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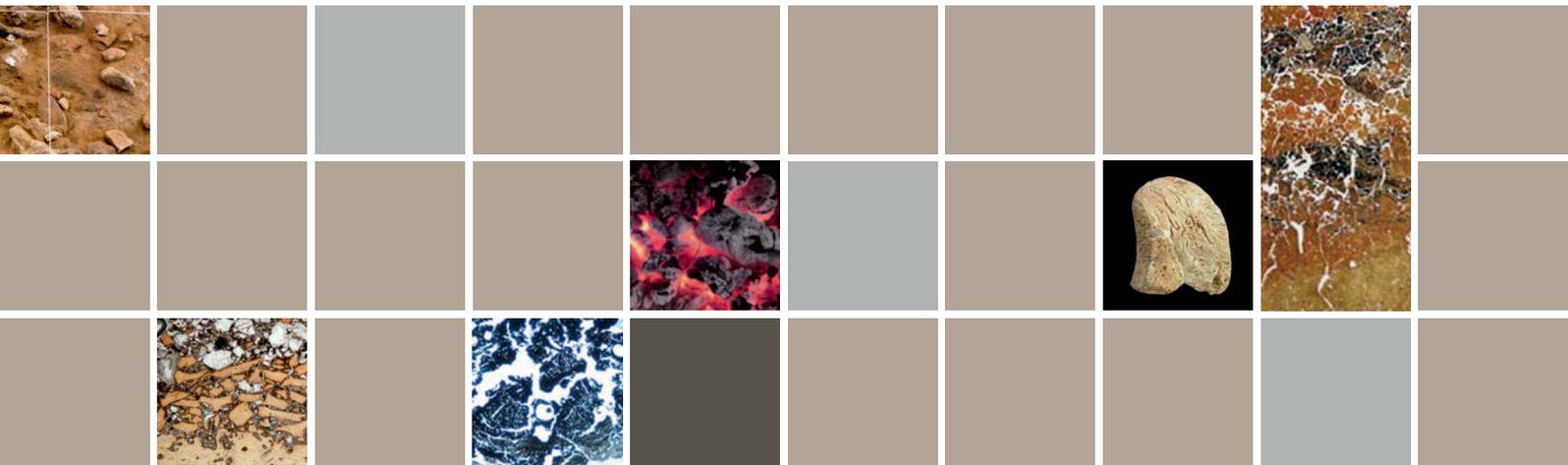
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**THE TAPHONOMY OF BURNED ORGANIC RESIDUES AND  
COMBUSTION FEATURES IN ARCHAEOLOGICAL CONTEXTS**



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# DUMPING, SWEEPING AND TRAMPLING: EXPERIMENTAL MICROMORPHOLOGICAL ANALYSIS OF ANTHROPOGENICALLY MODIFIED COMBUSTION FEATURES

Christopher E. MILLER, Nicholas J. CONARD,  
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## Abstract

Six experimental fireplaces were constructed to investigate the ability of micromorphology to identify anthropogenic reworking of combustion features and to build a reference base of experimentally-derived conditions to calibrate micromorphological conditions. After burning, the fireplaces were either swept out, swept out and the material dumped, trampled, or a combination of these three. Micromorphological examination showed that these processes produce distinct characteristics readily identifiable at the microscopic scale. The application of this experiment to combustion-related features at the Paleolithic site of Hohle Fels in Germany showed that micromorphological examination of anthropogenic deposits—supported by experimental observations—provides an important context in which to evaluate other classes of artefacts.

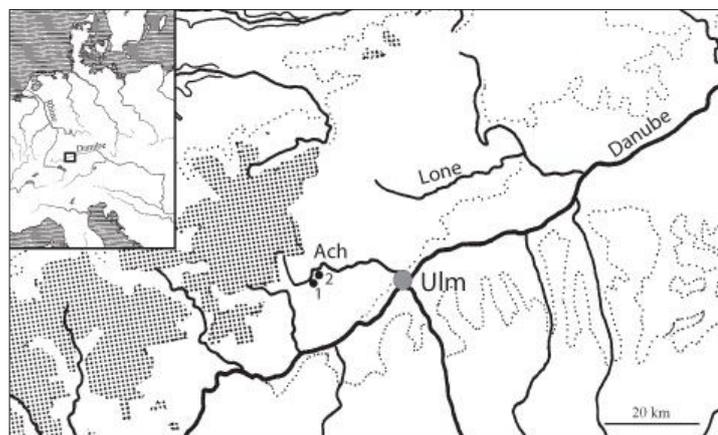
**Keywords :** micromorphology, site-formation processes, combustion-related features, Hohle Fels

## Introduction

As is apparent by the numerous contributions to this volume, research on combustion-related archaeology has intensified in the past decade. Our contribution provides an original point of view not discussed broadly in the literature: experimental micromorphology of combustion features. Although ethnographic and experimental studies have been a part of archaeological micromorphology for the past couple decades (e.g. Goldberg and Whitbread, 1993; Mallol *et al.*, 2007), many interpretations of certain characteristics of microstructures found at archaeological sites are based on logical deductions reinforced by analogy with known geological processes. While such interpretations are perfectly valid when dealing with natural systems, any system that incorporates anthropogenic factors, such as the formation of archaeological sites, can become so complex that simple analogy with known natural systems may fail. Despite this problem, we think that certain human activities—especially those related to combustion—leave traces in the archaeological record and are readily visible at the microscopic scale (Courty *et al.*, 1993). In fact, we believe that many single, discrete events are recorded not at the site- or even meso-scale, but occurred at and are recorded within the micro-scale. This has been one of the driving theoretical concepts in micromorphology since the publication of Courty *et al.* (1989). In this paper we provide some experimental results to test the effects of different human actions at the microscopic scale.

The inspiration for this experiment came from our excavations at Hohle Fels, a cave site located in the Swabian Jura of southwestern Germany (fig. 1). This cave site contains a stratified sequence of layers with archaeological material corresponding to Middle Paleolithic, Aurignacian, Gravettian, and Magdalenian occupations. Numerous features have been found, mostly within the Upper Paleolithic layers, and consist of lenses and laterally extensive layers of burnt bone, charcoal, and ash.

