Report No: 2006R020

Royal Anne Galley, Lizard Point, Cornwall

Marine Environmental Assessment

Phase 1 Desk-based Assessment

Historic Environment Service (Projects)

Cornwall County Council

A Report for English Heritage

Royal Anne Galley, Lizard Point, Cornwall

Marine Environmental Assessment

Phase 1 Desk-based Assessment

Kevin Camidge, Charlie Johns
and Phillip Rees

with contributions and help from
David Gregory, Mike Hall, Mark Jones,
Jon Rees, Robert Sherratt,
Bryn Perry Tapper, Janet Witheridge &

Robin Witheridge

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Historic Environment Service, Environment and Heritage,

Cornwall County Council

Kennall Building, Old County Hall, Station Road, Truro, Cornwall, TR1 3AY

tel (01872) 323603 fax (01872) 323811 E-mail hes@cornwall.gov.uk

www.cornwall.gov.uk

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Help with the historical research was provided by: the Cornwall Record Office, Truro; the Royal Institution of Cornwall, Truro; the Bartlett Library at the National Maritime Museum., Falmouth; the Picture Library and Historic Photographs and Ship Plans Section at the National Maritime Museum, London; the Public Records Office, Kew; the Archives and Wrecks Sections at the UK Hydrographic Office, Taunton; the Scottish National Portrait Gallery; East Lothian Library Headquarters, Hilary Broadbent of the Education, Arts and Libraries, CCC; Helston and Falmouth public libraries, Plymouth Central Library.

Within the Historic Environment Service Charlie Johns, who collated the final report, was the Project Manager, Bryn Perry Tapper was responsible for GIS mapping of acquired data and generating illustrative material for the report. Marine consultants were Kevin Camidge, maritime archaeologist; Philip Rees, marine geologist; Robert Sherratt, licensee for the ***Royal Anne***; John Rees, physical oceanographer CEFAS ; Mark Jones, Research Director, Mary Rose Archaeological Services Ltd; David Gregory, iron corrosion specialist, In Situ Group, Conservation Department, Archaeological Section, National Museum of Denmark. Background information was provided by Mike Hall and Rob Sherratt. Robin and Janet Witheridge assisted with the PRO research.

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

Cover illustration

Clockwise from left: the ***Charles*** Galley by Jeremy Roche *c*1688; Peregrine Osborne, marquis of Carmarthen; fork handle from the ***Royal Anne*** Galley site bearing the Belhaven crest (K Camidge); the Quadrant anchor (© Wessex Archaeology); diver (© D Gregory); Quadrant and Man of War Rocks viewed from Old Lizard Head (© CCC)

Back cover illustration

Inscribed gold disc, possibly a watch part, find no 152 (photo: Kevin Camidge)

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Abbreviations

ACop	Acceptable Code of Practice
ADP	Accoustic Doppler Profiler (Nortek Aquadopp)
ADU	Archaeological Diving Unit
ATT	Admiralty Tide Table
BODC	British Oceanic Data Centre
BGS	British Geological Society
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CRO	Cornwall County Record Office
DBA	Desk-based assessment
DCMS	Department of Media Culture and Sport
DEFRA	Department of the Environment, Fisheries and Rural Affairs
DGPS	Differential Global Positioning System
EH	English Heritage
GOOS-AG	UK Global Ocean Observing System Action Group
HAT	Highest Astronomical Tide
HER	Cornwall and the Isles of Scilly Historic Environment Record
HES	Historic Environment Service, Cornwall County Council
HW	High Water
IACMST	Inter-Agency Committee on Marine Science and Technology
ICH	Integrated Coastal Hydrography Project
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
MAFF	Ministry of Agriculture, Fisheries and Food
MCA	Maritime Coastguard Agency
MDIP	Marine Data and Information Partnership
MEA	Marine Environmental Assessment
MHLN	Mean Low Water Neaps
MHLS	Mean Low Water Springs
MHWN	Mean High Water Neaps
MHWS	Mean High Water Springs
MOD	Ministry of Defence
MPMMG	Marine Pollution Monitoring Management Group
NERC	Natural Environment Research Council
NGR	National Grid Reference
NMM	National Maritime Museum

NMMP	National Marine Monitoring Programme
OS	Ordnance Survey
OSGB	Ordnance Survey of Great Britain
POL	Proudman Oceanographic Laboratory
PRN	Primary Record Number in Cornwall HER
PRO	Public Record Office, Kew
PVD	Progressive Vector Diagram
RAG	*Royal Anne* Galley
RIC	Royal Institution of Cornwall
RTK GPS	Real Time Kinematics Global Positioning System
RN	Royal Navy
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
SMP	Shoreline Management Plan
UKAS	United Kingdom Accreditation Service. 'UKAS is the sole national accreditation body recognised by government to assess against internationally agreed standards organisations that provide certification, testing, inspection and calibration services'.
UKHO	United Kingdom Hydrographic Office

Glossary

BENTHIC	Living in or on the bottom of a body of water
EPIFAUNAL	Organisms attached to but above the substrate (rocks or sediment)
INFAUNAL	Organisms within the sediment
LIDAR	Airborne radar bathymetry. A technique for measuring the depths of relatively shallow coastal waters from an aircraft by the means of a scanning, pulsed laser beam.

1 Executive summary

This report describes the results of a desk-based assessment of the ***Royal Anne*** Galley, a protected wreck site, carried out by Cornwall County Council's Historic Environment Service (Projects) for English Heritage between October 2005 and April 2006. The desk-based assessment represents Phase 1 of a wider Marine Environmental Assessment (MEA) of the site.

The National Heritage Act (2002) extended English Heritage's remit to include ancient monuments in, on or under the seabed to the 12-mile limit around England, including 42 historic wreck sites designated under the Protection of Wrecks Act 1973. It is intended that the ***Royal Anne*** Galley MEA will form one of the stages of a series of initiatives leading to the development of archaeological management plans for designated wreck sites and informing English Heritage's future research and amenity and education developments for the benefit of the wider community.

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 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*** in 1993. The designation extends for a radius of 100m from position Latitude 49° 57'.27N, Longitude 005° 12'.56W (datum unknown).

The centre of the protected area lies about 150m from the Quadrant Rock undesignated site. It has long been suspected that the Quadrant site may represent part of the wreck of the ***Royal Anne*** and the report considers the evidence for this. English Heritage have advised the DCMS that they can recommended re-designation of the ***Royal Anne*** Galley site comprising expansion of the designated area to a radius of 200m but excluding any part of that area which lies above MHWS in order to encompass the Quadrant site.

Although the ***Royal Anne*** lies close inshore in less than 5m 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.

The MEA includes an archaeological and environmental assessment of the ***Royal Anne*** and also an assessment of methods of data collection and a methodology to integrate all the disparate oceanographic data sets in order to provide high quality, auditable advice which is applicable not just to the management of the ***Royal Anne*** but protected wreck sites in general. The Phase 1 main section of the report concludes with a strategy for the envisaged Phase 2 field assessment of the ***Royal Anne***. This includes obtaining data on waves, tides, water quality, sediment, flora and fauna as well as airborne LIDAR bathymetry survey, undertaking artefact dispersal trials, monitoring corrosion of iron cannon and biological degradation of timber.

According to local tradition and 19th century literary sources the ship's crew and passengers are buried in nearby Pistol Meadow, now owned by the National Trust. To contribute to the seamless management of the terrestrial and maritime archaeological resource a geophysical survey should be undertaken to locate the position of the grave pits, further

documentary research undertaken and the site considered for protection through designation.

2 Introduction

2.1 Project background

2.1.1 Reasons for and circumstances of the project

The National Heritage Act (2002) extended EH's remit to include ancient monuments in, on or under the seabed to the 12-mile limit around England, including 42 historic wreck sites designated under the Protection of Wrecks Act 1973.

In 2004 EH proposed to engage consultants to carry out a Marine Environmental Assessment (MEA) of the *Royal Anne* Galley, a protected wreck site that lies off the Lizard, Cornwall. It is intended that the MEA will form one of the stages of a series of initiatives that will lead to the development of archaeological management plans for designated wreck sites and inform EH's future research, amenity and education developments for the benefit of the wider community (English Heritage 2004).

2.1.2 The original specification

In November HES and Kevin Camidge submitted a project design based on EH's tender specification for the MEA of the *Royal Anne* (English Heritage 2004; Camidge and Johns 2004). The original specification comprised the following elements:

Phase 1 Desk-based assessment

Environmental

- Identify all known sources of environmental data relating to the study area including:
    - Physical oceanographic status- waves, tides, water depth;
    - Sediment transport, mobility;
    - Water quality status- chemistry, pollution;
- Assess the quality of data;
- Identify any areas that need further data collection.

Archaeological

- Establish the material type and known extent of archaeological site;
- Assess archaeological potential of site.

Phase 2 Field assessment

- Collection of data relating to:
- Chemical- REDOX, salinity, PH, dissolved oxygen;
- Physical- min/max depth, fetch, temperature, ground swell, tides, wave height, currents, sediment grain size, seabed strength, depth of sediment, bathymetry, sub-bottom profiling;
- Biological – flora, fauna.

Establish the effect of the above on the preservation of archaeological material.

Identify the material most at risk.

Phase 3 Monitoring

- Identify features of interest for monitoring:
- Identify attributes to monitor:
- Establish assessment methodology;
- Monitor site for a five year period

2.1.3 The restructured specification

The HES/KC tender was the only one submitted for the project and, because they wish to develop future methodologies for MEAs within the constraints of the Maritime budget, EH decided to commission HES and KC to re-focus the project design and undertake the Phase 1 desk-based assessment only, so that the results of the Phase 1 work would allow EH to make an informed judgement as how best to proceed with phases 2 and 3.

Consequently a meeting was held in London on 21 February 2005 to discuss the re-focussing of the project design. The meeting was attended by CJ, KC, Ian Oxley, EH Head of Maritime Archaeology, Jesse Ransley, then of the EH Maritime Archaeology Team and Ian Panter, Regional Science Advisor. The conclusions of the meeting were summarised in a letter from Ian Oxley dated 7 March which was circulated to the attendees:

- Central to the restructuring of the project is the need to incorporate the development of methodologies for the MEAs of Protected Wreck Sites, particularly as the *Stirling Castle* initiative is not going forward as a unified project at this time;
- Consequently it is appropriate to split the project into two phases:
    - 2005/6 – an extended Phase 1 Desk-based Assessment (DBA) and a methodological assessment (leading into a more detailed project design for Phase 2);
    - 2006/7 – field assessment work (Phase 2);
- The Phase 1 desk-based assessment should not consist simply of a DBA of the *Royal Anne* Galley site, but should also explore the potential of various marine environmental field assessment methods. Because of the highly dynamic nature of the site the assessment methods will have to be site specific, but the DBA should include an exploration of a variety of potential methods. This will demonstrate how the Phase 2 field assessment project design is derived;
- Questions such as methods for assessing the stability of cannon or other large metal objects, alternative methods for assessing sedimentary chemistry and alternatives to other probes and data loggers that might be lost on this dynamic site will be developed through consultation with Ian Panter and the wider marine environmental industry;
- Phase 1 should include:
    - DBA of the *Royal Anne* – including Quadrant and Wessex material;
    - Assessment of the broad environmental context and collation of available environmental information/sources;
    - Discussion and evaluation of potential environmental assessment methods;

- Production of an assessment strategy informed by the conclusions drawn from the Phase 1 work and resulting hypotheses about the site. This will form the basis of the project design for the Phase 2 fieldwork.

The restructured project design for the MEA was finalised in July 2005 (Camidge and Johns 2005).

2.2 Site location

The designated site of the wreck of the *Royal Anne* Galley lies south of Lizard Point, on the Lizard Peninsula, Cornwall – position 49º 57.27'N 05º 12.56'W (datum unknown). The centre of the protected area lies 154m from the Quadrant Rock undesignated wreck site, and it has long been suspected that the Quadrant site represents part of the wreck of the *Royal Anne*.

Fig 1 Location Plan – The red circle shows the extent of the designated area

2.3 Ownership

The wreck of the *Royal Anne* Galley is owned by the Ministry of Defence (MoD).

2.4 Condition of site

The site lies in a depth of about 5m of seawater at Lowest Astronomical Tide (LAT). The site is unusual in that there are very few soft sediments; the seabed around the site consists of exposed reefs of serpentinised gabbro, an extremely hard rock. The remains of the *Royal Anne* Galley located to date have been found in small gullies and crevices containing shallow deposits of coarse sand and boulders.

2.5 Legal status

The current site is designated under the Protection of Wrecks Act 1973 (order number 2 1993). The designation extends for a distance of 100m from position Latitude 49° 57'.27N, Longitude 005° 12'.56W (datum unknown).

2.6 Licensing history

- 10 November 1993: Licence to survey awarded to Robert Sherratt for 1994. Reports on progress required by 1 March and 31 October 1994.
- 1995; Licence to survey during the period 1 March to 31 October 1995 awarded to Robert Sherratt. Authorised divers: K Camidge (archaeologist), M Hall, R Sherratt (team leader).
- 9 February 1996: licence to survey during the period 1 November 1995 to 21 March 1996 awarded to Robert Sherratt. Authorised divers: K Camidge (archaeologist), M Hall, B Redman (added 24 October), R Sherratt (team leader).
- 13 May 1997: Licence to excavate during the period 13 May to 31 October 1997 awarded to Robert Sherratt. Authorised divers: K Camidge (archaeologist), M Hall, R Sherratt (team leader).
- 28 November 1997: licence to excavate during the period 1 March to 31 October 1998 awarded to Robert Sherratt. Authorised divers: K Camidge (archaeologist), M Hall, R Sherratt (team leader).
- 15 December 1998: licence to excavate during the period 1 March to 31 October 1999 awarded to Robert Sherratt. Authorised divers: K Camidge (archaeologist), M Hall, R Sherratt (team leader).
- 9 March 2000: licence to excavate during the period 9 March to 31 October 2000 awarded to Robert Sherratt authorised divers K Camidge (archaeologist), M Hall, R Sherratt (team leader).
- 15 February 2001: surface recovery licence during the period 12 February to 31 October 2001 awarded to Robert Sherratt.
- 17 April 2001: licence to excavate during the period 17 April to 31 October 2001 awarded to Robert Sherratt. Authorised divers: K Camidge (archaeologist), M Hall, R Sherratt (team leader), D Roberts.
- 21 January 2002: licence to excavate during the period 21 January to 31 October 2002 awarded to Robert Sherratt. Authorised divers: K Camidge (archaeologist), M Hall, R Sherratt (team leader), D Roberts, K Codling, S Cadman, P Harris.
- 2003 Visitor, Survey and Surface Recovery Licences to 31 October 2003. Excavation licence refused.
- 2003/4**:** Visitors licence 1 December 2003 to 31 October 2004.
- 2004/5: Surface recovery licence from 1 December 2004 to 30 November 2005. Authorised divers: K Camidge, S Cadman, R Cox, D Glover. M Hall, D Roberts, R Sherratt.
- 2005 Survey and surface recovery licence awarded 7 July 2005 to 30 November 2005. Authorised divers K Camidge, S Cadman, D Roberts, D Glover, R Sherratt

- 2005: November application made for renewal of surface recovery licence by R Sherratt.

