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Time to shine
The effect of metal traces on the functional analysis of lithic artefacts

Dries CNUTS, Sonja TOMASSO & Veerle ROTS

1. Introduction

Within the field of functional analysis, a lot of attention has been devoted to understanding the effect of post-depositional alterations on the preservation of functional traces (*i.e.*, use-wear and residues) (*e.g.*, Semenov, 1964; Keeley, 1974, 1980; Tringham *et al.*, 1974; Plisson, 1985; Mansur-Franchomme, 1986; Knutsson, 1988; Plisson & Mauger, 1988; Plisson & van Gijn, 1989; Rots *et al.*, 2017). Experimental research succeeded in demonstrating the role of various post-depositional processes in the formation of surface alterations, either when the lithic tools are deposited on the soil surface (*e.g.*, Levi Sala, 1986; Shea & Klenck, 1993; Burroni *et al.*, 2002; Chu & Hosfield, 2020) or buried within the soil (*e.g.*, Plisson, 1985; Levi Sala, 1986; Asryan *et al.*, 2014; Michel *et al.*, 2019). In addition, it has been recognized that post-excavation procedures (*i.e.*, handling and storage) may damage artefacts (Gero, 1978) or even hamper the study of functional traces (Wylie, 1975; Plisson, 1985; Rots, 2002; Pedergnana *et al.*, 2016). On the contrary, the exact impact of artefact recovery processes, such as excavation and sieving, on the preservation of functional traces remains largely unknown due to the lack of empirical evidence. However, several analysts have suggested that contact with excavation equipment or sieving meshes may deposit metal residues or surface modifications (*i.e.*, metal polish) that may hinder the observation of functional traces (*e.g.*, Plisson & van Gijn, 1989; Donahue & Burroni, 2004; Langejans & Lombard, 2015).

While the use of excavation equipment (*i.e.*, shovels, trowels) remained generally the same, various sieving techniques have been adopted since the introduction of sieving during the 70's (*e.g.*, French, 1971; Payne, 1972; Gueresschi, 1973). These involve both manual and mechanical sieving equipment and sediment is removed with (wet sieving) or without (dry sieving) the aid of water. Nowadays, recovering of lithic artefacts by sieving has become a key element within the methodology of systematic excavation strategy (Legge & Hacker, 2010) as it allows collecting the small fraction of lithic and organic remains. Moreover, within the framework of Flemish rescue archaeology, sieving has become the key part of the excavation strategies used as it offers solutions to collect all artefacts within a limited time span (*e.g.*, van Gils & De Bie, 2004; Perdaen *et al.*, 2015; van Gils *et al.*, 2017). The observation that the contact with a metal mesh may create residual traces on stone implements and thus potentially hinder functional analysis has led to an obligatory use of plastic meshes within the framework of Flemish rescue archaeology (*Code Goede Praktijk* or CGP).

In this paper, the effect of various sieving techniques on the surface state of stone artefacts is investigated more closely. Four Final Palaeolithic and Mesolithic sites from Flanders have been selected for this study: Lommel-Maatheide, Tongeren-Plinius, Meeuwen-Monnikswijer and Beveren-Schoorhavenweg. Differing sieving and excavation techniques were employed during the excavation of these sites, which provides a good range of possible scenarios in which metal wear could be formed to obtain a good insight into the consequences of these strategies for the potential of functional analysis. The study framed in a larger project focussing on the functional analysis of the aforementioned sites (see Cnuts *et al.*, 2020).

2. Materials and Methods

2.1. Archaeological material

Lithics from four different sites (Fig. 1) were selected to study the impact of sieving on the lithic artefacts and the assemblages were selected to represent a wide range of variables that could have made an impact on the presence of metal traces. Therefore, the selected assemblages were composed of unretouched and retouched artefacts, large and small artefacts to permit a comprehensive understanding of the possible effect of contact with the sieve on the potential of functional analysis. The presence or absence of metal traces and their exact location were recorded with stereo- and incident light microscopy. Also, possible edge damage, striations, abrasion caused by contact with sieves or excavation material was considered.