The most striking feature at the site is the Gravettian layer 3cf which extends across more than 20 square meters and is locally up to 15cm thick. Schiegl *et al.* (2003) published a micromorphological study of the layer, interpreting this feature as a dumping zone. They noted that 3cf consisted mostly of angular sand-sized fragments of burnt and unburnt bone that were adjacent to one another. Although there was some weak bedding present, the bones were structured loosely and exhibited no evidence of graded bedding, ruling out water as a possible depositional agent. The open structure of the layer (exhibiting little to no compaction) and the lack of any in-situ crushed bone also suggested to the authors that 3cf was not extensively trampled. Altogether, the interpretation of 3cf produced by Schiegl *et al.* (2003) was that early Gravettian people at Hohle Fels used mostly bone as fuel and that the fireplaces that they constructed were located within a different part of the cave than the 3cf deposit, possibly closer to the entrance. They repeatedly built fires, removed the burnt waste from the main occupation area and dumped it elsewhere. These activities eventually formed layer 3cf. Although these interpretations explain all of the micromorphological observations, we wanted to experimentally test some of the ideas of anthropogenic deposition and modification, particularly related to dumping and trampling. We specifically chose to test the effects of different types of anthropogenic, post-combustion activities on burnt material. These activities included sweeping out of hearths, trampling of hearths, dumping of hearth



**Fig. 1** - Location map of Hohle Fels, located within the Swabian Jura of SW Germany. Hohle Fels is indicated by number 1 on the map.

material, and combinations of these three activities. Many combustion features (not just at Hohle Fels, when investigated micromorphologically, do not appear intact. In other words, the simple presence of delimited lenses of charcoal at a site does not necessarily mean that the charcoal was produced exactly where it was excavated. Burnt material can be reworked by natural processes (Weiner *et al.*, 1998); however, it is possible that burnt material can be reworked and moved by humans (Meignen *et al.*, 2007). Although such anthropogenically reworked deposits are removed from their primary context, the action of removing or reworking burnt material can inform us about past behaviors, site maintenance, and use of space. An evaluation of the depositional history of a combustion-related feature also provides a better context in which to evaluate other classes of artifacts and their spatial distribution.

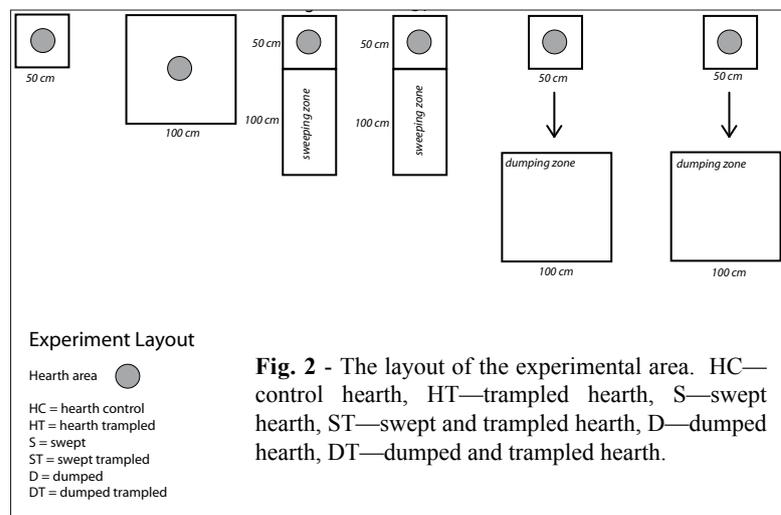
### Experiment design and Method

We constructed six experimental fireplaces. The experimental areas were covered with a 3-5 cm-thick layer of reworked—and archaeologically sterile—cave sediment from Hohle Fels. Wood was collected from recently felled trees of the Schönbuch Forrest near Tübingen, Germany, which consisted mostly of beech and oak. The wood was dried in a 60° C oven overnight before the experiment. Each fire consisted of 5 kg of dried wood along with 2 kg of defleshed pork ribs and vertebrae, cut into 5-10 cm cubes.

Although these bones were defleshed, some marrow, fat and meat were still attached. The fires were built using a small amount of dried leaves and grass as kindling; wood was stacked into a cone above the fire (fig. 2). Once the fire had started to burn, the bones were added on top of the wood. Except for the control hearth, the other fires were managed: pieces of unburnt wood and bone were moved into the flame to promote complete (or at least near

complete) combustion of all material. The fires took approximately 1.5 to 2 hours to completely burn through the fuel (from lighting the fire to the point where no more flames were visible) (tab. 1). The fire experiment was conducted in November with a high temperature of 12° C during the day, and nighttime temperatures dipping below freezing. There was a mist on the day of the experiment, slowly turning into a light drizzle. After letting the experimental hearths cool overnight, we returned the next day to rework five of the six fireplaces (excluding the control). The reworking processes included trampling of a hearth (HT), sweeping out of a hearth (S), trampling of a swept-out hearth (ST), sweeping-out of a hearth, removing and dumping that material (D), and trampling of a similarly dumped hearth (DT). Trampling was carried out for a minute by two of the experimenters (fig. 3). They wore shoes with rubber soles and very little tread. Sweeping was conducted with a natural-grass hand-broom. We pushed the majority of the material out of the hearth and then swept the surface of the former hearth briskly, causing some of the finer combusted material to travel through the air as dust. The dumping of the hearths was carried out similarly to the sweeping action; however, the material was swept into a skin and carried to another experimental area, where it was quickly dumped by rapidly tossing the material to the ground. After the hearths were reworked, we waited a week to return and collect samples for micromorphological analysis.

We removed undisturbed sample blocks by excavating



**Fig. 2** - The layout of the experimental area. HC—control hearth, HT—trampled hearth, S—swept hearth, ST—swept and trampled hearth, D—dumped hearth, DT—dumped and trampled hearth.

