Report No: 2011R001

Royal Anne Galley

Marine Environmental Assessment

The Lizard, Cornwall

Phase 3 Monitoring: Initial Inspection and Recovery

Historic Environment Projects

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This study was commissioned by the National Heritage Protection Commissions Programme, English Heritage and carried out by Historic Environment Projects, Cornwall Council with maritime archaeologist Kevin Camidge, members of CISMAS and Ian Panter, Principal Conservator, York Archaeological Trust. The Project Manager was Charles Johns. Advice on licensing was given by Lai Ip of the Marine and Fisheries Agency and advice on dispersal patterns was given by Jon Rees of Cefas.

The views and recommendations expressed in this report are those of Historic Environment Projects and are presented in good faith on the basis of professional judgement and on information currently available.

Freedom of Information Act

As Cornwall Council is a public authority it is subject to the terms of the Freedom of Information Act 2000, which came into effect from 1st January 2005.

Historic Environment, Cornwall Council is a Registered Organisation with the

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Cover illustration

The site of the wreck of the Royal Anne Galley, just off Lizard Point, Cornwall (photo: HE Projects)

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Abbreviations

Cefas	Centre for Environment, Fisheries and aquaculture Science
CISMAS	Cornwall and Isles of Scilly Maritime Archaeology Group
CPA	Coast Protection Act, 1949
EH	English Heritage
FEPA	Food and Environment Protection Act, 1985
HE	Historic Environment, Cornwall Council
MEA	Marine Environmental Assessment
NAS	Nautical Archaeological Society
NGR	National Grid Reference
OS	Ordnance Survey

1 Summary

This report describes the results of the Phase 3 monitoring of the *Royal Anne* Galley, a protected wreck site lying off the Lizard Point, carried out for English Heritage as part of the Marine Environmental Assessment of the site by Historic Environment Projects, Cornwall Council, with maritime archaeologist Kevin Camidge, members of the Cornwall and Isles of Scilly Maritime Archaeological Society (CISMAS) and Ian Panter, Principal Conservator for the York Archaeological Trust.

The purpose of the Phase 3 monitoring was to make an inspection of the site to recover the oak sample blocks for analysis and locate the dispersal trials objects, spheres and bricks, which had been placed on and below the seabed in April 2009 during the Phase 2 field assessment. The results would inform whether any further monitoring is required.

In total, 21 of the original 40 objects were located and recorded (8 spheres and 13 bricks). The objects have been moved on the seabed by an average of 5.15m (spheres) and 4.89m (bricks). The distances moved by the spheres varied between 2.22m and 11.4m; the bricks moved between 0.80m and 9.79m. Although some of the objects may have been missed by the survey it is more likely that many lay outside the 10m radius searched.

With a single exception the objects were 'sorted' by the environmental forces acting on the site – the spheres being moved west and the bricks to the east. This result was not anticipated. All the dispersal objects occupy a long thin corridor aligned north-east / south-west, and this is likely to be a good indicator of the direction the seabed forces are acting along.

Analysis of the oak blocks exposed on the seabed of this site shows they are subject to attack by wood-boring organisms. The rate of attack is comparable with that measured on other sites in waters off southern England. Burial of timber within the sparse sediment of this site affords some protection from such organisms. However, one of the two recovered buried samples exhibited slight attack from wood-borers, indicating that survival of any timber from the wreck of the *Royal Anne* Galley is unlikely.

It is recommended that further observation and study of the disposition of the dispersal objects in 2011 should be considered and that the control point network on the site should be renewed so that future work can be tied in to the existing plan and artefact positions. Detailed recording of the two iron guns on the site should also be considered.

2 Introduction

2.1 Project background

The *Royal Anne* Galley was a galley frigate, a type of small, fast warship, combining sail with oar propulsion. Built at Woolwich Dockyard in 1709, she was wrecked off the Lizard Point on 10th November 1721. About two hundred crew and passengers were lost including John, 3rd Lord Belhaven, who was en voyage to take up a new post as the Governor of Barbados.

The wreck site was rediscovered in 1991 by local diver Robert Sherratt when a large sounding lead was found adjacent to two iron guns. Subsequently numerous objects were recovered from the seabed in the vicinity of the iron guns, including items of cutlery bearing the Belhaven crest, which led to the identification of the wreck. The wreck was designated under the Protection of Wrecks Act (1973) as the *Royal Anne* Galley in 1993. The designation extends for a radius of 200m from position Latitude 49° 57'.48N, Longitude 05° 12'.99W (datum unknown).

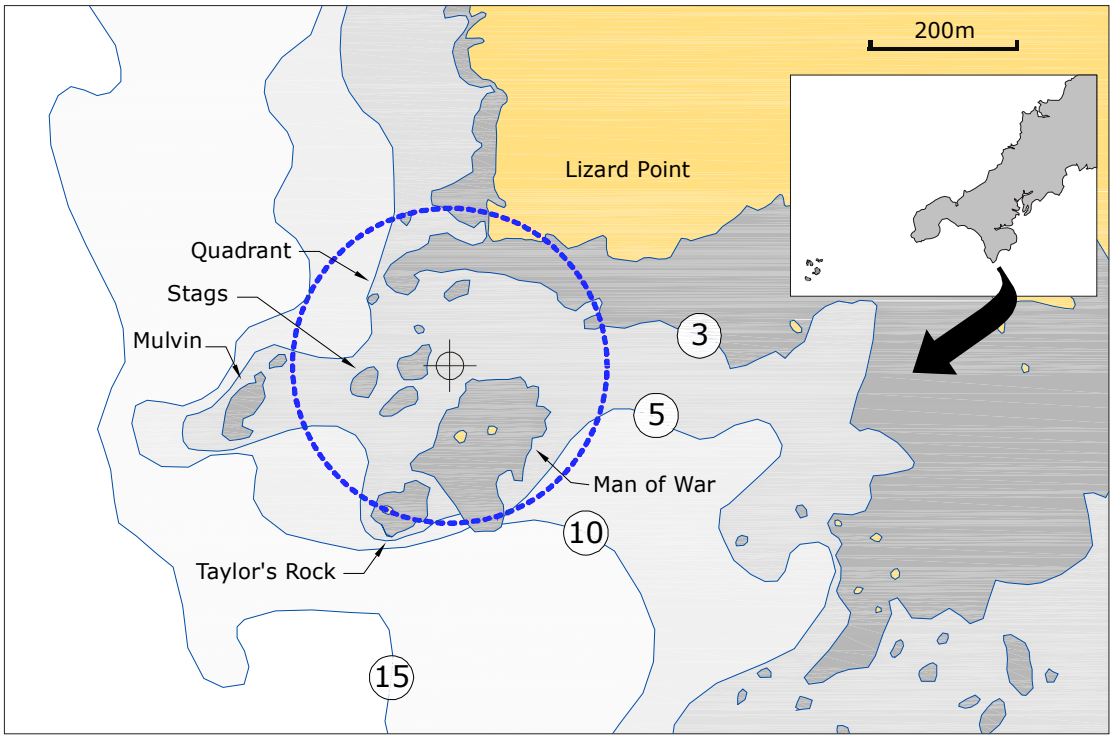


Fig 1 Location of the Royal Anne Galley designated wreck site off Lizard Point

Although the *Royal Anne* Galley lies close inshore in about 6m of seawater, the area is surrounded by rocks and large Atlantic swells make access difficult. The rocky seabed is a very dynamic environment with deep gullies and crevices obscured by thick kelp. No organic material has been recovered to date and the site seems to be artefact-bearing rather than containing any remaining ship's structure.

