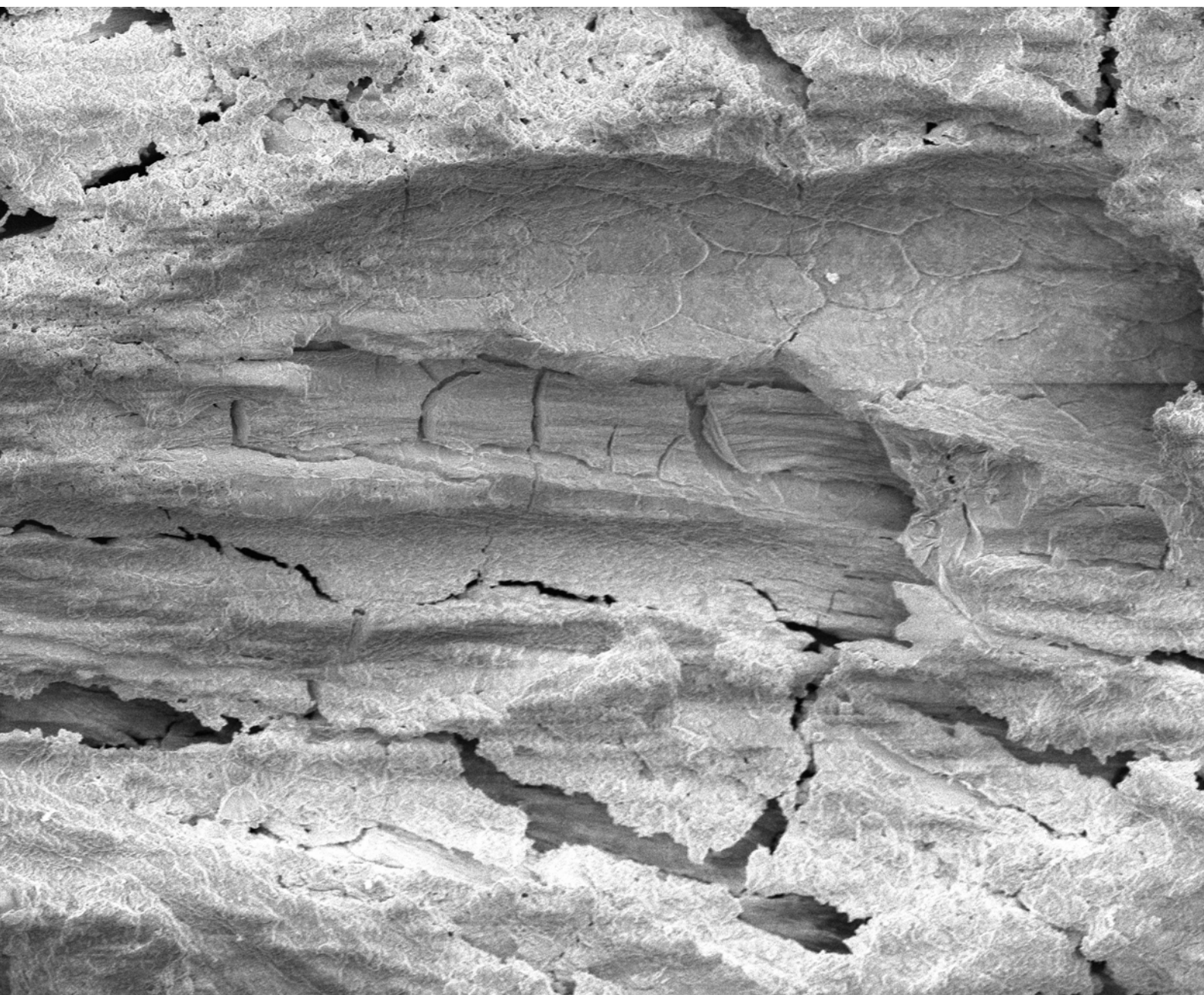


# WEST HESLERTON, NORTH YORKSHIRE INVESTIGATIVE CONSERVATION OF A HUMAN SKULL AND ASSOCIATED TEXTILES

## ARCHAEOLOGICAL CONSERVATION REPORT

Ada-Maria Gravgaard



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**WEST HESLERTON  
NORTH YORKSHIRE**

**INVESTIGATIVE CONSERVATION OF A HUMAN SKULL  
AND ASSOCIATED TEXTILES**

Ada-Maria Gravgaard

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## **SUMMARY**

This report covers the conservation of a human skull with preserved organic materials from the 1977-1987 West Heslerton excavation: grave 123: skeleton 2BA606, Laboratory number 8650177. It includes results from the 1978-1991 investigative conservation and results from further investigative conservation undertaken in 2010 to assess the skull and to record and determine materials. Remedial conservation was undertaken in 2010 to remove the skull from its soil block.

