Spatial use at Große Grotte (Blaubeuren, Southern Germany), and Implications for Middle Paleolithic Stratigraphy, Spatiality and Chronology

Raumnutzung in der Großen Grotte (Blaubeuren, Süddeutschland) und Implikationen für die mittelpaläolithische Stratigraphie, Räumlichkeit und Chronologie

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Abstract - Große Grotte is one of the few Middle Paleolithic sites in the Swabian Jura where it is possible to perform intra-spatial analyses based on stratigraphic, chorological and chronological observations. In this paper, the spatial use of the site is discussed. This is of great importance both for the interpretation of the site use and for the understanding of the settlement system in general. The settlement remains in Große Grotte were distributed in individual concentrations within the ten Middle Paleolithic layers and were also not found diachronically at the same spot. The settlement shifted successively over time towards the northern cave wall. The layers were deposited during the time span between MIS 5 and 3. Regarding the stone artifacts of the respective layers, a diachronic increase in complexity and diversity is evident. Due to the location of the cave within the landscape, the site can be considered primarily as a base for observing the migration of animal herds. The site was not usable all year because of hibernating cave bears, indicating seasonal use of the location by humans.

Zusammenfassung - *Die Große Grotte ist eine der wenigen mittelpaläolithischen Fundstellen auf der Schwäbischen Alb, an der innerräumliche Analysen auf der Grundlage stratigraphischer, räumlicher und chronologischer Beobachtungen durchgeführt werden können. In diesem Beitrag wird die räumliche Nutzung des Fundplatzes diskutiert. Dies ist sowohl für die Interpretation der Raumnutzung als auch für das Verständnis des Siedlungssystems im Allgemeinen von großer Bedeutung. Die Siedlungsreste in der Großen Grotte waren in einzelnen Konzentrationen innerhalb der zehn mittelpaläolithischen Schichten verteilt und wurden auch nicht diachron an derselben Stelle gefunden. Die Besiedlung verlagerte sich im Laufe der Zeit sukzessive in Richtung der nördlichen Höhlenwand. Die Schichten wurden in der Zeitspanne von MIS 5 bis 3 abgelagert. Bei den Steinartefakten der jeweiligen Schichten ist eine diachrone Zunahme der Komplexität und Vielfalt zu beobachten. Aufgrund der Lage der Höhle in der Landschaft kann die Fundstelle in erster Linie als Stützpunkt zur Beobachtung von Tierherdenwanderungen angesehen werden. Wegen der überwinternden Höhlenbären war der Ort nicht ganzjährig nutzbar, was auf eine saisonale Nutzung durch den Menschen hinweist.*

Keywords - Neanderthals, Swabian Jura, spatial analysis of lithic artifacts, short term stay, observation site, migration of animal herds, MIS 4 and 3
Neandertaler, Schwäbische Alb, räumliche Analyse von lithischen Artefakten, Kurzzeitaufenthalt, Beochbachtungsstandort, Migration von Tierherden, MIS 4 und 3

Introduction

Große Grotte was first mentioned in a description of the town of Blaubeuren in the 17th century (Merian & Zeiller 1643: 38). Since that time, the cave has been known under different names: Gerhauser Höhle (Memminger 1830; Moser 1843), Gerhauser Grotte (Quenstedt 1864), Große Felsenhöhle (Lehmann 1907) and finally Große Grotte or Grosse Grotte (Binder 1961; Riek 1962, 1964), Rusenschloßhöhle (Wais & Wais 1962) or Große Rusenschloßhöhle (Frank 1963), named after the castle ruins located above the cave. In the archeological context, the name Große Grotte has primarily been used since the excavations of Riek.

The recognition of the cave as a Paleolithic site goes back to an unknown student who dug there in 1958 and discovered artifacts such as lithics, bones and teeth of cave bears and horses, as well as medieval ceramics (Wagner 1983: 17; Zürn 1961: 19). In October 1959, on behalf of the State Office for Cultural

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Heritage Baden-Wuerttemberg, a test pit was carried out under the direction of G. Riek. A few centimeters below the surface, stone artifacts and faunal remains were found (Riek 1962). The regular excavation included three campaigns between 1960 and 1964 (Riek 1962; Wagner 1983: 17). No further excavations have been carried out since Riek's three campaigns, as it is strongly suspected that the Riek excavation completely cleared the site and that there are no sediment remains left in situ. Riek himself published only two brief mentions about the site Große Grotte (Riek 1962, 1964). In 1965, Wagner received the finds from the site from Riek for the preparation of a doctoral thesis, which he presented in 1968 (Wagner 1983).

Since the publication of the excavations at Große Grotte in the second half of the 20th century (Wagner 1973-1974, 1979a, 1979b, 1983, 1991), the site has been the subject of lively discussions about its significance and its cultural and chronological classification (Burkert et al. 1992; Haas-Campen 1997; Kind 1992; Müller-Beck 1973, 1983, 1988; Riethmüller & Floss 2016; Roebroeks 1985; Weinstock 1999). Große Grotte has been repeatedly mentioned in conjunction with other known sites in the Swabian Jura. However, while other sites with Middle Paleolithic layers such as Geißenklösterle (Conard & Bolus 2003; Conard et al. 2019a; Conard et al. 2019b; Hahn et al. 1988; Richard et al. 2019), Hohle Fels (Bataille & Conard 2018; Conard & Bolus 2003; Conard et al. 2012; Münzel & Conard 2004a), Sirgenstein (Çep 1996; Schmidt 1907, 1910), Bockstein (Çep 2014; Çep et al. 2011; Çep & Krönneck 2015; Krönneck 2012; Wetzel 1958; Wetzel & Bosinski 1969a, 1969b) or Hohlenstein-Stadel (Beck 1999; Kind 2019; Richard et al. 2020) are quite well studied, there are relatively few analyses and publications on Große Grotte. It is worth noting here that the discovery of a bone point in layer 2 took on special significance, as there was little evidence of the use of organic artifacts from the late Middle Paleolithic at the time. However, in the last decades, more organic tools were found in the Middle Palaeolithic of Europe (Soressi et al. 2013; Toniato et al. 2018; Villa & D'Errico 2001). During his reanalysis of the fauna, Weinstock (1999) discovered a smoother made from a mammoth rib, which also originates from layer 2.

Even though the doctoral thesis submitted by Wagner in 1968 was not published until 15 years later and was already considered outdated at the time, since little new data were included, as a reviewer criticized two years later (Roebroeks 1985), most mentions of the site refer to Wagner's work (Wagner 1983) and to the more recent faunal analysis of Weinstock in the late 1990s (Weinstock 1999).

The sediments included a total of 13 apparently clearly separable geological layers, eleven of which yielded Middle Paleolithic stone artifacts (layer II to XI, hereinafter layer 2 to 11) (Wagner 1983: 19). At the moment, Große Grotte is considered the site with the longest Middle Paleolithic sequence of layers in the Swabian Jura. A first description of the artifact composition of the layers was given by Riek (Riek 1962: 199-200). Based on sedimentological, faunal and typological criteria, as well as in comparison with other sites in southern Germany and with the knowledge of the chrono-stratigraphy at that time, Wagner created an ideal profile of the layer sequence of Große Grotte (Wagner 1983: Beilage 2). There are several indications that suggest that this idealized chronology is questionable and a finer classification of temporally different assemblage groups may not apply. For instance, excavation-related and subsequent mixing of finds from different find units or wrongly labeled artifacts are possible. Indications of this are the two freshly broken halves of a cave bear mandible with different layer designations (layers 2 and 5) and two bear paws from one individual belonging to layers 2 and 11, respectively (Weinstock 1999: 3), as well as the Roman/early medieval age of a red deer from layer 2 (Waiblinger 2001), although this young date could also be related to a wall that was supposedly built later.

In contrast, however, artifact units that were separated as individual layers may belong together. A possible indication could be that the assemblages of each layer, which were assigned to different assemblage groups, do not show any technological differences with the exception of those of layer 10 (Schäfer 1993a: 146). Wagner (1983) himself believed that several layers, such as layer 2 to 8, should be combined because of the small amounts of artifacts in each layer.

Wagner's publication on Große Grotte was followed by several other analyses that contributed to the understanding of the assemblage units, the cave use by humans and animals, relative dating of the layer sequence and the technological features of the lithic material (Çep 2000; Çep & Waiblinger 2001; Chazan 1992, 1995; Schäfer 1993a, 1993b, 1997; Weinstock 1999).

Spatial investigations, which could also provide insights in this context, were not carried out, with one small exception for a Collaborative Research Centre (CRC) report (Hahn & Kind 1997). Therefore, this paper uses the spatial distribution of the artifacts to identify the relationship between the artifact units and the stratigraphic sequence, to verify the sequence of the layers as known to date. In this way, we aim to reconstruct the spatial use and function of the site.

Geographical setting of Große Grotte

Große Grotte is located on a slope of an incised meander of the Blau river and lies right below the ruins of Rusenschloss above Gerhausen, which is a district of the small city Blaubeuren (Alb-Donau-Kreis, Baden-Wuerttemberg, Germany) (Fig. 1: a). Within a radius of about 4 km, there are the well-known sites of Brillenhöhle, Geißenklösterle, Sirgenstein, Hohle Fels and Helga Abri (Fig. 1: b). The cave was formed by the karst,

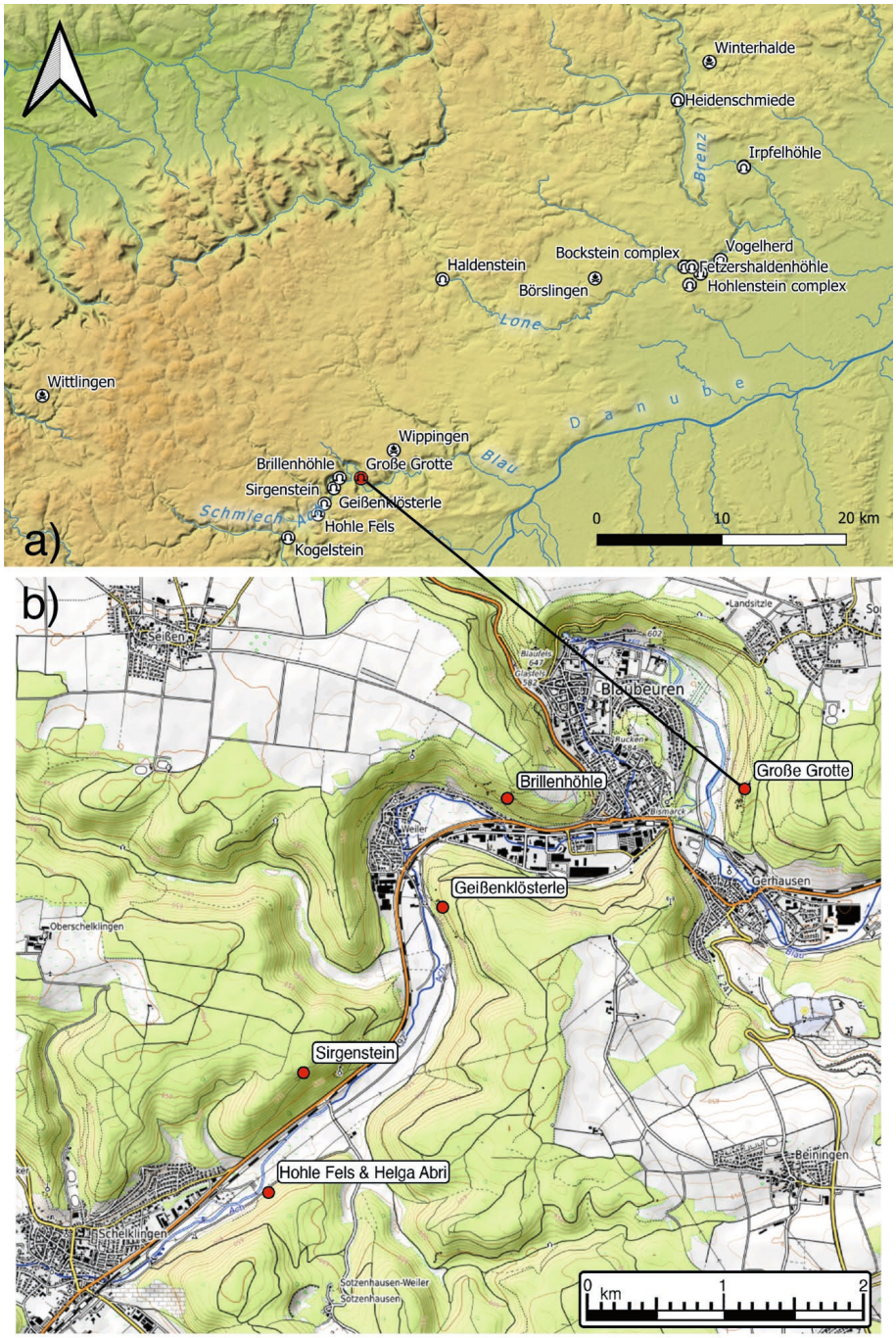

Fig. 1. Geographical setting of Große Grotte. Legend: a) relief map of Middle Paleolithic sites in the Swabian Jura. Große Grotte is marked red. Cave symbol – cave sites and rockshelters; Fireplace symbol – open-air sites (basemap from C. Sommer, ROCEEH) and b) topographical map of the Blau and Ach valley including the sites of Große Grotte, Brillenhöhle, Geißenklösterle, Sirgenstein, Hohle Fels and Helga Abri (basemap from www.opentopomap.org).

