RESEARCH DEPARTMENT REPORT SERIES no. 84-2011 ISSN 1749-8775

ST AUGUSTINE'S ABBEY, CANTERBURY, KENT INVESTIGATIVE CONSERVATION OF A HUMAN SKULL

ARCHAEOLOGICAL CONSERVATION REPORT

Ada-Maria Gravgaard and Karla Graham

ARCHAEOLOGICAL SCIENCE

ENGLISH HERITAGE

Research Department Report Series 84-2011

ST. AUGUSTINE'S ABBEY
CANTERBURY
KENT

INVESTIGATIVE CONSERVATION OF A HUMAN SKULL

Ada-Maria Gravgaard and Karla Graham

NGR: TR 1549 5785

ISSN 1749-8775

SUMMARY

St. Augustine's Abbey, Canterbury was founded shortly after AD 597 as a burial place for the Anglo-Saxon kings of Kent. This report covers the investigative conservation of some of the human remains (a skull) on display at the museum. The skull exhibited surface flaking and cracking and the aim of the investigative conservation was to identify the cause of this deterioration. Remedial conservation was also undertaken.

CONTRIBUTORS

Ada-Maria Gravgaard and Karla Graham

ACKNOWLEDGEMENTS

Thanks to the following individuals: Joanne Gray (Regional Curator) for providing background information; Sarah Paynter (Archaeological Conservation and Technology) for assistance with the XRD analysis and Vince Griffin (Archaeological Graphics) for assistance with figures 3 and 4.

ARCHIVE LOCATION

The analytical data (XRF and XRD) are archived at Fort Cumberland. The human remains are on display at St. Augustine's Abbey, Canterbury, Kent CT1 1TF

DATE OF RESEARCH

2010-11

CONTACT DETAILS

Archaeological Conservation and Technology team, Fort Cumberland, Fort Cumberland Road, Eastney, Portsmouth PO4 9LD
Karla Graham: karla.graham@english-heritage.org.uk

CONTENTS

INTRODUCTION

St. Augustine's Abbey, Canterbury was founded shortly after AD 597 as a burial place for the Anglo-Saxon kings of Kent. This report covers the investigative conservation of some of the human remains (a skull) on display at the museum (English Heritage accession number 88211412). The skull exhibited surface flaking and cracking and the aim of the investigative conservation was to identify the cause of this deterioration. Remedial conservation was also undertaken.

The skull is part of a skeleton displayed in a lead coffin. The skeleton was buried in the lead coffin with an outer coffin probably of oak. Only fragments of the inner coffin survived. At the time of the excavation the lead coffin was extremely corroded in the area underlying the torso but was otherwise in an excellent state of preservation as was the skeleton inside it. The head was wrapped in a woollen bandage, the hair and organic matter surviving within this wrapping. The skeleton was identified as a woman aged between 18 and 25 (Sherlock and Woods 1988).

ASSESSMENT METHOD

The skull was examined under binocular magnification and X-rayed at Fort Cumberland. Computed Radiography (Kodak Industrex imaging plates and a Kodak Industrex HPX-1 scanner) and an AGO HS 225kV Hi-Stability X-ray system were used. Industrial AGFA D4 film was also used and the X-radiographs packaged in archival enclosures (polyester sleeves and acid free envelopes). A sample of white deposits was taken from an area under the right eye socket and examined by X-ray fluorescence (XRF) and X-ray diffraction (XRD) analysis.

ASSESSMENT RESULTS

Condition

The skull consists of four parts: cranium, forehead, mandible and maxilla. The four parts are disconnected from each other and the mandible is furthermore broken into two fragments (Figs. 1 to 4).

Bone

The bone is fragile and has several cracks and surface flaking (Figs. 5 to 7). The surface is dirty and has areas of white powdery discolorations (Figs. 5a and 5f). The discolorations may have been caused by chemical degradation during burial, especially considering the

bone has been buried together with lead and oak (*see* Discussion). A sample from under the right eye socket was examined by XRD and XRF analysis and identified as containing the lead salt pyromorphite $Pb_5(PO_4)_3Cl$ (*see* Figs. 5c, 8 and 9). The surface flaking and powdery white bone is most likely to be caused by the formation of pyromorphite and associated volume changes.

