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"A Materiality-Focused Exploration of Human-Thing Relationships : A Comparative Study of Late Upper Paleolithic Sites"

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Abstract

This thesis investigates the cognitive evolution and technological advancements of Late Upper Paleolithic societies through a comparative study from Guenfouda in Morocco and Moli del Salt in Spain, while integrating the emerging framework of materiality theory and object-oriented approaches. Despite the significant influence of materiality considerations on contemporary archaeological theory, Paleolithic archaeology has been slow to adopt these perspectives, particularly in examining the deep human past. This study aims to bridge that gap by exploring how the material dynamics of the Plio-Pleistocene can be clarified through materiality theory, re-articulating the debate on human evolution with broader discourses in archaeology and the humanities. By analyzing the typology, production techniques, and material properties of lithic assemblages, and mapping the ecological, technical, and evolutionary axes of human–thing relations, the research demonstrates that the unique temporalities and geospatial scales of the Palaeolithic record offer unparalleled opportunities to examine the active role of material objects, artifacts, and technologies in the emergence, stabilization, and transformation of hominin lifeworlds. Through a critical reassessment of material agency, the thesis not only introduces novel insights but also refines existing knowledge of the human deep past, emphasizing the co-adaptive processes through which hominids and their material environments continuously influenced and co-created each other. This integrated, object-oriented perspective highlights the human condition as a product of millennial-scale human–thing co-adaptation, positioning materiality as a central nexus for exchange and inspiration within Paleolithic archaeology.

Introduction

Paleolithic archaeology is traditionally defined as the study of the behaviors and lifeways of hominins during the earliest periods of prehistory, spanning from the emergence of the first stone tools around 3 to 4 million years ago to the end of the last Ice Age, approximately 11,800 years ago. This field uniquely relies on the fragmented and often incomplete record of lithic tools that have survived the millennia of human and geological history. Despite the apparent abundance of material evidence—artefacts and ecofacts—relative to hominin fossils and biosignatures, Paleolithic archaeology has conventionally focused on the examination of hominin behavior and their interactions with the environment. This human-centric approach has often overlooked the crucial role that material things, particularly lithic tools, have played in the cognitive and cultural evolution of our species.

The discourse surrounding lithic technology highlights this dilemma: Stone tools are either viewed as intimately connected with hominin biology, behavior, and culture, serving as reflections of hominin activity and cognition, or as adaptive interfaces that helped early humans navigate their paleoenvironments. This creates a paradox, as the pre-Holocene archaeological record is dominated by material remains, yet the inherent value of these objects in shaping human history has been underexplored. Consequently, Palaeolithic archaeologists have often neglected the development of conceptual and methodological approaches that fully embrace the foundational materiality of their record.

This thesis aims to address this gap by integrating materiality theory and object-oriented approaches into the study of lithic tools from the Late Upper Paleolithic sites of Guenfouda in Morocco and Moli del Salt in Spain. By focusing on the agency of material things, this research seeks to recalibrate our understanding of the active role that lithic artifacts and technologies have played in the emergence, stabilization, and transformation of hominin lifeworlds. The study begins with an overview of key concepts from materiality theory that can be applied to the study of the deep human past. It then revisits the nature of the Palaeolithic record, discussing the advantages of employing materiality-based approaches and exploring how these perspectives can enhance our understanding of macro-archaeological patterns and the formative role of material environments.

Focusing on lithic technology, which represents the most abundant evidence from the Palaeolithic, the thesis identifies three axes of inquiry—ecological, technical, and evolutionary—that benefit from a materiality-centered approach. Through case studies from Guenfouda and Moli del Salt, this research demonstrates how a focus on the agency and impact of material things and technologies can inform new interpretations of lithic reduction systems, ecological landscape archaeology, and the millennial-scale evolution of stone artifacts. Finally, the integrated perspective offered by this thesis assesses the potential of materiality-based approaches to bridge disciplinary divides and advance our understanding of the material conditions that shaped human evolution in the non-analogous Paleolithic past.

Theoretical Framework

Materiality in Archaeology

Materiality theory represents a tectonic change in the way material things, objects, artifacts, and technologies are thought of by archaeologists—no longer as mere mirrors or manifestations of human behavior, cognition, or ecological needs, but as materially active forces shaping human life and culture. This perspective underscores the 'thingness' of things and the agency of objects, suggesting that material factors can substantially determine human action, thought, and social structure (Henare et al., 2007; Carlile and Langley, 2013; Lemonnier, 2014).

In such a way, materiality theory stands against traditional dualisms, for example, the hylomorphism of ancient Greece, which divorces form from matter, and the Cartesian perception of objects as passive. Instead, material things are seen as active agents in the co-formation of human realities that drive forward the creation of shared lifeworlds and set the course for the biocultural trajectory of evolution. This theoretical reorientation belongs to a much broader intellectual movement within the humanities and social sciences that also includes the 'material turn' and the 'non-human turn,' both of which are critical of the longtime focus on human exceptionalism (Miller 1998; Grusin 2015). These movements, along with object-oriented approaches, want to decenter the human and explore material worlds for the implications they have on human behavior, culture, and evolution (Hayles 1999; Knappett and Malafouris 2008; Bogost 2012).

This entails the new attention to the material conditions of human life, which is also coming from inside material culture studies and science and technology studies (STS), with their stresses on the perpetual co-constitution of humans and things (Miller 1998, 2005; Hahn 2005, 2015; Tilley et al. 2006a; Eggert 2014; Hicks and Beaudry 2018). This means that materiality theory presents an altogether new perspective in considering the role of lithic tools within the cognitive and cultural evolution of early human societies. This thesis follows a materiality-centered approach to the study of lithic assemblages from the Late Upper Paleolithic sites of Guenfouda in Morocco and Moli del Salt in Spain in order to explore how such material objects contributed to the development of hominin lifeworlds. The research therefore attempts to direct attention to the agency of lithic artifacts and show that they were not passively reflecting human behavior but participated in co-evolutionary processes that shaped the trajectory of human history.

This approach adheres to the general purposes of materiality theory, which stress the value of material things in understanding the complex web of past human realities and call into question traditional human-centered narratives in archaeology (e.g. Tilley et al. 2006b; Barrett 2014). Therefore, this thesis contributes to the rapidly growing scholarship on the recognition of the importance of material agency within the remit of lithic technology. It provides a theoretical framework through which objects' potency in the past might be analyzed, thus throwing novel light on the role lithic technology played in the cognitive and cultural development of Late Upper Paleolithic societies. In this way, materiality-focused scholarship becomes uniquely sensitive to questions about human-thing interactions, specifically by emphasizing the necessity of taking the active dimension of the material entity seriously in addressing issues related to human origins.

Material Agency

The concept of material agency addresses the active and consequential roles that material things play in human societies, an idea that has gained increasing traction in archaeology and related disciplines (Henare et al. 2007; Knappett and Malafouris 2008; Kirchhoff 2009; Pickering 2010; Lindstrøm 2015; Jones and Boivin 2018). This framework allows for a nuanced exploration of how material entities—ranging from tools and artifacts to technologies—interact with humans and shape cultural, cosmological, and social dynamics. Understanding material agency requires engaging with various research traditions, including material culture studies and French techno-anthropology, which emphasize the importance of distinguishing between different types of material entities, such as objects, things, artifacts, instruments, and technologies (Rabardel 1995; Hahn et al. 2014; Guchet 2018).

According to Guchet (2018), technological objects, while man-made and intentional, possess their own activity within both natural and social worlds, linking unpredictably with other entities and generating processes that can escape human control. Similarly, Hahn (2005) warns against narrowly focusing on the intentional products of human behavior and technical action, advocating instead for an examination of the "totality of material objects" that influence human lifeworlds. Hahn stresses the context dependency and inherent polyvalency of material objects, which transform human experience and draw people into evolving material engagements. This polyvalency, distinct from the semantic incompleteness found in language, challenges the notion of material culture as a mere text and supports a view of the material world as a self-contained reality with its own logic and rules.

In the context of this thesis, which examines lithic tools from the Late Upper Paleolithic sites of Guenfouda in Morocco and Moli del Salt in Spain, the concept of material agency is crucial for understanding how these artifacts actively participated in shaping hominin cognitive and cultural evolution. By exploring the difference-making propensity of lithic tools beyond their function as mediums of human expression, this research highlights the complex and dynamic interactions between hominins and their material environments. The application of material agency theory in this context underscores the importance of considering the active roles that material objects play in human history, offering new insights into the co-evolutionary processes that have shaped the trajectory of human development.

Rethinking Causality and Agency

Traditional views of agency in archaeology largely represent human intention. Objects are perceived as inanimate and lifeless until enlivened by human hands. The view integrates into a more general anthropocentric view, which considers humans as the major agents of change in the world, while material objects work for them or as the conduit through which human desires and intentions are fulfilled. However, materiality theory challenges this and suggests a more distributed or network-theoretical model of agency, where many heterogeneous entities—human and non-human—interact in complicated ways to bring change into the world.

This definition of distributed agency dovetails closely with actor-network theory (ANT), as elaborated by scholars like Bruno Latour (2005). ANT holds that agency is not the solely human attribute but instead a capacity distributed across networks of actors, which might include humans, objects, animals, and even such abstract entities as ideas or technologies. In this view, material objects are not simply passive recipients of human action but are active agents in networks of agency where their specific properties, possibilities, and limitations contribute to the making of outcomes. By these means, human agency becomes more widely conceived than in conventional humanistic explanations, which assume intentionality and purposeful action, and takes place in a much more complex form than with an appreciation of nonhuman agencies as determinants of human history.

The Concept of the Actant

In this context, Latour's concept of the 'actant' is most helpful. An actant is an entity that can perform within a network, and it can be human, non-human, even conceptual; this serves to include a broader view of who and what has the agency, without the distinction between human or non-human actors. The notion of the actant thus makes it possible to provide a theoretical grounding for understanding how objects can influence human agency, culture, or evolution by recognizing the specificity of human agency and at the same time the influence of another reality-making agent—in this case, material objects.

Effect vs. Affect and Direct Action vs. Action at a Distance

To develop further the idea of material agency, it is useful to compare two sets of related concepts: effect vs. affect and direct action vs. action at a distance. The impact that material objects have on human behavior is conventionally regarded in terms of direct causality, and indeed, objects are regarded as instrumental in producing some direct effect when used by humans. Materiality theory introduces the concept of affect, in the sense that objects might influence human behavior not as a result of direct causality but more in subtle, roundabout ways.

Affect has been defined as a 'relay between subject and object' in which an object's physical properties, its design, and its relation to other objects and entities together open up possibilities for action and bring about certain ways that humans relate to the material world (Houser 2018). The notion closely links with that of affordances, developed by James Gibson (1979) and furthered by Reed (1988, 1996) and Lemonnier (2014). Affordance is the potential actions an object allows or invites based on its physical properties and how it interacts with the environment. For instance, a stone tool with a sharp edge may afford cutting; a blunt object may afford hammering or pounding.

By affectivity we mean the material ability of objects to solicit or influence human action and thought in ways not directly causal but relational and contextual. Objects can solicit some actions, suggest metaphors, provoke certain cognitive associations, or indeed even disturb or prevent certain behaviors. This relational aspect of materiality underlines that things are not just lifeless instruments but active in the process of constructing human experience; they can entangle humans in complex webs of interdependence, action, and interaction shaping the actions of both individuals and groups.

Enchantment and Entrapment: The Affective Capacity of Objects

One of the most important contributions to material agency and affectivity comes from the work of Alfred Gell (1992, 1996, 1998), who introduced the idea that objects can 'enchant' and 'entrapping' humans in their human–thing dialectics. In his elaboration of agency, Gell accounts for more than the basic relation of cause and effect between human beings and objects: he gives focus to how material things can be enchanting and so captivating human beings in ways that may not be read as such immediately.

He uses the term "enchantment" to explain how objects draw human beings into emotional or cognitive responses, pulling them into performances beyond their use-value. For instance, a perfectly chiseled stone tool may not only be for the practical use it is made but also come out more aesthetically formed with a sense of admiration or awe, thus leading to its preservation as a symbolic object, or it is used within ritual contexts. An enchantment can create a strong connection between human beings and objects where the object's materiality and form evoke responses that can be said to have powerful effects on human behavior.

Entrapment, in contrast, can be thought of as how objects give rise to dependencies or obligations that structure human action. For example, use of a certain tool may only be possible with certain types of skills or knowledge, in which case, social organizations or hierarchies are formed around the control and transmission of these skills and knowledge. Objects can, in this sense, entrap humans within networks of relationships that shape their behavior and social organization. It creates, thus, a dynamic interplay between material things and human agency.

Action at a Distance: The Indirect Influence of Material Objects

Beyond these direct impacts that objects might have on human behavior, materiality theory also focuses on the concept of action at a distance whereby objects are able to act upon an individual through more indirect and, typically, subtler means. Unlike the conception of a direct action, which is both immediate and seen as interaction between man and object, the idea of an action at a distance is rather a term that refers to a form of space-ized context material things use in shaping human action. They create spaces of potentiality in which actual behavior is affected without their intervention.

This concept of action at a distance is closely related to material possibility, which considers the ways through which objects open up or further constrain possibilities for acting. Material things in their design, placement, and interaction with other entities create the environment that regulates human thought, action, and interaction with one another. For example, the presence of certain types of tools within an environment instigates certain forms of labor or social organization, and the absence of those tools will limit or restrict human activities in a different manner.

Material possibility also extends to the notion that objects might constrain human behavior by setting the cognitive and perceptual frameworks within which people understand and engage with the world. For example, some objects become related to specific meanings, metaphors, or cognitive schemes that prescribe a way people think about and approach their environment. Normally, this is subtle and indirect, operating through the affordances and affective capacities of objects, rather than through direct causality.

Application of Affectivity and Material Possibility to Lithic Technology in the Late Upper Paleolithic

In this thesis, lithic tools from the Late Upper Paleolithic sites of Guenfouda in Morocco and Moli del Salt in Spain are examined. The key concepts needed for understanding the role played by these tools in shaping cognitive and cultural evolution are those of affectivity and material possibility. As physical objects, the lithic tools that were used by early humans not only became functional implements but also played an active part in the co-evolutionary processes that shaped human societies and their material environments.

Such a focus demonstrates that the lithic artifacts impacted the action, thinking, and social interaction of human beings to a large degree, playing a major role in establishing spaces of potentiality for hominins' optimization, modification, and coevolution of human societies. In these tools lie the affective capacity that enables them to 'enchant' and 'entrap' early humans, fashioning cognitive frameworks and social structures.

A clear example might be how the use of particular kinds of stone tools influenced specific cognitive skills, like spatial reasoning or fine motor control, that would then give typical shape to cognitive evolution in human beings. Similarly, the social and cultural practices linked to the production, use, and transmission of lithic technology could have contributed to the development of social hierarchies, trade networks, and other forms of social organization.

In this sense, the lithic tools of Guenfouda and Moli del Salt, among others, have to be taken as active agents themselves, not the passive reflection of human intention, but active elements taking part in co-creating both worlds—the human and the material. Application of affectivity and material possibility to the study of these tools allows for a deeper, more nuanced understanding of their role in shaping cognitive and cultural evolution of Late Upper Paleolithic societies, providing new insights into the complex interplay of humans and their material environments

Vibrancy and Conactivity

Within the realm of human evolution, materiality, and the archaeological record, there is now substantial recognition that the relations of power between humans and material objects are seldom symmetrical. In these conventional models of archaeology, artifacts and tools are often presented as passive things that merely reflect or carry out human intention. This has, however, increasingly been criticized by a line of thought that emphasizes an active constitutive role on the part of material things in shaping human behavior, cognition, and culture. Such a theoretical shift is encapsulated in the notions of "vibrancy" and "conactivity" as articulated by Jane Bennett among others. These ideas constitute a backdrop against which material things, far from being inert or passive, are known to be dynamic in character and agency, and sometimes even propel human behavior and shaping in social contexts.

Reconceiving Material Agency: Passivity to Vibrancy

In classic archaeological practice, human agency is often emphasized as a leading actor of material culture.

Artifacts are viewed as results of the human will, as tools contrived and utilized by humans for certain ends. This reading gives a brief glimpse into the conventional, anthropocentric point of view: human beings as the only agents of history and material objects as merely instruments of human intent. Against this worldview, Jane Bennett has theorized what she calls the "material vibrancy"-that is, the idea that there is a dynamic quality existing in objects, one that is never completely under the control of humans. This vibrancy refers to the inherent ability of things to have an impact on, and to adjust, human-object relationships in ways that are not entirely foreseen or controllable by humans. Bennett 2010, 2018).

As Bennett has phrased it, agency does not reside as a property within the exclusive domain of human actors. Rather, agency is relational: it results from interactions between multiple entities along with human and nonhuman. This relational view of agency-or what Bennett sometimes calls "confederate agency" or "conactivity"-is one where the actions and effects which we see in the world are a consequence of interconnected networks of various actants operating together rather than a result of an individual actor's intentions. This view rhymes with the actor-network theory suggested by Bruno Latour, 2005, which conceives that agency is distributed within networks of actors that include, but are not confined to, humans, objects, technologies, and even abstract entities such as ideas or concepts.

Conactivity: The Interconnectedness of Human and Non-Human Entities

As a model of agency, conactivity underlines interdependence between humans and things. It holds that no singular being has agency but emerges from the summation of interaction within different entities, all contributing their specific properties and capacities to the network. This interconnected agency is not an abstract manner of thinking; it's real ways through which material things actually participate in human history.

Conactivity brings forth also the important insight that, aside from being responsive to human action, material objects are agents in shaping the action. Drawing on two conceptions of thing-powers - "positive" and "negative" - Bennett does that. Negative thing-powers denote the constraining effects of materiality: the ways in which objects introduce friction into human acts, narrowing the horizon of what is possible or feasible. This negative agency is rooted in the fact that humans are born into pre-existing material worlds that shape their perceptions, cognitive frameworks, and behaviors, and thus influence the probability and nature of material discovery, innovation, and modification.

For example, in lithic technology, the physical properties of certain stone types may raise limitations on the variability of tool forms. A particularly hard or brittle stone resists specific forms of knapping; toolmakers thus develop specific techniques that work within such limitations. This resistance constitutes a negative agency in that material qualities of the stone impose constraints on what could be done to it. Yet, these are not merely negative constraints; they also outline the development of technical skills and cultural practices when artisans learn to work within limits set by the material.

On the other hand, positive thing-powers refer to the capacity of material objects to actively produce effects and bring about change. These are powers which are not just affective but bound up with the distinctive affordances,. tendencies and lines of development that belong to specific nonhuman things. In other words, any material is disposed to some uses or actions rather than others. A fine-grained stone, for example, would be eminently appropriate for grinding sharp edges. This enabling agency is not only a question of the material properties but, importantly, how these properties intersect with human intentionality and competence in bringing about new forms and practices.

The idea of affordances, initially developed by James Gibson (1979) and later extended by among others Reed (1988, 1996) and Lemonnier (2014), is seminal here. Affordances are the possibilities for action that an object affords or invites because of its physical properties in relation to the environment. A sharp-edged flint tool, for example, would afford cutting, whereas a blunt object would afford hammering or pounding. These affordances are more than just opportunities for action; they reside within the material qualities of the objects themselves and inform human interaction with them.

The Role of Conactivity in Human–Thing Relationships

Conactivity highlights how the relationships between humans and material things are paramount, considering that whatever is associated with them is reciprocal. Within a conative framework, material things are not passive recipients of human action but active co-participants in the creation of shared lifeworlds. This view challenges the traditional archaeological notion wherein artefactual things are considered as exclusively the product of human intention. Instead, they are regarded as products of mutual infusion, orchestration, and interlocking of both human and non-human factors.

