The Danube Corridor after 29,000 BP – New results on raw material procurement patterns in the Gravettian of southwestern Germany

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Abstract: *This contribution presents new results on lithic raw material distribution and procurement patterns in the Gravettian of southwestern Germany, with a special emphasis on the cave site of Hohle Fels situated in the Ach Valley near Schelklingen (Swabian Jura). The analysis of lithic raw material acquisition is based on a detailed study of the regional geological background and the natural distribution and characteristics of the different types of raw materials. In this context the important studies of W. Burkert, C. Pasda, J. Hahn, and others should be emphasized. The most important varieties of raw materials in southwestern Germany are different types of Jurassic chert including Bavarian tabular chert and 'Bohnerzhornstein' from the Upper Rhine Valley. Other important raw materials are radiolarite, tertiary chert from Randecker Maar and alpine quartzites. In comparison with the Aurignacian record of the region, Gravettian raw materials for the first time indicate a high degree of long distance raw material transport. The most important axis of long distance raw material transport is oriented along the Danube River from the Black Forest in the West to the Altmühl area in Bavaria in the East. In comparison, contacts to the North and to the South are rare. Besides the identification of raw material origins and the question of mobility and supra-regional contacts, our contribution aims to point out the specific relation between the composition of lithic assemblages and the distances to their raw material sources.*
Keywords: *Upper Paleolithic, Gravettian, Swabian Jura, Lithic technology, Raw material procurement, Danube Corridor*

Der Donau-Korridor nach 29.000 BP – Neue Ergebnisse zur Rohmaterialversorgung im Gravettien Südwestdeutschlands
Zusammenfassung: In Süddeutschland existieren zwei Hauptregionen mit Gravettienfundstellen: die Höhlenfundstellen im Achtal auf der östlichen Schwäbischen Alb und die Höhlen und Freilandstationen der Fränkischen Alb, zu denen u.a. die Weinberghöhlen bei Mauern sowie die Freilandstation Salching gehören. Ferner liegt ganz im Südwesten Deutschlands in der Nähe von Freiburg die Freilandfundstelle ‚Steinacker', die zur Rohmaterialgewinnung des feinkörnigen Bohnerzhornsteins („Bohnerzjaspis") diente.
In diesem Beitrag werden neue Ergebnisse zur Rohmaterialversorgung im Gravettien Südwestdeutschlands vorgestellt. Von besonderem Interesse ist hier die Fundstelle Hohle Fels im Achtal bei Schelklingen (Alb-Donau-Kreis), die mehrere reiche Gravettien-Schichten geliefert hat.
Die Gravettieninventare Süddeutschlands zeichnen sich durch eine Dominanz von verschiedenen Sticheltypen aus. Die charakteristischen Leitformen des Gravettien wie Font-Robert Spitzen, Mikrogravettespitzen und Fléchettes finden sich zumeist in ein und demselben Fundhorizont und scheinen im Gegensatz zu französischen und belgischen Gravettieninventaren keine chronologische Signifikanz zu haben. Nach den 14C-Daten gehören die süddeutschen Gravettieninventare in einen sehr frühen Zeitraum zwischen 29.000 und 27.000 BP. Im Gravettien wird die Klingen- und Lamellenproduktion im Vergleich zu den vorhergehenden Aurignacieninventaren verfeinert. Die Klingen und Lamellen sind nun regelmäßiger, schmaler und länger. Die Kerne zeigen in aller Regel einen uni- oder bipolaren Abbau.
Die Analysen zur Rohmaterialversorgung beruhen auf geologischen Untersuchungen in der Region sowie auf Erkundungen zu den natürlichen Vorkommen und Charakteristiken der verschiedenen Rohmaterialtypen. In diesem Zusammenhang sind vor allem die Arbeiten von W. Burkert, J. Hahn und C. Pasda zu nennen.
In den Gravettieninventaren lassen sich diverse Rohmaterialien belegen. Das wichtigste Rohmaterial bildet der Jurahornstein, der in verschiedenen Varianten vorliegt. Dazu zählen unter anderem Plattenhornstein aus Bayern, Bohnerzhornstein vom Südrand der Schwäbischen Alb sowie „Bohnerzjaspis" aus dem Oberen Rheintal. Andere wichtige Rohmaterialien sind Radiolarit und alpiner Quarzit aus

den Schottern und Moränen des Alpenvorlandes, Tertiärsilex vom Randecker Maar sowie triaszeitliche Muschelkalk- und Keuperhornsteine.
Im Gravettien lässt sich erstmals ein größerer Anteil an nichtlokalen Rohmaterialien in den Inventaren feststellen. Insbesondere Radiolarit zeigt deutlich höhere Anteile als in den vorhergehenden Aurignacieninventaren. Die durch Rohmaterialien etablierte Hauptverbindungsachse liegt in Ost-West-Richtung und orientiert sich entlang der Donau vom Schwarzwald im Westen bis zur Altmühlregion im Osten. Dagegen sind Kontakte in Nord-Süd-Richtung deutlich seltener.
Im Zusammenhang mit der Frage zur Rohmaterialherkunft und zur Mobilität und überregionalen Verbindungen liegt ein besonderes Gewicht der Ausarbeitung auf dem spezifischen Verhältnis zwischen der Komposition der Silex-Ensembles und der Distanz zum Rohmaterialvorkommen. So sind beim lokalen Rohmaterial in der Regel alle Phasen des Umformungsprozesses belegt: Von angeschlagenen Rohknollen bis hin zu Werkzeugen sind alle Produktionsstufen nachgewiesen. Rohmaterial aus größerer Distanz wurde hingegen häufig in Form von Halbfabrikaten oder Werkzeugen importiert. Eine örtliche Produktion lässt sich nicht belegen. Im Magdalénien ist ein ähnliches Verhalten zu beobachten. Es lassen sich somit keine großen Brüche in der Rohmaterialnutzung und Artefaktproduktion feststellen. Es ist lediglich eine Verstärkung des Einbringens ortsfremder Materialien festzustellen. Vergleichbare Ergebnisse wurden durch die Arbeiten von Harald Floss (1994) im Jungpaläolithikum des Mittelrheingebietes nachgewiesen.
Im Hohle Fels, der hier exemplarisch vorgestellt wird, kommen drei Gravettienschichten: AH IIb, IIc und IIcf vor, die insgesamt 60 bis 80 cm mächtig sind. Davon ist der nur 3 bis 10 cm mächtige Horizont AH IIcf der markanteste. Er besteht aus dunkler Knochenasche, die als Leithorizont dient. Etwa zwei Drittel aller gravettienzeitlichen Silexartefakte stammen aus diesem geringmächtigen Horizont. Die ersten Untersuchungsergebnisse der dreidimensional eingemessenen Silexartefakte aus dem AH IIcf sprechen dafür, dass es sich um die Abfallzone eines Begehungshorizontes handelt.
Im AH IIcf sind 92% der Silexartefakte aus lokalem Jurahornstein hergestellt. Der nur geringe Anteil an Radiolarit (ca. 5%) bildet einen starken Kontrast zu den deutlich höheren Radiolaritanteilen der Horizonte AH IIc und IIb sowie zu den Gravettienschichten der anderen Achtalhöhlen. Im AH IIcf kommen in geringen Anteilen außerdem Bohnerzhornsteine vom Südrand der Schwäbischen Alb sowie nicht lokaler Jurahornstein und Tertiärsilex vom Nordrand der Schwäbischen Alb vor.
Die Analyse der Kortex- und Grundformanteile zeigt, dass beim lokalen Jurahornstein alle Stufen des Umformungsprozesses vorliegen und dieser vollständig in der Höhle verarbeitet wurde. Der geringe durchschnittliche Anteil von drei Werkzeugen pro Kern belegt, dass hauptsächlich Grundproduktion stattfand. Die Produktion von Sticheln wird durch Stichellamellen angezeigt. Beim Radiolarit ist der Anteil an Werkzeugen mit 14 Stücken pro Kern deutlich höher. Mit einem Anteil von 40% dokumentieren Klingen und Lamellen die Hauptzielprodukte des Kernabbaus. Beim braunen und bunten Bohnerzhornstein sowie nicht lokalen Jurahornstein und Tertiärsilex sind nicht alle Stufen des Umformungsprozesses im AH IIcf belegt. Vermutlich wurden diese nur teilweise im Hohle Fels verarbeitet oder als Grundformen und Werkzeuge eingebracht.
Der Werkzeuganteil im AH IIcf liegt bei 4,2%. Die meisten Werkzeuge sind aus lokalem Jurahornstein hergestellt. Lateral- und endretuschierte Werkzeuge sind mit knapp 60% am häufigsten belegt. Die charakteristischen Werkzeuge des Gravettien wie Stichel, Gravettespitzen, Mikrogravettespitzen und Fléchettes haben Anteile von 12% bzw. 15%. Daneben liegen als weitere Geräteformen Ausgesplitterte Stücke, Kratzer, spitz retuschierte Klingen und Abschläge, Bohrer, Kombinationswerkzeuge sowie wenige große Schaber vor. Im Vergleich zu den anderen Gravettieninventaren des Achtals, bei denen der Werkzeuganteil bei ca. 10% liegt, ist der Werkzeuganteil im AH IIcf eher gering. Dies ist vermutlich auf die umfangreiche Grundproduktion zurückzuführen und deutet eventuell auf eine unterschiedliche Nutzung, eine unterschiedliche chronologische Stellung oder auf eine generelle Variabilität der Werkzeugensembles im frühen Gravettien hin.
Schlagwörter: Jungpaläolithikum, Gravettien, Schwäbische Alb, Steintechnologie, Rohmaterialherkunft, Donaukorridor

