Original Study

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The Use of Ochre and Painting During the Upper Paleolithic of the Swabian Jura in the Context of the Development of Ochre Use in Africa and Europe

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Abstract: While the earliest evidence for ochre use is very sparse, the habitual use of ochre by hominins appeared about 140,000 years ago and accompanied them ever since. Here, we present an overview of archaeological sites in southwestern Germany, which yielded remains of ochre. We focus on the artifacts belonging exclusively to anatomically modern humans who were the inhabitants of the cave sites in the Swabian Jura during the Upper Paleolithic. The painted limestones from the Magdalenian layers of Hohle Fels Cave are a particular focus. We present these artifacts in detail and argue that they represent the beginning of a tradition of painting in Central Europe.

Keywords: ochre use, Middle Stone Age, Swabian Jura, Upper Paleolithic, Magdalenian painting

1 The Earliest Use of Ochre in the *Homo* Lineage

Modern humans have three types of cone cells in the retina of the eye. These cells are a requirement for trichromatic vision and hence, a requirement for the perception of the color red. The capacity for trichromatic vision dates back about 35 million years, within our shared evolutionary lineage in the Catarrhini subdivision of the higher primates (Jacobs, 2013, 2015). Trichromatic vision may have evolved as a result of the benefits for recognizing ripe yellow, orange, and red fruits in front of a background of green foliage (Regan et al.,

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2001). Another advantage is the ability to observe the subtle changes in blood flow beneath hairless parts of the skin, which carry relevant information about the emotional state of conspecifics (Changizi et al., 2006).

Ochre is a term used by archaeologists to describe earth pigments, usually of reddish color, which contain iron oxides. The most common iron oxides are the minerals hematite and goethite. These materials are typically found as lumps or nodules in archaeological layers, or in the form of residue or powder adhering to rocks and artifacts. The use of artificial coloring material by hominins can be traced back at least half a million years in the form of red ochre found in the archaeological record of Africa.

In this article, we review the data about early use of ochre to demonstrate that this behavior was already incorporated into the cultural repertoire of anatomically modern humans before their arrival in Europe. The use of ochre is closely linked to complex cognitive and social behaviors, and here we present and discuss the long-term development of behaviors surrounding ochre use, which is currently available. Our focus lies on the finds of the Upper Paleolithic in Central Europe, where the earliest examples of painted parietal and portable art appear (e.g., Hahn, 1988; Conard & Floss 1999; Floss, 2007; Conard, 2007, 2009).

2 The Emergence of Habitual Ochre Use in Africa

The oldest reliable evidence of ochre use dates to about 500,000 to 310,000 years ago and comes from several South African sites of the Late Acheulean and transitional industries such as the Fauresmith. These sites include Kathu Pan 1, Canteen Kopje and Wonderwerk Cave (Watts et al., 2016). Other ochre pieces from this period of initial ochre use are known from scattered sites in Kenya (Brooks, 2011, Fig. 4; McBrearty & Tryon, 2006), Zambia (Barham, 2002) and Ethiopia (Chavaillon & Berthelet, 2004). Initial use of ochre is very sparse, and restricted to a few localities in sub-Saharan Africa, though there appears to be no apparent center of innovation. Some of these early ochre artifacts exhibit anthropogenic use-traces such as scraping and grinding (Watts et al., 2016). It is likely that these artifacts are behavioral remains of archaic hominins, such as *Homo heidelbergensis*.

In the early part of the Middle Stone Age (MSA), a slight increase in ochre use occurred from about 310,000 to 210,000 years ago and was likely associated with early *Homo sapiens*. Sites include Mumbwa (Barham et al., 2000) and Twin Rivers (Barham, 2002) in Zambia, Kapthurin in Kenya (McBrearty & Tryon, 2006) and others. While ochre use during this period was geographically widespread, an obvious center of innovation was still not apparent, and its occurrence remained sparse.

The subsequent period between about 210,000 and 140,000 years ago corresponds to a marked rise in ochre use across the majority of the African continent and is clearly associated with *Homo sapiens*. Important ochre finds come from Sai Island in Sudan (van Peer et al., 2003; van Peer et al., 2004), Kalambo Falls in Zambia (Clark, 2001, Tab. 1.2, 59, 665; Barham et al., 2015), Bambata Cave (Watts, 1998, App. 5/13: 129) and Pomongwe Cave in Zimbabwe (Cooke, 1963; Watts, 1998, p. 30, App. 5a/14: 130), and Pinnacle Point Cave 13B in South Africa (Watts, 2010).

Habitual use of ochre starts about 140,000 years ago. During this phase, ochre becomes the most frequent archaeological find after lithics and faunal remains. Centers of ochre use can be seen in southern, eastern and northwestern Africa. High concentrations of ochre are reported from many southern African sites, especially during the Still Bay and Howiesons Poort sub-phases of the MSA. However, this trend may reflect a longer and more intense research history in this region. Several sites such as Sibudu Cave (Hodgskiss, 2012, 2013a, 2013b) and Blombos Cave (Henshilwood et al., 2001; Watts, 2009) yielded large assemblages ranging between hundreds and thousands of individual ochre pieces weighing a total of several kilograms.