In more traditional archaeology, the concept of the artifact is mobilised in order to map and explain the human past. The artifact is typically viewed as the material remains of human activity, an object worked by human hands to serve a particular purpose. Within a conative framework, this would be a very simplistic and reductionist position. In fact, artifacts are not simply the product of a will imposed by humans onto passive matter; rather, they are the result of dynamic relations between humans and materials, wherein both human and non-human agentive factors impinge on the final form and function of the object.

This reconceptualization opens up a broader context for thinking about intentionality and technical concept formation during early human prehistory. The traditional models tend to be predominantly hylomorphic, based on a dualistic view of form separated from matter, and generally pitched against the nonhuman. This may also be recognized in the so-called "finished artifact fallacy," whereby an artifact's final form is considered to be the direct expression of human will without considering that material properties may have determined, or at least influenced, that particular form; Davidson and Noble 1993; Dibble et al. 2017.

However, the conative model denies this dualism and instead puts forward that the artefact is a continuous negotiation between human beings and matter. The making of the artefact should be thought of as a dialectical relation or conversation between the intentions of the craftsman on one side and the resistances and affordances of his material on the other. As Deleuze and Guattari have pointed out, artisans have to "surrender" in part to the physical qualities of materials they work with, let the material partly control their movements. Such "surrender" is not tantamount to weakness or lack of control but recognition of material agency in creative processes.

Conactivity and Material Resistance: The Role of Lithic Technology

The ideas of vibrancy and conativity provide a powerful tool with which to articulate the role of material objects as an active factor in the cognitive and cultural evolutionary process within the study of lithic technology. Lithic tools, often considered to be the archetypal artifacts of human prehistory, have traditionally been regarded as the products of human skill and intention. However, considered in terms of conactivity, such tools amount to much more than the instruments of human will. They are co-creative agents in the constitution of human lifeworlds, engaging not only technological developments associated with tool making but also the wider social, cognitive, and ecological processes through which prehistoric societies were constituted.

The idea of material resistance is most pertinent here. Specific properties characterize lithic materials like flints, cherts, and obsidians. Whereas the hardness and brittleness of flint make it ideal for producing sharp edges, this nevertheless limits the range of possible forms for tools. This would again force toolmakers to devise appropriate techniques in working with these materials, which again are shaped by affordances and resistances of the material in question.

This negotiation between toolmaker and material arguably constitutes a very clear example of conactivity in action. The form that the lithic tool finally takes is not solely the result of human intention but rather the result of dynamic interplay between the toolmaker's skills and the properties of the material being manipulated. The toolmaker must, at all times, adapt to the material by responding to its resistances and facilitating its affordances. Working with such materials is thus not only a technical but also a cognitive and cultural challenge, whereby the knowledge and skill are passed on through generations and shape the cultural tradition of that society.

The concept of vibrancy will go a long way in providing reasons why lithic tools influence human behavior and social organization. A flint blade, for example, allows for certain kinds of actions-cutting, say, or scraping-due to its sharp edges. These, in turn, influence the kinds of tasks that can be performed and the ways in which those tasks are organized. But these affordances are not only functional; they are also social, since they contribute to the division of labor, the organization of work, and the development of social hierarchies.

Ecological Force of Material Objects

Bennett's concept of conactivity makes a case for yet another ecological force of material objects, wherein they stipulate how humans intersect with their environment. Material objects cannot be conceptualized to be something detached but find a deep embedment in ecological networks comprising human and non-human actors. Ecological networks are in constant motion through the interaction between material objects and their surroundings, acting upon and being

Assemblage theory

The application of assemblage theory is rapidly becoming influential in the humanities and social sciences, taking up studies related to configurations of materials and their impacts on human life, behavior, and evolution. This framework postulates a new perspective on understanding the complex and interconnected nature of the sociomaterial real, having available to researchers large conceptual tools in order to fathom interactions, influences, and mutual transformations between different and heterogeneous entities, both human and not human (Marcus and Saka 2006; DeLanda 2006, 2016; Webb 2009; Allen 2011; Butler 2015; Hamilakis and Jones 2017; Jervis 2018). The conceptual underpinnings of such a frame would conceptually span from thoughts of Freud's "complex" (Freud 1985) to notions of "assemblage" put forward by Deleuze and Guattari (Deleuze and Guattari 1983), to Foucault's very work on "power" and "governmentality" itself (Foucault 2005; Buchanan 2015). Taking all these positions together, the focus of material analysis becomes the fluid, contentious, and often precarious nature of reality as the meeting, collision, and reassembling of sets of entities that might possess comparable yet more often divergent effects in continuous processes of relation-building and transformation (DeLanda 2016).

Assemblages are, in their etymology, the French term "agencement" Phillips 2006; they connote multidimensional interactions between objects, ideas, and forces that are foci of some kind of organization or identity, but are complicated within and can experience internal conflict. These entities do maintain a structure, however-one that Deleuze and Guattari 1980 define as "rhizomatic"-a non-hierarchical network model within which coherence is always partial and temporary, and whose internal structure is always subject to rearrangement. The rhizomatic nature of assemblages makes for a fluid and often chaotic unfolding of social development, stability coming to be seen as the exception rather than the rule. From such light, social realities appear precisely precarious constructions of variable orientation and divergent standpoints, themselves creating assemblages and sub-assemblages, linked within layered hierarchies and complicated infrastructures.

Assemblage Theory presents an alternative view to the rigid and deterministic traditions within the study of archaeology, much of which has centered around lithic technologies. Traditional approaches tend to view such lithic artifacts as products emerging from a process controlled by humans or as a series of linear events. In this respect, Assemblage Theory sees the essence of negotiation and renegotiation in power dynamics concerning elements of the assemblage. This view emphasizes the role of internal friction, which is produced when the specific propensities of the constitutive parts of a system are exercised and these parts interact with one another-a continuous rub that drives change and transformation (DeLanda 2015). In theory, change and transformation are taken to be the default state of affairs, and stability and stagnation require special explanation to occur.

Assemblage theory is thus a flexible framework that accounts for reinterpreting relationships emanating between the tangible structure's emergence and agency exhibited by its discrete components. The power lies in the capacity of the objects, artifacts, and technologies to change the mesh of entanglements to which they belong. These are not fixed capacities of the objects but instead are in constant flux as the same objects interact with one another, form dependencies, alter developmental trajectories, and establish coevolutionary relationships. The continuous refueling and metamorphosis of material infrastructures epitomize the self-organizational dynamics of assemblages (DeLanda 2000, 2016) that are contingent on the specific material properties of the objects concerned. These material qualities determine what can emerge at the intersections of heterogeneous parts and make assemblages places of constraint and possibility.

The Assemblage Theory is an evolutionary context of new tools and work for describing and analyzing the sort of cyclic dynamics through which differentiation, re-organization, mutation, and integration may drive the evolution of material configurations. Assemblage Theory points to the study of "intra-action" (Barad 2007), a term that is sharply different from more conventional modes of conceptualizing "interaction." Intra-action encapsulates this very idea—that elements within an assemblage do not interact with each other merely from the outside, so to speak, but become entwined in ways that create constantly modulating and unique entities. These wholes cannot be sundered from their parts, but they are also at the same time in constant change under the pressure of continuous readjustment in their internal relations.

Assemblage theory could further be productively dialogued with emergent perspectives that arise from community ecology, such as Community Assembly Theory (Weiher et al. 2011) and Coexistence Theory (HilleRisLambers et al. 2012). The above ecological methodologies focus on the dynamics intrinsic to complex assemblages, taking into account interactions among disparate ecological entities within and across such assemblages through processes of filtering, grouping, niche partitioning, and differentiation. These are strongly in alignment with principles of friction, coordination, and structural dynamics that underpin the so-called Assemblage Theory emerging out of humanities and social sciences methodologies. Each of these ecological perspectives, whether as an ecological or socio-material assemblage, adds to our potential understanding of development, sustainability, and evolution.

In the case of lithic studies, Assemblage Theory is relied on in order to avoid the disposition to be bound by single outcomes of human intention as lithic artefacts. Instead, we might think of such artifacts as parts of larger assemblages, which consist of the tool types themselves, but also the raw materials from which they are manufactured, the technologies used in that manufacture, the social uses to which they are put, and the environmental setting in which they occur. These are not static agglomerations but dynamic spaces of incessant intra-action—the material properties of lithic artefacts influence and are influenced by the other constituents of the assemblage. Such views clarify how changes in one part of the assemblage—when, say, access to new forms of tools becomes available or resources from which tools are made becomes more or less accessible—come to have far-reaching effects into the social-material and the ecological contexts within which such tools are put into use.

Assemblage theory provides one approach for developing understandings of the interrelations of "being" and "becoming" material configurations.

This will allow, from an evolutionary viewpoint, the investigation of the functioning of the lithic assemblage as a residue not only of past human behaviors but also as an active party to ongoing cycles of changes and evolutions. It is such properties that create conditions within which new modes of material ordering and coevolution can occur. It draws attention to the dependency of structured wholes on one another, as well as the materiality of their opposing parts. Thus, it provides a more dynamic and integrative approach towards the way material assemblies contribute to the evolution of human societies.

It challenges the longstanding tradition of treating artefacts as the main units of analysis in archaeology. Instead of focusing on discrete artifacts as discreet objects, Assemblage Theory asks us to explore the complex webs of connections with which those artifacts are imbued. This shift in focus allows us to see artifacts not so much as final products but as element parts of dynamic assemblages in continual process. This notion is of particular relevance in the study of lithic technologies, in which the making, use, and discard of stone tools are all part of the material and social organization. It is through the brainwork placed on interactions within lithic assemblages that we will likely get brand new insights on the processes of difference, mutation, and integration characterizing the evolution of material culture. In short, Assemblage Theory puts forth a powerful conceptual framework in which the complex and dynamic nature of material configurations in human evolution might be brought into unitary meaning. By putting foregrounding on intra-action, self-organization, and dependence-relationality of organized holes upon individual parts and their relations, this theory enables transcendence beyond rigid and deterministic models for material culture. This makes it possible to see continuous processes of transformation and adjustment that characterize the making of lithic assemblages and other material configurations. The approach not only places our understanding in a broader historical context but also opens up a new possibility for trying to understand the material dimension of human history as being both dynamic and integrative.

Curation

Binford's curation has been the most debated topic since its introduction in the 1970s within archaeology. It consisted of the transport and future use of the items. Because it was so important, Binford never accurately defined what curation is, so this term has been used and interpreted many different ways over the course of these decades. But to Binford, curation was primarily the transportation of artifacts to ensure the availability of the resource for future needs but most importantly, the partial focus at the efficient utilization of the tools. Binford 1979 also shows that curation has five aspects of importance: production prior to use, design for multivocality, transfer to multiple locations, care of the resource, and all the more for reuse. It is mainly because the broader perspective manifests the complexity of human decision–making in the use and reuse of artifact. While this seems like a rather straightforward concept, its interpretation has been rather varied. Parry and Kelly further extended this to include within the definition such complex artifacts as those with hafting or with intricate flaking patterns, which really emphasized technological and functional aspects of curation.

Another central debate in the interpretation of curation also relates to understanding its relationship with mobility and settlement patterns. Odell (1996) attempted to limit curation's usage to those contexts in which mobility patterns were unmistakable and so once more supported the concept that more mobile groups would have to fall back on curated tools as a means of coping with resource stress and unpredictability. Conversely, Nash (1996) recommended that the term ought to be discarded due to its ambiguous and variable use and instead championed a nuanced approach toward artefactual use and behaviour. One of the more primary issues was a set of contrasting differences between curated and expedient tools. Curated artifacts were commonly understood as more retouched and thus more effort and planning went into its use, whereas an expedient tool is minimally altered and would have been used in a more immediate less planned way. For instance, Shott and Ballenger (2007) and Shott and Sillitoe (2005) viewed curation measures, which are expected to reflect the frequency of retouch, as indicative of the frequency of use or reuse of the artefacts concerned rather than as indication of any motives lying behind their curation. Their Dalton point curation study indicated that between-site variations in the degree of curation can be more significant than within-site variations, suggesting that at the very least, local factors such as raw material availability, duration of occupation, and the nature of activities performed play a very significant role in curatorial practices. These findings bring into strong focus the need to consider a wider range of factors when interpreting curation in archaeological contexts.

Ethnographic researches further complicate the understanding of curation, since it is showed that not only the retouched artifacts are curated. For instance, studies of the Australian archaeological assemblages have documented the selective transportation of non-retouched flakes away from their original production sites, what evidences that these items also have been curated in anticipation of use sometime in the future. This would suggest that curation does not necessarily need to involve retouch or any formal modification, since even simple flakes without modification can be considered worth preserving for use in a task other than the original one in which they were produced. In this respect, Kuhn's observation-that flakes represent a more efficient mass-to-cutting-edge ratio, especially in resource-poor environments where maximizing utility of available materials is critical-supports this view.

Paleoenvironmental studies of western New South Wales put into context how climatic fluctuations and resource scarcity played into the curatorial practices. These studies indicate that this region saw discontinuous occupation due to shifts toward a drier climate; hence, frequent movement would have been a strategy, and portable, efficient tools would be necessary. It would therefore mean that people curated flakes as a way of insuring against resource unpredictability, hence supporting Bamforth and Bleed's argument that being unprepared in resource-poor areas can be costly. Thus, curation in this context was a matter not of retouch or of artifact complexity but rather of access to a usable cutting edge if and when desired.

These examples represent varied behaviors associated with curation that are context-dependent and challenge the rigid association of curation with particular artifact forms or degrees of retouch. As ethnographic and archaeological studies have shown, a wide range of artifact categories, including non-retouched flakes, can be curated. This range of solutions not only reflects the complex decision-making that is being pursued by past people, but also the manner in which their strategies were altered in accordance with the challenges presented by their environment and resources. Thus, archaeological analysis of curation needs to take into account all types of artifacts, while recognising that curation represents a flexible, adaptive behaviour which cannot be constrained by traditional definitions derived solely from artefact retouch or complexity.

Archaeological Context :

Site Description: Moli del Salt

Moli del Salt is a key Late Upper Paleolithic archaeological site located in the Conca de Barberà, Catalonia, Spain, close to the village of Vimbodí i Poblet. It has a strategic location on the left bank of the Milans River, a tributary of the Francolí, around 750 meters southeast of Vimbodí. The site is located 10 meters above the modern riverbed at an elevation of 490 meters above sea level. It is situated on the eastern edge of the Ebro Depression in a transitional zone between the huge expanses of the Conca de Barberà and the abrupt terrain of the Prades Mountains.

Geologically, Moli del Salt is an open rock shelter hollowed in the top of Upper Oligocene conglomerates of the Blancafort Formation, a geological unit quite common to the south of Conca de Barberà. The shelter developed by differential erosion processes initiated along the contact between the harder conglomerates and underlying softer lutites that led to the development of protective overhangs. These geological features made it an especially suitable area for human habitation during the Paleolithic, and several natural shelters preserved archaeological deposits over millennia.

The site shows a very rich stratigraphic sequence that exceeds two meters in depth and contains continuous human occupation deposits during the Late Upper Paleolithic. The archaeological deposits are further separable into many distinct units, representing different occupations and environmental conditions. The lowest unit, named Conjunt B, comprises yellowish-brown gravels and sands with anthropic remains. It has been dated to around 12,510-11,940 years before present, corresponding to the final Late Upper Paleolithic phase. Just above Conjunt B is Conjunt A. They are composed of silts and sands with lenticular layers very poorly stratified, and represent continuous occupation and environmental change into the Holocene transition. The uppermost layers in this section represent the Boreal period, dated between around 10,840 to 10,990 before present.

The site is remarkable for the preservation of its archaeological record, with dense accumulations of lithic artifacts, faunal remains, and evidence of hearths and other anthropogenic features. Especially rich in the lithic assemblage are kinds of tools and debris that attest to the diversity of activities carried out within the hunter-gatherer groups that inhabited the site. The location of the site in a transition zone between mountains and plains would have given access to a variety of resources, from flint to other lithic materials to a variety of plant and animal species. It is one of the many Late Upper Paleolithic sites in the region, as it is represented by open-air sites along with the other rock shelters, and therefore documents the widespread human occupation of the Prades Mountains and surrounding areas during this period. The strategic location of the site and good state of preservation of its archaeological deposits make it a key location for understanding lifeways of hunter-gatherer groups living in this region at the end of the last Ice Age, providing insight into their economic strategies, social organization, and interactions with the environment."

Stratigraphy

The stratigraphic sequence of Moli del Salt represents more than 2 meters of deposits, differentiated into several well-defined units, each of which reflects distinct moments in sedimentation and human activity:

Conjunt B: Directly overlaying the lutites of the substrate, this unit consists of 75-centimeter-thick dark yellow-brown gravels and sands. These deposits are in lenticular beds, in which two sub-units have been distinguished, B1 and B2. The formation processes of this unit are relating to diffuse runoff flows. Importantly, anthropogenic sedimentary structures have been identified at the base of this unit. Radiocarbon dating (14C AMS) gave dates of 12,510 ± 100 for Level B2 and 11,940 ± 100 BP for Level B1, placing the archaeological assemblages of this unit firmly within the Late Upper Paleolithic.

Conjunt A: This unit consists of about 70 centimeters of thick, poorly stratified silts and sands, disposed in lenticular layers. In this unit, three archaeological sub-units have been differentiated. In this unit, three archaeological sub-units have been differentially distinguished (from base to top: A1, A, and Asup). The dominant sedimentary process in this unit is the disintegration of the wall's sandy material. While the upper part of this unit forms the first great blocks that fell down because of the collapse of the shelter's cornice, radiocarbon dates for the upper part of Conjunt A (Asup level) have been given at 10,840 ± 50 BP and 10,990 ± 50 BP. Similar to Conjunt B, the archaeological assemblages within this unit have been attributed to the Late Upper Paleolithic as well.

Collapse Level: Above Conjunt A, there is evidence of an important episode of cornice collapse, which has involved the fall of large conglomerate blocks. The latter laterally grade into a deposits of red channelized sands and silts, well represented particularly in areas nearest to the shelter wall - tapering off towards the outer parts of the site. Although no radiometric dates are available for this level, an important erosional episode occurred at the end of this phase.

Nivel superficial Sup: this surface level is constituted by poorly stratified dark gray sands deposited against conglomerate blocks and concentrated runoff deposits of the previous unit. This level reaches up to 20 centimeters in thickness in the outer parts of the shelter. The dominant processes involved in the formation of this unit were slope dynamics. A bone fragment recovered from this level has provided a radiocarbon date of 8,040 ± 40 BP. The lithic industry found in this level is quite different from the lower assemblages and has been attributed to the macrolithic Mesolithic.

