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LE CATILLON II: CONSERVING THE WORLD'S LARGEST IRON AGE HOARD

Abstract

In early 2012, two amateur metal detectorists in the British Channel Isle of Jersey discovered the Le Catillon II Iron Age hoard. This contained over sixty-nine thousand coins, eight complete gold torques and numerous other pieces of jewellery. The hoard appears to have been buried around 30-40BCE by the Coriosolitae tribe from the nearby French coast and is the largest Celtic hoard ever discovered. It was excavated intact and transferred to a conservation laboratory on the island. Here it was decided to disassemble the hoard and record its contents at a level of detail never attempted before. A computer controlled six axis metrology arm with a contact probe point head was used to record the position of every coin and other item to a sub centimetre accuracy before removal. A laser scanner was also used to record the entire hoard at various stages of disassembly. In this way, a complete three-dimensional virtual map of the hoard contents was created. Work is now being done to link this map to the object database so that it may be interrogated for distributions of different ages, types, makers of coins etc.

Keywords

Le Catillon II, Hoard, Numismatic and Archaeometry

The Catillon II hoard was discovered in May 2012 by two local metal detectorists, Reg Mead and Richard Miles. On realizing what they'd found, they refilled the hole immediately and contacted Jersey Heritage, the professional museum body on the island. A team of local archaeologists and a conservator was then formed and began the excavation four weeks later. Only a two by two metre hole was dug because at that time it was expected that only a small hoard of several hundred coins, possibly in a pot, would be found. In fact, it soon became apparent that the hoard was much larger. Indeed it wasn't until the end of the second day that all of the hoard's edges were uncovered. It was apparently completely composed of coins fused together by a layer of green corrosion product. Even at this stage it was possible to tell that many of the coins were silver/copper alloy staters and quarter staters made by the Coriosolitae tribe of Celts from the neighbouring French coast in the second half of the first century BCE (Philip De Jersey, Guernsey Museums Archaeologist, conversation with authors, July 2012). The hoard was found to measure approximately 140 x 70 x 15cm in size.

Once the hoard was fully visible its importance became obvious. It was therefore decided to excavate it intact in one block if possible. In order to keep it damp during the excavation period, a thin layer (10-30mm) of earth was left on its top and side surfaces, (fig.1). A layer of earth between 150 and 200mm thick was left beneath the hoard to act both as a supporting base and as a reservoir of water in order to buffer the hoard itself. The entire exposed area of the block was wrapped in Clingfilm at all times when not being worked on.

For the hoard's safe extraction from the trench, the layer beneath the coin block was removed as far as it was believed safe to do so, leaving it the full width of the hoard where it touched the coins but tapering down to a smaller base. Hand tools were then used to dig four evenly-spaced, parallel tunnels, each 120mm in diameter, through the remaining under-hoard earth across its long axis. A metal scaffold structure was constructed to fit closely around the hoard, with four nylon belts fitted through the tunnels underneath it and around the scaffold so that it could all be lifted out by crane, (Fig.2). The belts thus supported the hoard's weight as fully and evenly as possible, while the crane's chains and hooks touched only the metal structure. To prevent the belts compressing the hoard's top edge it was protected by a Plastazote and plywood shield.

Concern remained that the earth/broken shale layer beneath the hoard was very hard and that it might resist the pull of the crane during the lift. To counter this possibility, three people crouched down in the pit beside the hoard to gently push it until the hoard block was felt to move very slightly. It was then known that the solid connection with the pit floor was broken and that the hoard was being held in place only by its weight. With the hoard block lifted about 200mm, a 75mm Plastazote LD45 foam layer, on a specially constructed wood pallet, was placed beneath it and

Figure 1 – The hoard before lifting

Figure 2 – The hoard being tied to the scaffold support before lifting

Figure 3 – The hoard on the back of the truck after lifting

the hoard lowered onto its new support. The hoard block and support were finally lifted by an extending crane onto a flat-bed truck, (Fig.3).

INITIAL LABORATORY EXCAVATION 2012-2014

During this period Jersey Heritage was granted permission to remove overlying earth to fully reveal the hoard surface, and to perform non-invasive research to reveal more about the nature of the hoard.

