

# THE SURVEY OF CATHOLE CAVE, GOWER PENINSULA, SOUTH WALES

by

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## ABSTRACT

In September 2010 one of the authors (GHN) discovered a Late Upper Palaeolithic engraving of a cervid in Cathole Cave on the Gower peninsula in South Wales. The cave site has been designated a Scheduled Monument (GM 349). As part of the remit to record this and other features within the cave, the Welsh heritage agency CADW commissioned a 3D digital survey of the main galley and side chambers of the cave. Data from this exercise allowed the production of an accurate plan of the south-western section of the cave to be made. However, due to technical constraints, the northern and north-eastern section of the cave could not be digitally surveyed. In July 2012 one of the authors (GHN) accompanied a small team of archaeologists and completed the survey, the results of this work reported in this paper.

## INTRODUCTION

Following the discovery of a Late Upper Palaeolithic (LUP) engraving of a cervid, possibly a stylised reindeer (*Rangifer tarandus*), within the rear section of Cathole Cave in September 2010, the authors were commissioned by the Welsh heritage agency CADW to undertake a detailed 3D measured survey of the cave. This part of the project was undertaken in April 2011 and involved a 3D laser scanning survey. Although 3D laser scanning technology has been applied to other archaeological sites, its application in recording a cave context is still an infrequent event (e.g. Doering, Collins and Branas, 2006; Buchroithner and Gaisecker, 2009).

Downloaded data from site processing allowed a detailed 2D plan of much of the southern section of the cave to be constructed. However, only the main gallery and an antechamber to the north-west could be surveyed due to access issues within the cave. In 2012, working alongside a team from the National Museum of Wales (directed by Elizabeth Walker) one of the authors (GHN) undertook a measured survey within a shallow section of the cave, north and north-east of the main gallery.

## GEOMORPHOLOGICAL SETTING

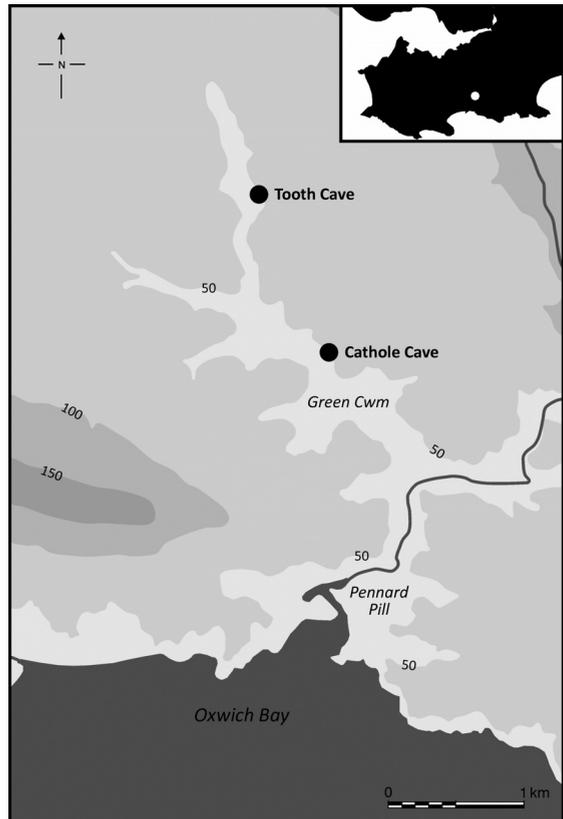
Cathole Cave is one of a small number of caves on the Gower Peninsula that has an inland location; a further 95 or so are located along the southern and western Gower coastline, but most are regarded as sea caves (Oldham, 1982; RCAHM (Wales) 1976; Rutter, 1949; Waltham, *et al.* 1997). Cathole Cave is located around 30 m AOD on the north-east side of a dry limestone valley, approximately 2 km north of the present coastline (Figure 1), standing at around 15 m above the valley floor, with the present-day phreas probably 5 m or more below the valley floor.

The cave appears to have formed in a landscape very different from what is seen today. The V-shaped Parkmill Valley (or Cwm) may not have existed at that time; the valley

floor being probably tens of metres higher than today and well above the present ceiling of the cave. It is possible that the various water-worn relict passages within the rear section of the cave and in the ceiling represent remnants of a former subterranean river system or sub-valley drainage system that was in operation when the valley floor lay significantly higher than the cave. The subsequent incision of the valley to its present level may be the result of erosion by glacial meltwater runoff during periods when periglacial conditions prevented significant subterranean flow (Waltham, *et al.* 1997). The surface stream originally flowed through the Parkmill Valley but now resurges at the southern end of the valley, before reaching the sea (Ede and Bull, 1989).

