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Identifying potential Upper Palaeolithic paintings in Church Hole, Creswell Crags, Nottinghamshire, England

Abstract

This paper examines the discovery and mapping of newly identified painted imagery in Church Hole, located within the Creswell Crags, a natural gorge with caves that contain evidence of Late Upper Palaeolithic activity, in Nottinghamshire (within the northern Midlands of England). The recent findings, made in 2021 and 2024, build upon an earlier discovery by an Anglo-Spanish research team in 2003, which marked the identification of the first verifiable engraved Upper Palaeolithic rock art in the British Isles. This earlier discovery included engraved figurative representations and simple geometric motifs. Notably, several of the panels featured a calcite flow, which were chronometrically dated to the Late Upper Palaeolithic (approximately 13,000 years before present) using Uranium-Thorium dating techniques.

Currently, these newly discovered painted images, similar to the majority of the engraved images discovered in 2003 cannot be directly dated using chronometric dating techniques, owing to the absence of calcite flowstone over applied painted areas.

Introduction

In 2021, the author proposed a project to the Creswell Crags Museum that involved a detailed survey of Church Hole to identify potential painted imagery. This project employed photogrammetric methods alongside a desk-based colour-filtering algorithm, Decorrelation-Stretch (D-Stretch), to aid in the identification process. Following the completion of the survey, the cave was systematically mapped using point-cloud capture technology, and the results of these investigations will be published in early 2025, with elements of these findings incorporated into this current paper (Nash, Beardsley & Herrod 2025 - *forthcoming).*

Creswell Crags is a naturally occurring gorge formed within magnesian limestone, centred upon NGR SK 53350 74262, straddling the border between Derbyshire and Nottinghamshire. The gorge contains over 20 natural caves, rock shelters, and overhangs, nine of which have been the focus of archaeological research since the mid-19th century (Bahn & Pettitt 2009).

This paper presents the findings of a photogrammetric survey conducted in Church Hole, situated on the southern side of the gorge (NGR SK 53380 74109). The survey was carried out in two phases: June 18th-19th 2021, and April 16th, 2024. The results of these surveys are discussed below.

Previous surveys aimed at identifying engraved Upper Palaeolithic rock art were undertaken in 2003 (Pettitt et al., 2007; Bahn & Pettitt, 2009), and the art was sub-

sequently chronometrically dated (Pike et al., 2005; Pike et al., 2009). At this time, the Creswell Crags rock art assemblage was regarded by the academic world as the earliest discovered in the British Isles.

Creswell Crags is a significant archaeological site located within the Limestone Heritage Area, which also includes 11 other vales, gorges, and grips (Davies et al., 2004). It has been designated as a geological Site of Special Scientific Interest (SSSI) and a Scheduled Monument (NHLE 1006384). The site is part of the Welbeck Estate, which also contains the Creswell Crags Museum and Heritage Centre, as well as associated woodlands that serve as a prominent tourism destination and educational resource.

According to information provided by the two county Historic Environment Records (HERs), Creswell Crags is primarily described as a Palaeolithic site, though several localities within the gorge have yielded artefacts from later periods, including the Mesolithic, Neolithic, Roman, Medieval, and post-medieval eras. The site is best known for its Middle and Upper Palaeolithic archaeology and sediments, particularly from caves within the gorge. On the Derbyshire side (north), notable sites include Mother Grundy's Parlour, Robin Hood's Cave, and Pin Hole Cave, while the Nottinghamshire side (south) includes Church Hole and Boat House Cave (Figure 1).

It is important to acknowledge that despite significant damage caused by post-medieval landscaping activities under the ownership of the Bentinck family and the Duke of Portland, various areas within the gorge still reserve early prehistoric remains. Additionally, the landscape regime of the Welbeck Abbey Estate has been designated as a Grade II Registered Park and Garden (List Entry 1000556). The garden/landscaping regime of the Welbeck Abbey Estate included the planting of native and exotic trees and shrubbery, along with the flooding of the base of the gorge to form a lake [forming part of a complex water management system] during the early 18th century (Figure 2). At roughly the same time, the limestone cliffs of the gorge were quarried for building stone.[1]

