
Crossing the line: Multi-layer analysis and the identification of different borderlines

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Abstract:

This paper introduces a volume that brings together specialists in lithic studies to explore how this proxy can reveal different spatial patterns across a large European territory. It examines how diverse behaviours in various environmental and geographical areas can enhance our understanding of social processes during European neolithisation. Initially, we investigate the concept of borders and borderlines, proposing models based on the space considered as a border, the presence of sought-after resources within this space, the agents present, and the nature of interactions between these agents. Subsequently, we discuss the potential of lithic analysis for identifying social groups and different types of borders. Neolithic cultural entities have primarily been defined through typo-stylistic analysis of pottery, while lithics are underutilised in this context. Lithics, however, offer a valuable proxy for understanding the spatial distribution of these entities. Petrographic studies now allow us to precisely define lithic sources, and all actions carried out on these raw materials are readable. Lithics thus enable the tracking of raw material origins and the movement of these materials within a given area. Establishing these circulation networks is crucial for understanding the spaces occupied by prehistoric people and the nature of their interactions. This approach allows us to map and compare spatial groupings based on consumer and producer perspectives. We argue for the necessity of multi-proxy studies and modelling to gain new insights into spatial grouping patterns and their evolution, particularly by considering borderlines at the scale of social groups.

Keywords: Mesolithic; Neolithic; Europe; lithic artefacts; raw materials; circulation networks; spatial patterns; social organisation

1. Introduction and background

This paper is conceived as an introduction to the special volume entitled "Borderline lithics: from spatial patterns to social processes during the European neolithisation". This volume is the result of session 252 of the 28th Annual Meeting of the European Association



of Archaeologists, held in Budapest (Hungary) in 2022. In what follows, the term “borderline” is understood as an umbrella term for spatial and temporal overlapping and social processes, which clearly includes the notion of indefinite situations or so-called transformations *i.e.*, periods or places where borders become fluid and new social configurations emerge. Our aim is to explore this notion through lithic analysis. This choice is based on the ubiquity of lithics in prehistoric societies, making this proxy relevant for discussing the transition from foraging to Neolithic production economies. Moreover, for a long time our comprehension of Neolithic societies has primarily centred on the study of pottery, an innovation very often concomitant with neolithisation. So, the ambition of this session was to gather specialists in lithic studies to question how this proxy can highlight different spatial patterns in a large European territory and how this diversity of behaviours in the face of different environmental and geographical areas can help us to better understand the social processes at play during the European neolithisation.

First, we begin by briefly examining two key concepts that extend beyond the social sciences and are frequently employed by prehistorians: archaeological culture and territory. These concepts can be approached through the lens of their boundaries, raising questions of frontiers, borders, and liminal spaces. Our objective is not to provide an exhaustive definition or a comprehensive history of their use, but rather to clarify how we interpret these notions and to highlight their relevance for understanding the processes of neolithisation. The second section focuses on the methodological tools used to identify and analyse borderlines -whether geographical, chronological, or cultural- based on lithic data. Finally, we underscore the importance of multi-layered analysis for gaining a deeper understanding of the complexity inherent in Mesolithic and Neolithic trajectories.

This volume brings together a series of case studies that explore how lithic analysis can help identify and interpret border phenomena - be they spatial, technical, or social - across Neolithic and Mesolithic Europe. Through diverse regional perspectives and timeframes, the papers address questions of mobility, interaction, and group identity, demonstrating that lithics provide independent and complementary insights into traditional cultural definitions. These contributions offer a rich comparative ground for discussing the heuristic value of concepts such as liminality, technical traditions, and circulation networks.

1.1. The Core: Material Culture, Identity and Archaeological Cultures

One of the challenges of archaeological research is to answer questions such as 'Who made these tools? Who decorated these pots?' and 'What meanings can be attached to these gestures?' (for a historical account of the theoretical approach to these questions, see Harris & Cipolla 2017). To do this, we draw, implicitly or not, on the notions of cultures or cultural identities as defined by anthropology. It is primarily a question of positioning ourselves as observers of a human group to which we do not belong. This concept is above all a tool for comparing entities with one another (Boissinot 2015). It should also be borne in mind that individuals within the same group may hold multiple identities, and that the hierarchy of these identities can vary depending on the social, political, or economic context (Tremblay 1999).

The documentary records available to prehistorians are obviously not the same as those available to anthropologists. However, ways of doing (in the sense of a community of practices), living, burying and representing have meaning for those who produce and reproduce them. For these reasons, the traditional cultural-historical approach, which defines (prehistoric) archaeological cultures through shared traditions or ways of doing (Childe 1936) and more recently referred to 'cultural groups' in Cauliez (2009) or 'social groups carrying traditions' in Roux (2020), remains useful for reconstructing how human communities occupied territories, exploited environments, and managed their economies.

1.2. Territory as a Lens for Culture and Space Interactions

In prehistory, the question of territory is very often linked to that of culture, since it involves understanding the relationships between human groups and space. Historically, questions of territory have often been approached either through ethnographic comparisons, especially with subactual hunter-gatherer populations, or through questions of human mobility (*e.g.*, Binford 1980; Bracco 2005; Renfrew 1984). Several parameters are involved in the definition of territory:

- The geographical aspect, which has to do, for example, with topographical and climatic constraints and the availability of different resources (Brunet 2001).
- Human action on this space (*e.g.*, in terms of resource management) and, conversely, how this space is interpreted by human communities (*e.g.*, Bracco 2005; Delvigne 2016).
- The link between an ideal space and a material space, in particular the way in which culture is integrated into a territory (Claval 2002), since "it is through the existence of a culture that a territory is created, and it is through the territory that the symbolic relationship between culture and space is reinforced and expressed" (translated from Bonnemaïson 1981: 254).
- The use of territories in the long term, since it is the notion of repetitive mobility, of routes and repeated use of places that allows the shaping of the territory beyond simple one-off movements (Bonnemaïson 1981; Gouletquer 2022).
- The question of geographical scales of observation and routes is also important, since territories are a combination of different spaces or places, more or less extensive, more or less known and travelled, and more or less nested within each other. Thus, depending on the approach taken, we can see territories as a patchwork of contiguous areas within a geographical division or, on the contrary, we can have a more dynamic vision made up of different geographical spaces that more or less fit into each other and are not necessarily contiguous.

Obviously, archaeology alone does not give us access to all the dimensions of prehistoric territories. In most cases, we limit ourselves to an economic and geographical approach to the territory, based on mobility (seasonality, circulation of certain objects, isotopic analyses, etc.) and networks of places (archaeological sites with different functions and areas where different raw materials were acquired, etc.).

1.3. Liminal Spaces as a Means to Decompartmentalise Archaeological Cultures

In prehistory, archaeological entities cannot be approached in the same way as modern states, with their clear dividing lines. We prefer the term 'liminal zone' over frontier, border, or periphery, as it moves us away from a polarised model that opposes a centre (concentrating power, wealth, and dense populations) to peripheries defined merely as the centre's negative (Cattan 2006). Instead, our focus is on the set of dialectical interactions occurring within contact zones, which Parker aptly describes as 'boundary processes' (Parker 2006: 78).

For this special issue, we have chosen to focus on the phenomenon of transitions and liminalities - whether social, spatial, or temporal - which we regard as a powerful lens by which to counter the tendency to view cultures as fixed in time and space. By 'liminal zone' or 'borderline', we refer to fluid, dynamic, shifting spheres that are constantly reshaped by complex systems of mobility and interaction. This perspective provides a valuable framework for understanding archaeological phenomena, particularly the processes of neolithisation.