Introduction

At least ten Gravettian sites are known from the Upper Paleolithic of southern Germany, concentrated in two main zones of occupation (Fig. 1) (Hahn 2000). The first zone, which is the focus of this investigation, is situated in the eastern part of the Swabian Jura and includes the river valleys of the Ach and the Lone. The Ach Valley has yielded extremely rich Gravettian remains exclusively from cave sites, such as Hohle Fels, Geißenklösterle, Brillenhöhle and Sirgenstein. However, the nearby Lone Valley, which is also characterized by a dense accumulation of Upper Paleolithic sites, contains just a single, atypical Gravettian assemblage, that of Bockstein-Törle, layer VI. The second zone of Gravettian occupation is situated in Bavaria and includes cave sites such as Weinberghöhlen and open air sites like the important assemblage from Salching (Weißmüller and Bausch 1986).

In the southwestern angle of Germany on the eastern flank of the Upper Rhine Valley, Stephan Holdermann (1996) studied the open air site of Steinacker, which is located near an outcrop of fine-grained Jurassic chert, a lithic raw material of excellent quality. The presence of about 400 cores indicates that raw material extraction and core reduction played an important role in the activities carried out at Steinacker. Lithic artifacts forming several distinct concentrations could be refitted, with a maximum distance between refitted pieces of 44 m. As is generally the case at the Gravettian sites of southern Germany, various types of burins predominate the typological spectrum. The archaeological dating of Steinacker is based on the presence of several microgravette points and five Font-Robert points. This latter tool type is also represented by two examples from Hohle Fels (Conard and Uerpmann 1999) and one example from Geißenklösterle. Anne Scheer (2000) argues that Font-Robert points seem to occur more frequently at open air sites, as typified by the 20 examples found at Bilzingsleben in Thuringia (Mania 1981).

__Fig. 1:__ Gravettian sites in southern Germany. 1 Steinacker-Müllheim, 2 Hohle Fels, 3 Sirgenstein, 4 Geißenklösterle, 5 Brillenhöhle, 6 Bockstein-Törle, 7 Weinberghöhlen, 8 Abri im Dorf, 9 Mittlere Klause, 10 Salching (modified after Hahn 2000, Fig. 1).

We, however, do not see a significant correlation between the occurrence of specific tool types, such as Font-Robert points, and caves or open air sites. New discoveries by Ralf Schmitz in the Neandertal (Neander Valley) provide evidence that Font-Robert points can also occur in high frequencies in caves (Feine 2003). In several cases from the Gravettian of southern Germany, Font-Robert points, microgravettes and fléchettes were found in the same stratigraphic context, demonstrating that these forms are not necessarily of chronological significance. Radiocarbon dates place the Gravettian of southwestern Germany in an early chronological framework (Conard and Moreau, this volume) in which different types of lithic projectiles seem to occur at the same time. The late Gravettian assemblage of Bockstein-Törle VI is too small to allow statements about a possible tool evolution from early to late Gravettian in our region.

In comparison to the preceding Aurignacian, Gravettian blade production becomes more sophisticated. Crest preparation is frequent, blades and bladelets become more regular, longer and narrower. Typical cores have one or two opposed striking platforms and one or two removal surfaces.

The raw materials

The most common lithic raw material in southwestern Germany is Jurassic chert, which is widespread in the Swabian Jura (Fig. 2). Nevertheless, as a result of tectonic uplifting, the preservation of soils containing Jurassic chert is best in the eastern parts of the Swabian upland (Burkert 2001; Burkert and Floss 2005). The Jurassic chert is grey, mostly opaque and occurs in nodules. From the Upper Paleolithic sites of the Ach Valley,

