doi: 10.7485/QU65_1 Quartär 65 (2018): 7-49

Burin-core technology in Aurignacian horizons IIIa and IV of Hohle Fels Cave (Southwestern Germany)

Die Stichelkern-Technologie der Aurignacien-Horizonte IIIa und IV der Hohle Fels-Höhle (Südwestdeutschland)

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Abstract - Hohle Fels Cave near Schelklingen in the Ach Valley (Swabian Jura) has yielded a rich archaeological sequence with Magdalenian, Gravettian, Aurignacian and Middle Palaeolithic horizons. One meter of deposits preserve the Aurignacian archaeological horizons AH IIIa to Vb (Conard et al. 2015; Miller 2015). Bladelet production from AH IIIa (GH 6a) and AH IV (GH 7) document the importance of formal burins as bladelet cores (Bataille & Conard 2016 & 2018). These cores deliver small and narrow blanks, often with straight as well as on- and off-axis twisted profiles. Lamellar burin spalls with intentional modifications and use wear traces are characteristic for AHs IIIa and IV (Bataille & Conard 2018). Here we examine technological and typological features of these archaeological horizons. Specific lihic tools seem to have played an important role in the production of the large number of ornamental and symbolic organic artefacts produced on site (e.g. Conard 2009; Conard & Malina 2006 & 2009; Wolf 2015). In this context, the presence of lamellar burin spalls with distal use traces in the Hohle Fels assemblages was interpreted as tools for the incision of tiny holes into perforated beads (Bataille & Conard 2018). While characteristic Aurignacian types constitute one part of burin-cores, such as carinated and busked burins, another part is comprised by burin-cores with multiple lamellar scars on the small and lateral edges preferentially produced on straight blades, such as dihedral burins and burins on truncation. The potential core-character of different burin types is discussed. Among them are carinated, busked, dihedral, simple burins and burins on truncation. Carinated and nosed endscraper-cores with small reduction faces are also present in AH IIIa with only three pieces. In contrast, burin-cores dominate the bladelet core category. We discuss the technological and morphological variability of burin-cores as well as burins with less than three lamellar negatives from AHs IIIa and IV. The potential function of burin-core reduction in the context of activities in Hohle Fels Cave is discussed. The application of specific concepts of bladelet production in the Aurignacian assemblages is likely the result of functional demands. The paper highlights the importance of regional studies to understand the choice of specific reduction processes in the context of varying economical and socio-cultural settings.

***Zusammenfassung -** Der Hohle Fels bei Schelklingen im Achtal (Schwäbische Alb) weist eine reichhaltige archäologische Sequenz mit Horizonten des Magdalénien, Gravettien, Aurignacien und des späten Mittelpaläolithikums auf. Die archäologischen Horizonte des Aurignacien AH IIIa bis Vb lagern in einem ein Meter mächtigen Sedimentpaket (Conard et al. 2015; Miller 2015). Die Lamellenproduktion der AH IIIa und AH IV basiert auf der Reduktion formaler Stichel (Bataille & Conard 2016 & 2018). Von diesen Kernen wurden kleine schmale Lamellen, häufig mit geraden und tordierten Profilen gewonnen. Stichellamellen mit intentional angebrachten Retuschen sowie Gebrauchsspuren sind charakteristisch für die archäologischen Horizonte IIIa and IV (Bataille & Conard 2018). Wir untersuchen technologische und typologische Merkmale dieser archäologischen Horizonte. Spezifische Steingeräte scheinen eine wichtige Rolle bei der am Fundplatz durchgeführten Herstellung der zahlreichen ornamentalen und symbolischen organischen Artefakte gespielt zu haben (z.B. Conard 2009; Conard & Malina 2006 & 2009; Wolf 2015). In diesem Kontext wurden Stichellamellen mit distalen Gebrauchsspuren als Geräte zur abschließenden Durchlochung kleiner Perlen interpretiert (Bataille & Conard 2018). Während charakteristische Artefakt-Typen des Aurignacien, wie Kiel- und Bogenstichel, einen Teil der Stichelkerne ausmachen, handelt es sich bei anderen um Stichelkerne mit lamellaren Negativen an den Schmal- und Lateralkanten, wie Dihedral- und Stichel an Endretusche. Diese wurden vorzugweise an Klingen präpariert. Die wahrscheinliche Nutzung unterschiedlicher Sticheltypen als Lamellenkerne wird in diesem Zusammenhang diskutiert. Kiel- und Nasenkratzerkerne mit kleinen Reduktionsflächen sind im AH IIIa mit nur drei Stücken vertreten, wohingegen Stichelkerne unter den Lamellenkernen dominieren. Wir diskutieren die technologische und morphologische Variabilität von Lamellenkernen sowie von formalen Sticheln mit weniger als drei lamellaren Negativen am Beispiel der AH IIIa und IV. Desweiteren diskutieren wir die mögliche Funktion von Stichelkernen im Kontext der Aktivitäten im Hohle Fels. Die Anwendung unterschiedlicher Konzepte der Lamellenproduktion in Aurignacien-Inventaren lässt sich wahrscheinlich auf unterschiedliche funktionale Anforderungen zurückführen. Damit*

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zusammenhängend verweisen wir in diesem Artikel auf die Wichtigkeit regionaler Studien, um ein besseres Verständnis für die Auswahl und Anwendung spezifischer Reduktionskonzepte durch spät-pleistozäne Menschen im Kontext variierender ökonomischer und sozio-funktionaler Gegebenheiten zu erlangen.

Keywords - Aurignacian, techno-functional facies, Working Stage Analysis, burin-core reduction
Aurignacien, techno-funktionale Fazies, Arbeitsschrittanalyse, Stichelkernreduktion

Introduction

Hohle Fels Cave is situated near the "town of Schelklingen" in the Ach Valley, a secondary valley of the Danube Valley, which crosses the Swabian Jura from west to east (Fig. 1). The cave yields a rich Pleistocene archaeological sequence with Magdalenian, Gravettian, Aurignacian and late Middle Palaeolithic horizons. Deposits (GH 6a, 6b, 7, 7a, 7aa & 8) of one meter thickness exhibit Aurignacian archaeological horizons AH IIIa to Vb over an excavation area of 32 m^2 (AHs IIIa & IV) (Conard et al. 2015; Miller 2015) (Fig. 2). On top of AH IIIa two further archaeological horizons (AHs IId & IIe) exhibit artefacts of Aurignacian and Gravettian association; potential causal taphonomic and cultural factors are under investigation. Calibrated radiocarbon dates of the Aurignacian sequence (AH IIIa to Vb) range between 42.0 ka and 35.5 ka calBP (Conard & Bolus 2008; Bataille & Conard 2018). The Aurignacian commences in a warm phase during Greenland Interstadial (GI) 10 preceding the marked cold phase of the Heinrich 4 event. Absolute ages of the upper Aurignacian horizons AH IIIa, IIIb and IV range between 38'900 and 34'000 calBP. Palynological and micromorphological analyses show that the deposition took place during stadial (AH IV)

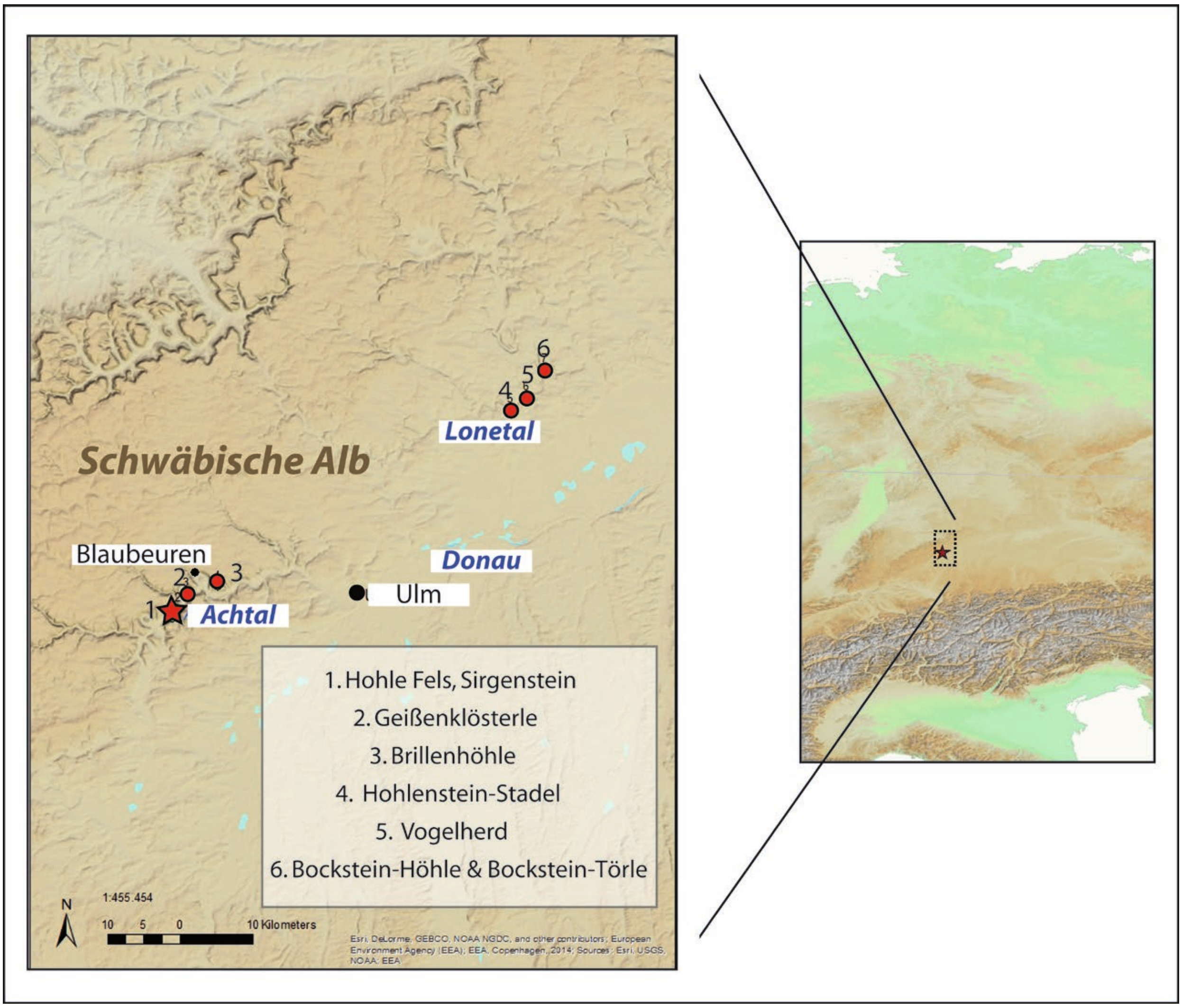


Fig. 1. Map with cave sites of the Ach and the Lone Valley in the Swabian Jura ("Schwäbische Alb") bearing Aurignacian assemblages (Southwestern Germany).

Abb. 1. *Karte der Höhlenfundplätze in Ach- und Lonetal auf der Schwäbischen Alb (Südwestdeutschland) .mit Inventare des Aurignacien.*

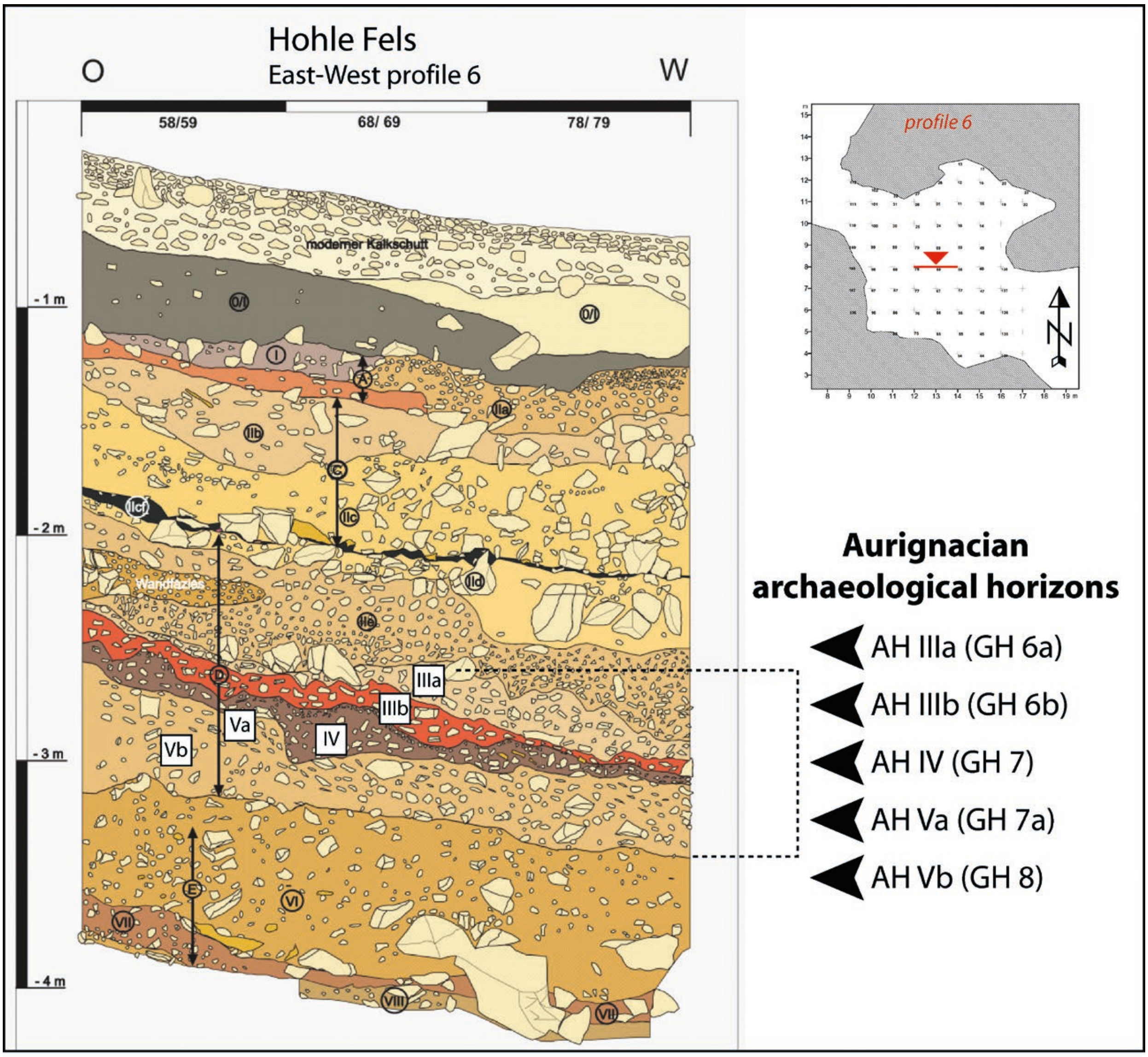


Fig. 2. Hohle Fels Cave, archaeological stratigraphy, East-West profile 6, direction of view: south. Aurignacian archaeological (AH) and geological (GH) main horizons from bottom to top: AHs Vb, Va, IV, IIIb & IIIa. The Aurignacian deposits, indicated by the letter D, are of about one metre thickness. Modified after: Conard et al. 2015: Fig. 83.

Abb. 2. *Hohle Fels, archäologische Stratigrafie, Ost-West-Profil 6, Blickrichtung: Süd. Archäologische (AH) und geologische (GH) Horizonte des Aurignacien vom Liegenden zum Hangenden: AH Vb, Va, IV, IIIb & IIIa. Die Ablagerungen des Aurignacien, markiert durch den Buchstaben D, weisen eine Mächtigkeit von rund einem Meter auf. Modifiziert nach: Conard et al. 2015: Fig. 83.*

and interstadial conditions (AH V, IIIa & IIIb) (Riehl et al. 2014: 164 f.; Miller 2015: 157 ff.; Rhodes et al. 2019). At the same time, the late Aurignacian phase coincides with an increase of cool conditions after 40'000 calBP. The time range of AH IV indicates the deposition during the end of Heinrich 4 event (Greenland stadial 9 / GS 9) or according to Riehl et al. (2014) during GS 8. The deposition of the upper AHs IIIa and IIIb took place during GI 7. The calibrated ages of the lower Aurignacian-Gravettian transitional horizon AH IIe is in accordance with AH IIIa, while the upper one AH IId is temporarily consistent with the Gravettian onset at Hohle Fels Cave after GI 7 (Conard & Bolus 2008; Taller & Conard 2016; Bataille & Conard 2018). New micro-mammal studies confirm that the environment during the late MP was slightly warmer than during the preceding Aurignacian occupations (Rhodes et al. 2018: 40). However, there was no severe cold phase between the uppermost MP (GH 9 / AH VI) and the lowermost Aurignacian horizon (GH 8 upper section / AH Vb) which could explain the described occupational hiatus GH 8 (lower section) between both archaeological chrono-cultural entities (Rhodes et al. 2019: 30 f.). The results of the same study indicate gradual cooling during the Aurignacian occupation of the site and a cold signal in GH 7a/7aa which ends with the accumulation of AH 7 (AH IV), followed by a shift back to more temperate conditions (Rhodes et al. 2019: 30-31). In this context, Rhodes et al. state that there is the "possibility that the markedly cold period recognized in the sedimentary and small mammal material directly following the earliest Aurignacian in

GH 7a/7aa reflects the onset of H4 in the region. The effect of this cold event extends through GH 7a/7aa and ends with the onset of a warm phase beginning in GH 7. This warming signal is slightly earlier in the stratigraphic chronology than expected, as sedimentary and C14 dating place interstadial 7 at GH 6a (directly overlying GH 7)" (Rhodes et al.: 39). Our technological investigations of the upper part of the Aurignacian sequence (GH 7 to GH 6a) indicate the production of narrow microblades by the application of the burin technology (Bataille & Conard 2016, 2018). The present article addresses the morphological and technological variety as well as specific concepts of burin-core reduction. For this, the authors present production and reduction sequences of burins from the uppermost Aurignacian horizon AH IIIa (GH 6a) and the underlying horizon AH IV (GH 7).

A short research history of burins

The burin is an important but functionally bipartite artifact category. Scholars established the burin as lithic artifact type early in Prehistoric research of France (e.g. Troyon 1860; Le Gay 1877; Mortillet & Mortillet 1900; Bardon & Bouyssonie 1906 & 1910; Bourlon 1911; Breuil 1912; Cheynier 1963). During the first decades of research, an interpretation of burins solely as tools was common, while in the second half of the 20th century their core-function shifted into focus (e.g. Pradel 1962; Cheynier 1963; Brézillon 1968; Brou & Le Brun-Ricalens 2005; Le Brun-Ricalens 2005: 29; Le Brun-Ricalens et al. 2006b). The considered use of burins analogue to modern metal burins, by incising the small edge ("*Stichelschneide*", "*biseau*") into hard material such as mammoth ivory was eponymous for the burin category (e.g. Hahn 1991; Guthrie 2005). European artists and artisans, among them Albrecht Dürer, use metal burins manually since the second half of the fifteenth century in the context of engravings on metal plates in order to produce etchings ("*Radierungen*") (Brockhaus Conversations-Lexikon 1809, 341 ff.). Today, modern metal burins are used in a variety of carving tasks on hard material. A similar use was assumed for Palaeolithic burins in the context of carving hard organic material. Scholars assumed that such processing of hard organic material as bone, antler and ivory was conducted by the use of Palaeolithic burins (e.g. Bosinski 1987: 25; Hahn 1991: 230; Knecht 1988; Plisson 2006: 29). Results of microscope use-wear analyses since the 1970s changed this picture (Pasda 2013: 426). Experimental and microscopic analyses showed that burin-tools functioned in a variety of different tasks (Hahn 1991, 230; Hilbert et al. 2018; Hardy et al. 2008). In cases in which burins bear micro-traces, these traces usually occur along the lateral edges of the burin negatives and of the blank itself (e.g. Gassin et al. 2006; Ibánez & Urquijo 2006).

French researchers defined different burin types according to morphological and typological features, among them the Aurignacian directory fossils "burins carénés", "burins busqués" and "burins des Vachons" (e.g. Bardon & Bouyssonie 1906; Perpère 1972; Pessesse & Michel 2006). While the burins are primarily associated with the Upper Palaeolithic, they occasionally occur in Acheuléen and Middle Palaeolithic contexts, like in the Crimean Middle Palaeolithic (Pradel 1948; Bordes 1961: 32; Schmider 1988; Chabai 2005: Fig II-28). These simple burins often exhibit only one, sometimes more negatives. The latter are often dihedral burins with a pointed distal end that is formed by the detachment of two oblique negatives along the lateral edges. Moreover, the "burin moustérien" is a common type in François Bordes' Middle Palaeolithic tool list enlisted under number 32 ("burins typique") (Bordes 1961 & 1992: 134). Different from many Upper Palaeolithic examples, these burins often lack lamellar negatives and are interpreted as tools. In these cases, which also occur in Upper Palaeolithic contexts, the detached burin waste might be by-products from the manufacturing of burin-tools ("*Stichelabfall*"). On the other hand, among the burin types subsumed under the term "burin moustérien" are burins on truncation (Bordes 1961: Pl. 34, 6 & 9) and dihedral burins (Bordes 1961: Pl. 34, 12). Technological and functional analyses of burins with series of lamellar scars, among them carinated and busked pieces, from Aurignacian assemblages of le Flageolet I (France) emphasized that such artefacts were cores for the production of bladelets (Hays & Lucas 2000). Although J. Hahn generally considered burins as tools, he referred to the potential core character of formal burins and the specific burin technique by the production of different kinds of blank forms he subsumes among the term burin waste (Hahn 1991, 174). "*Die Sticheltechnik entfernt längliche, aber auch kurze Späne von einer Plattform aus, die in der Regel mit einem Winkel von etwa 90° quer zur Ventralfläche liegt. Im Grunde ist ein Stichel eine Art von Kern an einer geschlagenen Grundform*" (Hahn 1991, 172). Studies that are more recent confirm the core function of burin types typical for the Aurignacian (e.g. Le Brun-Ricalens & Brou 2003; Le Brun-Ricalens 2005; Brou & Le Brun-Ricalens 2006; Le Brun-Ricalens et al. 2006a & b; Dinnis & Flas 2006; Flas et al. 2006). Burin-core technology incorporated within the regular blade production sequences from the initial Upper Palaeolithic site Kara-Bom in the Siberian Altai was described as characteristic strategy for bladelet production (Zwyns et al. 2012). In addition, Middle Palaeolithic horizons, as Wallertheim D Riencourt-lès-Bapaume, Grotte de Néron and Champ Grand exhibit lithic assemblages showing the intentional production of lamellar blanks from burin-cores (Slimak & Lucas 2005; Slimak 2006; Conard & Adler 1997).

Regarding the discussion about the reduction of burin-cores in the Aurignacian context, especially "*burins épais*" were considered as bladelet cores under the terms "*burins carénés*" and "*burins nucléiformes*" (Le Brun-Ricalens 2005; Le Brun-Ricalens & Brou 2013). Scholars interpret the specific Aurignacian directory fossils carinated and nosed endscrapers as bladelet cores, as well (e.g. Inizan et al. 1995; Le Brun-Ricalens 2005; Lucas 2006).