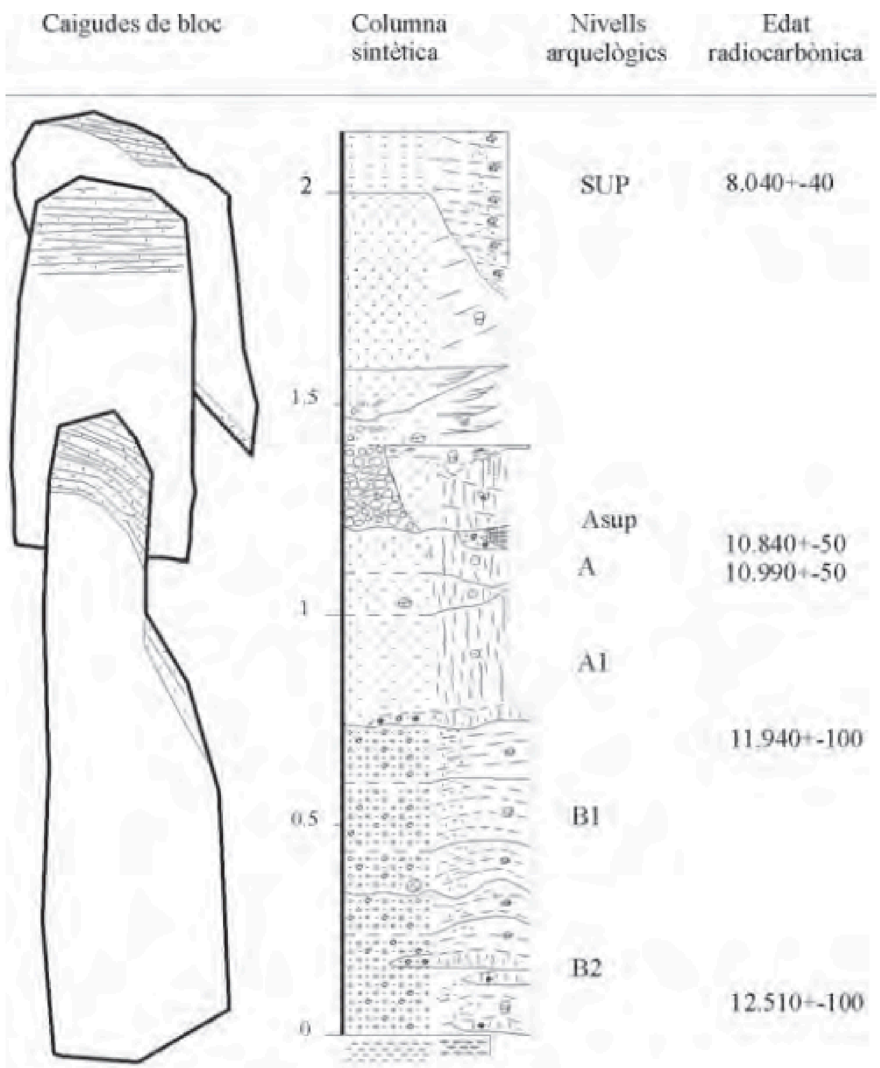

Figure 1 : Stratigraphic sequence of Molí del Salt. Excerpt from Vallverdú and Carrancho, 2004.

The radiometric data enables an initial correlation with major climatic episodes at the end of the Pleistocene and the beginning of the Holocene. Conjunt B and A are situated within the relatively warm context of the Bølling-Allerød interstadial complex (GIS 1). Although no radiometric dates are available, an episode of cornice collapse and subsequent erosional impact may be tentatively correlated with the final stadial episode of the Pleistocene, the Younger Dryas, and the transition to the Holocene. Analogous phenomena have been documented in other sites with the same chronology, such as Filador, Font Voltada, and Balma de Guilanyà. The Sup level, finally, falls entirely within the Holocene, in fact within the Boreal period.

Technology

Molí del Salt is located in the Conca Barberà area, which has sufficient evidence of flint, which was a heavily exploited raw material by its prehistoric inhabitants. This kind of flint and others from other close areas such as the evaporitic Paleogene formations on the edges of the Ebro Basin supplied the main raw material for making artefacts. It also reveals that other rocks were used, such as limestone, schist, hornfels, and sandstone, although more rarely. These are primarily used as pebbles for specific purposes, including hammering or giving work surfaces or blanks for graphic representations.

The diversity in types of flint within Molí del Salt would speak of different procurement strategies. Some of the flint shows features typical of the Conca Barberà area, but other types have been linked to more distant provenances, such as the outcrops of Ulldemolins, which lie about 15 km away from the site. The especially high quality of the Ulldemolins flint favored its use in knapping, especially during the earliest levels of occupation in Molí del Salt, Unit B. While documented by the archaeological sequence, over time, there is a shift towards more locally sourced flint in the Mesolithic layers, suggesting changes in mobility and resource exploitation strategies. This might be indicative of a contraction in the territories exploited during the end of the Paleolithic by the inhabitants, related either to environmental or social changes.

The knapping methods used to create the lithic assemblages at Molí del Salt vary greatly. The typological variety is accordingly great because of varied knapping techniques and methods. Blade production is present although not as a dominant method. Systematic blade débitage is testified by cores especially prepared for this purpose; however, these represent only a minor part of the assemblage. Normally blades form about 20% of the blanks. More often, however, the site evidences a preference for the production of elongated flakes which were largely taken from unipolar or bipolar cores. These cores showed hierarchical structures with a well-defined flaking surface on one part and a totally unworked surface on the other.

More precisely, the expedient knapping methods concentrate on the production of shorter flakes from discoidal or polyhedral cores. Such variability of the knapping methods might signify flexibility in tool-making for specific task performance or adjustment to the available raw materials.

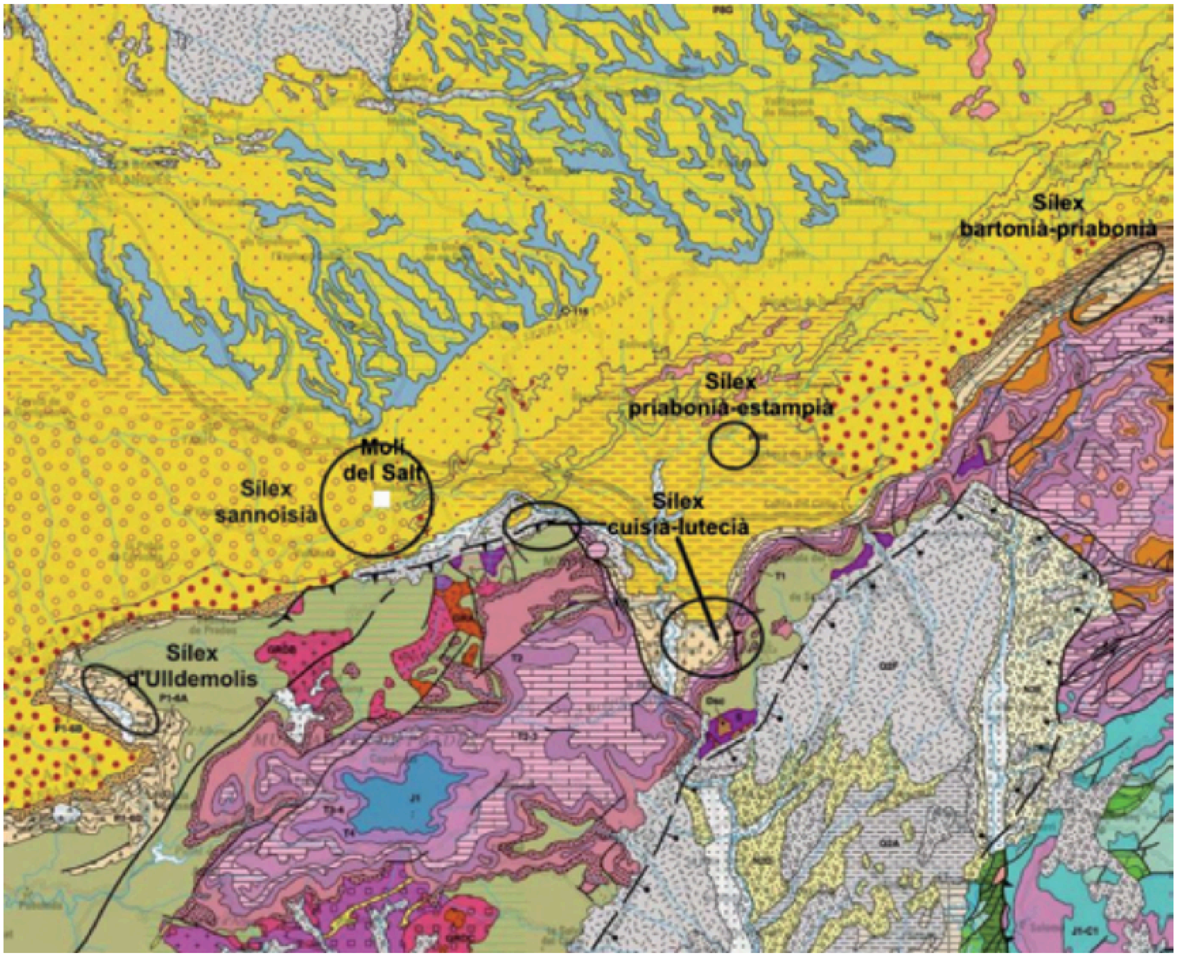

Figure 2 : Geological map showing the main source area of flint documented around the site.

Among the resharpened tools, end-scrapers are the most frequent in the Molí del Salt series and dominate, above all, the upper levels, reaching a proportion of almost 40% of the toolkit. The rest are more infrequent. The frequency varies radically between one occupational level and another, depending on changes in tool-making behaviors.

In the lower levels, truncations are overwhelmingly dominant-22-27% of tools. Other tool types that are well-represented in these layers include endscrapers, denticulates, and backed artifacts, while burins are completely absent. On the other hand, upper levels in Unit A show a drop in truncations to about 5%, while the percentage of endscrapers correspondingly increases. The presence of burins is also very high, reaching to about 10%.

These typological differences are what place Molí del Salt into other Late Upper Paleolithic sites along the coastline of the Mediterranean coast of the Iberian Peninsula, such as Font Voltada, Els Colls, and Cova del Vidre. It is in the prevalence of truncations within Unit B where the distinctiveness of the site diminishes, though similar patterns can be teased out in other Late Upper Pleistocene sites, such as the Nerja Cave and

Tossal de la Roca.

However, functional analysis at Molí del Salt gave details on the specific uses of these tools. For example, endscrapers were used mainly for hide working; wear patterns indicate fresh and dry hide processing, suggesting that the whole hide-working sequence took place on-site. Other tools-truncations, denticulates, and even unretouched flakes-show signs of hide processing. Projectile points include backed elements such as points and blades, evidenced by impact scars and fractures. The unretouched flakes were mainly used for the activities of defleshing. Such tools are thus multifunctional.

Whereas plant material working, bone tool production, and engraving are documented, use-wear analysis has not confirmed these activities. This may suggest that the traces on these tools are more difficult to trace, or that different tools were used for these activities.

A key dimension of technological behavior at Molí del Salt involves the recycling and reuse of artifacts. This would have considerably biased the composition of the lithic assemblages. Evidence of recycling comes from the fact that those artifacts show signs of previous use and/or damage and were, nevertheless, intentionally modified, such as heat-altered flint tools that were later retouched. Such recycling accounts for at least 7.5% of the artifacts at this site and thus constitutes a strategy for making the most out of available resources. Recycling at Molí del Salt appears to be mainly associated with domestic contexts; tools such as endscrapers, denticulates, and borers show the practical and opportunistic nature of tool use.

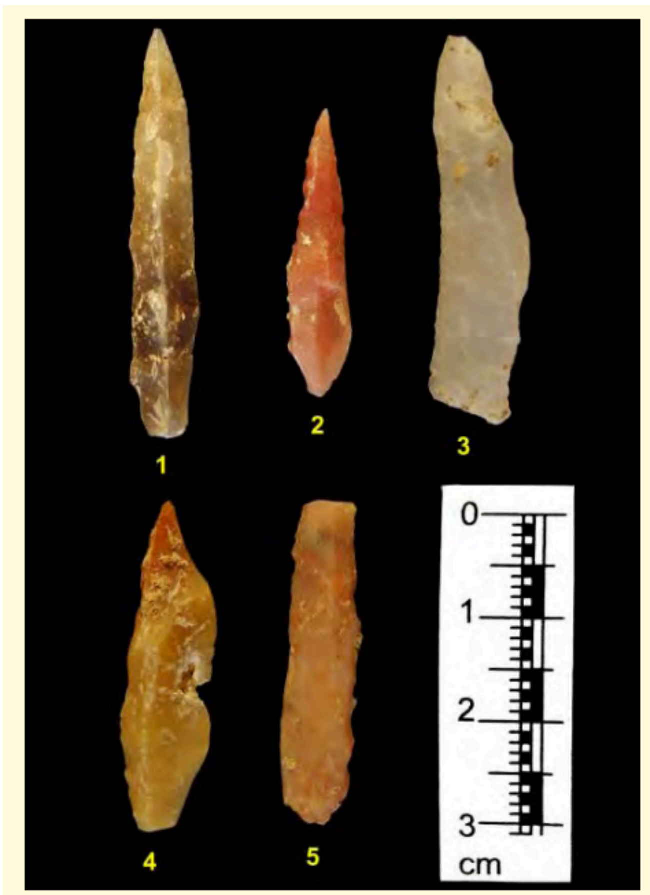

Figure 3 : Tips (1-4) and back lamina (5) of conjunct A from the Molí del Salt.

Site Description: Guenfouda

Guenfouda Cave, more commonly Ghar Z'bouj, is one of the major archaeological sites situated in the northern area of the Oujda Mountains within the Oriental Moroccan region. The cave is situated about 30 km southwest of the urban center of Oujda and 6 km from the village of Guenfouda, more precisely in the Douar of Aït Bou Saïd in the zone of Metssila – Ben Yala. The place is actually a few kilometers from the Moroccan-Algerian border and lies at an altitude of 930 meters above sea level. The coordinates of the cave are X = 810.20 and Y = 440.95, Lambert coordinates, and its entrance looks southwest over a valley intersected by tributaries of the Oued Isly.

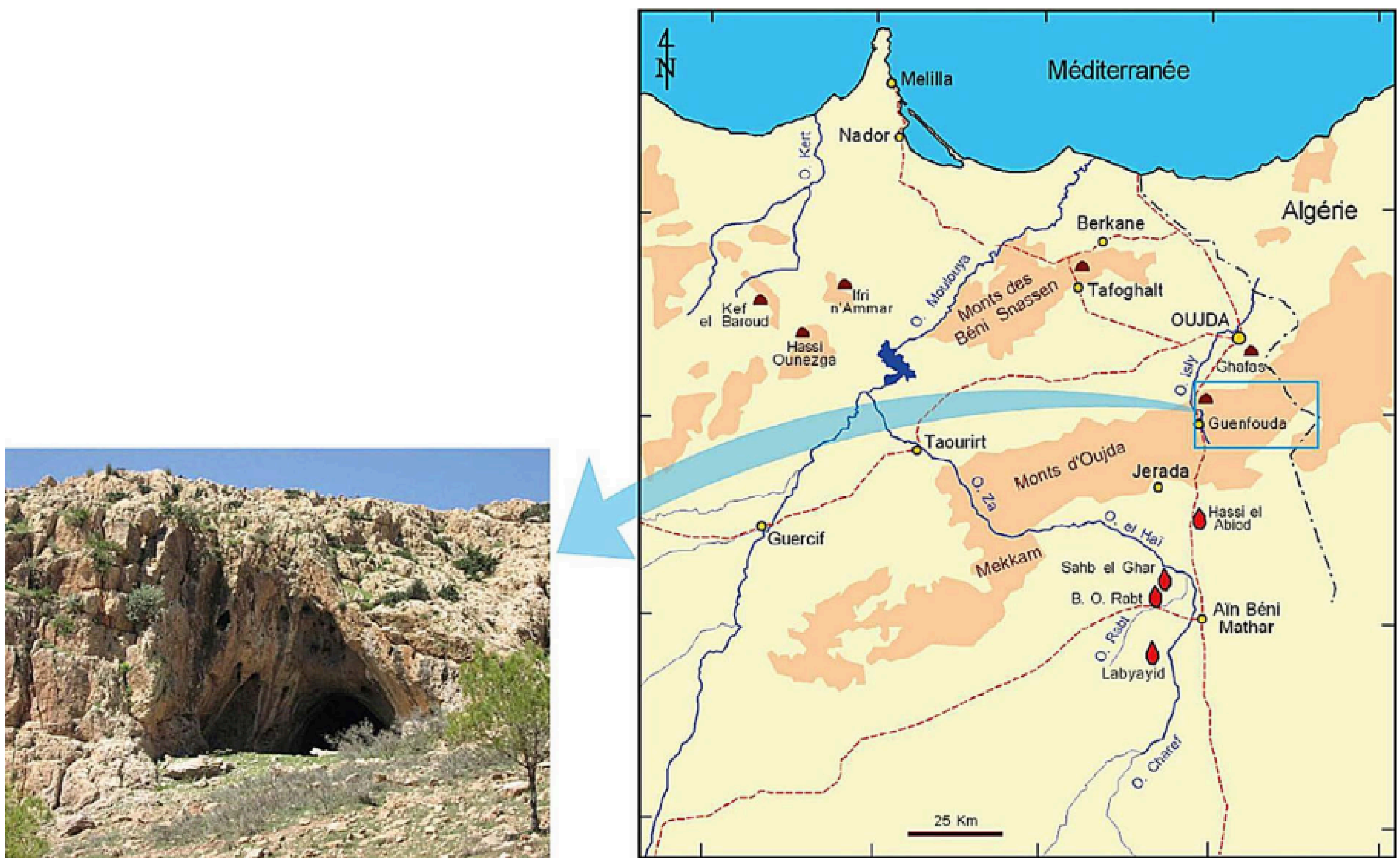

Figure 4 : Site map [Aourague et al., 2014]

The cave consists of a gallery made up of two rooms divided by a central stalagmitic column. The right chamber, oriented to the northwest, is larger in length and width, with approximately 6 and 3.5 meters, respectively, while the left chamber, oriented toward the southwest, is smaller in dimension with about 3.5 meters in length and 2.5 meters in width. The entire cavity develops within a geological unity made up of oolitic limestone and dolomitic rock datable to the Aalenian-Bajocian age, approximately 171.6 million years ago. Originally, such rocks have been deposited in a marine platform that characterizes Jebel Metssila and the broader region of the Oujda Mountains.

The on-ground geology is characterized by the presence of many basalt outcrops resulting from Plio-Quaternary volcanic activity. These features provide the unique environmental context of the site, moulded through millions of years as a result of marine sedimentation and volcanic processes.

Until 2004, the first systematic archaeological interest in the Guenfouda cave started, in fact, with the opening of excavations. In fact, these focused on two fundamental areas: one at the entrance and one in the interior of the cave, beside an extraordinary stalagmitic pillar. In both, excavations have indeed contributed significantly to the knowledge of prehistoric human activities that occurred at the site, adding a great deal to our knowledge of the ancient history of the region and its inhabitants.

Stratigraphy

The stratigraphic record of the Guenfouda cave is complex and quite well-preserved; its archaeological sequence has provided a very good understanding of the different human occupations and activities carried out within the site. According to the tomographic survey carried out by Professor D. Khattach from the Faculty of Sciences in Oujda using geophysical methods, the filling of the cave is quite deep; the sedimentary depth ranges from 2 to 5 meters along the edges of the cavity. This depth in stratification allows for a rich context of understanding in terms of the sequential deposition of materials and activities conducted within the cave over time.

Superficial Layer

The top level in any cave usually consists of ashy deposits and heated stones mixed together in an archaeological treasure trove. These superficial levels do attest to the presence of humans, in essence fire and ash disposals from general household activities. Ashy levels of this kind are not uncommon in prehistoric contexts but are more relevant to the chronic usage of caves.

Archaeological Sequence

The stratigraphy of the Guenfouda cave shows distinct layers from top to bottom, reflecting different periods of human occupation and several successive cultural phases. For example,

C0 Layer : The uppermost stratigraphic layer, C0, consists of remains such as metal objects and earthenware pottery, which would point to relatively recent occupation phases. This layer simply represents the most modern deposits related, surely, with post-Neolithic or even historic activities of people in the cave.