A considerable number of ochre pieces show evidence of anthropogenic modification, including faceted surfaces with striations indicating the production of powder, as well as scoring or engraving marks (Rifkin, 2012; Hodgskiss, 2013a). Intensively ground pieces with three or more facets converging to a point are often referred to as “crayons” (Henshilwood et al., 2001, p. 433; Watts, 2002, p. 5; d’Errico, 2003, p. 19; Rifkin, 2012, pp. 180–181, 189–190). Some of the crayon pieces might indeed have been used as tools for painting filigree lines and geometrical motifs on rocks, artifacts, or human skin (Rifkin, 2012, p. 188, Fig. 13). Alternatively, other pieces could just be waste products from intensive grinding. Strong evidence suggesting

they were used in a fashion similar to modern-day writing utensils does not exist (Wadley, 2005a), though both scenarios could have occurred simultaneously.

3 Exceptional Findings

Several pieces of ochre from Blombos Cave (Henshilwood et al., 2009), Klasies River (d’Errico et al., 2012), Klein Kliphuis (Mackay & Welz, 2008) and Pinnacle Point 13B (Watts, 2010) exhibit geometrical or quasi-geometrical score-marks, or engravings. These artifacts provide an important topic for discussion on the emergence of symbolically mediated behavior, as they solidified Africa-based theoretical models over the Eurocentric “cultural revolution” model (Henshilwood & d’Errico, 2011). Some striking recent findings allow glimpses into the production and storage of liquefied ochre-rich mixtures. During excavations in 2008 at Blombos Cave, located in the Western Cape Province of South Africa, two ochre toolkits were found *in situ* within a 100,000-year-old MSA layer. The toolkits comprised of a set of different materials contained within abalone shells, including the remains of an ochre compound (Henshilwood et al., 2011). On the east side of the country at Sibudu Cave in KwaZulu-Natal, residue on a stone flake from a 49,000-year-old layer was found to contain a liquid composite of powdered ochre mixed with milk as a binder, which was likely obtained by killing a lactating wild bovid (Villa et al., 2015).

Other discoveries of red ochre residues on personal ornaments such as perforated marine shell beads date between 130,000 and 70,000 years ago and include Sibudu Cave (d’Errico et al. 2008) and Blombos Cave in South Africa (d’Errico et al., 2005; Vanhaeren et al., 2013), as well as a number of sites in Morocco (Bouzouggar et al., 2007; d’Errico et al., 2009) and Qafzeh in Israel (Bar-Yosef Mayer et al., 2009). The nature of these finds suggests that the beads were continuously rubbing against ochred surfaces, such as human skin or animal hides. Other possible interpretations are that the shell beads were deliberately covered with ochre upon initial use, or that the threads holding them were impregnated with ochre. However, these possibilities are not mutually exclusive and could have operated simultaneously (Dapschaskas, 2015). Shells with traces of ochre powder were also found beyond the context of personal ornamentation, for example at Border Cave in South Africa. Here, a perforated *Conus* shell with red residue was found associated with the burial of a four to six-month-old infant, dated to ca. 74,000 years BP (d’Errico & Backwell, 2016).

4 Contemporary Neanderthals in Europe

There are several frequently cited, alleged ochre findings dating to the European Late Acheulean. These sites include Isernia (Italy; Cremaschi & Peretto, 1988, p. 1036), Terra Amata (France; de Lumley, 1966, 1969; Wreschner, 1980, 1983, 1985) and Ambrona (Spain; Howell, 1966, p. 129; Butzer, 1980; Wreschner 1980, 1985). A handful of ochre pieces from Late Acheulean contexts are also reported from Hunsgi, Locality 5 in South India (Paddayya, 1976, 1977) and from Dashtadem-3 in Armenia (Kolpakov, 2009). However, in all of these instances, their status as anthropogenic artifacts is questionable.

There is very sparse evidence for Neanderthal ochre use in the early Mousterian from Achenheim (France; Wernert, 1957, p. 211; Thévenin, 1976) and Bečov I (Czech Republic; Fridrich, 1976; Marshak, 1981; Wreschner, 1985; Fridrich & Fridrichová-Sýkorová, 2010). The oldest reliable evidence for the use of red ochre by early Neanderthals comes from Maastricht-Belvédère in the Netherlands dated between about 250,000 and 200,000 years BP (Roebroeks, 1988, pp. 38–40; Roebroeks et al. 2012). Following these sporadic events, a gap of more than 100,000 years is noted by the absence of ochre use in the European archaeological record.

