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## Reviewed Article:

# Barely Scratching the Surface: An Experimental Approach to Engraved Magdalenian Plaquettes

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This paper investigates the creation, utilisation, and destruction of engraved Magdalenian plaquettes through the application of actualistic experimental replication. Archaeological evidence suggests that there is a relationship between plaquettes and hearth structures, as well as engraved depictions and the destruction of the plaquettes through heating. However, this relationship between fire and plaquettes has not yet been tested using experimental

archaeology. This paper focuses on understanding the relationship of the plaquettes with hearth construction, and how this stage of their object biography may relate to and inform the depictions produced. Further, the experiments presented here explored whether there was a practical benefit to utilising plaquettes in hearth construction, as well as the effects of heating within specific hearth configurations, informed by observed spatial patterning of plaquettes at Magdalenian sites. The results of these experiments showed that the stacking of plaquettes to form an oven-like hearth structure decreased fuel consumption by over 50% whilst still producing adequate directional heat. However, the heat modification exhibited on the experimental plaquettes did not match those of the archaeological examples, with very few experimental examples of cracking and colour change. The paper discusses some potential explanations for the disparity between experimental results and archaeological patterning.



Whilst today art and functionality are more separated as concepts, the growing evidence from the Upper Palaeolithic shows less of a distinction between the two. The intricately carved spear throwers from the Magdalenian period are a good example of this blend of function and artistic value.

## Introduction

Engraved plaquettes are a relatively abundant and yet largely misunderstood feature of the Magdalenian Period. They are generally made up of small, flat stones and have been discovered at a range of securely dated Magdalenian sites across Europe (Sieveking, 1987, p.1). Often found broken, burnt and discarded amongst site debitage, their purpose and importance to Magdalenian culture remains elusive. Previous research has tended to focus on the images engraved upon the support rather than the processes of creation, utilisation, destruction and their eventual discard. This research has been directed by this image-focused mindset to apply actualistic experimental replication to increase understanding of these processes. This paper focusses upon the utilisation and destruction of the plaquettes specifically. By testing three scenarios of hearth construction utilising engraved plaquettes, this experiment aimed to evaluate any benefits they provide in

fuel consumption and hearth temperature whilst also attempting to reproduce the heat signatures found on archaeological examples. In doing so, a reference collection will also be formed of the resultant plaquettes which can aid further research into their creation and deposition processes. Before discussing the experiments conducted by this research, it is first necessary to contextualise the research within the broader archaeological context of engraved Magdalenian plaquettes.

## Plaquettes and their Archaeological Context

A plaquette is defined by Sieveking (1987, p.1) as a piece of stone, bone, antler or ivory with at least one surface flat enough for engraving. They are tabular in shape and can be angular,

oval or round depending on the support material. They are generally small, with 95.5% of examples less than 30cm in maximum dimensions (Sieveking, 1987, p.1). Whilst not all plaquettes are engraved, only the engraved examples made in limestone are pertinent to this study. Historically, plaquettes have received little attention since their recognition in the late 19th Century, and in comparison to other types of Palaeolithic art, remain relatively poorly understood. Previously published work on plaquettes has focussed almost exclusively on the aesthetic features of plaquettes (Sieveking, 1987; Tosello, 2003; Clavijo, 2017). The regional and stylistic analysis performed by Sieveking (1987) and the more comprehensive analysis of French examples by Tosello (2003) are perhaps the most comprehensive studies of this type. As stated by Sieveking (1987, p.2), this can be explained by the difficulty in interpreting the images created and the lack of information available related to their excavation. This highlights the issues in researching artefacts excavated in the late 19th and early 20th centuries, although Sieveking (1987, p.4) notes that even amongst Palaeolithic art pieces, plaquettes are 'exceptionally bereft' of such information related to context. Many excavations of cave sites throughout this period were undertaken in an industrial fashion. With no attempt made to record the immediate context of the plaquettes, only their descriptions in post excavation processes are available today, making research challenging. However, with the continued study of these artefacts, combined with modern excavation techniques, contextual data on plaquettes may become more readily available in future (Ontañón and Arias, 2012).