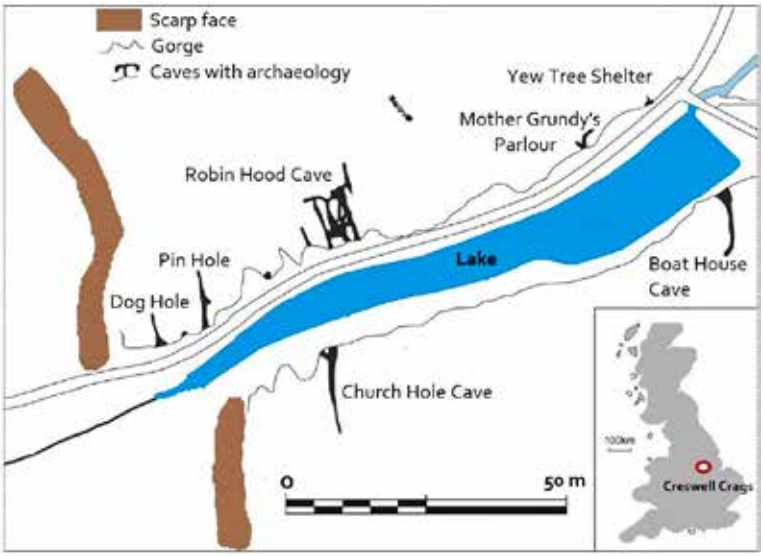


Figure 1. Plan of the Creswell Crags Gorge. Plan adapted from Stewart & Jacobi (2015)

Figure 2. View of the Creswell Crags Gorge and its 19th century lake, looking west

Historical and Archaeological Background

Archaeological research at Creswell Crags dates back to the 1850s, with subsequent excavations occurring throughout the 1920s to 1980s, and more recently in the early 2000s. This body of research is extensively summarised in works such as Jenkinson (1984), Pettitt et al. (2012), and Pettitt and White (2012). Over time, these investigations have led to Creswell Crags being considered "Britain's primary resource for the archaeology and palaeontology of the later Upper Pleistocene" (Pettitt et al., 2012). It is recognised as one of the largest known clusters of Upper Palaeolithic sites in Britain, although four other significant clusters—located south of the glacial advance during the Devensian—are also notable (the Gower Peninsula, the Mendip Hills, the Wye Valley Gorge and the Jurassic coast, from Hengistbury Head to Kent's Cavern). The wealth of research conducted within the Creswell Crags area has provided a valuable dataset upon which further investigations can build (Davies et al., 2004). Nevertheless, gaps in the existing research persist, leading to some inaccurate assumptions. Despite these challenges, Creswell Crags remains an essential site for understanding later Neanderthal and early modern human occupation and adaptation at what is considered the northernmost edge of the habitable world during the later Pleistocene (40 to 10 kyr) — a region often referred to as the 'Northern Frontier' (Ashton et al., 2010; Pettitt and White, 2012).

Over the course of 150 years, the quality of excavation techniques has varied, resulting in several interpretative issues regarding the archaeological record. Excavation documentation is often vague and incomplete, dating is frequently problematic, and many of the collections have been dispersed across multiple museums in the UK and abroad. Some of these challenges have been addressed, at least in part, through initiatives such as the *Ancient Human Occupation of Britain* (AHOB) project (Ashton et al., 2010), the assessment of the dispersed Creswell Collections (Wall and Jacobi, 2000), and more recently, excavations within the entrance area at Church Hole (Pettitt et al., 2007). The potential for further material recovery from the Creswell Gorge deposits has been highlighted by these and other studies.

Regarding the current photographic survey, it became apparent that a large quantity of material had been removed from beneath

the original floor level of the cave, with only the rear section retaining its original floor. In 2003, an Anglo-Spanish team discovered Upper Palaeolithic rock art in Church Hole, with approximately 16 engravings predominantly located in the central and northern sections of the cave, just south of the current entrance (Ripoll & Muñoz 2007: Bahn & Pettitt 2009). The engravings mainly depict megafauna that roamed the north-western European landscape during the later Pleistocene. Following a debate regarding the classification of certain features as rock art, several areas where stalagmite deposits were in direct contact with the engravings were dated using Uranium-Thorium dating (Pike et al., 2005). Despite this significant discovery, the exploration of the cave walls for painted art has been largely overlooked until recently.

In 2021 and 2024, the author conducted preliminary surveys of several caves in the gorge, specifically aiming to identify potential painted prehistoric art. The caves surveyed included Church Hole and Robin Hood's Cave, with the findings communicated to the Creswell Heritage Trust shortly after. Although this survey was limited to certain areas within each cave, several potential instances of painted imagery were identified, some of which overlapped with or were situated beneath the engraved images discovered in 2003. While the cave walls exposed during the Pleistocene contained naturally occurring haematite deposits, the author was able to distinguish between these and iron oxide pigments that had been intentionally applied. The findings included both animal and geometric motifs, common features in caves with coexisting engraved and painted rock art from this period.