The guiding principle was to reveal as much as possible about the hoard but not to deliberately remove any part of its structure. In practical terms this meant that all overlying earth was removed and the object was recorded as fully as possible. In addition to photography, a laser scan of its surface was sought but could not be arranged. Instead, a cast was made, using silicon rubber moulds, one for the top surface and five for the edges, with de-ionised water as a release agent and polyurethane foam as a rigid backing. The cast itself was made from epoxy resin and glass fibre. The bulk of it was painted with enamel paints and the exposed gold jewellery surfaces were replicated with gold leaf.

Figure 4 – The hoard after the initial removal the of earth revealed two pieces gold jewellery

The possibility of X-raying the entire structure was discussed with colleagues at Southampton University, but it was too large for available equipment (Graeme Earl and Ian Sinclair, Southampton University, emails to authors, 2012). Limited X-ray fluorescence (XRF) analysis of the coin surfaces and exposed gold and silver jewellery was undertaken by Karl Harrison and Andrew Shortland of Cranfield University.

A number of coins had become separated during the excavation and later earth removal, some of which were treated by manual cleaning and the use of formic acid to reveal their surfaces. Limited microscopic study of organic finds was made by the authors which revealed various plant and animal remains.

During the initial two-year period following excavation it had become clear that the nature of the hoard was more varied than at first thought. Amid the coins on its surface, partially exposed gold torques, silver bracelets, flat gold sheet, glass beads and many other artefacts were identified, (Fig.4). Some consideration had initially been given to preserving the hoard block intact, as it was such an impressive object. In light of the varied finds, however, it was decided that the disassembly of the hoard in order to reveal all of its contents was a more appropriate course.

DISASSEMBLY AND CONSERVATION 2014-17

A full proposal for the conservation of the hoard was presented by Jersey Heritage in early 2014. It was proposed to disassemble the hoard at an object-by-object level, conserving and recording each piece. The step-by-step conservation work would follow conventional best practice, but would operate alongside an innovative method of recording the find. This involved use of a Faro Edge six-axis metrology arm and laser attachment, to record surface laser scans of the hoard and its contents at regular stages of the work. Its physical contact probe head was also used daily to record the position of every single coin and all the other finds on the hoard's surface to fractions of a centimetre in three dimensions. This would allow future researchers to have a virtual model of the hoard as found, in which the coin positions would be linked to their database records of tribe, chronology and so on.

The team was keen that its work should allow the maximum amount of research both during the disassembly phase and for many years to come, so advice was taken on recognition, extraction and preservation of samples of interesting soil, organics or corrosion encountered during the work (Pieta Greaves, Jenni Butterworth, Drakon Heritage & Conservation, conversations with and emails to authors, 2014-17)(Julia

Figure 5 – The glass walled lab showing the public's view of hoard and Faro Edge metrology arm

Tubman, Philippa Pearce, Marilyn Hockey, Eleanor Ghey, British Museum, conversations with and emails to authors, 2012-14). In addition it was planned to remove 1,500 coins which would be left untreated as a research archive, as well as a solid, full height 15 x 15 x 15cm section of the hoard to be left frozen, intact with all earth, organics etc. remaining in place between the coins.

The total budget was £250,000, of which the bulk would be applied to salaries, while £40,000 was allocated for the Faro Edge unit and £20,000 for research. The work was to be carried out by a staff of three professionals: two conservation assistants, both qualified archaeologists, led by the Jersey Heritage Trust Conservator. This team was supported by a wider range of professional advisors and a group of twenty part-time volunteers who did much of the hands-on work. The use of such a volunteer group was initially somewhat controversial but good examples of such expert-led volunteer work had already proved the concept, (Lithgow, Timbrell 2014, 3-14). Georgia Kelly and Victoria Le Quélenec were appointed as the conservation assistants, the latter eventually replaced by Heather Truscott. Olga Finch, the archaeology curator for Jersey Heritage, acted as the archaeology/research advisor, and the two finders, Reg Mead and Richard Miles, acted as principal coin identifiers, their work overseen by Philip De Jersey, Guernsey Museum Service archaeologist.

This second phase of the project commenced in July 2014. The final coins were removed from the hoard in January 2017, and the project concluded in July 2017.

EXCAVATION METHOD

The hoard block was disassembled one coin at a time. The daily work involved a team of two people: one to physically remove the coin and operate the metrology arm that measured the coin position; the other to operate the computer linked to the arm and assign a sequential number to each new coin, and then bag the coin.

