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The Preservation Potential of Residues on Stone Tools from Less Favourable Contexts: A Case Study from the Late Mesolithic Site of Tomaszów II, Poland

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This article is a preliminary discussion of the scientific value of archival lithics kept in museum collections and storage based on a small sample of Late Mesolithic flint artefacts from the site of Tomaszów II in south-eastern Poland, which was subjected to organic residue analysis. The aim of the trial study was to investigate and assess the preservation potential of organic residues on stone tools from sites located in areas not favourable to the survival of organic material and subsequently handled during post-excavation (especially those kept in museum collections). While the authors initially assumed that the chances of discovering residues indicating human use were slight and expected a general absence of organic material, the analysis of the lithics from Tomaszów II indicated that a small amount of ancient plant residues can survive on archival flint artefacts even in such unfavourable circumstances.

Keywords: Poland, Mesolithic, organic analysis, organic residues, lithics

Introduction

Over a century ago, scholars established that chocolate flint played an extremely important role as a source material for the Late Palaeolithic and Late Mesolithic communities that once inhabited the territories of Mazovia and central Poland (Krukowski, 1920, 1922), prompting them to search for outcrops of this raw material. The intensive exploratory research carried out in the interwar period resulted in the discovery of numerous excavation and mining sites such as Wierzbica, Orońsko, Polany, and Iłża (Krukowski, 1923, 1939; Samsonowicz, 1923), which, in turn, sparked an interest in the development of flint mining in Poland. Among the findings made by archaeologists before World War II was the discovery of the Tomaszów II and Tomaszów I mining sites in 1935 by Stefan Krukowski (Schild, 2023).

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The site of Tomaszów II is located in south-eastern Poland, on the northern edge of the Świętokrzyskie Mountains (Figure 1.1). It is situated on an eroded dune complex approximately 500 m from the shafts of the mine that gave its name to the Tomaszów site. This mine is one of several documented and archaeologically investigated sites of chocolate flint mining in the Świętokrzyskie region (Figure 1.2). In 1973–74, three trenches were excavated at the Tomaszów II site. In Trench 2, which is the main focus of this article, archaeologists recorded an area of 206 m^2 (Figure 2) and recovered a total of over 21,000 flints, the vast majority of which belonged to the remains of workshops associated with the Mesolithic communities of the Janisławice culture (Figure 3). The ^{14}C date obtained from a charcoal sample taken from the remains of a campfire was 6555±45 BP (Gr-7051) (Figure 4).

Methods and Materials

The aim of this preliminary study was to assess the preservation potential of residues on stone tools from Tomaszów II and thus to evaluate the likely presence of

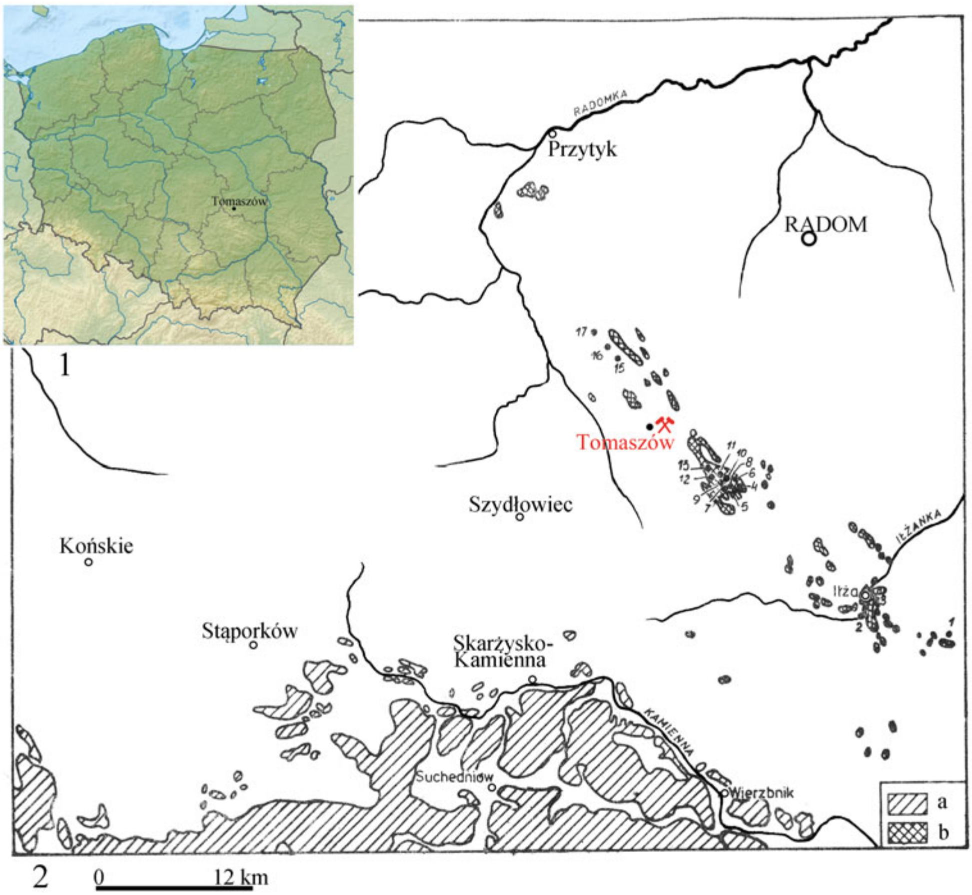

Figure 1. *Tomaszów, Mazovian voivodeship. 1: Location of the site Tomaszów. 2: The Tomaszów mine in the context of other chocolate flint mining sites (after Schild et al., 1985: 14).* Reproduced by permission of H. Królik.