Neolithisation, a key moment for human societies, in particular in terms of changing relationships with the environment, is a perfect object of study for questioning these notions

of boundary processes. Indeed, the neolithisation process involves ‘movement and contact’ (Zvelebil 2001: 1), in particular:

- i) The colonisation of new areas, *i.e.*, the appropriation of territories (whether inhabited or not) for settlement or resource exploitation, and
- ii) Interactions between different human groups, such as late Mesolithic hunter-gatherers and early agro-pastoral communities

Examining the phenomenon through its margins is particularly fruitful, as it highlights two perspectives on liminal spaces. First, there are spaces at the margins or the confines of an entity, which are considered to be an uncertain, less populated and less controlled periphery. The space of the frontier then becomes a territory to be appropriated or colonised, for example, in order to deal with demographic pressure, to control a new territory and to appropriate its resources (Parker 2006: 81). Second, there are spaces of variable breadth (ranging from an imaginary line to a defined area) that separate or connect two entities. Depending on their permeability, these spaces can function either as lines of demarcation (gaps) or as bridges linking entities (Donnan & Wilson 1999: 19-42). Liminal spaces can thus be understood in terms of the bridge *versus* gap dialectic framework.

Consequently, these zones are mobile and constantly shaped by processes of opening and closing, offering a lens through which to examine the dynamic relationship with technical and cultural norms, including their potential transgression (Amilhat Szary 2013). As such, they serve as a crucial conceptual tool for understanding complex territorialities and interactions among prehistoric communities.

2. Lithics at the Centre: Methodological Tools for Deciphering Spatial Patterns

This volume brings together lithic studies that question how this technical sub-system can provide essential data for qualifying transitions and liminalities. The development of relevant methods for characterising siliceous raw materials (Brandl 2016; Bressy 2003; Delvigne *et al.* 2019; 2020; Fernandes 2012) allows us to reconstruct the biographies of stone tools (van Gijn 2010), from the extraction of the raw materials to the disposal of the tools, especially following the concept of the *chaîne opératoire* (*e.g.*, Cresswell 1976; Leroi-Gourhan 1964; Tostevin 2011). To explore entities (concentration *versus* expansion) and their borderline effects (gap *versus* bridge), a set of tools that delineate different entities based on the social reproduction of technical systems and practices can be particularly useful: the study of the toolkits, the study of technical identities, the question of craft specialisation and the study of raw material circulation networks.

2.1. Cultural Entities Based on Toolkits: The Consumers' Perspective

To decipher spatial patterns through the medium of lithic studies, one approach can be to focus on the toolkits themselves. This method can combine typo-technology or use-wear analysis to highlight specific characteristics shared among different communities in order to compare different entities. The emphasis on the toolkit essentially allows us to define spatial groupings from the consumers' perspective, as it exclusively centres on the final products and their use.

The typology-based methods allow a detailed descriptive approach to the tools, which in this case are made of stone. This approach is therefore fundamentally classificatory, allowing the comparison of different assemblages. Certain tools or weapons, by virtue of their function, are believed to have had an important value in the eyes of those who produced and reproduced them, as is the case, for example, of arrowheads (see Allard & Delvigne 2025, in this volume) or sickle blades (see Barrera-Cruz *et al.* 2025, in this volume) (Figure 1). We have to bear in mind that the typology is not sufficient in itself, but the recognition in time

and space of certain types of tools or toolkits allows us to approach a certain reality of prehistoric groups. That is to say, it participates to a certain extent in defining archaeological cultures, *i.e.*, entities defined by i) an external observer (as opposed to so-called emic cultures, *i.e.*, as perceived by the groups studied) and by ii) an association of common material traits (Boissinot 1998; Gallay 2016; Sackett 1982; 1986; Tremblay 1999).

In order to be effective, this approach must not simply document a single comparative parameter but must propose a global approach, taking into account the technical processes of manufacture, the morphology of the objects and the functional data for certain types of tools (Defranould *et al.* 2022; Léa *et al.* 2009). If we take the example of sickle inserts, emblematic tools of the Neolithic, the study of such variations (hafting, types of blanks, intensity of use) makes it possible to highlight differentiated practices on the scale of the northern Mediterranean, testifying to the adaptation of human groups to the processes of territorial extension and as well as to different agricultural and harvesting practices (Mazzucco *et al.* 2020).

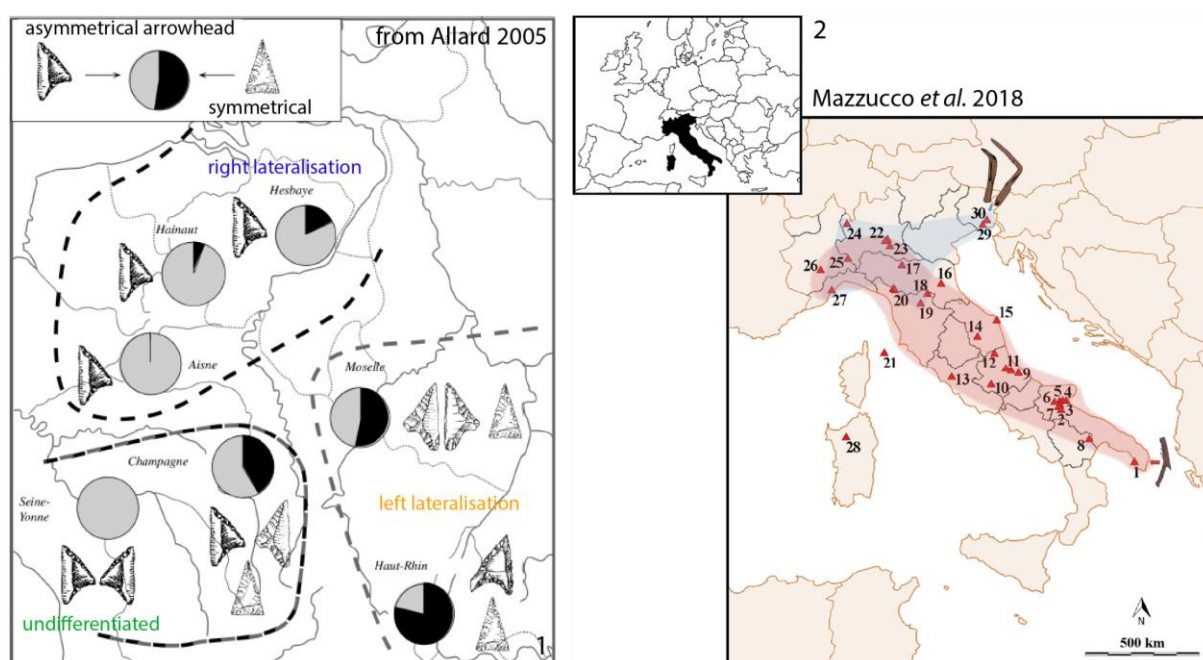


Figure 1. Examples of groupings obtained through the study of the toolkit. 1) Sub-groups within the LBK in Northwestern Europe based on typo-technological characteristics of arrowheads, from Allard 2005, modified; 2) Sickle blades and harvesting technology, from Mazzucco *et al.* 2018.

Abbildung 1. Beispiele für Gruppierungen, die durch Forschung zu Werkzeugensembles gewonnen wurden. 1) Untergruppen innerhalb des LBK in Nordwesteuropa auf der Grundlage typo-technologischer Merkmale von Pfeilspitzen, aus Allard 2005; 2) Sichelmesser und Erntetechnik, aus Mazzucco *et al.* 2018.

1. ábra. A kőeszközészlet elemzése alapján meghatározott csoportok példái. 1) A Vonaldiszes kultúrkör északnyugat-európai alcsoportjai a nyílhegyek tipológiai és technológiai jellemzői alapján, Allard 2005 alapján módosítva; 2) Sarlópengék és betakarítási technológia, Mazzucco *et al.* 2018 nyomán.

