

# MOBILITHICS: Fingerprinting the exploitation of lithic resources during the Upper Pleistocene

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## ABSTRACT

Mobilithics is a multiscale project aimed at characterizing the lithic resources exploitation and territorial adaptive responses among the last *Homo neanderthalensis* and *Homo sapiens* to different climatic, cultural, and biological dynamics. The project focuses on the Middle-to-Later Stone Age, in North Africa, and the Middle to Upper Palaeolithic Transition in the Mediterranean basin of the Iberian Peninsula, as key scenarios for the origin and expansion of our species. Results on geospatial modelling, petrographic and geochemical analyses, and multivariate statistics and predictive models determine the variability on resource procurement and territorial structure. These will contribute to the international debate on the adaptability of our species to different palaeoenvironments, sociocultural realities, and changing climatic conditions.

**Section:** RESEARCH PAPER

**Keywords:** Pleistocene; Middle-to-Upper Palaeolithic; MSA-LSA; lithics, mobility; settlement

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## 1. INTRODUCTION

The emergence of *Homo sapiens*, or Anatomically Modern Humans (henceforth AMH) during the African Middle Pleistocene has been traditionally explained by a single origin paradigm [1]. However, this perspective is being challenged by a new theory supporting a pan-African process in which “modern”

anatomical and cultural traits appeared independently across a continental metapopulation structure [2], [3].

The major Pleistocene climatic fluctuations caused drastic oscillations in the African landscapes [4]-[6], including contractions and expansions of deserts and rainforests that lead to events of splitting and merging of human populations. This fusion – fission model resulted in different evolutionary

trajectories and the progressive amalgamation of independently evolved anatomical and cultural traits [7]. This model is based on one hand on the basal *Homo sapiens* genomic structure in Africa, consisting of four major original lineages dating back to approximately 300 ka BP: the south African khoe-san, the central Africa mbuti and aka groups, the Eastern African lineage that gave rise to all non-African populations, and the Western African lineage or “ghost moderns” [8], [9]. On the other hand, it is also based on the alleged polycentric evolution of the Middle Stone Age cultural tradition [10]-[13]. This process shaped a highly versatile species that eventually spread beyond its original African niches through Eurasia and Australasia, with major consequences for the different human species encountered along the way.

This adaptive versatility is claimed to be an AMH defining and is supported by the increase of behavioral complexity and the ramifications of economic strategies documented during the Upper Pleistocene (120 – 12 ka BP). Allegedly, this process 1) allowed AMH to thrive in some of the harsher African ecological niches such as rainforests and desertic and semi-desertic areas, and 2) constituted a competitive advantage against other hominin species during their out-of-Africa expansion.

MobiLithics is a research project aimed at testing both scenarios through a diachronic characterization of the AMH resource procurement strategies during its evolution in Africa, as a proxy for their adaptive flexibility to environmental oscillations and changes, and their later expansion through Eurasia, to evaluate whether it truly supposed a competitive advantage [14]. The final objective of the project is to provide high-resolution resource procurement data from two key territories: Eastern Morocco during the Middle Stone Age (MSA) and the emergence of the bladelet technologies defining the Later Stone Age (LSA) by one hand, and Mediterranean Iberia during the Middle-to-Upper Paleolithic Transition, as straightforward way of contraposing the procurement dynamics of local Neanderthal populations against those exhibited by the incoming AMH groups by the other.

Research challenges in understanding the expansive pattern of AMH comes from understanding their demographic structure and potential interactions with other human species, such as *Homo neanderthalensis*. Overcoming these challenges requires integrating novel points of view, the combination of different disciplines, and to pose innovative paradigms and alternative hypotheses to offer new data to traditional debates [12].

MobiLithics focuses on the analysis of procurement and management strategies of lithic resources as key archaeometric proxies to evaluate human adaptability. The main pillars of the project are the geospatial study on the location, distribution, and abundance of the available lithic resources, and the petrographic, mineralogical, and geochemical analyses of the archaeological lithic assemblages [15], [16]. This will lead to determine the patterns of variability in the palaeoeconomic behaviours across time and territorial boundaries, as tangible adaptive responses on a global scale.

The ongoing first phase of MobiLithics targets the evolution of raw material procurement strategies during the MSA and LSA.

## 2. STATE-OF-THE-ART

The Upper Pleistocene in North Africa is characterized by strong climatic fluctuations that caused unstable conditions for habitability [17]. However, it constitutes an interesting territory for human evolution, as it is considered one of the main foci

within the polycentric model for the emergence of AMH [12] based on the recent taxonomic attribution to our species of the Jebel Irhoud skull (Morocco), dated back to ca. 300 ka [18].

