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HMS COLOSSUS

HMS Colossus Stabilisation Trial Progress Report 2004

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This report is intended only to record the progress of the stabilisation trial. Conclusions and results will be included in the final report which will be produced at the end of the project next year. Most of this document has already been submitted to English Heritage in the form of routine progress reports. A copy of this report will also be deposited with the National Monuments Record of England.

Summary

The Colossus site has been the subject of three separate projects this year. Firstly, the continuing works on the stabilisation trial, which is the subject of this progress report. Secondly, the debris field survey (phase I) carried out by CISMAS in September of this year; a separate report on the debris field survey has been produced. Thirdly, the archaeological diving contractor (Wessex Archaeology) spent three weeks surveying the site in June and July of this year.

Three different sets of samples have also been recovered from Colossus this year. Sediment samples were sent for analysis by Matt Canti of English Heritage. Timber samples were taken for timber identification, which will be carried out by Mary Rose Archaeological Services. Finally, samples of the copper sheathing [421], a fastening bolt [420] and a bolt-rove [403] were taken for metallurgic analysis by English Heritage.

Stabilisation trial

This work was commissioned by English Heritage. The intention of the stabilisation trial is to ascertain whether it is possible to protect the timber which is currently exposed and to prevent the buried timber from becoming exposed. The aim of the trial is to establish the efficacy and economic viability of three different protection strategies in the conditions prevailing on this site. By recording the prevailing conditions on the site, it is hoped that a link can be made between the protection methods and the environmental conditions prevailing.¹

Work on the stabilisation trials was conducted in March and June of this year. In March the datalogger was returned to the seabed, after its removal for the winter. In June the datalogger was retrieved, having collected the final data-set of the trial. The trial is scheduled to end in May 2005; the final report will be submitted by July 2005.

An inspection of the site made in September revealed some apparent disturbance on the site. In my opinion several small holes have been dug around the exposed timber in the region of guns 2 and 3. There has also been some damage to the sandbags securing the Terram mat (V1); either by an anchor or possibly by a divers knife.

¹ For full details see *HMS Colossus Stabilisation Trial Project Design*

Stabilisation Trial – Progress Report March 2004

Work on the sample retrieval and installation of the datalogger began on 29th March 2004. Everything went smoothly and in accordance with the project design.

Visual Inspection

The equipment and samples installed in May 2003 were all still in place and in reasonably good order. Inspection of the three mats showed that some sediment accumulation had occurred over the winter months – possibly due to the high energy conditions occurring during the winter storms.

V0 – Control

All control blocks were still in place. Weed growth is evident on the blocks in this area. All of the blocks in the control area are now showing clear signs of attack by wood borers (see photograph). The seabed level around the control area appears to have decreased by some 3 to 5 mm (measured from the top of the stainless hoops used to secure the sample blocks to the seabed).

V1 – Terram 4000

This mat was still in place. The seaweed growing on the mat has been buried by coarse sand. The depth of sand, which is not uniform across the Terram mat, is now 100 to 150mm in depth (measured from the sand surface to the mat).

V2 – Debris Mat

Both layers of mesh were still in place. The upper layer had become partly detached from the sand bags used to anchor it in place, and it was re attached with plastic cable ties. Some evidence of sediment accumulation was evident under the mesh – this was measured at two points (V2-C and V2-D). About 10mm of sediment has accumulated at these two points under the mesh.

V3 – Floating frond mat

This mat was also still in position. The artificial fronds continue to attract natural weed growth. Several different types of weed are growing on the artificial fronds – including kelp (see photograph below). Some sediment has accumulated over the base fabric of the mat – this was measured at three different locations and was in each case between 50 and 60mm.

The area of the wreck

The kelp growth was slightly less than when I last saw the wreck in October of last year. The copper alloy fastening bolts along the north side of the wreck are in several instances showing newly exposed sections at their base where timber has recently broken away. This is shown in the photographs below and seems to amount to about 50mm thickness of timber loss. This gives an indication of the possible process of timber erosion on the wreck; first exposure, then attack by gribble which weakens the timber until it breaks off and is carried away by the tide.

The row of sandbags emplaced against the south-eastern edge of the timber (October 2003) is still in place. The gaps between the sand bags and the timber have filled in with sand (see photograph below). The sand bags have not caused the exposed timber to rebury – so it continues to be attacked by gribble – but

they have probably prevented the timber from breaking up along the vulnerable south-eastern edge.

New material continues to be exposed around the wreck, particularly on the west side where remains of the port side main chains are now visible as well as new timbers (see photograph).