Geology

According to the British Geological Survey (BGS), Church Hole, along with other cave systems within the Creswell Crags Gorge, is situated within a dolostone substrate that is typically grey to buff in colour and often exhibits an oolitic or granular texture. This bedrock is part of the Cadeby Formation (Magnesian Limestone) (BGS Code: CDF).

The late Quaternary cave stratigraphy was initially investigated by Mello (1875) and Heath (1879), and later summarized by Davis (2004) and Jacobi (2007). Researchers generally agree on the stratigraphic sequence, which consists of seven distinct units, collectively representing 3.2 meters of deposition. This stratigraphy is significant for understanding human activity at the site, dating back to at least the Upper Palaeolithic (40 to 10 kyr) and potentially extending as far back as the latter part of the Middle Palaeolithic (60 to 40 kyr), with artefacts from both these periods recovered in Units 3, 4, and 5 (Mello 1875, 1876, 1877; Jacobi 2007). Units 1 to 3 are believed to be contemporary with both the engraved and possibly the painted rock art (Figure 3).

The stratigraphic units are as follows:

1. **Breccia**: A calcite deposit that forms the original floor level between Panel B, extending approximately 3-4 m southward, with traces of the floor level continuing beyond Panel C.
2. **Cave-earth A**: A substrate lens situated beneath the breccia deposit.
3. **Cave-earth B**: This deposit extends northward, from beyond Panel B to Panel E, and has an approximate thickness of 0.75 m.
4. **Mottled bed substrate**: This layer is sealed by the overlying cave-earth and extends northward from beyond Panel B to Panel C.
5. **Red sand deposit**: This deposit extends from beyond Panel B to Panel E, with a thickness of approximately 1.1 m.
6. **White sand deposit**: A thin lens underlying the red sand deposit, extending from Panel B to Panel F, with a thickness of approximately 0.3 m (probably

synchronous with late Middle Palaeolithic activity).

7. **Bedrock**: The underlying grey to buff grey dolostone.

This stratigraphy provides valuable context for understanding both the palaeoenvironmental and archaeological conditions that shaped human activity within the cave, as well as in the locality during the latter part of the Pleistocene.

Project Rationale

The identification of Upper Palaeolithic imagery at Creswell Crags offers significant opportunities for advancing research, especially with the discovery of Palaeolithic rock art that includes both engravings and now, potential painted imagery. The engraved rock art, initially identified by the Anglo-Spanish team in 2003, represents a key asset for further study.

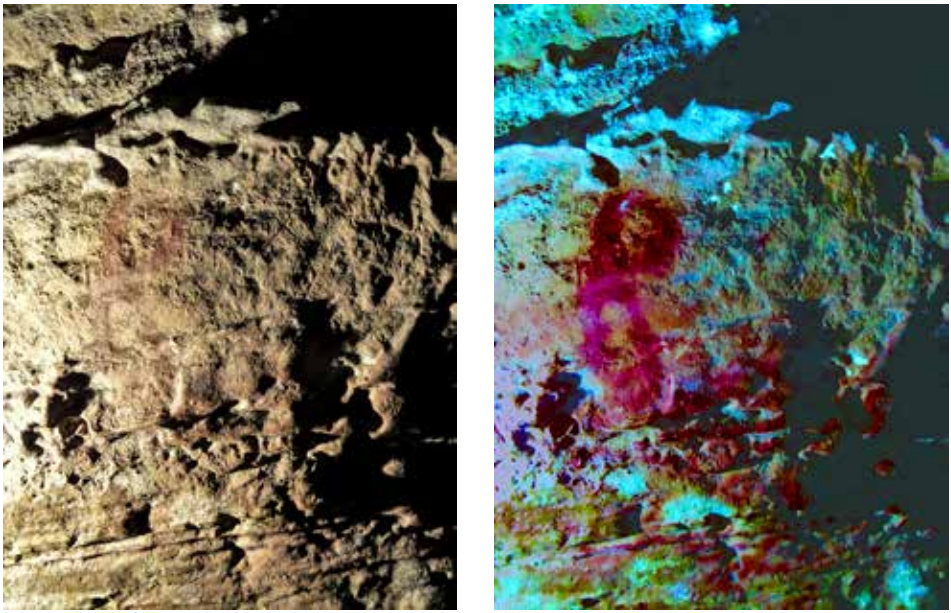
The photogrammetric survey conducted in June 2021 initially identified nine panels with probable painted imagery, and an additional two panels were discovered in the April 2024 survey. Notably, three engraved panels—depicting red deer, bovines, and wild fowl/cervids (labelled Panels A, B, and C)—appear to have been largely painted previous to the engravings. These painted images, which are not visible to the naked eye, were analysed using the Decorrelation-Stretch (D-Stretch) algorithm (e.g., Figures 4 and 5).

