# Understanding Stone Tool Function: Methods and Examples from the Aurignacian Levels at Hohle Fels

Bruce L. Hardy
Department of Anthropology
Kenyon College
Gambier, Ohio, USA
hardyb@kenyon.edu

***Abstract:*** *Although stone tools are often the most common artifact at Paleolithic sites, we know relatively little about their function. Indirect methods, such as ethnographic analogy or experimental archaeology, only provide us with a range of possible uses. More direct methods involve microscopic examination of archaeological tools in an attempt to observe either wear patterns (use-wear analysis) or traces of the worked material (residue analysis). A combination of use-wear and residue analysis was applied to tools from the Aurignacian levels at Hohle Fels, southwestern Germany. The results suggest that, in spite of the general assumption that the Aurignacian is characterized by greater standardization of tools, the tools from Hohle Fels were used for a wide variety of tasks and were not specialized.*
***Keywords:*** *Southwestern Germany, Aurignacian, residue analysis, use-wear analysis, typology, specialization*

**Zum Verständnis der Funktion von Steinartefakten: Methoden und Beispiele aus den Aurignacienschichten des Hohle Fels**

**Zusammenfassung:** Obwohl Steinartefakte oft die häufigste Fundkategorie auf paläolithischen Fundplätzen sind, wissen wir relativ wenig über ihre Funktion. Ein möglicher, indirekter, Weg zum Verständnis ihrer Funktion führt über ethnographische Analogien, also Vergleiche mit modernen Gruppen, die Steinartefakte herstellen und benutzen. Letztlich führt diese Methode aber nur dazu, dass wir einen Ausschnitt aus möglichen Verwendungsweisen erschließen. Dies gilt ebenso für eine zweite indirekte Methode, die experimentelle Archäologie. Hierbei werden urgeschichtliche Werkzeuge nachgefertigt und dann für verschiedene Zwecke eingesetzt, um auf diese Weise festzustellen, für welche Tätigkeiten sie am besten geeignet sind. So zeigen z.B. Experimente, dass Kratzer das für die Fellbearbeitung bestgeeignete Gerät sind. Andere Experimente demonstrieren aber, dass Kratzer ebenso effektiv bei der Bearbeitung von Holz einsetzbar sind. Das bedeutet, dass wir letztlich erneut nur einen Ausschnitt möglicher Verwendungsweisen erschließen können.

Andere, direktere Methoden zur Erschließung der Funktion von Steinwerkzeugen umfassen die Gebrauchsspurenanalyse sowie die Residuenanalyse. Bei der Gebrauchsspurenanalyse werden unter dem Mikroskop winzige Veränderungen an der Oberfläche der Steinartefakte untersucht, die bei der Benutzung dieser Stücke entstanden sind. Hierzu gehören Aussplitterungen, Kantenverrundungen, längliche, mikroskopisch feine Schrammen sowie feine Oberflächenpolituren. Durch Experimente wurde gezeigt, dass die Verwendung von Steinwerkzeugen auf verschiedenen Materialien, z.B. Knochen, Holz, Fell usw., unterschiedliche, oft charakteristische Mikrogebrauchsspuren hinterlässt. Jedoch ist die eindeutige Zuordnung der Spuren zu bestimmten Materialien oft nicht völlig eindeutig. Bei der Verwendung bleiben jedoch oft auch winzige Partikel des bearbeiteten Materials an den Artefakten haften. Mit einem Mikroskop lassen sich bei 50-500facher Vergrößerung solche Partikel, Residuen genannt, sichtbar machen und identifizieren. Zu den nachweisbaren Residuen gehören Blut, Haare, Federn, Knochen, Pflanzenzellen- und fasern, Holz, Stärkekörner, Phytolithen und Harze. Durch die Residuenanalyse lassen sich zumindest sehr direkt diejenigen Materialien feststellen, mit denen Steinartefakte in Kontakt gekommen sind. Eine Schwierigkeit besteht jedoch darin, nachzuweisen, dass die anhaftenden Partikel tatsächlich mit der Verwendung der Artefakte in Verbindung stehen. Es wird deswegen durch den Verfasser eine kombinierte Methode aus Gebrauchsspuren- und Residuenanalyse angewandt. Auf diese Weise ist es möglich, mit der einen Methode erzielte Ergebnisse anhand der jeweils anderen Methode zu kontrollieren. Wenn also die beobachteten Mikrogebrauchsspuren auf ein bestimmtes Material hinweisen und sich dieses Material tatsächlich auch mit der Residuenanalyse nachweisen lässt, so ist die