Conclusions

All the trial mats have resulted in some sediment accumulation over the winter months. The Terram 4000 mat (V1) has attracted the greatest depth of sediment - currently 100 to 150mm from 10mm in October of last year. Next in terms of sediment accumulation is the floating frond mat (V3) which has collected 50 to 60mm of sediment since October 2003. The least sediment was attracted by the Mesh mat (V2) at only 10mm of sand. The mesh mat is also the only one which has required 'repair'; to date this has been repaired to some extent on each inspection.

Below are a few thoughts on why the mats have performed differently. I must, however, emphasize that these observations are only speculation on my part. At first sight it is difficult to see why the Terram 4000 mat (V1) has outperformed the floating frond mat (V3). By October 2003 the Terram had accumulated a luxuriant growth of fine seaweed across its upper surface some 0.20m high. However the frond mat has 0.65m height of fronds. The only difference apart from the length of the fronds is the cross-sectional area and density of the fronds/weed. The weed growing on the Terram 4000 is much finer than the floating fronds and much denser (in terms of fronds per square metre). It is also more tightly interwoven - the floating fronds of mat (V3) are largely untangled.

It will be interesting to see what happens to these accumulated sand levels in the next three months.

Sand level monitoring

Sand monitor levels taken 21st October 2003. For location of points see plan below.

Outlying sand monitor points (on the sand) – all measurements are in millimetres.

Monitor	Position	Height above the seabed 21/10/03 (mm)	Height above the seabed 30/03/04 (mm)	Change (mm)
M1	260134.63 / 5535582.30	35	Missing	-
M2	260139.21 / 5535577.81	25	92	- 87
M3b	260154.79 / 5535577.27	90	96	- 6
M4	260148.74 / 5535588.34	110	174	- 64
M5	260144.43 / 5535590.22	95	90	+ 5
M6	260152.61 / 5535594.58	43	Missing	-
M7	260164.66 / 5535589.07	80	Missing	-
M8	260164.05 / 5535595.79	80	110	- 30

Additional sand monitor points installed August 2003 (attached to timber) – all measurements are in millimetres.

Monitor	Position	Height above the seabed on 22/10/03	Height above the seabed on 30/03/04	Change (mm)
M10	260158.94 / 5535594.51	0	25	- 25
M11	260145.54 / 5535588.37	39	72	- 33
M12	260136.34 / 5535581.65	42	72	- 30
M13	260145.30 / 5535578.35	19	62	- 43
M14	260153.30 / 5535582.53	33	60	- 27
M15	260164.26 / 5535590.60	80	112	- 32

Three of the monitoring pins could not be relocated (M1, M6 and M7). These were probably casualties of the winter storms. All the surviving pins except one (M5) bore witness to a fall in seabed sediment levels since last measured in October 2003. Taking all the readings from around the wreck together the mean change is a fall in sediment levels of 33.8mm.

Timber sample retrieval

The oak and pine sample blocks were retrieved from each of the test areas. These were then labelled, packed into a cool box with ice packs and dispatched to Mark Jones at MRAS by 24-hour courier. The blocks from the seabed (control V0) clearly show attack by wood borers – see photograph below. Preliminary results (communicated verbally by Mark Jones) from the X-rays of these blocks indicate that there is heavy attack in the control (V0) samples, no attack in those from the Terram (V1) mat, and slight attack from the mesh (V2) and frond (V3) mats. These blocks had been in place for just under 12 months.

Timber samples recovered March 2004

Sample	Type	Location	Deployed	Retrieved
P3	Pine	V0-C (Control)	13.V.2003	29.III.2004
O3	Oak	V0-C (Control)	13.V.2003	29.III.2004
P8	Pine	V1-C (Terram)	14.V.2003	29.III.2004
O8	Oak	V1-C (Terram)	14.V.2003	29.III.2004
P12	Pine	V2-C (Mesh)	14.V.2003	29.III.2004
O12	Oak	V2-C (Mesh)	14.V.2003	29.III.2004
P16	Pine	V3-C (Fronds)	16.V.2003	29.III.2004
O20	Oak	V3-C (Fronds)	16.V.2003	29.III.2004