The photogrammetric surveys of Church Hole were conducted in June 2021 and April 2024, with the results of the 2021 survey shared among the Creswell Heritage Trust and Historic England's Inspector of Monuments. These surveys revealed evidence of painted motifs, likely executed using local haematite (iron oxide), although dating these motifs remains a challenge. The 2021 survey, though non-systematic, employed robust non-invasive methods that provided valuable insight, revealing several potential panels of interest, including Panels A to F.

Due to the fragility of the surface geology within Church Hole, no scales came into direct contact with the walls of the cave, unless there were convenient natural ledges on which scales could rest. Where possible, painted surfaces were roughly measured, using a hand tape.

The survey employed high-resolution photography under blue (cold) light to avoid the use of flash, with all images exceeding 5 MB in size. Although the pigments had faded over time and were not discernible to the naked eye, the application of the D-Stretch algorithm enabled the enhancement of the images (Figures 4 and 5). Developed by Jon Harman in 1995 and initially used

Figure 3. Cross-section of Church Hole showing the stratigraphy and the approximate locations of the panels containing evidence of painted surfaces (adapted from Mello 1877; Jacobi 2007 and the Terra Measurement Ltd. 3D digital plan)



Figures 4 & 5. Raw image (left) and enhanced image (right) using D-Stretch, showing painted curvilinear motifs (Panel D)

by NASA's Jet Propulsion Laboratory as a remote-sensing GIS tool, D-Stretch is specifically designed for the manipulation of RGB matrices in digital photography, facilitating the detection of rock art features, particularly in pigments like red, yellow, and black. This tool has proven effective in distinguishing between natural deposits and human-applied haematite. Using D-Stretch, at least six potential painted panels were identified across the two surveys.

Initially, identified panels were georeferenced relative to the cave's entrance grille, based on a cave plan published by Jacobi in 2007. However, 3D Point Cloud imagery which involved surveying the cave, followed by digitised georeferencing and rendering processes was issued by Terra Measurement Ltd in late 2024. This 3D rendered animated image enabled the author to accurately plot the various discoveries throughout Church Hole (see Figure 3).

For this paper, the author has produced two side-by-side images which shows the same frame. The left-hand frame is the raw image, as taken during the survey of the cave. The right-hand frame is the colour filter manipulated image showing the D-Stretch image, used for specific colour enhancement (i.e., varying hues of red).

Results of the Survey

Church Hole, along with Robin Hood's Cave and Pin Hole Cave, was initially explored for the presence of rock art before 2003. The 2021 and 2024 surveys revealed evidence of Late Upper Palaeolithic painted rock art across at least six panels within Church Hole, along with several [unpublished] panels in Robin Hood's Cave.

Many of the newly discovered panels were obscured by historical and modern graffiti. Panels A to C exhibit engraved images, with potential painted surfaces beneath the engravings, including a cervid (red deer) on Panel A, a bison on Panel B, and potential a bird and cervid with long necks on Panel C. The engravings from these panels, as well

as other engravings in the cave, have been discussed in detail in previous works (e.g., Ripoll & Muñoz 2007; Bahn & Pettitt 2009).

Panel A:
The engraved red deer, probably first discovered sometime during the mid- to latter part of the 20th century (Bahn & Pettitt 2009) and re-identified in 2003, measures 0.68 m by 0.58 m and is accompanied by historic and modern graffiti. The engraved outline of the deer is clearly visible, despite the addition of a straggly beard that was added by a visitor at some time during the mid- to latter part of the 20th century. A calcite flow covering the lower section of the panel contains notches that were dated to a minimum age of 13.1 kyr (Pike et al. 2009) (Figure 6). These notches, numbering seven short vertical lines were beneath the hind leg of the deer.