The early Upper Palaeolithic so called Spitsynian industry is known from the two nearby sites Kostenki 12, Level II and Kostenki 17, Level II situated within the Central Russian plain near the river Don (Clarke 1969; Anikovich 1992; Hoffecker et al. 2008). The latter assemblage marks together with Kostenki 14/IVb1-2 the initial phase of the early Upper Palaeolithic in the Eastern European Plain. While Kostenki 14 IVb1-2 exhibits Aurignacian elements, Kostenki 17 / II is void of Aurignacian tool and core types. Carefully and regularly produced burins on truncation are directory fossils of that industry. Technological studies on the lithic assemblage of Kostenki 17, layer II show that dihedral burins and burins on (concave) truncation, which is the diagnostic lithic form of the so called Spitsynian industry, functioned as cores for the production of narrow microblades (Bataille, 2013, in press). The burin-cores (Bataille 2013, Taf. 14.3.5) exhibit straight and narrow reduction faces for the production of narrow and straight microblades. Although technologically and typologically different from the so called Protoaurignacian researchers falsely assigned this assemblage to that industry, (Dinnis et al. 2019). However, technological differences to assemblages classified as Protoaurignacian from Siuren 1, Units H and G (Demidenko 2008-2009, 2012), as well as Fumane layers A1 and A2 (Falcucci et al. 2017) are evident: sub-pyramidal, sub-cylindrical, sub-prismatic and carinated bladelet cores with straight reduction faces typical for Protoaurigancian assemblages are lacking in Kostenki 17, layer II (Bataille 2013). Burin technique for bladelet production, different from the one present at Kostenki 17/II, was also applied in the Aurignacian *sensu lato* assemblages from Kostenki 14/IVb1-2 (Bataille 2013; Bataille et al. 2018). The latter horizon shows burin-like production of straight and long bladelets from the narrow edges of plaquettes (narrow-faced cores with sub-cylindric reduction faces) and often from formal dihedral burins. Moreover, knappers reduced formal nosed endscrapers, carinated and busked burins as bladelet cores in Kostenki 14, layer IVb1-2 (Sinitsyn 2010; Bataille, 2013). Comparatively high proportions of lamellar burin spalls (lbs in the following) representing the most important category among modified lamellar blanks confirm the important role of burin-cores (Bataille 2013, 531).

Technological investigations of AH IV from Hohle Fels Cave showed that carinated, busked and other burin core types on blanks with reduction faces on the lateral or small edges were reduced in order to obtain bladelets and lamellar microliths (Bataille & Conard 2016, 2018). Laterally retouched lbs exhibiting mainly on-axis twisted and straight profiles, two ventral faces as well as triangular and trapezoidal cross-sections were detached from the lateral edges of burin-cores (Bataille & Conard 2018: 26 & 32 ff.). "*Especially the long and slim lamellar burin spalls exhibit on-axis twisted profiles, which are a result of the reduction along the slim, mostly lateral core edges*" (Bataille & Conard 2018: 33). Such burin-cores were mainly prepared on blades and longitudinal blanks in order to provide longitudinal and slim lateral edges as reduction faces. In spite of the specific combination of burin-core technology with a unidirectional blade core strategy and a tool composition characteristic for the Aurignacian of the Swabian Jura we proposed to name this techno-functional variant as "*Hohle Fels IV facies*" (Bataille & Conard 2018). The present article starts from this point of research and broadens the focus on regular burin types with multiple and singular lamellar scars. The specific burin-core technology in its functional context and in relation to the burin core types represented in the upper Aurignacian sequence of the Hohle Fels Cave is the central scope of this article.

Research questions

The importance of formal burins with core-function as well as the high number of lamellar burin spalls is characteristic for the assemblages of the upper Aurignacian sequence of Hohle Fels Cave (Bataille & Conard 2018). These characteristics reflect a formerly not discribed variant of the "Swabian Aurignacian" (e.g. Conard & Bolus 2006; Teyssandier et al. 2006). Formal burins with series of lamellar negatives as well as (lbs in the following) with intentional modifications and use traces indicate the core character of such burins. In this paper, we technologically investigate the burin assemblage of upper Aurignacian horizon IIIa and compare it with published results from lower-situated AH IV (Bataille & Conard 2018). By technological analyses of formal burins, we investigated their potential core function. Moreover, we examined technological convergences and divergences to the techno-functional variant, which we described for Hohle Fels AH IV. By directly comparing the tool and core components of both assemblages as well as technological and morphological properties, we aim to find out, if both assemblages represent the same technological variety of the western Central European Aurignacian.

Materials and Methods

For this study, likewise for AH IV (Bataille & Conard 2018) the authors investigated all cores and formal tools as well as a sample of blanks from the uppermost Aurignacian horizon AH IIIa by a combined techno-typological protocol. For a better understanding of the specific technological character of the assemblage, we describe in detail characteristic burins with multiple lamellar scars, which represent the whole range of burin types of AH IIIa. In the next step, we discusse convergences and divergences with identical analyses of AH IV (Bataille & Conard 2018). The main target is the reconstruction of the complete transformation history and the underlying technological concepts of the investigated burins-cores. This Working Stage Analysis (WSA in the following) is a variant of the diacritic method (Richter 1997; Pastoors 2001; Bataille 2016) (Fig. 3). Different from the latter, in the context of the WSA negatives struck from the same direction during a connected reduction step are regarded as one single working stage (ws in the following). The specific reduction sequence is observed by investigating the relation between different working stages (Bataille & Conard 2018). Finally, the respective function of single reduction steps is reconstructed. The observation of chronological relations between working stages is achieved by the observation of time-relations and varying orders of the negatives (Kurbjuhn 2005). More pronounced concavities as well as fissures, lanceolate and scaled splinters along the crest of younger negatives indicate time-relations to older ones (Richter 1997). Younger negatives, which usually show a more pronounced concavity than adjacent older ones, follow the shape of the older negatives. Additional to the WSA, the author investigated specific technological attributes, among them reduction angles and characteristics of platform preparation, in order to adress the potential core function of undoubted burin-cores (carinated and busked burins) and other burin types. In a second step, diagnostic reduction schemes and results of attribute analyses are discussed in the context of the chain opératoire of AH IIIa and compared with results of analyses from AH IV (Bataille & Conard 2018).

Tools and cores of AH IIIa and AH IV

For this study, all formal tools and cores of AH IIIa were investigated. Similair to AH IV, in AH IIIa blades

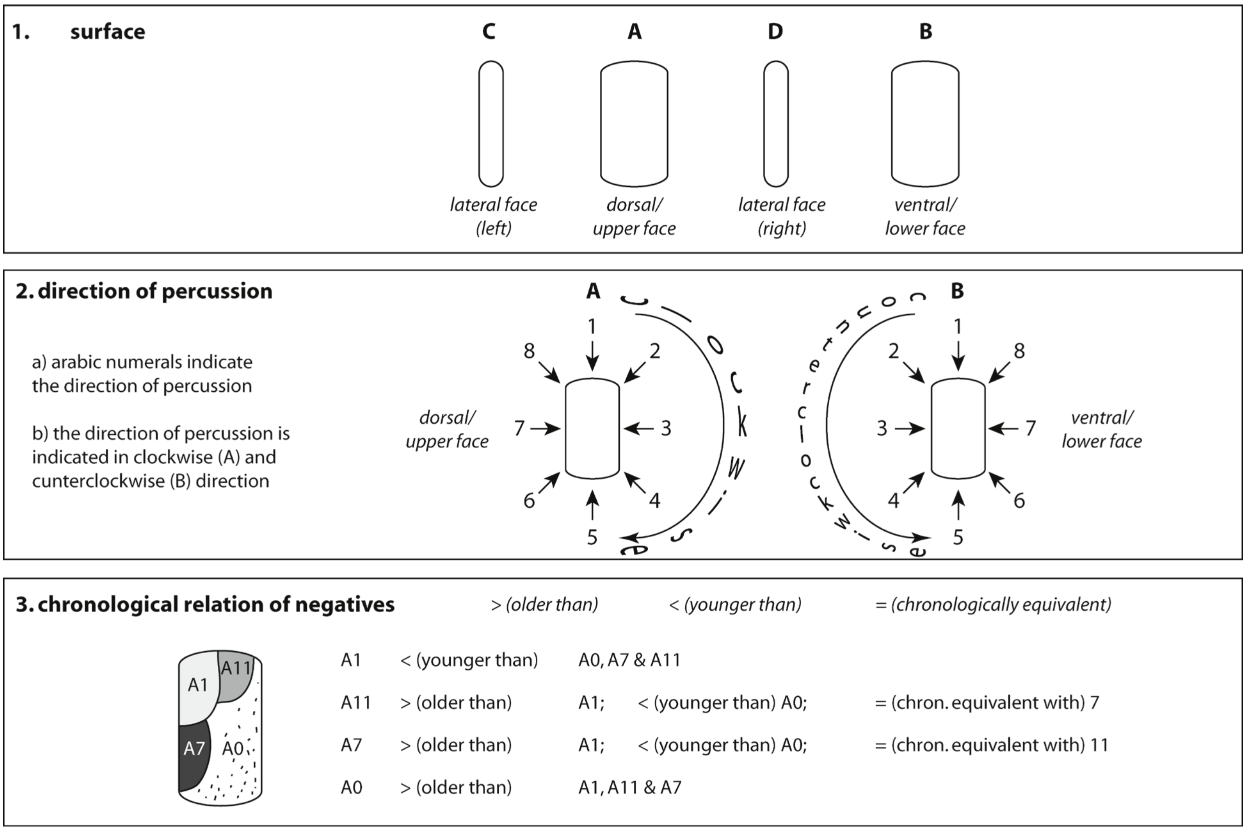


Fig. 3. Explanation of the main components of the Working Stage Analysis (WSA in the following). 1. The faces of the investigated burin-cores are indicated in Latin letters A, B, C & D. 2. The direction of percussion is indicated in Arabic numerals (e.g. A1, A2...A8) in clockwise and counter-clockwise direction. 3. The chronological relations between the working stages (single negatives or a series of negatives, which were struck within one connected sequence from one and the same direction) are indicated as older than (>), younger than (<) or chronologically equivalent (=). In cases when more than one working stage were struck from identical edges within the same direction, a second Arabic numeral marks the different reduction steps, e.g. surface A, direction of percussion 1, working stage number 1 etc. (A1, A11, A12, A13, A14 etc.).

Abb. 3. *Erläuterung der Hauptkomponenten der Arbeitsschrittanalyse (WSA im Folgenden). 1. Die Flächen der untersuchten Stichelkerne werden durch die lateinischen Buchstaben A, B, C & D codiert. 2. Die jeweilige Schlagrichtung wird durch arabische Zahlen (z. B. A1, A2…A8) im und gegen den Uhrzeigersinn angezeigt. 3. Chronologische Beziehungen zwischen Arbeitsschritten (einzelne Negative oder Serien von Negativen, welche im Zuge einer zusammengehörenden Handlungsfolge aus derselben Richtung angelegt wurden) werden als älter als (>), jünger als (<) oder chronologisch gleichzeitig (=) angegeben. In Fällen, in denen mehrere Arbeitsschritte von derselben Kante aus in identischer Richtung ausgeführt wurden, wird dies durch eine weitere zweite arabische Nummerierung angezeigt, z. B. Oberfläche A, Schlagrichtung 1, Arbeitsschritt-Nummer 1 etc. (A1, A11, A12, A13, A14 etc.).*

and bladelets are dominant blank products and lbs represent the majority of lamellar blanks (Bataille & Conard 2018: Tab. 4) (Fig. 4). In AH IIIa blades are dominant among modified blanks (Fig. 5). Among the 44 cores of AH IIIa, bladelet cores represent the dominant category (n = 33) (Fig. 6). In most cases, bladelet cores exhibit one reduction face (n = 25), while eight cores show multiple reduction faces. The comparatively low number of flake (n = 5) and blade cores (n = 3) indicates intensive on-site reduction processes in which such cores were probably reduced until exhaustion and bladelet production from formal burins marks the end of the operational chain. They are also a result of the import of pre-site prepared cores and blank sets, which could be proven in the course of raw material analyses and the sorting of the lithic material to raw material units (Transformation Analysis) (Bataille & Conard in preparation). The majority of bladelet cores are formal tools, among them 25 burins and three flat endscraper-cores: one carinated endscraper and two nosed endscrapers (Fig. 7). The two former bladelet cores show short reduction sequences while the latter indicates more intensive lamellar reduction from the steep reduction face (~90°) (Appendix, Plate 1). Five further artefacts can be considered as regular bladelet cores with sub-prismatic, sub-cylindrical and sub-pyramidal reduction faces. The number of regular cores prepared on raw nodules is comparatively low (n = 8). Most bladelet cores were produced on blanks. Two unreduced chert nodules indicate that also raw nodules were imported. Most bladelet cores were produced on blades (n = 19) and in only six cases on flakes (Fig. 8). The three carinated / nosed endscraper cores were prepared on flakes, while blades functioned as blanks for most burin-cores (n = 19). The latter is due to the preferred lamellar blanks, which are usually very slim with maximum width below six millimeter and mostly exhibit straight or twisted profiles (Bataille & Conard 2018).

Blade production of AH IIIa is consistent with the regular blade production system of the Aurignacian in the Swabian Jura; the same is true for AH IV. Usually, unidirectional-parallel and more seldom unidirectional-convergent blades were struck from cores with one or two adjacent reduction faces. Often cores exhibit only few target negatives (2-4) within one reduction cycle (Hahn 1988; Bataille & Conard 2018). Blades are the preferred blanks for lateral modification or the application of endscraper caps.

AH IIIa - blank type		n	%	n	%
flake	flake, simple	75	*12.1*	153	*24.6*
	flake, transversal	2	*0.3*		
	flake, crested	4	*0.6*		
	flake, remnant crest	7	*1.1*		
	flake, cortical edge	5	*0.8*		
	flake, resharpening	2	*0.3*		
	small flake (~1 cm)	58	*9.3*		
blade	blade, simple	113	*18.2*	176	*28.3*
	blade, crested	28	*4.5*		
	blade, remnant crest	21	*3.4*		
	blade, cortical edge	14	*2.3*		
bladelet	bladelet, simple	39	*6.3*	132	*21.3*
	bladelet, crested	3	*0.5*		
	bladelet, cortical edge	7	*1.1*		
	lamellar burin spall (lbs)	69	*11.1*		
	microblade, simple	14	*2.3*		
other	chip, retouch	4	*0.6*	160	*25.8*
	core tablet	4	*0.6*		
	chunk	32	*5.2*		
	chunk, frost	1	*0.2*		
	chunk, heating	1	*0.2*		
	burin waste	3	*0.5*		
	not recognizable	104	*16.8*		
	core	11	*1.8*		
total		**621**	***100***	**621**	***100***

Fig. 4. Hohle Fels, AH IIIa. Investigated blanks products including formal tools and cores.

Abb. 4. *Hohle Fels, AH IIIa. Untersuchte Grundformen, darunter formale Geräte und Kerne.*

AH IIIa - modified blanks		n	%	n	%
flake	flake, simple	29	*17.2*	39	*23.1*
	flake, remnant crest	5	*3.0*		
	flake, cortical edge	1	*0.6*		
	small flake (~1 cm)	4	*2.4*		
blade	blade, simple	58	*34.3*	92	*54.4*
	blade, crested	12	*7.1*		
	blade, remnant crest	13	*7.7*		
	blade, cortical edge	9	*5.3*		
bladelet	bladelet, simple	8	*4.7*	16	*9.5*
	lamellar burin spall (lbs)	8	*4.7*		
other	chunk	3	*1.8*	22	*13.0*
	chunk, frost	1	*0.6*		
	not recognizable	18	*10.7*		
total		**169**	***100***	**169**	***100***

Fig. 5. Hohle Fels, AH IIIa. Modified blanks.
Abb. 5. *Hohle Fels, AH IIIa. Modifizierte Grundformen.*

Especially, the forming of formal burins, among them burin-cores, was in many cases conducted on blades in AH IIIa and IV. The latter was not at least due to technological decisions.

The technological analysis of bladelets (maximum width 11.99-7.0 mm), microblades (<7.0 mm) and lamellar burin spalls (<12 mm) from AH IV showed the dominance of straight and on-axis twisted profiles among the latter and mostly straight profiles among bladelets as well as a dominance of on- and off-axis twisted profiles among the microblades (Bataille & Conard 2018). The reason for that is twofold: technologically, most lamellar burins were struck from burins on blades with reduction faces along the lateral edges. Strategically, slim but robust lamellar blanks were the main goal of burin-core reduction. These blanks were struck from burins on blades with straight reduction faces at the lateral edges. Concerning that, we argued that the triangular cross-section of these slim and long lamellar blanks achieved a certain robustness needed for working (hard) organic artefacts (Bataille & Conard 2018). Preliminary results of ongoing analyses of recognized lamellar blanks and the fine fraction from AH IIIa point into the same direction.

The tool and core composition of AH IIIa is techno-typologically quite close to the stratigraphically lower situated AH IV (Fig. 9). A high share of burin-cores and lamellar burin spalls, among them intentionally retouched and use trace bearing pieces characterize both assemblages. Also in AH IV, carinated and nosed endscrapers in most cases exhibit comparatively small and flat reduction faces. Likewise in AH IV, the formal burin component is high (23.1 %) in relation to formal endscrapers (7.1 %) and truncated pieces (10.9 %).

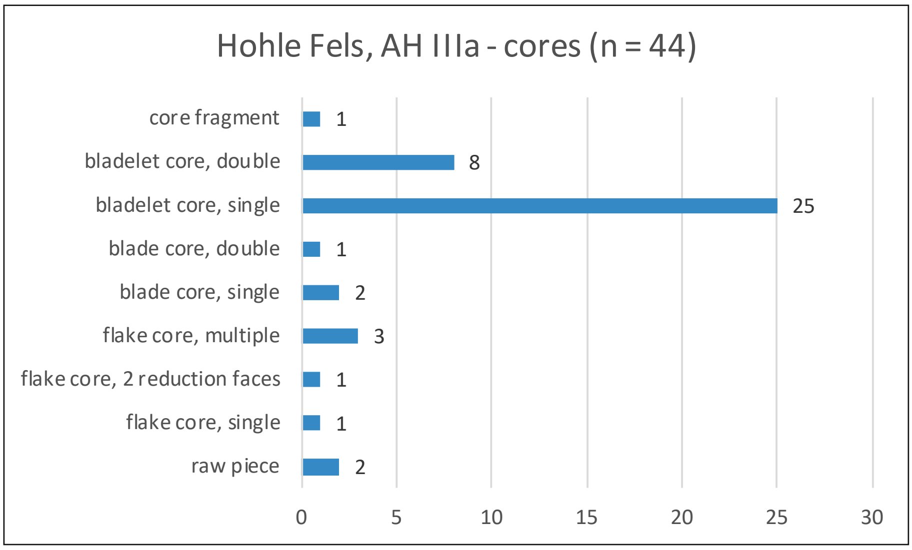


Fig. 6. Hohle Fels, AH IIIa. Core categories.
Abb. 6. *Hohle Fels, AH IIIa. Kernkategorien.*

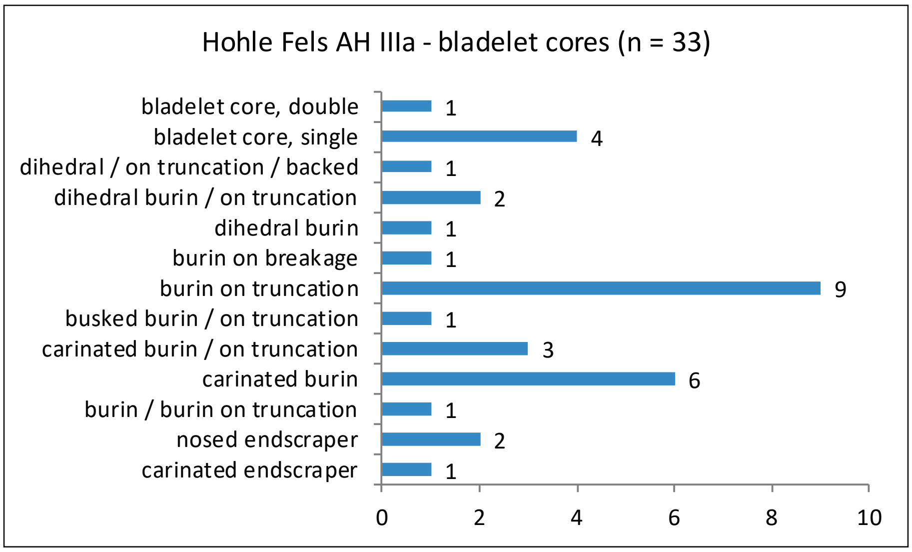


Fig. 7. Hohle Fels, AH IIIa. Core categories.
Abb. 7. *Hohle Fels, AH IIIa. Kernkategorien.*

Laterally retouched tools dominate in AH IIIa (39.1 %) and less pronounced in AH IV (32.1 %). We counted pointed blades here as lateral retouched pieces; in AH IIIa there is one simple point on blade and one pointed blade. The latter occur in AH IV in slightly bigger numbers (n = 9) (Bataille & Conard 2018). Altogether 23 artefacts count as lamellar microliths (14.7 %), among them 14 pieces with use traces. Since the analysis of artefacts <1cm and the fine fraction is not finished yet, it is likely that more lamellar blanks with intentional retouch and use traces will be found. To sum up, the lithic assemblages of both archeological horizons share a similar tool and core assemblage, a dominating unidirectional blade core reduction and a tool composition typical for the Aurignacian from Swabia. The characteristic bladelet production from burin-cores deviates the assemblages from regular description of the regional Aurignacian. The latter will be further elucidated in the following.

Burin variability in AHs IV and IIIa

Like in AH IV, the high number of burins, burin-cores and lamellar burin spalls in relation to other formal tools and lamellar blanks are a central characteristic of the assemblage (Bataille & Conard 2016 & 2018). From a qualitative point of view, the same types of burins with multiple lamellar scars are present in both horizons (Fig. 10). Aurignacian directory fossils are carinated and busked burins (Appendix, Plate 2). Burins on truncation form a characteristic group. The carefully prepared truncations function as striking platform with acute reduction angles (Appendix, Plate 3). Such striking platforms are present on carinated and busked burin-cores, as well.