Wahrscheinlichkeit ausgesprochen groß, dass die Residuen unmittelbar auf die Verwendung der Stücke zurückgehen. Die kombinierte Methode ist sehr zeitaufwändig, und für die Residuenanalyse ist es wichtig, dass die Artefakte vorher so wenig wie möglich gesäubert und angefasst wurden. Für ein einziges Stück kann die mikroskopische Analyse bis zu einer Stunde in Anspruch nehmen, zumal alle erkannten Spuren sorgfältig dokumentiert und fotografiert werden müssen.
Gewöhnlich wird allgemein für das Jungpaläolithikum davon ausgegangen, dass die Steinwerkzeuge im Gegensatz zum vorhergehenden Mittelpaläolithikum einen wesentlich höheren Grad an typologischer Standardisierung und Spezialisierung zeigen. Der technologische Wandel am Beginn des Jungpaläolithikums sowie die höhere Standardisierung bei den Steinwerkzeugen werden von verschiedenen Forschern als Beleg für höhere kognitive Fähigkeiten der anatomisch modernen Menschen als Erzeuger der jungpaläolithischen Artefakte angesehen. Zwar ist es offensichtlich, dass sich die Formen der Steinwerkzeuge im Jungpaläolithikum geändert haben, aber bedeutet dies automatisch, dass damit auch die Funktionen andere sind? Heißt es, dass, beginnend mit dem Aurignacien, jungpaläolithische Menschen spezialisierte Werkzeuge für jeweils ganz bestimmte Tätigkeiten herstellten? An einer Artefaktstichprobe aus den Aurignacienschichten des Hohle Fels bei Schelklingen hat der Verfasser dies überprüft. Die Datierungen für die tiefsten Aurignacienschichten (Archäologische Horizonte Va und Vb) reichen bis zu 35.000-40.000 Jahre vor heute zurück und damit in eine Zeit, als die ersten anatomisch modernen Menschen Europa betraten. Seit 2005 wurden 78 Artefakte aus den Aurignacienhorizonten IIIa bis Vb mit der kombinierten Methode aus Gebrauchsspuren- und Residuenanalyse untersucht. Im Beitrag wird eine Spitzklinge beschrieben (Abb. 3), die geschäftet war und zum einen als Projektil bzw. als Bewehrung einer Stoßwaffe verwendet wurde, aber zum anderen auch zum Schlachten diente. Ein langer Klingenkratzer (Abb. 4) war ebenfalls geschäftet und diente zum Schaben von Fell. Die Analysen am Hohle Fels zeigen, dass keine Verbindung bestimmter Werkzeugtypen mit der Bearbeitung bestimmter Materialien vorliegt. Stattdessen lässt sich zeigen, dass die Werkzeuge jeweils zur Bearbeitung verschiedenster Materialien und für unterschiedliche Zwecke verwendet wurden (Tabelle 1). Eine Spezialisierung liegt damit zumindest im Aurignacien des Hohle Fels nicht vor. Stattdessen war Multi-Funktionalität hier die Regel. Bevor man also die sich ändernden Formen von Steinwerkzeugen als Ausdruck veränderter kognitiver Fähigkeiten deutet, sollte man erst versuchen, mehr über die Verwendung dieser Werkzeuge zu erfahren.
**Schlagwörter:** Südwestdeutschland, Aurignacien, Residuenanalyse, Gebrauchsspurenanalyse, Typologie, Spezialisierung

Stone tools are ubiquitous at Paleolithic archaeology sites. They are typically the most common humanly modified artifacts and come in a wide variety of shapes and sizes, particularly in the Upper Paleolithic. As archaeologists, we create typologies which categorize and classify stone tools into different tool types. For the Upper Paleolithic, as many as 92 different tool types have been defined (de Sonneville-Bordes and Perrot 1956). What does this diversity of categories mean? Do they represent specialized tools with different functions? Tool types often describe technological attributes (e.g. location of retouch, technique of manufacture) but the names for different tool types often imply a function as well. For example endscraper, sidescraper, and hand-axe all imply a function, but do we understand what their functions really were?

Because Paleolithic archaeologists have so little to work with in the first place, it is important to extract as much information as possible from what we do have. And, since we are ultimately interested in behavioral questions, understanding stone tool function is paramount. This article reviews the methods that can be used to understand prehistoric tool function and provides examples from Aurignacian levels at the site of Hohle Fels, southwestern Germany.

## Ethnographic Analogy

One possible way to understand prehistoric stone tool function is through analogy with modern groups who make and use stone tools. If the modern and prehistoric tools are similar in morphology, then, by analogy, their functions may also be similar. Modern and ethnohistoric examples are limited but include some Native American and Australian aboriginal groups. More recently, work by Brandt and colleagues revived interest in Ethiopian hideworking with stone tools among the Gamo, Gurage, Hadiya, Konso, Sidama, and Wolayta peoples (Brandt 1996; Brandt et al. 1996; Brandt and Weedman 1997). The highlands of southern Ethiopia are among the very few places in the world where flaked stone tools are still regularly made and used for hidescraping. Here, obsidian or chert scrapers are hafted and used to scrape skin off of the inner portion of cow hides. The scrapers are retouched when necessary and eventually discarded along with scraper manufacturing debris (Brandt and Weedman 1997).

Scraper morphology varies by ethnic group (Brandt et al. 1996) but many are quite similar to Upper Paleolithic endscrapers in morphology. While these similarities certainly demonstrate that stone endscrapers can be used for hidescraping, it only suggests the possibility but does not demonstrate that Upper Paleolithic endscrapers were hideworking tools. Ethnographic analogy, then, can provide us with a range of possible uses for particular tool morphologies as well as the social context in which they occur (Weedman 2002, 2006) but cannot be used to show prehistoric tool function.

## Experimental Archaeology

Another method of inferring prehistoric tool function is through replication of prehistoric tool morphologies and experimentation with their use. Since flaked stone technology is well understood, it is a relatively easy task for a skilled modern flintknapper to recreate tools which are virtually identical to their prehistoric counterparts (Whittaker 1994). Archaeologists can then use the stone tools to see the tasks for which they are best suited. As with the previous example, many experiments show that scrapers are suited for hideworking (e.g. Keeley, 1980; Vaughan 1985; Bamforth 1986; Hayden 1990 and others). However, other experiments demonstrate that scrapers are also useful for working wood (Beyries, 1988; Hardy and Garufi 1998). Once again, a range of possible uses is suggested. Were prehistoric scrapers used for hideworking, woodworking, or some other task?