Therefore, the study of the toolkit involves two main aspects: i) the investigation of shared material characteristics which enables researchers to identify spatial groupings, interpreted as archaeological cultures or techno-complexes (see Kačar 2025, in this volume); ii) the examination of specific features within individual tools, particularly arrowheads or sickles, which enables researchers to discern sub-groupings, representing regional groups associated with specific activities such as hunting or harvesting (see Barrera-Cruz *et al.* 2025). The relationship between both layers (archaeological cultures *versus* sub-groupings) remains difficult to assess in terms of interpretation and attempts to propose a holistic view of these multi-layer perspectives are rare. One point that is repeatedly raised is the lack of

correlation between these sub-groups and the regional groups established on the basis of stylistic studies of ceramics (Allard 2005; Mazzucco *et al.* 2020); this issue is highlighted here by Allard & Delvigne (2025). Mazzucco and colleagues (2020) pointed out another aspect related to the processes of change in harvesting toolkits: the link with the degree of specialisation of the knappers (see section 2.3). The relationship with the technical know-how of the knappers is also raised as an interesting perspective by Barrera-Cruz *et al.* (2025). This involves coupling these sub-groupings with analysis of how the producers were organized.

2.2. Technical Entities Based on Production Practices: The Producers' Perspective

The second approach focuses on learning networks, shifting our perspective to the producers' point of view. The same kinds of toolkits can in fact be produced by different groups of knappers. The study of blade production has highlighted the existence of discrete features specific to different learning networks during the LBK and the post-LBK (especially the Blicquy/Villeneuve-Saint-Germain culture, henceforth BVSG) in Northwestern Europe (Allard & Denis 2022; Denis *et al.* 2021). Indeed, treatment of platforms and preparation of blade detachment can be linked to specific tools and gestures. This allows us to distinguish different technical traditions. The development of these technical traditions is connected to the apprenticeship process which links a tutor and his/her apprentices from the same social group (*e.g.*, Roux 2010). The geographical extent of these specific technical practices corresponds to the territory of this social group, whatever its nature (Roux 2020). This observation concerns only the producers; therefore, the relationship between space and technical practices must be understood solely from the producers' perspective. Among the BVSG, a first insight into these spatial groupings based on the producers' point of view reveals different patterns: some regions are characterised by a high diversity of ways of doing things, even within the same household, suggesting that different social groups co-inhabited the same areas while some regions are “socially” very homogeneous (Figure 2).

By superimposing this spatial division on that of cultural entities, mostly defined by ceramic decoration and architecture, the high social diversity observed through lithics seems to be especially characteristic of the eastern margins of the space defined as the territory of the BVSG culture. Here, the borderline effect is underlined by a technical diversification, probably linked to the coexistence of different social groups gathered in the liminal space between the BVSG in the West and Grossgartach and Planig-Friedberg cultural entities in the East. This would recall the definition of a liminal space perceived as a zone of contact and exchange between distinct peoples with different practices and cultures (bridge notion).

Mapping these entities and especially their interwoven spatial constructs can bring new understandings of these social constructions. Furthermore, the question of borrowings, syncretic practices or avoidance is central for eliciting the borderline effects between these entities. This approach based on learning networks focuses on management of local productions, *i.e.*, domestic or village scale. At this stage of analysis, it is important to consider specialised production and how its circulation influences the development of village-level production.

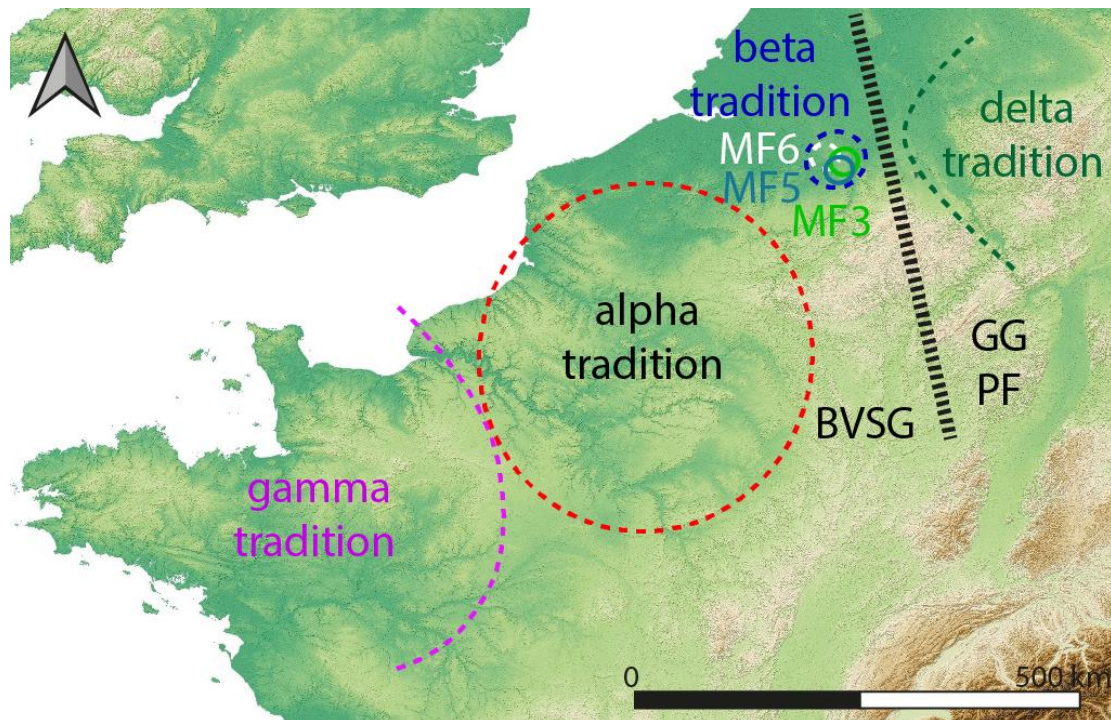


Figure 2. Map representing the various learning networks identified to date in post-LBK assemblages (c.a. 4950–4650 BCE). The black hachured line separates the territories of the Blicquy/Villeneuve-Saint-Germain populations (on the left, BVS'G) from the Rhineland populations Grossgartach and Planig-Friedberg (on the right, GG/PF). The division into these large archaeological cultures is largely based on typological analyses and the very general constitution of the toolkits.

Abbildung 2. Karte der bislang in post-LBK-Fundkomplexen (ca. 4950–4650 v. Chr.) identifizierten Lernnetzwerke. Die schwarze Schraffur trennt die Gebiete der BVS'G-Gruppen (Blicquy/Villeneuve-Saint-Germain, links) von den rheinländischen Gruppen GG/PF (Grossgartach und Planig-Friedberg, rechts).

Die Unterscheidung dieser großräumigen archäologischen Kulturen beruht im Wesentlichen auf typologischen Analysen und der allgemeinen Zusammensetzung der Werkzeuginventare.

2. ábra. A térkép a vonalízes (LBK) időszakot követő (Kr.e. 4950–4650 körül) leletgyűtesekben eddig azonosított különböző tanulási hálózatokat ábrázolja. A fekete vonalkázott határvonal elválasztja a Blicquy/Villeneuve-Saint-Germain (balra, BVS'G) populáció területét a Grossgartach és Planig-Friedberg rajnai népességtől (jobbra, GG/PF). A nagyobb régészeti kultúrák elkülönítése elsősorban tipológiai elemzéseken és az eszközkészletek általános összetételén alapul.

