HMS *Colossus*

Reburial Trial – First Retrieval

Interim Project Report

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Historic England

Weezle Undersuites

Ambient Pressure Diving

Otter Watersports

The Dive Team

Sharon Austin

Kevin Camidge

Andrew Earle

Sean Hester

Bren Rowe

Nick Sodergren

Izzy Allsop
Boat Skipper

Contents

Cover Photograph: Looking across the wreck of Colossus. Copper bolts and hull timbers in the foreground. Eighteen-pound guns (G4 & G5) in the background, upstanding with their muzzles buried in the seabed (Scale = 50cm).

Dead archaeology is the driest dust that blows (Wheeler, 1956)

Colossus Recording Project 2023

Project Summary

In 2012 CISMAS undertook a small excavation on the wreck of His Majesty's Ship *Colossus*. The majority of the artefacts recovered are now in the Isles of Scilly Museum; however a representative sample were used in a long term reburial trial on the site. These objects were placed into two separate repositories buried in the seabed close to the wreck. The contents of one repository were to be retrieved after 10 years, the other after 25 years. This report is concerned with the objects which were recovered in 2022 after ten years reburial.

The selected objects were analysed by the conservation laboratories at York Archaeological Trust (now York Archaeology) before being reburied on site. In 2022, after ten years of reburial one of these repositories was recovered. The recovered objects were again analysed by the labs at York and an assessment of any deterioration was made.

Historic England Conservation Laboratories decided to have their own collection of objects placed into the finds repositories alongside the artefacts recovered from the 2012 excavation. The HE objects included 'tokens' (modern samples of various materials) as well as some objects from other archaeological sites. The HE objects from the 10 year repository were sent to Angela Middleton at HE Fort Cumberland. Unfortunately they did not have the capacity to undertake the analysis within the agreed timeframe, and the schedule for this work is currently indeterminate.

Because only part of the scheduled analysis has been undertaken we feel it would be foolhardy to publish conclusions at this stage which might well be contradicted by future analysis. However, as there is no date for completion of the HE analysis we have been asked to produce this interim report, which is not intended for publication or for external distribution.

The results so far indicate that reburial of archaeological objects is a viable process for preserving archaeological objects from this site, and probably by extension from other maritime sites with similar sediments. More importantly, several valuable lessons have been learned from parts of the project which did not go as planned – learning from mistakes is often the most valuable part of any experiment.

Background

Fig 1
The stern of *Colossus*. The inset shows the location of the wreck in St Mary's Roads in the Isles of Scilly.

The Ship

Length (gun deck)	172' 3" (52.5m)	Guns	28 x 32lb gun deck
Length (keel)	140' 1" (42.7m)		28 x 18lb upper deck
Breadth	48' 0" (14.6m)		14 x 9lb quarterdeck
Tonnage	1717 tons		4 x 9lb forecastle
Draught (hold)	20' 9½" (6.3m)	Carronades	6 x 18lb poop deck
Draught (aft)	23' 2" (7.1m)		2 x 32lb forecastle
Cost	£40,561		
Ordered	13th December 1781	Ballast	110 tons of iron
Laid down	October 1782		250 tons of shingle
Due date	February 1786		
Launched	4th April 1787	Crew	640 complement
			562 actual
Builder	William Cleverly	Wrecked	12th December 1798

HMS *Colossus* was a 74-gun warship built in 1787 and wrecked eleven years later on the Isles of Scilly. She was the first warship to bear the name; five others were built over the years, culminating in an aircraft carrier launched in 1943.

In December 1798 *Colossus* was on her way home to England with wounded from the Battle of the Nile and other unusual cargo, including part of Sir William Hamilton's second collection of Greek pottery and the body of a dead admiral.

Loss

Colossus reached Scilly in December 1798, in charge of a convoy of merchant vessels. The ship was at anchor in St Mary's Roads sheltering from a storm when the anchor cable parted and she was driven onto shallow ground, losing her rudder and sustaining progressively worsening damage until she foundered with only the poop and quarterdeck above water. All but one of the 595 souls aboard (562 of them crew) were taken off safely in small boats. The ship soon turned onto her beam ends and began to break up, a process hastened the following month when the crew of HMS *Fearless* were employed *'breaking up the wreck'* (Camidge, 2005, p.73).

The Site

The wreck of HMS *Colossus* lies to the south of Samson in the Isles of Scilly. To date two main areas of wreckage have been identified, the 'bow' site and the 'stern' site. In 1975 part of the wreck (probably mostly the bow) was designated under the Protection of Wrecks Act. This designation was revoked in 1984. The current site, the stern, was designated in 2001, and is located at Latitude 49˚ 55'.471N, Longitude 006˚ 20'.505W (260154.906E 5535593.077N UTM zone 30, WGS84). The designated area was extended in August 2017 and is now defined by the following co-ordinates:

N: 49.92688286, -6.34111824 E: 49.92371411, -6.33617442 S: 49.91861193, -6.34401542 W: 49.92178068, -6.34895924

Previous work

Salvage work took place on *Colossus* from the time of her loss until the early part of last century. Work included Braithwaite and Tonkin 1803-1806, and the Dean Brothers in 1833 (Bevan, 2010, p.90).

Roland Morris, a marine salver and proprietor of the Penzance Maritime Museum, began searching for the wreck of *Colossus* in 1967 using a small team of divers. In August 1974 they located material relating to *Colossus*. The site was designated in 1975 under the Protection of Wrecks Act 1973. A large quantity of pottery, remains of Hamilton's second collection, was recovered and deposited in the British Museum. Once Morris' team had finished their work, the site was de-designated in 1984. The current whereabouts of the other material removed from the site by Morris is for the most part unknown.

Areas of exposed timber and iron guns were discovered by local divers in 2001. This material was hundreds of metres to the east of the area worked by Morris and turned out to be part of the stern of *Colossus*. This was designated in July 2001. Late in 2001, the Archaeological Diving Unit (ADU) excavated at the stern of *Colossus* where there was a piece of carved timber, which turned out to be one of the stern quarter-pieces of the vessel.

In 2002 the quarter-piece was recovered from the site by the licensee Mac Mace. This was conserved at the Mary Rose Trust, and has now been returned to Scilly for display on Tresco. Later that year a small, limited excavation was undertaken on the site to establish the nature and extent of the structural remains.

Considerable survey and some limited excavation has been carried out on the site by CISMAS in the last twenty years – the reports of this work are all available to download at: www.cismas.org.uk

A guided video tour of the site with commentary was recorded in 2017 and can be viewed at: https://youtu.be/FOJ0SUOV7QU

The Reburial Trial

Origins of the reburial trial

In 2012 a small excavation was undertaken on the stern section of the designated wreck site of HMS *Colossus*. There were a number of objectives: investigation of the main gun deck ordnance, recording of a main gun-deck port, and detailed recording of the post-wrecking stratigraphy present on the wreck.

In addition to these site specific enquiries, a number of more general aims were achieved. These included investigation and appraisal of different excavation methods and recording regimes, and the initiation of a long-term reburial trial on the site using real archaeological objects rather than modern tokens. Finally, an opportunity to gain experience in underwater excavation was offered to two separate 'trainees', who were able to use the experience towards their NAS part II and III qualifications. The full report for the 2012 project (EH6114) can be downloaded from the CISMAS website: Monitoring and Investigation 2012

Why undertake a reburial trial?

In situ preservation of underwater cultural heritage has been highlighted as the preferred option in most literature on the subject. 'UNESCO underscores the use of *in situ* methods in its 2001 convention on the protection of the underwater cultural heritage' and 'If *in situ* methods are to be used as the primary means of preserving underwater cultural heritage they must be explored in depth' (Ortmann, 2009, p.2).

A number of studies have looked at aspects of reburial as a means of preserving underwater material. Burial of modern timber to quantify preservation has been undertaken by a number of projects, in Denmark (Gregory, 1998), in the UK on the protected wreck sites of *Colossus* (Camidge, 2005) and the Swash Channel wreck (Palma, 2009), and as part of the pan-European MoSS project (Cederland, 2004). But by far the most comprehensive long term study undertaken up to 2012 was the Reburial and Analysis of Archaeological Remains (RAAR) in Marstrand, Sweden (Bergstrand et al., 2005). This project aims to investigate the reburial of archaeological objects over a 50 year period. Organic materials (wood, textile, leather, bone and antler) and inorganic materials (silicates and metals) are being used. Interestingly, with the exception of the silicates (glass and ceramics), modern material (or 'tokens') is being used for the reburial rather than archaeological material. The efficacy of packaging, labelling and marking methods is also being investigated. Preliminary results suggest that the reburial environment is an important factor in the preservation of cultural material. The *Colossus* reburial trials will be a useful supplement to this work as we will be using archaeological material rather than 'tokens' in our reburial trials. Marking and labelling of reburial objects in the *Colossus* trials used the most successful of the methods indicated by the preliminary RAAR results (Godfrey et al., 2009).

In addition to the reburial objects from the *Colossus* excavation, Angela Middleton of EH proposed burying a number of additional objects including some modern tokens. Accordingly these were added to the reburial trial – for more details see appendix III.

The reburial in 2012

During the 2012 excavation the objects to be used in the reburial trial were selected by the conservator, Ian Panter. These were then taken to the conservation lab at York Archaeological Trust for detailed recording and analysis. They were reburied on site in September 2012. Objects were contained in PE (polyethylene) re-sealable bags with write-on panels; they were perforated with c. 100 holes of c. 1mm diameter.

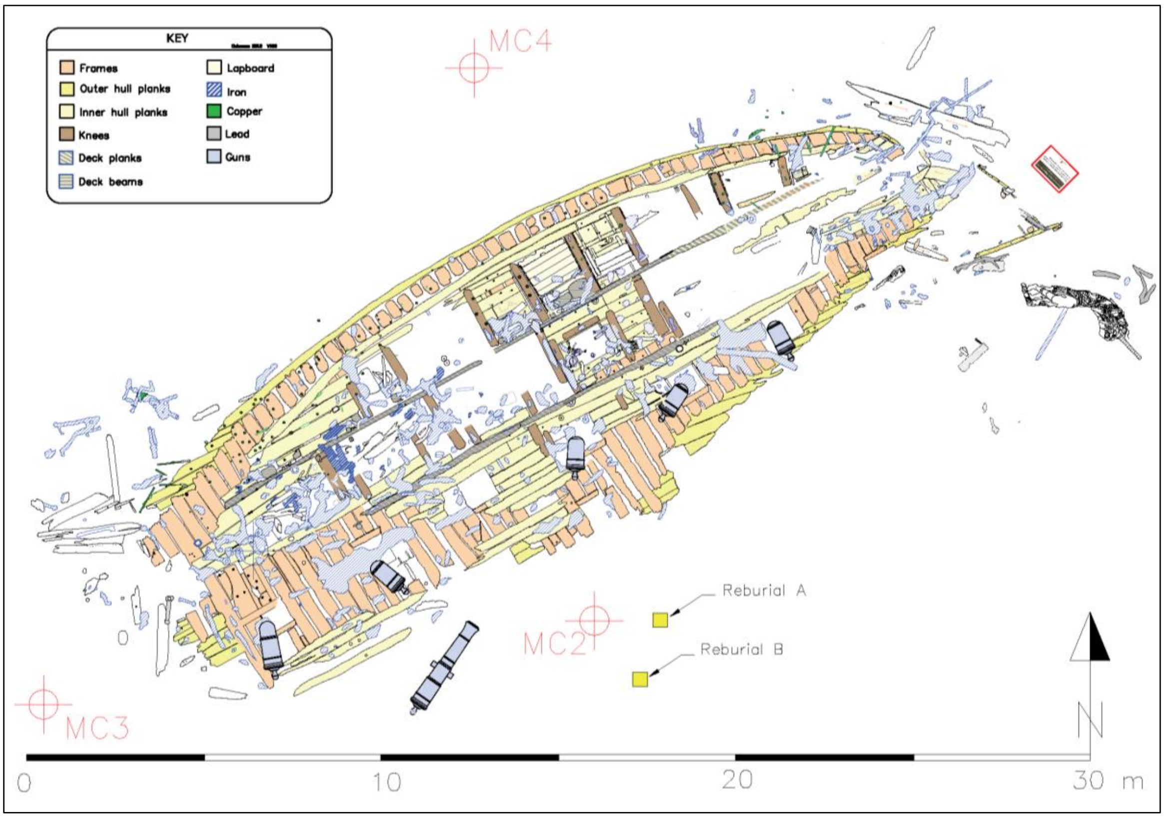

Fig 2
Plan showing the location of the two reburial pits A and B, to the south of the exposed wreckage

The reburial sites are situated to the south of the exposed wreckage as shown in fig 2: reburial site A is at 260153.50E 5535579.33N, and reburial site B at 260152.98E 5535577.68N (UTM WGS84). Both reburial sites are close to master control point MC2, which is set into a large granite mooring block (0.65m x 0.50m x 0.40m) – this made relocating the reburial sites relatively straightforward. Burial site A is 1.82m east of MC2, and site B is 2.12m SE of MC2. Each burial site consists of a polythene box 0.75m long, 0.36m wide and 0.40m deep. These boxes were pre-perforated with 5mm holes placed roughly every 50mm throughout the box (figs 4 & 5). Each box was buried so that its top was 0.20m below the seabed. The reburial objects were then placed in the box on a layer of sediment. These were then covered with 0.15m of sediment upon which the additional EH objects were placed.

The boxes were then filled to seabed level with sediment and a layer of sandbags placed over the top (fig 3).

When the small trenches were excavated to bury the two plastic finds boxes, sediment samples were taken. These were analysed to determine the composition of the sediment in which the artefacts were to be reburied. The results suggested that the sediments were unlikely to cause any problems for the reburied artefacts. The detailed results can be seen in the geochemical analysis section of appendix I.

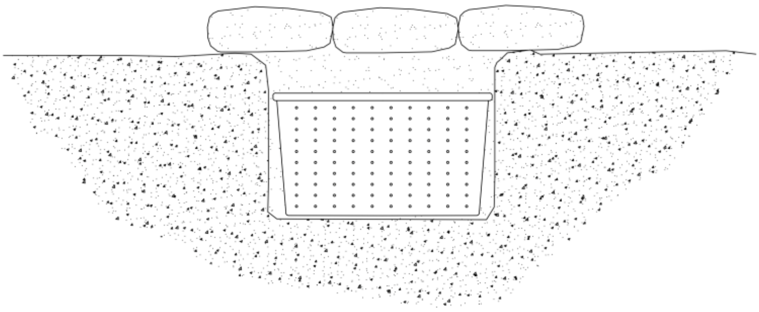

Fig 3
Schematic section showing one of the reburial boxes buried beneath the seabed and covered with sandbags

Fig 4 – The finds reburial box – scale 0.5m

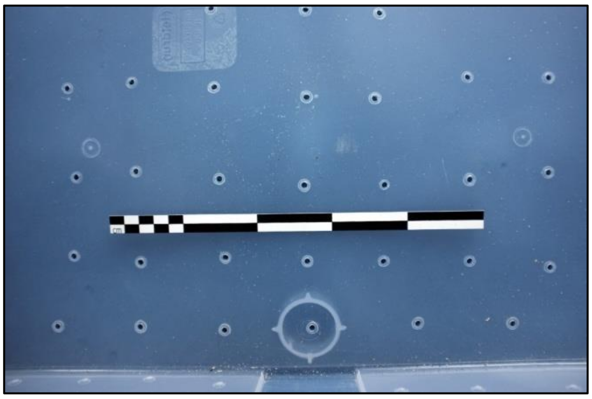

Fig 5 - Detail of the holes in the reburial box – scale 0.25m

Fig 6
The reburial site A with sandbags in place on the seabed – scale 0.5m.

Labelling the artefacts

The reburial objects were all placed into perforated polythene bags. The bags were labelled using a 'Sharpie' permanent black felt tip marker pen on the white 'write-on' panels. Sharpie pens are made by Newell Custom Writing Instruments. In addition, a plastic Dymo embossed label was included in the bag. Both these techniques have proved effective in the RAAR trials (Bergstrand et al., 2005).

Fig 7

An example of the artefact labelling system – site code (C2012) & object number (F737)

Above: plastic embossed 'Dymo' label (9mm wide tape) – one label was placed inside each bag

Left: polythene re-sealable bag with write-on panels and perforations, marked using a 'Sharpie' permanent marker pen. The bags used were of various sizes to suit the objects they contained. The bag illustrated was the commonest size used (125 x 210mm)

What was reburied?

A total of 30 objects excavated from the site in 2012 were reburied in each of the two crates (a total of 60 objects). Each crate contained objects composed of copper alloy, ceramics, glass, leather, bone, rope, wood and iron. The range was restricted by what was recovered in the excavation. The list of objects buried is contained in the tables below.

The objects recovered in 2022 are those from reburial site A. The objects contained in reburial site B were not disturbed, and remain buried on site.