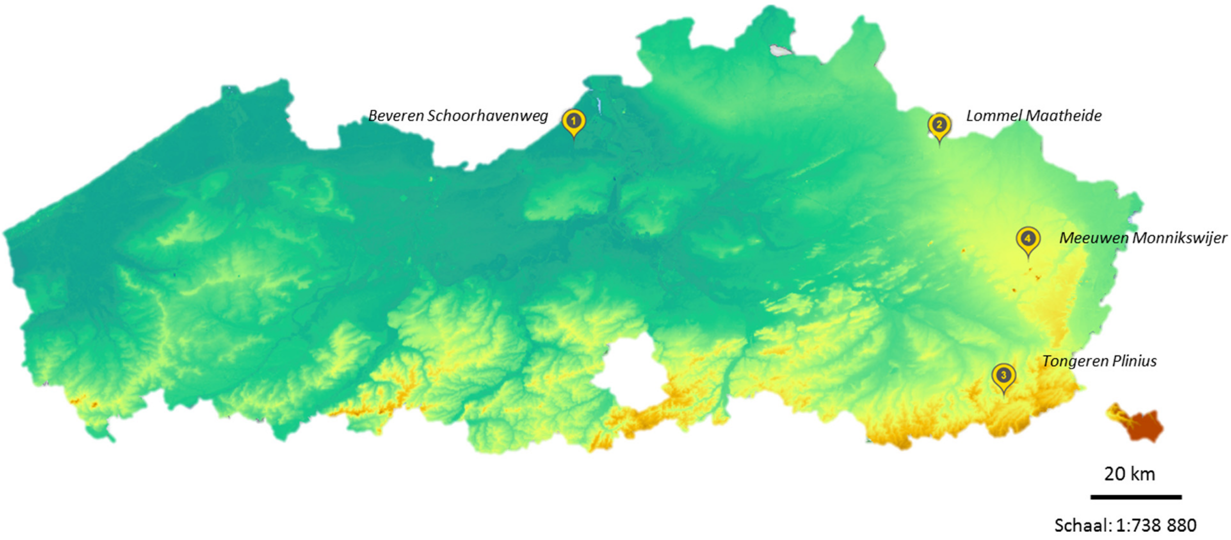

Fig. 1 – Map showing the location of the selected sites, with Beveren-Schoorhavenweg, Lommel-Maatheide, Tongeren-Plinius and Meeuwen-Monnikswijer.

The site of Lommel-Maatheide is located in the Campine region, in Northern Belgium, and revealed the presence of numerous Final Palaeolithic concentrations situated close to a lake on a large Late Glacial sand ridge (van Gils & De Bie, 2004, 2005; Geerts *et al.*, 2008; De Bie *et al.*, 2009). Most concentrations were excavated according to a 50 by 50 cm grid cell system and dry sieved with a motorised swing sieve on a 6 mm metal mesh. Also situated in the Campine region, the lithic artefacts from the site of Meeuwen-Monnikswijer have been attributed to the Final Palaeolithic or the Early Mesolithic (van Gils *et al.*, 2017). The artefacts were recovered with a wet sieving technique carried out on a 2 mm metal wire (see Tab. 1). The assemblage of Tongeren-Plinius dates to the late or final Palaeolithic (Dijkstra *et al.*, 2006; Bink, 2007). The archaeological site is situated on a hill 500 m northwest of the Roman city walls of Tongeren, close to the *Plinius* spring. Five concentrations, dated to the Final Palaeolithic were discovered during the excavation. These assemblages have been interpreted as an atypical variant of the *Federmessergruppen* and represent the first excavated final Palaeolithic site in the region of the Belgian loess area (De Bie & van Gils, 2006). Due to time constraints, the lithic artefacts could not be recorded individually, but they were collected per 1/4 m^2 and then sifted out wet on 3 mm wide metal mesh (see Tab. 1). Located within the sandy lowlands of northern Belgium, the lithic assemblages from the site of Beveren-Schoorhavenweg were mainly attributed to the Early Mesolithic. Two sieving techniques were used at the site but both involved the use of plastic meshes in order to avoid contact between the metal and the stone tool surface (Perdaen *et al*., 2015) (see Tab. 1).

	Sites	*Sieving protocol*	*References*	*Number of lithics*
1	Beveren-Schoorhavenweg	Mechanical wet sieving on 2 mm plastic mesh	Perdaen, Woltinge & Opbroek *et al.*, 2015	598
2	Lommel-Maatheide	Mechanical dry sieving on 6 mm metal mesh	Van Gils & De Bie, 2004	506
3	Tongeren-Plinius	Manual wet sieving on 3 mm metal mesh	Dijkstra *et al.*, 2006	443
4	Meeuwen-Monnikswijer	Manual wet sieving on 2 mm metal mesh	Van Gils *et al.*, 2017	551

Tab. 1 – Summary of the sieving protocols used at the selected sites and total number of studied archaeological artefacts.