This focus on the final form of plaquettes and the lack of archaeological context available for these objects has resulted in the meaning(s) of plaquettes remaining enigmatic. They have historically been characterised as non-utilised objects. This definition derives from an early study by Cartailhac (1885) in which the difference between utilised objects; tools, ornaments and arms, and non-utilised objects; stones and fragments of bone that are engraved, was first made explicit (Sieveking, 1987, p.1). This binary definition is problematic when trying to interpret the meaning or use of plaquettes as it does not allow for the possibility that plaquettes may have been utilised for functional purposes. Recent research has tried to investigate the meaning of plaquettes and have been more sensitive to the full 'biography' or life history of plaquettes (Needham, 2017; Tosello, 2003). These recent studies have highlighted important patterns within phases of the biography of plaquettes, including: evidence of colour change, cracking, pot lids, and breakage (Tosello, 2003, p.550; Needham, 2017, p.90) (Figures 6, 7 and 8). These effects appear to be linked to the heating of the stones via proximity to fire (Tosello, 2003, p.550; Needham, 2017, p.90). Limestone is especially affected by heat and will often split, crack or shed sections after heating (Needham, 2017, p.266). This is evidenced at Montastruc by vivid colour changes on the stone, a common feature of Magdalenian plaquettes (Needham, 2017, p.263) (Figure 1). The case study of Montastruc is a rare example of a collection from which a percentage of heat affected plaquettes (50.94%) is available (Needham, 2017, p.263). Poor recording of heat patterns or heat affected breakage on engraved plaquettes in previous studies currently hampers further

investigation into its frequency as a phenomenon though it is regularly mentioned. It is interesting here to note that the two in-depth studies by Sieveking (1987) and Tosello (2003) only briefly mention heating or breakage and make no significant attempts to investigate this evidence further.

Previous research has attributed the heating and subsequent breakage of plaquettes to accidental or incidental processes. For example, initial investigation into the plaquettes discovered at the Magdalenian site of Grotte d'Enlène, France concluded that heating and breakage was the result of incidental processes, linked to the discard of the plaquettes after engraving (Begouen and Clottes, 1991, p.77). Sieveking (1987, p.13), whilst open to the idea of deliberate breakage of plaquettes as part of their life history, is sceptical as there is difficulty in proving this theory, especially as the archaeological context for many assemblages of plaquettes is compromised. However, more recent research has moved towards appreciating heating and breakage processes as a significant stage in the object biographies of plaquettes. Needham (2017, p.259), for example, challenges Sieveking (1987, p.13) sceptical perception of understanding plaquette biographies for the site of Montastruc, noting that intentional heating and destruction may be valid at this site due to the high levels of destruction, low levels of plaquette refitting, and low levels of heating evidenced on organic art evidence, possibly indicating intentionality rather than post-depositional accidental heating in this case. This argument is convincing, with the evidence of breakage and low levels of refitting also being raised by Sieveking (1987, p.13), however the argument against the low levels of heating evidence in organic artefacts could be explained by the complete destruction of these objects by heating due to their organic nature. This highlights the challenge of trying to establish intentionality of heating and fragmentation from the archaeological context alone, which is typically compromised at sites such as Montastruc due to excavation protocols used during the 19th Century at their time of discovery. However, recent high-resolution studies with high levels of contextual control have similarly concluded that intentional fragmentation of plaquettes was likely, at least in some cases (de Figueiredo, *et al.* 2014; de Figueiredo, *et al.* 2016).

Needham's object biography approach to plaquettes from Montastruc is a good example of a modern approach to understanding art objects. Whilst previous research attributed burning and destruction to chance, Needham created a life history for the artefacts which must have retained some significant importance to their creators shown by the time and effort given to creating them. Although Sieveking (1987, p.15) argued that this significance may not extend into the later discard or destruction of plaquettes, suggesting breakage appears to correlate to the strength of the support and that there is limited evidence the plaquettes were retained once broken, the sheer volume of fragmented and burnt plaquettes implies some significance was attributed to this process. Needham accepted that the burning and breaking may simply form a practical use for the stone, regardless of whether it is engraved or not, as part of its life history. This is supported by evidence from recently excavated sites in which both

decorated and undecorated stones are found in relation to hearth structures (Roldán, *et al.*, 2013). Unfortunately, the poor recording of early excavations limits research into whether this is the case at other sites as it cannot always be established with confidence whether undecorated blocks were recorded or retained (Needham, 2017, p.261).