3 Aims and objectives

3.1 The overarching aim

As set out in the original specification, the MEA will form one of the stages of a series of initiatives that will lead to the development of archaeological management plans for designated wreck sites that will inform English Heritage's future research, amenity and education developments for the benefit of the wider community (English Heritage 2004).

3.2 Objectives

- To assess the broad environmental context and collate available environmental information /sources;
- To discuss and evaluate potential marine environmental assessment methods;
- To collate and assess the existing fieldwork results/archival material from the site;
- To establish the material type and known extent of the archaeological site;
- To assess the archaeological potential of the site; and
- To establish the assessment strategy.

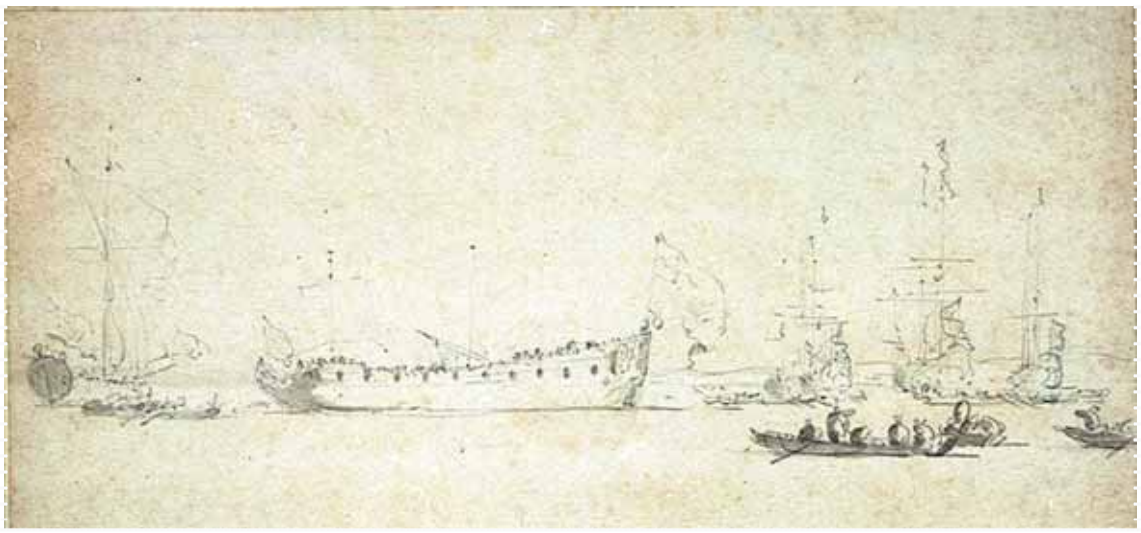

Fig 2 Launch of an English ship, possibly the James Galley c1676 by William Van de Velde the Younger (© National Maritime Museum)

4 Methodology

4.1 The study area

The study area includes the whole designated area, a circle of radius 100m, and its environs in order to place the wreck site in its wider context.

4.2 Archaeological assessment

The archaeological assessment established the material type and known extent of the site and assessed its archaeological potential. All relevant identified published and unpublished sources of historic, archaeological, geographical, topographical, and environmental data relevant to the *Royal Anne* Galley and the study area were consulted. The assessment included the data from the nearby Quadrant Rock undesignated site and results of Wessex Archaeology's 2004 fieldwork. The current location of the silver coins from the Quadrant site was investigated. The method for research and data varied according to the form of the data and availability of the material on the Internet. The following sources were consulted:

- The archive material and records held by Robert Sherratt, these were catalogued and photographs taken of selected artefacts for illustrative purposes;
- Divers who have worked on the site (by personal interview);
- The Royal Institution of Cornwall, Truro;
- The Cornwall Record Office, Truro:
- The National Maritime Museum, London and Falmouth;
- UKHO, Taunton; records were searched for information about the site, including the wreck section's 'surveying history' files;
- The Public Record Office, Kew and at the National Maritime Museum, London. These records were investigated for information about the history of the ship, the crew, passengers, cargo and early attempts at salvage;
- Secondary sources held by local libraries or obtained through inter-library loans.
- Secondary sources held by HES or in the authors' personal libraries.

4.3 Environmental assessment

4.3.1 General

All known sources of environmental data relating to the study area were identified. The quality of existing data was assessed and areas that need further data collection were identified. The project team liaised with EH, DEFRA, CEFAS, CCC Natural Environment Service and other specialists. The following sources were consulted:

The sources of data investigated were:

- The Shoreline Management Plan for Cornwall (Halcrow Maritime 1999a, b and c);
- English Nature/Joint Committee for Nature Conservation (JNCC)
- Admiralty Chart 2345 at 1:15,000 scale
- The UK Hydrographic Office Research Room and Wreck Section to identify the original source material for the Admiralty Chart and the survey history of the site;

- The British Geological Survey (BGS) website and sheets of Sea Bed Sediments and Quaternary 1:250,000 series which shows the general disposition of sediment types and sample locations;
- The relevant BGS offshore regional report (Evans 1990);
- Relevant geophysical and sample/borehole data held by the BGS for sediment transport and mobility: it is proposed to review metocean design parameters by using established empirical formulae to revaluate the bottom orbital velocities acting on the seabed (eg Leenknecht *et al* 1992);
- Centre for Environment, Fisheries and Aquaculture (CEFAS)
- Environmental Agency
- Relevant data held by the Meteorological Office (Met Office), Exeter;
- British Oceanographic Data Centre (BODC)
- Relevant data held by the Proudman Oceanographic Institute, Liverpool (POL);
- Cornwall County Council photographic archives

4.3.2 Assessment of methods for data collection

Potential environmental assessment methods, conventional and alternative, were discussed and evaluated, including collection methods for the following data:

- Chemical – REDOX, salinity, pH, dissolved oxygen;
- Physical – min/max depth, fetch, temperature, ground swell, tides, wave height, currents, sediment grain size, seabed strength, depth of sediment, bathymetry, sub-bottom profiling;
- Biological – flora, fauna;
- Measuring corrosion of large iron objects and possible stabilisation.

4.4 GIS mapping

Admiralty Chart data, BGS data, tidal stream currents, wind and wave data etc were digitally mapped on an OSGB grid using GIS ArcView.

Opportunities for seabed / site modelling were explored. This was fairly straightforward using ArcView GIS, digital vector Ordnance Survey maps and Admiralty Charts (projected to OSGB36) to provide a seamless coverage of the site showing location, topography, land use and bathymetry. Simple elevation models, based on OS elevation data and UKHO bathymetry, adjusted to match differences between OS and Chart datum, were modelled to provide a 3D demonstration of the site and to provide a terrestrial/marine profile of the site.

5 Timeline

Year	Date	Location	Activity	Notes	Source
1709	21 Mar	Woolwich	RAG building	Carmarthen visits the yard and wants more hands employed in building RAG.	ADM 106/648
1709	5 July	Woolwich	RAG launched	Said to be of a new invention, under the direction of the Marquis of Carmarthen. Date is not explicit. Captain Robert Trevor commands.	RAG032
1710	January	Woolwich	Refit	Alterations?	ADM 2/41
1710	March - May	Scotland	Sailing	Carmarthen and Captain Trevor onboard. Probably sea trials.	ADM 51/791
1710	May	Sheerness	In dock		ADM 51/791
1710	June	Channel	Sailing	Carmarthen and Captain Trevor onboard. Probably sea trials.	ADM 2/42
1710	24 July	Spithead	Waiting to put to sea	Carmarthen in command. In company of *Swallow* Prize.	RAG006
1710	25 Aug	Plymouth	Entered port	Carmarthen brought RAG into Plymouth. Mentions *Swallow* Prize and a small prize he took off the Bass	RAG024
1710	9 Sept	Spithead	Transfer of crew	Captain Trevor commands RAG. He is ordered to transfer the second lieutenant and all men above highest complement to *HMS Newark*. These extra men were allowed Carmarthen for the trials of RAG, which are presumably now concluded.	RAG021; ADM 2/42: ADM 1/557
1710	October	Norway	Convoy duty	Safeguarding Russia trade.	ADM 51/791; ADM 2/42
1711	July	Portsmouth	Refit	Refitting for channel service.	ADM 2/43
1711	August	Norway	Convoy duty	Between Yarmouth and Norway.	ADM 2/44
1711		Channel		Channel. Russian convoy. Captain Trevor commands.	NMM form
1712		Portuguese coast		Stationed with Vice Admiral Baker's Squadron on the Portuguese coast. Captain Trevor commands.	NMM form
1712 – 1713	Apr 1712 – Aug 1713	Iberia & Mediterranean		Incl Gibraltar, Tangier and Lisbon.	ADM 51/791
1712 - 1713	Nov 1712 – Jan 1713	Off Sallee (Salé, Morocco)		Operations against the Rovers of Sallee (pirates)	
1713-14	Sept-Mar	Lisbon	Convoy duty		ADM 51/791, ADM/2/46
1713-14		Off Sallee		Captain Robert Trevor commands. To deliver presents from Queen Anne to the Emperor of Morocco	NMM form/ADM 2/46
1714?	21 March	Spithead			ADM 51/791
1714	April		In service	'*Royal Anne* Galley 42 In sea pay, in good condition'.	The state of the Navy Apr 1714

Year	Date	Location	Activity	Notes	Source
1714-15	July 1714 – July 1715	Portsmouth?	Laid-up	No logs or orders for this period. No listed captain between Nov 1714 and July 1715. Order of 23.03.1713 reduces compliment to lowest.	ADM 2/246
1714			Not at sea	In lists of ships station condition of RAG said not to be good.	ADM 7/550A
1715	26 July		New captain	Captain James Stewart (sometimes spelt Stuart) appointed to RAG.	ADM 7/655
1715-16	Sept 1715 – Mar 1716	Scotland	At sea	Royal Anne at sea off Scotland during the Jacobite rebellion. Captain James Stewart commands.	ADM 51/791
1715	10 October	Cromarty, Scotland	At sea	"	SP54/9/31 SP54/9/51E
1716	April	Woolwich	Refit		ADM 51/791 ADM 2/48
1716	June	Baltic	Convoy duty	Escorting 46 vessels bound for the Baltic.	ADM 51/791
1716	July	Nore	Anchored		ADM 51/791
1716	11 -15 July	Gravesend - Holland	Escort duty	Accompanying George I's retinue.	Lediard 1734, 868 (n)
1716	Aug – Oct	North Sea	Convoy duty	Protecting the Archangel trade.	ADM 2/49 ADM 51/791
1716	Nov	Sheerness	Refit		ADM 2/49 ADM 51/791
1716-17	Dec-Jan	North Sea	Escort duty	Escorting convoys between Holland and Britain.	ADM 2/49 ADM 51/791
1717	January	Nore			ADM 51/791
1717	17 Jan	Margate	Escort duty	Despatched to advise of his Majesty's return to England.	Dalton 2002, 72
1717	Feb-Apr	Norway	Sailing	Collecting intelligence on the activities of the Swedes.	ADM 2/49 ADM 51/791
1717	April?	Channel/Norway		With Admiral Byng's fleet in the Channel. To Norway? Captain James Stewart commands.	NMM form
1717	May	Chatham	Refit		ADM 2/49 ADM 51/791
1717	June	North Sea	Cruising	Orders to cruise between England and Holland, calling at Yarmouth.	ADM 51/791 ADM 2/49
1717	23 July	Sheerness	Refit	Order to be laid-up and paid off at Sheerness.	ADM 2/29 ADM 51/791
1717	8 August		Captain	End of James Stewart's command of RAG.	ADM 7/655
1717-19	July 1717 – Aug 1719	Sheerness	Laid up	No logs or orders for RAG in this period. No captain listed for the period Aug 1717 to Aug 1719.	ADM 7/655
1719	21 Aug	Sheerness	Captain Willis appointed to the command of RAG	Officers and men of the Deal Castle to be transferred to RAG. RAG to be cleaned and graved with white stuff. Ship to be fitted out for channel service and provisioned for 4 months.	RAG026
1719	September	Sheerness		RAG ordered onto full rations.	ADM 2/50

Year	Date	Location	Activity	Notes	Source
1719	20th Nov	Nore	RAG ordered to Guinea, Cape Verde and Africa	RAG to proceed to Guinea, Cape Verde and Africa with the *Lynn*. Rations for 8-months. Both ships to hunt pirates.	RAG025
1719-21	Dec 1719 – Apr 1721	West Africa	Cruising		ADM 51/4315
1721	May	Deptford	Refit		ADM 51/4315
1721	10 June	Deptford	RAG ordered to West Indies	Captain Willis to fit out RAG for voyage to West Indies. Ship to be sheathed & graved with white stuff. Provisions for 8 months. Accommodation for the Governor of Barbados.	RAG028 ADM 2/50
1721	16 Aug	Deptford?	Repairs?	37 men from Deptford dockyard were victualled onboard RAG – possibly for repairs to RAG after collision with the *Spolswood*.	RAG019
1721	12 Sept	Spithead	Orders for trip to West Indies	Willis ordered to Barbados with Lord Belhaven. Then on to Leeward Isles, Jamaica to hunt pirates. Then home via Carolina and Newfoundland, again hunting pirates. To be home by late next summer.	RAG027 ADM 2/50
1721	12 Sept	South Break Head, The Downs	Ran aground and collision	Willis reports RAG run aground on South Break Head, then in collision with Virginian ship *Spolswood*.	ADM 106/743
1721	7 Nov am	Catwater	Set sail	Sailed from Catwater (Plymouth) to anchor in Causon-Bay (Cawsands?).	RAG016
1721	7t Nov 10pm	Cawsand Bay (Plymouth)	Set sail	Sailed from Causon-Bay (Cawsands?) about 10 that night. Little wind at NW	RAG016
1721	8 Nov	Deadman (Dodman?)	On voyage	Wind variable, most westerly … after 12 noon made the Deadman and tack'd and stood to the southward.	RAG016
1721	9 Nov	At sea	Lay by	At four in the afternoon they saw land about five leagues off which they took to be the Lizard. Wind WSW blowing fresh. They tacked to southward and lay by with the foremast to the mast until 12 midnight	RAG016
1721	10 Nov	At sea	Heading back to Plymouth	About midnight started back for Plymouth, steered NE. About 3am the ship struck a submerged rock which was not above pistol shot from the land of the Lizard. Wind SW. The ship bulged and in about a quarter hour or more broke to pieces. The larboard side falling away and many men with it.	RAG016
1721	15 Nov	Lizard	Salvage	Orders to Captain Rowley of *Lively* to sail from Plymouth to Lizard to save what he can of the wreck of RAG.	RAG003 ADM 3/33
1722	2 May	Lizard	Salvage	Letter from Lizard fishermen concerning 26cwt anchor and 21 guns salvaged from RAG.	RAG008
1722	2 Aug	Pendennis	Salvage	Letter to Mr Pearce storekeeper at Pendennis about 20 guns salvaged from	WO47/20B