2.2. *Sieving experiment*

A small-scale sieving experiment was carried out to verify whether the use of plastic mats within the metal sieves is an appropriate procedure to avoid metal traces or other damage to lithic artefacts during sieving. The sieving experiment was performed at Lommel-Kristalpark while using the same sieving installation as the one used at Beveren-Schoorhavenweg. A total of 150 experimental artefacts out of Harmignies flint were manufactured by experienced flint knapper Christian Lepers (TraceoLab). The experimental assemblage consisted of artefacts with a variety of sizes and morphologies (e.g., blades, micro-blades, flakes). After their manufacture, all surfaces and edges of the artefacts were screened macroscopically for possible production wear and both surfaces were also photographed.

Artefacts were subsequently grouped per 10 and buried in a box filled with sand from the local compact E/B horizon which was also rich in gravel (see Fig. 2). The sediment was compacted within the boxes and all 15 containers were subsequently sieved by the same person (D. Cnuts). During the sieving, the sediment and the lithics of each container were exposed to water from sprinklers, gradually exposing the artefacts on the plastic mats after about five minutes. The artefacts were then removed from the installation and left to dry. Artefacts were placed in separate plastic bags and transported back to TraceoLab for analysis.

2.3. *Analysis*

To evaluate the state of preservation and record potential traces of metal from excavation procedures, all selected archaeological stone tools were screened with a Zeiss stereomicroscope Discovery V12 (oblique external light source, magnifications up to ×100) and a Zeiss Macro-Zoom Microscope V16 (oblique external light source, magnifications up to 180x). The presence of metal traces and residues were recorded based on their location and distribution pattern and association with additional edge scarring.

Fig. 2 – Sieving experiment at Lommel-Kristalpark with a) overview of the sieving installation; b) lithic artefacts deposited on the sediment in the box; c) wet sieving of the artefacts while using a plastic mesh; d) detail of the recovered artefacts during the sieving procedure.

All artefacts with metal traces and residues were further studied on microscopic level using a Zeiss metallurgical reflected-light microscope AxioImager (magnifications 50–500×), equipped with polarizing filters and differential interference contrast (DIC). The metal residues were further evaluated with a JEOL IT300 scanning electron microscope with an EDS detector JEOL ex-230.

	Absence		*Presence*	
Archaeological site	%	N	%	N
Beveren-Schoorhavenweg	79.60	476	20.40	122
Lommel-Maatheide	81.84	410	18.16	91
Meeuwen-Monnikswijer	76.23	420	23.77	131
Tongeren-Plinius	77.20	342	22.80	101
Total	*78.74*	*1648*	*21.26*	*445*

Tab. 2 – Absence and presence of metal traces recorded on the selected artefacts from the four sites.

3. Results

3.1. Archaeological material

Metal traces were present on 21 % (N = 444) of the studied lithics with little variation in their intensity between the different sites (between 18.16 % at Lommel-Maatheide and 23.77 % at Meeuwen-Monnikswijer) (see Tab. 2).

In order to precisely map the density of metal traces on each artefact, each artefact was divided into twenty-six zones. On the vast majority of artefacts (69 %), the metal traces were present only in a single zone of the artefact and only for a minority of artefacts (12 %) metal traces were present in three or more zones (see Fig. 3, Fig, 4). Metal residues proved to be deposited in association with the traces on the artefact surfaces and SEM-EDS analysis revealed high peaks of Iron (Fe), Chromium (Cr) and Nickel (Ni) (Fig. 5) corresponding to a contact with stainless steel.