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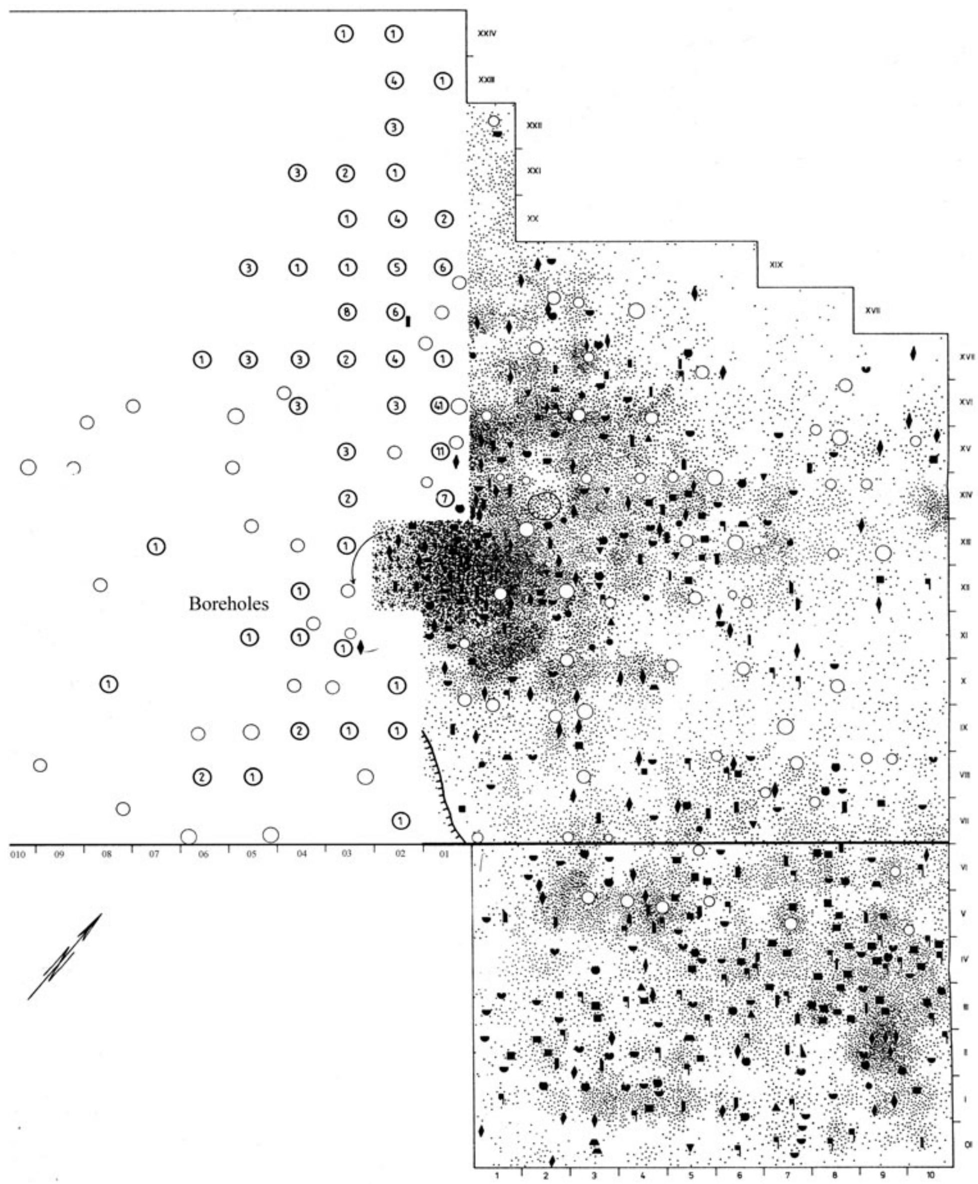

Figure 2. *Plan of Trench 2 at Tomaszów II (after Schild et al., 1985: fig. 107).* Reproduced by permission of H. Królik.

organic residues at Late Mesolithic sites located in sandy areas, where environmental conditions do not favour the survival of organic material. The degree of such survival was unknown and hence we undertook such a study within a project funded by the National Science Centre of Poland. We thought that the intensive manipulation of these lithic artefacts (i.e. cleaning, labelling, processing, and treatment since the pre-war excavations) and the general absence of organic materials at these sites were likely to result in a relatively low survival of organic residues, in particular on

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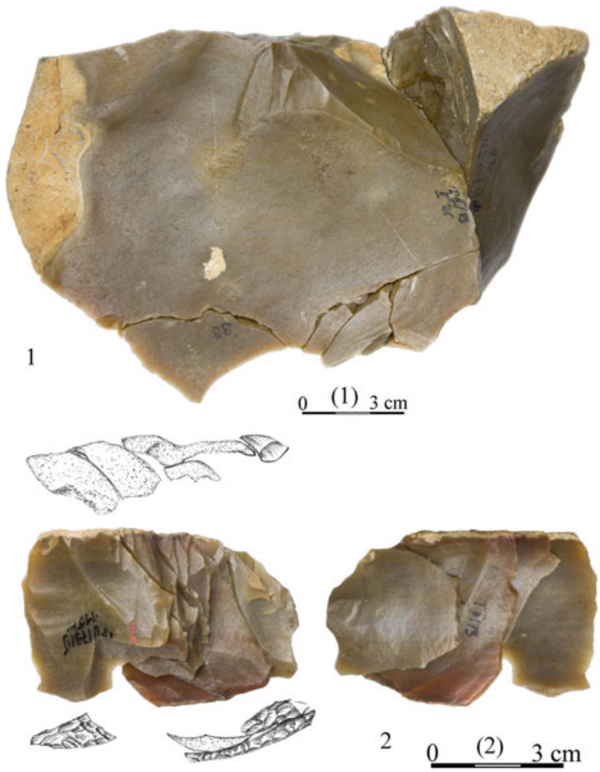