Occasional use of red ochre and black manganese appears again between about 100,000 and 60,000 years BP (Couraud, 1991, Tab. XVI; Demars, 1992), but substantial evidence only occurs after that. In this period, the largest assemblages come from Grotte du Renne (Salomon, 2009; Beck et al., 2012), Pech de l’Azé I & IV (Soressi & d’Errico, 2007; Soressi et al., 2008; d’Errico, 2008), Ormesson (Bodu et al., 2014), and Roc-de-Combe (Dayet et al., 2014) in France. In contrast to their cousins in Africa, Neanderthals utilized

not only red ochre but also a considerable amount of black manganese (d’Errico, 2008). However, recent experiments show that manganese dioxide could also function as a combustive agent to produce fire on demand (Heyes et al., 2016).

5 Interpretation of Ochre Use

Today, ochre plays a major role in the debate about the emergence of modern cognitive abilities in the lineage *Homo*. Interpretations of ochre use in the MSA range from symbolically mediated behavior and ritual display to a variety of functional applications. Arguments for the symbolic or ritual use of ochre include:

- Domination of red ochre at MSA sites versus other easily available pigments like yellow ochre from weathered shales or black manganese (Watts, 2002; Watts et al., 2016)
- Evidence for intentional selection of saturated blood red or bright red hues in rigorously analyzed assemblages (Blombos: Watts, 2009; Pinnacle Point 13 B: Watts, 2010; Sibudu: Hodgskiss, 2012)
- Red ochre residues on many MSA shell beads which could indicate body painting (d’Errico et al., 2005)
- Dominance of grinding use-wear indicating powder production (Hodgskiss, 2010)
- Evidence for preparation of ochre-rich coloring material with (semi-) liquid binders (Villa et al., 2015)
- Association with some human (Hovers et al., 2003; d’Errico & Backwell, 2016) and animal burials (Solecki, 1982), as well as a possible ritual cache (Coulson et al., 2011)
- Procurement from distant sources and great effort needed to produce powder, indicating costly signaling (Rifkin, 2012; Salomon et al., 2012; Watts, 2015; Watts et al., 2016).

Indeed, a controversial model concerning the emergence of collective rituals and symbolic communication in humans, named *The Female Cosmetic Coalition hypothesis*, is based heavily on the record of archaeological ochre (Knight et al., 1995; Power et al., 2013; Watts, 2015). It is also important to note the growing literature on color psychology (Elliot, 2015; Elliot et al., 2015). Many insightful experiments assess the perceptual and behavioral impact of red stimuli in different psychological contexts (Folk, 2015; Maier et al., 2015; Stephen & Perrett, 2015). Most experiments focused on the “romantic red effect,” that is, on men viewing women in the context of choosing a mate. Relative to other colors, red leads men to unconsciously view young and fertile women as more attractive and more sexually desirable across cultures (Elliot & Niesta, 2008; Schwarz & Singer, 2013; Elliot et al., 2013; Pazda & Greitemeyer, 2015). These studies have a variety of evolutionary implications for the early use of red ochre.

In the past decade, several authors tested functional uses of ochre through actualistic experiments, including ochre used as an:

- Ingredient in compound adhesives (Wadley, 2005b; Wadley et al., 2009; Zipkin et al., 2014)
- Hide tanning agent (Audouin & Plissan, 1982; Rifkin, 2011)
- Mosquito repellent (Rifkin, 2015)
- Sunscreen (Rifkin et al., 2015a; Rifkin et al., 2015b)

Other functional uses of ochre are reported from the ethnographical record, such as medicinal applications, nutritional supplement, and the neutralization of smells (Peile, 1979; Velo, 1984; Cordwell, 1985; Sagona 1994). Another approach to the material is the assessment of cognitive abilities needed for the processing of ochre (Hodgskiss, 2014) or its application in composite tools (Wadley, 2011). Furthermore, some ochre nodules seem to have been used as soft hammers for the shaping of stone tools (Soriano et al., 2009).

Current research into the Paleolithic recognizes red ochre as a valuable archaeological material with a long evolutionary history. Therefore, ochre is attracting increasing attention not only in theoretical discussions about the emergence of modern cognitive abilities but also in Upper Paleolithic research as a distinct find category with unique significance. Because of the relation of ochre to the theoretical implications of modernity and symbolic behaviors, the painted stones of the Magdalenian of the Swabian Jura are of particular interest.

6 Ochre Use and Painting During the Upper Paleolithic of the Swabian Jura

Hohle Fels Cave (Fig.1) near the town of Schelklingen, and Geißenklösterle Cave near the town of Blaubeuren, lie in the Ach Valley in southwestern Germany. These caves have yielded ochre remains and painted stones which date to the Upper Paleolithic. The Swabian Jura has a history of archaeological interest that extends back to the late 19th century, beginning with Oscar Fraas' excavations of Hohle Fels in 1870/71 with Theodor Hartmann (Fraas, 1872). The Magdalenian layers of Hohle Fels Cave present a unique circumstance (e.g., Taller, 2014, pp. 49–56), in that the archaeological strata are not intact. Instead, several geological horizons (GH), namely GH 1/1ks to GH 3ag, represent erosional processes (Fig. 2). Thus, the oldest Magdalenian units are mixed with Gravettian artifacts. The archaeological horizons (AH) are layers Ia to IIa. The main phase of Magdalenian occupation is dated to about 15,000 years cal. BP (see Conard & Malina, 2011; Taller, 2014).