Eastern Morocco has been recurrently occupied by Modern populations at least since the MIS5 (123 ka BP), coinciding with climatic ameliorations, associated to the ‘Green Sahara’ model that caused an increase in precipitations and the expansion of the savannah and wooded grasslands. These improvements were followed by a series of regionally unstable periods (70 – 30 ka BP) until the arrival of arid conditions (ca. 20 ka BP), and by later climatic improvements until the Holocene [19], [20].

The MSA, and the posterior appearance of the LSA technologies, occurred during this unstable period. The regional MSA is characterized by the so called Atero-Mousterian tradition, so often equated to the European Middle Paleolithic. The Atero-Mousterian displays a strong internal variability by the coexistence of allegedly different technological structures. The Aterian, by one side is defined by the presence of Levallois reduction sequences, tanged or “Aterian” points and scrapers, coexisting with occasional bifacial points and blade production [21]. The Mousterian, by the other, also exhibits a Levallois technical tradition but contrasts with the Aterian by the absolute absence of tanged tools. It is not yet known whether Aterian and Mousterian represents functional variations of the same technocomplex or different evolutionary stages within the MSA. Sites, such as Contrabandiers or Grotte de Rafhas, show Aterian – Mousterian superposition [22]-[24]. However, recent evidence from Ifri N’Ammar and Wadi Gran, tend to show the alternance or even the reversal of this sequence, confirming the need of novel approaches to overcome strict techno-typological approaches [25]-[27].

Traditionally, the MSA have been characterized by the long-term perdurance of the Atero-Mousterian technological structure and by an apparent scarce variability on site function. On the contrary, during the LSA a change in the settlement patterns is detected; the number of sites increases exponentially and are systematically associated to the immediate areas of fluvial systems. Except for the isolated Dabban assemblages from the Cyrenaica [28], the Moroccan Iberomaurusian represents the earliest LSA appearance in North Africa (25 – 23 ka BP) and seems to represent a migratory flow, propitiated by the Sahara contraction and the interconnection among different regions [29], [30].

Beyond the techno-typological changes, the LSA seems to be characterized by an increase of gathering strategies and vegetable processing, the origin of necropolis as complex funerary practices and the generalization of dental avulsion, based on the evidence documented at sites such as Ghar Cahal, Hattab II, Kefh el Hammar, Taforal, Ifri el Baroud, Ifri N’Ammar o Tamar Hat [31]-[34].

The upcoming second phase of MobiLithics will be focused on contraposing the procurement strategies during the Late Middle Palaeolithic and the Early Upper Palaeolithic (43-35 ka BP) on the Mediterranean Iberian Peninsula. The so-called Middle-to-Upper Paleolithic Transition is a key period regarding evolutionary biology and culture defined by disappearance of *Homo neanderthalensis* and its substitution by AMH populations [35] occurring through the climatic oscillations of Marine Isotopic Stage (MIS) 3 (57 – 29 ka BP). The general stratigraphy in SW Europe is structured by the succession of Late Middle Palaeolithic assemblages, the so-called Transitional Complexes as the Chatelperronian, whose association to either *H.*

*neanderthalensis* or AMH is still disputed, and the Aurignacian traditions, linked to incoming AMH populations.

However, for the Iberian Peninsula, climate-derived conditions have been proposed as the ruling factors constraining the rhythm of the biological and cultural substitution. Some proposals claim that AMH, adapted to the steppe-like environments with abundant biomass, did not thrive in the desert-stepped and arid conditions of Central Iberia [36], [37]. This scenario however clash with the global rapid expansion of *Homo sapiens* and their ability to adapt and prosper in challenging environments [38], [39].

Within this paradigm, Iberia represents the southernmost and latest area for the AMH expansion and consolidation in Europe. Their arrival occurred synchronically to the rest of Western Europe, however it seemed to be limited to the northern Cantabric area and the Pyrenees [40], where the succession among the Late Middle Palaeolithic, Chatelperronian, and Aurignacian is documented. Based on current evidence, the total occupation of the peninsula by AMH did not occur until much later, at least five millennia according to recent dating from SE Iberia [40]. During this lapse, *H. neanderthalensis* apparently continued occupying the territory [41].

Determining the differences between the palaeoeconomic behaviours of both human species will offer the possibility to evaluate whether AMH exhibited a higher adaptive flexibility by adopting *ad hoc* procurement strategies. The data from Eastern Morocco will set a null model for the ecological adaptability of AMH to oscillating ecological conditions, allowing to evaluate the specific influence of inter-specific competition for the study case of the Iberian Peninsula.

### 3. STUDY AREAS

MobiLithics address human evolutionary dynamics during the Upper Pleistocene in two critical regions for investigating the origin, evolution, and dispersion of AMH: North Africa and the Iberian Peninsula (Figure 1).