Figure 3. *Tomaszów II, Trench 2. Refitting of chocolate flint from the Tomaszów mine (photograph: M. Osiadacz; drawing: E. Gumińska).*

artefacts kept in museum collections (Croft et al., 2016; Pedergnana et al., 2016; Cnuts & Rots, 2017; Cnuts, 2021). Lithic artefacts in such conditions are generally not considered suitable for residue analysis; recent studies have, however, shown that certain residue types may still survive despite unfavourable conditions (Croft et al., 2016; Cnuts, 2021). In order to assess the wider potential (including future analyses) of this type of archaeological source, it was considered essential to conduct a study on a representative assemblage of lithic artefacts, consisting of a wide array of tool types. We hoped that a detailed residue study would allow us to detect the range of residue types that survived on these stone tools and provide insights into the impact intensive manipulation and depositional environment had on residue preservation. Therefore, it was crucial to conduct a detailed taphonomic analysis prior to the functional analysis, to determine the concentration of residues derived from handling the artefacts (i.e. modern contamination residues) and their burial (i.e. environmental residues).

This article summarizes the findings of this trial. It presents the detailed analysis of residues conducted on sixty-one lithic artefacts from the site of Tomaszów II, Trench 2. The main objectives of the study, carried out at TraceoLab in Liège, were to document and identify the range of residues on these lithics and understand which processes were responsible for the deposition and diagenesis of stone tool residues.

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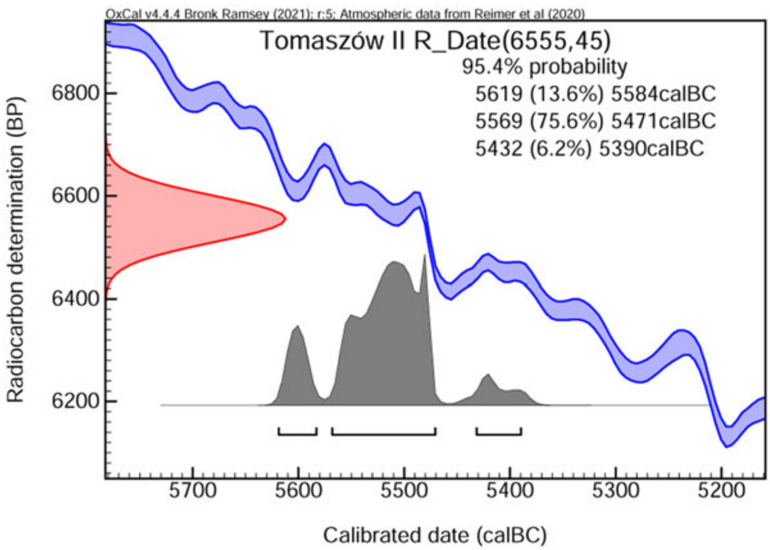

Figure 4. *Calibration diagram of* ^{14}*C date - Tomaszów II, Trench 2.*

The sixty-one lithics made of chocolate flint were chosen primarily on the basis of typology and selected to meet the criteria of our project's schedule of tasks. The assemblage submitted for analysis comprised five becs (robust, flake-based piercers), two borers, two burins, fourteen endscrapers, five microliths, five notched tools, four retouched blades, thirteen scrapers, six trapezes, and five truncated pieces. All the artefacts came from archival collections kept in the Institute of Archaeology and Ethnology of the Polish Academy of Sciences in Warsaw and thus had been cleaned, labelled, and intensively handled, which hampered the detection of reliable functional residues.

The lithics were first examined under a stereomicroscope (Zeiss V12 and V16) and an incident light microscope (Zeiss AxioImager) to detect, map, and visually record the residues present on the stone tools. Characteristics such as the degree of smearing, association with use-wear, and distribution pattern were used to identify the residue deposition processes according to the methodology developed at the TraceoLab (Cnuts & Rots, 2018; Cnuts, 2021). Non-distinctive residue types (Croft et al., 2016; Cnuts, 2021) were further examined with scanning electron microscopy (SEM) (JEOLIT300) and characterized with energy-dispersive X-ray spectroscopy (EDX) according to the methodology developed by Hayes and colleagues (Hayes & Rots, 2019; Hayes et al., 2019). Interpretations were based on comparison with a residue library of the TRAIL reference collection, which contains around 500 residue samples, both experimental and archaeological (Rots, 2021). These residues include a wide variety of organic and mineral materials.

Results

Residue analysis

Residues were observed on sixty-two per cent (n=38) of the lithic artefacts, comprising ten different residue types. Some residues could be linked to a possible deposition process from various tool

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lifecycle stages (Table 1). The detected residues included both non-distinctive and distinctive residue types. Relying solely on optical microscopy proved inadequate for precise identification, as certain residue types exhibited identical visual characteristics. While distinctive residue types were distinguishable through optical microscopy, the level of confidence remains relatively low when compared to diagnostic residue types, which can be identified with a high degree of certainty. Among the non-distinctive residue types are various black, white, and red residues, whose lack of distinctive feature poses an identification challenge. Furthermore, the microscopic analysis revealed that most artefacts were in a poor state of preservation, due to the presence of strongly developed alterations (Figure 5.1).

Modern systemic context

The frequent presence and wide range of modern contamination residues (plasticine, ink, skin flakes, finger lipids, and varnish) indicate the intensive manipulation of these lithics, which undoubtedly had an impact on the survival of ancient residues and our ability to observe their presence. Modern handling residues (except for ink and varnish) were removed by rinsing the tool edges with ethanol (C_2H_5OH) to dislodge the often very strong bond between these contaminants and the mineral stone tool surface (Figure 5.2).