Another example of the drawbacks of using experimental archaeology concerns the Acheulean hand-axe. This long, tear-dropped or almond shaped bifacial tool was widely produced across Africa and Europe for over a million years. The ubiquity and longevity of the hand-axe suggests that it was a very useful tool, but useful for what? The name itself implies a function, an axe held in the hand. While it can function in this way, it is inefficient and the sharp edge that extends around the entire surface makes it dangerous to wield. Experimentation has shown that hand-axes work well as butchery tools (Jones 1981) even on animals as large as elephants (Toth and Schick 2007). However, other experiments demonstrate that hand-axes can be used as projectiles when thrown like a discus (O'Brien 1981). How are archaeologists to distinguish between these different possibilities? Were hand-axes used for woodworking, butchery, or as projectiles? Or were they used for all three? Based on experimental archaeology, we only get a range of possible uses.

## Use-wear Analysis

Because ethnographic analogy and experimental archaeology offer only a range of possible functions, we must have a way to distinguish between them. As early as the 1840s, Scandinavian archaeologists were using ethnographic analogy to look at prehistoric tool use. Nilsson (1868) went as far as to suggest that ethnographic parallels should be tested through the study of wear patterns. Over 100 years later, beginning in the 1960s, this type of approach was developed in depth (Semenov 1964). When a stone tool comes into contact with another material, damage or wear can result. Wear patterns include the production of microflake scars, edge rounding, striations and micropolishes on the tool surface. Microscopic examination of these wear traces can reveal patterns that offer clues to a tool's use.

The study of microflake scars, edge rounding, and striations often occurs at relatively low magnifications (less than 100x) and can provide information about the relative hardness of the material being worked as well as the motion of the tool, or use-action (Odell and Odell-Vereecken 1980). This technique is generally referred to as the low-power approach. Higher magnifications (100-500x) are generally used to observe small striations and micropolishes. In the 1970s and 80s, analysts using the high power approach to examine micropolishes were able to distinguish between different worked materials (wet and dry hide, bone, antler, wood, meat, etc.) based on the characteristics of the polish (e.g. Keeley 1980). A series of blind tests in the late 1980s, however, highlighted the subjective nature of the interpretation of worked material based on polishes and showed that polishes produced by different materials may overlap (Newcomer et al. 1986). Fullagar (1991) demonstrated that factors such as the relative hardness of the worked material, the presence or absence of water, and the amount of silica in both the raw material and the worked material could all affect polish formation. As a result of these studies and through personal observations, I have adopted a conservative approach to use-wear interpretation, limiting my identifications to soft vs. hard or high silica materials (Fig. 1; see also Hardy et al. 2008). A conservative combination of low and high-power approaches still allows identification of the broad category of worked material as well as use-action.

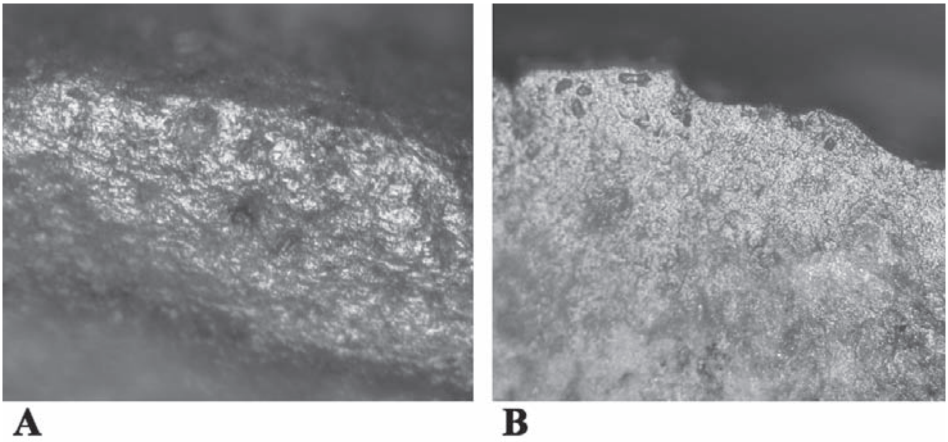


***Fig. 1:*** *Use-wear polishes. A) soft polish, B) hard/high silica polish.*

## Residue Analysis

When a stone tool comes into contact with a worked material, not only is wear formed but some of the worked material may transfer to the tool surface. High power use-wear analysis often involves cleaning a tool with a solvent, such as dilute potassium hydroxide or hydrochloric acid (Keeley 1980). This process allows better observation of polishes and removes adhering organic or inorganic residues. Reflected light microscopy at magnifications ranging from 50-500x can be used to identify the origins of adhering residues. Despite the fact that these residues had been recognized (Semenov 1964; White 1969; Brose 1975; Briuer 1976; Anderson 1980; Anderson-Gerfaud 1981), systematic investigation was slow to start. With the recognition of the potential value of these residues (e.g. Loy 1983), many researchers advocate that tools not be cleaned in any manner prior to analysis. Residue analysts have developed criteria to identify blood, hair, feathers, bone, plant tissue (including individual cell types), wood, plant fibers, starch grains, raphides, phytoliths and resins (see Wadley et al. 2004 for a recent review). Below are some diagnostic criteria for common residue types and information on the specificity of identification.