Reburial Site A		
Material	**Number used**	**Find numbers**
Copper alloy	6	F706, F734, F735, F841, F849 & F885A
Ceramics	5	F701, F713, F732C, F737 & F820A
Glass	5	F703, F707, F730, F731 & F844
Leather	1	F828A
Bone	1	F775
Rope	2	F771A & F818
Wood	5	F751, F764, F811A, F827 & F855A
Iron concretion	5	F762, F814, F816, F827 & F852
TOTAL	**30**	

Reburial Site B		
Material	**Number used**	**Find numbers**
Copper alloy	5	F721, F739, F824B, F845 & F885B
Ceramics	5	F715, F716, F732A, F732B & F820B
Glass	5	F708, F708A, F709, F722 & F888
Leather	1	F828B
Bone	1	F712
Rope	2	F771B, F817
Wood	5	F752B, F756, F811B, F825 & F855A2
Iron concretion	5	F760, F763, F766, F883 & F884
TOTAL	**30**	

Additional objects reburied

Listed below are the 26 objects supplied by English Heritage (now Historic England) for inclusion in the 10-year reburial box (A). For further details see appendix III.

Additional (HE) objects. - Reburial Site A			
Object No	**Object ID**	**Object No**	**Object ID**
EH01	Ceramic, base of a dish	EH27	wood, oak
EH03	Ceramic, body sherd	EH29	bronze cc494k
EH05	Ceramic, rim of bowl	EH31	bronze c932
EH07	Glass, base of bottle	EH33	ceramic modern stoneware
EH09	Glass, stopper	EH35	pewter
EH11	Ceramic, clay pipe	EH37	modern lead glaze
EH13	Metal, Iron	EH39	brass CW508L
EH15	Leather, Sole	EH41	brass CW505L
EH17	Leather, Sole	EH43	modern lead crystal glass
EH19	Metal, CuA	EH45	modern potash glass
EH21	Wood, modern oak	EH47	modern HLLA glass
EH23	Wood, modern pine	EH49	modern wrought iron
EH25	Modern cast iron	EH51	ceramic, modern tin glaze
TOTAL	26		

Recovery of the objects

The 10-year recovery crate (A) was located and the remains of the sand bags over the top were removed. The sediment was then excavated by hand until the first objects were encountered at depth of about 20cm below the top of the crate. Objects were then transferred into a lidded plastic crate, one at a time until the repository crate was completely empty. This was undertaken by a team of three divers. One diver excavated the sediment over and within the crate, the second diver placed recovered objects into the recovery crate (fig 8) and the third diver photographed the whole process. The excavation of the sediment was entirely by hand to avoid any damage to the buried objects. The sealed recovery crate containing the objects was then transferred to the support vessel by two divers.

Fig 8
Left: the crate used to transfer the objects to the surface. Right: the partially excavated 10-year finds repository.

The objects were then individually photographed to record their general state and how well the labelling systems had performed. The original bags were not disturbed; they were lifted out of the recovery crate, placed onto a white board and photographed. They were then put into sealed polythene bags to prevent them from drying out, and returned to the recovery crate. The crate was kept in a cool, shaded location covered with wet towels until transported back to the mainland.

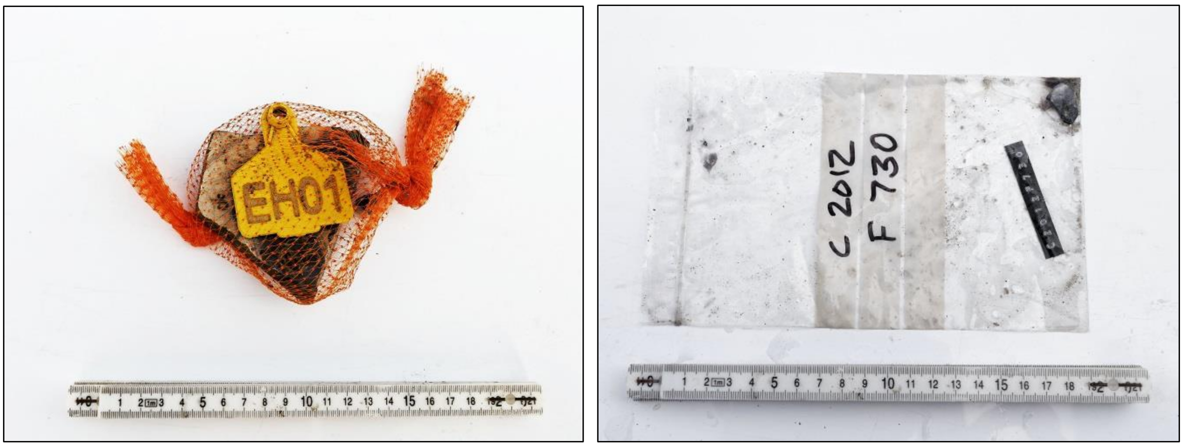

Fig 9
Left One of the English Heritage objects, EH01 in its net container, labelled with a purpose-made plastic tag.
Right: One of the objects from the 2012 *Colossus* excavation F730, the marker pen labelling still clear after 10 years buried on site. Note also the embossed Dymo label within the bag.

Once back on the mainland the objects were sent by next day courier service to their respective labs at York and Fort Cumberland. The boxes were collected on Monday 12th September from Penzance, but neither was delivered until Wednesday 14th September. Thus there was a gap of 10 days between recovery of the objects and delivery to the labs.

Colossus Objects - Reburial Site A		
Material	**Number used**	**Find numbers**
Copper alloy	6	F706, F734, F735, F841, F849 & F885A
Ceramics	5	F701, F713, F732C, F737 & F820A
Glass	5	F703, F707, F730, F731 & F844
Leather	1	F828A
Bone	1	F775
Rope	2	F771A & F818
Wood	5	F751, F764, F811A, F827 & F855A
Iron concretion	5	F762, F814, F816, F847 & F852
TOTAL	**30 [26 in 2022]**	

Above are listed the 30 *Colossus* finds placed into reburial site A. Of these, only 26 were present when the repository was emptied in 2022 (those missing are shown light blue in the above table). Five pieces of loose wood found in the repository were bagged with the label '*Colossus* 2022, F885A?'.

HE additional objects - Reburial Site A			
Object No	**Object ID**	**Object No**	**Object ID**
EH01	Ceramic, base of a dish	EH27	wood, oak
EH03	Ceramic, body sherd	EH29	bronze cc494k
EH05	Ceramic, rim of bowl	EH31	bronze c932
EH07	Glass, base of bottle	EH33	ceramic modern stoneware
EH09	Glass, stopper	EH35	pewter
EH11	Ceramic, clay pipe	EH37	modern lead glaze
EH13	Metal, Iron	EH39	brass CW508L
EH15	Leather, Sole	EH41	brass CW505L
EH17	Leather, Sole	EH43	modern lead crystal glass
EH19	Metal, CuA	EH45	modern potash glass
EH21	Wood, modern oak	EH47	modern HLLA glass
EH23	Wood, modern pine	EH49	modern wrought iron
EH25	Modern cast iron	EH51	ceramic, modern tin glaze
TOTAL	26 [23 in 2022]		

The objects from other wrecks and modern materials buried in repository A were packaged differently. They were stored in net bags containing purpose-made tags (fig 9). 26 objects were originally buried, 23 of which were found to be within the repository when excavated in 2022. The missing items are shown in light blue text in the table above.

Missing objects

A total of 56 objects (30 from the Colossus excavation and 26 from HE) were deposited into reburial crate A in 2012. In 2022 only 49 were found to remain, a loss of 7 objects (12.5%). We are fairly confident that no objects were lost during the retrieval process. The underwater visibility was good and the excavator was assisted by two other divers who watched throughout the process. The retrieved objects were placed into a net bag, which was transported inside a plastic crate with closed lid (fig 8).

So - how did this happen? We think there are two possibilities. The loss of objects occurred either when they were placed into the repository crate in 2012, or during their 10 years of burial on the site. The top edge of the reburial crate was exposed by falling sediment levels over the site on at least two occasions. After this was noticed, we placed additional sandbags over the top to protect the crate – but it is possible that visiting divers may have 'investigated' the contents, causing the loss of some objects. We will probably never know for certain how the loss occurred but there are several ways to prevent this happening.

1. When the objects were deposited they were transported to the crates on the seabed in a closed transfer crate – the same kind as was used for the retrieval. To ensure no objects are lost in the transfer process we suggest that all reburial objects are bagged as in this trial, but that the bags are collectively contained within a plastic net such as 'Netlon' – so that none can 'escape'.
2. To ensure that the crates are not exposed by falling sediment levels, they should be buried deeper below the seabed – perhaps 0.5m instead of the 0.2m used in this trial.
3. Once buried, the crates should be covered with a sheet of Terram 4000, held in place with sandbags. This technique was successfully employed to stabilise the backfilled 2012 excavation trenches. The would prevent exposure by falling sediment levels and make casual process by visiting divers impossible.

Fig 10 - Terram and sandbags one day after installation over the site of the small excavation in June 2012

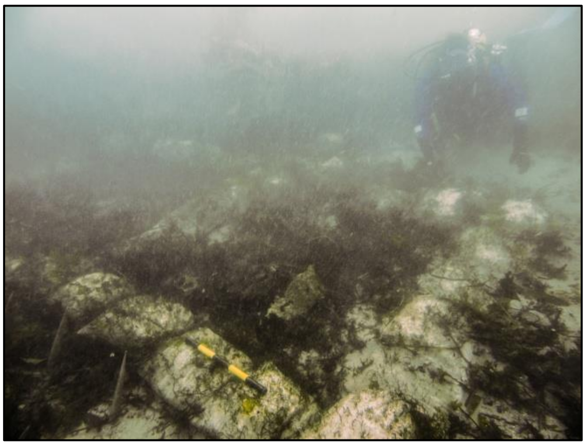

Fig 11 - The same Terram and sandbags three months later.

We have found that Terram sheet held in place with a continuous line of sand bags around the edges is a most effective method of stabilising the seabed on this site. It has also been found effective on the Swash Channel site (personal correspondence with Dave Parham). The Terram and sandbags are quickly populated by sea weeds and grasses. The shallow trough created by the sandbags then fills with sediment. Within 12 months the mat and sandbags are buried with heavily weeded sediment and are very difficult to recognise even when looking for them.

Contamination

One very noticeable problem when recovering the objects from the reburial crate was a clump of material concreted together with what appeared to be iron corrosion. The centre of this corrosion was a large block of iron, EH2 - one of the HE additional objects. This might well account for some of the iron staining noticed in the analysis of the *Colossus* excavated objects (see appendix II below). The iron objects which had been recovered from *Colossus* (F762, F814, F816, F847 & F852) were already covered in corrosion products and did not seem to be causing a contamination problem within the crate; this was apparently caused by the large blocks of modern iron (EH13 and EH25).

This suggests that archaeological and modern (tokens) material should not be reburied together. Any future reburial of artefacts should perhaps as a precaution use separate receptacles for iron objects. There might also be a case for separating different materials into separate crates. It will be interesting to see whether the problem is significantly worse in repository B, when it is retrieved in 2037.

Analysis of the *Colossus* objects

The analysis of the ten-year reburial objects was undertaken by Ian Panter of York Archaeology. His assessment of the objects prior to reburial in 2012 and after recovery in 2022 appear below in appendices I & II. The short extract below gives an outline of the results which appear in full in appendix II.

> There has been little overall change in the condition of the materials that were buried on the seabed between 2012 and 2022.
>
> Where weight loss was observed, the changes were usually minimal and not significant and likely reflect a combination of margins of error inherent in the balance used, as well as changes in water content through handling and processing.
>
> Physically, the artefacts have altered little, although all the iron concretions are now more iron-stained than there were ten years ago and one of the ceramic sherds has darkened, whilst another one, F713, has bleached with time (although there is some doubt about whether this is the original item). The copper alloy tacks/nails have changed little in appearance, apart from the strip, F849, where red cuprite (copper oxide) has formed on the surface. This artefact appears to have undergone more mineralisation, based on its X-ray image.

The results of this assessment suggest that the seabed environment has not been aggressive towards the majority of the materials over the last ten years. The combination of bagging in perforated resealable polythene bags and reburial to a depth of 20cm below seabed level has worked well. It is noted that there was a reduction in seabed level on at least two occasions after which the divers placed sandbags on top of crate A for protection. These sandbags will have helped maintain a benign burial environment but retarding the ingress of oxygenated seawater.

The performance of the labelling

The labelling methods used all performed well and were legible without any signs of deterioration. The marker pen on the polythene bags performed surprisingly well with no deterioration of the bag markings discernible after 10 years of burial. It will be interesting to see how well these markings survive after 25 years of burial. The embossed ‘Dymo’ plastic labels also all survived without visible signs of deterioration. Below are photographs of the first four bags in the reburial sequence (F703, F706, F707 and F713) – these are representative of all the bag markings.

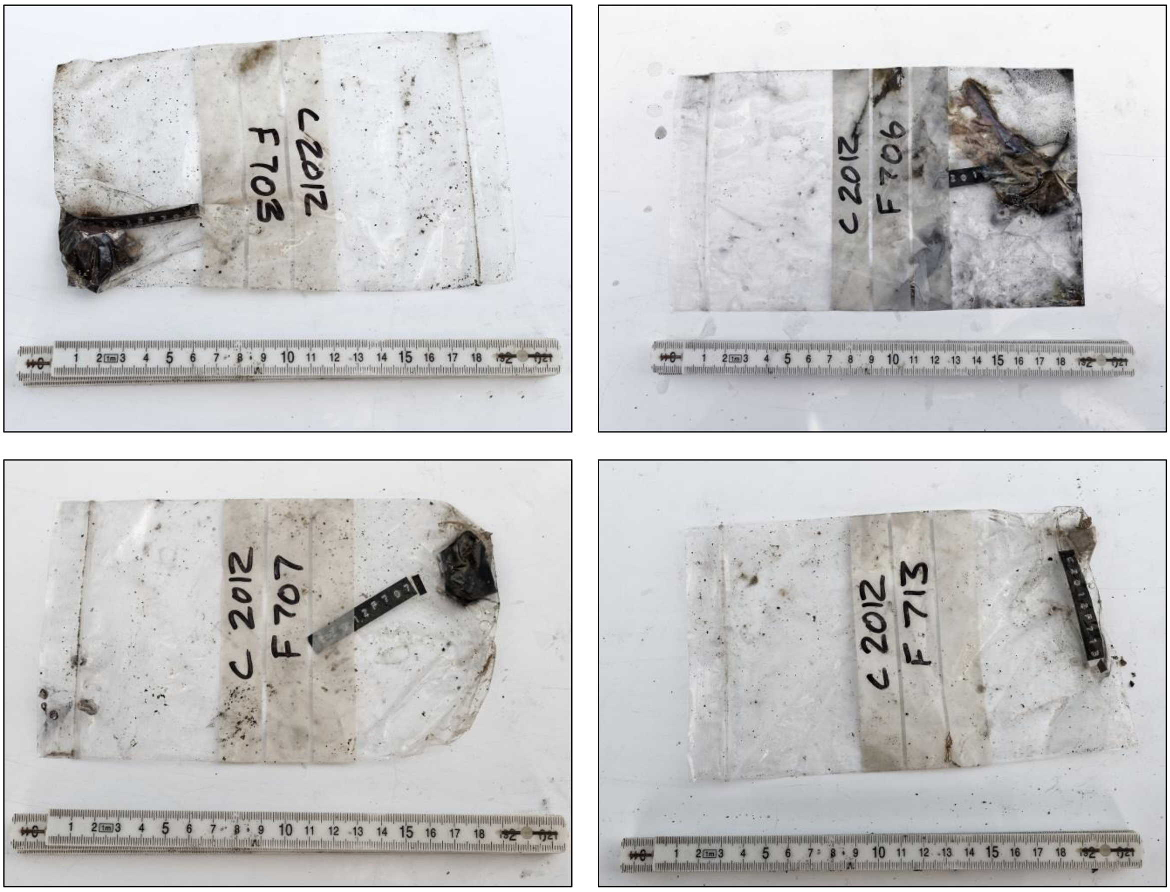

Fig 12 - Examples of the artefact bags photographed 24 hours after recovery after recovery in 2022

The more sophisticated labelling system employed by HE on the additional objects they supplied has also survived well. The plastic cow tags are still clearly legible. The HE iron objects EH13, EH25 & EH49 have all corroded and caused the cable ties and 'Netlon' to be entrapped within the corrosion products. This suggests that net should not be used on iron objects.

Conclusions

The overall outcome of these reburial trials cannot be determined until the results for the additional objects supplied by HE are known. And the final outcome of the trials will not be concluded until the artefacts in repository B are recovered and analysed in 2037.

It is, however, already clear that reburial of the excavated objects was largely successful over the ten-year period they were buried. We have also learned some valuable lessons which will inform the design of future reburials of marine archaeological artefacts.

What have we learned?

We have learned a number of valuable lessons from the mistakes made during the execution of this trial. The first of these was the discovery during the trial that the crates of objects were becoming exposed, which could have been avoided. Secondly, we were very surprised when we recovered the objects and found that 7 of the original 56 were no longer in the reburial crate. We have devised strategies to minimise these risks in any future use of the technique. If everything had gone exactly to plan we would have learned far less. Failure can have compensations!