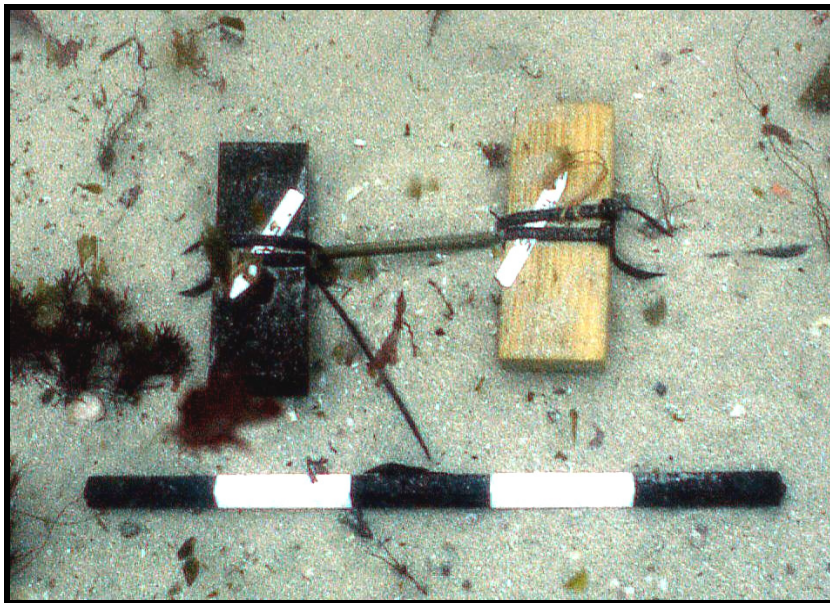
Proximity blocks

We were keen to establish whether proximity to the main area of exposed timber had any effect on the speed of infestation by organisms attacking the timber sample blocks. To this end we installed three sets of timber blocks on the seabed (31.III.2004) at varying distances from the exposed timber of the wreck. These will enable us to determine if there is any difference in rate of attack in relation to proximity to the wreck.

Sample	Type	Position (UTM zone 30 WGS84)	Deployed	Distance from exposed timber
P23	Pine	260156.74 E	13.V.2003	2.3m
O23	Oak	5535582.91 N		
P24	Pine	260156.74 E	13.V.2003	14.4m
O24	Oak	5535568.33 N		
P25	Pine	260156.43 E	13.V.2003	24.3m
O25	Oak	5535556.58 N		

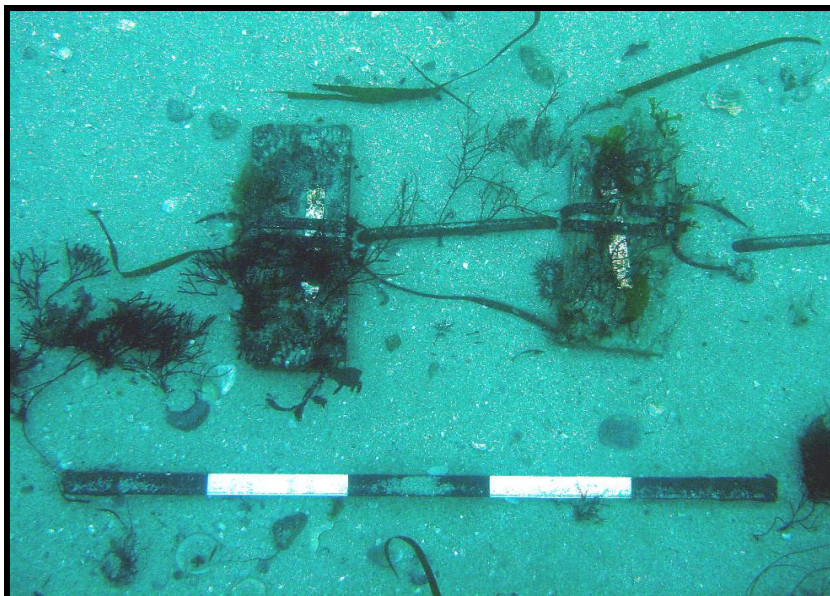
Sub-sea datalogger

The sub-sea datalogger was removed from the seabed in October 2003 to avoid any possible damage during the winter storms. In February 2004 the unit was returned to the manufacturers, Eauxsys of Camelford, to be serviced and recalibrated. While there, it was found that the Sealock connectors were defective and these were replaced. The unit was recalibrated by Eauxsys and recharged by me just prior its return to the seabed. The logger was installed on the seabed at 14:08 on 29.III.2004; the probes were located under the Terram 4000 mat at position V1-A. The data logger will collect one set of readings every 60 minutes for the next three months.