Archaeological context

The frequent observation of hyphae on these lithics (Figure 5.3) suggests that they were exposed to intense fungal activity after deposition. Although intense fungal activity has been considered a proxy for the presence of initial functional residues, there is too little evidence to suggest that this is also the case here. The high frequency of hyphae further suggests that initial functional residues may have disappeared, at least those residue types that are most vulnerable to fungal activity, in the first place soft animal tissue (i.e. collagen, muscle tissue, connective tissue). The high intensity of hyphae thus further confirms the low potential for the preservation of ancient functional residues.

Furthermore, amorphous black or white deposits have been observed on several lithics; lacking distinctive visual properties, they could not be accurately identified by optical microscopy (Figure 5.4). The black residues may include a wide range of residue types, such as authigenically formed manganese or charcoal from contact with anthropogenic sedimentation or decomposed organic matter from contact with a humic horizon. However, the high density and spread of these deposits suggest that residues have been

Table 1. *Overview of observed deposition processes based on Schiffers' (1972, 1987) flow model (*).*

Lifecycle stage*	Deposition process	Residue type
Modern systemic context	Handling	Plasticine, ink, skin flakes, finger lipids, varnish
Archaeological context	Biological activity Contact with hearth-related sediment or humic horizon Heat exposure	Hyphae(Carbonized) plant tissue Charred material
Ancient systemic context	Tool use Tool use Tool hafting	Plant tissue Possible iron oxide, amorphous black deposit

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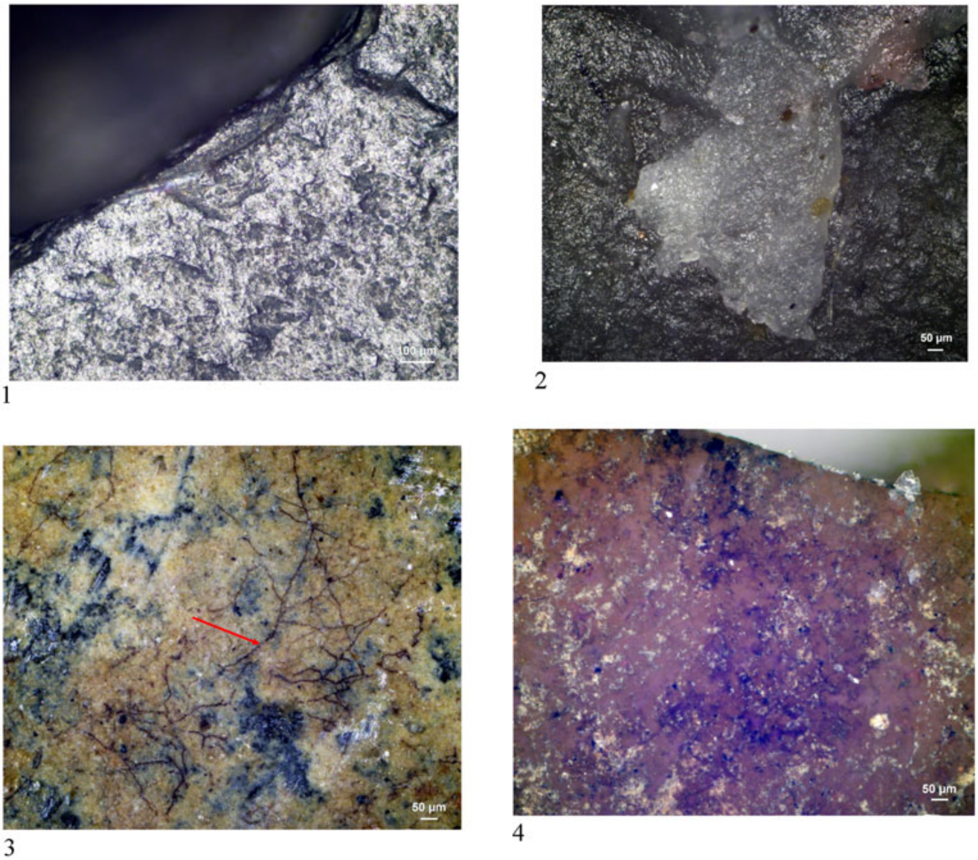

Figure 5. *Tomaszów II, Trench 2. Macroscopic photographs. 1: The surface of the majority of lithic artefacts was characterized by strong alteration (end scraper ventral distal right edge 100×, bright field). 2: Contamination residue: a large patch of transparent plasticine on the distal dorsal surface of a bec (×100, cross-polarized filter). 3: Environmental residues: a patch of hyphae in association with sediment on the ventral distal right edge of a bec. 4: Environmental residue: amorphous black and white residues on the ventral distal right edge of an endscraper.*

transferred onto the lithics through contact with organic sediments, e.g. a hearth-related sediment or humic horizon.

Ancient systemic context

The detailed residue analysis of the sixty-one lithics from Tomaszów II allowed us to observe three possible functional residues (Table 2; Figures 6–8), where only one of the residues could be attributed with confidence to a functional deposition process. This functional residue was a plant tissue directly associated with the distal ventral edge of a scraper (Figure 8.4), which allowed us to interpret it as being use-related. Corresponding use-wear evidence and the presence of smearing/directionality would have further confirmed the use-related origin of this residue. Other potential functional residues included possible iron oxide located on the used edge of a scraper (Figure 8.1). These were therefore linked with possible tool use, but the low density and absence of smearing or directionality resulted in an uncertain interpretation.