Figure 1. Hohle Fels Cave, entrance. Photo: E. Sobkowiak.

7 Geological Setting of the Ach Valley Caves and Potential Source Insight

Hohle Fels and Geißenklösterle Caves are located in the eastern portion of the Swabian Jura and belong to a larger geological complex, the Jura Mountains. As the name suggests, the range consists of Jurassic limestone and contains numerous caves, dry valleys, underground watercourses, and sinkholes, all characteristic features of a karstic landscape (Geyer & Gwinner, 1991; Goldberg et al., 2003; Schiegl et al., 2003; Miller, 2015). The landscape and geological formation of the Swabian Jura, and specifically the region near Hohle Fels, results from extensive erosional processes and weathering since the Cretaceous period caused by severe climatic fluctuations (Borger et al., 2001).

Characteristic of the Swabian Jura are the *Bohnerze*, or pebbles of iron ore consisting of limonite or goethite (Reiff, 1993; Schall, 2002). These mineral formations are found embedded in kaolinitic clay and quartz sand (Ufrecht, 2008) in karstic fissures and solution pits, and once likely constituted a widespread *Bohnerz* sheet across southern Germany (Barberi, pers. comm. 2016). In addition to the *Bohnerz* deposits,

Figure 2. Hohle Fels Cave, stratigraphy, Magdalenian geological horizons. After Conard and Malina (2011).

Bohnerzlehm is an iron-rich silty-clay consisting mostly of kaolinite. Both of these geological features are the result of the weathering and dissolution of transported foreign sediments through the limestone bedrock. Similar erosional and uplift effects during the Pliocene and Pleistocene caused karstic pits in the region to fill with lateritic materials and hematite-rich lateritic pebbles (Borger & Widdowson, 2001). Other geomorphological studies in the area have found patches of red clay and hematite layers throughout the limestone beds, as well as iron oxide enriched sediments (Koch et al., 1994). The presence of red clay and hematite layers in the limestone, along with patches of weathered lateritic sediments, are strong indicators that there are many red ochre and hematite sources in and around the Swabian Jura.

8 Painting in the Aurignacian

Cave painting originated about 32,000 years ago during the Aurignacian period (Chauvet et al., 1995; Clottes, 2001; Clottes & Geneste, 2007). Grotte Chauvet in France is renowned for its spectacular perspective representations of animals, and Grotta di Fumane in Italy contained yellow ochre-painted limestone that

dates to the Aurignacian (Broglia & Gurioli, 2004; Broglia et al., 2007). The Aurignacian period of the Swabian Jura is especially famous for the various animal figurines made from mammoth ivory (e.g., Riek, 1934; Hahn, 1988; Floss, 2007; Conard, 2009) and dates to 42,000 years cal. BP (Richter et al., 2000; Higham et al., 2012). As for painted artifacts, only one has so far been uncovered in the Swabian Jura. This artifact from Geißenklösterle Cave (Hahn, 1986, 1988; Conard & Floss, 1999) is an 8.5 x 6 x 4.5 cm piece of limestone which derives from AH IIB (Fig. 3). This artifact contains three indistinctly demarcated zones with remains of black, red and yellow color. It is possible that the stone was originally painted completely. Chemical analyses support the use of pulverized charcoal for black coloring, hematite for red, and iron oxide for the color yellow (Conard & Floss, 2001). The arranged order of the pigments demonstrates a deliberate staining and makes an accidental contact with coloring substances unlikely.

Figure 3. Geißenklösterle, trichromatic painted limestone, Aurignacian. Photo: H. Jensen, Univ. Tübingen.

9 The Magdalenian

The Magdalenian began after the Last Glacial Maximum and dates between 16,000 and 14,000 years cal. BP in southwestern Germany (Taller, 2014). On a supra-regional scale, the Magdalenian is regarded for its florescence of Ice Age art, as even mundane objects were decorated and often regarded as “mobile art objects.” The famous caves of Lascaux in France or Altamira in Spain date to this period and depict spectacular paintings mainly of animals and abstract designs (e.g., Obermaier, 1928; Leroi-Gourhan, 1979).

