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THE CAVE ART OF MLADEÈ CAVE, CZECH REPUBLIC

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Abstract. Mladeè Cave is known primarily as a site that yielded a series of Early Aurignacian human remains combining archaic and modern characteristics, which contradict the ‘replacement hypothesis’. The cave also contains a series of red pigment wall markings, whose possible Pleistocene age has been speculated about. Here, the results of a survey and investigation of these markings, including a digitised colorimetric analysis of them, are presented. The complex exploration history of the site for well over a century is considered and it is concluded that the rock art is largely, if not entirely, modern.

Despite its considerable importance to Palaeolithic studies of Europe, the archaeology of Mladeè Cave, one of the key sites of central Europe, has never been the subject of a comprehensive publication. Here I will only very briefly review the history of the site’s research and then consider in detail a series of pigment markings on the walls of the cave. The site is located in the scarp of Tøesín Hill, immediately to the north of the village Mladeè, in the upper valley of the Morava, 22 km from the town Olomouc (north-east of Brno). The cave has been subjected to extensive excavations for over 120 years, with only a fraction of the substantial sediment filling now remaining. Formed by solution and water action initially, the cave is an extensive system with several spacious halls and many hundreds of metres of galleries. A substantial building has been erected contiguous to its entrance, housing guides’ and visitors’ facilities and a small museum. The visitor now walks directly from this building into the cave, negotiating passages on wide concrete paths and stairs.

As a result of the excavations commenced by J. Szombathy in 1881 and continued by numerous others, as well as due to the removal of cave fill (which is still continuing) to facilitate the passage of visitors, the floor of the cave is now considerably lower in most parts of the cave. Flowstone formations are not particularly luxuriant and most are inactive now. The ochre markings described here occur in various parts of the cave, as do numerous 19th and 20th century inscriptions, but the majority of the red pigment motifs occurs in a small area about 30 m from the artificial entrance.

History of research

The first group of documented archaeological materials in Mladeè Cave originates from J. Szombathy’s second digging season in 1882. The centre of space *D* (‘Dome of the Dead’, see Fig. 1) yielded in the upper part of the sediments twenty-two perforated animal teeth, a long bone point, several fragments of points or awls and a utilised

lower jaw of *Ursus spelaeus* (Szombathy 1925: 8, Figs 5, 6–9). A small cave, just a few metres deep and about 30 m west of the current entrance of the main cave, contained several bone tools and a few undiagnostic chert artefacts. The finds in the main cave were mixed with bones of reindeer and *Bos* or *Bison*, and with human skeletal fragments. The palaeoanthropological finds discovered in the previous year at points *a* and *b* had apparently not been accompanied by any artefacts. Five almost complete bone points were submitted to the Moravian Museum along with the collection of Jan Knies. It is very difficult to establish the exact locations where they were found. Knies concentrated on studying the area adjoining the debris cone between sites *D* and *E* (see Knies’ research diary IV; Szombathy 1925: 9), but there is no mention of the finds of bone points in his records. Perhaps he did not acquire them during his own excavations, but obtained them from some of the local people.

In 1904 a small quarry was opened west of the entrance to the cave (site *P* in Szombathy’s 1925 plan) and the sediments with the archaeological material of the collapsed portal of the small horizontal passage were removed without informing any of the archaeologists (Knies 1906; Maška 1905; Smyèka 1907: 114). Besides important anthropological and palaeontological material, some lithics were saved, while others, without doubt, were lost. Knies reports that there were scattered and trampled bones along the road leading to the top of the Tøesín Hill at that time. He later also mentioned that for some time, phosphate loam was quarried at the site (Knies 1928) and it can be presumed that during this operation numerous finds may have been destroyed.

In 1911, the area became the property of the Museum Society in Litovel, a turning point in the history of the research of Mladeè Cave. The Society cleared the sediments from all areas forming part of the route now used by visitors. Until 1922, little is known about these clearing operations. In 1922, a group of amateur researchers (J. Fürst, E.

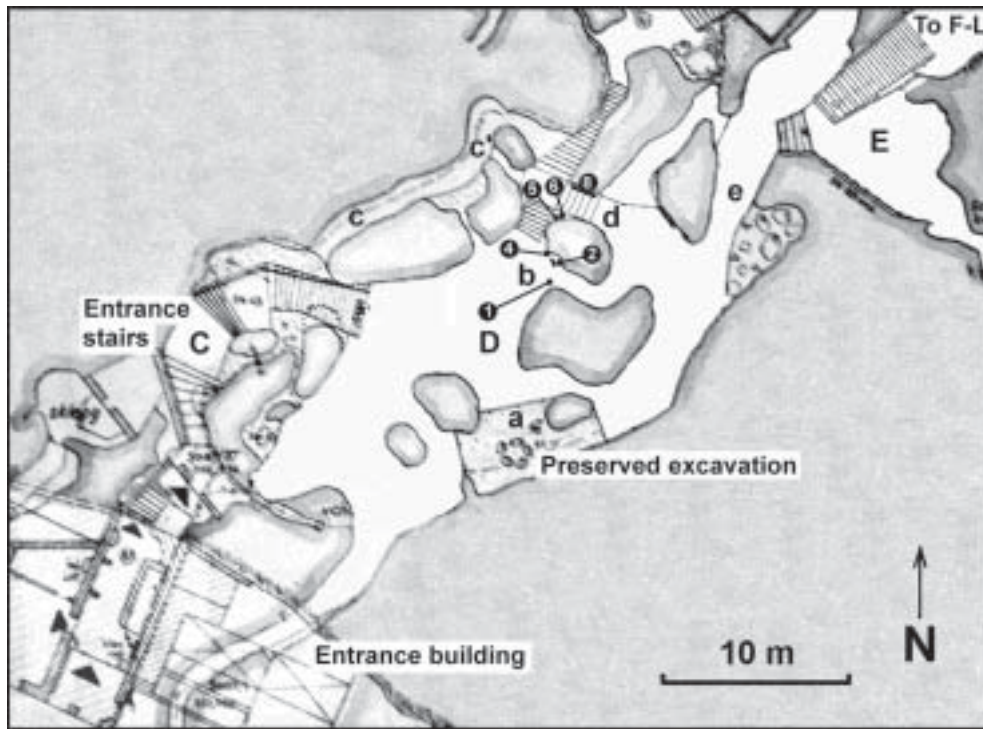


Figure 1. Map of Mladeč Cave, showing the location of the main concentration of pictograms; only spaces C–E are shown, numbers indicate motif locations, locations a to e after Szombathy (1925: Fig. 1).