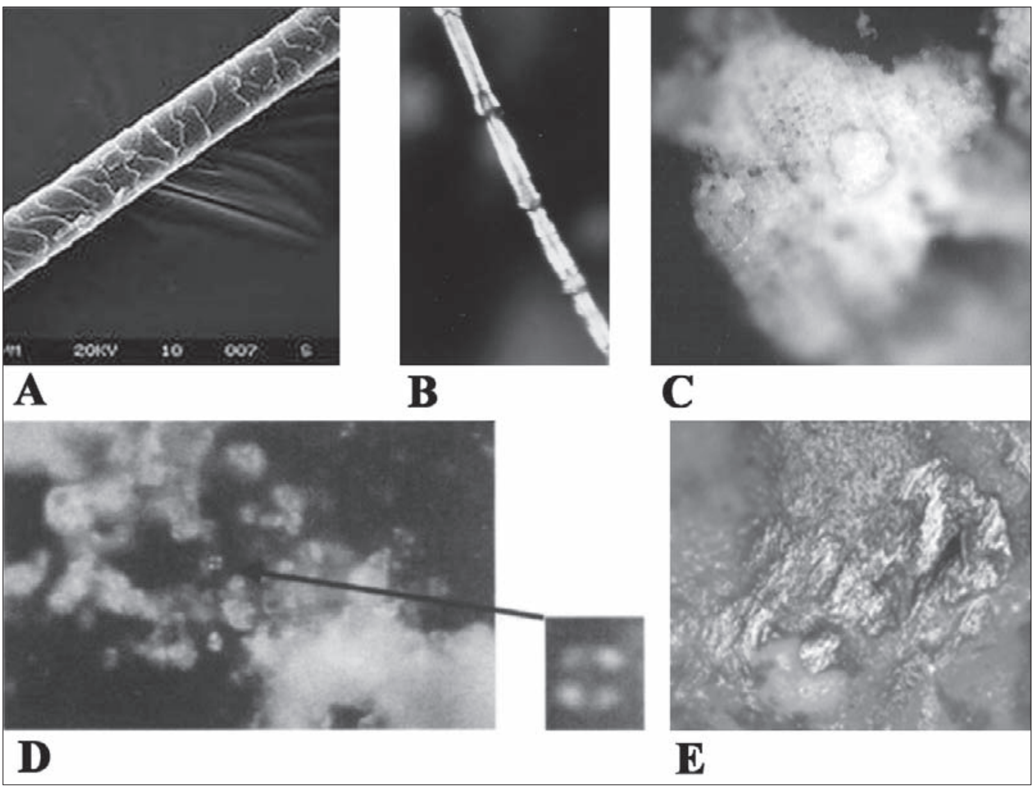


***Fig. 2:** Examples of typical microscopic residues. A) hair showing cuticular scales, B) downy feather barbules with nodes and internodes, C) wood fragment showing tracheids in cross-section, D) starch grains showing extinction cross, E) bright resin with striations.*

## Hair

Hairs are made up of three layers: the cuticle, the cortex, and the medulla. The cuticle is further characterized by the presence of overlapping cuticular scales. The shape and arrangement of these scales is potentially diagnostic to the species level (Teerink 1991). Figure 2A shows a hair with cuticular scales visible. While it is hypothetically possible to identify a hair to the species level, scale patterns within a single species will vary depending on the part of the body the hair is from as well as how close you are to the root or tip of the hair. In addition, closely related species of animals may have very different scale patterns. As a result, the identification of isolated hair fragments, such as those found on stone tools, to the species level is relatively rare. Species identification is best accomplished with a variety of complete hairs of different types.

## Feathers

The identification of birds through microscopic feather evidence is a long-established technique (Chandler 1916) that has been used for the identification of anthropological and archaeological materials, the study of prey remains, and to investigate bird strikes in aviation (Day 1966; Brom 1986; Dove and Peurach 2002; Rogers et al. 2002). Downy (plumulaceous) feather barbules resemble a piece of bamboo with nodes and internodes. The morphology of the nodes (presence/absence/number of protruding prongs) as well as their spacing can be taxonomically diagnostic (see Figure 2B). Most commonly, feathers can be identified to the Order level. If the remains are fragmentary isolated barbules, they specific identification is much more difficult.

## Wood

The following description of wood residues is taken from Hardy and Garufi (1998, 179): "Wood is defined as secondary vascular thickening in plants and can be found in trees, vines and shrubs (Fahn, 1982). Features of microscopic anatomy can allow classification of wood fragments as angiosperm (hardwood) or gymnosperm (softwood). In some cases, microscopic features allow identification of wood fragments to species. Identifiable features of wood anatomy, including characteristic cell types, pits, resin canals, etc., are best seen along three axes of the wood. Wood features are more easily identified on cross-sectional (X), radial (R), and tangential (T) axes than on oblique cuts cross these axes. Planes which are oblique to these axes cut diagonally across cells making diagnostic features more difficult to see."

Figure 2C shows this type of wood residue which is diagnostic of gymnosperms (softwoods). Unfortunately, stone tools most often cut wood along the less diagnostic oblique plane.

## Starch

Starch granules preserve as plant microfossils and are quite common in the archaeological record (Torrence 2006). Starch is a semicrystalline substance composed of two different branched glucose chains, amylase and amylopectine. These substances form semicrystalline lamellae around the hilum or center. Because of the semicrystalline structure, starch granules exhibit a dark extinction crossed when viewed under cross-polarized light (Figure 2D). The size and shape of starch granules and the position of the hilum can be diagnostic to the species level (Gott et al. 2006).

### Resin

Resins or plant exudates are commonly used to aid in hafting. Microscopically, however, they are amorphous, lack internal structure, and may be clear or dark in color (Figure 2E). In appearance, they are highly reflective, glassy films that may be confused with blood films (Wadley et al. 2004). Resins most often derive from plant parenchyma (storage cells). Since storage cells are also the site of starch granule production, the resinous origin of a residue can be confirmed by the presence of starch granules and other plant parts in the film (Parr 2002).