Abb. 1. *Geografische Lage der Großen Grotte. Legende: a) Reliefkarte mit mittelpaläolithischen Fundstellen auf der Schwäbischen Alb. Die Große Grotte ist rot markiert. Höhlensymbol – Höhlen- und Abrifundstellen; Feuerstellensymbol – Freilandfundstelle (Basiskarte von C. Sommer, ROCEEH) und b) Topographische Karte des Blau- und Achstals mit den Fundstellen Große Grotte, Brillenhöhle, Geißenklösterle, Sirgenstein, Hohle Fels und Helga Abri (Basiskarte von www.opentopomap.org).*

as well as by washing out of the compact limestone (geological signature: jo) of the Upper Jurassic by the primeval or ancestral Danube (*Urdonau*) (Huth et al. 2006: 52). The cave is situated on the dividing line between the lower *Felsenkalke-Formation* (joFU) and the upper *Felsenkalke-Formation* (joFO) (Nitsch et al. 2016). The floor of the cave entrance is located at an approximate altitude of 580 m a.s.l. and is about 75 m above the modern valley floor of the Blau (Wagner 1983: 14) (Fig. 2: a). According to Groschopf

(1961, 1963), approximately 5 m of limestone debris from the Late Pleistocene and 10 m of Holocene sediments were deposited at the bottom of the valley (see also Wagner 1983: 14), which is consistent with the work of Barbieri for the Ach and Lone valley (Barbieri 2017; Barbieri et al. 2018; Barbieri et al. 2021). Nowadays, the cave entrance is about 25 m wide and 18 m high, facing west. With a length of only about 30 m the cave tapers greatly towards the rear (Fig. 2: b).

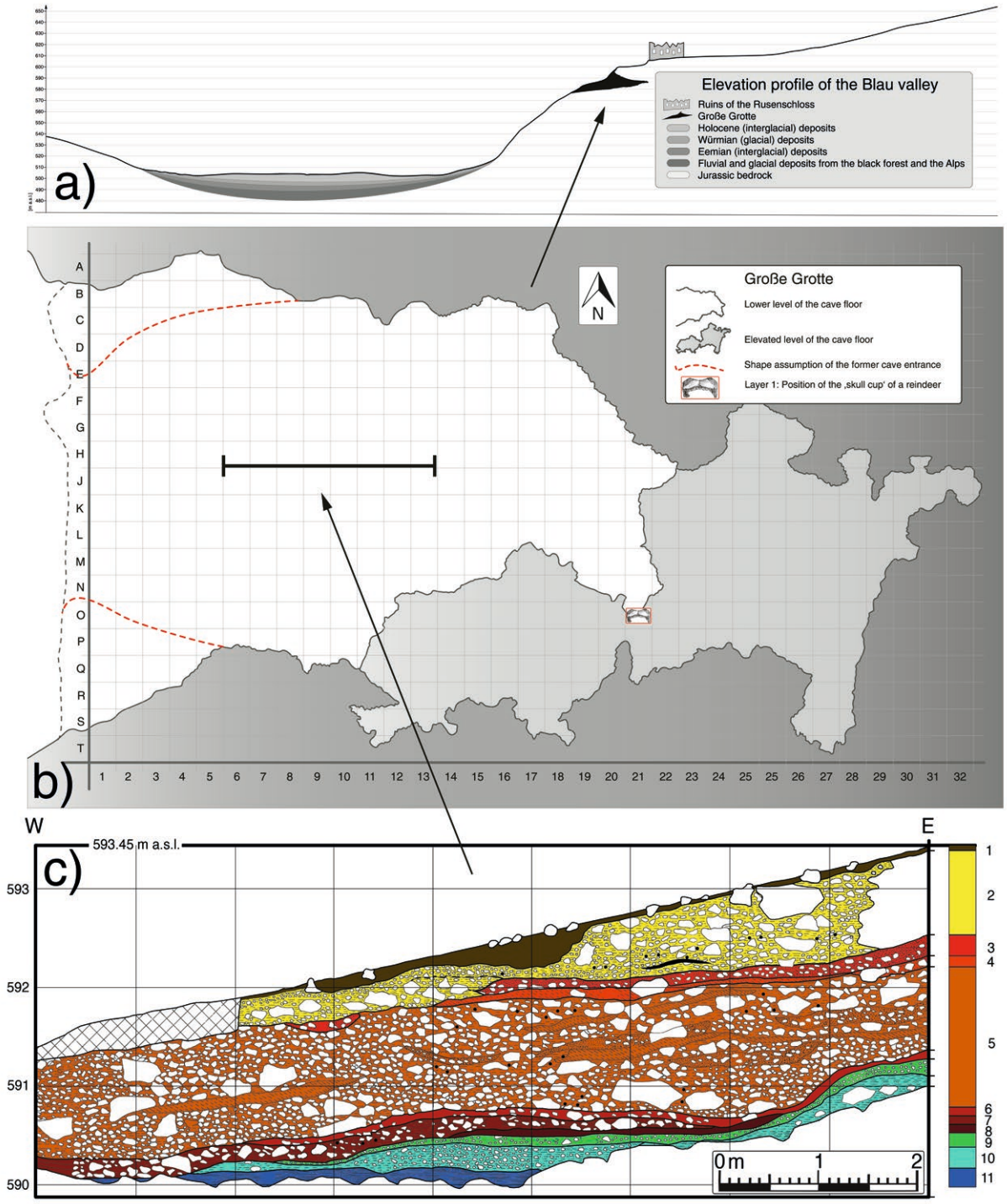

Fig. 2. Geographical and geomorphological features of the Große Grotte. Legend: a) elevation profile of the Blau valley (taken and redrawn from GoogleEarth) and added assumed deposits in the valley (data from Groschopf 1961, 1963); b) ground plan of the cave and assumption of the shape of the former cave entrance (basemap is an approximation and compiled from Wagner (1983: 18, Abb. 7 &: 63, Abb. 15) and Striebel (1996: 153, Plan 2a)); and c) longest sediment profile of the site (redrawn from Wagner 1983: Tafel 70).

Abb. 2. *Geografische und geomorphologische Merkmale der Großen Grotte. Legende: a) Höhenprofil des Blautals (entnommen und nachgezeichnet aus GoogleEarth) und hinzugefügte angenommene Ablagerungen im Tal (Daten aus Groschopf 1961, 1963); b) Grundriss der Höhle und Annahme der Form des ehemaligen Höhleneingangs (Basiskarte ist eine Annäherung und zusammengestellt aus Wagner (1983: 18, Abb. 7 & : 63, Abb. 15) und Striebel (1996: 153, Plan 2a)); und c) Längstes Sedimentprofil der Fundstelle (neu gezeichnet nach Wagner 1983: Tafel 70).*

According to Wagner, the modern trampling surface was inclined about 22° towards the cave entrance, which makes solifluction probable (Wagner 1983: 15). However, a closer look at the east-to-west profiles (especially Wagner's profile 1) shows an inclination of the trampling surface of 12.5°. The lower layers are barely inclined, the upper layers 2 to 4 are inclined slightly at most. Considering the largest longitudinal profile of Riek's excavation (profile 1), the lower layers lie directly above and follow the topography of the cave floor, which is fairly horizontal in the front and rises slightly further inside the cave (Fig. 2: c).

Wagner also describes that in winter the snow is blown into the inner part of the cave, which is confirmed by our observations. Wagner assumes that the cave entrance of the Große Grotte was much smaller in former times (see our assumption marked in figure 2: b), since no phosphatic sediments (chiropterite, also known as guano) could have been deposited otherwise (Wagner 1983: 17).

Former assemblage classifications

The assemblages of the site have been classified quite differently over time. Riek (1962, 1964) considered the finds related to the Mousterian and drew attention to the Levallois component. Wagner (1973-1974, 1983, 1991) also referred to the bifacial component and assigned the upper layers to a Mousterian, layer 9 to the Micoquian and layer 11 to the Acheulian. In the same year that Wagner published his dissertation, 1983, Müller-Beck (1983: 498) summarized the layer attribution as follows: Middle Paleolithic with leaf points (layer 2), Mousterian in several layers (layer 3 to 8), Micoquian Mousterian (layer 9) and Levallois Middle Paleolithic (layer 11), abandoning the proximity to an Upper Acheulian. These views were revised in the 1990s by the works of Chazan (1992, 1995), Jöris (1992), Burkert et al. (1992), Kind (1992) and Schäfer (1993a, 1993b, 1997). Chazan (1992, 1995) classified the assemblage of layer 2 as belonging to the end of the Middle Paleolithic. Jöris (1992) saw an affiliation to the Pradnik horizon due to a Keilmesser from layer 2. The cluster and correspondence analysis by Kind (1992) and Burkert et al. (1992) assigned the layers 2, 4 and 5 to the Mousterian and layer 6 as a mixed group (between Mousterian and Micoquian). Schäfer (1993a), who examined the blank production of the layers 2, 4, 5, 6, 10 and 11, assigned all these layers to the Middle Paleolithic (*sensu strictu*). While Chazan or Schäfer reanalyzed only parts of the stone artifacts, Çep (2000), who analyzed all pieces that could be assigned to a layer, classified them all more generally to the Middle Paleolithic. Conard and Fischer saw a dichotomy in the cultural attribution and assigned layers 2 to 8 to the late Mousterian and layer 9 to a Late Middle Paleolithic with handaxes (Conard & Fischer 2000). Uthmeier, in turn, classified layer 2 as Micoquian with leaf points (Uthmeier 2004: 275). Çep & Waiblinger (2001) determined the lithic raw materials used at the site.

A further investigation was devoted to the so-called "skull cup" (*Schädelbecher*) from a reindeer (Riethmüller & Floss 2016). According to Wagner (1983: 58), this was found in a layer above layer 2 on the upper plateau. However, no processing traces could be detected on the "skull cup". The layers above layer 2 cannot be attributed to the Middle Paleolithic, therefore the find is mentioned only for the sake of completeness.

In more recent times, the assemblages of the Große Grotte are assigned to Swabian Mousterian (Bolus 2011, 2015; Bolus & Conard 2019), which Bolus characterizes as follows (Bolus 2011: 4): "*Most Middle Paleolithic deposits, however, yielded non-standardized assemblages usually classified as Swabian Mousterian. In most cases these assemblages are not very rich and characterized by small irregular levallois cores and a limited set of formal tools, mostly side-scrapers.*" The definition was later supplemented by the existing bifacial component (Bolus & Conard 2019: 53). Our preliminary analyses have shown that layers 2, 4 and 9 contain elements commonly attributed to the Keilmessergruppen (Çep et al. 2018). With regard to Große Grotte, the dichotomy between assemblages that are referred to as Micoquian or Mousterian is very clear. This problem has also been mentioned several times for other sites and entities (Freund 2001; Frick 2020; Hussain & Riede 2019; Reynolds & Riede 2019; Richter 1997; Riede et al. 2020; Shea 2014; Uthmeier 2004, 2016). Due to the presence of Keilmesser and handaxes, the site has been repeatedly assigned to the Micoquian (acc. to Wagner 1983, layer 9 is late Micoquian with Mousterian influence) or later to the Keilmessergruppen (mostly layer 2, e.g. Conard et al. 2015; Conard & Fischer 2000).