The case for the use of stones in hearth structures for practical purposes in the Magdalenian is an interesting one. Work by Dumarçay and Caron (2010) shows that in sites such as Pincevent and Verberie in France, stones were carefully collected and transported for their utility in the domestic environment. They state that not only were these stones carried over considerable distances, but that this process was performed to select stones of a particular geology for different purposes (Dumarçay and Caron 2010, p.101). Only a single decorated example was discovered at the site of Etiolles, France found in relation to a hearth structure, showing a clear association between the use of transported stones and decorated plaquettes in hearths (Fritz and Tosello 2011, p.50). The refitting of larger, undecorated stone slabs at these sites demonstrated these were frequently reused in hearth structures for retaining heat or simply fire containment. The authors state that this process was repeated up to 10 times in one example until the stone fragments were too small to be of anymore use and were then discarded (Dumarçay and Caron 2010, p.98). It is evident that the stone fragments were of a similar size to the average size of decorated plaquettes and their utilisation in hearth construction is a repeated cycle. It is interesting to note that the authors also emphasized the in-depth knowledge of geology available to Magdalenian peoples and that this appears to have affected their decision making when collecting stones for the creation of hearth structures (Dumarçay and Caron 2010, p.95). Another point of note is in the multiple references here to refitting pieces of undecorated stones, whilst the general case with decorated plaquettes is the opposite. Whether this is merely due to excavation issues or a genuine example of retention of decorated pieces is difficult to establish, however it is a remarkable contrast.

## Methodology

### Experimental archaeology

The application of experimental replication to the study of engraved Magdalenian plaquettes is one way to increase understanding of the processes involved in creation and destruction, bringing a modern approach to their study. Experimental archaeology has historically been neglected as an avenue of research due to mistaken associations with re-enactment groups and attempts to recreate past experiences (Outram, 2008, p.2). Outram (2008, p. 2) suggests instead using the term 'actualistic' to describe the experimental research, therefore removing the suggestion of creating exact replicas or in any way creating a 'true' recreation of the past. Actualistic experiments instead test a range of hypotheses, utilising potentially authentic materials and conditions (Outram, 2008, p. 2; Foulds, 2013, p.1). Needham (2017, p.312) suggests exactly this actualistic replication as the next avenue of research into the plaquettes

at Montastruc, emphasising their value in the creation of fresh engravings for future research into line analysis and understanding production.

Experiments by Leesch *et al.* (2010) are perhaps the closest any researcher has come to testing the use of stones in hearth structures as seen in the Magdalenian period. Their experiments revolve around the ability to sustain fire using little fuel through the use of stone slabs. Whilst they discuss the effect of the fire upon the slabs, it was not the main focus of the experiment. Leesch's use of the stone to contain the fire is interesting in that it only allows a single burn event, with the stones smothering the fire in the process (Leesch, *et al.*, 2010, p.61). With the evidence of repeated burning events in hearths from Magdalenian sites, further experiments using different hearth structures, including those that can be easily refuelled and maintain a burn event for a longer period, are needed. The use of actualistic experimental archaeology in understanding engraved Magdalenian plaquettes can align with and expand upon work already completed and open new avenues of research into their use and destruction.

This research thus conducted experiments to explore any benefits in utilisation of plaquettes in reusable hearths for fuel consumption and heat production. Then to evaluate the effects of heating on the supports and the images engraved upon them and compare to archaeological examples.

### **Stage 1: Raw materials collection**

Limestone was selected using guidance on typical size and shape set out by Sieveking (1987). Sieveking (1987, p.1) records that the highest percentage over all have maximum dimensions of less than 10 cm with the second largest percentage being between 10-30 cm (Sieveking 1987, p.31) Therefore, limestone was selected that had at least one flat surface and typically not exceeding 10 cm in maximum dimension. Some larger plaquettes (15-30 cm) were included to ascertain whether the size of support made a difference in completing the engravings in stage one of the experiments.

### **Stage 2: Engraving**

The first stage involved the engraving of plaquettes by a group of volunteers from the archaeology and art departments at the University of York. This stage produced a total of 53 engraved plaquettes and included the application of pigment mixtures (combination of ochre or charcoal pigments with binders such as animal fat and/or water) to some examples to understand their effect on the freshly engraved lines, a practice that has been seen in archaeological examples (Roldán, *et al.*, 2013). The results of this stage of the experiment involved the recording of the difficulty in producing engravings related to size of support and artistic experience of the volunteers and will be reported in full separately (Amy forthcoming)

### **Stage 3: Heating/Burning**

Three small fires were built for this stage of the experiment: configuration A was an open fire

with plaquettes placed directly in and around it; configuration B used plaquettes stacked up to create a small oven-like structure; and configuration C used plaquettes to line a bowl-shaped depression with others standing upright to contain the fire (See Figure 3). These three configurations were chosen to both replicate examples described in literature and increase the likelihood of producing similar results to archaeological examples of burned plaquettes. Configuration A was designed to test the effects of proximity of plaquettes to heat by either accidental or deliberate insertion directly into the hearth and the associated high temperatures. Configuration B was designed to replicate examples described by Dumarçay and Caron (2010) and described by Leroi-Gourhan at Pincevent, in their use of stone to contain a fire whilst also decreasing fuel requirements, a survival requirement in the sparsely wooded Magdalenian environment (Whallon 2006, p.261). Configuration C was linked to archaeological examples described by Leesch *et al.* (2010, p.57) and again noted in archaeological examples at Pincevent of stones lining a bowl-shaped depression in the ground. The addition of plaquettes arranged standing around the fire was introduced by the author. Some archaeological examples show clearly defined lines of heat-affected areas (See Figure 1), which were taken into account in the experiment by partially burying the plaquettes in the ground, so part of the plaquette was protected.