Year	Date	Location	Activity	Notes	Source
				RAG, delivered to Flushing quay.	
1722	3 Aug	Lizard	Salvage	£103-13-6 paid to 12 named individuals for material salvaged from RAG. Also says that *Plymouth Transport* is to be sent to collect 5 anchors taken up from the RAG.	ADM 106/748
1722	12 Jan	Lizard	Salvage	*Jolly Bachelor* and *Henrietta* Yacht going down to Lizard with newly invented diving machine to fish on the wreck of RAG	RAG035
1724	24 July	Lizard	Salvage	George Robinson complains of damage caused to his estate by the salvage of RAG.	ADM 106/765
1848				Local lore about the wreck and Pistol Meadow first recorded by Revd CA Johns.	A Week at he Lizard
1969				Quadrant site investigated by Bristol University SAC.	Fenwick & Gale 1999,91
1973				Bulk of fieldwork carried out by Bristol University.	Wessex Archaeology 2005b, 2-3
1983				Items recovered from the site by Tom Berry.	"
1991	5 May			*Royal Anne* Galley site rediscovered by Rob Sherratt.	
1993	11 Nov			Site designated as the *Royal Anne.*	
1993-				Survey & excavation work undertaken by Robert Sherratt and Mike Hall, over 400 artefacts recovered.	
2004				Site assessments of the *Royal Anne* and Quadrant sites by Wessex Archaeology.	Wessex Archaeology 2005a and b

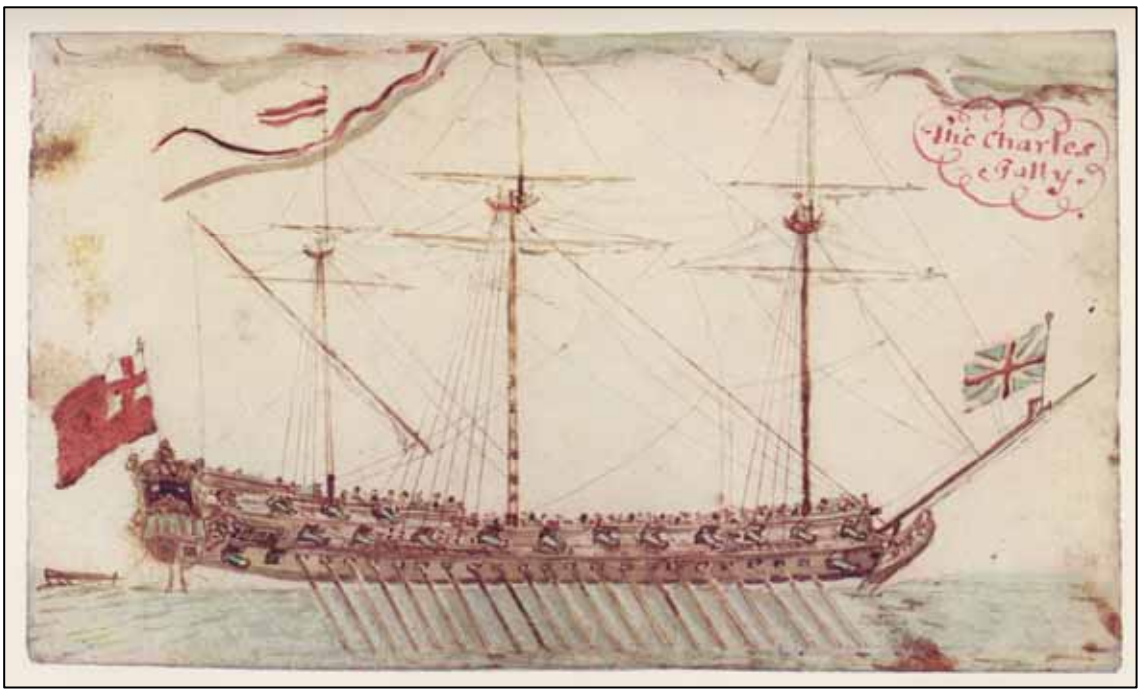

Fig 3 The Charles Galley by Jeremy Roche c1688

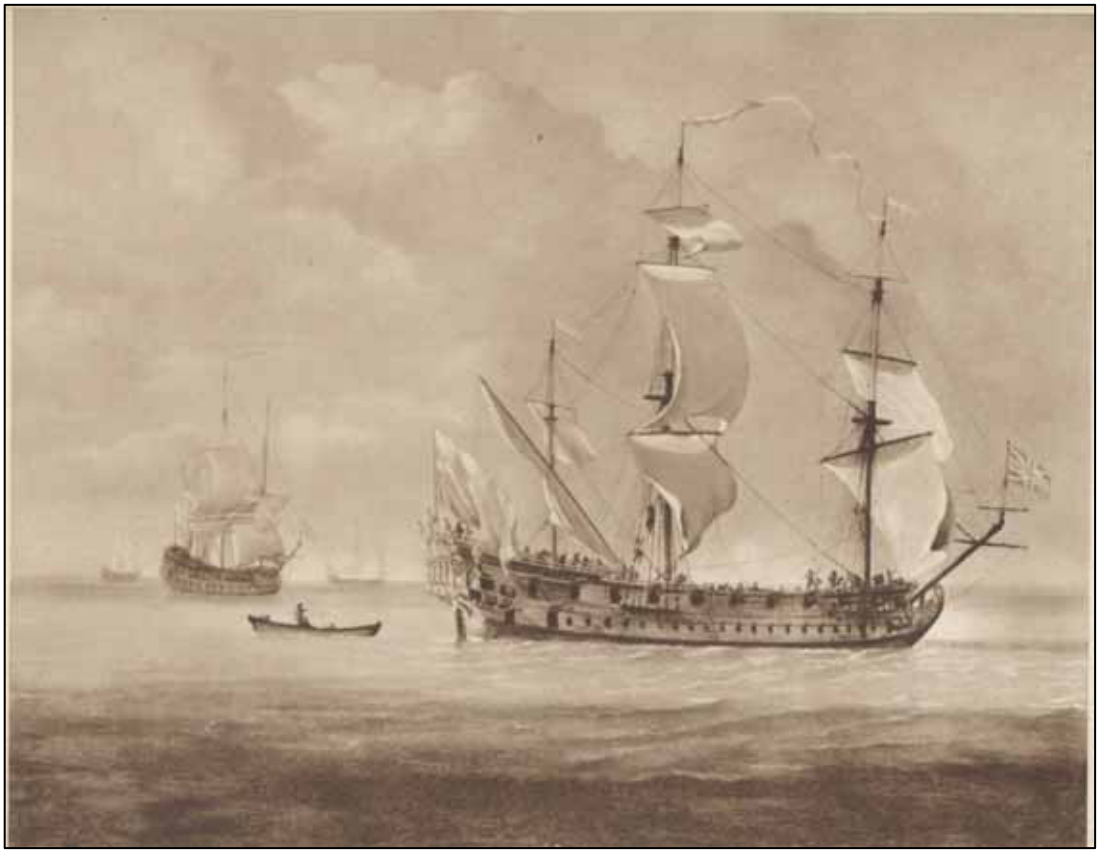

Fig 4 The Charles Galley c 1676 by William Van Velde the Younger (© National Maritime Museum)

6 Results of the archaeological assessment

By Kevin Camidge and Charlie Johns

6.1 Introduction

6.1.1 Galley frigates

The *Royal Anne* Galley was a galley frigate; a small, speedy, warship equipped with oars and designed to be rowed if additional speed or manoeuvrability were required. The use of sweeps (oars) was quite common on smaller vessels between 1670 and 1846, and was introduced to the English Navy for various reasons during the later 17th century. One reason was the number of successful attacks made on British ships in the Western Mediterranean by fast galleys used by the Barbary corsairs (privateers from the Barbary Coast of North Africa). The galleys could take advantage of the comparatively weak defences at the head and stern of a vessel, where there was very little armament. A galley carried her armament at her head and stern, the sides being taken up with sweep ports, and she would manoeuvred ahead or astern of a rival vessel and proceeded to rake her with shot (Goodwin 1987, 191).

The galley frigate prototype was the *Charles* Galley, built in 1676 to a special design by Anthony Deane to combat the Barbary corsairs. She was a small two-decked vessel with fine lines, designed to row as efficiently as she could sail; her guns could be brought to bear by manoeuvring with her oars. The majority of her armament was on the upper deck, the lower deck was mainly occupied by the long sweeps and therefore the number of guns carried was less than for an ordinary warship of the same size. The concept of a vessel propelled by both oar and sail proved relatively successful, and the design was used until the mid-19th century. Larger ships such as the 46-gun Fourth Rate, *Tiger*, built at Deptford in 1681, were equipped with sweeps but she had two complete gun decks so the sweeps were likely to have been used just for manoeuvring, and she was not described as a galley (Goodwin 1987, 191; Lyon 1993, 27).

Jeremy Roche, a captain of the King's Navy during the reigns of Charles II, James II and William III, was commander of the *Charles* Galley, 'the best sailor in the fleet', between April 1688 and July 1690. Roche describes the *Charles* Galley as 'a 4th Rate, carrying but 32 guns and rows with 42 oars, she was 125 foot by the keel, her complement of men 220' (Ingram 1946, 131); this differs from the official lists where she appears as being 114 ft in length. Roche also made a painting of the *Charles* Galley showing her with 21 oars (Fig 3), while other contemporary illustrations and the ship's plan showing 20 oars on each side (Figs 4 and 5).

Roche recorded in his journal for 27 July 1688 that, approaching Dartmouth in the late afternoon '…having little wind, I had a mind to try how the Galley would row, so I ordered the sails to he haled up and ran out all our oars being 42 and put 3 men to each oar and found we could row 3 mile an hour; upon which my men were so proud that they would row all the way into Plymouth sound…' (*ibid,* 117).

The *James* Galley, built in the same year, was essentially a slightly smaller version of the *Charles*; she was followed by the *Mary* Galley in 1687, 'To be built to the same form as the *James* Galley' (Lyon 1993, 13). These were the first generation of galley frigates, named after Charles II, his brother James and sister, Mary.

Naval galleys of the 1690s included Their Matᵢᵉˢ Ship *Bridget* Galley (1693, PROB 11/416), the *Slaughter* Galley (1696, PRO ADM 106/482/302), the *St George* Galley (1696, ADM 287/373), the *King William* Galley (1696, ADM 106/482/87); the *Carmarthen* Galley (1696, ADM106/482/125).

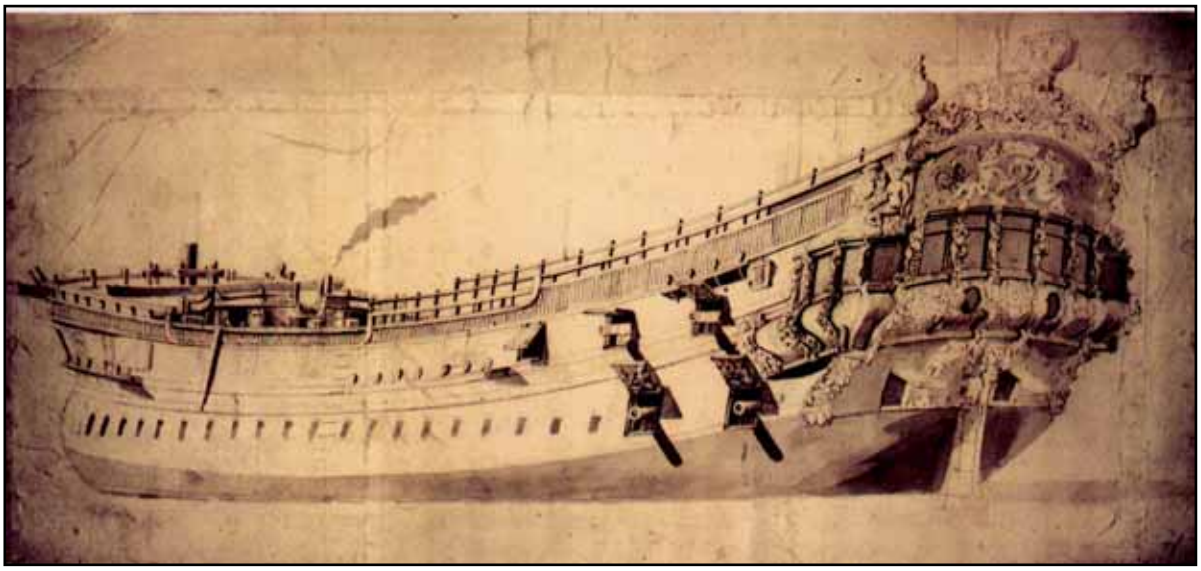

Fig 5 The Charles Galley 1676 by William Van Velde the Elder (© National Maritime Museum)

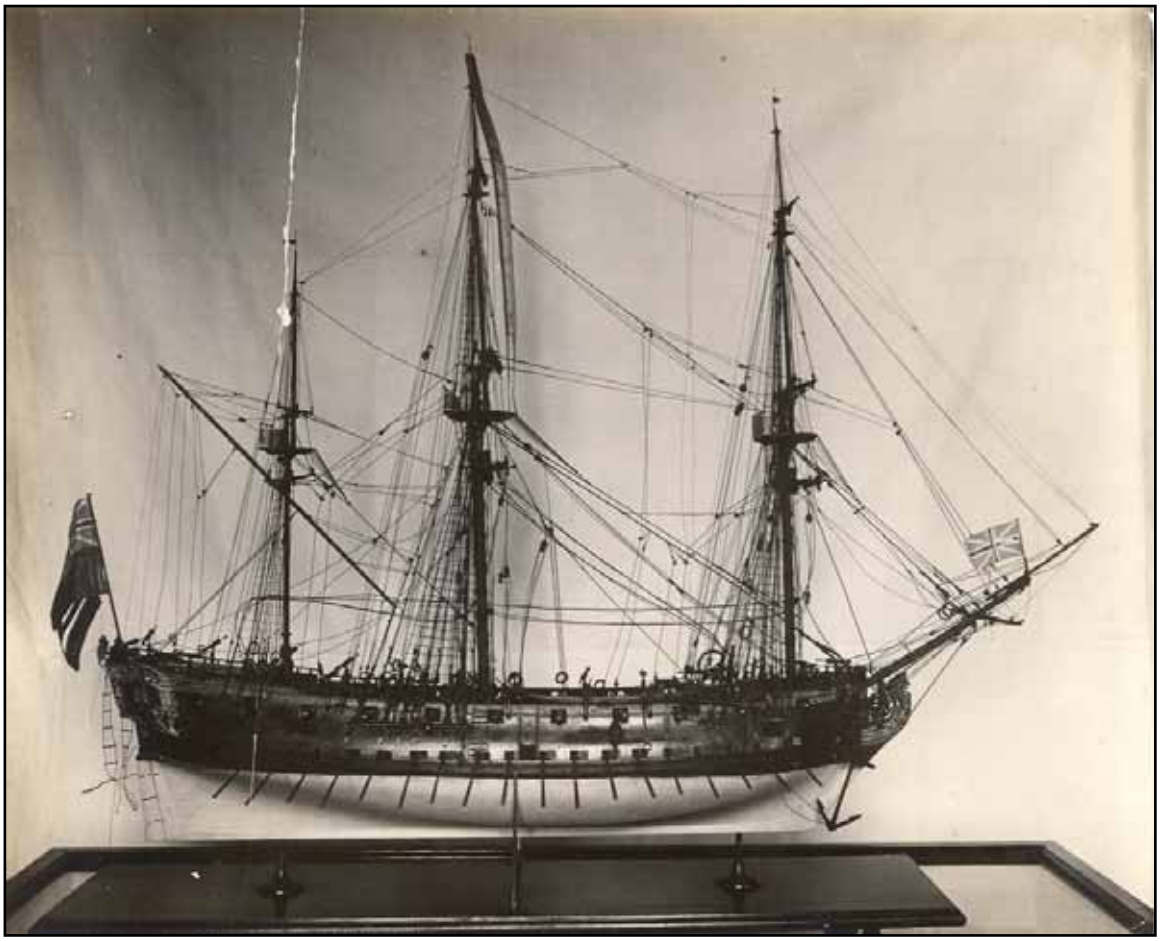

Fig 6 Model of the Blandford c1720 (Courtesy of Maidstone Museum and Bentlif Art Gallery