In 2005 English Heritage (EH) commissioned Historic Environment Projects, Cornwall Council (HE Projects), and Penzance-based maritime archaeologist Kevin Camidge to undertake a desk-based assessment of the *Royal Anne* Galley.

The desk-based assessment was Phase 1 of a proposed Marine Environmental Assessment (MEA) of the site. The purpose of the MEA is to allow English Heritage to

make an informed judgment on best practice for field assessment and therefore to establish site stability and preservation potential.

Following completion of the Phase 1 report (Camidge *et al* 2006) which outlined a strategy for field assessment and monitoring of the site EH commissioned a Project Design for field assessment (Phase 2) and monitoring (Phase 3), which was submitted at the end of January 2007 (Camidge *et al* 2007). Because of budgetary constraints EH subsequently asked HE Projects to re-cast the project design to encompass only a reduced Phase 2 field assessment with recommendations for further monitoring (Camidge *et al* 2008).

The Phase 2 field assessment was carried out during 2008 and 2009 and the following objectives were successfully accomplished:

- A bathymetric survey was undertaken;
- A marine biological assessment was undertaken;
- A water sample was collected and analysed;
- Sediment samples were collected and analysed;
- Objects for monitoring dispersal (bricks and spheres) were installed on the site;
- Objects to monitor the biological degradation of timber were installed on the site.

The report on the Phase 2 field assessment recommended that at least one recovery/inspection should be undertaken in 2010 and the results from this would inform whether any further monitoring is required (Camidge *et al* 2009).

2.2 Aims

The aim of this stage of the project, Phase 3 Monitoring, was to make an inspection of the site to recover the timber sample blocks for analysis and locate the dispersal trials objects. The results would inform whether any further monitoring is required.

2.3 Methods

The work was carried out according to an agreed project design for the Phase 3 monitoring (Camidge *et al* 2010), and the methodology is described in detail below in the relevant sections of the report.

FEPA and CPA licences were obtained in 2008 for the deposition of the objects on and in below the seabed, but no licences were required for the retrieval of these objects.

3 Inspection and recovery

By Kevin Camidge

3.1 Logistics

Diving operations were undertaken on 7 and 8 August 2010 by a team of CISMAS divers operating from a 5m cove boat based at the Lizard. Although the team spent the day at sea on 7 August it was not possible to undertake any diving on that occasion due to excessive swell on the site. The following day, 8 August, the swell had diminished and diving operations were undertaken. Even so, there was significant surge on the seabed due to swell, which made taking measurements and photographs difficult. The team returned to the site on 16 October in near-perfect conditions with only slight swell and underwater visibility in excess of 10m. Conditions this good are extremely rare on this site.

The dive team was Peter Batchelor, Kevin Camidge, Mike Hall, and Peter Menear.

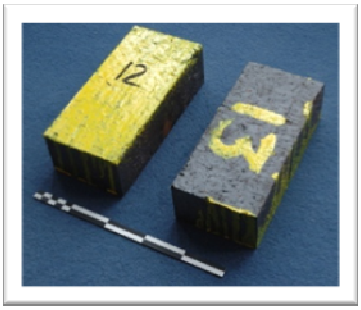
3.2 Mapping the Dispersal Objects

Tracer objects have been used elsewhere on historic wreck sites to map the direction and force of water movements (Camidge *et al* 2008). The usual technique is to place tracer objects on the seabed at known locations and to record their positions at set time intervals. At Kinlochbervie, practice golf balls and halved tennis balls were used, weighted respectively with washers and bolts. These relatively light objects did not move far over an annual cycle, indicating relatively benign conditions over the period measured (Robertson 2004).

More recently, ceramic bricks have been deployed on the protected *Hazardous Prize* wreck site and the undesignated St Peter Port Harbour wreck. The bricks were of two types, engineering and architectural bricks of different (but unknown) densities. The bricks were used whole, cut in half and into thirds. They were painted to aid location and tagged so that each brick could be individually identified (Holland 2005; Holland 2006; and personal correspondence). This work is on-going but latest reports indicate that some movement of bricks has been noted. Some bricks could not be relocated, indicating that they were missed by the divers, have become buried or have moved to outside the study area (Holland 2005).

This technique is a useful indicator of potential artefact mobility. It has the advantage of simplicity and low cost. This means that it could be used widely on historic wreck sites, and direct comparisons of the forces acting at the seabed of each site made.

Two different tracer objects were employed in this trial. The first group were class 'A' engineering bricks conforming to BS EN 771-1. These have water absorption of $\leq 4.5\%$ and a minimum density of 2200 kg/m^3. The particular bricks used here were 0.214 x 0.064 x 0.10m and weighed 3.3kg, giving an actual density of 2408 kg/ m^3. The bricks were painted yellow to aid visibility on the seabed and numbered (1-20) so that individual bricks could be tracked. Secondly, numbered white ceramic balls (steatite) of 51mm diameter and an average weight of 0.190kg, giving a density of 2735 kg/m^3 were used (Fig 2).



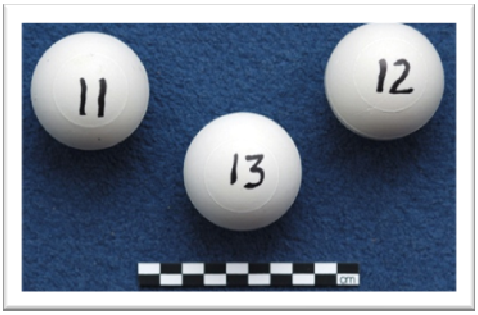


Fig 2

Numbered bricks and steatite spheres, 20 of each were deployed

Both types of tracer object (20 of each) were placed on the seabed in a symmetric arrangement at position 340978E 5536253N (UTM zone 30 WGS84) on 16 April 2009 (Fig 3). The positions of these objects were recorded again on 16 October 2010 (18 months after deployment). The record was made by recording the distance and bearing of each object from the original position. The objects were located by undertaking a circular search cantered on the origin point of the dispersal objects. The seabed around the *Royal Anne* Galley site is covered with a thick growth of kelp which makes locating small objects difficult. A circle of radius 5m around the dispersal object starting point was searched thoroughly; a further 5m (from 5m to 10m radius) was also searched, but not quite as thoroughly. It is unlikely that any objects within the 5m radius have been missed (the ground was covered meticulously by several different divers). It is possible that a few objects were missed in the 5-10m radius as this area was only searched once. Thirteen of the original 20 bricks were located while only eight of the original 20 spheres were located.