## Residue and Use-wear Analysis - A Combined Approach

One of the greatest difficulties of microscopic residue analysis is establishing that the observed residues are use-related. By combining residue analysis with use-wear analysis, an analyst is able to use each technique to cross-check the other (Hardy et al. 2001). If wear patterns and residues co-occur, then the residues are more likely to be use-related. For example, if a hard or high silica polish is found along an edge which also exhibits microscopic wood fragments and striations, the multiple lines of evidence would all point to woodworking as the function of the tool. Furthermore, the inclusion of use-wear along with the patterning of residue distribution (as determined through replication experiments) can help identify the use-action of the tool.

In a combined use-wear and residue analysis, minimally handled tools are examined under reflected light (100-500x) and the locations of wear or residue recorded on a line drawing of an artifact. Residues are digitally photographed and identified by comparison with published materials or experimental replicates (see Hardy et al. 2008 for more details). The primary goal of the analysis is the recognition of residues and therefore the tools are left unwashed or washed as little as possible. This may obscure some wear patterns. The technique is labor intensive, requiring 20 minutes to one hour of observation per tool.

## Aurignacian tools

The Aurignacian Industry typically marks the beginning of the Upper Paleolithic and is often defined in comparison to Middle Paleolithic Mousterian Industries (Marks et al. 2001). The Middle Paleolithic is characterized by the production of flakes; the Aurignacian is characterized by the production of blades (flakes at least twice as long as they are wide). It is also generally assumed that the Aurignacian demonstrates a greater degree of standardization of tool types than the Middle Paleolithic. According to many archaeologists, formal retouched tools of the Aurignacian were made primarily on blades while Middle Paleolithic tools were made on a much more varied set of flake blanks (Mellars 1989). These differences in perceived degree of standardization have been further used to argue that the makers of the Aurignacian, antomically modern humans, were cognitively different from Neanderthals (Mellars 1996) and that they had ”more clearly conceived mental templates” than their Neanderthal predecessors (Mellars 1989, 526). While some researchers have questioned the degree to which the Aurignacian is ”standardized” (Marks et al. 2001), the technological change associated with the Upper Paleolithic continues to be cited as evidence of more complex cognitive abilities on the part of modern humans (Mellars 2005). Given the persistence of the use of this argument, it is imperative that we gain a better understanding of Aurignacian tool function. The shapes of the tools and the technology of their manufacture change, but do their uses? Do the more precise ”mental templates” reflect a specialization in tool production, with specialized tools being produced for certain tasks? Or were Aurignacian tools multi-functional?

## Stone Tool Function at Hohle Fels

Hohle Fels is located in the Ach Valley of southwestern Germany and contains a deep sequence of Paleolithic deposits. Recent excavations have reached early Aurignacian layers, radiocarbon dated to 35,000-40,000 b.p. (AH [Archaeological Horizon] Va and Vb), marking the entry of the earliest modern humans into the region (Conard and Bolus 2008; Conard 2009). Since 2005, I have undertaken a combination of microscopic use-wear and residue analyses in an attempt to reconstruct tool function in the Aurignacian levels at Hohle Fels (AH IIIa-Vb).

Figure 3 shows an example of the complementary nature of use-wear and residue analysis. This pointed blade from AH Va at Hohle Fels was hafted and used as a projectile or thrusting implement as well as for butchery. Use-wear shows and impact fracture and polish from contact with a soft material. Striations confined to the proximal half of the tool help demonstrate the area that was under a haft. Residues of plant fiber are found in the same area. On the distal tip, hair fragments suggest that the soft polish represents contact with hide, most likely due to butchery.

Figure 4 illustrates a large (ca. 13 cm long) endscraper on a blade also from AH Va. This tool was hafted and used to scrape hide. The hafting was accomplished with the aid of a resin or plant exudate. The resin itself is striated due to movement of the tool within the haft. Plant fibers and hair are trapped within the mastic. At the distal end along the scraper edge, soft polish and hair fragments are consistent with a hideworking interpretation.

These examples demonstrate that a combination of use-wear and residue analyses provide detailed and robust interpretations of stone tool use. Armed with these techniques, I analyzed 78 artifacts from the Aurignacian levels at Hohle Fels. These included a wide variety of tool types that fell into 6 broader categories: blades, retouched blades, burins, endscrapers, pointed blades and flakes. If the hypothesis of tool specialization holds true, we should see certain materials being associated with certain tool types but not with others. If the opposite is true, we should see a range of overlapping materials as we look at different tool types. Table 1 demonstrates that the latter is the case. Retouched blades, for example, are used on a wide range of materials including animal, bird, bone, plant, wood, and starchy plants.

