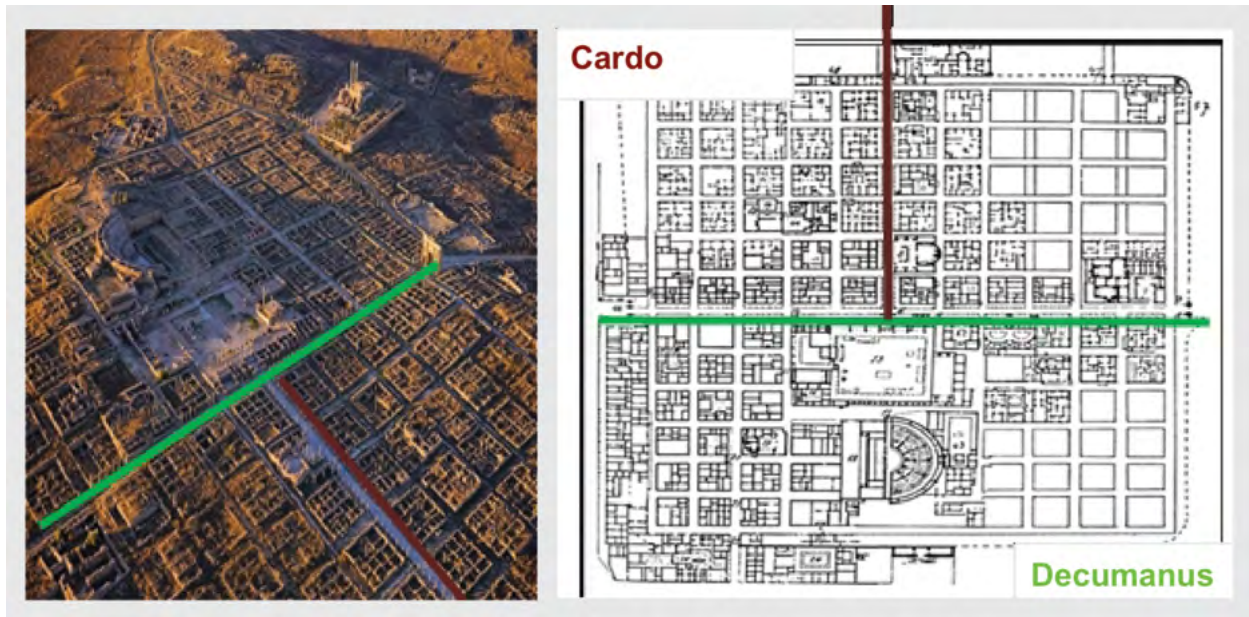


Fig. 5 - *Cardo* and *decumanus* of Timgad [GUERBABI, BAHOUL 2016].

tianus library is one of the libraries considered in this thesis, about which the author writes: “*The grammar is able to generate the plan of the apsidal main hall, the niches, the interrupted podium with steps, the focal point as an aedicula, and the general layout of the library with the U-shaped stoa, the courtyard, and the additional rooms*” (Mamoli 2013, p. 369). The author also drew a plan for this library, based on the outcomes of her research (figs 3a-b).

Very recently the team “Trasancos 3D” has undertaken a big project aimed at the restitution of the entire town of Timgad (Armesto *et alii* 2020). This project employed specialists and professional experts in the historical reconstruction of archaeological sites, incorporating also various kinds of information. The team creating these renderings consists of a collaboration between Anxo Miján, Andrés Armesto, Carlos Paz, Diego Blanco and Alejandro Soriano. Using the new technologies, these three-dimensional reconstructions allow the visitor to immerse himself in the city as it could have existed during Roman times (figs 4a-b).

3. ROMAN PUBLIC LIBRARY ROGATIANUS OF THAMUGADI: HISTORY AND ARCHITECTURAL DESCRIPTION

3.1 Location

The Rogatianus library is located on the northern *cardo*, about fifty meters from the crossing with the *decumanus maximus* (Boeswillwald, Cagnat 1892) (fig. 5). The building is therefore located in the central district of the city, close to other major public monuments such

as the forum and the theater (Nicholls 2013). According to *in situ* observation, this building certainly occupied the space of a previous *insula* or private house as asserted by Ballu (1901 p. 08): “*All we can say is that this monument, built in fine materials (marble and limestone columns, marble veneers, very neat paving), has certainly taken the place of an insula or private house. Isolated by four streets and occupying 20 m square, not including the portico, like the other buildings along the northern Cardo Maximus.*”.

3.2 Brief historical overview of the Rogatianus library

The library was founded and financed by M. Julius Quintianus Flavius Rogatianus, a wealthy citizen from Timgad. He probably lived in the third century and died before the library was even completed (Houston, 2014). The lack of additional information about this donor makes difficult to define the exact construction date of this library. Cagnat estimates, on paleographic bases, a construction date at the end of the third century. Gsell instead placed it in the fourth century because of its “dry and thin” capitals, a detail that according to him “indicates the Lower Empire” (Boeswillwald, Cagnat, 1892, p.301). In these years the identification of the library has been the subject of various controversies among researchers. Later in 1906, three inscription fragments of the building of Timgad allowed to identify it definitively as a municipal library (fig. 6).



Figure. 6 - Inscription dating from the 4th century [photo by authors].

3.3 Architectural and spatial characteristics

Rogatianus library possesses the architectural and spatial components of all typical Roman libraries: the main hall, reading room, podium, colonnade, apertures, roof, floor, stairs, and walls. The library of Rogatianus occupied an entire 24.69m x 23.47m *insula*. It consists of a large semicircular room, flanked by two secondary rectangular rooms, and preceded by a colonnaded portico surrounding three sides of an open court facing the *cardo* (Pfeiffer 1931).

3.3.1 Access and courtyard

The building is accessible through five steps leading to an open-to-sky courtyard 12 m wide (Houston 2014). Today, only few steps of the entrance subsist. The courtyard is paved with white limestone slabs (Pfeiffer 1931).

3.3.2 Portico

The portico surrounds the open sky courtyard on three sides, with six corinthian columns in white limestone along the width and three similar columns on each side along the depth.

In Roman architecture, the floor's mosaic is an omnipresent element of all high-profile buildings. In the courtyard east portico, a great mosaic surely existed (fig. 7), but except for some traces on the edges, this mosaic has completely disappeared. In his study about the mosaics of Timgad, Germain (1969, p.24) points out that until nowadays no architectural study has mentioned this mosaic (Germain 1969, p.24):

«It is curious to note that no importance has ever been given to the presence of this mosaic under the floor of one of the porticoes of the library; it is true that we have no architectural study of this monument, to which we cannot attribute a precise date. It re-



Fig. 7- Mosaics in the Timgad Library [GERMAIN 1969].

placed an earlier building, of which this mosaic of sober motif and careful execution remains an interesting witness, which can date back to the 2nd century; it is one of the oldest in Timgad».

3.3.3 Semicircular main room

The main room is approximately 15 m wide and 10 m deep according to Cagnat (1909), but only 12 m wide and 10 m deep according to Houston (2014). It served the functions of reading, checking and archiving the books (Pfeiffer 1931). This space is paved with blue limestone slabs (Cagnat 1909) and its large semicircular hall is preceded by two short side walls, offset about eighteen inches (0,46 m) on each side from the semicircle (Pfeiffer, 1931). The walls are built largely in brick but covered in white or green marble decorated with moldings and bas-reliefs (Langie 1908). The decorative elements such as columns, steps and entablature are built in freestone.

3.3.4 Podium

Except the central niche location, the main hall is surrounded by a series of *podia* 50 cm wide and 60 cm

deep. Two steps with a depth of 30 cm and a height of 20 cm precede each podium. The steps are interrupted in front of the walls between the niches by plinths 55 cm high, surmounted by columns.

3.3.5 Niches

Inside and facing the entrance door, is located the famous niche where is exposed the statue of Minerva the goddess of wisdom and studies. This large niche is 1,80 m wide and 1 m deep and is flanked by pilasters with two corinthian columns, 5 m high (Cagnat, 1909). It is framed by two projecting columns of white marble with spiral grooves of 0,6 m (Boeswillwald, Cagnat 1892). Eight smaller niches are hollowed out around the main hall, four on the left and four on the right. These rectangular niches were 1,25 m wide and 0,5 m deep and are located 0,75 m above the level of the *podia*. Each niche is flanked by pilasters from which rise stone columns. The niches are intended to host manuscripts' wooden cabinets (Langie 1908). This was also the function of the 40 centimeters deep niche located in the southern side room.

3.3.6 Secondary rooms

The building contains six secondary rooms. Four rectangular reading rooms are located on the northern and southern sides of the portico. They are 2,5 m deep and 5,5 m wide (Houston 2014). On both sides of the semi-circular room, two other large rooms are intended to store manuscripts.

3.3.7 Columns

The building comprises numerous columns both outside and inside the semi-circular hall. Two columns are part of the main façade. In the entrance courtyard and the semi-circular hall, the number of columns amounts to twelve. These latter are corinthian ones with a diameter of 0,45 m and 3,5 m high. The columns rest on cubic blocks of white limestone, 0,55 m high and 0,6 m deep (Boeswillwald, Cagnat 1892), with the two columns surrounding the central niche taller than the others.

3.3.8 Roof

We have no information or evidence about the roof (as stated by Mamoli 2014). The apsidal area is restored with a semi-dome, and the area around the short side-walls with a flat roof (Langie 1908). This restoration recalls the Ulpia library of Trajan, and in this case the

main room would have been illuminated by a central opening placed in the roof.

3.3.9 *Armaria* wooden cabinets

The books and/or manuscripts were kept in sixteen wooden cases (*armaria*) arranged in rectangles around the walls of the main room. There is no evidence about the texture and color of these book cases.

3.3.10 Stairs

Cagnat asserts that there must have been an upper floor in Timgad's library, although all traces have disappeared. We found no material evidence to support this opinion because there is no trace of a staircase and not sufficient space to allow for one (Pfeiffer 1931).

3.3.11 Daylighting devices

Daylighting design is crucial for reading spaces like libraries even nowadays. In the layout of the libraries of the Forum of Trajan and Palatine in Rome, Celsus in Ephesus as well as Rogatianus in Timgad, it's evident the choice of using particularly wide doors to ensure, among other functions, adequate lighting for the readers (Nicholls 2013).

In Timgad's library, under the portico and facing the main street is located a large door giving access to the semi-circular main room. According to Cagnat this entrance, decorated with engaged columns, was 3,8 m in height (Cagnat 1909). Pfeiffer (1931) underlines the use of a bronze grille instead of a wooden door for this room entrance, a device that would allow the air circulation necessary for the books. This solution could be easily done without the risk of rain soaking inside, thanks to the shelter protection provided by the portico. The four rectangular rooms were directly accessible through large openings, which confirms the absence of doors. For Houston (2014) the related issue is whether there were really windows in these rooms. The two large rooms adjacent to the semicircular room have very narrow doors. According to Mamoli (2014), this suggests that they were used to store books, unless there were some other means of illumination. Furthermore the same author argues that there is no material or immaterial evidence of windows existence in the building. Such lack of information encourages undertaking additional research about the daylighting strategies in this library since they played an important role as a design factor, but also because this Roman antique building was located in a region with a luminous cli-



Fig. 8 - Restitution of the Roman library of Timgad [Author 2019].

mate, characterized by a significant period of the year with a clear and sunny sky.

3.4 Rogatianus library towards a virtual restitution

This step aims to exceed the current graphical knowledge relating to Timgad Rogatianus library, which is limited to some sketches and plans available in Roman architecture related documents, particularly those of Pfeiffer (1931) Nickolls (2013) and Mamoli (2014). The current outcome consists of a virtual model of the library of Timgad, built using Archicad 16. This work

has been done taking into account the textures of all used materials in the building by means of a cladding operation using the 3DS software (fig. 8) Such a virtual model construction is based on the synthesis of the previous research steps: literature review and *in situ* collected data.

4. CONCLUSION

In North Africa, the Timgad Rogatianus Library is one of the most studied and best preserved public libraries. These studies mainly date from the colonial

period. The current research work attempts to update the state of knowledge about this building by using new technologies and as well by extending the research path within the environmental related issues of the present time. This will be done, respectively, firstly by means of a virtual restitution of the building and secondly by the study of the various ambiances that were present inside the library.

Because of the lack of information about several architectural details, the resulting virtual model needs to be more enriched basing on other libraries located in the Roman provinces with geographical contexts similar to Algeria. Examples of libraries from the Roman provinces of present day Tunisia and Morocco could serve this objective.

Once achieved, this virtual model will eventually be the subject of an experimental research work evaluating the experience of ambiances in ancient Roman buildings, in order to serve as a mean for the cultural and economic development of the heritage archeological sites.

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THE ROMAN BASINS OF GAFSA OASIS: PAST AND CURRENT AMBIENCES

Dorsaf Zid¹, Hind Karoui², Azeddine Belakehal³

¹ ERA-EDSIA, Université de Carthage, Tunisia.

² Université de Carthage, Tunisia.

³ LACOMOFA Laboratory, Department of architecture, Faculty of Sciences and Technology, Université de Biskra, Algeria.

In this study, we are interested in the old urban core of the oasis of Gafsa located in the southwestern territory of Tunisia called “Guebli-Gafsa”¹. This médinal district is built on the remains of the ancient roman-numid city “Capsa”. Built around a square, the district encloses a water system built during the 2nd century for the collection and veneration of the main water resurgence of the ancient city. These two pools, called nowadays “the roman basins”, were classified as Tunisian national heritage since 1915.

In this research, we attempt to explore, identify and then assess the importance of the presence of water in these basins, on the degree of appreciation of their ambiances perceived and experienced by the occupants of the place, both in the past and the present time. We put forward the hypothesis that the water element is a generator of particular urban atmospheres, capable of contributing considerably to the heritage enhancement and requalification of the oasis medina of Gafsa. To this end, we have adopted a tripartite approach including the historical, social and urban aspects. The related research methods encompass: i) a historical-urban reading of the urban center of the medina of Gafsa aiming to understand the structuring role of roman basins; ii) an experiential study of practices and uses by means of in situ surveys and observations as well as interviews with current district residents; iii) a content analysis of ancient texts and iconographic sources evoking memories sensitive to the place.

The outcomes of this investigation reveal that, even nowadays, the presence of water within these roman basins is a crucial factor that makes the surrounding district an authentic lively and social urban space, it is an element capable of stimulating a strong sense of belonging in the inhabitants. Thus our question is whether such an ancestral link to water would allow us to use this environmental factor as a main parameter in a strategic vision for the future and sustainability of this place. Moreover we enquire whether this same link could evoke and define the challenges of the ambient heritage’s development for the case of North African oases’ urban spaces.

KEYWORDS: historic oasis centers, water system, roman heritage, sensitive experience, ambiances valorization

INTRODUCTION

Saharan and pre-Saharan Tunisia regions constitute a vast territory equivalent to more than half of the country. The oases are high density populated living areas and represent the specific type of human settlements in these territories. Within these latter, life is mainly conditioned by the hydro-geological conditions and imperatively requires the best use of rare and precious water. The importance of catchment and exploitation works of the underground waters of this area is attested by the various writings of the medieval period on water systems and arrangements as well as by the local archaeological sites, several of which are dating back to the numid or roman times (Mamou, Kassah 2002). At the present time, and even constituting an important part of the local heritage, these oasis towns

and societies look somewhat marginalized, forgotten, fragile and vulnerable, facing the urban sprawl and modernization challenges.

Our contribution ties in with questions relating to the enhancement, identity development and requalification of historic oasis centers. It adopts a sensitive approach of the urban environments characterized by the water’s presence in outdoor spaces. In fact, both a source of architecture² and an object of culture³, the presence of water in the city is also a significant catalyst of perceptions and practices contributing to the survival of the relative urban centers.

¹ “Guebli” (South) is a locally used Arabic word referring to the direction of the Qibla (Mekka).

² A term used during the exhibition entitled “Water, source of architecture” organized in Paris in 2006 by the French Institute of Architecture and the EDF foundation (Rambert 2006).

³ This question concerns the heritage dimension of water and relates to the work carried out within the framework of ICO-MOS 2011 on the “cultural heritage of water” (see https://www.icomos.org/18thapril/2011/index_fr.html).