The three fires were lit at the same time, using incrementally larger fuel as the fire developed, eventually fuelling each configuration with kiln dried birch logs, to maintain consistency throughout the experiment. Logs were chosen at random and fed into each fire as required to maintain burning. For the purpose of this experiment and to maintain consistency in recording fuel usage, a log was defined as a piece or pieces of kiln dried silver birch approximately 20 cm in length and weighing 1 kg. Thermometers were positioned next to each fire at a distance of 50 cm to record ambient temperatures, these temperatures were logged at 1-hour intervals throughout the 5-hour duration of the experiment. Temperatures in the heart of each fire and the plaquettes themselves were also recorded at intervals using a laser thermometer. In addition to these recordings, a separate thermometer was positioned, level with the other static thermometers, 20 meters distant from the fires as a control.

At the completion of the 5-hour burning experiment, the plaquettes were left to cool and removed from the hearth after a period of 24 hours. After recovery, each plaquette was summarily examined and photographed. Each plaquette was then cleaned with water to remove adhering ash and soot and individually examined in greater detail to record any cracking, pot scars, colour changes of stone and/or pigment and clarity of engraving, with a full supporting photograph log recorded, both before and after cleaning for each plaquette.

To facilitate future analysis, each plaquette was carefully packaged in a sealed plastic bag and grouped with the exact stone tool used to engrave the image upon it. A label detailing the experimental protocols for each plaquette was also included. The plaquettes have been

stored at the Department of Archaeology, University of York, to serve as a reference collection.

## Results

The results of this experiment are displayed as both quantitative data in the form of graphs displaying the temperatures recorded during the experiment and the amount of fuel required for each fire, and qualitative data in the form of discussion with the volunteers that helped in running the experiment and observations by the author. The fires are referred to here by their configuration: Configuration A was the open fire; Configuration B the oven structure; Configuration C the pit lined and surrounded with standing plaquettes.

The ambient temperature at the time of experimentation was 6°C which is comparable to Magdalenian conditions (Coope and Elias 2000, p.171). All three fires were lit at 09.30 and had become established by 10.00. Lighting configuration C was reported as challenging due to the cold stones lining the bottom of the pit (Langley, pers. comm.). This was likely the result of the cold temperature of the stones reducing the likelihood of an ember catching the tinder alight (Langley pers. comm.).

Graph 1 shows that the amount of fuel required to maintain the 5-hour burn displayed considerable variation between configurations. Configuration A required 51 kg of fuel to maintain just 5 hours of burn time and during this time the size of the hearth spread considerably as it was not contained. Compared to configuration B this is highly inefficient, with the oven structure requiring only 19kg of fuel to maintain the same burn time. Configuration C was maintained with 34 kg of fuel which was an improvement on the open fire. This was perhaps due to the containment of the fire by the stones, which limited the increase in size of the hearths footprint.

Graph 2 shows that configurations A and C both increased in temperature towards the end of the experiment as fuel was no longer added after 14:00. Once the glowing charcoal of the fire was exposed in the final hour an increase in ambient temperature was observed. Configuration B however did not show this same increase and instead maintained a more constant temperature throughout the day. Because the embers were not open to the air their heat was instead absorbed by the stones. Whilst these results show configuration B as only raising the temperature by 4°C throughout the day, the thermometer was placed on the opposite side to the fuel opening. This can be argued to have skewed the results as the majority of heat was in fact directed away from the thermometer. If repeated, this result would be expected to be different with the thermometer placed facing the fuel opening. Observations by experiments confirmed that there was an appreciable increase in temperature around the opening of the oven structure.

The results of the direct temperature of the fires using a laser thermometer was not successful. The open fire quickly became so hot that the thermometer reached its maximum recording limit of 550°C and was unable to read the temperature for the rest of the experiment. The thermometer did however provide some readings for the temperature of the stones during the experiment (See Graph 3). In future it would be recommended to utilise more specialist equipment for recording the internal temperatures of the fires, such as a thermocouple.