The North African region provides a complete evolutionary record of AMH, including their Middle Pleistocene origin and their cultural evolution through the Middle Stone Age and Later Stone Age technocomplexes. Despite facing a fluctuating climatic scenario marked by the cyclic expansion and contraction of the Sahara Desert, our species thrived in North Africa, adapting to moderate and hyper-arid phases [30], [42], [43].

The project focuses specifically on the Aïn Beni Mathar (ABM) – Guefait (GFT) basin, located in the NW Intra-Atlas Maghrebian Cenozoic depression in Eastern Morocco [44], [45]. The basin is rich in various lithologies such as rhyolite, basalts, sandstones, limestones, dolerites, and cherts. These lithologies are associated with Carboniferous, Triassic, Jurassic, and Early Miocene geological formations, including an extensive Neogene chert outcrop related to a sabhka-type palaeoenvironment.

Conversely, the Iberian Peninsula represents the area where the expansion of AMH culminated in Europe, and where the last alleged interactions with *H. neanderthalensis* took place [46]. In contrast to the first phase of the project, the second phase will focus on a cluster of sites from NE Mediterranean Iberia. The area is geologically limited by the Catalan Prelitoral Range and the Ebro basin, and characterized by Triassic [47], Lutetian and Bartonian aged formations yielding abundant silicifications [48] that were exploited for lithic raw materials procurement since the Early Pleistocene. NE Mediterranean Iberia is structured on three main geological features, the Central Catalan Depression,

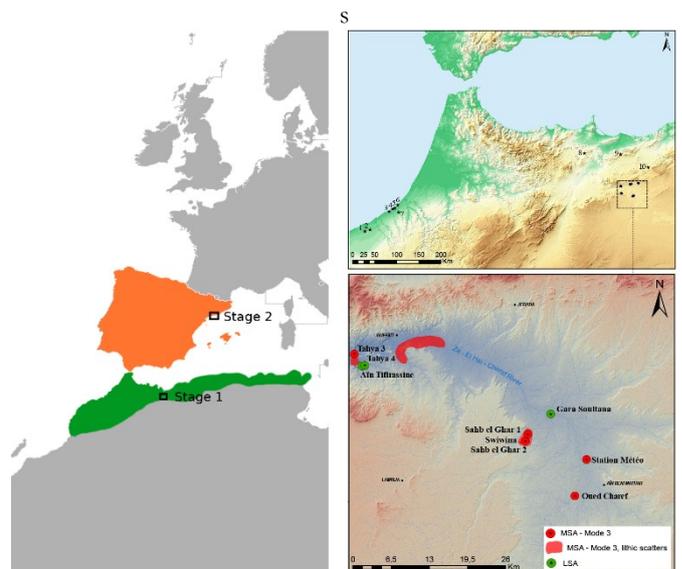


Figure 1. Study areas of the different research stages designed for MobiLithics Project (Left). Location map of MSA-LSA sites: 1. Sidi Abderrahmane; 2. Thomas Quarries; 3. Contrabandiers; 4. El Mansra; 5. El Harhoura I y II; 7. Chaperon-Rouge; 8. Ifri n’Ammar; 9. Taforalt; 10. Rhafas (Top Right). Detail of the ABM-GFT basin (Stage 1) and the MSA-LSA sites included in the project (Bottom Right).

the Catalan Coast Ranges, and the Prelitoral Depression. The Central Catalan Depression is characterized by Cenozoic (Paleogene) lithofacies, including lutites, gypsum, marls, limestones, and conglomerates, while the Catalan Coast Ranges are defined by Paleozoic slates and schists covered by Triassic and Jurassic limestones, dolomites, occasional gypsums, clays, and sandstones. The Prelitoral Depression consists of detrital materials from the Lower Oligocene and Pliocene, as well as Quaternary sediments [49].

### 4. MATERIALS AND METHODS

The first phase of this project is being developed on the ABM – GFT basin, in Eastern Morocco, within the framework of a bilateral Spanish – Moroccan research project ongoing since 2006 [50]. In this area, intensive surveying has allowed to document abundant archaeological evidence dating back from the Lower Pleistocene to the Holocene. However, the most ubiquitous record documented so far clearly associates to the MSA and LSA periods. This includes abundant open-air lithic scatters and constrained activity areas, but also well-stratified open-air sites such as Sabh el Ghar 1 and 2 or Tahya 3, associated to the MSA, or Aïn Tifirassine and Tahya 4, associated to the LSA. Archaeological excavations of different extension have been developed on the abovementioned sites leading to document mainly abundant stone tool assemblages, but also preserved faunal remains and structured hearths [51], [52].