In 1697 Peregrine Osborne, the marquis of Carmarthen persuaded William III to allow him to design the *Peregrine* Galley, named after himself and launched at Chatham in 1700. The *Peregrine* Galley was a small 190 ton frigate, *c*86 feet long by 22 feet wide, armed with 20 small calibre cannon and 12 swivel guns (Sixth Rate). The *Peregrine* Galley was exceptionally successful; she had an interesting bell-shaped keel, which would have offered greater resistance to lateral movement and thus counter any tendency to drift down-wind. The hull lines were to be the basis for warship design for much of the next two centuries (Dalton 2002, 60). Although designed for the navy she was often used as a yacht (Fig 10) and in 1716 she was converted to become the royal yacht *Carolina* (Bellabarba and Osculti 1989, 207).

The *Bedford* Galley was purchased from a Mr Taylor for the Royal Navy after her completion in the same year, but had probably been built for the navy from the start (Lyon 1993, 27).

The shipbuilding fashions of the later Stuart period continued into the reign of Queen Anne, although curtailed by the Establishment of 1703 (Clowes and Trew 1937, 105) and on 5 August 1704 it was recorded that 'Three new gallies are building at Woolwich and Blackwell, each to have 40 oars to row in the calm' and on 9th November of the same year 'sixteen Gallies are ordered to be forthwith built, each to carry 16 oars, to be made use of in the Mediterranean, if occasion requires' (in 'CF' 1921, 122).

The *Royal Anne* Galley was one of a group of naval galley frigates built in 1709 which included the *Dursley* Galley, also designed by the Marquis of Carmarthen, and the *Diligence* Galley. The *Diligence*, a merchant galley of similar design to the *Royal Anne*, was bought from a Mr Johnson, who was probably her builder, on 23 May 1709 and sold again in 1712 (Lyon 1993, 197). Lyon records that the *Dursley* Galley was launched on13 February 1719, although it is not clear if she was in fact a rebuild of an unnamed galley frigate built in 1709 (Lyon 1993, 36, 37).

Some of the late 17th and early 18th century galley frigates continued in use until at least the 1740s. In 1720-1 the *Bedfor*d Galley is listed as fireship in Sir John Norris' Baltic squadron (Lediard 1734, 887, 889). The *Dursley* Galley won an engagement with a Spanish Ship in 1728 (Clowes 1898, 263) and along with the *Mary* Galley is recorded in the Navy List for 1735 ('CF' 1921, 122). She was either broken up or sold in 1745, probably the latter as there is a note that she became a privateer after the sale and was taken by the French on 8 May 1746 (Lyon 1993, 37). The *Mary* Galley was rebuilt several times, she was broken up in 1743 and used as a breakwater in 1764 (Lyon 1993, 13). The *Charles* Galley was rebuilt as the *Torrington* and was still in sea-pay in 1734 (Lediard 1734, iv). The *Peregrine* Galley, having been refitted as a yacht in 1716, was rebuilt and renamed *Royal Caroline* in 1733. In 1749 she was converted to a sloop and re-named *Peregrine* Sloop, being lost with all hands in the Bay of Biscay in 1764 (Lyon 1993, 13).

By 1712 a similar type of vessel carrying 32 guns was introduced, although these no longer seem to be described as galleys. The distinction of the term 'galley' as part of a ship's name seems to have been that a galley was specifically designed to row as efficiently as she could sail. The new Fifth Rates carried twenty 6-pounders on their upper, or main, deck and eight 9-pounders on their lower deck, the remaining space on the lower deck was used for 18 sweeps on either side which may have been used simply for manoeuvring or if the ship was becalmed.

In 1719 a class of 20-gun Sixth Rates was introduced, their design based on the Fifth Rates. Although these were very similar their armament was on the upper deck only; on the lower

deck were 18 sweep ports and a single ballast port. Figure 6 shows a model of one of these vessels, the *Blandford*. Between 1719 and 1727 twenty-one of these vessels were built, proving their success. Other vessels were built to similar designs in later years, including the *Dolphin*, a 20-gun sloop built in 1731 and a class of 24-gun ships built after 1741 which carried some guns on the lower deck. During the later 18th century the number of vessels carrying sweeps decreased. From 1750 the gundeck was lowered to give more cover for those manning the guns, the berthing deck then became too low so the sweep ports were moved to the upper deck and placed between the gunports, this remained the general fashion until the disappearance of sweeps in the mid-19th century (Goodwin 1987, 191-2).

Note: The abbreviation HMS to indicate a ship in the Royal Navy came into use from about 1790. The custom before this date was to use the form 'His Maties Ship (Kemp 1988). Regarding the *Royal Anne*, the spelling of *Anne* and Galley varies in contemporary documents. Lediard (1734) refers to galley frigates as *Royal Anne*-Gally, *Charles*-Gally etc, and other ships are described as *Carolina*-Yacht, *Ann*-Sloop etc.

6.1.2 Gwyn's Book of Ships

A manuscript book of ship's drawings drawn and coloured by Edward Gwyn, coach herald painter of London, possibly dating to 1769-80 contains an image of an oared frigate of a later period than the *Royal Anne* (Fig 7). This shows some interesting detail, which although unusual is considered likely to be accurate; Gwyn's boat carries 32 guns, two of them bow-chasers, and pulls 28 oars. The gun ports seem to have been closed by port lids hinged on the after side and opening aft, painted red on their inner side. The oars too are painted red. The lower part of the hull is painted black and the upper part French grey. The ship has a female figurehead with a spear in her right hand and a shield with a cross on her left. The big stern lantern is conspicuous. She carries a spritsail and a topsail, her spanker has no boom, and the mizzen topsail and topgallant braces lead to the peak. The ensign is red but the pennant is blue and white at the hoist with two long trails, red and white (Dingley 1921, 46-52).

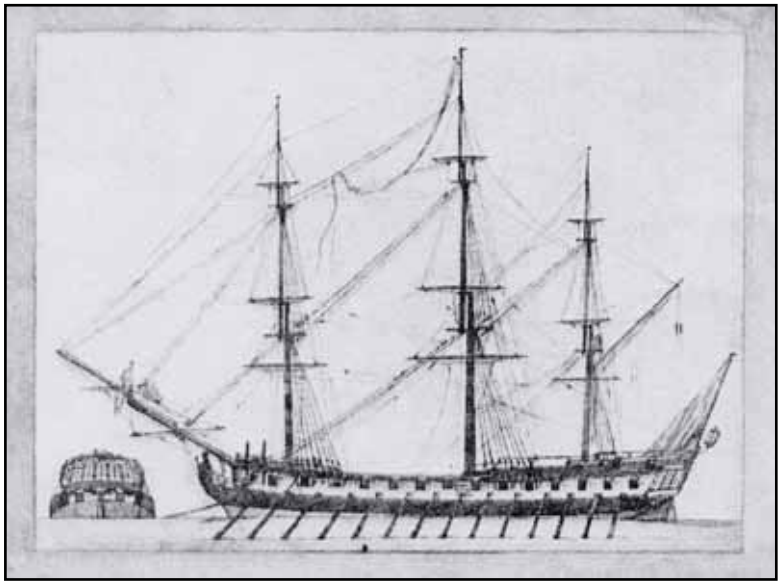

Fig 7 An 18th century oared frigate from 'Gwyn's Book of Ships' c1769 (reproduced with kind permission of the Honorary Editor of the 'Mariner's Mirror')

Name	**Date built (b) / referred to (r)**	**Dockyard**	**Surveyor**	**Ordnance**	**Last recorded**
Charles Galley	1676 (b)	Woolwich	Phineas Pett	32/28	Rebuilt 1693. In service 1717. Renamed the *Torrington* and in sea-pay in 1734
James Galley	1676 (b)	Blackwall	Anthony Deane Jnr	30	Wrecked on Longsand Head in1694
Mary Galley	1687 (b)	Rotherhithe	John Deane	40	Rebuilt 1708. Navy list 1735, broken up 1743, breakwater 1764
Bridget Galley	1693 (r)				PRP ADM 106/486/9
Slaughter Galley	1696 (r)				PRO ADM 106/482/302
St George Galley	1696 (r)				PRO ADM 106/487/373)
King William Galley	1696 (r)				PRO106/482/336)
Carmarthen Galley	1696 (b)				PRO ADM 106/482/125 & 209
Peregrine Galley	1697 (b)	Sheerness Dockyard	Lee	32	Converted to Royal yacht *Carolina* in1716
Rye Galley	1697 (b)	Sheerness Dockyard	-	32/28	1720, with Sir John Norris' squadron in the Baltic (Lediard 1734, 883)
Bedford Galley	1697 (b)	Holland, New England	Bagwell	32/28	Broken up 1709? Fireship in 1720/1 (Lediard 1734, 887-9)
Milford Galley	1702 (r)				PRO ADM 11/465)
Dursley Galley	1709 (b?) Rebuilt 1719?	Deptford	Stacey	20	Navy List 1735, sold or broken up in 1745
Galley frigate (unnamed)	1709 (b)			40/42	In Lyon 1993, 36
Galley frigate (unnamed)	1709 (b)				In Lyon 1883, 37
Diligence Galley	1709 (b)	Deptford	Stacey	?	Sold in 1712
Royal Anne Galley	1709 (b)	Woolwich	Stacey	42	Wrecked 1721
Earl Galley	1702 (b)	?	?	?	Presented to the Crown by the

Name	Date built (b)/referred to (r)	Dockyard	Surveyor	Ordnance	Last recorded
					Governor of Jamaica, sold in 1705
Stringer Galley	1713 (r)				POOB 5/42
Province Galley	?	?	?	?	Lediard 1734, 848
Pearl Galley?	1723				SP 89/30/
George Galley	1724(r)	?	?	?	Mutiny (Rediker 2004, 53, 70)
Genoa Galley	1742 (r)				PRO ADM 354/120/87
Conqueror Galley	1750 (r)				PRO ADM 106/0080/327, lost 1750
Comet Galley	1780-2 (r)				PRO ADM 34/210

Fig 8 List of galley frigates

6.1.3 Late 17th century and early 18th century merchant and pirate galleys

In addition to the naval galley frigates, galleys were popular during this period with merchants, privateers and pirates. On 14 October 1691 it was noted; 'Several persons are going to build privateers to carry from 18 to 40 guns after the galley fashion with oares and hope to have an act passed at next sessions encouraging the same' (Luttrell in 'CF' 1921, 122).

Typical of these galleys was Captain Kidd's *Adventure* Galley, described as '287 tons, with 34 guns and 154 crew', she was launched at Castle's Yard in Deptford in December 1695 but lasted only three years before being burnt in the Indian Ocean in November 1698 ('CF' 1921, 122; Baer 2005, 121-7).

The *Whydah* Galley, launched in 1715, was built for the slave trade and capable of a speed of 13 knots under sail. On her second voyage in February 1717 she was seized by pirates led by 'Black Sam' Bellamy and sank in a storm off Massachusetts in April of that year www.nationalgeographic.com/whydah/story.html

Trading galleys were described in detail in a rejoinder to a committee of the House of Lords which had been set up in 1707 to report on a petition by 154 London Merchants complaining of inadequate protection afforded by the Admiralty to overseas trade, during the recent French privateering war. The Lord High Admiral had first expressed his concern that 1,146 ships were said to have been lost in the war 'although it is possible that the greater part of that number consists of galleys and runners'. In their rejoinder the merchants had explained the difference between galleys and runners (ships proceeding across the high seas independent of convoys and at their own risk). In a galley speed was the dominating factor of the design to the sacrifice of cargo capacity. The galley is 'broad and sharp and carries twice the breadth in sail of common ships that usually sail with convoy, and is double the charge in number of seamen. Galleys are generally 'Act' ships and are free of the Custom House (that is, are of force from 16 to 40 guns) which are fitted and proposed to sail without convoy and carry no more goods than is necessary to sailing –

not heavy loaden to impede their sailing, as is pretended in the [Admiralty] answer, but will sail four times faster than your common sailing ships of the old-fashioned building…With such nimble galleys has the trade been carried to the great advantage of the Kingdom and increase of the Customs during the late war as well as in this war, until lately, when there have not been either cruisers or men-of-war to guard the coast of England in proper stations – with the result that it is now almost a miracle for a trading vessel to escape the enemy in British Seas' (in Corbett 1921, 133-4).

6.2 *Royal Anne* Galley – the ship

6.2.1 The Marquis of Carmarthen

As mentioned above, the *Royal Anne* Galley was designed by Peregrine Osborne, marquis of Carmarthen (1659-1729). The younger son of the first duke of Leeds, Osborne was known by a succession of titles as his life progressed: Viscount Dumblane from 1674-89, earl of Danby from 1689-94, marquis of Carmarthen from 1694; on his father's death in 1712 he became the second duke of Leeds (Matthew and Harrison (eds) 2004, vol 42, 18-19).

Fig 9 The Marquis of Carmarthen (after Petitot, from Walpole 1806)

Carmarthen's naval career developed from a series of gallant exploits and his hobby of designing yachts. In 1690 he became colonel of the first ever regiment of marines, in 1693 he was promoted to rear admiral of the red, the rear admiral of the blue the following year; his naval career culminated in his appointment as admiral of the red in 1708 (*ibid*).