The internal temperatures of configurations A and B both exceeded 550°C during the experiment, with configuration C reaching a maximum of 523°C. The maximum temperature reached by the plaquettes is shown in Graph 3. Again, the open fire shows the highest temperatures, however in this case the difference between configurations A and B is considerably less than the ambient temperature seen in Graph 2. This shows that the plaquettes are able to reach extreme temperatures even in a fire that appears to provide considerably less heat. Added to this recording of maximum temperature, the temperature variation across the plaquettes, particularly in configuration B were measured throughout the experiment. The large plaquette placed as a capstone on configuration B was shown to increase from just 44°C at the outside edge, to 260°C in the centre above the fire. This significant variation in temperature across a single plaquette was also recorded on examples in the open fire with temperatures increasing from 150°C to 290°C depending on proximity to the centre of the hearth.

Cracking was observed in plaquettes in configuration B from two hours into the experiment. A crack in the large capstone in particular could be visibly seen to open and close with the addition of fuel and subsequent increase in temperature. No examples from configuration C could be seen to crack and similarly cracking was difficult to observe in configuration A as the plaquettes were mostly obscured by the spreading embers and ash. The most common colour changes that were visible were the blackening by smoke of plaquettes in configurations B and C. Only a single plaquette placed in configuration A showed colour change somewhat similar to archaeological examples, which had changed to a pinkish orange colour in parts (See Figure 4). This plaquette had like the others in the same configuration, eventually become engulfed by the spreading hearth throughout the experiment and was therefore in a far hotter part of the fire than any plaquette in the other two hearths.

Similarly to this colour changed plaquette, the only example of a full break by any plaquette was plaquette no. 42, placed directly in the centre of configuration A (See Figure 5).

On closer inspection of the plaquettes during photography a number of examples did however show evidence of cracking. Again, the majority of these examples of cracking came from configuration A, with only a few cracks evident from plaquettes in the other two hearths.

No evidence of pot scars, a feature of plaquettes from Montastruc (Needham, 2017, p.89), were seen in these experiments.

## Discussion

### Use in hearths

The experiment determined that by creating an oven like structure, fuel consumption could be reduced by over 50%. This would have been particularly pertinent in the Magdalenian where fuel would have been much less abundant (Cuenca-Bescós, *et al.*, 2012, p.134). Whilst not providing the same radiating heat as open hearths, there was an appreciable cone of warming surrounding the opening of the structure. Future experiments will quantify this. The savings in fuel are enough that two hearths could be utilised in a settlement and still require less fuel than a single open fire. The hearths' openings could then hypothetically be directed to maximise the heat being provided into a rock shelter, cave, or tent.

Although heating is likely to be the primary purpose for these hearths, it is also possible that they provided secondary roles. For example, Configuration B would allow for cooking meat on the surface of the capstone, and this experiment showed that even under high temperatures the limestone was resistant to breaking. Although beyond the scope of this research, further experimentation could establish additional roles for different hearth configurations of plaquettes.

### Breakage and colour changes

As stated above, the replication of archaeological evidence of breakage and colour changes linked to heating was unsuccessful in this experiment. Whilst this experiment cannot fully establish the reasons for this, some suggestions can be made which may aid future research into this area.

Whilst the colour change is evident in the experimentally reproduced plaquettes, it is markedly different to those seen in archaeological examples. The plaquettes from Montastruc for example show varying degrees of purples and pinks (See Figure 1) spread across the surface showing evidence of heating. The experimental reproductions however, show only black smoke damage as any form of colour change barring one example. During cleaning, the smoke damage could be largely removed and underneath the limestone was unchanged in colour. Plaquette 1, however, did show a pinkish orange colour change in one corner (See Figure 4).

Plaquette 1 was placed directly in the centre of configuration A which was the hottest of the three hearths. This would suggest that perhaps higher temperatures were required, repeated burning events, or a greater change from cold to hot, to create a change in colour. The other plaquettes in this fire however did not change and only one other showed a breakage. Graph 3 shows that the plaquettes in configurations A and B reached temperatures in excess of

250°C and yet no plaquettes in the oven showed any colour change other than smoke damage. This would suggest that whilst exposure to high temperature is required, it is not the only factor affecting colour change. It could also be suggested that repeated episodes of burning resulted in more pronounced colour change in the archaeological examples. Given the evidence of transport of stones and their repeated use at sites such as Pincevent and Verberie (Dumarcay and Caron, 2010, p.101) this is likely. The possibility that colour change is linked to temperature change over time could be easily tested by experimenting with both gradual and rapid raising and lowering of temperature. Given the cold climate of the Magdalenian it would be assumed that the plaquettes could be increasing from sub-zero temperatures to those in excess of 250°C in a very short time frame (Coope and Elias, 2000, p.171). Further experiments could also be performed to understand if this process of colour change could be somehow controlled via heating and then rapid cooling in water.