C1 Layer: This layer is sub-divided, with two sub-layers: C1a and C1b. These have yielded highly relevant archaeological materials. The sediment characteristic of Layer C1 basically consists of calcareous aggregates with powdery silt. Fine silt-clay fractions and wood ash abound according to the results of the granulometric analysis; the latter shows, beyond all doubt, proof of human activity. The sediment is also fine and ashy in nature, quite consistent with other Neolithic contexts of the Maghreb region and often related to aeolian formations, Lubell 2004). Without absolute dating, based on archaeological contents, the Neolithic phase of the site could be attributed to Layer C1. This layer contains an especially high concentration of lithic tools, faunal and malacofauna remains, fragments of pottery, grinding and stone polishing tools, polished implements, tools used in the processing of pottery, beads, and ostrich eggshells fragments. Aouraghe et al., 2014.

Layer C2 represents the base of this sequence, and it also constitutes the oldest stratigraphic unit of this sequence. The lithic assemblage characterizes the Middle and Upper Paleolithic. The layer therefore gives indication that human activity within the cave began several millennia before the Neolithic occupation. The lithic tools recovered from this layer add to the importance of understanding technological behavior and cultural adaptations of the earliest inhabitants in the cave.

Stratigraphic Integrity and Post-Depositional Processes: The stratigraphy of the Guenfouda cave site is generally well-preserved but suffers from some local disturbances, especially in the top parts of Layer C1. The disturbances came essentially from the top layer of C0 with a lot of recent remains, such as metal pieces and potsherds fragments inside the top centimeters of the deposits. Such stratigraphic changes have been brought about frequently by bioturbation and recent human activities, quite common in caves with low compact sediments. However, on the whole, archaeological remains from Layer C1 remain coherent with no serious post-depositional changes and preserve their integrity for archaeological analysis.

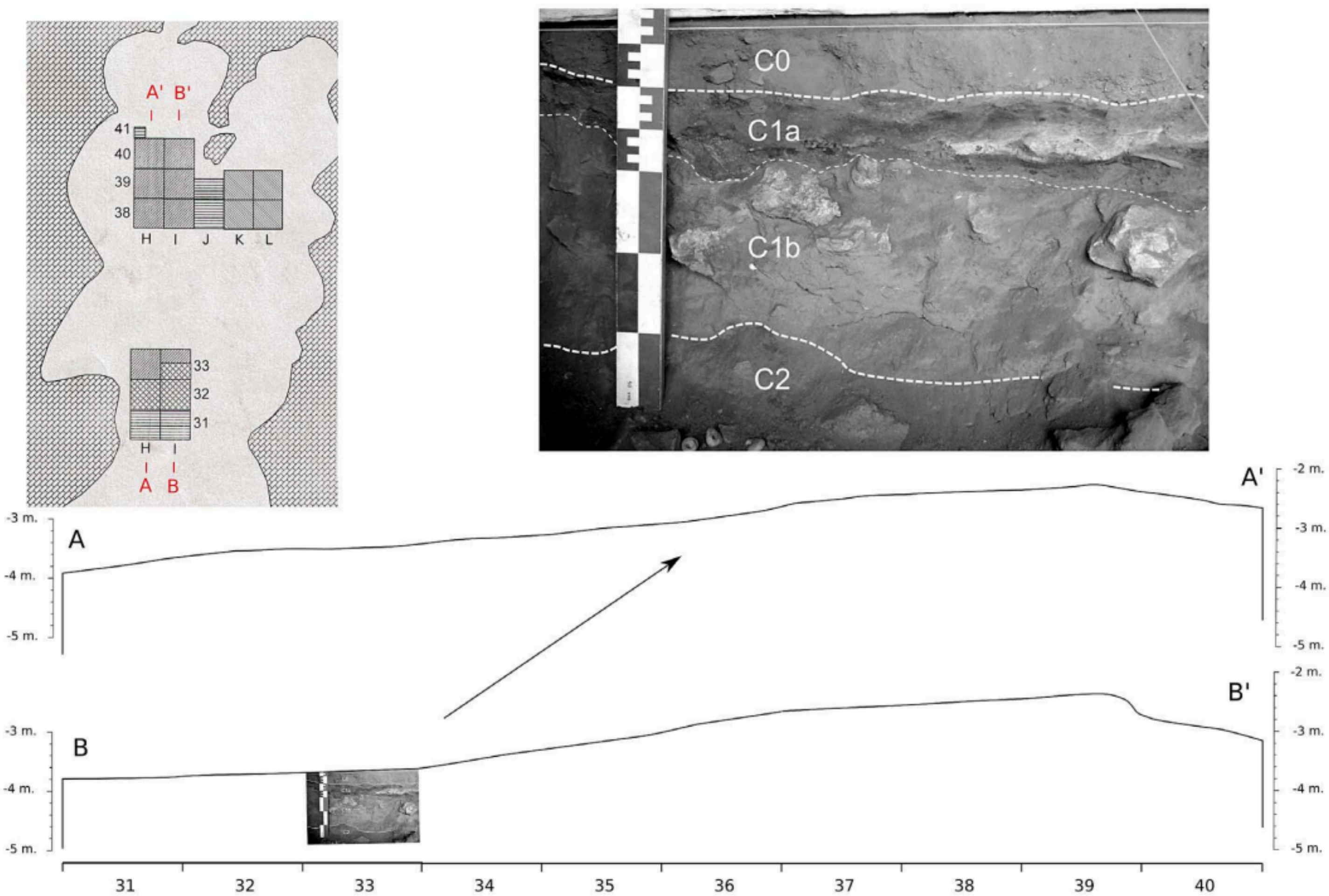

Figure 5 : Profile and stratigraphy of Guenfouda [Aourague et al., 2014]

Technology

The lithic assemblage was studied through the Logical-Analytic System methodology, developed from the methodological propositions that the Georges Laplace work released-the work furthered in the research project by Eudald Carbonell. This method consists of several classes that represent, according to the proposal of a Laplace typology, the technological and typological characteristics of each lithic artefact.

It is an assemblage that comprises cores [BN1G-First Generation Negative Base], flakes and blades [BP-Positive Bases], by-products from knapping [ORT], and items showing evidence of retouching [BN2G-Second Generation Negative Bases]. As for the raw material composition of the assemblage, it is dominated by silicified green schist, followed by chalcedony and flint with respective percentages of 34.37%, 29.86%, and 27.01%. Other raw materials such as limestone, poor-quality pink flint, basalt, quartz, quartzite, radiolarite, sandstone, and siliceous limestone are found in much fewer proportions.

A total of 87 cores were identified in this analysis, among which unipolar, bipolar, polyhedral, initial stage, multipolar centripetal, and prismatic cores were represented. These cores further indicate different reduction strategies, attesting to a fine level of understanding in the process of lithic reduction. The presence of the non-cortical striking platforms and the high degree of core exploitation suggest that the Guenfouda inhabitants were skilled in maximizing the utility of their raw materials, often completely exhausting cores to produce microflakes, laminar microflakes, microblades, and narrow microblades.

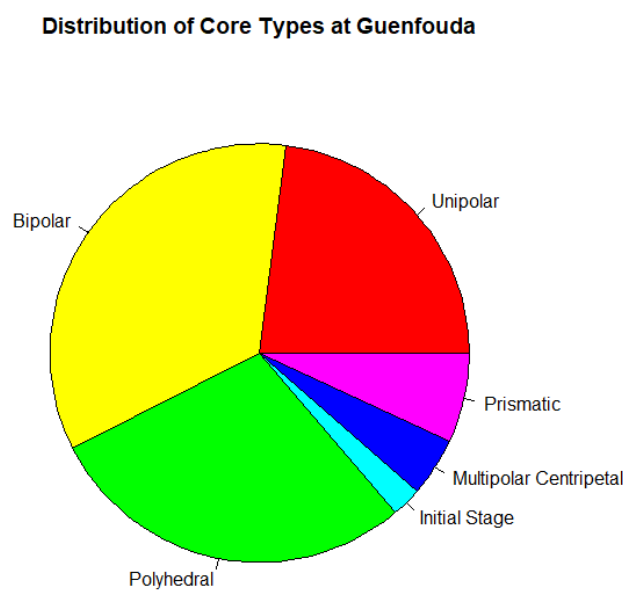

Figure 6 : Distribution of core types at guenfouda

Other evidence of the knapping strategies at Guenfouda comes from the Positive Bases, of which 1,094 pieces were found. These included flakes related to the first phases of the reduction sequence, core preparation flakes, and internal flakes, which were the most abundant. The presence of Levallois flakes, related to multipolar centripetal knapping strategies, points to a continuation into the Neolithic of some Middle Paleolithic methods.

The assemblage contains a high proportion of retouched artifacts, totaling 174 pieces. In total, tool types comprise various elements such as backed points and bladelets, notches and denticulated tools, end-scrapers, backed flakes, burins, truncations, backed bipoints, bitruncations, perforators, and backed truncated bladelets. Laminar supports dominate within the retouched tool assemblage, suggesting a precise and controlled knapping method directed toward producing straight, regular blanks fit for further modification.

the most common raw materials selected during lithic production included silicified schist, chalcedony, and flint, each with a silicified schist representation just slightly more frequent. This also confirms the selection of material that offered good knapping qualities, despite some of the materials, such as silicified schist and chalcedony, being procured from considerable distances. Carefully selected and used, it gives evidence of really advanced knowledge both in the use of raw material properties and in their suitability for certain tool types.

The assemblage gives evidence of the whole continuum in the production of lithic, from knapping at its initial stage to the production of the retouched tools. The unmarked bulbs, prepared striking platforms, and controlled knapping techniques dominating the technical characteristics of the assemblages reflect the technological competence of the occupants. The expedient tools manufactured with hurried but basic preparation co-occur with those having high investment in planning and execution. Such co-occurrence indirectly indicates that the production of tools was flexible to suit the needs and contexts at hand.

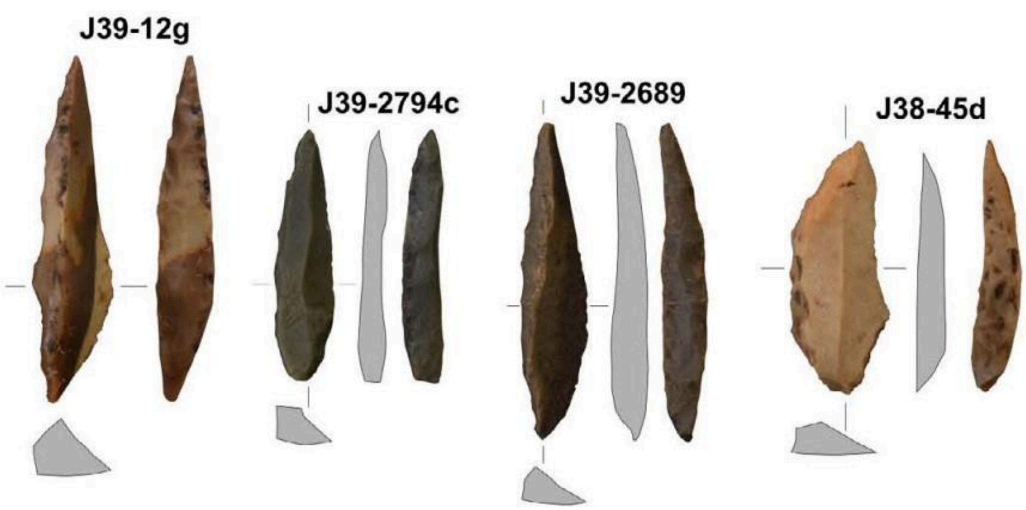

Figure 7 : lithic tools uncovered from guenfouda

Methodology

Moli del salt case :

Raw Material Selection, Tool Production and Use at Moli del Salt

The most general statement of archaeology is the study of human behaviors over long periods of time using the analysis of objects that make up material culture. Material culture has been an integral dimension of human life for over three million years. It is inextricably linked with the social and natural environments within which these objects were created and utilized. Hamilakis & Jones (2017) suggest that the distinctive contexts in which material culture is implicated texture its meaning. However, to reconstruct the social context of ancient prehistory is not easy. The environments within which our early ancestors existed were much unlike our own today, and they also experienced economic strategies and technologies that might not be considered "life" in many of our understanding contexts. Besides that, their material culture is mostly gone due to organic decay and other post-depositional disturbances, which has made the archaeological record incomplete. (Romagnoli et al., 2018)

Given the predominance-if not monopoly-of flint within the Moli del Salt lithic assemblages, this raw material therefore offers a means of grasping both cognitive processes and cultural practices within Late Upper Paleolithic societies. Among other reasons, flint was chosen for being the most suitable raw material on account of its excellent knapping properties. Qualities such as a cryptocrystalline structure would have allowed the hunter-gatherers at the site to achieve very fine control in knapping. Advanced cognitive abilities, then, are reflected within choices such as the kind of material chosen.

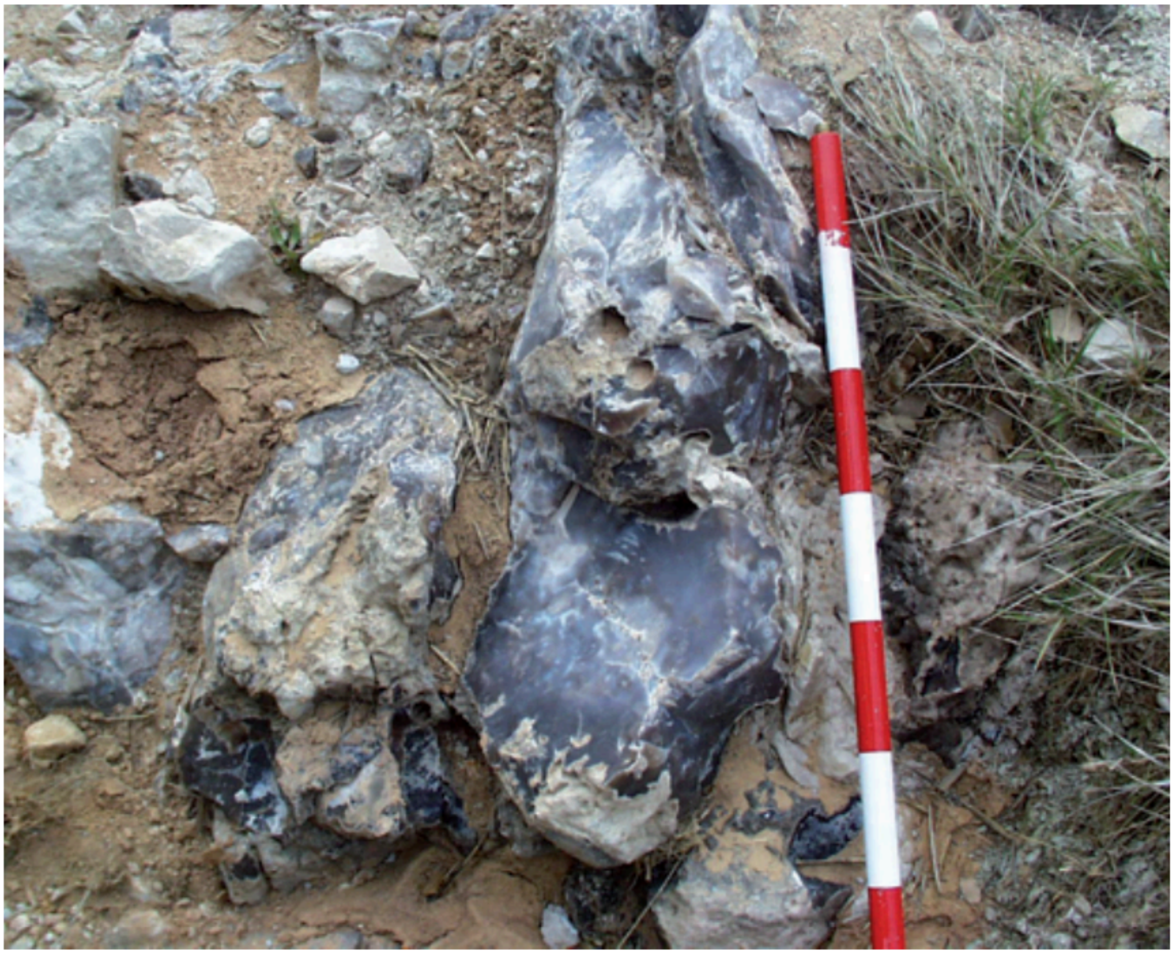

Figure 8 : Detail of flint veins from the outcrops of the Priabonian Bartonian of Vallespinosa.(Vaquero et al 2012)

The choice of flint from a cognitive perspective provides insight into the understanding of its mechanical properties and how those influenced tool production. In fact, this would be accomplished through internalized cognitive mapping, allowing communities around Moli del Salt to make long-distance trips to procure high-quality flints-as far away as 30 km-and which therefore presumed a degree of strategic planning and awareness of geological resources, thus showing great foresight and awareness of the environment.

This is further confirmed by the cultural evidence that flint was not only valued for utility but also served as a symbol reflecting social and economic organization. The difficulty of procurement from distant sources, such as the complex of Ulldemolins or the cuisià-luteci̇à formations, may indicate the content of such material with a social or symbolic meaning other than its functional use. Flint was, therefore, more than a mere raw material for making tools; it could have served as a factor in group identity or status, with prestige no doubt accorded within the group to whoever was able to procure and work good-quality flint.

The tool production which occurred at Moli del Salt is representative of a very fine understanding of technological processes and in that way reveals the cognitive complexity of the populations of the Late

Upper Paleolithic. Advanced methodologies were used in the treatment and preparation of the flint, such as the Levallois method and discoid, requiring careful planning in controlled reduction. The more abstract abilities that are necessary to think through such processes include thinking in abstract, reasoning spatially, and solving problems. Artisans should have been able to conceptualize a tool in their mind, plan out what order flakes would have to be removed, and then make changes in techniques on the fly to accommodate the desired outcome.

It could also be observed from the production of standard tool types across different archaeological layers at the site of Moli del Salt that a certain form of cultural transmission had taken place. The consistency in toolmaking methods over time here would suggest that this knowledge was shared across generations and might have followed an apprenticeship model whereby younger people learned the craft from more experienced artisans. This sort of knowledge transmission speaks for a complex social organization in which technological know-how has gained a high value and was transferred within the group.

The range of tools that have been unearthed at Moli del Salt indicates the range of activities pursued-several for hunting, preparing hides, and working with wood-each requiring specific tool types. Specificity and range of tool types indicate a nuanced knowledge of how tools might be fitted for specific tasks. Cognitively, this suggests an ability to generalize across tool types, recognizing that some tools were suited for very restricted activities while others were more multipurpose.

Socially, tool specialization would suggest division of labor in a group; that individual members or subgroups were specialized in hunting, in tool making, or in resource processing. The tools are spread out over the site, which might provide us with information on the spatiality of the social organization, such as specific areas designated for certain activities as tool production or food preparation.

Co-Evolution of Humans and Lithic Technology

In this regard, the relationship between humans and lithic technology at Moli del Salt represents a very good example of the co-evolutionary process that is happening within human cognition and culture and the material world. Materiality theory, which puts an emphasis on the active role of materials in shaping life, allows us to look at lithic technology not just as passive tools but rather agents shaping human behavior and cognitive evolution (Hamilakis & Jones 2017). For example, the properties of flint imposed one set of constraints on tool production at any one time and, therefore, shaped hominin techniques and, in general terms, influenced how hominins could solve problems.

The functionality of flint and the other materials of Moli del Salt-such as the schist for mobiliary art-finding their uses in this area does not imply that materiality was restricted to this field. Indeed, Guarinello (2005) stated that an object exists in three fields: functional, social, and expressive. While the functional role of flint tools is clear, their selection and use also express social identities for instance the ability to access and work high-quality materials. The expressive field is more complex because objects may bear meanings which are not readily detectable but which were shared by the group, for example symbolic or ritual significance.