2.3. Craft Specialisation as a Link Between Technical Identities and Circulation Networks

Kiosak (2025, in this volume) addresses an essential aspect of lithic production, namely variability in the socio-economic organisation of knapping activities, which he frames through a model distinguishing two recurrent "modes" of production. This dual structure between local or domestic knapping (Mode 1) and more formalised, possibly centralised production for exchange or external use (Mode 2) provides a compelling lens to assess the degree of specialisation and social integration within Neolithic communities. Mode 1 is generally associated with expedient production using local raw materials and reflects autonomous household-level organisation. Mode 2, by contrast, involves the use of non-local, high-quality flint, with tools often produced using more elaborate techniques such as the punch technique, and is suggestive of inclusion within broader exchange and learning networks.

Similarly, Mazzucco *et al.* (2020) underline how the variation in harvesting toolkits across the northern Mediterranean corresponds not only to ecological adaptation but also to the degree of craft specialisation, with certain knappers showing the ability to produce highly standardised, durable tools over long distances. These tools circulated through networks that

connected producers and consumers across regional boundaries, forming a key link between technical tradition and the dynamics of material exchange.

Importantly, specialisation does not necessarily emerge as a result of distinct learning traditions; rather, it can develop within the same technical group, and even within the same learning networks. In the case of the BVSG culture, for example, certain communities within the broader technical entity developed specialised production centres dedicated to the large-scale manufacture of long blades of Tertiary Bartonian silicite (Bostyn 1997). These products circulated over considerable distances within the BVSG territory, following well-structured and homogeneous modalities of circulation. However, once they crossed into the territories of other technical groups, such as in Brittany or the Hesbaye region, circulation patterns changed significantly, suggesting that inter-group exchange operated under different principles, possibly reflecting different social or economic frameworks (Bostyn & Denis 2016; Bostyn *et al.* 2019).

In this sense, craft specialisation functions as a bridge between the study of technical entities (understood through the *chaîne opératoire* and apprenticeship systems) and the identification of broader circulation networks. Specialised production often implies the existence of standardisation, training systems, and targeted distribution, all of which are indicators of structured social organisation. Moreover, it provides a tangible marker of the degree of connectivity between groups, which can be mapped onto the spatial patterns revealed by raw material sourcing (see in this volume, Bauer 2025 and Allard & Delvigne 2025).

Thus, when evaluating the variability of lithic production systems, it is not enough to consider tool types or raw materials in isolation. The organisation of production itself (who knaps what, for whom, and how) is a crucial component in identifying border zones, degrees of integration, and the nature of prehistoric social relationships. Craft specialisation, as such, becomes both a diagnostic and interpretive tool for understanding how technical identities were maintained, transformed, or transmitted across cultural boundaries.

2.4. Circulation Networks: Mobility, Exchange, and Spatial Dynamics

The identification of circulation networks can reveal the mobility of prehistoric peoples and contacts between distinct geographical, social or cultural groups. It is also a relevant way of identifying the routes, directions and modalities of expansion of different spatial entities. As demonstrated in this volume by Bauer's paper (2025), the transition to high-resolution characterisation of siliceous raw materials, thanks to petrological microscopic analysis, now constitutes an essential step toward a detailed understanding of circulation networks. Indeed, current approaches in petroarchaeology aim to specify the places where siliceous materials were collected, according to i) their initial geological origin (primary deposits) and ii) their geological origin (the various secondary deposits) (*e.g.*, Affolter *et al.* 2021; Brandl 2016; Bressy 2003; Delvigne *et al.* 2019; 2020; Fernandes 2012).

Firstly, these analyses of the origin of raw materials make it possible to identify 'lithospaces' (Delvigne 2016). Secondly, the studies make it possible to establish relationships between several types of places (raw material deposits, archaeological sites, spatial extent of the use of certain raw materials, technical features, finished objects), which fit into each other and make it possible to reconstruct the territories inhabited and traversed by prehistoric groups, as well as exchanges between different groups or parts of groups.

In Neolithic studies, lithic assemblages have often served as proxies for reconstructing prehistoric networks, primarily through raw material circulation (*e.g.*, obsidian: Ibáñez *et al.* 2015; Vianello & Tykot 2016; radiolarite: Mateiciucová 2010; silicite: Trampota & Přichystal 2024), combined with technological practices such as pressure flaking (Pelegrin 2012;

Guilbeau & Perlès 2019) or the “*livre de beurre*” method (Pelegri 2002; Mallet *et al.* 2012) for example, and through specific tool categories like large blades (Gurova 2024; Vinet & Guilbeau 2024). In addition, compared to earlier periods, data from Neolithic contexts sometimes allow for better resolution, integrating questions relating to craft specialisations, based on the identification of producer and receiver sites (*e.g.*, Léa 2004). For these issues, liminal spaces become dynamic objects of study, where identities are not necessarily fixed, interstices being conducive to change and encounters. They are therefore appropriate spaces in which to observe imitations, changes in the status of certain objects, experiments and reinterpretations of technical schemes.

To refine our narratives of these past societies, the challenge is to develop tools that allow a better perception and understanding of the entanglement between the different observational layers, for example between the different scales of raw material circulation networks.

The presence of exogenous raw materials, such as siliceous rocks found outside their geological source areas, is typically interpreted as evidence of either group mobility (reflecting the extent of territories exploited) or intergroup exchange, understood within the broader framework of social or exchange networks.

Evidence for long-distance circulation, understood here as movement of materials over distances exceeding 100 km from their source, is well documented in hunter-gatherer contexts. For instance, such cases are observed during the Magdalenian (*e.g.*, Delvigne *et al.* 2016, 2019; Sánchez de la Torre *et al.* 2017) and the Mesolithic, particularly with the distribution of Melian obsidian (Binder & Perlès 1990; Perlès 2001: 51; 2009) or Wommersom quartzite (Noens & Van Baelen 2019). However, in pre-Neolithic contexts, the presence of non-local raw materials has traditionally been interpreted more often as evidence of mobility and direct acquisition rather than as a result of structured exchange networks (Binder & Perlès 1990; Perlès 2001: 51; Sánchez de la Torre *et al.* 2017).

In southeastern Europe (Figure 3), the onset of the Neolithic often coincides with the establishment of new raw material exchange networks (Biagi & Starnini 2013; Gurova 2012; Kaczanowska & Kozłowski 2008). Some operated on a regional scale, such as those involving radiolarites in the western Pannonian Plain or radiolarites and “chocolate flints” from the Pindos Range in northern Greece (Perlès 1990; 2001; Perlès & Papagiannaki 2022: 263-266; Šošić Klindžić 2011). Others had a much broader reach, often exceeding 200 km and crossing major geographic barriers, including seas and mountain ranges (*e.g.*, White Spotted - Balkan flint: Gurova 2012; Kaczanowska & Kozłowski 2008 and Gargano cherts: Forenbaher 2021; Forenbaher & Perhoč 2017; Kačar 2019) which can be considered interregional in scale. Tracing the development and extent of these networks not only allows for the reconstruction of potential contacts between distinct geographical groups, but may also shed light on the routes and directions of neolithisation. Although the adoption of Neolithic lifeways in many of these regions was primarily driven by colonisation, as suggested by aDNA studies (see for example Bramanti *et al.* 2009; Haak *et al.* 2010; Hofmanová *et al.* 2016), it is significant that certain exchange networks, such as those involving Melian and Carpathian obsidian, as well as Szentgál radiolarite, were already established in the Mesolithic (Bánffy 2005; Mateiciucová 2010; Perlès 2001: 51). This suggests that existing hunter-gatherer networks facilitated the eventual expansion of farming communities into these areas (Bánffy 2005; Horejs *et al.* 2015; Mateiciucová 2010; Perlès 2001: 51; Reingruber 2011).