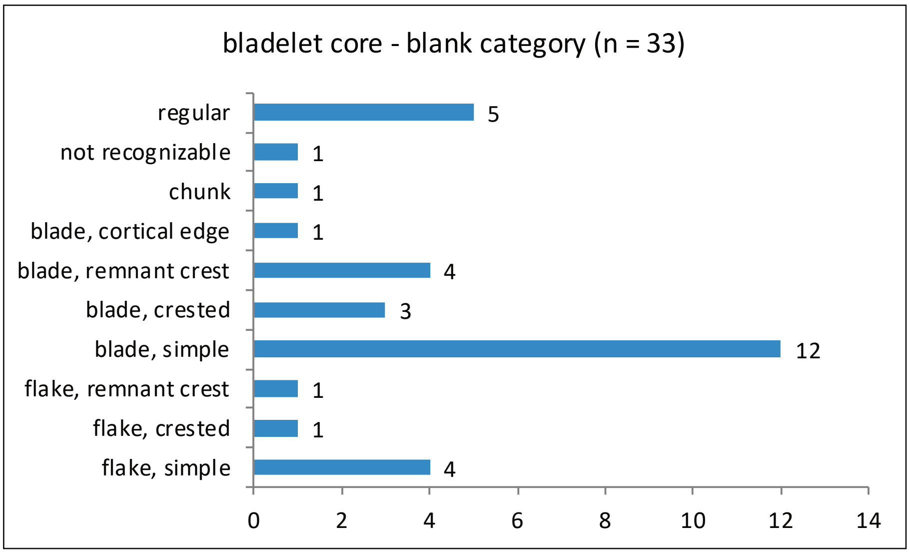


Fig. 8. Hohle Fels, AH IIIa. Blanks modified as bladelet cores.
Abb. 8. *Hohle Fels, AH IIIa. Als Lamellenkerne modifizierte Grundformen.*

AH IIIa - formal tools		n	%	lateral retouch	use / sediment
endscraper	simple	6	*3.6*	1	1
	simple / borer	1	*0.6*		
	simple / truncation	1	*0.6*		
	carinated	1	*0.6*		
	nosed / shouldered	2	*1.2*	1	1
truncation	truncation	17	*10.1*	6	4
	truncation / notch	1	*0.6*		
burin	simple	3	*1.8*		
	simple / borer	1	*0.6*	1	
	simple / on truncation	2	*1.2*	1	
	carinated	6	*3.6*	1	
	carinated / on truncation	3	*1.8*		
	busked / on truncation	1	*0.6*	1	
	dihedral	3	*1.8*	1	
	dihedral / on truncation	1	*0.6*		
	dihedral / on truncation / backed	1	*0.6*		1
	on truncation	15	*8.9*	5	
	on truncation / on breakage	1	*0.6*	1	1
	on breakage	1	*0.6*		
lateral retouch	sidescraper, simple	1	*0.6*		
	unilateral	29	*17.2*		3
	bilateral	13	*7.7*		1
	circulating	2	*1.2*		
	denticulate	5	*3.0*	3	
	notch	12	*7.1*	5	
	pointed blade	1	*0.6*		
	point, simple	1	*0.6*	1	
other	splintered piece	3	*1.8*		
	borer	4	*2.4*	3	2
	use / sediment	15	*8.9*		
microlith (lamellar)	truncation	1	*0.6*		1
	unilateral retouch	6	*3.6*		1
	bilateral retouch	5	*3.0*		
	borer	1	*0.6*		1
	use / sediment	3	*1.8*		
total		**169**	***100***	**31**	**17**

Fig. 9. Hohle Fels, AH IIIa. Formal tools.
Abb. 9. *Hohle Fels, AH IIIa. Formale Geräte.*

Concave truncations are present on burins on blades with straight reduction faces on the lateral edges, as well as on typical Aurignacian types such as busked burins produced on flakes. Dihedral burins and burins on lateral retouch are morphologically similar and exhibit acute reduction angles (Appendix, Plate 4 & 5: 3-4). Further types are on breakage and laterally reduced burins exhibiting reduction faces with multiple lamellar scars. Usually, all formal burin types exhibit a series of lamellar scars on one or more reduction edges. Remnants of core crests on lbs, often a series of lateral retouched negatives, capped by their ventral faces, indicate the careful preparation of reduction faces. Moreover, raw material units, use traces and intentional modifications on lbs (Appendix, Plate 5, 6 & Fig. 11) indicate the intentional removal of such blanks from burin cores in AHs IIIa and IV (Bataille & Conard 2018).

Morphological and technological properties of burin cores from AHs IV and IIIa

The burin cores from AH's IIIa and IV share formal and morphological analogies. Most of them are prepared on blades or on longitudinal blanks (Fig. 12). This is

core type - presence / absence	AH IV (n)	AH IIIa (n)
carinated burin	1	1
busked burin	1	1
dihedral burin	1	1
burin on truncation	1	1
burin on lateral retouch	1	1
burin on breakage	1	1
multiple lateral burin	1	0
simple lateral burin	1	1
simple burin on truncation	1	0
total types	9	7

Fig. 10. Hohle Fels, AHs IIIa & IV. Qualitative presence of burin core types.

Abb. 10. *Hohle Fels, AHs IIIa & IV. Qualitative Anwesenheit von Stichelkern-Typen.*

especially true for burin-cores, of which most were prepared on blades and few on flakes (Bataille & Conard 2018). Carinated and nosed endscraper-cores of AH IV were produced both on blades and on flakes. In AH IIIa knappers produced the three carinated and nosed endscraper-cores on flakes and a chunk. The striking surfaces for bladelet production from burin-cores in AH's IIIa and IV were usually prepared by the application of a regular "truncation" or "edge modification". From a formal point of view, many burin-cores can be described as "burins on truncation". Among them are carinated and busked burins as well as burins on blades with multiple lamellar negatives along one or both lateral edges. Moreover, these cores exhibit comparable reduction angles and sizes.

The angles between striking platform and lamellar reduction faces of considered burin-cores from AHs IIIa and IV emphasize the core character of these artefacts. The burin-cores exhibit angles between platforms and lamellar reduction faces which are close to the striking angles of regular blade cores (Bataille & Conard 2018). In most cases, they exhibit reduction angles around 60° (Fig. 13). In few cases blade and bladelet cores exhibit more acute angles around 45°. Contrary to these outliers, more blade and bladelet cores exhibit angles of 75° to 90°. Taking into consideration only burins from AHs IIIa and IV, the picture changes slightly (Fig. 14). Also in these cases angles around 60° dominate. At the same time, more burins show acute angles around 45°, especially in AH IV. The main reason for this is the high number of dihedral burins with comparatively acute edges at the small ends. In addition, burins with truncation-like laterally retouched striking platforms exhibit comparative angles. Only these burin categories exhibit extreme values around 30°. Another cause for acute reduction angles might be the application of a tangential striking technique when reducing bladelet cores (Bataille & Conard 2018). Also objects with by most scholars undoubted core functions, as carinated and busked burins as well as regular blade and bladelet cores from AHs IIIa and IV exhibit in few cases acute reduction angles around 45°. Regarding all investigated burins according to the respective type, angles around 60°

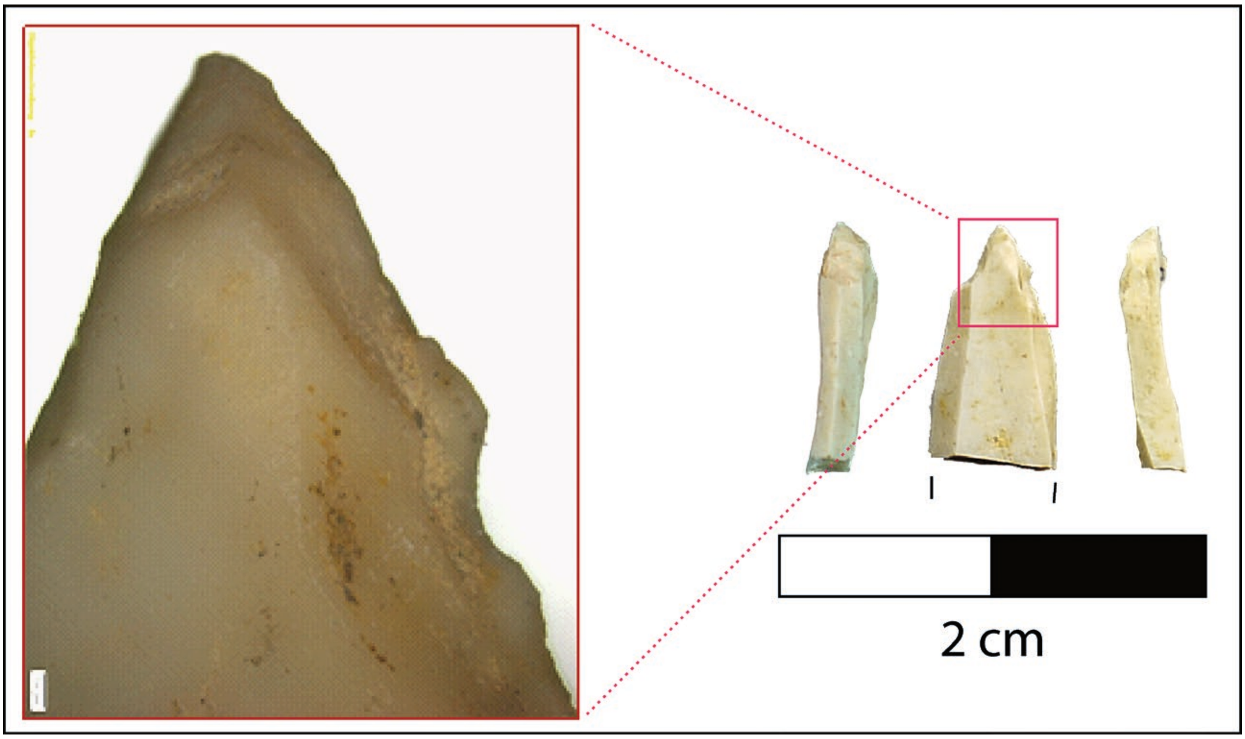


Fig. 11. Hohle Fels, AH IV. Lamellar burin spall with splintered distal end. The splinterings come from rotating movement on hard material. Measurements: max. width 5.6 mm, max. thickness 1.89 mm. Microscopic analysis & Graphic: G. Bataille; artefact photo: A. Falcucci.

Abb. 11. *Hohle Fels, AH IV. Stichellamelle mit gesplittertem Distalende. Die Aussplitterungen entstanden durch rotierende Bewegungen auf hartem Material. Maβe: max. Breite 5.6 mm, max. Dicke 1.89 mm. Microskopische Analyse & Grafik: G. Bataille; Artefaktfoto: A. Falcucci.*

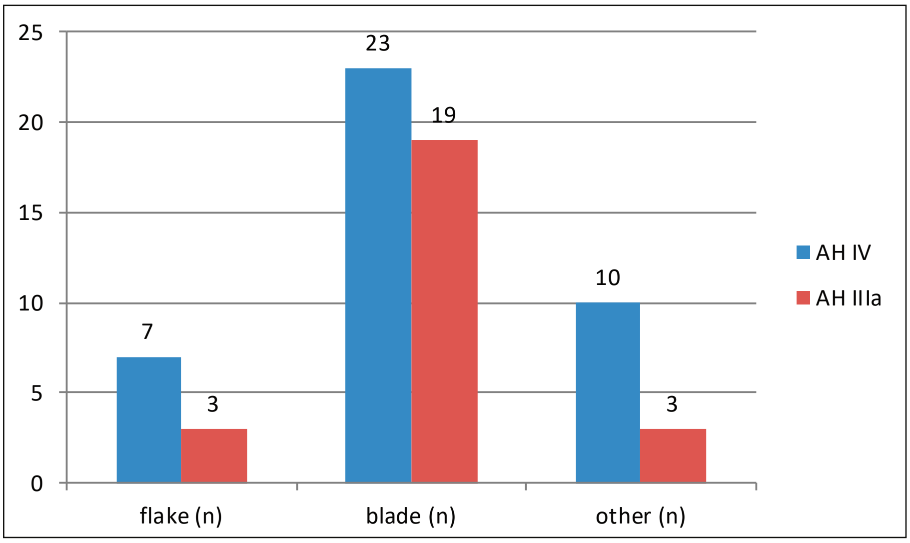


Fig. 12. Hohle Fels, AHs III & IV. Blank categories modified into burin-cores; AH IV: n = 43, AH IIIa: n = 25.

Abb. 12. *Hohle Fels, AHs III & IV. Zu Stichelkernen modifizierte Grundformkategorien; AH IV: n = 43, AH IIIa: n = 25.*

and more obtuse angles dominate, as well. The latter is also true regarding laterally reduced burins exhibiting less than three lamellar negatives. Angles around 60° dominate and steeper angles around 45° as well as blunt angles of 75° and 90° are present. This and the morphological accordance with burins exhibiting three or more lamellar negatives emphasize their potential core function. In these cases, a character as early stage cores can be considered.

To conclude, burin cores exhibit reduction angles, which are comparable to regular bladelet and blade cores. The same is true for the three carinated / nosed endscraper cores from AH IIIa, which range between 45° and 75°. Contrary to most investigated burins, active edges of retouched and unretouched blanks usually exhibit acute angles less than 45°. Exceptions are steeply retouched endscraper caps or thick blades with steep or stepped retouch. These results speak for the primary core character of the investigated carinated objects and the bulk of investigated burins and contradict their potential primary use as chisel-like objects for ivory working etc.

Artefacts used like a chisel for the working of organic material exhibit working angles around 45° (Le Brun-Ricalens 2013), which represent the upper end of the range of reduction angles of investigated burins. Moreover, such activities would be connected with characteristic morphological traces and splintering on the active edges and impacts marks at the opposite ends coming from organic or lithic striking

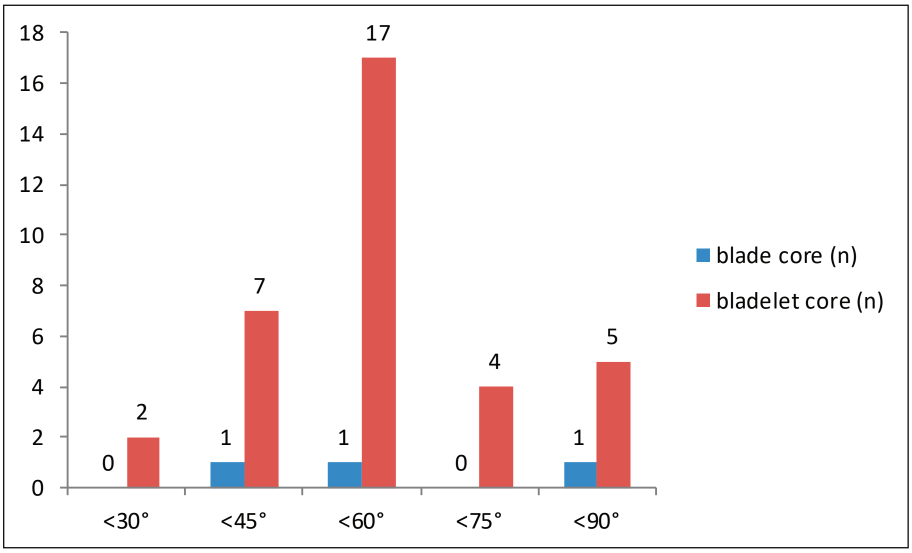


Fig. 13. Hohle Fels, AH IIIa. Reduction angles of blade and bladelet cores; blade cores: n = 3, bladelet cores: n = 35 (including double burins).

Abb. 13. *Hohle Fels, AH IIIa. Reduktionswinkel von Klingen- und Lamellenkernen; Klingenkerne: n = 3, Lamellenkerne: n = 35 (inklusive Doppelstichel).*

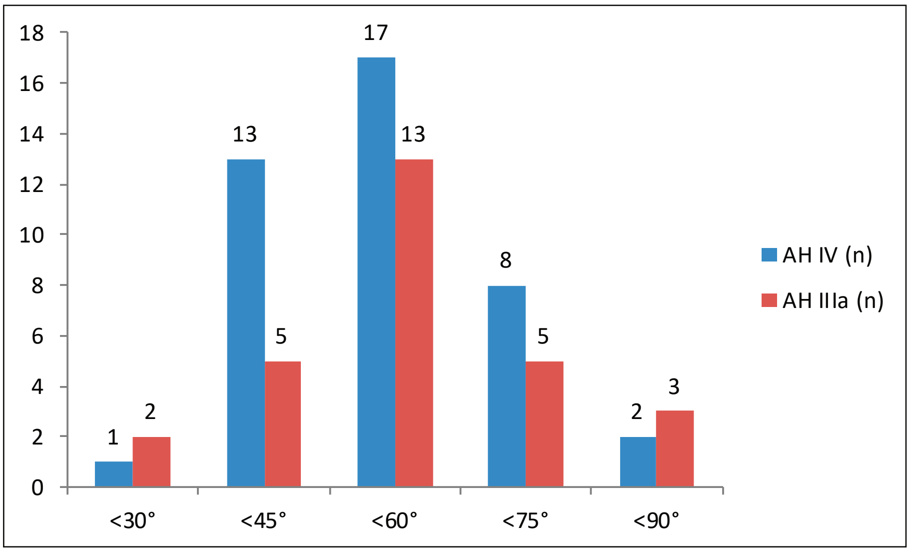


Fig. 14. Hohle Fels, AHs IIIa & IV. Reduction angles of burin cores including double burins; AH IV: n = 41, AH IIIa: n = 28.

Abb. 14. *Hohle Fels, AHs IIIa & IV. Reduktionswinkel von Stichelkernen inklusive Doppelstichel; AH IV: n = 41, AH IIIa: n = 28.*

instruments. Such morphologic traces are mostly absent from the considered burin-cores. Only the early stage nosed endscraper of AH IIIa bears scars at its basal end, potentially from the final use as scaled piece (Appendix, Plate 1:1). In general, the rarity of macroscopic splinterings and potential use traces on burins argues against a primary tool-function of these pieces. Although acute reduction angles are achieved in order to precisely produce bladelets / microblades by soft hammer retouch in tangential gesture, blunt reduction angles of 75-90° might occur in the course of the progressing reduction of the cores.

Regarding technological and typological accordance among the different burin types, it makes sense that most of them are cores with carefully prepared striking platforms (e.g. concave and oblique truncations, preparation of the core crest). The above-described morphological characteristics are typical for AHs IIIa and IV. As a result, burins with core function are in the focus of this article. To subsume, burin-cores of AH IIIa and IV exhibit formal and morphological analogies, which transcend the different burin types. Convergences and divergences of the different burin types and their assumed core function will be elucidated at the example of detailed working stage analyses of typical formal burins from AH IIIa in the next chapter. Additionally, characteristic lithic reduction sequences from AH IIIa will help to illustrate the role of burins in the bladelet production strategy.

Working stage analyses on selected burin cores of AH IIIa

In the following, working stage analyses (WSA) of different burin types exhibiting series of lamellar negatives are presented. The investigated burins are described in detail, comprising reconstructable preparatory and reduction stages. For each artifact the individual number (ID) and the belonging raw material unit (RMU) are indicated in Arabic numerals. We will present the results of the raw material sorting and the Transformation Analysis in an upcoming article (Bataille & Conard in prep.).

Double burin-core (on oblique lateral truncation / cortical edge) (ID 972, squ. 31, RMU 50)

One double burin was prepared at the opposite terminal and proximal ends of a blade with small dorsal cortical remains (<25 %) (Appendix, Plate 7). Oldest recognizable activities are stored in two adjacent longitudinal negatives, which were struck in unidirectional-parallel manner. Likely, these negatives come from the preparation phase of the original blade core. The main blank production of the original core, the piece has been struck from, is indicated in a big blade negative. The striking direction is identical to the one of the double burin's ventral face (ws B5). The older preparatory negatives A51 and A52 are a little oblique to the main reduction axis (unidirectional-convergent) and were possible struck from a supplementary platform. As next recognizable step, the blank was struck from the original blade core as indicated in ventral face B5. A ventral retouch was applied at the proximal half of the left (ws A6) dorsal edge of the blade in order to delimit the distal reduction face C1 which is indicated by two parallel negatives from burin blows (bladelet production phase I). As next steps the stone knapper turned the burin-core in a 180°-angle and applied a striking platform at the opposite basal end by producing a small negative (A4) in order to adjust the striking angle. As last step, at least two further bladelets (ws D5) were struck in burin technique identical to the first bladelet production phase. Fresh distal and basal small edges and the lack of use traces at the lateral edges speak against a further use as tool.

Dihedral burin (ID 1039, squ. 97, RMU 65)
The next burin core on blade is from a morphological point of view comparable to the former one (Appendix, Plate 8). The oldest recognizable step is a series of negatives stemming from the preparation of the left lateral edge which achieved the original core's convexity (ws A51 & C5). A bidirectional-parallel blade production is indicated by the two adjacent longitudinal blade negatives A1 and A5, which were struck from two opposed platforms. Both platforms must have been applied at the small edges of the original core. Wallner lines of the artefact's ventral surface (ws B1) indicate that the piece has been struck from the identical direction and thus from the same striking platform as ws A1. Ws A5, which is older than ws A1, indicates a shift of the striking direction of the original blade core. Bladelet production commenced on the left distal edge (ws C12) and afterwards alternatingly along both lateral edges in burin technology (ws C1/C11 & D1/D12). Small but macroscopic visible abrasions at the distal edge might argue for a secondary use of this edge after bladelet production. Nevertheless, these fine scars argue against the manipulation of hard organic material, such as mammoth ivory, by this edge – an often stressed but seldom attested functional interpretation of such burin edges ("Stichelschneiden") (Hahn 1991, 230). To the contrary, microscopic use traces usually occur along the lateral edges of burin blow negatives and burin waste and indicate different functions (cutting, scraping and carving) (Hahn 1991, 230).

Carinated burin (ID 1201, squ. 89, RMU 22)
Knappers produced a carinated burin on a blade with remains of the lateral core flank (Appendix, Plate 9). That plain core crest (ws C) represents the oldest negative of the artifact. Next recognizable step is negative A located at the upper left edge of the burin-core, which likely stems from the preparation of the convexity of the blade core. Contours of the artifact and the dorsal scar pattern indicate a long but narrow sub-cylindrical reduction face of the original blade core. Three adjacent blade negatives (ws A4, A41 & A42) stem from successive removals of blades in unidirectional-parallel manner from one single striking platform. If striking platform B functioned as striking platform not only for the artifact itself, but as well for the production of blades which left the negatives A4, A41 and A42 is not possible to determine. These negatives are separated from ws B by the dorsal thinning ws A51, which was applied chronologically after the preparation of the striking platform. As next step, the knapper struck the artefact from the blade core as indicated by ventral face B5. A short sequence of bladelet production (two negatives) was conducted from the plain core flank C, which featured as striking platform. Since only two bladelet negatives are present, the artefact is an early stage core, which was abandoned possibly due to the small but wide reduction face and a nearly rectangular reduction angle. Youngest traces are tiny abrasive negatives located on reduction face A2 (ws A21) and core flank C.

Busked burin (ID 1926, squ. 58, RMU 33)
Small cortical remains (ws A0) on the dorsal face of the flake indicate the original state of the bladelet core (Appendix, Plate 10). Blank production from the original core is conserved in one big negative (ws A), which cuts into the cortical remains. The striking direction of this negative is not determinable without doubt. A preparatory flake is conserved in ws A2, which was struck orthogonally to the main reduction axis visible in the Wallner lines of ventral face B4. As next step, the flake was detached from the original core. Truncation-like parallel negatives (ws D7) at the distal edge of the flake represent the preparation of the striking platform C1, from which a series of bladelets were struck. A small negative might indicate the presence of a former notch (ws A61) at the left basal edge in order to delimit the bladelet reduction face. This negative is capped by younger negatives of a working edge (ws A6), which was applied after the bladet production sequence. A fracture plain (ws B3) delimits the thinning negatives from the ventral face and probably indicates the breakage of the artifact inside the haft during usage. Youngest negatives are located at the ventral face. They are whether functionally unclear (ws B5) or the result of edge damage (ws B3). The knapper applied a further working edge (truncation and lateral modification) at the edge between striking platform and ventral surface (ws A1/B1). To conclude, after bladelet production the core was secondarily transformed into a tool for cutting or scraping without using the sharp edges, which originated along the reduction surface in the course of bladelet production. Accordingly, these latter edges are not connected to the tool use activities.