Figure 1: The cranium from superior (left) and inferior (right) view

Figure 2: The forehead from superior (left) and inferior (right) view.

Teeth

The teeth are dirty but for the most part they are in a relatively good condition (Figs. 3-4).

Maxilla

Three teeth are missing: the two third molars and right second incisor (Fig. 3b). Five teeth are loosely set in their sockets: right second premolar, the two first incisors, left second incisor and left canine (Fig. 3b). Three teeth are flaking and the left canine tooth has a large crack (Fig. 3d and 4b). A cavity can be seen in the second molar on the right (Fig. 3b).

Mandible

Five teeth are loosely set in their sockets: the two second incisor, the two first incisors and second premolar at the left (Fig. 3a). The left second incisor has cracked so only the root remains. Three teeth have cavities: both second molars and the right canine (Figs. 3a and 4a).

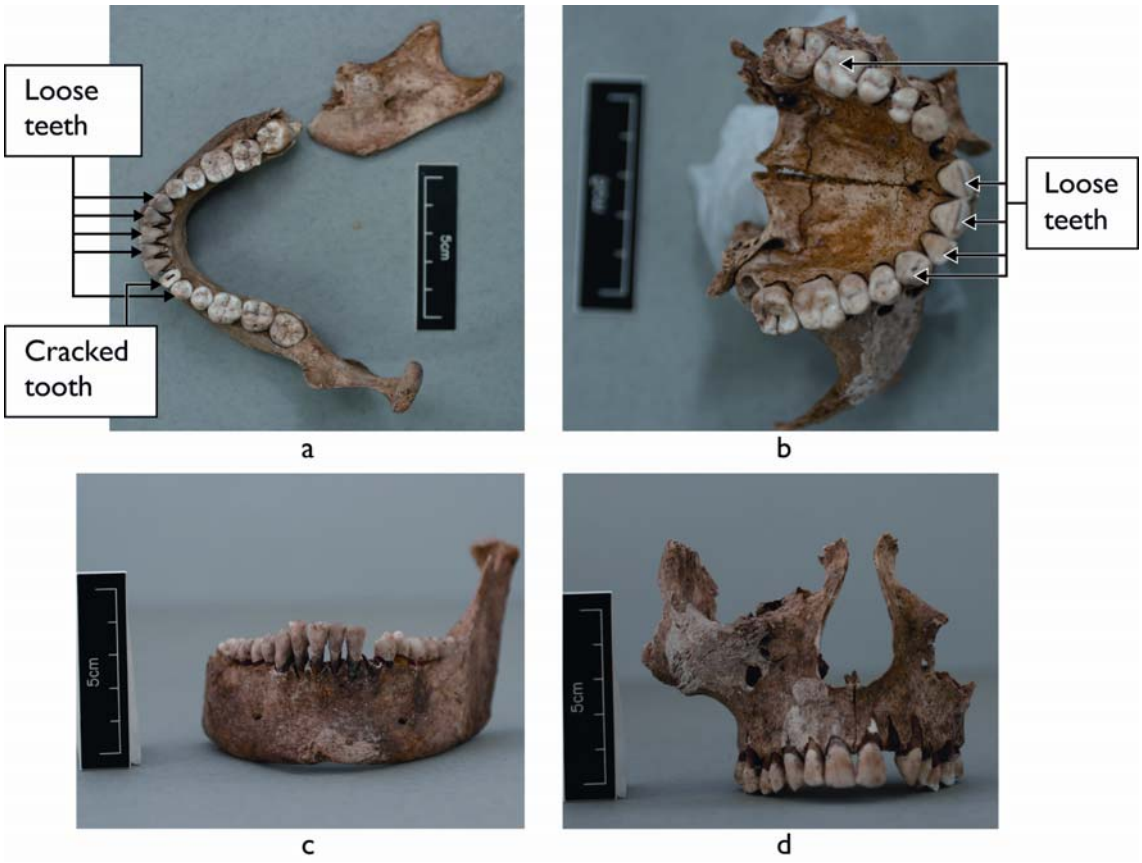