The cave comprises two principal components: a wide passage with an undulating roof and a series of tall, narrow, joint-influenced rifts that rise several metres above the general roof level. In plan, the cave has two entrances: the southern entrance leads to a large low-roofed main gallery extending about 11 m to the east (Figure 2). To either side of the main gallery are side-chambers; the northern side-chamber diverts westwards to an antechamber and, beyond this, eventually, to an exit at Lower Cat Hole, located some 20 m north of and 3-4 m lower than the main cave (Simms, 2011).<sup>1</sup> To the east and north-east of the main gallery is a further gallery that extends an additional c. 9 m. This section of the cave is difficult to access and, as far as the authors were aware, it had, until July 2012 never been fully investigated, although clear excavation activity was recorded (Nash, in Walker 2013).

The undulating surface of the roof suggests that the gallery was formed originally in a phreatic environment (Nash, *et al.* 2012). Based on a recent archaeological excavation, in advance of the installation of a steel bat grille, the rock floor of the cave is concealed by shallow sediments. This deposition may have largely accumulated following an excavation by Colonel Wood during the 1860s (Garrod, 1926). Discoloration of the lower part of the walls within the main gallery suggests that these (unrecorded) excavations removed between 0.7 m and 1 m of this sediment fill. This suggestion is the basis for the two distinct floor levels shown in Figure 3.



**Figure 1.** Map showing the location of Cathole Cave, Gower.

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An Ordnance Survey/EDINA supplied service.

<sup>1</sup> A section between the main cave and Lower Cathole is blocked with cave earth and rock fall. It was not shown as passable on the sketch plans in Oldham (1982).

Based on the quantity of frost-shattered stone both above and below the surface<sup>2</sup>, the cave entrance may perhaps have extended a further 3-5 m westwards towards a pronounced tongue formed by thermoclastic scree, probably augmented by spoil from 19<sup>th</sup> century excavations.



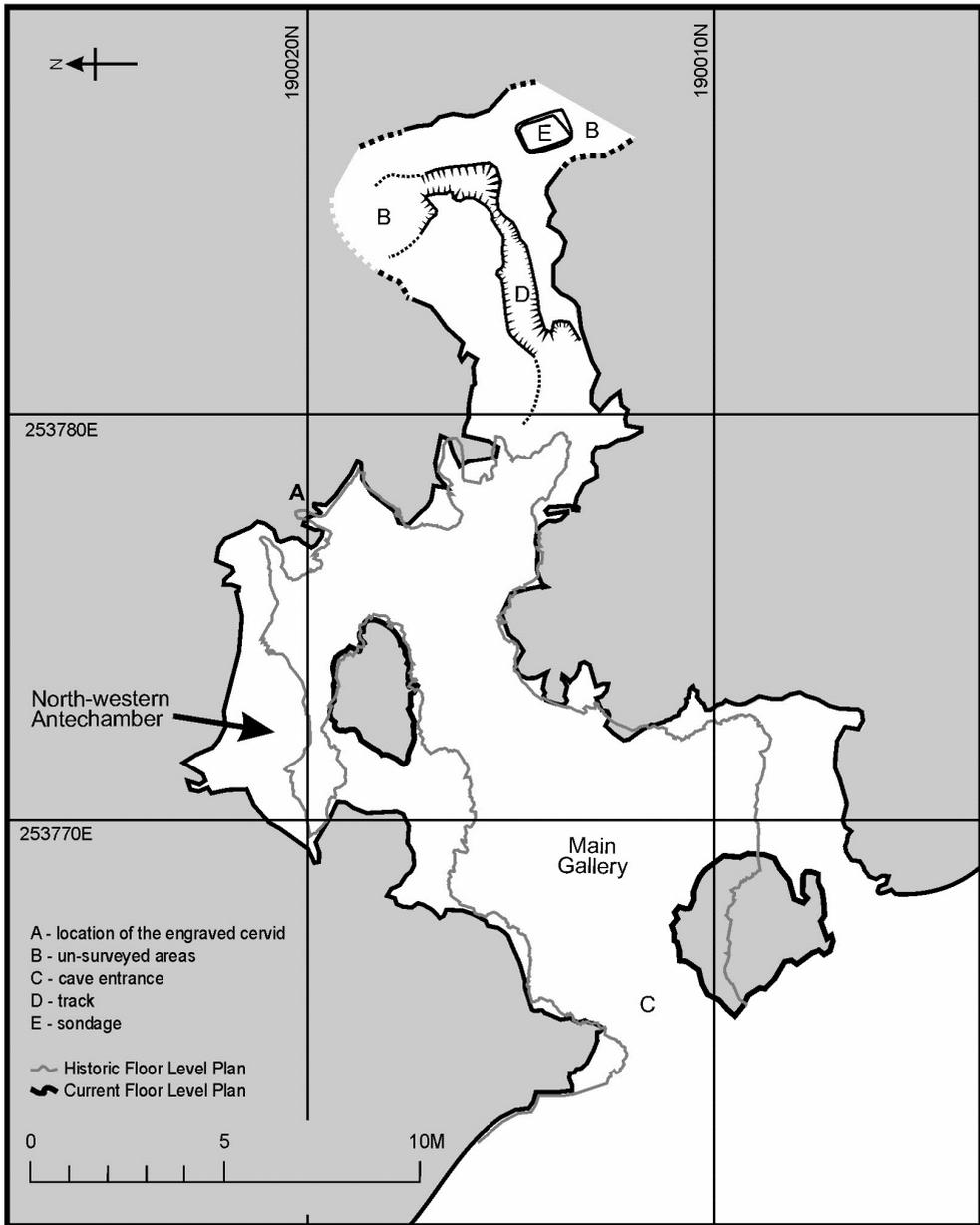
**Figure 2.** *Entrance to Cathole Cave following recent brush clearance.*  
**Photo: G.H. Nash.**