Double burin (dihedral / on truncation) (ID 2468, squ. 67, RMU 50)
A flake with cortical remains (<25 %) was transformed into a double burin-core with two opposite ends – a burin on truncation at the distal and a dihedral burin at the basal end (Appendix, Plate 11). Youngest recognizable negatives result of a blank production sequence from the original core (ws A5, A51 & A52). Dorsal scar pattern and the striking direction of these negatives indicate a blade core, which was reduced in unidirectional-parallel manner. Striking direction and axis of the ventral face (ws B5) suggest that the artefact was struck from the identical striking platform as ws A5, A51 and A52. As next step, the piece was

transformed as a burin on truncation at the distal end by the application of a concave truncation (ws A2) and the following burin blows C11 and C12. The second sequence of burin reduction was conducted from the opposite small end by a 180° shift of the striking direction. The artefact was reduced as a dihedral burin by first producing long and slim bladelets / microblades from the left edge of the core (ws C5, C51 & C52) and in a third sequence from the right edge (ws D5 & D51). The sharp and fresh small and lateral edges indicate the primary core function. A secondary use of striking platform / truncation A2 is possible.

Carinated burin (ID 1684, squ. 77, RMU 59)
A small flake was transformed into a carinated burin. Oldest negatives come from the unidirectional reduction of a blade core (ws A7, A71 & A72) (Appendix, Plate 12). As following step, the artefact itself was struck from the original core; the direction of reduction of ventral negative B is not clearly deducible. A medial fracture plain (ws B3) indicates the breakage of the blank prior to its transformation into a burin-core. In order to prepare the striking platform for a microblade core the knapper applied a short series of negatives (ws A1) along the proximal end of one lateral edge, in order to achieve a steep reduction edge of ~50°. Two short series of microblade production (ws C1 & C11) followed.

Burin on truncation with lateral retouch (ID 1089, squ. 97, RMU 65)
A thick blade with medial fracture plain was transformed into a laterally reduced burin on truncation and afterwards by partial lateral retouch (Appendix, Plate 13). The original state of the artefact is indicated in small cortical remains (<25%). Ws A51, A7 and A71 represent decortication and preparation phases of the original cores. Ws A5 and A52 conserved a unidirectional blank production corresponding to the direction of reduction of the artefact itself, as indicated in ventral surface B5. In between, the knapper shifted the direction of percussion and struck at least one blank in an oblique angle from the former striking axis (ws A6). Potentially, the knapper intended a unidirectional-convergent reduction. Afterwards, the artefact itself was struck from the core as indicated in ventral face B5. As next step, the knapper prepared a striking platform by big parallel truncation-like negatives at the distal small edge (ws A8 & A81) and a small notch (ws B7) by parallel negatives in order to deliminate the reduction surface. This was followed by bladelet production (A1) along the left lateral edge in burin-technique and successive cycles of re-preparation of the striking platform and bladelet production. The breakage of the artefact potentially took place during the use of working edge A3, which was applied after the use as bladelet / microblade core.

Burin on concave truncation (ID 2497, squ. 67, RMU 13)
The original state of the medially broken longitudinal blank, which was transformed into a burin on concave truncation, is conserved within a tiny cortical remnant at the left edge (ws D0) (Appendix, Plate 14). Ws A6 and A61 conserve the preparation stage of a blade core and ws A3 the lateral preparation of the core flank. The core itself was reduced in unidirectional-parallel manner, as indicated in ws A1. The detachment of the wide blade from the core (ws B2) is the next deducible step. A medial fracture plain (ws D), which is younger than the adjacent dorsal and ventral negatives, indicates the breakage of the artefact. Since there is no direct contact between the fracture plane D and the burin end, it is not ultimately possible to deduce the temporal relations between the breakage and the bladelet production. Nevertheless, it is likely that the knapper transformed the proximal blank fragment into a burin-core after the breakage. Bladelets were struck along one lateral edge (ws D1). At least one phase of striking platform preparation was applied by an oblique truncation (ws D3) achieving a steep reduction angle. It was followed by further sequences of microblade production by burin blows (ws C11-C13).

Busked burin on truncation (ID 1785, squ. 58, RMU 23)
After preparing the lateral convexity of a blade core a sequence of blades was detached by unidirectional-parallel removals and the artifact itself was detached from the core (ventral face B5) (Appendix, Plate 15). As next recognizable step bladelets were struck along the left distal edge. Recurrent series of bladelets were struck from the same reduction face and the striking platform was prepared and rejuvenated alternatingly. In-between these cycles the artifact was turned around by 180° and bladelets were detached by burin-technique from the opposite small edge. A notch, which was rejuvenated at least one time, functioned to delimit the reduction face (ws C1/C11/12/13). From a typological point of view, this double burin-core is a busked burin with carefully prepared platform at the distal and a dihedral burin at the basal end.

Carinated burin (ID 2205, squ. 78, RMU 17)
The knapper transformed a flake with a cortical edge into a carinated burin. Cortical remains at one small edge indicate the original state of the artefact (Appendix, Plate 16). A striking platform and a reduction face for bladelet production by burin technology were applied at the opposite edge. The oldest recognizable reduction step is an old ventral surface (A6) indicating the reduction of a Kombewa core. Negative A7 stems from blank production. After the detachment of the artefact from the original core (ventral face B7), bladelet production resp. burin core reduction (ws A & A8) was conducted by using the opposite small edge as striking platform. Afterwards a

striking platform was established at an adjacent edge and bladelets were produced in burin technology.

Burin on truncation (ID 1216, squ. 98, RMU 57)
The laterally reduced burin on truncation (Appendix, Plate 17) is morphologically and technologically very close to burin-core ID 1089 (chapter 5.7). It is also comparable to the double burin-core ID 2468 (chapter 5.5) in regard to the distal section of the core exhibiting a concave striking platform prepared by wide negatives and a comparatively wide reduction face.

Small cortical remnants (A0) indicate the original stage of the light grey Jurassic chert of residual origin. A natural plain ("Kluftfläche" B) at the basal-ventral edge is older than the surrounding negatives. It bears a shining patina. Likely, this natural plane originated from core formatting or early core reduction processes during which the core broke along a natural fissure. Dorsal scar pattern, direction of reduction and the bordering cortex of ws A1 and A11 indicate the early reduction phase of the core, in which the knapper produced cortical unidirectional blades. Negative A12 adjacent to A1 represents a unidirectional-parallel blade production. Ventral face B1 shows the detachment of the blade blank from the original core. One negative at the lateral reduction face C represents an early stage of bladelet production by a burin-blow (ws C1). Afterwards a series of detachments (D31, D31, A3 & A31) at the right distal end perpendicular to the longitudinal axis of the artefact formed the concave striking platform for reduction face C. The latter was reduced in burin technique by two further lamellar negatives (C11 & C12). Sediment movements might have caused few negatives (A33) at the right dorsal edge, which is sharp at the remaining parts. At the ventral face negative B3 and a short (0.5 cm) regular series of fine edge retouch (ws B31) indicate the secondary usage of the lateral edge opposite to the lamellar reduction face.

The chronological succession of the reconstructed reduction steps clearly confirms the core character of the artefact. At least two bladelet production sequences were disrupted by an intermediate sequence of detachments for the preparation of platform A3/A31. The latter functioned as striking platform for bladelet reduction face C. The capped ventral Wallner lines indicate that the blade prior to its transformation into a burin with concave striking platform must have been longer. Lamellar negative C11 was detached from the negatives of working stage A31 as indicated by the point of percussion at the negative bordering ws C11. The last of the three recognizable lamellar negatives C12 was struck from D31/D3.

Comparison of the Working Stage Analyses
The results of the analysis of formal burins by the *working stage analysis* (WSA) confirm the primary core function of these pieces. Although from a typological point of view these artifacts represent different burin types, they share specific ways of preparation and reduction. All burins investigated by WSA indicate a purposeful preparation of striking platforms, reduction faces and the control of suitable reduction angles. The main target was the intentional production of lamellar blanks. These intended target products are usually slim microblades with triangular cross-section (Bataille & Conard 2018: 47 f., Fig. 22). Typically, the reduction of the burin-cores was conducted along the lateral edges. The artefacts usually show carefully prepared striking platforms, whether by (concave) truncations or by retouched oblique lateral edges. Series of wider negatives formed suitable shapes and angles of these platforms. In case of dihedral burins the adjacent reduction face bordering in a steep angle was used as striking platform. Common is the preparation of oblique reduction angles. The benefitted reduction of burin-cores was conducted along the lateral edges. By this, long and slim blank products with straight or on- and off-axis twisted profiles were detached from the longitudinal and straight (lateral) reduction faces (Bataille & Conard 2018). In some cases, macroscopic traces of splintering and abrasions indicate a secondary use of sharp lateral or small edges of the burins subsequent to the core reduction phase. Nevertheless, sharp lateral and distal/basal edges around burin blow negatives speak against the use as tools for the production of hard organic artefacts, as ivory or antler. In cases of burins with use wear, these traces not necessarily occur at the sharp edges, which originated in the context of burin blows, but for instance at the opposite lateral edge (e.g. Burin on truncation ID 1216; Appendix, Plate 17). The reconstruction of different stages of preparation, reduction and rejuvenation of striking platforms, angles and reduction surfaces of burins highlight their primary core function – the main goal was the detachment of bladelets and microblades.

Discussion – technology and function

The reduction of burin-cores characterizes the bladelet production of AH IIIa (GH 6a) and AH IV (GH 7) (Bataille & Conard 2016, 2018). While typical Aurignacian types, such as carinated and busked burins on blades and flakes constitute one part of burin-cores another part comprises burin-cores often on truncation with multiple lamellar scars on the small and lateral edges preferentially produced on straight blades. Nevertheless, different burin-core types exhibit common technological and morphological features (Fig. 15):

1. In most cases, knappers prepared burin-cores on suitable blanks for the production of straight and on- and off-axis twisted microblades, usually on blades and more rarely flakes.

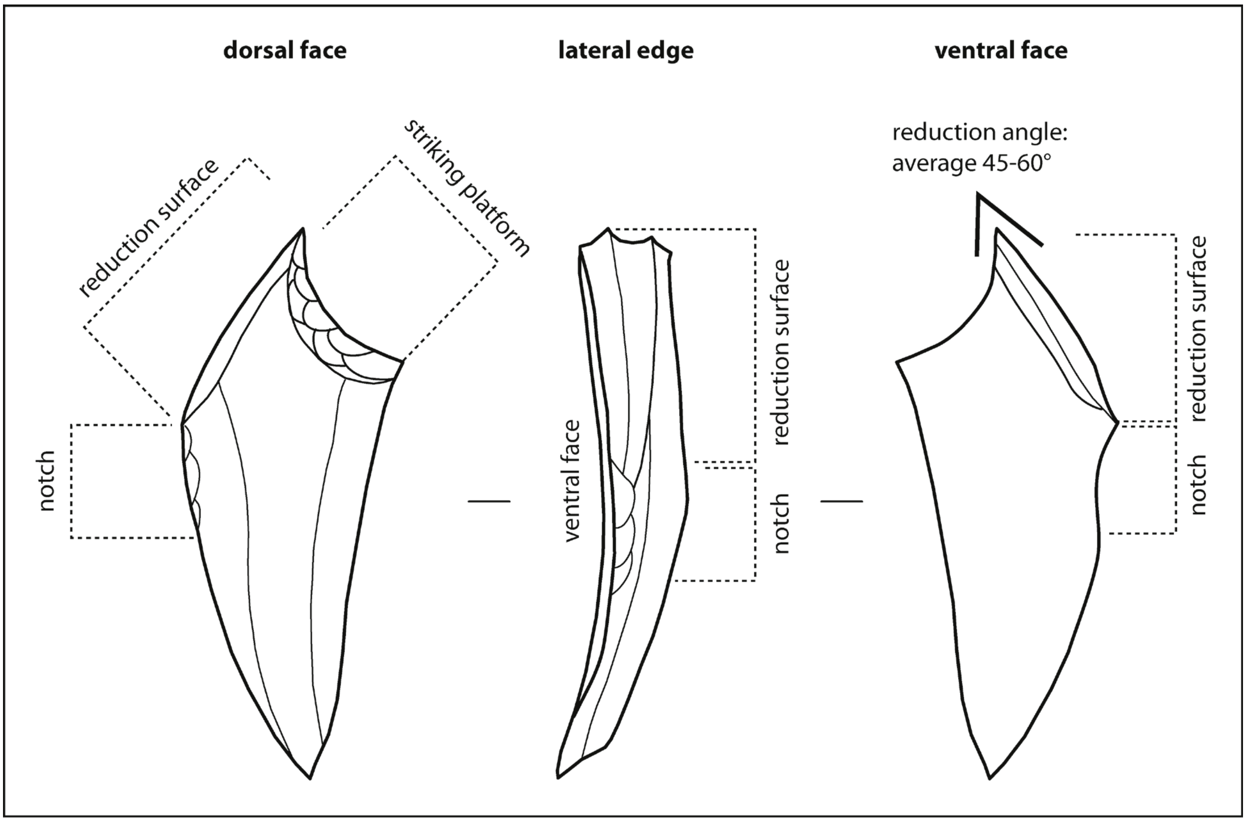


Fig. 15. Abstract scheme of a burin-core of the upper Aurignacian horizons from Hohle Fels Cave. A burin core should exhibit a reduction face long and wide enough to provide the detachment of series of lamellar blanks – the reduction face with its lamellar negatives might extend over the ventral or the dorsal face of the core blank. A suitable reduction angle between the intentionally prepared striking platform and the reduction face, usually between 45 and 60°, allows the controlled detachment of long and slim bladelets. The striking platform and the angle between this platform and the reduction face is often prepared by series of (parallel) negatives or by few wide negatives (= truncation). Truncations are usually concave or oblique or both. Among striking platforms, concave and oblique truncations provide the recurrent detachment of bladelets without the necessity to rejuvenate the striking angle after every burin blow-cycle. In other cases, tablet-like bladelets are detached in order to create the reduction angle and to prepare a negative along this adjacent reduction face which is used as striking platform (dihedral burins). Not only busked burins, also other burin types might exhibit lateral modification or small notches in order to delimit the lateral reduction face. Different burin types as carinated, busked, truncated or regular burins exhibit the same technological features: (a) striking platform preparation by concave / oblique truncations, (b) reduction angle of 45-60°, (c) lateral modification for the distal bordering of the reduction face and (d) general morphological accordances of platforms and reduction faces. Ensuing from the described features, we suggest to transfer the burin-core definition of carinated and busked burins as provided by e.g. Brou & Le Brun-Ricalens (2006) on further burin types with lamellar negatives as described in this study.

***Abb. 15.** Schema eines Stichelkernes der oberen Aurignacien-Horizonte der Hohle Fels-Höhle. Ein Stichelkern sollte eine Reduktionsfläche aufweisen, die lang und breit genug ist, um die Abtrennung von Lamellenserien zu ermöglichen – die Reduktionsfläche kann mit ihren lamellaren Negativen auf die angrenzende Ventral- oder Dorsalfläche des Trägerstücks übergreifen. Ein geeigneter Reduktionswinkel, meist zwischen 45° und 60°, zwischen der intentionell zugerichteten Schlag- und der Reduktionsfläche gestattet den kontrollierten Abbau von langen schlanken Lamellen. Die Schlagfläche sowie der Winkel zwischen Schlag- und Reduktionsfläche wird häufig durch Serien (paralleler) Negative oder durch wenige breitere Negative (= Endretusche) präpariert. Endretuschen bzw. Schlagflächen sind gewöhnlich konkav, schräg oder beides. Unter den Schlagflächen gewährleisten solche mit konkaver und schräger Endretusche den wiederholten Abbau von Lamellen, ohne die Notwendigkeit der Wiederherstellung des Abbauwinkels nach jedem Stichelschlag-Zyklus. In anderen Fällen werden kernscheiben-ähnliche Lamellen oder längliche Grundformen abgetrennt, um den Reduktionswinkel sowie ein langes Negativ entlang der angrenzenden Reduktionsfläche zu erzeugen, welches als Schlagfläche dient (Dihedralstichel). Nicht einzig Bogenstichel, auch andere Sticheltypen können laterale Modifikationen oder schmale Kerben aufweisen, welche der Begrenzung der lateralen Lamellenreduktionsflächen dienen. Unterschiedliche Sticheltypen, wie Kiel- und Bogenstichel oder Stichel an Endretusche oder reguläre Lateralstichel weisen gemeinsame technologische Merkmale auf: (a) Schlagflächenpräparation durch konkave / schräge Endretuschen, (b) Reduktionswinkel von 45-60°, (c) laterale Modifikation zur distalen Begrenzung der Reduktionsflächen und (d) generelle morphologische Übereinstimmungen von Schlagflächen und Reduktionsflächen. Ausgehend von den beschriebenen Merkmalen schlagen wir vor, die Stichelkern-Definition, wie sie von z. B. Brou & Le Brun-Ricalens (2006) auf Kiel- und Bogenstichel angewandt wurde, auf weitere in unserer Studie vorgestellte Sticheltypen mit lamellaren Negativen zu übertragen.*

2. Apart from dihedral burins, striking platforms for the detachment of lamellar blanks were prepared at small edges or at the end of lateral edges bordering the adjacent lamellar reduction faces.
3. Striking platforms were shaped by lateral modification, exhibiting steep, sometimes oblique angles between the platforms and the ventral surfaces of the core blanks. Such truncations or lateral modifications often show wide parallel negatives, which shape a concave outline.
4. Reduction surfaces of burin-cores usually run along one or two lateral edges, or in some cases along the distal and proximal edges oblique to one lateral edge. In some cases a concave notch

("Stoppkerbe") or a short series of straight lateral negatives delimits the reduction face.

5. Burin-cores exhibit two or more lamellar negatives. The lbs were struck from the core by knapping at the prepared striking platform, which is often a concave truncation.
6. The edges ("*Stichelschneiden*" or "biseau" / "dièdre terminal" acc. to Le Brun-Ricalens et al. 2006b: 362) between striking platform and reduction face are usually fresh and void of macroscopic use wear. The same is true for lateral edges, which originated from the detachment of lamellar blanks along lateral edges. Such use wear (e.g. splinters) would occur when the burin would be used as tool for the production of artifacts from hard organic material. Often the angles around burin blow negatives are not steep enough, sometimes around 90°, to count as working edges (see e.g. WSA 11). If present, use wear or sediment retouch usually cover short sections of lateral edges and can be the result of secondary use or slow sediment movement or unintentional damage. The fact that only a part of burin-cores exhibits macroscopic use wear speaks for (a) an occasional secondary usage of edges and (b) a primary core character of these pieces.
7. Reduction angles usually range around 60°. Dihedral and burins on lateral retouch might exhibit steeper angles around 30-45°.

Preferentially, knappers produced burins on blades in order to use the narrow edges and the adjacent ventral faces, or more seldom the dorsal one, as reduction faces for bladelet and microblade production. The lateral and distal surrounding burin blow negatives of formal burins and burin-cores are most of the time sharp and lack macroscopic use wear. Investigated burins of the Hohle Fels assemblages with fewer than three lamellar negatives exhibit striking platforms and reduction angles, which are equivalent to the burin-cores with multiple lamellar negatives. Due to that, it is highly likely that these burins, usually interpreted as tools by many researchers, had a main function as bladelet/ microblade cores. We, however, do not exclude a potential secondary use for other tasks. Nevertheless, the focus of burin production targets in first intention to the production of lamellar blanks for specific tasks in and outside the cave.

The burin-cores deliver in most cases small, narrow blanks, often with straight as well as on- and off-axis twisted profiles. The presence of lbs with intentional modification and macroscopically observed use wear in AHs IIIa and IV indicates the intentional production of bladelets and microblades by the reduction of burin cores (Fig. 5; Bataille & Conard 2018: Tab. 5). Consequently, the target aim of burin reduction was the intentional modification and use these lamellar blanks. The peculiar technological and typological composition of the investigated lithic assemblages might have had an important function in the production and use of decorative and symbolic organic objects (e.g. Conard 2009; Conard & Malina 2006 & 2009; Wolf 2015).

While the function of laterally retouched microliths as well as lamellar blanks exhibiting lateral use traces remains in many cases unsolved yet, some lbs were likely used in rotating manner on hard organic material. Such pieces exhibit use wear, such as traces of splintering and lateral abrasion at the (distal) tips (Fig. 11). Regarding the extraordinary high number of organic objects within the Aurignacian horizons, among them at least 230 perforated mammoth ivory beads and 87 pieces alone in AH IV (Conard & Wolf 2014: 77; Conard et al. 2015: 215), we assumed that these latter lamellar products had an important function in the production of these organic artefacts (Bataille & Conard 2018). It seems reasonable that such bladelets with use wear at the distal tips had a specific function in the production sequence. Narrow but stabile lbs are likely tools for the final step of drilling tiny holes into these small objects; their maximum dimensions are often below 1 cm. We proposed, that at Hohle Fels lbs exhibiting scars from rotating movements at the distal tips and a pronounced stability by their triangular and trapecoidal cross-sections were used for the final step of incising tiny holes into ivory beads (Fig. 16).

Conclusion and future directions

The core and tool composition of AH IIIa shows techno-typological analogies with the horizon AH IV. In both assemblages the unidirectional-parallel blade concept is the main strategy for blade production (Bataille & Conard 2018). Cores exhibit wide and narrow reduction faces, sometimes in combination on one and the same artifact (Conard et al. 2013; Bataille & Conard 2018). Cores showing unidirectional-convergent and bidirectional concepts are rare. In both assemblages the transformation of blades into burins is a central characteristic. Furthermore, a high proportion of formal burins were reduced as bladelet cores (Fig. 17). In contrast to other Aurignacian assemblages of the Swabian Jura, the exploitation of carinated and nosed endscraper-cores is less common. In AH IIIa only one carinated endscraper and two nosed endscrapers are present. The technological analyses presented in this paper indicate the intentional production of lbs, which dominate the lamellar blank category in AH IIIa (Fig. 4) and more pronounced in AH IV (Bataille & Conard 2018: Tab. 4). Among these artefacts are pieces with intentional retouch and use wear. One reason for the high proportion of burin-cores and lbs relates to the need for tools for the production of organic artifacts. Further microscopic and experimental studies will help to test these hypotheses.