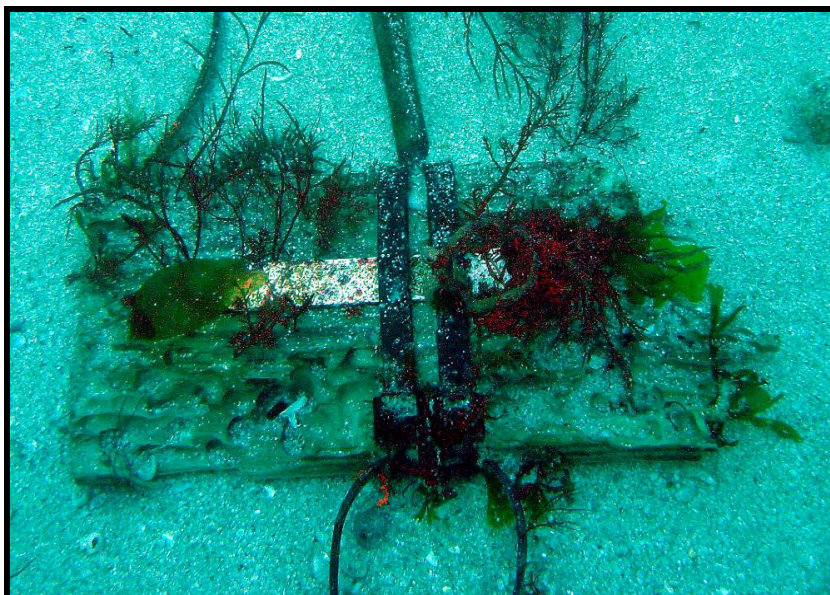


TIMBER SAMPLE BLOCKS

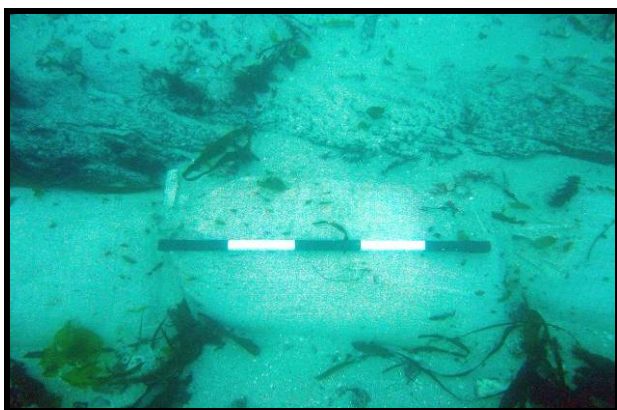
Blocks as installed in the control area (V0)
13.V.2003



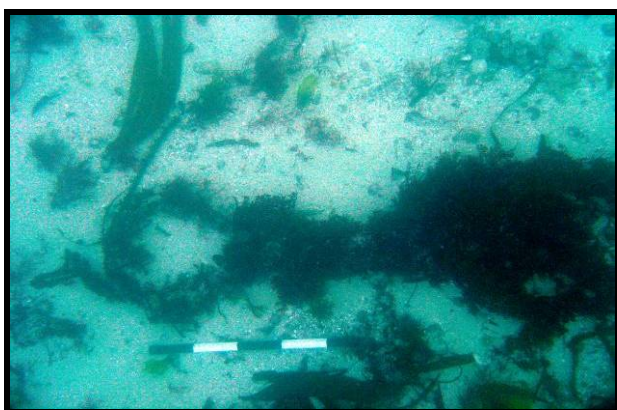
The same blocks almost
12 months later
29.III.2004. Note the
weed growth and the
teredo attack.



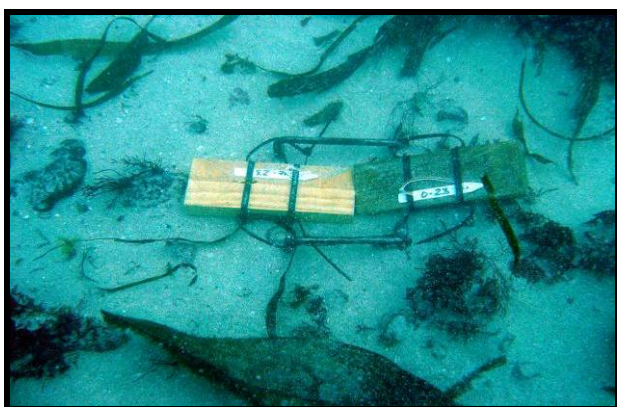
Closer view of the pine
block after nearly 12
months on the seabed.



Sandbags deployed October 2003 – note how sand has filled in the space between the timber and the bags.



Material exposed on the west side of the wreck – here is part of the main chains



Proximity blocks installed March 2004



Newly exposed timber and a rigging block sheave.