Hearth Name	Hearth Type	Management
HC	Control	<ul style="list-style-type: none"> <li>Allowed to burn to completion without moving unburned materials to center</li> <li>Incompletely burned wood and bone were placed in center of hearth to promote complete burning</li> </ul>
HT	Trampled	<ul style="list-style-type: none"> <li>Burned to completion</li> <li>Incompletely burned wood and bone were placed in center of hearth to promote complete burning</li> <li>After cooling overnight, was trampled for a minute</li> </ul>
S	Swept	<ul style="list-style-type: none"> <li>Burned to completion</li> <li>Incompletely burned wood and bone were placed in center of hearth to promote complete burning</li> <li>After cooling overnight, was swept out with a grass hand broom</li> </ul>
ST	Swept	<ul style="list-style-type: none"> <li>Burned to completion</li> <li>Incompletely burned wood and bone were placed in center of hearth to promote complete burning</li> <li>After cooling overnight, was swept out with a grass hand broom</li> <li>Was then trampled for a minute</li> </ul>
D	Dumped	<ul style="list-style-type: none"> <li>Burned to completion</li> <li>Incompletely burned wood and bone were placed in center of hearth to promote complete burning</li> <li>After cooling overnight, burned material was swept into an animal skin, moved several meters away, and dumped on a patch of Hohle Fels sediment</li> </ul>
DT	Dumped and Trampled	<ul style="list-style-type: none"> <li>Burned to completion</li> <li>Incompletely burned wood and bone were placed in center of hearth to promote complete burning</li> <li>After cooling overnight, burned material was swept into an animal skin, moved several meters away, and dumped on a patch of Hohle Fels sediment</li> <li>Was then trampled for a minute</li> </ul>

**Tab. 1** - List of hearth name (as used in following figures), the type of hearth, and the specific management of the hearths.

around the desired location and covering them with plaster bandages. The blocks were moved to the micromorphology laboratory at the University of Tübingen, where they were dried for several days in an oven at 60° C. They were then impregnated with a mixture of unpromoted polyester resin (Viscovoss, Vosschemie GmbH) that was diluted with styrene (VWR International). Methyl ethyl ketone peroxide (MEKP) was used as the polymerization catalyst. The samples were allowed to set for a week before being heated to 60° C overnight, causing full polymerization of the resin. Slices of the blocks were cut with a rock-saw and sent to Spectrum Petrographics (Vancouver, Washington, USA) to produce thin sections, 5 x 7.5 cm in dimension. These thin sections were analyzed using a standard, polarizing petrographic microscope, with magnification of 4-20 x. Nomenclature and descriptions follow that of Courty *et al.* (1989) and Stoops (2003).

## Micromorphological Results

### *HT (trampled hearth)*

We collected two slides from the trampled, *in situ* hearth (fig. 4 and 5; tab. 2). Both of these slides showed

that the trampled hearth retained a typical hearth structure with a layer of charcoal overlying a rubefied base of sediment. Although the general hearth structure was preserved, there were several characteristics of sample HT that distinguished it as trampled. This included compaction of the underlying cave sediment, evident by a lack of void structure when compared with non-trampled samples. Furthermore, several larger pieces of bone and charcoal were pressed into the underlying sediment. Some of the pieces of bone appeared to be snapped and crushed. There appeared to be very little horizontal movement or displacement of components; most



A



B



C

**Fig. 3** - Photographs of the various anthropogenic reworking activities. A) trampling of hearth ST, B) sweeping out of hearth D onto a skin, C) dumping of hearth D.

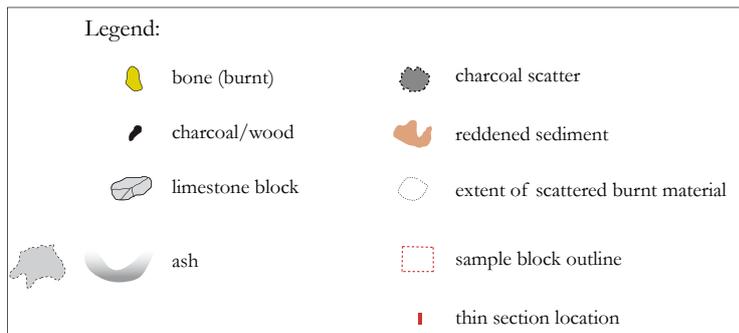


Fig. 4 - Legend for the plans of the hearths, as seen in figures 5-9.

non-rubefied sediment. Associated with the larger fragments of burnt bone and charcoal were some finer, mm-size clasts of rubefied sediment, presumably swept out with the larger burnt components. The overall structure of this sample is not realistic archaeologically, since successive periods of deposition and post-depositional alteration would most likely not preserve such an open structure.