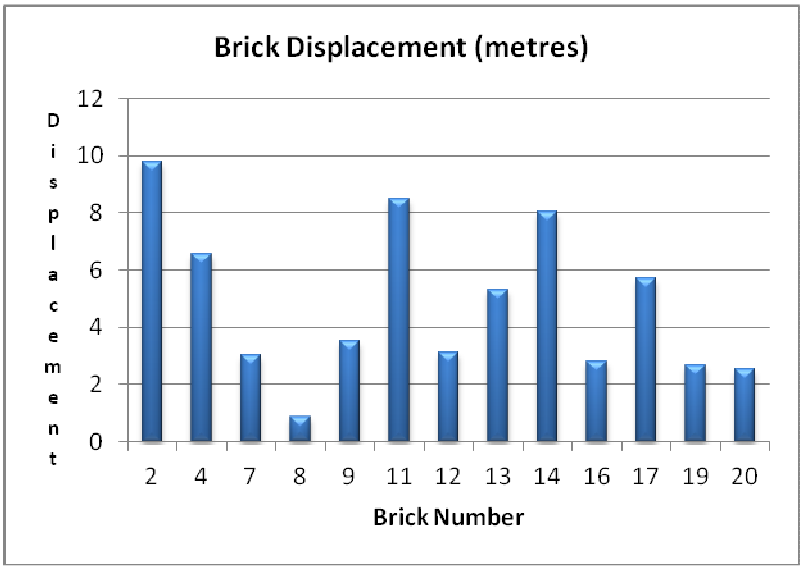
Fig 3

The numbered bricks and spheres deployed on the seabed (April 2009).

Steatite spheres – positions Oct 2010				
No	Easting	Northing	Moved (m)	Direction °
5	340975.85	5536251.69	4.00	230
7	340976.09	5536251.97	3.70	231
8	340988.95	5536259.83	11.40	61
10	340977.87	5536249.35	5.05	190
11	340976.76	5536254.38	2.22	270
12	340974.94	5536250.81	5.33	230
17	340976.33	5536253.66	2.72	260
18	340976.33	5536248.04	6.78	200
		Mean	5.15	209

Bricks – positions Oct 2010				
No	Easting	Northing	Moved (m)	Direction °
2	340978.98	5536254.28	9.79	40
4	340983.13	5536259.37	6.56	40
7	340979.94	5536251.41	3.02	160
8	340979.80	5536254.53	0.86	75
9	340979.88	5536250.87	3.52	165
11	340984.65	5536260.61	8.49	40
12	340981.73	5536255.78	3.13	60
13	340982.35	5536258.37	5.29	40
14	340982.25	5536261.62	8.03	25
16	340979.95	5536251.63	2.82	160
17	340982.56	5536258.76	5.73	40
19	340981.65	5536254.27	2.66	90
20	340981.52	5536254.53	2.55	85
		Mean	4.80	78

Fig 4 Tables showing the positions of the bricks and spheres as recorded on 16 October 2010. Displacement in metres and directions in degrees (north = 0°,' east = 90° south = 180° and west = 270°)



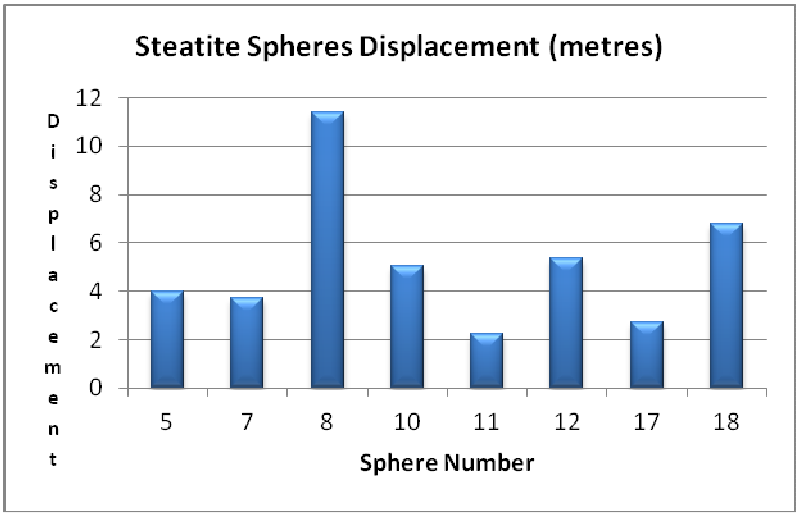


Fig 5

Charts showing the distance of each brick and sphere from their starting point (October 2010)

What is remarkable for such a high energy site is the high percentage of the dispersion objects relocated within 10m of their starting position. Those who know this site all predicted that most - if not all - of the dispersion objects would be lost. What is even more surprising is the distribution of the dispersal objects as recorded in October 2010 (Fig 6 below). With the single exception of sphere 8, the objects have been sorted into two distinct areas; the bricks have all been moved to the east while the spheres have all been moved to the west of their original positions. This 'sorting' of the dispersal objects is a most unexpected result. As the two types of object have similar densities (2408 kg/m^3 and 2735 kg/ m^3) the differentiation is likely to be due to their different size and shape. This theory is bolstered by the fact that the granite block SS1 measuring 0.2m x 0.35m x 0.25m and weighing 30kg was moved by 5m to the east between deployment and recovery – thus behaving in the same way as the bricks. Why the smaller spheres have been moved in a different direction is not clear. It will be interesting to see if the dispersal objects now remain relatively static or whether further dispersal will take place. Monitoring should ideally be undertaken in late summer 2011. The following comments were received from Jon Rees, principal oceanographer at Cefas:

> *I think these results are incredibly good – two very distinct groups. The consistency of the results is also very strong – no "outliers". In terms of analysis, the distributions are also explainable – several different solutions are possible (1) depth variation over tidal cycle – at low tide particles move inshore or high tide offshore (2) different size/density/shape objects will move according to the stress applied to them (the "bed shear stress" – combination of wave and tidal current components and also depth related) and the critical "movement stress" for that object.*
>
> *I don't know the specific densities of brick or spheres but one group could have been moved north-east during a south-west storm at low tide whilst the other group moved south-west on the same storm at high tide (undertow). Conversely, during a single storm event and with increasing bed shear stress applied to each group could of lead to different transport paths. As well as analysing the "found" objects the difference in "lost" objects may give useful information.*

The dispersal objects now all occupy a narrow corridor aligned north-east/south-west (see Fig 7). This perhaps suggests that the main forces acting on these objects are aligned in a similar direction. This is also surprising as the main observable force acting on the site is the prevailing swell which invariably sweeps the site from west to east, which is different from the observed movement of the dispersal objects. The key to understanding this may lie in the sub-surface terrain of the area around the site. Plotting the rocks which break water at spring lows shows that the site lies in a long north-east / south-west gulley, which may well channel the swell and current along this alignment (Fig 8). Without proper measurements of water movements over the site, it is not possible to be certain; but the dispersal objects would seem to indicate this.