## **CONTRIBUTORS**

Ada-Maria Gravgaard

## **ACKNOWLEDGEMENTS**

Simon Mays (EH) for identification of bone fragments and Karla Graham (EH) for editing this report.

## **ARCHIVE LOCATION**

The skull is to be deposited with the remaining physical archive at Hull Museum. The digital SEM and FTIR data are archived at English Heritage, Fort Cumberland.

## **DATE OF RESEARCH**

2010-2011

## **CONTACT DETAILS**

Archaeological Conservation and Technology team, Fort Cumberland, Fort Cumberland Road, Eastney, Portsmouth PO4 9LD

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## INTRODUCTION

The early Anglo-Saxon cemetery at West Heslerton, North Yorkshire was excavated on a seasonal basis between 1977 and 1987. The project was undertaken as part of the national rescue archaeology programme with funding provided by English Heritage (formerly the Department of the Environment) through North Yorkshire County Council. The excavation was one of the first in the north of England to investigate finds using modern techniques. An appraisal of the excavation can be found in the published excavation reports (Haughton et al 1999a and 1999b).

This report covers a human skull from West Heslerton grave 123: skeleton 2BA606, Laboratory number 8650177. The skull, which has preserved organic materials, was still in a soil block at the start of this project.

A summary of the work and analysis already undertaken is presented in this report together with a review and an assessment of the human skull based on new investigative conservation undertaken in 2010. Excavation and cleaning of the skull was also undertaken to stabilise the object for archive deposition.



*Figure 1: Grave 123: skeleton 2BA606, Laboratory number 8650177. Skull before it was removed from the excavation (from Haughton and Powlesland 1999b, 209).*

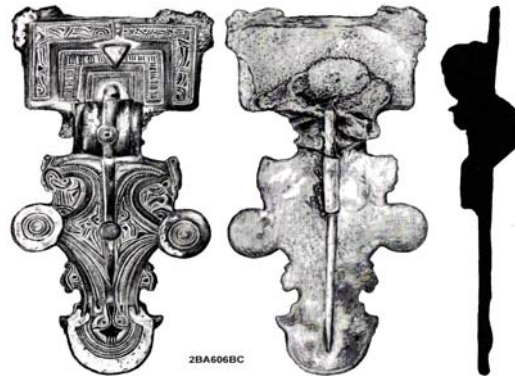
## RESULTS TO DATE (HAUGHTON AND POWLESLAND 1999A AND 1999B)

The following description is derived from Haughton et al Volume II, *Grave 123* (1999b) and Haughton et al Volume I *The textiles* (1999a).

The skeleton was excavated in 1977 from an acidic environment of sandy soil. During excavation, the front part of the skull was cleaned *in-situ* which revealed the preservation of a facial structure including teeth and mandible as shown in figure 1. The skull was assessed as being comparatively well-preserved except for the teeth; of which several had



suffered such extreme attrition that only the roots had survived. The right side of the cranium was resting on a very elaborate brooch of copper alloy with an iron pin (see figure 2). The toxic copper alloy corrosion products had prevented microorganisms from breaking down the organic materials on the right part of the skull. The structure of the right ear was preserved by replacement of the organic material with corrosion products from the iron pin. Detailed information on the brooch can be found in the excavation catalogue (Haughton et al 1999b, Grave 123).



*Figure 2: the copper alloy brooch, which was placed underneath the skull in the grave (from Haughton and Powlesland 1999b, 207).*

Since excavation, the skull had been stored in a soil block with the front left part of the skull covered by soil and the area in which the organics have been preserved exposed (see figure 3).

The excavation catalogue noted that a corrosion-replaced right ear, an unidentified small thread from a braid and a cremated but complete adult foot phalanx were present in the soil block.