10 Painting of the Magdalenian of the Swabian Jura

Until two decades ago, paintings of the Magdalenian from the Swabian Jura were nearly unknown. The majority of the regions in Western Europe boast wall paintings and engravings that often contain complex drawings of animals and abstract signs; however, the Swabian Jura almost entirely lacks painted parietal art. This changed in 1998 with the discovery of a painted limestone piece during excavations at Hohle Fels (Conard & Uerpmann, 1999; Conard & Floss, 1999). The fragment is of the same material as the cave walls, measures 7.5 x 5.9 x 1.7 cm, and was recovered from AH IIa (Find 55/253) (Conard & Floss, 2001) (Fig. 4) (for an overview of all mentioned painted stones see table 1). The front is rounded and bears a painting of two double rows of dark red dots. The rows are roughly parallel and consist of seven dots. The second dot row is oriented at an angle of 35° to the first series and capped by a break in the limestone. It contains two parallel rows with four double points each. All points have a slightly oval shape, a diameter of about 5 mm, and were painted with fingers or a brush. The fragment likely belonged to the former wall of the cave, as numerous fragments of the cave wall indicate frost wedging. This process was already taking place during the Upper Paleolithic (Conard & Floss, 2001; Floss & Conard, 2001).

Figure 4. Hohle Fels, painted limestone, excavated 1998. Photo: M. Malina.

Table 1. Overview of the painted stones mentioned in the article.

Object	Find number	Site	AH	Measurements (Length, Width, Thickness in cm)	find year
trichromatic painted stone	no number	Geißenklösterle	IIb	8.5 x 6 x 4.5	1970ies
painted stone	55/253	Hohle Fels	IIa	7.5 x 5.9 x 1.7	1998
painted stone	102/487	Hohle Fels	Isa	6.8 x 5.7 x 2.5	2009
painted stone	102/495	Hohle Fels	I	9 x 6	2009
painted stone	135/197	Hohle Fels	I	7.6 x 5.6 x 4.6	2010
painted stone	110/985	Hohle Fels	IIad	4.2 x 4.1 x 3.8	2010
hematite fragment	102/630.1	Hohle Fels	IIag	2.3 x 1.3 x 0.8	2009
ochre “crayon-shaped” artefact	102/555.1	Hohle Fels	IIaf	0.8 x 0.7 x 0.6	2009
rondelle (two pieces)	110/1104.1 & 110/992	Hohle Fels	IIad	3.4 x 2.1 x 0.4	2010
rondelle part	110/434.1	Hohle Fels	IIad	2 x 1.4 x 0.1	2010
painted stone	44/92	Hohle Fels	Iwf	5.6 x 4.4 x 1.9	2013

11 The 2009 and 2010 Finds

During 2009, the excavators unearthed two red-painted stones in Hohle Fels (Conard & Malina, 2010) (Fig. 5). The first stone is made of fine-grained dolomitic limestone measuring 6.8 x 5.7 x 2.5 cm and was found in AH Isa (Find 102/487). Painted on it are two double rows of red dots within discernible traces of painting on the back. It is most likely a fragment that originally belonged to the cave wall. This stone fragment was found about seven meters away from the similar piece discovered in 1998, but the two do not refit. The characteristic double rows on both the pieces clearly show that this painting style is typical for the Magdalenian of the Swabian Jura. The second piece, also a fine-grained dolomitic limestone, was found in AH I only a few centimeters from the cave wall (Find 102/495). It measures 9 x 6 cm. On it are two distinct red color areas truncated by the fracture surfaces. The painting is less clear than on the other stones. One side appears smooth and squared off, and likely broke off the cave wall.

Figure 5. Hohle Fels, painted limestones, excavated 2009. Photo: M. Malina, Drawings: R. Ehmann.

In 2010, the excavation team unearthed two further painted limestones (Conard & Malina, 2011) (Fig. 6). The larger piece derives from AH I and measures 7.6 x 5.6 x 4.6 cm (Find 135/197). It depicts three groups of double rows with eight to ten red dots. The smaller stone came from AH IIad, measures 4.2 x 4.1 x 3.8 cm and shows a double row of six or three visible dots (Find 110/985). Both stones are from the gravels of the nearby Ach River and do not refit to any of the other pieces.

Figure 6. Hohle Fels, painted limestones, excavated 2010. Photo: M. Malina.

The shapes of the dots are symmetrical and were precisely executed. The accuracy of the application indicates that the dot rows were painted using a tool or stamp to maintain consistency. Modern experiments support this assumption (Huber & Floss, 2014). Another interesting piece is an engraved limestone fragment from Magdalenian layer AH IIa, found in 1977 (no find number; Floss et al., 2009). One surface is decorated with alternating parallel incised lines, though there appears to be no consistent pattern and the engravings do not resemble designs on the painted limestone artifacts. It is possible that this piece was originally part of the cave wall.

The ochre bearing artifacts from Hohle Fels, include the painted pieces of limestone and dolomite, faunal elements with traces of red ochre, and modified ochre pieces and display clear evidence for the use of red ochre at the site. Five pieces of red ochre from Magdalenian levels display clear signs of anthropogenic modification. These include one piece of hematite, one piece of iron-rich red chalk, both found in 2009 (Conard & Malina, 2010), and the so-called “*Rondelle*” found in 2010 (Conard & Malina, 2011).