He had designed the *Peregrine* Galley in 1697 and also a yacht, the *Royal Transport*, which was given as a present by William III to Peter the Great, Czar of Russia in the autumn of that year. She was of an unusual design, a heavily armed yacht, said to be the fastest built in

Fig 10 The Peregrine and Other Royal Yachts off Greenwich c1710 by Jan Griffier the Elder (© National Maritime Museum)

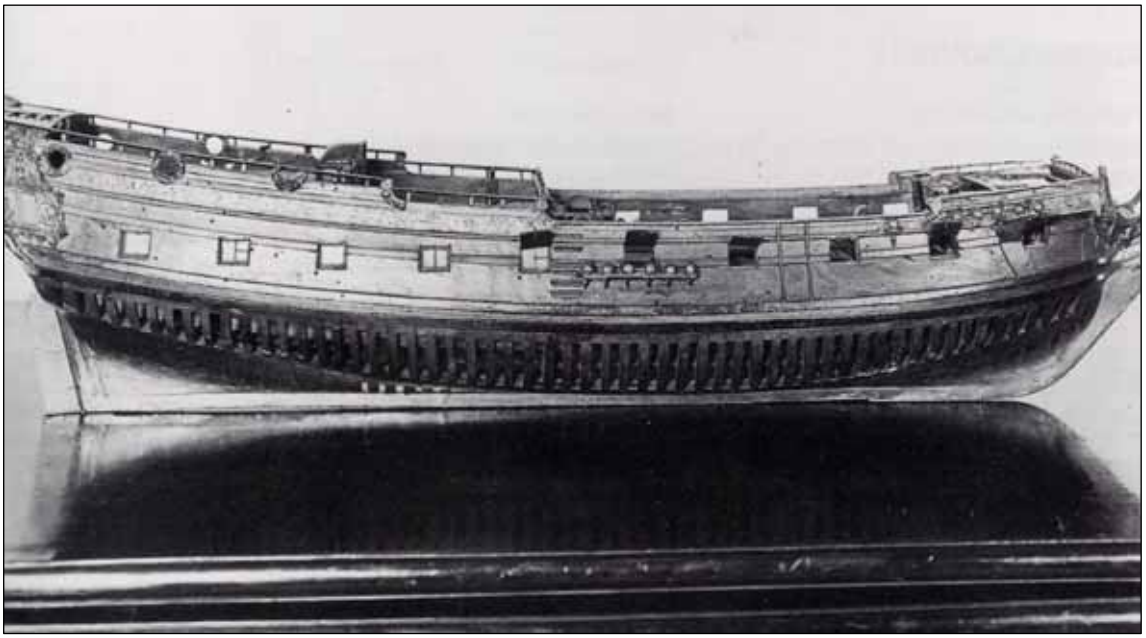

Fig 11 Model of the Peregrine Galley *(© National Maritime Museum)*

England up to that date and the 'best sailer' in the fleet (Ryan 1983, 65-88; Bellabarba and Osculti 1989, 207). Carmarthen had become the boon friend and drinking companion of the tsar and he was responsible to a large extent for the success of Anglo-Russian trade negotiations at the time (Dalton 2002, 59).

Carmarthen was certainly paid by the Admiralty for '*his attendance in giving Directions, &c relating to the building of the Royal Anne Gally*' (PRO ADM 3/24). This would explain why Carmarthen, a marquis and an admiral in the Royal Navy, was appointed as the Captain of a lowly fifth rate. Upon accepting the commission as her first captain (Robert Trevor was the second captain) he replied to the Admiralty, '*I shall submit to take commission as first captain of the Royal Anne Gally; On condition it may be entered in the Admiralty Office, that the said commission is given only for me to make trial of the said gally, and that it shall be in no ways prejudicial to me either in regard to my pay, or my rights of post in the navy*' (PRO ADM 1/577).

6.2.2 Building and launch

The *Royal Anne* Galley was built at Woolwich Royal Dockyard; the surveyor, or supervisor of construction, was Richard Stacey, the Master Shipwright at the dockyard.

Her launch was recorded in The London Journal… '*Tuesday* [30th June 1709] *was launched at Woolwich the Royal Anne* Galley*, of a new invention under the direction of the Marquis of Carmarthen, carrying 40 guns, being the finest that was ever built*' (in 'CF' 1921, 122).

She was a fifth rate with an armament of 42 guns and crew of 247, weighing 511 tons; the length of the gun deck was 127 feet, the length of the keel 100 feet, beam 31 feet and the depth of the hold 13 feet (builder's measurement).

It should be noted that there was another ship of the same period named the *Royal Anne*; a first rate carrying 100 guns she was a rebuild of the *St Andrew* in 1704, possibly to a design by the Marquis of Carmarthen. Carmarthen was appointed Admiral of the Red in 1708 and in 1710, somewhat confusingly, the *Royal Anne* was his flagship (Ryan 1983, 79). There was also a naval sloop, named *Anne*-Sloop, recorded in 1708 (Lediard 1734, 635).

6.2.3 Sea trials

Carmarthen was ready to start sea trials with the *Royal Anne* on 24th July 1710 (PRO ADM 1/577). At the time of her trials she could be rowed with 66 oars and was allowed 60 men over her establishment on this account. She also had on board 48 guns of bronze and iron (PRO ADM 1/577). There is some indication that these extra guns were only carried during the trials, '*I do not desire such an Officer any longer than during the Time the Eight Supanumerary Guns, and Sixty men (over and above the establishment) are Born upon Her; which were only allow'd Her 'till She has been Try'd; by reason that no true trial of Her Rowing and benfitt of Her additional force could be made without them*' (PRO ADM 1/577). However the Pay List for the *Royal Anne* at the time shows that exception may have become permanent (PRO ADM 33/271).

6.2.4 Service

By October 1710 the *Royal Anne* was on convoy duty off Norway, safeguarding the Russia trade (ADM 51/791; ADM 2/42), and again on convoy duty between Yarmouth and Norway in August 1711 ((ADM 2/44). In July 1711 she was at Portsmouth refitting for Channel service (ADM 2/43).

Between April 1712 and August 1713, towards the end of the War of the Spanish Succession, she was stationed with Vice Admiral Baker's squadron off the coast of Portugal and in the Western Mediterranean (ADM 51/791).

In November 1712 she received orders to protect vessels against the Rovers of Sallee, pirates operating from the port of Salé, Morocco and similar to the Barbary corsairs (ADM 2/46). In September 1713 she was ordered to deliver presents from Queen Anne to the Emperor of Morocco and then to consult with the Governor of Gibraltar about bringing troops home to Great Britain (ADM 2/46)

From July 1714 and July 1715 she appears to have been laid up, perhaps at Portsmouth. There are no logs or orders for this period and no listed captain between November 1714 and July 1715. An order of 23 March 1715 reduced the ship's compliment to the lowest possible (ADM 2/246); her condition at this time was said to be not good (ADM 7/550A).

On 26 July 1715 a new captain, James Stewart (or Stuart) was appointed to the ***Royal Anne*** (ADM 7/655) and between September of that year and March 1716 she was at sea off Scotland during the first Jacobite rebellion (ADM 51/791).

In January 1716, she was one of a squadron of ten ships under the command of Sir John Jennings, Admiral of the White, appointed to cruise on the east coast of Scotland and the Firth of Forth for suppression of the rebels (other ships cruised on the west coast for a similar purpose while others were kept in the Channel to blockade sympathetic Frenchmen). A body of French officers, trying to escape from Peterhead, was driven back, but the Pretender, James Stuart, contrived to get away safely. There were some imputations of negligence upon the Navy, but the Government was satisfied that sufficient diligence had been shown and the following was published in the [London?] Gazette:

> 'The ***Royal Anne***, galley, ***Pearl***, ***Port Mahon***, ***Deal Castle*** and ***Phoenix*** are returned from cruising, it appears by the journal of Captain [Charles] Stuart [of the ***Alborough***h], that he had early intelligence of the Pretender having put to sea, in a clean-tallowed
>
> French snow, which rowed out of the harbour and close in along shore a good way with her sails furled. The ***Port Mahon*** lay all night within two leagues of the harbour's mouth, but 'twas so dark there was no seeing a ship a quarter of a mile distant' (Lediard in Clowes 1898, 257).

In June 1716 she was on convoy duty, escorting 46 vessels bound for the Baltic (ADM 51/791).

In July 1716 the ***Royal Anne*** was part of a flotilla accompanying King George I to Holland:

> 'The 11th July His Majesty embarked at Gravesend on board the ***Carolina***-Yacht for Holland on his way to Hanover and …arrived the 15th at the Capital of his German Dominions' (Lediard 1734, 868).
>
> 'This yacht was accompanied by several others, with his Majesty's Retinue, and attended by the ***Monk***, York, ***Royal Anne***-Gally, ***Launceston*** and ***Alliance*** under command of Admiral Aylmer' (***ibid***, 868 footnote (n)).

Between August and October 1716 she was on convoy duty once again, in the North Sea, protecting the Archangel Trade (ADM 249; ADM 51/791), in November she was refitted at Sheerness and in December 1716 and January 1717 was once more on convoy duty escorting between Britain and Holland (ADM 2/29; ADM 51/791).

The King remained on the Continent until 17 January 1717 when he embarked at Helvoetsluys for England. The escorting squadron and yachts were under the command of Admiral Aylmer, who despatched the ***Royal Anne*** Galley 'to best make her way to Margate,

or any other part of Great Britain, which she could soonest reach'. On arrival she was to despatch a message to His Royal Highness that His Majesty was on passage, and if the wind stayed fair 'tis judged His Majesty will be at Margate in six or seven hours time' (in Dalton 2002, 72).

Between February and April 1717 she was sailing off Norway, collecting evidence on the activities of the Swedes, who had supported the Jacobite rebellion (ADM 2.49; ADM 51/791). In March 1717, during the Great Northern War, a ship recorded as the ***Royal Anna***, of 40 guns, was reported as sailing to Norway with four other ships, ***Roebuck*** (40), ***Charles*** Galley (40), ***Kinsale*** (36), ***Deal Castle*** (24) under the command of Admiral Byng (in Anderson 1910, 177). The Sailing Navy list does not record any ship named the ***Royal Anna*** (Lyon 1993), and considering the vagaries of early 18th century spelling and nomenclature it is possible that this refers to the ***Royal Anne*** Galley although the ***Charles*** Galley is referred to by its correct name in the list.

In May 1717 she was sent to Chatham for a refit and in June received orders to cruise between England and Holland, calling at Yarmouth. In July she was sent to Sheerness for a refit, ordered to be laid-up and her crew paid off (ADM 2/49; ADM 51/791).

Between July 1717 and August 1719 the ***Royal Anne*** was laid-up at Sheerness, there are no logs or orders for this period and no captain was listed between the dismissal of Captain Stewart on 8 August 1717 and August 1719 (ADM 7/655).

6.3 The last voyage

6.3.1 Her mission

The Golden Age of Atlantic piracy lasted for only a decade, from 1716 to 1726, reaching a peak in the first part of this period and declining thereafter as retributive measures increased (Rediker 2004). From early 1719 the damage caused by pirates to the slave trade worsened; more than 500 pirates were reported to be sailing in squadrons off the West Coast of Africa under their various captains, taking 34 ships between April and August, several of which they burned (***ibid***, 141). As a result of petitions and use of political influence by merchants and slave traders, men-of-war were despatched to Africa from 1719 to protect the slave trade against the 'terrour of the pirates' (***ibid*** 142).

The ***Royal Anne*** was one of these men-of war. Having been laid up at Sheerness for two years a new captain, Captain Willis, was appointed to her command on 21 August 1719. Officers and men from the ***Deal Castle*** were transferred to her; she was cleaned and 'graved with white stuff' fitted out for Channel service and provisioned for four months. In September she was ordered onto full rations and in November of that year she was ordered to proceed to Guinea, Cape Verde and Africa with the ***Lynn*** with rations for eight months; both ships were to hunt pirates (ADM 2/250; ADM 51/4315).

In February 1720 Captain John Dagges wrote; 'I was informed att Barbados that the Pirates had taken upon the Coast of Guinea 38 Saile of Ships' (***ibid***, 141). In the early months of that year Humphrey Morice, a London based slave trader drafted two petitions to King George, one on behalf of 'Planters Merchants &c Traders concerned in the West Indies', warning that 'pirates are so encreased in number that they are become dangerous to you Majesties plantations as well as destructive to the navigation of the West Indies'. The other 'The Memoriall of the Merchants of London Trading to Africa humbly Offered to the Rt Hon,ble The Lords Commissioners for Executing the Office of Lord High Admirall of Great Brittaine &c.,' warned that pirates might 'do as much mischeife as others did the last year'. In both petitions he argued for naval force and using political

connections was able to dispatch ships to the African coast to protect the slave trade. In February 1721 a new bill for the suppression of piracy was passed in Parliament.

The *Royal Anne* Galley was anchored at Spithead when Captain Willis received orders on 12 September 1721 to sail to Barbados with Lord Belhaven, the new governor; then to sail on to the Leeward Isles and Jamaica to hunt pirates. Then home via Carolina and Newfoundland, again hunting pirates. He was to be home by the late summer of 1722 (ADM 2/50). The voyage appears to have had an unlucky start with the Royal Anne running aground on South Break Head on the Downs and then colliding with the Virginian ship *Spolswood* (ADM106/743).

6.3.2 Armament

The London Journal of 18 November 1721 states that the *Royal Anne* was equipped with 41 guns at the time of her loss. No records have been located to indicate that she ever carried guns smaller than 6pdrs, although the 1703 Gun Establishment confirms that some fifth rate warships carried 4pdrs (Howard 1979).

6.3.3 Crew

Her Pay list at the time of loss shows a crew 185 men aboard (PRO ADM/33/271).

6.3.4 Passengers

The principal passenger was Douglas John Hamilton of Biel, 3rd Lord (Baron?) Belhaven and Stenton (Fig 12) who was en voyage to take up the Governorship of Barbados, apparently to avoid the scandal of having murdered his wife (Fenwick and Gale 1999, 91).

Fig 12 John 3rd Lord Belhaven, portrait attributed to William Aikman (in a private Scottish collection)

Lord Belhaven was the eldest son of John Hamilton, 2nd Lord Belhaven and Stenton (1656-1708), noted for his parliamentary speech opposing the act of Union in November 1706 and his involvement in the Darien disaster. Born in 1692, he became the 3rd lord at the age of sixteen on his father's death in 1708. In the same year he was appointed as one of the

sixteen representative Scottish peers in the English House of Lords, in which position he continued until his death. He was appointed a Gentleman of the Bedchamber in 1714. During the first Jacobite rebellion he fought on the English side at the battle of Sheriffmuir in November 1715, commanding the East Lothian troop of horse. He married Anne Bruce, daughter of Andrew Bruce, an Edinburgh merchant, by whom he had three children. He was succeeded by his son John (died 1764).