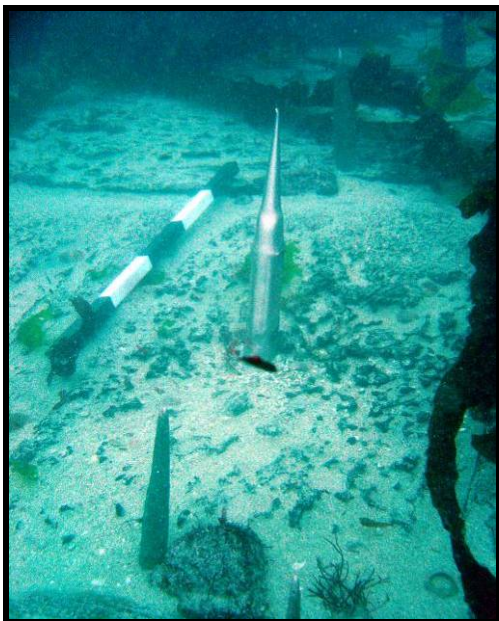


Floating frond mat (V3)

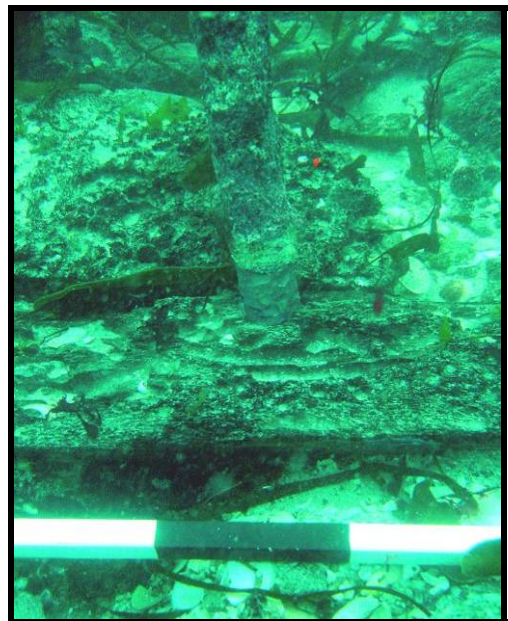


Copper alloy bolt – base exposed by timber decay

Copper alloy bolt – polished, probably by sand abrasion



Copper alloy bolt – base exposed by timber decay



Stabilisation Trial – Progress Report June 2004

Work on the stabilisation trial continued, commencing on 28th June 2004. Everything went smoothly and in accordance with the project design.

Visual Inspection

The equipment and samples were all still in place and in reasonably good order. Inspection of the test mats showed that in some cases the sediment levels had decreased slightly since the last inspection in March of this year.

V0 – Control

The remaining control blocks were still in place. These blocks now exhibit clear signs of attack by wood borers and are beginning to break-up.

V1 – Terram 4000

This mat was still in place. The seaweed growing on the mat is still buried by coarse sand. The depth of sand, which is not uniform across the Terram mat is now 60 to 70mm in depth (measured from the sand surface to the mat). This represents a loss of some 40 to 80mm since last measured in March this year.

V2 – Debris Mat

Both layers of mesh were still in place. The sediment levels were measured at three points under this mat V2-A, V2-B and V2-D. The levels varied between 10mm and 20mm of accumulated sand. This represents a slight increase since last measured in March.

V3 – Floating frond mat

This mat was also still in position. The artificial fronds continue to attract natural weed growth. In places, particularly at the eastern end, the artificial fronds are becoming tangled (see photograph). The depth of sand was measured in three places: V3-A (55mm), V3-B (0mm) and V3-D (85mm). The eastern end of the mat now has no sediment accumulation at all – this has possibly shifted to the western end of the mat – which may account for the slightly raised level at V3-D.

Conclusions - test mats

Overall there appears to have been some sand loss from over the Terram 4000 [Mat V1] – but there is still significant sand cover over the whole of this mat. The sand levels under the debris netting [Mat V2] have not changed significantly. The overall amount of sand on the floating frond [Mat V3] has probably not changed significantly – but sand has been shifted from the eastern to the western end of the mat. It is not clear what has caused this sand movement.

General observations

The weed cover over the wreck has increased since March of this year. Several of the copper alloy fastening bolts which were upright in March of this year are now lying flat on the seabed. The exposed timber of the wreck continues to deteriorate. The newly exposed timber at the NW end of the wreck, noticed in March 2004, has been recorded by Wessex Archaeology during their visit to the site – hopefully this data will be made available so that it can be added to the overall site plan.

Sand level monitoring

Sand monitor levels taken 29th June 2004. For the location of these points please refer to the site plan below.

Table I - Outlying sand monitor points (on the sand) – all measurements are in millimetres.