These technological innovations within Moli del Salt's lithic technology are a reflection of wider trends in human cognitive and cultural evolution. Standardization of tool production, core reduction strategies, and procuratorial tasks of raw material acquisition are indicative of the increasing complexity of hominin cognitive abilities. These technological innovations did not happen in isolation; they were, in fact, part of a self-reinforcing development whereby human evolution and technological development were taking place in mutual interaction, therefore promoting new ways of abstract thinking, planning, and social learning.

The flint-made tools from Moli del Salt suggest that technology was leading to patterned changes in human behavior. Innovation, says Saxenian (1994), is an individual and collective activity based upon the incentive to adapt to new environments. The sophisticated tool-making skills that were evinced at Moli del Salt reflect the social grouping of the individuals, and knowledge transmission ensures that technological know-how is conserved and honed generation after generation. The point has been aptly made that this type of cultural learning was an essential condition for the development of the increasingly complex tool-making practices that sustain more advanced economic and social systems.

The Dynamic Interaction Between Humans, Tools, and Environment

The theoretical consideration taken into perspective on raw material selection and the production and use of tools within Moli del Salt indeed express dynamic interaction among human cognition, culture, and materiality. Flint predominates for the raw material selection based upon the cognitive competency of the group in recognizing as well as exploiting high-quality resources and the cultural importance such materials have in the way they organized themselves socially. It is in the production and use of tools that an intricate articulation between human behavior and material culture was achieved since tools were active agents in the shaping of social practices rather than passive instruments of human activity in cognitive evolution itself.

Materiality theory finds its application in interpreting co-evolution between humans and lithic technology. Insofar as tools, artifacts, and raw materials literally formed human life, they also embodied surplus meanings, which were codified and socially shared in the group. Objects should therefore be understood not only by use but as expressions of social identities and symbolic meanings. By bringing together materiality theory and the archaeology of Moli del Salt, our understanding of how human populations interacted with their environment, materials, and each other in effecting both their technological trajectories and their cognitive evolution is greatly enriched. Such a perspective moves our view of lithic technology away from static reflection toward that of a dynamic, co-creative agent in human history.

Guenfouda case :

Raw Material Selection, Tool Production and Use at Guenfouda

Traditionally, the natural environment has been regarded as a passive container by the Western archaeological approaches from which resources are extracted in a materialistic perspective. This generally leads to approaches to ancient technologies that emphasize techno-economy by interpreting the identification of production sequences, the productivity of knapping methods, the time and energy costs of resource procurement, and efficiency of tool designs. However, as this paper will argue, artifacts are not just passive functional tools. Taking insight from Harris and Robb (2012) and Hamilakis and Jones (2017), material culture is a complex ontology that brings together materiality, sensoriality, and affectivity. Objects speak where words are not able to, and the meanings produced can be shared within the group, even though they are not always intentional or widely socialized.

(Guarinello, 2005) reveals that meaning of artifacts can be understood in three fields comprising the functional, the social, and the expressive. The functional field embraces the raw material and the shape of the object, which are directly related with the function and mode of operation of the entity. The social field is about how objects create and express identity, and thus act as social classifiers related with the division of labor into genders, social classes, and other configurations of society. The expressive field is also more complicated and has something to do with the semiotics of cultural material. In other words, objects in a culture carry deeper, often symbolic meanings.

If this can be taken one step further, the lithic assemblage from Guenfouda will represent the complex interplay between cognitive processes, environmental knowledge, and cultural practices in the selection of raw material. The range of rocks exploited-from Paleozoic quartzites and phthanites to Mesozoic flints and Cenozoic basalts-indicates a highly developed perception of local geology and the specific properties of different materials. Such a selection process implies high-level cognitive abilities whereby the inhabitants assessed the aptitude of various rocks for specific knapping methods and tool types.

This indeed advocates for a tactical way of acquiring resources in the choice of materials, such as silicified green schist and flint obtained between 10 and 60 kilometers away from the site. Such decisions probably involved a kind of cognition of the landscape, whereby the inhabitants mentally mapped and accessed the terrain in order to obtain particular raw materials. Collection of raw material from faraway places, as can be inferred from chalcedony coming from Oued El Hay, would for sure mean that such materials had special value because of their superior qualities or for symbolic meaning within the community.

The choice of these raw materials shows the social organization and cultural practices of the inhabitants of Guenfouda. Less common and more distant materials are chosen, which, in fact, indicates that such stones can be status or identity markers of the group. Difficult procurement conditions explain the particular balance, for example, of chalcedony. This would confirm the reasons social and cultural in choosing their raw material.

The various lithic production in Guenfouda, made on an unusually large variety of raw material types, attests to an important cognitive complexity and technical competence. Its inhabitants were able to control various knapping techniques, adapting to the particular properties of each material. The good representation of flint and chalcedony, for example, among the best knapping raw materials, implies a well-developed knowledge concerning the production of sharp and resistant tools.

Such technological sophistication implicitly carries a high level of problem-solving ability, abstract thinking, and planning. Toolmakers at Guenfouda probably required mental templates or models of the wanted tool forms, which they adjusted according to the material that chanced to be in hand. Working with various materials, each needing different approaches, does not exclude the fact that the toolmakers were very adaptable and flexible, altering their techniques to suit the available resources.

The use of materials from diverse geological sources-some of them local, others transported over a substantial distance-points to complex social organization where toolmaking is a collaborative effort. Transmission of knowledge and cultural transmission are likely to have played an important part in sustaining and refining technological skills within the community.

Tool use at Guenfouda represents insight into the social organization and cognitive evolution of its occupants. The distribution of raw materials in the lithic assemblage seems to indicate that some material resources were preferred for specific tool types or tasks, thus standing for knowledge about their functional properties. Such is represented by the fact that cutting tools consist mainly of flint and silicified green schist, showing preference for raw materials which could provide sharpness and strength.

Such an ability to choose and utilize specific materials for particular tasks indicates a high degree of functional specialization and knowledge of the properties of various rocks. This level of cognition is further implied in the ability to plan and execute complex tasks, such as acquiring material from a source far away from the immediate site.

Such a wide range of materials used, some of which are differentially distant from the site itself, suggests specialization and division of labor in the social group. That is, some individuals or groups may have been procurement specialists for particular materials while others were tool producers. The presence of rare or distant materials, such as the chalcedony from Oued El Hay, may also indicate that the material had symbolic or social meaning, perhaps part of ritual use or used as an indicator of status within the community.

The presence of such variability in the differential representation of materials through time would suggest that changes occurred in social organization, mobility, and territorial use. Where the representation of certain materials decreases in the upper levels of the site, one can infer a shift either in resource procurement strategies or in the narrowing of the territorial range utilized by the group-a shift that would reflect broader changes in social dynamics and environmental adaptation.

Co-evolution of Humans and Lithic Technology

The procurement and use of raw materials at Guenfouda represent a co-evolutionary relationship between humans and their material environment. In this respect, materiality theory will provide a useful framework with which to understand this relationship, through its emphasis on the active role of materials in shaping human behaviour and cognition. We can therefore say that such a variety in the raw material type at Guenfouda makes the application of the lithic technology look much more proactive than some sort of a passive reflection of human needs with the aim of shaping both cognitive and social structures of the community.

The use of materials from diverse geological contexts with their particular properties probably influenced the way specific knapping techniques and tool forms were developed, which, in turn, influenced the cognition of the maker. Working with a wide range of diverse materials, each needing a different approach in tool production, may have driven the development toward more complex cognitive abilities, such as abstract thinking, problem-solving, and planning.

Selection of certain materials over others and the effort involved in their procurement from faraway sources are in themselves indicative of broader social and symbolic practices. Any rare or exotic materials that are part of the assemblage may have had special significance within the community-for example, used in rituals or even as status markers. This would confirm that the relationship between individuals and their material environment in Guenfouda was not strictly functional but rather deeply implicated with the social and cultural dimensions of the human group.

The theoretical discussion on raw material selection, tool production, and use at Guenfouda demonstrates the complex relationships among cognitive, cultural, and environmental factors. The diversity of raw materials used on the site reflects a highly developed understanding of the properties of various rocks and their specific tasks, as well as a sophisticated social organization able to procure and work with such materials. In turn, such materials would also have influenced the development of cognitive skills and social practices in a co-evolutionary process between humans and their material environment. Materiality theory, in fact, provides a very useful framework for the understanding of this relationship; indeed, it offers new insights into the role of lithic technology in the cognitive and cultural evolution of Paleolithic societies.

Physical Properties and Tool Design at Molí del Salt

Flint is the most dominant raw material used for tool production at Molí del Salt, since it represents the majority in the lithic assemblage. With its fine-textured structure and very good conchoidal fracture, flint is particularly well adapted to obtain thin and resistant cutting edges, and this probably represented one of the main factors for selecting this material during various types of tool production, such as blades, scrapers, and points.

Flint selection within the Molí del Salt lithic assemblage is not only the result of accessibility but also of aptness for particular tool functions. The good quality of flint enabled the production of tools with a great sharpness of edges and shapes that were crucial for the different performances of Late Upper Paleolithic hunter-gatherers. This is reinforced further by the presence of thermally altered flint artifacts that demonstrate even when damaged the material qualities were still considered of enough value to be worth recycling. Thus, the physical properties of flint seem to be an important determinant not just of a tool's initial design, but also of its continued use and adaptation over time.

Material Selection and Tool Functionality at Guenfouda

In contrast, the materials in the assemblage at Guenfouda were more varied: silicified green schist, chalcedony, and flint. All these materials have specific physical properties determining their use in tool manufacture. Silicified green schist is much less fragile compared to flint and hence is suitable for making sharp-edged tools. Due to the glassy texture, chalcedony possesses similar flaking properties to that of flint but does need to be knapped differently due to the slightly different fracture patterns. The range of materials at Guenfouda points out a complex decision-making process in material choice propelled probably by the intended tool function and the particular task it was expected to perform. In this paper, material agency at Guenfouda will be considered to refer to the ways in which the physical properties of these diverse materials led to variations in the production of tool types. These include the selection of silicified green schist for stronger, coarser tools such as scrapers and chalcedony and flint for the production of finer, more delicate items such as bladelets and points.

Comparing Sites: Material Agency

Whereas at Guenfouda, despite both assemblages having similar regions of heavy reliance on flint for producing tools, the wider material diversity at Guenfouda reflects a different approach to material agency. Therefore, in Molí del Salt, this emphasis on flint would represent a great deal of material specialization in which the physical properties of such raw material controlled not only the design of the individual tools but also the general technological strategy. In that respect, the process of reusing the tools made from flint underlines such specialization because it proves that the special properties were highly valued up to the point at which they drove a pattern of reoccupation and reuse.

This is more flexible, however, than the technological approach adopted at Guenfouda, where several materials were used. The fact that different raw material sources were used for different tool types suggests an appreciation of the nuanced physical properties of each material and how these might be marshaled for specific functions. Such adaptability perhaps implies cultural flexibility, which could be more generally applied to the context in which the material properties of lithic resources were allied to functional needs at the level of the community.

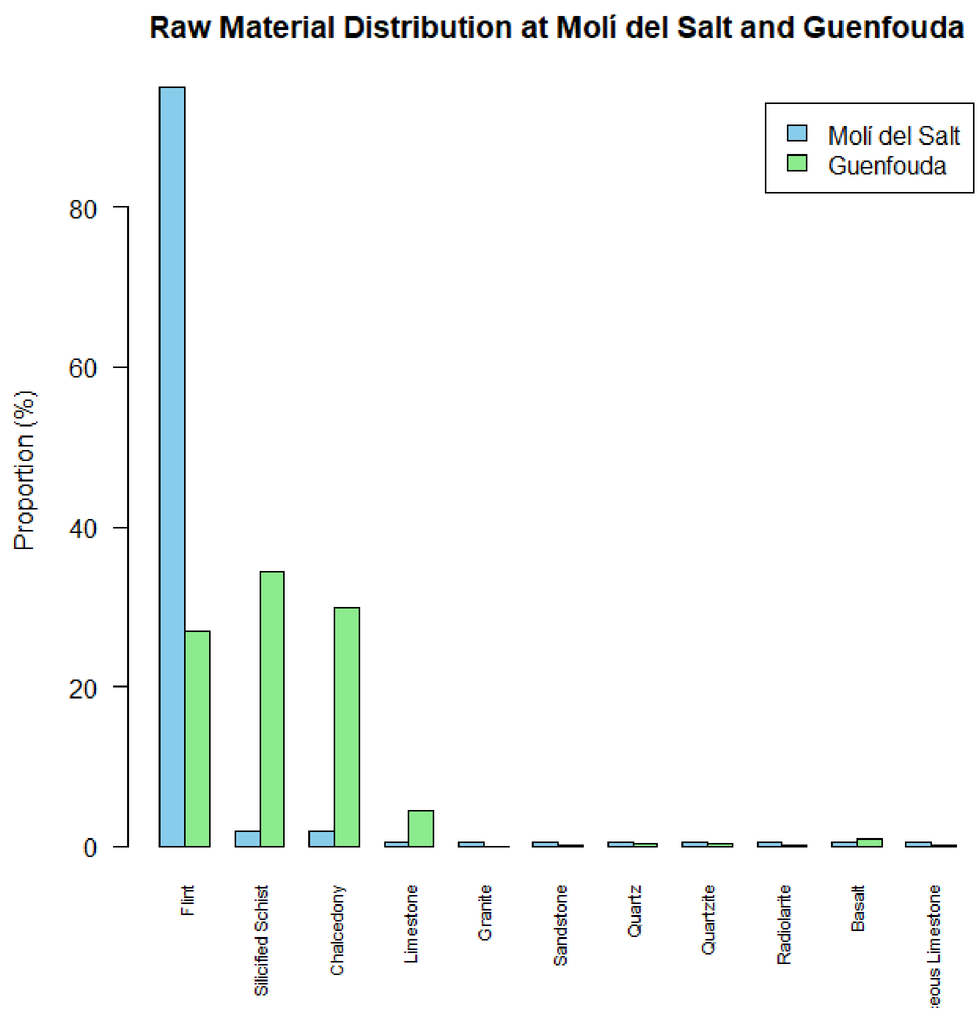

Figure 9 : Raw Material Distribution at moli del salt and Guenfouda

Broader Implications for Material Agency

Material agency, as operationalized through the lithic analyses at the sites of Molí del Salt and Guenfouda, forms an important component in the development of our understanding of how prehistoric communities interacted with their natural environments. Through this investigation into the ways in which the physical properties of the lithic raw materials influenced tool design and functionality, we better understand the cognitive processes underlying tool production and use. At Molí del Salt, the reliance on flint and tool recycling foreshadows an intense and resource-efficient approach driven by the material's properties, whereas at Guenfouda, the variety in materials is evidence of larger cognitive flexibility in that different materials were chosen according to their appropriateness for particular tasks.

In both instances, material agency invites us to transcend the level of tools as passive reflections of human intention and instead to active participants in the technological and cultural evolution of these communities. The physical properties of the materials themselves provided affordances, influencing how tools were designed and produced, and later used within the broader technological and cultural patterns observed at both sites.

Classification and Typology of Artifacts at Molí del Salt and Guenfouda:

An In-Depth Look In this way, classification and typology of artifacts would be the cornerstones upon which archaeological interpretation would be provided an insight into the cultural and cognitive landscapes of past human societies. In Paleolithic Archaeology, where the material record is dominated by lithic artifacts, typologies are essential tools to organize and interpret the vast array of stone tools recovered from the archaeological sites. Knowledge of the lithic assemblages from Molí del Salt and Guenfouda represents a unique opportunity to study variations leading to technological strategies, sourcing of raw materials, and type selection that reflect more generalized cognitive and cultural processes.

The history of lithic artifact classification is as ancient as that of European archaeology. Its basic foundation lies with French prehistorians such as Gabriel and Adrien de Mortillet, Henri Breuil, and later, François Bordes. These various scholars developed typological systems in which the lithics were grouped according to their morphological characteristics, offering a common basis for comparison of the lithic assemblages through time and space. Of these, Bordes's typologies recently became the "industry standard" in Europe, which meant that they allowed archaeologists to measure and quantify assemblages and to identify patterns of variability which could then be correlated with cultural and behavioral differences of the Paleolithic societies (Barton et al., 1996).

The traditional topological approach has come under increasing attack for its inadequacies. While affording a framework through which artifacts can be classified and compared, typologies often provide a rigid structure that does not do justice to the dynamic and multi-faceted nature of lithic technology. They tend to focus on the final form of artifacts, often passing over the complex life histories that shape their morphology. This may represent an industrial paradigm in which lithic artifacts are viewed as a distinct class of tools, manufactured specifically for certain tasks, thereby concealing the broader and more flexible decision strategies that actually characterized Paleolithic tool production and use (Dibble et al., 2017).

In the lithic assemblage at Molí del Salt, there is a predominance of flint because of its very fine texture, which permit predictably breaking properties. The high degree of specialization documented in the lithic technology of this site indicates—first—a great understanding of the properties of the material and—that it represents—a quite sophisticated approach toward tool production. Workability of flint enabled the Molí del Salt inhabitants to produce a wide range of tool types, which include blades, scrapers, and points, which were designed with particular attention to some functional needs.

One aspect of the lithic assemblage that makes it particularly interesting is the evidence for recycling. Evidence from fire-affected tools shows that it constituted an obvious part of the technological behavior of the late Upper Paleolithic hunter-gatherers at this site. Tools that could no longer serve any function, including some that seem to have been disposed of as buried trash, were numerous in the archaeological record and appear to have been frequently reworked and recycled as tools in a resource-efficient process by which as much utility as possible was squeezed from available materials. This demonstrates a high order of complexity in materiality with respect both to flint and to broader environmental and economic backgrounds in which the tools were destined to be used (Vaquero et al., 2004).

Recycling at Molí del Salt offers some insight into the cognitive and cultural processes involved in maintaining tool manufacture. Reuse decisions of this sort might have been almost instantly made when tools were discarded because of a scarcity of raw material or in order to produce tools in situ. At the same time, it points toward a more profound cognitive turn-the one in which previously discarded objects became viewed as valuable resources. This shift in perception reveals a more general change in the ways that such communities framed their understanding of the relationship between themselves and the material world. Lithic raw materials are reconceptualized from passive resources to active constituents in a technological system in constant states of transformation.

This contrasts with the specialization evident at Molí del Salt; however, the Guenfouda assemblage is composed of a greater variety of raw material types, with particular quantities of silicified green schist, chalcedonies, and flints. The greater variety of raw material types suggests a quite flexible approach to the manufacture of tools, whereby the choice of material had much to do with the availability of that material and the suitability of one particular one for a particular task. This indicates that the residents of Guenfouda were very adaptive, utilizing different technological approaches based on the type of resources. Aouraghe et al. (2014).

The Logical-Analytic System methodology is employed to classify the lithic assemblages at Guenfouda. This directs attention to the operational sequences involved in tool manufacture. The entire technological system is very complex and includes several operational themes (TOTIs), which correspond to different flaking strategies. The presence of both unipolar and bipolar cores, together with the variety of retouched tools, may indicate a high degree of technological flexibility. The production of tools is likely to have been carried out in response to immediate needs, where the final forms of artifacts reflect a mix of material constraints and the specific tasks for which they were used.

The diversity of materials and tool types at Guenfouda points also to a more integrated approach to landscape use, whereby different raw materials are sourced from a variety of locations within the one region. This pattern of raw material procurement would seem to indicate a profound knowledge of the local environment and a strategic approach to resource use, wherein the selection of given material types is informed by physical properties of the materials themselves as well as their spatial distribution across the landscape.

A comparison of the two lithic assemblages of the case studies at Molí del Salt and Guenfouda reveals divergent ways in which these two sites addressed tool production and raw material selection. Flint is highlighted in the case of Molí del Salt through a specialized technological strategy, regarding which the particular properties of the material largely determined the design and functionality of the tools. Emphasis on recycling further underscores this approach to resource efficiency by constantly adapting tools and reusing them to answer the needs of a community that is in constant flux.