The London Journal of 25 November 1721 states that as well as Lord Belhaven there were 'about twenty-four other gentlemen' on the *Royal Anne*. The total number of passengers is unclear. The Daily Post of 27 November 1721 states that 'it is believed that about 300 persons lost their Lives by this unfortunate accident'. The London Journal mentions that 'Lord Belhaven's luggage, and the chief part of his servants, were gone to Barbados about two months ago; (25.11.1721).

Fig 13 View from Old Lizard Head, looking approximately south-east (© CCC)

6.3.5 Circumstances of loss

The *Royal Anne* was wrecked on the Stags off Lizard Point on 10 November 1721. 'Two hundred and seven members of the crew drowned in addition to her captain, all the lieutenants, twenty-four gentlemen and Lord Belhaven. Most of the bodies are believed to be buried in a cliff-top grave at Pistol Meadow (Larn and Carter 1969, 109). It is not at present known if Lord Belhaven's body was been taken home for burial.

The passage around the Lizard Point is renowned for being difficult to navigate, with over 200 recorded wrecks in the area. There had briefly been a lighthouse, built by Sir John Killigrew in 1619 (possibly at Rill Point rather than Lizard Point – see Johns 1848, 111-2)

but 'by late 1624 or early 1625 the light was extinguished, the tower demolished and the patent withdrawn', the present lighthouse not being built until 1751 (Dobson 1996, 70-2).

The London Journal of 25th November 1721 states that she was sailing "the course but 11 leagues [33 or 34.98 nautical miles, depending upon the convention used] beyond the Lizard; whereas it seems the correct practice is 18 or 20 leagues, and a strong gale coming at [from the] South West, drove the ship into the Bay, upon the stagg rocks, so that she was staved to pieces. They write from Cornwall that upon the 1st notice of this misfortune the people on the sea coast ran out of the churches in quest of plunder". 'The Stags' is the name currently given to a group of rocks to the south-west of the wreck of the ***Royal Anne***.

There is some divergence of opinion with regard to exactly where the vessel struck, with Larn and Larn (1997) citing Taylor's Rock, which is slightly to the east. For the purpose of this discussion The Stags has been accepted as a likely striking point. The Daily Post of 27 November 1721 states that there were two impacts and that the vessel broke up after the second.

6.3.6 Survivors

There were only three survivors (Fenwick and Gale 1999, 91), said to be local men. A contemporary article records that the three were Thomas Goodall, William James and Robert Wilson, who arrived in London on Saturday 25 November to be examined at the Board of Admiralty (The Daily Post, 17.11.1721).

According to Hart (1996, 79), a ballad written about the tragedy gives their names as Thomas Lawrence, a boy, George Hain and William Godfrey, although the source is not referenced.

6.3.7 Contemporary accounts of loss

…Captain Willis cry'd, 'Brave sailors, do your best, or die we must:

Lord have mercy! New relieve us! In Thy Providence we trust;

Save us in the time of danger, for death before our eyes appear!'

And when they found all hopes were over, in tears they all fell down to Prayer.

Then against the fatal rock the Royal Galley split in twain,

Two hundred souls aloud were crying, 'Lord, save us from the wat'ry main!'

To see each for his life a-shifting, as the waves tost mountains high,

The Galley in the deep a sinking, while dying groans did pierce the sky…

From '*The Unhappy Voyage*'

To the tune of *Women's Work is Never Done*

It was said that Lord Belhaven was asleep in his cabin, as were the three survivors and many others in their hammocks, when the ship first struck upon the rock. They were awakened by the shock of the impact and a 'dismal Cry above Deck', all hands were at work in their shirts to get her off the rock, but the second shock, which happened some minutes after the first, dashed her to pieces. The three survivors were saved by clinging to pieces of wreckage; Robert Wilson was on a plank with four others who were washed off by the waves, but he saved himself by swimming to a rock where he stayed until the next morning (The Daily Post, 17.11.1721).

6.4 The aftermath

6.4.1 Burial

Until the 1808 Act of Parliament decreed that bodies washed ashore from shipwrecks should be interred in consecrated ground after being afforded the rites of Christian burial, such bodies were buried, if at all, in unconsecrated ground as near as possible to the place of discovery.

Nineteenth century writers (see below Appendix 13.4) record that the local inhabitants buried the two hundred bodies from the *Royal Anne* shipwreck in pits in Pistol Meadow, just above the nearest cove to the shipwreck (NGR SW 69854 11623). Each pit is said to have contained between ten and thirty individuals; until the 1850s, at least, the location of the pits was revealed by low irregular mounds chequering the surface of the field (Collins 1851, 69-70).

The 1842 Tithe Award Apportionment for the parish of Landewednack records this field as *Pistole Furze Garden* (TA no 616) and *Pistole Meadow* (TA no 617).

6.4.2 Salvage

A few weeks later two ships, the *Jolly Bachelor* and the *Henrietta* were noted as going down to the Lizard with a newly invented diving engine to 'fish' upon the wreck of the *Royal Anne*, the results of this venture are not known (Larn and Carter 1969, 109).

Admiralty minutes dated 15 November 1721 order Captain Rowley of the Lively from Plymouth to '*proceed immediately off the Lizard and endaver to save what he can of the wreck of the Royal Anne Gally*' (PRO ADM 3/33).

Later, on 3 August 1722 £103.13s.6d was paid to 12 (named) individuals for the salvage of stores from the *Royal Anne* and the *Plymouth Transport* to be sent to collect five anchors '*taken from the Royal Ann Gally*' (PRO ADM 106/748) On 10 August the *Plymouth Transport* sailed for the Lizard to '*bring away the Royal Ann Gally's anchors*' (*ibid*).

There is also a letter from three local fishermen claiming salvage for 21 guns and 26cwt anchor (the anchor apparently found lying on top of the guns) recovered from the wreck of the *Royal Anne*. These were apparently '*lodged…on Port Pears* [Polpeor] *in the S^d parish of Landewednack*' (PRO ADM 106/754.

Twenty iron guns from the *Royal Anne* were delivered to Flushing Quay (PRO WO 47/20B).

On 26 August 1722 it was reported that Captain Rowe's invention for fishing on wrecks recovered 1.5 tons of cables from the *Royal Anne* (PRO ADM 106/752).

This suggests that considerable salvage activity followed the wreck and may well account for only two cannon remaining on the site. It also suggests that much of the fabric of the ship may have been broken up by the 'fishing' on the wreck, an activity which probably involved much use of grapnels and other such devices. It also seems likely that much from the wreck was recovered for local use and never offered for salvage, especially in view of the numerous letters of the time wrangling over the price paid for salvaged material.

It seems that by the early 18th century the Polpeor area had become 'a recognised testing ground for new diving apparatus' following the recovery of 'impressive' quantities of treasure from two 16th century wrecks; a Spanish ship lost in 1619 and Genoese one lost in 1667 (Larn and Carter 1969, 109).

6.4.3 Local lore

Local legend, still current, has it that the bodies of those drowned in the wreck were buried in large grave pits in the valley at Pistol Meadow, above the nearest beach to the scene of the wreck and that 'Pistol' is haunted by their ghosts. The cliffs above the beach are, perhaps, 30 – 40 feet high and today the beach is reached by steep, slippery rock-cut steps leading down from 'Pistol'.

Fig 14 Pistol Meadow (© CCC)

The story was first recounted by the Rev[d] CA Johns in 'A Week at the Lizard', first published in 1848; essentially over a century before a transport ship 'having on board the governor of some distant colony, with his suite and 700 men, was driven on a group of rocks, still called from the incident the Man-of-War Rocks, and dashed to pieces'. According to this account there were only two survivors who had local knowledge and remonstrated with the captain for sailing too close to the dangerous headland and were clapped in irons for their trouble (a similar tale is attached to the wreck of Sir Cloudesley Shovell's fleet off Scilly in 1707). Two hundred bodies were washed ashore and buried in pits in Pistol Meadow. Horrifically a great number of dogs appeared and began to eat the dead bodies and consequently these animals were greatly detested in the parish because of this. As recently as *c*1820 local fishermen said they could even then see pieces of cannon lying on the seabed where the ship went to pieces and many people were still afraid to pass through Pistol Meadow after dark' (Johns 1848, 73-4).

The story was subsequently retold by other mid-19[th] century visitors to the Lizard, with additional detail or variations (Collins 1851, White 1855, Craik 1883) and later by Daphne du Maurier (1967). Relevant extracts from these sources are given in Appendix 13.4.

6.5 Discussion of documentary and pictorial sources

By Charlie Johns

6.5.1 Documentary sources

The history of the ***Royal Anne*** Galley is very well documented in primary sources held at the PRO (see Appendix 13.5) but is less well represented in secondary sources; two references in Lediard (1734, 868 footnotes (m) and (n)) and one in Clowes (1898, 257), one in Dalton (2002, 72), an entry in 'The Sailing Navy List' (Lyon 1993, 36), an entry in the 'Shipwreck Index of the British Isles' (Larn and Larn 1997) and also in 'Historic Shipwrecks Discovered, Protected and Investigated' (Fenwick and Gale 1999, 90-91) Of the galley frigates, the ***Charles*** Galley and the ***Peregrine*** Galley are the best represented in secondary sources.

Fenwick and Gale state that 'There were only six galleys classified as such in the Royal Navy' (1999, 91) while the ADU report 98/09 mentions that 'The type appeared in the 1670s but only a few were built and it appears that the ***Royal Anne*** was the last in service' (in Wessex Archaeology 2005a, 3 ; 2005b 15). Research for this project has identified 22 Royal Navy galleys dating to the late 17th century or early 18th century (Fig 8), some of which were still in service in the mid-18th century. The last naval ship to be specifically described as a galley may have been the ***Comet*** galley in 1780-2 (PRO ADM 34/210).

According to Fenwick and Gale, members of the University of Bristol Sub Aqua Club thought that they had found the ***Royal Anne*** in 1969; their finds included eight iron guns and silver coins dating to the period 1710 to 1720 (1999, 91), although the coins are only reported from the site and their current location is unknown (J Ransley pers comm).

Similarly, Richard Larn notes that the wreck site was located in 1969 and identified by a possible broad arrow mark on one of the eight iron cannon, silver coins of 1710-20 and marks on pewter items. A survey was undertaken by himself and the University Sub Aqua Club, who hold copies of the work carried out and artefact recoveries (Larn and Larn 1997).

Wessex Archaeology conclude that, although it was not known when the site was originally located, the available documentation indicates that the bulk of the recorded fieldwork by the University of Bristol actually took place in 1973, although variously given as 1975/6. Site plans were produced and the site partially excavated. The results of the fieldwork were not published but the limited archive has survived in private hands. It is not known to what extent the excavations were recorded, other than by marking their approximate position of the excavated area on the site plan (Wessex Archaeology 2005b, 2-3).

There is some confusion in secondary sources regarding the marquis of Carmarthen. The Wessex Archaeology assessments of the ***Royal Anne*** and Quadrant Rock undesignated site refer to Lord Dursley, Marquis of Carmarthen as reputed designer of the ***Royal Anne*** (Wessex Archaeology 2005a, 5 and 2005b, 15). In fact, Lord Dursley (1680-1736) was a contemporary of the marquis of Carmarthen, also a naval officer and later also an admiral, who became the 3rd earl of Berkeley (Mathew and Harrison (eds) 2004, vol 5, 379). The confusion seems to have arisen because of references in Lyon's 'Sailing Navy Lists' where he refers to galley frigates built by Lord Carmarthen, Lord Dursley (1993 36, 37). Conflation of the two may have arisen because of the ***Dursley*** Galley, designed by the marquis of Carmarthen, who was formerly the earl of Danby. Similarly Lyon refers to the yacht Royal ***Transport*** being built by Peregrine Butler, earl of Denbeigh (1993, 29), when it was of course Peregrine Osborne, formerly earl of Danby.

Lord Belhaven remains a shadowy figure, his life is less well documented than his better known father and there is potential for further research into his life and the circumstances of his appointment as the Governor of Barbados. Unfortunately Fenwick and Gale do not give a source for their imputation that he had murdered his wife (1999, 91). An enquiry has been made to Tempus Publishing about this. We do not know at present if his body was recovered and returned home or buried with the rest of the ship's complement.

The 19th century literary sources all concur that the number of corpses washed ashore and buried in Pistol Meadow was about 200, which approximates to the number of the ship's crew and a implies that this was an approximation which must have survived in local oral tradition. Although it seems likely that many bodies from the shipwrecked *Royal Anne* were driven by the tide and washed up along the coast perhaps the weather conditions were such that night that most were brought ashore in Pistol Cove. Daphne du Maurier (1967) identified the burial found as the small, flat area edged by tamarisk trees to the east of the Pistol stream, although this seems much too small to hold 200 burials. There is no mention of the story in Esquiros' 1865 traveller's guide 'Cornwall and its Coasts' (contra Du Maurier 1967) and it may well be the Du Maurier confused this book with the Revd CA Johns' 'A Week at the Lizard' (1848).

6.5.2 Pictorial sources

To date no contemporary images of the *Royal Anne* Galley have been located but we can appreciate the appearance of the earliest group of galley frigates because the *Charles* Galley was drawn by both William Van de Velde the Elder (Fig 3) and the Younger (Fig 4). The Van de Veldes, father and son were the greatest marine artists of their age, leaving a masterly record of mid- to late 17th century ships (Winfield 1997, 8); they worked mainly from detailed drawings of ships in port which usually show ships without their rigging, since this was standard on medium and large sized ships a ship model could be used when adding it to the finished painting (Lavery and Stephens 1995, 42).

The *Charles* Galley was also drawn in *c*1688 by her Captain, Jeremy Roche (Fig 5) who depicted her with 21 oar ports as opposed to the 20 shown by the Van de Veldes.

There were few ships' plans before 1715 and there is no known existing plan of the *Royal Anne* but there are 'lines' of the *Charles* Galley (Fig 65) and a plan of the *Mary* Galley (PRO ADM 106/3070), which were built 33 and 22 years before the *Royal Anne*.

An illustration of the *Royal Anne* accompanying a Daily Telegraph article about the designation of the site dated is likely to be the 1st rate *Royal Anne* rather than the *Royal Anne* Galley (Daily Telegraph 12.11.1993).

6.6 Discovery and previous work

6.6.1 The *Royal Anne* site

The *Royal Anne* site was rediscovered on 5 May 1991 by local diver Rob Sherratt during a recreational dive; a large sounding lead was found adjacent to two iron guns. Further investigation located an area of concreted cannon balls.

Subsequently Rob Sherratt and Mike Hall spent about 15 hours (underwater time) investigating the site. In that time numerous objects were recovered from the seabed in the immediate vicinity of the iron guns, including a piece of cutlery bearing the Belhaven crest.

In 1992 Rob Sherratt wrote to the MoD requesting to either purchase the wreck or obtain salvage rights. He also wrote to the ADU explaining the situation. After initial approaches to the Royal Navy he and Mike Hall decided to apply to have the wreck protected under the Protection of Historic Shipwrecks Act 1973.