No relationship could be established between the presence of metal traces and the size or morphology of the artefact. Larger artefacts such as scrapers or blades revealed an equal percentage of metal traces as small artefacts such as microliths. Also, no

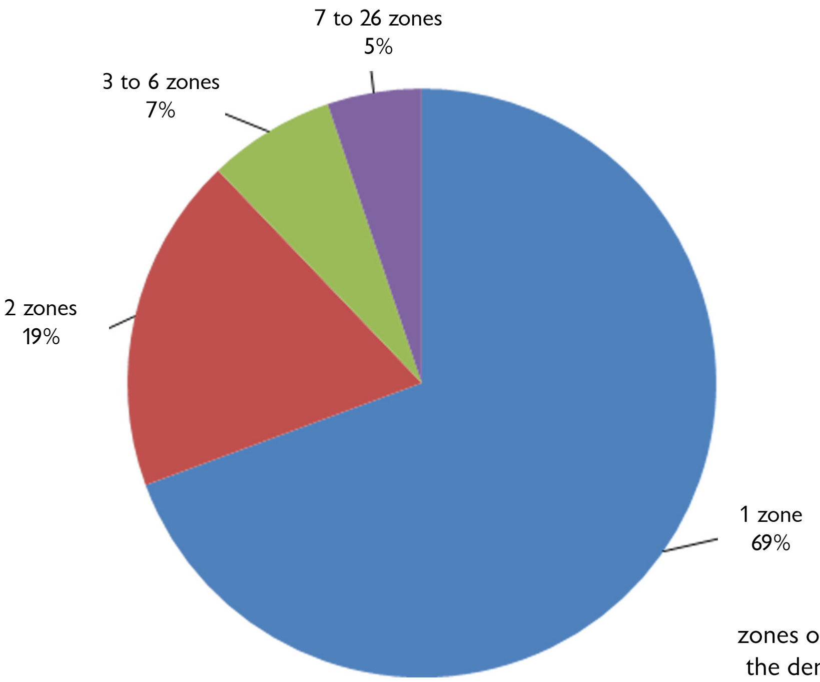

Fig. 3 – Based on the subdivision of twenty-six zones on each analysed archaeological artefact, the density of metal traces could be evaluated.

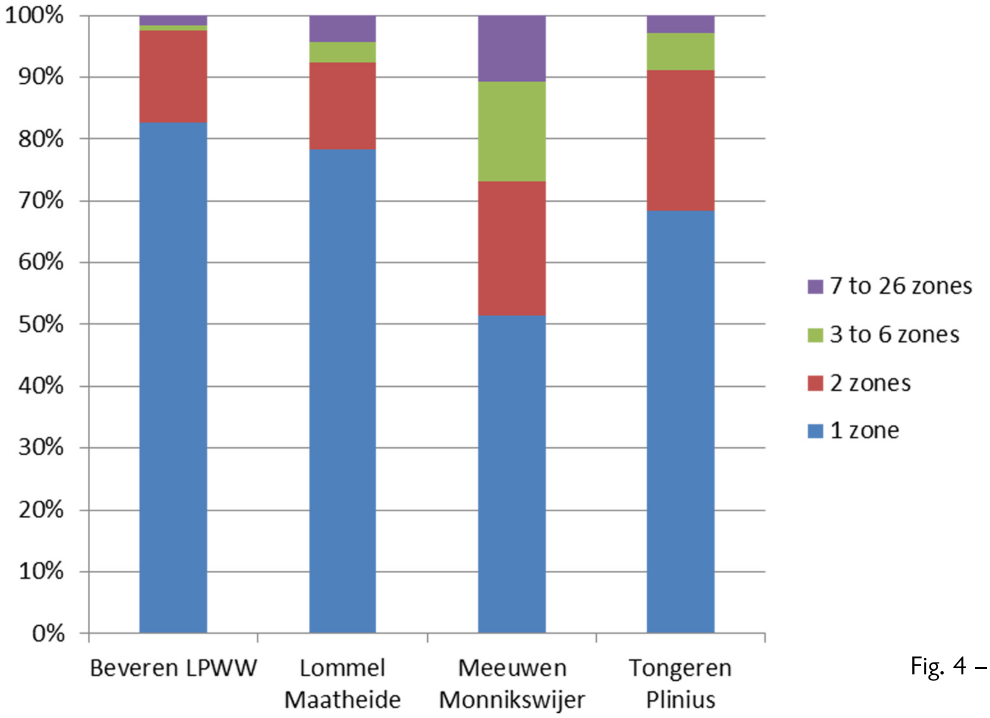

Fig. 4 – Intensity of metal traces for each archaeological site.