Smékal, H. Rohm and others) dug their way to the surface beneath the big debris cone near the point *e* and found there a great concentration of animal and human bones. On the basis of the incomplete and fragmentary records made by the participants of these excavations (Fürst 1922, 1923–24; Smyčka 1922, 1925) it is impossible to locate exactly the site where the human remains were found, except for the approximate indications in Szombathy's plan (1925: Fig. 1, points *a–e*, also shown in Fig. 1 here). H. Rohm, one of the participants of the excavation, marked the site of the find in a sketch of the cave system (Rohm in Weiser 1928: 281, Point 3), in line with the report by Szombathy who located it at point *e*. It follows from the above records that the human bones were discovered in the corridor between Szombathy's dome *D* and *E*, near the debris cone. Szombathy (1925: 10) informs us about the discovery of two 'fireplaces', at least one of them with a thin layer of charcoal, and lined with a circle of stones. Its discoverers speak of a 'stone hearth' (Fürst 1923–24; Smyčka 1925). Around it, at the same level, were said to be numerous crushed animal and human bones and several stones. Another 'fireplace' was situated somewhat closer to the surface and was closer to the debris cone. Large quantities of animal bones were found north-west of the presumed but unconfirmed fireplaces. Most of these finds are non-fragmented skeletal remains of *Bos* or *Bison*, with a very low degree of mineralisation, related to similar finds by Szombathy at point *d*. All these finds come from the upper layers of the trench, roughly one metre thick. The trench reached down to the depth of two metres, and the sediments beneath the finds were removed. The lower layers probably also contained Middle Pleistocene fauna. J. Smyčka (1922: 118) mentions numerous finds of molluscs

and 'backbones of small animals', probably snake remains from the lower layers. There is no doubt that a large number of bones and artefacts were pillaged, unlawfully appropriated by visitors (e.g. the Moravian Museum acquired in 1935 a collection of worked bones from M. Charvát from Tøbejë), and later numerous items from the collection of the Litovel Museum were lost (e.g. lithics and all bones published by Szombathy 1925: Fig. 9). Unclear is also the further fate of fifty-one fragments of 'bone awls' (?) from the old exposition near the cave (cf. Skutil 1938: Note 76).

In the following years no important discoveries occurred in the cave; only J. Skutil (1938: Note 77) mentions that J. Novotný found a blade core below the chimney. Skutil himself discovered apparent Aurignacian stone tools in the loess-loam of the second entrance (Skutil 1938: 32, Fig. 60). The excavations organised by the Moravian Museum from 1958 to 1961 did not lead to the discovery of further traces of an Upper Palaeolithic settlement and resulted in the view that the cave was not accessible to Late Pleistocene humans, and that all remains relating to them fell in or were thrown in through the chimney (see below).

On 20 August 1981 Martin Oliva and Pøemysl Ryšavý visited Mladeč Cave to examine the prospects of a possible continuation of research. On that occasion Oliva noticed several ochre-coloured marks on the walls of the 'Dome of the Dead' *D* as well as in other locations. So far, only preliminary comments have been published on these observations (Oliva 1987, 1989). On 6 November 2003 I examined and recorded the pigment marks under the guidance of M. Oliva and my findings are presented below. More recently, Wild et al. (2005) presented a series of dates derived from five of the hominin remains, Mladeč 1, 2, 8, 9a and 25c. Their carbon isotope ages range from about

26 330 BP (the ulna of 25c) to 31 500 BP. It is therefore doubtful that the humans represent a typical population relating to the Aurignacian tool tradition, as had been assumed for over a century. Most of them are more likely of the Gravettian, and chronologically as well as physically perhaps relatable to the populations from Pavlov Hill and Pøedmostí, or only marginally older than the finds from Dolní Vstonice. Since they are intermediate between robusts (such as the so-called Neanderthals) and graciles, and of distinct sexual dimorphism, they provide no support for the replacement hypothesis (Bednarik 2006).

It needs to be emphasised that all of the current palaeo-anthropological, cultural and technological evidence of the period from c. 40 000 to c. 25 000 years BP repudiates the replacement hypothesis utterly. Not only is there no sound evidence separating the robusts from the graciles — in Europe, Africa, Asia or Australia — there is a gradual decrease in robusticity in four continents during the second half of the Late Pleistocene, and continuing throughout the Holocene. Modern Europeans most certainly descend from what has simplistically been called ‘Neanderthals’, and the so-called Aurignacian is essentially a tool tradition of robusts, or Neanderthal-like people. That includes in all probability ‘Aurignacian’ rock art and portable art. This, of course, is the precise opposite of what archaeologists have believed until now (see Lecture 2 of Bednarik 2006).

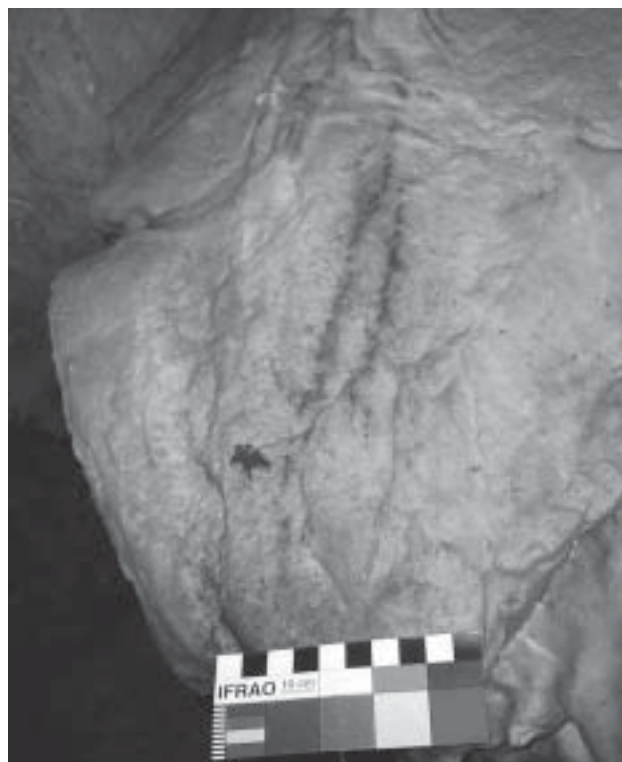


Figure 2. Motif No. 1.