After a pre-disturbance survey a number of seasons' excavation were undertaken on the site. This resulted in the recovery of over 400 recorded artefacts.

Fig 15 Detail of the silver fork handle bearing the Belhaven crest (photo: Kevin Camidge)

6.6.2 Identification

Positive identification of the wreck as the ***Royal Anne*** Galley was made from a crest and motto appearing on three pieces of silver cutlery recovered from the site. These appear to be part of a matching set and bear hallmark dates of 1717. The crest is that of Lord Belhaven, the principal passenger on the ship, a nag's head couped argent and bridled gules; the motto is 'Ride through' (Fox-Davies 1892, 37 and plate 51.5).

Another find from the site, a pair of copper alloy dividers, are stamped with the initials 'JD', presumably the initials of the owner (Fig 16). Two men with the initials JD are entered on the Pay List for the ***Royal Anne***; they are 'Jn Davis 2nd Mar' and 'Jn Degrushy Mastr' (PRO ADM 33/271). As the sailing master John Degrushy would have owned navigation instruments and the initials on the dividers may well be his.

Fig 16 Detail of copper alloy dividers bearing the initials 'JD' (photo Kevin Camidge)

6.6.3 Designation

The Order cited as the Protection of Wrecks (Designation No 2) Order 1993 was made on 18 October 1993, was laid before Parliament on 21 October and came into force on 11 November 1993 (1993 No 2526). The site was designated under the Protection of Wrecks

Act (1973) as the *Royal Anne* in 1999. The centre of the protected area lies 154m from the Quadrant Rock undesignated site and it has long been suspected that the Quadrant site represents part of the wreck of the *Royal Anne*.

6.6.4 Summary of ADU reports

Three site reports were made by the Archaeological Diving Unit (ADU):

ADU report 93/01

This was an assessment of the wreck, prior to designation. Considered it is unlikely that any significant proportion of the hull will have survived in such a dynamic environment and that this would reduce the importance of this particular wreck site. ADU visit is thought to be first diving on site since 1991. Two iron cannons close to an area of concreted cannonballs were the only archaeological remains visible on the site. Finds from an area of excavation 1m square were shown to the ADU, who commented on different condition of finds held by the two finders. Lists some finds and considered there is a high degree of probability that the assemblage comes from the *Royal Anne*.

'The site is located in shallow water less than 8m deep within an area of rocks. Some of the rocks are permanently exposed but may are just underwater at low water making it a difficult and unpleasant place to take any boat except in perfect conditions. It is a very dynamic environment exposed to prevailing SW winds and, according to the finders, diveable conditions are rare and unpredictable'.

'The seabed is gullied bedrock with stones and boulders either wedged or concreted in place. There is abundant kelp cover'.

Considered that there was no obvious natural threat to this site as it appears to have reached a relative equilibrium with its environment. There was a potential threat from divers, and one of the reasons the finders did not often visit the site was to avoid attracting attention to it. It would be impossible to indicate the site.

ADU report 97/13

On 9 July 1997 the ADU visited site with the nominated archaeologist Kevin Camidge, the Licensee Rob Sherratt and Mike Hall. The only archaeological material seen was two iron guns, iron shot and some amorphous concretions. Both guns were heavily concreted, one having been severely abraded due to its proximity to a large rock. Most of the shot was concreted in a large mass, but one example was loose on the seabed. After the ADU visit work on the project involved the recovery of c250 items, some of which were of high intrinsic value. The ADU (or KC) believed that all of the objects were reported to the Receiver of Wreck. The report concluded that the site did not appear to be under any threat other than the expected natural deterioration. There was no evidence of diver interference and the Licensee and archaeological adviser seemed to be working well together.

ADU report 98/09

Visit on 18 May 1998. No archaeological remains were seen on the site.

6.6.5 Summary of licensees' reports

February 1994 Survey Progress Report

Since the licence to survey was awarded in November of the previous year poor weather had prevented any diving operations on the site. The last diving on site was by the ADU in October 1994.

Proposals for survey were set out and credentials for identification of the site. The report mentioned that Richard Larn thought that the Quadrant Rock site was the *Royal Anne* Galley, following fieldwork in 1975/6 by Bristol University, accompanied by RL in the second season. Licensees intend to investigate whether this is a different wreck or part of the *Royal Anne* once the pre-disturbance survey had been completed.

The report was illustrated by photographs of the silver fork (small find no 80) bearing the Belhaven crest.

October 1994 Survey Progress Report

Work resulted in a detailed survey progress report. Thick growth of kelp cut before trying to fix the grid points, a variety of cutting implements were tried, the best being a 6in lino knife. Once cleared of kelp the central part of the site was transformed into an easily recognisable landscape. The original intention was to drill holes to fix rock bolts as grid points but rock proved too hard to drill holes into. Instead a variety of objects were hammered into the natural fissures in the rock. The most successful were cold chisels, usually about 0.2m long. Hammered well into the fissures these became very secure and were then labelled, alphabetically. The site is covered with gullies and large boulders so finding suitable fissures in the right places for survey work was often difficult. However, by placing extra points where possible suitable coverage of the whole site was eventually built up.

Gullies were planned by placing a tape along the bottom for as far as possible (rarely more than 10m).the ends of the tape were then plotted using triangulation from as many grid points as possible. The gully was then planned using standard offset planning techniques, principal features being measured by independent triangulation to grid points. Depth measurements were taken with dive computers.

Buoys were to be placed on the extreme easterly and westerly points of the completed grid and horizontal sextant angles taken to land based marks at slack water to establish the exact location of the site grid relative to OS.

The report mentions that documentary research was ongoing. Appendices comprise: a finds list, a plan of survey and grid point, some photographs and drawings of finds, sample finds record sheets, the dive log and copies of the *Royal Anne*'s pay lists.

1995 Survey progress report

Work on the survey had progressed slowly, the site was visited on eight occasions but diving was only possible on five of these. The grid points had survived the winter, but the labels had not. The kelp was cleared in April and the grid points re-labelled. A large rock 3m by 2m had 'appeared' in an area that was clear the previous year.

1996 Survey progress report

Work continued on the survey when conditions allowed. The licensee would like to apply for a licence to excavate for 1997.

1997 Excavation report

Approximately 40 square metres was excavated; resulting in the fullest excavation report.

Recording system: an on site grid consisting of steel pins driven into fissures in the rock. Where possible these were placed at high-level points to allow easy measuring. The points were labelled alphabetically and are shown on the site plan (Fig 17). The site also had a virtual grid of 2m squares to which all finds were referenced. All finds were plotted on an

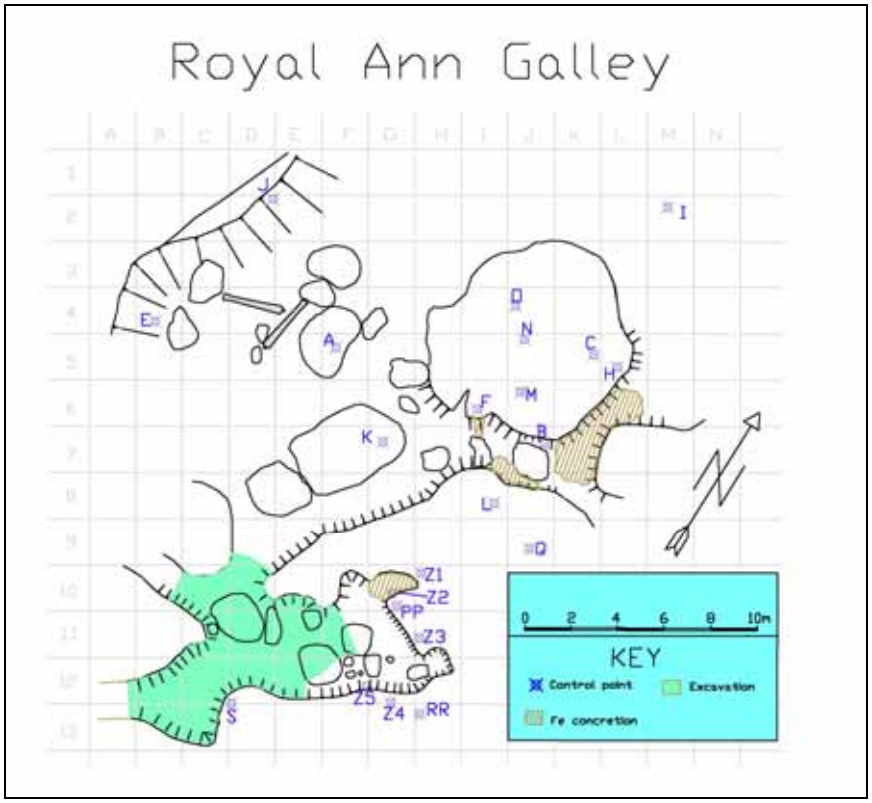

Fig 17 Plan showing grid points and area of 1997 excavation (K Camidge)

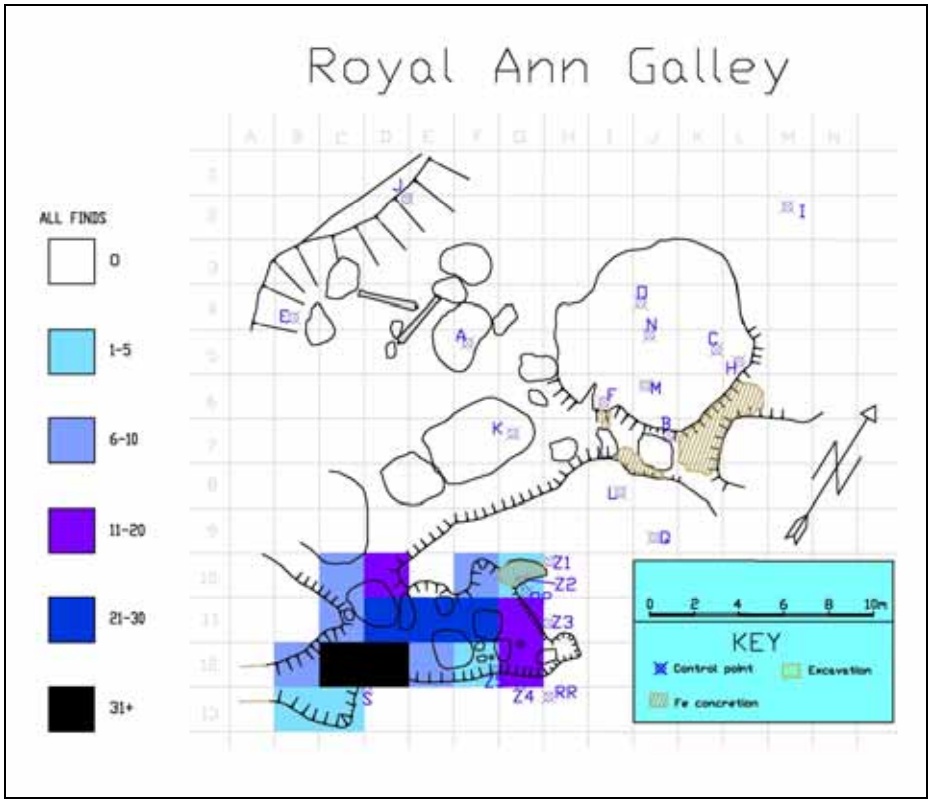

Fig 18 Distribution of finds (K Camidge)

overlay to the main site plan. Periodic sections were drawn illustrating the stratigraphy, where appropriate.

Excavation technique: experience showed that the best method of excavation on site was by hand. First the overburden of rock and boulders was removed; the layer of coarse sand was then carefully excavated until bedrock was reached. Due to the shallow depth of the stratigraphy use of reaction dredges was judged inappropriate.

Conservation: All artefacts were kept in conditions as near as possible to those in which they were found until suitable stabilisation could be undertaken. The artefacts wee stored in a stable environment and regularly monitored for deterioration.

1998 Report

The site was visited on three occasions between August and October; total hours spent underwater were 4.7. On each of these short visits there was too much swell to allow any work to be undertaken. There was a severe storm at the beginning of September and when visited towards the end of the month it was apparent there had been a considerable movement of material. Large rocks (2m by 1m) had been moved around the site and much of the site had been 'turned over'.

1999 Report

A total of 6.5 man hours were spent underwater in July and October. After removal of kelp grid points were checked. Several of these were found to be missing, probably due to movement of boulders in the winter storms. Work was started on replacing the missing pegs and labels. As usual there had been minor changes to the site topography over the winter.

2000 Report

The Licensee sent the MCA a copy of the *Royal Anne* archive (hard copy and CD ROM).

Artefacts recovered from the site were reported to the Receiver of Wreck who was unable to find a museum to take the artefacts. DROIT No 635/97 awarded finds numbers 151-400 to Rob Sherratt in lieu of a salvage award (letters from the Receiver of Wreck dated 8 December 1999 and 14 November 2000).

2001 Report

Kelp was cut and grid points located. Two survey points were replaced; surprisingly the others had survived almost continual gales over winter. Two sea bed profiles were taken across the site.

Excavation work continued in the gully where left in 2000. This involved moving, ie rolling over, a large rock (estimated 4 tons) using chains, long ropes and the hard boat engine's power. Some artefacts were found under the rock. The artefacts were sorted according to (mainly) composition, and stored in 'environmentally controlled' containers. It was planned to finish excavating the remainder of the gully in 2002, ending a section line P-R.

Research design for 2002

The excavation was seen principally as rescue. Material previously recovered from the site was located in shallow gullies beneath coarse sand and boulders, usually at a depth of 0.3 to 0.5 m below the seabed. Some areas of iron concretion are exposed on the surface of the seabed. Considerable movement of rocks and scouring of the gullies was evident, especially after storms. The vulnerability of the cultural material is evidenced by quantities of loose artefacts observed on the site after such storms. It was concluded that each winter sees the dispersal of some part of the material remains on the site. Judging by previous years it is

rarely possible to work on the site more than 10-12 days per season so progress will inevitably be slow.

2002 Report

The Licensee dived the site and the following tasks were undertaken. New site datums were added and surveyed and depth readings were taken. It was stated that the control points were to be fixed using the Site Surveyor computer programme. Three items were found lying on the seabed. It was noted that a small gully at grid K8 would need to be monitored for change, as the storms appear to breaking up the seabed in this area. No excavation took place this season. A cascade washer was made to facilitate the thorough washing of artefacts.

The Licensee requested permission for a guided diver trail around the site and a surface recovery licence.

2003 Research design

Research design 2003 stressed the need to complete excavation of gully Z1-Z5. Excavation had proceeded in this gully since 1997, principally because the deposits in the gully were considered to be at risk from very active erosion occurring in this part of the site. The stratigraphy in the gully is isolated from the rest of the site – the deposits are wholly contained within the gully. Excavation of the gully had proceeded east-west with only about 5m remaining to be dug. The surviving deposits are very shallow, at most 0.25m, and therefore very vulnerable to erosion caused by large mobile rocks on this part of the site. These rocks, some of which are several tonnes in weight, can be seen to have moved up and down the gully during winter storms. This causes erosion of the deposits within the gully and dispersal of the cultural material therein.