Attempts at chronological classification

So far, we have only one radiocarbon date for the site (Fig. 3: a). Unfortunately, the ^{14}C date of a cervus mandible from layer 2 dates within the Roman/early medieval period (Waiblinger 2001; Weinstock 1999). However, this date can also be taken as an indication that at least parts of layer 2 were affected by removal of overlying layers or solifluction.

Wagner (1973-1974) placed the layers into a broad chronological frame (Fig. 3: b). Thus, he assumed that the layers 2 to 8 should be placed at the end of the early Würmian, layer 9 at the beginning of the early Würmian and layer 11 at the end of the Rissian-Würmian interglacial (Wagner 1983) (Fig 3: d). Later, he wrote that the site was visited sporadically by Neanderthals over a period of 30,000 years (Wagner 1991). Schwabedissen (1973) agreed with Wagner's remarks on the chronology (Fig. 3: c). The most specific information on the chronology of the Große Grotte comes from Müller-Beck, who assigns layer 2 to the period between Turicum 5a and 4

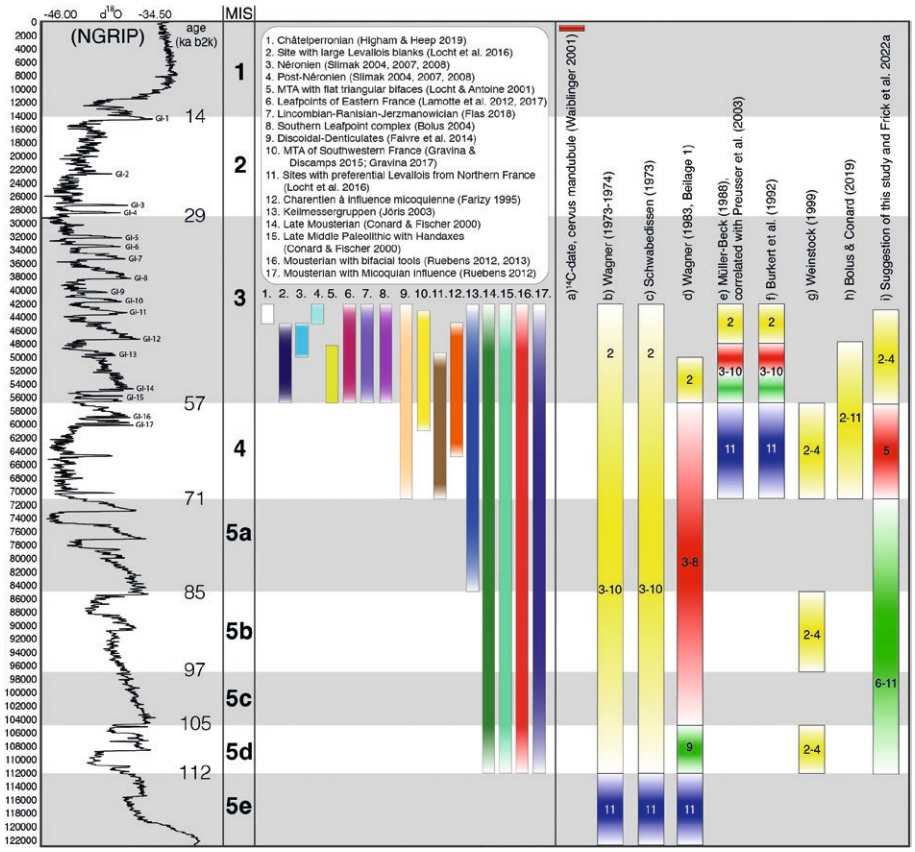

Fig. 3. Supposed chronological setting for Große Grotte. Legend: 1-17) dating for units in time and space according to different authors; a) medieval ^{14}C date of a cervus mandibule (Waiblinger 2001); b) long chronology suggested by Wagner (1973-1974); c) long chronology suggested by Schwabedissen (1973); d) long chronology suggested by Wagner (1983); e) short chronology of Müller-Beck (1988); correlated with Preusser et al. (2003); f) acceptance of the former dating by Burkert et al. (1992); g) "cold" fauna as dating reference by Weinstock (1999); h) suggested dating through sites and assemblage comparisons by Bolus & Conard (2019) and i) dating suggested by this study, as well as Frick et al. (2022a).

Abb. 3. *Angenommene zeitliche Einordnung der Großen Grotte. Legende: 1-17) Datierungen für Zeit- und Raumeinheiten nach verschiedenen Autoren; a) Mittelalterliches ^{14}C-Datum eines Rothirschunterkiefers (Waiblinger 2001); b) Lange Chronologie nach Wagner (1973-1974); c) Lange Chronologie nach Schwabedissen (1973); d) Lange Chronologie nach Wagner (1983); e) Kurze Chronologie nach Müller-Beck (1988); korreliert mit Preusser et al. (2003); f) Akzeptanz der früheren Datierung durch Burkert et al. (1992); g) „Kalte" Fauna als Datierungsreferenz von Weinstock (1999); h) Vorgeschlagene Datierung durch Fundstelle- und Inventarvergleiche von Bolus & Conard (2019) und i) durch diese Studie, wie auch Frick et al. (2022a) vorgeschlagene Datierung.*

and layer 11 to Turicum 3 (Müller-Beck 1988). If we correlate these data with the marine isotope stages (MIS) according to Preusser et al. (2003), we can assign Turicum 4-5a to the early MIS 3 and Turicum 3 to MIS 4 (Fig. 3: e). Burkert et al. (1992) also assume that the site should be dated to MIS 3 to 4 (Fig. 3: f). Based on the faunal analyses, Weinstock (1999) supposes that the upper layers (2 to 4) were deposited during a cold phase of the first half of the Würmian glacial (Fig. 3: g). Bolus & Conard (2019) presume a time frame of MIS 3 to 4 (Fig. 3: h). Palynological studies on drill cores from Füramoos Lake (LKr. Biberach, about 50 km south) suggest that the northern foothills of the Alps and the adjoining low mountain ranges had a relatively mild climate between 50 and 40 ka b2k (before 2000). Synthesizing the data from the macrofaunal analyses (Conard et al. 2019a; Kitagawa et al. 2018; Krönneck 2012; Münzel et al. 2011; Weinstock 1999) and microfaunal studies (Rhodes 2019a, b) of the Ach valley, one can conclude that a cold climate was required to deposit the sediments in the Große Grotte. Since no further radiometric dating of the site is known, it has to be chronologically classified by sedimentological analogies and the dating of other regional sites. By using the sedimentary descriptions of Wagner (1983), we propose a different chronological interpretation of the layers, which differs from the currently preferred interpretation that probably all layers of Große Grotte should be placed in MIS 4 and 3 (Müller-Beck 1988; Burkert et al. 1992; Chazan 1992, 1995; Conard et al. 2015; Bolus & Conard 2019; Çep 2019). We interpret the thick coarse layer 5 (Fig. 2: c) with its very few artifacts but a high proportion of cave bear bones as a separating deposit that divided the thinner, quite clearly defined layers above and below. If this layer is assigned to the

First Glacial Maximum (MIS 4), numerous short visits occurred in the somewhat more moderate phases before (late MIS 5) and after (early MIS 3), repeatedly depositing small amounts of remains. The latest radiometric data of the also small assemblages from the Middle Paleolithic of the Geißenklösterle point in a similar direction to late MIS 5 for layer VII, as well as MIS 4 and early MIS 3 for layer IV (Conard et al. 2019a; Richard et al. 2019). Previously, only the assemblages from Bocksteinschmiede I to III (Krönneck 2012) and Vogelherd IX (Niven 2006) could be assigned to a MIS 5 context in the Swabian Jura (see also Frick et al. 2022a) (Fig. 3: i).

Spatial analyses in the course of the CRC 275

First spatial analyses on Jurassic chert from layer 2 are briefly described in the final report 1997 of the CRC 275 C5 (Hahn & Kind 1997), but have never been published comprehensively. We will therefore summarize the results contained in this report: The overall distribution of the individual layers is described as quite confusing and is derived from short single events. Different areas with different emphases in artifact production can be differentiated. It seems that these are not simultaneous events but short independent and non-contemporaneous activities. The pieces from layer 11 were described in more detail, but unfortunately, they cannot be assigned to individual excavation square meters. This layer almost exclusively contains small cortical flakes (probably from one raw material unit). However, the corresponding core is missing. Therefore, it is assumed that these are remnants of a production sequence left over from the production of a bifacial tool. Furthermore, the site contains numerous individual pieces of raw materials that are scarce or absent otherwise. The report concludes that this must be an indication of short-term settlement, with artifacts produced off-site.

Materials, methods, and data

In addition to our new analyses of the material from the Wuerttemberg State Museum (*Landesmuseum Württemberg*, LMW) in March 2018 and February 2019, we used the data and overview of Wagner (1983) and the data of Çep (2000, 2013, 2019; Çep & Waiblinger 2001). The Çep's data contains square meter data of each piece, if it was labeled. When faunal aspects are taken into account, we refer mainly to Weinstock (1999) and Münzel & Conard (2004b). We did not include the faunal remains in the spatial analysis because they are not labeled with the square meter information, but can only be assigned to individual layers.

Most of the lithic artifacts were labeled during the excavations with an assignment to their excavation square meter and a layer. This square meter information was recorded in a database along with the dimensions and characteristics of the lithic finds. In order to create distribution plans, it was necessary to superimpose the existing plans. It became clear that the plans drawn up thus far (Striebel 1996; Striebel & Eckenfels 1983; Wagner 1983) did not reflect the actual conditions. We therefore decided to interpolate the existing outlines so that all finds could be located within the cave. Wagner has created spatial distribution plans of all stone artifacts in the individual layers (Wagner 1983: 45-47). Since the stone artifacts are labeled with square meters, these were assigned to the center of each square so that a kernel density could be created. In addition, we were able to plot the distribution of the pieces in categories. This enabled us to clarify different aspects:

1) differences between the layers,
2) mapping of clusters within the layers,
3) spatial relationships between cores, blanks and bifacial objects and
4) the relationships between lithics and spatial circumstances (e.g., the location of the fireplaces or the distance to the rock face) or archeological features.

Results

General spatial features

Figure 4 shows the overall distribution of all stone artifacts with coordinates. The fact that there are two levels of the cave floor must be kept in mind. The lower level is located in the northwest of the cave, and the higher level in the southeast. It is noticeable that the largest concentrations are in the center of the lower level of the cave floor (Fig. 2: b, white area).

No stone artifacts were found in the southern and eastern parts of the cave. The location of the "stone wall" in relation to the distribution of the lithics shows that the artifacts are mainly located outside the "stone wall" (which was embedded in layer 2) and therefore it cannot be considered a windbreak (*Wetterschutz* or *Schutzmauer*, acc. to Wagner 1983: 63) that separates the area directly exposed to the weather ('outside world') from the cave space. The "stone wall" can only be found in a ground plan (Wagner 1983: 62, Abb. 15 & 63, Abb. 16), but not in the corresponding profiles 13 and 14 (Wagner 1983: Tafel 76 & 77).