After the excavation the skull was brought into the Historic Building and Monuments Commission (HBMC) laboratory for examination and recording. The skull and organic materials were not fully conserved and removed from the soil block. According to the excavation catalogue examinations of the teeth and headdress were made but an investigation of the skull was impossible due to the condition and presence of the textiles.



*Figure 3: The two images show the right side of the skull when the skull was brought into the HBMC laboratory after excavation [Negative reference numbers A860883 and A860869]. The right image is a close up of the organic materials preserved on the skull.*

## **Age and Sex**

Based on examinations of skeleton and teeth, undertaken by Margaret Cox, the skeleton was determined to be a female aged over 50 at death. More detailed information on the teeth can be found in the excavation catalogue (Haughton et al 1999b, Grave 123).

## **Preserved Organics**

Three different textiles were identified on the skull (tabby, diamond twill wool and braid) together with the woman's own hair (see figure 3). Weave, yarn type and thread-count were identified by using a hand-lens or a low power binocular microscope. The fibres in the textiles were identified by using a high power transmitted-light microscope, fitted with polarising analyser and scanning electron microscope (SEM) images. The SEM work was undertaken by Jacqui Watson and J. Webb from English Heritage. All other work on the textiles was undertaken by Penelope Walton Rogers.

## **Tabby**

On the right side of the cranium, a very fine, gauzy tabby, was found, of unidentified material. A folded edge runs horizontally across the temple and over the right ear and is edged by a narrow tablet-woven braid. A red dye of wild madder or bedstraw was detected in the tabby by spectrophotometry and thin layer chromatography. It was not possible to determine whether the red tabby is the upper part of a head veil or some other part of a headdress. Unfortunately no traces of the same textile were detectable on the shoulder brooches in the grave, although the lightweight character of the weave is typical of the veils in other graves.



## **Diamond twill wool**

Another textile was identified as wool, woven in diamond twill. The textile was in contact with the copper alloy brooch but was not pinned by it. The textile was pinned by brooches at the shoulders.

## **Braid**

A braid was preserved on the cranium, next to the right ear bone. The braid was preserved in its complete width of 9 mm. The braid had outer borders; each with two wool warp cords (*see figure 11a*). In the middle was a decayed area in which the wool weft is clear, but there are also traces of a linen wrap, which passed over the weft in places. It was not clear whether this band had been brocaded, with the pattern carried by a weft thread floating on the surface of the weave; or warp-patterned, the pattern formed by differently coloured yarn in the wrap (*see figure 11a*). The braid showed a trace of the same colour as the one identified in the tabby, although this may have bled from the tabby.

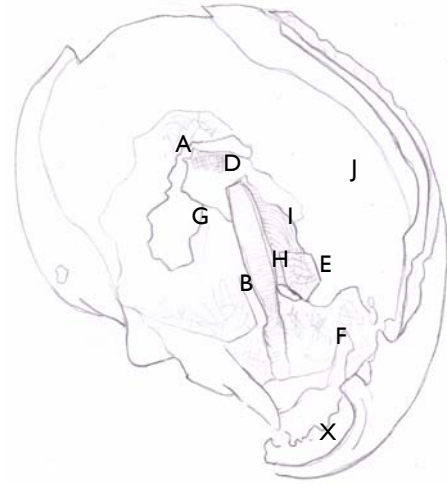
## **Hair**

At the time of excavation, a strand of hair was pulled back from the temple, behind the braid, while the rest of the hair seemed to be hanging downwards.

# **INVESTIGATIVE CONSERVATION 2010**

## **Methodology**

To assess condition, the skull was X-rayed in 2010 at Fort Cumberland using Computed Radiography (Kodak Industrex imaging plates and a Kodak Industrex HPX-I scanner) and an AGO HS 225kV Hi-Stability x-ray system. Industrial AGFA D4 film was also used and the X-radiographs packaged in polyester sleeves. The supposed corrosion replaced right ear and the loose braid were X-rayed using Computed Radiography to assure the accuracy of the identification of the ear and to try and determine weaving details on the braid.