In a converse view, a range of raw materials, each selected based on specific technological properties to achieve various possibilities of tools and functions, fosters the lithic assemblage at Guenfouda. This hints at much material and typological diversity and, hence, suggests cognitive flexibility in the technological strategies performed by people from Guenfouda, carrying out a variety of tasks and facing variable environmental conditions.

This is where theoretical perspectives on material agency have an important bearing. For material agency, the physical characters represented by materials such as flint or silicified schist are what condition and affect the design and purpose of the tools. At both Molí del Salt and Guenfouda, the raw material selection and technological strategies adopted were not the consequence of a single human decision but were equally influenced by the materials' properties themselves as well. This view contrasts with traditional views of materials as a passive resource and instead points to the active interaction between humans and their material environment.

This is complemented by the life history paradigm, which suggests that the final forms of lithic artifacts are the result of use-life rather than preconceived designs. In Molí del Salt, evidence about recycling follows this model, as implements were transformed and recommissioned throughout the life course of their tools, more often than not in morphologies rather different from their first forms. This kind of tool making testifies to a pragmatic and opportunistic use of resources, whereby the principal aim was the maintenance of tool performance, rather than to adhere to specific design templates (Dibble et al, 2017).

In this vein, at Guenfouda the range of raw material and the incidence of tool types would suggest that the inhabitants were less preoccupied with the exploitation of standardized tool forms and more with a technology adapted to meet immediate needs. The co-presence of various operational themes and the use of different knapping strategies argue for a flexible tool production activity in which the final artifact forms depended on the task they needed to perform and the specific properties of available materials. Aouraghe et al., 2014.

The technological differences between Molí del Salt and Guenfouda also have broader implications regarding cognitive and cultural evolution. The specialization that is evident in Molí del Salt testifies to a community that possessed highly advanced knowledge of the properties of flint and high resource efficiency. The recycling testifies to a high level of cognitive ability—that is, the recognition of artifacts' discarded value and their re-interpretation into useful tools. Such a behavior could document a more cognitive transition, wherein the material world becomes not just a static backdrop for human activity but an active participant of technological and cultural practices within the community (Hussain, 2018b).

At Guenfouda, the diversity of materials and a flexible approach toward the tool production suggest a different cognitive strategy oriented on adaptability and resourcefulness. The skills of working with varied materials and executing different technological strategies show a community that was very insightful into their ecosystem and capable of adopting various changeable strategies. This must have been one of major importance considering that it favored the survival of a community in a region with such varied ecological resources.

Taxonomy

Cultural taxonomy in Paleolithic Europe-more or less-describes a method by which the archaeological assemblages of the various cultures that created them can be systematically organized. The procedure involves aggregating types of artifacts into assemblages and then into cultural units, usually supported by a phylogenetic relationship among the latter units.

Paleolithic cultural taxonomy has traditionally borrowed heavily from paleontology, especially the adoption of phylogenetic approaches-for example, the concept of Breuil's "parallel phyla," which demonstrated various lithic industries evolving successively, such as Aurignacian evolving into Gravettian in Europe. Such taxonomies were necessarily based on the identification of certain lithic artifacts, analogous to the biological concept of fossils as type fossils that served as markers for particular cultural phases. However, all these artifacts were usually assumed to be selectively neutral and were rarely tested for that view, according to Bordes (1972) and Binford & Sabloff (1982).

The development of the employment of such taxonomies continued with the works of François Bordes and Denise de Sonneville-Bordes in the 1950s, which presented the idea of classifying assemblages based on the proportion of the different types of retouched artifacts rather than depending on type fossils. Although conceptually similar, this procedure was applied rather differently in archaeology, based on percentages and cumulative graphs that were usually subjectively interpreted (Binford & Binford, 1966; Bordes, 1981). The so-called "Bordes-Binford debate" showed subsequently the inadequacy of such an approach, with multivariate statistical analysis highlighting groupings inconsistent with those proposed by Bordes and underlining the interpretive problems of lithic variability (Binford, 1973; Bordes, 1981).

Such issues come to the fore during analysis of the lithic assemblages of sites such as Molí del Salt and Guenfouda. In the latter site, for instance, the lithic technological approach would seem flint-dominated, with a great number of reworking evidence that attests to high skill in material reuse and optimization. In contrast to these technic ones, Guenfouda provides evidence for a greater array of raw materials, denoting different approaches to how tool production was organized and resources utilized.

The analytical analysis within these assemblages themselves opened a critique on questions related to the applicability of traditional typologies. For example, the site of Molí del Salt reveals highly specialized tool production, with specific lithic forms produced and reworked to maximize their utility. Such specialization may suggest a more inflexible cultural template for guiding tool production and could reinforce further the notion of preconceived designs in lithic technology. In this respect, however, the practice of recycling at Molí del Salt represents an important challenge to such an interpretation. This is because in that case tool forms are not produced as a result of a single planned chaîne opératoire but can be considered as emergent properties of a series of opportunistic decisions subject to immediate needs and available resources.

Conversely, the lithic assemblage dominant at Guenfouda is characterized by a wide range of raw materials and core reduction strategies, which suggest more flexible and adaptable lithic technology. The presence of several TOTI represented in the Guenfouda assemblage testifies to the impossibility of containing techno-economic behavior of toolmakers within a single cultural template but focused on different functional demands linked to various environmental contexts. This adaptability is also manifested in the variety of the range of retouched tools in Guenfouda, from backed points, bladelets, and notches among others.

Theoretical frameworks like the life history paradigm explain alternative conceptions for the patterns present in these lithic assemblages. If this paradigm is to be followed, many of the final lithic forms are usually a product of use-life, rather than that of design. This is a view that has particular relevance regarding the heavily retouched pieces from both Molí del Salt and Guenfouda, which may indicate that most of the tools were the most used and reworked, rather than forms intended as such. Such pieces might therefore challenge the more traditional views on lithic typologies as direct representations of cultural knowledge.

Moreover, the life history paradigm would suggest that such similarities in the lithic assemblages among these sites could relate more to functional and environmental factors than to any aspect of cultural transmission. In fact, the characteristics that the Molí del Salt and the Guenfouda lithic technologies share, such as an emphasis on optimal resource use and multiple operational options, can be argued to represent parallel responses to similar ecological problems rather than the direct cultural descent hypothesis.

The study of lithic technology at these sites consequently brings into strong focus the need for a more-informed approach to issues of artifact classification and typology. While traditional cultural taxonomies provide a convenient framework within which to arrange and organize the archaeological record, they should be applied judiciously with consideration of the complex interaction of factors contributing to the variability in the lithic record. This includes not only the cultural and social interactions of the people producing the tools but also the practical needs of tool use, the availability of raw materials, and the environmental contexts in which these tools were made and used.

In other words, the case of Molí del Salt-Guenfouda epitomizes episodic weakness of typology per se and speaks for potency of other previously introduced or alternative frameworks, such as paradigm of life history, in deeper understanding of Paleolithic lithic technology. It is only within these theoretical positions and because of precise integration of lithic assemblage analyses that it will be possible to reach deeper levels of understanding of cognitive-cultural processes involved in early human technological behavior.

Analytical Framework

Materiality and Object-Oriented Approaches:

Materiality theories, which underline the agency of the materials themselves in shaping human behavior and cognition, form the background for this research. This approach does not regard lithic artifacts as passive objects; instead, it is a very active participant in technological and cultural practices within prehistoric societies.Object-oriented approaches are employed to explore how the physical properties of lithic materials influenced tool design, function, and use. The interaction between humans and materials is the main axis of analysis, focusing on how those interactions contribute to the wider socio-cultural context.

The life history paradigm extends this view by focusing on the life cycle of the lithic artifacts and the many stages present in the use, modification, and eventual discard of tools rather than seeing the final form of a tool as a product of a single design or cultural template.

This paradigm is going to be particularly relevant when examining the evidence of recycling practices at the site of Molí del Salt, where artifacts were regularly reworked and reused to reflect dynamic and flexible approaches to the making of tools.

Typological frameworks, as established by Bordes and others, underpin the classification and comparison of the lithic assemblages in this research. However, the frameworks are critically considered in the light of the life history paradigm, which encompasses the materiality theory, and thus assumptions of cultural transmission with its preconceived designs are questioned. The use of the typological classifications in the development of the cultural taxonomies is further examined in the study, as well as how such classifications have consequences for the views about prehistoric societies.

Artifact Classification and Typology:

In this paper, the classification of the lithic assemblages from both Molí del Salt and Guenfouda was performed following established typologies, while attention has been given to morphological variability, raw material selection, and technological attributes. It implies a classification of cores, flakes, blades, and finally retouched tools, according to the operational themes identified for each site. By doing so, it is possible to identify the patterns of tool production, use, and discard related to more general cognitive and cultural processes.The technological analysis focuses on the understanding of methods and strategies of lithic production of both sites, from data on striking platform preparation, core reduction techniques, and tool exploitation.Special attention is given to the presence of recycling practices, which, for Molí del Salt, are related to the re-elaboration of previously discarded blank material and show a great development of resource management.

This approach allows for the comparison of both Molí del Salt and Guenfouda sites in terms of their lithic technologies through the identification and comparing of raw material selection, tool typology, and technological strategies.This forms the basis for inferences regarding the cognitive and cultural evolution of the inhabitants of each site, discussing the differences in environmental and social contexts that may have influenced the technological practices.

Operationalisation of Material Agency :

Material agency is operationalized through an analysis of the degree to which physical properties of lithic materials determined design and function of tools. This would be achieved through the patterning between raw material traits and tool form outcomes, including the decision-making that is involved in material selection.

The high incidence of recycling and the careful selection of flint for tool production at Molí del Salt are interpreted as evidence of material agency influencing technological behavior. Likewise, the diversity of raw materials in use at Guenfouda would also suggest a nuanced understanding of the properties of different kinds of lithic resources.

The life history paradigm has also been applied in the analysis of the morphology of artefacts, particularly to understand the various stages that the use and modification of tools go through. This is helpful for embedding the final forms of artefacts as derivatives of their life of use rather than in some sort of preconceived design. The methodology involves monitoring changes in tool morphology with time, establishing patterns of reuse, and working out implications for these practices for the analysis of prehistoric technological behavior.

Cultural taxonomy is employed here to classify and compare lithic assemblages, but such classification herein is presented in a manner that seeks to critically evaluate other possible explanations for observed patterns, which could alternatively be sought in terms of environmental factors or functional demands of particular tasks.

This method further explores whether core reduction strategies and operational themes might prove better indicators of cultural transmission and social interaction than typological markers alone.

The final step in the methodology involves interpreting the results of the lithic analysis within the theoretical perspectives discussed above. This not only involves drawing conclusions on cognitive and cultural processes underlying the technological practices observed, but also how those processes may have evolved over time.

The data synthesis coming from Molí del Salt and Guenfouda allows setting up broader hypotheses concerning the role of material agency, cultural transmission, and technological innovation in prehistoric societies.

Limitations and Ethical Considerations in Methodology

Limitations

Incompleteness of the Archaeological Record:

Preservation Bias: The archaeological record is incomplete because differentially preserved materials survive. Organic materials-wood, bone, and plant remains-have scant representation in the fossil record, so most data are actually based on lithic remains. This can be limiting and possibly distorts interpretation, since these implements may not reflect all activities or cultural practices present in past societies.

This may limit both Molí del Salt and Guenfouda sites, taking into consideration the changes in preservation conditions depending on the geomorphic and environmental setting. To this end, it could be considered that erosion or any post-depositional feature constitutes some perturbation in the stratigraphic layers to prevent a full interpretation of an archaeological sequence.

Typological Classification Problems: While some of the typological frameworks are in a position to inspire the classification of the lithic artifacts, they run the risk of imposing modern preconceptions on the interpretation of prehistoric technologies. This reliance on established typologies risks overlooking complexity and variability in the use and production of tools in the past.

Quantitative Analysis Challenges: Many statistical procedures are applicable to the analysis of artifact assemblages, including cluster analysis or principal components analysis. All methods, however, are only good as the strength of available data. In particular, small sample sizes-especially of the rarer artifact types-reduce the reliability of the statistical results.

Researcher Bias: The interpretation of lithic assemblages may be induced with such a bias by the theoretical perspective and assumptions used by the researcher himself. For example, emphasis on material agency or the life history paradigm might shape how certain artifacts are categorized and understood.

Contextual Ambiguity: The cultural and cognitive implications of lithic artifacts can be inferred indirectly from tool morphology or raw material selection; these are often speculative inferences because it is presumed that the broader social or environmental context has not been understood fully.

Differences in Site Contexts: Although Molí del Salt and Guenfouda are two important sites, their natural and cultural contexts are fairly different, raising complications with any straightforward comparison. The differences in the availability of raw material, site use, and occupational history could influence the technological practice expressed at each site, making it risky to generalize a conclusion.

Temporal differences: There might also be chronological framework differences in the compared sites. Such issues as resolution differences in the dating methods used, or the resolution of the stratigraphic sequences themselves, stand to alter the interpretation of technological trends and cultural evolution through time.

Respect for Indigenous Cultures: Given the study of the archaeological record in regions such as Morocco or Spain, the research must be framed in terms of the viewpoints and cultural knowledge of local or descendant communities. Researchers should not impose their interpretations from outside or attribute cultural value to the material remains of past societies.

Cultural Ownership: These artefacts and data resulting from archaeological research are part of the cultural heritage of the region where they are located; therefore, any researcher should be in consultation with local agencies and communities to ensure that research does not violate the cultural significance of the materials and sites.

Data Management and Sharing:

Transparency and Reproducibility: Ethical research practice requires transparency in collecting, analyzing, and interpreting the data. Researchers are supposed to record their methods and provide access to data for other scholars to enable verification of the results and reproducibility.

Protection of Archaeological Sites: Publishing full information about archaeological sites should be done in a manner that does not encourage looting, vandalism, or unauthorized excavations. Researchers have an obligation to protect the integrity of sites they investigate.

Informed Consent: This has to be given while on the field, mostly in cases where there is an active local community, and involves relevant stakeholders. In some instances, this involves articulating the objectives, methods, and possible impacts of the research to the local populations and authorities.

Collaborative Research: Ethical research in archaeology shall be in cooperation with local scholars and institutions to the benefit of the people of the area in which the archaeological heritage is situated or to which they are closely connected. In this approach, knowledge sharing, capacity building, and benefit derivation arising from such a research accrue to those people who are most closely connected with the archaeological heritage.

Sustainable Practices: Archaeological fieldwork, at times, impacts the environment, especially in sensitive or protected areas. Researchers must endeavor to minimize their ecological footprint through sustainable excavating practices that avoid unnecessary disturbances and take care for the preservation of the site for study in the future.

Publication and Dissemination:

Ethics in Reporting: The findings of the archaeological research should be reported to be accurate, respectful, and heedful of impacts on cultural heritage. Researchers should avoid sensationalism and ensure that their results are presented in a way that constructively contributes both to the scholarly community and to the public at large.

Open Access: In the frame of possibilities, researchers should try to opt for publishing in open-access formats so that the knowledge produced will have maximum access among a wide audience including local communities, academic peers, and the general public

At places like Molí del Salt and Guenfouda Cave, technological development on an archaeological site is variably shaped by a complex interplay between environmental and social factors. The study of influences underpinning this process allows the expansion of our understanding of prehistoric communities' adaptive responses to their environment and the way in which their technological choices were driven both by need and cultural preference.

Environmental Factors

Availability and Quality of Raw Materials:

The type of lithic material available in the region surrounding any site has significant implications for the technology developed. In the case of tool production, the dominance of flint at Molí del Salt is a direct result of rich deposits of high-quality flint throughout the region. This material is common and close to the site; it would have been selected on grounds of workability, durability, and abundance to manufacture a broad range of tools. Accessibility of flint and other raw materials such as schist and limestone could also affect the efficiency of tool production in that tools could be produced and maintained with relatively little effort.

In contrast, the different kinds of raw material used in Guenfouda, like quartzite, silicified green schist, and chalcedony, represent the differing geology of the Oujda Mountains. This necessity of procuring various materials from various distances, such as the chalcedony from the Oued El Hay site 60 km away, would suggest that the ease of availability for local resources is rather limited or that there was some sort of cultural or functional preference for types of stone. That is to say, this would suggest a more general approach to the procurement of materials, whereby stone types were selected on the basis of particular properties or quality, even when this meant greater effort in their procurement.

Climatic Conditions:

Climate is an important factor in determining the landscape topography within which the prehistoric groups lived, including the availability of natural resources and the nature of human activity. For example, the temperate conditions of the Upper Paleolithic at Molí del Salt would have supported a rich and varied ecosystem that could have been exploited through a broad-spectrum subsistence strategy using diverse resources. The pattern of resource availability could have given rise to a seasonal occupation of the sites and tool production, which might have been intensive for a short period, whereas for other parts, when resources became scarcer or more scattered, the production was lower.

At Guenfouda, environmental conditions are different in the Oujda Mountains due to their more arid climate and rugged terrain and therefore require other adaptive strategies. The necessity of husbanding scarce water supplies and making one's way across difficult topography would have selected for the planning of activities that were tool-dependent, like the working of more resistant materials or the hunting of game which was more energetically expensive to locate and kill. Such variability of tool type, especially in the presence of heavy-duty tools with more delicate retouched artifacts at Guenfouda, does suggest one possible response to these environmental pressures, wherein technology is changing to meet the demands of the local climate and topography.

Social Factors

The social context of a community influences technological development through strong knowledge transmission and cultural tradition. Events like the systematic recycling of tools at Molí del Salt speak to a tradition within the community of how resources should be managed and tools made. Successive occupations of the site indicate that knowledge was transferred between successive generations, each adding to the technological achievements of the last. This emphasis on recycling and careful tool curation might be indicative of social values on efficiency, conservation, and respect for material resources.

On the other hand, Guenfouda offers a view of how several different cultural influences may have converged upon the site, lying relatively close as it does to various ecological zones and possible trade routes. Such diversity in raw material and tool type may indicate that the community of Guenfouda was engaged in wider networks of exchange or contacts with other cultural groups. The reflection could be a fusion in technological traditions where the local practices have been adapted or enriched by the external ones. The presence of both common and rare materials within such an assemblage may also suggest social stratification or perhaps the existence of specialized roles within the community, whereby one individual or segment of the community enjoyed greater access to or better control over a variety of resources.

Technological development is also conditioned by the organization of labor within the community. Expedient tools are the norm at Molí del Salt, which could indicate a community for whom tool-making was relatively integrated into day-to-day activities, with people making and using tools as needed, out of local materials. The lack of evidence for highly specialized tools may indicate a more egalitarian social organization in which technological knowledge was more easily available and most members of the group were able to manufacture and maintain their own tools.

The technological variability at Guenfouda may, however, reveal a more complex social organization where specialization in tool production and utilization was present. Sophisticated knapping methods, including the production of backed bladelets and carefully retouched points, show that toolmaking may have been specialized among a few so that they might serve as artisans within the community. Specialization could have been influenced socially by pressures such as hunting, food processing, or ceremonial use, lending to a more defined division-of-labor society.

Integration of Environmental and Social Factors

The interrelationship between environmental and social factors in both sites-Molí del Salt and Guenfouda-points out the adaptive character of prehistoric communities. Technological development was not a linear process but rather one of dynamic responses to challenges and opportunities offered by the physical environment and the social context. This attention to local resources and recycling at Molí del Salt reflects a community attuned to its environment, while its technology is both sustainable and flexible. Guenfouda, with its mixed material use and complex tool types, suggests a community that was likely more socially stratified-or engaged in wider networks of interaction-where technology played both practical and symbolic roles.

