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PRELIMINARY EXPERIMENTAL INSIGHTS INTO FLINT CHARACTERISTICS AND PATINATION USING MICRO-CT

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Summary: This study aims to analyse the characteristics and weathering of flint in order to investigate the preservation of use wear traces on prehistoric artefacts. Beside both destructive and non-destructive classical methods for characterization of flint, micro-CT is applied on flint providing additional 3D surface and internal information. Laboratory experiments simulating patina formation are performed to evaluate the influence on the preservation of use wear traces.

1. INTRODUCTION

In most regions of Europe, flint or chert was by far the most important raw material for the production of stone tools during the Stone Age (> 2000 BC). Because tools made from organic material (bones, wood, …) are rarely preserved in the archaeological record, our knowledge about the Stone Age is considerably based on the study of stone tools.

Flint is a sedimentary rock composed of microcrystalline quartz, cryptocrystalline chalcedony and a small amount of amorphous silica. Several mineral impurities can occur in flint including carbonates, clay minerals, iron and manganese oxides, carbonaceous matter, organic compounds, etc. The formation process (heterogenic diagenetic silicification) determines the internal structures and chemical variations of the source material. Additionally, weathering processes, e.g. patination, can alter the flint material and cause additional changes. This results in a large variation of macroscopic (colour variations, presence or absence of a cortex, etc.) and microscopic aspects of flint making the study of this type of material complex. One of the main research questions that arise is: "How will the properties of unaltered flint influence the process of patination?" Beside classical methods for the characterization of flint (e.g. macroscopic identification, optical microscopy, XRD, SEM-EDX, XRF), the feasibility of micro-CT will be explored in this study.

An important archaeological aspect of lithic studies is the analysis of microwear traces. During the use of flint tools, wear traces can develop on the edges which are usually only microscopically visible [1]. Use wear traces vary regarding the contact material (hide, wood, soil, plants, meat, etc.) and mode of utilization (direction, angle, etc.). There are four main types of traces that can be distinguished: polish, striation, edge removals and edge rounding. Thus, microwear analysis provides insight into the usage of stone tools and indirectly also into the activities of prehistoric man [2]. Nowadays, the relation between use wear traces and the characteristics of flint is not fully understood and requires further investigation. The application of micro-CT on use wear traces can be an added value for microwear analysis, as this technique is non-destructive and can register a 3D surface in combination with internal 3D information [3].

However, special attention should be paid to the state of preservation of flint artefacts. Flint artefacts can be affected by natural (chemical and physical) weathering processes, which can complicate the analyses of use wear traces by partial or complete obliteration of the traces [4,5]. For this reason, altered artefacts are often neglected during analysis and may bias our understanding of the use of stone tools by prehistoric man.

The focus of this study will be the characterization and the patina formation of flint artefacts. Afterwards, laboratory experiments will be performed to examine the influence of these alterations on the preservation of prehistoric use wear traces.

2. EXPERIMENTAL METHOD

In order to fully understand the properties of flint, initial experiments are performed on raw flint material. At a later stage of this project, the non-destructive methods can be performed on real prehistoric artefacts and these results can be compared to the results of raw flint material. The X-ray micro-CT scans of flint material will be done using a custom built micro-CT set-up, HECTOR [6], at the Centre of X-ray Tomography of the Ghent University

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After reconstruction of the micro-CT scans using Octopus software (Inside Matters, Belgium), 3D analysis will reveal the internal structure of the flint material. Emphasis will be given on the distribution of high density particles present in the flint samples of which size and shape parameters can be deduced. Possibly these can be used to distinguish between different types of flint. Volumes, rendered using VGStudio MAX software, show 3D information about the external surface and internal structures of the flint material.

A second goal is to investigate the relation between patination and the type of flint. Connected to this, the preservation of experimentally produced use wear traces on experimentally patinated flint samples will be examined.

Complementary to the micro-CT analysis, a detailed petrographical study (optical microscopy, SEM-EDX, XRF), which gives information about the mineralogical composition and texture of the flint material and in case patinated, the patina, will be performed in order to interpret the X-ray micro-CT results.

3. RESULTS

During preliminary experiments we try to distinguish between natural surface modifications and laboratory induced patina with micro-CT. Figure 1 shows results of scanned cylindrical flint samples from Harmignies (Belgium) with a natural surface modification (either patina or cortex, a and b) and a laboratory induced patina (c). A sharp transition between the surface modification and the unaltered flint can be observed in Figure 1b while the transition between laboratory induced patina and unaltered flint seems gradual in Figure 1c. Further experiments are necessary to make proper interpretations. The distribution of higher density particles (visualized in blue; Figure 1a), probably preserved fossils and/or high density minerals, seems random and different sizes and orientations can be recognized. Complementary petrographical studies will demonstrate the chemical composition of these higher density particles and of the cortex or patina.

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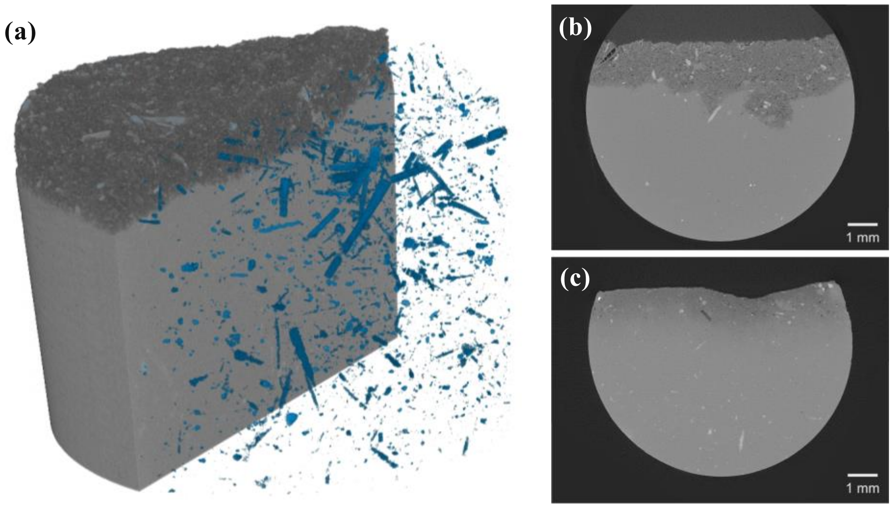

Figure 1: (a) 3D visualization of a drilled flint sample (9 mm diameter) from Harmignies, Belgium. Light grey represents the flint unaltered material and dark grey represents the natural surface modification. The higher density particles are visualized in blue. (b) and (c) are 2D sections of the flint sample of (a) and a flint sample with laboratory induced patination, respectively.