The plotting of each coin took only a few seconds. The operator of the metrology arm touched its point probe three times across the coin's centre axis and three more times around the edge of the coin, at 120 degree intervals. Using Geomagic software, the computer generated a numbered disc each time a coin was plotted, correctly positioned in three dimensions.

As the process was repeated, a three dimensional map of the relative coin positions was built up by the software, (Fig. 6). Typically, between 200 and 500 coins would be removed in one day in this way. A separate file was saved of each day's patch of removed coins and these were combined regularly to produce the master model of the entire hoard. The different day models were combined by relating each to a series of fixed points around the whole hoard. These fixed points consisted of 20mm stainless steel spheres on metal rods, inserted into the earth beneath the hoard

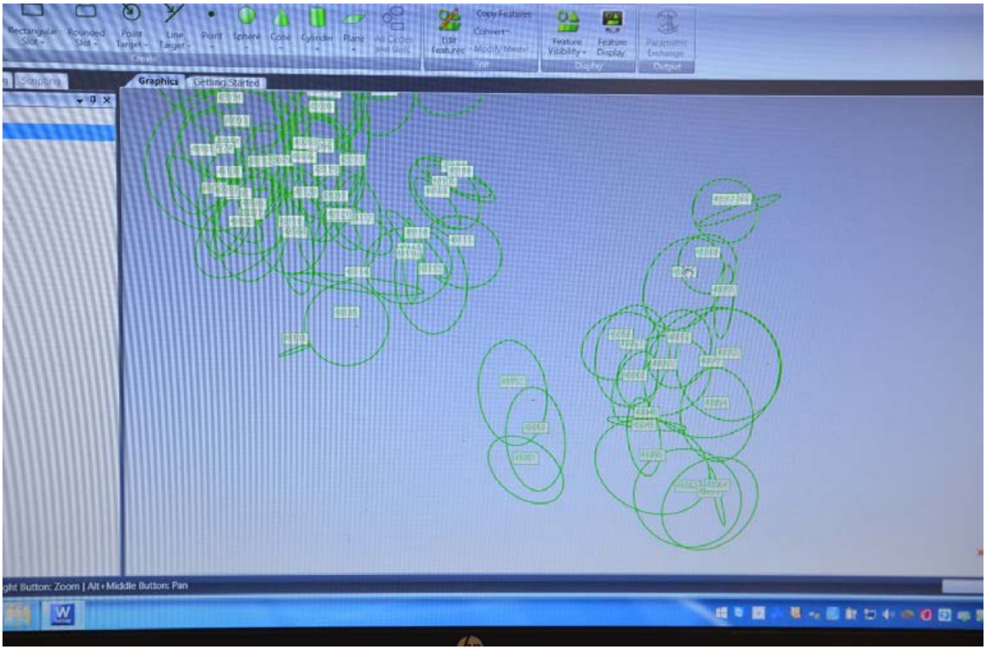

Figure 6 – Screen shot of three dimensional coin map produced each day when removing coins

at equidistant points. At the end of each day’s coin removals, the position of these spheres would be plotted by the arm on the same model as the coins.

Other objects found with the hoard had their position recorded in two ways using the metrology arm. Firstly, the point probe would be used in the same way as for the coins. A circular object, such as a torque, would be saved as a disc; a long thin object as a two-dimensional line. Secondly, the laser head would be fitted and once the object was revealed, but still in situ it, would be scanned. In the same way as with each day’s coin model, by using the reference spheres around the hoard, these laser scans could be superimposed on others to record the positions of items relative to the whole hoard.

The intention by the end of the project was that these partial laser scans of the in situ objects would be combined with full ones made after their removal, (Fig.7). The complete laser scans of each object would then be placed correctly back into the final three dimensional virtual hoard model.