MobiLithics proposes a multiscale analysis to locate the sources and characterize the raw materials exploited during the MSA and LSA occupations. The field and analytical workflows of the project include: 1) systematic geoarchaeological surveys and sampling; 2) creation of thematic cartography and bilateral regional reference collections following the principles of Open Science Framework to ensure the accessibility to raw data and guaranteeing the accomplishment of FAIR principles through certified repositories and pre-prints for data interoperability; 3) definition of the availability indexes through geospatial statistical

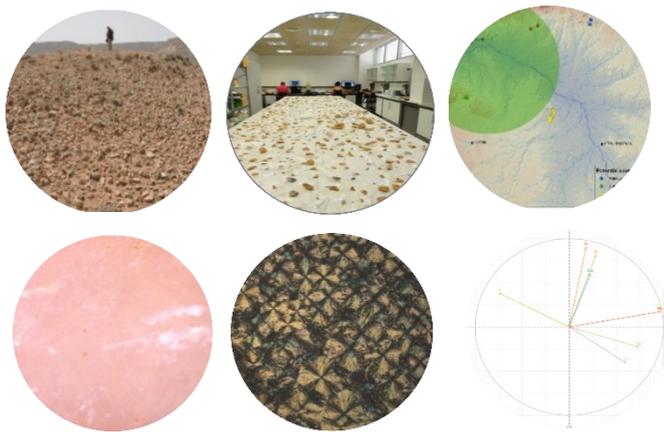


Figure 2. Representation of the Mobilithics methodological approach and designed workplan including: Systematic surveys and prospections; Sampling for the bilateral reference collection; Elaboration of specific cartography (Upper section); Macroscopic analyses; Petrographic thin sections; and geochemical analyses to determine lithic raw materials provenance.

methods such as Kernel Density and Path Distance; probabilistic models of resource distribution and regression models; 4) macroscopic, mineralogical and geochemical analysis, through thin sections, Raman Spectroscopy, Energy Dispersive X-Ray Spectroscopy and Energy Dispersive X-Ray Fluorescence; and 5) multivariant statistical analyses through Principal Component, Factor, Cluster and Discriminant Analyses, and predictive models to determine the procurement patterns and territorial extents (Figure 2).

The geospatial, petrographic and chemical characterization of the lithic resources available in the territory and its correlation with the raw material representation in the archaeological assemblages will allow to determine 1) the procurement strategies and exploitation territories during the MSA; 2) the continuity or discontinuity on the procurement strategies and exploitation territories occurring during the LSA; and 3) the correlation among the observed adaptive responses and the regional climatic cycles. This last aspect is one of the main research lines within the bilateral project, and a multiproxy approach is being developed by the project's research team including geochronology (magnetostratigraphy, ESR, TL, OSL U-TH, Cosmogenics and  $^{14}\text{C}$ ), palynology, phytoliths, anthracology, palaeontology of macro and small vertebrates, and isotopic analysis on plant wax biomarkers, faunal remains and pedogenic carbonates [51].

This first phase of the project will result in the creation of models of diachronic evolutionary trends and adaptation to changing climatic conditions during the Upper Pleistocene in Eastern Morocco. These models will serve as referential and comparative proxies to interpret the results from the second phase of the project and the differences in territorial management and raw material exploitation between *H. neanderthalensis* and AMH [53].

Recent investigations in the Mediterranean area of Spain have allowed to discover new archaeological sites dating back between 45-to-35 ka BP recording the complete cultural sequence of the Transition in sites such as Cova Foradada, Griera, Cova Gran de Collbató and Cova del Trader [54], [55]. These archaeological sites show for the first time a continuous record of Late Middle Paleolithic, Chatelperronian and Early Upper Paleolithic occupations in the Mediterranean region, and the analysis of the abundant lithic assemblages will allow to describe whether

differential strategies of territorial management and procurement between *H. neanderthalensis* and AMH occurred.

The multiscalar methodology outlined in Mobilithics is planned to be applied to both geographic units to determine whether variation between territorial exploitation strategies existed between *H. neanderthalensis* and AMH, and correlate the adaptive strategies exhibited by the later with the null model described in North Africa, where the potential interaction with other species is not considered. Expected results will allow to evaluate specific AMH responses in terms of adaptations to local conditions and whether the potential competition between species triggered novel adaptive strategies.

The initial schedule of Mobilithics planned the development of the first phase of the project, focused on Eastern Morocco, between 2019 and 2022, while the work on Mediterranean Iberia was planned to be developed since 2023. However, mobility restrictions imposed by the pandemic made it impossible to conduct the necessary fieldwork during 2020 and 2021. Due to this, preliminary results are currently available from the systematic surveys in the ABM - GFT area carried out during 2017 - 2019, as well as preliminary petrographic data analyzed, out of over a hundred thin sections.