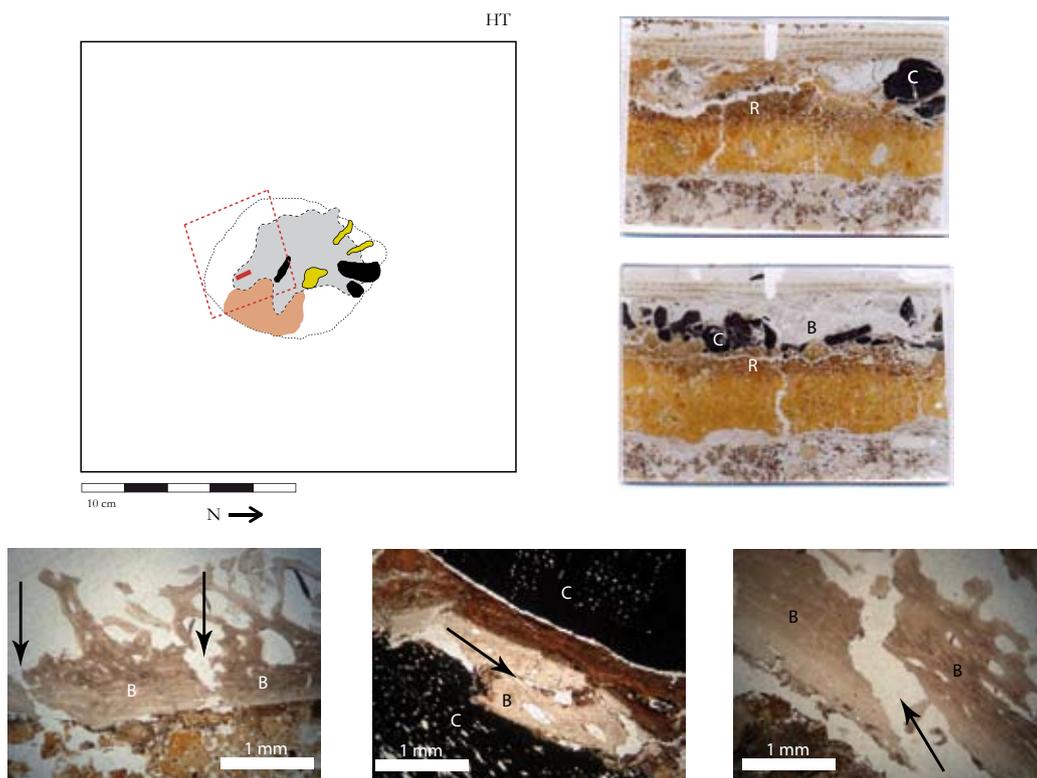


Fig. 5 - Trampled hearth (HT). See table 1 for a description of the types of hearths and table 2 for the macro- and microscopic descriptions. The plan view of the experimental area indicates where the samples were taken. Scans of the slides (dimensions are 5 x 7.5 cm) are provided in the upper right-hand corner of the figure. The lettering on the scans and the photomicrographs indicate: R—rubefied substrate, C—charcoal and B—bone. In the scanned slides, one can note that the charcoal and burned bone overlie a rubefied substrate. In the photomicrographs and the base of the figure, one can note (from left to right) a burnt bone snapped in several locations (indicated by arrows), a piece of burned bone crushed between two pieces of charcoal, and another snapped bone (indicated by the arrow).

movement was vertical, probably as a result of the compaction and pressure.

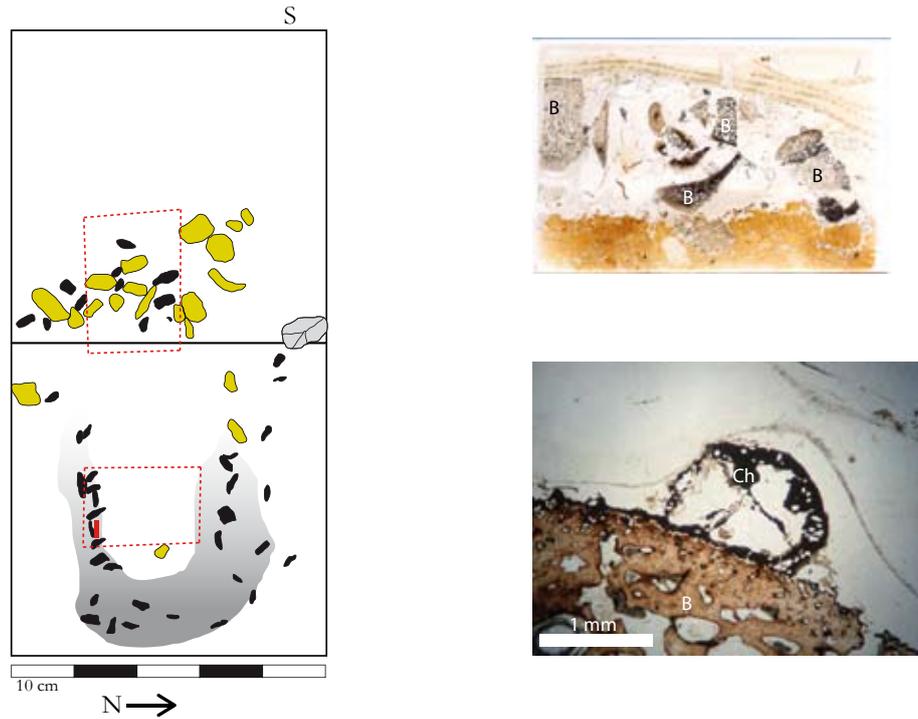
*S (swept hearth)*

A single slide was made from the swept sample (fig. 6). This slide consisted of large, cm-sized pieces of burnt bone and charcoal, very loosely organized, overlying a substrate of

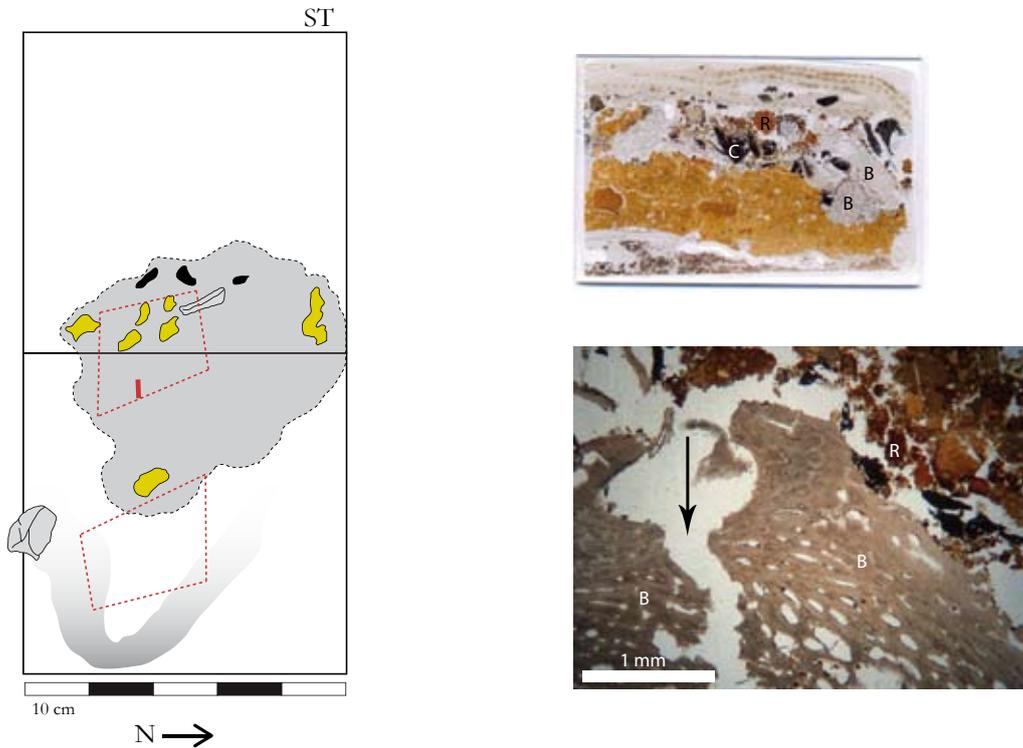
*ST (swept and trampled)*

The single slide collected from the swept and trampled hearth showed generally similar characteristics to both HT and S (fig. 7). Like S, a layer of cm-sized pieces of burnt bone and charcoal overlie a non-rubefied substrate of cave sediment. Unlike S, the bone and charcoal components form a less-open