The pigment markings

Most of the pigment wall markings are clustered in a small area in Dome D (Dóm mrtvých, the ‘Dome of the Dead’), at Szombathy’s locations *b* and *d*. They are without exception well over two metres above the present floor, but from indications such as remains of flowstone rims the former sediment levels can be reconstructed. On that basis it appears that the markings may have been executed approximately at eye level above the maximal sediment height. The following numbering of motifs commences at *b* and then proceeds around the western side of the column separating it from *d*. Thus the first group of markings occur within a few metres of each other (Fig. 1). The columns consist of bedrock and are partially covered by reprecipitated calcite formations, including speleothem deposits of low-relief ‘pearly flowstone’. Such deposits are typically only one or two centimetres thick and they have locally exfoliated, especially on prominent surface features. The morphology of the exfoliation scars suggests that frost action could account for this damage. Some of the scars present very minor subsequent calcite growth, typically under 1 mm thick.

Motif No. 1

This marking was executed on such an exfoliation scar, about 2.3 m above the present concrete floor, just above a rock edge on which one calcite straw formation remains still active. It is located immediately to the right of the entrance into a short passage through the column, and well visible. It consists of two slightly curved lines of red pigment, both drawn from the top downwards. The left stroke is 20.5 cm long, with interruptions; the right measures 13.5

cm (Fig. 2). Both lines have experienced considerable diffusion from subsequent surface migration of pigment through moisture. The two lines run sub-parallel most of their course, 15 mm to 20 mm apart, but they are slightly curved to almost join near the top. Minor recesses in the surface caused the several interruptions in their course, and each mark was only drawn once.

The lines appear to have been drawn with dry pigment powder, but they are so diffuse now that this is uncertain. Under magnification, mass residues of the red pigment still remain locally, but most of the colouration consists merely of microscopic particles lodged in the porous ‘dead’ flowstone.

Motif No. 2

This marking also consists of two lines, which in this case are joined at the lower end. It is located about 1.5 m north of No. 1, i.e. on the left of the passage entrance, about 2.35 m above the concrete floor. It occurs almost immediately above of the plaque inscribed ‘DILUV. MÁLEZ - Dra FÜRSTA - 1922’ (which is wrongly placed here). The right-hand stroke is 17 cm long, the left is slightly shorter and near vertical, and the two are splayed 22 mm at the top. Both lines are straight (Fig. 3). The motif occurs on a thin veneer of reprecipitated calcite, but has no subsequent coating of such material. The support surface has distinctive pockmarks of water solution, 5–8 mm in size and oval to circular in shape, distributed over its surface. These solution pits clearly predate the pigment application.

Like the first motif, this also may have been drawn with dry pigment, which is now partially removed by water flow. At present the wall is almost entirely dry. There are three



Figure 3. Motif No. 2.

parallel cut marks occasioned with a metal tool near the upper end of the left line, 3.7 mm to 5.3 mm long, where someone has apparently probed the degree of pigment penetration. It is evident from these cuts that the pigment has not penetrated at all; it has remained restricted to the uppermost 30 to 40 microns of the calcite deposit. Where pigment remains in bulk, in isolated small patches, these are of much darker colour than the thin film elsewhere.

Motif No. 3

Between motifs 2 and 4, 2.4 m above the present floor, are two faint patches of reddish pigment, well recognisable only over one or two centimetres length. This pigment is poorly bonded to the rock surface, and appears rather as if ochre-covered fingers had incidentally touched the wall. The colour of these small patches is more towards a pink hue than the other motifs, but most certainly these small patches are also anthropic, and are not a natural form of deposit or discolouring. A sample of the pigment taken from motif No. 3 was subjected to semi-quantitative analysis (performed by V. Selucká). The analysis revealed spectral lines of Fe and Cu, and smaller components of Si, Mg and Ca.

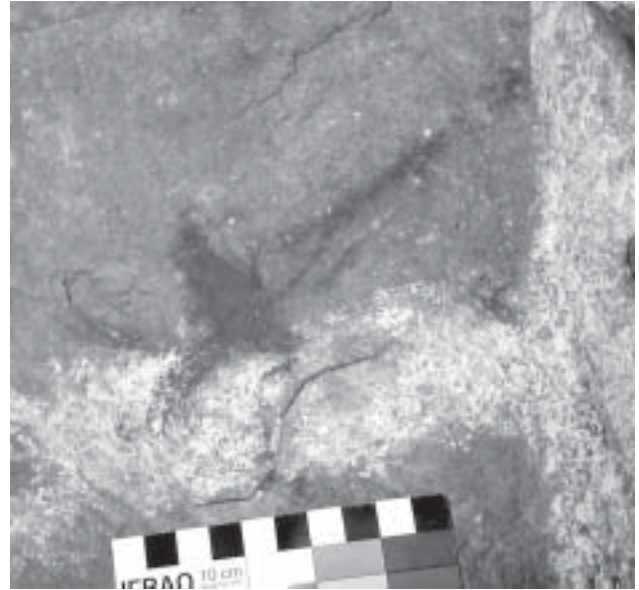


Figure 4. Motif No. 4.

Motif No. 4

This marking is just under a metre to the left of No. 2 and 2.5 m above the floor. Like the previous motifs, it would have been approximately 1.5 m above the floor level before excavation. It is, however, on the brown weathered primary rock and is much better preserved than the previous marks. There is no smudging from later moisture, the pigment is preserved well in bulk and has remained intact in situ, and the motif looks therefore 'younger'. However, under magnification it is apparent that the pigment is also weathered, but has not experienced water transport and smudging. The difference in appearance is probably attributable to location and moisture effects, and the same pigment could have been involved as in the previous marks. This motif has roughly the shape of a cross and is partly executed over a formation of fluffy white calcite, a very thin and dry form of 'moonmilk' speleothem that has subsequently experienced some minor exfoliation, but still before the red pigment was applied. There is none of the white growth superimposed over the red pigment, although superficially it might appear so in one location.