A 30-kilometer radius around the ABM-GFT basin was established as the prospection area, based on several archaeological and ethnographic studies focused on examining Pleistocene lithic procurement strategies [56]-[60]. After gathering geological information about potential raw material outcrops and utilizing available cartographic resources such as geological maps, ortophotos, aerial photographs, and satellite images, we were able to delimitate the primary areas to investigate. During field surveying seasons, lithic raw materials outcrops were located and recorded in a database containing important descriptive characteristics such as location, accessibility, geological and lithostratigraphic context, raw material availability, and potential evidence of human exploitation [49]. The location data was imported into digitalized basemaps to create a specific raw materials cartography of the area. Located outcrops were systematically sampled, and the available raw materials collected creating a complete bilateral lithotheque yielding a representative sample of the lithic raw materials availability and variety in the region [54], that is allowing us to determine the principal characteristics of geological raw materials and determine the convergences with the lithic material from the MSA-LSA archaeological assemblages excavated.

## 5. RESULTS

Systematic geoarchaeological surveys and the first petrographic and geochemical analyses have allowed to differentiate and described four potential raw materials source area displaying a high variety of lithotypes that were available for Pleistocene hunter - gatherer's groups in the ABM-GFT basin (Figure 3):

### *ABM-Jerada area*

Along Carboniferous formations, located in the northeastern sector of the ABM-GFT basin, with an extension of ca. 20 km, biosparitic and microsparitic limestones, porphyritic mafic rhyolites, aphanitic basalts, and hematite are available as lithic raw materials in both primary and secondary position.

### *N-NE Hakam area*

In this area, a kilometric stretch of Triassic-aged formations composed by stromatolitic limestones veins are located yielding Very fine-textured flint with orange hues (10YR 7/4 Grayish

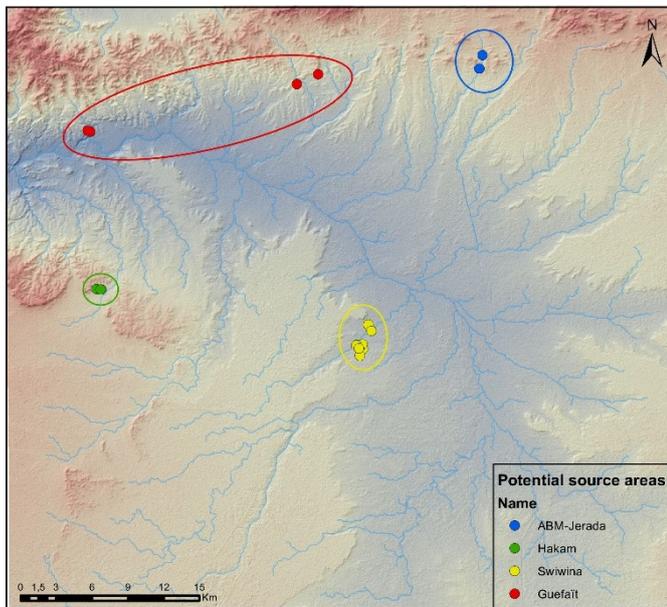


Figure 3. Distribution of the four potential source areas for lithic raw materials procurement within the ABM-GFT basin: ABM-Jerada; Hakam; Guefait and Swiwina.

Orange), opaque and highly patinated, with laminations of oxidations, with macrofossils and ooids on surfaces, and frequent fissures, describing a mudstone-wackestone texture. Analyzed cherts are product of silica replacement processes from calcareous lithologies with mudstone/wackestone texture.

#### *Guefait area*

Jurassic aged (Lias) formations located in the northwestern area of the prospected area are described along ca 10 km<sup>2</sup>, allowing to recognize recrystallized limestones and lithographic dolomites as main lithologies. Occasionally altered ophites and dolerites are described as enclosing rocks for vein-appearing decimetric jaspoid cherts, product of hydrothermal activity in the area

#### *Swiwina area*

Neogene-aged formations also known as Fosse de l'Oued Haï formation. are located along over 10km<sup>2</sup> in the central area of the ABM-GFT basin prospected. Composed of gypsarenites, secondary gypsums, gypsiferous marls and limestones related to a sabkha-type palaeoenvironment are defined as enclosing rocks

of nodular and mega-nodular fine-grained cherts. These cherts present gray to white colours, translucent surfaces with lenticular gypsum crystals, and chicken-wire anhydrite structures. Mineralogically they are mainly composed of microcrystalline quartz as matrix and negative-elongated fibrous quartz replacing the gypsiferous dissolution structures of the primary textures (Figure 4).

The macroscopic and petrographic characterization of the lithic assemblages ( $n = 2201$ ) from the MSA sites such as Sabh el Ghar (SBG) 1 ( $n = 439$ ) and 2 ( $n = 1530$ ), and Oued Charef ( $n = 232$ ), points to the preferential procurement and exploitation of the Swiwina cherts, being almost the exclusive lithic raw material exploited (representing over the 97 % of the described RMG) for the SBG occupations, and the most represented lithic raw material (54 %) for Oued Charef, followed up by Jurassic cherts (39 %).