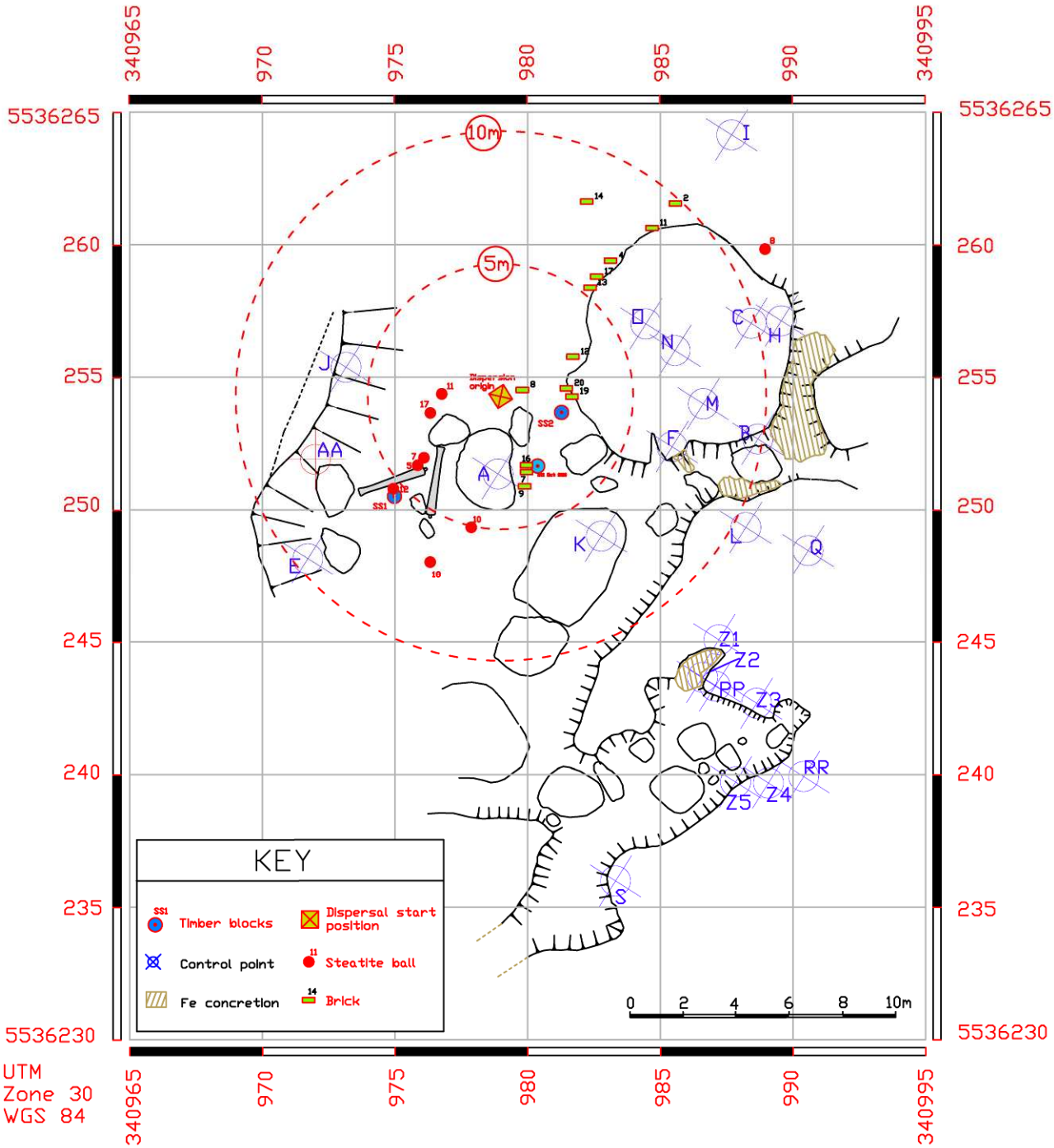


Fig 6 Site plan showing the positions of the dispersal objects (start 16 April 2009 and their positions 18 months later, on 16 October 2010). Note also the displaced granite block SS1, moved approximately 5m to the east

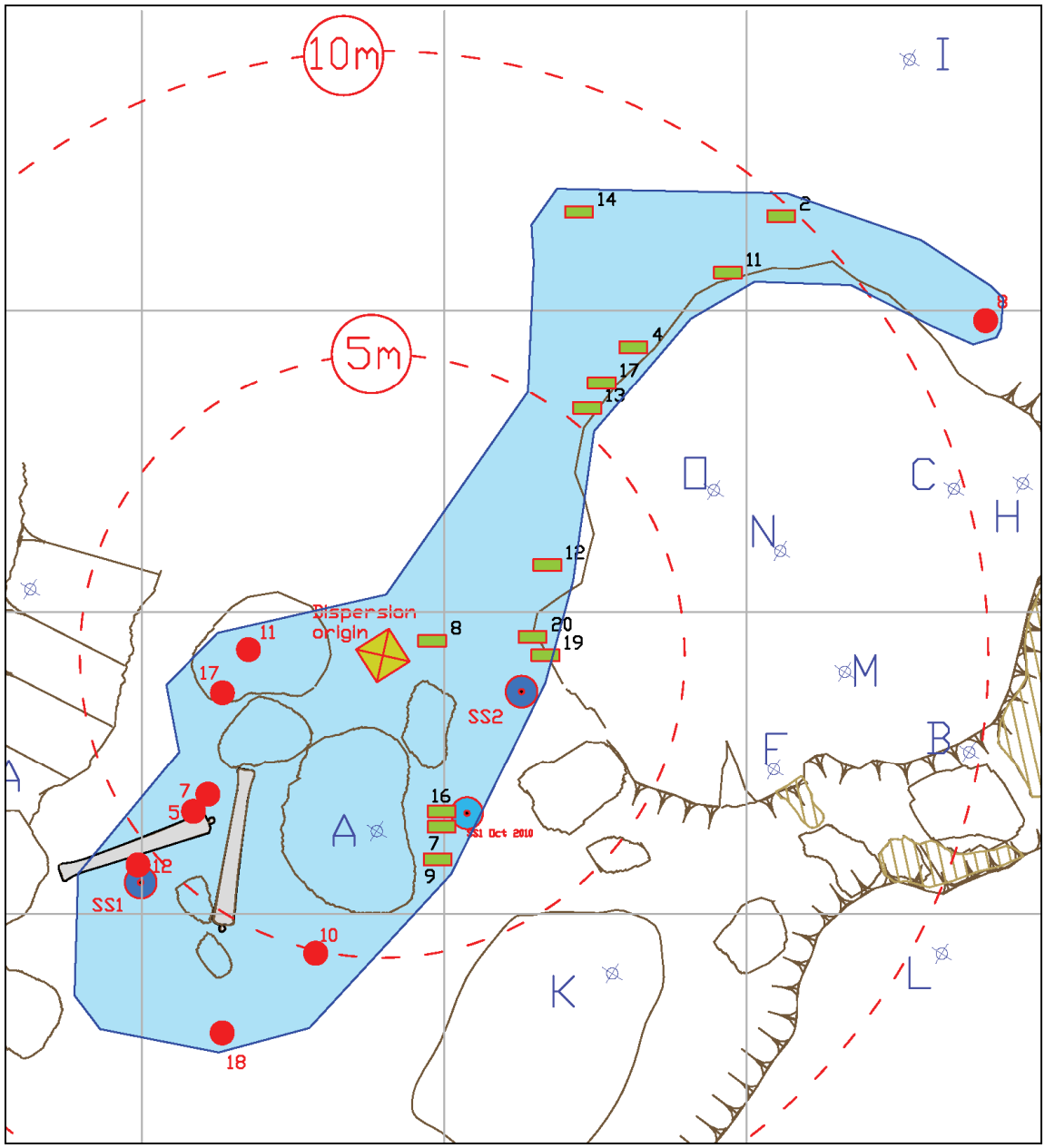


Fig 7 The dispersal objects all fall within the north-east / south-west corridor outlined in blue above. The grid squares are 5m; north is up