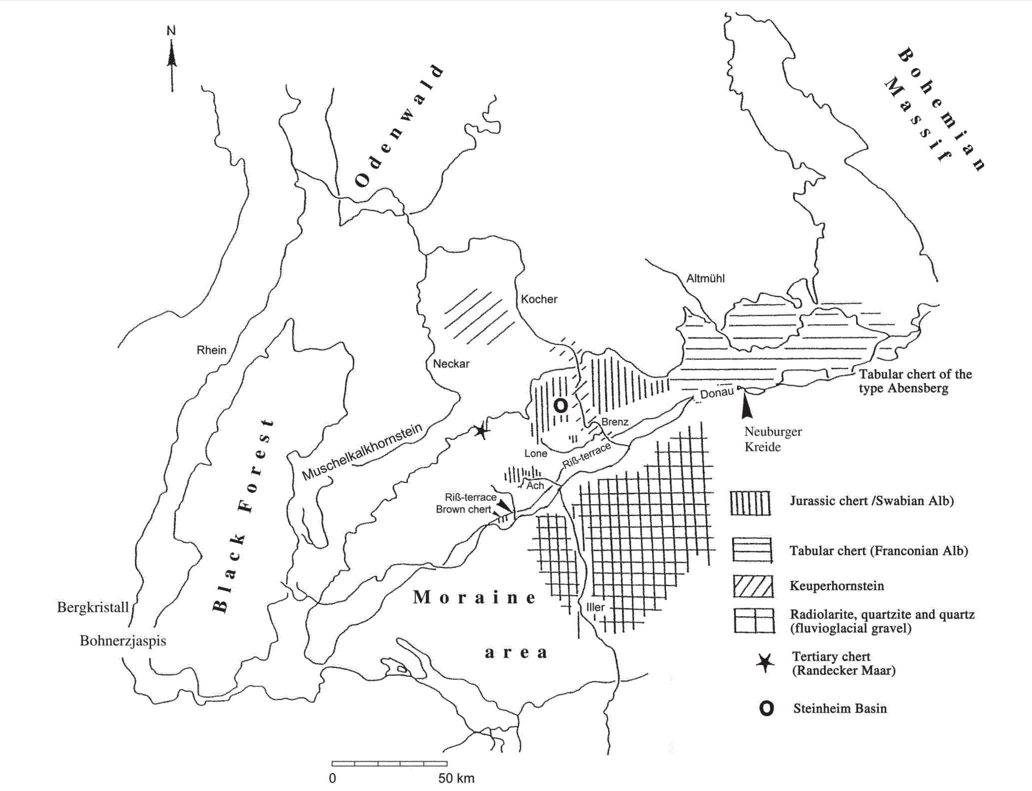

Fig. 2: *Raw Material sources in southwest Germany (after Burkert and Floss 2005, Fig. 1).*

the nearest outcrops of grey Jurassic chert are found at a distance of about 3 km. Another variety of chert, usually brown colored, occurs at the southern edge of the Swabian Jura and in river deposits crossing the Mesozoic plateau. This material is generally called 'Bohnerz' chert.

The two lithic raw materials that serve as the best indicators of long distance transports are very fine grained, grey or red chert and high quality tabular chert that is often banded. The fine grained variety occurs in a restricted area of the Upper Rhine Valley south of Freiburg near the site of Steinacker. The red and the yellow varieties are locally known as 'Bohnerz' jasper, although they are not true jasper, but rather Jurassic chert that has been altered under the influence of iron ore deposits. The outcrops of red jasper are situated 180 km west of the Ach Valley. Tabular chert is widespread in the Franconian Jura, the easterly continuation of the Swabian Jura, and occurs from the eastern edge of the Nördlingen basin. The best varieties of this type of chert are found 160 km east of the Ach Valley.

In addition to these Jurassic cherts, another important raw material of the region is radiolarian chert, known as radiolarite. This chert was formed in Mesozoic units of the Alps and can be found in river deposits of the Danube, moraines and fluvioglacial gravels, all situated south of the Swabian Jura, 10 to 20 km from the Ach Valley. In the same deposits, a lower Jurassic black alpine quartzite occurs that is often described as siliceous slate or lydite. In the area north of the Swabian Jura, two distinct types of non-Jurassic chert also occur. Middle Triassic 'Muschelkalk' chert is mostly grey or black, rich in fossils and often with an oolithic structure. Upper Triassic 'Keuper' chert is heterogeneous, blue-grey or orange in color. Finally, in contrast to the widespread Mesozoic cherts, a Tertiary chert is found only in the area of the Randecker Maar at the northern edge of the Swabian upland. This variety of chert allows the specific identification of raw material provenance.

Patterns of raw material procurement during the Gravettian

Even if we observe examples of longer distance transport of raw materials during the late Middle Paleolithic and Aurignacian of Swabia, local Jurassic chert predominates. In the Gravettian we see an abrupt change, as the amount of imported material increases, particularly radiolarite from the adjacent southern lowlands. At the same time, the amount of local Jurassic chert decreases, even if this material still predominates. According to Joachim Hahn (2000, 254), the changes in raw material use could be caused by overexploitation during the Aurignacian or by change of an environmental or geomorphological nature.

As was the case in the preceding Aurignacian, the East-West connection along the river Danube is indicated by the presence of a few artifacts made of Upper Rhine 'jasper' and of Bavarian tabular chert (Fig. 3). Moreover, the presence of radiolarite in the Bavarian Weinberghöhlen demonstrates movement in the opposite direction and strengthens the hypothesis for the existence of an East-West axis along the Danube. We see a clear relationship between the composition of distinct raw materials and the distances to their origins. Whereas local materials show the total production sequence from raw material

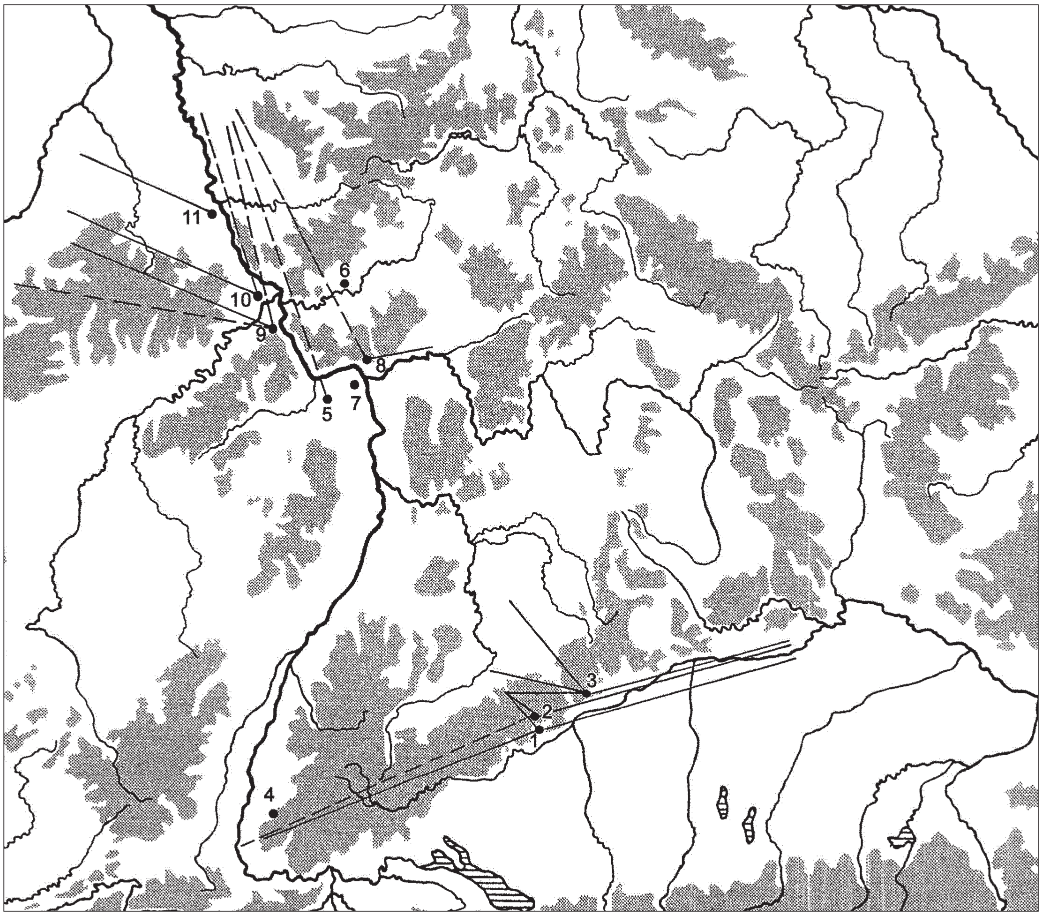

Fig. 3: *Provenance of raw materials in the Gravettian of west and southwest Germany (interrupted line: origin is uncertain). 1 Hohle Fels, 2 Geißenklösterle, 3 Bockstein-Törle, 4 Steinacker, 5 Sprendlingen, 6 Wildscheuer IV, 7 Mainz-Linsenberg, 8 Wiesbaden-Adlerquelle, 9 Rhens, 10 Koblenz-Metternich, 11 Muffendorf (after Burkert and Floss 2005, Fig. 8).*

testing to core reduction and tool production, materials from greater distances were frequently imported as blanks, blades or tools, so that core reduction would not have taken place on site. In the subsequent Magdalenian, we do not see such decisive changes in the pattern of lithic raw material procurement. The Magdalenian is characterized by behavioral continuity, even if non-local raw material is present in greater quantity and variety.