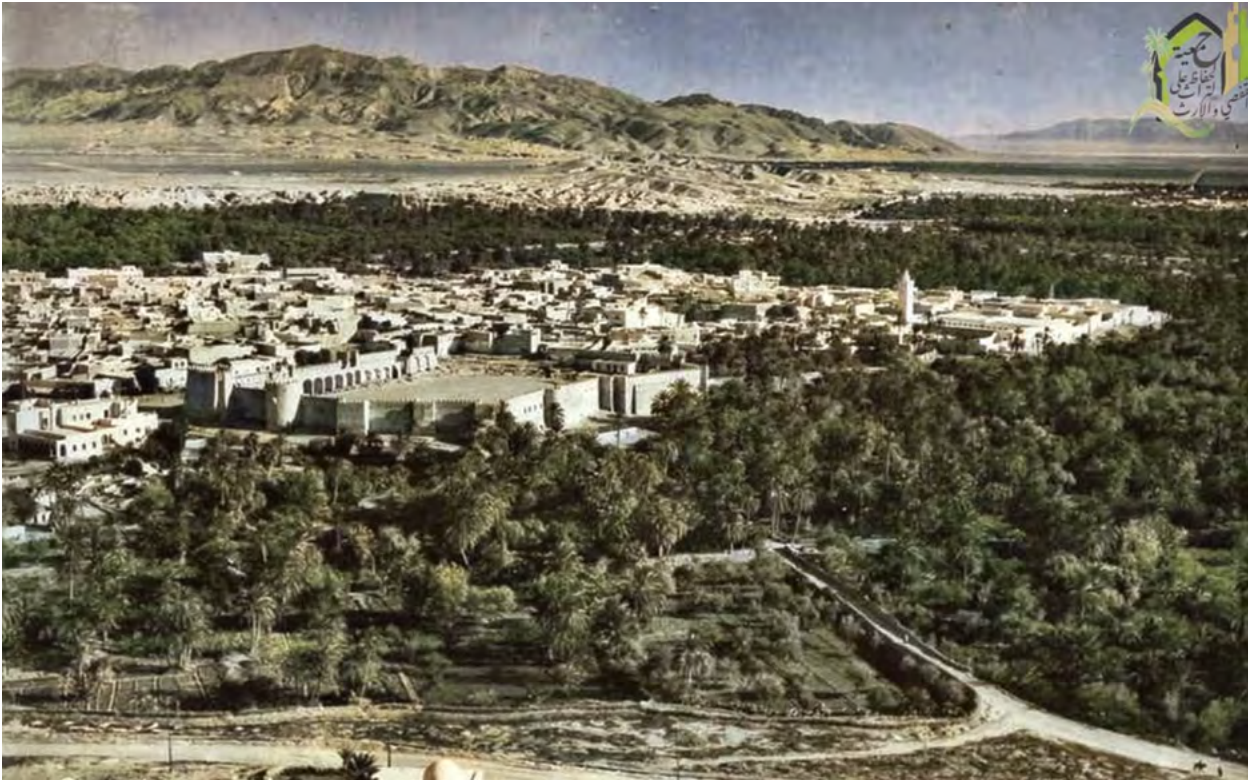


Fig 1 – General view of the old town of Gafsa at the beginning of the 20th century. [archive of the local association of heritage preservation of Gafsa].

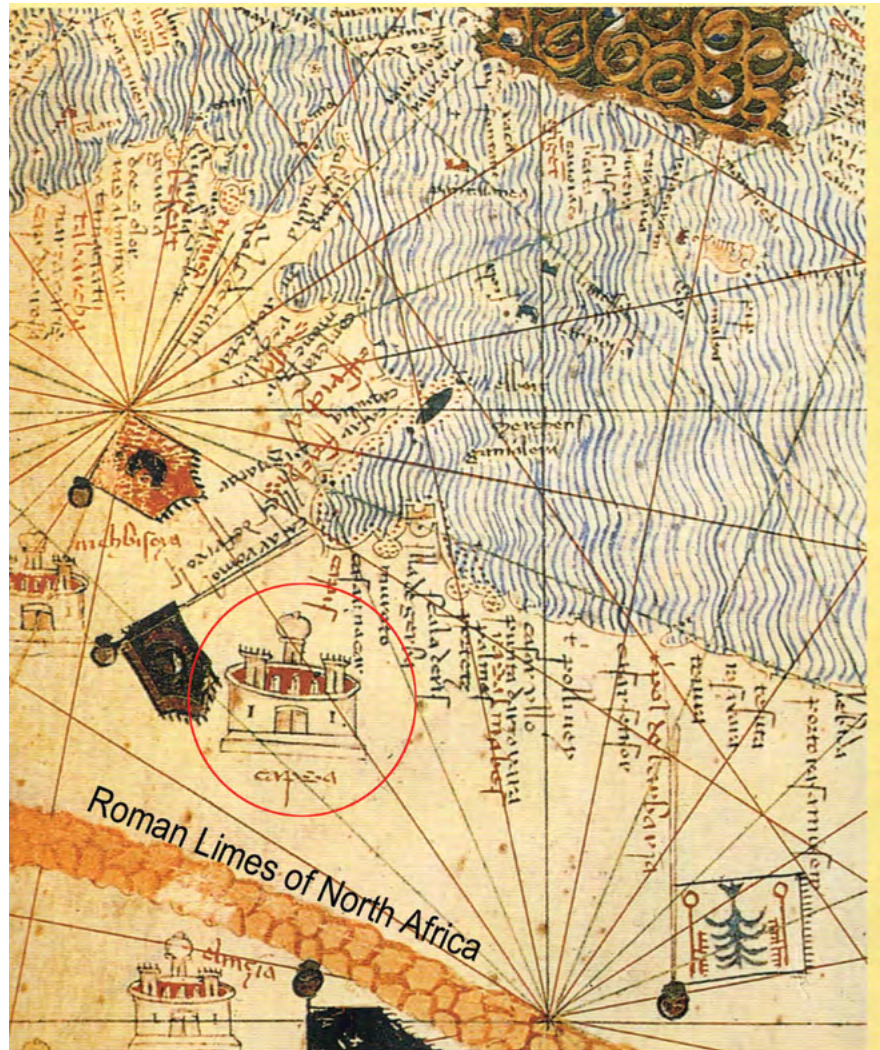
Our case study is the old “Guebli-Gafsa” district built around the roman basins and linked to one of the main public places of the old town of Gafsa. This latter is located in the south-west of Tunisia. The roman water system was built during the 2nd century for the collection and veneration of the main water resurgence of the ancient city of Capsa, ancestor of the current city of Gafsa (Trousset 2012). It should be noted that the natural water sources formerly supplying the basins have dried up definitively at the beginning of the 21st century. Nowadays, the basins’ filling up is done mainly during the hot season, from April to October. For this purpose, water deeply extracted is exclusively used⁴. This study firstly investigates the influence of the water’s presence in the basins and how it affects the manners of occupying and living the place. Secondly, it aims to understand to what extent this water’s generated environmental potential has affected the living practices and

⁴ This action is a part of the historic oasis Gafsa preservation and renovation project. Indeed: “with the extension of the oasis perimeter and the drying up of many of these sources, the water potential needs to be reinforced by extracted water from several deep boreholes carried out as a part of the oasis conservation plan” (Khanoussi, Ayachi 2014, p.82). This project’ studies were carried out in 1985 with the works starting in 1987 and ending in 1991 (Ben Amor 2010).

sensory experiences of the inhabitants. Did the experienced ambiances progress over time? Could we compare the users’ present conducts with the past ones?

Our methodological process will take into account three components. First of all, we will examine the urban history of the medina of Gafsa. This will allow better understanding the interconnections established over time, between the city oldest core and the water infrastructure of roman times. Then we will study the interrelationships between the conformational, configurational and environmental specificities surrounding the basins on one hand and the practices and current users’ sensitive experiences on the other. Finally, we will try to reconstitute the past times users’ experiences in order to identify their role in the development of what could be qualified as the “sensitive and spiritual dimensions of identity”. This latter is suggested as mainly linked to the roman basins existence in the old town of Gafsa. To come up to our research work purpose, we will cross the various acquired results through a comparative reading between both past and present time situation of the roman basins place. This confrontation will reveal the “permanencies” of the place in terms of the inhabitants’ cultural and social representations. In fact, this set of perceptual conducts could ensure the survival of this oasis heritage in southern Tunisia.

Fig. 2 - Map from *Atlas Català* of 1375, showing the city of “Capsa” on the edge of the Roman Limes of North Africa. [from Binouss et alii 2004, p. 33 - annotated by author]



A RETROSPECTIVE READING OF THE MEDINA OF GAFSA: THE STRUCTURING ROLE OF THE ROMAN BASINS

The old town of Gafsa is built in the transition zone between the high steppes and the desert of Tunisia. This is the plains region located down below the south versant of the Atlas mountain ridges and extending to the east of the Aurès massif (Bodereau 1907). The area overlooks the northernmost palm groves in the region of North Africa, which date back to prehistory (Ben Amor 2010). This “mountainous oasis” (Kassah 1996) is precisely located on the “Oued Bayech” left bank. This latter is a temporary watercourse typical of this sub-Saharan region of southern Tunisia and it cuts through the site (fig. 1). The area is crossed from south-east to north-west by the geological Gafsa fault (Castany, Gobert 1954) resulting in numerous natural sources. The latter are one of the primary conditions for the existence and survival of the oasis, medina of Gafsa established around them and upon previous city ruins (Khanoussi 2010).

Indeed the first testimony drawn from literary sources mentioning Capsa, the ancient city, is from Sallust⁵ who recounts that “a fountain of living water” existed around 109 BC in the numidian⁶ city intramural space. These facilities were probably embellished by the Romans at the end of the 2nd century CE (Bodereau 1907). In order to raise the oasis to the rank of a “water sanctuary” (*Sacrum Aquarium*), this place was built for collecting and revering the main water resurgence of the ancient city (Pellisier 1853). At that time, the “romanized” numid Capsa became an important crossroads and a regional tax collection hub in the southwestern region of Tunisia (fig. 2), thus on the edge of the roman *limes* in North Africa (Khanoussi 1995). The

⁵ Sallust (86-35 BCE) accompanied Julius Caesar during his african campaign; in his *Bellum Jugurthinum* he wrote about a previous war which occurred in North Africa 110-104 BCE, between the Romans and the Numidian king Jugurtha.

⁶ The Numidian kingdom (or Numidia) is the ancient North African Berber kingdom (202-40 BCE) founded by Massinissa after the second Punic War.



Fig. 3 - The two urban structures of the medina of Gafsa. [Author]

prosperity and greatness of the roman city of Capsa is testified by many mosaics and fragments of inscriptions discovered in the basements of the medina of Gafsa during various excavation works. Today, this water complex is located in the heart of the old “Guebli-Gafsa” district and constitutes one of the main places of the medina of Gafsa. It consists of two open-air water basins, built with cut stone blocks and whose foundations have remained unchanged.

The plan of the old town of Gafsa allows to easily distinguish two units, clearly differentiated by their urban structures (fig. 3). Indeed, the médinal urban fabric is divided into two large groups which in turn are subdivided into quarters. We can distinguish that Guebli-Gafsa (Southern Gafsa) and Joufi-Gafsa (Northern Gafsa) districts are clearly separated by the street named Kilani Métoui, formerly called “Rue Général Philibert”. According to historians, Guebli-Gafsa encompassed the entire Arab-Muslim city until the early 18th century. This old district is considered to be the starting point of the first urban core of the current

city of Gafsa (Binous *et alii* 2004). It could be described as an urban structure with a radial arrangement. The centre of this latter overlies the location of the roman basins. The urban radial layout of this historic district is also revealed by the orientation of the streets and alleys converging towards the place of the roman basins. This centrality around water confirms the hypothesis of the authenticity of this urban core established on the remains of the ancient Capsa. In this sense, the historian Mustapha Tlili explains that the existence of this historic water structure conditioned the organization of the old médinal urban fabric as it is attested by the radioconcentric scheme (Tlili 2009). Additionally, this scheme will later constitute an urban constraint dictating the sites selection for the emblematic monuments of the medieval civilizations. According to Tlili the peripheral location of the Great Mosque or the Byzantine fortification, ancestor of the Kasbah of Gafsa, confirms this hypothesis. The medina later extended northward, outside the walls, in order to house the Jewish quarter or Hara, similarly to what happened to the medina of Tunis.

EXPERIENTIAL STUDY OF CURRENT USES AND PRACTICES NEAR THE ROMAN BASINS

Nowadays, the roman basins’ place presents an irregular shape resulting from the arrangement and the spatial configuration of the surrounding buildings. It consists of a set of platforms of various levels that are connected by several steps. This main public space in Gafsa historic center has a total area of about 1900 m² and the two roman basins cover a total area of 500 m². The western basin is larger than the eastern one and both are respectively of 7m and 5m deep (fig. 4). They are linked together by means of an arched underground passage. The water flows by gravity from



Fig.4 – Aerial photo showing the current aspect of the square of the Roman basins. [ABDELKEFI 2009]

the smallest basin to the largest one through underground ablution rooms. This water flows finally into the oasis located below the medina, thus allowing for a large irrigation of the palm grove. It should be noted that the whole is well preserved, as described by geographers and arab historians of the medieval period (El Bakri 1858; Abed Al-Hamid 1985) or even european travelers at the end of the 19th century (Pellisier 1853; Labouche 1932; Poinssot, Saumagne 1933).

During *in situ* investigations we observed the users pathways towards the roman basins' place and took note of their behavior as precisely and objectively as possible. This work has been undertaken at various times during the day and every day of the week. The investigations were spread over two years (from 2016 to 2018) but in the table below we will refer to the week of immersion in our land which took place from April 10 to April 16, 2016 (table 1).

In addition, all aspects related to the occupants' daily life within the place have been examined. The photographic and videographic sequences, at various times of the day and observation points of the place, allowed the study of the variation of the users' behaviors as well as the urban ambiances successively generated.

The investigation results revealed that the factors of surface area and centrality had favored and influenced the attendance in terms of occupants' type and number. These users are mainly local inhabitants averagely estimated as 60 visitors per hour and constituting 80% of the total number of the place's occupants. Early in the morning and at the afternoon end, most of them are bathers and a minor number sit on the coffee shop's terrace. The place is more and more attended starting from sunset time. Thus, both factors would generate a high attendance and a fairly long stay in the studied public space (Le Corre 2006). Besides, we noted that the population spending a significant time in this space comes mainly from the neighboring residential area. As a "convergence center" and an urban "patio" embedded in the heart of the medina of

Date	Days	Time slots
April 10	Sunday	10 at 6:00 p.m.
April 11	Monday	between 12:00 p.m. and 2:00 p.m.
April 12	Tuesday	between 2:00 p.m. and 6:00 p.m.
April 13	Wednesday	between 10:00 a.m. and 2:00 p.m.
April 14	Thursday	between 12:00 p.m. and 4:00 p.m.
April 15	Friday	between 11:00 a.m. and 3:00 p.m.
April 16	Saturday	between 3:00 p.m. and 7:00 p.m.

Table 1 - Organization of the *in situ* immersion (week from April 10 to April 16, 2016)



Fig. 5 - In the morning on the café terrace. [Author 19 August 2018]

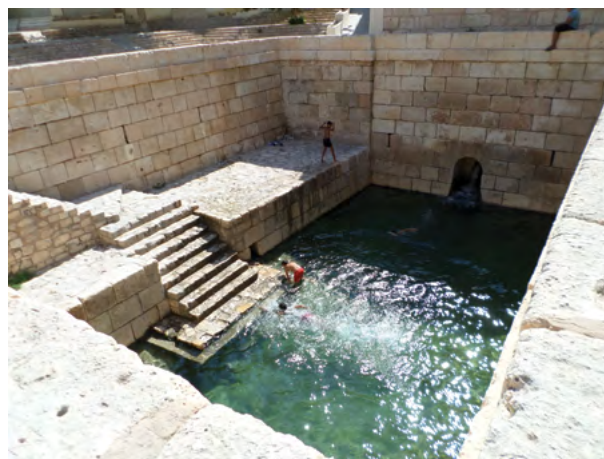


Fig. 6 - Bathers in the eastern basin [Author, 19 August 2018]

Gafsa, the place provides entertainment and pleasure spaces that are animated by a mixture of cultural and touristic activities (café, museum, presence of historic homes and places of worship to visit, etc.). Such diversity has allowed visitors and inhabitants to enjoy simultaneously a space of leisure and movement (passage, walk, movement, strolling, discovery ...) and a place to stay (take a break, stop, rest ...) (fig. 5).

Our *in situ* observations have also shown that when filled with water, the roman basins themselves can be considered as a place in its own right. This is due to its spatial configuration and especially its function as a public "swimming pool". Indeed their dimensions, depth and arrangements (stairs, platforms, etc.) allow for diversified behaviors and various kinds of distinctive and specific uses. These latter are mainly and deeply associated with a spatial experience related to the presence of the water, namely bathing (fig. 6). The roman basins users' practices reflect their sensitive relationship with this place.

We were then able to conduct a spatial-temporal reading of the users' current practices within the roman basins place. Effectively, each day is punctuated by "temporal sequences" during which certain "collective actions" can be precisely located in time and space. These social demonstrations follow one another during an ordinary day⁷ within a hot season. Below, we relate, as example, what has been observed on May 12, 2018.

At nearly 8 am, few groups of elderly people begin frequent the area of roman basins. They gradually settle within the shaded area of the café terrace. As the day progresses, other shaded areas around the café and on the square become more and more lively. That is the case of the shadowed areas by the trees or even beside the edge of the basins. From 11 a.m., the square begins to receive several users of varied ages but especially young people and children. The end of the morning marks the time of day when the attendance rate increases considerably. As the temperature rises and the shadows decrease, between noon and 4 p.m., the place gradually begins to empty. Here and there appear some small groups of people, conversing while protecting themselves against heat effects. When the pools are full of water, the bathers make the place lively. From 6 p.m. until sunset, the temperature drops and the square is frequented again. The fairly hectic "nightlife" is characterized by people sitting on the lit café terrace and bathers having fun in the basin's waters.