As a back up to the computerized system, the hoard surface was also divided into a grid of 40 x 22 squares. Each coin and object, in addition to being located

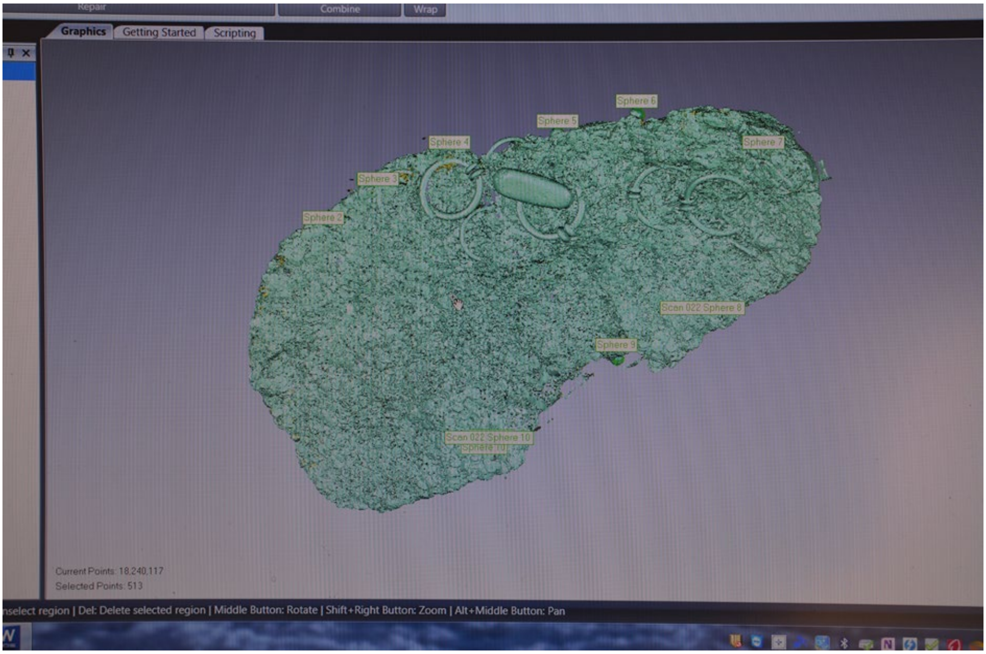

Figure 7 – Laser scan of hoard contents during its disassembly

by the metrology arm, was also given a grid reference such as *M23, top, middle or bottom*. A Melinex (clear polyester) sheet with the hoard outline and grid system on it was laid over the hoard to record this each day, and used to position a plastic square, similar to a painting frame marked with grid references, over the area to be worked on.

The physical separation of the coins proved easier than had been envisaged. The coins were connected to one another only by the fusion of their copper corrosion products. This bond fortunately proved weak and it was always possible to remove a coin one at a time using a metal hand tool, usually a specially blunted knife. Sufficiently robust jewellery and other objects were cleared of all surrounding coins and then the number around their base was reduced. At some point in this process they usually came loose and if not they would be gently manipulated by hand until they did loosen.

It was considered necessary to maintain the original moisture content of the hoard as far as possible in the laboratory. This was partly due to uncertainty as to how the soil would react if dried out – the British Museum had trouble with earth that

Figure 8 – The ultrasonic humidifier keeping the hoard damp

dried rock hard on the Bath hoard (Julia Tubman, British Museum, conversation with authors, 2012). Mainly however it was to avoid drying out the large amount of potentially important organic material in the hoard dating from the time of the burial (Fell 1996, 48-51).

The hoard was kept moist in two ways. At night, or during longer periods when the hoard was not being worked on, it was kept tightly wrapped in layers of Clingfilm. It spent the majority of the 2012-14 period wrapped in this way, kept in a cold store at 4°C. During the following period, when it was being excavated in a publicly viewable open lab, it was kept wrapped in Clingfilm at night but had to be actively moistened when it was on display.

When not being worked on, an ultrasonic humidifier was used to produce a stream of cold, water saturated air that exited from a series of holes in a special device positioned along one long edge of the hoard so that the vapour slowly rolled over its surface, (Fig. 8). During periods of coin removal, when the humidifier equipment had to be removed, the hoard surface was sprayed with hand sprayers. Deionised water was used for both the humidifier and the hand sprayers.

CONSERVATION METHODS

Coins

It was decided early in the project that the sheer number of the coins meant they would be cleaned only enough to allow identification, rather than being polished to display standard. The method of cleaning the bulk of the coins evolved over the first few months of the project, but did not change substantially. It was based upon using formic acid to remove the copper corrosion products from the silver/copper alloy coins. This technique was used by the British Museum team working on coins of a similar alloy from the Bath hoard, and proved to work very well on Jersey's coins (Julia Tubman, British Museum, conversation with authors, 2012). It was necessitated in Jersey, as it was for the Bath hoard, by the sheer number of coins to be treated. The authors had previously cleaned 150 similar coins from a different hoard using hand tools only, at an average rate of one hour per coin. For the present project, it was necessary to treat about 120 per day, or about four minutes per coin.