Raw material procurement patterns in the Gravettian of Hohle Fels cave

State of research

In the following, we investigate a case study from Hohle Fels cave. We present technological and typological data of the Gravettian lithic assemblage and examine the lithic supply system. Hohle Fels contains rich Gravettian layers, like the neighboring cave sites of Geißenklösterle and Brillenhöhle, all located in the Ach Valley between Blaubeuren and Schelklingen in southwestern Germany (see Fig. 1). Refitting of stone artifacts from the Gravettian layers has demonstrated that the caves were used more or less contemporaneously (Scheer 1986, 1990, 1993).

Hohle Fels lies on the eastern side of the river Ach, about 7 m above the valley floor and 345 m above sea level. The cave is part of the limestone massif of the Swabian Jura and has an ground area of 500 m² and a volume of 6000 m³. The first investigations at Hohle Fels date to 1870/71, when Oscar Fraas of 'Königliches Naturalienkabinett' in Stuttgart and Theodor Hartmann excavated the immense interior hall (Blumentritt and Hahn 1991; Saier 1994). In 1958-1960 Gustav Riek of the 'Institut für Vor- und Frühgeschichte' in Tübingen and Gertrud Matschak (Schelklingen) conducted a small excavation in the entrance corridor, where they found sediments undisturbed by the previous activities. Thus it was here that Joachim Hahn of the 'Institut für Urgeschichte' in Tübingen began new research in 1977 using modern methods of excavation. The excavations continued until 1979 and from 1988 through 1996 (Hahn 1977, 1979, 1989, 1991, 1992,

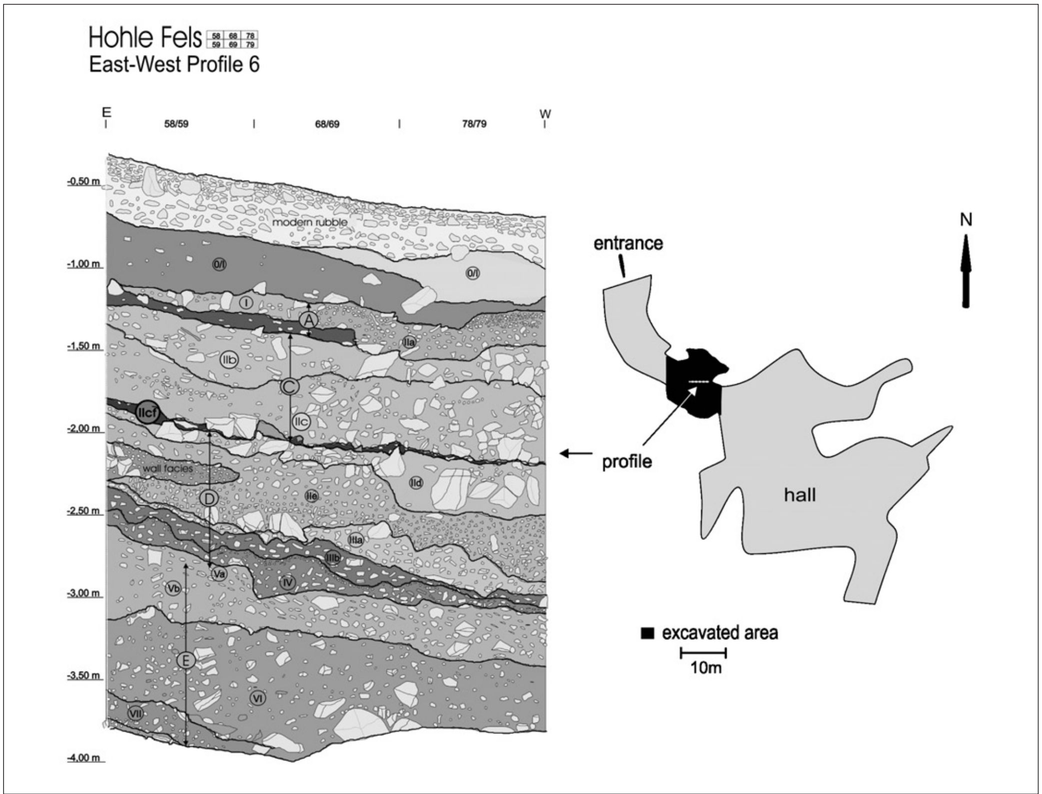

Fig. 4: Hohle Fels. Schematic plan of the cave with excavation area and East–West Profile 6. A: Magdalenian, C: Gravettian, D: Gravettian –Aurignacian, E: Aurignacian (after Fischer 1995, Fig. 2, modified, and after Conard et al. 2003, Fig. 5).

1995, 1996; Hahn and Pasda 1990; Fischer et al. 1993; Scheer 1994; Hahn and Waiblinger 1997). Since 1997, Nicholas J. Conard and Hans-Peter Uerpmann of the 'Institut für Ur- und Frühgeschichte und Archäologie des Mittelalters' in Tübingen have led ongoing annual excavations (Conard and Uerpmann 1999; Conard et al. 2000, 2001, 2002, 2003; Schiegl et al. 2003). The stratigraphy (Fig. 4), which spans from modern times back to the Middle Paleolithic, contains three Gravettian layers, Archaeological Horizons (AH) IIb, IIc, and IIcf, which date between 27,000 and 30,000 BP (Conard and Moreau, this volume). From these 60 – 80 cm thick Gravettian layers, the lower horizon IIcf is the most distinctive. It is 3 – 10 cm thick and consists mainly of burnt bone. Because of its dark color and extension over most of the excavated surface, this layer serves as a key horizon. Micromorphological analyses suggest that this ash layer characterizes a dumping zone (Schiegl et al. 2003), a finding supported by the absence of clear fire structures. Most of the Gravettian finds come from this layer. Radiocarbon dates on bone from AH IIcf date between 27,000 and 28,000 BP.