Assumed fireplaces

Looking at the position of the fireplaces on the basis of the charcoal residues drawn into the profiles as well, the issues mentioned are confirmed (Figs. 5 & 6). Some fireplaces have already been mentioned briefly by Riek (1962, 1964) and are a further argument for shorter stays of small groups of people (see also Cascalheira & Picin 2020). The distribution of the lithics in each layer, as well as the position of the suggested fireplaces are depicted in figures 5 and 6. Often, these features are associated with concentrations of lithic artifacts, for example in layers 8 and 11 (Fig. 6). In

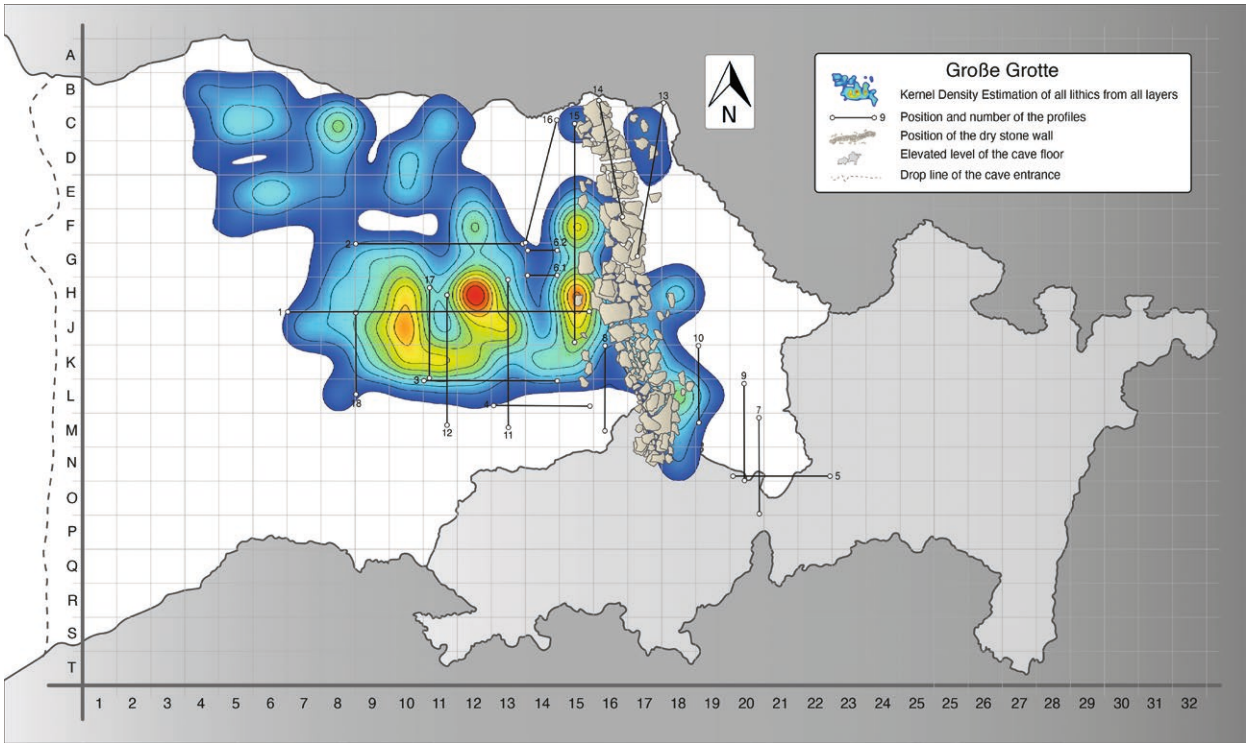

Fig. 4. Cave plan with general features. Legend: cave ground plan with kernel density estimations (KDE) of all lithics from all layers and position of profiles, according to Wagner (Wagner 1983: 18, Abb. 7). The course of the cave wall was interpolated according to different plans (Striebel 1996: 153, Plan 2a; Wagner 1983: 18, Abb. 7; : 62, Abb. 15; : 63, Abb. 16), as they do not all coincide.

Abb. 4. *Höhlenplan mit allgemeinen Merkmalen. Legende: Höhlengrundriss mit Kerndichteschätzungen (KDE) aller Steinartefakte aus allen Schichten und Lage der Profile, nach Wagner (Wagner 1983: S. 18, Abb. 7). Der Verlauf der Höhlenwand wurde nach verschiedenen Plänen interpoliert (Striebel 1996: S. 153, Plan 2a; Wagner 1983: S. 18, Abb. 7; S. 62, Abb. 15; S. 63, Abb. 16), da diese nicht übereinstimmen.*

layers 2, 4 to 7 and 10 there is always a concentration of stone artifacts right next to a potential fireplace (Figs. 5 & 6).

Spatial distribution of lithics

We observed that the respective find distributions were diachronically deposited successively further north in all layers (Figs. 5 & 6). We assume that the cave was successively enlarged by ceiling and wall collapses, thus offering the possibility of settling further north in the cave. This corresponds with Wagner's presumption that the cave entrance only increased in size over time (Fig. 2: b). He based his assumption on the conditions of the formation of guano in more closed systems (Wagner 1983: 17).

Spatial distribution of cores and its products

In layer 2, blanks and cores are distributed evenly. The discoidal cores are much more concentrated than the Levallois cores. Simple flake cores and cores-on-blanks are more common in the eastern part of the cave and blade cores are more common in the northern part (Fig. 7: a). Some of the underlying layers do not allow for much interpretation, as they are often containing very small assemblages. There are no cores in layer 3 and blanks form individual patches (Fig. 7: c). Cores and blanks do occur in layer 4, but they do not form a coherent pattern. Levallois cores both appear next to concentrations of blanks (including a few Levallois flakes), but can also be found separate from them (Fig. 8: a). In layer 5, most cores are within the distribution of the blanks, but they are slightly shifted and concentrated in the center (Fig. 8: c). The distribution differs a lot from layer 6, where the cores are also found next to the three concentrations of the blanks. However, only one core lies in the densest area of blanks. Within the other concentrations, there are both Levallois cores and cores-on-blanks (Fig. 9: a). In layer 7, the distributions of blanks and cores correspond to each other (Fig. 9: c). Similar to layer 3, there are no cores in layer 8 and the blanks form individual patches (Fig. 10: a). In layer 9, there is only one blank in the center (Fig. 10: b). The distribution of the cores and blanks is extremely concentrated in layer 10 (Fig. 10: c). In layer 11, the cores are next to the concentrations of the blanks again (Fig. 10: e).

Spatial distribution of bifacial objects

In layer 2, bifacial objects are located in the southeast, where two accumulations of blanks are also located. In the northwestern concentration of blanks, there are no bifacial objects. Five pieces have no square meter label, so their position cannot be determined, but the layer assignment on the artifacts has at least been preserved (Fig. 7: b). For layer 4, it is more difficult to determine the distribution, because only

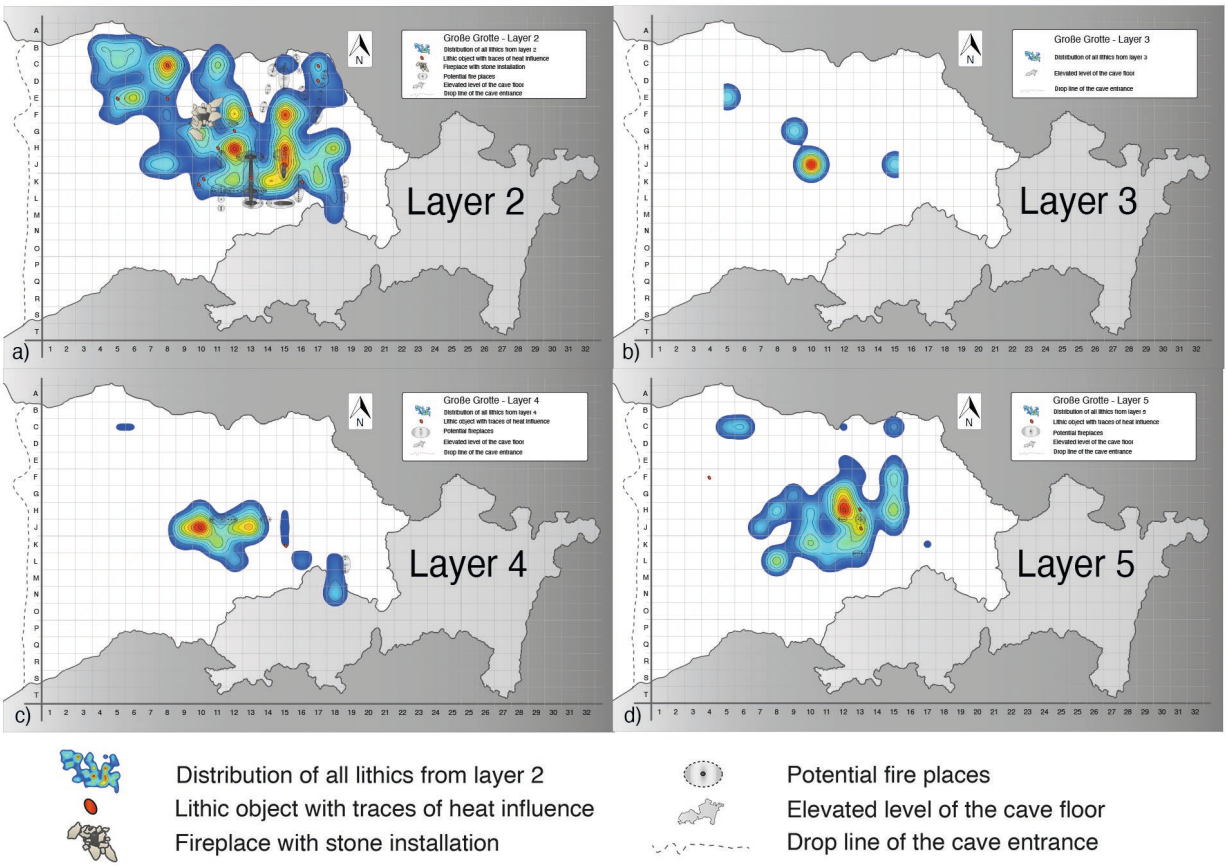

Fig. 5. Position of possible fireplaces from layer 2 to 5. Legend: cave plans with the distribution of the potential fireplaces, according to the profiles in Wagner (Wagner 1983: Taf. 70-78) and the lithic distribution of each layer; a) layer 2; b) layer 3; c) layer 4, and d) layer 5.

Abb. 5. *Lage der möglichen Feuerstellen aus Schicht 2 bis 5. Legende: Höhlenpläne mit der Verteilung der möglichen Feuerstellen nach den Profilen von Wagner (Wagner 1983: Taf. 70-78) und der Verteilung der Steinartefakte der einzelnen Schichten; a) Schicht 2; b) Schicht 3; c) Schicht 4 und d) Schicht 5.*

one of the two pieces has a square meter label. This bifacial preform is located in one of the two concentrations of blanks (Fig. 8: b). In layer 5, the concentrations of the bifacial objects do not coincide with those of the blanks. One bifacial scraper is located far in the east. From this layer, there is another piece also without any square meter label (Fig. 8: d). In layer 6, none of the four pieces assigned to this layer has a square meter label and thus cannot be placed in spatial relation to the blanks (Fig. 9: b). Within layer 7, there is a bifacial preform, which lies on the edge of the concentration of the blanks. Apart from this, there are no other bifacial objects in this layer (Fig. 9: d). The situation within layer 9 is even worse, since the square meter label on all four bifacial objects can no longer be deciphered, so it is no longer possible to assign them spatially (Fig. 10: b). In layer 10, a bifacial preform is at the margin of the blank concentration (Fig. 10: d). The bifacial piece from layer 10 is also not spatially assignable (Fig. 10: e).

Discussion

By combining the spatial distributions presented above, we can now visualize individual patterns for each layer. This suggests that the layers should be viewed as individual units, contrary to the suggestions by Wagner (1983) and Schäfer (1993a). A different approach was taken by Çep (2000), who analyzed the lithics of the layers separately and attempted refittings. In the final report from 1997 of CRC 275, only a few refits are mentioned (refitting of broken pieces, as well as frost breaks, refits by J. Waiblinger & B. Çep), but no reduction sequences could be refitted (Hahn & Kind 1997). Even within the new analyses presented here, it was only possible to refit lithic pieces in two cases. A total of four refitting groups are substantiated (Tab. 1). The first two are the refits of two mandibular fragments of a cave bear from layers 2 and 5 as well as a pair of paws of a cave bear from layers 3 and 11 (Weinstock 1999: 3). The other two are the refits of a core from fragments from layers 6 and 7 and a core from fragments from layer 11 (see also Frick et al. 2022a, 2022b).

On the one hand, the traces of occupation observably shift to the northwest in the course of the settlement. On the other hand, the find concentrations of the individual layers are manifestly very different.