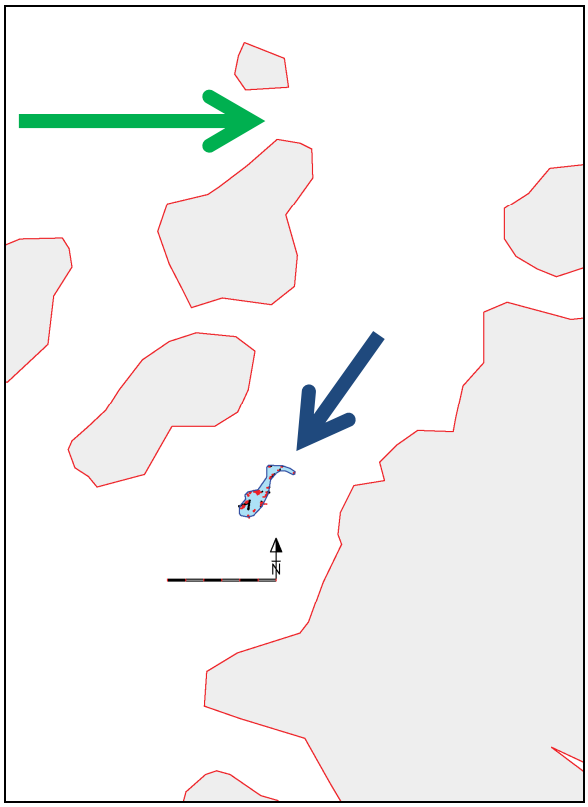
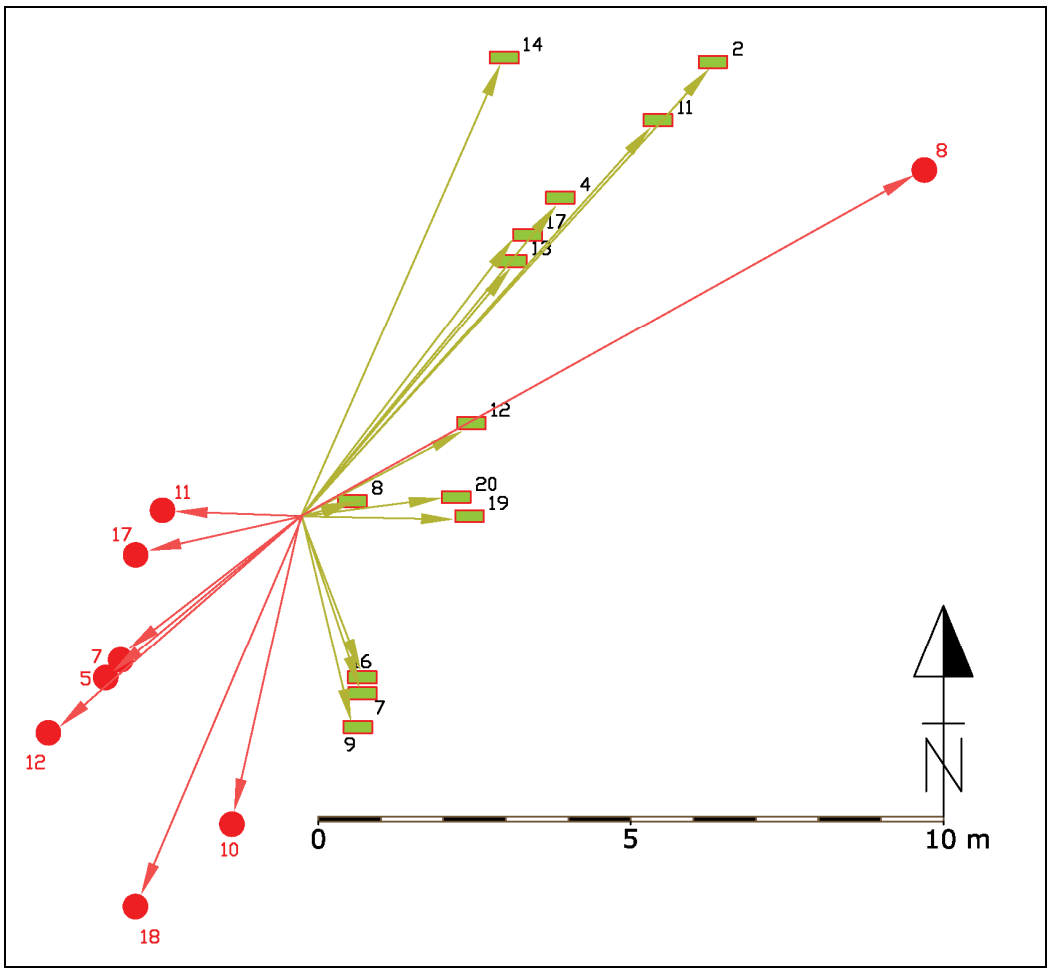


Fig 8 (left)

The outline of the dispersal corridor is shown (blue arrow) relative to the rocks which dry at low water. This demonstrates how the dispersal objects form a pattern which aligns with the deeper water running north-east / south west through the site. The scale bar is 30m long with 5m divisions. The green arrow indicates the direction of travel of the prevailing swell

Fig 9 (below)

Dispersal objects: movement, clearly showing how the bricks and spheres have been differentially moved. Bricks are shown in yellow and spheres in red



3.3 Wood Samples

Eight oak sample blocks were deployed, four on the surface and four buried within the seabed sediments, in two separate locations on the site. These locations were the same as those for sediment samples SS1 and SS2 and are shown in Figs 6 and 7. The buried blocks were labelled and buried approximately 0.20m deep. The oak blocks secured to the seabed surface were fastened to granite blocks each approximately 0.25 x 0.25 x 0.20m (approximately 30kg). The sample blocks were attached to the granite by means of cable ties and stainless steel rods, which were set into the granite block using polyvinyl resin. These surface blocks were placed in the same location as the buried sample blocks.

The buried sample blocks were placed at a depth of 0.20m below the level of the seabed. The granite block was placed to one side of the backfilled hole in which they were placed. The sediment excavated to emplace the blocks consisted of angular granite cobbles (0.05-0.15m) with some coarse grey sand and shell fragments. The sand was unevenly distributed within the sediment and some sand-free spaces between the granite cobbles were evident. The two buried samples SS1-5 and SS1-6 could not be located on retrieval.

Fig 10

Two of the surface oak samples secured to a granite block (prior to deployment). The scale is 0.10m long

By August 2010 one of the oak blocks (SS2-4) had become detached from the granite block and lost. This was due to the failure of the cable ties used to secure it to the block. The other pair of surface samples (SS1-1 and SS1-2) had been displaced approximately 5m to the east but were intact and still attached to the granite block. This event demonstrates just how dynamic the site is, given that a 30kg block, which was partly sunk into the seabed sediment, was moved by 5m.