**Fig. 6** - Swept hearth (S). Lettering on the scan and photomicrograph indicate: B—bone and Ch—char. Note the loose and open structure evident in the scanned slide (dimension of 5 x 7.5 cm). Also note that the burned bone and charcoal overlie a substrate that is not rubefied. The photomicrograph shows a piece of char attached to a burned bone.



**Fig. 7** - Swept and trampled hearth (ST). Lettering on the scan and photomicrograph indicate: C—charcoal, B—bone, R—rubefied clast. Note how more compact the burned material is in this scanned slide compared to that from the swept hearth (S—figure 6). Some of the larger pieces of bone are pressed into the underlying substrate, which is not rubefied. Some rubefied clasts, however, are incorporated into the reworked deposit. The photomicrograph shows evidence of a snapped bone (indicated by the arrow).

Hearth Name	Macroscopic observations	Microscopic observations
HT	<ul style="list-style-type: none"> <li>• Circular outline of hearth area retained, similar to control</li> <li>• A patch of rubefied substrate was visible in the southeast corner</li> <li>• Larger pieces of burned bone and charcoal visible</li> <li>• Small pieces of charcoal and possible ash scattered around the central hearth area</li> </ul>	<ul style="list-style-type: none"> <li>• “classic” hearth structure visible—a rubefied base overlain by charcoal and burned bone</li> <li>• Larger pieces of bone and charcoal appear pressed into the underlying substrate, deforming the substrate</li> <li>• Some pieces of burned bone appear snapped in place, others appear crushed</li> </ul>
S	<ul style="list-style-type: none"> <li>• Burned material forms an elongated patch, oriented eastwards</li> <li>• The original outline and form of the hearth is no longer visible</li> <li>• Some coarser material (bone and charcoal) remain closer to the hearth center</li> <li>• Finer material is scattered further away (east) from the original hearth center</li> </ul>	<ul style="list-style-type: none"> <li>• Centimeter-sized pieces of charcoal and burned bone are loosely structured</li> <li>• They overlie sediment that has not been rubefied</li> </ul>
ST	<ul style="list-style-type: none"> <li>• Like S, this reworked hearth forms an elongated patch of burned material</li> <li>• Coarser material remained near the hearth center, whereas finer burned material is located further away from the center, forming an arc of sediment</li> </ul>	<ul style="list-style-type: none"> <li>• Centimeter-sized pieces of burned bone and charcoal overlie a non-rubefied substrate</li> <li>• The burned components are more compact compared to those from S</li> <li>• Clasts of rubefied material are found above and next to the pieces of charcoal and burned bone</li> <li>• The burned components are pressed into the substrate, deforming it</li> <li>• Some burned bones are snapped and/or crushed</li> </ul>
D	<ul style="list-style-type: none"> <li>• The burned material forms a patch slightly elongated in the northeast direction</li> <li>• A circular patch of charcoal was noted in the southwest portion of the patch</li> <li>• Larger pieces of burned bone are scattered throughout the patch</li> </ul>	<ul style="list-style-type: none"> <li>• Most pieces of charcoal and burned bone are finer (sub-centimeter) than in the previous hearths</li> <li>• The components are organized loosely and chaotically, especially the numerous sub-millimeter fragments of charcoal and burned bone</li> <li>• Sub-millimeter clasts of rubefied sediment are visible, scattered throughout the dumped deposit</li> </ul>
DT	<ul style="list-style-type: none"> <li>• The burned material here formed a more circular patch</li> <li>• Larger pieces of burned bone and charcoal were visible</li> </ul>	<ul style="list-style-type: none"> <li>• A loose, chaotically structured organization of the burned components was visible, although more compact</li> <li>• Larger pieces of burned bone and charcoal were pressed into the underlying sediment, deforming it</li> <li>• Some pieces of burned bone were snapped</li> </ul>

**Tab. 2** : Comparison of macroscopic and microscopic observations of the different hearths. des différents foyers.

structure. Within the layer of combusted material are several clasts and aggregates of rubefied sediment, obviously reworked from its primary context. It is not clear from these experiments if the rubefied material was reworked during the sweeping or the trampling, although both possibilities are plausible. Like HT, ST has evidence of several snapped and crushed bones.

#### *D and DT (dumped and dumped & trampled)*

Based on simple non-microscopic observation of the sample blocks from the dumped hearth, it is difficult to distinguish it from the swept-out material from the S hearth (Fig. 8 and Fig. 9). At a larger scale, the structure of the dumped deposit does not appear as elongated as the swept deposits, although this is probably a highly variable aspect of these deposits. Certainly one way