Carinated and busked burins with multiple lamellar scars clearly served as cores. The same is likely for other types featuring multiple lamellar scars. The

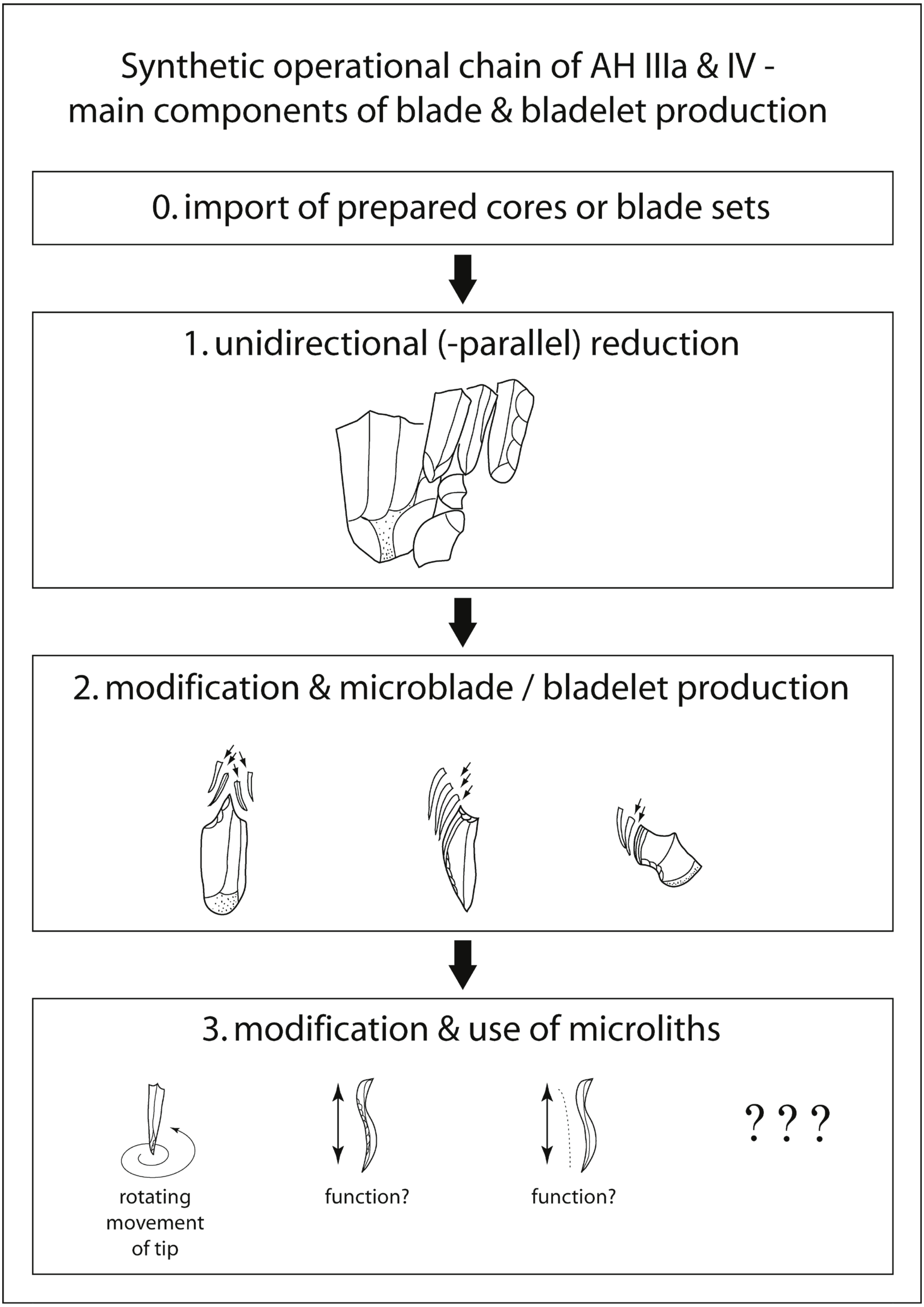


Fig. 16. The operational chain of AH IIIa is in agreement with the one from AH IV (Bataille & Conard 2018). Bladelet production by the reduction from burin-cores is one main target of the operational sequence which commences with the on-site reduction of unidirectional blade cores.

Abb. 16. *Die Operationskette von AH IIIa stimmt mit der von AH IV (Bataille & Conard 2018) weitestgehend überein. Die Lamellengewinnung im Zuge der Reduktion von Stichelkernen stellt ein Hauptziel der Operationssequenzen dar, welche mit der Reduktion von unidirektionalen Klingenkernen beginnen.*

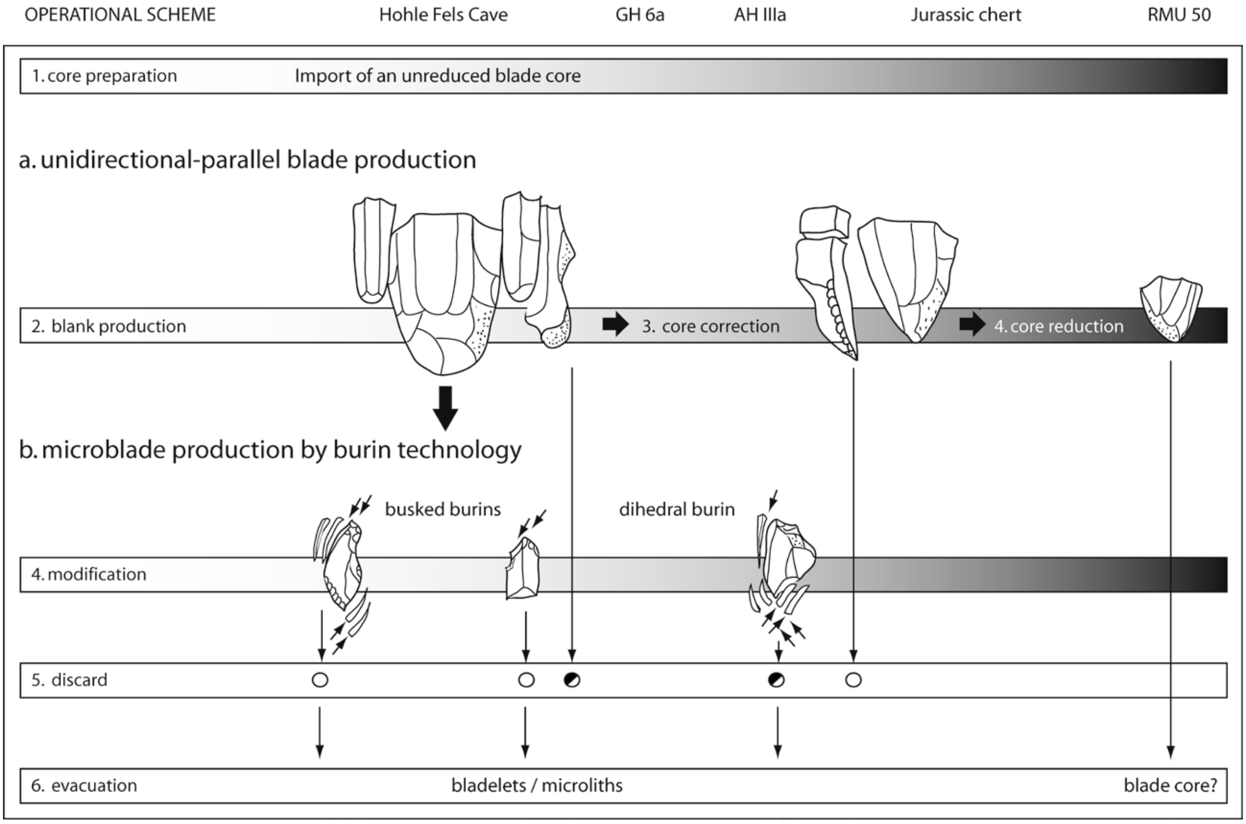


Fig. 17. Hohle Fels, AH IIIa. Raw material unit 50 represents a typical operational scheme of the techno-functional "Hohle Fels IV facies" (Bataille & Conard in prep.). A prepared and partially reduced blade core was brought to the cave and on-site exploited in unidirectional manner. Blades were later-on modified as domestic tools and formal burins with core-function.

Abb. 17. *Hohle Fels, AH IIIa. Rohmaterialeinheit 50 zeigt ein typisches Reduktionsschema der techno-funktionalen "Hohle Fels IV -Fazies" (Bataille & Conard in prep.). Ein präparierter und zum Teil reduzierter Klingenkern wurde zur Höhle gebracht und vor Ort in unidirektionaler Weise abgebaut. Klingen wurden daraufhin als Geräte sowie formale Stichel mit Kernfunktion modifiziert.*

primary core function of the latter burin types is indicated in morphological and technological features which are present also among carinated and busked burin-cores. These features are carefully prepared striking platforms ("truncations"), reduction angles around 60° and the general morphological organization of the investigated formal burins. Furthermore, the sharp edges resulting from burin blows mostly lack macroscopic use wear. Moreover, the angles around burin blow negatives are often unsuitable for the use as tool and also indicate a primary core function. In this context, the results of the WSAs confirm the core character of burins on truncation and dihedral burins as well. Planned experiments and microscopic use wear analyses should shed light on the potential (secondary) use of burins as tools, especially those exhibiting steep angles.

Less clear cases are represented by simple laterally reduced burins with fewer than three lamellar blanks. These burins share technological and morphological features with undisputed burin-cores. Among these features are identical truncations, which functioned as striking platforms for bladelet production. Comparative reduction angles and the general morphological organization of these burins indicate the potential core function. In general, the production of lbs with triangular-cross-section was achieved by the general morphology and the position of the reduction faces orthogonally to the ventral/dorsal faces of the burin-cores. The triangular cross-section of the lamellar blanks provided the stability which was needed to make (hard) organic artefacts. On the other hand, burins lacking these morphological and technological features may be considered as tools. Moreover, a secondary use of suitable edges and angles for different tasks is entirely possible.

Most researchers today agree about the core function of carinated and nosed endscrapers as well as carinated and busked burins. They also agree with a possible tool-use of such pieces. In this context, an additional secondary *ad hoc* use of "working" edges with suitable edge angles should not be neglected (Le Brun-Ricalens 2005: 55; Le Brun-Ricalens et al. 2006: 348). Use wear studies show that in different assemblages burins were used as tools for working hard materials (e.g. Araujo Igreja 2011: 36 ff.). In addition, carinated endscrapers with heavily reworked edges between the ventral surface and the reduction face indicate the potential *ad hoc* use of suitable edges of bladelet cores (e.g. Bataille 2013 & 2016). Refits of lithic material from Thèmes (Yonne, France) indicate that not only in Aurignacian context carinated and busked burins were reduced as burin cores, but also during the Western European Magdalenian (Brou & Le Brun-Ricalens 2006: 225 ff.). Moreover, recent studies on late Paleolithic burins on truncation from Dhofar (Oman) indicate, that "*rather, the burin blow functioned to stabilize the truncation and working edge of the tool*" which was used in the context of wood working (Hilbert et al. 2018). On the other hand, most burins lack "*traces of use-wear on the actual burin edge as well as on the truncation*" and "*direct evidence of hafting wear*" (Hilbert et al. 2018, 126). "*Given the restricted number of tools with traces of use-wear on the chisel edge produced by the burin blow*" the authors "*suggest that the burin blow served not to create a chisel edge, but as a stabilizing technical element*" (Hilbert et al. 2018, 132). Accordingly, the authors conclude that the burins "*likely served as tools, rather than cores for the production of burin spall blanks*" (Hilbert et al. 2018, 133). Contrary to these conclusions, the technological investigations of burins and lbs from Hohle Fels Cave indicate that burins with multiple lamellar negatives more likely represent cores. Use wear analyses on burins from Aurignacian assemblags of Hohle Fels report the rarity of use traces: "The burin has long been classified as an important feature of Upper Paleolithic assemblages, yet it is clear that, at least in many cases, burin edges were not used" (Hardy et al. 2008). A potential secondary tool function cannot and should not be excluded. Upcoming experimental and microscopic observations will help to prove these considerations.

A parsimonious explanation for the bipartite character of formal burins would be that in an assemblage with lamellar burin spalls, which bear traces of intentional modifications or use wear, burins with multiple lamellar negatives represent the cores from which these blanks were struck. Burins with fewer lamellar negatives but with analogues reduction angles, striking platforms and reduction faces likely served as cores with short reduction sequences. A double function of burins as tools and cores is possible in cases where suitable angles can be used as active edges. The use of different types of tools and cores for different tasks is always possible and an often reported phenomenon when analyzing lithic assemblages (e.g. Hardy et al. 2008; Nowak & Wolski 2015). Simple burins with one or two lamellar negatives lacking morphological and technological features of burin-cores might be considered as tools without an intended core-function. Nevertheless, microscopic and experimental analyses should test a proposed tool function. Robust simple burins with invasive burin-blow negatives by the detachment of thick burin spalls might be considered as tools without secondary core function – as long as the opposite has not been proven.

The lithic assemblages from AHs IIIa and IV represent the same technological variant, which extends the variability described so far in the Aurignacian of the Swabian Jura. The Hohle Fels IV facies is a regional techno-functional variant of the Aurignacian in the Swabian Jura. The most prominent characteristic is the reduction of burin-cores for the production of elongated microblades.

Planned analyses of the lithic assemblages from the lower Aurignacian horizons from Hohle Fels and of further assemblages of the region will address the important question, if this technological variant represents a diachronic functional phenomenon or a chronological phase of the regional Aurignacian. Burin-cores are part of the assemblages from Geißenklösterle AHs II and III, Bocksteinhöhle, Bockstein-Törle AH VII and Sirgenstein AH IV (Hahn 1977). Their association with purportedly early Aurignacian directory fossils such as split-based points, thick carinated endscrapers and "Aurignacian" blades may speak against a chronological interpretation (Fig. 18; Bataille & Conard 2018). Viewed from an interregional perspective, the chrono-cultural position within the framework of the late Aurignacian of Central Europe is of special importance. Technological conformities and disconformities with late dating assemblages like Breitenbach-Schneidemühle (eastern Germany), Willendorf II and Alberndorf I (Lower Austria) (Moreau 2011, 2012; Moreau & Jöris 2010, 2012) might inform about the techno-functional variability of the Central European Aurignacian after 38'000 calBP. Judging from radiometric dates, Hohle Fels horizon IV predates these assemblages (*compare* Bataille & Conard 2018 & Jöris et al. 2010). In the context of supra-regional comparisons, analogies and differences to the Western European *Aurignacien récent* from Abri Pataud, Level 8, Caminade Est (both France) (Michel 2010), Maisières-Canale and Trou du Renard (both Belgium) (Flas et al. 2006; Dinnis & Flas 2016) still need to be adressed (Brou & Le Brun-Ricalens 2005). Nevertheless, the present study highlights the necessity to discuss techno-typological variations above all on a regional base in order to investigate potential chrono-cultural and functional variables (Bataille & Conard 2018).

The variability and function of the Hohle Fels burin-cores must be discussed in a diachronic perspective before the background of the cave's role in the geographical and cultural landscape. Such regional studies are important means to understand the selection of specific reduction processes in the context of varying economical and socio-cultural demands as well as the working of cultural transmission. For this, we conduct comparative studies with assemblages from the region.

The core character of the different burin types described in this paper is further confirmed by raw material units of AH IIIa (Appendix, Plate 5:1-7 & Fig. 17). In ongoing studies, we sort back lithic artefacts of the Hohle Fels Aurignacian assemblages to lithic raw material units and refitting sequences. By doing this, we want to provide a more detailed insight into

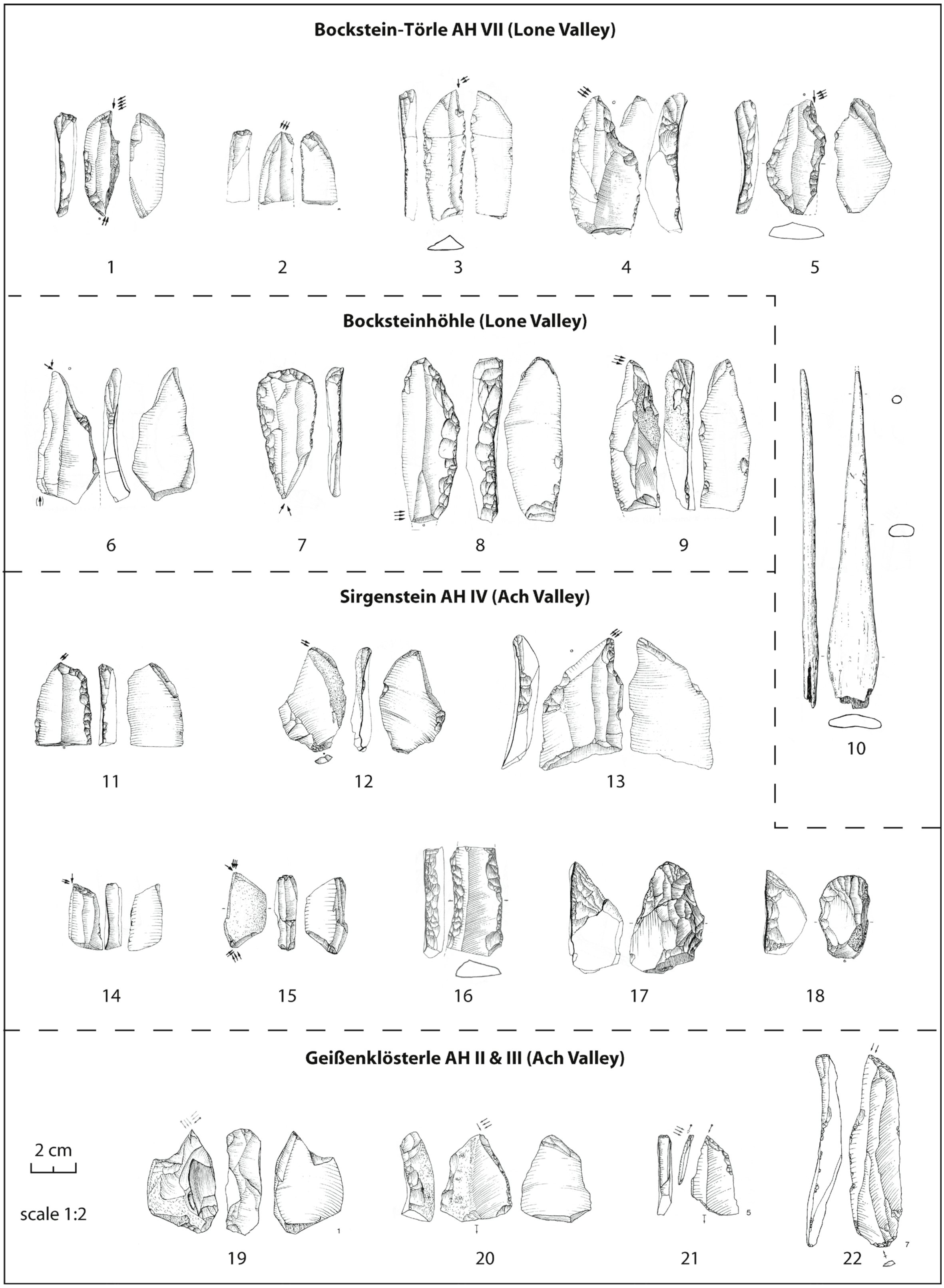
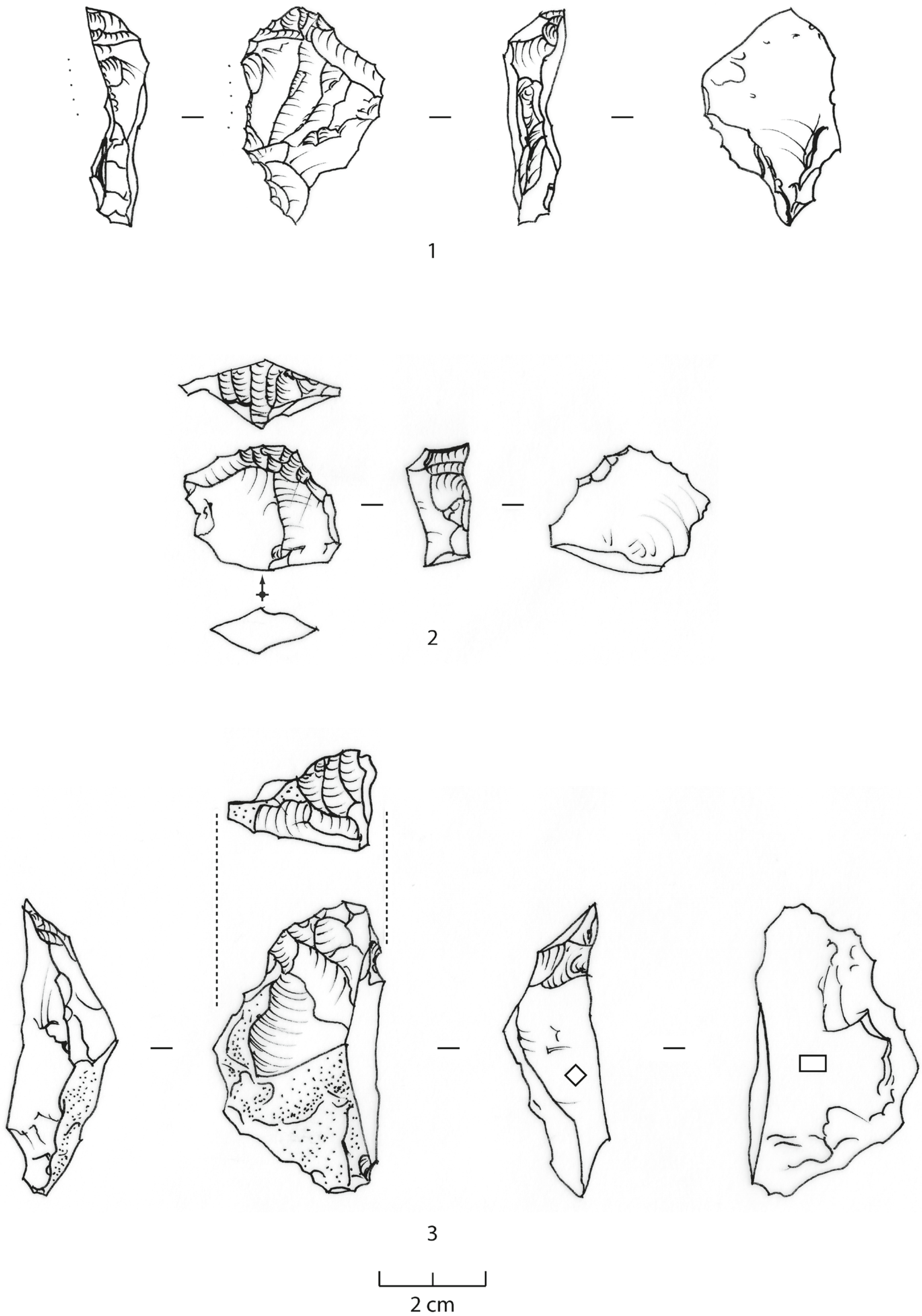


Fig. 18. Formal burins with (potential) core function from Geißenklösterle AH II & III, Bockstein-Törle AH VII, Bocksteinhöhle and Sirgenstein AH IV. The latter three assemblages might belong to the same techno-functional variant ("Hohle Fels IV facies") as the Hohle Fels assemblages AH IIIa and IV. Figures after J. Hahn (1977 & 1988). (Double) carinated burins (1-3, 12, 13, 20 & 21), busked burins (4, 5 & 9), double dihedral & busked burin (6), (double) dihedral burins (14, 15 & 19), burins on truncation (11 & 22), endscraper-burins on retouched blade (7 & 8), blade with stepped retouch (16), thick carinated endscrapers (17 & 18) and split-based point (10).