Motif No. 4 is 15.5 cm long, and the short thick mark crossing the long line is about 5.5 cm long (Fig. 4). However, there are distinctive traces extending for several centimetres from the lower ends of both marks, as if they had been executed somewhat carelessly. In the case of this motif, application of the pigment in wet condition seems more likely. The longer mark may well consist of two separate applications of paint, and it appears that these were with a finger dipped in coarse-grained paint of poor bonding qualities. This is implied by the distribution of pigment in cross-section, with most paint retained along the margins of contact.

Motif No. 5

About 1.5 m further to the left (north), on the NW corner of the column and above the stair, facing west, are two further motifs, one above the other. The upper one is des-



Figure 5. Motif No. 5.

ignated No. 5 here. It consists of six roughly vertical, sub-parallel lines clearly forming a set, beginning about 15 cm from the prominent vertical rock ridge (Fig. 5). Although this motif is of greater absolute height and now hard to reach, it was located only about 1.7 m above the floor before excavation. The first, very discontinuous line on the left is separated from the others by several centimetres, whereas the rest of the set is spaced more closely. Lines 2, 3, 4 and 6 are fairly evenly spaced and range from 12 cm to 14 cm, the longest being the third line. Line 5 is much shorter at about 5 cm, and does not conform to the prevalent spacing. The motif has been subjected to moisture damage, as indicated by the surface migration of pigment and by the yellow discolouration of the primary limestone near the pigment from diffused pigment.

Motif No. 6

This is located approximately 35 cm below motif No. 5, but commencing immediately at the prominent rock ridge extending downwards. Pigment traces extend at least 30 cm from the edge to the right horizontally, to just below a heavily corroded iron peg firmly lodged in a rock crack. Vertically the motif extends at least 25 cm, possibly more, but there is a dark 12-cm-long soot stain over the lower part, probably caused by a candle or torch (perhaps related to the iron peg). The motif comprised a horizontally meandering line and a few indistinct colour patches. A meaningful arrangement is not apparent in the configuration of the paint residues.

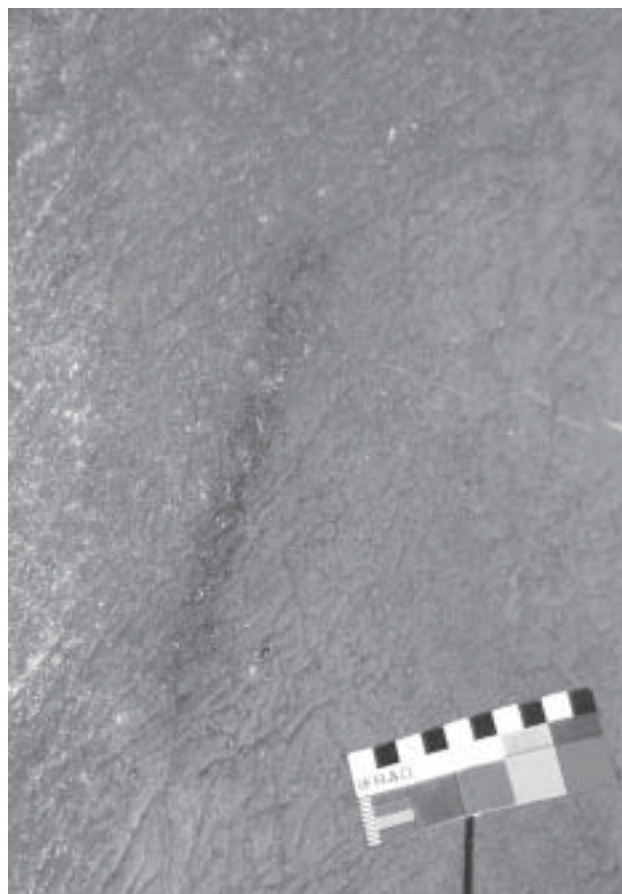


Figure 6. Motif No. 9.

Motif No. 7

This group comprises some unclear parallel vertical lines, c. 15 cm long, approximately 3.5 m above the stairs between *c'*/*F* to *E* on the Szombathy's plan. The very faint markings are located about 4 m from motifs 5 and 6 and their anthropogenic status is uncertain.

Motif No. 8

On the wall north of point 'd' on Szombathy's plan, opposite the column bearing most of the motifs so far considered, occurs a roughly horizontal stripe of about 2–3 cm width. The marking continues with interruptions, particularly a large gap in its left part where it crosses an erosion furrow, over a length of c. 2.5 m. There is also a section where it is concealed over several centimetres by a very thin greyish mineral deposit washed down from above. The colour of this marking averages R54, G30, B15, and is thus brownish rather than red. Below the line occur some faint stains of the same colour. Unfortunately we could not examine the marking closely, it is about 3.5 m above the stairs connecting *c'* and *d* and of difficult access because of the stairs. The first impression is that it is a natural colouration in the rock, but I tend to favour an anthropic origin, because of the way it avoids recesses in the wall surface and due to aspects of its point of commencement on the left end.

Motif No. 9

This is a single red line on the eastern wall of the pas-



Figure 7. Motif No. 12.

sageway from Dome *E* to the Panenská jeskyn ('Virgin Cave', north-east of the cave portion shown in Fig. 1), 19 cm long and 15 mm wide. It appears to have been drawn with a finger (Fig. 6). It is aligned at about 15° from the vertical. The mark occurs on a coarsely textured but thin veneer of flowstone. It has experienced some water damage, as evidenced by colour diffusion in its immediate vicinity, but on the whole it is well preserved. The motif is now located about 3 m above the floor, but is only 60 cm above a rim of reprecipitated calcite that may indicate the top of the former sediment deposit.

Motif No. 10

Several blurred ochre blotches occur on smooth flowstone to the right of the passageway from Dome *E* to the Panenská Cave, under an overhanging rock. These markings, about 1.4 m above the present floor, are probably of natural origin, however.