The conservation process was as follows:

1. The coin was removed from the hoard, kept damp and then sealed in a polythene bag.
2. The coin was removed from the bag and placed in one of the 14 chambers of an ice cube tray. The trays were modified by drilling holes in each chamber to allow them to drain.
3. The coins were cleaned of loose mud using a stiff rotary brush on a bench grinder/polisher.
4. Particularly thick corrosion was manually removed where possible with a blunt hand tool.
5. Nine ice cube trays of coins were placed in 15% formic v/v acid solution overnight.
6. The trays were removed from the acid and rinsed in a first bath of tap water.
7. The coins were brushed, again using the rotary bench brush, to remove remaining earth and corrosion products.
8. They were given six thirty-minute rinses, three in tap water and three in deionised water
9. They were then air-dried, still in the trays, for forty eight hours. During this period any remaining corrosion large enough to prevent the full examination of the coins was removed using a vibrating tip engraving tool under a stereomicroscope.

10. All coins were given a final dry brush with the rotary bench brush.
11. The coins were then placed in numbered, perforated polythene bags and placed in sealed polythene containers with silica gel, to maintain a low humidity.

The recording and tracking of each coin through this process was particularly important. When removed from the hoard, the coin's number was written on its individual polythene bag. Each ice cube tray was marked with a letter, and each chamber within it marked with a number, (Fig. 8). Thus, for example, coin CAT II/H/23564 from location mid B26 was placed in tray E, chamber 5. This was recorded on paper records and on an Excel spreadsheet. Each stage of the treatment was recorded in this way, and the paper records permanently preserved. In case one of the trays was dropped, each was photographed during the treatment process so as to allow each coin to be identified and placed back into the correct chamber. These images were retained, as were paper records of tray layouts.

After the conclusion of the drying process, each coin was transferred to a new polythene bag marked with the individual number and the grid reference. Each coin was then identified to tribe, sub-type, etc. This information along with its weight, images of both sides and details of conservation treatment was then entered as a record on Adlib collection management database software.

Figure 8 – Coins in a converted ice cube tray, individually recorded as I,1-14

Other artefacts

Inorganic artefacts other than coins divided broadly into the following types: gold jewellery and sheet; silver jewellery and wire; silver alloy ingots; and glass beads.

The treatment of gold jewellery had two phases during the project, i.e. with or without chemicals. The first groups of gold torques and other items removed from the hoard were treated as follows:

1. Initial manual cleaning while still damp, consisting mostly of the removal of loose earth by the application of water and soft brushes.
2. The objects were often partly covered in a layer of green copper corrosion products from the coins that had surrounded them in the hoard. Fortunately, the mechanical connection of this material to the underlying gold was generally not strong, and it was mostly removed by use of a pin vice and berberis thorn, (Staffordshire hoard conservation team 2015, 20-21). Occasionally, a vibrating tip engraving tool was used for thicker, more stubborn corrosion and earth. This could be played over the corrosion product with no contact with the gold at all, breaking it up well.
3. The objects were then rinsed in de-ionised water and air-dried.
4. This treatment could only safely remove about 90-95% of the corrosion. Advice was sought and at this stage that it was deemed safe (for future metallurgical research) to use dilute formic acid locally and for short periods (followed by rinsing) to remove the remaining translucent green glaze of corrosion product (Pieta Greaves, Drakon Heritage and Conservation, email to authors 2015).
5. The only material left on the surface was a bright red substance at first thought to possibly be remains of organic material from the hollow torques' interiors, but later confirmed as iron corrosion.

The second phase of the gold cleaning followed the same methodology, but no longer using formic acid. This was suggested during a research conference in the summer of 2016 as there was some concern that, contrary to earlier advice, its use could affect analysis of the alloy composition of the metal surface layers. It is likely that at least some of the material cleaned this way will be treated with the acid at the completion of future analytical work.

Silver artefacts were generally treated in the same way as the gold: mechanical cleaning then the use of formic acid if necessary, although once again the use of the acid ceased after the summer of 2016.