Abb. 18. *Formale Stichel mit (potentieller) Kernfunktion der Fundplätze Geißenklösterle AH II & III, Bockstein-Törle AH VII, Bocksteinhöhle und Sirgenstein AH IV. Die drei letzteren Inventare können Teil der gleichen techno-funktionalen Variante ("Hohle Fels IV-Facies") wie die Inventare IIIa und IV der Hohle Fels-Höhle sein. Abbildungen nach J. Hahn (1977 & 1988). (Doppel-) Kielstichel (1-3, 12, 13, 20 & 21), Bogenstichel (4, 5 & 9), doppelter Dihedral- & Bogenstichel (6), (Doppel-) Dihedralstichel (14, 15 & 19), Stichel an Endretusche (11 & 22), Kratzer-Stichel an retuschierten Klingen (7 & 8), Klinge mit schuppiger Retusche (16), Kielkratzer (17 & 18) und organische Spitze mit gespaltener Basis (10).*

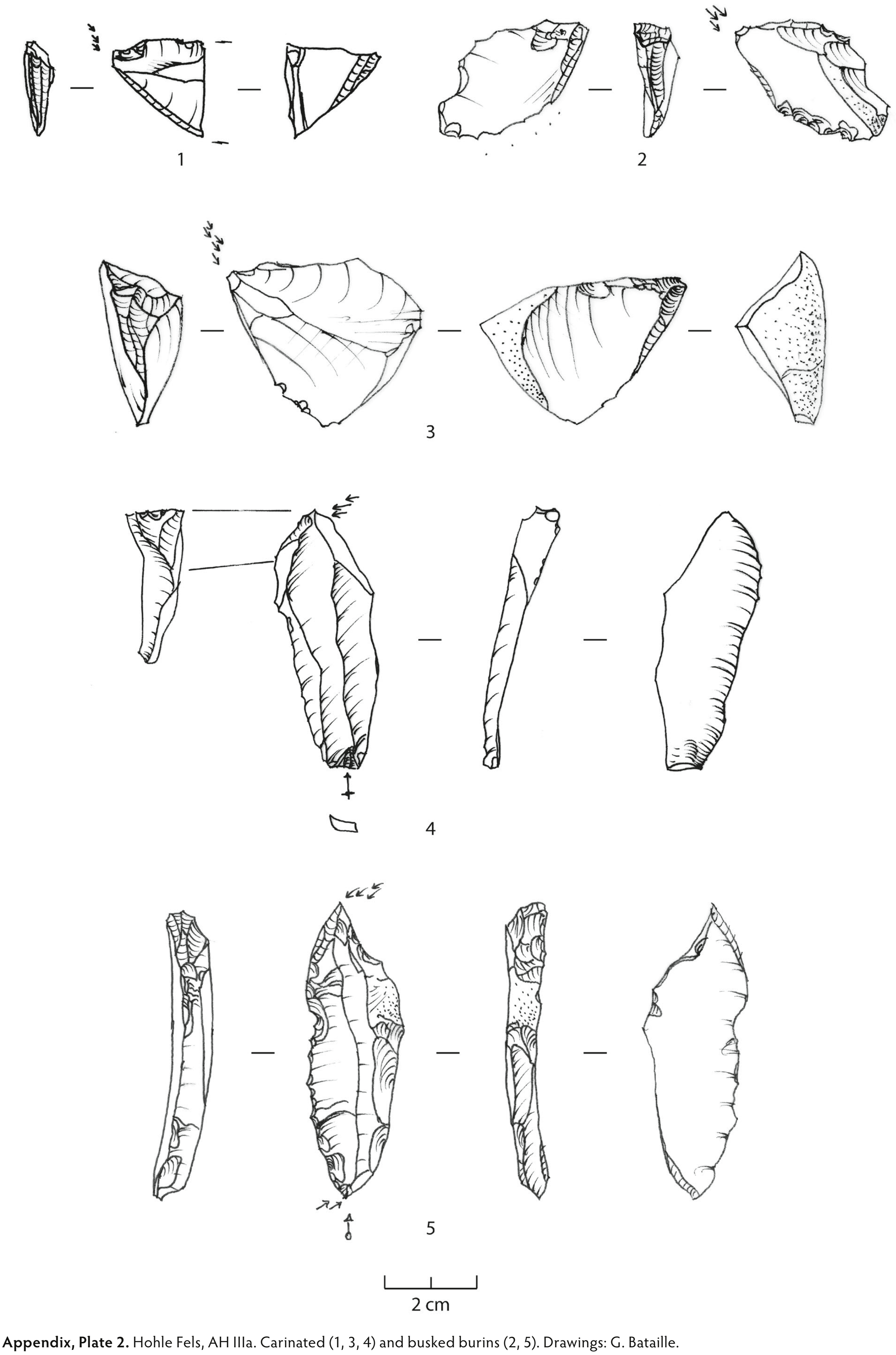
site-formation processes and potential post-depositional processes, the reconstruction of technological processes and on-site spatial relations between artefacts as well as the cultural and functional variability. Here, it is important to underline the regional signature of the Aurignacian in the Swabian Jura as it is well documented in the rich organic assemblages of practical tools and diverse symbolic artifacts such as personal ornaments, figurative representations and musical instruments (Conard & Bolus 2006; Conard et al. 2015). Finally, use-wear and experimental analyses will help to elucidate the function of specific tools and blanks in the production processes of organic artifacts found at the site and to understand the behavior of Aurignacian groups in Central Europe.

Acknowledgements: For collaboration and support, we thank Prof. Dr. Klaus-Joachim Kind and the State Heritage of Baden-Württemberg. We thank the excavation team from Hohle Fels, namely Maria Malina and Alexander Janas M.A. The authors thank the editors of Quartär, especially Dr. habil. Andreas Pastoors who invited us to present results of our ongoing investigations and the editor in charge Dr. Luc Moreau. We are also grateful to three reviewers who provided helpful improvement suggestions. We thank especially Dr. Foni Le Brun-Ricalens for his comprehensive and critical revision of our paper as well as his profound suggestions and advices. The corresponding author is alone responsible for any shortcomings or failures.



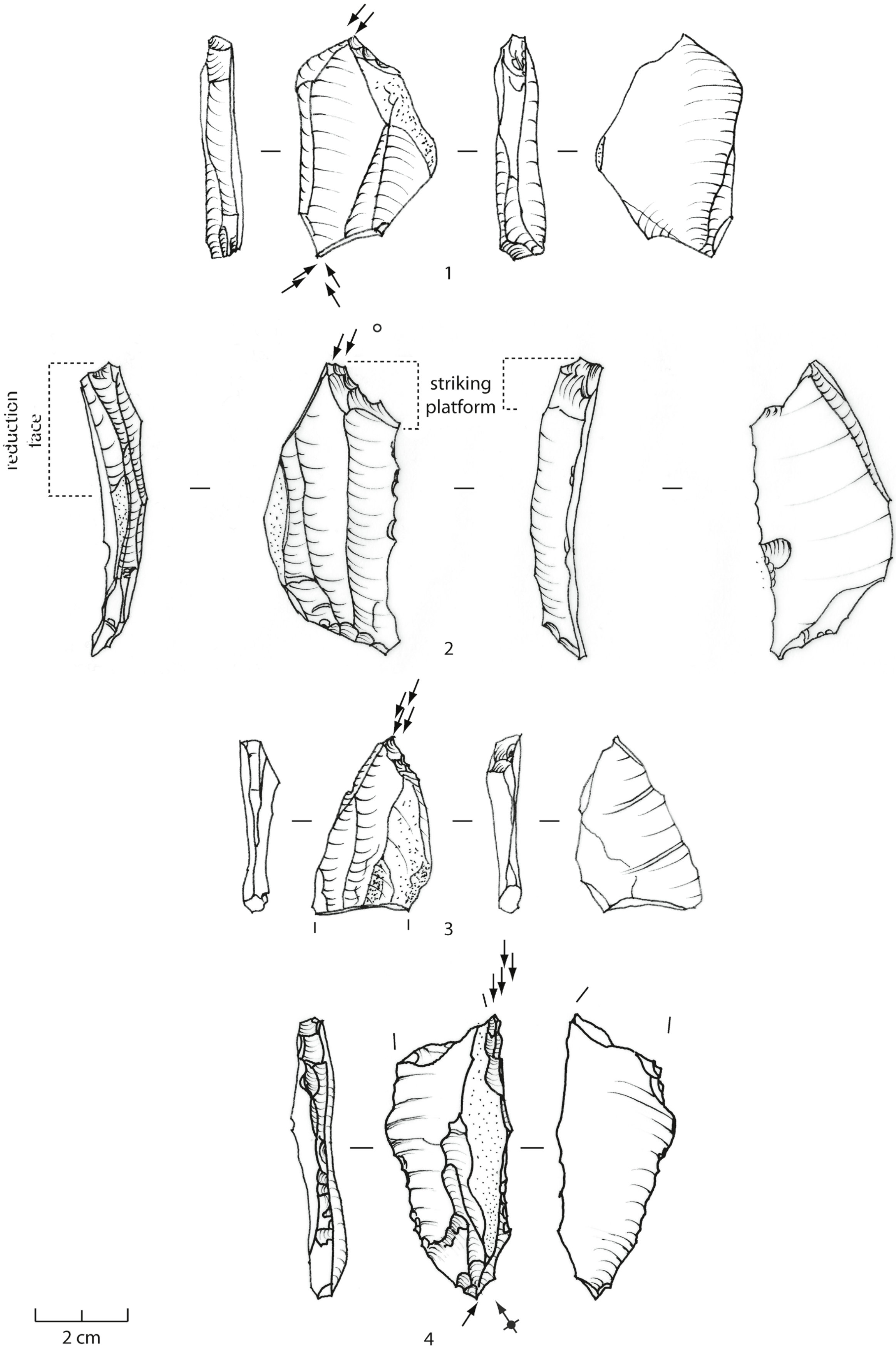
Appendix, Plate 1. Hohle Fels, AH IIIa. Bladelet cores. Nosed endscrapers exhibiting nosed reduction faces with lamellar negatives and bordered by concave lateral sections created by bilateral detachments delimiting the core fronts (1-2) & early stage carinated endscraper on natural cleavage plain ("Kluftfläche") with a bladelet reduction face created along a lateral breakage plain (3). Nosed endscraper (1) can be considered as early stage core with a short reduction sequence and final use as splintered piece (dorsal negatives at the base). These endscraper-cores were used to produced small and short (twisted) microblades. Drawings: G. Bataille.

Appendix, Tafel 1. *Hohle Fels, AH IIIa. Lamellenkerne. Nasenkratzer mit konvex herauspräparierten Reduktionsflächen mit lamellaren Negativen begrenzt durch laterale konkave Abschnitte, die durch kleine bilaterale Abhübe geschaffen wurden (1-2). Im frühen Reduktionsstadium verworfener Kielkratzer an natürlicher Kluftfläche mit Lamellenabbaufläche, die entlang einer lateralen Bruchfläche angelegt wurde (3). Der Nasenkratzer (1) kann als in einer frühen Reduktionsphase abgelegter Kern angesprochen werden, der final als ausgesplittertes Stück bzw. Zwischenstück, angezeigt durch ausgesplitterte dorsal-basale Negative, verwendet wurde. Diese Kratzerkerne dienten zur Gewinnung von kleinen und kurzen (tordierten) Mikro-Lamellen. Zeichnungen: G. Bataille.*



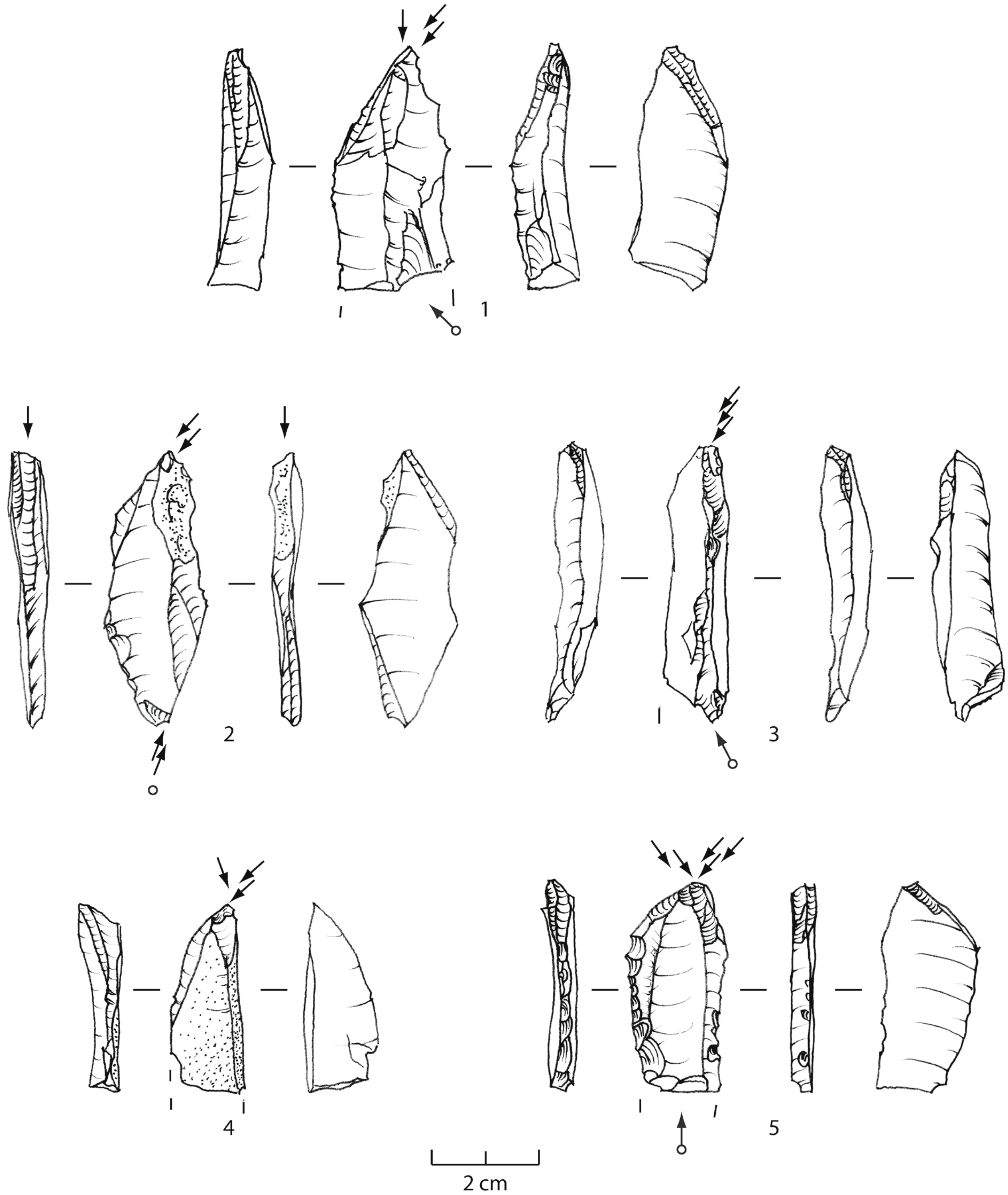
Appendix, Plate 2. Hohle Fels, AH IIIa. Carinated (1, 3, 4) and busked burins (2, 5). Drawings: G. Bataille.

Appendix, Tafel 2. *Hohle Fels, AH IIIa. Kiel- (1, 3, 4) und Bogenstichel (2, 5). Zeichnungen: G. Bataille.*



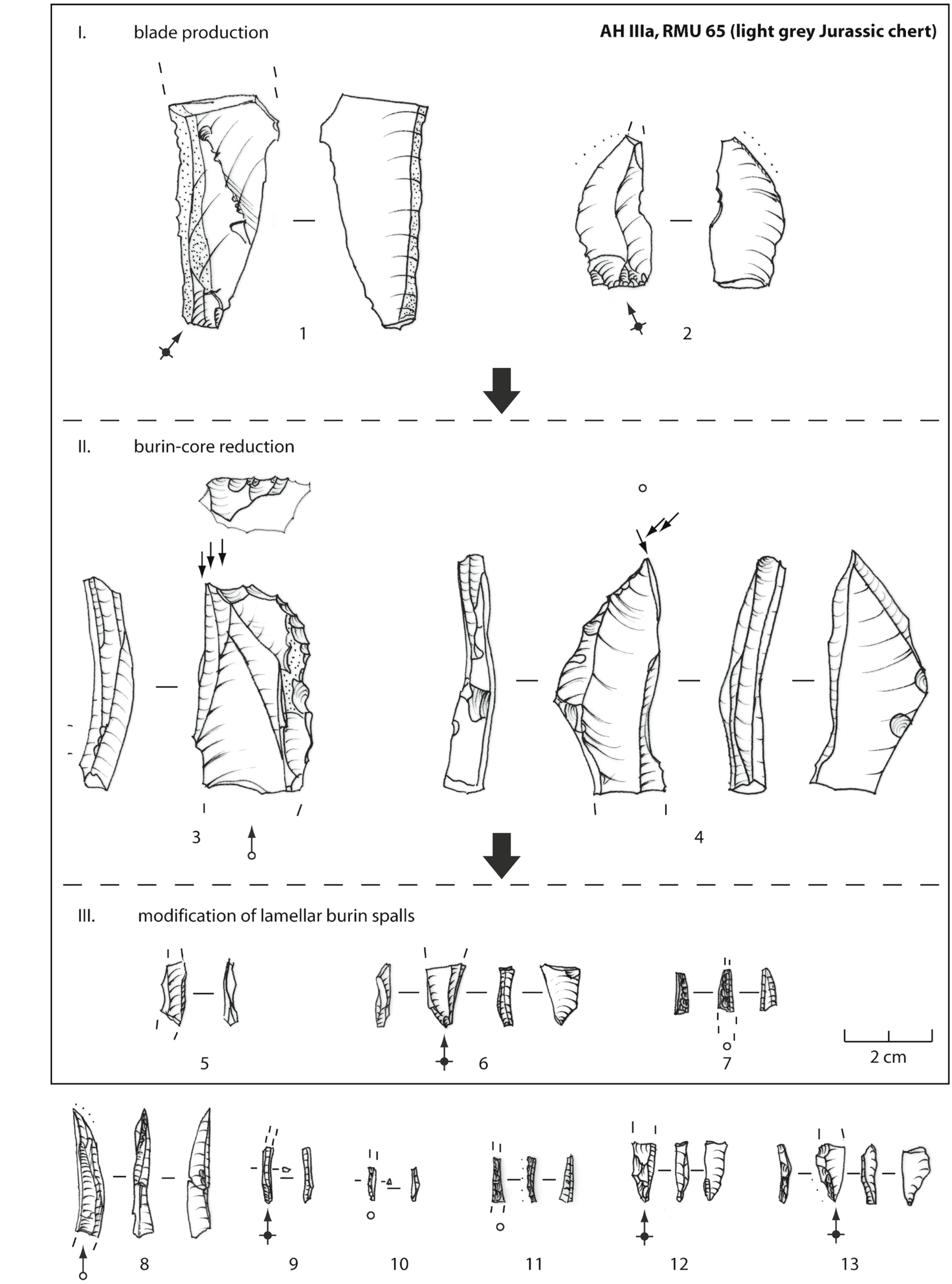
Appendix, Plate 3. Hohle Fels, AH IIIa. Double burin on truncation and dihedral (1), burins on truncation (2-3) and on breakage (4). Drawings: G. Bataille.

Appendix, Tafel 3. *Hohle Fels, AH IIIa. Doppelstichel an Endretusche und mit Dihedralstichelende (1), Stichel an Endretusche (2-3) und an Bruchfläche (4). Zeichnungen: G. Bataille.*



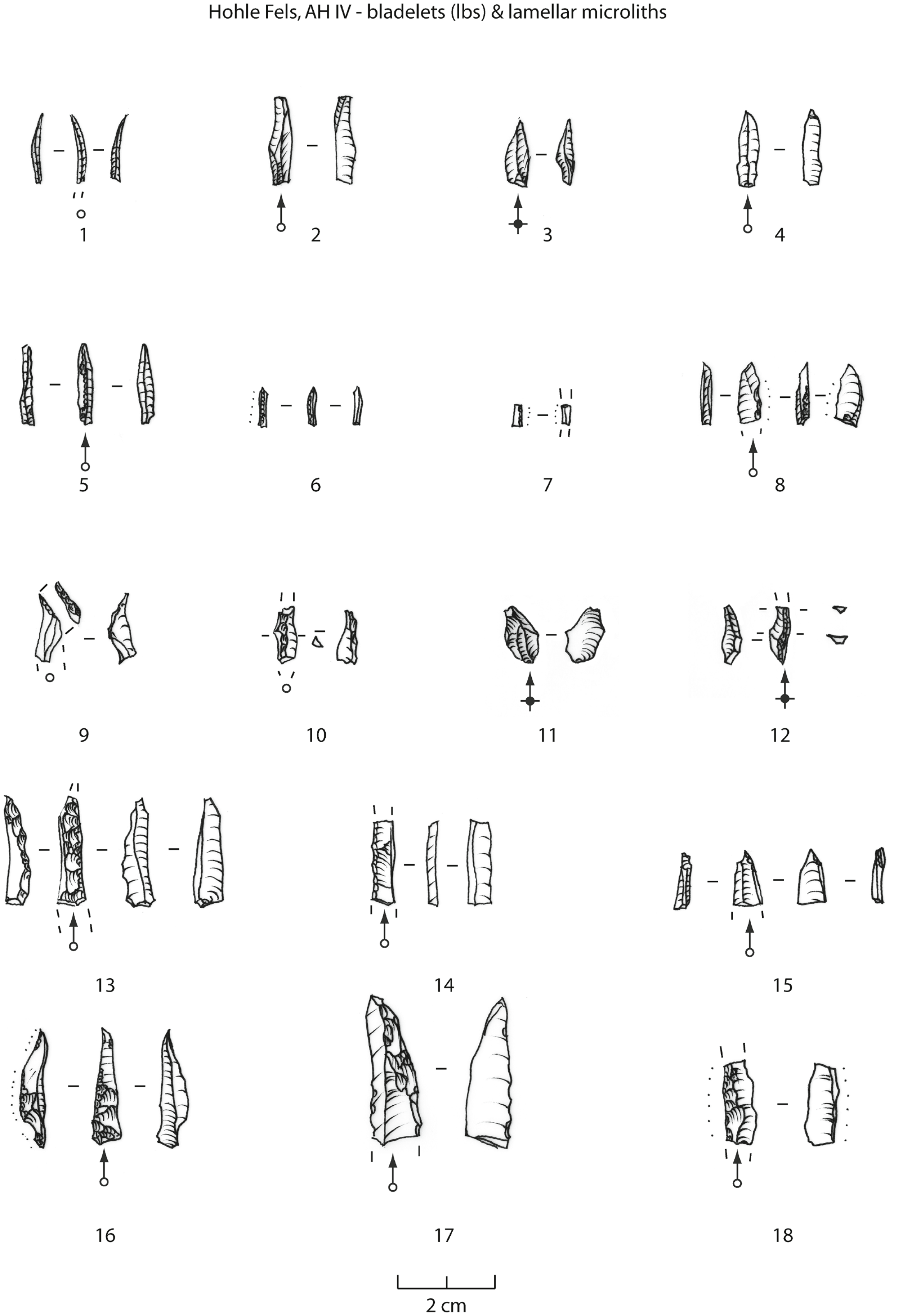
Appendix, Plate 4. Hohle Fels, AH IIIa. Hohle Fels, AH IIIa. (Double) burins on lateral truncation (1-3) and dihedral burins (4-5). Drawings: G. Bataille.