A: Textile, loosely woven  
 C: Fibre from glass (not showed in fig.)  
 E: A loose part of textile, loosely woven  
 G: Bare green skull where brooch has been sitting  
 I: Hair  
 X: removed rust replaced ear

B: Textile, loosely woven  
 D: Textile, tightly woven  
 F: Textile, loosely woven  
 H: Braid  
 J: Black deposit

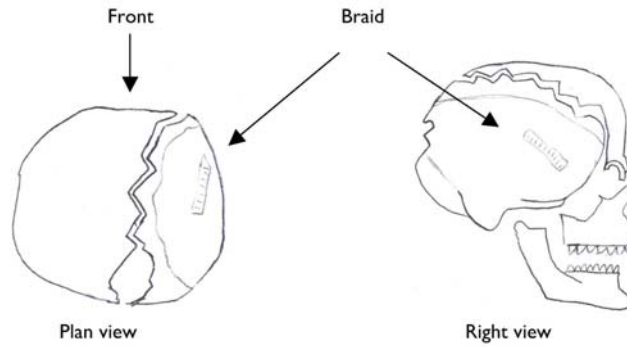
*Figure 4: Photograph and sketch of the right side of the skull including organic materials. Fibre samples have been taken from area A, B, D, E, F, J to identify organic materials.*

An examination of the object was made by using low power binocular magnification to record the organic materials and to make a conservation assessment of the skull. Fibre samples were taken from the cranium and examined under high power transmitted-light microscope and by SEM to identify and distinguish materials (see figure 4 and table 1). Samples were taken from black deposits on the skull and examined by FTIR (see figure 4 and table 1).

## Condition

The skull is in two main pieces and extremely fragile. A crack separates the right part from the rest of the cranium and a large hole is present in the back of the skull (figures 5). The face structure no longer exists as it did at the time of excavation (see figure 1). Only two teeth roots are still present in the soil block.

A corroded object (corrosion replaced right ear) with textile and hair impressions is loosely placed in front of the skull (see figures 4, 6 and 13). A small thread from the braid was located in a glass vial next to the skull.



*Figure 5: Image showing an overview of cracks and disconnections on the skull. The mandible and maxilla are scattered in small fragments but are included complete on the sketch to get a better understanding of the cranium.*

On the right part of the cranium organic material is either preserved or replaced by minerals caused by copper alloy corrosion. The corrosion has resulted in the right part of the cranium together with some hair, turning green, especially in the area covered by organic material and where the brooch has been sitting (see figure 4). The organic material includes hair, a woven braid, woven textile (the tabby and the diamond twill) and black deposit (thin layer) on the right part of the skull (see figure 4).

The organic material is stiff and dry. The woven braid together with other organic fragments is loosely sitting on top of the skull (see figure 4). Some of the organic material has disappeared from the skull since the excavation (see figure 3 and 4). This is especially evident in the area at the right side of the braid. It is not known whether the organics have been removed for testing, storage or have decomposed. Roots from the soil are entangled in the organic material.

### **X-radiography results**

The X-ray images did not show any coherent bone structure to indicate that either the mandible or maxilla were located in the soil block. Small bone fragments are scattered underneath the cranium. The skull is partly held together by the soil inside the skull and partly by the way the skull is packed (see figures 4 and 6). The soil is dry and sandy and falls apart easily.

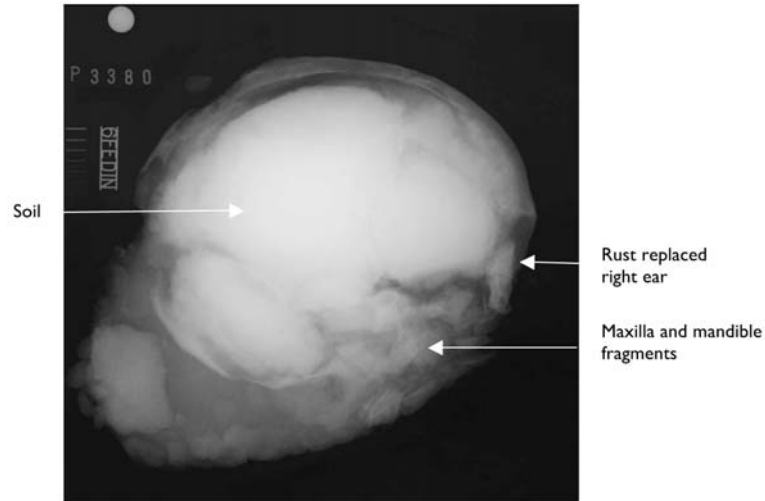


Figure 6: Computed radiography image of cranium from side view (P3380: 80kV, 3mA, 1 minute)