However, available archaeological data indicate that with the onset of the Neolithic, significant transformations occurred in the structure, reach, and function of raw material circulation networks (Binder & Perlès 1990; Perlès 2001: 207-209; 2009). These changes are particularly evident in more complex strategies for raw material procurement, involving the

controlled exploitation of lithic sources, their long-distance distribution, and specialised production, which in turn signal a more segmented organisation of labour and suggest early forms of socio-economic specialisation (Binder & Perlès 1990; Perlès 2001: 200-210; 2009).

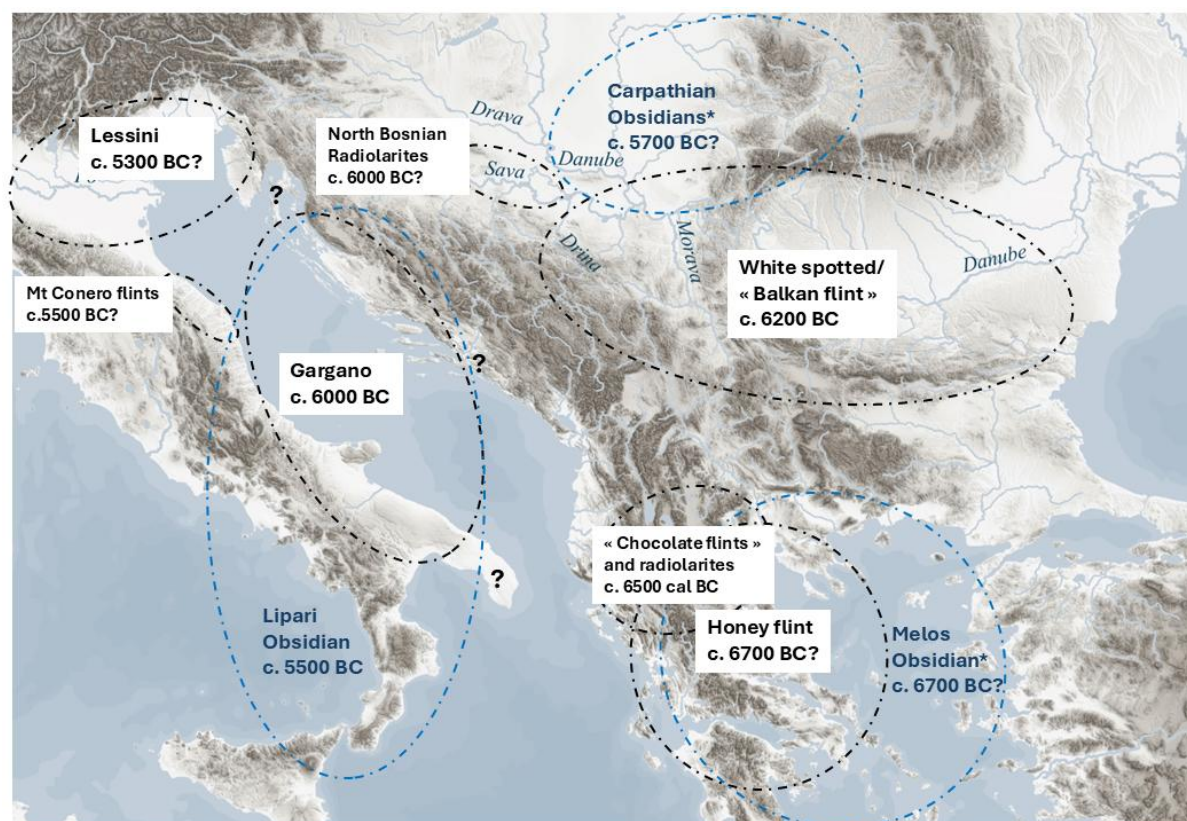


Figure 3. Illustration of known raw material distribution networks in the Central Mediterranean and the Balkans during the Early/Middle Neolithic, between c. 6700 and 5000 cal. BCE (the displayed dates indicate the beginning of distribution in the Neolithic). Dotted lines: maximum extension of the network in the Early Neolithic (light blue dotted lines with titles in bold represent obsidian distribution networks). A question mark (?) indicates the presence of high-quality chert of unknown, but probable exogenous, origin. An asterisk (*) indicates the existence of pre-Neolithic networks (modified according to Kačar 2019 with references therein, base map: ÖAI/ÖAW)

Abbildung 3. Bekannte Rohmaterialverteilungsnetzwerke im zentralen Mittelmeerraum und auf dem Balkan während des Früh- und Mittelneolithikums, zwischen ca. 6700 und 5000 v. Chr. (die angezeigten Daten zeigen den Beginn der Verteilung im Neolithikum an). Gepunktete Linien: maximale Ausdehnung des Netzwerks im Frühneolithikum (hell gepunktete Linien mit fettgedruckten Titeln stellen Obsidian-Verteilungsnetze dar). Ein Fragezeichen (?) weist auf das Vorkommen von hochwertigem Hornstein unbekannter, aber wahrscheinlich exogenen Ursprungs hin. Ein Sternchen (*) kennzeichnet das Bestehen präneolithischer Netzwerke (modifiziert nach Kačar 2019 mit den dort angegebenen Referenzen, Basiskarte: ÖAI/ÖAW).

3. ábra: Az ismert nyersanyagelosztási hálózatok illusztrációja a Földközi-tenger középső részén és a Balkánon a kora/középső Neolitikumban, kb. Kr.e. 6700 és 5000 között (a feltüntetett dátumok a Neolitikumban történt elosztás kezdetét jelzik). Szaggatott vonalak: a hálózat maximális kiterjedése a kora Neolitikumban (a világoskék szaggatott vonalak vastagon szedett címkékkel az obszidián-elosztási hálózatokat jelölik). Kérdőjel (?) jelzi az ismeretlen, de valószínűleg exogén eredetű, jó minőségű kovakő jelenlétét. A csillag (*) a Neolitikum előtti hálózatok meglétét jelzi (módosítva Kačar 2019 nyomán az abban található hivatkozásokkal; alaptérkép: ÖAI/ÖAW).

In this sense, although evidence for chert extraction predates the Neolithic, typically in the form of small-scale quarry pits approximately 2 or 3 metres deep (Kerneder-Gubala 2019), the emergence of structured mining systems is still primarily associated with the Neolithic (e.g., Gargano in southeastern Italy: Tarantini *et al.* 2016; Casa Montero in central Spain: Consuegra *et al.* 2018). These systems involved specialised knowledge, specific

technologies and tools, and imply a certain degree of social organisation. Beyond the technical skills required for knapping and mining itself, this phenomenon reflects the capacity to manage a surplus of raw materials and finished objects, as well as the labour time and subsistence resources necessary to support such production (Pelegrin 2007). This surplus was then redistributed across a network of consumer sites, often in the form of nucleus preforms or blanks, which required skilled craftsmen for further transformation. From this perspective, the rise of large-scale mining and surplus production can be considered one of the distinctive features of neolithisation.

Furthermore, Neolithic raw material circulation networks appear to have functioned primarily to maintain and reinforce social relationships, suggesting that their operation extended beyond purely functional or economic necessity (Forenbaher & Perhoč 2017; Perlès 2009). For example, the preference for Gargano chert in blade production in Dalmatia, despite the availability of suitable local sources (see section 3.2), demonstrates that lithic organisation in the Neolithic did not always prioritise proximity or efficiency. Rather, certain choices were shaped by social patterns, reflecting culturally mediated preferences and interactions.

Lithic studies allow us to identify different levels of spatial organisation and complementary groupings, based on typology, technology, and raw materials (see for example, in this volume, Barrera-Cruz *et al.* 2025, Kačar 2025 or Kiosak 2025). Across the contributions in this volume, the use of petrographic characterization of raw materials to reconstruct circulation networks emerges as a key approach for understanding both the spaces occupied by prehistoric people and the nature of interactions between agents (see for example Bauer 2025). However, integrating these different analytical layers often remains challenging. This volume offers two original perspectives to address this issue: Faragó (2025) examines the articulation between layers through differential rhythms and tempi revealed by temporal scaling, while Furholt (2025) proposes a methodological framework at micro-, meso-, and macro-scales to analyse various forms of lithic groupings.