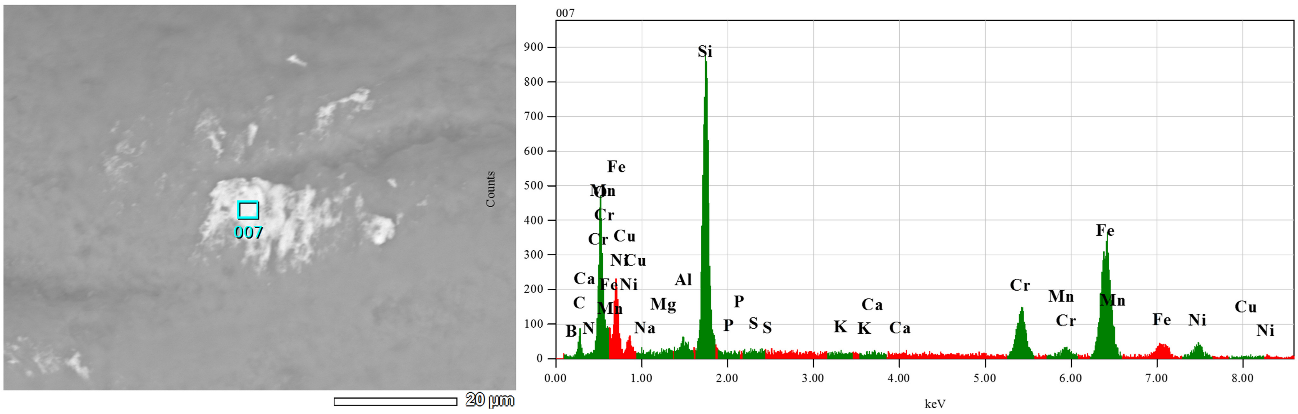

Fig. 5 – SEM-EDS analysis of the metal residues on the artefact LB 25_63 (Lommel-Maatheide), with high peaks of Iron (Fe), Chromium (Cr) and Nickel (Ni).