In addition to these artifacts, there are numerous newly discovered ochre pieces from the site, some of which are not yet reported. One Magdalenian hematite fragment (Find 102/630.1) was found in AH IIag in 2009 (Conard & Malina, 2010) and is 2.3 x 1.3 x 0.8 cm in size (Fig. 7). The fragment is dark purple and contains numerous mica inclusions thereby rendering a “glittery” luster common of specular hematite or specularite. The worked faces display two faceted or flattened juxtaposed surfaces, forming a single ridge along the artifact. In anthropogenically modified ochre pieces, faceting is often a by-product of grinding or rubbing, though it may not directly show striations or micro-striations. The primary purpose of grinding of ochre materials is to acquire pigments or fine powder more efficiently. Rubbing or soft-surface grinding suggests direct skin contact, whether on animal hides or human skin (Hodgskiss, 2010, 2013a, 2013b).

Figure 7. Hohle Fels, hematite fragment, excavated 2009. Photo: M. Malina.

A red ochre chalk piece (Find 102/555.1) was found in 2009 in AH IIaf (Conard & Malina, 2010) and measures 0.8 x 0.7 x 0.6 cm (Fig. 8). It shows three worked surfaces with highly weathered scoring or incision marks, flanked by micro-striations. Henshilwood et al. (2001, p. 433) define this artefact type as a “crayon”, that indicates direct pigment application on a flat surface, similar to a real crayon or writing utensil. However, for the red chalk piece from Hohle Fels, this scenario seems unlikely, given the high amount of use-traces on three of the small surfaces which indicate intensive grinding. Furthermore, the tip that was broken or removed from the piece shows no indication of direct contact. During experiments conducted by Lyn Wadley (2005), she found that ochre fragments, morphologically defined as “crayons,” could indeed be the by-product of powder production from ochre nodules. Even so, the piece from Hohle Fels is unique amongst

known modified ochre artifacts, as the color and texture differ from that of hematite. It is also one of the only pieces with both micro-striations and scoring marks, indicating a variety of modifications and perhaps the utilization of different tool types.

Figure 8. Hohle Fels, “crayon”-shaped artifact made from ochre, excavated 2009, four views. Photo: M. Malina.

The *Rondelle* consists of three separate fragments, two of which fit together (Find 110/1104.1 & 110/992) (Fig. 9). The latter come from AH IIad. When combined, these pieces construct a unique artifact, as the nature of modification suggests that the pieces were shaped and not necessarily used for acquiring pigment, though both scenarios could have occurred simultaneously. Together, the two refitted pieces are made of the same hematite rich material and measure 3.4 x 2.1 x 0.4 cm (Conard & Malina, 2011). The outer edge of the complete ochre artifact depicts the arc of a circle, with a ground hole in the center. Its appearance suggests a pendant; however, the exact function of this object is unclear. Further micro-wear and residue analyses of the central perforation may provide more information. The smaller third piece (Find 110/434.1), which also appears to be hematite, measures 2 x 1.4 x 0.1 cm and was uncovered in AH IIad. Even though there is no evidence of a ground central hole, the rounded edges show clear striations indicating that grinding on a hard stone was the primary shaping mechanism. Though the smaller piece does not refit with the larger, the similar rounded edge suggests the pieces were originally comparable in their appearance and function.

Figure 9. Hohle Fels, fragments of hematite rondelles, excavated 2010. Photo: M. Malina.

12 The 2013 Find

In 2013, a painted limestone fragment with dimensions of 5.6 x 4.4 x 1.9 cm was uncovered from AH Iwf (Find 44/92) (Conard et al., 2014) (Fig. 10). The artifact was covered with sinter and after cleaning revealed a pattern of small ochre dots each with a diameter between 0.3–0.4 cm in precisely arranged rows. One group contains two parallel rows of dots, and another single row is visible to the side. Both of the paintings on the stone likely extended further originally; however, due to damage only 14 dots are visible in all. Since the damaged areas are also coated with sinter, the damage is likely of ancient origin and not recent. One exception is a fresh-looking break that probably took place during excavation. In addition to the dot patterns, there is a small area with the same reddish color along the edge of the stone.

Figure 10. Hohle Fels, painted limestone, excavated 2013. Photo: M. Malina.

13 New Ochre Finds from Hohle Fels

An on-going assessment of the Hohle Fels ochre assemblage conducted by doctoral student Elizabeth Velliky has revealed numerous previously overlooked ochre pieces. The new additions to the ochre assemblage comprise a total of 259 individual artifacts, including 15 anthropogenically modified, four possibly modified, and 240 unmodified ochre pieces. It is likely that even more ochre artifacts will be found as the assessment continues. Of the newly discovered anthropogenically modified pieces, the majority of these are hematite ($n = 7$), followed, by unspecified red clays and sedimentary rocks ($n = 6$) and specular hematite ($n = 2$). Further mineralogical and geochemical analyses will shed light on the geochemical composition of these materials.