## Identification of Organics

Table 1: An overview of samples taken from the skull for analysis

| Number of sample | Location              | Description of textile/area           | Analysing technique | Result                                      |
|------------------|-----------------------|---------------------------------------|---------------------|---|
| 1                | A in figure 4         | Loosely woven textile (Tabby).        | SEM                 | Flat vegetable fibre (figure 7)             |
| 2                | B in figure 4         | Loosely woven textile (Tabby).        | SEM                 | Flat vegetable fibre (figure 8)             |
| 3                | Fibre from glass vial | Fibre from glass vial                 | SEM                 | Round fibre (figure 9)                      |
| 4                | D in figure 4         | Tightly woven (diamond twill)         | SEM                 | Unidentified fibre (figure 10)              |
| 5                | E in figure 4         | Loosely woven textile (Tabby)         | SEM                 | Flat vegetable fibre                        |
| 6                | F in figure 4         | Loosely woven textile (Tabby)         | SEM                 | Flat vegetable fibre                        |
| 7.1 and 7.2      | J in figure 4         | Black deposit                         | FTIR                | Protein with no structure (figures 14 & 15) |
| 8                | Figure 13             | Impression of weave from corroded ear | SEM                 | Round fibre (figure 12)                     |

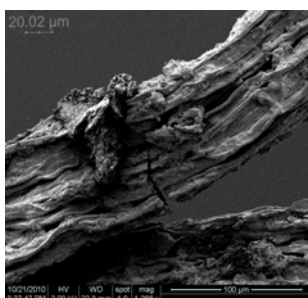
Fibre samples were taken from 7 different areas on the skull and one sample was taken from the thread in the glass vial (sample 3) as shown in table 1 and figure 4. The fibre samples were examined using both a high power transmitted-light microscope and SEM (see figures 7 to 10). The fibres are very stiff, dirty and damaged.

A small sample was taken from the imprint on the corroded object (the ear) and examined using SEM (sample 8 see figure 12). One sample was taken from the black

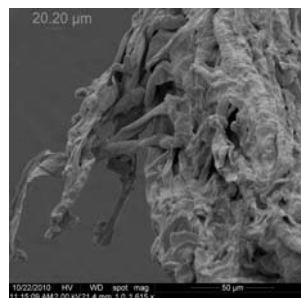
deposit with no structure (samples 7.1 and 7.2, *see* figure 4) and examined by Fourier transform infrared spectroscopy (FTIR) analysis (*see* figures 14 and 15).

## Tabby

Sample numbers 1, 2, 5 and 6 are taken from areas with loose, gauzy woven textile. The flat fibres are all identified as vegetable fibres (most likely to be hemp, *see* figure 7 and 8). The similar weave and fibre suggests that the samples are likely to belong to the tabby described in the Catalogue of the West Heslerton Cemetery (Haughton et al 1999a, *The textiles*). The tabby seems to cover most of the area around the right ear bone. As described in the catalogue the tabby is folded so that as an edge can be seen running horizontally across the temple and over the right ear (*see* figure 4).



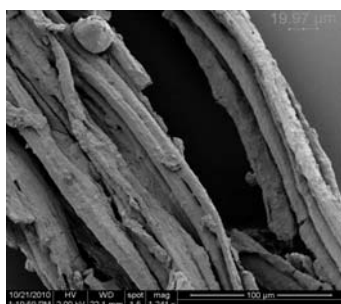
*Figure 7: SEM image of sample 1, flat fibres. A crack and dirt is showing on the fibres*



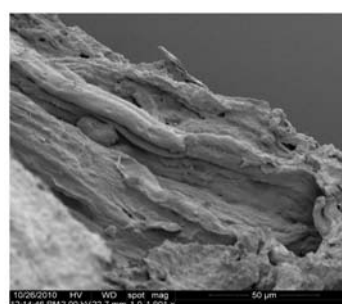
*Figure 8: SEM image of sample 2, Flat fibre*

## Diamond twill

Sample 4 is taken from the diamond twill placed at the end of the braid (*see* figures 4 and 10). The textile appears at the end and left of the braid but, according to the catalogue, the textile was also sitting underneath the removed brooch at the right of the braid. The textile has earlier been identified as wool.