The position of the "stone wall" in relation to the distribution of the lithics (Fig. 4) is a strong argument for us to doubt that the wall is related to the Middle Paleolithic settlement as speculated by Wagner (1983). The

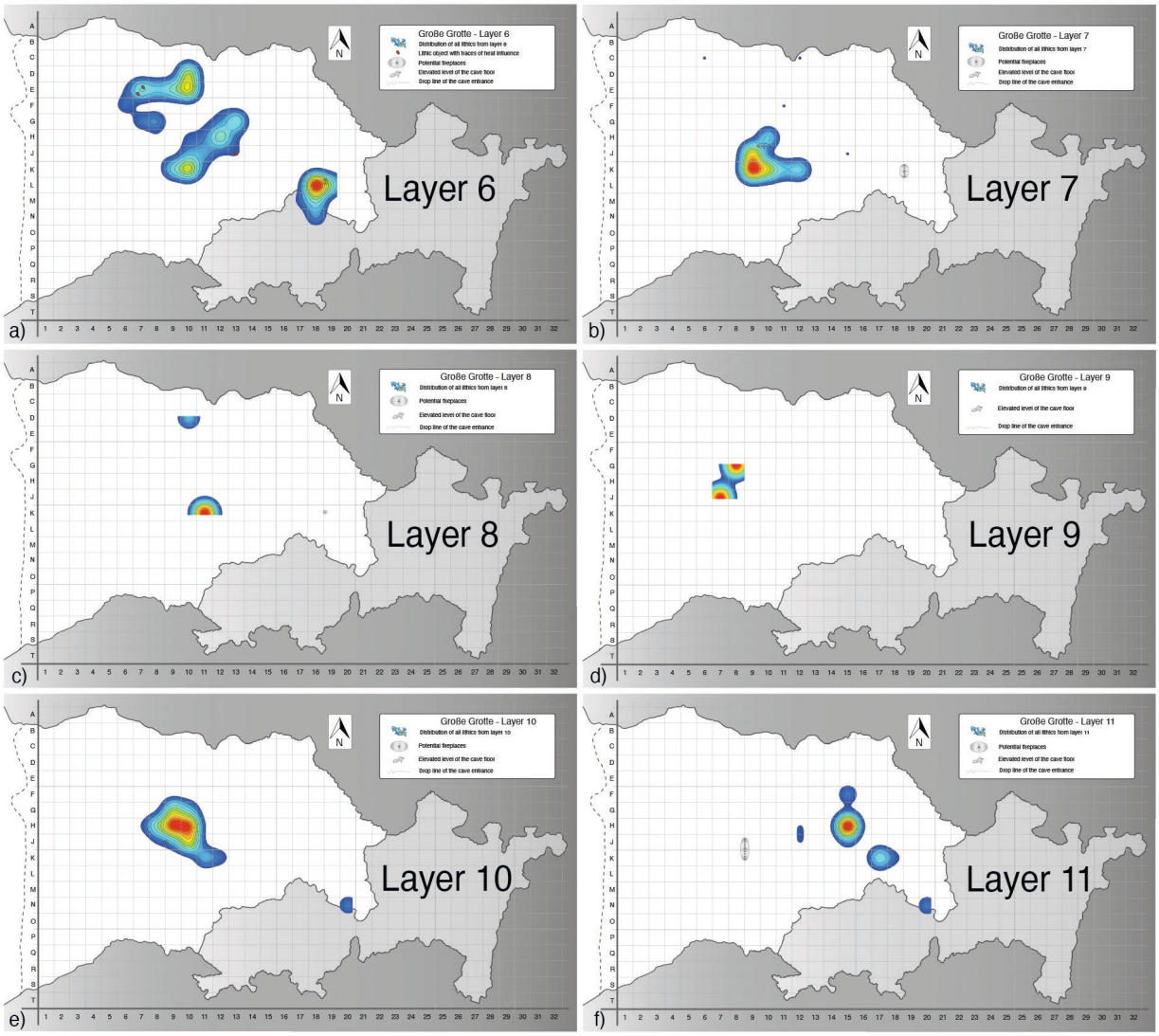

Fig. 6. Position of possible fireplaces from layer 6 to 11. Legend: cave plans with the distribution of the potential fireplaces, according to the profiles in Wagner (Wagner 1983: Taf. 70-78) and the lithic distribution of each layer; a) layer 6; b) layer 7; c) layer 8; d) layer 9; e) layer 10, and f) layer 11.

Abb. 6. *Lage der möglichen Feuerstellen aus Schicht 6 bis 11. Legende: Höhlenpläne mit der Verteilung der möglichen Feuerstellen nach den Profilen von Wagner (Wagner 1983: Taf. 70-78) und der Steinverteilung der einzelnen Schichten; a) Schicht 6; b) Schicht 7; c) Schicht 8; d) Schicht 9; e) Schicht 10 und f) Schicht 11.*

argument put forward by Wagner that the settlement in the cave was oriented in such a way that the sunlight could be used as long as possible (Wagner 1983: 45), however, can be verified on the basis of the distribution of finds.

Within the layers, there are usually other smaller find concentrations in addition to a main cluster. The largest concentrations are usually located in the center of the lower level of the cave floor (white area in Figs. 4-10), but always slightly displaced from each other. Due to the large thickness of layer 5, it is likely that it contains several individual events, which, however, cannot be separated (Figs. 2: c & 8: c), and the concentration of the finds is clustered to some extent. If we compare the position of the blanks in all layer with that of the cores, it is reasonable to assume that these could be individual knapping events (Figs. 4-10).

As researchers have also shown (Çep 2000; Schäfer 1993a), it is likely that during the excavation, the finds were selected according to unknown criteria. This is also clear from the fact that the micro-debitage (<15 mm) is almost completely missing. Consulting the main stratigraphic profile (Fig. 2: c), one may assume that the position of the finds was influenced by solifluction and that they were shifted to the cave entrance in the west of the middle and upper layers. However, there is also a shift of the finds to the north in the direction to the cave wall, which cannot be explained thusly. It remains to be considered that an equally possible vertical mixing of finds cannot be excluded. However, this cannot be tested well with the given spatial data and the degree of artifact labeling. Only the above-mentioned refits of the fauna by Weinstock give some small indications for this.

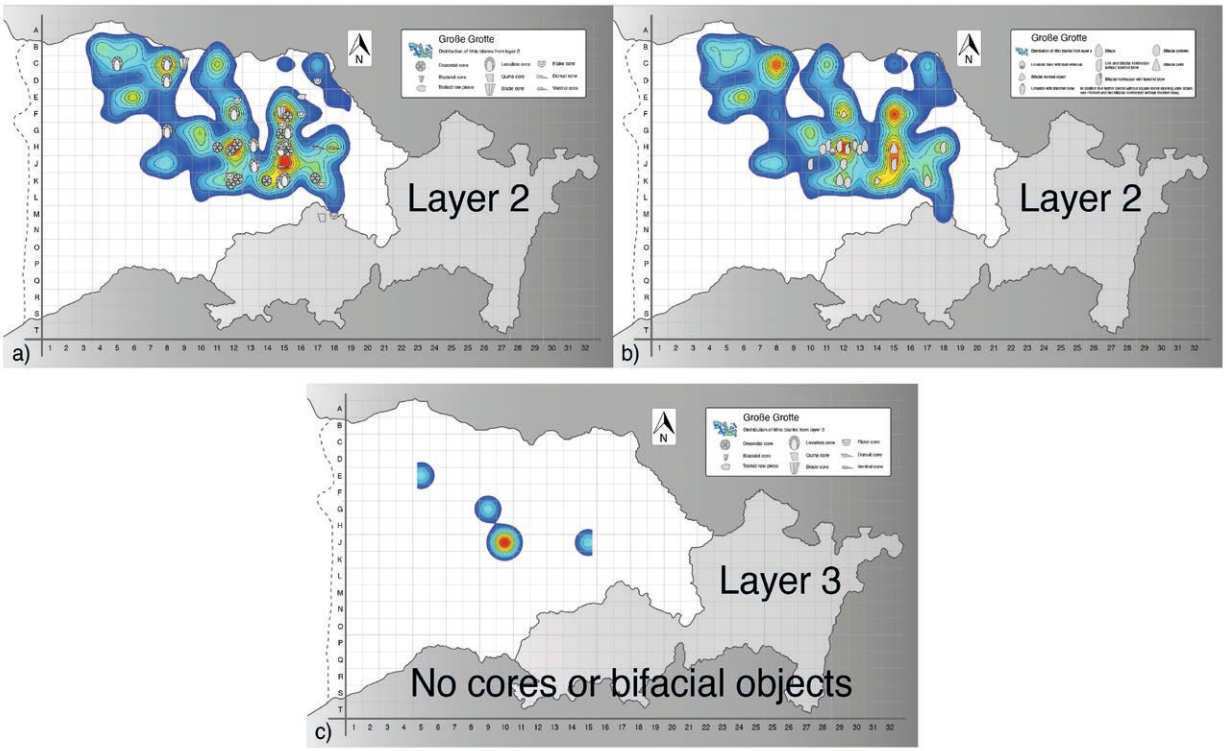

Fig. 7. Distribution of cores, products and bifacial objects in layer 2 to 3. Legend: a) cave plan with the distribution of cores and products (blanks like flakes and blades) of layer 2; b) cave plan with the distribution of bifacial objects and products (blanks like flakes and blades) of layer 2 and c) cave plan with the distribution of products (blanks like flakes and blades) of layer 3, note that there are no cores or bifacial objects.

Abb. 7. *Verteilung von Kernen, Produkten und bifaziellen Objekten in den Schichten 2 bis 3. Legende: a) Höhlenplan mit der Verteilung von Kernen und Produkten (Rohlinge wie Flocken und Klingen) der Schicht 2; b) Höhlenpläne mit der Verteilung von bifaziellen Objekten und Produkten (Grundformen wie Abschläge und Klingen) der Schicht 2 und c) Höhlenpläne mit der Verteilung von Produkten (Grundformen wie Abschläge und Klingen) der Schicht 3, wobei zu beachten ist, dass es keine Kerne und bifazielle Objekte gibt.*

Site function

Various pieces of evidence of the occupation patterns come together to form a fairly coherent picture: The position of the cave (Wagner 1983) allows a look upstream into the Blau valley and its river bend. Due to the topography of the Blau valley and the nearby Ach valley, the view from the cave is about 2 km to the north, south and to the west. Although the smoke of a campfire can be seen from far away, the entrance to the cave is high above the valley floor, so that herds of large herbivores were not scared. Likewise, the slope in front of the cave is quite steep nowadays and was similar during the Late Pleistocene glacial period or even a little steeper, so that it took great effort to transport large quantities of food straight up from the valley. It should be noted, however, that the plateau of the Swabian Jura adjoins Große Grotte to the north-east and the cave can also be accessed from there. Geomorphologically, the Heidenschmiede site in Heidenheim is similarly situated. It is located just as high above the cave floor and allows to get an overview of the valley of the Brenz (Çep et al. 2021; Münzel & Çep 2021; Peters 1931).

The high percentage of faunal remains of cave bears (Weinstock 1999) suggests that the cave was mainly inhabited by these large mammals, possibly serving as a hibernation site. In addition, "[…] *the high percentage of bones of bear neonates in the assemblage suggests that it may have been mainly females which made use of the cave* [...]." (Weinstock 2000: 178). Looking at the example of the Grotte Goyet B4, Belgium, and Mont Ventoux, France, the hibernation of female cave bears began in October, the birth of the offspring took place in November or December, and after raising them in spring, the cave was abandoned in June (Fosse & Cregut-Bonnoure 2014; Germonpré & Sablin 2001). Thus, the hominids would only have the months of July to September left to settle in the cave. Supplementing these remarks on seasonality with the information from Münzel (1997) on Geißenklösterle, as well as the hibernation model of Grandal-d'Anglade et al. (2019), only the summer (June to September) remains for occupation by humans (Fig. 11).