Figure 3: Maxilla (a & c) and mandible (b & d) from plan and side view

Figure 4: Detail of maxilla and teeth

CONSERVATION

Dirt and mould were removed from the cranium with a 50% solution of Industrial Methylated Spirits (ethanol>85%, methanol<5%) and distilled water. The most fragile parts of the skull (Fig. 5) were consolidated using a 10% solution of Paraloid B72 (ethyl methacrylate) to prevent further surface loss. Paraloid B72 is one of the most stable polymers available and has the advantage of being stronger and less brittle than other popular consolidants for conservation (Johnson 1994, Koob 1986). The two mandible fragments were reattached using Paraloid B72.

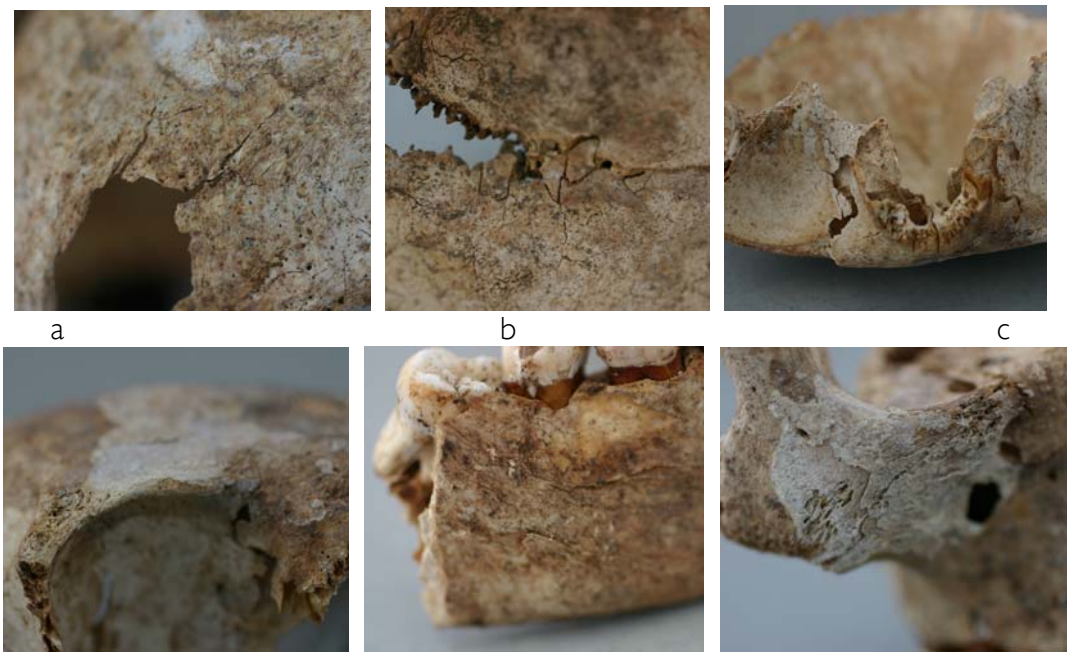


Figure 5: a: Hairline cracks on the front of the cranium
b: Open suture with loose bone fragments from cranium
c: Perforation in eye socket
d: Damaged bone and salt deposits by eye socket
e: Flaking surface on mandible
f: Discoloured powdery bone with salt deposits under right eye socket