## SURVEY METHODOLOGY

As part of the research agenda for Cathole Cave, the heritage agency for Wales CADW commissioned a 3D laser scanning survey of the main sections of the cave, including

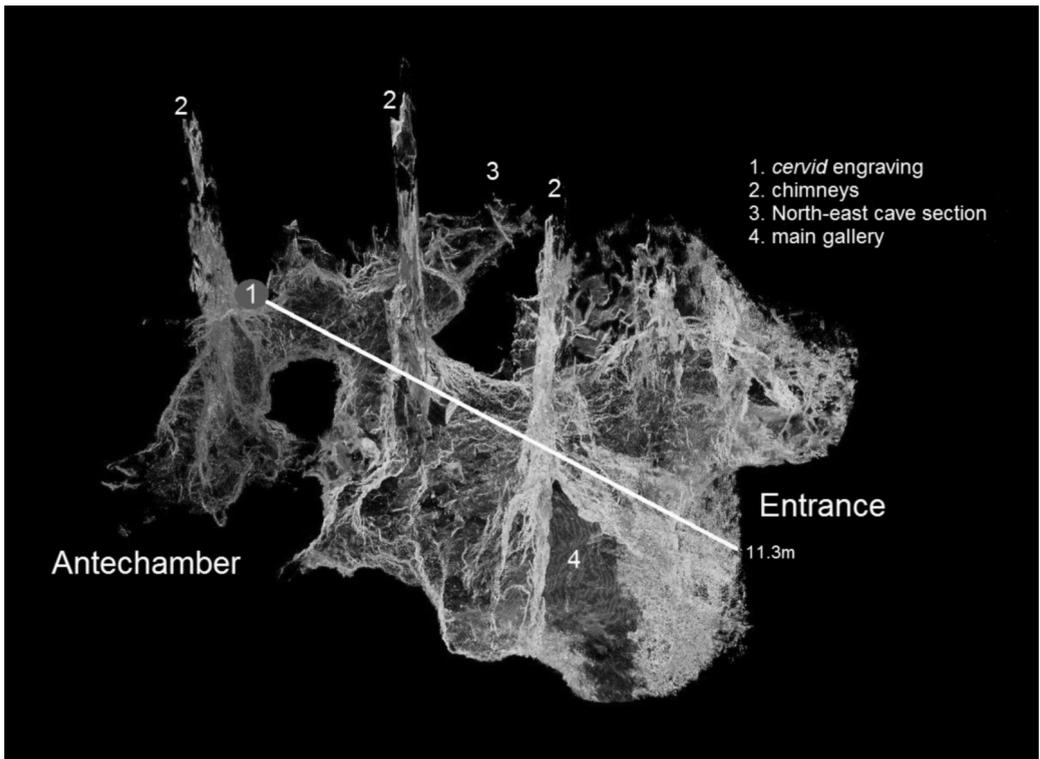
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<sup>2</sup> Based on photographs and a section drawing from the McBurney and Campbell excavations