Blocks	Type	Deployed	Recovered	Duration (days)
SS1-1	SS1 – surface	16/04/2009	16/10/2010	548
SS1-2	SS1 – surface	16/04/2009	16/10/2010	548
SS2-3	SS2 – surface	16/04/2009	08/08/2010	479
SS2-4	SS2 – surface	16/04/2009	Lost	∞
SS1-5	SS1 – buried	16/04/2009	Lost	∞
SS1-6	SS1 – buried	16/04/2009	Lost	∞
SS1-7	SS2 – buried	16/04/2009	08/08/2010	479
SS1-8	SS2 – buried	16/04/2009	08/08/2010	479

Fig 11

Table showing the deployment and recovery dates of the eight oak sample blocks

Comparing the results of the blocks exposed on the seabed surface with those from the Swash Channel site (Palma 2009) and the *Colossus* site (Camidge 2009) gives roughly comparable results using the scheme defined by British Standard EN 275:1992. What is more surprising is the degree of protection afforded in the very coarse sediments on this site as evidenced by the results obtained for the two buried blocks SS2-7 and SS2-8. These samples were graded 0 and 1 respectively, which indicates no attack and slight attack (see below Fig 25). Given the absence of any organic material from the 400+ artefacts recovered from excavation on this site, these results may be seen as unexpected. However, they may be due in part to the absence of any substantial sediment deposits for organic material to lodge in.

Site	Exposure	EN 275:1992	Sample
RAG	18	2	SS1-1
RAG	18	2	SS1-2
RAG	15.5	1	SS2-3
Swash Channel	12	1	SSF2
Swash Channel	12	1	SSF5
Swash Channel	12	1	SSF8
Colossus	12	2	V(0)-2
Colossus	24	4	V(0)-4

Fig 12

Comparison of oak blocks exposed on the seabed from RAG, Swash Channel and Colossus.

4 Wood Decay Analysis

By Ian Panter (YAT Conservation Report 2010/60)

4.1 Introduction

Eight oak timber blocks were deployed at the site of the *Royal Anne* Galley in 2009 to test whether the seabed environment could potentially support the preservation of structural or artefactual remains from the vessel. Prior to deployment each sample was weighed and labelled. Following recovery in 2010, each block was sealed in mini-grip bags and despatched to the conservation laboratory of the York Archaeological Trust for analysis. Upon arrival, the blocks were stored in a refrigerator at 5°C until processing. Only five blocks were retrieved from the seabed (Nos 1, 2, 3, 7 and 8), the other three having been lost between deployment and subsequent recovery.

Each block was photographed and carefully washed to remove adhering marine growths and encrustations, and then X-radiographed using the in-house Faxitron unit with Kodak D4 film at an exposure of 30Kv for 4.25 minutes. The blocks were weighed, measured and oven dried at 105° C until a constant dry weight was achieved.

Standard decay testing methodologies adopted by the MoSS project were followed (Palma 2004). The water content was determined from the equation (wet weight – dry weight)/dry weight x 100 and the weight loss by the equation (original dry weight – final dry weight)/original dry weight x 100

The density of each block was derived from the equation oven-dried weight/wet volume.

4.2 Results

4.2.1 Physical description

The blocks were washed to remove loosely adhering sediment and photographed. Blocks 7 and 8 had been buried beneath the sediment and had no marine growth attached to the wood surface.

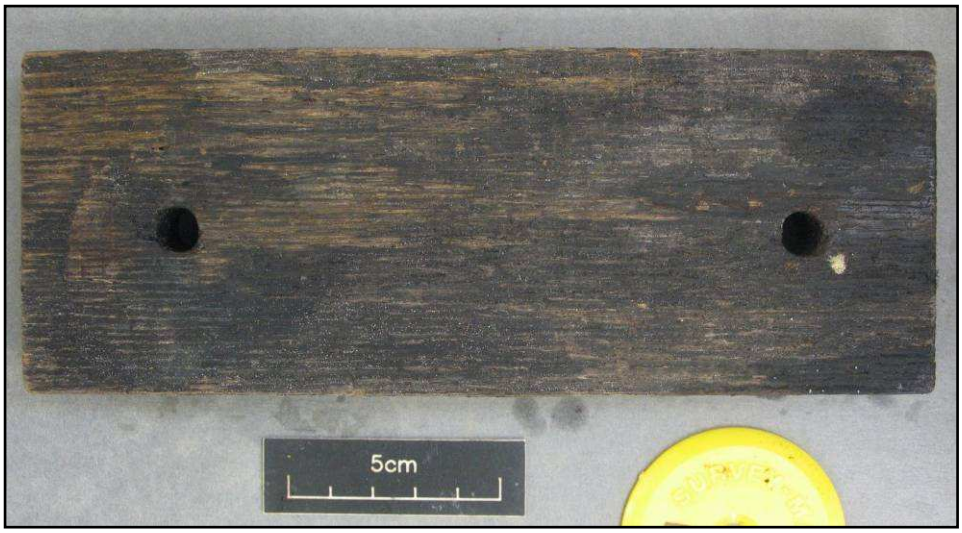


Fig 13 Block 7 before drying, intact surfaces, no signs of biofouling

Fig 14 Although block 8 had been buried c.20cm below the seabed surface, and there was no evidence of marine growths on the surface, there was however, evidence of marine borer attack visible on the lower right edge and centre:

Fig 15 Block 1 showing algal growth on uppermost and exposed surfaces. Blocks 2 and 3 were very similar in appearance. The presence of the yellow plastic number tags has conferred a small degree of protection to the wood surface

The undersides and edges of blocks 1, 2 and 3 all show evidence for wood boring attack, and block 1 is illustrated in Figure 16 below:

Fig 16 Close-up of decay to block 1. The decay appears to be initiated through the cut ends and sides, in effect proceeding along the vessels and other wood cells. The edges and exposed surfaces of wood blocks1, 2 and 3 are all deteriorated

4.2.2 Weight loss and water content

Sample #	Original Weight g.	Wet weight g.	Dry weight g.	%Water Content	Weight Loss g.	% Weight Loss
1	286.9	410	217.7	88	69.2	24
2	262.1	418	213.2	96	48.9	19
3	215.4	393	188.9	108	26.5	12
4	244.4	n/a	n/a	n/a	n/a	n/a
5	221.3	n/a	n/a	n/a	n/a	n/a
6	303.9	n/a	n/a	n/a	n/a	n/a
7	242.3	448	239.2	87	3.1	1
8	217.7	420	209.1	101	8.6	4

Fig 17 Weight loss and percentage water content for each block

The greatest weight losses were observed in those samples (1 – 3) which were deployed on the surface of the seabed whilst the least levels of decay were observed in blocks 7 and 8 which were buried at location SS2. Block 7 produced a weight loss of only 1% but as there were no visual signs of decay, the variation is probably due to margins of error from weighing – the blocks were weighed by another person and on a different set of scales. However, block 8 has undergone slight decay as evidenced by the presence of marine wood borer holes – see Figure 18 below. The water content values were determined without degassing the samples before weighing and hence do not represent the maximum water contents. Some drying out is likely to have occurred since recovery however the results indicate a low level of decay of the wood.