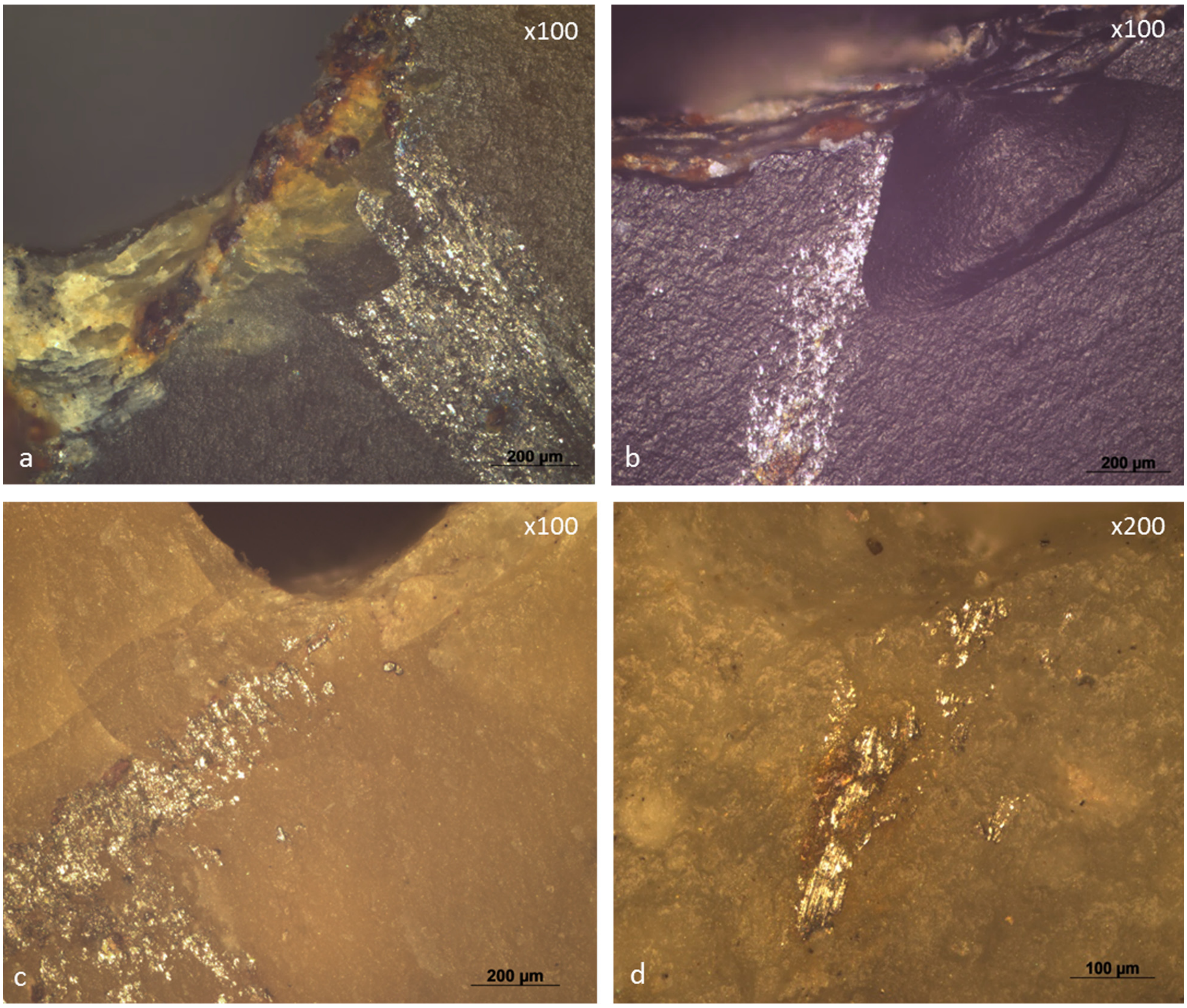

Fig. 6 – Examples of metal traces associated with edge scarring, probably caused by excavation equipment, on the surface of the artefacts from a) LPWW_2049109813 (Beveren-Schoorhavenweg) (100x); b) TP_1381 (Tongeren-Plinius) (100x); c) LPWW_2069209201 (Beveren-Schoorhavenweg) (100x); d) LPWW_2083309901 (Beveren-Schoorhavenweg) (200x).

correlation was found between the type of sediment or the compactness of the sediment and the presence of metal traces.

For a single case (out of the 2098 examined artefacts), the metal traces were so intense and widespread over the surface of the tool that it hindered use-wear analysis. This concerns a scraper from Meeuwen-Monnikswijer (MMW405).

Two main types of metal traces could be distinguished: relatively severe damage (see Fig. 6) and less intense metal traces (see Fig. 7). The few metal traces observed on the artefacts from Beveren-LPWW proved to be very intense and associated with edge scarring, which is remarkable given the sieving method (using plastic mats) used at this site. This leads to suggest that the metal alteration and associated damage were not caused by a contact with the sieve, but by a contact with excavation material. It seemed that the large metal traces (200-300 µm), which were often recorded in association with edge damage (*e.g.*, edge scarring, crushing) were the result of a contact with more intense force, such as scratches from a trowel or shovel, while fine metal traces (20 µm) (*e.g.*, striations) without edge damage were likely caused by contact with a metal sieve. This was tested with the aid of the sieving experiment discussed below.