**Figure 3.** Plan survey of Cathole Cave, at floor level. This has been produced by combining the laser scanning data for the majority of the cave with conventional tape and offset data for the north-eastern section.

the central gallery and an antechamber to the north-west. The purpose of this project was to provide detailed 3D documentation of the cave that could be manipulated to create plans and sections of the cave (e.g. Figures 4 and 5), and a 3D model if required. The equipment used to undertake the 3D laser scanning survey included a Leica TCRP 1205 Total Station, Leica Viva GS08 Net Rover GNSS (Global Navigation Satellite System) and Leica HDS6000 Laser Scanner. The software used to process the data was Leica Cyclone, LSS, AutoCAD, Leica CloudWorx. The density of the point cloud captured throughout the cave area is on average 2 mm between 3D points. The end result was a fully connected 3D point cloud of all visible surfaces of the cave. The subsequent data enabled an accurate current floor plan as well as identifying historic levels and any vertical sections that may later be required (Figure 5).



**Figure 4.** *Isometric plan showing the targeted pixelated outline of the southern section of the cave.*

**Image: Andrew Beardsley.**

The project involved several processes that included:

- Survey control points were established outside the cave and related to the OSGPSN (Ordnance Survey GPS Network – the definitive National Grid) using the Leica Net Rover;

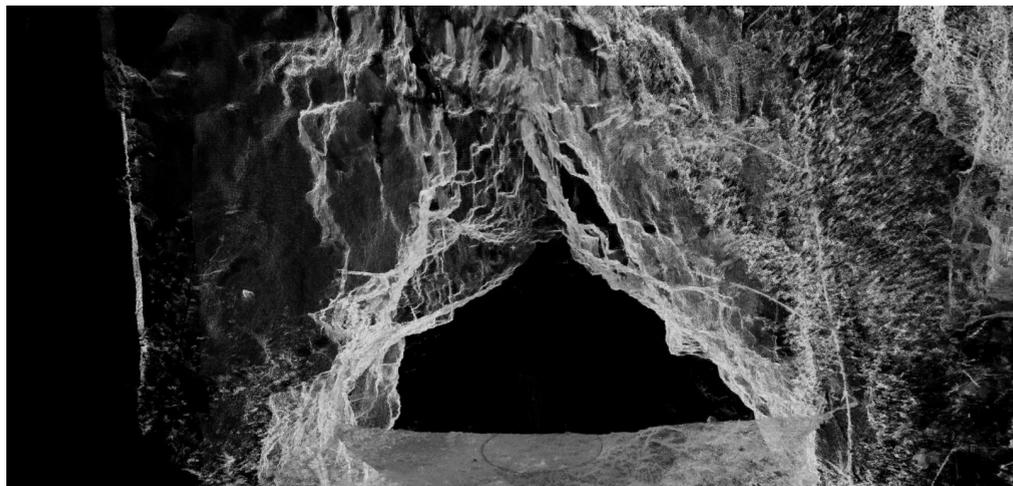
- The same control points were also measured with total station and an additional control point was established within the cave entrance;
- The installation of nine laser scan targets which were positioned at key points throughout the main section of the cave. Care was taken so as to not damage the historic fabric of the cave.
- The nine targets were then measured and controlled with a total station to provide accurate 3D co-ordinates for each target; and
- 3D laser scans were then performed at 14 positions to best provide overlapping data and target coverage.
- Care was taken to ensure there was no movement in front of the scanner throughout the process.

The office process, considered an essential part of the overall methodology included the downloading and adjustments of the laser scan target positions surveyed with the total station (using LSS software).