1. The system of reburial within a lidless, perforated plastic crate appears to have worked well. Unfortunately the crate was partly exposed during the reburial by falling sediment levels; this was corrected by placing more sandbags over the crate. To prevent this the crate should have been buried deeper in the seabed. It should also have been covered with a protective layer of geotextile sheet such as Terram 4000.

2. To avoid loss of artefacts on the seabed they should be collectively contained in net bags. The net bags would contain the bagged artefacts in groups of 20 to30 depending on the size of the objects. The objects should be secured in the net bags on the surface, then transferred into the repository in the net bags, and reburied in them.

3. Separate crates should be used for iron objects. Use of separate crates for other categories of artefacts could also be considered if space and budget allow.

4. Modern materials (especially iron) should not be reburied alongside archaeological material.

Recommendations

We should cover the site of reburial crate 'B' with a 2m square of Terram 4000 held in place with a sandbags. We recommend that this is put in place as soon as possible to prevent any further exposure by falling sediment levels on the site. It would also offer additional protection if the site is not inspected regularly, as has been the case in the past.

Sediment Level Monitoring

The sediment levels on the site have been monitored since 2003. This has been accomplished by means of 14 fixed survey pins driven into the seabed at various locations around the site. The results of the sediment monitoring have been reported every year in the annual licensees' report submitted to English Heritage (and now to Historic England). The sediment monitoring points were renewed in July 2014.

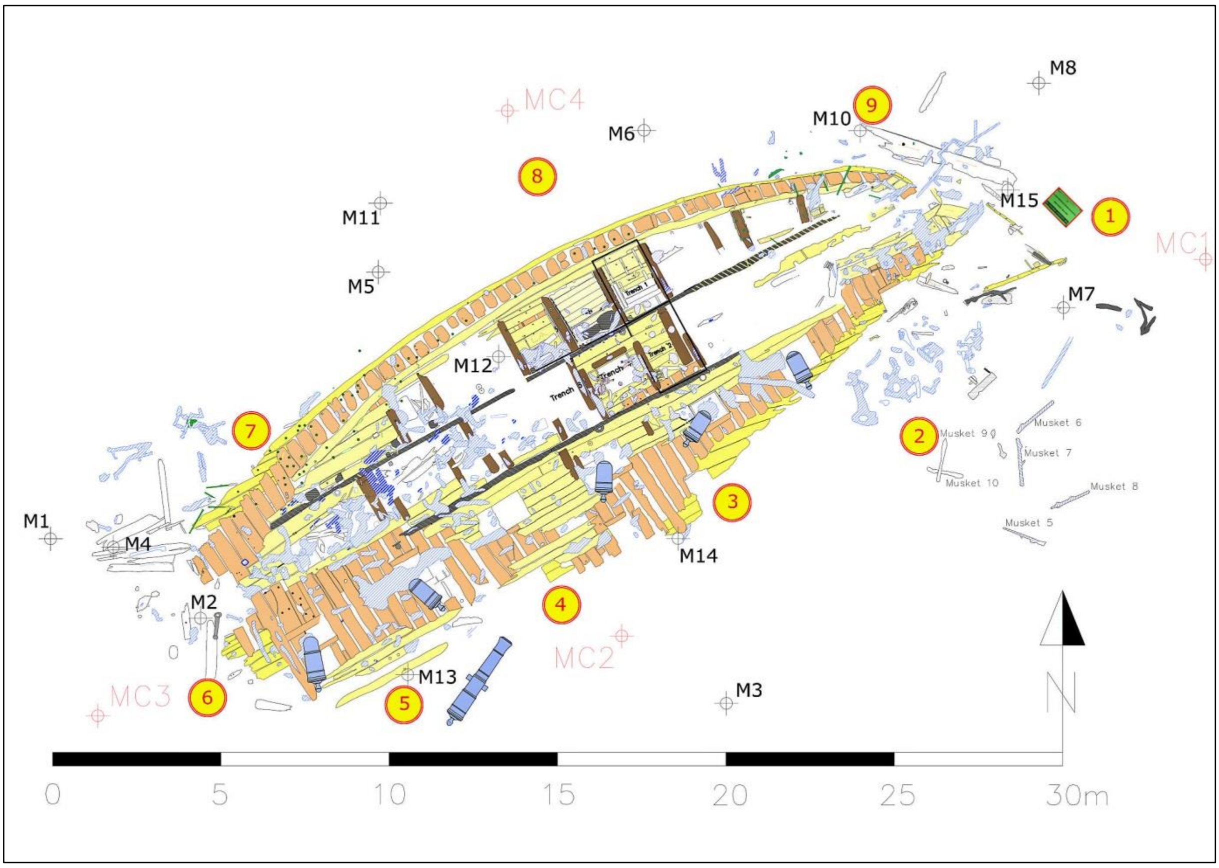

Fig 13
The location of the fourteen sediment monitoring points M1-M8 and M10=M15. Note there is no M9

The mean sediment levels on the site were 2.7mm lower than they were in September 2021. When measured again in September 2023 they had fallen by a further 12.2mm. The trend of the mean level change can be seen in Fig 15 and appears to show a steady fall over the last two years.

However, reference to Fig 14 below demonstrates that the levels have fallen most on the north side of the wreck, which probably accounts for the newly-exposed material observed to the north of the wreck. This is best demonstrated by looking at the largest fall, monitor points M5 and M6, which are both on the north side of the wreck - while the largest increase of sediment level was at monitoring point M13, which is on the south-west corner of the wreck.

Monitor Point	Sep 2021	Sept 2022	Sept 2023	Position
M1	15	-40	-20	NW
M2	-5	40	-25	W
M3	15	-	-	S
M4	100	0	-	NW
M5	45	60	-75	N
M6	20	-	-75	N
M7		-	-65	SE
M8	27	-50	30	E
M10	15	-35	15	N
M11	0	60	-	N
M12	30	-15	20	Central
M13	5	-45	80	SW
M14	20	10	-10	S
M15	25	-15	-10	E
Mean	**+24**	**-2.73**	**-12.27**	

Fig 14
The recorded change of sediment level at the various sediment monitoring points in 2022 and in 2023. A dash indicates that the monitoring point could not be located

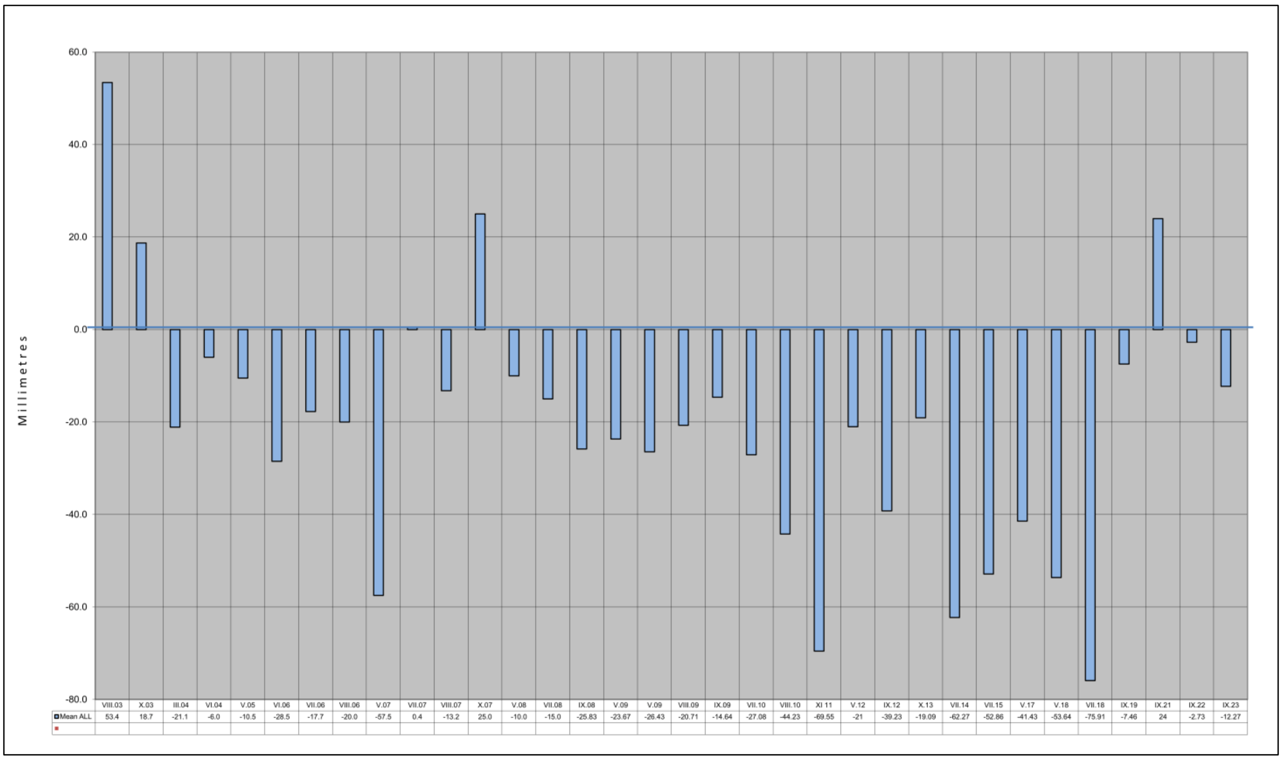

Fig 15
Chart showing the mean sediment level change on the site relative to the sediment levels in 2003 when monitoring began – this is represented by the horizontal zero line in the centre of the chart. These values are the mean of all 14 readings. Note how the plot for 2019-2023 seems to repeat the pattern recorded in 2007-2008

Newly Exposed Wreck Material

On the last dive of the project an area of new wreck material was discovered to the north of the wreck. This new material had been exposed by falling sediment levels. Given very limited time, the items were photographed and quickly plotted on a measured sketch plan. These items were subsequently surveyed and recorded in September 2023 (Camidge et al., 2023). All the items were left in place on the seabed in 2022.

Number	Object	Material
1	Complete lead gun-apron	Lead
1	Part of gun apron?	Lead
2	Muskets	Composite
1	Sash weight	Lead
1	Ring bolt	Iron
2	Scuppers	Lead
2	Sheaves	Wood & copper
1	Sheathing	Lead

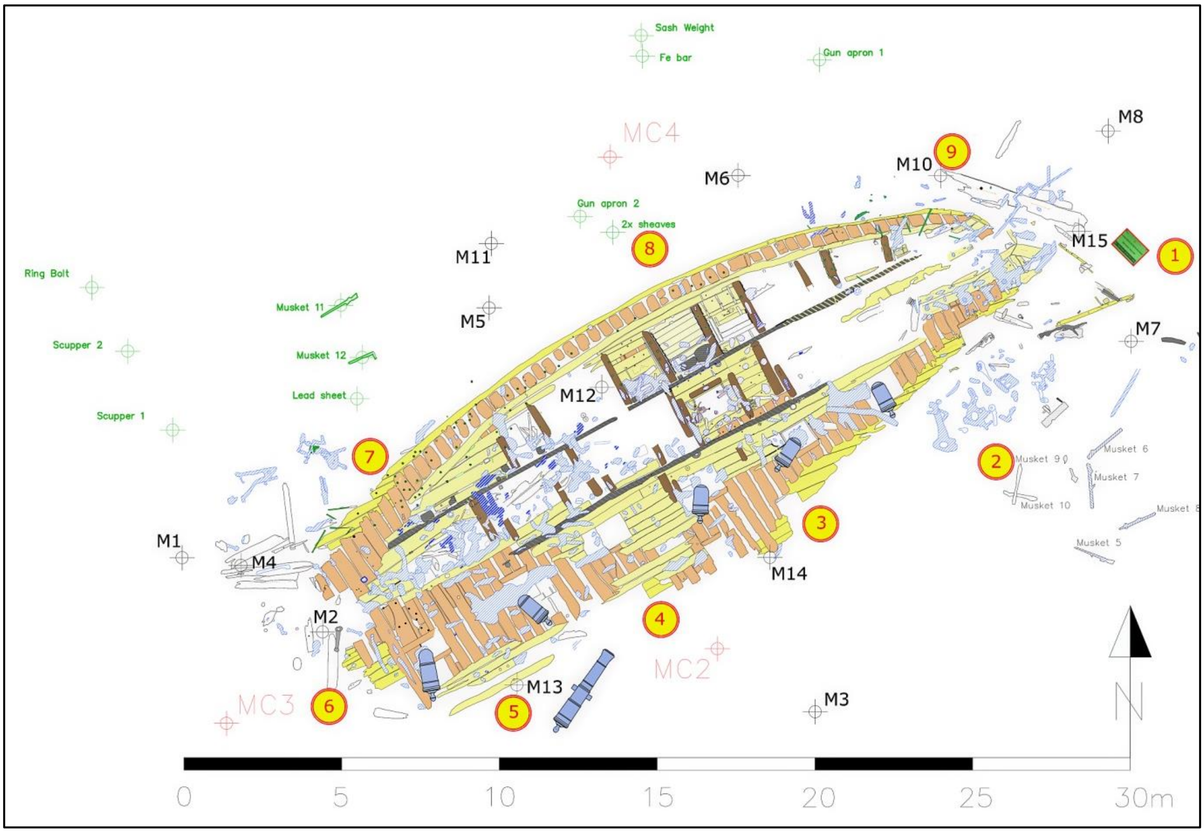

Fig 16

Sketch showing the new wreck material to the north of the wreck (shown in green). The positioning of these objects is approximate.

Two new muskets were found (musket 11 & musket 12 on fig 6), lying partly exposed on the seabed some 5m north of the main area of wreckage.

Fig 17 - Musket 11 exposed on the seabed – scale = 0.5m

Several lead objects were observed, including a lead gun-apron, and part of another (gun aprons 1 & 2 on fig 16). Gun aprons were covers for the touch hole of cannon, in this case with a shaped pod to accommodate the flintlock firing mechanism. They quite often have the calibre and the number of the gun inscribed into the lead. These objects should be considered for recovery.

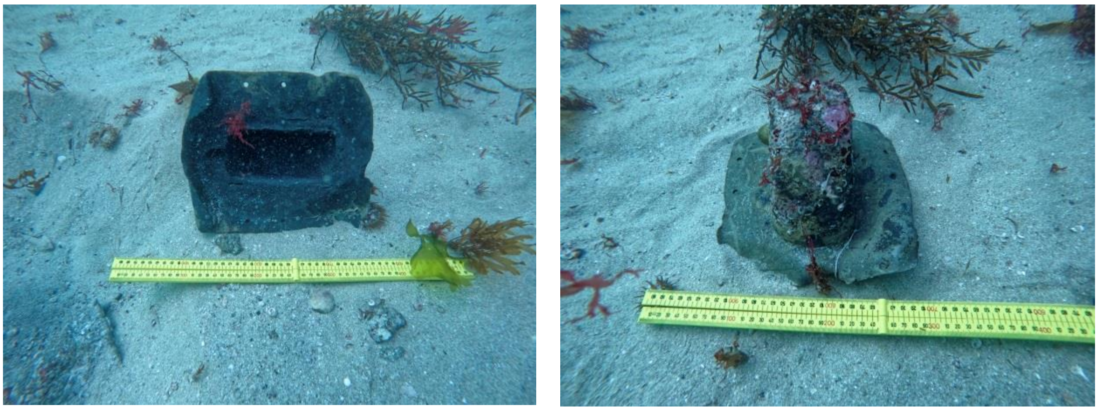

Fig 18
Gun apron 1, as found on the right, and turned over on the left. Note the holes to secure the apron to the gun.

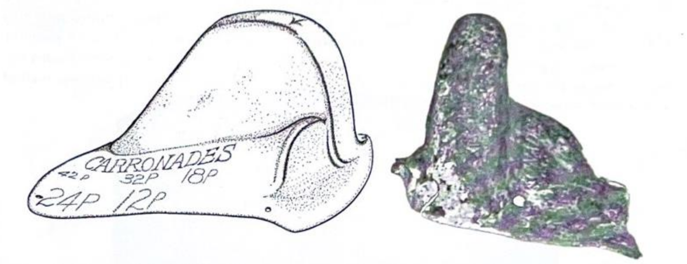

Fig 19
A gun apron found on the wreck of the Pomone 1811
(Bingeman, 2010, p127)

Two lead scupper pipes were also found (scupper 1 & scupper 2 on fig 16); these were part of the drainage system on the gun decks.