Motif No. 11

Several indistinct, vertically blurred ochre blotches also occur in a newly discovered part of the cave system, called Netopýří Cave. This is located south of area *H* in Szombathy's plan, above the eastern lateral room. The wall markings are about 3 m high above the ground and their anthropic origin is uncertain.

Motif No. 12

Much deeper into the cave system, to the east of area *K* in Szombathy's plan, above the stairs leading to the Nová (New) Cave occurs a compact group of blotches and lines, now 4–5 m above the floor. This motif, sometimes called the 'hedgehog', is between 30 cm and 40 cm long but could not be measured or closely examined due to its height on the wall (Fig. 7). It was executed over an area of comparatively luxuriant flowstone formations, here of a distinctive, vertically rippled morphology. This deposit remains very reflective and seems to be still partly 'active', yet subsequent precipitation of calcite over the paint remains appears to be absent. Because of the continuing presence of moisture there has been particularly extensive diffusion of pigment, perhaps giving what was a simple grouping of a horizontal line and several short strokes the appearance of a more complex motif.

Motifs Nos 13-16

Before the locality of motif No. 12 is reached, east of site *J*, there is a panel densely covered by several inscriptions immediately next to the present walkway. These markings seem to be mostly or entirely of the 19th century and are predominantly in pencil and charcoal. The panel bears also four red pigment marks, however, whose smudging by moisture matches very well what is observed in the most weathered of the previous motifs. The same diffusion of pigment is evident, as is the yellowing of the surrounding rock over a distance averaging about 10 mm. In fact it is even more pronounced on a motif that appears to be a letter 'D', where the smudging reaches up to 25 mm from the actual motif.

The upper right motif is a capital 'D' executed in the slightly ornate cursive style of the period, and two of the remaining figures are somewhat misshapen copies of this letter, of a similar style but less readily decipherable (Fig. 8). The remaining figure, immediately adjacent to the lower D-figure, is a flattened or distorted circle, but may well be an attempt to render the letter 'O'. All four motifs appear to have been made with dry or semi-dry powdered pigment and all are evidently the result of single applications.

Discussion of the site's archaeology

The question of the age of the marks remains open to debate, and there is not even any obvious indication that they necessarily need to be all of the same period. Some of the pigment markings occur on the weathered primary rock (notably No. 4), most others are found on cutaneous deposits of reprecipitated calcite (flowstone). When illuminated by ultraviolet light, recent flowstone deposits emit a distinct glow, whereas the older, long 'dead' speleothems appear black, as does the pigment and the cave loam. Most of the markings are today far above the floor and they are likely to relate to the significantly higher floor level before excavations began in 1881. Markings 1 to 6 and 8 all occur above locations where human skulls were recovered in 1882.

It cannot be regarded as certain that Pleistocene humans ever entered the cave system. While most of the early

researchers assumed that the cave was a habitation site, J. Smyčka, who visited the diggings occasionally, advocates the opinion that the human remains were dropped into the caves through a chimney, perhaps as part of a ritual (Smyčka 1922: 118–9). Following the excavations by the Moravian Museum from 1958 to 1961 the view developed that the cave was not accessible to humans during the Würm Glacial, and that all Upper Pleistocene sediments had fallen in or been washed down from the surface of Tøesín Hill above, particularly through the chimney over the Middle Pleistocene debris cone. The evidence supporting this opinion was summarised by J. Jelínek (1987) and followed up by J. Svoboda (2000, 2001). In this they were guided by their reconstruction of the former sediment strata and by a comparison with the locality Konìpruské jeskynì (Zlatý Kùd) in the Bohemian Karst, where similar circumstances pertain. The paucity of stone implements in the entire cave (except J. Skutil's two specimens of 1937 in the opened up entrance) is conspicuous. While this could be attributable to the use of the cave primarily as a funerary site, this seems contradicted by the interpretation of the animal remains as being of anthropic origin. At least a substantial portion of the animal bones has been assumed to have entered the site through gravity, and the inability of the Moravian Museum team to find any human occupation evidence is attributable either to its absence, or to its complete removal by previous investigators.

The opposite view, held by M. Oliva, is that there was no connection between the south-eastern projection of Dome *D* (with the find of a human skull near point *a*) and space *E* below the chimney in Szombathy's original floor plan. Considering the absence of any significant fluvial transport, the translocation of sediments containing finds from the talus to the spaces 20 m away would imply a considerable slope. Before the investigations began, a horizontal course of loamy sediments without any larger clasts was noted in the vicinity of point *a* in the Dome of the Dead. Smyčka (1925) reported that the remains found in 1922 lay four metres deeper (in a 'lower storey') than those from 1881–1882. Also, Szombathy's observations indicate that the slope necessary for the transport of sediments was directed elsewhere: the deepest point in Dome *E* below the chimney was in the middle of the space, not in the direction towards the Dome of the Dead. However, the vertical