3. Contributions to Archaeological Narratives

3.1. Boundary Processes and the Mesolithic Neolithic Transition

As mentioned, the question of borderlines cannot be considered solely from a geographical perspective, but must also be examined in terms of historical transitions. This is particularly relevant when studying neolithisation, as it represents a transition between two states, hunter-gatherer and agro-pastoralist, during which traits of both states can coexist. This coexistence illustrates the complexity of the processes involved and highlights their liminal nature.

Generally, the Mesolithic and Neolithic are considered distinct periods or ways of life, reflecting the “gap” dialectic of this transition. This distinction can be observed in several ways: (i) Chronologically, as the Neolithic succeeds the Mesolithic in many contexts; (ii) Economically, with the emergence of agriculture and animal husbandry; (iii) Technologically, particularly with innovations such as ceramics, which are generally attributed to agro-pastoral communities in Continental Europe. Lithic production also allows us to distinguish between two spheres. This is particularly evident in the types of tools represented (hunting weapons *versus* the appearance of sickle blades), the *chaîne opératoire* - for instance, in southern France, the disappearance of pressure debitage during the Cardial Early Neolithic (Binder 1987) - and the emergence of circulation networks for specialized production in the Neolithic, such as blades made from Bedoulian chert or obsidian from the Tyrrhenian Sea (Binder 1998; Defranould 2021; Manen *et al.* 2019).

However, if we emphasize the “bridge” character of this liminal zone, the boundary between Mesolithic and Neolithic entities is not always clear (Klimscha *et al.* 2022).

Nevertheless, examining the transition between the two remains highly informative for understanding the diverse patterns of neolithisation processes (Hofmann *et al.* 2022). When neolithisation is not a simple colonisation of virgin territory, there may be contacts between Mesolithic and Neolithic populations, for example in the Swifterbant culture of Northern Europe (Teetaert & Crombé 2021) or on the Atlantic coast (Arzelier *et al.* 2022; Marchand 2005). In these cases, the lithic productions of both the last hunter-gatherers and the first farmers can be very useful for characterising the contacts, as they were used by both the last Mesolithic hunter-gatherers and the first Neolithic farmers. In particular, analysing the transfer of know-how can be enlightening: is it the whole technical know-how that circulates, signalling acculturation, or specific borrowings, indicating little contact (Marchand 2005)? Or, is there a rejection of innovations, even though the different groups are close in both time and space, indicating exclusion and lack of contact (Perrin & Manen 2021)?

Regarding the Swifterbant culture and their Neolithic neighbours of the BVSG culture, lithic technology and traceology help to better characterise the contacts between both spheres. Indeed, lithics testify to some contacts surrounding a very specific kind of production: faceted tools (Halbrucker *et al.* 2022). However, these tools are not related to blade productions but to non-predetermined productions. In a BVSG context, it is argued that these products were not made by the same group of knappers who were responsible for producing blades (Augereau 2004; Denis 2017); sometimes they have even been attributed to female knappers (Augereau 2019). Whatever the case, the fact that the exchanges between the two groups involve relatively simple productions rather than highly specialized ones may provide crucial insights into the nature of their interactions and the social dynamics underlying contacts between Mesolithic and Neolithic communities.

This shows that thinking of borderlines at the scale of social groups reveals a more complex picture of prehistoric socio-spatial groupings and their evolution, as has already been stated elsewhere with regard to the notion of trans-local communities (Furholt 2018) or communities of practices (Lave & Wenger 1991). Incorporating the degree of social affiliation into spatial modelling using GIS (see Whitley 2010) could offer a powerful perspective for the analysis of boundary processes, and thus represents a promising avenue for future research

3.2. Beyond Lithics

We have argued that lithic studies can bring new layers to our understanding of spatial archaeological groupings, especially with regard to neolithisation. But it is the articulation between the lithics analytical layers (see the methodological proposition in this volume by Faragó 2025 or Furholt 2025) and the other proxies that would open up a better comprehension of these past societies.

Figure 4 illustrates the geographical distribution of Italo-Dalmatian Impressed ware pottery, marking the start of the Neolithic across the eastern Adriatic and parts of the western Adriatic. Due to this similarity in ceramic styles, the whole area is regarded as a unified cultural entity, referred to as the Impressed Ware culture. However, when we integrate lithic data, new cultural entities emerge. In the central Adriatic area (highlighted in red), a sophisticated network operated for the procurement and distribution of Gargano cherts. At several locations on the Gargano promontory, chert nodules were mined, shaped on-site through initial reduction (Tarantini *et al.* 2016), and subsequently distributed inland, southward along the peninsula, and eastward across the sea. The raw material was likely transported both as (semi-)prepared cores and (semi-)finished products (blade blanks, tools). In southeastern Italy and Dalmatia, this raw material was primarily used to produce blades using the pressure technique (Forenbaher & Perhoč 2017; Guilbeau 2011; Kačar 2019).