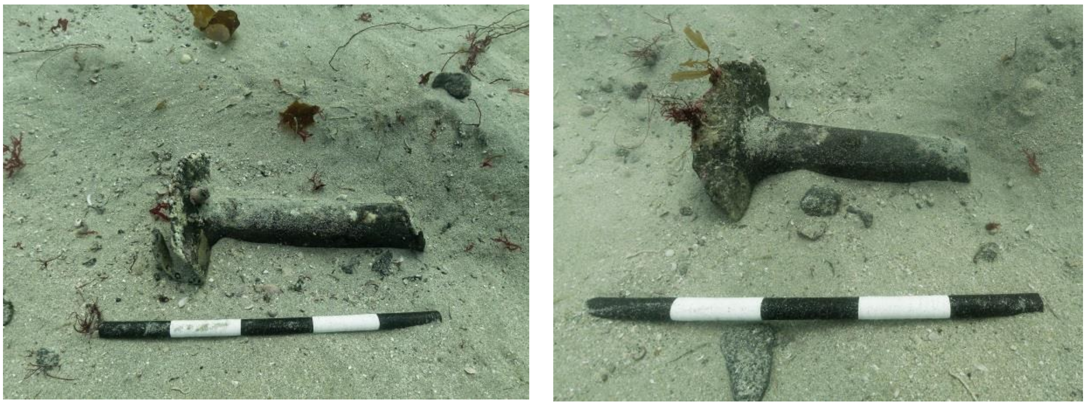

Fig 19 - Lead scupper pipes. Scale = 0.5m

A lead sash weight was also seen. This would have been a counter-weight for one of the sash windows at the stern of the ship, either in the captain's cabin or one deck lower down in the wardroom.

Fig 20
Lead sash weight. Several of these have been seen on the site in the past.

An area of crumpled lead sheeting was also found, and appeared to be quite extensive. Lead sheet has previously been found covering the window head of the quarter-gallery; this was recovered attached to the quarter-piece carving (Oscar) recovered in 2002. Large areas at the stern would also have been covered with lead sheeting.

The nature and location of this new material suggests it may have originated in the now missing, starboard side of the vessel, which would have lain above the surviving port side remains when the ship turned onto her beam ends. It is interesting that five of the eleven objects recorded are armament-related (two gun aprons, a ring bolt and two muskets).

Appendix I – Artefact Appraisal 2012 by Ian Panter

Introduction

Artefacts recovered during the 2012 excavation were recorded and sent to the conservation labs at York Archaeological Trust for condition assessment. Two groups of artefacts have now been reburied at the wreck site for re-excavation in ten and twenty-five years' time. This section is concerned with the methodologies adopted to characterise the condition of each material type and the preliminary results obtained to date. It is planned to run further destructive tests on sub-samples of the objects as soon as work schedules permit and this additional work will be reported on accordingly.

Methodology

Excavated artefacts underwent preliminary recording and packing on the dive support vessel to minimise the impact of environmental changes brought about by excavation, each artefact being sealed into a polythene bag containing sufficient seawater and seabed sediment to prevent drying out during the transfer to the shore-based facility.

The recording undertaken on the Scilly Isles included digital photography, measurement and visual examination of surface condition, noting colour and evidence of active corrosion or decay. Throughout the course of the excavation the artefacts were maintained in a dark and cool environment until decisions had been taken as to whether they would be discarded or despatched to York for further investigation. A number of artefacts were also selected for conservation and future display in the local museum.

Artefacts were selected from the following material categories: ceramics, glass, wood, copper alloy and concretions. As only one example of leather was retrieved (a shoe sole fragment) six examples of rope and two animal bones (ribs) were included in the investigation. To ensure that there were ten examples in each material category it was necessary to cut some artefacts into two: the leather sole (F828), rope (F771) and a fragment of hazel barrel binding (F855A).

Artefacts to be sent to York were repacked without sediment but with a small amount of seawater to prevent drying out, and then heat sealed into an oxygen-free environment using the ESCAL® transparent barrier film and the RP System® Type K oxygen scavengers. The Type K system has been developed to protect organic materials that are sensitive to fluctuating moisture levels – only oxygen and corrosive gases are removed. An oxygen indicator tablet (Ageless Eye Oxygen Indicator®) was inserted into each ESCAL package before excess air was squeezed out and the barrier film heat sealed. In the presence of oxygen these tablets are blue in colour but turn pink once the oxygen concentration falls below 1%. All tablets were pink when the artefacts arrived in York and therefore there was a high degree of confidence that the artefacts had not undergone oxidation since their removal from the seabed. Comparison with the digital images taken soon after the artefacts were retrieved from the seabed indicated no change had occurred during transportation, and hence the packaging system has proved effective.

All artefacts were carefully washed under running water to remove loosely adhering sediment and general detritus, excess surface water was removed by blotting with absorbent paper towels and weighed. Securely attached concretions were kept in place to avoid damaging the artefact. The artefacts were examined using light microscopy at X20 magnification to assess surface features, and identify active corrosion.

Concretions, copper alloy and wood artefacts were X-rayed using the Hewlett Packard Faxitron Cabinet system at the laboratory. Individual sheets of Agfa Structurix D7 film (a fine grain film with high contrast and high speed) were used in lead screened cassettes. An exposure of 120KV and 15 seconds was used for the copper alloys, 125KV and 60 or 90 seconds for the concretions and 30 KV and 30 or 120 seconds for the wood, depending upon species and density. The lead screens were removed from the film cassettes for these low exposures.

Using the X-ray images the degree of decay to the wood has been classified according to British Standard, (BS_EN275, 1992):

Grade No	Description of Condition	Condition and appearance of test wood sample
0	No attack	No sign of attack
1	Slight attack	Single or few scattered tunnels covering not more than 15% of the area of the specimen as it appears on the X-ray film
2	Moderate attack	Tunnels covering not more than about 25% of the area of the specimen as it appears on the X-ray film.
3	Severe attack	Tunnels covering between 25% and 50% of the area of the specimen as it appears on the X-ray film.
4	Failure	Tunnels covering more than 50% of the area of the specimen as it appears on the X-ray film.

For the concretions an assessment of the percentage area of mineralisation or voiding (depending upon the severity of deterioration) was determined using the X-ray images.

Density assays were conducted on the wood artefacts using the “Archimedes Principle” technique. Before testing, each sample was fully saturated using the standard technique (Hoffmann, 1982), then weighed whilst submerged under water and then in air. The actual density of the wood is calculated thus (Cook & Grattan, DW, 1990):
3 * Wsub /(Wair - Wsub)

Where Wsub is the weight submerged and Wair the weight in air.

When compared with the normal density of wood of the same species, an estimate of the percentage wood loss (LWS) can be calculated based on the following:

LWS (w/v) = 100 (Rgn - Rg) / Rgn %weight/volume

Where Rgn is the normal density and Rg the actual density of the wood.

The density technique was not applied to the other materials due to uncertainties over obtaining accurate normal densities.

An objective measurement of colour was carried out using the Minolta Chroma Meter CR-100 using the Illuminant C (6774K) condition (simulated daylight with correlated colour temperature of 6774Kelvin). The device is a spectrophotometer that fires a pulsed xenon light onto a surface, captures the reflectance and utilises software to numerically characterise the “Hue” (i.e. colour), the “Value” (the lightness of the colour) and “Chroma” (the saturation of the colour).

The Chroma Meter was configured to record the colour characteristics of the ceramics using two standard notation systems:

- Yxy – where Y = Value, x = hue and y = chroma
- L*a*b* - where L* = value, a*= hue and b* = chroma

For each ceramic shard, three readings were taken for outer and inner surfaces and the broken edge to produce a reading for the body fabric. Readings have been averaged and included in the relevant table below.

The accuracy of the measurements depend upon the amount of light reflected back to the spectrophotometer – the less the reflected light the greater the inaccuracy. For this reason, the Chroma Meter was not used to characterise the glass because almost all the pieces were transparent, nor was it used on the copper alloy tacks which were smaller than the diameter of the emitter of the spectrophotometer.

Results

Iron Concretions

Number	X-Ray No.	Assessment	% Voided	Weight (g)	Reburial trench
F760	8067	Smooth concretion comprised of fine grained sand and tiny pieces of shell, and tiny grit/stone. Large stone embedded at one end. No evidence of fracturing or iron staining. X-ray image reveals large nail, no metal or mineralisation products remaining.	100	202.1	B
F762	8039	Intact concretion mainly smooth and fine grained sands with larger shells embedded, and a pot sherd. No evidence of fractures and no iron staining. X-ray shows large nail with mineralised iron surviving.	25	722.6	A
F763	8043	Intact concretion made from fine grained sands and tiny pieces of shell. No visible fracture or iron staining. X-ray image long bolt/fitting, no metal or mineralised products remaining.	100	1201.0	B
F766	8068	Concreted nail in two fragments with timber still attached. Covered in fine grained sandy concretion with tiny shells embedded in the matrix. Initially recovered in one piece, but concretion broke during transit to York. No iron staining. X-ray confirms nail, and shows presence of mineralised iron.	90	940.4	B
F814	8037	Concretion of fine grained sands with moderate sized shells embedded. No fractures and no iron staining, concretion appears intact. X-ray image shows long bolt/fitting with areas of mineralised iron surviving.	85	697.2	A
F816	8067	Relatively smooth intact concretion composed of fine grained sand and a few larger shells. No fractures or iron staining. X-ray image if of an undiagnostic object, no metal or mineralised products remaining.	100	178.7	A

Number	X-Ray No.	Assessment	% Voided	Weight (g)	Reburial trench
F847	8067	Concretion comprising fine grained sand and grit, any tiny pieces of shell and stone. One end is broken, exposing the object within. No iron staining. X-ray image is of an undiagnostic object with mineralised iron evident. This indicates a recent breakage of the concretion.	80	159.0	A
F852	8044	Compact concretion comprised of fine grained sand and tiny pieces of shell. No evidence for fractures, concretion intact. X-ray image suggests an 'L'- shaped bar/fitting. Most of the iron has undergone mineralisation.	10	1500.0	A
F883	8067	Compact concretion mainly composed of fine grained sand and shells cemented together. No fractures or iron staining present, concretion is intact. X-ray image shows an undiagnostic object , no metal or mineralisation surviving.	100	118.8	B
F884	8067, 8068	Compact concretion made of fine grained sand and tiny shells. No evidence of fracturing or iron staining. X-ray image is of an undiagnostic object, with traces of mineralised iron remaining. In four fragments.	90	526.1	B

Wood artefacts

Number	Species	Actual Density (g/cc)	% Loss in wood substance	X-ray No	EN275 Grade	Assessment	Reburial trench
F751	Lignum vitae	0.942	17.4	8065	0	Very hard and dense sheave, with concretion to rim and iron staining over faces. Rim physically eroded, and slight erosion to the faces. No evidence for exit holes. X-ray reveals no evidence of shipworm attack.	A
F752	Lignum vitae	0.865	24.1	8064	1	Very hard and dense sheave, slight cracking and erosion to the faces, and iron staining. No evidence for exit holes. X-ray image reveals one small tunnel lined with a calcareous deposit, probable shipworm attack.	B
F756	Ash	0.153	71.1	8063	1	Lathe turned handle, evidence for slight biological attack – tiny exit holes - to surfaces. X-ray reveals several calcareous lined tunnels scattered throughout. Can be snapped easily by hand.	B
F764	Ash	0.182	65.7	8063	1	Almost identical to F756, probably part of same artefact. Identical visible features and calcareous lined tunnels on X-ray image. Easily snapped by hand.	A
F825	Lignum vitae	0.897	21.3	8069	0	Very hard and dense sheave, slight cracking has developed and slight erosion through use. No evidence for shipworm from X-ray image.	B
F827	Lignum vitae	0.855	25.0	8055	1	Very hard and dense sheave, physical erosion to both faces through use. One crack visible and possible exit holes. X-ray image shows one large calcareous lined tunnel from worm attack.	A

Number	Species	Actual Density (g/cc)	% Loss in wood substance	X-ray No	EN275 Grade	Assessment	Reburial trench
F811a	Scots pine	0.362	13.8	8063	0	Billet of worked wood, one iron nail in situ, originally encrusted with concretion when retrieved. Most concretion removed from the wood but left in situ around the nail head. No evidence for biological decay, but physical erosion beneath corrosion. X-ray image reveals well preserved wood and nail has 85% metallic iron remaining. No evidence for biological activity. Joins onto F811b	A
F811b	Scots pine	0.403	4.0	8063	0	Billet of worked wood, one iron nail in situ, originally encrusted with concretion when retrieved. Most concretion removed from the wood but left in situ around the nail head. No evidence for biological decay, but physical erosion beneath corrosion. X-ray image reveals well preserved wood and nail has 95% metallic iron remaining. No evidence for biological activity. Joins onto F811a	B
F855Ai	Hazel	0.226	43.5	8063	0	Fragment of barrel binding strip, joins onto F855Aii. Slight physical erosion of surfaces, no visual evidence for biological activity. X-ray image shows no tunnels either. Easily snapped in half by hand.	A
F855Aii	Hazel	0.195	51.3	8063	0	Fragment of barrel binding strip, joins onto F855Ai. Identical condition, no evidence for biological activity either visually or from the X-ray image.	B

Normal density (Rg) (g/cc):

Ash	0.53
Hazel	0.40
Lignum vitae	1.14
Scots pine	0.42

Copper Alloy

Number	X-Ray No.	Assessment	% Mineralised	Weight (g)	Reburial trench
F706	8050	Small tack with a pitted surface having a dull red and black patina. Spots of green corrosion around the head and top of the shank. X-ray reveals a substantial core of metal surviving.	<5	2.141	A
F721	8050	Well preserved small tack, with traces of a grey/black layer covering the head and upper shank. Where this layer has spalled away is a typical "bronze" coloured surface, tarnished in places. Stable, no evidence for active corrosion. X-ray images reveals substantial core of metal.	<5	3.064	B
F734	8050	Well preserved tack whose surface is slightly corroded with a variegated green and orange/red corrosion. No evidence for active corrosion, object is stable. X-ray image shows substantial metal present.	<5	1.099	A
F735	8050	Well preserved tack, slight corrosion to surfaces, mainly black and orange/red and light green corrosion products. No evidence for active corrosion. X-ray image reveals substantial amount of metal surviving.	<5	2.220	A
F739	8050	Well preserved tack, slightly pitted surface which has spots of red and black corrosion products present. X-ray image shows substantial amount of metal remaining, but areas of slight mineralisation.	10	2.110	B
F824b	8050	Possible bowl fragment, pitted surface which has an overall pink copper colouration with areas of dull black corrosion. A fragment of concretion adheres to the artefact and this has caused orange iron staining in the immediate area. X-ray image shows no iron present, and around 50% mineralisation of the metal.	50	84.743	B
F841	8050	Well preserved small tack with an even pale black patinated surface. X-ray image shows substantial metal remaining.	<5	1.386	A
F845	8050	Well preserved small tack with dark green patina and a thin crust of concretion underneath the head and upper shank. X-	<10	1.532	B

Number	X-Ray No.	Assessment	% Mineralised	Weight (g)	Reburial trench
		ray image reveals substantial amount of metal remaining.			
F849	8050	Strip fragment, undiagnostic, having a brown coppery surface, with an area of black corrosion and a few holes. X-ray image shows around 45% mineralisation has occurred.	45	27.978	A
F885a	8050	Well preserved small tack, having a black patinated surface with a few spots of green corrosion. X-ray image suggests a substantial amount of metal remains.	<5	1.639	A
F885b	8050	Well preserved small tack, with traces of a grey/black layer covering the head and upper shank. Where this layer has spalled away is a typical "bronze" coloured surface with spots of green corrosion. X-ray image reveals a substantial amount of metal survives.	<5	1.812	B

Glass

Number	Assessment	Weight (g)	Reburial trench
F703	Transparent fragment of glass, one rounded edge, all others broken, probably vessel fragment. Areas of staining, internal striations visible under microscope, but no iridescence develops as surface dries.	4.620	A
F707	Fragment of transparent glass with slight green hue and internal brown discolouration. Air bubbles visible under microscope, but no iridescence developing as surface dries. Possible bottle fragment.	4.050	A
F708	Base of small square bottle (ink or medicine?), transparent glass, with slight green/blue hue. Concave base. No iridescence develops on drying.	13.941	B
F708a	Fragment of thin sheet glass, function unknown. Opaque glass, no iridescence developing on drying.	22.611	B
F709	Translucent fragment of glass, function unknown. Well preserved, no iridescence developing on drying.	3.101	B
F722	Thin sheet fragment, transparent glass, no iridescence developed when surface dried out.	2.344	B
F730	Fragment of clear transparent glass with incised linear decoration. Slight staining to the glass but no iridescence developed as the glass dried.	1.328	A
F731	Fragment of translucent brown bottle glass, with a thin and hard smooth deposit obscuring much of the surface. No iridescence appeared as the surface dried though.	6.015	A
F788	Three fragments of translucent green glass, internal air bubbles visible. No iridescence developing as the glass began to dry out.	12.623	B
F844	Large sheet of clear transparent window glass, stained and scratched. No iridescence developed as the glass began to dry out.	67.386	A