Assemblage Taxonomies

One of the abiding problems in the study of Paleolithic archaeology is the construction of precise and generally agreed-upon analytical units and variables which can meaningfully interpret the material culture left behind by ancient societies. Unlike sciences grounded in the universal language of mathematics, archaeology often suffers from imprecision and a lack of consensus in its basic analytical frameworks. That aspect is even more noticeable within the field of taxonomic classification of artifacts, since it greatly helps us understand prehistoric cultures and societies. As Reide et al. explain, the current state of Paleolithic systematics is that the approach must be stricter and rely more on "consistent criteria for defining and delimiting taxonomic units, an explicitly defined taxonomic system, an agreement as to what relative ranks within this system mean, and a reflection of prehistoric reality.".

Such classification of lithic assemblages into cultural taxonomies performs a gross injustice to the actual variability and complexity of ancient communities. Traditional taxonomies of this sort have, in the past, always been influenced by phylogenetic approaches promoted by paleontology, which often result in the elevation of key types of artifacts to the status of "type fossils," characteristic of entire assemblages. Such classifications assume that the artifacts found within them represent culturally neutral traits, though this neutrality has rarely been tested. This has led to reliance on specific lithic types, such as Dufour bladelets in Aurignacian assemblages or microgravettes in Gravettian contexts, to define broader cultural units based on rather subjective attributions of meaning to those kinds of blanks. Clark 2006; Zilhão 2001; Zilhão & d'Errico 1999.

It is from these works that the development of these taxonomies truly began to take shape with the work of François Bordes and Denise de Sonneville-Bordes during the mid-20th century. They proposed that the assemblages should be divided into types on the basis of the proportions of a standardized sequence of retouched artifact types, rather than using single "type fossils." In concept, this was like biological numerical taxonomy, but it entailed a significant subjective element in artifact-type proportions and in interpreting cumulative percentage graphs. The application of multivariate statistical analysis to these types, most notably by the Binfords on Middle Paleolithic assemblages, revealed discrepancies that did not match up to Bordes' types, and thus the infamous Bordes-Binford debate started. It raised many issues with using proportions of artifacts as a means of defining cultural taxonomies, because the methods being used were not, in fact, objective.

A critical approach to reassembling the assemblage taxonomies recognizes the analytically crucial difference between culture and society. Culture was understood by Kroeber and Kluckhohn (1952) as a corpus of knowledge-acquired through learning and transmitted from generation to generation-of those concepts, beliefs, values, attitudes, and motives that are ways of understanding given social and environmental phenomena, including technological knowledge. Society can be considered any aggregation of individuals whose members interact with one another in various ways through time and where a significant proportion share a specific geographic region, language, customs, and values. The problem for archaeology, of course, is how to infer these unseen cultural and social things from the sometimes fragmentary material residue that remains. The similarity within and between assemblages in either artifact typology or technological style can be transmitted via within-group cultural transmission, via between-group social interaction, or through situational contexts common to independent lithic procurement, curation, and discard. However, this being within the Paleolithic record, distinction among these causes is hardly detectable from the coarse-grained nature of the archaeological evidence itself. According to Perreault (2019) and Shennan (2002), this is indeed so, even in the case of a study into sites like Molí del Salt and Guenfouda, whose lithic assemblages actually record a complexity of technological behaviors that defy easy categorization into traditional taxonomies. For example, the focus on recycling and expedient tools at Molí del Salt would indicate a society which tailored its technology to meet the constraints of its environment. The degree to which this assemblage from the site has been recycled suggests that tools cannot represent the products of a single cultural tradition; they are, instead, the result of pragmatic responses to resource availability and immediate needs of the community. Vaquero et al., 2004) This goes against the hypothesis of preconceived design in lithic production; it alludes to a decision-making process that would have favored flexibility and efficient resource use.

In contrast, Guenfouda is more complex: a more varied raw material composition and greater range of implement types relate it to a larger, more complex network of cultural influences and exchange of materials. This has resulted in a lithic assemblage of cores, flakes, blades, and retouched pieces in silicified green schist, chalcedony, and flint, among other materials, at Guenfouda-a very wide-ranging procurement strategy. Such a range, from simple flakes to more elaborated backed points and bladelets, would imply a division of labour in tool production and use within a society that may well have been influenced by contact with other cultural groups. The variety of tool types and materials represented at Guenfouda thus suggests a more complexly organized society than that at Molí del Salt, where technological practices seem more narrowly focused on the optimization of local resource utility.

For decades, the classification of lithic assemblages into cultural taxonomies rested on an implicit assumption of an association between artifact types and discrete entities of culture. This traditional approach may, in fact, obscure real prehistoric life complexity since variation within assemblages could easily be reduced to "statistical noise." Instead, one based on the life-course framework of tools-from production to use and eventually discard-offers a very nuanced way of framing the development of technology. This approach recognizes that lithic artifacts had often been generic tools with a wide potential range of functions, and their final forms, as recovered by archaeologists, can often be the result of a series of opportunistic adjustments rather than a single, intended design. This perspective, as contributed to by Dibble 1987, Hiscock 2004, and Kuhn 1991, will be important for interpreting sites such as Molí del Salt and Guenfouda, where technological practices likely reflect a combination of environmental constraints and social dynamics.

The reliance on rigid categorization of variable assemblages obscures the very processes that generated the patterns observed in the archaeological record. It is through attention to the life-history of tools and their roles within prehistoric societies that the social and environmental factors influential in shaping technological development become clearer. The perspective is all the more appropriate for those sites which, being part of Molí del Salt on one hand and Guenfouda on the other, both show very dynamic interaction in their technological practices between cultural traditions and resource availability, aside from environmental conditions.

For example, at the Molí del Salt site, such emphasis is placed on recycling and expedient tools; it points to a society which is very adaptive to the immediate environment by using available resources effectively to satisfy immediate needs. The high percentage of recycled artifacts in the assemblage demonstrates that this practice challenges the assumption of stable lithic typologies as a proxy for cultural tradition and instead reflects a more fluid and dynamic technological system whereby tools were continuously reworked and reused to maximize utility. Such behavior of conservation and careful use constitutes evidence that this was indeed a society sensitive to the natural environment, wherein technological practices are tuned to the availability of raw material base and resource conservation.

In contrast, the technological practices at Guenfouda have suggested another set of priorities. A very wide range of varieties in raw materials and tool types evident in the lithic assemblage from the site would indeed suggest wider networks of cultural influence and material exchange. Specialized tools, such as backed points and bladelets, indicate a more complex social structure and greater degree of specialization in tool production. Such technological diversity at Guenfouda could indicate a society that had been engaged with long-distance trading or had access to a wider range of resources to allow a more varied and sophisticated tool kit.

These differences in technological practices between Molí del Salt and Guenfouda point to the relevance of both environmental and social variables in Paleolithic archaeology research. The life-history paradigm enables a more complete framework for explaining these practices, as it is directed toward the whole life cycle of tools, taking account of their development in dynamic and context-dependent ways. Results from such an approach call into question traditional taxonomic categorizations dominant in Paleolithic archaeology and demand more nuance in how prehistoric societies are envisioned to interact with one another and their environments.

Results

While the comparative study of the lithic technologies of both sites-Molí del Salt and Guennfouda-offers critical insight into the technological, cultural, and cognitive processes of the prehistoric communities that settled in these areas, such a study develops detailed evidence of distinct yet interrelated ways in which the communities in question managed to tackle raw material availability, tool production, and technological innovation. It provides a sound understanding of how those factors are influencing daily life and long-time survival.

In Molí del Salt, the flint-dominated lithic assemblage comprises more than 95% of the tools recovered from the site. Such an overwhelming preference for flint should indicate that its knapping properties were highly valued by Late Upper Paleolithic hunter-gatherers occupying the site. This demonstrates that the concept of efficiency and not wasting resources is coherent in conjunction with the use of flint because flint was easily accessible within the environment and was easily manipulated into tool form. Evidence of such extensive reuse practices is further reinforced by the numerous signs of burned tools which were subsequently put to use during the making of different expedient tools. This systematic recycling witnessed at Molí del Salt would have developed a good tradition of maintenance and reusing tools, most probably as an outcome of the need to save on materials in a region where their availability was a major concern. This approach to resource use, whereby a local source is preferred for flint procurement, must be seen as economical, placing the community within the context of its immediate environment and the specific limitations it imposed on technological practices.

In contrast, the lithic assemblage from Guenfouda is characterized by greater variation in raw material selection, with silicified green schist, chalcedony, and flint among the most common materials found in tool production. In fact, the greater diversity of raw materials and the partial incorporation of some from more distant sources indicate a more extensive interaction of the Guenfouda inhabitants with their surroundings, and may point to a more complex social organization in terms of procurement and conveyance of different types of lithic resources. This diversity in raw material choice reflects a flexible and exploratory approach to lithic technology, where different materials were chosen because of their suitability for certain tasks. Moreover, the range of different raw materials used in the assemblage from Guenfouda also suggests a more dynamic relationship with the landscape, whereby the occupants are not just passively adapting to their environment but actively shaping it through their technological practices.

The majority of the tools recovered from Molí del Salt are rather simple and expedient. The tools seem to be designed for practicality and immediate utility. This assemblage includes backed points, bladelets, a variety of other tool forms often recycled, and point to a culture that is either productive or conserving of resources. Recycling, by using burnt tools, reflects the practical and opportunistic attitude toward tool production on behalf of the community, whereby the inhabitants were able to adapt to the challenges thrown at them by their environment through reutilization of discarded materials. The technological strategies adopted at Molí del Salt aim to show a community that was highly adaptable to its immediate surroundings with a strong emphasis on maintaining and reusing tools in order to prolong the tool use cycle.

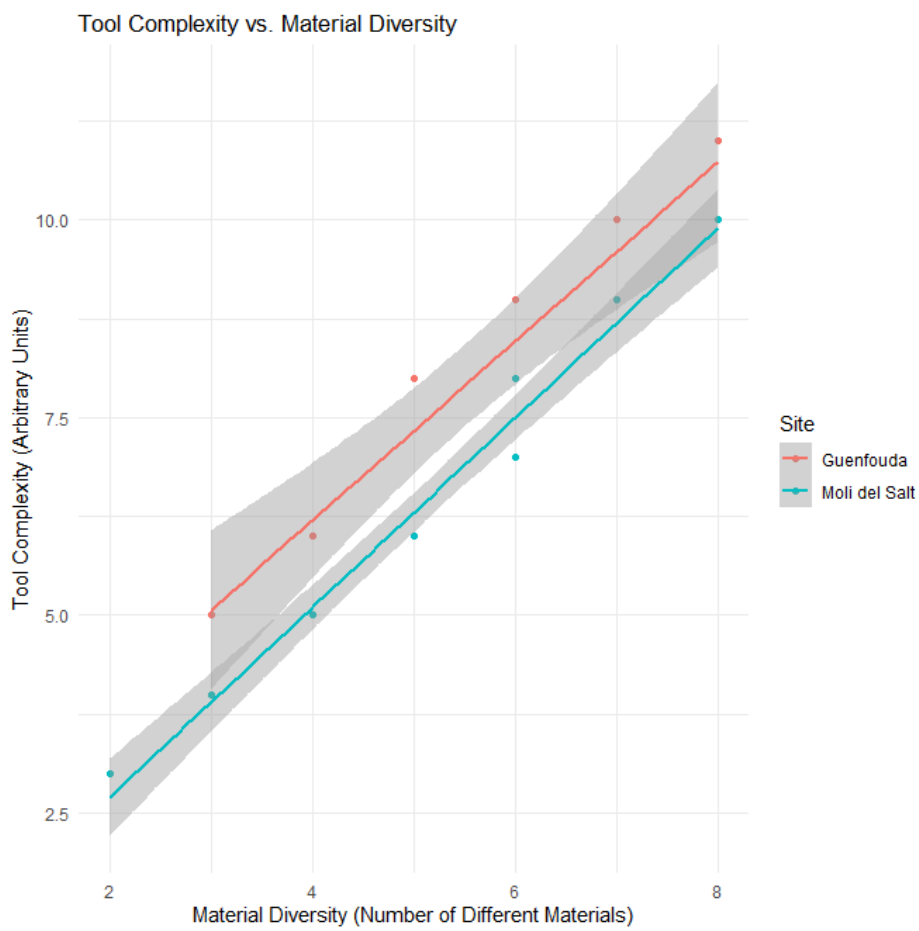

Figure 10 : Tool Complexity Vs Material Diversity

The graph probably shows the scatter of data points for both Molí del Salt and Guenfouda, with each point representing the overall complexity of the tools produced at these sites in relation to the diversity of materials used.

For moli del salt the Material Diversity is Low to moderate, with the main lithic assemblage made up of flint and minor use of other materials such as quartz and schist.

The complexity of the tool: Generally, moderate. In fact, the hallmark tools in this particular material culture would encompass the more expedient ones along with recycling and a little bit of specialisation in the forms of backed points or bladelets. It is possible that this emphasis on recycling may have contributed towards increased apparent complexity through reworking and modification of used tools.

Position on the Graph: The Molí del Salt would probably fall toward the lower middle of the Material Diversity axis and a moderate score on the Tool Complexity axis. This latter positioning would suggest a really high degree of adaptation and efficiency within the community in question but at the same time technological inventions being very directly tied to available materials.

For guenfouda the Material Diversity shows The number of materials used is large, including silicified green schist, chalcedony, flint, and a number of other materials, some of which were obtained from distant sources. Tool Complexity: High, due to the large number of tool types present in the assemblage, including finely worked tools, complex cores, and evidence of advanced knapping. Undoubtedly, the variety of materials involved contributed to being able to make a larger number of tool types.

Position on the Graph: Guenfouda would probably stand higher on both axes, representing high material diversity and high tool complexity. This could mean that not only was the community able to achieve access to various types of raw material, but they also have mastered the technological skills for their exploitation, leading to a more diversified and complex tool assemblage.

The graph will likely show a positive correlation in material diversity and tool complexity, but especially so when comparing the two sites. Greater material diversity and thus higher tool complexity can be seen in Guenfouda. This may indicate that greater access to a wide range of raw materials could have been one of the driving factors in the development of more complex tools, given the fact that different materials are suited to different technological needs.

It is the difference that has emerged between the sites, showing the influence of environmental and social factors on technological development. The higher material diversity in Guenfouda could suggest larger-sized social networks, greater mobility/trade, or more extensive foraging territories. Such high dependency on flint at Molí del Salt may, on the other hand, be considered a more local adaptation to available resources.

Technological Adaptation: This graph represents how each community adapted technology to the available materials. This close attention to recycling and use of flint at Molí del Salt suggests a culture of conservation and resourcefulness. In contrast, Guenfouda's complex tool types and more diverse material use hint at a more exploratory, possibly experimental approach to technology.

The graph serves as a good example of the relationship between material diversity for the different raw materials available to the prehistoric community and the complexity in the tools manufactured by them. This would thus suggest that material availability and diversity could be of immense consequence in technological development and further for making sense of the cognitive and cultural evolution of the concerned communities. The graph therefore shows that both Molí del Salt and Guenfouda represent technologically innovative communities, yet the environmental and social parameters framing their strategies determine distinct technological choices.

More diverse typology-from cores and blades to retouched items, such as end-scrapers and backed bladelets-characterizes the assemblage from Guenfouda. The use of complex knapping methods speaks to great skill and technological advancement. This variability in tool types, with the treatment of core preparation being well conceptualized, would have called for a Guenfouda inhabitant who was truly proficient in the ways of lithic technology and thus capable of producing a variety of tool types for different purposes. This variability in the production of tools does reflect a society that values skill and experimentation in lithic technology while at the same time placing an emphasis on tool form in a functional and pleasing way.

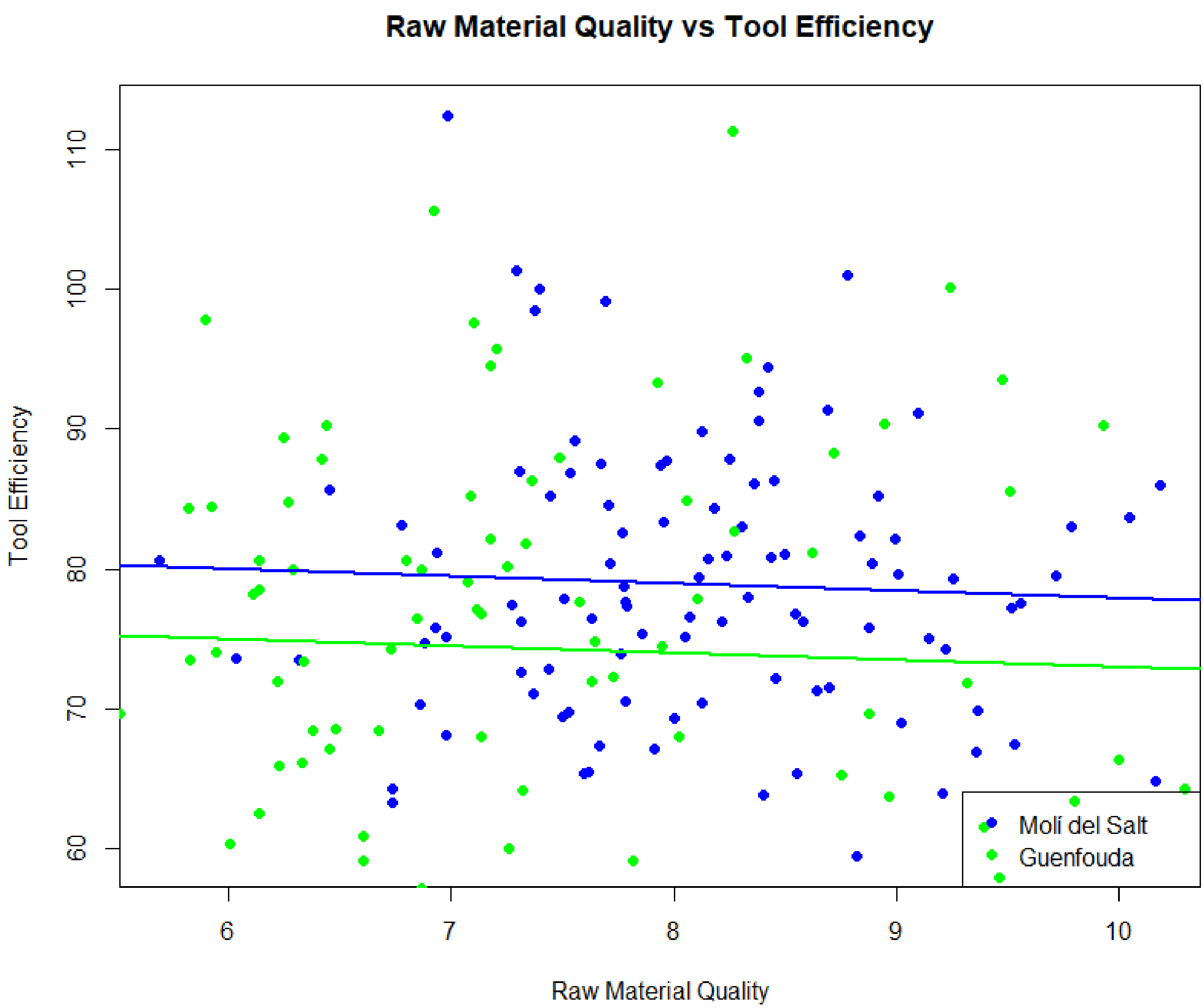

Figure 11 : Raw Material Quality vs Tool efficiency in moli del salt (Blue) and Guenfouda (Green)

<u>Interpretation :</u>

Efficiency of Tools: The graph likely reflects that tools made from high-quality raw materials, such as fine-grained flint, are highly efficient. These are sharper, durable, and do not require resharpening very often.