The placement of plaquettes in an oven structure around a fire creates a situation in which the plaquettes are raised above the ground surface and therefore, the flames. This placement increases the amount of smoke reaching the plaquettes surface and then adhering to it. It is possible that either the archaeological examples were not placed in this arrangement, or, more likely, they were placed in this arrangement but utilised on multiple occasions which affected the colour changes and the removal of the smoke damage is taphonomic.

No evidence of smoke damage to genuine examples are described in the literature. Sieveking (1987, p.2) described the likelihood that pigments applied to the surface could have faded through time. The same processes that would be capable of removing pigment might also be capable of removing any smoke damage. When cleaning the experimental plaquettes it was noticed quite how resistant this smoke damage was to removal. Given the chemical stability of charcoal and its strong adherence to stone in the form of smoke damage, it could be suggested that significant smoke damage was never present on the archaeological examples (Bednarik, 1994, p.70). However, given the benefits seen in this experiment to fuel economy and heat transference, it is perhaps more likely that this smoke damage has been removed by taphonomic processes.

Even when included in a format based upon evidence from Leesch *et al.* (2010) of stones lining a sunken pit, the fire was difficult to light and provided limited appreciable benefit when compared to an open fire (Langley, pers. comm.) and within the confines of this particular experiment. The stones lining the pit failed to show colour change or breakage and again suffered smoke damage. The use then of these stones in hearth construction is in need of further investigation to understand any benefits and better replicate archaeological examples.

The evidence provided from this experiment would argue against previous interpretations suggesting the evidence of heating and breakage as being a result of coincidental inclusion in

hearth structures. These experiments suggest that the plaquettes do have the potential of practical benefits in hearth construction by their nature as flat stones, and yet the archaeological evidence of smoke damage resulting from this usage is not present or remains unrecorded. Recent suggestions by Lopez (2017, p.920) are leaning towards the idea that the plaquettes were in fact items of multiple uses, due to exactly this nature as a flat stone. They provide practical benefits as hearth structures whilst also providing a flat surface for engraving. Their use in both circumstances then leads to further questions of course, such as whether the two processes are linked or separate.

## Conclusion

This experiment tested hypotheses suggested by research, to understand how and why the plaquettes were often heated and broken. Of the three scenarios tested, the creation of an oven-like hearth structure provided significant benefits in fuel consumption compared to other hearth configurations. All three configurations exposed the plaquettes to high levels of heat and yet only the most extreme heat provided by the centre of an open fire was able to recreate similar colour changes to archaeological examples. The reasons behind this are yet to be fully understood but it is suggested here that repeated episodes of burning may be required to achieve this. This repeated use of stone in hearths is consistent with archaeological evidence. Combining repeated burning episodes with the oven configuration perhaps provides the best hypothesis for hearth constructions at Magdalenian sites and the use of plaquettes within them (Dumarcay and Caron, 2010, p.98).

Whilst today art and functionality are more separated as concepts, the growing evidence from the Upper Palaeolithic shows less of a distinction between the two. The intricately carved spear throwers from the Magdalenian period are a good example of this blend of function and artistic value (Garrod, 1956, p.25). This same blend of values may also be evident in engraved plaquettes; their sheer abundance at some archaeological sites perhaps evidences their value to Magdalenian communities. Once this prevalence is linked to their artistic value and a further practical benefit in hearth structure, their apparent discard amongst the debitage of a site appears more questionable. It is not yet understood why the broken fragments of engraved examples are rarely accounted for, however the phenomenon of breaking/burning plaquettes now seems significant given the likelihood that plaquettes had both functional and non-functional significance(s) as hearth structures and pieces of art.

This research has shown that by applying actualistic experimental replication to engraved Magdalenian plaquettes we can better understand the processes by which they were created, utilised and destroyed. The results presented here show the potential that engraved plaquettes served multiple purposes in Magdalenian society as both artistic and practical objects. While these concepts are often deemed separate, it is suggested here that this dichotomy is unhelpful in understanding prehistoric lifeways. Suggestions made in previous

research into plaquettes have been tested to provide quantitative data which can help further researchers question assumptions and understand these enigmatic and fascinating objects.

## Further Work

The results of experiments presented here an important first step in understanding plaquette life histories through actualistic experimental replication. While the results highlight the importance of this approach and the important data that can be generated, in particular to explore areas that cannot be addressed by other means due to compromised archaeological contexts, further research is needed.