Ceramics

Number	Weight (g)	Assessment	Chroma meter values			Reburial trench
			Location	Yxy	L*a*b*	
F701	9.904	Sherd of tin-glazed earthenware, the glaze has crizzled with the cracks now stained black. Glaze is still adhering to the underlying fabric. Stable.	i)	23.4, 0.338, 0.348	56.3, -0.2, 10.7	A
			ii)	22.3, 0.342, 0.347	53.6, -0.8, 11.1	
			iii)	27.3, 0.346, 0.349	64.5, 1.0, 13.4	
F713	1.169	Tin-glazed earthenware, glaze has crizzled and fabric stained black. Glaze is still attached to body and the sherd is stable.	i)	23.8, 0.329, 0.336	55.7, -0.5, 6.8	A
			ii)	18.1, 0.321, 0.332	50.7, -0.5, 4.6	
			Iii)	61.8, 0.335, 0.337	82.7, 0.7, 10.9	
F715	28.915	Sherd of unglazed red earthenware, no staining and stable. Good condition.	i)	9.7, 0.377, 0.369	36.8, 3.3, 13.9	B
			ii)	12.0, 0.415, 0.378	40.6, 9.5, 22.2	
			iii)	6.7, 0.410, 0.374	28.3, 7.1, 15.1	
F716	70.088	Rim fragment, brown stoneware, good condition, glaze intact no crizzling. Stable.	i)	12.4, 0.391, 0.367	41.0, 8.3, 17.7	B
			ii)	13.3, 0.381, 0.363	47.2, 3.4, 13.2	
			iii)	19.1, 0.332, 0.334	54.2, 1.5, 5.9	
F732a	17.789	Rim sherd of white tin-glazed earthenware, with crizzled glaze over the entire surface, especially to the outer surface which is speckled with black staining. This affected the operation of the Chroma Meter and no readings were possible from the outer surface. However glaze remains attached to ceramic fabric. Snapped into two sections, designated a and b	i)	Not possible	Not possible	B
			ii)	46.9, 0.307, 0.317	72.5, -1.2, -0.7	
			iii)	20.3, 0.363, 0.367	54.1, 0.9, 17.2	

Number	Weight (g)	Description	Chroma meter values			Reburial trench
			Location	Yxy	L*a*b*	
F732b	13.573	Rim sherd of white tin-glazed earthenware, with crizzled glaze over the entire surface, especially to the outer surface which is speckled with black staining. This affected the operation of the Chroma Meter and no readings were possible from the outer surface. However glaze remains attached to ceramic fabric. Snapped into two sections, designated a and b	i)	Not possible	Not possible	B
			ii)	61.4, 0.308, 0.318	82.1, -1.8. 0.3	
			iii)	17.1, 0.357, 0.361	46.5, 0.5, 15.2	
F732c	12.334	Body sherd of white tin-glazed earthenware, with crizzled glaze over the entire surface, especially to the outer surface which is speckled with black staining. This affected the operation of the Chroma Meter and no readings were possible from the outer surface. However glaze remains attached to ceramic fabric.	i)	Not possible	Not possible	A
			ii)	40.2, 0.304, 0.315	10, -5.2, -0.5	
			iii)	21.9, 0.356, 0.364	57.3, -0.7, 17.8	
F737	73.859	White tin-glazed dish/plate fragment. Crizzled glaze all over, but glaze remains attached to ceramic fabric. Stable.	i)	25.7, 0.332, 0.341	58.4, -1.6. 8.5	A
			ii)	21.9, 0.349, 0.357	52.0, -0.8, 13.1	
			iii)	12.0, 0.383, 0.371	54.2, 4.4, 21.2	
F820a	38.440	Sherd of Post Medieval reduced slipware, joins F820b. No evidence for crizzling to the slip, and sherd is intact and stable.	i)	14.5, 0.346, 0.354	45.1, -0.2, 15.3	A
			ii)	19.9, 0.347, 0.346	51.3, 3.0, 11.5	
			iii)	9.4, 0.326, 0.328	34.1, 1.2, 3.3	
F820b	64.409	Sherd of Post Medieval reduced slipware, joins F820a. No evidence for crizzling to the slip, and sherd is intact and stable.	i)	15.0, 0.363, 0.364	46.9, 3.1, 14.3	B
			ii)	22.6, 0.344, 0.343	55.8, 2.2, 10.2	
			iii)	14.7, 0.320, 0.320	44.9, 1.3, 1.7	

Key
Location i) outer surface, ii) inner surface, iii) broken edge

Other materials

Number	Material	Assessment	Weight (g)	Reburial trench
F712	Bone, animal	Rib, stained even dark brown over entire surface. Areas of pitting but overall, physically robust.	47.376	B
F775	Bone, animal	Rib, stained an even dark brown/black over entire surface. Physically robust.	48.910	A
F771A	Rope	Rope, good condition. Fibre strands still tightly bound, but slight loosening at both ends. No aroma from tar or pitch.	81.194	A
F771B	Rope		69.103	B
F817	Rope	Rope, good condition. Strands are not unravelling apart from the torn ends. No tar or pitch present.	641.9	B
F818	Rope	Rope, good condition. Strands are not unravelling apart from the torn ends. No tar or pitch has been applied to the rope.	575.9	A
F828A	Leather	Sole, flexible and no delamination. Physical damage- tears – to the lasting margin, and large lump of concretion adhering which has been carefully removed. Cut into two pieces for reburial.	6.391	A
F828B	Leather		8.445	B

Note: Scans of the X-rays appear on the DVD ROM which accompanies this report.

Geochemical analyses of sediment samples from the site

Six sediment samples were retrieved from the seabed, SS11 to SS13 from reburial site A and SS14 to SS16 from site B. Initially these were packed into re-sealable polythene bags and despatched to the shore HQ where they were heat-sealed into ESCAL™ barrier film which also included several sachets of the RP System Type K™ oxygen scavengers to prevent oxidation of the samples during transit back to the mainland. The samples were kept in cool conditions at all times. On arrival in York it was observed that the indicators, "Ageless Eye"™ Oxygen indicating tablets, had a blue hue which implied that some oxygen was still present in the sealed bags.

Four samples (two from trench A and two from trench B) were sent to Derwentside Environmental Testing Services, a UKAS accredited facility for geochemical assays, to determine the following chemical parameters:

Test	Units	DETSxx	LOD	SS13	SS11	SS14	SS16
Moisture Content	%	DETS 046*	0.1	22	29	25	28
Nitrate as NO3	mg/kg	DETSC 2055	1	3.2	< 1.00	12	< 1.00
Carbonate (as CO2)	%	DETS 005*	1	18	18	21	17
Loss on ignition	%	DETSC 2003#	0.01	1.5	1.3	1.5	1.3
Ammoniacal Nitrogen as N	mg/kg	DETSC 2119#	0.5	9.5	9.2	12	10
Total Sulphate as SO4	%	DETSC 2321#	0.01	0.28	0.29	0.24	0.27
Sulphate Aqueous Extract as SO4	mg/l	DETSC 2076#	10	520	420	550	540
Oxidisable Sulphide as SO4	%	*	0.01	< 0.01	0.05	0.05	< 0.01
Total Potential Sulphate as SO4	%	*	0.03	0.24	0.34	0.29	0.25
Total Sulphur as S	%	DETSC 2320	0.01	0.08	0.11	0.10	0.08
pH		DETSC 2008#		8.9	9.0	8.9	8.8

The results indicate that the sandy sediments are alkaline (pH values range between 8.8 to 9.0), have low organic contents (loss on ignition values range from 1.3% to 1.5%) with variable concentrations of total sulphate (between 0.24 and 0.29%). Sulphides are recorded from samples SS11 and SS14, and sulphur is present too. Whilst higher levels of sulphate have been measured from the aqueous extracts, the presence of ammoniacal nitrogen in all four samples, as well as low levels of nitrate indicate reducing conditions. Oxidation of sulphides to sulphates is a rapid reaction and hence some oxidation would have occurred in the time between recovery from the seabed and analysis by the laboratory. Overall, there is nothing in the results to suggest potentially aggressive conditions that would impact upon continued in situ preservation of the artefacts and timber structures.

Porosity tests were conducted on two of the sediment samples by first determining the mass of a dried sample of known wet volume, and using the following equation:

$$\text{soil porosity } \varnothing = (1 - P_b/P_p) \times 100$$

where P_b = soil bulk density (defined as mass of dry soil/volume of bulk soil samples) and P_p = soil particle density, commonly taken as 2.65g/cm^3.

Sample	Mass, dry (g)	Volume bulk (cm^3)	Bulk density (g/cm^3)	Porosity (%)
12 (Tr A)	60.3	50	1.206	54
15 (Tr B)	62	50	1.24	53

Porosity is a measurement of the ratio of the volume of voids to the total volume of the soil, with well-sorted sands or gravels ranging between 25 and 50%, and both samples from the *Colossus* wreck site fall into this category. Sands in general have a higher permeability than finer grained soils such as clays so seawater will be flowing through the sediments.

Conclusions

The aim of this study has been to characterise the current condition of artefacts retrieved during the 2012 excavation season on the wreck of HMS *Colossus*. The artefacts have now been reburied at the wreck site in two trenches and will be re-excavated and re-examined in 2022 and 2037, in order to assess the effectiveness of in-situ preservation as the on-going management strategy for the designated wreck.

Using artefacts as proxy indicators of decay is innovative and may provide a more accurate indicator of site environmental conditions than using the more common techniques of burying modern replicates or measuring seabed parameters , including redox, for example.

Wooden artefacts recovered in 2012 were well preserved, especially the *lignum vitae* sheaves. A low level of biological activity, in the form of shipworm infestation, was recorded in several artefacts and is easily discernible from X-ray images. X-radiography is an extremely useful, rapid and non-destructive technique for carrying out condition assessments of wood from a marine environment.

Similarly X-radiography of the copper alloys and concretions proved very effective at assessing overall condition. Whilst very little iron survived, the copper alloy artefacts were, on the whole, very well preserved.

Assessment of the copper alloy and wooden artefacts in later years should provide very useful data about site conditions.

Assessing silicate-based materials, such as glass and ceramics, often requires destructive technique such as a scanning electron microscope with micro analyser (SEM EDX). Sub-samples of all the glass and ceramics have been taken and will be analysed presently and the results incorporated into the site archive for future comparison. However, future analytical techniques may be entirely different in ten years' time and data may not be comparable.

The ceramic and glass artefacts were, overall, quite well preserved. Visual examination of the glass under light reflected microscopy revealed no iridescent surfaces developing as the glass partially dried. This is indicative of little, or no, deterioration. However, the tin glaze present on most of the ceramics had undergone decay resulting in the formation of many micro-cracks., subsequently stained black. This staining had affected the accuracy of the colorimetry investigation and the effectiveness of this technique will only become apparent in ten years' time following re-excavation.