Swiwina cherts, the most exploited lithic raw material during the MSA occupation of the basin, present a highly heterogeneous aspect, that has allowed the identification of up to six different macroscopic varieties (Figure 5):

- Swiwina A: Silicifications of gray colours (N7 Light Gray - 5Y 6/1 Light Olive Gray), medium-fine texture, and opaque with transparent edges and gypsiferous primary cortex (5YR 6/4 Light Brown). In surfaces and thin sections lenticular and chicken-wire anhydrite are described, confirming the evaporitic nature of the enclosing lithologies.
- Swiwina B: Described as gray-black hue (N5 Medium Gray – N4 Medium Dark gray) cherts with fine-very fine texture, translucent, with superficial lenticular gypsums and with cortical areas (5YR 6/4 Light Brown) indicating a calcareous lithofacies as enclosing rocks.
- Swiwina C: These cherts are described as chalcedony, presenting white colours (N8 Very Light Gray, N7 Light Gray), very fine to fine textures. They are translucent and present occasional lenticular gypsums in their surfaces and cortical areas (5YR 6/4 Light Brown) confirming they are product of an early silica replacement process from primary gypsums. Occasionally a subvariety of these chalcedonic cherts is identified, presenting grayish colors (N6 Medium Light



Figure 4. Hand samples of the bilateral reference collection including hematite and rhyolites from the ABM-GFT area (top left); chert from stromatolithic limestones from Hakam (top right); jaspoid cherts from Guefait (bottom left); and Swiwina cherts (bottom).

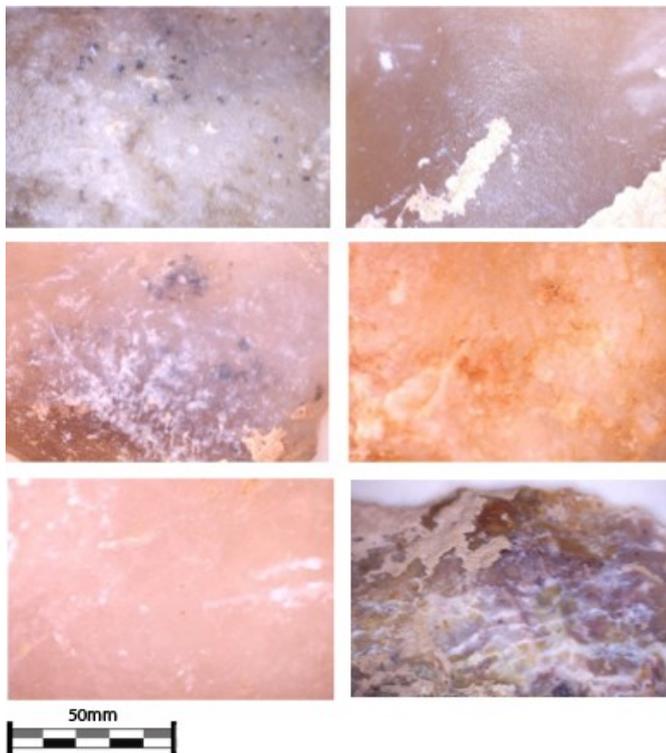


Figure 5. Macroscopic aspect of the chert varieties defined for the Swiwina area: Swiwina A (top left); Swiwina B (top right); Swiwina C (middle left); Swiwina D (middle right); Swiwina E (bottom left); and Swiwina F (bottom right).

Gray) and preserved dendrites observable in their surfaces.

- Swiwina D: Silicifications presenting white colors (N9 White, N5 Medium Gray), opaque surfaces and medium to coarse textures, with lenticular gypsum and entherolithic structures, confirming their evaporitic origin.
- Swiwina E: This variety are associated to blackish cherts (N5 Medium Gray, N4 Medium Dark Gray), with coarse to medium textures, and occasional lenticular cherts confirming they are product of an early diagenetic replacement of primary gypsum rich in organic matter.

MobiLithics team is currently analyzing petrographically and geochemically the systematic sampling of the Swiwina cherts, including a collection of over 100 uncovered thin sections of the cherts and their enclosing rocks.

Preliminary analysis confirms the six macroscopic varieties identified are mainly composed on microcrystalline quartz as matrix, with negative-elongated fibrous quartz forms (quartzine and lutecite) replacing frequent gypsiferous dissolution structures (Figure 6). Positive-elongated fibrous quartz is occasionally observed, probably related to the replacement of calcareous relicts from the primary textures replaced. These features hint, as pointed, to an early replacement from the evaporitic lithologies described along the stratigraphic sequence of Swiwina area, related with progressive-regressive episodes of a sabkha-like environment, and therefore with alternant evaporitic and calcareous facies.