Silver wire was often found in bundles on the coins, usually encased in a block of copper corrosion product. The wire is so thin (0.1 x 0.4mm) and brittle that no

Figure 9 – Leather purse still on coin block. Belt loops on right side

mechanical cleaning was attempted, and the corrosion products were removed with 15% formic acid. The silver alloy ingots had almost no work done on them other than a light manual clean to remove earth, and then air-drying.

Glass beads were usually simply washed in deionised water. Where there were copper corrosion products on their surfaces it was removed with a scalpel, working under a stereomicroscope.

Organic material

A partially surviving leather purse or pouch was found full of coins. It was excavated as a block from the surrounding hoard, slid onto a Correx (corrugated plastic) sheet, (Fig.9). All possible coins were then removed from its exterior. The block was then immersed in 20% polyethylene glycol (PEG) 400 for three days before freeze-drying in a conventional freezer. Untreated, the leather would have shrunk, twisted and hardened on drying, but the PEG permeates and bulks out the leather allowing it to dry safely. Fragments of the purse were kept untreated for analysis.

Figure 10 – A part of the textile bag of jewellery

A very fragmentary textile container full of gold and silver jewellery and metal fragments was found, excavated and removed in a block in the same way as the leather pouch, (Fig. 10). It was freeze-dried as the purse except without any use of PEG on the advice of Elizabeth Goodman of Museum of London Archaeology. At the time of writing, analysis of the textiles and leather has been commenced by Esther Cameron.

SCIENTIFIC ANALYSIS

All of the gold torques, both partial and complete, as well as other items of jewellery have been X-rayed, initially in the Jersey General Hospital and then at higher resolution in the conservation department of the Birmingham Museums Trust. The majority have been analysed at Birmingham with an XRF unit.

Over nine hundred samples of organic material (generally plant fibres and stems) were taken, placed in wet in polythene bags and stored in air-tight containers in a

Figure 11 – A millipede found in the middle of the hoard

refrigerator for future research, (Neal and Watkinson 2001, 25-26). The arthropods among these have been identified to family if not species level by Sally-Ann Spence of Oxford University Museum of Natural History.

RECORDING

The conservation procedure for the individual finds is recorded within a field in the Adlib database record for each item. The entry is standardised for all coins that have gone through the conventional treatment and is a description of the treatment process with no post-treatment description. There is no individual conservation job or day number for each treatment. A medium resolution JPEG image of both sides of the cleaned coin is stored on the same record. The images are taken with a Nikon D80 digital SLR with a 50mm macro lens at f10, 100 ISO.

Conservation records for the non-coin items such as jewellery were initially recorded long-hand on paper. They were then transferred to the same Adlib database as is used for all finds from the hoard. Unlike the coins, these items have individual conservation job numbers, such as 'Cons 1/23.9.2016'. The records consist of a written description of the object's pre-treatment condition; a detailed account of the conservation process including any new discoveries about the object; results of any analyses; and digital images of the item before, during and after treatment, in high resolution.

The Geomagic software used to control the Faro Edge metrology arm and laser scanner records on .wrp files. These are stored and backed up and may be amended and added to, and will be available for research in the future.

FUTURE RESEARCH

A research framework for future work on the hoard was produced in 2016. In addition to specific proposals on metallurgy, numismatics and so forth it was agreed that it was important to return to the find site to continue work there. It is hoped that field walking, geophysical surveying and further excavations would be able to produce a clearer context for the discovery. Sadly, although many institutions both in the UK and Europe have expressed an interest in becoming involved, neither funding for the research nor permission to work on the site again have been procured at the present time. It is hoped that both of these issues will be resolved in the near future

Bibliography

Fell, Vanessa 1996. "Washing away the evidence". *IIC, Archaeological conservation and its consequences, Preprints of the Copenhagen Conference, 26-30 August 1996*. 48-51

Lithgow, Katy and Timbrell, Helen 2014. "How better volunteering can improve conservation: why we need to stop wondering whether volunteering in conservation is a good thing and just get better at doing it well." *Journal of the Institute of Conservation*, Vol. 37, no.1 3-14

Neal Virginia and Watkinson, David. 2001. *First aid for finds*. London : Rescue

Staffordshire Hoard Conservation Team. 2015 "A new conservation tool" *ICON News*, Issue 58. 20-21