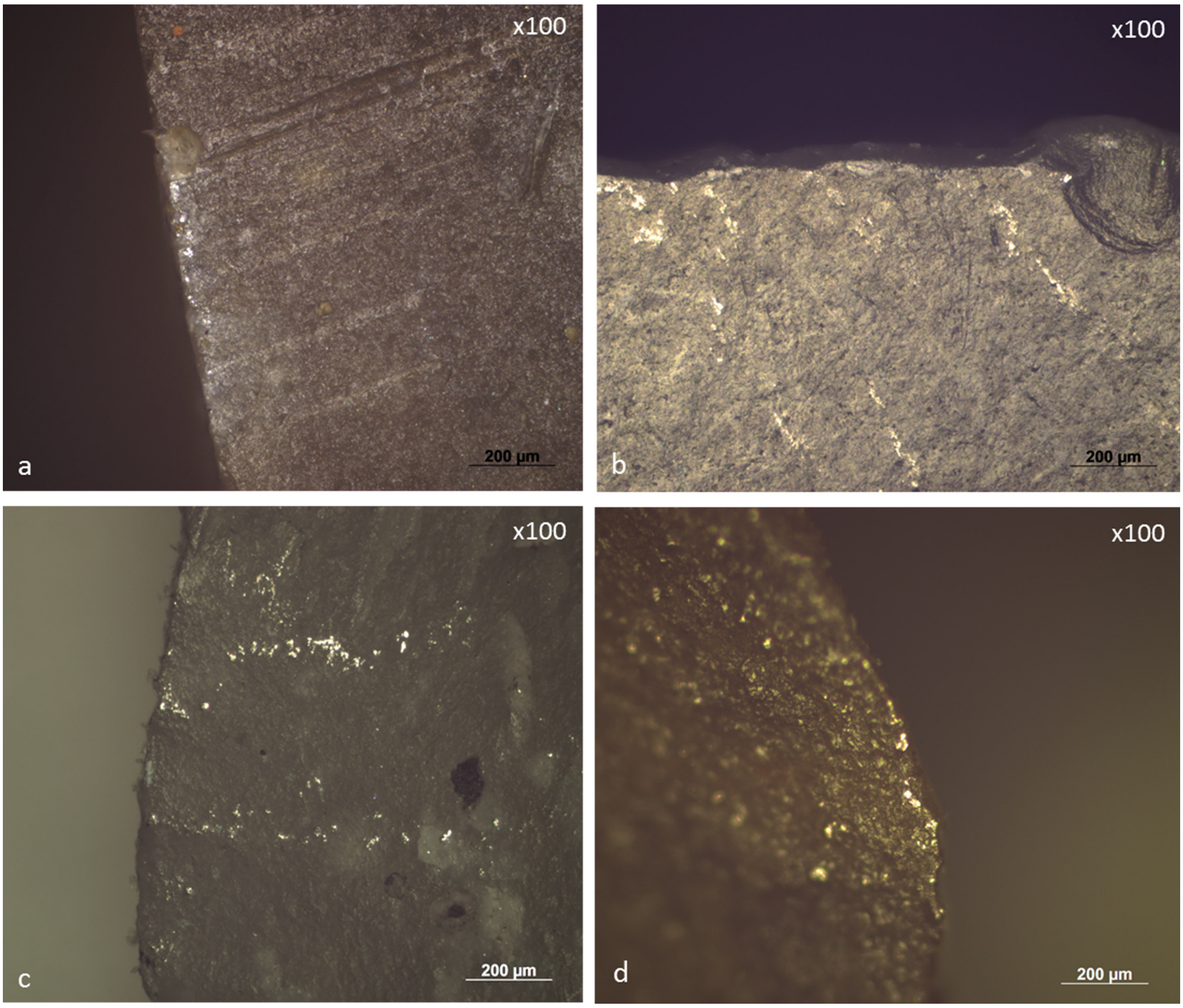

Fig. 7 – Examples of metal traces, probably caused by contact with the metal sieve mesh, on the edges of artefacts from a) T505 (Tongeren-Plinius) (100x); b) LB 25_24 (Lommel-Maatheide) (100x); c) MMW1158 (Meeuwen-Monnikswijer) (100x); d) MMW130 (Meeuwen-Monnikswijer) (100x).

3.2. Experimental material

After a detailed microscopic analysis of the experimental pieces, none of the 150 artefacts proved to show metal traces or any other form of alteration (e.g., edge scarring). On the basis of these results, it could therefore be confirmed that the sieving technique used at Beveren-Schoorhavenweg does not generate metal traces and that the observed metal traces were most likely the result of contact with the excavation material.

It shows that metal traces caused by sieving can be avoided when the design of the sieving, *i.e.*, the use of plastic mats, equipment prevents contact with metal (Code Goed Praktijk (or CGP), as was the case in Beveren-Schoorhavenweg.

3.3. Effect of metal wear on results of functional analysis

The observations on archaeological material show that both excavation and sieving may lead to the formation of metal traces, with differing characteristics for each. Despite the rather frequent formation of metal traces (on 21 % of the studied tools), the effect of these traces on the possibilities of a functional analysis are rather negligible, as metal traces proved to be restricted in their distribution. If metal traces were present on a possibly used edge, they were only present on a small portion, which did not hamper the examination of the use wear. Only in one case (MMW405) was metal wear so intense and widespread on the used edge that possible use-wear could no longer be distinguished. While sieving only seems to lead to the formation of fine metal striations, contact with a trowel or shovel leads to broad striations and also to the formation of edge scarring. Edge scarring from contact with excavation equipment can be distinguished from functional or post-depositional scarring on the basis of its systematic association with metal wear. Moreover, edge scarring from contact with excavation equipment is isolated in nature as the contact between the metal equipment and the stone tool is brief. These observations suggest that the excavation and sieving protocols studied within this research do not have a significant negative effect on the possibilities of a functional analysis and are thus in themselves not a sufficient argument to exclude an assemblage from functional analysis.