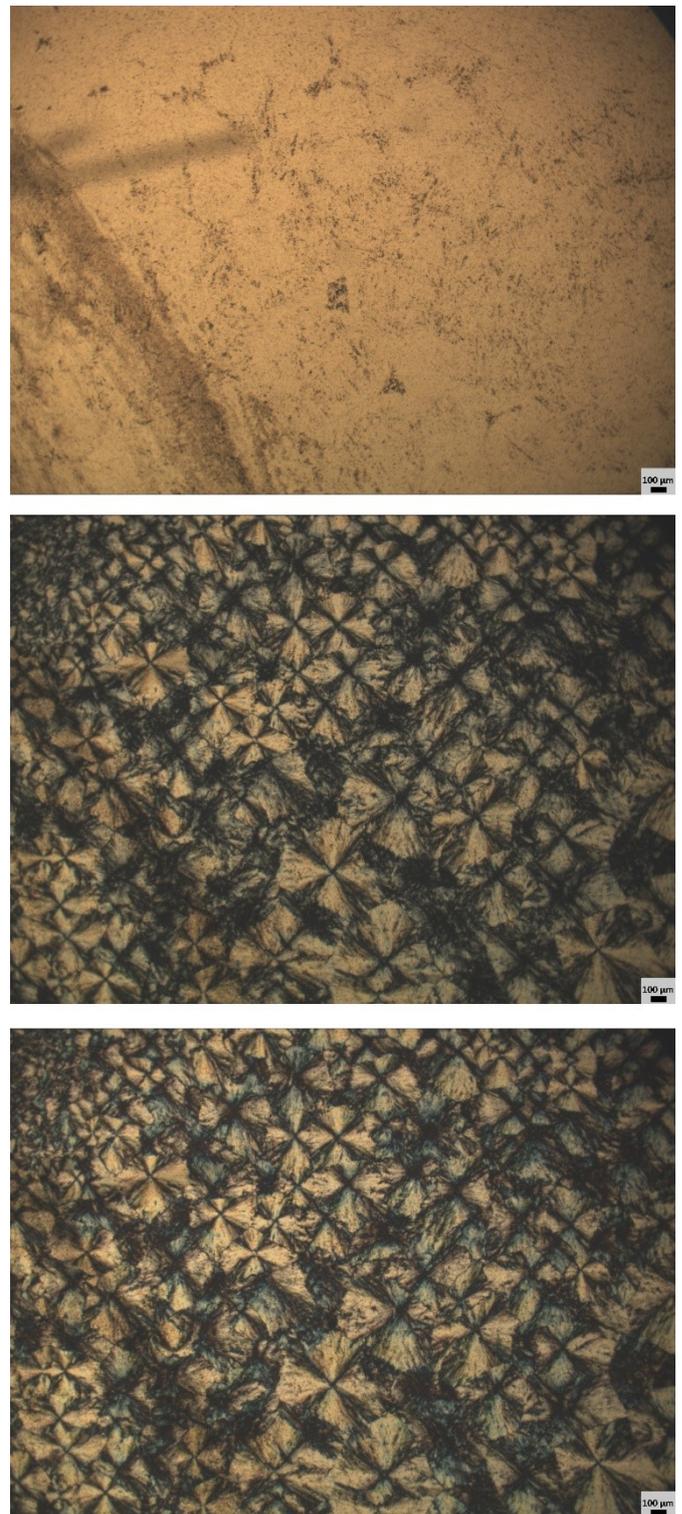


Figure 6. Microphotographs with Plane Polarized Light (top); Cross Polarized Light (middle), and waveplate of petrographic thin sections from Swiwina C cherts (chalcedony), showing microcrystalline matrix and negative elongated quartz replacing the gypsiferous dissolution structures.

In terms of procurement a local procurement range, from 0 up to 5km radius, can be attested for the MSA occupations of the basin, pointing to a direct lithic raw material catchment from primary deposits, in areas with extreme and rich availability of nodular and meganodular evaporitic cherts.

The local and almost exclusive exploitation of Neogene silicifications trend observed during the MSA occupations in the

eastern sector of the basin, changes when analyzing the lithic assemblages from the western sector, thus more distant to the primary outcrops, such as Tahya 3. The first approach to these assemblages has allowed to identify up to 19 raw materials groups including the exploitation of chert, limestones, and even silicified marls.

Macroscopic convergence with the reference collection confirms the presence of lithologies associated to all the knappable materials sampled in the basin. Thus, microsparithic limestones and mudstone limestones, associated to Carboniferous and Triassic formations from ABM-Jerada, and Hakam area, jaspoid cherts from Guefait and Neogene cherts from Swiwina area.

Preserved cortical areas points to a direct procurement from secondary deposits originated by the Charef-Haï Valley and tributary valleys yielding glacial and fluvial terraces consisting of fine-grained sediments and occasional gravels.