The new pieces show a variety of modification types. One hematite piece (Find 99/202), found in AH IIwaf, shows two faceted surfaces reminiscent of the previously found hematite artifact (see figure 7). Two pieces found in AH IIb (Finds 100/263.2 and 136/340.1), display rounded edges and a central perforated hole similar to the *Rondelle*. The majority ($n = 11$) show various forms of striations and micro-striations, caused either by grinding, rubbing, smoothing, or a combination of these. All of these pieces tend to be <1 cm in size.

A single ochre artifact is yellow (Find 87/1271) and measures 3 x 2.7 x 1.2 cm. This piece is the only modified ochre artifact from the Aurignacian layers at Hohle Fels, though the Aurignacian contains more unmodified pieces ($n = 136$) compared to the Gravettian ($n = 68$), the Magdalenian ($n = 22$), or either of the transitional phases (Magdalenian/Gravettian, $n = 7$; Gravettian/Aurignacian, $n = 7$).

The yellow ochre artifact contains one surface with two long, deep scoring or incision marks, and two small circular points in between. The profile of the incisions contains micro-striations, which is characteristic of this form of modification (Hodgskiss, 2010, 2013b), as well as accumulation of sediments and minerals, indicating an ancient origin rather than post-deposition processes. The incisions are both deeper at one end and taper off as they grow wider, forming a “V” shape with the two points near the wider end. To date, this is the only piece showing conclusive evidence of scoring or incising modification at Hohle Fels. Upon visual evaluation, the artifact could be a form of iron oxide called limonite. A local source of limonite exists in Schelklingen, the town nearest Hohle Fels (Walter, pers. comm. 2016). However, this conclusion is speculative and further geochemical analyses are warranted to provide definitive answers as to the exact mineral identification of this artifact.

14 Discussion and Conclusion

During the Aurignacian settlement of Hohle Fels, the local Jurassic chert was used almost exclusively in the creation of various types of lithic tools (Hahn, 1987). There is a slight increase of exotic materials during the Gravettian (Moreau, 2009), but only during the Magdalenian is there a significant increase in the use of non-local lithic materials (e.g., Taller, 2014). If the acquisition patterns of red ochre and hematite mimic those of the lithic materials, then Aurignacian people of Hohle Fels acquired pigment-bearing minerals from the immediate area of the Swabian Jura. Various types of clays, rich in iron oxide, would have been abundant in the region. A preference for non-local lithic sources increased over time (Floss & Kieselbach, 2004; Burkert & Floss, 2005; Çep, 2013). During the Magdalenian the distances of the raw material sources became vaster than during the previous cultures. People brought artifacts such as shells from the Mediterranean Sea to the Swabian Jura (Kölbl & Conard, 2003). We assume a similar behavior concerning the ochre artifacts and sources but this has to be proven by future research. Indeed, Joachim Hahn (1987) notes that despite the predominantly local raw material procurement strategies during the Aurignacian (<10 km), the overall area of exotic resource extraction for Upper Paleolithic people during the Aurignacian in the Swabian Jura measures around 7,000 km² (Hahn, 1987, p. 255). Given the marked increase in exotic raw materials during the Gravettian and Magdalenian it is likely that 7,000km² is a conservative estimate for these time periods. A broadening of resource acquisition networks or perhaps a wider range of seasonal migration (Hahn, 1987, p. 259; e.g., Floss, 1994; Maier, 2015) indicate that prehistoric populations had more access to useable materials, such as lithics and shells, during the later part of the Upper Paleolithic.

Painted limestones from earlier excavations at Hohle Fels are well-known. There are at least eight limestone pieces dating to the Magdalenian that carry residues of stripes or dot-like red paintings (Saier, 1994; Conard & Floss, 2001) (Fig. 11). Gustav Riek (1934) mentioned a minimum of five limestone pieces with ochre traces and paintings from Vogelherd Cave in the Lone Valley, which date to the Magdalenian (cf. Hahn, 1986). However, the most significant comparative finds for the Hohle Fels pieces are those from the Magdalenian layers of the Mittlere Klause and Obere Klause Caves in the Altmühl Valley near Kelheim in Bavaria (Obermaier, 1914; Freund, 1963; Kaulich, 1994; Huber & Floss, 2014) where a minimum of five painted stones with dot rows and residues of paints are known (Huber & Floss, 2014; Floss et al., 2015). The most similar artifact from Obere Klause is 16 cm long and bears three double rows of seven red dots (Fig. 12). The color of the pigments and the arrangement of dots show striking similarities with the pieces from Hohle Fels. The similarities indicate common artistic traditions held by groups over a distance of more than 200 km along the Danube River. Further supporting this connection, Bavarian chert found at Hohle Fels was imported from the same region (Burkert & Floss, 2005; Taller, 2014).