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Table 2. *Observed functional residues.*

	Residue description	Deposition process	Degree of certainty
Scraper	Plant tissue in direct association with the used edge (Figure 6.1–2, Figure 8.4)	Tool use	High certainty
Scraper	Possible iron oxide directly associated with used edge (Figure 6.3, Figure 8.1)	Possible tool use	Uncertain
Truncated piece	Black residue on the ventral part of right lateral edge (possible adhesive) (Figure 6.4, Figure 8.2)	Possible tool hafting	Uncertain
Scraper	Plant tissue associated with the bulb (Figure 7, Figure 8.3)	Possible tool hafting	Uncertain

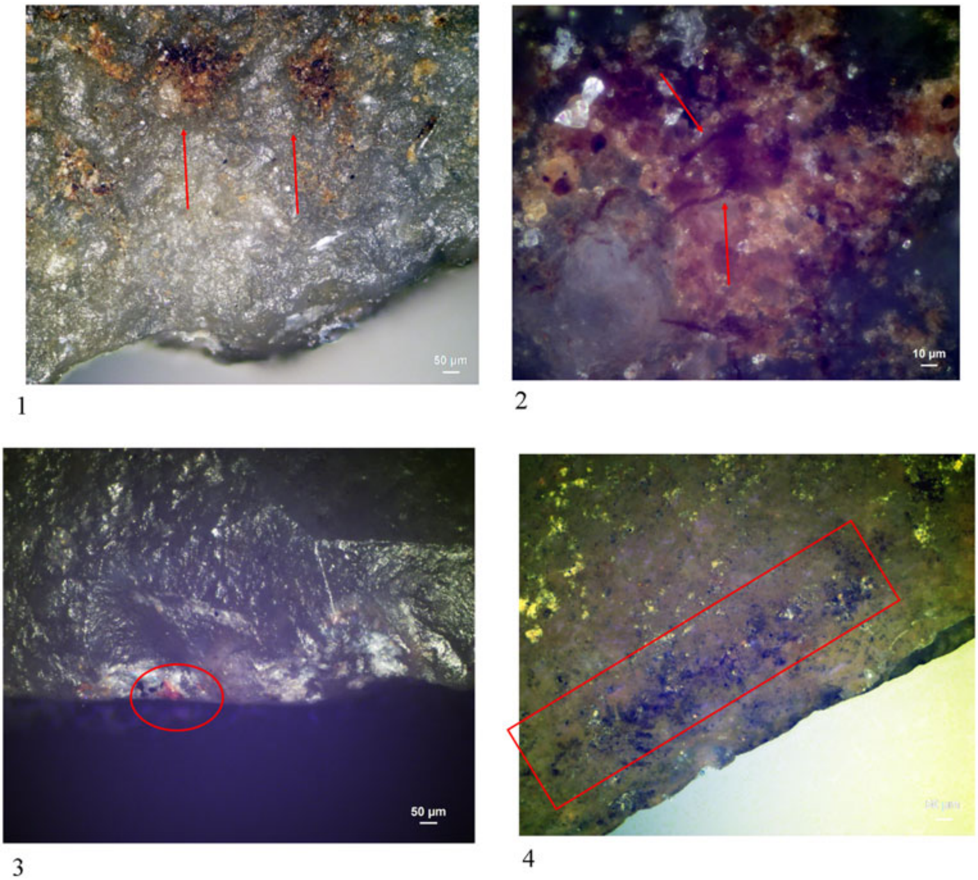

Figure 6. *Tomaszów II, Trench 2. Macroscopic photographs. 1: Use-related residue: multiple plant tissue residues (indicated by red arrows) near the distal ventral edge of a scraper interpreted as possible plant processing residue (×200, cross-polarized light). 2: Use-related residue: detail of a plant tissue residue with macerated plant cell wall (indicated by red arrow) near the distal ventral edge of a scraper interpreted as possible plant processing residue (×500, cross-polarized light). 3: Use-related residue: red residue directly associated with the used edge of a scraper interpreted as tool-use residue (×100, cross-polarized light). 4: Hafting-related residue: black deposit on ventral proximal part of a truncated piece interpreted as possibly hafting glue (×100, cross-polarized light).*

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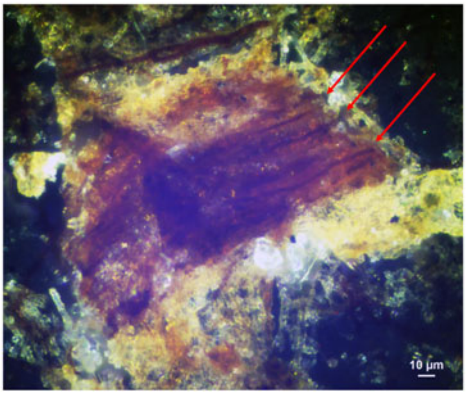

Figure 7. *Tomaszów II, Trench 2. Macroscopic photograph. Hafting-related residue: plant tissue with visible cell wall structure associated with the bulb of a scraper interpreted as possible handle residue (×500, cross-polarized light).*

Two other residues were interpreted as possible hafting-related residue due to their location on the tools' non-operational (passive) part. The first was a black deposit on the passive part of a truncated piece (Figure 8.2). Caution is needed when interpreting this deposit as a hafting residue since similar black residues have been interpreted as environmental residues; in this case, however, the exclusive location on the proximal part of the tool was considered as key evidence of a potential adhesive, unlike similar black residues that are spread all over the surface of a tool. Nonetheless, a more detailed molecular analysis, in particular gas chromatography-mass spectrometry (GCMS), is required to identify the exact nature of such an amorphous organic residue. Moreover, the presence of corresponding hafting wear and smearing would have led to a higher degree of certainty concerning the interpretation of this residue. The second hafting-related residue was a plant tissue associated with the bulb of a scraper (Figure 8.3), which could be linked with hafting due to its location on the passive part of the tool. Again, the absence of smearing and corresponding hafting wear did not allow us to interpret this residue with any certainty.

Use-wear analysis

To allow us to determine the function of the Tomaszów II lithics through the traces of use on their edges and surfaces, both use-wear analysis and organic residue analysis were conducted. The sixty-one flints originally chosen for analysis were subject to residue analysis, which yielded evidence of plant processing. Since previous studies on other Mesolithic inventories from Europe suggested that plant processing at this time was primarily undertaken with blades, nine unworked blades also from the Tomaszów II inventory were subjected to use-wear analysis alongside the other sixty-one pieces (thus, in total, seventy lithics from Tomaszów II were analysed).