The *in situ* observations were compared with users' opinions collected by means of a questionnaire survey. This allowed us to identify the users' perceptual and behavioral conducts associated to the place ambience, particularly as a heritage value space (Belakehal 2012). Such conducts are, in fact, strongly conditioned by the place kind and conformation, the water' presence or absence in the roman basins, but also by the various elements arising from the physical and social context. In addition, the survey reveals that users' own perception of this place is deeply affected by the water's acoustic ambient character, expressed by the flow, the lapping and the sounds of bathers' dives, as well as the related visual effects (shimmer, reflection, sparkle).

We can conclude that the roman basins, as well as the square enclosing them, still represent nowadays a tangible historical permanence and a "palimpsest place" (Said 2014). The square is always lively and vivacious providing the inhabitants as well the visitors a leisure

⁷ We consider an ordinary day a day when water is present in the roman basins and the day is not characterized by the particular events that generate specific types of uses. We are thus excluding the holy month of Ramadan but also periods of cultural events and as well as the festive events occasionally organized in this area.

and pleasure space, particularly when the basins are filled with water.

THE PAST EXPERIENCES AROUND THE ROMAN BASINS

The characterization of the experiences lived in the past was undertaken by means of a content analysis of: i) a *corpus* of travel accounts⁸ and iconographic sources⁹ of dating from the 19th to the early 20th century; ii) the users' answers to the open questions collected by means of the aforementioned survey¹⁰.

This analysis¹¹ informs about several significant indications related to the ambience around the roman basins, specifically as these latter were perceived or expressed (literally and iconographically) by the travelers and the European explorers. These visitors assert that the roman basins constitute the main urban space of the oasis town of Gafsa. Three elements are highlighted from their descriptions: i) the water structure as a roman archaeological feature (origin, history and architectural layout); ii) the water specificities (type, quality, quantity, nature); and finally iii) the water related uses and practices.

First of all, the roman basin's waters were an attractive and eye-catching element, particularly under the hot and semi-arid climate of Gafsa region. Moreover, several testimonies underlined its relationship to the oasis located at the desert gateway. As an example, Labouche (1932, p. 48) said "at the exit (from the basins), it (the water) spreads in the gardens of the oasis watering them in all directions and will be lost in the sands". As well, Guérin describes (1892, p. 277) the dynamic character of the water which "flows" from one basin to another and in which "a crowd of small fish are playing", alike Lallemand (1892, p.158) telling that one can "see at the bottom" basins where "the sand, always moving, reveals the arrival of numerous vaucluse sources". Both descriptions confirm the water visual potential, in a context where hydraulic resources are so scarce. The most distinctive visual effects of the waters from the roman basins are qualitative: transparency, clarity, depth, sparkle and shimmer. These ef-

⁸ We will cite, for example: Tissot (1884), Guérin (1862), Lallemand (1892) and Labouche (1932).

⁹ These data are mainly the outcomes of the work of Eugène Sadoux in 1892, Reclus Onésime' in 1900 and those of other anonymous authors.

¹⁰ These questions mainly concerned the knowledge of the history of this place, the memories of the past and the water related sensitive memory. As an example, we will cite the following question: "What image (souvenir/memory) does this place evoke in you?"

¹¹ The thematic content analysis has been selected as an objective method for studying the various sources gathered. The applied method has been focused on the nature related particular themes (AKTOUF 1987).



Fig. 7 - Old postcard from the western basin depicting a scene of life in 1904 [www.delcampe.net]



Fig. 8 - Photography of the acrobatic jumps of the young bathers taken in 1948 [www.delcampe.net]

fects constitute the roman basins' ambient characteristics notoriously perceived or even felt by the authors. In terms of performed practices carried out in the past, an important role is played by the users-water direct (tactile) contact. The practices and behaviours mentioned by travelers could be categorized as follows: i) bathing in the pools spring waters (hot thermal water) (fig. 7); ii) catching fish typical of saharan sources at the bottom of the pools; iii) playful activities of young Gafsians mainly consisting of dives and jumps into the water from the top of buildings and neighboring palm trees (fig. 8); and finally iv) the spectacle provided by young people playing in the pools the consequent water jets.

The joint analysis of these results with those derived from the inhabitants' souvenirs and investigated sensitive memories allowed us to state a first interpretation on the water related ambiances memorization. Indeed we can assert that the 19th-early 20th century travelers and the current users of this area both underline elements and environmental characteristics of the past linked mainly to the presence or water.

In addition, much more than a tangible heritage, Gafsa roman basins represent a component of the place identity, providing a level of sharing and intersubjectivity that brings together users of different profiles. Also, a sacredness aspect linked to this place has been extracted from the memories of past's users. This sacral aura is closely linked to the natural sources that formerly supplied the roman basins. The collective memory convey-

ing stories and beliefs around these ancient water basins recalls the existence of ritual practices that brought together the inhabitants of the old town of Gafsa.

We thus find a strong similarity to the old travel accounts and iconographic sources content both previously mentioned. This reveals the survival of practices and sensory experiences around the roman basins of the oasis medina of Gafsa: space becomes a place which is a territory of encounter, familiarity, collective memory and identity.

CONCLUSION

This research work concerns the Oasis medina of Gafsa and its roman basins. These latter are considered as a water device generating particular ambiances able to contribute to the heritage enhancement and requalification of this historic oasis center. In particular, this study investigates the sustainability of environments that are facing changes affecting the place: water scarcity, transformations of the surrounding built environment and even evolution of lifestyle. Thus, the ambient heritage has been at the core of our questions inquiring about the present and the future of this oasis medina. To this purpose we investigated the users' experience of past and present times around the roman basins.

The outcomes of our research reveal that the sensory and inter-sensory qualities are related to the location of the roman basins in the heart of the medina of Gaf-

sa and they contribute, up until the present day, to express the identity of the place in which the inhabitants recognize themselves. These pools highlight the sensitive experience through the combination of visual, sound and thermal effects produced by the water. This also applies to the playful uses created by the spatial configuration of the public space and the water system in this particular oasis context. In addition, memories of the past and current experiences maintain a sensitive relationship with the roman basins, dominated by references to the water element and votive practices. Finally, the promotion of historic oasis centers through a human-environmental approach requires reflecting about the significant potential of water to generate a quality public space, particularly in the marginalized neighborhoods of nowadays.

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CIVIL PARTECIPATION IN THE RESTORATION OF THE ANCIENT NUCLEUS OF THE M'CID MOSQUE IN BISKRA, ALGERIA

Rachida Aboudil¹, Aomar Dali²

¹ Department of architecture, Faculty of Sciences and Technology, Université de Biskra, Algeria.

² Department of architecture, Faculty of Sciences and Technology, Université de Biskra, Algeria.

In this article, we present an experiment we carried out together with the inhabitants of an old neighborhood of Biskra (southern Algeria) in order to save and restore their local old Sidi Moussa El Khoudri mosque, also known simply as M'CID mosque. A great movement involving a broad civil participation developed in order to achieve this restoration purpose. Saving this mosque from demolition, restoring it to pass it on to future generations has been the goal of the work and commitment of this civil community over the course of more than eight years. In this article we will try to present all the phases and results of this operation, started in 2012 and lasting until the present day. This project was an exceptional experience in the field of volunteering for us and for the civil community as a whole.

KEYWORDS: civil participation, touisa, mosque, restoration, community, formation, traditional know-how.

INTRODUCTION - "TOUISA"

"Touisa" is an ancestral civil participation practice dating back to the dawn of time, it is a community mutual aid that involves several people belonging to the same family or to the same tribe, coming together to carry out work for the benefit of the community or for a different subset of its members, taking turns. It has been widely used throughout the Algerian territory, particularly in the southern Saharian areas where life conditions are harsh, with the purpose of building houses, religious buildings, defensive structures and above all hydraulic works (foggaras, wells, ghotts). This practice helped maintain and restore the principal monuments and it is the main factor behind monuments withstanding the test of time and reaching the current generations.

DATING THE M'CID MOSQUE

The M'CID mosque is located south of Biskra, two kilometers from the city center, in one of the oldest districts of old Biskra (fig. 1). The district of M'CID, from which the mosque takes its name, is one of the seven villages that was formed when the Turkish Forum was abandoned in the early 18th century after the outbreak of the plague.

This mosque can be considered one of the oldest mosques in the Biskra region; it was probably built during the local medieval period but the exact date of its foundation remains uncertain.

In order to date the construction we have relied on two essential documents.

The first document is a very important parchment (fig. 2) that was found hidden in a crack in the wall of the minaret of the mosque, following its last collapse in 1952 (fig. 3). The parchment is a testimony of the date of construction of the mosque and its builders, as well as the materials used and the cost of its construction. This document testifies to the reconstruction of the minaret which previously collapsed around 1040 *Anno Hegirae* (1630 CE). The minaret was probably rebuilt shortly after the collapse, so we can rest assured that the mosque was built some time before 1630 CE.

The second document is a commemorative plaque found in the mosque, which states that the building was built by the Turks in 1550 CE and restored in 1950 CE during the colonial period.

The two documents are thus compatible with a XVI century CE date of construction.

RELEVANCE OF THE M'CID MOSQUE

The M'CID Mosque has a great historical value and a relevant architectural quality. Its construction system is unique, very rich in structural and decorative elements that give it a very characteristic style (fig. 4). In addition to its historical and architectural importance, the mosque also has a religious relevance because it houses the tomb of the "holy man" Sidi Moussa El Khoudri. The mosque is also called Djamaa El M'cid which translates to "M'CID school mosque", since it is traditionally a place of transmission of knowledge.

The mosque also has great social importance: it has always played a unifying role throughout the neighbor-

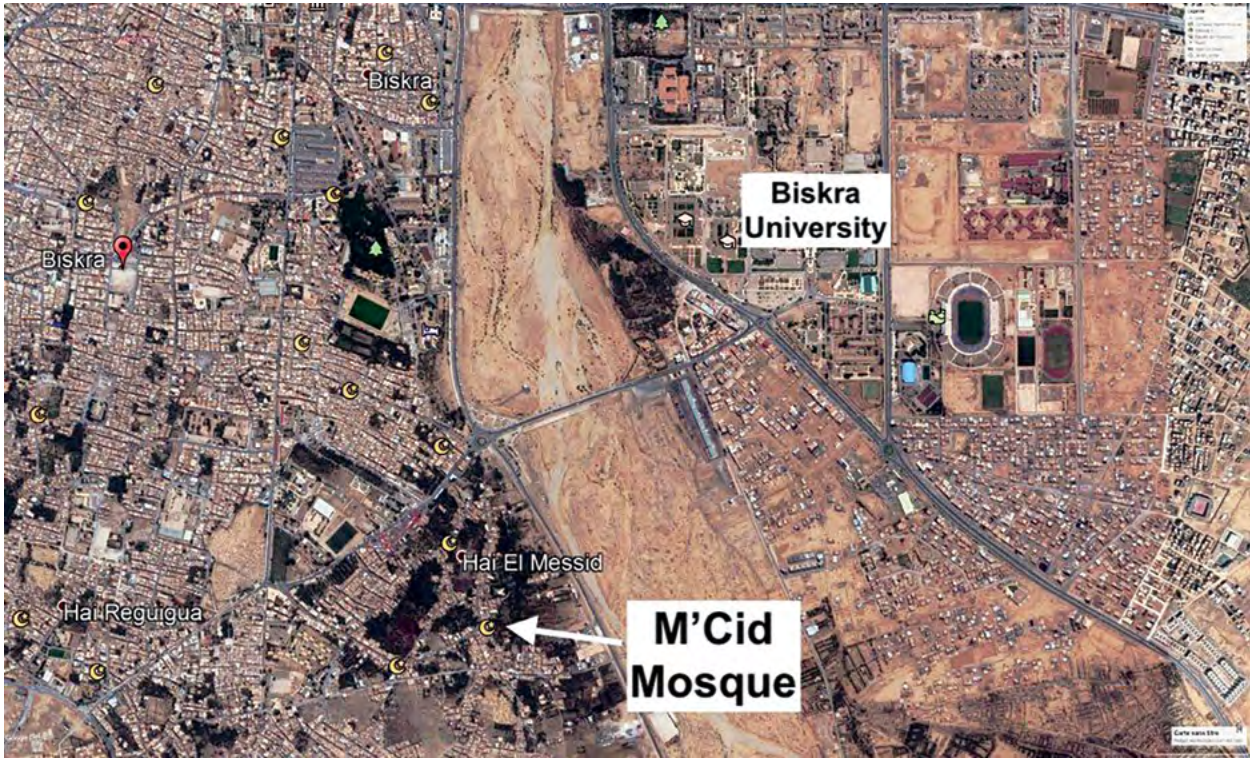


Fig. 1 - Ubication of the M'Cid Mosque (source: Google 2020).



Fig. 2 - Parchment found inside the wall of the minaret (source: archives of M'Cid Mosque)

hood: usually in this place of worship many problems arising between different members of the community are resolved.

RESTORATION HISTORY

The entire history of this recovery and restoration operation began in 2012, after different vital parts of the building presented some pathologies of instability. The arches and the outer wall on the side of the Mihrab showed signs of subsidence that could have led to a collapse at any time, forcing the authorities to classify the mosque as a public danger. The competence regarding the state of conservation of the mosque was entrusted to CTC Biskra (Biskra Technical Control of Construction) which issued a report concluding that the mosque was at risk of collapse and therefore, constituting a danger to the attendance of the faithfuls, had to be removed in the short term. Following the conclusions of the CTC experts, the local authorities, the technical services of the municipality and the direction of religious affairs deliberated to completely demolish the old part of this mosque and a demolition statement was issued in 2012.

The inhabitants of the neighborhood, and the imam of the mosque in the first place, had never accepted the idea of demolishing their old mosque, a place which embodied the memory of their community. To save the mosque, the neighborhood association called

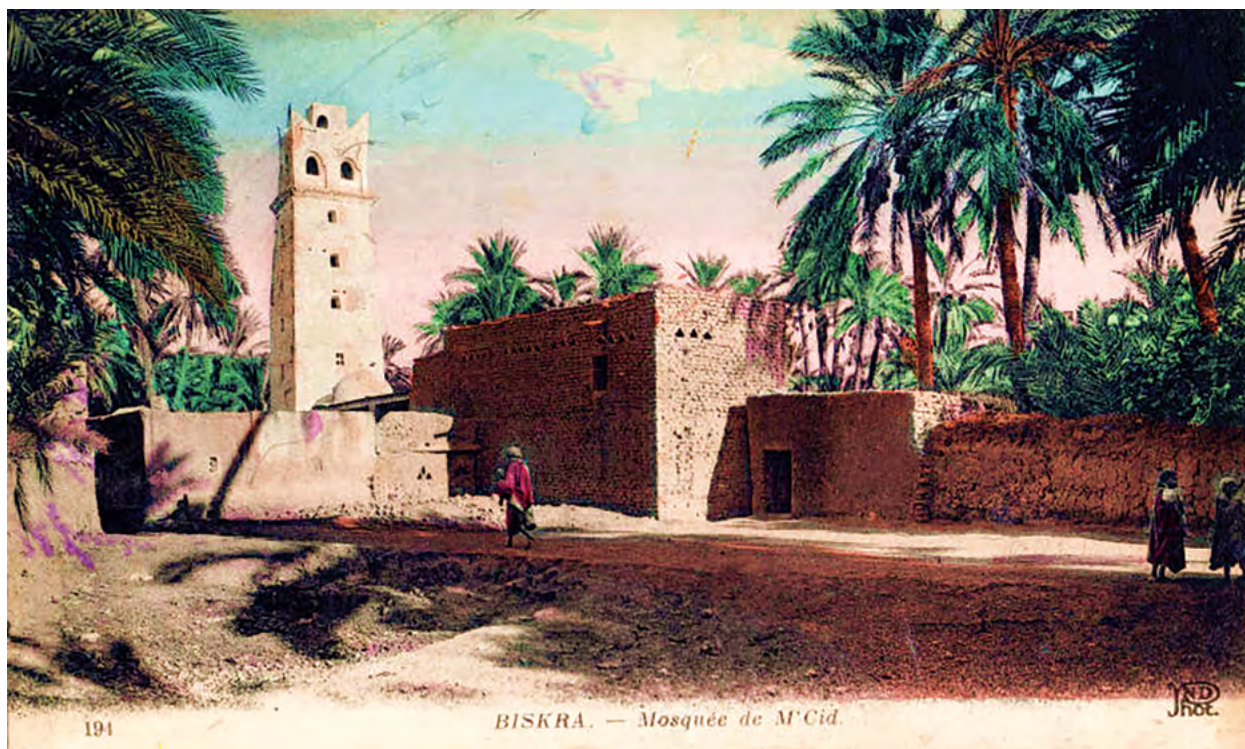


Fig. 3 - Old colorized picture showing the mosque during the colonial period, before the last collapse of the minaret (source: www.decampe.net).

the authors, who are experts and architects accredited by the Minister of Culture for the safeguard of historical monuments and protected sites, asking for a second opinion.