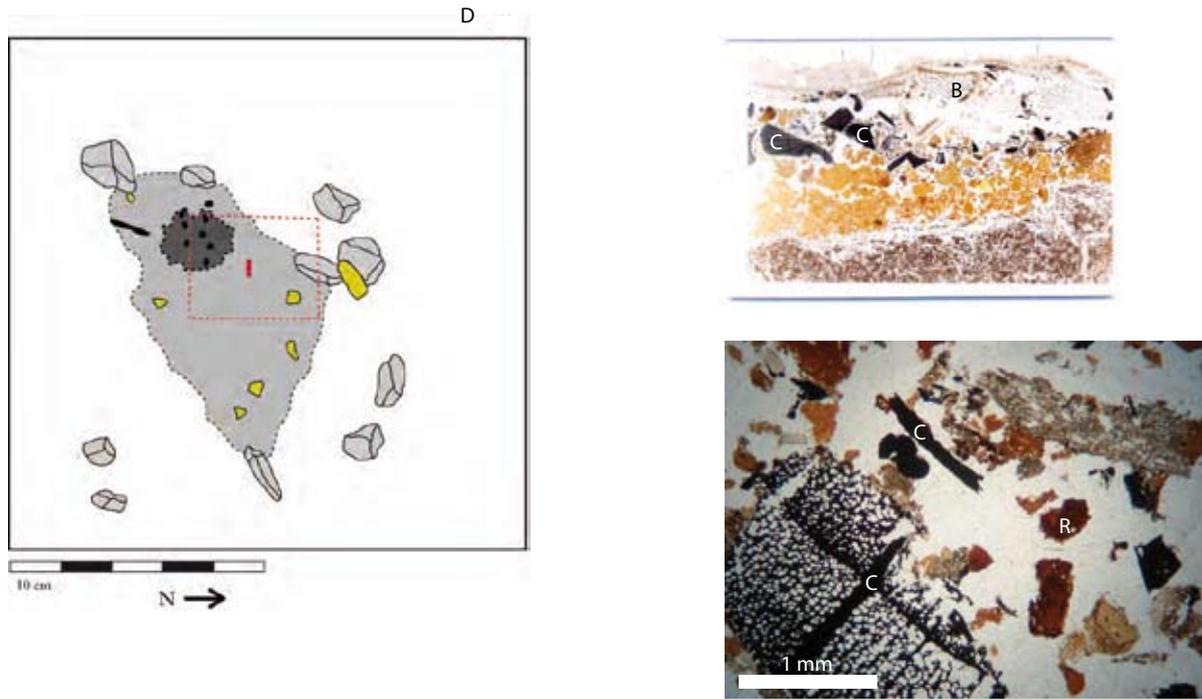
of telling the swept hearths (S and ST) from the dumped deposits is that the dumped deposits (D and DT) are radically removed from any burned substrate. Microscopically there are some distinctions between the swept and the dumped deposits. The dumped deposits are organized more chaotically, with a wider range of size classes of charcoal and burnt bone adjacent. The dumped deposit that was not trampled also had a more open structure, similar to that of S.

#### Discussion

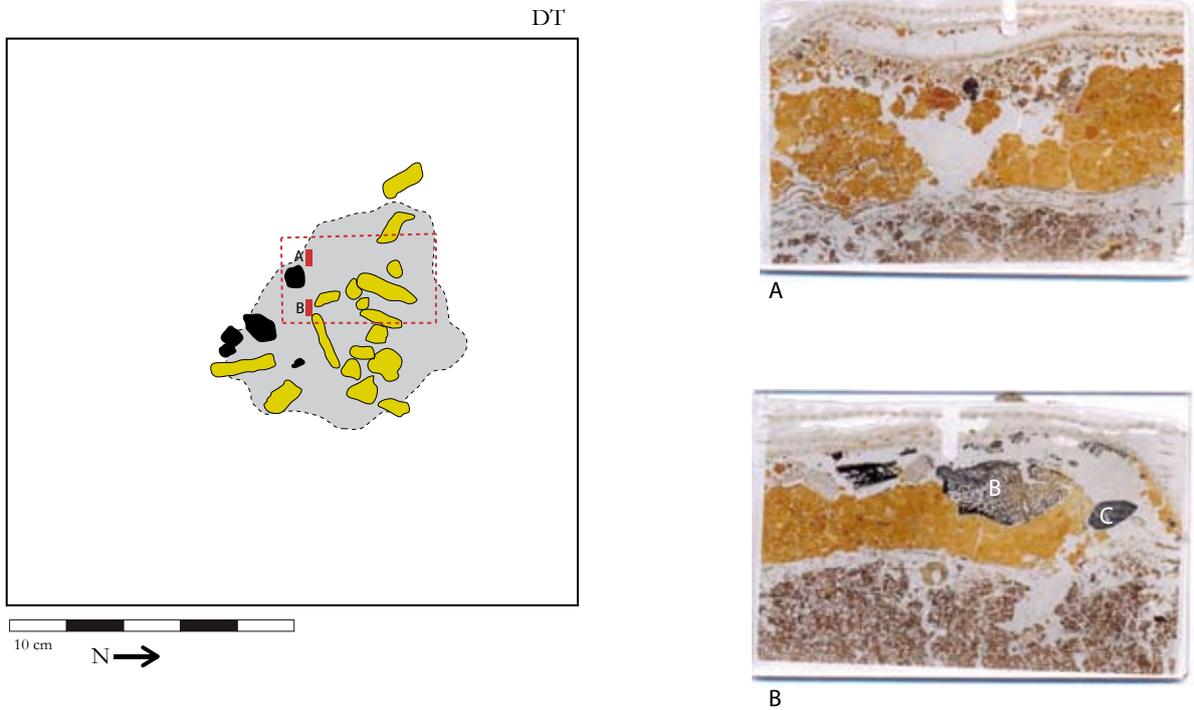
Looking at the results of the six fireplace experiments, there are several patterns that are applicable to the interpretation of archaeological samples. The first is the difference in the association between combusted material (bone and charcoal) and a rubefied substrate. For the control and the trampled hearth, the combusted material remained relatively in place: it lies directly above the rubefied

substrate; even with trampling, the original structure and organization of the hearth was still visible. This could be a result of the short time that the samples were trampled (only for one minute); longer-term periods of trampling may have the effect of transporting the burnt material farther or significantly reworking the original structure of the hearth. Sweeping out of a hearth obviously disturbs this original structuring: in the thin section one notices that clasts of rubefied substrate have been reworked (similar to rip-up clasts) by the sweeping action. Furthermore, the deposit of combusted material overlies a layer of sediment that has not been affected by heating. The last situation examined here, the dumped deposits, are almost completely removed from any association with a reddened substrate. Some small (sub-mm) pieces of fire-reddened sediment were noted in the D and DT thin sections. However, their presence was negligible when compared to the swept or





**Fig. 8** - Dumped hearth (D). Lettering on the scan and photomicrograph indicate: C—charcoal, B—bone, R—rubefied clasts. Although some larger, centimeter pieces of charcoal are visible in the scanned slide, the matrix of the deposit consists of millimeter and sub-millimeter pieces of charcoal, burned bone, and rubefied clasts. In the photomicrograph one can note the open, loose and chaotic structuring of the sub-millimeter components.