Monitor	Position	Height above the seabed 30/03/04 (mm)	Height above the seabed 29/06/04 (mm)	Change (mm)
M1	260134.63 / 5535582.30	Missing	Replaced	-
M2	260139.21 / 5535577.81	92	46	+46
M3b	260154.79 / 5535577.27	96	110	- 14
M4	260148.74 / 5535588.34	174	163	+11
M5	260144.43 / 5535590.22	90	102	-12
M6	260152.61 / 5535594.58	Missing	Replaced	-
M7	260164.66 / 5535589.07	Missing	75	-
M8	260164.05 / 5535595.79	110	80	+30

Table II - Additional sand monitor points installed August 2003 (attached to timber) – all measurements are in millimetres.

Monitor	Position	Height above the seabed on 30/03/04	Height above the seabed on 29/06/04	Change (mm)
M10	260158.94 / 5535594.51	25	40	- 15
M11	260145.54 / 5535588.37	72	64	+8
M12	260136.34 / 5535581.65	72	65	+7
M13	260145.30 / 5535578.35	62	0	- 62
M14	260153.30 / 5535582.53	60	60	0
M15	260164.26 / 5535590.60	112	90	+22

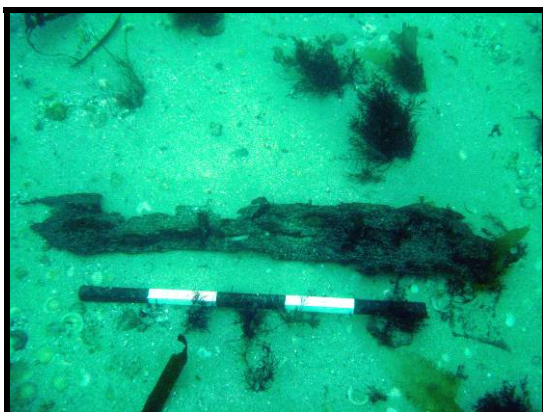
Two of the missing sand monitor pins M1 and M6 were replaced – stainless steel staples were used (similar in appearance to croquet hoops) – the cross-bar of the staple was set to seabed level. One monitor pin, M7, which was not found in March, was found to be still in place – it was probably hidden by weed in March.

Conclusions – sand levels

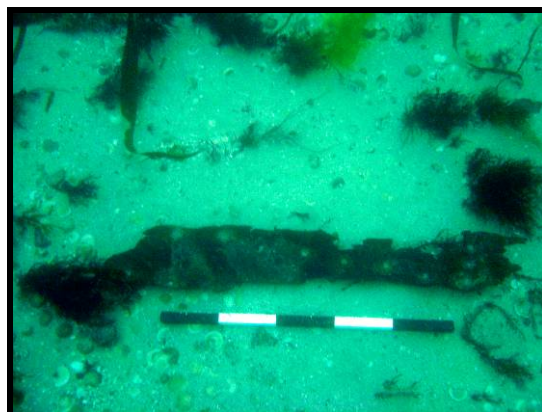
It is evident from the above tables that the changes in sand levels since the March of this year do not represent a consistent trend. The mean of the changes recorded over all the sand monitor points was a rise in sand levels of 4.9mm. However the mean of the outlying points (table I above) shows an increase of 12.2mm overall, while the mean of the additional points attached to the wreck timbers (table II) shows a decrease of -6.6mm overall. This probably represents scouring of the seabed around the timber of the wreck itself – supporting the general observation that timber once exposed on the site appears to promote scouring of the seabed in the immediate vicinity.

Carved Timber

During the work on site a small piece of badly eroded carved timber was observed on the northern edge of the wreck. It measured approximately 0.75 x 0.15 x 0.03m, had the remains of carving on one side and was planed flat on the other. There were the remains of what appeared to be a number of copper fastenings evident on the smooth side of the board. This timber was mobile, and when first seen was travelling slowly along the seabed. It was photographed and placed beneath the line of 'anti erosion' sandbags at position 260158.8E 5535588.2N (UTM zone 30) to prevent its loss.



Carved side of the timber



Flat side of the timber with copper fastenings visible

Timber sample retrieval

No timber samples were scheduled for retrieval at this time. The final set of timber sample blocks is due for retrieval at 24 months – which will be in the spring of 2005.