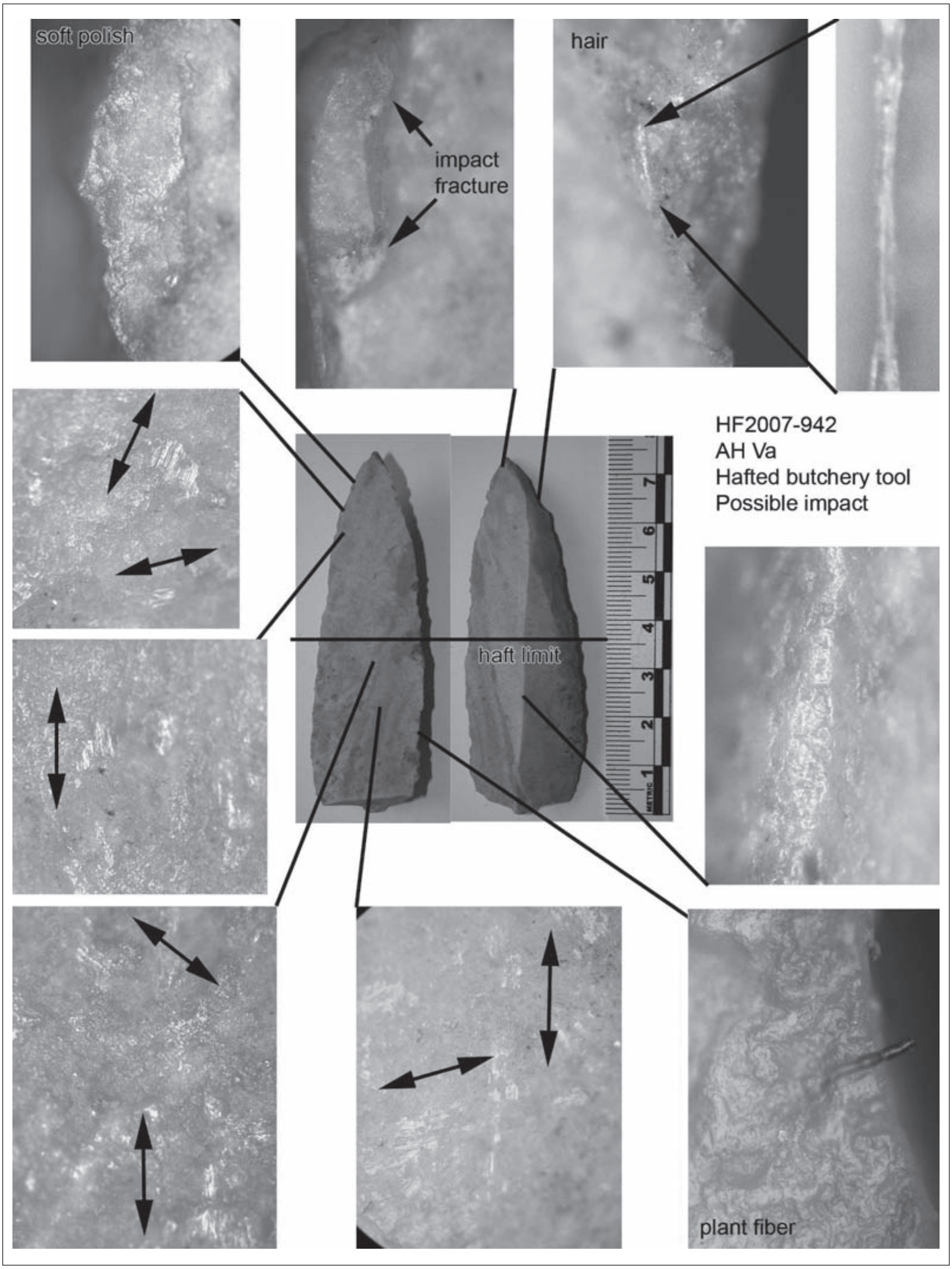


***Fig. 3:*** *Hohle Fels 2007-942. Pointed blade, Archaeological horizon Va.*

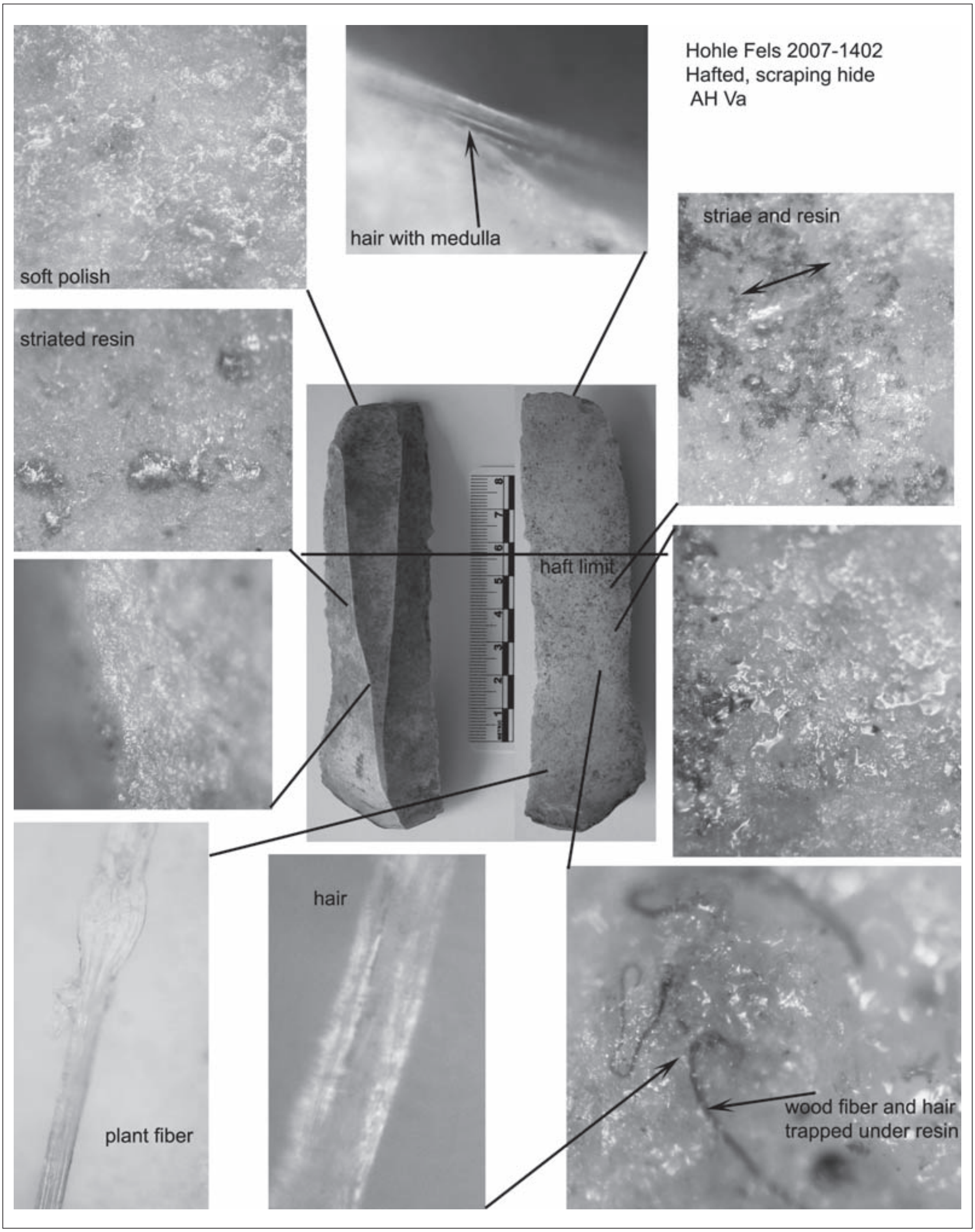


***Fig. 4:*** *Hohle Fels 2007-1402. Endscraper on blade, Archaeological Horizon Va.*

| Tool type | Animal | Bird | Bone | Plant | Wood | Starch | Soft | Hard | Unknown |
|---|---|---|---|---|---|---|---|---|---|
| Blades | √ | | | √ | √ | | √ | | √ |
| Retouched blades | √ | √ | √ | √ | √ | √ | | √ | √ |
| Burins | | | √ | √ | | | √ | √ | |
| Endscrapers | √ | √ | √ | √ | | | | √ | √ |
| Flakes | √ | | √ | √ | √ | √ | √ | | √ |
| Pointed blades | | | | √ | √ | | √ | √ | |

***Table 1:*** *Tool type categories and worked materials from the Aurignacian of Hohle Fels.*

Thus, at least in the Aurignacian at Hohle Fels, tool types do not appear to indicate specialization. Instead, multiple different materials are processed by any single typological category. Multi-functionality is the norm. So even though technology changes and becomes, according to some, more standardized, this is not accompanied by the creation of specialized tool types. In reference to the presumed increasing standardization of Upper Paleolithic stone tools, Marks et al. (2001, 41) conclude: "We feel it is incumbent upon those who accept the questionable clichés of traditional West European typology to document their validity before using them as even collateral evidence for generalizations about symbolic behavior that may be more convincingly seen elsewhere". In light of the evidence presented here, I suggest that their cautionary critique be extended to the realm of stone tool function. Rather than just basing arguments for differences in cognitive abilities on the changing shapes of stone tools, we should first seek to understand their use.