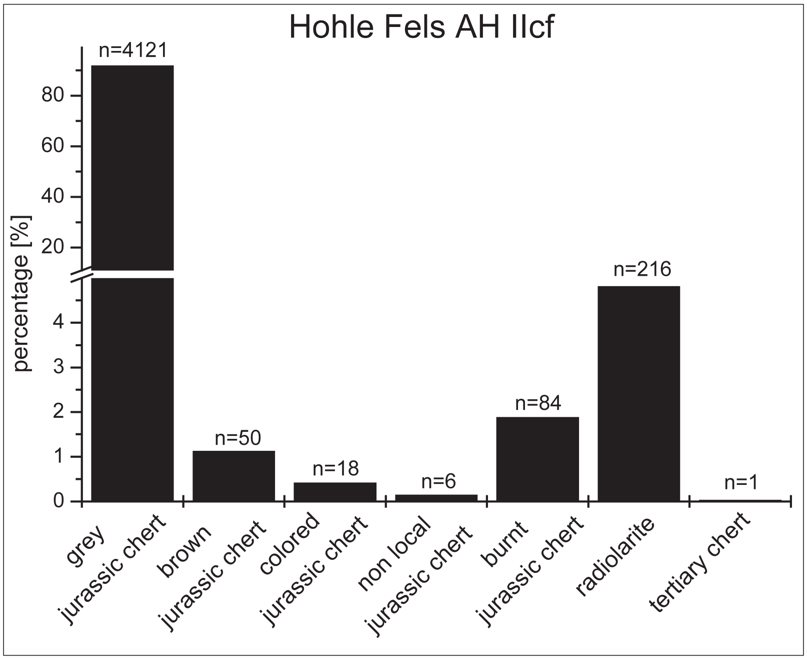

Fig. 5: *Raw material frequencies of Gravettian horizon IIcf (data from provisional database).*

The investigation of the Gravettian lithic assemblages from the excavation campaigns of 1977 through 2003 is still in progress. A large part of the water-screened artifacts and some of the piece-plotted artifacts still await analysis. Therefore, we present only preliminary data in this paper. In the following, we concentrate on AH IIcf because almost all of the piece-plotted artifacts from this horizon have been analyzed. Currently, the distribution patterns of the artifacts, as well as the refitting, suggest that this thin ash layer results from an event of short duration and very likely represents the trash zone from one living floor.

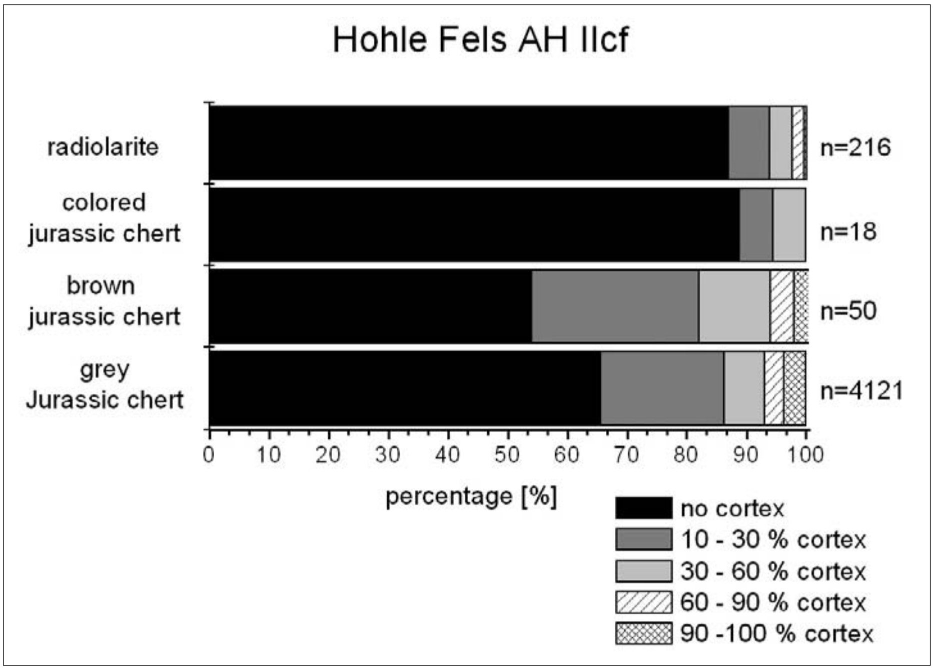

Fig. 6: *Cortex frequencies of the different raw materials of the Gravettian horizon IIcf (data from provisional database).*

Raw material

Several raw materials have been documented in the lithic assemblage of AH IIcf (Fig. 5). The most prominent raw material is grey Jurassic chert, comprising 92% of the lithic artifacts. Field surveys show that this key variety of chert was mainly extracted from outcrops in the local vicinity (<5 km) (Burkert 2001, 183; Burkert and Floss 2005). The variable quality of the nodules points to the use of different sources of raw material. The mostly intact cortex of the nodules indicates that they came from primary sources on the uplands of the Swabian Jura, weathered out of the Jurassic bedrock.

The second most common raw material is radiolarite with 4.8%. Red varieties clearly predominate over green ones. Rare examples of cortex indicate nodules from fluvial gravels. As mentioned before, radiolarite is found in the Danube gravels and in the moraines and fluvioglacial gravels of the alpine foreland, 10 to 20 km south of the cave (Fig. 2). The low percentage of radiolarite contrasts with other Gravettian lithic assemblages of the Ach valley. Wolfgang Burkert (2001, 183, table 1), who examined the raw material of the Gravettian lithic assemblage from nearby Geißenklösterle cave, discovered that up to 40% is radiolarite. There is also a much higher percentage of radiolarite (20 to 30%) in the lithic assemblages of AH IIb and IIc of Hohle Fels, based on our preliminary data. Thus, the very low percentage of radiolarite in AH IIcf may be attributed to the short time of occupation. Refits, however, show, that some of the radiolarite artifacts of AH IIcf conjoin with radiolarite artifacts from AH IIc. Therefore, it is also possible that a portion of the lithic assemblage of AH IIcf and IIc belongs together.