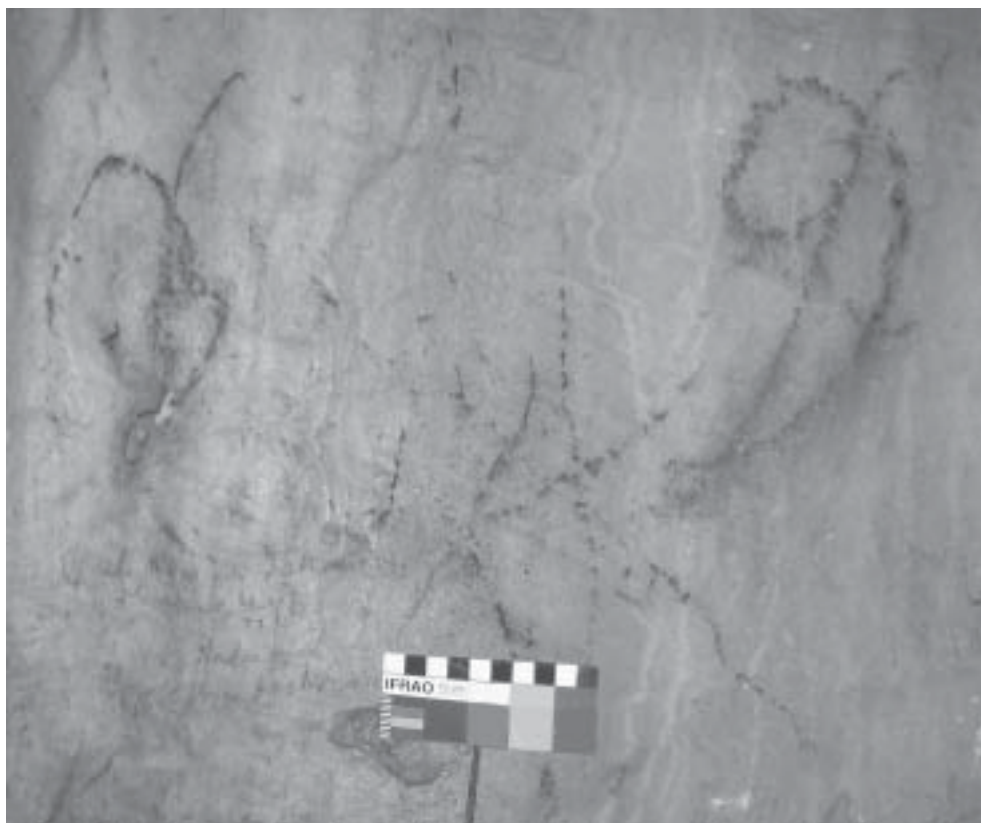


Figure 8. Motifs Nos 13 and 14 (see colour version of this image on back cover).

fissure or small chasm mentioned by Knies and containing reindeer bones was situated in that very direction (towards point *a*). Between the foot of the debris cone and the chimney wall was a crevice that contained mostly bones of microfauna — above all, abundant skeletons of snakes — and molluscs. Snake remains, however, appear to be typical of the Lower or Middle Pleistocene fauna in Mladeč Cave. Bones of bovids, predominating in the finds from 1922–1923, were altogether missing in the debris cone. These remains are thus thought by Oliva not to have entered through the chimney.

This interpretation is based on several assumptions, and it must also be remembered that most large cave systems of this type, barring entry to large species, are nevertheless frequented by small scavengers. This can include caves with vertical shaft entries (Bednarik 1991). The course of the surface of the sediments as reconstructed by Svoboda can perhaps not be conclusively established in all cases, but it is probably correct in a general sense. The dating obtained from the reprecipitated calcite on the wall 7 m westwards from point *a* (about 34 000 years BP) and for some time assumed to refer to the human remains is not relevant to them, being over 8000 years too high (Svoboda et al. 2002; cf. also Wild et al. 2004). The thickness of the layer may not decrease in the direction away from the chimney, except in space *E*. According to Szombathy, it was 50 cm deep in the western part of the Dome of the Dead (i.e. in the most distant place); 60 cm in the middle of the Dome and at point *a* (with the finds being only found 20–30 cm deep); and at point *d*, lying nearest to the chimney, bovid

bones were found almost on the very surface. In contrast to uniformly distributed sediments, archaeological finds show a conspicuously unequal distribution. In the Dome of the Dead they occurred only in the middle of the space roughly 20 m³ in area, and that only in the upper half of the layer containing the bones. The perforated animal teeth are probably from a single necklace, and the needles from point *e* beneath the chimney were deposited in a single group, as indicated by the specimens still connected with flowstone. Both circumstances could support entry via the chimney. Human skulls from point *b* were accompanied by an almost complete selection of reindeer bones from a single individual. Concerning the charcoal Szombathy reports, it is contradicted by Maška's identification as manganese precipitate. Besides, the presence of charcoal in the sediment does of course not demonstrate human habitation.

Since it must remain uncertain that the cave was accessible to humans in the Late Pleistocene, the question of the age of the paint marks cannot be resolved through the site's archaeology. A far more useful indicator are contextual issues, notably the height of the motifs above the former floor level and their chronological relationship with specific speleomorphological features. The uppermost former floor can easily be established where the most recent flowstone sheets curl out from the vertical wall, indicating that there was considerable flowstone deposition after the maximum sediment level had been reached, and that the flowstone sheet continued out from the walls and extended over the floor in many locations. Clearly, any Palaeolithic material must have been beneath this deposit, and in some cases at least would have been well below the flowstone floor. Yet all pigment markings physically related to the last phase of calcite precipitation certainly postdate that event, and do so by a considerable time span. Moreover, at least in some cases the markings can be assumed to have been well beyond a person's reach at the lower Final Pleistocene floor level.

Close examination of the speleothem sequence, especially at the locations of motifs Nos 1 and 2, established the following detailed chronological sequence:

1. Period of sediment deposition and formation of possible occupation floors.
2. Formation of flowstone speleothems and pearly flowstone sheets on walls and, locally, on floors.
3. Cessation of flowstone growth, followed by localised exfoliation of the flowstone sheets, perhaps as a result of frost spalling.
4. Local pitting of the flowstone by water solution, on both original surfaces and on exfoliation scars.
5. In some cases, formation of thin white fluffy speleothem (<1 mm thick) follows this development.
6. Application of red pigment.
7. Weathering of this pigment and its diffusion by minor exposure to moisture.

On this basis, the evidence of the purported Aurignacian or Gravettian occupation of the site is in a spatio-chronological sense very widely separated from the production of the red paint marks, which appear to be significantly younger. Their condition of preservation is very similar to

those of motifs Nos 13 to 16, with the same diffusion of pigment and yellowing of the rock surface within about 10 mm of the paint residues. Nos 13 to 16 are clearly of 19th century origin, and may well have been made by Szombathy's work crew. With one exception, the motifs all postdate any speleothem activity they can spatially be related to, and they were certainly executed well after the cessation of flowstone deposition. Only motif No. 8 is over several centimetres covered by a very thin mineral stain (presumably calcite or aragonite), which could have formed in a few decades. The distinctive presence of copper in the pigment of No. 3 also points to a modern substance, as this is usually not present in pre-Historic paint residues. The best preserved of the sixteen motifs is No. 4, the one clear from any flowstone deposit. The fairly uniform preservation of all others might imply a similar age to that of Nos 13 to 16. To investigate the variability of the pigment more closely I attempted detailed colorimetric analysis of all motifs that provided adequate data.