The examination of use-wear traces was carried out using an Olympus SZX9 stereomicroscope and an Olympus BX53M metallographic microscope. The results of the analysis, according to the method used (as discussed in Marreiros et al., 2015), were interpreted based on the database resulting from the previously completed experiments.

It should be strongly emphasized that the analysed artefacts had very damaged surfaces resulting from post-depositional processes, which made it impossible or difficult to make observations. This also affected the interpretation of the observed modifications or alterations, which ultimately were described as unspecified.

Twenty-seven specimens showed signs of use (Table 3). They were used for scraping hides (becs, endscrapers, scraper) (Figure 9.1) or scraping inorganic raw material (bec), scraping (truncated piece), processing and cutting antler (blades), and bone scraping (scraper) (Figure 9.2). They

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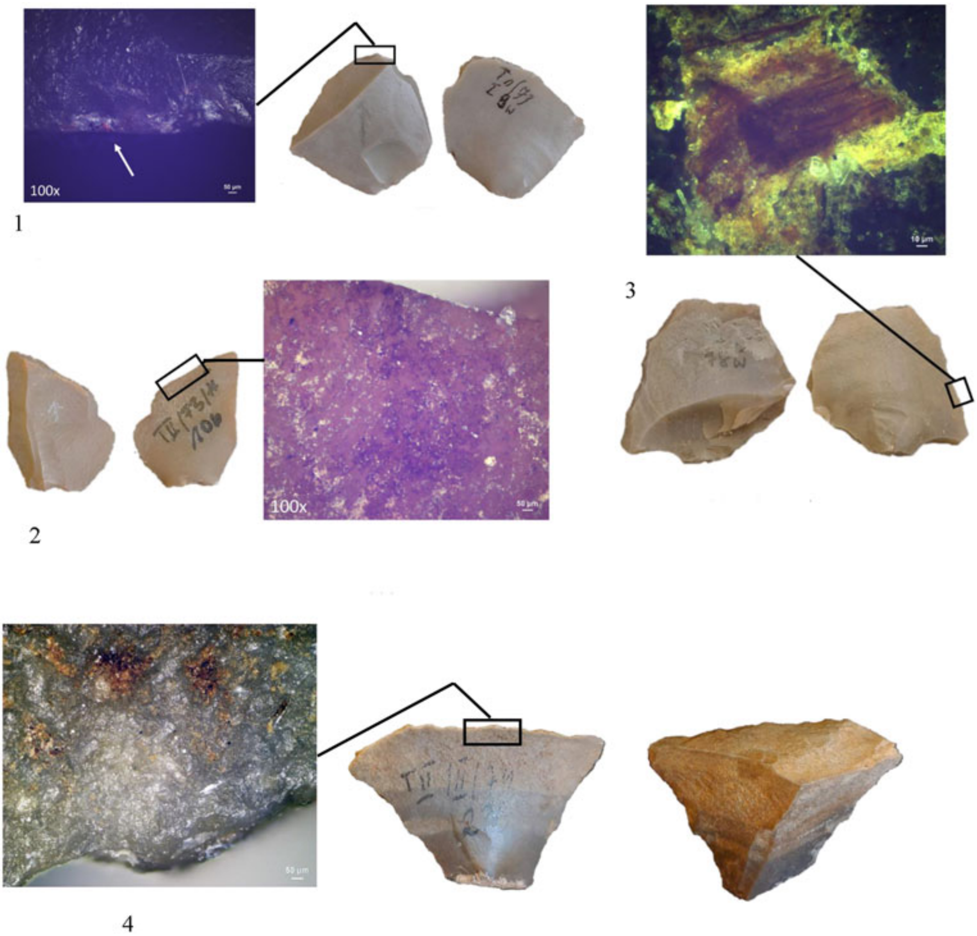

Figure 8. *Tomaszów II, Trench 2. 1: Location of use-related residue on a scraper. 2: Location of use-related residue on a truncated piece. 3: Location of haft-related residue on a scraper. 4: Location of use-related residue on a scraper.*

were also used for scraping wood (scrapers) as well as for various activities associated with plant processing (scraper, notched tool, blade). A microlith had marks on its lateral edge that probably were the result of hafting and could thus have been an inset of a composite tool mounted in the shaft with this edge. The fracture recorded on the lateral edge of a trapeze, on the other hand, can be associated with its presumed use as an inset in a shaft.

The four artefacts on which organic remains were found had very poorly preserved traces of use. The scraper with plant remains identified on the working edge of the tool was used for scraping plants (Figure 8.4); the other two scrapers (Figure 8.1, Figure 8.3) were used for unspecified activities. The truncated piece showed no identifiable modifications (Figure 8.2).

The traces of use-wear recorded in analysis allowed us to determine the function of the artefacts in question. The activities for which these tools were used fit into the range of activities of Mesolithic communities, although the study of this assemblage was limited by its state of preservation.

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Table 3. *Overview of the functions of the analysed artefacts.*

Tool type	Activity	Number of tools
Becs	Scraping hide	2
	Scraping of inorganic raw material	1
Truncated pieces	Scraping antler	2
Endscrapers	Unspecified	2
	Scraping hide	2
Scrapers	Scraping wood	3
	Scraping hide	1
	Scraping bone	1
	Unspecified	3
	Scraping plants	1
Microliths	Evidence of hafting	1
Trapezes	Fracture marks	1
Notched tools	Processing plants	1
Retouched blades	Unspecified	1
Retouched flakes	Unspecified	1
Unworked blades	Processing plants	1
	Cutting plants	1
	Processing antler	1
	Cutting antler	1
Total		27

Plant use

The use-wear analysis confirmed that, in addition to the plant substances detected on the surfaces of the flints, there were also visible traces of microwear indicating the processing of plants with the tools examined. In addition, there were also other traces indicating the working of bone, antler, or hide on the surfaces of the analysed tools (Table 3). Such a wide range of activities is a common phenomenon in Mesolithic campsites (Healy et al., 1992: 61; Crombé & Beugnier, 2013: 180; Guéret, 2013: 150, 2017; Vandendriessche et al., 2019: 306).