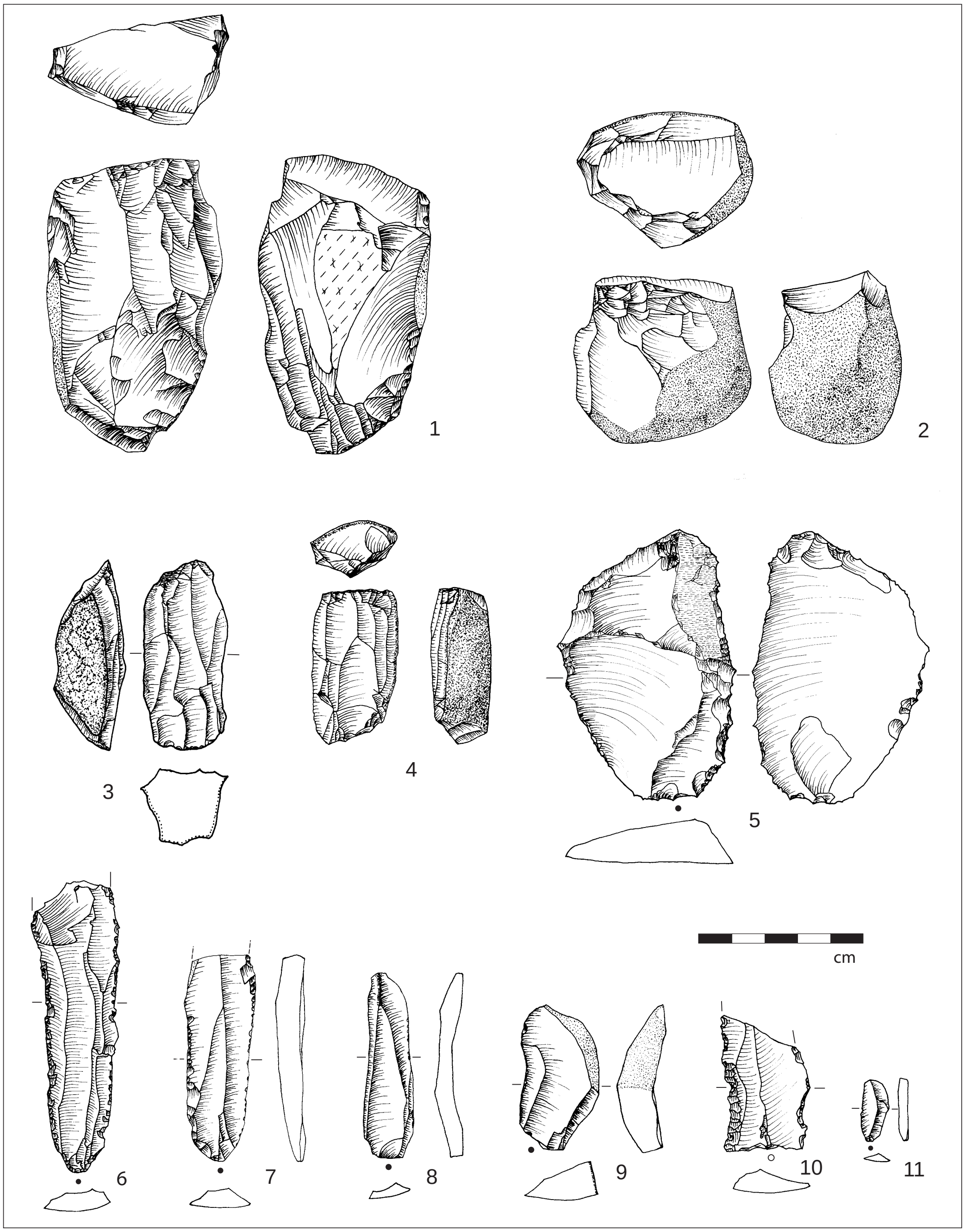

Fig. 7: *Hohle Fels. Gravettian horizon IIcf. 1–4 cores, 5 side scraper, 6.7.10 bilateral retouched blades, 9 lateral retouched flake, 8 blade with use retouch, 11 microblade. 1-3.6.7 grey Jurassic chert, 4-5 radiolarite, 8 non-local Jurassic chert, 9 'Bohnerz' chert, 10 colored 'Bohnerz' chert, 11 Tertiary chert (3.5 after Conard et al. 2001, Fig. 4; 6.10 after Conard et al. 2000, Fig. 4).*

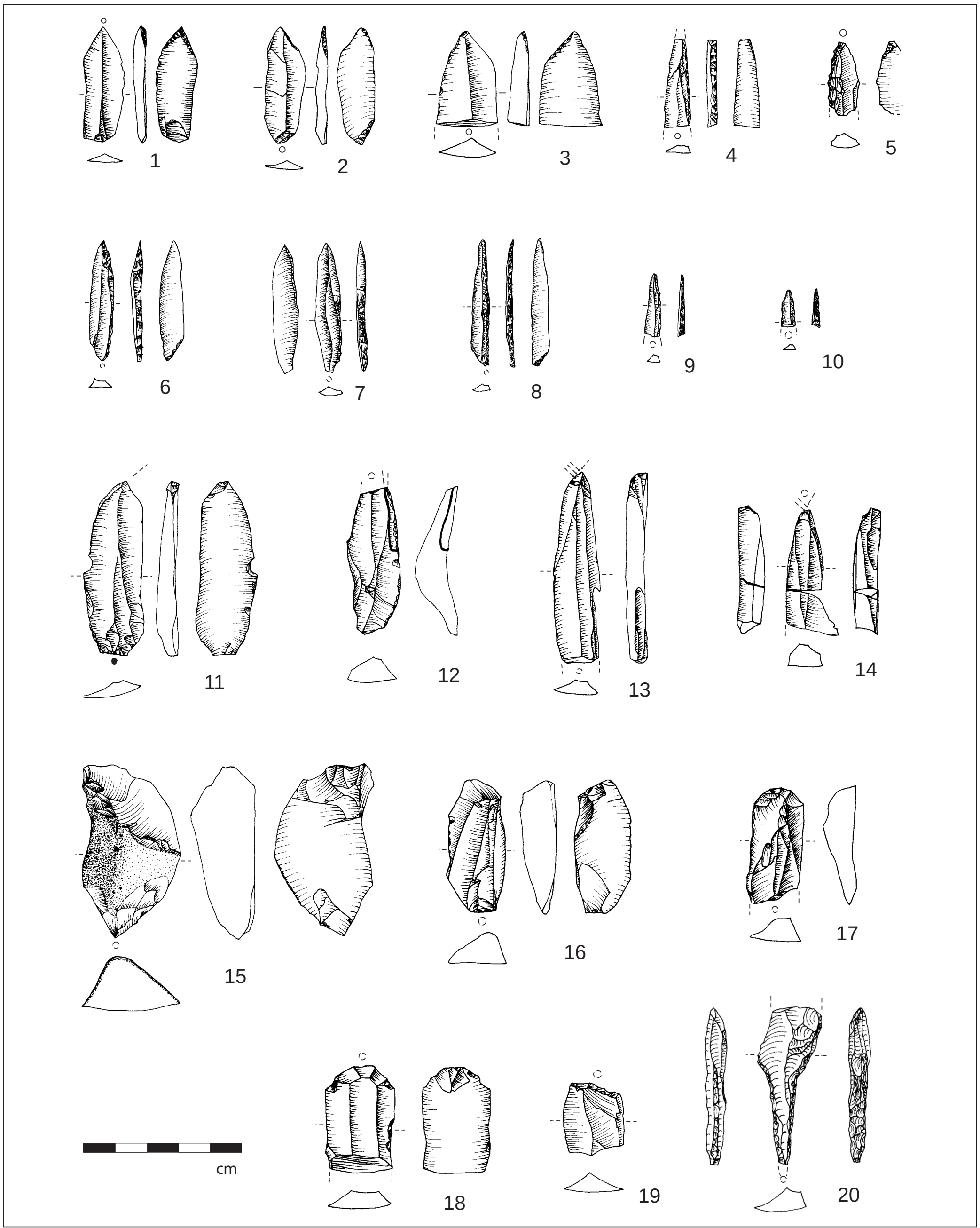

Fig. 8: *Hohle Fels. Gravettian horizon IIcf. 1-3 fléchettes, 4.5 gravette points, 6-10 microgravette points, 11 burin on truncation, 12 burin on break, 13.14 multiple burins, 15.16 splintered pieces, 17.18 end scrapers, 19 truncation, 20 Font-Robert point (horizon IIc). 1.8-11.14 radiolarite, 2-7.13.15.16.18-20 grey Jurassic chert, 12 non-local Jurassic chert, 17 'Bohnerz' chert (6.8-10 after Conard et al. 2001, Fig. 4; 5.19 after Conard et al. 2000, Fig. 4; 20 after Conard and Uerpmann 1999, Fig. 28).*

Besides these two types of raw material, small amounts of brown and colored 'Bohnerz' chert are present from outcrops along the southern edge of the Swabian Jura 10 to 12 km away. A single artifact made of Tertiary chert found only in the Randecker Maar volcanic region 25 km northwest of the Ach Valley suggests contact to the northern uplands of the Swabian Jura (Fig. 7.11). Ammonites used as ornamental objects also reflect communication with this area. Additionally, there are six pieces of light-colored, fine-grained, non-local Jurassic chert of uncertain origin (Fig. 7.8, Fig. 8.12). Also of unclear origin are 1.9% of artifacts identified as burnt Jurassic chert, although it is very likely that most of them are of grey Jurassic chert.