Colorimetry of the Mladeč Cave pictograms

The methodology used in this study follows on from earlier colorimetric analyses of rock art (Bednarik 2002; Bednarik and Khan 2005) and uses the same standardised methodology. Colour-calibrated high-resolution digital photographs were taken of all twelve motifs that offered adequate pigment remains. The IFRAO Standard Scale was used as the dedicated device profile. Among many images collected, the most suitable was then selected in each case, as determined by colour fidelity of the calibration device in the image and other photographic factors (particularly resolution). This selected image was in each case colour corrected by the standard procedure (colour re-constitution; Bednarik and Seshadri 1995), using Adobe Photoshop CS2.

Next, each of the chosen images was enlarged to the available limit, and carefully scanned to establish the type and range of colour variation present within the heavily pigmented areas. In selecting suitable sampling sites, degraded pigment was avoided and test readings were taken in various parts of the object area to establish the broad ranges present. Typically areas of smallest variation located in the medium range of the spectrum were then selected and marked with square black surrounds of one pixel width, each containing thirty-six pixels. In each of the twelve motifs sampled, two sampling sites (A and B) were in this way determined. Depending on resolution and focal length, the sizes of the square sampling sites were typically under one millimetre. The RGB values of each pixel in each aliquot were measured and tabulated, and the repeatability of selected readings was randomly ascertained. Therefore a total of 2592 individual colour determinations were made on the Mladeč Cave motifs. The mean values were subsequently determined from the resulting matrixes and their distribution is plotted in Figure 9. The range of the RGB means is tabulated in Table 1.

Several relevant points emerge from this quantified assessment of the colours of the Mladeč Cave pictograms:

- a. While in some samples the two individual readings A

Sample	R	G	B	%R	%G	%B
1A	127.72	34.28	6.17	76.2	20.2	3.6
1B	137.97	43.08	11.42	71.9	22.4	5.7
2A	133.42	30.42	3.61	79.7	18.6	1.7
2B	148.86	37.97	11.22	75.2	19.2	5.6
4A	115.75	41.56	9.61	69.3	24.9	5.8
4B	115.92	42.03	16.11	66.7	24.1	9.2
5A	184.53	74.47	38.14	62.1	25.1	12.8
5B	179.11	68.94	33.92	63.5	24.6	11.9
6A	189.19	87.44	16.58	64.5	29.9	5.6
6B	183.00	82.53	10.61	66.3	29.9	3.8
8A	193.39	105.78	49.11	55.5	30.4	14.1
8B	195.39	108.58	58.72	53.9	30.0	16.1
9A	113.28	26.72	7.67	76.7	18.1	5.2
9B	120.03	31.69	5.03	76.6	20.2	3.2
12A	167.03	74.53	24.42	62.8	28.0	9.2
12B	176.47	71.53	14.39	67.3	27.2	5.5
13A	116.75	49.42	24.11	61.4	26.0	12.6
13B	116.75	38.22	15.67	68.4	22.4	9.2
14A	109.94	36.83	16.06	67.5	22.7	9.8
14B	121.39	45.22	21.58	64.5	24.0	11.5
15A	157.86	41.19	20.92	71.8	18.7	9.5
15B	161.28	44.06	22.22	70.9	19.3	9.8
16A	97.11	29.81	18.42	66.8	20.5	12.7
16B	79.86	32.14	22.81	59.2	23.8	17.0

Table 1. The mean colour indices determined by the colorimetric analysis of twelve of the Mladeè Cave pictograms.

- and B are in close proximity in Cartesian colour space, the ranges are much greater in others, especially Nos 2, 13 and 16.
- In comparing samples Nos 13–16, which are clearly of the 19th or early 20th century, with the undated samples, it is apparent that the ranges of both groups overlap significantly. The only exception is motif No. 8, which is distinctly separated from all others.
 - Most of the samples show a statistically significant trend to limit variation mostly to the green spectrum, the exceptions being Nos 1, 9, 13 and 16. In all other samples, the 'green drift' is limited to less than 1.3%.

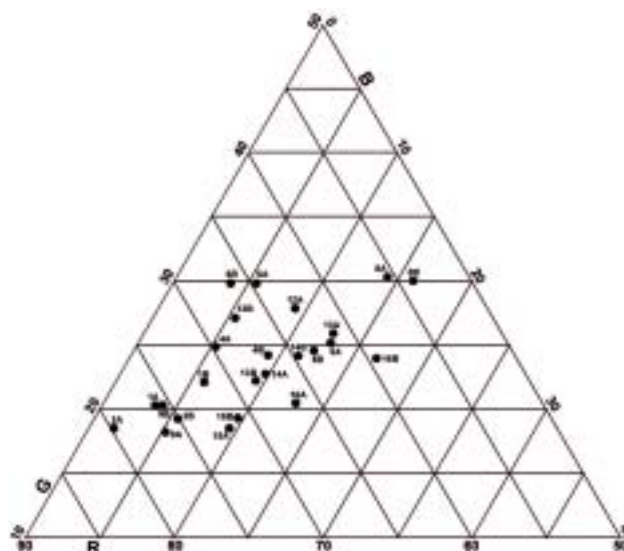


Figure 9. Position of all sampled motifs in Mladeè Cave in three-dimensional Cartesian colour space. Only a small part of the spectral ranges is depicted here for ease of illustration. For each sample, two aliquots (A and B) were determined.

- The samples on the lower left of the diagram (Fig. 9) are assumed to have been subjected to more leaching by moisture than those in the central area of the population. This applies especially to Nos 1, 2 and 9. If this were compensated for they would probably fall into the central region.
- The variation among all undated samples except No. 8 is very similar to that among the four dated samples, Nos 13–16.

Bearing in mind that variations need to be anticipated at different locations within the cave, due to the obvious leaching and hydration of pigment, it is apparent that colorimetry cannot effectively distinguish between the four dated samples and most of the others. They could well have been created with the very same pigment. Only one motif, No. 8, displays sufficient distinguishing characteristics to reasonably justify the suggestion that it may have been executed with a different colouring material. This proposition can be tested by quantitative chemical analyses of the colouring matter. Moreover, it is noteworthy that motif No. 8 is the only one that displays some very minor concealment by mineral accretion. It is therefore the only realistic contender for an age of greater than the 19th century, although a Pleistocene age is not likely. The remaining fifteen motifs I have described are more likely to relate to the activities of excavators and visitors during the early phase of the site's archaeological investigations.