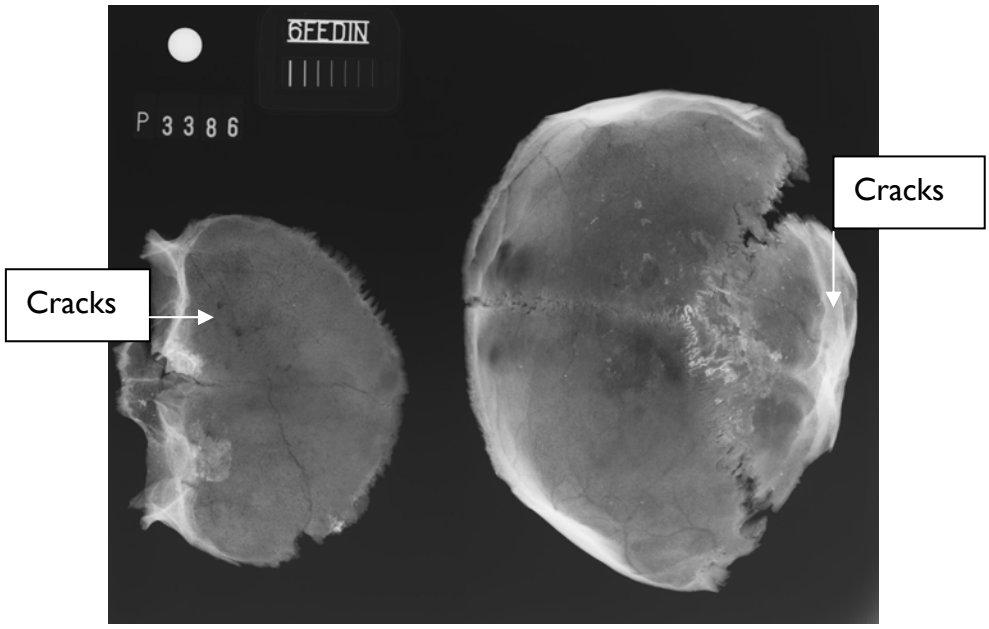


Figure 6: Computed radiography image: Inferior view of Cranium (right) and forehead (left) (P3386: 60kV, 3mA, 1.5 minutes; 1 meter distance)

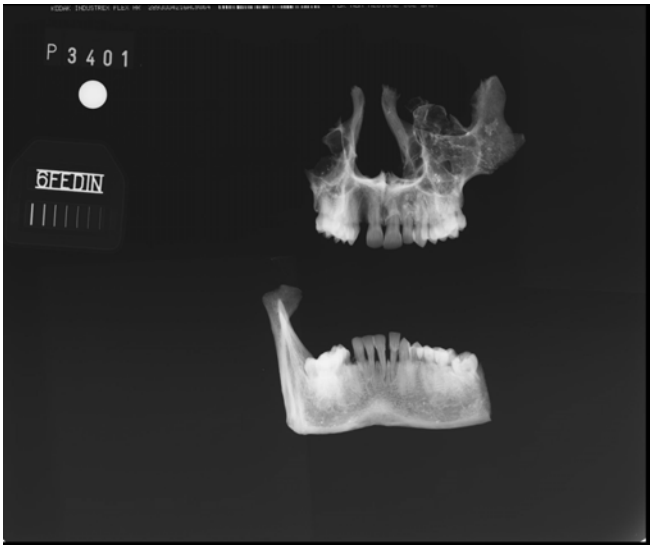


Figure 7: Computed radiography image: Front view of maxilla (top) and mandible (bottom) (P3401: 60kV, 3mA, 2.5 minutes; 1 meter distance).