Procurement and reduction strategies

The frequency of cortex of the different raw material varieties indicates how raw material was acquired as well as how the nodules were reduced (Fig. 6). For the local grey Jurassic chert, the percentage of cortical artifacts makes up 34% of the assemblage, but only 7% of the artifacts have more than 60% cortex. Compared with a flaking experiment

	Flaking experiment			AH IIcf Grey jurassic chert			AH IIcf Brown 'Bohnerz' chert			AH IIcf Radiolarite		
Cortex	FL	BL	MB	FL	BL	MB	FL	BL	MB	FL	BL	MB
n	95	33	3	1360	733	335	21	16	10	71	53	33
no cortex %	37.9	81.8	66.7	51.8	52.9	71.0	33.3	75.0	60.0	81.7	83.0	87.9
10 – 30 %	12.6	9.1	33.3	27.9	29.8	13.5	42.9	12.5	20.0	11.3	9.4	6.1
30 – 60 %	24.2	6.1	-	8.2	9.0	11.0	9.5	12.5	20.0	2.8	5.7	3.0
60 – 90 %	9.5	3.0	-	4.7	4.8	2.7	9.5	-	-	4.2	1.9	-
90 –100 %	15.8	-	-	7.4	3.5	1.8	4.8	-	-	-	-	3.0
Total cortex %	62.1	18.2	33.3	48.2	47.1	29.0	66.7	25.0	40.0	18.3	17.0	12.1

Table 1: *Comparison of the cortex frequencies of the different raw materials of horizon IIcf of Hohle Fels cave (data from provisional database) with the cortex frequencies of a flaking experiment. FL: flakes; BL: blades; MB: microblades.*

in which one quartzite nodule was reduced (Cziesla 1990, 307, table 24), it turned out that the percentage of cortical flakes is especially low in AH IIcf, whereas the percentage of blades preserving cortex is high (Table 1). Taking this into account, and the fact that almost all cores of grey Jurassic chert have cortex (Fig. 7.1-3), it seems very likely that unchipped nodules were brought into the cave, but were reduced differently than in Cziesla's flaking experiment. The cores indicate that cortex was not removed initially, but rather step by step throughout the course of reduction. This might have been a good tactic due to the relatively small size of the Jurassic chert nodules. The different core sizes and stages of core reduction, such as whole nodules, prepared cores, as well as exhausted cores, may reflect a lengthy occupation. On the other hand, it is not out of the question, that cores were brought into the cave at different stages of preparation and reduction.

For radiolarite, the proportion of cortical artifacts is low with 13%, so we assume that mainly prepared or used cores were introduced to the cave. Since one of the two radiolarite cores has a cortical back (Fig. 7.4) it seems likely that the Gravettian people took whole nodules from the source, prepared them and possibly used the artifacts elsewhere, before bringing them into the cave. Furthermore, the small number of cores indicates that some were carried out again after use. The refitting of artifacts between Hohle Fels (AH IIb), Brillenhöhle (AH VII), and Geißenklösterle (AH It) provides evidence for the circulation of radiolarite cores (Scheer 1993, 203-204).

For brown and colored 'Bohnerz' chert, non-local Jurassic chert and Tertiary chert the number of artifacts is too small to make statements about raw material procurement and production. No cores have yet been documented for any of these raw materials. At least for brown 'Bohnerz' chert, the small number of artifacts with more than 60% cortex may indicate that the Gravettian occupants brought in a few used or tested cores, which

		Grey JC		Brown BC		Colored BC		NJC	Burnt JC		Radiolarite		TC	total	
Blank type		n	%	n	%	n	%	n	n	%	n	%	n	n	%
1	unmod	1233	29.9	16	32.0	6	33.2	1	39	46.4	57	26.4	-	1352	30.1
	mod	41	1.0	1	2.0	2	11.1	-	-	-	3	1.4	-	47	1.1
2	unmod	87	2.1	3	6.0	1	5.6	-	2	2.4	9	4.2	-	102	2.3
	mod	4	0.1	1	2.0	-	-	-	-		2	0.9	-	7	0.2
3	unmod	582	14.1	14	28.0	3	16.7	2	7	8.3	34	15.7	-	642	14.3
	mod	75	1.8	2	4.0	-	-	2	2	2.4	11	5.1	-	92	2.0
4	unmod	74	1.8	-	-	-	-	-	1	1.2	6	2.8	-	81	1.8
	mod	3	0.07	-	-	-	-	-	-		2	0.9	-	5	0.1
5	unmod	306	7.4	7	14.0	1	5.6	-	6	7.1	19	8.8	1	340	7.6
	mod	12	0.3	-	-	-	-	-	-		10	4.6	-	22	0.5
6	unmod	17	0.4	3	6.0	-	-	-	2	2.4	4	1.9	-	26	0.6
7	unmod	149	3.6	1	2.0	-	-	-	4	4.8	4	1.9	-	158	3.5
	mod	8	0.2	-	-	-	-	-	-		3	1.4	-	11	0.2
8	unmod	793	19.2	2	4.0	1	5.6	-	9	10.7	24	11.1	-	829	18.4
	mod	1	0.04	-	-	-	-	-	-		-		-	1	0.02
9	unmod	538	13.0	-	-	-	-	-	-	-	15	6.9	-	553	12.3
	mod	1	0.02	-	-	-	-	-	-	-	-	-	-	1	0.02
10	unmod	51	1.2	-	-	-	-	-	2	2.4	2	0.9	-	55	1.2
11	unmod	2	0.05	-	-	-	-	-	-	-	-	-	-	2	0.04
12	unmod	121	2.9	-	-	3	16.7	-	10	11.9	9	4.2	-	143	3.2
13	unmod	20	0.5	-	-	1	5.6	-	-	-	2	0.9	-	23	0.5
	mod	3	0.07	-	-	-	-	1	-	-	-	-	-	4	0.09
total	unmod	3973	96.4	46	92.0	16	88.9	3	82	97.6	185	85.6	1	4306	95.8
	mod	148	3.6	4	8.0	2	11.1	3	2	2.4	31	14.4	-	190	4.2
	total	4121	100	50	100	18	100	6	84	100	216	100	1	4496	100

Table 2: *Blank frequencies of the different raw materials of Gravettian horizon IIcf of Hohle Fels cave (data from provisional database). 1 flakes, 2 preparation flakes, 3 blades, 4 crested blades, 5 microblades, 6 crested microblades, 7 flakes or blades, 8 small debitage (<10 mm), 9 micro debitage (<5 mm), 10 cores, 11 tested nodules, 12 angular debris, 13 modification debris; JC: Jurassic chert; BC: 'Bohnerz' chert; NJC: non-local Jurassic chert; TC: Tertiary chert; unmod: unmodified, mod: modified.*

were subsequently removed from the site after producing some blanks and tools in the cave. Further investigations are necessary, but perhaps the cores may be found in one of the other caves of the Ach Valley. This may also be true for the few artifacts of colored 'Bohnerz' chert.

The proportion of blanks also documents a different use of the raw materials in horizon IIcf (Table 2). For the dominant grey Jurassic chert, all stages of the *chaîne opératoire* are represented. The number of flakes, blades, preparation artifacts, cores, angular debris, small and micro debitage, not including the water-screened artifacts, implies extensive knapping activities. The low ratio of three tools per core indicates that core reduction for blanks was the most important activity. Thus, the proportion of tools is very low at 3.6%. Modification debris, mostly burin spalls, documents the production of burins.