*Figure 9: SEM image of sample 3, round fibres from glass vial.*



*Figure 10: SEM image of sample 4, from tightly woven textile*

## The braid

The braid is too stiff and fragile to sample. The catalogue identifies the braid as wool and linen. The fibres from the glass vial (sample 3) are not identified but they do not resemble the flat fibres recognized in the tabby (see figure 7 and 8). The X-ray image shows a more detailed picture of the weaving (see figure 11b). The sketch in figure 11c shows a band, which, according to the catalogue, resembles the weaving of the braid.

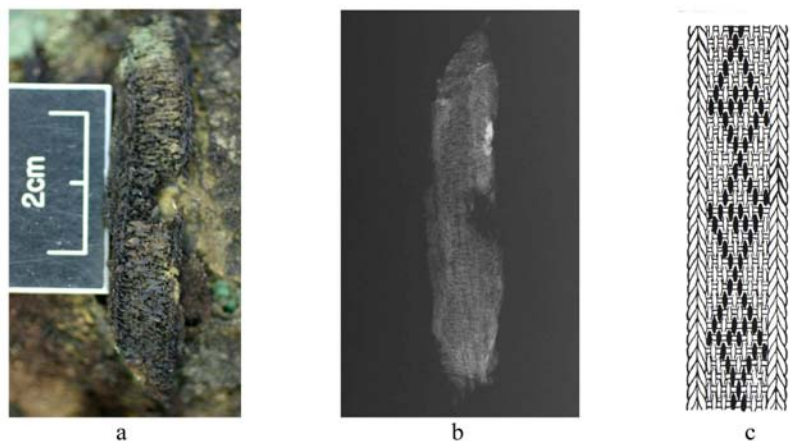


Figure 11: (a) shows a picture of the braid, (b) shows a Computed radiography image of the braid and image P3523: 25kV, 2mA, 0.5 minute), (c) shows a sketch of a warp-patterned band that resemble the braid on the skull (Haughton et al 1999a fig 72a). The exact geometric design of the braid is not known.

### Iron corroded object (ear)

The fibre and weave is not completely clear from SEM-images of the impression on the iron corroded object. The textile resembles the diamond twill in weaving. In a few areas a structure with scales was observed. The round and large fibres might therefore be identified as animal fibres, likely wool (see figure 12).

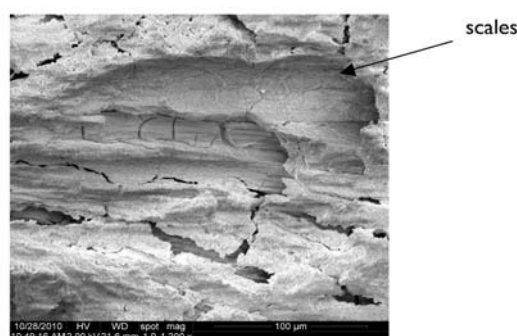


Figure 12: SEM image of sample 8, an imprint of a fibre with scales, likely to be a wool fibre

The X-ray image does not reveal any iron inside the supposed corrosion replaced ear. The X-ray image and the shape of the object imply that the object is the corrosion replaced ear described in the catalogue (see figure 13c).