Ian Panter
York Archaeological Trust
December 2012

X-ray images 2012

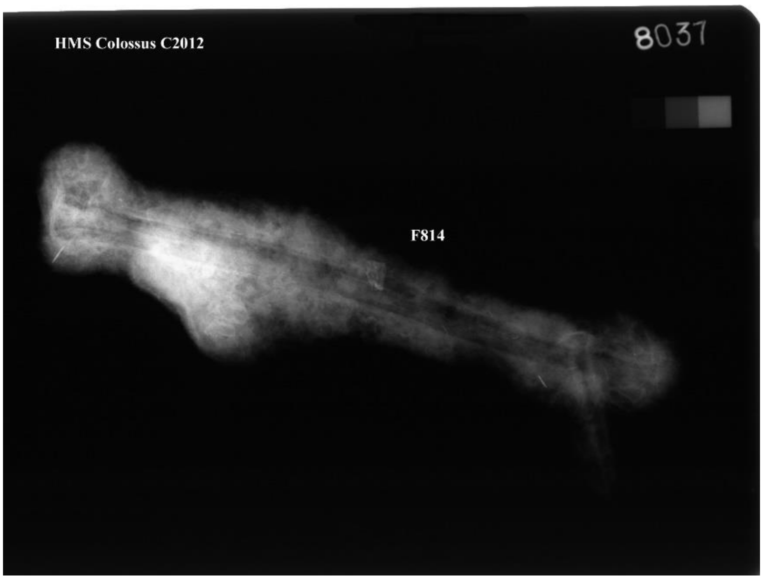

Fig 21
X-ray 8037

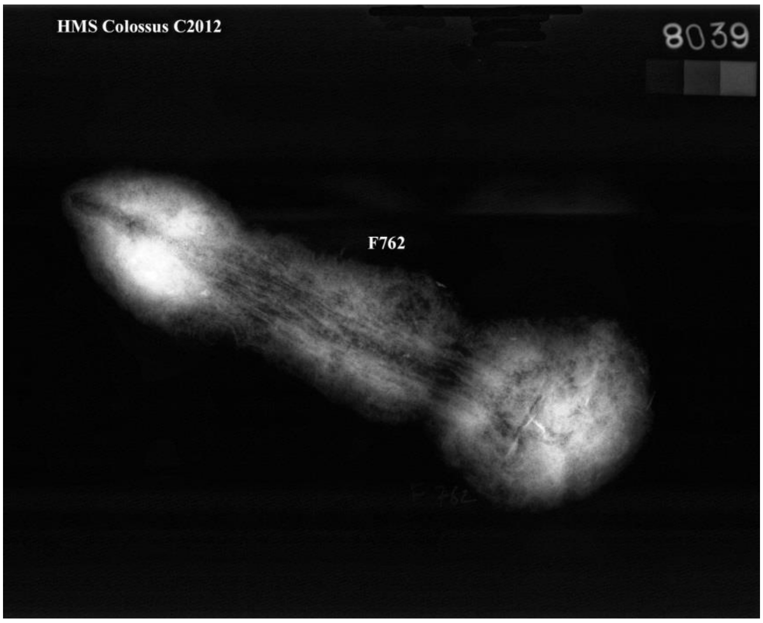

Fig 22
X-ray 8039

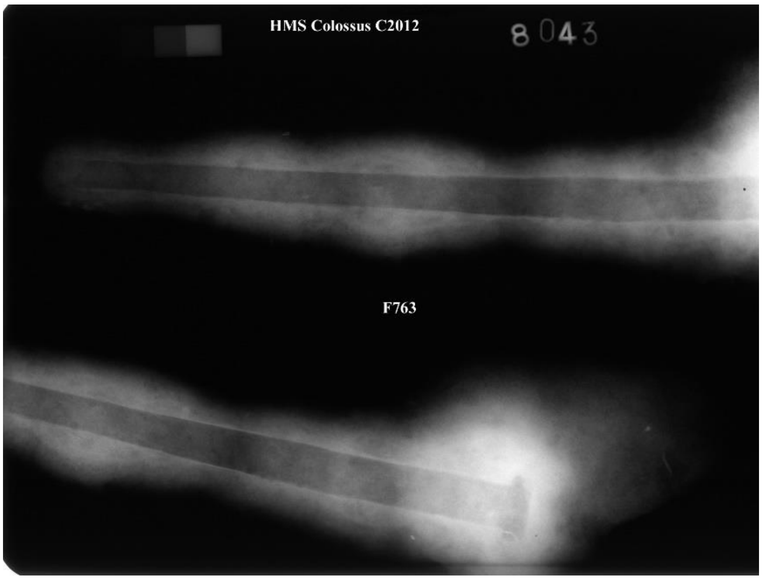

Fig 23
X-ray 8043

Fig 24
X-ray 8044

Fig 25
X-ray 8049

Fig 26
X-ray 8050

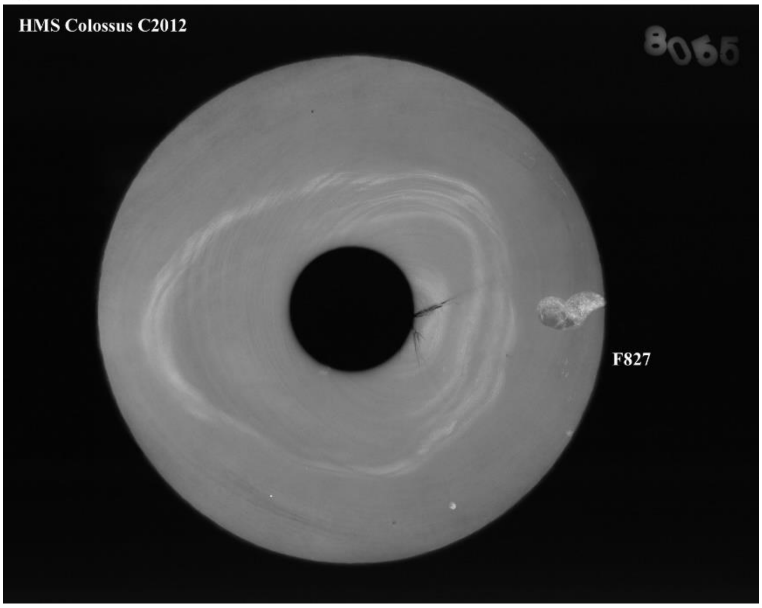

Fig 27
X-ray 8055

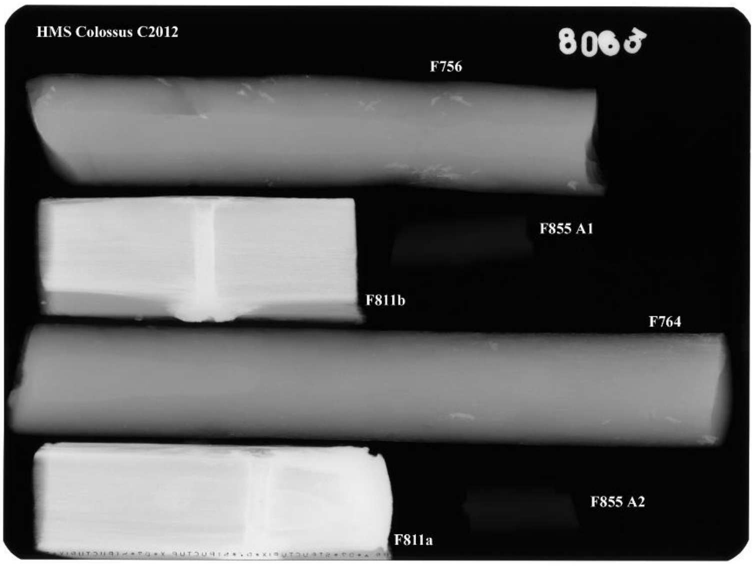

Fig 28
X-ray 8063

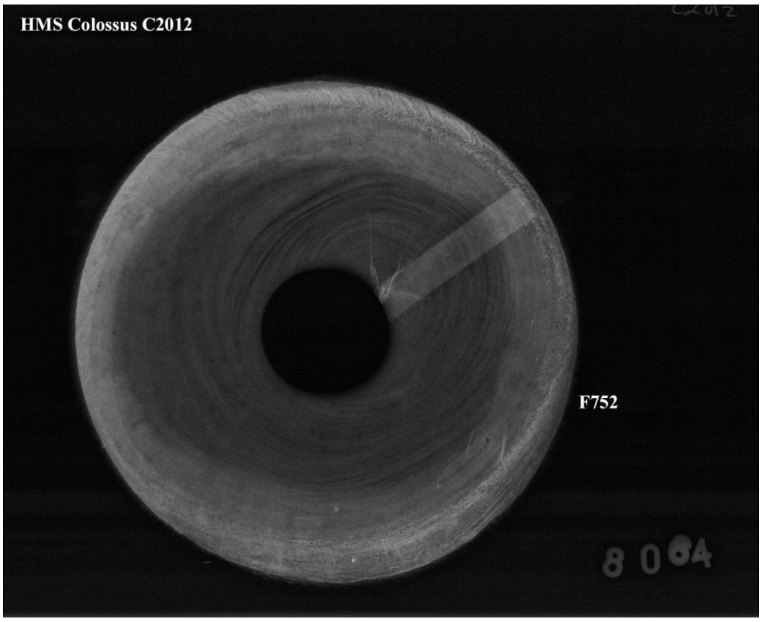

Fig 29
X-ray 8064

Fig 30
X-ray 8065

Fig 31
X-ray 8067

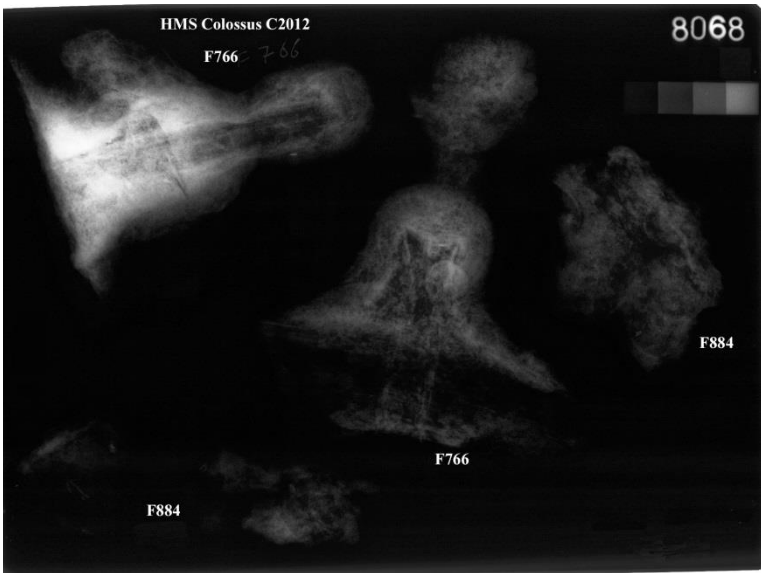

Fig 32
X-ray 8068

Fig 33
X-ray 8069

Appendix II – Artefact Appraisal 2022 by Ian Panter

Introduction

Artefacts reburied in 2012 were retrieved and sent to the York Archaeology conservation laboratory during the Autumn of 2022. Upon arrival, all finds were kept in cool and dark storage conditions until further analyses could be carried out.

Basic assessment tests include:

- Examination of all artefacts under light microscopy at x 20 magnification
- X-radiography of the metal, concretions to assess extent of mineralisation
- X-radiography of the wood to assess extent of shipworm infestation
- Colour measurement of ceramics using a chromameter.
- Weight loss of all artefacts
- Density determination of the wood as a means of calculating deterioration.

Further information relating to these tests were described in the initial condition assessment report (Appendix I above).

Of the original 30 artefacts reburied in crate A, only 26 were relocated and sent to York. One of these, a bag of 5 loose wood fragments, had been designated as F855A. However, as the original F855A was a fragment of hazel barrel binding strip, and these 5 fragments were all oak, it was decided to exclude them from this assessment exercise.

Artefacts examined in 2022:

Iron concretions	F762, F814, F816, F847, F852
Copper Alloy	F706, F734, F735, F841, F849, F885A
Wood	F751, F764, F811A, F827
Glass	F703, F707, F730, F731, F844
Ceramics	F713, F737, F820A
Bone	F775
Rope	F818

The current condition of each artefact has been defined by comparison with the baseline assessment established in 2012.

Condition assessment summaries

The full results for each material class are tabulated below.

Iron Concretions:
All concretions remain intact and robust, although all now exhibit some degree of surface iron staining which has developed following reburial.

Mineralised iron is present in three of the concretions – F762, F814 and F852. The latter appears to be the more stable of all as the volume of mineralised metal remains the same, whereas voiding has increased in F762 and F814.

Overall, the concretions are stable and well preserved.

Copper Alloy:
The small tacks/nails are very well preserved, show no signs of active corrosion, nor any physical changes from when recorded in 2012 (Figures 7 and 8). The X-radiography suggests less than 5% of the metal has been mineralised.

The sheet/strip fragment, F 849, has become slightly more mineralised over time, and an area of red cuprite has developed on the surface. However, there are no indicators of active corrosion in the form of green powdery spots.

There has been a slight weight loss recorded for all the copper alloy artefacts, although the values are insignificant and lie within the accuracy margins of the equipment.

Wood:
All four wooden artefacts remain well preserved and there is no evidence for ongoing shipworm activity following reburial. There has been no increase in shipworm activity observed in sheave F827 (Figures 5 and 6) and handle F764 in 2012, and both remain classified Grade 1 under EN275 (British Standard, 1992).

Visually there has been no change to the surface appearance of the wood although F811A has seen an increase in iron staining due to the presence of a corroding iron nail in the wood. There is no evidence of cracking or physical erosion of any of the artefacts.

However, an increase in the percentage loss in wood substance (based on comparisons of wood densities) indicates that three of the four wood artefacts have undergone slight degradation, This is likely to be the result of hydrolytic decay – the action of water on the cellulose component of wood.

Glass:
The glass remains well preserved and in good condition. However, one observable difference is that four of the five samples now exhibit light iridescence as the surfaces dry, indicative of the onset of deterioration.

Weight loss was recorded in all five samples, although the very low values from four are not significant and likely reflect the error margin of the equipment.

Ceramics:
All the ceramic sherds are robust, and the glazes are stable and remain attached to the underlying ceramic fabric. No further cracking has occurred to the glazes but the chromameter readings indicate that the appearance is changing. For example, the outer surface of F737, a tin-glazed dish/plate, has become more mottled, and darker in colour whilst there has been slight reduction in colour to the F820A.

Interestingly, the sherd of tin-glazed earthenware, F713, has become bleached during reburial, and is now bright white in colour. It is also the only sherd that has lost weight, and its profile/appearance does not match the photograph taken in 2012. Therefore, there is doubt as to whether this is the original sherd (see Figures 3 and 4 below).

Rope:
The single item of rope, F818, is in a very good condition, with no evidence of microbial activity or physical loss/disruption to the fibres. A weight loss of 2.76% may be the result of a low level of biodeterioration through anaerobic microbes.

Bone:
The single bone, animal rib F775, remains in a robust and stable condition, with no physical change when compared with 2012. It has undergone a very slight weight loss of 1.62%, which may be due to the accuracy of the top-pan balance used for weighing.

Packaging/labelling materials:
The resealable polythene bags that each artefact had been buried in were found to be intact and little affected by the ten years under the seabed. The majority of bags were unstained, although the bags containing the concretions were stained from rusty iron corrosion, and/or black deposits and the Dymo™ labels were also intact and well preserved, and remained legible in all cases (Figures 1 and 2).

Conclusions

There has been little overall change in the condition of the materials that were buried on the seabed between 2012 and 2022.

Where weight loss was observed, the changes were usually minimal and not significant and likely reflect a combination of margins of error inherent in the balance used, as well as changes in water content through handling and processing.

Physically, the artefacts have altered little, although all the iron concretions are now more iron-stained than there were ten years ago and one of the ceramic sherds has darkened, whilst another one, F713, has bleached with time (although there is some doubt about whether this is the original item). The copper alloy tacks/nails have changed little in appearance, apart from the strip, F849, where red cuprite (copper oxide) has formed on the surface. This artefact appears to have undergone more mineralisation, based on its X-ray image.

Slight iridescence is now visible on the surfaces of four of the glass sherds (F703, F707, F731 and F844) indicating that the glass is breaking down and beginning to decay.

Where present, the iron component of the concretions appears to have undergone a slight increase in mineralisation, F814 and F817, whilst the larger fitting, F852, appears not to have altered at all, implying that the overlying concretion remains intact and protecting the mineralised iron inside.

There is no evidence for increased shipworm activity in the wood, nor is any other form of biodeterioration evident, although anaerobic bacteria are likely to be active. Density determinations, based on the Archimedes principal of weighing in air and submerged under water, indicate a slight increase in loss in wood substance, which is likely to be a result of the action of anaerobic bacteria and hydrolysis (the action of water on the cellulose component). The single piece of rope has also survived well, with little apparent change in appearance and slight weight loss.

The results of this assessment suggest that the seabed environment has not been aggressive towards the majority of the materials over the last ten years. The combination of bagging in perforated resealable polythene bags and reburial to a depth of 20cm below seabed level has worked well. It is noted that there was a reduction in seabed level on at least two occasions after which the divers placed sandbags on top of crate A for protection. These sandbags will have helped maintain a benign burial environment but retarding the ingress of oxygenated seawater.

Ian Panter
York Archaeology
March 2023

References

British Standard EN 275:1992. Wood preservatives – determination of the protective effectiveness against marine borers.

Panter, I., 2012, "Artefact Characterisation", in HMS Colossus: Monitoring and Investigation 2012 Project Report, Kevin Camidge (https://cismas.org.uk/wp-content/uploads/2021/11/Colossus-Monitoring-and-Investigation-Report.pdf, Accessed 16/3/23)

Table of Results

1. IRON CONCRETIONS

Number	X-Ray No.	Assessment	% Voided	% change	Weight (g)	% Wt. Change
F762	9819	Mineralised nail, encapsulated in sandy/shelly hard concretion. Little change to structure and integrity of concretion, but light iron staining is now present, and a greater volume is now voided.	50	+100	720.5	-0.29
F814	9819	Bolt/fitting encapsulated in sandy/shelly hard concretion, slight iron staining now forming on surface. Increase in amount of voiding.	95	+11%	695.0	-0.31
F816	9818	Completely voided object, encapsulated in sandy/shelly hard concretion, iron staining now forming on surface.	100	n/a	178.0	-0.39
F847	9818	Undiagnostic object, now completely voided and iron staining to the surface of the concretion.	100	+25%	159.00	0.0
F852	9820	L-shaped fitting encapsulated in hard and compact concretion; light iron staining now forming on the surface, but object appears to have not changed during reburial.	10	No change	1500.0	0.0

2. WOOD

Number	Species	Actual Density (g/cc)	% Loss in wood substance	% Change in LWS	X-ray No	EN275 Grade	Assessment
F751	Lignum vitae	0.939	17.63	+1.32	9928	0	No change in appearance or condition and no shipworm activity visible on the X-ray image.
F764	Ash	0.173	67.36	+2.53	9920	1	No change in appearance or condition, X-ray shows no change to calcareous lined tunnels.
F827	Lignum vitae	0.855	25.0	0.00	9929	1	No change to appearance and condition, and no additional shipworm tunnels. The single tunnel from 2012 remains the same size and shape.
F811a	Scots pine	0.353	15.95	+15.57	9820	0	Increase in iron staining to wood surface, plus one small hole, but X-ray image does not reveal any calcareous lined tunnels.
F855Ai	Hazel	n/a	n/a	n/a	n/a	n/a	No recovered

Normal density (Rg) (g/cc):

Ash	0.53
Hazel	0.40
Lignum vitae	1.14
Scots pine	0.42

3. COPPER ALLOY

Number	X-Ray No.	Assessment	% Mineralised	Weight (g)	% change
F706	9852	No change to overall appearance, and absence of active corrosion. X-ray reveals a substantial core of metal surviving.	<5	2.074	-3.13
F734	9852	No change to surface, and no evidence for active corrosion, object is stable. X-ray image shows substantial metal present.	<5	1.089	-0.91
F735	9852	No change in appearance. No evidence for active corrosion. X-ray image reveals substantial amount of metal surviving.	<5	2.184	-1.65
F841	9852	No change in appearance - well preserved small tack with an even pale black patinated surface. X-ray image shows substantial metal remaining.	<5	1.377	-0.65
F849	9852	Strip fragment, undiagnostic, having a brown coppery surface, areas of cuprite have developed since reburial, but no signs of active corrosion. X-ray suggests an increase in mineralisation	50	27.754	-0.80
F885a	9852	No change in appearance, and no signs of active corrosion. X-ray image suggests a substantial amount of metal remains.	<5	1.639	0.0

4. GLASS

Number	Assessment	Weight (g)	% change
F703	Fragment of transparent glass, slight iridescence now visible as surface dries.	4.597	-2.3%
F707	Fragment of transparent glass, slight iridescence now developing as surface dries.	4.022	-0.69
F730	Fragment of clear transparent glass, no iridescence developed as the glass dried.	1.327	-0.08
F731	Fragment of translucent brown bottle glass; iridescence now appearing as the surface dries though.	6.011	-0.07
F844	Large sheet of clear transparent window glass, stained and scratched, iridescence beginning to form as the surface dries out.	67.272	-0.17

5. CERAMICS

Number	Weight (g)	Assessment	Chroma meter values		
			Location	Yxy	L*a*b*
F701		Not recovered			
F713	1.112	Sherd of tin-glazed earthenware fabric, originally stained black, but now free of staining, and bleached white. Stable. Weight loss of 4.87%.	i) ii) Iii)	70.3, .339, .350 72.0, .336, .349 50.6, .339, .345	87.0, -1.8, 16.1 87.9, -3.0, 15.6 76.4, 0.4, 13.0
F737	73.859	Sherd of white tin-glazed dish/plate, no change to crizzled glaze, but outer surface has become more mottled and appears darker too. No changes to broken edges (one fresh break is white, others are black), and the glaze is still attached to the ceramic body. No change in weight. Stable	i) ii) iii)	64.8, .342, .354 21.9, .344, .352 65.5, .334, .341	84.3, -2.2, 17.6 53.8, -0.4, 12.0 84.6, -0.4, 12.2
F820A	38.440	Sherd of Post Medieval reduced slipware, no evidence of crizzling, sherd is robust and stable	i) ii) iii)	13.4, .365, .364 21.7, .348, .348 13.0, .326, .331	43.3, 1.9, 14.7 53.6, 1.6, 11.6 42.8, 0.2, 4.5

Key
Location i) outer surface, ii) inner surface, iii) broken edge

6. OTHER MATERIALS

Number	Material	Assessment	Weight (g)	% Change
F775	Bone, animal	No change - rib, stained an even dark brown/black over entire surface. Physically robust.	46.61	-1.62
F771A	Rope	Not recovered	n/a	n/a
F818	Rope	Rope, still in a good condition. Intact, no unravelling of fibres,	560.0	-2.76
F828A	Leather	Not recovered	n/a	n/a

Appendix II: figures

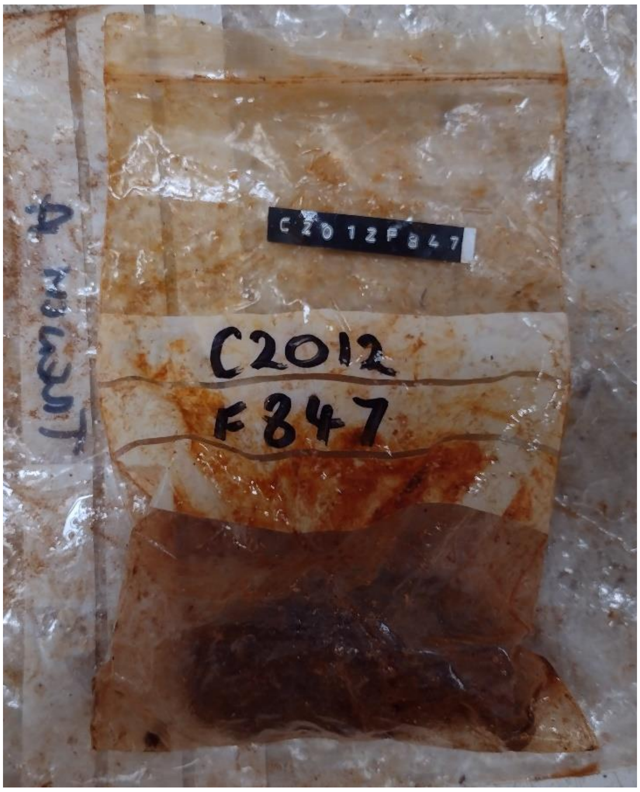

Fig 33: example of iron stained bag containing concretion

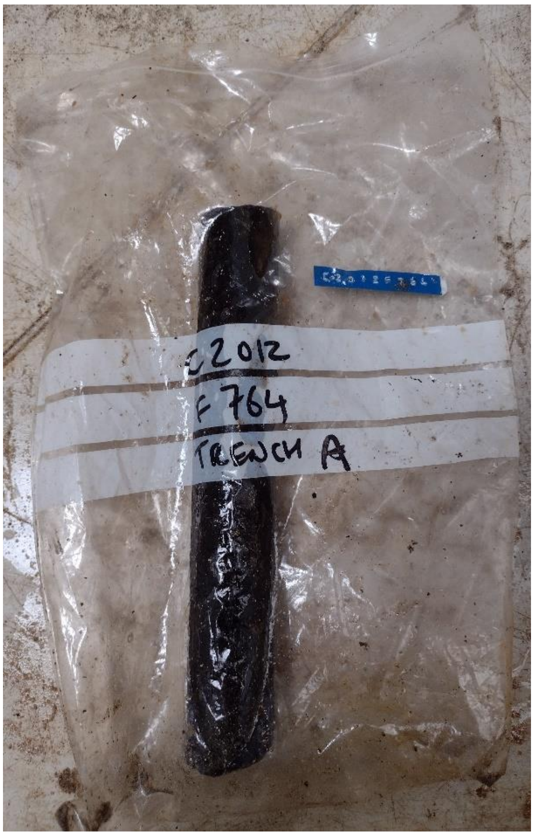

Fig 34: the majority of bags were unstained.