Mesolithic communities intensively explored and exploited the environment for plant resources to consume (Zvelebil, 1994; Mithen et al., 2001; Svoboda, 2008: 230; Marchand et al., 2018: 982). A wide variety of plant-based foods were consumed, as shown by the results from Mesolithic sites ranging from south-western Germany, north-eastern France, southern Belgium, Luxemburg and Switzerland to the Czech Republic (Divišová & Šída, 2015: 99–100; Jacomet & Vandorpe, 2022: 7) and ethnoarchaeological observations of contemporary hunter-gatherer communities. The consumption of plant foods is also evidenced by analyses of residues discovered on the surfaces of flints from northern Bohemia (Hardy, 1999: 277; Hardy & Svoboda, 2009: 167).

Detailed studies of the vegetation cover in relation to the archaeological context show that Mesolithic communities located their settlements at the boundary of qualitatively different biotopes to maximize the benefits of monitoring raw material resources (Regnell et al., 1995: 89). Archaeobotanical studies (Kubiak-Martens & Tobolski, 2008; Kubiak-Martens, 2019; Bishop et al., 2023: 75) conducted on plant macro-remains obtained from northern European archaeological sites have shown that Mesolithic communities made considerable use of the abundance of roots, tubers, and fruits for consumption, also probably for hygiene and medicinal purposes.

People also manufactured items necessary for everyday life from material derived from plants, such as containers made of tree bark, baskets, ropes and mats, as illustrated, for instance, by the numerous finds from the Veret'e site 1 in Russia (Ošibkina, 2006: 19–21).

Intensive harvesting and processing of plants by Mesolithic communities is indicated by the recorded traces of use-wear on numerous flint assemblages from regions as widespread as Brittany, Flanders, Pomerania, and the Iberian Peninsula (Beugnier & Crombé, 2005: 537; Pyżewicz, 2013: 177; Guéret et al.,

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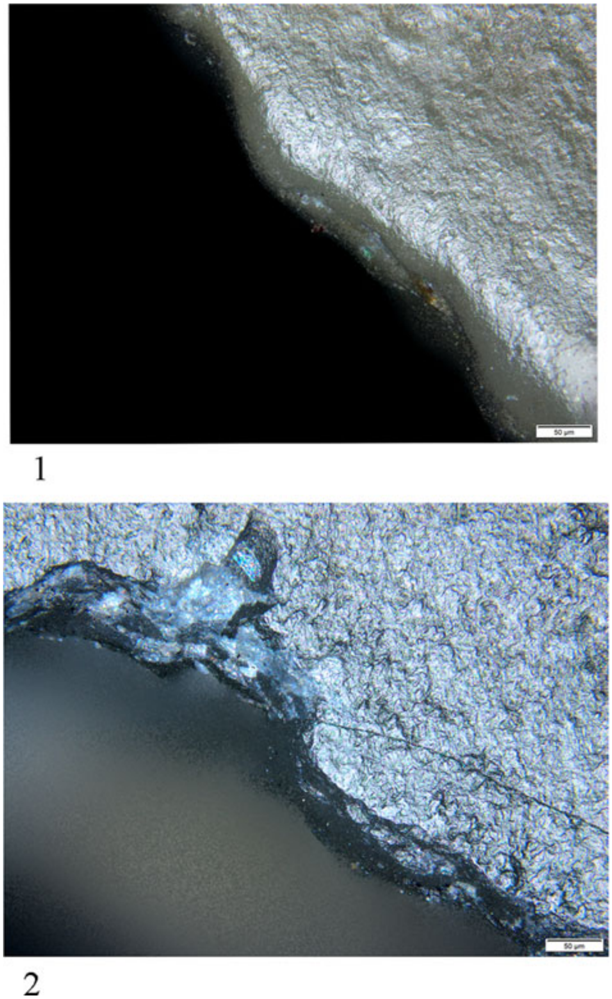

Figure 9. *Tomaszów II, Trench 2. Microscopic images. 1: Scraper, for scraping hide. 2: Scraper, for scraping bone.*

2014: 7; Winiarska-Kabacińska, 2015: 278–79; Mazzucco et al., 2016: 155; Osipowicz, 2017, 2018).

Discussion and Conclusions

The small-scale study of intensively manipulated lithics from Trench 2 at Tomaszów II presented here has shown that a small number of ancient residues may survive on flint artefacts despite a preservation potential assumed to be poor and subsequent processing. Most ancient residues could only be observed by first removing modern contaminants with ethanol to break the chemical bonding between these proteinaceous (e.g. skin flakes) or greasy (e.g. finger lipids) residues and the flint surface (Craig & Collins, 2002; Cnuts & Rots, 2018). In the case of the flints from Tomaszów II, the preserved ancient residues on the stone tools consisted exclusively of plant, fungal, and mineral residues; residues of animal origin seem not to have survived on these

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artefacts. The observed preservation bias is most likely caused by exposure to acidic conditions in combination with high microbial activity. Animal residues (including collagen, muscle tissue, blood and bone tissue) are more vulnerable to such environmental conditions than plant, mineral, or fungal residues (Cnuts & Rots, 2017; Cnuts, 2021).