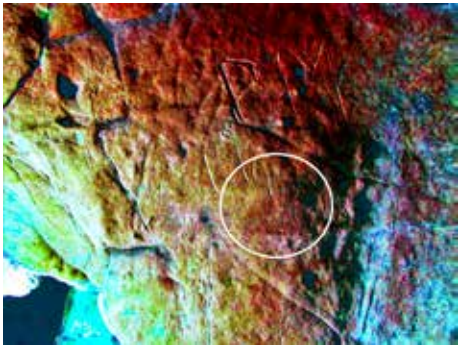
From the 2021 survey, D-Stretch imagery revealed a geometric form – an infilled triangle within the lower neck area of the red deer, which is indicative of human-applied haematite rather than natural secretion (Figures 7 & 8). The triangle measured 3-4cm from the apex to its base. Other potential faint motifs are outside the neck of the red deer, suggesting that painted imagery was not initially associated with the later engraving.

Figure 6. 0A set of vertical engraved notches, partially covered by a calcite flow and dated by Pike et al. (2005)

Panel B:
The bison engraving (Figures 9 to 14), measuring 0.45 m by 0.30 m, features a haematite spread that extends along the legs and central torso area of the bison. The haematite spread is likely the result of multiple painting events, possibly incorporating earlier motifs into the animal's outline (prior to engraving). The engraving style of the bison is consistent with Upper Palaeolithic bison imagery found elsewhere, in particular, within the Franco-Cantabrian areas of SW Europe. Of particular interest is the head and neck areas of the engraving where the artist appears to have either utilised natural haematite flow or painted inside the engraved lines to further enhance this area of the engraved animal (Figures 11 & 12).

Figure 7. Panel A. The head and neck sections of an engraved red deer (no scale used)

Figure 8. Panel A. Image showing a faint painted infilled triangle that was exposed using D-Stretch, located centre-right



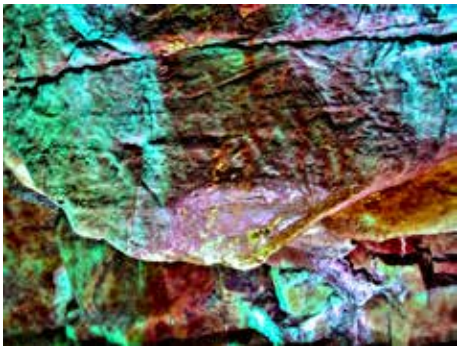


Figure 9. Panel B. Panel south of the engraved red deer, showing a side-on view of a bovine, probably a bison (no scale used)

Figure 10. Panel B. D-Stretch image showing a haematite flow or applied paint

However, contrary to the above, the haematite spread may be a natural secretion and the artist has inadvertently or deliberately modelled the engraved lines that form the legs to embrace a natural haematite spread (Figures 13 & 14); either way, I consider the relationship between the engraving and the haematite spread to be a deliberate act, say, a way of manipulating a natural phenomenon into a work of art. This is not uncommon in the way Upper Palaeolithic artists were executing painted and engraved art onto rock surfaces. As in the case of the Church Hole bison, the artist has also utilised the topography of the rock surface to further enhance the engraving (with

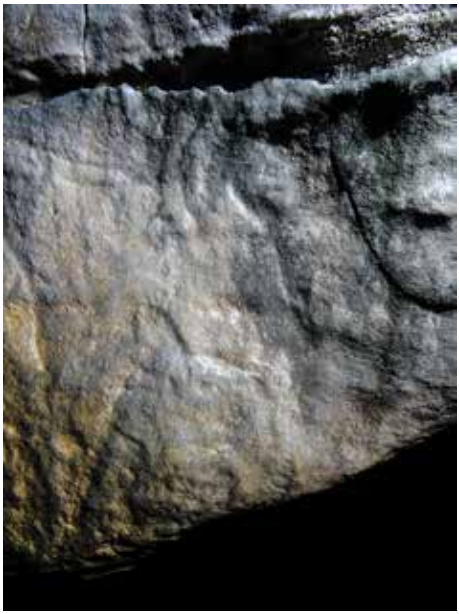


Figure 11. Panel B. Detail of the head, neck and torso (no scale used)

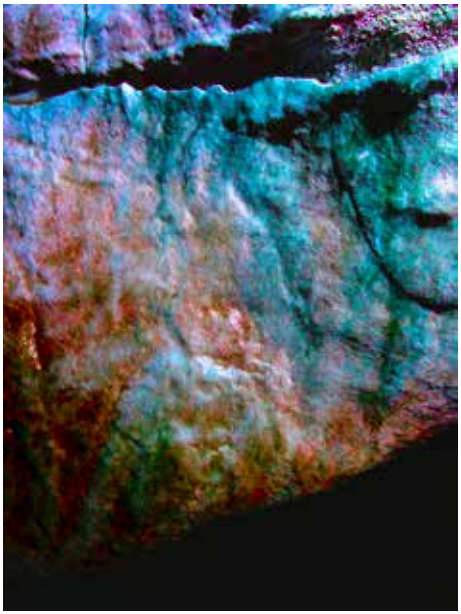


Figure 12. Panel B. D-Stretch image showing the haematite infill within the foreleg and neck of the bovine