4.2.3 Density determinations

The original density is based on the wet volume of the wood as measured in York, and is based on the assumption that each block has not swollen significantly during burial.

Sample #	Original Density Kg/m^3	Final Density Kg/m^3	% Loss
1	727	551	24
2	672	547	19
3	597	525	12
4	n/a	n/a	n/a
5	n/a	n/a	n/a
6	n/a	n/a	n/a
7	612	605	1
8	569	546	4

Fig 18 Loss in density

Loss in density reflects the weight loss values and again indicates a low level of decay for those two samples that were buried at location SS2 whilst the blocks deployed on the seabed underwent higher levels of decay.

4.2.4 X-radiography

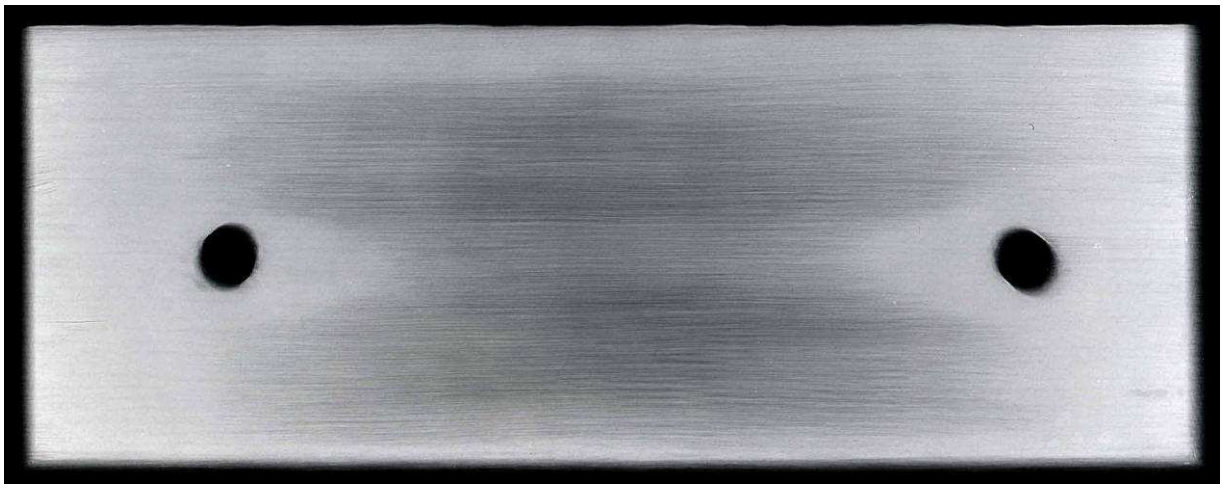


Fig 19 Block 7, no infestation, and no calcareous deposits, wood block intact

Fig 20 Block 8, slight infestation with galleries to lower left and centre of block

Figures 20 to 22 are the X-ray images for blocks 1- 3 respectively and infestation by marine borers is clearly visible in all three samples.

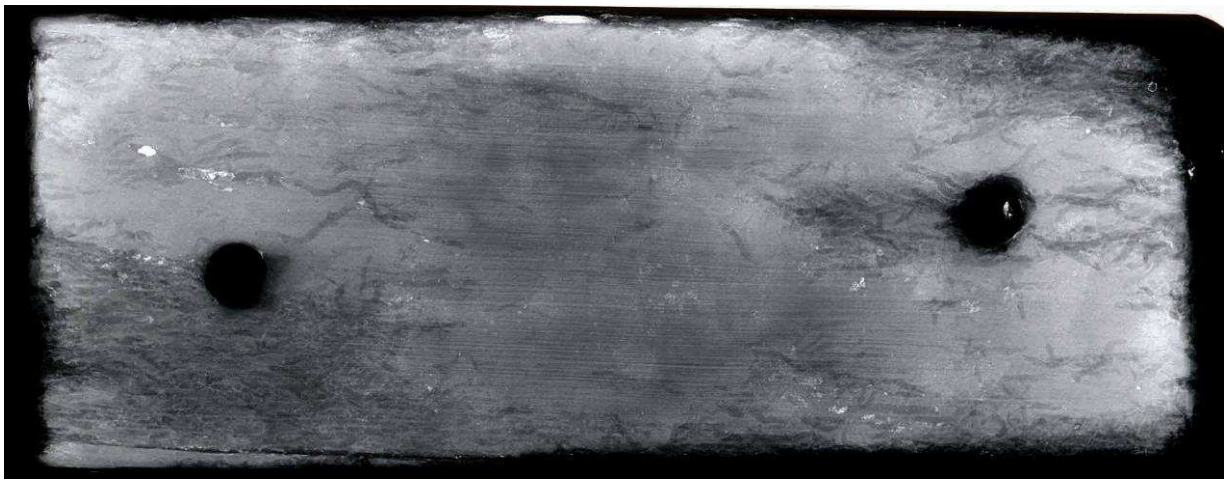


Fig 21 Block 1 showing heavy infestation to lower left and upper right areas

Fig 22 Block 2 calcareous surface deposits and galleries throughout body of wood

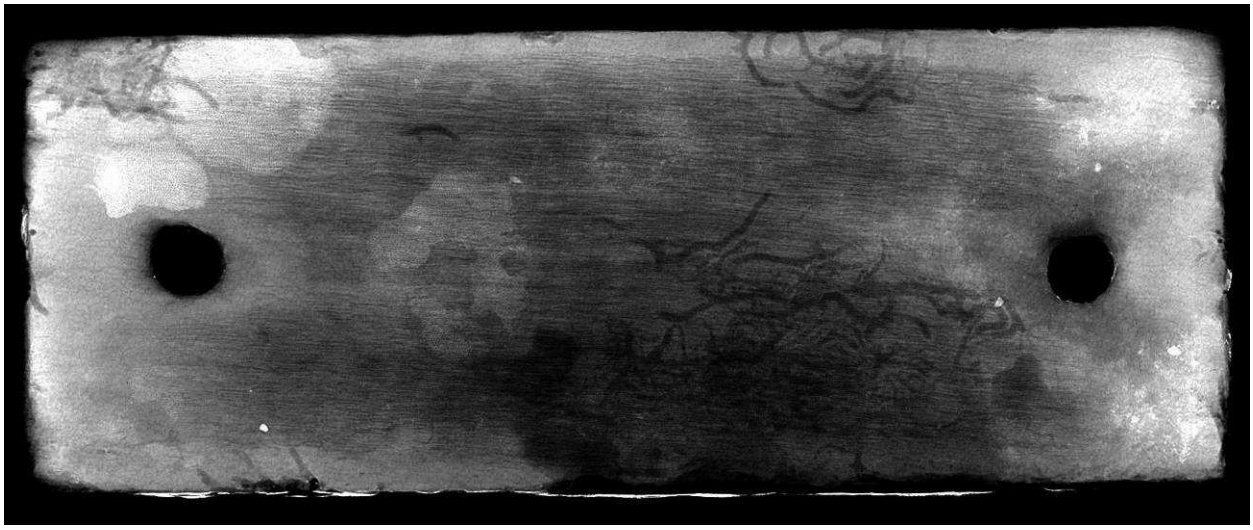


Fig 23 Block 3 showing calcareous surface deposits along bottom edge and three distinct zones of infestation

4.3 Conclusions

The degree of decay can be classified either as a function of weight loss or the percentage area affected by tunnels as viewed on the X-ray image, using the scheme defined by the relevant British Standard (EN 275:1992) thus:

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.