Appendix, Tafel 4. *Hohle Fels, AH IIIa. Hohle Fels, AH IIIa. (Doppel-) Stichel an lateraler Endretusche (1-3) und Dihedralstichel (4-5). Zeichnungen: G. Bataille.*



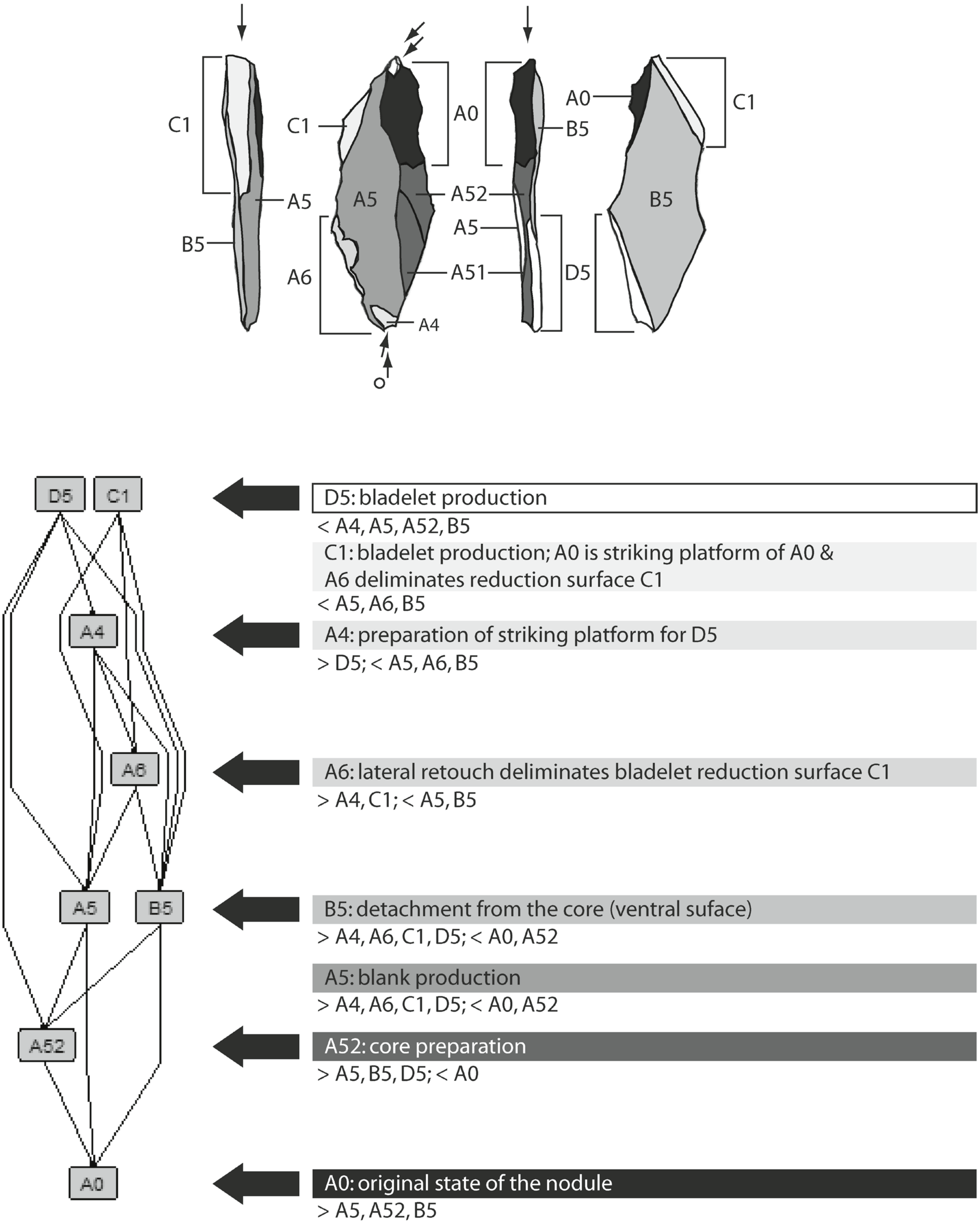
Appendix, Plate 5. Hohle Fels, AH IIIa. RMU 65 (1-7) indicates a diagnostic reduction scheme of the Hohle Fels IV-facies: I) unidirectional blade production (1-2), II) formatting and reduction of burin-cores on blades (3-4) as well as III) lbs from burin-cores (5-6) and laterally modified lbs (7). Blades (1-2), burin on truncation (3), dihedral burin (4), lbs (5 & 9), lbs from the correction of the distal tip of a dihedral burin (6) unilaterally retouched lamellar microlith on lbs (7-8, 10 & 11), lbs with core crest (12) and lbs from the correction of a burin on oblique / concave truncation (13). Drawings: G. Bataille.

Appendix, Tafel 5. *Hohle Fels, AH IIIa. RM 65 (1-7) repräsentiert ein diagnostisches Reduktionsschema der Hohle Fels IV-Fazies: I) unidirektionale Klingenproduktion (1-2), II) Präparation von Stichelkernen an Klingen (3-4) sowie III) von Stichelkernen abgetrennte Stichellamellen (5-6) und lateral modifizierte Stichellamellen (7). Klingen (1-2), Stichel an Endretusche (3), Dihedralstichel (4), Stichellamellen (5 & 9), Stichellamelle der Korrektur des Distalendes eines Dihedralstichels (6) unilateral retuschierte lamellare Mikrolithen an Stichellamelle (7-8, 10 & 11), Stichellamelle mit Kernkante (12) und Stichellamelle der Korrektur eines Stichels an schräger / konkaver Endretusche (13). Zeichnungen: G. Bataille.*



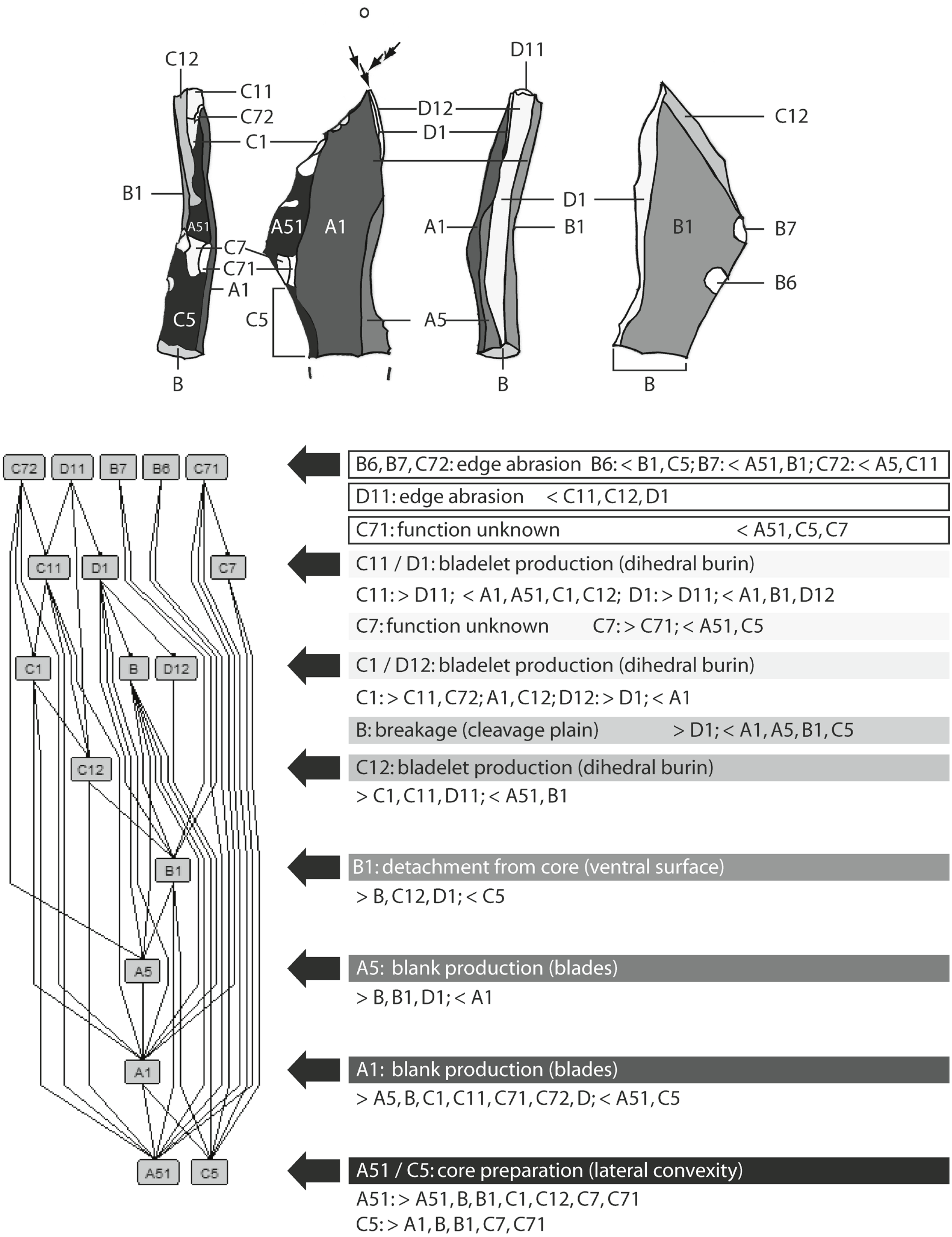
Appendix, Plate 6. Hohle Fels, AH IV. Bladelets and lamellar microliths. Lbs (1 & 2), simple microblades (3 & 4), lbs with use retouch (5 & 7), microliths / laterally modified lbs (6, 9, 12-14, 16 & 18), lbs with core crest (10 & 17), correction bladelet from the reduction face of a carinated / nosed endscraper (11) and borer on lbs (15). Drawings: G. Bataille.

Appendix, Tafel 6. *Hohle Fels, AH IV. Lamellen und lamellare Mikrolithen. Stichellamellen (1 & 2), einfache Mikro-Lamellen (3 & 4), Stichellamellen mit Gebrauchsretusche (5 & 7), Mikrolithen / lateral modifizierte Stichellamellen (6, 9, 12-14, 16 & 18), Stichellamellen mit Kernkante (10 & 17), Korrekturlamelle von der Reduktionsfläche eines Kiel-/ Nasenkratzers (11) und Bohrer an Stichellamelle (15). Zeichnungen: G. Bataille.*



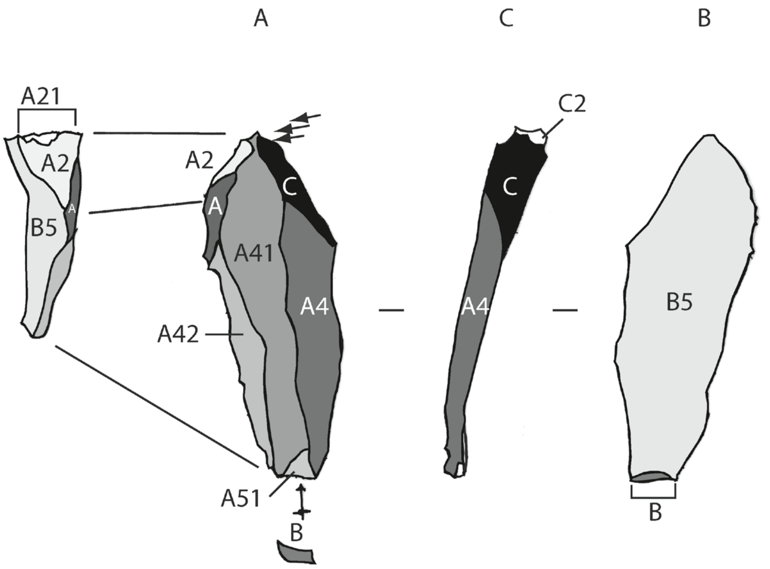
Appendix, Plate 7. Hohle Fels, AH IIIa. WSA 1. Top: double burin. From left to right: left lateral face C, dorsal face A, right lateral face D and ventral face B. Older working stages are indicated in black and dark grey shades, younger working stages in white to light grey shades. Bottom left: the Harris diagram shows the time relations between the working stages. Neighbouring negatives are indicated by contact lines. The timeline runs from the bottom to the top. Bottom right: indicated are the reduction stages and the time relations between the working stages.

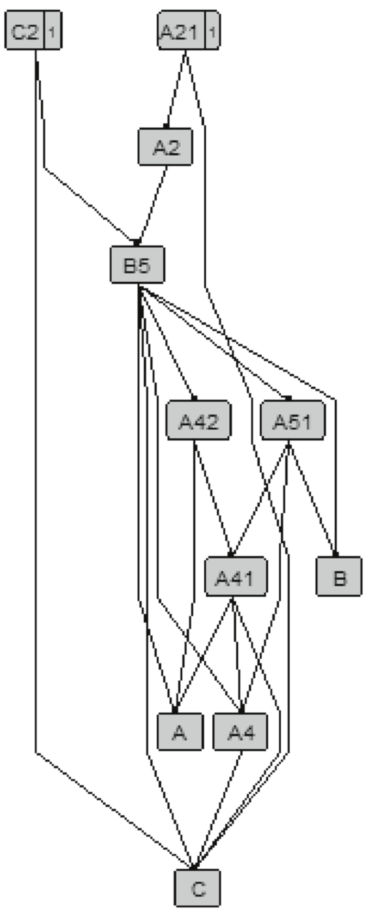
Appendix, Tafel 7. *Hohle Fels, AH IIIa. Arbeitsschrittanalyse (ASA) 1. Oben: Doppelstichel. Von links nach rechts: linke Lateralfläche C, Dorsalfläche A, rechte Lateralfläche D und Ventralfläche B. Ältere Arbeitsschritte werden durch schwarze und dunkelgraue Flächen, jüngere durch weiße bis hellgraue Flächen angegeben. Unten links: das Harris-Diagramm stellt die Zeitbezüge zwischen den Arbeitsschritten dar. Bezüge benachbarter Negative werden durch Kontaktlinien angezeigt. Die Zeitlinie verläuft von unten (älter) nach oben (jünger). Unten rechts: Reduktionsstadien und Zeitbezüge zwischen Arbeitsschritten.*



Appendix, Plate 8. Hohle Fels, AH IIIa. WSA 2.

Appendix, Tafel 8. *Hohle Fels, AH IIIa. ASA 2.*





C2 / A21: abrasion C2: < C; = A21 / A21: < A2, C; = C2

A51: dorsal reduction >B5; < A4, A41, A42, B

A2: bladelet production (early stage)

>A21; < B5, C, A, A41

B5: detachment from core (ventral surface)

> A2, C2; < A42, A4, C, A

A51: dorsal reduction

> B5; < B

A42: blade production

> B5; < A41, A

A41: blade production

> A42; < A4, A, C

B: striking platform remnant of original blade core

> B5, A51

A4: blade production

> A41, B5; < C

A: core preparation (lateral convexity)

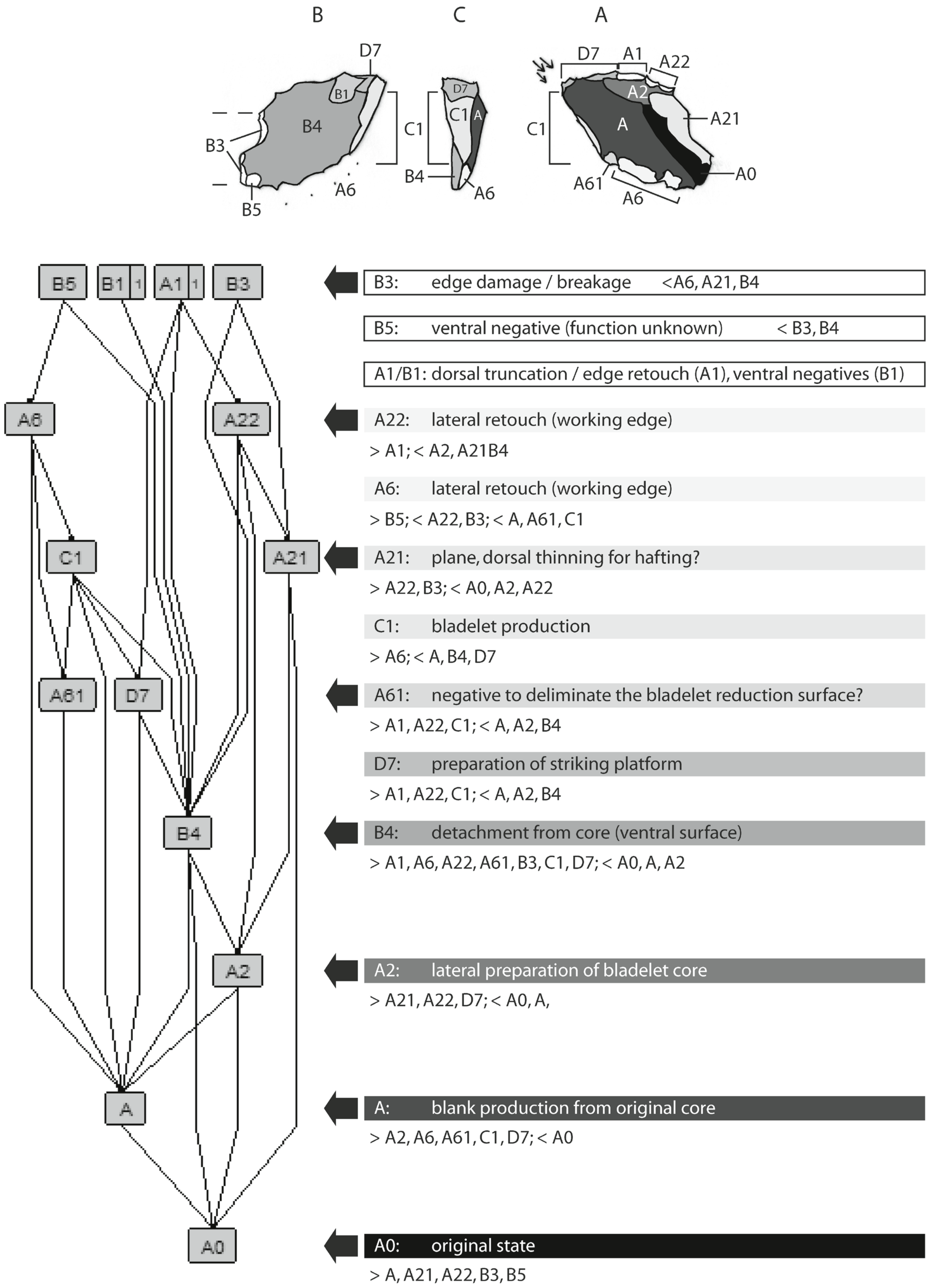
> B5, A41, A42

C: lateral flank of the original core

> B5, C2, A4, A41

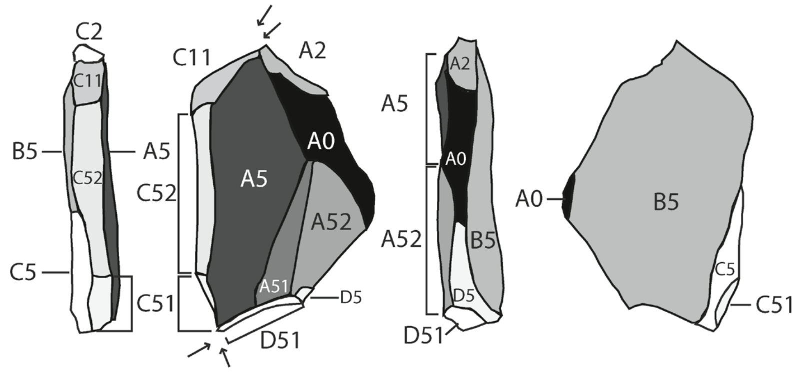
Appendix, Plate 9. Hohle Fels, AH IIIa. WSA 3.

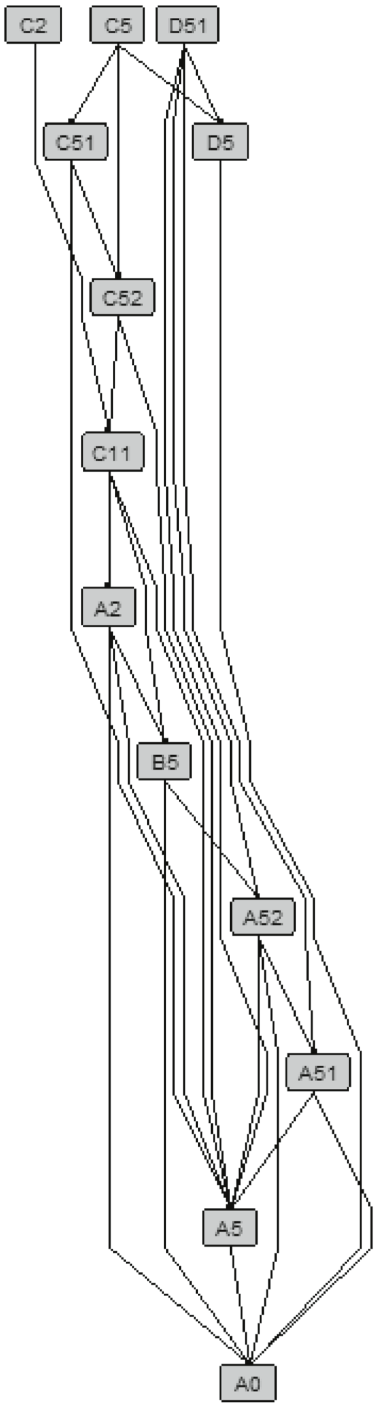
Appendix, Tafel 9. *Hohle Fels, AH IIIa. ASA 3.*



Appendix, Plate 10. Hohle Fels, AH IIIa. WSA 4.