Additional processes included:

- Processing of the GNSS Ordnance Survey coordinates including the meaning of all observations at each control point.
- Download and adjust the laser scan target position surveyed with total station in LSS software.
- Import the xyz co-ordinates into Leica Cyclone.
- Download raw laser scan data and identify and name all target positions in each laser scan (see image laser scan targets).
- Match all individual scans targets to the known co-ordinates scan target to create an initial point cloud registration.
- Perform a point cloud to point cloud registration using unique overlapping geometry.
- Registration of all scans to create one whole point cloud made up of all 14 scans.
- Check the registration constraints. The worst RMS (Root Mean Square) error was 6 mm. The majority of constraints had RMS 0 mm-1 mm.
- Create point cloud model space and inspect the point cloud.
- Produce images of the point cloud as end-product visuals.
- View the point cloud in AutoCAD using Leica CloudWorx to draw historic floor layouts (see Figure 4); and
- View the point cloud in AutoCAD using Leica CloudWorx to draw vertical sections (see Figure 5).

During this survey not all areas of the cave were accessible, due to limited space and height restrictions; in particular, a narrow recess leading to the northern rear section of the cave and the niche where the engraved cervid is located. These areas were later surveyed using more conventional surveying methods.



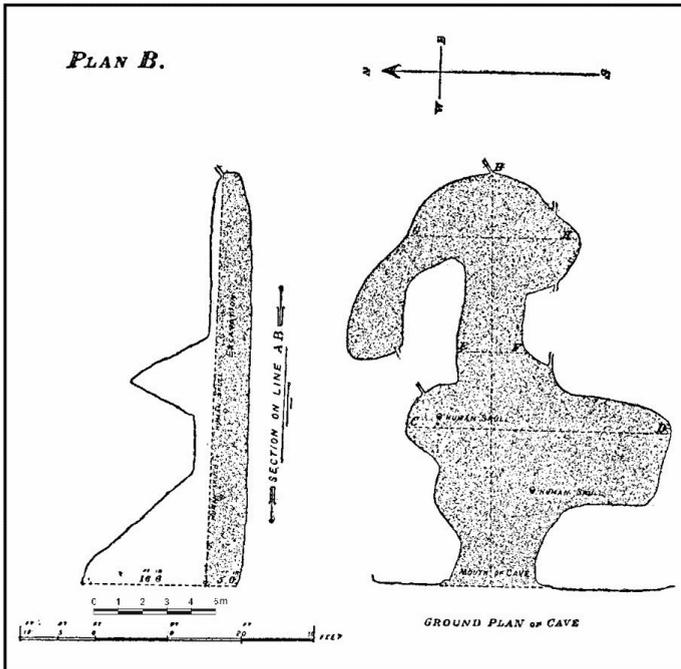
**Figure 5.** *Vertical section of the entrance area of the cave, looking south-west, worked from the 3D laser scan survey.*

**Image: Andrew Beardsley.**

## OBSERVATIONS

### *Previous investigations*

Cathole Cave has, since September 2010, been the focus for several research projects. This followed the discovery, verification and publication of an engraved cervid, which was hidden within a tight niche at the rear of the main gallery (Figure 4) (Nash *et al.* 2012; Nash, 2013), and excavation of a 7 m trench in advance of the installation of a steel bat grille. This was installed for a variety of reasons that included the protection of hibernating bats (and other cave-dwelling fauna) and recognised sensitive archaeological remains; both the archaeology and the wild life had recently been under increased threat from periodic graffiti episodes, fires and other petty vandalism. The excavation, undertaken by archaeologists from the National Museum of Wales was the first intrusive investigation since Campbell's trial trenching within the entrance area of the cave in 1968 (Campbell 1977). His excavations established clear evidence for Late Upper Palaeolithic (Creswellian culture) and Mesolithic horizons, similar to that of the previous excavation programme undertaken by McBurney in 1958 (McBurney, 1959). Prior to this scant records in secondary sources report an excavation by Colonel Wood, who is believed to have cleared much of the cave stratigraphy to the present floor surface. Based on the 3D laser scan survey, it is believed that up to 1 m of material was removed throughout the main gallery. Based on reports in Roberts (1887), Vivian (1887), Garrod (1926), McBurney (1959) and Campbell (1977), the Wood excavation uncovered a significant quantity of faunal remains as well as a large lithic assemblage. This is attested in the results from the recent excavation in 2012 where remains of glacial fauna and lithics were encountered within a shallow trench that extended across the rear section of the cave (Walker *forthcoming*). The shallow stratigraphy recorded within the 2012 trench suggests that Wood's excavations removed most of the cave floor to areas where bedrock was exposed. This is probably