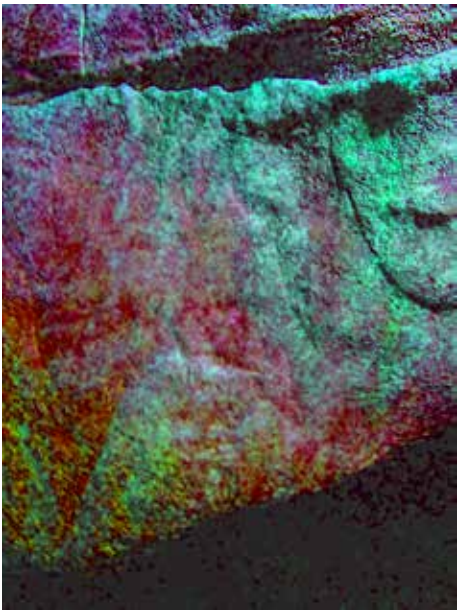


Figure 13. Panel B. D-Stretch showing the haematite infill within the foreleg and neck of the bovine (no scale used)

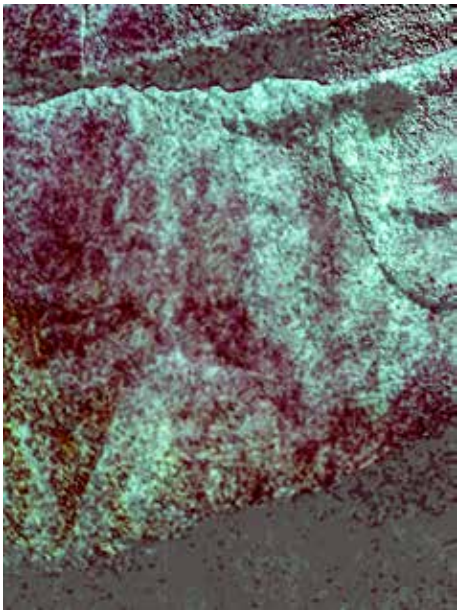


Figure 14. Panel B. D-Stretch showing the haematite infill within the foreleg and neck of the bovine, using a different filter to Figures 12 and 13

painted infilling) as seen with the lower leg sections extending no further than a wavy ridge within the lower section of the panel (Figures 13 & 14). Arguably, the artist, has placed the bison on a virtual land surface, (a natural ridge in the geology of the panel), a phenomenon that is rare within Upper Palaeolithic panel composition.

Panel C:
Located c. 20 m south of the cave entrance, and standing 0.5 m from the original floor, this panel features engravings of two animals, likely the head and neck of a cervid and wild fowl (possibly sp. *Anatidae*). These engraved figures are unique to NW Upper Palaeolithic Europe, but similar engraving styles for both animals are also found in south and central coastal Norway during the Mesolithic period, c. 10-11 kyr, usually emphasizing the neck areas of both animals (Nash 2008).

Interestingly (and coincidentally), the panel escaped mining activity, that occurred immediately north of the panel (towards the entrance). Panel C is a smooth natural section of cave wall, whilst the cave wall to the north is jagged and hewn, suggesting that the original cave walls have been widened, probably for recent access.

Using D-Stretch, potential applied haematite was identified, suggesting human agency in the painting process. Additionally, a black charcoal line was detected, extending across parts of the panel, the age of which is unknown (Figures 15 to 18).

Panels D:
This panel is located within the central section of the cave. Of particular interest is the painted triangle, with a single short vertical painted line extending downwards from the apex. The image has been applied using finger dots in a linear fashion, forming three short lines, each measuring between

Figure 15. Panel C. The engraved cervid and/ or wild fowl figures and the surrounding rock surface [centre of image] (30cm scale used)

Figure 16. Panel C. D-Stretch image showing a haematite spread that is located on the RHS of the panel

Figure 17 & 18. Panel C. Raw and D-Stretch images showing a curvilinear haematite spread, probably the result of the application of an applied haematite. Note, the change in colour hue [from deep red (L) to crimson (R)], suggests the formation of a calcite flow over the two engravings.