## References


Anderson, P. 1980: A Testimony of Prehistoric Tasks: Diagnostic Residues on Stone Tool Working Edges. World Archaeology 12(2), 181-194.

Anderson-Gerfaud, P. 1981: Contribution méthodologique a l'analyse des microtraces d'utilisation sur les outils préhistoriques. Thèse de Troisième Cycle, Université de Bordeaux.

Bamforth, D. 1986: Technological Efficiency and Tool Curation. American Antiquity 51, 38-50.

Beyries, S. 1988: Industries Lithiques: Tracéologie et Technologie. BAR International Series 411. 2 volumes, London.

Brandt, S. 1996: The Ethnoarchaeology of Flaked Stone-tool Use in Southern Ethiopia. In: Pwitit, G. and Soper, R. (eds.), Aspects of African Archaeology. Papers from the 10th Congress of the PanAfrican Association for Prehistory and Related Studies. Harare: University of Zimbabwe Publications, 733-738.

Brandt, S., Weedman, K., and Hundle, G. 1996: Gurage Hideworking, Stone-tool Use and Social Identity: An Ethnoarchaeological Perspective. In: Hudson, G. (ed.), Essays on Gurage Language and Culture. Wiesbaden: Harrassowitz Verlag, 35-51.

Brandt, S. and Weedman, K. 1997: The Ethnoarchaeology of Hideworking and Flaked Stone-tool Use in Southern Ethiopia. In: Fukui, F., Kuimoto, E., and Shigeta, M. (eds.), Ethiopia in Broader Perspective. Papers of the XIIth International Conference on Ethiopian Studies. Kyoto: Shokado Book Sellers, 315-361.

Briuer, F. 1976: New clues to stone tool function: plant and animal residues. American Antiquity 41(4), 478-484.

Brom, T. 1986: Microscopic identification of feathers and feather fragments of palearctic birds. Bijdragen tot de Dierkunde 56, 181-204.

Brose, D. 1975: Functional analysis of stone tools: a cautionary note on the role of animal fats. American Antiquity 40, 86–94.