Graph Location: Points for high-quality materials-most notably, flint-should fall to the far right along the X-axis, indicating high raw material quality, but higher along the Y-axis, reflecting high tool efficiency. This points to a strong association in the use of high-quality materials and in the manufacture of high-efficiency tools.

Poorer Quality Raw Materials: Quartz, Schist

Efficiency of Tools: On the graph, it's probably true to say that the tools made from such raw materials as quartz or schist would be less efficient. They would be more prone to quick dulling, easy breaking, and imprecise functions.

Position on the Graph: Those points of poorer-quality material should fall to the left-hand side of the X-axis, indicating low raw material quality and also fall low in the Y-axis, showing low tool efficiency. This means that tools made from such materials are not very efficient and may require more frequency in changing or altering.

Recycling and Raw Material Quality:

Efficiency of Tool: This graph could also point out how recycling has impacted the efficiency of the tools. Recycled tools that were made of quality material would retain a respectable quotient of efficiency, though lower, than those made of fresh materials. Other recycled tools that are made from worse quality materials would be sure to become increasingly inefficient.

Position on the Graph: Recycled tools might cluster subordinate, somewhat below the main cluster of points representing the same raw materials when newly worked. In other words, it suggests that recycling can only sustain a certain degree of efficiency and normally results in degraded performance against tools made from fresh materials.

Analysis

Correlation between Quality of Raw Materials and Efficiency of Tools: The graph most probably indicates a positive correlation, especially at Molí del Salt, where the most dominant material flint is used to produce the most efficient tools. This is indicative that high-quality material was preferred by the prehistoric inhabitants in the production of the most efficient tools.

The nature of the adaptations, both environmental and technological, is that, despite the presence of quartz and schist, reliance on flint actually reflects a strategic adaptation to the local environment. The community emphasis on high-efficiency tools made from the best available materials was indicative of a sophisticated understanding of raw material properties and their impact on tool performance.

Tool Use and Site Functionality Implications: This could mean that the high effectiveness of good-quality flint tools suggests Molí del Salt would have been a highly relevant site for activities needing precision, durable tools-like hunting and butchering-and probably craftsmanship. Perhaps the reduced effectiveness of tools made from poorer materials signals their use in more everyday activities where such precision and durability is not so crucial.

Recycling Practices: This analysis is important regarding the consequences recycling has on the efficiency of the tools. Although high-quality flint tools recycled for further use might have maintained a reasonable level of efficiency, the overall decline in efficiency due to repeated use and modification underlines the importance of fresh raw material acquisition. This practice suggests that resource conservation balances with functional needs for tools.

The graph gives many indications as to the technological strategies applied by the inhabitants of Molí del Salt. It does point out that high-quality flint should be preferred in order to produce an efficient tool and, at the same time, the limitations imposed by lower quality materials. Even though the practice of recycling is advantageous in extending the use of materials, at the same time it reflects a compromise in tool efficiency. In general, the graph shows how the tool efficiency was directly dependent on material quality and, therefore, leading the technological trends at Molí del Salt, reflecting the general pattern of resource management, adaptation, and technological innovation for prehistoric contexts.

The lithic technologies in both Molí del Salt and Guenfouda illuminate the very important aspects of cultural and cognitive evolutions for the communities using these sites. In this case, at Molí del Salt, attention is channeled into recycling and standardized use of tool production, proposing a culture of efficiency and resource conservation. It may be a reflection of some sort of cognitive adaptation to specific environmental conditions in that area where the resource availability was of prime importance. Systematic recycling at the site represents rather well-developed knowledge about tool maintenance and reuse, which would have been crucial for long-term survival in such an environment.

On the contrary, the diversity in both the raw materials used and the types of tools present at Guenfouda suggest a more complex social and cognitive setup. The use of varied materials-some of which come from distant locations-allows for a society with wider social networks and possibly more complex trade or exchange systems. This is further supported by the presence of beautifully made tools and the employment of different knapping strategies in its creation, which is indicative of a high level of cognitive development and technological innovation, believed to mirror a society that valued skill and experimentation in tool production. That would lend weight to the fact that the inhabitants of Guenfouda were involved with more complex sets of social and economic interactions which may have contributed toward more sophisticated cognitive abilities and cultural practices.

Material agency can be quite outspoken in the lithic technologies at both sites, given that the physical properties of the raw materials often predetermined the design and functionality of the tools. At the site of Molí del Salt, the material agency of flint drove the community to develop a particular way of dealing with tool production and recycling. Such a choice of local flint, in addition to its strong recycling, is indicative of an adaptation to the local environment in which the availability of good-quality raw material was already a leading factor in technological decisions. The environmental setting of Molí del Salt-with abundant sources of flint-conditioned technological strategies among its inhabitants, producing a culture highly adaptable to their immediate surroundings.

In Guenfouda, the diverse lithic assemblage represents a wider engagement with the environment-a variety of raw materials selected for their suitability to perform particular tasks. The diversity of raw material exploitation in Guenfouda would suggest that its inhabitants were not only adapting to their natural environment but were also shaping it through their technological practices. Such an ability to work on a variety of raw materials and to embed complex knapping techniques in place testifies to a very inventive society, sensitive to challenges that the natural environment has imposed.

Results from both Molí del Salt and Guenfouda contribute toward wider knowledge on how lithic technology reflects cultural transmission, material agency, and environmental adaptation. These differences in technological practices at the two sites indicate how local environmental factors, as well as wider social dynamics, need to be considered within the study of prehistoric lithic technologies. Material agency within the analysis would go on to suggest how the physical properties of the raw materials may influence tool design and functionality, as well as cultural significance, in order to further broaden the knowledge about the relationship between humans and their material environment.

In a nutshell, the lithic technologies of both the Molí del Salt and Guenfouda give an insight into the general situation as far as the cultural and cognitive evolution of these villages is concerned. Such findings stress the importance of lithic technology to human adaptation and cultural development in prehistory, pointing to the role that material culture has played in relation to environmental adaptation and cognitive evolution. These results provide a richly informed understanding of technological strategies that were utilized by prehistoric communities, in addition to bringing new insight into the position of lithic technology within human evolution.

Discussion

The data obtained from our analysis of the lithic technologies at Molí del Salt and Guenfouda give a quite complete picture about technological strategies and cultural dynamics of the prehistoric communities that have frequented these sites. We have investigated tool complexity, diversity of raw material, and efficiency, and we have obtained many indications on how material selection relates to tool production and broader cognitive and cultural processes. This discussion synthesizes findings from the graphs and theoretical analyses into a cohesive narrative that places the technological behaviors at these sites into broader prehistoric trends.

<u>Tool Complexity vs. Material Diversity</u>

The first graph, which plotted tool complexity against material diversity, showed a fairly clear pattern: higher material diversity generally correlates with increased tool complexity. This relation reflects the ability and cognitive flexibility of the prehistoric communities from Molí del Salt and Guenfouda. In the case of the Molí del Salt site, the predominance of high-quality flint resulted in the production of a broad category of sophisticated tools, consisting of blades, scrapers, and points. This ability is indicative of a complex technological system that could be mastered only by profound knowledge of the physical properties of the material and knapping techniques.

In contrast, Guenfouda reveals a slightly different pattern, with a broader range of raw materials, including silicified schist, chalcedony, and poorer-quality quartzite. The diversity in raw material types at Guenfouda would seem to indicate an opportunistic attitude toward tool production whereby the availability of a range of materials resulted in the production of a range of tool types, although with less complexity. At Guenfouda, however, the use of poorer quality raw materials seems to have restrained some tool complexity; it would, therefore, point out the balance of an overall technological strategy between resource availability and functional demand.

Material diversity-tool complexity relationships also support the cultural differences between the two sites. The implication of such a high investment in quality flint and the production of complex tools within the confines of Molí del Salt is that of a community valuing efficiency and precision in tool use, likely driven by particular environmental and subsistence demands. While this was not the case with material base from Guenfouda, which is higher and more generalized, indicating a more flexible community that could not have produced highly specialized tools for the variability in material quality.

Raw Material Quality vs. Tool Efficiency

The second graph discussed the relationship between raw material quality and tool efficiency. This relationship further explained the technological strategies of the prehistoric communities from Molí del Salt. The high quality of the raw material and the efficiency of the tool are positively correlated at Molí del Salt, thus with good-quality flint come effective tools. The predominance of flint in this assemblage would suggest that the community relied on this material for tasks thought to require durable yet sharp tools, such as hunting and butchering.

These results also bring out the constraints imposed by the poorer raw materials of quartzite and schist. Implements of these materials were considerably less efficient and hence probably fell back on less demanding uses. This corroborates the general pattern in the prehistoric lithic technological tradition whereby high-quality materials were often used only for implements which had to retain a keen cutting edge or endure heavy wear. The other important aspect of this analysis is the impact of recycling on tool efficiency. One of the practices that could be suggested by a strategy in saving valuable resources while maintaining reasonable tool efficiency is the recycling of high-quality flint tools within the site at Molí del Salt. However, the slight decline in efficiency for the recycled tools does show that while the recycling was advantageous to the extent that it prolonged the use of materials, it also came with some compromise in functionality. Such a balancing between resource conservation and tool effectiveness represents nuanced knowledge of material properties and technological needs within the community.

Theoretical interpretation of lithic technologies in both sites further contextualizes these findings within the broader framework of human evolution and cultural development. This correlation of material quality with tool efficiency in Molí del Salt highlights, with particular vividness, the concept of material agency: how it is the physical properties of materials that provide an influence on the design and functionality of the tools being created. This is, however, in contest by the recognition of the active materials said to, in effect, drive the technological strategy.

These differences in raw material selection and tool production indicate different cultural and environmental factors driving the technological development between Molí del Salt and Guenfouda. The focus on high-quality flints and the making of complex tools at Molí del Salt represent a community probably responding to specific environmental challenges, such as demands for effective hunting tools within a resource-rich yet competitive landscape. While Guenfouda suggests a more diverse material base, reflecting perhaps an adaptable and resourceful community, the great variability in material quality may have restricted a very specialized tool kit. The recycling habit, especially evident at Molí del Salt, evidences the cognitive processes driving tool production and use. This is not only a functional response to the scarcity of materials but also partakes in foresightedness or planning in technological strategies. The efficiency that recycled tools retained at Molí del Salt suggests a high level of sophistication in how people maximized utility from resources, balancing immediate needs against longer-term needs.

Comparative Analysis and Broader Implications

The comparison of technological strategies between Molí del Salt and Guenfouda reveals some important differences. The high-quality flint dependency and complex tool production in Molí del Salt point toward a very specialized technological system of a community driven, likely, by specific demands set by the environment and thorough knowledge of material properties. In contrast, the more opportunistic approach observable at Guenfouda-with its wider range of raw materials and tools with more variable complexity in themselves-would represent a different set of environmental and cultural challenges.

These differences have wider implications for the interpretation of prehistoric human behavior and cultural evolution. The technological strategies adopted at Molí del Salt point to a good awareness of the community with its environment, selecting and using the best available resources for the making of efficient tools to meet specific functional requirements. This efficiency and precision suggest a culture that values technological innovation along with resource management, probably contributing to its long success in the region.

The technological strategies at Guenfouda are adaptive and resourceful, but clearly reflect difficulties of working with a more diverse and generally lower-quality material base. The degree of adaptability represented by the community's ability to make a wide range of tools from this material base is quite high, but also suggests that limitations were imposed on the community's ability to achieve the same degree of tool efficiency and complexity as that seen at Molí del Salt. This range underlines the participation of environmental factors in technological development, yet again, underlining the role of resource availability in human cultural evolution.

From the analysis, the differentiated technological strategies from the prehistoric communities of Molí del Salt and Guenfouda follow a well-documented information record. The clear correlation between raw material quality and tool efficiency in Molí del Salt pointed to high-quality materials being a prerequisite to the manufacture of effective tools, while a wider material base and more variable tool complexity within Guenfouda reflect another set of environmental and cultural challenges.

All these observations together set a wider framework for understanding how prehistoric communities adapted to the environments in which they were living and utilized any available resources to meet their technological needs. On this score, the focus on recycling at Molí del Salt will shed light on the cognitive and cultural processes underlying tool production and use and thus highlight the complex interplays between material properties, resource management, and technological innovation.

This comparative study, therefore, provides insight into the different strategies adopted by prehistoric communities within their varied environmental and cultural contexts, thereby yielding a better understanding of human evolution with the support of lithic technology.

Conclusion

The present extensive research work has treated both lithic technologies and cultural dynamics of the prehistoric communities at both Molí del Salt and Guenfouda in depth and has thus allowed wide-ranging and detailed insight into the communities' adaptations to the natural environment and the available resources. By integrating archaeological data, theoretical perspectives, and advanced analytical methods, we have been in a position to reconstruct technological strategies, cognitive processes, and cultural behaviors that defined these early human societies.

One of the main arguments to be followed in this thesis is the determining role of material selection in the crystallization of technological performance both at Molí del Salt and at Guenfouda. At Molí del Salt, the prevalence of high-quality flint as the primary raw material used underlines the community's subtle knowledge of the properties of materials and their implications for tool efficiency. This attention to flint facilitated a wide range of complex tool production, including blades, scrapers, and points, all of which were crucial elements in hunting, butchering, and other subsistence activities.

By contrast, technological strategies at Guenfouda show a wider range of raw materials, such as silicified schist, chalcedony, and low-quality quartzite. This indicates an opportunistic attitude towards tool manufacture, where different available materials produced various types of tools in varying degrees of complexity. While the use of poorer materials in Guenfouda has demonstrated adaptability, it also had several implications for the manufacture of specialized tools, which no doubt were technologies with trade-offs that prehistoric communities needed to negotiate.

The comparison of tool complexity to the diversity of materials in both sites provides an interesting insight into the cognitive processes which underlie tool production and use. It is fair to note that the positive correlation between material diversity and tool complexity, especially for the case of Molí del Salt, indicates a high level of cognitive flexibility and innovation within the community. The production of such a wide range of sophisticated tools from a single high-quality material such as flint indicates considerable advances both in the knapping technique and in recognition of functional properties attaching to distinct tool forms.

At Guenfouda, the broader material base enabled production of a more diverse tool assemblage, but it was a less complex one. It represents a very adaptable community able to employ different materials to meet various functional needs. On the other hand, this reliance on lower-quality raw material sources might be telling of the community challenges in terms of the cognition and technologies invested in the production of tools which are as efficient and precise as those at Molí del Salt site.

Evidence such as this of recycling, especially at the site of Molí del Salt, speaks volumes to cognitive sophistication within these prehistoric communities. Recycling is not only functional regarding material scarcity but also foresight and planning in technological strategies. The slight efficiency decline apparent in recycled tools suggests that while there was considerable benefit in prolonging the utility of materials, a little functionality cost was associated with recycling. This would make the resources last, but not necessarily make the tools less effective. Such a balance does indeed indicate the important level of understanding of the material properties and technological needs within this community.

The comparative analysis of Molí del Salt and Guenfouda also showed how far cultural and environmental influences play in technological development. The high value placed on good quality flint at Molí del Salt combined with complex tools manufactured speaks to a community very aware of its immediate environment and utilizes the best available resources in order to make efficient tools for the purposes intended. Attention to functionality and precision probably reflects the response of the community to environmental stresses, such as demands for effective hunting tools in a resource-rich yet competitive landscape.

This is in contrast to the more material-base diversified and variable tool complexity of Guenfouda, indicative of a more adaptable community with a host of environmental and cultural challenges. The wider range of material use would imply that the community was resourceful in meeting its needs; on the other hand, variable material quality may have constrained the production of highly specialized tools. Such a contrast in technological strategies reinforces how environmental factors shape the course of lithic technological development and highlights the key role of resource availability in human cultural evolution.

In this thesis, deep integration of theoretical perspectives has allowed further insight into the role of lithic technology in human evolution. At the forefront of our analysis here is the idea of **material agency**, or of the active physical properties of materials informing tool design and function. This challenges the traditional view of tools as passive objects and instead asserts the active role that materials play in informing technological strategies and cognitive processes.

The Molí del Salt recycling case represents an especially good example of how material agency can be operationalized within a prehistoric framework. Community competence in recycling high-quality flint tools while maintaining efficiency to a remarkable degree reflects great knowledge of the properties of materials and resource management. This behavior evidences not only technological ingenuity, but also some of the cognitive and cultural processes underpinning their tool production and use.

The differences in raw material selection and in tool production between Molí del Salt and Guenfouda add up to indicate cultural and environmental influences on technological development. In the case of Molí del Salt, the concentration on high-quality flint and the production of complex tools indicate a community likely responding to certain environmental challenges. An example would be the efficiency required for hunting tools in a resource-rich but competitive landscape. This in turn would suggest that the community represented at Guenfouda was perhaps more resilient and resourceful but, at the same time, highly specialized in tool production given the variability in material quality.

The methodological approach pursued in this thesis has brought together detailed typological analysis with advanced statistical methods, making possible a robust investigation into lithic technology at both sites. The focus on the relationships between tool complexity, material diversity, and efficiency using multivariate analysis has truly added value to the technological strategies and cognitive processes of these prehistoric communities. Integration with theoretical perspectives will further reinforce broader cultural and environmental factors as influential in technological development.

However, it is also essential to turn one's mind to the limitations and challenges implicit in this research. We are not allowed easily to present conclusive findings because of the inability to escape the confines of incomplete or fragmented archaeological data. Some of these patterns in the data may, further be due to factors not fully considered in our analysis-the nature of prehistoric technological systems being rather complex. Nevertheless, the results provided in this thesis create a fairly detailed and nuanced picture regarding both the course of lithic technology and its significance in human evolution.

The important insights gained from this study go beyond prehistoric human behavior and cultural evolution; technological strategies followed both at Molí del Salt and Guenfouda really mirror the adaptability of early human communities to the resourceful environment. For example, the efficiency and precision evident at Molí del Salt indicate a culture that was highly invested in technological innovation and resource management, and thus one that likely contributed to the long-term success of the culture in the region.

In contrast, the technological strategies evident at Guenfouda represent adaptive and resourceful means but also reveal the challenges of dealing with a more diverse and generally lower-quality material base. This capability therefore reflects a high degree of adaptability, yet at the same time suggests that they were not especially in the position to produce tools as efficiently and with as much complexity as those at Molí del Salt. This difference underlines how environmental factors contribute to technological development and strikingly underlines resource availability within the history of human cultures.

Such recycling at Molí del Salt has further provided important insights into the cognitive and cultural processes that underlie tool production and use at the site. Recycling, besides showing a realistic response to material scarcity, speaks of foresight and planning in technological strategies. This reflects a better balance between resource conservation and tool effectiveness within the group and is, therefore, a good example of how early humans adapted to the challenges of their environment.

The present thesis has attempted, through a detailed and thorough analysis of the lithic technologies at both Molí del Salt and Guenfouda, to provide meaningful insight into technological strategies, cognitive processes, and cultural behaviors in these prehistorical communities. These findings here presented form part of a greater understanding of how early humans adapted to their environments, utilized available resources, and developed complex technological systems that would have played a crucial role in survival and cultural evolution.

These studies were able to reach such complexity due to the combination of theoretical perspectives with both the advanced state of the analytical methods and the robust condition of the methodological framework. As will be seen by the foregoing comparison between the technological strategies at Molí del Salt and Guenfouda, the agency of environmental factors and that of material availability together shape the development of lithic technology. In turn, the practice of recycling provides insights into the cognitive and cultural processes underlying tool production and use.

In addition, this thesis offers a fresh theoretical framework for understanding the place of lithic technology in human evolution, where the active role of materials within technological strategy is interwoven with the complex interplay of material properties, cognitive processes, and cultural behaviors. Insights gained in this study have broader implications for our current understanding of prehistoric human behavior and cultural evolution; these add to a greater appreciation of early human communities' adaptiveness and ingenuity.

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