After various researches on the mosque and a careful diagnosis of the various pathologies that affected the structures, we concluded that this building could indeed be saved from demolition and restored. The building had to be secured first and the outer wall, which threatened to collapse, would have to be consolidated. Following this second opinion, in the following year the outstanding demolition statement was withdrawn and a restoration permit was issued instead.

We then contacted Mr. Mousselmah Bahmed, from the research department specialized in restoration, in order to develop the project for the necessary urgent works and subsequent restoration of the mosque. Mr. Bahmed agreed to perform his duties for free as a volunteer.

PEOPLE AND INSTITUTIONS INVOLVED IN THE PROJECT

For the realization of this project several people were involved, divided into five groups:

- Group 1: technical team for the study and monitoring of restoration work, made up of qualified architects, experts from the design office and civil engineers.

- Group 2: entrepreneurs and artisans.
- Group 3: civil society, the inhabitants of the neighborhood, the imam of the mosque and the various associations.
- Group 4: students and teachers of architecture.
- Group 5: the administrative staff, people responsible for the direction of religious affairs, the direction of culture and the municipal authorities.

FINANCIAL ASPECT

The entire restoration operation had to rely on volunteering only, starting from funding itself. Since the M'cid mosque is not formally under a cultural heritage protection constraint, the project could not have benefited from state aid, according to Algerian state law regulations. The Ministry of Culture can finance protection and restoration projects involving only listed cultural heritage monuments, therefore our project had to depend on itself for funding and workforce.

Funding was mainly based on donations from neighborhood residents. This funding generally consisted in money, but in-kind donations were not uncommon, taking the form of building materials, tools or equipment, obviously not forgetting the manual work itself offered as “Touisa”, particularly coming from the young people of the neighborhood. But the aspect that



Fig. 4 - Interior of the prayer room with Roman columns and wooden tie rod system (source: photo by the authors, 2020).

played a very important role in the success of the operation was undoubtedly the moral support, solidarity and the great interest that civil society has shown in this project, a support that lasted throughout the eight years duration of this endeavor.

One of the main objectives of this operation was undoubtedly the transmission of ancestral know-how on every subject related to traditional construction techniques and the use of local materials. For the success of this objective we requested to include, in the contract with the entrepreneurs, a training course involving the young people of the neighborhood and the architecture students. These training courses were carried out as construction-site schools which were organized by Tourab, a youth collective made up of students which deals with the preservation of earth brick architecture, which operated under the supervision of the manager of the project and the master craftsmen (fig. 5).

The inhabitants of the neighborhood organized in order to take care of the various involved companies and their teams of workers, most of whom were coming

from afar. The companies and external workers had to be provided with housing and reception facilities located near the mosque, and of course all the necessary logistics they needed to perform their job.

One of the residents made his palm grove available to the various construction teams, an area that subsequently became a living space and the headquarters of the entire organization that was in charge of the restoration project of the mosque. This area was used to host the different groups and became an exceptional convivial space, a meeting place between the inhabitants and the different teams, including the lead architect of the project, the numerous donors, the imams and the members of the association. In this palm grove the various guests who came to the mosque were received, and group lunches and receptions were organized. It was above all a meeting place where the various decisions involving the progress of the project were discussed and taken (fig. 6). This space played an important role in the success of the entire mosque restoration operation.



Fig. 5 - Construction-site school, training in earth brick construction techniques (source: photo by the authors, 2018).



Fig. 6 - Meeting of the community members inside the palm grove (source: photo by the authors, 2018).



Fig. 7 - Group of artisans specialized in clay brick constructions (source: photo by the authors, 2015).

THE DIFFERENT PHASES OF THE RESTORATION PROJECT

Four different companies participated in the restoration of the mosque over the course of more than eight years. The work was divided into four phases, each of the companies dealing with one of them.

First phase: emergency work. The first phase concerned the urgent works, which were limited to the shoring of the arches and the upper levels. The aim was to limit damage and prevent injuries, these procedures were also required in order to follow the recommendations of the commission that, issuing the restoration permit, required the building area to be safe and protected first. The assignment was entrusted to a company specialized in shoring and consolidating buildings and the operations started in 2014.

Second phase: reconstruction of the external wall. The construction of the external wall was entrusted to another company specialized in the construction of clay

bricks, a family-based company made up of artisans: a father and his children coming from the city of Mes-saad, in the province of Djelfa (fig. 7). Their task was use clay bricks to reconstruct the external wall that was in a very advanced state of decay. Some of the materials were recovered from a house near the mosque, the owner kindly donated the bricks for free. To reach the required quantity of bricks, some had to be made on site using the traditional techniques. This whole family of artisans was taken care of by the organizers and by the inhabitants of the neighborhood and they were hosted in a house nearby the mosque.

Third phase: pickling the surfaces. The pickling of the internal walls, arches and ceiling and all the architectural elements was entrusted to a third company, the only local company. The job was to remove all the layers of plaster and paint on the architectural elements of the prayer hall. For the maintenance of the mosques, it is common practice every year to redo the plaster and paint



Fig. 8 - View of the prayer room before the third phase (source: photo by the authors, 2013).

the walls, arches and columns and this is usually done without removing the old layers. Since this process was repeated over a long time, all the architectural elements had been covered with a multitude of layers that hid the rich and detailed texture of the underlying surface (fig. 8). During these operations we discovered that the columns, believed to be palm trunks as in the other old mosques in the region, were instead roman stone columns, probably recovered during the construction of the mosque from pre-existing roman sites around Biskra.

Fourth phase: restoration work. This is the most crucial phase of the whole project; the task was entrusted to a fourth company specialized in the conservation of architectural heritage, a company having proved record of successful operations throughout Algeria. The company will take care of all the restoration work, beginning in February 2018 and continuing to this day. After the dismantling work, it was discovered that the clay brick arches and the palm wood ceiling were greatly altered; the brick had lost all its consistency and the palm trunks that formed the floor were very degraded. Thus, it was necessary to dismantle the entire ceiling, remove the



Fig. 9 - Application of the plaster using a palm branch (source: photo by the authors, 2020).

palm trunks and select the parts that could be restored and reassembled. This work was done manually, taking great care not to damage the architectural elements.

In order to lighten and strengthen the arches and load-bearing walls originally made with clay bricks, it was decided to use a hybrid structure made with wood and metal profiles incorporated into the thickness of the structure. This structure had the task to support the weight of the roof, which was previously resting on roman columns only. In order to extend the life of this building even more, it was also necessary to consolidate these columns and create new foundations.

The last stage of the work involved the restoration of the roof, which had to be completely dismantled and reassembled. The existing bituminous waterproofing has been replaced by a traditional one made with a mixture of lime and polyester balls on which two layers of waterproof resin have been spread to lighten the pressure of the roof on the structure.

The application of the plasters was the last operation undertaken to complete the restoration work. In the Biskra region a clay-based plaster is usually ap-



Fig 10 - Celebration of a wedding ceremony inside the mosque after the restoration (source: photo by the authors, 2019).

plied on the raw earth brick walls; it is however a demanding practice since it must be redone at least every two years. To overcome this problem, we experimented with a new technique and a new material for brick wall cladding: a lime-based plaster. To improve the adhesion of the plaster to the clay brick surface, a plastic mesh was laid as reinforcement. This mesh was applied to both sides of the wall to make it more solid, and fixed to the surface with galvanized wires.

The cladding was carried out in three successive layers, with clay added as the last finishing layer which gave the façade the typical clay color. To obtain a rough texture similar to the traditional one, we used the old method of manually applying and texturing the plaster with a palm branch (fig. 9).

The very last operation consisted in providing the carpets for the prayer room. At the end of the Friday prayer that gathered all the faithful, the imam asked the inhabitants to offer traditional carpets to the mosque. Almost everyone responded favorably to the request of the mosque and an overabundant number of carpets were collected in order to cover the whole prayer room, with the excess carpets kept as a reserve (fig. 10).

CONCLUSIONS

The eight years of work that were necessary to bring this project to completion are the result of continuous efforts that have yielded remarkable results. The restoration project of the M'cid mosque was a dynamic project that mobilized all the sectors involved and provided jobs for the inhabitants of the neighborhood. This is a remarkable example of cooperation and coordination between different people, companies and associations. This experience should undoubtedly become a model and source of inspiration for the entire national territory: a blueprint to recover and restore numerous unclassified monuments that are waiting to be saved from disappearance, with the objective to pass them on to future generations as a testimony of the creative genius and know-how of our ancestors.

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THE IMPORTANCE OF FOGGARA IN THE ALGERIAN SAHARAN HERITAGE

Yamina Abdou¹, Djamed Alkama²

¹ Laboratory LACOMOEA, Department of Architecture, University Mohamed Khidder, Biskra, Algeria.

² Department of Architecture, Université 08 mai 1945, Guelma, Algeria.

The foggara is a vernacular system for acquiring and distributing water by means of horizontal drainage galleries. This study is focused on the foggara systems of Touat, Tidikelt and Gourara, all located on the border of the Western Erg. The findings come from a field study conducted in 2010 in the lower Sahara and also from surveys undertaken among the inhabitants of the oases of these regions. The aim is to draw up an assessment of the current situation of foggaras, which is characterized by several harmful problems due to the chaotic urbanization, despite the existence of planning instruments employed to both control urban growth and preserve the foggaras.

KEYWORDS: Bas Sahara, Algeria, Touat, Gourara and Tidikelt, foggara, urban planning instruments.

1. INTRODUCTION

Since the middle of the 20th century, the Sahara experienced a massive urbanization. This phenomenon certainly was the main change marker that characterized the region. This happened particularly by facilitating to redesign and polarize the geographical distribution of its inhabitants. The observation over more than two decades of urban dynamics reveals the full extent of the changes that affected the regions of Touat, Gourara and Tidikelt. This change generated a significant growth in terms of populations and activities, resulting in an important increase of water demand. However, this service still remains managed by the ancestral and vernacular water collection system known as the foggara, which is really the mental and spiritual universe-structuring element of the oasis inhabitants, as well as the foundation of their social organization. The system were introduced in the Algerian Sahara by El Malik El Mansour, who allegedly dug the first foggara in Tamantit (15 km from Adrar) in the eleventh-twelfth century (Hassani 1988). Then, the foggara were developed in Touat and Guorara by the arab-berber tribes of southern Morocco (Mrabtime, Chorfa) exploiting the local (Harratins) black labour force from Mali, Niger and Sudan neighbouring regions (Arrus 1985). The largest foggara in Timimoun region is located in El Meghier (200 km from Adrar). It was drilled at an unknown period and was reportedly developed by the Marabout Sidi Othmane and his son (Remini, Achour 2008). However this system is disappearing nowadays due to the over-exploitation of resources such as water and agricultural lands, in a context where these re-

sources are so invaluable. The foggara is a national cultural heritage, or even a global one, due to its presence just in 50 countries worldwide (PNUD 1986). Thanks to this technique the oasis natural context, that is originally hot and dry, can be transformed into a semi-arid environment. The foggara is notably the main component of the oases of the lower Sahara.

This article aims mainly to provide a better understanding of the preservation and survival of this heritage which contributed to the urbanization of these regions. This hydraulic heritage is unfortunately exposed to various risks due to urbanization, even if the adopted tools are the main reference instruments for the traditional management and control of human settlements (i.e. a rehabilitation path).

2. PRESENTATION OF THE CASE STUDY

Created with the 1974 administrative departmental division, the *wilaya* (governorate) of Adrar extends over the northern part of the Algerian south-west (fig. 1). It covers an area of 427.968 km², constituting 17,97% of the national territory. This *wilaya* accounts for 11 *daira* (districts) and 28 municipalities. Its population is estimated at 320.390 inhabitants (2008), corresponding to a population density of 0,75 inhabitants/km². All this population is distributed through 294 traditional human settlements, the *ksour*. The latter is the plural of *ksar*, a north African term for a fortified village characterized by a typical form of very dense and compact settlement that is built in traditional materials (adobe and/or local earth bricks called *toub*). In the Algerian lower Sahara, the *ksour* are located through-

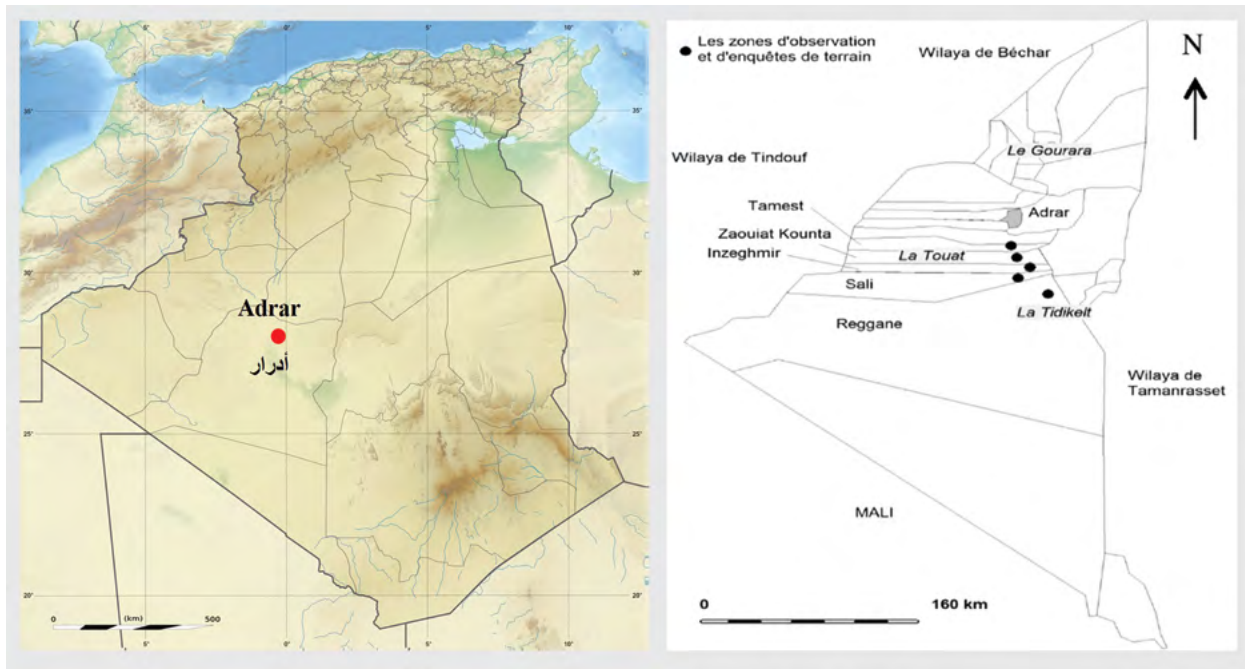


Fig. 1 - Location of the study area [Dari, Bellal, Hadeid et Ghodbani, 2014, annotated by authors].

out three main regions: Gourara (Timimoun), Touat (Adrar) and Tidikelt (Aoulef).

The *wilaya* of Adrar is limited to the north by the *wilaya* of El-Bayadh, to the north-west by the *wilaya* of Bechar, to the west by the *wilaya* of Tindouf, to the south by Mali, to the south-west by Mauritania, to the south-east by the *wilaya* of Tamanrasset and to the north-east by the *wilaya* of Ghardaïa. The climate in this region is characterized by a severe aridity. The temperature is high all year round, especially during the summer when it exceeds the threshold beyond which life becomes impossible. Precipitation and surface water are rare. Indeed, the continental intercalary has been exploited for centuries in these regions (see Table 01).

At the present time and in all these regions, the foggara is endangered (degradation, depletion, deterioration of water quality and lowering of the water level). This tragic situation falls within local and regional issues mainly related to unregulated urbanization. In addition, the urban policy and urban planning tools implemented by the local authorities did not include protec-

tion strategies for such an ancestral hydraulic system, neither considered the foggara as a main component of an efficient and sustainable regional development.

3. METHODOLOGY

To undertake this research work a methodological approach of three steps has been adopted:

1. A literature review related to the global topic of both past and present urbanization of the Lower Sahara and more precisely the one associated to the foggara.
2. A collection of official data by means of field surveys with several administrations of the *wilaya* of Adrar (The Planning and Land Use Directorate, the Urban Planning and Construction Directorate) as well as the National Statistics Office.
3. Interviews during *in situ* surveys with the inhabitants of the local settlements, in order to collect relatively informal data.