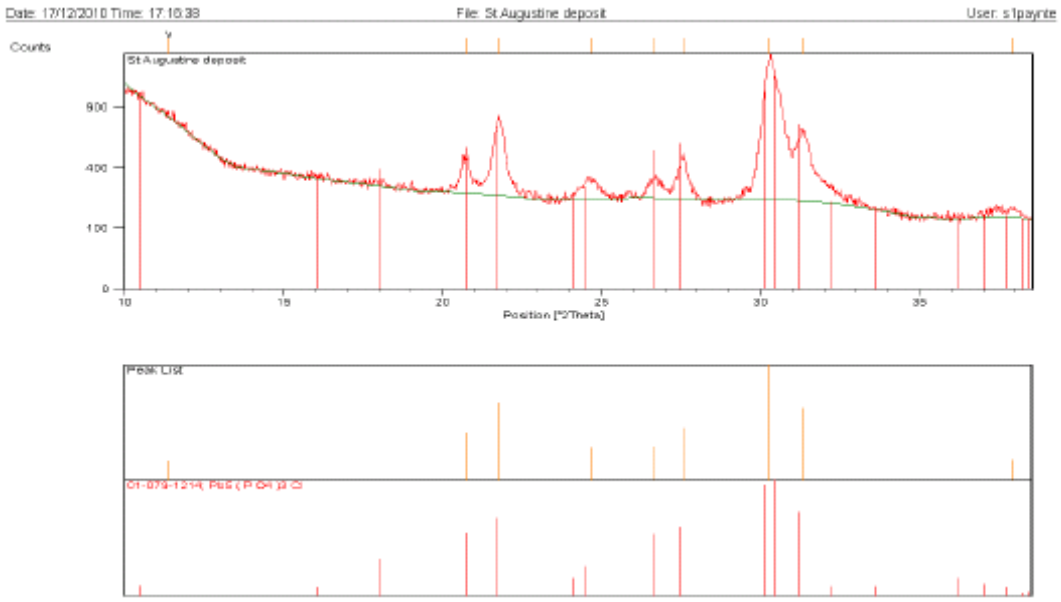
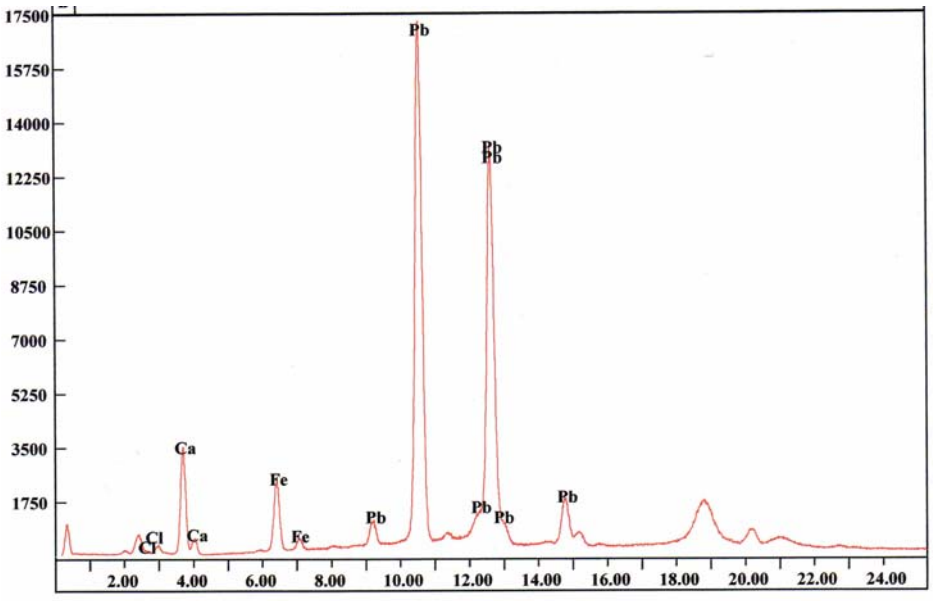


Figure 8: Image showing the XRD spectrum of the sample taken from under right eye socket. The red columns are a reference showing peaks of Pyromorphite . The yellow columns are showing the actual peaks of the sample. The figure shows that the sample peaks are generally placed in the same areas as the reference, which means that the sample can be identified as Pyromorphite.



1:19 PM 17-Dec-2010

Elem:	Net	Wt%	At%	Error%	BG	P/B
ClK	4.6	0.82	2.4	4.29	2.3	1.95
CaK	127.7	20.65	53.9	0.58	2.6	48.92
FeK	93.2	2.99	5.6	0.73	8.6	10.82
PbL	824.2	75.54	38.1	0.23	27.0	30.54

Figure 9: Image showing the XRF spectrum of the sample taken from under right eye socket. The calculation table underneath the spectrum confirms the XRF results by identifying that a large amount of lead and a small amount of chlorides are present in the sample.