Proximity blocks

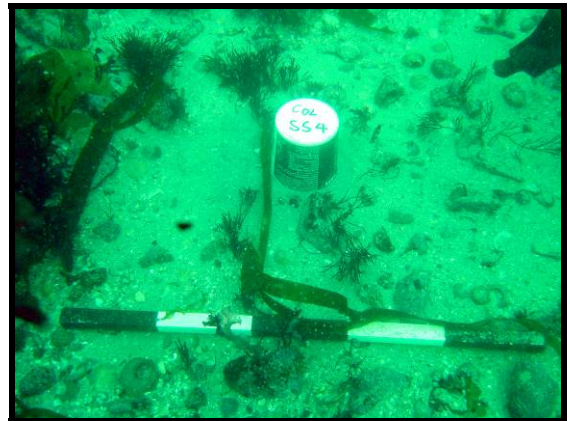
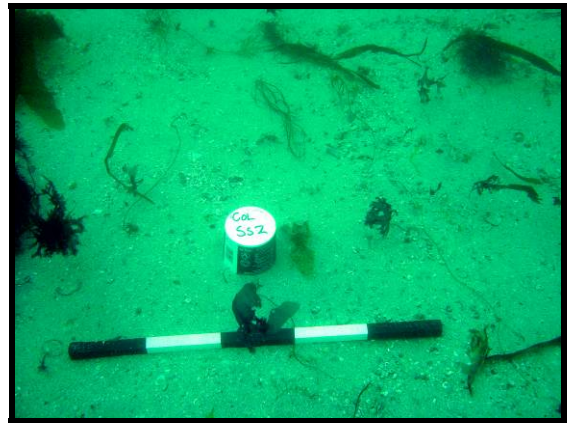
These blocks, placed in March of this year, were still in place and are due for retrieval along with the 24-month sample blocks in spring of 2005.

Sediment samples

To help in our understanding of the sediment transport around the wreck, a number of sediment samples were taken for physical analysis by Matt Canti of English Heritage. Surface samples were taken on 30th June 2004; the subsurface samples were taken during the excavation of the stern carving [285] in 2002.

Seabed surface samples SS1 to SS5 (see location plan)

These were taken from the top 60mm of the seabed – approximately 500ml of sediment was taken in each sample. The seabed in each sample location was photographed (see below) to indicate the general nature of the sampled area. The position of each of these samples is shown on the location plan below.



Below seabed samples SS6 to SS8

The stratigraphy on the site has been observed in three different places; to the SE when the stern carving was excavated; the NE where the finds were reburied [location AB] and in the centre of the site where the exploratory excavation took place. In each case the observed stratigraphic sequence was similar. The top 0.20-0.25m of the seabed [SS6] consists of coarse sand and broken shell. Below this is a layer 0.15-0.35m deep consisting of very fine, white compact sand or silt [SS7]. Under this there is a layer of coarser, light grey sand [SS8]. Each of these was sampled during the excavation of the finds reburial repository [AB] in 2002.

Timber identification samples

Three small timber samples were taken on 30th June 2004 to confirm the identification of the timber species used in the Colossus. These have been forwarded to Mark Jones of MRAS for identification.

Sample number	Position	Structure
ColT1	260151E 5535581N	Frame timber – upper gun deck (oak?)
ColT2	260144E 5535578N	Inner planking – upper gun deck (oak?)
ColT3	260152E 5535590N	Lining – orlop deck (pine?)

Sub-sea datalogger

The final set of data monitoring the Terram 4000 (Mat V1) was retrieved successfully. The data set looked reasonable with the exception of the pH readings, which were variable. This problem also occurred with the pH readings from the previous data set (debris netting, mat V2). As the data logger was newly serviced and calibrated by the manufacturers prior to this deployment these anomalous readings were probably due to a malfunction of the unit. Copies of the data set have been forwarded to Mark Jones (MRAS) and to David Precious (Eauxsys) for analysis – see comments from David Precious below. The sub-sea datalogger was removed from the seabed and returned to English Heritage.

Comments from David Precious on the last data-set

Observing the overall data trend shows predictable trends in most of the responses. The datalogger being located close to the seabed with redox, pH and dissolved oxygen sensors provided with flying leads to allow placement of the measuring sensor below a protective 'matting' placed over the wreck site.

The temperature measurement showed typical seasonal variations. The depth sensor clearly shows the passage of the tides and the longer term cycles of neap and spring tides.

Dissolved oxygen rapidly descends to zero indicating anaerobic conditions below the mat and this is confirmed by the negative redox readings indicating highly reducing conditions beneath the mat. Redox is a measurement of the degree of oxidising or reducing reaction taking place positive readings would

indicate oxidation reactions taking place. The redox and dissolved oxygen together clearly confirming the deeply anoxic state of the sub matting material.