The different kinds of data collected with these methods have been examined, analyzed and cross-referenced.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
P (mm)	0	2.8	3.1	6	12.4	3	3.1	0	0	3.1	0	0
T (C°)	12	15	19.5	24	28.5	33.5	33.5	35	31	25	18	12.5

Table 1 - Monthly average rainfall and temperature (1986-2019) [Weather station Adrar]

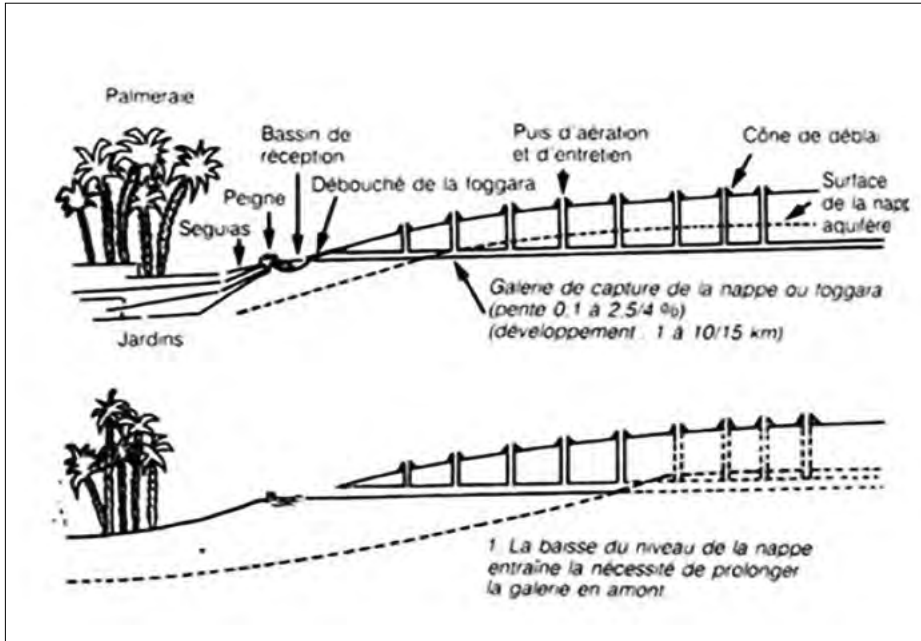


Fig. 2 - Layout of a traditional foggara system [Oliel, 1959].

4. RESULTS AND DISCUSSION

4.1 Region' local water resources use

In the regions of Touat, Gourara and Tidikelt, water supply is based on the exploitation of groundwater by the traditional method of collection and irrigation that is the foggara. The foggara in Arabic recalls the verb *fakra* to dig; other authors believe that the word foggara is related to the homonymous arabic term for vertebra (Kobori 1982). The water in the foggara generally comes from the continental intercalary, as explained by Cornet: «The continental intercalary corresponds to regions of very attenuated relief; it contains abundant aquifers which, in depressed areas or at the foot of cliffs, provide a shallow water table that sometimes flows, or may have done so in the past, into sebkhas (areas of coastal salt flats). Its permeability is very great,

and it can locally allow large flows under a low drawdown.» (Cornet, 1952). The foggara is a draining gallery dug in a straight line upstream to downstream, collecting and bringing the underground water to the land to be irrigated, thanks to an appropriate slope (fig. 2).

The watering is done by gravity flow and it is aided by the appropriate topographical conditions, consisting of the fact that the ground level is lower than the piezometric level of the continental intercalary water table. The essential and draining part of the foggara is the porous part of the channel, also called the draining gallery (figs. 3-4), this channel is dug so that it can circulate the water, allowing at the same time the passage of the workers during the construction phase.

A series of wells is dug along the foggara, allowing access to the gallery for maintenance and cleaning duties. The minimum distance between two wells is 80 m.



Fig. 3 - View of the foggara's draining gallery. [Authors, 2020].



Fig. 4 - View of the foggara's draining gallery. [Authors, 2020].



Fig 5 - View of the tertiary *kasria* of the foggara in Timimoun. [Authors, 2020].

(Cheylan 1990). Its implementation, maintenance, and water distribution must be controlled by the leaders of oasis society. The foggara is a technique related to a social system of collective work, headed by a committee of councillors, called the *Djema*, whose role is to direct and supervise the maintenance of the foggara and the distribution of its water.

We identify seven types of foggaras in the lower Sahara (Remini *et alii* 2010): i) foggara of the Albien (or classic foggara); ii) foggara of the *ergs*; iii) foggara of the sources (*al ain* foggara); iv) foggara of the mountains; v) foggara of the streams (meaning *oued / wadi*); vi) foggara of the floods and vii) foggara of the gardens. In any

case the foggara can be given a personal name, just like a real person, when it is under construction.

Once the foggara water reaches the area of the gardens, its water is shared according to two methods: water volume or supply time (fig. 5).

The volumetric method (water volume)

In all classic (Albien) foggaras oases, the water is distributed following the volume method. Each co-owner receives a volume of water determined according to his contribution to the maintenance of the foggara. This distribution accomplished out by a network of *kasriates* (plural of *kasria*). The number of *kasriates* that is proportional to the number of the owners. From the main *kasria* (fig. 5) a triangular basin with a water supply system is built. The water collected within this main *kasria* goes through a comb-shape device allowing to divide the flow into three, four and even five channels called *seguias*. These channels fan out in various directions. At the end of these *seguias* (fig. 7), other secondary *kasriates* are present, allowing for a further distribution of water. Similarly more *kasriates* will be found down the line, until finally reaching the *guemouns* (gardens) (fig. 5, see Remini *et alii* 2010).

The hourly method (supply time)

This method of distributing water is specific to the foggara of the sources, mountains and streams and it is

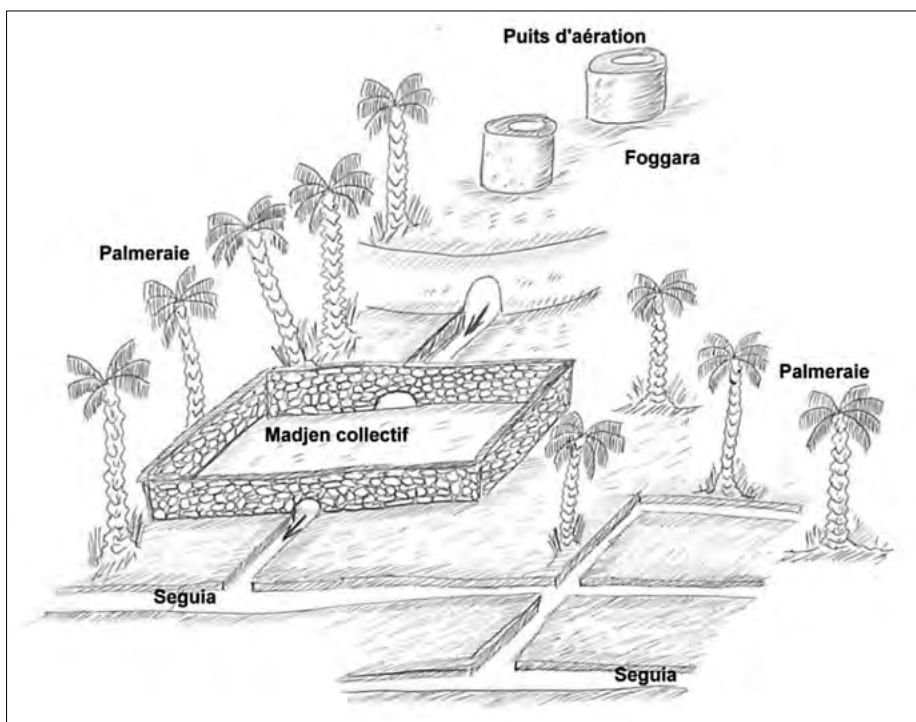


Fig 6 - Synoptic diagram of an hourly foggara (schematised by Remini, 2015).



Fig. 7 - View of the *seguias* of the hourly foggara in Timimoun. [Authors, 2020].

based on a unit time called *nuba*, that simply means turn. It is defined as the sufficient duration of time to irrigate completely the garden. In Algeria, there is only the foggara of Hanou d'Adrar, which is an hourly foggara and without *kasriates* as in the other neighbouring foggaras (Remini alii 2010). In this method, relatively wide *seguias* directly branch off from a large *madjen* (water reservoir). The foggara is closed by obstruction once or twice per day in order to restore the required level. Then, the water is released for a given time, proportional to the beneficiary's financial contribution (see fig. 6 and Oleil 1994).

4.2. Urban growth: a very spread out and fast-developing phenomenon

Today the urbanization in these regions is evolving but its strong development is destroying the ecological balance and seriously impairing human well-being. The first stage in the formation of Saharan cities dates back to the colonial period (since 1900) when villages were created near the most important *ksour* to initially accommodate military barracks. This has contributed to the creation of a new standardized urban fabric meeting the needs of a technical-military logic and locating the colonial villages facing the *ksour* (figs. 8-9). This urban fabric has been further extended by the massive establishment of collective facilities and new infrastructures for the local populations. So we are witnessing a spatial boom in oasis regions, “*moving from ethnic segregation in the colonial period to functional segregation after the independence*” (La Bruyère 1988, p. 343). This accelerated, widespread urbanization is closely linked to its new functions related to the administration and management of these very extensive areas, as similar-



Fig. 8 - View of the massive urbanization of *ksar* at different scales. [Authors, 2020].

ly happened in the northern regions with the creation of massive and open urban fabrics. The urbanization process is undertaken without any significant concern for urbanity or the Saharan climate and even less for the cultural heritage. Hence, the environment deterioration and the ecosystem imbalance are compromised, and one of the main reasons is the squandering of the natural resources of these oasis regions.

4.3 Urban planning tools / legislation

Urban planning tools are part of the organizational and operational structure of the city and its area, commonly used in many world countries in respect of their various political systems (Hattab, 2014). Their aim is to design and provide the best spatial and social conditions for city development and for the management or urbanization of the functional areas. The reference to a sustainable development is now essential in Algerian laws related to urban planning and in the public policies, particularly since the adoption of the laws introduced in 2006 concerning the city planning policies.

Relating to the protection of the environment within the framework of a sustainable development, the law n. 03-10 of 07/19/2003 aims, among other objectives, to set the fundamental principles and the rules of environmental management, promoting a national sustainable development by improving the living and working conditions to guarantee a healthy living environment.

Moreover, the law n. 06-06 of 20/02/2006 concerning the city planning policies, aims to define the city policies within the framework of the regional planning and the sustainable development policies. This law is designed to provide for a concerted and coordinated development process that will have to be

also implemented within a framework of de-concentration, decentralization, and local management. This law has two main components: urban development and management. Concerning the urban component, its objectives include, among other things, the control of urban growth, the correction of urban imbalances, the restructuring, rehabilitation and modernization of the urban fabric to render it more functional. Regarding the management aspect, its objective is to promote good governance by the reaffirmation of the responsibility of the public authorities and the participation of associations and citizens in the management of their city.

The *plan directeur d'aménagement et d'urbanisme* (PDAU, development and urban master plan) and the *plan d'occupation des sols* (POS, land use plan) were established by law n. 90-29 of 01/12/1990 (and its implementing decrees 91-177 of 28/05/1991 and 91-178 of 05/28/1991) and they establish the guidelines of town development and planning.

The PDAU sets the fundamental guidelines for the development of the concerned territories. It determines the general destination of the soils as well as the nature and the layout of the major infrastructures. The PDAU must be respectful of the guidelines of the coastal development plan (law n. 02-02 of 05/02/2002) and also set the reference terms for the POS. It provides for the assessment of areas of conflicting uses, the impact of pollution, and the evaluation of foreseeable natural risks. The POS is a regulatory urban planning instrument, resulting from a protection policy. In accordance with the provisions of the PDAU, the POS sets out in detail the land use and construction rights for the concerned sectors and makes it possible to integrate the specificities of the place and to protect sensitive areas (Saidouni, 2000). Apart from these two laws which give no recommendations and remain vague in determining the protection measures, the planning methods also do not take any consideration, during their development by design offices (state or private), regarding the foggara (restoration, preservation etc) or the future of the *ksar* itself.

However it must also be mentioned that there is a specific gubernatorial (*Wali*) decree (n. 426 of 23/06/96) relating to the protection of the foggara concerning the easements to be respected during the development work in the meadows of a foggara or its source.

4.4. The future of traditional hydraulic systems

The rapid urbanization has led to the emergence of dynamic Saharan cities and has generated, by spillover effect, multiple transformations in the small oases, such as the introduction of wage labor, outsourcing of activities,

change of habits, abandonment of agriculture in favor of other activities, use of modern means of water distribution, etc. Actions taken to preserve these traditional hydraulic systems are attested, but they are scattered and isolated, their effects reduced in space and time: these initiatives would require the establishment of a global safeguard project. The subsequent lack of maintenance has reduced the number of functional foggaras from more than 1300 to only 820 (Remini *et alii* 2010).

Demographic dynamics affect the spatial and social organization of the population and constitute an important element of the transformation of agglomerations and *ksour* in the Tidikelt, Gourara and Touat. This dynamic is spatially characterized by a trend of population concentration in agglomerated areas, resulting in a constant decrease in the water flow rate and the lowering of the hydrostatic level of the water table. Annual public funding to safeguard the foggaras often comes into help, but it faces many constraints due to the multiplicity of stakeholders. Various studies have been undertaken by scientists and researchers from Non-Governmental Organizations, asking the public authorities to find alternatives to allow the preservation of the foggaras that are still operational in some regions (Dubost, Moguedet 1998).

5. CONCLUSION

The transformation of society and space is much more profound than a simple deterioration of the production in the small oases and the relative traditional irrigation system. Unfortunately the traditional method cannot meet the current water needs and, in particular, the prospects of a widespread urban growth. It is also clear that an unregulated urbanization will contribute to the de-densification of the *ksours*, leading to the disappearance of their ancestral irrigation system, the foggara.

Through the presented case study, we conclude that the urban planning instruments in Algeria and the laws supposed to protect the environment encounter serious difficulties in terms of their application, mainly due to the reluctance arising among local administrations (town planning, tourism, etc.). There is also an evident lack of hierarchical control: the central administrations creating the legislation do not ensure any follow-up at the local level. Despite the changes that have affected the whole region and a lack of natural resources, the water from the foggara still gushes out thanks to the know-how and ingenuity of the oasis inhabitants. These populations have perpetuated their ancestral system for thousands of years and still support their human settlements with water from groundwater sources that still have to be quantified.

In order to sustain and promote this ancestral system we recommend the following:

- raise awareness and train the population about the collaboration in urban projects;
- mobilize and encourage the population to participate, act and make decisions concerning the preservation of the foggara;
- implement a financial funding for the rehabilitation of the foggara;
- implement a professional and specific training (having its own status) for the maintenance and rehabilitation of the foggara.

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BADIAS: THE ARCHEOLOGICAL SITE FROM THE COLONIAL PERIOD UNTIL THE CURRENT ERA

Soumaya Makhloufi¹, Abdelouahab Lebsir², Azeddine Belakehal³

¹ Department of architecture, Faculty of Sciences and Technology, Université de Biskra, Algeria.

² Department of architecture, Faculty of Sciences and Technology, Université de Biskra, Algeria.

³ LACOMOFA Laboratory, Department of architecture, Faculty of Sciences and Technology, Université de Biskra, Algeria.

The antique Badias (present day Bades) belongs to the set of archeological sites related to the numidian limes. It constitutes a part of an economic, social and military system inherited from the Romano-Byzantine period and that remained alive until the Islamic period. This antique place is located on the eastern meridional edge of the Aures mountain range. This work aims to deepen the knowledge about the urban history of Badias since its discovery by the French explorers (19th century) until the recent times (21st century). By means of a large literature review, fundamentally based on historical documents, a chronological classification of the various outcomes of the archeological explorations on the antique site of Badias will be presented.

KEYWORDS: Archeological explorations; Badias; Colonial period; Literature review; Urban history.

THE GEOGRAPHICAL LOCATION

The archaeological site *Badias* is located in the middle of the eastern limit of the current city of Bades. Ranked as a tier two town, this settlement is administratively attached to Zeribet El Oued municipality, 20 km away from the relative chief town. From a territorial point of view, Bades is situated in the eastern Zab of the Wilaya (province) of Biskra, 100 km away from its administrative capital. Bades city is crossed by the national road N°83 connecting Biskra to Khenchela via Khanguet Sidi Nadji (fig. 1). This road retraces partially the old track leading towards Tunisia.

The area of the archeological site (geographical coordinates 34°44'47.04"N and 6°40'21.72"E) is 3,99 hectares while the entire area including it measures about 24,91 ha.

1. HISTORY OF THE ARCHEOLOGICAL SITE

The toponym *Badias* as a human settlement is known from the Peutinger map as well as the military fort testified by a graffito discovered in El Kasbate. Also, *Badias* is cited by Ptolemy as located inside Libya, and was probably one of the *fulcrums* of the military border (*limes*) formed by *Trajan* to the south of the *Aures*. During the lower empire it is cited in the *Notitia dignitatum* (occ. xxv, 5 and 23) where the *limits bazensis* (for *Badiensis*, according to a frequent permutation in Africa) is assigned to a *praepositus*. *Badias* thus became a civilian settlement formed near the military fort and it was then promoted into a municipality as it is shown by a third century inscription

found in the current religious Islamic centre (*Zaouia*) of Bani-Barbar (since the inscription cites in *Badias* the presence of an *aedilicius*).

We should also probably associate *Badias* to a *Vadis episcopus* who attended the Council of Carthage in 256 CE and certainly a *Badiensis episcopus* (donatist) who was present at the conference of 411 CE. The Episcopal notice of 484 CE reveals that two *episcopi Vadenses* were present in Numidia. The seat of one of them was probably in *Badias*. Besides, the berber-roman author *Corripus* talks about the double barley harvests that were made annually by the natives of *Vadis*.