The first outcome of this research is the requirement for repeat experiments. Better investigation of the chemical composition of limestone used at archaeological sites is required to provide a more accurate support on which to engrave and then heat. This may be a particularly important factor to build into experiments, as it is conceivable that different limestones will react differently to heating, which may account for some of the variance observed between archaeological and experimental assemblages.

Building from this, different variations in temperature will be required to better replicate colour change and breakage. There is potential for raising or lowering the temperatures of the plaquettes more rapidly or from wider variations in temperature in the hope that this would increase the likelihood of colour change and/or breakage.

The improvements in modern excavation techniques present a future researcher with the opportunity to investigate plaquettes with a comprehensive record of context. Excavations such as those at La Garma, Spain by Ontañón and Arias (2012) have the potential to unlock vital information on the spatial distribution of plaquettes within the Magdalenian context of the cave. By comparison with artefacts from other sites and experimentally recreated examples any similarities or differences in heat patterns or breakage in relation to hearth proximity could then become apparent.

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## Gallery Image



FIG 1. EXAMPLE OF PLAQUETTE FROM MONTASTRUC SHOWING CLEAR COLOUR CHANGE PATTERN FROM HEATING.  
(NEEDHAM 2017, 243)

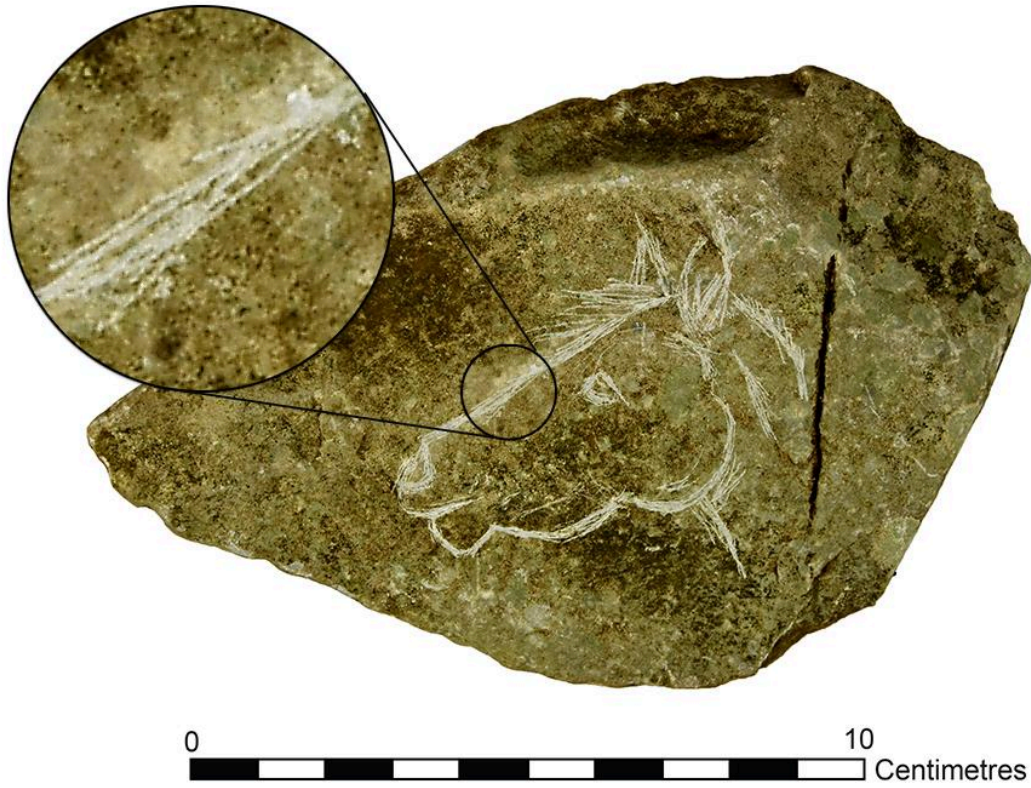


FIG 2. PLAQUETTE NO. 50 IMMEDIATELY AFTER ENGRAVING SHOWING CLARITY OF FRESH ENGRAVING. PHOTO BY MATTHEW AMY



FIG 3. FIRES 1, 2 AND 3 SHOWING ARRANGEMENT OF PLAQUETTES AND THERMOMETERS. PHOTO BY MATTHEW AMY



FIG 4. PLAQUETTE NO.1 AFTER BURNING. NOTE THE COLOUR CHANGE AT THE BOTTOM LEFT OF THE PLAQUETTE TO A PINKISH ORANGE. PHOTO BY MATTHEW AMY