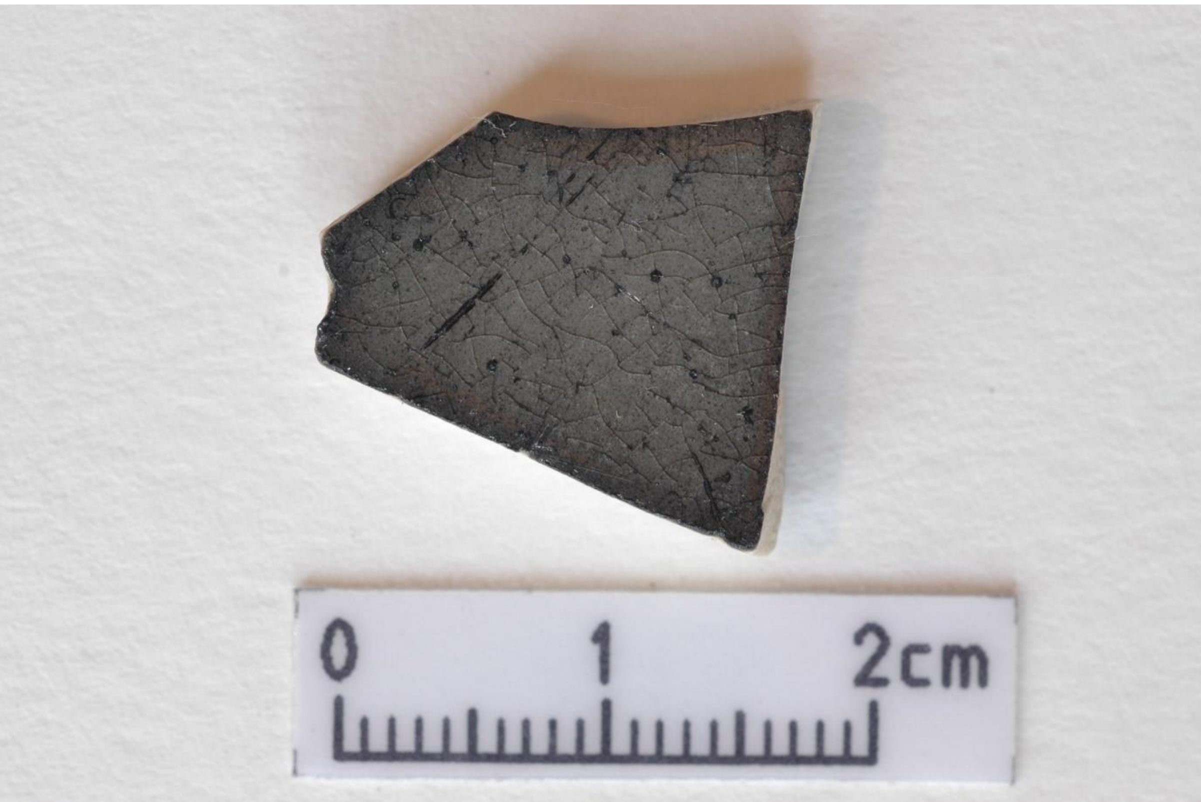

Fig 35: F713 in 2012

Fig 36: F713 in 2022

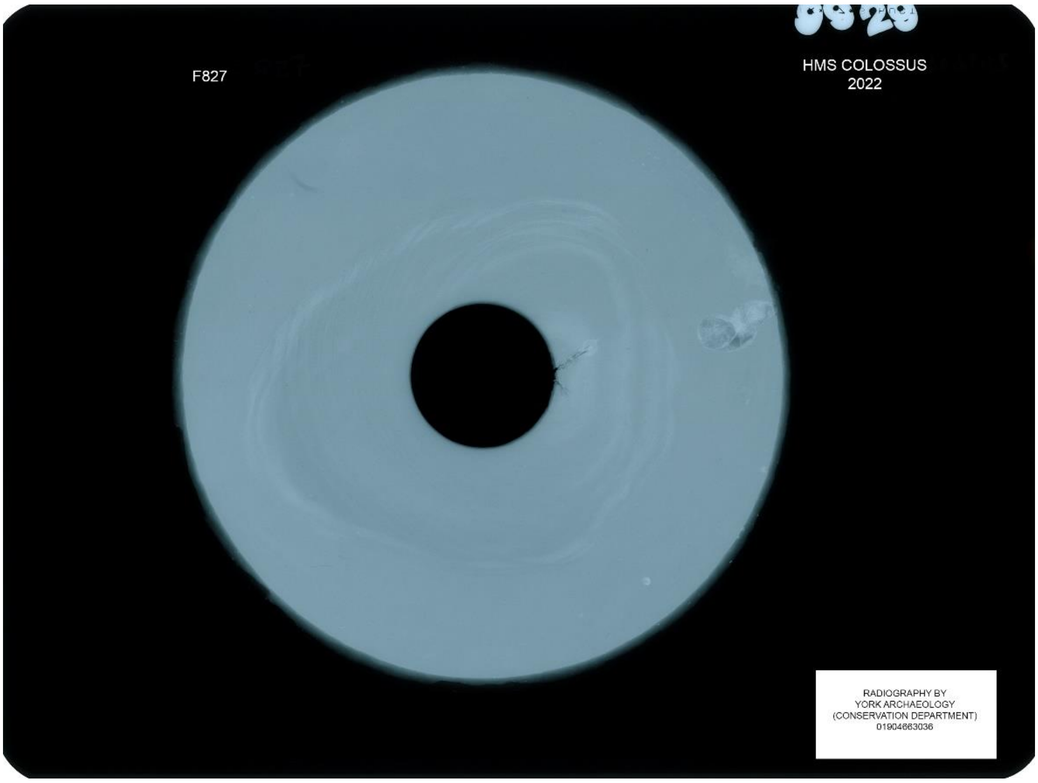

Fig 37: X-ray of F827, 2022, after 10 years in crate A

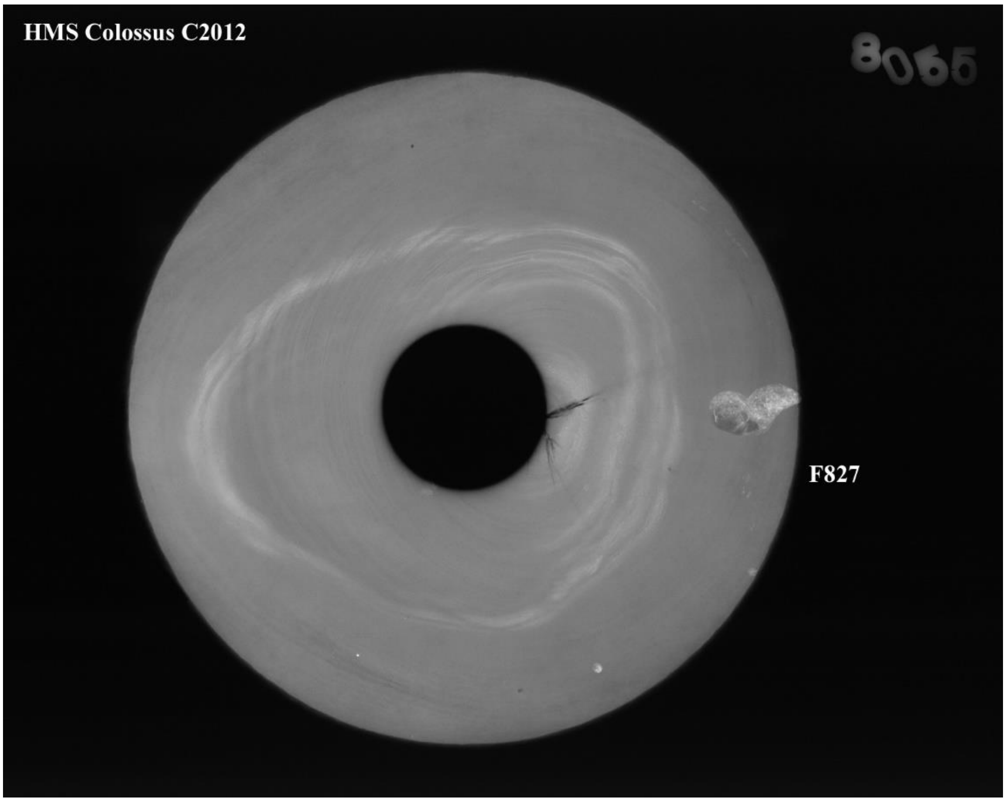

Fig 38: X-ray of F827, 2012, prior to reburial

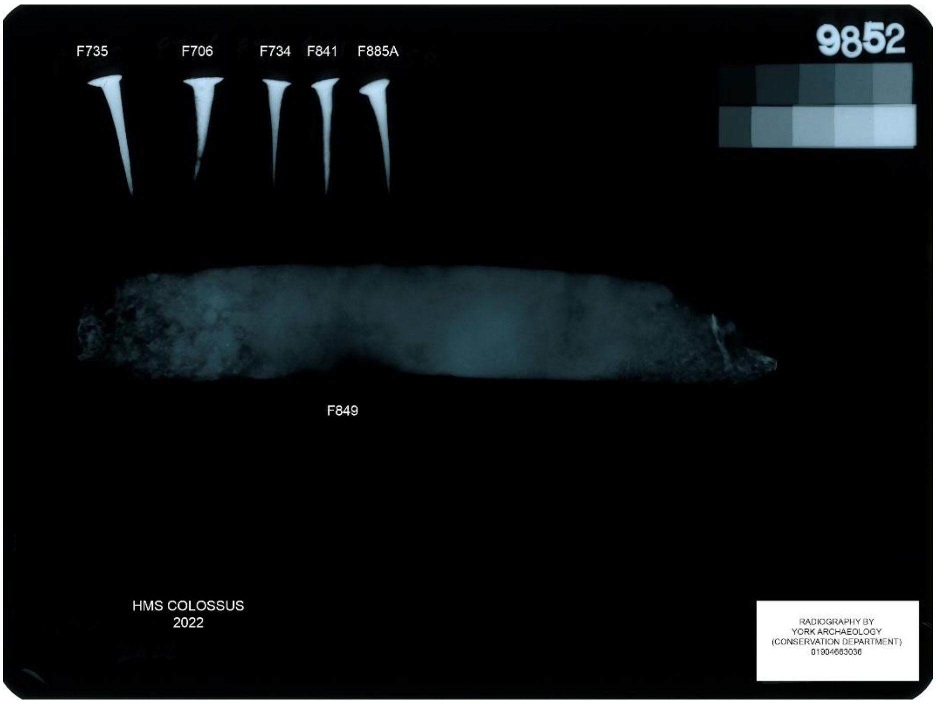

Fig 39: X-ray of copper alloy artefacts, 2022

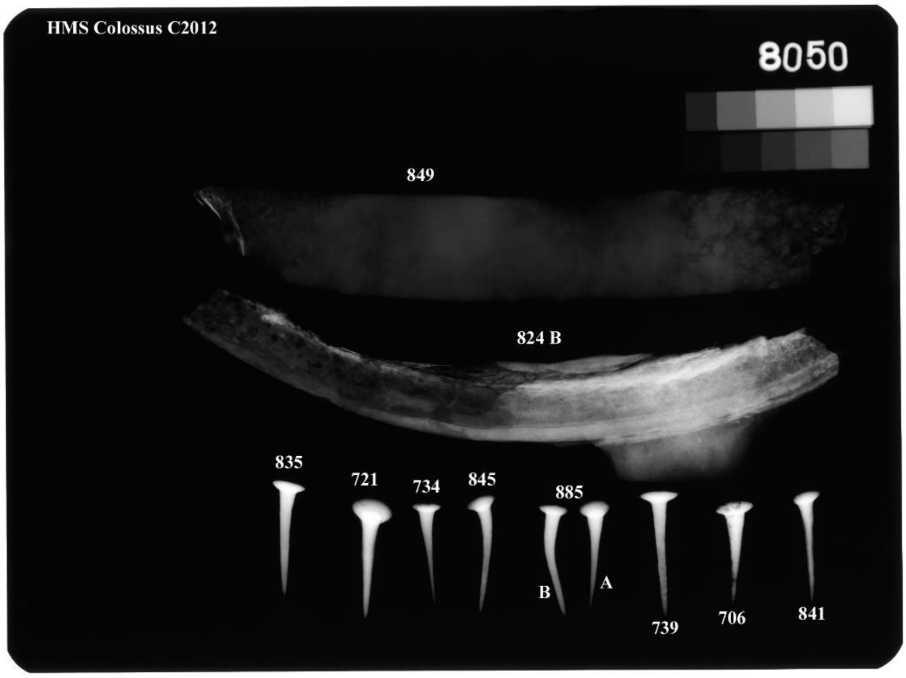

Fig 40: X-ray of all copper alloy artefacts, 2012.