**Figure 6.** Plan and cross-section of the southern section of the cave showing the extent of Wood's excavation (Vivian 1887).  
 Courtesy of *Archaeologia Cambrensis*.

confirmed in a plan of the southern section of cave made by H.H. Vivian in 1887 (Figure 6) which identifies all of the major features within this section of the cave, including the antechamber and the southern section of the main gallery, and also shows the extent of Colonel Wood's excavation. Based on this plan, his excavation removed a considerable quantity of material. Missing, though, from Vivian's plan are the southern entrance and the rear section of the cave. It is probable that at this time the rear section of the cave was still impenetrable, and remained so until the excavation of the track that was identified in the 2012 plan and which would have allowed access to the rear section of the cave (see Figure 9).

### *The 3D laser scanning survey*

The 3D laser scanning survey identified two clear cave floors, the present cave floor extent and a historic cave floor, between 0.7 and 1.0 m above the current floor level, which probably predates Colonel Wood's. Evidence for the probable removal of material by Wood is present upon many sections of the cave walls, especially on the western side of the cave. The 3D laser scanning survey also accurately mapped the position of at least three chimneys that extend across the ceiling of the main gallery (Figure 4).

### *Measured survey of the rear northern section of the cave*

The measured survey of the rear section of the cave was undertaken in July 2012, whilst excavations were taking place within the main gallery. The authors' remit was twofold, to prospect for more rock art and to produce a measured survey of the northern section of the cave. This section is accessed via a short, low-ceilinged recess (Figure 7). Beyond this point, the northern section comprised a shallow space which measured no more than c. 0.45 m between floor and ceiling. In addition, areas to the extreme north and south-east could not be accessed or surveyed due to the ceiling being too low.

A 4 m baseline between the recess and rear part of the northern section of the cave was established and from this all offsetting was undertaken. It became clear from this survey that several excavations had previously taken place within the northern section of the cave. One of these was an east-north-east track which cut into the cave earths. Deposits from this cut had been banked either side of the track including frost-shattered rock debris, most of which originating from the ceiling. About 4 m along the track, it veers to the north, avoiding a large square stone,



**Figure 7.** *The intersection between the main gallery and the north-eastern recess leading to the rear northern section.*

**Photo: G.H. Nash.**

which appears to have fallen from the ceiling. The age of the cut track is unclear but it is most likely it was made by a caving team exploring this section of the cave in the relatively recent past. Alternatively it may have been made by archaeologists during or after the Wood excavation. A second cut feature, rectangular in form, lies south-east of the track, but its purpose is unclear. Each of the features cut into the cave floor expose in section stratigraphic detail of the development of periodic cave-earth infilling (probably via the chimneys within the ceiling). Due to the low ceiling that descends beyond the track the far south-eastern and northern walls of the cave could not be completely surveyed; however, they do extend for a few metres.

Although a number of large cave chambers have been scanned previously using similar techniques, it is believed that this is the first time that the results of such a scan have been included in a survey of a whole cave. The usual grading scales for cave surveys were not constructed with this sort of work in mind, but it is considered that this survey, as a whole, will meet UISv1 6-4-BEF. (See <http://www.uisic.uis-speleo.org/UISmappingGrades.pdf>).

## CONCLUDING REMARKS

Prior to the recent work within Cathole Cave, the archaeological evidence was somewhat confused and compartmentalised between the three excavators, Wood, McBurney and Campbell. In each case successive reports and accounts had commented on previous archaeological activity but no detailed plans of the cave appeared to have been made. A plan was published by Vivian in 1887, but this was merely an inaccurate sketch.

By manipulating the 3D laser scan (Figure 4) to produce a plan of the cave floor (and an historic outline) the authors have managed to create the first accurate 2D plan of the cave using two well-established methodologies: 3D laser scanning for the main gallery and the

western antechamber and the more traditional tape-and-offset approach used within the north-eastern and northern sections of the cave (Figure 3). Apart from measurement data, both survey methods have also identified a number of changes and features that relate to recent archaeological and speleological activity within the cave, in particular an attempt to explore the rear section of cave, probably during the mid to latter part of the 19<sup>th</sup> century following the excavation by Wood.

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