From the Kleine Scheuer in the Lone Valley, a red painted pebble was found associated with the rodent layer in 1923 (Soergel-Rieth, 2011) (Fig. 13). However, the precise temporal assignment to the Magdalenian or Azilian remains unclear. The find is about 10 cm long and carries four fine double rows of red ochre, each composed of rows of dots.

Figure 11. Hohle Fels, painted chalk stone from J. Hahn's excavations. Photo: H. Jensen, Univ. Tübingen.

Figure 12. Obere Klause (Bavaria), painted limestone, found 1912. Photo: Prähistorische Staatssammlung, München, modified.

Figure 13. Kleine Scheuer (Lone Valley), painted pebble, found 1923. Photo: H. Jensen, Univ. Tübingen.

Stylistically, this piece dates to the so-called “Azilian” at the transitional phase between the Pleistocene and the Holocene (e.g., Thévenin, 1989). The artifacts assigned to this period are found mainly in eastern France and western Switzerland. Abstract signs and patterns are characteristic of this period, and the finds often show point and dot designs, which demonstrate both the longevity of this motif and its eastward extent into the Swabian Jura. The painted pebble from Kleine Scheuer shows similarities to painted pebbles of the French sites Rochedane and Le Mas d’Azil, as well as the Swiss cave Birseck-Ermitage, where 273 intentionally shattered fragments of red painted cobbles were found (Floss et al., 2009).

During the Magdalenian, dots are a well-known motif in the abundant cave art sites throughout France and Spain, such as Niaux (France) or El Castillo (Spain) (e.g., Clottes, 1995). However, in Central Europe this motif first appears on the painted stones from Hohle Fels Cave. Currently, we see no convincing evidence for cave art in the Swabian Jura. Thus, we are convinced that these objects from the Magdalenian of the Swabian Jura can be best described as portable art. The cave walls deteriorated during the Upper Paleolithic, and pieces broke off due to fluctuating climatic conditions. Frequent freezing and thawing cycles likely explain why most of the artistic artifacts, such as finds from the Mittlere and Obere Klause Caves in Bavaria,

are described as portable art; they are no longer attached to the cave wall. We do not rule out cave art categorically, but argue that the artifacts presented do not so far provide clear evidence for parietal art in this region. The dot row motif seems to have had particular importance during the Magdalenian, yet there is no way to establish the type of information people shared with these geometric signs. It could have perhaps operated as a notational system, or simply an attractive decorative pattern.

The Upper Paleolithic inhabitants of the Swabian Caves possessed detailed knowledge about how to acquire pigments and create artistic works. The evidence for this tradition of painting is apparent in the assemblage of decorated limestone pieces. The geological setting of the Swabian Jura indicates that there is an abundance of clays and sediments rich in iron oxide in the region. These sources could have provided hematite and other red earth minerals. Previous research on the late Neolithic in the surrounding area describes a knowledge of hematite and iron ore mines that was routinely extracted and used (Schreg et al., 2009, p. 321). In the Upper Paleolithic layers at Hohle Fels, many red minerals and hematite pieces were found (for a discussion about the meaning of the red color see Floss & Ostheider, 2013). Some of these ochre pieces display evidence of pigment extraction and extensive anthropogenic modification. These observations, along with the presence of artifacts with traces of red ochre from the Magdalenian of Hohle Fels, suggest that ancient populations in the Swabian Jura were knowledgeable about the mineral landscape and either extracted earth pigments from local spots or actively exchange materials from distant regions.

Ochre is a universal material that serves a variety of different applications. Therefore, interpretations of symbolic and ritual display, as well as possible utilitarian or functional uses might both be correct, depending on the particular circumstance in the past. In the case of the painted limestone fragments, a symbolic or at least decorative intent seems clear. It is likely that red ochre was also used for other applications during the Upper Paleolithic of the Swabian Jura, applications such as body painting, decoration of clothes, or various cosmetic purposes. Even though the original meaning of the Magdalenian painted stones remains obscure, the finds nevertheless stand at the beginning of a long tradition of painting with earth pigments in Central Europe.

In principle, the theoretical discussion as well as the experimental work concerning the different use of ochre during the MSA is much more advanced than it is for the Upper Paleolithic time period. This is surprising, given that ochre appears at some of the earliest Upper Paleolithic sites in Europe associated with anatomically modern humans as well as at some earlier Middle Paleolithic sites ascribed to Neanderthals. Taking the existing evidence in summation, the majority of research on ochre use in European contexts already assumes its symbolic role without proper investigation into the variety of contexts in which ochre is found, its association with other artifacts, and the range of cultural roles this single archeological material could have filled. Furthermore, little experimentation has been done on ochre use in the European Paleolithic compared to African MSA contexts. These discussions and previously conducted research on ochre use in the MSA could be used as a benchmark upon which to explore ochre use during the Upper Paleolithic in Europe. Exploring the range of uses for this material type could greatly alter and benefit the archaeological discourse surrounding the earliest onset of symbolic behaviors in the European Upper Paleolithic.

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