Although the number of artifacts made of radiolarite is much smaller, the existing blank types also document all phases of reduction. The scarcity of cortical artifacts indica-

	Grey JC		Brown BC	Colored BC	Non-local JC	Burnt JC	Radiolarite		total	
Tool type	n	%	n	n	n	n	n	%	n	%
Unilateral retouch	54	36.5	-	1	1	2	6	19.4	64	33.7
Bilateral retouch	7	4.7	1	-	1	-	2	6.5	11	5.8
Truncation	19	12.8	1	-	-	-	1	3.2	21	11.0
Lateral and end retouch	13	8.8	-	-	-	-	2	6.5	15	7.9
Backed bladelet	4	2.7	-	-	-	-	-	-	4	2.1
Gravette point	2	1.4	-	-	-	-	1	3.2	3	1.6
Microgravette point	3	2.0	-	-	-	-	5	16.1	8	4.2
Fléchette	4	2.7	1	-	-	-	1	3.2	6	3.2
Pointed blade	3	2.0	-	-	-	-	-	-	3	1.6
Pointed flake	3	2.0		-	-	-	-	-	3	1.6
Borer	3	2.0	-	-	-	-	-	-	3	1.6
Burin	14	9.5	1	-	1	-	7	22.5	23	12.1
Endscraper	8	5.4		-	-	-	-	-	8	4.2
Sidescraper	1	0.7	-	-	-	-	1	3.2	2	1.0
Combination tool	4	2.7	-	-	-	-	2	6.5	6	3.2
Splintered piece	5	3.4	-	1	-	-	3	9.7	9	4.7
Undetermined tool	1	0.7	-	-	-	-	-	-	1	0.5
total	148	100	4	2	3	2	31	100	190	100

Table 3: *Tool frequencies of the different raw materials of Gravettian horizon IIcf of Hohle Fels cave (data from provisional database). For abbreviations see Table 2.*

tes that previously prepared or used cores were preferred. Radiolarite blades and microblades are the main targets of production, comprising 40% of all radiolarite artifacts, and most tools were made from these blanks. In comparison to grey Jurassic chert, radiolarite tools make up more than 14%, and the tool/core ratio of 15 is much higher for radiolarite. Therefore, tool production was more important for this raw material.

For brown and colored 'Bohnerz' chert not all stages of reduction are documented. The small number of artifacts may indicate only limited blank and tool production. No cores have yet been found. Based on the presence of a few preparation flakes, crested blades and angular debris, it seems likely that only part of the core reduction took place at Hohle Fels. For non-local Jurassic and Tertiary chert, the number of artifacts is too small to make any clear statements about their production. Nonetheless, the import of blades and tools is striking for the non-local Jurassic chert.

Tool assemblage

Tools make up 4.2% of the total lithic assemblage of AH IIcf (Table 3). Most of the tools are made of grey Jurassic chert (77.9%), followed by radiolarite (16.3%). The other raw material groups represent only a few tools. Lateral and end retouched tools (Fig. 7.6-10, Fig. 8.19) are most frequent with a total of 58.4%, mainly consisting of Jurassic chert. The characteristic tool types of the Gravettian, such as backed bladelets, fléchettes (Fig. 8.1-3), gravette points (Fig. 8.4-5) and microgravette points (Fig. 8.6-10), form 11.1% of the tool assemblage. Burins (Fig. 8.11-14), which are also typical for the Gravettian, have a proportion of 12.1%. Most common are burins with a single burin facet, but there are also burins with two sides of burin facets as well as burins on truncations (Fig. 8.11), burins on breaks (Fig. 8.12), multiple burins (Fig. 8.13-14) and dihedral burins.

For radiolarite, the proportion of these classic Gravettian tool types is much higher than for Jurassic chert (22.5% and 22.5% vs. 8.8% and 9.5%). Splintered pieces (Fig. 8.15-16) and end scrapers (Fig. 8.17-18) occur in proportions of 4.7% and 4.2%, respectively. All end scrapers, as well as the few pointed blades and flakes and borers are made of Jurassic chert. One of the two side scrapers (Fig. 7.5) is also made of Jurassic chert, while the other is of radiolarite. The tool assemblage contains a few combination tools. Most frequent are end scrapers combined with burins, but there are also two splintered piece-side scraper combinations, one of Jurassic chert and the other of radiolarite.

Compared to other Gravettian sites in the Ach valley, the percentage of tools at Hohle Fels AH IIcf is low. According to Anne Scheer (2000, 258, table 1), the analysis of the Gravettian lithic assemblages from the cave sites of Geißenklösterle, Sirgenstein, and Brillenhöhle indicates that tools represent about 10% of the artifacts from each of the assemblages. Even if we were to exclude the small and micro debitage, as well as debris resulting from modification and microlithic elements, the tool frequency at Hohle Fels AH IIcf would remain low, at approximately 6%. At the present state of investigation, this appears to result from the extensive core reduction that took place in the cave and may speak for a different use of Hohle Fels in comparison to the other cave sites of the Ach Valley. A different use, a different time period or, alternatively, as Alexander Verpoorte (unpublished manuscript) suggests, a general "high variability in proportions and local idiosyncrasies" of early Gravettian tool assemblages may explain the varied proportions of tools and the absence of specific types of tools, like Font-Robert points, shouldered points and Kostienki-ends, in AH IIcf of Hohle Fels. Anne Scheer (2000, 258, table 1) reports that these types of tool are present at Geißenklösterle, Brillenhöhle and in AH IIb/IIc of Hohle Fels, which yields dates older than AH IIcf (see Conard and Moreau, this volume). In the excavation campaign of 1998, a fragment of a Font-Robert point was found in the Gravettian AH IIc (Fig. 8.20). A second one was found in AH IIb. These reasons may explain the absence of other microlithic elements, except of microgravette points and backed bladelets, which are typical for the younger tool assemblages of the Pavlovian and also occur together with Font-Robert points in the Gravettian assemblage of the Kleine Feldhofer Grotte (Neandertal) (Feine, 2003).

At Hohle Fels, we are at the early stages of investigation. More detailed analysis of the entire lithic assemblage is necessary to obtain better and more precise information about the procurement, manufacture and use of lithic artifacts during the Gravettian settlement in the Ach valley.

Conclusions

- The Danube corridor is an important East-West axis for the transport of lithic raw materials.
- There are significant changes in raw material procurement patterns from the Aurignacian to the Gravettian.
- Despite a clear chronological break we see a continuity in raw material procurement patterns from the Gravettian to the Magdalenian.
- There is a correlation between the distance of raw material provenance and the form in which the materials were imported to the sites.
- Archaeological Horizon IIcf of Hohle Fels is an event of short duration that documents the trash zone of one living floor.
- This event is characterized by a very high percentage of local Jurassic chert which contrasts with the general raw material patterns of that time.
- The raw material procurement patterns, core reduction strategies and tool production in AH IIcf are related to the quality of raw material and the distance to the raw material sources.
- Proportions and composition of the tool assemblage of AH IIcf of Hohle Fels differ in some respects from other Gravettian tool assemblages of the Ach Valley. This may be due to different usage, a different chronological position or a general variability of the tool assemblages in the early Gravettian.

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