The faunal analysis of Weinstock (1999) showed that there were no cut marks, but numerous gnawing traces on the bones. He therefore assumed that the majority of the faunal remains were not accumulated by humans but by carnivores. However, the presence of carnivores is documented by only a few specimens (N = 32), whereas the cave bear is accounted for by 861 specimens (Fig. 12). The absence of cut marks on

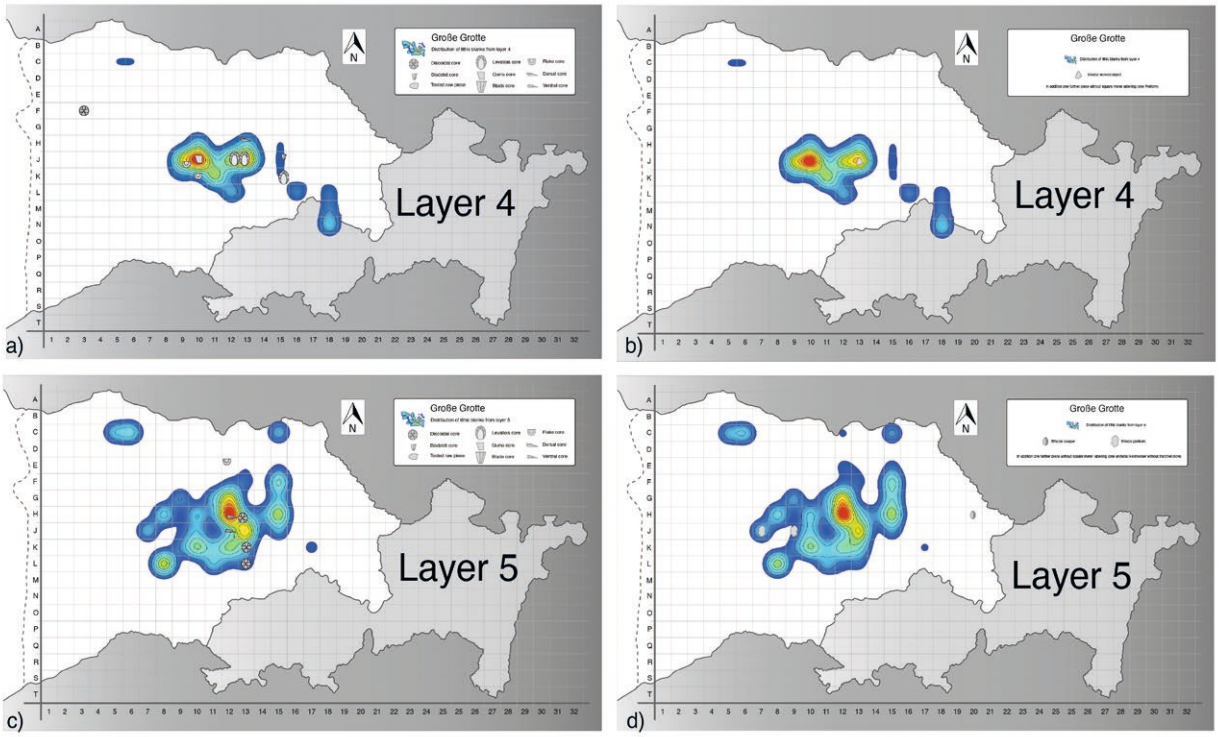

Fig. 8. Distribution of cores, products and bifacial objects in layer 4 to 5. Legend: a) cave plan with the distribution of cores and products (blanks like flakes and blades) of layer 4; b) cave plan with the distribution of bifacial objects and products (blanks like flakes and blades) of layer 4; c) cave plan with the distribution of cores and products (blanks like flakes and blades) of layer 5 and d) cave plan with the distribution of bifacial objects and products (blanks like flakes and blades) of layer 5.

Abb. 8. *Verteilung von Kernen, Produkten und bifaziellen Objekten in Schicht 4 bis 5. Legende: a) Höhlenplan mit der Verteilung der Kerne und Produkte (Grundformen wie Abschläge und Klingen) der Schicht 4; b) Höhlenplan mit der Verteilung der bifaziellen Objekte und Produkte (Grundformen wie Abschläge und Klingen) der Schicht 4; c) Höhlenplan mit der Verteilung der Kerne und Produkte (Grundformen wie Abschläge und Klingen) der Schicht 5 und d) Höhlenplan mit der Verteilung der bifaziellen Objekte und Produkte (Grundformen wie Abschläge und Klingen) der Schicht 5.*

the bones is another argument for very short-term stays, during which it was not necessary to dismember animals. The short-term stays are also supported by the intensity of the use of the fire places. Weinstock (1999) was only able to demonstrate heat effects on 1.6 percent by weight of the bones (N = 234 specimens). However, raw material sources are in the very proximity and the lithic artefacts were very intensively reduced. Considering the high altitude of the cave above the valley, it is conceivable that raw material was imported in small quantities and therefore intensively reduced.

The observed pattern that stone artefact concentrations are right next to the potential fireplaces (in layers 2,4 to 7 and 10) may indicate that stones were knapped in this spot by a person sitting next to the fire. However, we have to take into account that the location of the stone artifacts is mapped horizontally within the square meters and the information on charcoal remains comes from the profile drawings. Thus, it is clear that their positions to each other are determined by this mapping and therefore a margin of error is not ruled out. However, in this context, we do not want to base our correlations on the immediate proximity of both lithic and charcoal position, but to the relative proximity, or in other words, where there is evidence for fire use, stone artifacts have also been deposited. Fireplaces are usually considered the center of a settlement (Binford 1978), and the general settlement pattern seems to be mainly culturally determined (Galanidou 1997, 2000). Within the individual layers of Große Grotte, the potential fireplaces are usually located relatively centrally within the lower level of the cave floor. It can be assumed that the erosive enlargement of the cave portal did not have a direct impact on the choice of fireplace location.

However, in the uppermost layer 2 a change is noticeable (Fig. 5: a). Most of the evidence of fire is still located at the center of the cave, but there is also evidence of fire along the northern cave wall. This allows for speculation regarding whether these charcoal concentrations along the northern cave wall are toss zones (dumping areas) of the remains of the central fireplaces or whether these other fires had a different function. One might assume that at night heat should be released evenly between sleeping places here, as in the case of better documented findings known from Abric Romaní (Carbonell i Roura 2012). Another possibility for the short-time use of fires could be during activities of daily living, for example for repairing equipment (e.g. birch pitch production, Schmidt et al. 2019) or for smoking and fumigating food and clothes or blankets.

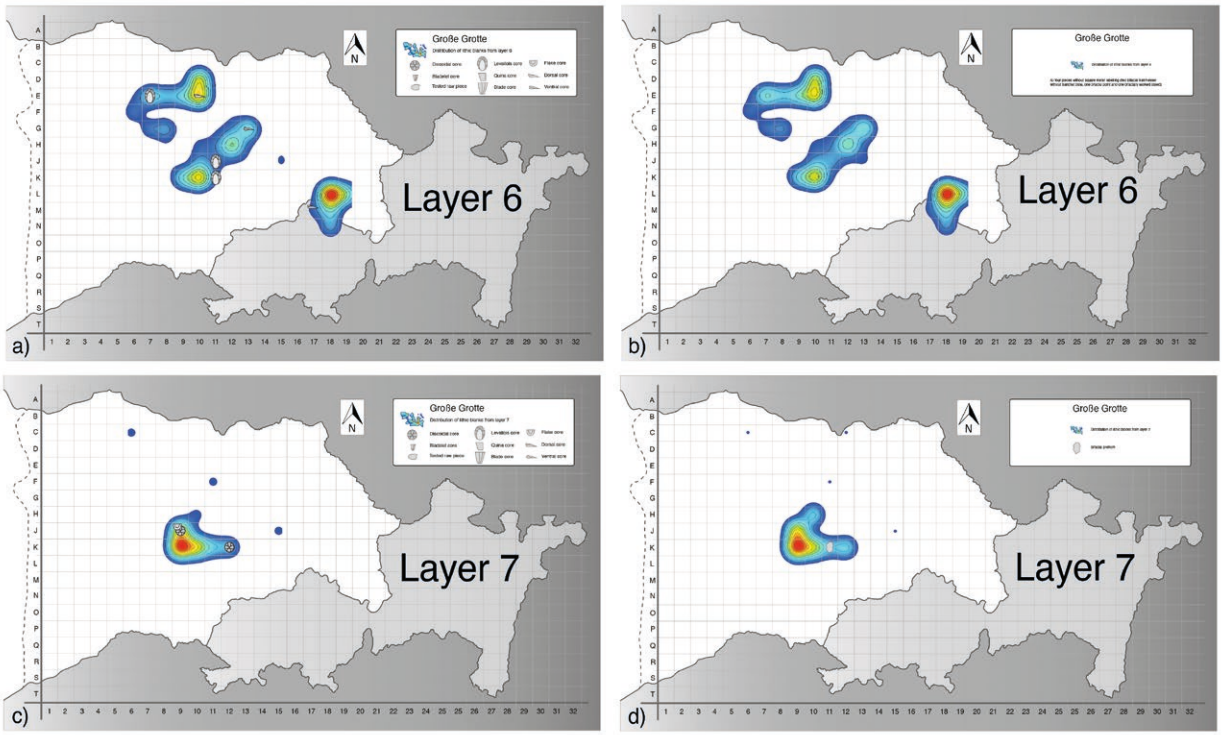

Fig. 9. Distribution of cores, products and bifacial objects in layer 6 to 7. Legend: a) cave plan with the distribution of cores and products (blanks like flakes and blades) of layer 6; b) cave plan with the distribution of bifacial objects and products (blanks like flakes and blades) of layer 6; c) cave plan with the distribution of cores and products (blanks like flakes and blades) of layer 7 and d) cave plan with the distribution of bifacial objects and products (blanks like flakes and blades) of layer 7.

Abb. 9. *Verteilung von Kernen, Produkten und bifazialen Objekten in Schicht 6 bis 7. Legende: a) Höhlenplan mit der Verteilung der Kerne und Produkte (Grundformen wie Abschläge und Klingen) der Schicht 6; b) Höhlenplan mit der Verteilung der bifaziellen Objekte und Produkte (Grundformen wie Abschläge und Klingen) der Schicht 6; c) Höhlenplan mit der Verteilung der Kerne und Produkte (Grundformen wie Abschläge und Klingen) der Schicht 7 und d) Höhlenplan mit der Verteilung der bifaziellen Objekte und Produkte (Grundformen wie Abschläge und Klingen) der Schicht 7.*

Recent data on the presence of foxes in the Paleolithic of the Swabian Jura suggest that foxes are overrepresented in the assemblages of the Große Grotte in relation to other carnivores (Baumann et al. 2020). Likewise, there are far more foxes than hares. This is explained by the low number of small mammalian remains and the higher probability that foxes will naturally inhabit the site. However, Weinstock (1999) identified only 16 fox specimens (red fox, *Vulpes vulpes* and arctic fox, *Alopex lagopus*). These are from layer 2 (N = 9), 5 (N = 3), and one each from layers 4, 7, 9 and 11. In contrast, 35 hare bones (*Lepus timidus*) could be identified, which all originate from the upper layers 2 to 7. Even if one assumes that these animals entered the cave by themselves or were brought by carnivores, it cannot be ruled out that they could also have been brought by humans. Altogether, seven of the hare bones and two of the fox bones show carnivore gnawing (Weinstock 1999). If we assume that the cave was only visited by humans for a short time and in small groups, it is possible that some hares served as source of food. Hares and foxes could also be used to provide furs, whether they were hunted or found dead.

Analogous to the results of the faunal analyses from Bocksteinschmiede in the Lone valley (Çep & Krönneck 2015; Krönneck 2012), we suspect that the animal herds in the Ach- and Blau valley system migrated seasonally. Horses and reindeer in particular preferred to spend the winters in the plains (Danube valley or Molasse basin), where their offspring were born in spring. Some time after, the herds set out to inhabit the high plains of the Jura mountains in summer (Müller-Beck 1988). For the same reason, Große Grotte, situated high above the valley bottom, served as a spot strategic for hunting for observing animal herds. Thus, Große Grotte was an observation point high up in the landscape during the migration of the herds to the high plains of the Jura at the beginning of summer and back into the valley at the beginning of autumn.