DISCUSSION

The investigative conservation suggests that the deterioration of the skull was caused by the proximity of the lead coffin to the bone and, the environmental conditions. The presence of the lead salt pyromorphite indicates that the lead coffin corroded and mobile lead has reacted with water, oxygen and chlorides from the environment to form lead chlorides. These chlorides have reacted with phosphate ions from the degraded bone to form pyromorphite (Zhang 2002). The volume changes associated with the salt formation would seem to have resulted in the physical damage (surface flaking) and deposits observed.

Causes of bone and lead deterioration include:

- Elevated relative humidity (RH).
- The presence of chlorides. These could be from remaining burial environment soil or the display environment (Thickett and Lee 2004).
- The presence of organic acids. These are damaging to both bone and lead and it is recommended to identify if any organic acids are present in the environment. This can be achieved by examining the lead coffin for evidence of active corrosion (areas of white powder)[1]. In display environments, the sources are usually wood (with oak and cedar being the worst), wood products, paint and cleaning products (Thickett and Lee 2004, Selwyn 2004 and Botfeldt 2008).

It is recommended to keep the skull in a stable environment, ideally at 55% RH and at 18°C. If the RH falls below 45% the bones will start to crack; if the RH increases above 60% microorganisms may appear (Bodtfeldt 2008). The display condition for lead in a mixed collection is 50% RH (MGC 1992).

REFERENCES

Botfeldt, K 2008 *Konservering af Knogler, Tak og Tænder [Conservation of Bone, Antler and Teeth]*. Copenhagen: Konservatorskolen, Det Kongelige Danske Kunstakademi

Johnson, JS 1994 'Consolidation of Archeaological Bone: A Conservation Perspective'. *Journal of Field Archaeology* 21

Koob, SP 1986 'The Use of Paraloid B-72 as an Adhesive: Its Application for Archaeological Materials', *Studies in Conservation* 31, 7-14

[1] Lead corrosion products are toxic which should be taken into consideration when working in the environment.

Museums and Galleries Commission 1992 *Standards in the Museum Care of Archaeological Collections.* London: Museums and Galleries Commission

Selwyn, L 2004 *Metals and Corrosion: A Handbook for the Conservation Professional*. Ottawa: Canadian Conservation Institute, Canadian Heritage

Sherlock, D and Woods, H 1988 *St. Augustine's Abbey: Report on Excavation, 1960-78*. Maidstone: Kent Archaeological Society

Thickett, D and Lee, LR 2004 *The selection of materials for the display and storage of museum objects.* The British Museum Occasional Paper Number 111. London: The British Museum

Zhang, X 2002 'An unusual corrosion product, pyromorphite, from a Bronze An: A technical note', *Studies in Conservation* 47 (1), 76-79






ENGLISH HERITAGE RESEARCH DEPARTMENT

English Heritage undertakes and commissions research into the historic environment, and the issues that affect its condition and survival, in order to provide the understanding necessary for informed policy and decision making, for sustainable management, and to promote the widest access, appreciation and enjoyment of our heritage.

The Research Department provides English Heritage with this capacity in the fields of buildings history, archaeology, and landscape history. It brings together seven teams with complementary investigative and analytical skills to provide integrated research expertise across the range of the historic environment. These are:

* *Aerial Survey and Investigation*
* *Archaeological Projects (excavation)*
* *Archaeological Science*
* *Archaeological Survey and Investigation (landscape analysis)*
* *Architectural Investigation*
* *Imaging, Graphics and Survey (including measured and metric survey, and photography)*
* *Survey of London*

The Research Department undertakes a wide range of investigative and analytical projects, and provides quality assurance and management support for externally-commissioned research. We aim for innovative work of the highest quality which will set agendas and standards for the historic environment sector. In support of this, and to build capacity and promote best practice in the sector, we also publish guidance and provide advice and training. We support outreach and education activities and build these in to our projects and programmes wherever possible.

We make the results of our work available through the Research Department Report Series, and through journal publications and monographs. Our publication Research News, which appears three times a year, aims to keep our partners within and outside English Heritage up-to-date with our projects and activities. A full list of Research Department Reports, with abstracts and information on how to obtain copies, may be found on www.english-heritage.org.uk/researchreports

For further information visit www.english-heritage.org.uk

ENGLISH HERITAGE