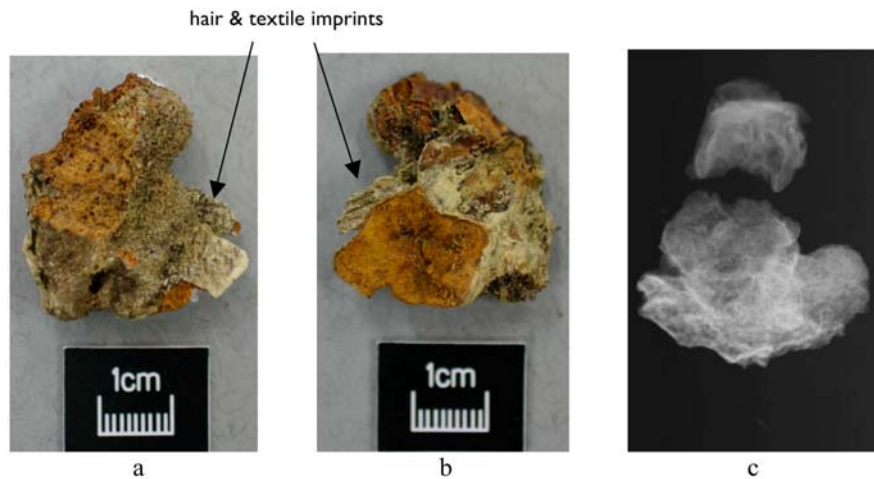


Figure 13: Corrosion replaced right ear from the front (a) and back (b). On the front of the ear an impression of a woven textile is showing. A hair imprint is present on the back of the ear. (c) is showing a Computed Radiography image of the ear (P3524: 90kV, 3mA, 1 minute)

### Identification of black deposit

FTIR-spectroscopy analysis identified the black deposit as a protein. The FTIR spectra show a high similarity to wool (see figure 14) but the possibility of the deposit being leather cannot be completely dismissed (see figure 15).

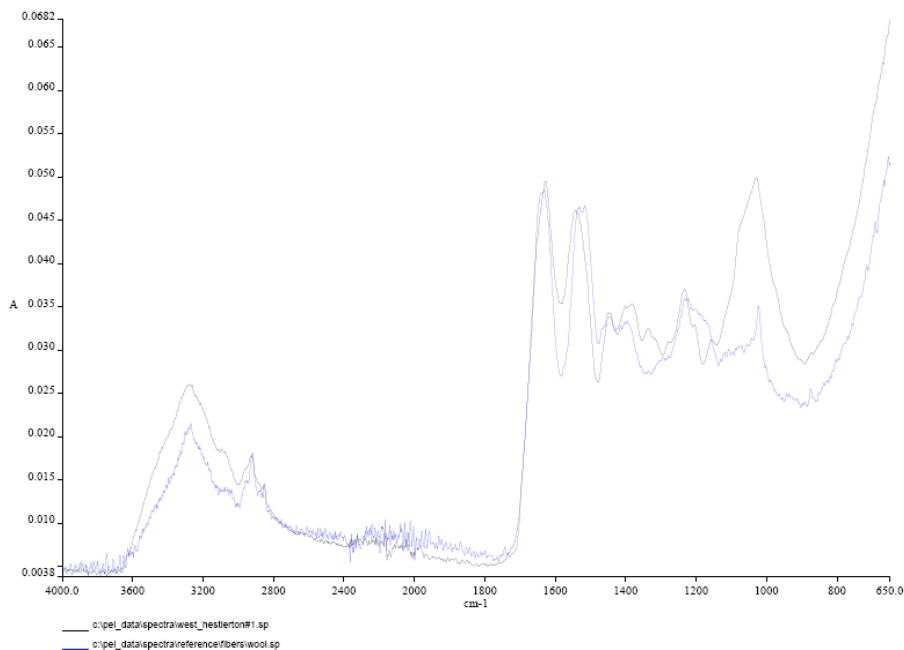


Figure 14: Image shows the FTIR spectre (black spectra) of the black deposit on the skull (Sample 7.1) and the FTIR spectra (blue) of a wool reference.