3 and 5 cm. Other faint painted imagery is present immediately north of the triangle, towards the entrance. This motif is common in Palaeolithic art and has traditionally been referred to as a pubic triangle (a term that I am not happy with) (Figures 19 & 20).

Panel E

Located on the eastern wall within the rear section of the cave, standing around 0.9 0m from the original cave floor (past a sump). This panel features two clear interconnected but broken painted ovoid motifs. Unlike other painted surfaces within Church Hole, the Panel E motifs are clearly visible; however, their date is unknown. Close in-

Figure 19. Panel D located south of the entrance area of the cave, on the eastern wall (no scale used)

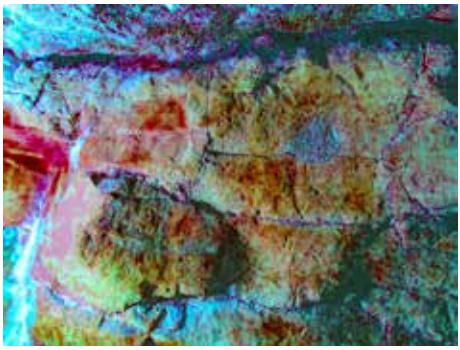


Figure 20. Panel D, using D-Stretch imagery, showing a probable triangle shape using applied finger-dot haematite

spection of these two motifs shows that the paint was applied as a thick [gloopy] paste and, therefore, was not fully absorbed into the surrounding rock surface (Figures 21-24). Assuming that these two motifs are ancient, one could suggest that they collectively represent the letter 'B' or 'R'. However, it should be noted that the paint has been applied using finger-dot impressions (a series of finger dots that form linear and curvilinear line sections). If this motif was relatively recent; the preferred application method would have been a brush, and haematite would not have been used.

Figure 21. Panel E. Raw image showing little or no indication of the motifs (no scale used)

Figure 22. Panel E. D-Stretch image showing two complete circular motifs and the absorption stains around the applied painting.

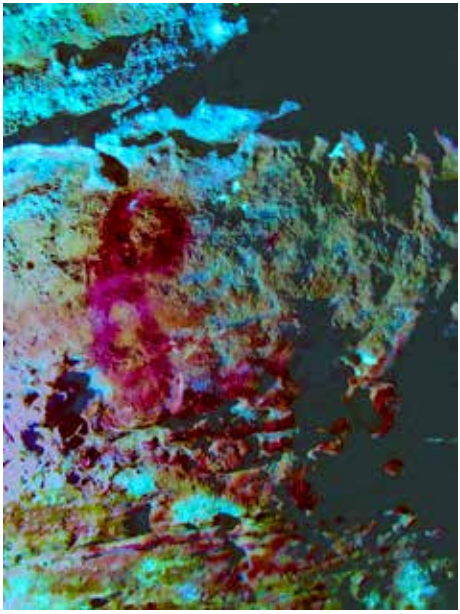


Figure 23. Panel E. D-Stretch image showing two complete circular motifs, along with naturally-secreted haematite

Figure 24. Panel E. Photoshop image showing two complete circular motifs.

To confirm the recipe constituents of the pigment, a sample would need to be taken and analysed using Raman spectroscopy. An application for Scheduled Monument Consent (SMC) has been recently made to Historic England to geochemically sample these and other identified applied haematite areas of the cave where no previously discovered Late Upper Palaeolithic engravings have been found.

Although this area of the cave was accessed from the mid-19th century onwards, all the historic graffiti is engraved, mainly with textual scratches and incisions using metal implements.

Panel F:

Located above the entrance to the sump at the rear end of the cave, at its northern end is a small dot that measures 3 x 2 cm (Figures 25 to 27). The dot represents a series of finger marks, a motif common in European Upper Palaeolithic cave art. The mark appears to be made from applied haematite, rather than from a secreted source. The mark appears to be placed strategically, probably indicating an area of the cave where access to the rear section was difficult. Note, that at this point the original floor level and the ceiling of the sump were separated by just a few centimetres and therefore, access to the rear of the cave would have required a tight crawl through a 3-4m traverse within this part of the cave section.