The pH readings are less easy to interpret. Very little information is available relating to the measurement of pH in highly anoxic conditions and it is possible that the electrode has been affected in some way resulting in the movement to zero pH which would indicate strongly acidic conditions. It is also possible that in the highly reducing conditions hydrogen sulphide gas has been generated resulting in a very localised strongly acidic medium below the matting. It would be necessary to carry out some additional testing to confirm these effects.

Post deployment calibration would have confirmed the operation of the sensor. Some research of previously published work on pH measurement in fermentation processes may reveal relevant information. In summary, the readings would tend to indicate that the covering material successfully produces anaerobic, reducing conditions on the site below.

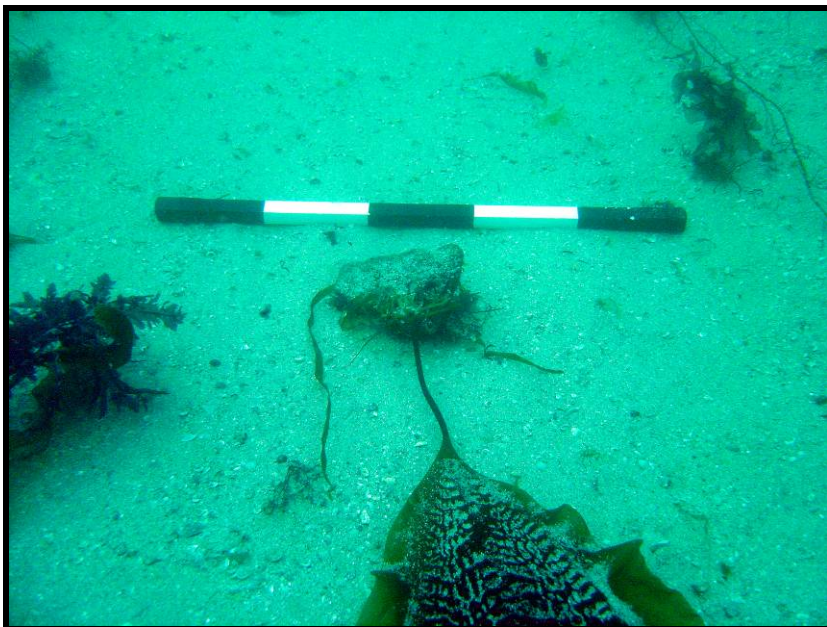
The use of a butyl rubber protection sleeve on the logger has dramatically improved resistance to fouling and the data logger has operated for the required periods on the internal batteries.

No major work was carried out on the datalogger during the operating period except for routine calibration and service.

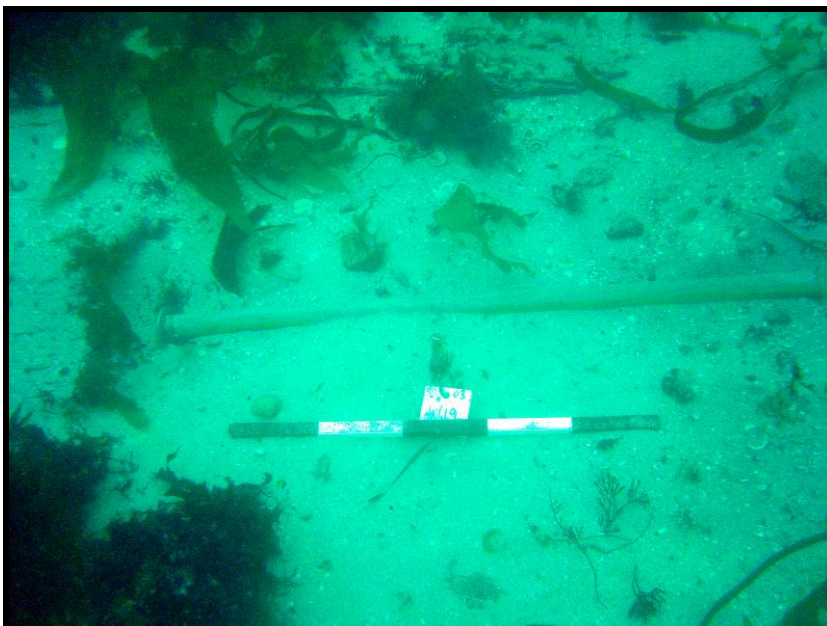
David Precious



Floating frond mat V3
showing tangling of the
fronds



An example of a stone
with an attached kelp
holdfast carried onto the
site by the tide



A copper alloy fastening
bolt [420] – now lying
flat on the seabed.
Temporary control point
W19 is just above the
scale