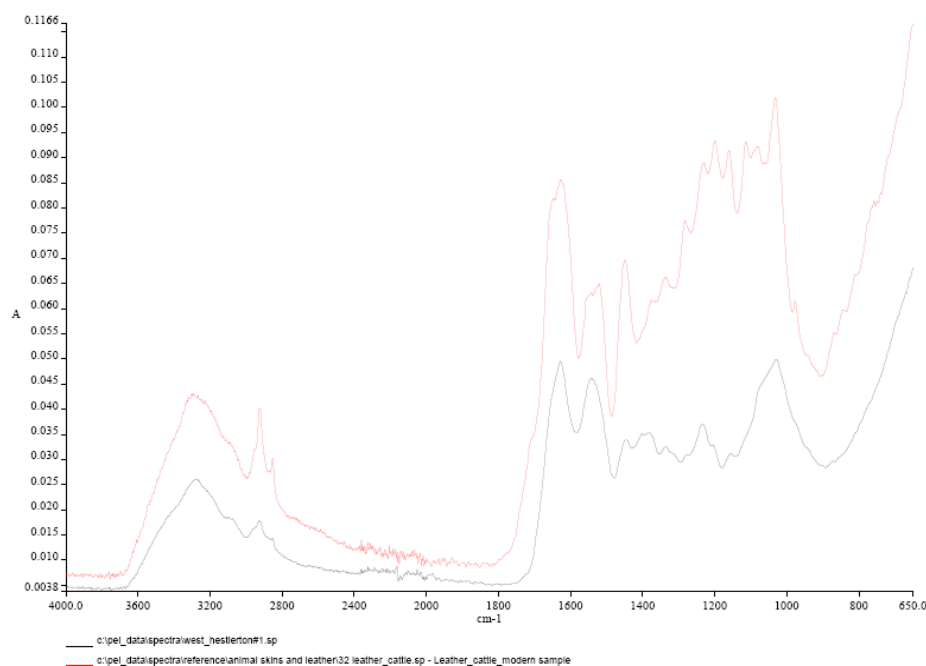


Figure 15: Image shows the FTIR spectre (black spectra) of the black deposit on the skull (Sample 7.2) and the FTIR spectra (red) of a leather reference.

## REMEDIAL CONSERVATION

As the skull was still in a soil block an excavation was needed to both investigate the object and to ensure the future stability of the skull. Before excavation most of the sand and vegetable roots were removed from the surface of the skull. This was undertaken to be able to distinguish and identify details in the organic material and to remove destructive and disintegrating dirt from the bone surface.

### Temporary consolidation for excavation

The exposed parts of the skull were temporarily covered and consolidated with the adhesive cyclododecane together with acid free tissue paper in order to protect the organic remains from damage whilst excavating the skull. Cyclododecane is a waxy consolidant that is able to sublime at room temperature over a period of days or weeks leaving no apparent residue and without contaminating the bone. Conservators have been using Cyclododecane as a temporary consolidant, binding medium, adhesive and support material since 1995 with good results. The chemical has been used on a wide variety of materials such as wall paintings, plaster, ceramic, paper, textiles and metal (Rowe and Rozeik 2008).

The adhesive is heated to approximately 60°C and applied to an object as liquid which then solidifies. A piece of acid free tissue paper was placed over the organic material to protect it from the warm wax (see figure 16). Strips of acid free tissue were then attached

with warm cyclododecane: one end was attached to the large piece of tissue paper and one end to the exposed parts of the skull.



*Figure 16: Images showing the application of cyclododecane and tissue paper*

### **Excavation and packing of skull**

After the consolidant and supporting tissue paper were applied, it was possible to lift the right part of the skull onto a pillow made of unbleached cotton and polyester batting (see figure 17). The rest of the skull was carefully excavated with small hand tools (spatula, wooden stick, brushes and a spoon). The soil was sieved after the excavation to ensure that no bone fragments were overlooked.



*Figure 17: The right part of the skull removed from the rest of the object before further excavation (left) and placed on a pillow (right)*

The remaining left part of the skull was excavated and lifted into a cardboard box padded with cotton and attached cords for handling. A protecting pillow was placed in the interior of the skull fragment.



*Figure 18: Images showing the left part of the cranium after removal of all soil (left) and placed in a padded cardboard box.*

Small fragments of bone were excavated from inside the skull and divided into the areas where they were found, identified if possible (Simon Mays pers com 2011) and kept in small cardboard boxes padded with acid free tissue paper.

After two months all of the cyclododecane had sublimed and it was possible to remove the supporting tissue paper without damaging the bone and lift the pillow with the right part of the skull into a cardboard box padded with cotton with attached cords for handling (see figure 19).



*Figure 19: Image showing the right part of the skull packed in a padded cardboard box*

## STORAGE RECOMMENDATION

The skull is kept in archival cardboard boxes and should be kept in a steady environment, (ideally at 55% RH and at 18°C) and direct sunlight should be avoided (Brown 2007 and Bodtfeldt 2008).

## CONCLUSION

The skull was excavated successfully by using cyclododecane. At least two different textiles are identified on the skull together with a corroded ear and two teeth. It is possible that the mandible and teeth have been removed from the soil block when analysing the teeth. No foot phalanx was identified despite that it was listed as being a part of the object in the catalogue.

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