Appendix, Tafel 10. *Hohle Fels, AH IIIa. ASA 4.*





C5 / D51: bladelet production (dihedral burin) / C2: burin blow

C5: < C51, C52, D5; D51: > C5, < D5; C2: < C11; C2<C11

D5: ventral negative (function unknown)

> A2, C11, C51, C52, D51; < A0, A52

C51: bladelet production (dihedral burin)

> C5; < D5

C52: bladelet production (dihedral burin)

> C5, C51; < A5, C11

C11: burin blow

> C2; < A0, B5

A2: preparation of striking platform for C11

> C11; < A0, B5

B5: detachment from core (ventral surface)

> A2, C11, C51, C52, D51; < A0, A52

A52: blank production from original core

> B5, D51; < A0, A51

A51: blank production from original core

> A52, D51; < A0, A5

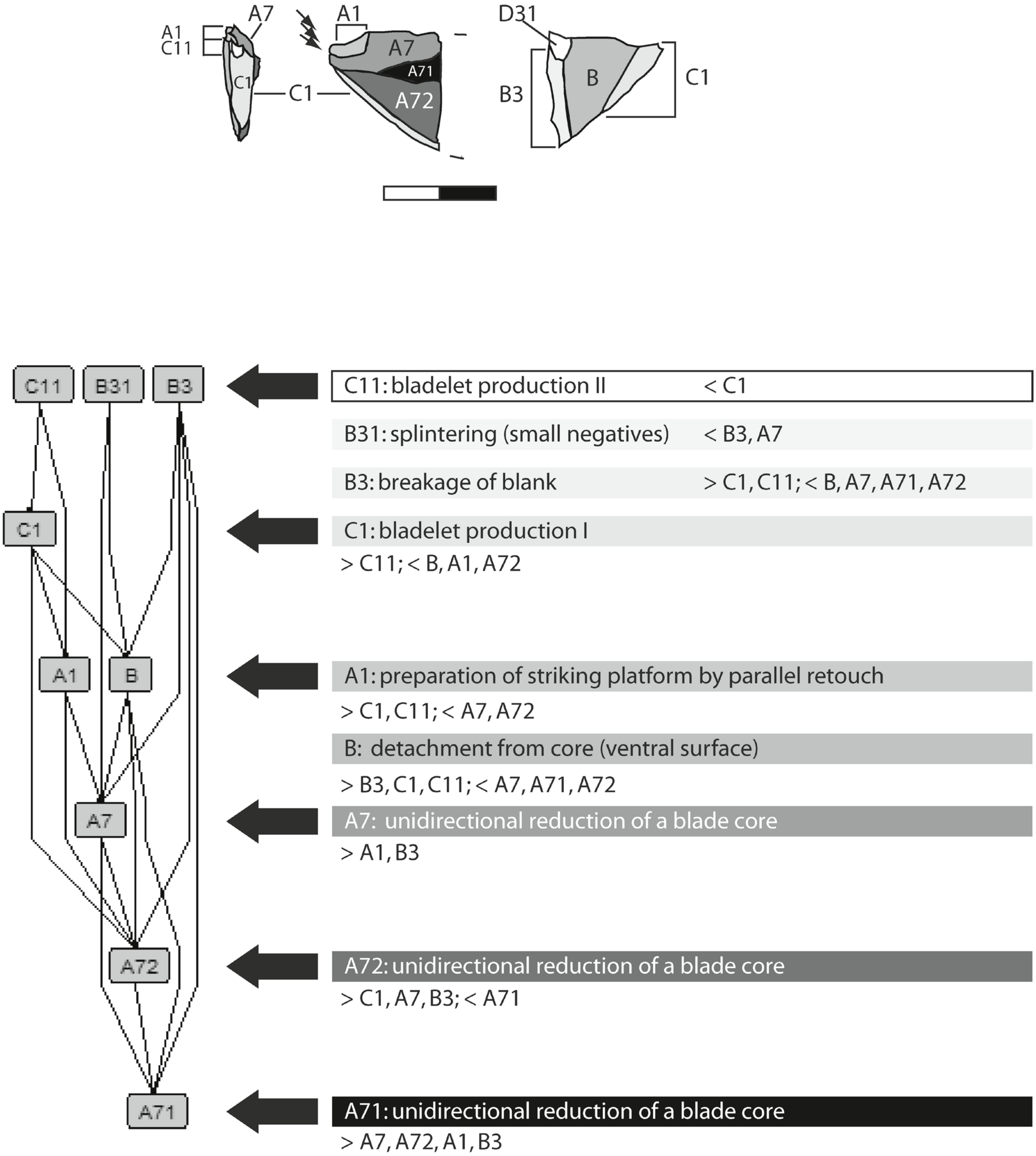
A5: blank production from original core

> A51, A52, C, C51, C52,D51; < A0

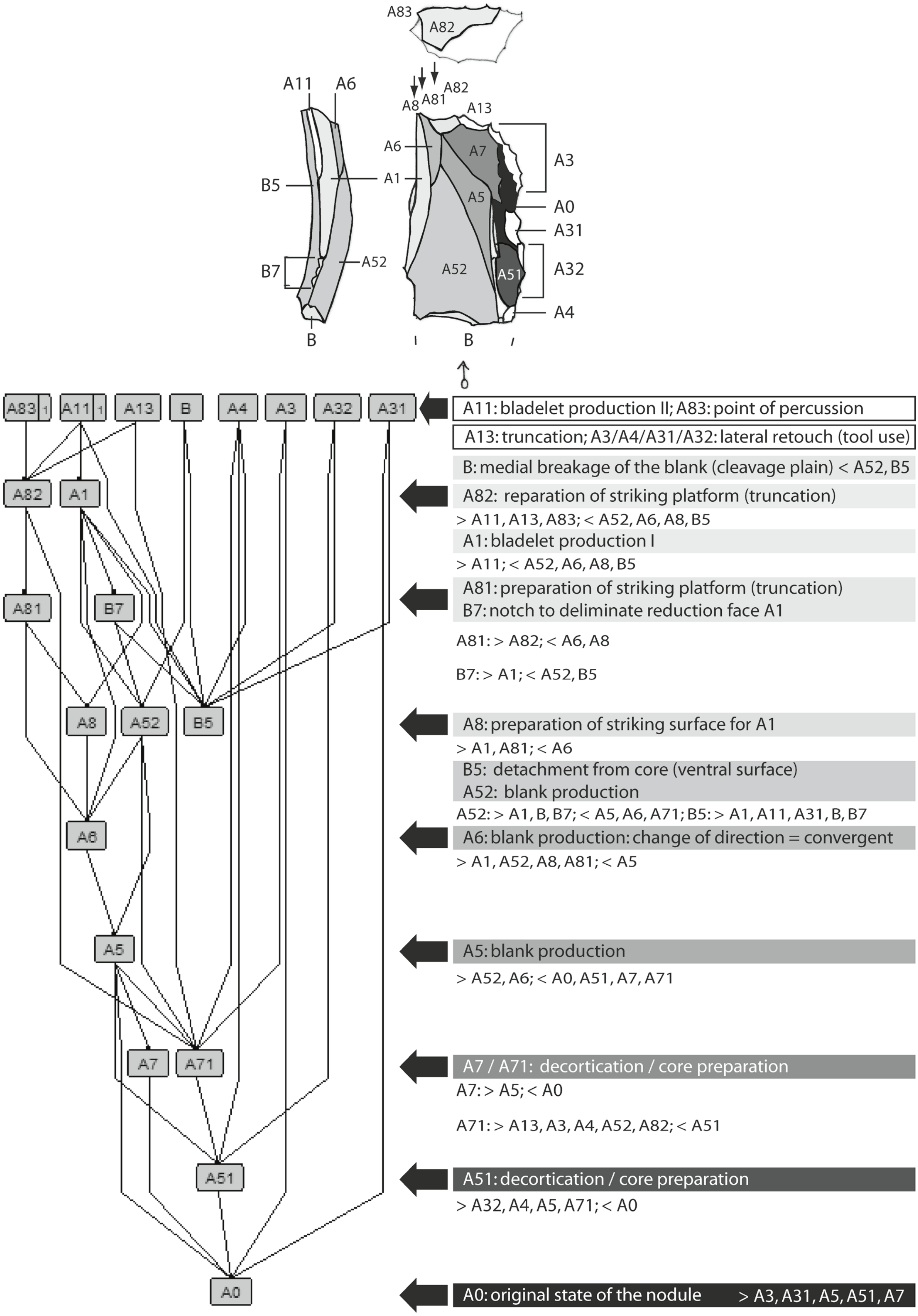
A0: original state > A5, A51, A52, A2, B5

Appendix, Plate 11. Hohle Fels, AH IIIa. WSA 5.

Appendix, Tafel 11. *Hohle Fels, AH IIIa. ASA 5.*

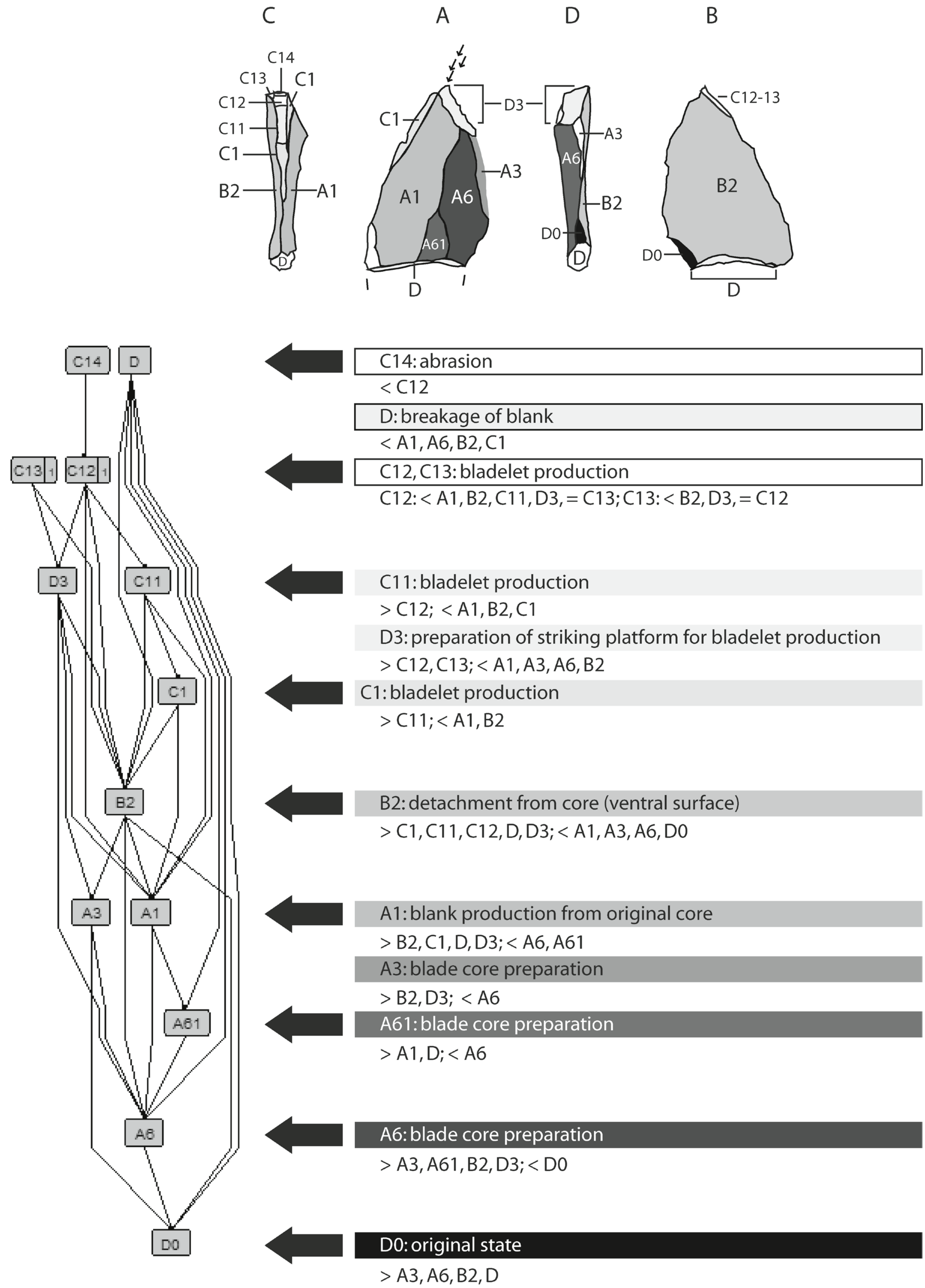


Appendix, Plate 12. Hohle Fels, AH IIIa. WSA 6.
Appendix, Tafel 12. *Hohle Fels, AH IIIa. ASA 6.*



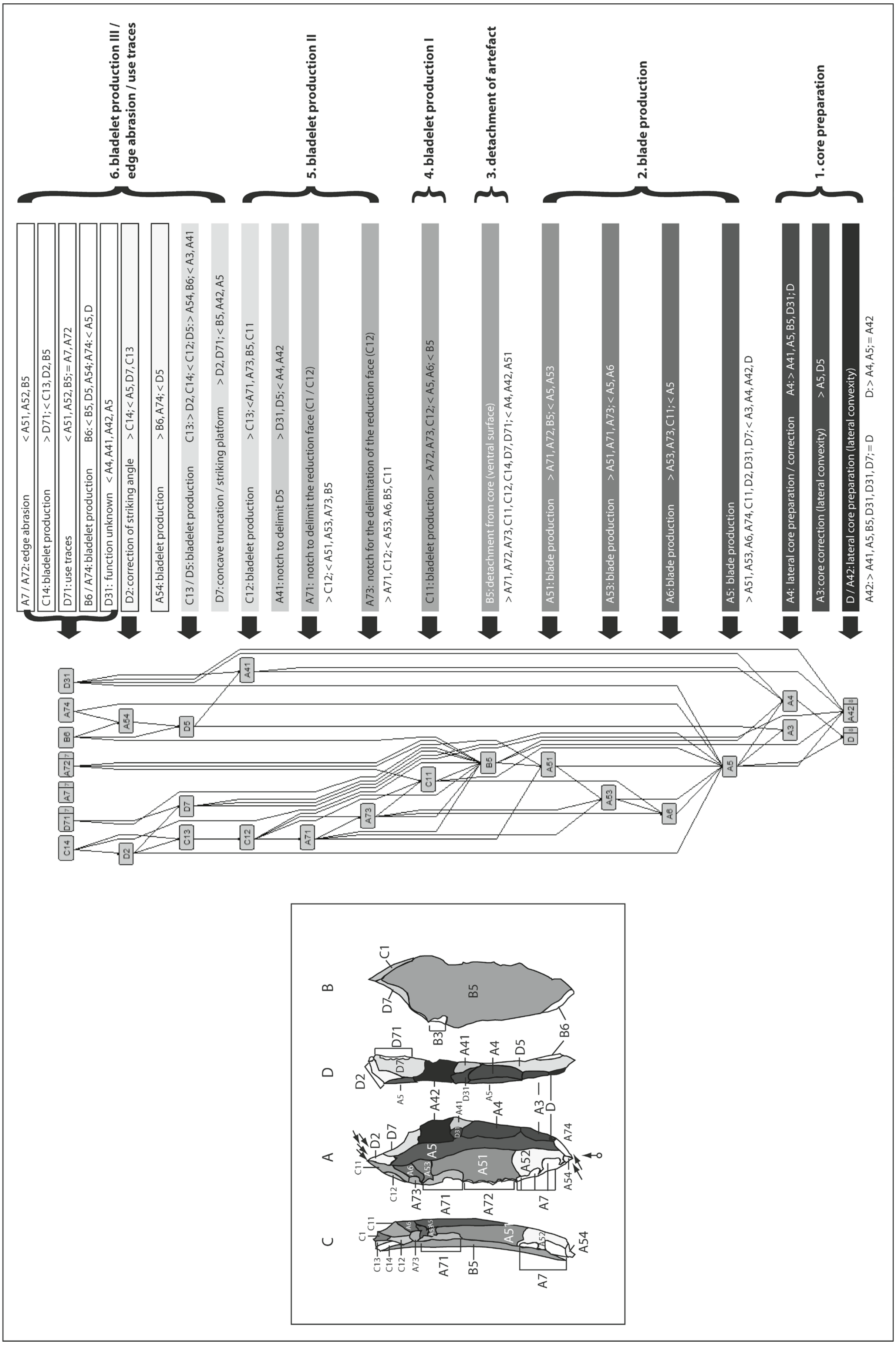
Appendix, Plate 13. Hohle Fels, AH IIIa. WSA 7.

Appendix, Tafel 13. *Hohle Fels, AH IIIa. ASA 7.*



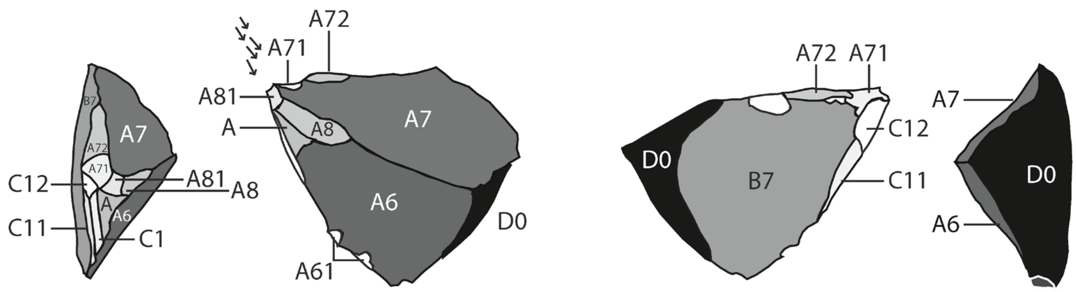
Appendix, Plate 14. Hohle Fels, AH IIIa. WSA 8.

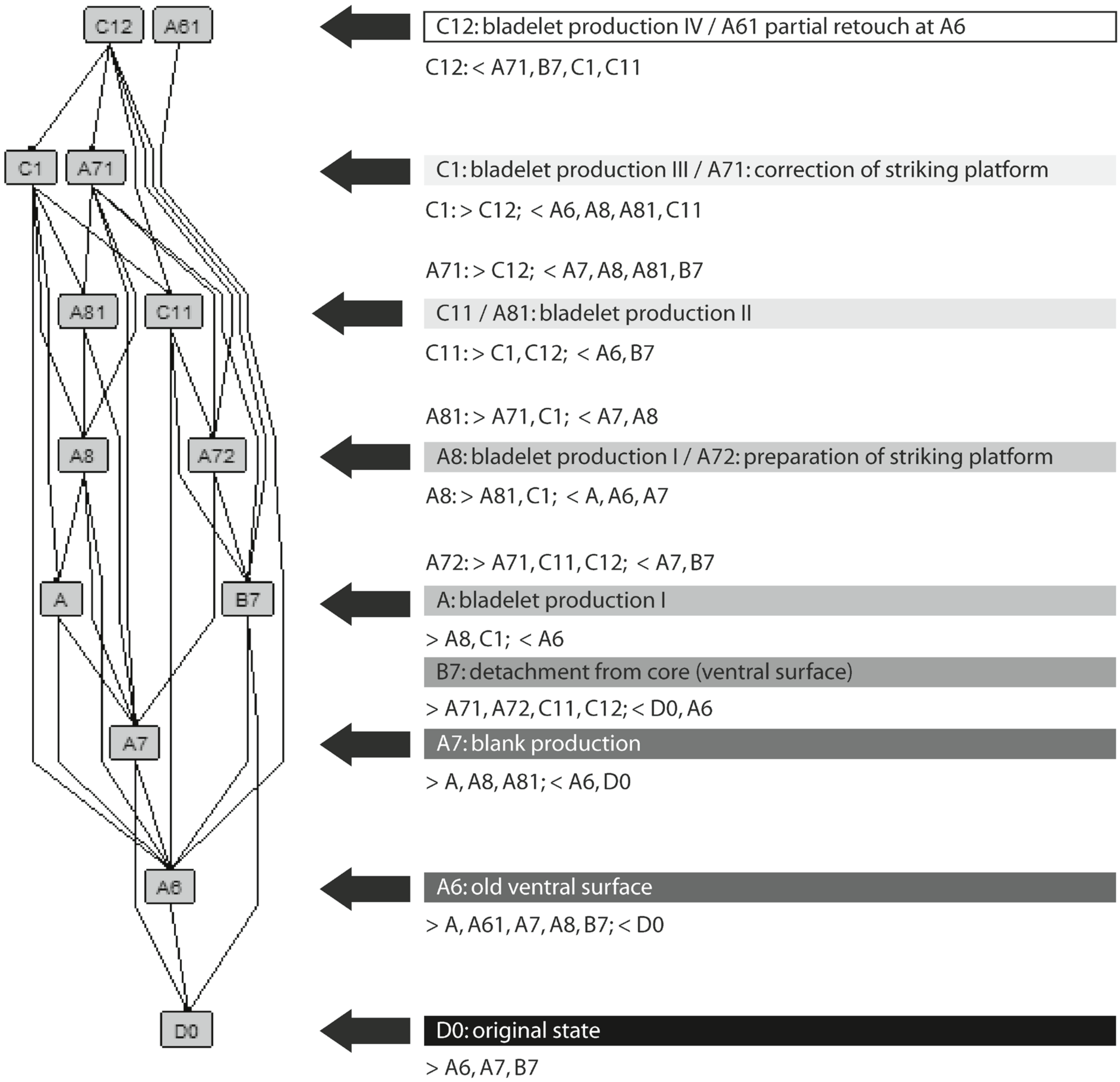
Appendix, Tafel 14. *Hohle Fels, AH IIIa. ASA 8.*



Appendix, Plate 15. Hohle Fels, AH IIIa. WSA 9.

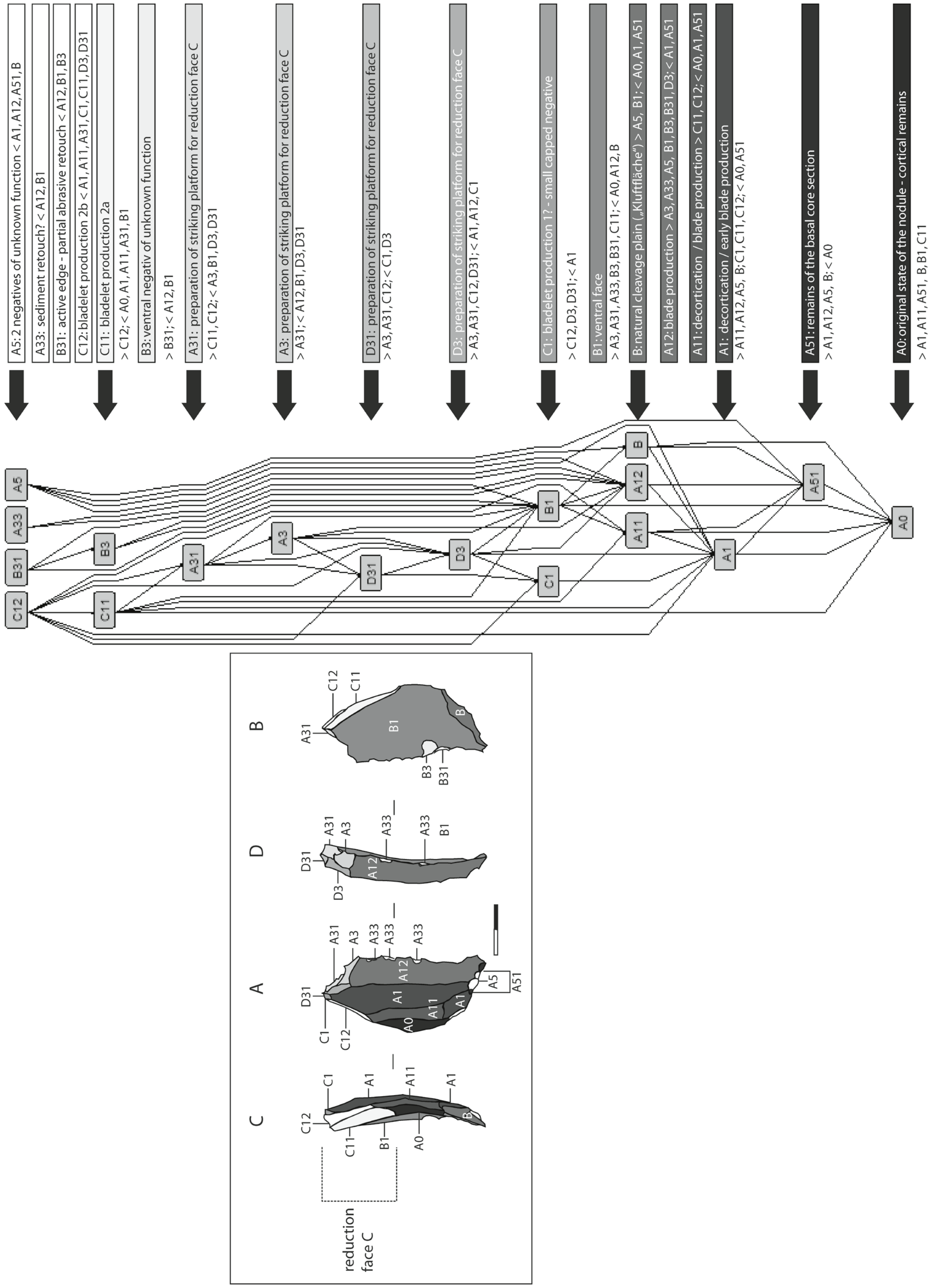
Appendix, Tafel 15. *Hohle Fels, AH IIIa. ASA 9.*





Appendix, Plate 16. Hohle Fels, AH IIIa. WSA 10.

Appendix, Tafel 16. *Hohle Fels, AH IIIa. ASA 10.*



Appendix, Plate 17. Hohle Fels, AH IIIa. WSA 11.

Appendix, Tafel 17. *Hohle Fels, AH IIIa. ASA 11.*

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