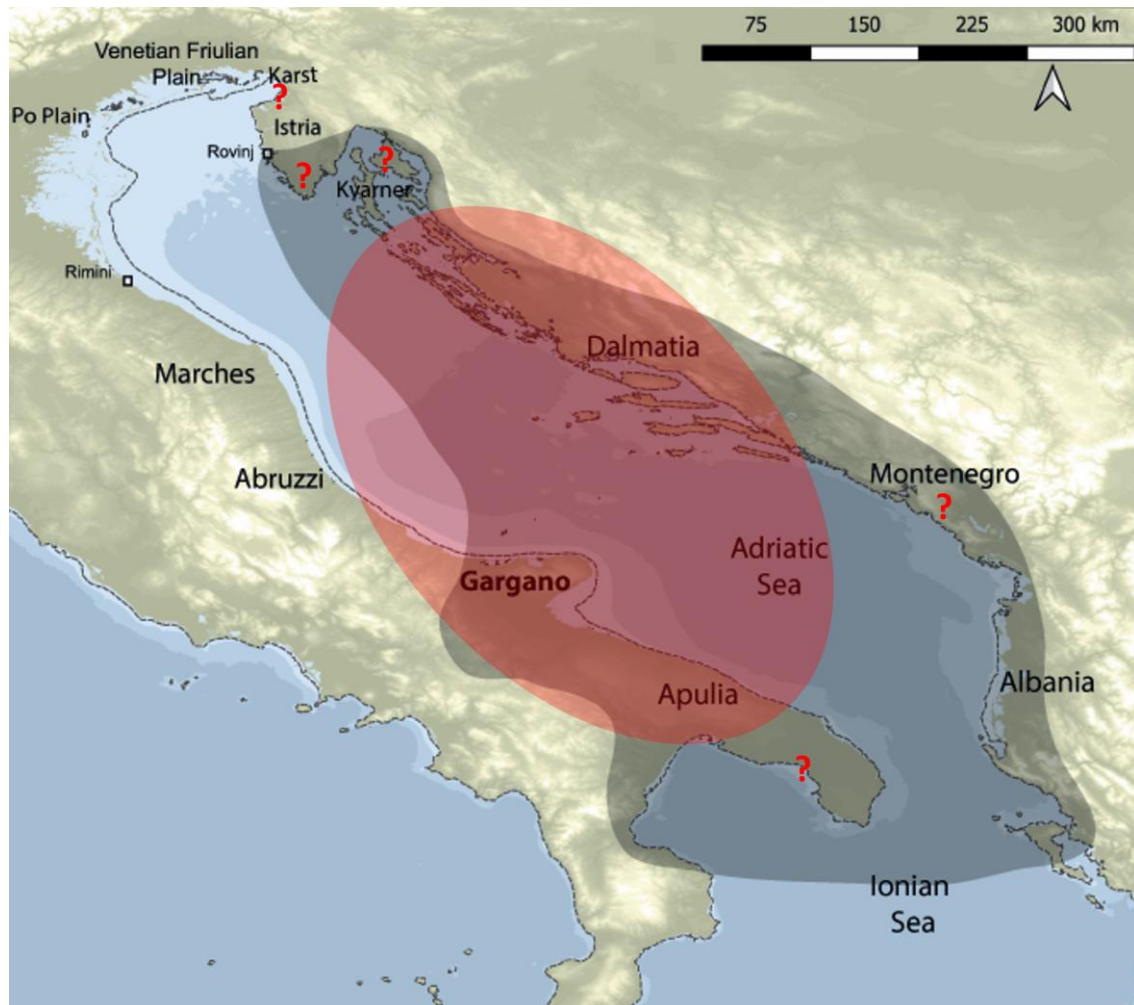


Figure 4. Map illustrating the geographical distribution of the Italo-Dalmatian Impressed Ware pottery ("Impressed Ware culture" shaded in grey) and the distribution of Gargano cherts (shaded in red). The dotted line indicates the hypothetical coastline during the Early Neolithic (with sea level approximately 15m lower than today). A question mark (?) indicates the presence of high-quality cherts of uncertain origin (in the north: possibly Monti Lessini; in the south possibly Gargano, Honey flint, Balkan flint).

Abbildung 4. Karte mit der geographischen Verbreitung der italo-dalmatinischen Impressokeramik ("Impressed Ware Culture", grau schattiert) und der Verbreitung der Gargano-Feuersteine (rot schattiert). Die gestrichelte Linie zeigt die hypothetische Küstenlinie des Frühneolithikums (bei einem Meeresspiegel etwa 15 m unter dem heutigen Niveau). Ein Fragezeichen (?) kennzeichnet das Vorkommen von hochwertigem Feuerstein unklarer Herkunft (im Norden vermutlich aus den Monti Lessini, im Süden möglicherweise aus dem Gargano, Honey Flint oder Balkan-Flint).

4. ábra. A térkép az itáliai-dalmáciai benyomott díszítésű kerámia ("Impressed Ware kultúra" szürkével jelölve) és a Gargano kova (pirossal jelölve) földrajzi elterjedését szemlélteti. A szaggatott vonal jelzi a feltételezett partvonalat a korai Neolitikum idején (a tengerszint a maihoz képest körülbelül 15 méterrel alacsonyabb volt). A kérdőjel (?) jelzi a bizonytalan eredetű, jó minőségű kova jelenlétét (északon: valószínűleg Monti Lessini; délen valószínűleg Gargano, Honey, Balkáni kova).

Surprisingly, in Dalmatia, current research indicates that blade production exclusively relied on Gargano cherts, with no utilisation of local raw materials (Perhoč 2020: 219-222). Given that cherts with similar knapping properties are available locally in Dalmatia (see Perhoč 2009: 48), the observed pattern suggests that raw material choices followed social rather than purely technological criteria. This underscores the importance of social networks in these interactions and supports the idea of cultural uniformity between the two coasts (Forenbaher 2021; Forenbaher & Perhoč 2017; Kačar 2019; 2021). However, outside this

zone, lithic data indicate that blade production is less elaborate, with only local cherts being used (Kačar 2019; 2021). In this context, we can distinguish between the centre and peripheral zones of the Impressed Ware culture: the central Adriatic, linked to the Gargano distribution network, represents the core, while regions beyond it are regarded as liminal zones. While these areas adopted Impressed Ware pottery, they relied on local cherts for lithic production and did not integrate into the Gargano chert network. Furthermore, in certain cases, such as in the northern Adriatic, the use of local chert in less sophisticated blade production, combined with economic data (*e.g.*, the role of fishing), may suggest a significant influence of local hunter-gatherers in the emergence of the Neolithic (Kačar 2021). Incorporating lithic data into the study of the transition to agriculture underscores the need to move beyond the traditional east-west division, in which the western and eastern shores of the Adriatic have been studied separately (Gori & Recchia 2021), and instead to adopt a unified, inter-regional perspective. Any predetermined limitation, whether geographical (viewing the sea as a border) or cultural (following present-day political borders), fails to accurately reflect the historical reality. In the (Early) Neolithic, any boundaries that existed were likely based on different, yet unclear, criteria. It is intriguing to speculate that these liminal areas may indicate areas with larger hunter-gatherer communities, suggesting that Neolithic development in these regions involved a form of cultural hybridization. However, further research is required to substantiate this hypothesis.

In the same sense, Bauer's paper (2025) talks about a "transitional zone" for the LBK area in Bavaria. Located on the periphery of the LBK territory, the circulation of siliceous raw materials exogenous to the LBK area illustrates how different territories could be interconnected through various forms of mobility associated with complementary activities (*e.g.*, animal husbandry or hunting in transitional zones). The empirical patterns identified through lithic analyses would benefit from further modelling approaches. The network analysis presented by Allard & Delvigne (2025), based on Proximal Point Analysis, allows, for example, tracking of clusters and identification of preferential pathways or economic frontiers. Incorporating additional parameters beyond lithics could offer a more comprehensive understanding of the multiple embedded layers within these systems.

Almost all the papers presented in this volume come to the unsurprising conclusion that the spatial groups delineated, on the one-hand, by ceramic typo-stylistics and, on the other, by lithic industries do not coincide. But the link between these different levels of analysis remains extremely complex to handle from a methodological point of view. This complexity arises because ceramic and lithic traditions often reflect different aspects of social practice. Additionally, these materials may have circulated through different networks or were moved at different scales, further complicating attempts to align their spatial patterns. As a result, the apparent disconnect between ceramic and lithic groupings likely reflects the complex, overlapping nature of past social boundaries. One possible avenue for research relies on the relationship existing between technical groups of producers and social groups (Roux 2010). For the LBK in Northwestern Europe, comparisons between lithic and ceramic technological groups may fit a gender-based repartition of both activities (Denis *et al.* 2024). This could serve as an entry point for a social interpretation of the various layers of observation and their spatial patterns. In this example, the pottery layer could be associated with women's activities and networks, while the lithic network might correspond to those of men. Comparing these patterns from a spatial perspective can, for instance, open up new discussions about the role and significance of liminal spaces, situated at the edges or intersections of cultural or social spheres.

Therefore, combining the horizontal and vertical superposition of identified spatial groupings will support a more complex picture of i) the identity of the agents structuring the shape of the perceptible frontiers and ii) the relationships between the different spatial

segmentations. This would benefit from cross-studies with other materials, with bioarchaeological data supported by modelling.

4. Conclusions

This volume highlights lithics as a proxy for identifying spatial groupings and for exploring their social relevance. Lithic studies allow us to distinguish multiple, complementary spatial groupings based on typology, technology, and raw materials. Understanding the articulation between these different analytical layers is crucial for deciphering the complex forms of lithic groupings. Raw materials provide invaluable data, as tracking their origin and circulation allows us to reconstruct the networks of movement and interaction that shaped prehistoric territories. By examining these networks, we gain an insight into the liminal zones that lie between social and cultural entities, where contact, negotiation, and adaptation occur. Such zones can function both as gaps, highlighting distinctions between Mesolithic and Neolithic ways of life, and as bridges, revealing the interactions and shared practices that facilitated the processes of neolithisation. Considering borderlines at the scale of social groups offers a more nuanced understanding of prehistoric socio-spatial structures and their evolution, complementing concepts such as trans-local communities or communities of practice. Spatial modelling emerges as an essential tool for integrating these multiple layers of analysis. In particular, incorporating degrees of social affiliation within GIS-based models provides a powerful perspective for examining boundary processes, interactions across liminal zones, and the dynamic relationships that underpin prehistoric cultural and technological transitions.