**Fig. 9** -Dumped and trampled hearth (DT). Lettering on the scans indicated: C—charcoal and B—bone. Note in sample B that larger pieces of bone and charcoal have been pressed into the underlying substrate, which is not rubefied.

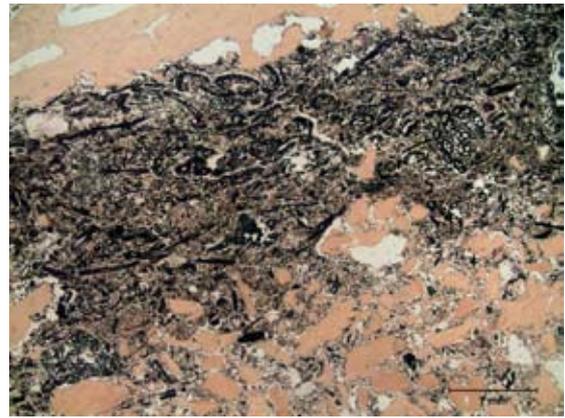
*in situ* samples. A lack of rubefication does not instantly suggest that a combustion-related feature is reworked: it is conceivable that some substrates may not redden in the presence of higher temperatures. However, the results from this experiment suggest that a lens of burnt material that is directly in contact with a substrate that is not rubefied—especially when it is known from experimentation that this sediment is commonly altered when subjected to heating—probably does not represent an *in situ* fireplace.

This experiment also showed that it is difficult to distinguish between swept and dumped material. One difference was that the grain-size distribution of burnt swept material was more homogenous compared to the grain-size distribution of dumped burnt deposits. This could be because sweeping causes a sorting of the material — especially if larger pieces of charcoal and burnt bone are removed by pushing to an area further away from the center of the hearth, while finer material is removed further from the hearth center by rapid sweeping motions. Since dumping is a more rapid movement—similar to a colluvial flow—it is not surprising that the material is more poorly sorted in terms of grain size. This observation, however, is cursory and needs further testing before it can be applied fully to archaeological material.

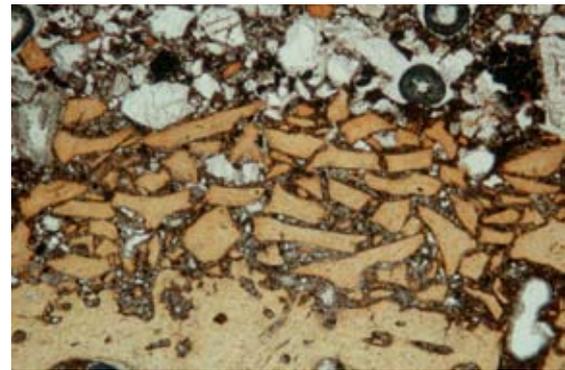
One of the most interesting results from this experiment was the very clear effect that trampling has on combustion features. The sediment was clearly compacted as a result of the trampling. In addition, burnt bones were snapped and also crushed. Such crushed and broken bones have been noted at several archaeological sites—including the South African Middle Stone Age site of Sibudu (Goldberg *et al.*, forthcoming) and the French Middle Paleolithic site of Pech de l'Azé (Dibble *et al.*, forthcoming; Fig. 10) — and have been reasonably assumed to represent trampling. This experiment shows that *in situ* snapped and crushed bone can occur as a result of only a minute of human trampling.

### Interpretation of Hohle Fels burnt bone layer (3cf) in the light of experimental results

We would like to provide a brief example of how this experiment is helping us interpret archaeological material from the site of Hohle Fels. A layer (3cf) of mostly sand-



A



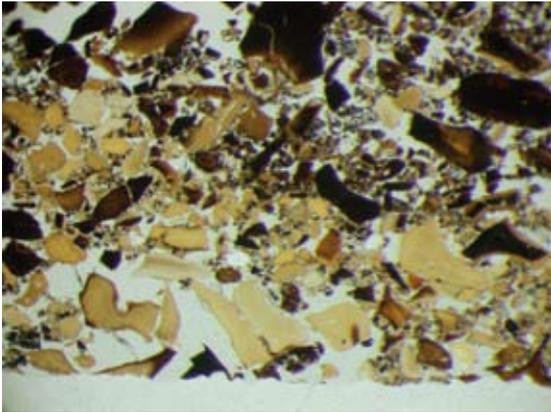
B

**Fig. 10** - A) an example of what has been interpreted as bone crushed by trampling at the MSA South African site of Sibudu. B) Another example of crushed bone, from the Middle Paleolithic site of Pech de l'Azé, France. Width of view in this photomicrograph is approximately 6.2 millimeters.

sized burnt bone, laterally extensive across the entire site and in some places up to 15 cm thick, was excavated within the Gravettian layers. Several hypotheses were proposed for the formation of this layer, including that it was possibly a sequence of *in situ* burning events, or that it may have been redeposited by flowing water. A micromorphological study of the layer (Schiegl *et al.*, 2003) showed several distinctive characteristics (Fig. 11). There was no rubefication of the substrate and no fire-reddened clasts of sediment within the deposit. The deposit consisted almost completely of sand-sized burnt bone, with some calcitic ash, numerous lithic and organic artifacts, and faunal remains. The pieces of sand-sized burnt bone were organized in an open, chaotic structure, with fragments exhibiting varying degrees of burning adjacent to one another. The authors concluded that these characteristics demonstrated that the deposit was not *in situ* — but neither was it reworked