Both, the dominance of Swiwina cherts in the East and the high diversity of RMG in the West, points to a generalist lithic exploitation characterized by the use of local / very local resources, generating so drastically different lithological profiles within the basin during the MSA.

The analyses of the procurement patterns from the LSA sites of the ABM-GFT (Taya 4 and Ain Tifirassine) is currently ongoing, and definitive results are not available yet. However, preliminary data points to the systematic presence of higher quality cherts whose provenance have not been documented in the basin, and potentially indicates a larger foraging territory and the exploitation of far more distant raw material sources.

The ongoing definition of the lithic procurement strategies within the ABM-GFT, will serve as a null model of the mobility pattern within a rich lithoscape subjected to strong climatic and environmental fluctuation. During the second phase of the project, these results will be compared through the same multiscale approach with the strategies defined in the NE of Iberia, as an area extremely rich in knappable materials [51], [15], and where the substitution of human species could have interfered in a diachronic change of the territorial exploitation patterns.

Systematic prospections and preliminary macroscopic analyses of the lithic assemblages associated to the Middle to Upper Palaeolithic Transition have determined the existence of at least eight chert varieties or Raw Materials Groups (RMG). Convergences with the systematic reference collection hosted at LithIPHES [60] points to the exploitation of lithic resources from primary and secondary deposits of geological formations dated on Triassic, Lutetian and Bartonian age [15] (Figure 7).

These formations are located in a varying range from local to regional procurement, from secondary deposits in the immediate areas of the archaeological sites up to 70 km from them, suggesting a progressive increase on the procurement and mobility ranges during the evolution of our species, that must be confirmed through the completion of the project presented in this paper.

## 6. DISCUSSION

The role played by resource distribution, procurement strategies, mobility, and site functionality on the adaptation to new territories, will provide data for the expansion process of our species.

A progressive diversification of exploited resources, increase of long-distance incomes, and the expeditization on local

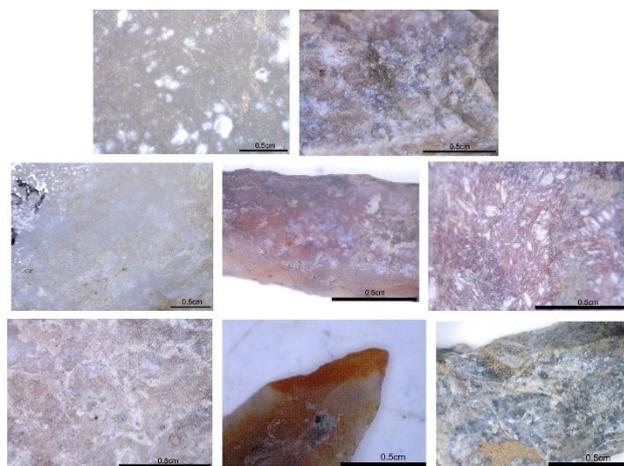


Figure 7. Macroscopic variability of the exploited cherts at the archaeological sites from NE Iberia included in Mobilithics, suggesting a lithic procurement on Triassic, Lutetian and Bartonian geological formations, that should be confirmed during the development of the second phase of Mobilithics.

resource management should be expected as result of stabilization and increase of residential settlements among highly mobile groups.

These proxies will determine discontinuities and differences in the settlement patterns between the Middle Stone Age-Later Stone Age and the Middle to Upper Palaeolithic Transition, evidencing the adaptive mechanisms of the first representatives of our species.

Definition of the raw materials sources and procurement strategies will provide us with novel quantitative insights for describe foraging (daily displacement between the source areas and procurement source) or logistical procurement strategies (based on specific displacements needing more than one night to return to base camps) and allow us to define the territorial mobility in the study areas [23], [21], [61].

To determine the patterns of continuity or discontinuity in the palaeoeconomic behaviours will define the scope of variability and flexibility in the subsistence strategies of *Homo sapiens*, determining whether these are explicit causes for the success and rapid expansion of our species, and contributing to the actual debate around their migratory flow, the interaction with other species, and the regional adaptive reactions to global environmental and climatic changes.

## 7. CONCLUSIONS

The multi-scalar approach designed for Mobilithics, based on geospatial modelling, petrographic and geochemical analyses, and predictive models will determine the variability of resource procurement, lithic management and land-use structure during Upper Pleistocene.

Quantitative and archaeometric data obtained during this project lifetime will be key to understand and contribute to the scientific debate on the adaptability of our species to diverse biological, sociocultural, climatic and paleoenvironmental settings.

Our preliminary results indicate different lithic procurement and mobility patterns can be differentiated through the origin and evolution of our species. These changes can be attributed to resources, palaeoecological changes, and/or different human species interactions, attesting the adaptability of *H. sapiens* as main characteristic to thrive to different eco-cultural scenarios.

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