Chandler, A. 1916: A study of feathers, with reference to their taxonomic significance. University of California Publications in Zoology 13(11), 243-446.
Conard, N. J. 2009: A female figurine from the basal Aurignacian of Hohle Fels Cave in southwestern Germany. Nature 459, 248-252.
Conard, N. and Bolus, M. 2008: Radiocarbon dating the late Middle Paleolithic and the Aurignacian of the Swabian Jura. Journal of Human Evolution 55, 886-897.
Day, M. 1966: Identification of hair and feather fragments in the guts and faeces of stoats and weasels. Journal of Zoology (Lond.) 148, 201-217.
de Sonneville-Bordes, D. and Perrot, J. 1956: Lexique typologique du Paléolithique supérieur. Bulletin de la Société Préhistorique Française 53(9), 547-559.
Dove, C. and Peurach, S. 2002: Microscopic analysis of feather and hair fragments associated with human mummified remains from Kagamil Island, Alaska. Ethnographical Series 20, 51-62.
Fahn, A. 1982: Plant Anatomy. Oxford: Pergamon.
Fullagar, R. 1991: The role of silica in polish formation. Journal of Archaeological Science 18, 1-24.
Gott, B., Barton, H., Samuel, D., and Torrence, R. 2006: Biology of Starch. In: Torrence, R. and Barton, H. (eds.), Ancient Starch Research. Left Coast Press, 35-46.
Hardy, B. L. and Garufi, G. T. 1998: Identification of woodworking on stone tools through residue and use-wear analyses: Experimental results. Journal of Archaeological Science 25, 177-184.
Hardy, B. L., Bolus, M., and Conard, N. J. 2008: Hammer or crescent wrench? Stone tool form and function in the Aurignacian of Southwest Germany. Journal of Human Evolution 54, 648-662.
Hardy, B. L., Kay, M., Marks, A. E., and Monigal, K. 2001: Stone tool function at the Paleolithic sites of Starosele and Buran Kaya III, Crimea: Behavioral implications. Proceedings of the National Academy of Sciences of the U.S.A. 98, 10972-10977.
Hayden, B. 1990: The right rub: hide working in high ranking households. In: Graslund, B. (ed.), The interpretative possibilities of microwear studies. Uppsala: Societas Archaeologica Upsaliensis, 89-102.
Jones, P. 1981: Experimental implement manufacture and use: A case study from Olduvai Gorge, Tanzania. Philosophical Transactions of the Royal Society of London, Series B, Biological Sciences 292(1057), 189-195.
Keeley, L. 1980: Experimental Determination of Stone Tool Uses: A Microwear Analysis. Chicago: University of Chicago.
Loy, T. 1983: Prehistoric blood residues: detection on tool surfaces and identification of species of origin. Science 220, 1269-1271.
Marks, A., Hietala, H., and Williams, J. 2001: Tool Standardization in the Middle and Upper Paleolithic: a Closer Look. Cambridge Archaeological Journal 11(1), 17-44.
Mellars, P. 1989: Technological changes across the Middle-Upper Palaeolithic transition: technological, social and cognitive perspectives. In: Mellars, P. and Stringer, C. (eds.), The human revolution: behavioural and biological perspectives on the origins of modern humans. Edinburgh: Edinburgh University Press, 338–365.
Mellars, P. 1996: The Neanderthal legacy: an archaeological perspective from Western Europe. Princeton: Princeton University Press.
Mellars, P. 2005: The Impossible Coincidence. A Single-Species Model for the Origins of Modern Human Behavior in Europe. Evolutionary Anthropology 14, 12-27.
Newcomer, M., Grace, R., and Unger-Hamilton, R. 1986: Investigating microwear polishes with blind tests. Journal of Archaeological Science 13, 203-17.
Nilsson, S. 1868: The Primitive Inhabitants of Scandinavia. 3rd Edition, transl. by J. Lubbock. London: Longman's, Green.
O'Brien, E. 1981: The Projectile Capabilities of an Acheulian Handaxe from Olorgesailie. Current Anthropology 22(1), 76-79.
Odell, G. and Odell-Vereecken, F. 1980: Verifying the reliability of lithic use-wear assessments by "blind tests": The low-power approach. Journal of Field Archaeology 7, 87-120.
Parr, J. F. 2002: The Identification of Xanthorrhoea Resins by Starch Morphology: Prospects for Archaeological and Taxonomic Applications. Economic Botany 56(3), 260-270.
Rogers, J., Dove, C., Heacker, M., and Graves, G. 2002: Identification of feathers in textiles from the Craig Mound at Sprio, Oklahoma. Southeastern Archaeology 21(2), 245-251.
Semenov, S. 1964: Prehistoric Technology. London: Cory, Adams and Mackay.
Teerink, B. 1991: Hair of West-European Mammals. Cambridge: University of Cambridge Press.

Torrence, R. 2006: Starch and Archaeology. In: Torrence, R. and Barton, H. (eds.), Ancient Starch Research. Left Coast Press, 17-34.

Toth, N. and Schick, K. 2007: Overview of Paleolithic Archaeology. In: Henke, W. and Tattersall, I. (eds.), Handbook of Paleoanthropology, Volume 3. New York: Springer-Verlag, 1943-1964

Vaughan, P. 1985: Use-wear analysis of flaked stone tools. Tucson, Arizona: University of Arizona Press.

Wadley, L., Lombard, M., and Williamson, B. 2004: The first residue analysis blind tests: results and lessons learnt. Journal of Archaeological Science 31, 1491-1501.

Weedman, K. 2002: On the Spur of the Moment: Effects of Age and Experience on Hafted Stone Scraper Morphology. American Antiquity 67(4), 731-744.

Weedman, K. 2006: An Ethnoarchaeological Study of hafting and stone Tool Diversity among the Gamo of Ethiopia. Journal of Archaeological Method and Theory 13(3), 189-238.

White, J. 1969: Typologies for some prehistoric flaked stone artefacts of the Australian New Guinea Highlands. Archaeology and Physical Anthropology in Oceania 4(1), 18-46.

Whittaker, J. 1994: Flintknapping: Making and Understanding Stone Tools. Austin: University of Texas Press.