FIG 5. PLAQUETTE NO. 42 SHOWING THE ONLY EXAMPLE OF A COMPLETE BREAKAGE DURING THE EXPERIMENT. PHOTO BY MATTHEW AMY



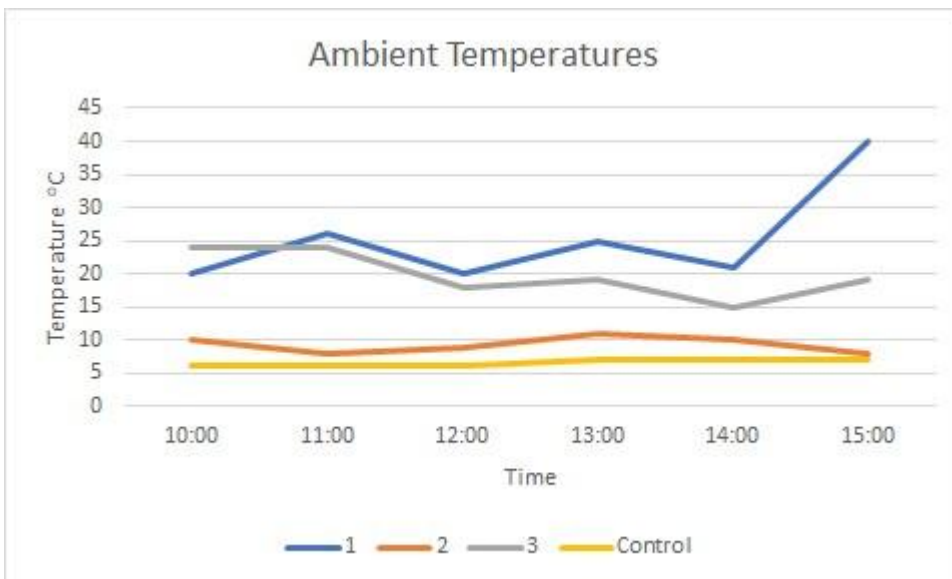
FIG 6. PLAQUETTE 49 IMMEDIATELY AFTER ENGRAVING. PHOTO BY MATTHEW AMY



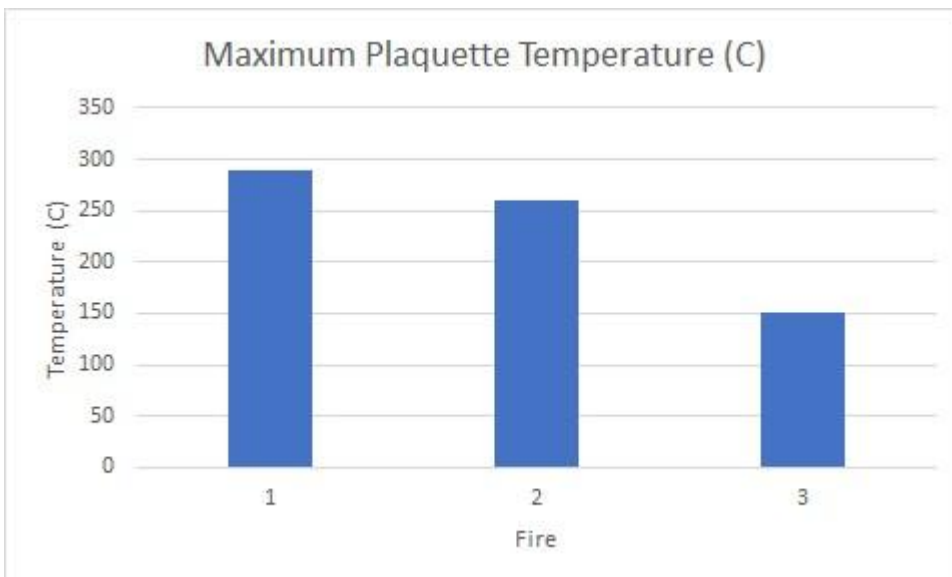
FIG 7. PLAQUETTE 49 AFTER USE IN HEARTH CONFIGURATION B. THE ONLY COLOUR CHANGE VISIBLE IS THE BLACKENING BY SMOKE DAMAGE. PHOTO BY MATTHEW AMY



GRAPH 1. GRAPH SHOWING NUMBER OF LOGS REQUIRED TO MAINTAIN THE FIVE HOUR BURN. IMAGE BY MATTHEW AMY



GRAPH 2. GRAPH SHOWING AMBIENT TEMPERATURE THROUGHOUT THE EXPERIMENT. IMAGE BY MATTHEW AMY



GRAPH 3. GRAPH SHOWING MAXIMUM TEMPERATURE REACHED BY PLAQUETTES PLACED IN OR AROUND EACH FIRE. IMAGE BY MATTHEW AMY