When it comes to the lithic legacy, the chaîne opératoire of individual raw piece units is incomplete in most cases. A large part of the micro-*débitage* is missing due to excavation techniques (Chazan 1995). But even for the larger pieces, most refitting attempts have not been successful, see also Schäfer (1993a) or Çep (Çep 2000, 2013, 2019; Çep & Waiblinger 2001). The fragmentary nature of the chaîne opératoire is certainly also due to a combination of the excavation technique (great lack of micro-*débitage*) and the assumed short stays (only individual working stages

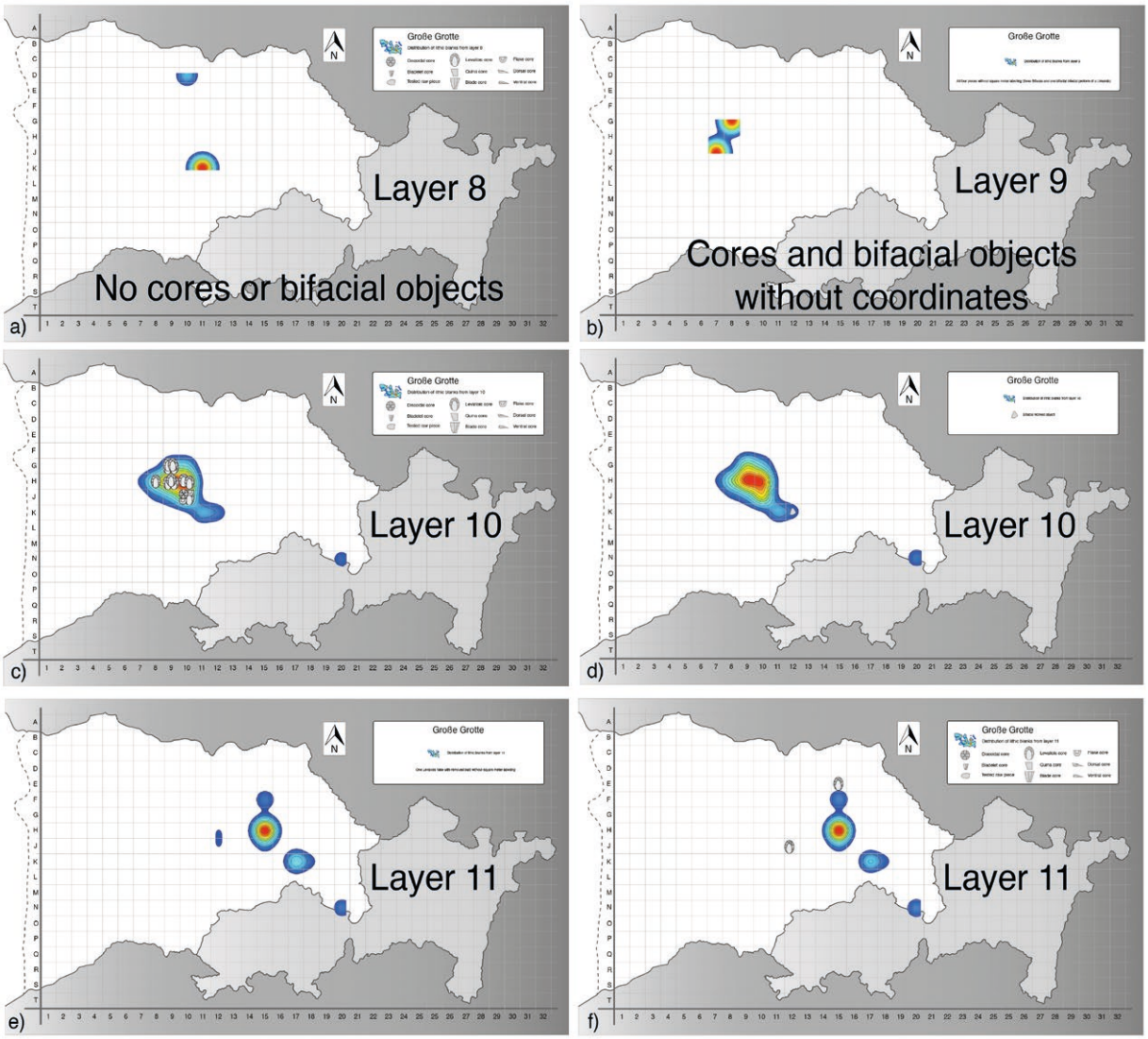

Fig. 10. Distribution of cores, products and bifacial objects in layers 8 to 11. Legend: a) cave plan showing the distribution of products (blanks such as flakes and blades) of layer 8, no cores and bifacial objects; b) cave plan showing the distribution of products (blanks such as flakes and blades) of layer 9, no cores and bifacial objects with coordinates; c) cave plan with the distribution of cores and products (blanks like flakes and blades) of layer 10; d) cave plan with the distribution of bifacial objects and products (blanks like flakes and blades) of layer 10; e) cave plan with the distribution of bifacial objects and products (blanks like flakes and blades) of layer 10; and f) cave plan with the distribution of cores and products (blanks like flakes and blades) of layer 11.

Abb. 10. *Verteilung von Kernen, Produkten und bifaziellen Objekten in Schicht 8 bis 11. Legende: a) Höhlenplan mit der Verteilung der Produkte (Grundformen wie Abschläge und Klingen) der Schicht 8, keine Kerne und bifazielle Objekte; b) Höhlenplan mit der Verteilung der Produkte (Grundformen wie Abschläge und Klingen) der Schicht 9, keine Kernee und bifazielle Objekte mit Koordinaten; c) Höhlenplan mit der Verteilung der Kerne und Produkte (Grundformen wie Abschläge und Klingen) der Schicht 10, d) Höhlenplan mit der Verteilung der bifaziellen Objekte und Produkte (Grundformen wie Abschläge und Klingen) der Schicht 10, e) Höhlenplan mit der Verteilung der bifaziellen Objekte und Produkte (Grundformen wie Abschläge und Klingen) der Schicht 10 und f) Höhlenplan mit der Verteilung der Kerne und Produkte (Grundformen wie Abschläge und Klingen) der Schicht 11.*

Material	Layer	Layer	Inv.-No.
Cave bear mandible halves	2	5	left half: SMNS 34078.58 (ly. 2) right half: SMNS 34110.141(ly. 5)
Anterior cave bear paws	2	11	left paw: SMNS 34091.48–50, 53–54, 56, 59, 61–68 (ly. 3) right paw: SMNS 34139.1–8 (ly. 11)
Hierarchized unifacial Discoidal core	6	7	V65,6-114
Recurrent parallel unidirectional Levallois core	11	11	V65,6-158 V65,6-159

Tab. 1. Refittings of bones and lithic core fragments. Faunal data from Weinstock (1999), lithic data from this study as well as Frick et al. (2022-a, b).

Tab. 1. *Zusammensetzungen von Knochen und lithischen Kernfragmenten. Faunendaten aus Weinstock (1999), lithische Daten aus dieser Studie sowie Frick et al. (2022-a, b).*

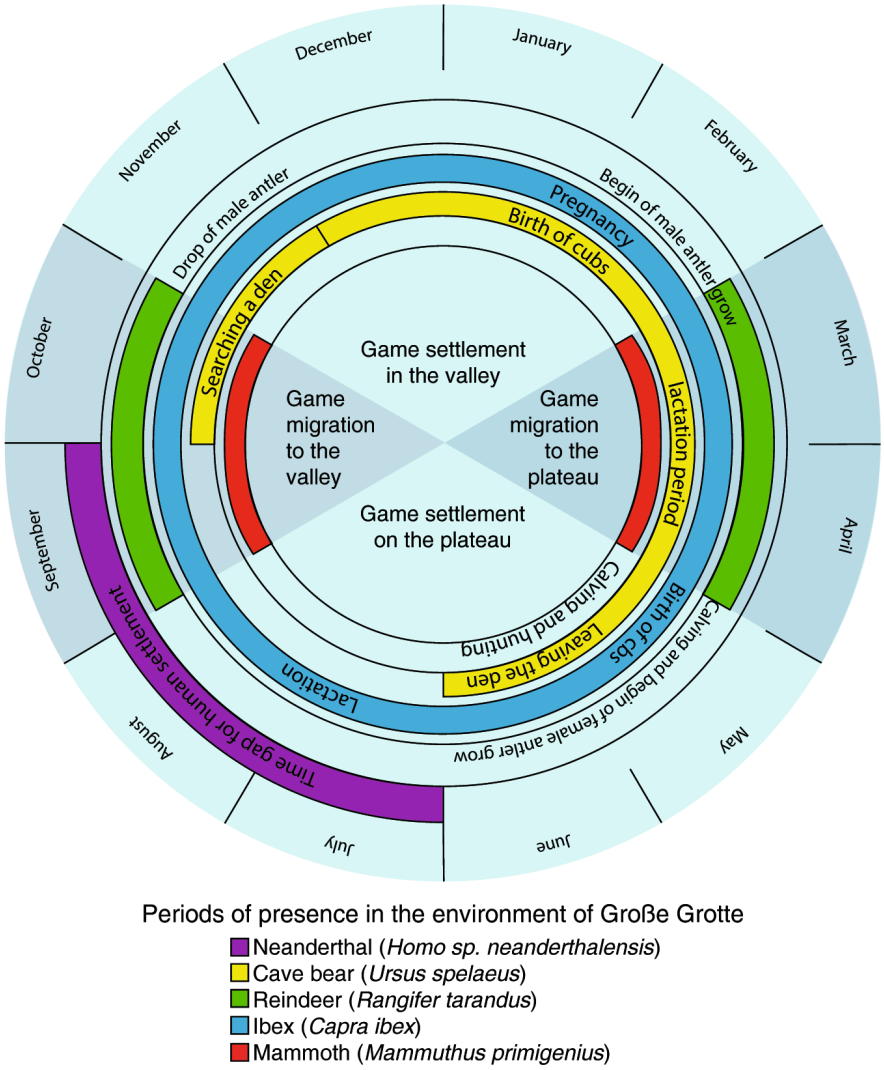

Fig. 11. *Seasonality of game found in Große Grotte. Legend: the illustration is based on faunal data from Weinstock (Weinstock 1999) and seasonal data from various authors (Fletcher et al. 2016; Germonpré & Sablin 2001; Grignolio et al. 2003; Grignolio et al. 2004; Hoppe 2004; Hoppe et al. 1999; Münzel 1997, 2001; Münzel & Conard 2004a; Stüwe & Grodinsky 1987; Weinstock 2000).*

Abb. 11. *Saisonabhängigkeit des in der Großen Grotte gefundenen Wildes. Legende: Die Abbildung basiert auf Faunendaten von Weinstock (Weinstock 1999) und saisonalen Daten verschiedener Autoren (Fletcher et al. 2016; Germonpré & Sablin 2001; Grignolio et al. 2003; Grignolio et al. 2004; Hoppe 2004; Hoppe et al. 1999; Münzel 1997, 2001; Münzel & Conard 2004a; Stüwe & Grodinsky 1987; Weinstock 2000).*

were carried out at the site itself for the individual raw material units). It would certainly be helpful to repeat the refitting activities more thoroughly. In the CRC report, a few refits are reported (Hahn & Kind 1997), but they could not be found. Fortunately, we were able to assemble two fragmented cores ourselves (Frick et al. 2022a).

If the cave had been occupied for a longer period of time, e.g., for one season, the entire surface of the cave would have been used as an area for occupation (for example at Abric Romaní, Rosell et al. 2019). However, the spatial distribution of the lithics shows very clearly that these were deposited in spots mainly in the northern part of the cave. Here, there are good light conditions due to direct sunlight (Wagner 1983: 45).

The size, as well as the extensive reduction of lithic cores and bifacial objects, document a comprehensive use of raw material volumes (Frick et al. 2022a), which were brought into and used in the cave, and left there exhausted.

The lithic raw material that was used primarily can be found in the immediate vicinity on the Jurassic Mountain plateau (Çep 2000, Çep 2013; Çep & Waiblinger 2001). The closest source of raw material of excellent quality is located in the northwest in about 1.5 km distance (as the crow flies) at the Blauberg region.