Discussion

Creswell Crags, with its designated heritage and paleoenvironmental assets, stands as one of northern Europe's most significant early prehistoric sites, with evidence of human occupation extending to the latter part of the Middle Palaeolithic (60–40 kyr). Among the 20 or so caves, rock shelters, and overhangs in the locality, nine have been extensively studied, particularly between 1870 and 1930, although early archaeological methods employed dur-

Figure 25. Location of Panel F and the location of the original floor level (indicated by two white arrows)

Figure 26. Panel F. Multiple finger dots forming a single spread

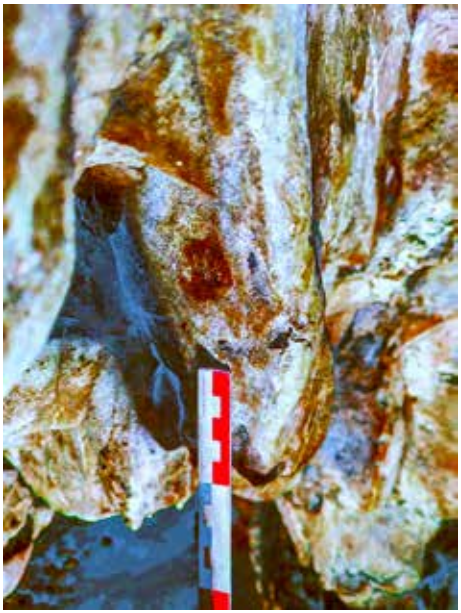


Figure 27. Panel F. D-Stretch image showing the enhanced finger dot spread

ing these excavations were less advanced than present, although Mello (1875, 1876 & 1877) and later, Heath (1879) working at Church Hole, provides an adequate baseline description of the stratigraphy of the southern section of the cave, following a series of excavations.

The issue, in terms of archaeology, is that these late 19th century excavations emptied Church Hole of its sediments; however, the recent 3D rendered plan of the cave does record the original floor in the cave wall sections (Nash, Beardsley & Herrod, *forthcoming*). The location of the original floor does provide some idea of the degree of difficulty to manoeuvre through the cave system and to produce rock art.

The discovery of engraved rock art in 2003, coupled with prior excavation work (e.g., Mello 1875, 1877; Heath 1879; Armstrong 1937, 1938), positions it as the most significant cave at Creswell Crags. Notably, it was at Church Hole where the first faunal remains were discovered in 1872, and where a

substantial lithic assemblage was recovered. Despite earlier excavations revealing no human traces in the cave's central areas, subsequent surveys have uncovered significant rock art, including, now, potential painted motifs.

It should be noted that the cave plan we witness today was probably not the plan that existed during the Upper Palaeolithic period. The current cave entrance, for example, would have extended many metres northwards but due to weathering, in particular, water percolation and freeze-thaw processes, the original cave entrance has receded over the millennia. Therefore, a rethink in terms of where the engraved and painted panels is and where they were in early prehistory is required. The current location of these images does not really fit the Upper Palaeolithic rule (i.e., my observations within Europe and the British Isles indicates that rock art is not usually found within or near cave entrances, but within discrete areas of a cave or cave system). It is therefore probable that the engraved red deer and bison and probable earlier painted areas were located some distance from the original cave entrance.

Another noteworthy point to consider is historic access. Clear references are made to when Church Hole was believed to have been first explored (Mello 1875). However, graffiti recorded within the southern section of the cave, several metres south of the sump, shows that access extends back to [at least] 1860 (Figure 28). At the time this graffiti was made and based on Mello's later account (Mello 1875), access from the entrance to the central section of the cave would have been difficult, owing to the low ceiling sections and narrow walls.

The photogrammetric surveys of 2021 and 2024 revealed six potential painted panels (Panels A to F) containing applied haematite motifs, including geometric forms, painted infills within engravings, and finger dots (some as single dots, others arranged in linear and curvilinear forms). The painted imagery identified, including Panels B and

Figure 28. Historic dated textural graffiti within the central section of the cave (no scale used)

E, aligns with typical Upper Palaeolithic rock art, with similarities to other European sites. The presence of calcite flows over several painted motifs offers further insight into the age of these images, and dating these panels using Uranium-Thorium techniques would provide a clearer chronology.

Given the rarity of both portable and static Upper Palaeolithic art in the British Isles, with only two caves containing verified rock art (e.g., Bahn & Pettitt 2009; Nash et al. 2012), these findings position Creswell Crags as a critical site for understanding prehistoric artistic practices. The integration of historical and modern graffiti with ancient rock art further complicates the cave's cultural significance, demanding careful analysis to separate contemporary markings from early prehistoric expressions of human agency.

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Note

[1] https://historicengland.org.uk/listing/the-list/list-entry/1000556?section=official-list-entry

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