Badias was the command post of the *Badiensis Limes*, the roman border that was connected with the *Ad Medias* camp on the East and the *Gemellae* fort on the West. Because of the location of this military place within an agricultural territory, its fort was crossed by a secondary canal from the great Oued El Arab canalization. This secondary canal comes out from the fort directly towards a large human settlement surrounded by several districts.

One of Baradez aerial photos, taken after heavy rains, reveals a whole set of canals, earth walls, very regular crops' beds that are no longer visible on the surface nowadays. The degraded state of the irrigation system at that period is easily observable from this image.

Bades fort experienced the succession of three different periods within the same area: the antique, the medieval and the contemporary (French colonial) periods. Thus, the superimposed construction techniques dating from these various eras constitute a very interesting palimpsest: foundations in freestone, pebble foundations, and mud brick walls respectively.

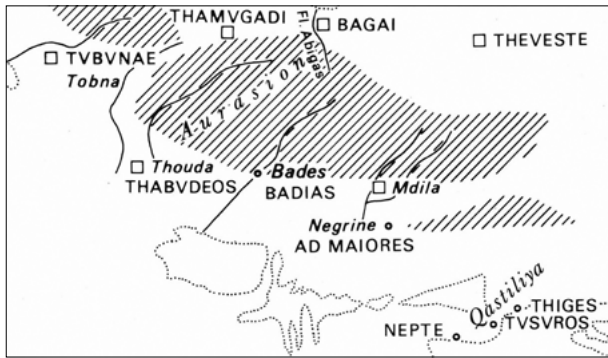


Fig. 1 - Location of Bades, on the Saharan limit of the Aurès (Drawing J. Lenne). [TROUSSET 1991].

archaeologists and historians	military	other
<ul style="list-style-type: none"> • De Lessert Pallu (1890) • Gsell Stéphane (1911) • Baradez Jean (1949) 	<ul style="list-style-type: none"> • De Borsedon Louis (1878) • Touchard (1902) • De Torcy Louis Joseph Gilles (1911) 	<ul style="list-style-type: none"> • Textier Charles - Inspector General of Civil Buildings - (1848) • Toulotte Anatole - Bishop (1894) • Jaubert H. - Canon - (1913)

Tab. 1 - Classification of publications from the 19th and 20th centuries. [Authors 2019].

Two main assets could have prompted the colonization of these regions: the presence of water (rivers and groundwater) and fertile lands. The semi-arid climate favored more and more harvests during the year and promoted certain crops such as wheat and olives, as evidenced by the presence of ancient oil mills.

Additionally, the antique dating of this site is similar to others in Biskra region, as it is attested by certain vestiges analogous to those found in Kairouan (ceramics particularly) and Mesopotamia and / or Egypt as well (specifically the construction system and techniques).

The proximity of Oued El Arab and also the presence of wells (catching from water table) explains the water exploitation during antiquity in such hot dry region. Also, it should be mentioned the existence of traces of antique thermal baths inside one of the current schools located near the military fort, an area undoubtedly included within the perimeter of the old human settlement. During the medieval era, the muslims settled in this fort, which was still operational.

2. METHODOLOGY

Being part of the Limes of Numidia, *Badias* is an important archaeological site whose research on its historical evolution as well as its archaeological exploration still remain nevertheless very limited. In order to deepen knowledge about the urban history of *Badias* since its discovery (19th century) to the present day (21st century), we relied on a review of a bibliography of around fifteen books and articles, mainly based on historical documents. The main selection criteria for study material are: (1) sources closely related to the study subject and whose authors have directly described the site and its components; (2) documents published during the 19th-21st centuries; (3) sources whose authors effectively visited and / or explored the site; (4) research works carried out by archaeologists and historians. In a second step, we classified the sources according to the author's

profile (travelers, archaeologists, military, etc.) and the chronological order of their publications (from the oldest to the most recent one).

Regarding the ancient sources, texts of Corripus (poet, 6th century) and El-Bakri (traveler, 10th-11th century) were also considered. Among the most recent ones (19th-20th centuries), nine documents have been selected and classified (see tab. 1).

Unfortunately, it turned out that the current sources (21st century) are limited to two documentary sources, namely the work of the archaeologist Hadji Yacine Rabah (2006, 2015, 2017) as well as the archaeological site's permanent development plan (2006). All of these historical documents have been subjected to a very thorough reading and examination for everything that deals with their authors' descriptions of the site of *Badias*. This allowed to highlight previously known components of the site as well as new archaeological discoveries. The information extracted from these ancient and current sources has enabled us to identify and constitute the main elements of *Badias* urban history, in terms of archaeological knowledge.

To be able to define a real inventory, matching the literature review's outcomes with the data collected from the archeological site proved to be more than necessary. This comparison was conducted by means of *in situ* observations consisting of: (1) identification of the general condition of the site, its surroundings, its extent, its limits and its protection devices; (2) localization of the various archaeological elements; (3) a photo coverage of the site and its various components, recording the state of conservation of each element.

3. BADIAS AS A CASE STUDY DURING THE 19TH AND 20TH CENTURIES

Buried under the earth, *Badias* antique site was discovered during the colonial period (the end of the 19th century). Until present time, this archeological site has

not been excavated, but several travelers and scientific explorers visited the region and recorded some information about this antique site.

In 1848, Charles Texier (1848) reported on the *Badias castrum* (the military fort of Bades), pointing out that the current city walls were raised by the inhabitants upon the ruins of this *castrum*. Inside the mosque of *Sidi Bakkarri*, Texier also discovered two columns with porticoes, a very particular ionic order capital nearby, as well as the ruins of an apse of a well conserved brick temple.

Thirty years later, De Bosredon (1878) thought that it should have existed, in roman times, a road leading directly from *Tebessa* to *Badias*, passing through *Cheria*, *El Adjedj*, *Fouanis* and *Taberdga*, even though this road did not appear on the old maps. His suggestion was proved by the discovery, 5-6 km from *Cheria*, of a milestone broken at its lower part, with the following inscription:

DN FL VAL
CONSTAN
TINO IN
VICTO P F
AVG NO
.....

« Domino Nostro Flavio Valerio Constantino Invicto
Pio Felici Augusto Nobilissimo.... »

Anatole Toulotte (1894) reports on berber and arab oral traditions, stating that the *ksar romana* of Bades was a monks' convent, similarly to other *ksour* (berber villages) in this region. Perhaps, he finally adds, the name might recall a memory of the fortified monasteries that Justinian had built.

At the beginning of the last decade of the 19th century, Clément Pallu de Lessert identified the *praepositi limitum* (border overseers) enumerated in the *Notitia dignitatum* pertaining to Africa, and one of these is the *praepositus limits bazensis*. Considering the Antonine Itinerary, E. Masqueray identified *Ad Badias* as the current day Bades, located at the southern base of the Aures, between Besseriani and Biskra. As for the transformation of *badiensis* into *bazensis/badensis*, he points very ingeniously out that this is not an isolated fact in African onomastics, where *Auzia* becomes *Auza*, *Auziense*, *Audiense* and where we find *Azabenicis* for *Adiabenicis*.

Supervised by the famous archeologist Stéphane Gsell, lieutenant Touchard fully presented the outcomes of his study, carried out in 1899, and some specifically detailed data regarding the potable water canal connecting Khanguet Sidi Nadji to Bades.

At the beginning of the 20th century, Commander De Torcy examined the archeological site and found

traces of a roman post under a mound located at the northern border of the village.

In 1911, Stéphane Gsell described *Badias* antique site in his Archaeological Atlas of Algeria (map 49). About the site, he reports the presence of sections of cut stones, a surrounding wall, round towers and a specific tower which is very distinct, with a diffuse presence of debris, column stems and capitals.

A year later Chanoine Jaubert mentioned that *Badias* is still cited as a bishopric (seat town of a bishop) on lists dating to the 8th-9th century (Cf. More, LXXII. - Toul., XII. - Mesnage, p. 253).

4. THE ARCHEOLOGICAL SITE ACCORDING TO THE DESCRIPTIONS OF EUROPEAN VISITORS

Due to the lack of research works and archaeological excavations during the colonial period and even to this day, the archeological site of *Badias* remains a virgin field for the discovery of the conditions of roman existence in the region of Numidia.

Based on the previously presented sources about the Badias site during the colonial era, and in particular those of Lieutenant Touchard and Commander De Torcy, we have succeeded in bringing out the following six different components of the site.

4.1 The enclosure wall

Among the visible elements through the bank of the land there was a surrounding wall made of red bricks (fig. 2). The red brick size, at the base of the wall, is 6 centimeters thick by 40 centimeters wide and long. These horizontal red brick courses were separated by 20 centimeters thick blockage layers.

Because the interior face is buried inside the mound which supports the arab village, it is difficult to measure the thickness of the enclosure wall, but it should be evidently considerable, around 1 meter at a minimum.

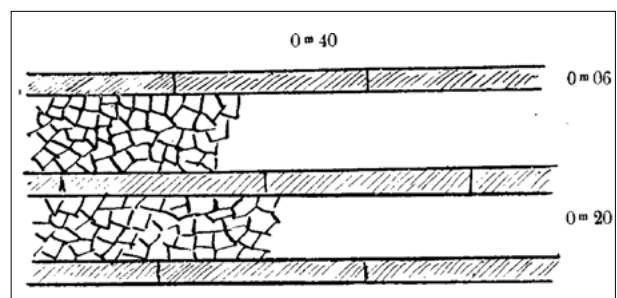


Fig. 2 - Enclosure wall thickness and composition. [De TORCY 1911]

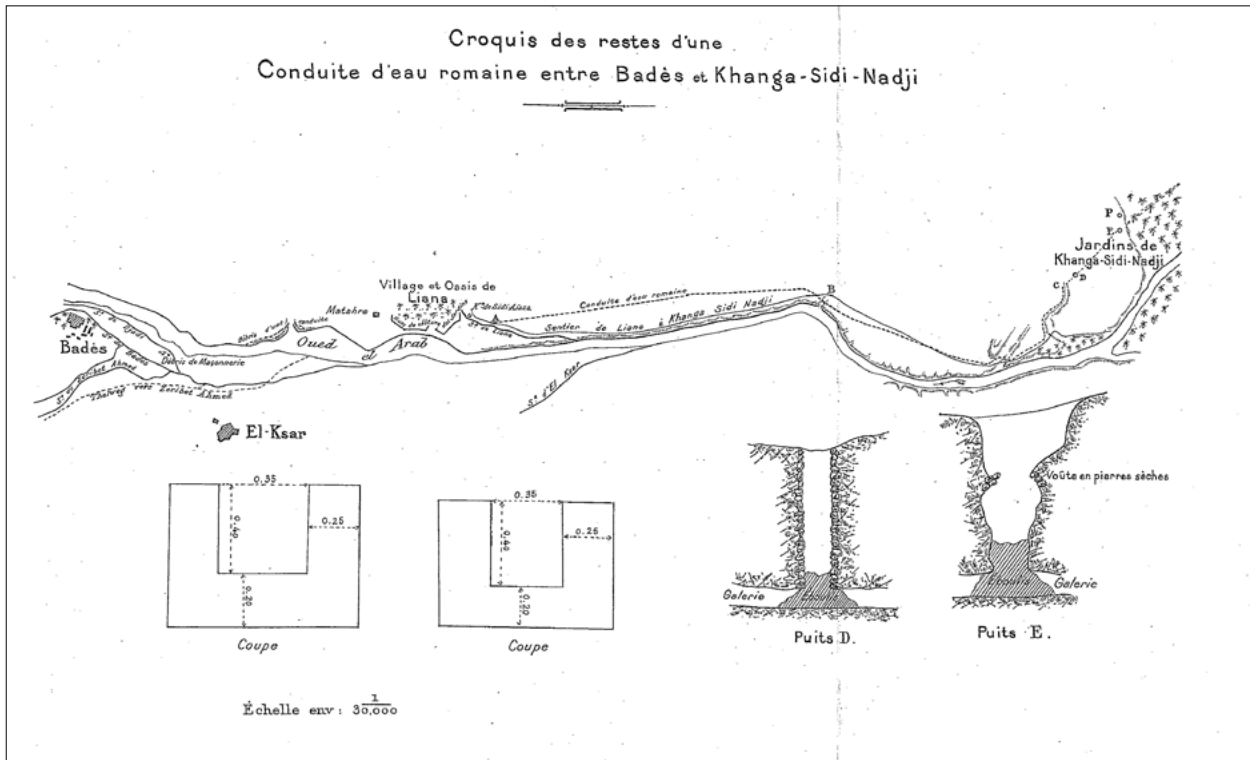


Fig. 3 - Water supply conduct connecting Bades to Khanguet Sidi Nadji: Location and details. [De TORCY 1911].

4.2 The door

The upper part of a gate facing east existed at the beginning of the 20th century. A large part of it is buried in the ground; also built in bricks and rubble, this opening is surmounted by a corbelled vault.

4.3 The two pools / basins (?)

In the northern part of Bades, two antique large pools are located outside the enclosure wall. One of them was still in use at the beginning of the 20th century, while the other was visible but dried up. The inhabitants of Bades still recall its stone stairs going down, allowing them to collect the water; these stairs are buried deep under the embankments nowadays.

4.5 The wells

At a distance of 800 meters north-east of the village, a Roman well is present, it is quite deep and has a large diameter, but no longer contains water. This well is completely built with bricks. A depth of 8 to 10 meters, most likely corresponding to the old water level, is reachable through an oblique gallery cut in the tuff and built in sections.

4.6 Water tower or control tower?

On the eastern face of Bades there is a nearly very large, 4 meters high, double section of wall; forming a semi-vault at the top, these two masonry blocks are the only roman ruins rising above the ground. Thus, they immediately catch the eye when approaching the village from the the south. They could constitute the remnants of a water tower or could be related to a control tower instead. However, the former hypothesis seems more plausible than the latter due to the fact that this remnant is not so distant from the village (only 80 meters) and it is near a probably roman, large and partly built *segua*.

4.7 The water supply conduct.

The conduit used by the Romans to bring water from Khanguet Sidi Nadji to Bades was still visible at the beginning of the 20th century (fig. 3). During roman times there was a water pipe built in river stones, hydraulic lime and cement. This conduit is located between Bades and the gorges of the Oued El Arab, upstream from the site. The place is occupied nowadays by the village and the gardens of Khanguet Sidi Nadji, and most section of the conduit are still intact and visible.

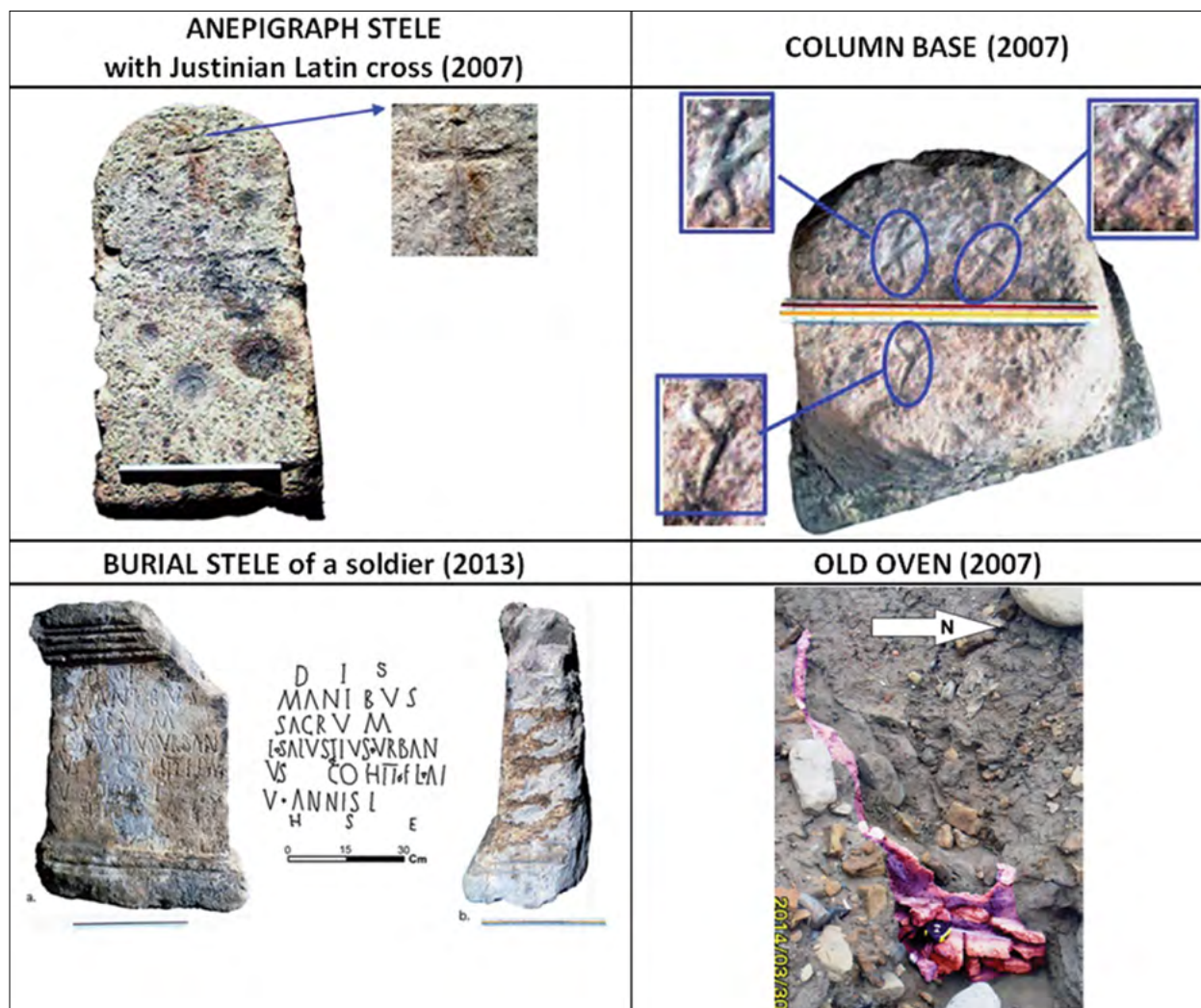


Fig. 4 - Recent archeological components discovered at antique Badias site. [HADJI 2017].