This study indicates that there is no potential for detecting animal residues on the lithics from the Tomaszów II site and that, therefore, animal-related activities (e.g. bone processing, butchering, or hunting) cannot be detected based on residues alone; in such cases, evidence from use-wear and macroscopic edge damage could provide more information. On the other hand, the preservation of plant residues allowed us to identify possible woodworking activities and provided new insights into the technological organization of the lithic technology (Nelson, 1991) employed at the site. There is potential evidence that at least some of the tools were hafted with wooden handles, possibly with a hafting glue, although more functional evidence is needed to confirm this hypothesis, preferably through the analysis of minimally manipulated lithic artefacts from the same site. In addition, use-wear analysis is crucial for obtaining more robust interpretations.

Considering the large numbers of important flint artefacts currently kept in museum collections and storage and the fact that in many cases it is not possible to re-examine archaeological sites investigated long ago, either because they were destroyed (by excavations or natural causes) or because a lack of funds for excavations, heritage protection policies, and/or an ostensibly 'poor' research potential prevent further investigations, analysing archival lithics is an exciting idea and a way forward. Modern science has equipped us with research methods and techniques that past generations of archaeologists could only dream about, and scientific research brings constant innovations. In our case, we are limited primarily by environmental factors (preservation *in situ*) and the way finds from historical excavations have been handled (processing, storage).

Potentially, analysing archival collections could greatly expand our knowledge and make it possible to re-evaluate past findings without the need to disturb important archaeological sites or where further excavations are no longer possible. Nonetheless, although residue analysis on stone tools yields very promising results in many cases, it is still under development and, being *in statu nascendi*, is prone to errors and misinterpretations (see e.g. Croft et al., 2018; Bordes et al., 2020). For this reason, the potential of applying such analysis to archival lithics on a wider scale requires further studies to eliminate risks associated with the contamination of samples in post-excavation processing (cleaning, refitting, curation), gather more data on the preservation potential of residues on different types of archaeological sites, and investigate correlations between the types of residues discovered on flint artefacts and actions or events that led to their deposition. Moreover, as this kind of analysis is currently rather time-consuming and relatively expensive, it should be proven to be reasonably reliable and cost-effective before being implemented more widely in research projects. We hope that the analysis of the stone tools from Trench 2 at Tomaszów II will contribute significantly to such studies. Although these are only preliminary results conducted on a trial basis, they are encouraging, considering that initially the probability of discovering residues indicating human use on archival lithics was regarded as very low or even close to zero. We hope to conduct a new analysis of

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use-related micro-residues (possibly using additional techniques such as Raman microspectroscopy) on a collection of flint artefacts from another carefully selected Late Mesolithic site in the Świętokrzyskie region with natural conditions similar to the Tomaszów II site, and confront it with a detailed 'traditional' use-wear study of the same lithic assemblage. This would allow us to verify whether the results obtained can be repeated or not. So far, the analyses of residues on flints from Tomaszów described here are unique and pioneering. For this reason, there is currently no basis for comparison with other results from the territory of Poland, not only from more environmentally friendly soil conditions, but also from sites located in less favourable settings.

Acknowledgements

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Le potentiel de conservation des résidus organiques sur outils en pierre provenant de contextes peu favorables à leur survie : l'exemple du site mésolithique tardif de Tomaszów II en Pologne

Cet article est une discussion préliminaire sur la valeur scientifique des artefacts lithiques conservés dans des collections et entrepôts de musées, basée sur un petit échantillon d'objets en silex du Mésolithique tardif du site de Tomaszów II dans le sud-est de la Pologne, qui ont été soumis à une analyse des résidus organiques. Le but de l'étude expérimentale était d'étudier et d'évaluer le potentiel de conservation des résidus organiques sur les outils en pierre provenant de sites situés sur des terrains peu favorables à la survie de matières organiques et par la suite soumis au traitement post-fouille (en particulier ceux conservés dans les collections de musées). Bien que les auteurs aient initialement pensé que les chances de découvrir des résidus indiquant une utilisation humaine fussent faibles, et anticipé une absence générale de matière organique, l'analyse des silex de Tomaszów II indique que même dans des *conditions aussi défavorables une petite quantité de résidus préhistoriques de matières végétales peut survivre sur des artefacts en silex.* Translation by the authors.

Mots-clés: Pologne, Mésolithique, analyse organique, résidus organiques, lithique

Das Potenzial für die Erhaltung organischer Rückstände auf Steinwerkzeugen in Kontexten mit ungünstigen Überlebensbedingungen: eine Fallstudie von Tomaszów II, Polen, im Spätmesolithikum

Dieser Aufsatz bildet einen Beitrag zur Diskussion über den wissenschaftlichen Wert von archivierten, in Museumssammlungen und -lagern aufbewahrten Feuersteinartefakten anhand einer kleinen Stichprobe spätmesolithischer Feuersteinartefakte aus der Fundstelle von Tomaszów II in Südostpolen, die auf das Vorhandensein organischer Reste untersucht wurden. Ziel der experimentellen Forschungen war es, das Potenzial für die Erhaltung organischer Rückstände auf Steinwerkzeugen von Fundorten, wo das Überleben von organischem Material ungünstig ist, und die anschließend einer dokumentarischen Behandlung unterzogen wurden (insbesondere solche, die in Museumssammlungen aufbewahrt werden) zu untersuchen und zu bewerten. Obwohl die Verfasser zunächst von einer sehr geringen Wahrscheinlichkeit ausgingen, Rückstände zu entdecken, die auf eine menschliche Nutzung hinweisen und mit einem generellen Fehlen von organischem Material rechneten, zeigte die Analyse der Feuersteine aus Tomaszów II, dass selbst unter solch ungünstigen Umständen eine kleine Menge von prähistorischen Pflanzenresten auf archivierten Feuersteinartefakten erhalten bleiben kann. Translation by the authors.

Stichworte: Polen, Mesolithikum, Analyse organischer Rückstände, organische Überreste, Feuersteinwerkzeuge