Fig 24 British Standard scheme for defining wood decay (EN 275:1992)

Using this scoring system the samples recovered from the site of the *Royal Anne* Galley can be graded as:

Block No	Grade
1	2
2	2
3	1
7	0
8	1

Fig 25 British Standard scheme applied to the oak blocks from the Royal Anne Galley site

Two blocks have undergone "moderate" attack, two samples show "slight" attack and one block exhibited no evidence of biological attack at all. These results are consistent with the weight losses recorded in Table 1 above, and indicate that aggressive conditions exist where wood is exposed above the seabed, whilst more benign conditions are to be found within the sediment "pockets" that typify the wreck site.

The previous geochemical investigation, as reported on in 2009 (Camidge *et al* 2009), indicated that the sediments at the site of the *Royal Anne* Galley are broadly reducing in character and conducive to the in situ preservation of organic materials. However a slight infestation to block 8 (one of the samples buried at SS2) suggests that the sediments are prone to bioturbation with the subsequent ingress of oxygenated sea water into the shallow deposits, and hence preservation is likely to be variable in the long-term. The loss of three blocks following deployment (one from the surface and two that had been buried) provides a good indicator as to how dynamic the site environment is, and material buried within the sediment "pockets" are at risk from physical processes.

The work at the *Royal Anne* Galley site has demonstrated the efficacy of using replicates as proxy indicators and it is recommended that their use is continued elsewhere when undertaking marine environmental assessments.

5 Conclusions

The dispersal objects were in place on the seabed for 18 months. In total, 21 of the original 40 objects were located and recorded (8 spheres and 13 bricks). The objects have been moved on the seabed by an average of 5.15m (spheres) and 4.89m (bricks). The distances moved by the spheres varied between 2.22m and 11.4m; the bricks moved between 0.80m and 9.79m. Although some of the objects may have been missed by the survey it is more likely that many lay outside the 10m radius searched.

With the single exception of sphere 8 the objects have been 'sorted' by the forces acting on the site – the spheres being moved west and the bricks to the east. This result was not anticipated. All the dispersal objects occupy a long thin corridor aligned north-east / south-west, and this is likely to be a good indicator of the direction the seabed forces are acting along.

Timber exposed on the seabed of this site is subject to attack by wood-boring organisms. The rate of attack is comparable with that measured on other sites in waters off southern England. Burial of timber within the sparse sediment of this site affords some protection from such organisms. However, one of the two recovered buried samples exhibited slight attack from wood-borers, indicating that survival of timber from the wreck of the *Royal Anne* Galley is unlikely.

6 Recommendations

Further observation of the dispersal objects in 2011 should be considered along with the possibility of getting an oceanographer involved in the project – there may well be more we can learn from the disposition of the dispersal objects. It would be particularly useful to determine whether the objects will continue to move or will now remain where they are.

Results from the *Hazardous Prize* and St Peter Port Harbour dispersal trials should be sought (attempts to contact Sarah Holland in October 2010 were not successful) so that a comparison with the results from RAG can be made.

The control point network on the site has now largely been lost, due mainly to corrosion of the steel pins used to mark the original control points. It would be desirable to be able to tie any future work into the existing site control network. To this end at least four marine grade stainless steel control points should be installed, either as replacements to existing control points (if they can be located) or positioned relative to existing features (for example the guns). Hopefully this will allow future work to be tied to the existing site plan and artefact positions.

Detailed recording of the two iron guns on the site should also be considered.

7 References

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

Camidge, K, 2005. *HMS Colossus Stabilisation Trial*, unpublished report for English Heritage.

Camidge, K, 2009. HMS Colossus, an Experimental Site Stabilization. *Conservation and Management of Archaeological Sites*, **11 (2)**,161-88.

Camidge, K, Johns, C and Rees, P, 2006. *Royal Anne Galley Marine Environmental Assessment: Phase 1 Desk-based Assessment*, HES, Truro

Camidge, K, Johns, C, Rees, P, Canti, M, Hoskin, M, Panter I and Rees, J, 2007. *Royal Anne Galley Marine Environmental Assessment: Project Design for Phase 2 Field Assessment*, and Phase 3 Monitoring, HES, Truro

Camidge, K, Johns, C, Rees, P, Canti, M, Hoskin, M, Panter I and Rees, J, 2008. *Royal Anne Galley Marine Environmental Assessment: Revised Project Design for Phase 2 Field Assessment*, HES, Truro

Camidge, K, Johns, C, Rees, P, Canti, M, Hoskin, M, Panter I and Rees, J, 2009. *Royal Anne Galley Marine Environmental Assessment Phase 2 Field Assessment Report*, HE Truro

Camidge, K, Johns, C, and Panter, 2010. *Royal Anne Galley Marine Environmental Assessment: Project Design for Phase 3 Monitoring*, HE Truro

English Heritage, 2004. *Marine Environmental Assessment of Designated Wreck Site Royal Anne Galley.* English Heritage Brief (Tender Document)

Holland, S E. 2005. Following the Yellow Brick Road. NAS, 2005.4.

Holland, S E, 2006. Following the Yellow Brick Road. *NAS*, 2006.1

Palma, P, 2004. Final Report for the Monitoring theme of the MoSS Project, in C O Cederlund (ed) *MoSS Final Report. Monitoring, Safeguarding and Visualizing North-European Shipwreck Sites: Common European Cultural Heritage - Challenges for Cultural Resource Management*, Helsinki: The National Board of Antiquities, 8–37.

Palma, P, 2009. *Swash Channel Wreck: Project Report for Environmental Scoping Study for in situ Stabilization of the Site*. Unpublished report for English Heritage. Bournmouth University.

Robertson, P, 2004. A Shipwreck near Kinlochbervie, Sutherland, Scotland. *The International Journal of Nautical Archaeology*, **33.1**

8 Project archive

The HE project number is **2010058**

The project's documentary, photographic and drawn archive is housed at the offices of Historic Environment, Cornwall Council, Kennall Building, Old County Hall, Station Road, Truro, TR1 3AY. The contents of this archive are as listed below:

1. A project file containing site records and notes, project correspondence and administration and copies of documentary/cartographic source material (file no 2010058).
2. Electronic drawings stored in the directory ..\CAD ARCHIVE\ Royal Anne Galley MEA Phase 3 2010058
3. Digital photographs stored in the directory ..\Images\Sites\ Maritime\Royal Anne Galley MEA Phase 3 2010058
4. English Heritage/ADS OASIS online reference: cornwall2-90679

This report text is held in digital form as: G:\CAU\HE Projects\Sites\Maritime\Royal Anne Galley MEA Phase 3 2010058