X-ray images 2022

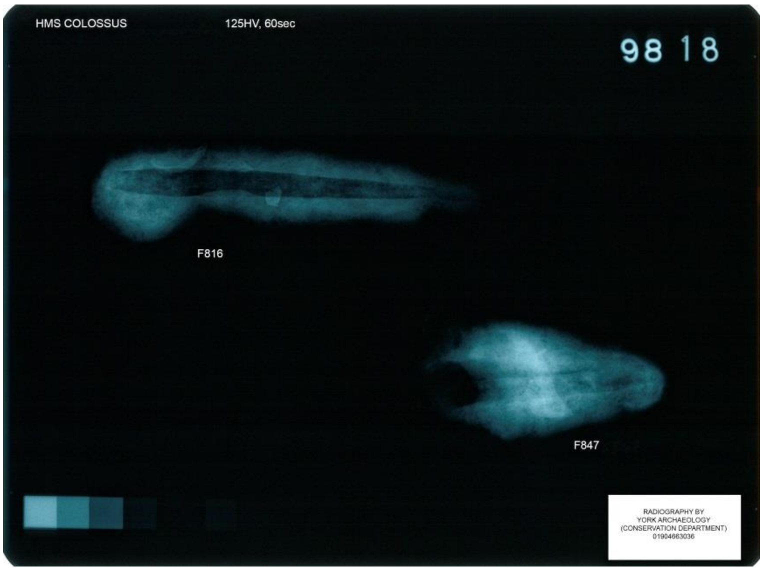

Fig 41
X-ray 9818

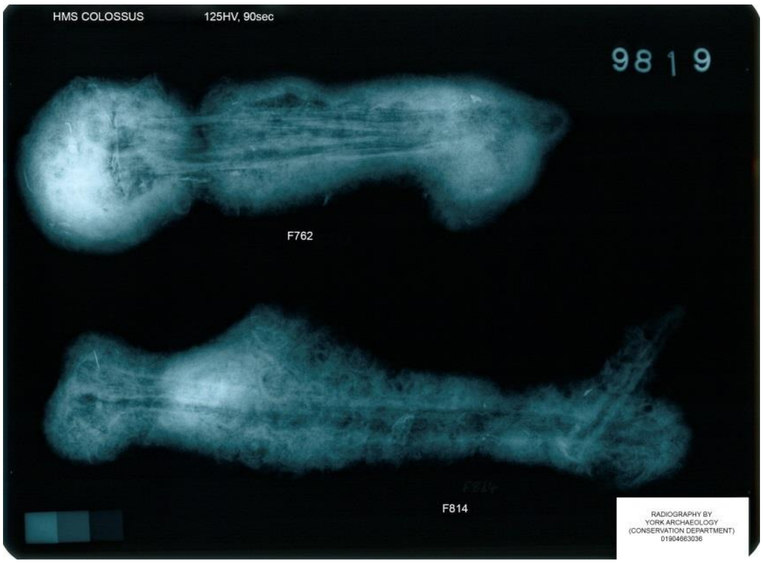

Fig 42
X-ray 9819

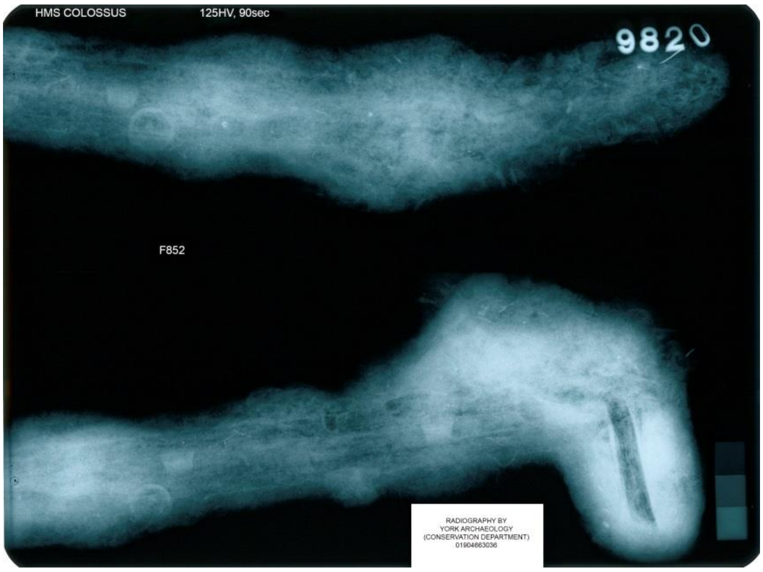

Fig 43
X-ray 9820

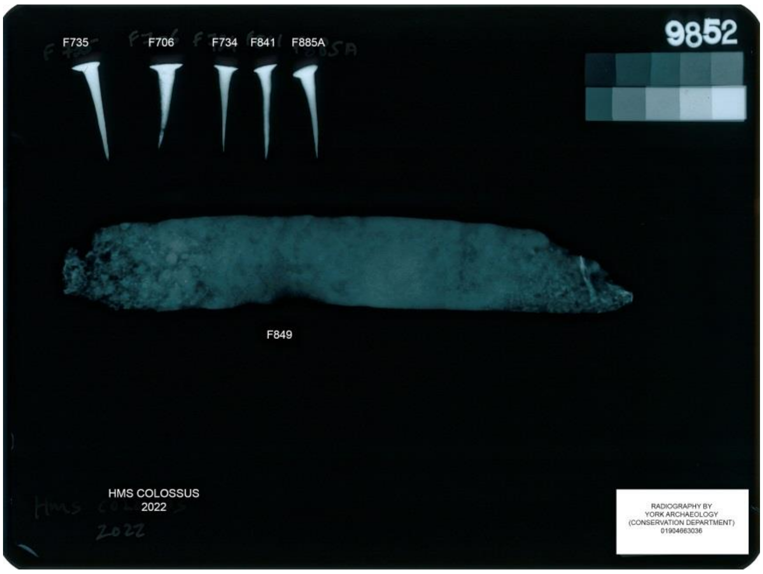

Fig 44
X-ray 9852

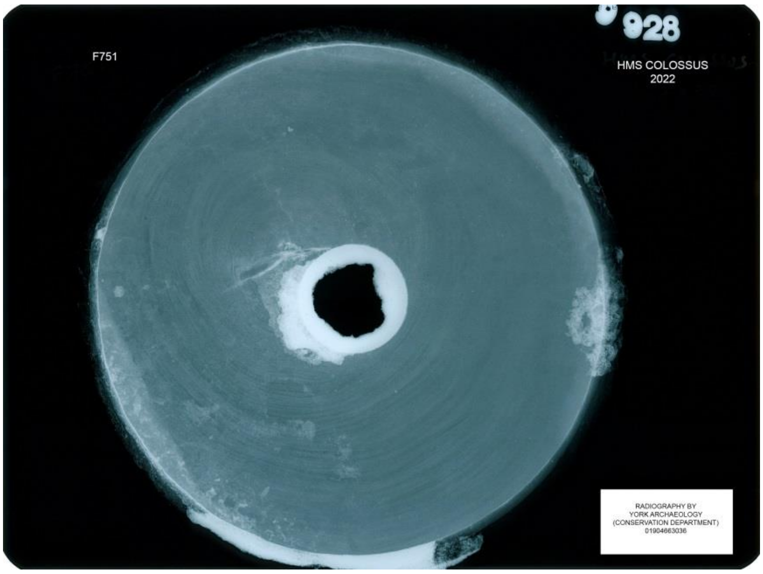

Fig 45
X-ray 9928

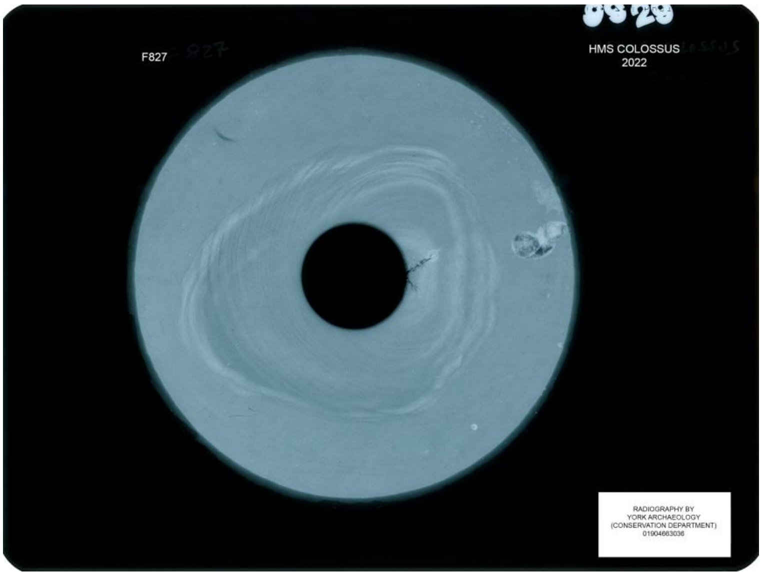

Fig 46
X-ray 9929

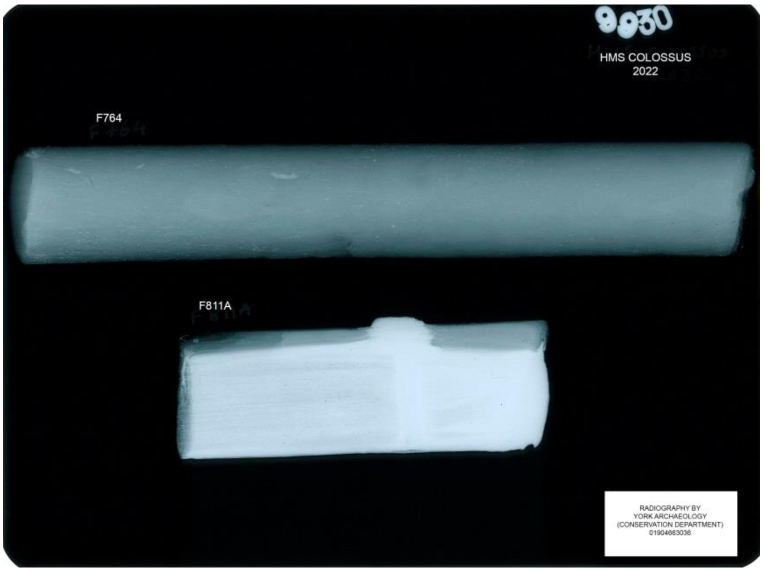

Fig 47
X-ray 9930

Appendix III – Additional Objects 2012 by Angela Middleton, Karla Graham & Sarah Paynter

Introduction

The English Heritage NHPP project 6576 *Reburial and analysis of Non-HMS Colossus wreck material and modern tokens* was carried out by the Archaeological and Conservation Team (ACAT), Intervention and Analysis. It is complimentary to the NHPC project 6114 *HMS Colossus – Monitoring and Investigation* carried out by CISMAS.

Aims and objectives

The EH project aims to obtain a second, complimentary level of information about the degradation of different materials at the Colossus site. Modern tokens and archaeological material from other UK marine sites have been added to the artefacts being reburied under the 6114 NHPC project. The detailed analysis of the EH material will enable an understanding of their chemical composition and extent of corrosion and decay before reburial. This information will be used to interpret corrosion and decay patterns following periods of reburial.

The project has the following direct aims:

1A: to establish the material composition and condition
1B: to study the effect of the burial environment on archaeological material as well as on modern tokens

The project has the following objectives:

2A: to understand corrosion and degradation processes on this site
2B: to understand site stability and preservation potential
2C: to inform the site management plan

Methodology

The material used in this study can be divided into two broad categories: archaeological artefacts from a marine environment and modern tokens. The archaeological material does not fall within the retention policies of the collecting or receiving organisations or the intended repositories. The archaeological and modern material categories comprise wood, copper alloys, ferrous alloys, glass and pottery. The source of each item can be found in Appendix III.

Recording involved photography, X-radiography, weights, sketches and a series of analyses as outlined in the tables below.

Proposed analysis for the archaeological maritime material			
Non-Colossus maritime material	**Proposed Analysis**	**Output**	**Aims**
Wood	Microscopy Density Water content Fourier transform infrared (FTIR) spectroscopy X-Radiography	Wood species Condition Condition Condition Condition	1A 1A, 1B, 2A, 2B 1A, 1B, 2A, 2B 1A, 1B, 2A, 2B 1A, 1B, 2A, 2B
Copper alloys	X-Radiography X-ray diffraction (XRD) analysis Scanning electron microscopy (SEM/ EDS)	Condition ID of corrosion products Composition; Condition	1A, 1B, 2A, 2B 1A, 1B, 2A, 2B 1A, 1B, 2A, 2B
Ferrous alloys	X-Radiography XRD SEM/ EDS	Condition ID of corrosion products Composition; Condition	1A, 1B, 2A, 2B 1A, 1B, 2A, 2B 1A, 1B, 2A, 2B
Glass	X-Radiography SEM/ EDS	Condition Composition; Condition	1A, 1B, 2A, 2B 1A, 1B, 2A, 2B
Pottery	X-Radiography SEM/ EDS	Condition Composition; Condition	1A, 1B, 2A, 2B 1A, 1B, 2A, 2B

Proposed analysis for the modern tokens			
Modern Tokens	**Proposed Analysis**	**Output**	**Aims**
Oak Pine	X-Radiography FTIR	Condition Condition	1A, 1B, 2A, 2B 1A, 1B, 2A, 2B
Copper alloys	X-Radiography XRD SEM/ EDS	Condition ID of corrosion products Composition; Condition	1A, 1B, 2A, 2B 1A, 1B, 2A, 2B 1A, 1B, 2A, 2B
Ferrous alloys	X-Radiography XRD SEM/ EDS	Condition ID of corrosion products Composition; Condition	1A, 1B, 2A, 2B 1A, 1B, 2A, 2B 1A, 1B, 2A, 2B
Glass	SEM/ EDS	Composition; Condition	1A, 1B, 2A, 2B
Pottery	X-Radiography SEM/ EDS	Condition Composition; Condition	1A, 1B, 2A, 2B 1A, 1B, 2A, 2B

Work carried out to date

A total of 52 items were prepared for reburial. The archaeological material was cut in half and sampled. The modern tokens were either cut and sampled or fabricated as 3 separate pieces. One of each of the archaeological materials and modern tokens was employed as follows (Fig 77).

- Pit A: reburial period 10 years
- Pit B: reburial period 25 years
- Retained for reference and analysis

Fig 48 - Overview of items to be reburied in Pit A

To date items have been recorded using the following methods:

- Description
- Photography (Fig. 78)
- Sketches with measurements where appropriate (Fig. 79)
- X-radiography (digital and film) (Fig. 80)
- Weight

All items have been labelled with custom made cow tags, in consecutive numbers from EH01 to EH52. Items were packed in Netlon bags containing the label (Fig. 81).

Fig 49 - Item EH 05

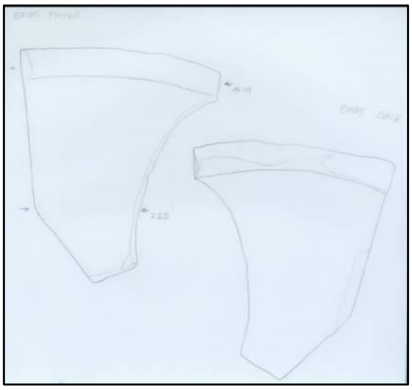
Fig 50 - Drawing (1:1) of item EH05, with measurements

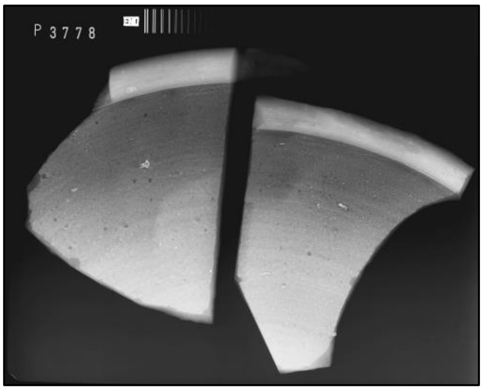

Fig 51 - X-Radiography of items EH05 and EH06

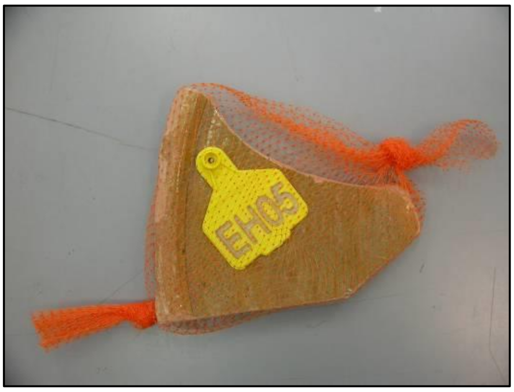

Fig 52 - Item EH05 packed with label inside Netlon

Outstanding tasks

The following tasks are outstanding:

- Analysis and interpretation of analytical results
- Report writing (English Heritage Research Report Series)
- Archiving

It is anticipated to complete these tasks by March 2013.

Table of additional reburial objects

Reburial Pit A		Reburial Pit B	
Object No	**Object ID**	**Object No**	**Object ID**
EH01	Ceramic, base of a dish	EH02	Ceramic, base of a dish
EH03	Ceramic, body sherd	EH04	Ceramic, body sherd
EH05	Ceramic, rim of bowl	EH06	Ceramic, rim of bowl
EH07	Glass, base of bottle	EH08	Glass, base of bottle
EH09	Glass, stopper	EH10	Glass, stopper
EH11	Ceramic, clay pipe	EH12	Ceramic, clay pipe
EH13	Metal, Iron	EH14	Metal, Iron
EH15	Leather, Sole	EH16	Leather, Sole
EH17	Leather, Sole	EH18	Leather, Sole
EH19	Metal, CuA	EH20	Metal, CuA
EH21	Wood, modern oak	EH22	Wood, modern oak
EH23	Wood, modern pine	EH24	Wood, modern pine
EH25	Modern cast iron	EH26	Modern cast iron
EH27	wood, oak	EH28	wood, oak
EH29	bronze cc494k	EH30	bronze cc494k
EH31	bronze c932	EH32	bronze c932
EH33	ceramic modern stoneware	EH34	ceramic, modern stoneware
EH35	pewter	EH36	pewter
EH37	modern lead glaze	EH38	modern lead glaze
EH39	brass CW508L	EH40	brass CW508L
EH41	brass CW505L	EH42	brass CW505L
EH43	modern lead crystal glass	EH44	modern lead crystal glass
EH45	modern potash glass	EH46	modern potash glass
EH47	modern HLLA glass	EH48	modern HLLA glass
EH49	modern wrought iron	EH50	modern wrought iron
EH51	ceramic, modern tin glaze	EH52	ceramic, modern tin glaze

Appendix IV – Additional Objects 2022 by Angela Middleton

[Add HE Additional Objects 2022 Report here]

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