A



B

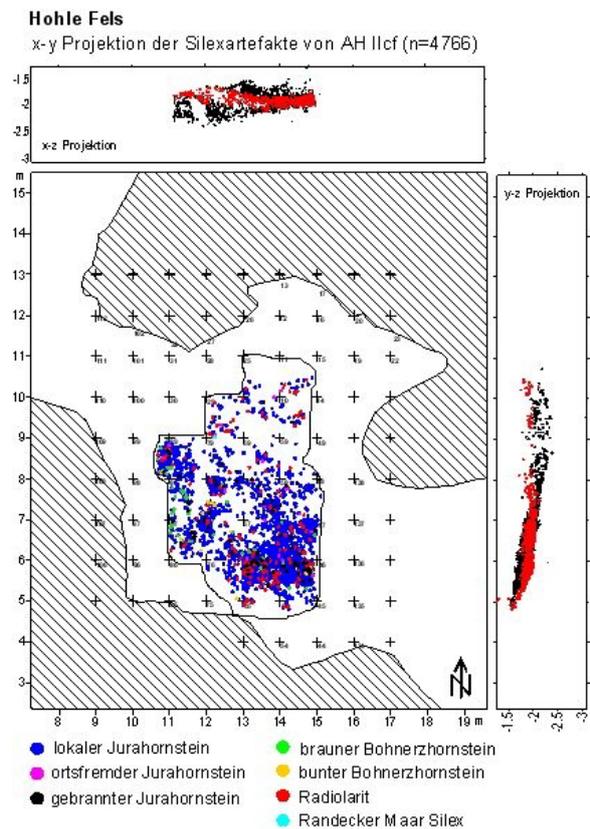
34

**Fig. 11** - A) A field photograph of the Gravettian layer 3cf from Hohle Fels. B) A photomicrograph of layer 3cf in plane polarized light (PPL). Height of view here is 5 mm. Note the relatively loose, disorganized structure of the sand-sized fragments of burnt bone. Bone fragments of varying degrees of burning are adjacent. This layer is interpreted as a dumped layer. Compare this with the photomicrograph from hearth D, which shows a similar loose, chaotic structure.

by natural processes. Instead, they suggested that it was reworked by humans, who removed the material from the original hearth location and dumped it at this place in the cave. The thickness and lateral extent of the layer imply that this was done repeatedly over multiple periods of occupation. Furthermore, the open structure and the lack of snapped and crushed bone suggest little trampling, implying that, during the deposition of this layer, occupation was centered elsewhere within or near the cave while this area was used almost solely as a dump.

Several of these interpretations and observations have been demonstrated in this experiment, including the open and chaotic structure of dumped deposits

and the fact that bones are commonly crushed when trampled. Understanding how deposits like this form—and understanding that these deposits are reworked anthropogenically — is very important for the interpretation of archaeological site formation processes. This understanding provides a context in which to interpret other classes of artifacts. For example, the burnt-bone layer at Hohle Fels contains numerous small flakes that are concentrated within several clusters (P. Kiesselbach, personal communication; Fig. 12); these flakes often refit. Without understanding how the burnt layer was deposited, it might be tempting to interpret these clusters of flakes as stone tool working loci representing *in situ* artifact scatters. However, because the micromorphological data show that



**Fig. 12** - **fig. 12** : A distribution map of lithic artefacts from Hohle Fels, layer 3cf (courtesy of P. Kiesselbach). Different types of local cherts (Hornstein) are indicated by different colors. Note that the distribution forms several clusters of artefacts. Based on the micromorphology of this layer, and supported by the experiments present here, these concentrations of lithic artefacts do not represent knapping loci or workshops, but most likely dumps of knapping by-products.

the flakes have been reworked, we therefore can conclude that these clusters do not represent *in situ* concentrations of flakes. Because the flake concentrations form clusters, and because there are so many refits, it seems that these concentrations represent byproducts of flaked stone tool production that, along with combusted material (burnt bone and ash) and other artifacts, were gathered together and dumped in a specific area of Hohle Fels cave.

## Conclusion

In this study we presented results from six fireplace experiments. Excluding a control hearth, the other hearths were anthropogenically reworked, including a trampled hearth (HT), a swept-out hearth (S), a swept and trampled hearth (ST), a dumped hearth (D), and a dumped and trampled hearth (DT). Although some macroscopic differences were noted, micromorphological examination of the deposits provided clear evidence for the anthropogenic formation processes of the reworked deposits. These observations include:

1. Trampled deposits showed clear signs of compaction, such as bones and pieces of charcoal that were pressed into the underlying sediment and a less open structure within the reworked deposit itself.
2. All trampled deposits showed evidence of crushed and snapped bones. Similar features have been found in archaeological deposits and are interpreted as evidence for trampling.
3. Dumped deposits are typically more fine-grained than the other reworked deposits, and exhibit a loose, chaotic structure microscopically. Furthermore, a larger range of grain-sizes of burnt components are located throughout the deposit—resembling a colluvial deposit—compared to the swept samples.
4. Sweeping seems to cause a sorting of the

burnt material, with finer-grained material located further out from the original hearth center. This conclusion is tentative, since this may be a result of the type of sweeping employed. More experiments should be conducted to test this.

5. Going from the trampled hearth to the dumped deposits, the association of the burned material with a rubefied substrate changes. In the trampled hearth (HT), the burned material was located directly above the rubefied substrate. In the swept samples, (S and ST), the burned material was not located above a rubefied substrate, although rip-up clasts of rubefied material were incorporated into the reworked deposit. In the dumped deposits (D and DT) some sub-millimeter-sized pieces of rubefied material were identified, although much less than those found in the swept deposits.

These microscopic observations show that distinct activities, such as trampling and dumping, are readily identifiable only at the microscopic scale. Although there are some distinctions between swept and dumped deposits, further experiments should strive to make these distinctions clearer. Further experiments should also aim to control natural taphonomic processes. This experiment was conducted outside, in a relatively moist environment. After waiting a week to collect the samples, most of the calcitic ash seemed to have blown away, or to have been dissolved. In a more protected cave setting, with a chemical environment that promotes at least short-term preservation of calcite, this would not be the case.

By using micromorphology to determine the depositional history of a combustion-related feature, we can begin to interpret how ancient people used fire, how they dealt with combusted material after it was no longer useful, and how ancient people organized their living space. Furthermore, a micromorphological investigation of combustion



deposits at archaeological sites provides a context in which to evaluate other classes of artifacts, such as was shown here with lithic concentrations within layer 3cf at Hohle Fels Cave.

We hope that this paper lays a foundation for future experimentation in micromorphology. It is through experiments like these that we can calibrate our interpretations made at the microscopic level and begin to unravel past human activities and behaviors preserved in anthropogenic deposits.

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