Summary

This review of the archaeology of Mladeè Cave has shown that, due to its chequered research history, the interpretation of this hominin site remains in many respects unresolved. There can be no doubt about the importance of the human remains from this site, which are among those that have been interpreted as implying genetic continuity

between *Homo sapiens neanderthalensis* and *Homo sapiens sapiens*. Against this background of uncertainty, the status and antiquity of the cave's series of red pictograms must be considered on their own merits. This is what has been attempted here.

The recent age of at least four of the pictograms is considered to be beyond doubt. Most of the pigment markings have experienced diffusion through moisture, and this modification is no more pronounced in any of them than it is in the inscriptions. Colorimetric analysis confirms that the variation in colour seems to reflect local preservation conditions, and that most of the markings appear to be of the same pigment as the inscriptions. Moreover, all of the markings were apparently only accessible before the extensive excavation of the cave sediments commenced. Hence it is not likely that they were of ready access from the floor levels during the Göttweig stadial, the time of the presumed but not demonstrated Upper Palaeolithic occupation, except where there may have been no subsequent sedimentation. The prominent presence of copper noted in one marking is unexpected for Palaeolithic pigment, and none of the motifs is of a shape bringing to mind typical confirmed Upper Palaeolithic markings observed elsewhere in Europe. Most important of all, the spatial context of the pictograms within the related or nearby features and their chronology decisively excludes a Pleistocene antiquity. Rather, the markings could be location markers made by the early excavators. It is relevant that motifs Nos 1 to 6 plus 8, i.e. all except two of the clear and undated markings, are located above the area where the initial human remains were found, so perhaps they were intended to indicate their find spots.

While this may not conclusively exclude the possibility that any of the motifs could be of the Pleistocene, the probability of that is so minute that it can be disregarded. I recommend that all of the sixteen pictograms be analysed chemically, preferably with the use of a portable x-ray fluorescence probe (such as the Spectrace 9000 instrument), to establish their degree of similarity. While this procedure would be non-destructive, there should be no objection to destructive sampling. While the proof of two or more pigment sources would not resolve the issue, uniformity in chemical composition would conclusively eliminate any possibility that Pleistocene pictograms occur in this cave.

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REFERENCES

- BEDNARIK, R. G. 1991. On natural cave markings. *Helictite* 29(2): 27–41.
- BEDNARIK, R. G. 2002. The survival of the Murujuga (Burrup) petroglyphs. *Rock Art Research* 19: 29–40.
- BEDNARIK, R. G. 2006. Short-range versus long-range theories. Cognition and symbolism in human evolution, lecture 2. <http://www.chass.utoronto.ca/epc/srb/cyber/rbednarik2.pdf>
- BEDNARIK, R. G. and M. KHAN 2005. Scientific studies of Saudi Arabian rock art. *Rock Art Research* 22: 49–81.
- BEDNARIK, R. G. and K. SESHADRI 1995. Digital colour re-constitution in rock art photography. *Rock Art Research* 12: 42–51.
- FÜRST, J. 1922. Nové nálezy v Mladečských jeskyních. *Litovelské novinsky* 26 August.
- FÜRST, J. 1923–24. Nálezy v jeskyních Mladečských. *Vlastivedný sborník střední a severní Moravy* 2: 6–7.
- JELÍNEK, J. 1987. Historie, identifikace a význam mladečských antropologických nálezů z počátku mladého paleolitu. *Anthropos* 25: 51–69.
- KNIES, J. 1906. Nový nález diluviálního člověka u Mladeče na Moravě. *Vestník klubu přírodovědného v Proestjove* 7: 1–19.
- KNIES, J. 1928. K 100. výročí objevení Mladečských jeskyní. *Litovelský kraj* 5: 45–49.
- MAŠKA, K. J. 1905. Poznámky k diluviálním nálezům v jeskyních mladečských a stopám glaciálním na severovýchodní Moravě. *ĚMMZ* 5: 1–3.
- OLIVA, M. 1987. *Aurignacien na Moravě. Studie muzea kroměřížska*. Kroměříž.
- OLIVA, M. 1989. Mladopaleolitické nálezy z Mladečských jeskyní. *Acta Musei Moraviae* 74: 35–54.
- SKUTIL, J. 1938. *Praveké nálezy v Mladeči u Litovle na Moravě*. Litovel.
- SMYĚKA, J. 1907. Litovel a okolí za praveku. *Pravek* 3: 140–50.
- SMYĚKA, J. 1922. Nálezy diluviálního člověka v Mladeči u Litovle na Moravě. *Obzor prehistorický* 1: 111–20.
- SMYĚKA, J. 1925. Kdy přišel první člověk do litovelského kraje. *Vlastivedný sborník střední a severní Moravy III, pářloha Olomoucko a Litovelsko* 6–7.
- SVOBODA, J. 2000. The depositional context of the Early Upper Paleolithic human fossils of the Konprusy (Zlatý Kùò) and Mladeč Caves, Czech Republic. *Journal of Human Evolution* 38: 523–36.
- SVOBODA, J. 2001. Mladeč and other caves in the Middle Danube region: early modern humans, late Neandertals, and projectiles. *Les premiers hommes modernes de la Péninsule Ibérique. Actes du Colloque de la Commission VIII de l'UISPP*, pp. 45–60. Lisbon.
- SVOBODA, J., J. VAN DER PLICHT and V. KUŠELKA 2002. Upper Palaeolithic and Mesolithic human fossils from Moravia and Bohemia (Czech Republic): some new ¹⁴C dates. *Antiquity* 76: 957–62.
- SZOMBATHY, J. 1925. Die diluvialen Menschenreste aus der Fürst-Johanns-Höhle bei Lautsch in Mähren. *Die Eiszeit* 2: 1–34, 73–95.
- WILD, E. M., M. TESCHLER-NICOLA, W. KUTSCHERA, P. STEIER, E. TRINKAUS and W. WANER 2005. Direct dating of Early Upper Palaeolithic human remains from Mladeč. *Nature*, 19 May.
- WEISER, E. 1928. *Reise und Wanderbuch*, 2nd volume. Freudenthal.