4. Conclusion

Although the impact of excavation strategies on the preservation of functional traces has not yet been thoroughly investigated, it has been assumed that contact with field equipment would leave irreversible damage on lithics and strongly hinder functional analysis.

Within the framework of a larger research project (*Functioneel onderzoek van Laat-Paleolithische en Vroeg-Mesolithische sites in Vlaanderen. Synthese-onderzoek archeologie 2018*), the surface state of lithic artefacts from four different Final Palaeolithic and Early Mesolithic sites from Flanders could be closely studied (Cnuts *et al.*, 2020). The analysis revealed that different excavation strategies lead to the production of metal traces and thus alter the surface state of lithic artefacts even the degree varies. During analysis, it was not always clear whether metal traces were caused by contact with excavation material, such as from a shovel or trowel, or by contact with a metal mesh from sieving. Thanks to large-scale analysis, it could be proposed that the contact with excavation material generates broad metal-induced striation in association with important damage, while the contact with a metal mesh during sieving leads to small and narrow metal-induced striations and little associated damage. The examination of the artefacts also indicates that sieving leads to metal traces on the artefact surface, but that these traces are generally poorly developed and isolated within a certain zone and thus do not severely hamper functional analysis. The experiment shows that the use of plastic mats within the sieve permits to entirely avoid the production of wear from contact with the sieve and is therefore an appropriate strategy to use. It could however also be established that contact with excavation equipment is an important source of alterations in the form of metal striations and damage. Such contact could thus influence the possibilities of functional analysis and contact with metal trowels and shovels should thus be avoided as much as possible.

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Dries Cnuts & Sonja Tomasso contributed equally to the publication.

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Abstract

Although a lot of attention has been devoted to the understanding of post-depositional processes, the possible impact of excavation procedures has largely been ignored. The increased use of mechanical recovering techniques, especially within the context of rescue archaeology, urges the need for assessing whether the application of these techniques may hamper functional analysis.

Taphonomic analysis of lithic artefacts from four Flemish Final Palaeolithic/Mesolithic sites allowed to observe that recently used excavation and sieving procedures may produce metal traces on these artefacts but without hampering the observation of functional traces. A subsequent experimentation further confirmed that lithic artefacts and excavation equipment is most likely the main source for intense damage, rather than contact with sieving equipment.

Keywords: Functional analysis, post-depositional processes, excavation strategies, metal traces.

Résumé

Bien que beaucoup d'attention ait été consacrée à la compréhension des processus post-dépositionnels, l'impact possible des procédures de fouilles a été largement ignoré. L'utilisation accrue des techniques de fouilles mécaniques, en particulier dans le contexte de l'archéologie de sauvetage, souligne la nécessité d'évaluer si l'application de ces techniques peut entraver l'analyse fonctionnelle.

L'analyse taphonomique d'artefacts lithiques provenant de quatre sites flamands du Paléolithique final/Mésolithique a permis d'observer que les procédures de fouilles et de tamisage récemment utilisées peuvent produire des traces métalliques sur ces artefacts mais sans en entraver l'observation des traces fonctionnelles. Une expérimentation ultérieure a confirmé que les artefacts lithiques et le matériel de fouilles sont très probablement la principale source de ces altérations intenses, plutôt que le contact avec les outils de tamisage.

Mots-clés : Analyse fonctionnelle, processus post-dépositionnels, techniques de fouille, traces de métal.

Samenvatting

Hoewel al veel aandacht werd besteed aan de mogelijke impact van post-depositionele processen op de bewaringstoestand van lithische artefacten, blijft de rol van opgravingsprocedures hierin grotendeels onbekend. Het toenemend gebruik van mechanische opgravingstechnieken, vooral binnen de context van de preventieve archeologie, onderstreept het belang om na te gaan deze technieken daadwerkelijk de observatie van functionele sporen kunnen bemoeilijken.

Een tafonomische analyse van lithische artefacten, afkomstig van vier Vlaamse finaal-paleolithische/mesolithische sites, bevestigde dat recent gebruikte opgravings- en zeefprocedures metaalsporen kunnen produceren, weliswaar met een beperkte impact voor de waarneming van functionele sporen. Een zeefexperiment toonde vervolgens aan dat het opgravingsmateriaal eerder verantwoordelijk is voor intense boordbeschadigingen in plaats van kortstondig contact met zeefdraad.

Trefwoorden: Functionele analyse, post-depositionele processen, opgravingsstrategieën, metaalsporen.

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