5. RECENT KNOWLEDGE OF THE SITE ARCHEOLOGICAL

Over a century after its discovery, *Badias* antique site is still buried, experiencing no extensive research or archaeological investigation, the main reasons being the difficulties and high costs of these kind of interventions. However, the archeological site already benefited from an archaeological site enhancement coming from a specific plan (PPMVSA, Protection and Enhancement Plan of Archaeological Sites) issued in 2009. On the basis of this plan, a fence was built in order to protect the site against looting, but apart some personal initiatives no academic research involving *Badias* archeological site is foreseen at the moment. In 2017 professor Y. R. Hadji surveyed this archeological site and reported about some components still visible including an anepigraph stele with a Justinian latin

cross, a column base, a burial stele of a soldier as well as an old oven (fig. 4).

6. CONCLUSION

Badias antique archeological site is one of the important places of the roman *limes* in Numidia. Since its discovery at the start of French colonization in Algeria, *Badias* has unfortunately received no special attention from Algerian or foreign scientists despite its richness and specificities. The colonial era archeological discoveries attest to its relevance. Hence, this site is still very poor in terms of recent archaeological knowledge due to the lack of field research investigations. More efforts will have to be undertaken in order to overcome such an unfavorable and neglected situation.

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PHOTOGRAMMETRY AND 3D MODELLING AS A MEAN OF CONSERVATION AND ACCESS TO ARCHAEOLOGICAL HERITAGE INFORMATION: EXAMPLES FROM TIPASA AND CHERCHELL (ALGERIA)

Sabah Ferdi¹, Fawzi Doumaz²

¹ Centre Nationale de Recherche en Archéologie (CNRA), sabah.ferdi@gmail.com

² Istituto Nazionale di Geofisica e Vulcanologia (INGV), fawzi.doumaz@ingv.it

The CNRA in partnership with the INGV have initiated a project of modelling and restitution in the sites of Cherchell and Tipasa. 2D and 3D surveys have allowed the digitization of a mosaic house in Cherchell and of the civil basilica in Tipasa in order to propose hypotheses of three-dimensional restitution. Different methods of photogrammetry and reconstitution have been used while trying to contain the costs of realization. The results are also the products of data processing using free and commercial software.

KEYWORDS: digital restitution, modelling, archaeological site, basilica, Domus.

INTRODUCTION

The creation of 3D models in the field of archaeological heritage responds to two concerns.

1. conservation, through the capture of a “Digital Memory”, whose transcription constitutes a document providing a geometric model intended to represent the morphology of the surveyed artifact as well as its appearance, when the measurement is accompanied by a photographic record;
2. enhancement, through its ability to be repeatedly viewed or visited and therefore to be understood by the greatest number of people, represented on a variety of media ranging from still images to animated ones, movies, broadcast on immersive museographic devices or accessible online on the web.

Recent technological innovations in terms of digital photography and 3D photogrammetry software now allow, at a reasonable cost, the creation and design of 3D digital models of even small to large objects as well as monumental sites.

Each prototype will become a real management tool for professionals and will allow the implementation of new interfaces for accessing information and presenting heritage to the public and decision makers.

The implementation of these models is carried out by multidisciplinary skills associating architects, archaeologists, geologists, geophysicists, computer scientists, geomaticians and graphic designers to obtain sustainable and exploitable knowledge models.

The preparation of the 3D digital model also requires specific skills of various kinds. Archaeological and historical knowledge of the studied site is as necessary as the knowledge of the site itself: topography of the remains still in place, characterization of materials, archaeo-geographical data of all kinds. The aim is to present a new process that allows the creation of 3D computer-generated images and animations, allowing specialists to validate the hypotheses of reconstruction, restoration and replication. It is implicit and very important that all the processes and methodologies are performed using full-scale dimensions and measures, even better when the information is accompanied and enriched by a geo-localization information. Good results depend on the used instrumentation and hardware, the method and practice during the data acquisition, the data processing in terms of computing power, and also interpretative skills based on a long experience in interpreting and reconstructing environments, avoiding false data and artifacts.

We present two case studies to illustrate our ongoing program named “from 2D to 3D or the digitalization of *disappeared spaces*”.

THE CASE OF THE CHERCHEL JONCHÉE HOUSE.

The Jonchée house is located in the south-east of the coastal plateau of Cherchel, the ruins of this vast residence, incompletely cleared, extended over more than 60 m from east to west, and over 30 m from north to

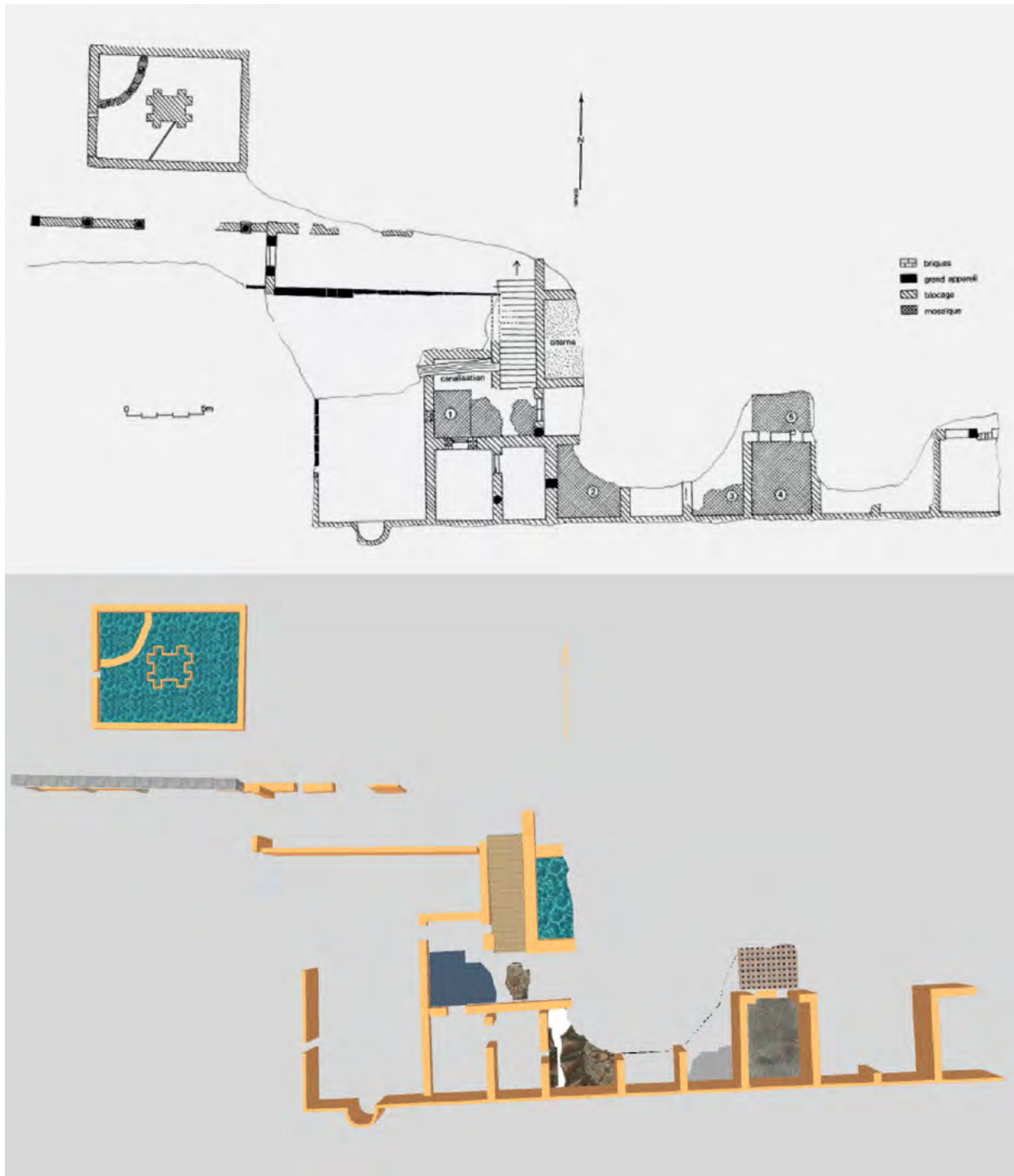


Fig. 1 - Planimetry executed during emergency excavation (1963), 2D restitution as top view of the 3D model.

south. Its overall plan included two levels separated by a terrace wall of large units, of which more than 15 m have been excavated. On the lower level to the north, a rectangular basin (10 m by 7,50 m, and 0,70 m deep) with a fountain built on a square plan of 2,80 m on each side was uncovered; it was pierced, on its sides, by

rectangular niches and had a water jet whose supply pipe was still visible.

The basin whose bottom was paved with a white mosaic and whose walls were made with blocks occupied perhaps the center of a peristyle. Of this peristyle, only traces of the southern gallery were cleared. A mosaic

corridor 17 m long and 3,30 m wide, communicating with the southern gallery of the peristyle, led to a staircase of 18 steps. The wall limiting this corridor to the south, of which only a stone foundation is preserved, probably rose to the level of the upper rooms and supported, in all likelihood, a gallery 3 m wide, which gave access to a living room. To the east of this staircase, there was a large room, 5 m wide, which was partially cleared. To the north of this, there were two small hypocaust rooms. The upper level, located 3 m above the first level, has a large room paved with mosaics and forming an entrance. Then, for a length of about forty meters, ten rooms aligned from west to east were cleared. South, leaning against a common back wall, more than half of the tenth room and the beginning of an eleventh disappeared under the modern dwelling of the owner.

All the rooms had the same depth of 4,5 m, except for one in the west which was much larger, being more than 6,60 m wide and more than 7,50 m from north to south and ending in the south with a niche intended to house a statue. Their width varied between 3 m and 3,80 m except for a clear room in the east whose width was 7,50 m. Several of these rooms were interconnected and had thresholds that opened into a long corridor to the north. According to the excavation reports, the house was built on a virgin soil and the test pits made under the mosaics before their removal did not reveal any shards above a layer of tuff 0,50 m which was absolutely sterile. The importance of this house lies mainly in the mosaics it has uncovered: about 70 m² were removed, including four large panels (Baghli, Février 1962; Baghli, Février 1968; Ferdi, Malek 1994; Ferdi 2005; Lassus 1975; Leveau 1982).

Starting from a simple planimetry and the existing archaeological documentation (fig. 1), along with other graphic and photographic data, it has been possible to model the spaces that have disappeared since their discovery in 1963. This was done using free software dedicated to 3D reconstruction, by simply extruding the 2D planimetry, texturing the walls and filling the room floors with the mosaic pictures, in the case of the Jonchée mosaic we made a 3D model of the mosaic to obtain an ortho-photography of the pavement (figs. 2-5).

We have chosen to present a very basic volumetric reconstruction of the building without restoring the architectural details, which for the most part are unknown and not well documented. The restored structures are also editable, so that the hypotheses can be updated and modified as future discoveries are made. In spite of the lack of information, a restitution of the volumes is still possible thanks essentially to the analysis of the plans and images are available to us.

The setting up of virtual collections could prove their utility in case of loss, alienation or disappearance of the objects, site or monument itself. It is in fact a new type of technological approach for safeguarding the enormous archaeological heritage of Algeria. The capitalization of knowledge by the digital tool would also make it possible to carry out the preventive conservation of this knowledge before its disappearance, its classification in optimal conditions and the development of point access to the information for the public and the research community. It is important to consider these techniques as communication tools in order to produce, disseminate and outreach at several levels concerning the archaeological heritage.

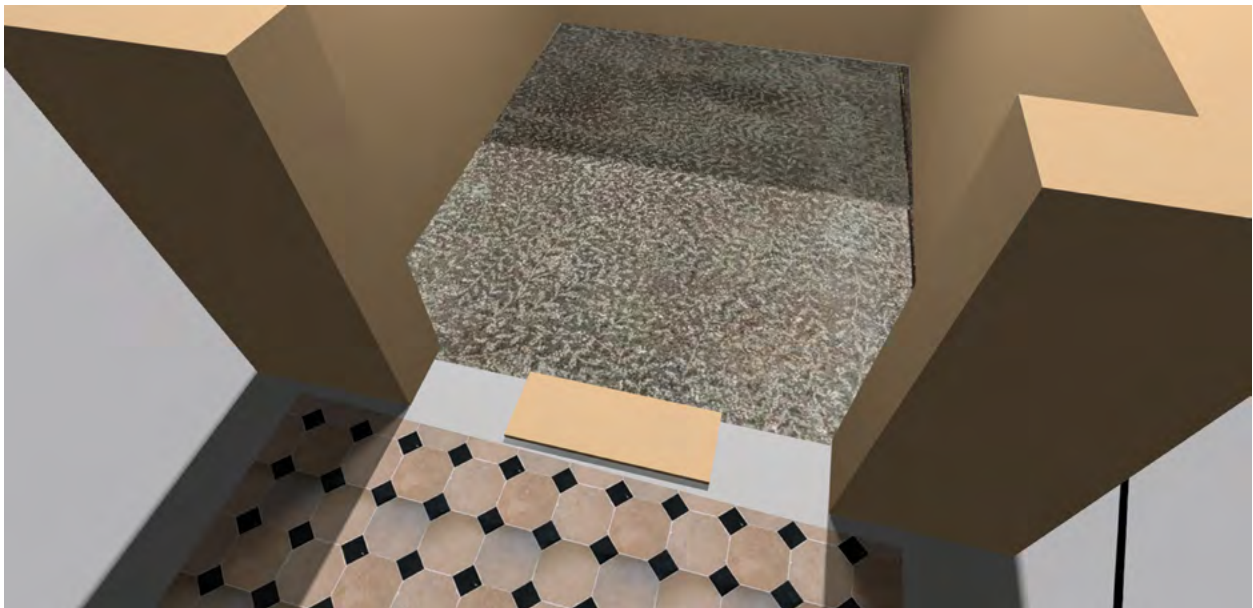


Fig. 2 - The Jonchée mosaic repositioned as a floor pavement in its original room proposed by the 2D planimetry.



Fig. 3 - Interpretation following the 2D plan of the mosaics positions.

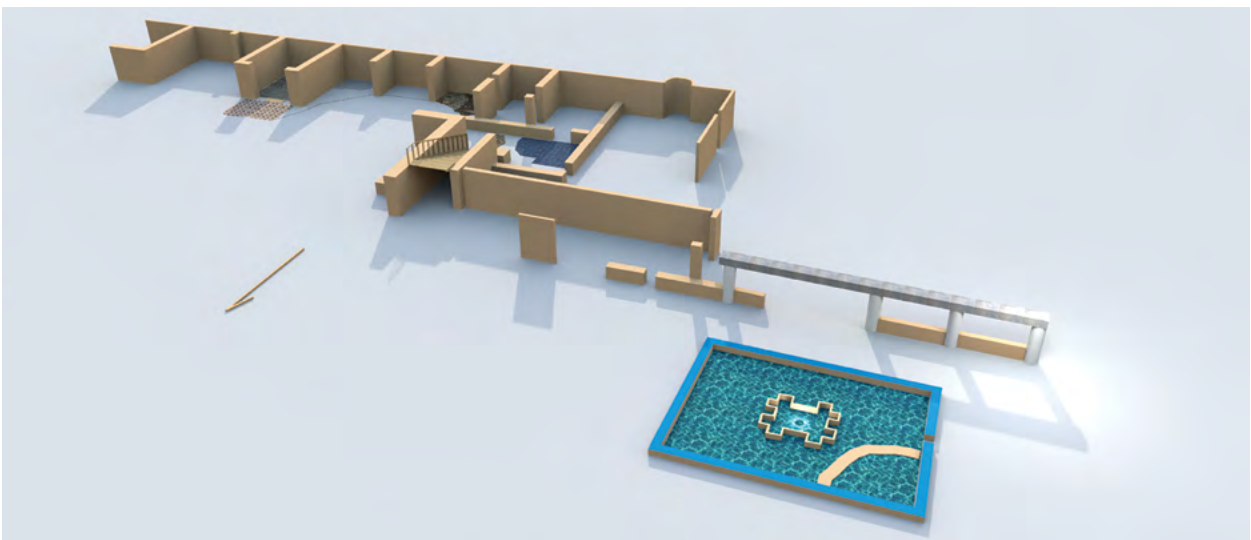


Fig. 4 - 3D tilted view of all the partly reconstructed Jonchée house.