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Au-delà des limites : analyses multiscalaires et identification de différentes frontières

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Résumé :

Cet article introduit un volume qui rassemble des spécialistes des études lithiques néolithiques pour explorer comment ce proxy peut révéler différentes organisations spatiales à travers un vaste territoire européen. Il examine si les comportements sont les mêmes selon les différentes zones géographiques et environnementales étudiées et en quoi ils peuvent enrichir notre compréhension des processus sociaux au cours de la néolithisation de l'Europe. Dans un premier temps, nous définissons le concept de frontières, en proposant des modèles basés sur l'espace considéré comme une frontière, la présence de ressources recherchées dans cet espace, les agents présents, et la nature des interactions entre ces agents. Ensuite, nous discutons du potentiel de l'analyse de l'industrie lithique pour identifier les groupements et différents types de frontières. Les entités culturelles néolithiques ont principalement été définies par l'analyse typo-stylistique de la poterie, tandis que les études lithiques ont été sous-utilisées dans ce contexte. Le lithique, pourtant, représente une variable précieuse pour comprendre la distribution spatiale des entités préhistoriques. Les études pétrographiques nous permettent maintenant de définir précisément l'origine des sources de matières premières exploitées, et toutes les actions réalisées sur ces matières siliceuses ne peuvent être supprimées et sont donc lisibles. Les industries lithiques permettent ainsi de suivre l'origine des matières premières et le mouvement de ces matériaux au sein d'une zone donnée. Établir ces réseaux de circulation est crucial pour comprendre les espaces occupés et traversés par les populations préhistoriques et la nature de leurs interactions. Cette approche nous permet de cartographier et de comparer les groupements spatiaux obtenus selon différentes perspectives, et notamment celles des consommateurs ou des producteurs. Nous plaçons pour la nécessité d'études à variables multiples et de modélisation afin de renouveler nos interprétations des groupements spatiaux et de leur évolution au cours du temps. Plus particulièrement, c'est par le prisme d'une cartographie des différents groupes sociaux qu'une première clef de lecture est proposée.

Mots-clefs : Mésolithique; Néolithique; Europe; industrie lithique; matières premières; réseaux de circulation; organisation spatiale; organisation sociale

Die Grenze überschreiten: Mehrschichtige Analyse und die Identifikation verschiedener Grenzlinien

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Zusammenfassung:

In diesem Beitrag wird ein Band vorgestellt, in dem Fachleute aus dem Bereich der Steingeräteforschung zusammenkommen, um zu untersuchen, wie diese Artefaktkategorie unterschiedliche räumliche Muster in einem großen europäischen Gebiet aufzeigen kann. Es wird diskutiert, wie die Untersuchung unterschiedlicher Verhaltensweisen in verschiedenen Umweltbereichen und geografischen Gebieten unser Verständnis sozialer Prozesse während der europäischen Neolithisierung verbessern kann. Zunächst untersuchen wir das Konzept von Grenzen und Grenzlinien und schlagen Modelle vor, die auf dem Vorhandensein von begehrten Ressourcen, den anwesenden Akteuren und der Art der Interaktionen zwischen diesen Akteuren basieren. Anschließend erörtern wir das Potenzial lithischer Analysen zur Identifizierung sozialer Gruppen und verschiedener Arten von Grenzen. Neolithische kulturelle Einheiten wurden in erster Linie durch die typo-stilistische Analyse von Keramik definiert, während die Lithik in diesem Zusammenhang nicht ausreichend genutzt wird. Steingeräte bieten jedoch einen wertvollen Anhaltspunkt für das Verständnis der räumlichen Verteilung solcher Einheiten. Petrographische Untersuchungen ermöglichen es uns heute, die Herkunft von lithischen Rohstoffen genau zu bestimmen, und viele an diesen vorgenommenen Handlungen sind rekonstruierbar. Anhand von Steinmaterial lassen sich somit die Herkunft von Rohstoffen und die Bewegung dieser Materialien in einem bestimmten Gebiet verfolgen. Die Ermittlung dieser Zirkulationsnetze ist entscheidend für das Verständnis der von prähistorischen Menschen bewohnten Räume und der Art ihrer Interaktionen. Dieser Ansatz ermöglicht es uns, räumliche Gruppierungen auf der Grundlage von Perspektiven der Konsumenten- und Produzenten der Steingeräte zu kartieren und zu vergleichen. Wir plädieren für die Notwendigkeit von Multi-Proxy-Studien und Modellierung, um neue Erkenntnisse über räumliche Muster und ihre Entwicklung zu gewinnen, insbesondere durch die Berücksichtigung von Grenzlinien auf der Ebene sozialer Gruppen.

Schlüsselwörter: Mesolithikum; Neolithikum; Europa; Steinartefakte; Rohstoffe; Zirkulationsnetzwerke, räumliche Muster; soziale Organisation

A határ átlépése: többrétegű elemzés és a különböző határvonalak azonosítása

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Absztrakt:

Ez a cikk egy olyan kötetet mutat be, amely a köeszközökkel foglalkozó szakembereket gyűjti össze annak érdekében, hogy feltárják, miként azonosíthatók különböző térbeli mintázatok proxy-k (közvetítő változó) segítségével egy kiterjedt európai területen. A kötet azt vizsgálja, hogy miként segítheti a különböző környezeti és földrajzi területeken tapasztalható eltérő viselkedésmódok tanulmányozása az európai neolitikáció során történt társadalmi folyamatok mélyebb megértését. Először a határok és határvonalak fogalmát vizsgáljuk, olyan modelleket javasolva, amelyek a határ, térként értelmezett tér, az ott található, keresett nyersanyagok, a jelenlévő cselekvő felek (ágensek), valamint e felek közötti interakciók természetének figyelembevételén alapulnak. Ezt követően a köeszközelemzésben rejlő lehetőségeket vitatjuk meg a társadalmi csoportok és különböző határtípusok azonosításában. A neolitikus kulturális entitásokat elsősorban a kerámia tipológiai-stilisztikai elemzésével határozták meg, míg a köeszközöket ebben az összefüggésben eddig nem használták ki kellőképpen. A kőzetek azonban értékes közvetítő változót nyújtanak ezen entítások térbeli eloszlásának megértéséhez. A petrográfiai vizsgálatok ma már lehetővé teszik a nyersanyagforrások pontos meghatározását, és ezeken a kőzeteken végzett minden tevékenység jól rekonstruálható. Ezáltal a köeszközök lehetővé teszik a nyersanyagok eredetének és egy adott területen belüli mozgásának nyomon követését. A köeszköz forgalmi/elterjedési hálózatainak megállapítása döntő fontosságú a Neolitikum előtti és neolitikus közösségek által lakott terek, valamint az ezek között zajló interakciók természetének megértéséhez. Ez a megközelítés lehetővé teszi a térbeli csoportosulások feltérképezését és összehasonlítását a fogyasztói és termelői perspektívák alapján. A tanulmány amellet érvel, hogy többféle proxy alkalmazását és modellezési megközelítéseket egyaránt szükséges bevonni annak érdekében, hogy új ismereteket nyerjünk a térbeli csoportosulások mintázatairól és azok alakulásáról különösen a társadalmi csoportok szintjén értelmezett határvonalak figyelembevételével.

Kulcsszavak: Mezolitikum; Neolitikum; Európa; köeszközök; kőnyersanyagok; elterjedési/forgalmi/elosztási hálózatok; térbeli mintázat; társadalomszervezet