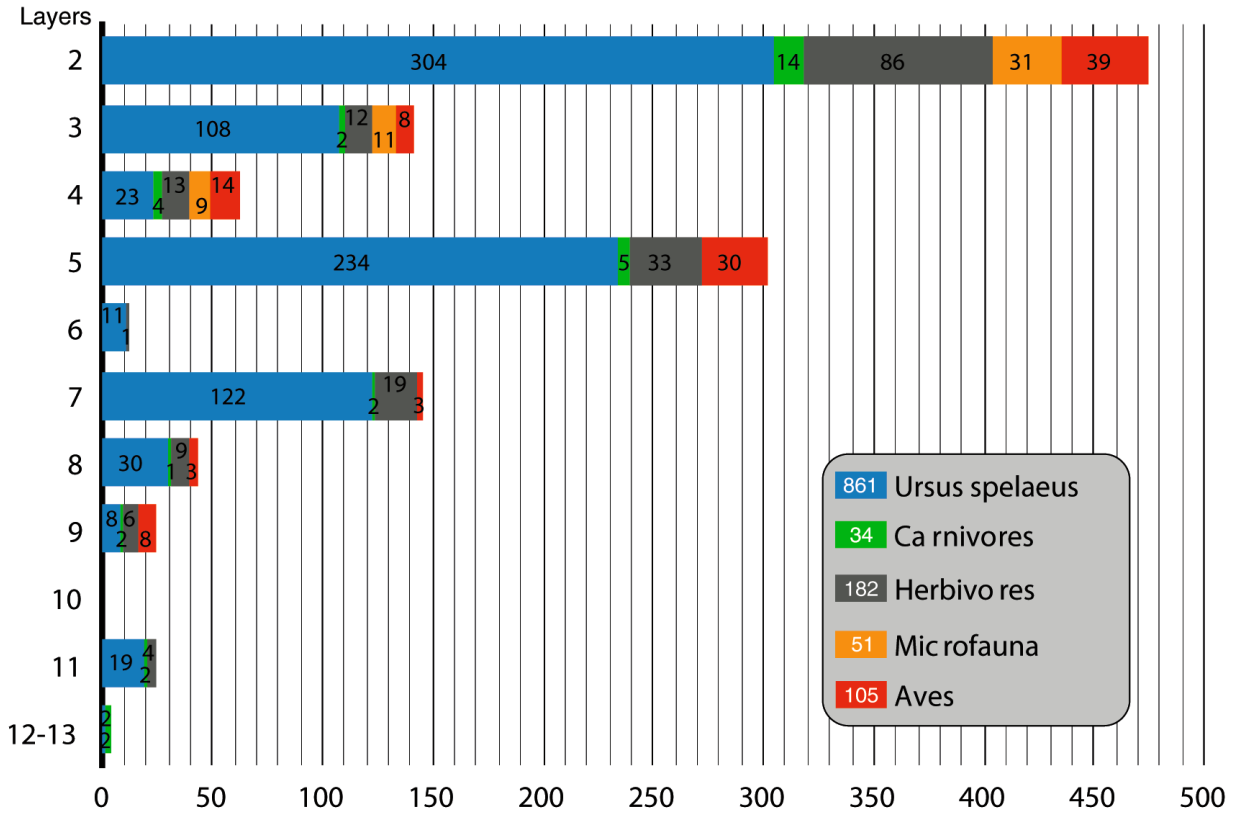

Fig. 12. Faunal remains from Große Grotte. Legend: Faunal analysis by Weinstock (1999). A few species (wildcat & chamois) were not listed, because the layer assignments were not available. The carnivore group includes polecat, marten, hyena and cave lion. The herbivore group includes mammoth, horse, wooly rhino, red deer, reindeer, ibex, chamois and hare.

Abb. 12. *Faunenreste aus der Großen Grotte. Legende: Faunenanalyse nach Weinstock (1999). Einige Arten (Wildkatze & Gämse) wurden nicht aufgeführt, da die Schichtzuordnungen nicht verfügbar waren. Zur Gruppe der Karnivoren gehören Iltis, Marder, Hyäne und Höhlenlöwe. Zur Gruppe der Herbivoren gehören Mammut, Pferd, Wollnashorn, Rothirsch, Rentier, Steinbock, Gämse und Hase.*

To summarize the results, it is highly probable that the cave was only sporadically accessible to humans, and probably not in winter, because of the presence of cave bears. The northern part of the cave may have been used as a kind of a shelter with campfires to warm up, keep an eye on the game in the valley and repair parts of the equipment. From time to time the site was used as a small camp for particular tasks. It is likely that each occupation of the site lasted only a few hours, or perhaps overnight, in order to observe the animal herds in the early morning hours.

Conclusions

The reevaluation of the spatial distribution shows a shift of the positions of the lithics in each layer (Fig. 13). This suggests that some layers should not be combined into one unit, as done by Wagner for layers 3 to 8 (Wagner 1983: 52-56). It is also worth asking whether the accumulations of finds within the layers are palimpsests of several visits. Chazan (1992: 124) pointed this out impressively for layer 2.

For a few lithic pieces, in addition to square meters and layer information, the excavator also noted whether these pieces were found in the layer at the top, in the middle or at the bottom. Unfortunately, this was not done consistently, so that a finer spatial analysis cannot currently be made.

This had already been suggested, due to differences in the lithic raw material use and the typology and technology of the assemblages (Çep 2000). The differences in the assemblages of the layers are not only visible in the lithics. The fauna, as well as the spatial distribution of the finds with square meter indications, clearly show that these are units that must be considered separately. According to Weinstock (1999), the cave bear is present in all layers except for layer 10 (Fig. 12). There are only a few carnivore remains in all layers. However, the remains of herbivores are present in all layers in which cave bears are also found. Microfauna was found only in the upper layers. Birds are present in layers 2 to 5 and 7 to 9. The existence of large herbivores such as mammoth or woolly rhinoceros, but also of reindeer and ibex, is due to the sporadic import by humans. However, both the herbivores and the carnivores may have also occupied the site. Weinstock (1999) could not detect any cut marks on the faunal remains, but traces of gnawing. However, Münzel found one possible cut mark during her reanalysis (pers. comm. S. Münzel, 2020-09-06).

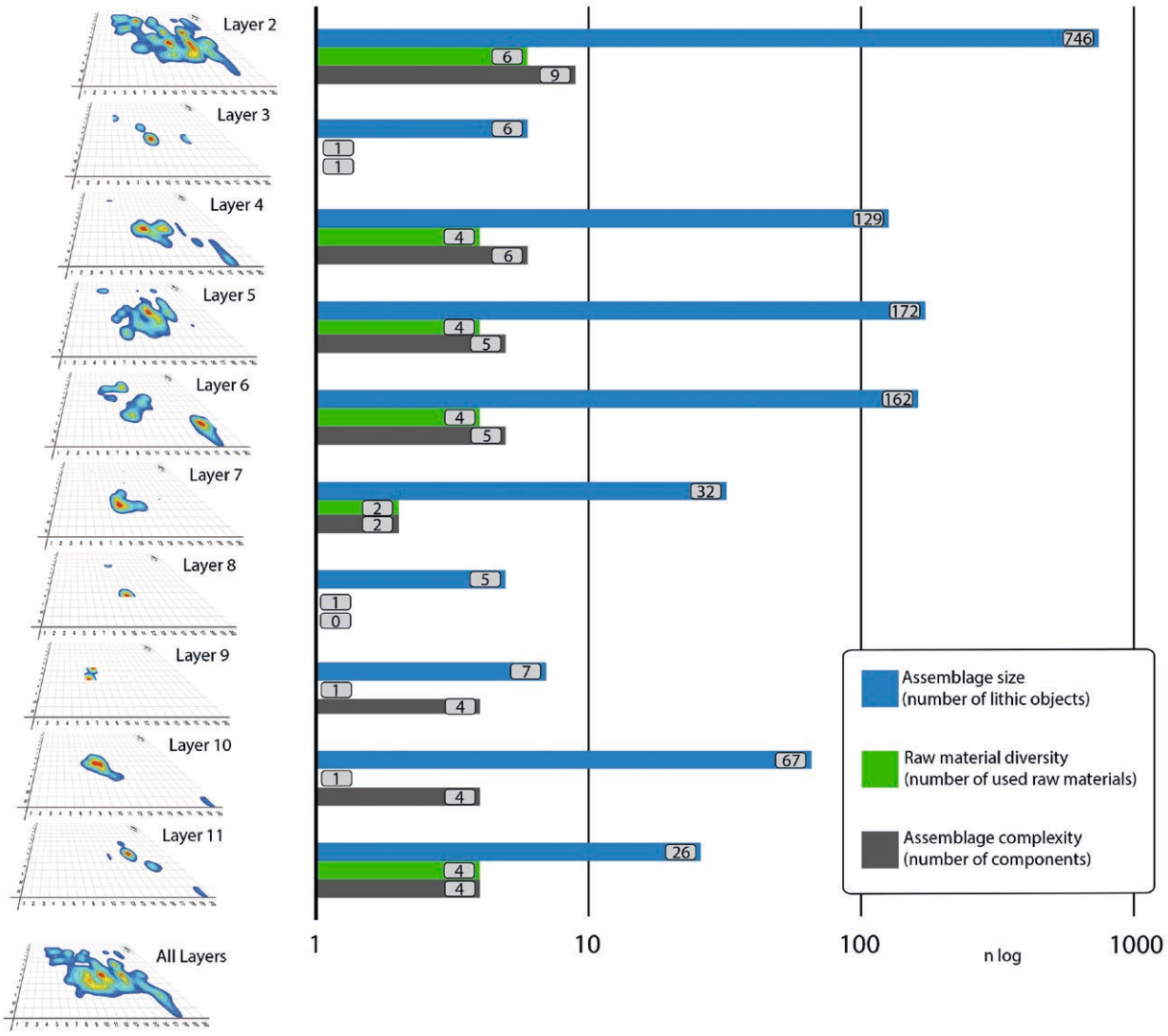

Fig. 13. Diachronic shift of settlement patterns and complexity of the assemblages at Große Grotte. Legend: left) position of the lithics in each layer and right) comparison of assemblage size, raw material diversity and assemblage complexity in each layer.

Abb. 13. *Diachrone Verschiebung der Siedlungsmuster und Komplexität der Inventare in der Großen Grotte. Legende: links) Position der Steinartefakte in jeder Schicht und rechts) Vergleich von Inventargröße, Rohstoffvielfalt und Inventarkomplexität in jeder Schicht.*

In layers 2 to 8, however, a total of 234 burnt bones were found. We interpret this as a further indication of human settlement.

The present study reinforces the assumption brought forth earlier that the cave was used for repeated short stays during its entire occupation (perhaps with the exception of layer 2). The density and distribution of the finds in layer 2 suggest that at this time, the cave was either visited more often or a group of people stayed there for a longer period of time (e.g., some weeks). Furthermore, it might be that the cave entrance was enlarged by cryo-processes over time, so that the settlement area within the cave may have shifted (Figs. 2: b & 13). Interestingly, the entire deposition of the remains of the settlement as well as the faunal remains of the cave took place in the front area. The question remains, to what extent there were sediments in the rear part of the cave, which were either removed during the excavation without being documented or were affected by a post-Middle Paleolithic cave use. A possible clearing and levelling of the cave floor is also suggested by the "stone wall" found.

At Große Grotte, a larger assemblage is not associated with higher complexity (Fig. 13) in all layers (complexity components used: presence of unifacial tools, Levallois cores, Discoidal cores, Quina cores, Blade and bladelet cores, tranchet blow, Keilmesser, almost symmetrical bifaces, general bifacial component and the presence of Groszaki, Frick et al. 2022a). Layer 9 stands out here; although only seven artifacts could be assigned to this layer, four complexity components are present.

When dividing the assemblages of the layers according to their complexity (Fig. 13), there are two groups with medium complexity (layers 9 to 11 with

four components, and layers 4 to 6 with five to six components), two groups with low complexity (layers 7 and 8 with one or two components, and layer 3 with one component), and one group with high complexity (layer 2 with nine components). In four of the layers, exclusively local raw material was found (layers 3, 8, 9, and 10). In the other layers of the site, mostly with larger assemblages, there is usually a greater diversity of raw material.

The pattern of repeated short-term stays is evident for the Middle Paleolithic of the Swabian Jura (Frick et al. 2022a). This characteristic was presented for the Große Grotte just recently (Frick et al. 2022a, 2022b) and is also evident for Geißenklösterle (Conard et al. 2019) or Heidenschmiede (Cep et al. 2021). This is impressively shown in a model of resource use in the Middle Paleolithic of the Swabian Jura by Cep (2013). Finding unambiguous classifications for individual assemblages seems not possible since they themselves consist of palimpsest (Frick et al. 2022a). Better results could be achieved at well excavated and directly dated material in individual layers of sites.

In summary, Große Grotte is a location that was used in the late Middle Paleolithic primarily for sporadic and short stays by small groups for observing animal routes. Hence, the site would be a game observation post with possible overnight stays, where equipment was probably repaired. For humans, however, the cave was accessible primarily between July and September (in the glacial late summer), when the animal herds left the plateau and moved through the valley to the lowlands. During this period, the cave was not used by bears.

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