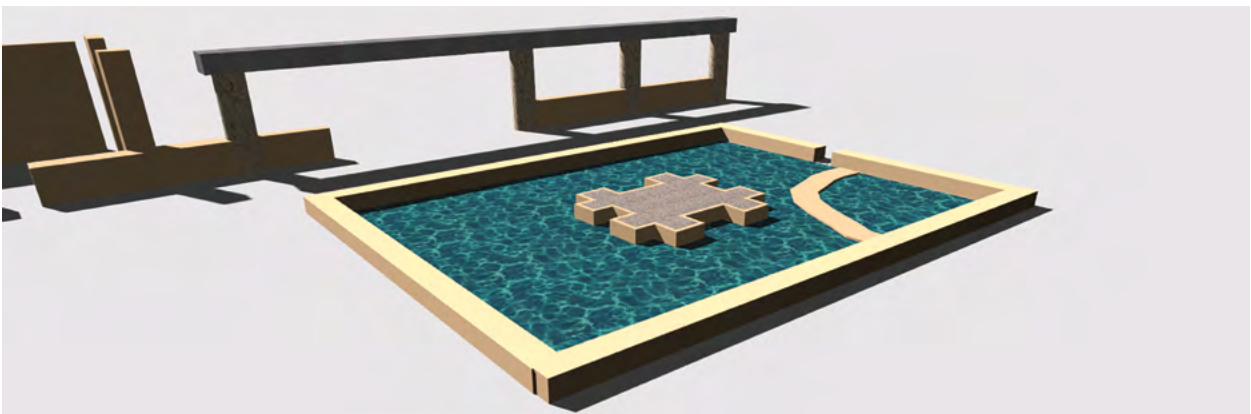


Fig. 5 - 3D reconstruction of the pool.



Fig. 6 - Proposal of reconstitution of the basilica after Mehdi Chayani and al. The floor mosaic is handmade reconstruction of a disappeared pavement.

THE CASE OF THE RESTORATION OF THE BASILICA OF SANCTA SALSA FROM TIPASA

It is within the framework of a collaborative project between the UMS SHS 3D Archaeovision and the *Centre National de Recherche en Archéologie* (CNRA) that the 3D photogrammetric survey has made possible a dig-

ital acquisition of the Sainte Salsa Basilica, in order to propose a hypothesis of a three dimensional restitution. During the photographic campaign of digitalization of the Sainte Salsa Basilica carried out by this project, the UMS SHS3D has enabled the acquisition of nearly 1300 photos. The survey methodology required a protocol for the acquisition of images divid-

ed into two stages: first the overall architectural survey of the monument segmented into several zones and then the survey of smaller architectural elements. The computer processing was carried out with the software developed by UMS SHS 3D Archaeovision, which integrates royalty-free algorithms (Sift, Bundler, CmvS, Pmvs). Eventually a high density 3D point cloud of the remains of the basilica was generated (13 million points) (fig. 6, Chayani *et alii* 2015)

RECONSTITUTION OF THE CIVIL BASILICA AND ITS CORRESPONDING “SLAVES MOSAIC”

The Judicial or civil basilica of the 2nd century A.D., in which the mosaic of the slaves was discovered and is now exhibited vertically in the Tipasa Museum, served both as a commerce chamber and as a trading center. The pavement covered the floor of the apse as shown in fig. 7, which is the result of a 3D reconstruction.

The civil basilica was at the same time civil court, meeting room and even place of trade exchange; it measures 40 m by 11 m. It was built in very beautifully worked stones, and columns support the main part and its two aisles. The south side was bordered by a portico with columns of various styles. Regarding the apse, the semicircular part is oriented to the north and its floor was paved with the mosaic of the captives which today is shown in the museum. On each side of the apse, there were two deliberation rooms. The staircase used to access the basilica is made of 6 high steps and it's located to the south (Baradez 1957; Lancel, Bouchenaki 1966).

The 3D modelisations of both the mosaic and the basilica's apse have been made separately. In 2015 a photo shooting session (Canon EOS 5D Mark II) was performed within the Tipasa museum on several exposed objects. The vertical mosaic of the Slaves was planned to be 3D modeled in order to make an orthomosaic composition and 3D reconstruction within its original place in the outdoor apse of the civil Basilica located in the Tipasa site. The apse has been later digitized in 2018 using a moving shooting technique with a GoPro. The mosaic instead, has been photographed with a Canon full frame camera, producing thus high quality images. Using then Agisoft Metashape software, it has been possible to produce all the necessary 3D material for the final reconstruction.

3D MODELLING: TECHNICAL AND TIME-CONSUMING CONSIDERATIONS

It is evident that each of the 3D models we have mentioned have undergone different and varied processes in terms of the type of data acquisition technique,

their preparation for processing and the processing itself. Each case will require an appropriate workflow, hardware and software resources adapted for that technique. The consumed time is also different for each technique of data preparation and processing starting from flat data to 3D information.

In the case of la Jonchée, the approach used free software (Sweet Home 3D) to extrude the vertical structures starting from a 2D paper plan that was scanned and then scaled in the software as a background image. The time was spent in the first phase tracing lines, polygons and patterns that we wanted in our final 3D model. Then the rendering phase will be more or less time consuming, depending on the complexity of the structures, lights, shadows, the shading algorithm and of course the performance of the workstation. A GPU (Graphical Processing Unit) embedded in the graphical card is often useful for a such work decreasing dramatically the processing time. In the case of the reconstitution of the civil basilica and its corresponding “Slaves mosaic” it's required a knowledge in photography and expertise in the use of photogrammetry software (Agisoft Metashape and Pix4D). The shooting in this case was done with an innovative technique using a GoPro 5 (with GPS) mounted on a stabilizer (gimbal) that provides the stabilization of the GoPro during the acquisition of pictures every 2 seconds, so we can get a coverage with a high level of overlap. This superposition will be useful for generating the 3D model (since we have many stereo pairs). The next and last steps are done in the laboratory. The first step will produce the alignment of the picture set helped also by the GeoTag (GPS coordinates) then after obtaining a scattered first cloud we proceed to its densification, finally a mesh network (nodes and segments) will provide the basis for the 3D model. At the end, we use the photomosaic draped as a colored texture for a final realistic 3D model. Even here the time spent has to be summed up as a “total necessary time” but considering the low cost and the excellent results, it is worth the effort.

For the final result, we use 3D editing software to assemble the two models (MeshLab, Blender, etc) made in different times and places to attempt an interpretative reconstitution under the watchful eye of a specialist (archaeologist, architect, historian).

CONCLUSIONS

The question must be asked whether digitalization should be limited to the production of a substitute or clone, rather than simply serving as a storage medium for the original heritage object. In this case the only problem would be to make a representation that can

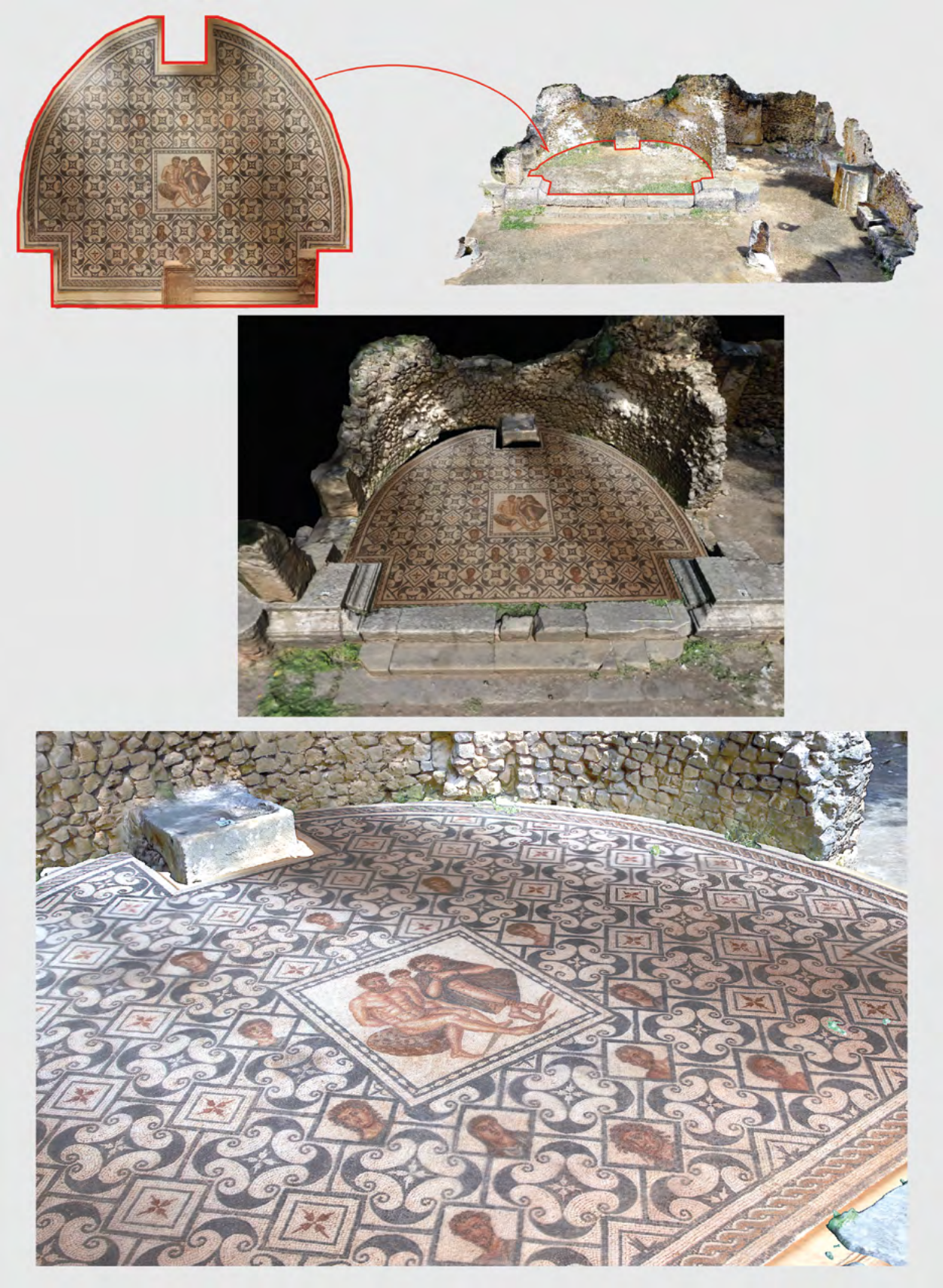


Fig 7 - Photogrammetry and 3D reconstruction of both the Mosaic pavement and the Apse of the Judicial basilica. The two last pictures illustrate the recomposition of the pavement exposed in the museum and the apse still outdoor in Tipasa archeological site.

be considered a faithful reference to the authentic object, enriched by a semantic information that enhances the simply digital object. Digitalization and modelling should also create a virtual environments in order to provide a full-immersion revisitation experience, providing hence a kind of shared information in a comprehensive manner.

The challenge is also elsewhere: the substitute (or “digital clone”) will not simply be an interchangeable support for a museum object, its role is also to augment the observation using a refined representation of the textures and materials of objects that are too fragmentary or fragile, or even missing. Moreover the digital substitute enables to multiply and amplify the potential of archeological heritage thanks to the Internet.

Finally, during an emergency excavation, when archaeologists are rushing under the pressure of an imminent urbanistic development work, this can be a method able to speed up field investigations. To allow a new preventive approach for archaeology, a technological approach and an accurate 3D acquisition are required.

The use of 3D in the heritage field is a consolidated and important approach. Heritage professionals can take advantage of many options to carry out various works such as archiving of structures for possible reconstructions, analysis of deterioration over time, creation of 3D models for visualization, file and data exchange, creation of public libraries.

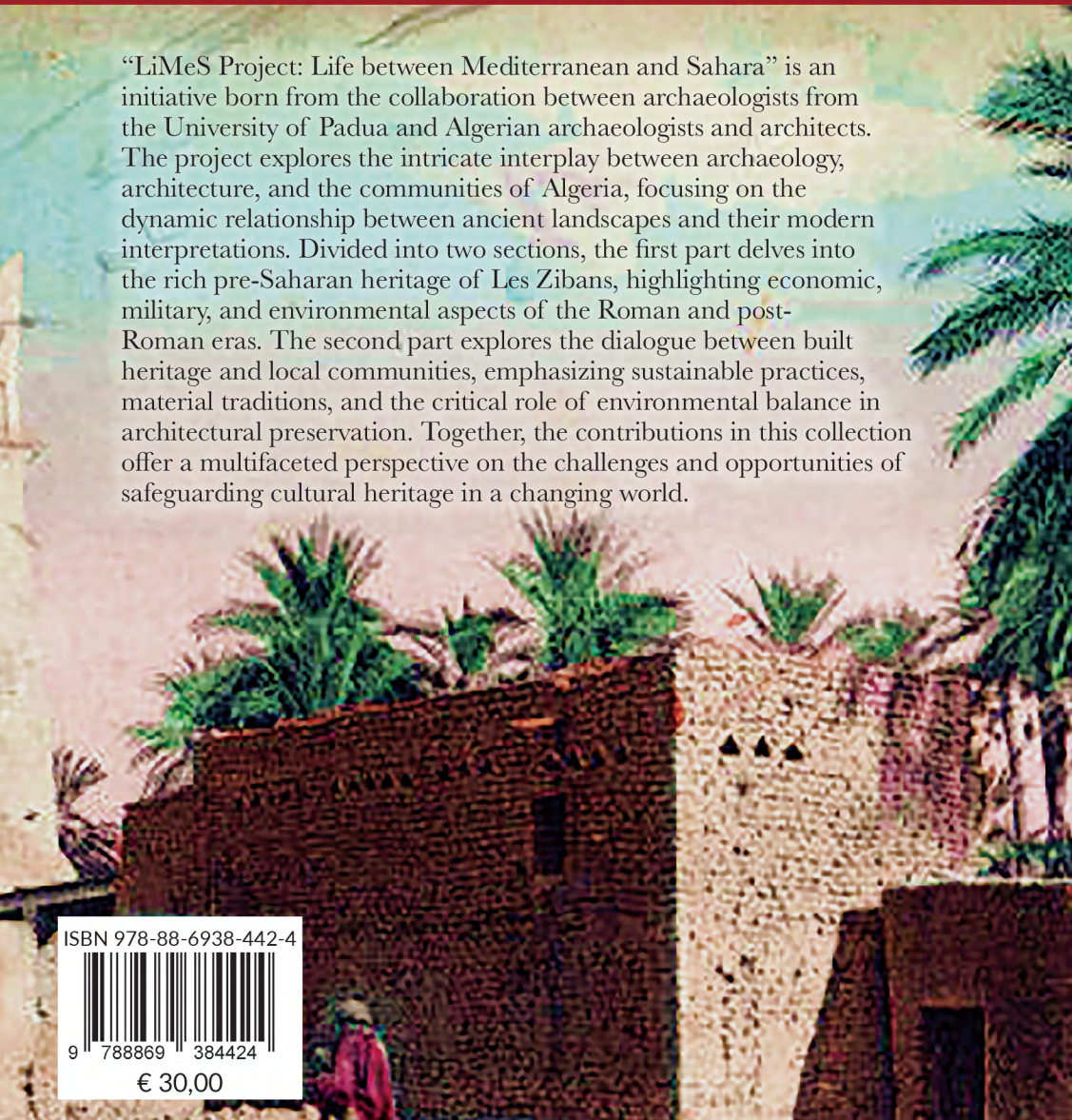
There are two ways to resolve the problem of digitalization of the patrimony, professional and expensive techniques are the best choice, but low cost and simple techniques can provide good results and reach the same goal. Emergent countries with a great historical past should enter in this race against time to save as much as possible of their cultural heritage.

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“LiMeS Project: Life between Mediterranean and Sahara” is an initiative born from the collaboration between archaeologists from the University of Padua and Algerian archaeologists and architects. The project explores the intricate interplay between archaeology, architecture, and the communities of Algeria, focusing on the dynamic relationship between ancient landscapes and their modern interpretations. Divided into two sections, the first part delves into the rich pre-Saharan heritage of Les Zibans, highlighting economic, military, and environmental aspects of the Roman and post-Roman eras. The second part explores the dialogue between built heritage and local communities, emphasizing sustainable practices, material traditions, and the critical role of environmental balance in architectural preservation. Together, the contributions in this collection offer a multifaceted perspective on the challenges and opportunities of safeguarding cultural heritage in a changing world.



ISBN 978-88-6938-442-4



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