2004 Visitors licence report

Robert Sherratt visited site twice in the last year with visiting divers; one of these was with the dive club from the local naval air base at Culdrose whose members had shown interest in diving on a very old naval shipwreck. Such visits could become more commonplace wit the enhanced public profile of maritime archaeology in the media.

2005 Report

The site was checked twice in the last year, once with two visiting divers. Loose iron objects (probably worn cannonballs) were observed on the seabed in many parts of the site. A local fisherman had reported seeing a large black RIB with yellow rubbing strakes as having divers down in the vicinity of the site.

6.6.6 Location of existing archive

The existing archive of the work to date is held by Mr Sherratt. Copies have been lodged with the National Monuments Record of England at Swindon (NMR).

6.6.7 Dissemination of previous work

Previous work has not been published.

6.7 Discussion of the archaeological evidence for the Quadrant Rock site

By Kevin Camidge

6.7.1 Introduction

The designated site of the *Royal Anne* Galley is situated to the north-west of the Man of War Rocks off Lizard Point. Limited excavation on this site has produced over 400 artefacts. These consist mainly of small personal items, often of relatively high value (see finds list Appendix 12.9). However, very little relating to the ship itself has been found to date. In fact, the only identified remains of the ship are two iron guns and a quantity of concreted iron shot. We know that material from the *Royal Anne* was salvaged immediately after she sank. Records show that at least 21 guns and 5 anchors were recovered (ADM 106/754; WWo47/20B; ADM 106/748). Notwithstanding this salvage work, the dearth of ship remains has led to the supposition that the designated wreck may be only a part of the vessel. The nature of the artefacts recovered to date suggests that this part may be the stern of the ship. For these reasons the nearby site of Quadrant Rock (about 150m NW of the designated site), where there are iron guns and an anchor, has always been considered a possible part of the *Royal Anne* Galley.

6.7.2 The Quadrant Rock site

The site is well known to local divers and was brought to the attention of Kevin Camidge (KC) by Rob Sherratt (RS) and Mike Hall (MH), licensees on the *Royal Anne* Galley and Rill Cove sites. In 1993, Richard Larn (RL), who was of the opinion that this site was the wreck of the *Royal Anne* Galley, gave KC photocopies of a site plan and finds list apparently produced in 1973 by Dr WT Griffiths and the Bristol University sub-aqua club.

During a visit to RL, MH and KC were shown a number of silver coins which apparently came from excavations conducted on the site by that group. To the best of KC's recollection the latest coin in this group was dated 1720. Recent communication with RL indicates that these coins are no longer in his possession.

It was also known that a local diver, Tom Berry, had recovered items from the area in the early 1980s (Wessex Archaeology 2005b, 2-3). These included a number of pewter bowls and an iron gun. The iron gun has been incorporated into a stone wall outside the premises of Falmouth Divers in Penryn (Fig 22).

6.7.3 The Bristol University survey

The photocopies of the Quadrant site supplied to KC by RL consist of a site plan (Fig 19) , a finds list and a sketch of an anchor and of a gun. The anchor sketch is titled 'UBUC project July 1973'; UBUC presumably standing for University of Bristol Underwater Club. The gun sketch is annotated BUSC '77, possibly standing for Bristol University Sub-aqua Club.

The site plan shows nine guns and an anchor, as well as three areas which were apparently excavated. Some topographical information is also shown (mainly what appear to be gullies surrounded by rock). This accords with the information from RS and MH who stated that the site had iron guns and an anchor.

6.7.4 The Wessex Archaeology site assessment

In August and September 2004 Wessex Archaeology carried out an undesignated site assessment of the Quadrant site (Wessex Archaeology 2005b). They located a number of iron guns and a small anchor. Conditions on the site were not ideal and the report states that adverse sea conditions limited the time spent on site. Poor visibility and dense kelp cover also hampered their survey and we should probably assume that they may not have established the full extent of this site.

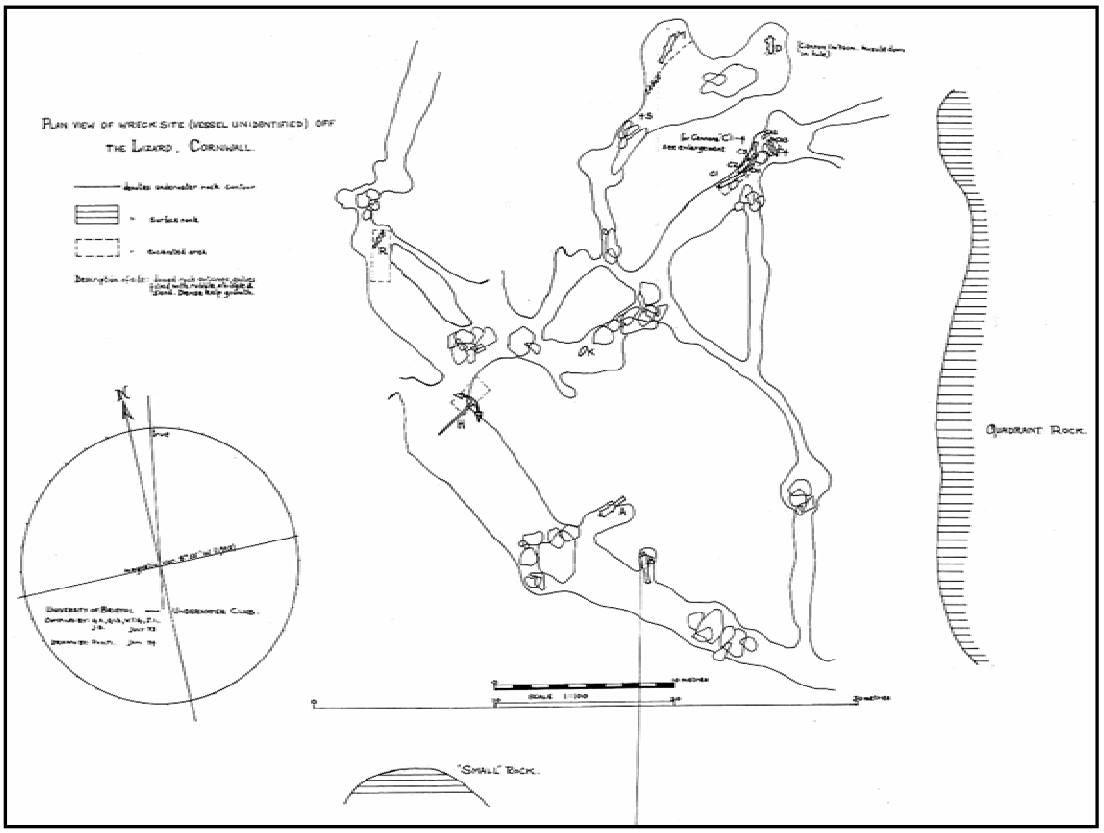

Fig 19 Quadrant Rock site plan, probably drawn by UBUC c1973

Two linear iron concretions (WA06 and WA07) were found, which were interpreted by Wessex as possible remains of iron guns removed from the seabed sometime between 1973 and 2004. Finally, a small iron anchor (WA04) was observed. No measured plan of these objects was made but the report states that 'it appeared that the disposition of archaeological features approximately matched that recorded in 1975/6 (fig 2)'. The report shows fig 2 as the 1973 UBUC plan reproduced above (Fig 19).

The report concludes that the date of the Quadrant material is 'the earliest possible date for the wrecking event … 1704', this is based mainly on the touch marks on the pewter bowls recovered by Tom Berry (Wessex Archaeology 2005b, 16, figs 13-15). The report goes on to say 'Although the available evidence is entirely circumstantial and there is some room for doubt, the balance of evidence reviewed for the purposes of this assessment indicates that there is an association between the site and the ***Royal Anne***' (*ibid*, 17).

Four cast iron guns were located (WA01-03 and WA05), measured and photographed.

6.7.5 The Quadrant guns

Four iron guns were located on the Quadrant site by Wessex Archaeology. They also located two linear iron concretions which may indicate where iron guns may have been on the seabed. This still leaves three guns shown on the Bristol University plan which have not been relocated. Mike Hall also says that there are at least two other iron guns on the inshore side of the Quadrant.

The four iron guns were measured by Wessex Archaeology. They stated that the guns were all very heavily concreted and therefore the measurements only give a general indication of the size of the guns. Their measurements for gun length are given in the table below.

Gun No	Recorded length	Recorded bore
WA 1	1.51m (5')	-
WA 2	1.70m (5' 6")	0.06m (2.36")
WA 3	1.52m (5')	-
WA 5	1.78m (6')	0.07 (2.75")

Fig 20 Iron gun measurements for the Quadrant site

The main question we need to ask is; do these gun dimensions accord with what we know about the armament of the *Royal Anne* Galley? The proposed complement of guns was as outlined below.

Complement	High	Mid	Low
Men	190	160	130
Gun Deck	20 x 9 lb	20 x 9 lb	18 x 9 lb
Upper deck	20 x 6 lb	20 x 6 lb	18 x 6 lb

Fig 21 Proposed complement for the Royal Anne Galley *(based on PRO ADM 7/337)*

But this is only what was intended; individual ships at this date often had guns which varied from the official complement for the vessel. To date, no documentary sources outlining the specific armament for the *Royal Anne* Galley have been located. We do, however, have such a record for a similar ship - the *Charles* Galley - for 30 March 1713. This shows the *Charles* Galley as carrying a 20 demi-culverin (9-pounder gun), 16 x 6-pounder guns and 4 x 3-pounder guns (Caruana 1994).

Identifying concreted iron guns from their bore-diameters is notoriously difficult but the recorded dimensions suggest guns of less than 6lb calibre. However, the recorded lengths of the Quadrant guns are very short indeed. The shortest guns likely to be on board a fifth rate of that date are the 3-pounder guns of 5' 6" length. Thus the two 5' guns are either of an unknown type or they have been eroded by at least 6". The 6' gun accords only with the

Fig 22 Gun believed to have been recovered from the Quadrant site by Tom Berry in 1983 and now mounted on a wall in Penryn (photo: Kevin Camidge)

Fig 23 Quadrant gun WA05 (photo: © Wessex Archaeology)

4-pounder gun of the period (Caruana 1994). The two guns recorded on the designated site are 2.4m (base ring to muzzle face) in length, which makes them 8' guns. This length accords with either the 9-pounder demi-culverin or the 6-pounder gun.

In conclusion, the guns recorded on the Quadrant site by Wessex Archaeology are probably of 3 or 4lb calibre and are not inconsistent with the lighter type of gun likely to have been borne by the *Royal Anne* Galley. However, the absence of any guns consistent with the recorded main armament of the *Royal Anne* (6 and 9lb) is significant.

The gun believed to have been recovered from the site by Mr Tom Berry in 1983 (Wessex Archaeology 2005b, 10 and fig 5) is now mounted on wall at Tidal House (Falmouth Divers), Penryn (Fig 22). The gun is 1.68m long (base ring to muzzle face) with a bore of 0.075m (the bore is damaged but free of concretion) which indicates a 3 or 4lb gun some 5ft 6in in length. Again this is smaller and lighter than what we might expect for a gun from the *Royal Anne* Galley.

6.7.6 The Quadrant anchor

The Bristol University drawing shows a round-crown anchor while that photographed by Wessex is of the older angle-crown type. Given the similarity of dimensions and its relative position to the guns, it seems likely that this is the same anchor.

Is this anchor of the correct type and size to have been one of the *Royal Anne's* anchors? The type is certainly correct, since all English navy ships of the 18th century would have carried anchors of the angle-crown type. We know that one of the salvaged anchors from the *Royal Anne* weighed 26 cwt (PRO ADM 106/754). Tables of anchor lengths and weights of this period suggest that the shank of a 26 cwt bower of this period would have been about 4m (13') long. The recorded dimensions of the Quadrant anchor suggest it is a little smaller (*c* 15 cwt) than we would expect for the *Royal Anne* bower and far too large for the stream anchor. However, as the *Royal Anne* Galley was designed to be rowed and was of an unusual design (Luttrell 1857) she may well have had slightly lighter second and third bowers than was customary.

	Wessex 2004	**Bristol 1973**
Shank length	3.5m (11' 6")	3.5m (11' 6")
Arm length	1.13 (3' 8½")	1.25m (4' 1")
Fluke length	0.63 (2' 1")	

Fig 24 Quadrant anchors: recorded dimensions

Fig 25 Quadrant angle-crown anchor (photo: © Wessex Archaeology)

We know that five anchors were salvaged from the wreck, but we do not know what size these were. How many anchors would the *Royal Anne* Galley have carried? The *Royal Anne* would have carried four or five bower anchors (including the sheet anchor) and two smaller auxiliary anchors, the stream and kedge anchors (cf Curryer 1999). So providing one of the salvaged anchors was the stream or kedge anchor then it is at least possible that a *Royal Anne* bower anchor remains on the seabed.

Ship size	625 tons	364 tons	225
Weight of biggest anchor	30 cwt (1.5 tonne)	18 cwt (0.95 tonne)	11 cwt (0.6 tonne)
Length of shank	14' 2" (4.3m)	12' 2" (3.7m)	10' 8" (3.25)
Length of arm	5' (1.52m)	4' (1.21m)	4' (1.21m)

Fig 26 Table of anchor sizes from Sutherland's Shipbuilding 1717 (in Lavery 1987), the Royal Anne Galley *was 511 tons)*

6.7.7 Dating of the Quadrant material

The dating of the Quadrant material can be summarised as follows:

Anchor

This is an angle-crown long shank type and as such is of 17th or 18th century manufacture.

Pewter bowls recovered by Tom Berry

From investigation of the touch-mark on the pewter bowls Wessex Archaeology concluded that '…the four pewter bowls were probably manufactured during the period 1704-1758' (2005b, 12).

Silver coins reported from the site

These were in Richard Larn's possession in 1993 when shown to Mike Hall and Kevin Camidge. The latest dated coin was 1720. The current whereabouts of these coins is unknown. The fact that there are no coins shown on the Bristol University finds list ads to the uncertainty. Unless the coins themselves - or further information as to their provenance - can be found, the dates provided by them should be treated with great caution.

Conclusions

The guns and anchor recorded by Wessex Archaeology to the west of the Quadrant could have been part of the *Royal Anne* Galley. They both tend towards the small end of the spectrum of feasible sizes for a vessel of the *Royal Anne's* type and therefore the possibility that these objects are from another, slightly smaller vessel cannot be discounted. The dating of the Quadrant material is not particularly precise but does not preclude its identification as the *Royal Anne* Galley.

Although there is plainly insufficient evidence to make a positive link between the Quadrant wreckage and the Royal Anne Galley, investigations to date have failed to rule out the possibility that this is part of the *Royal Anne*.

6.7.8 Recommendations for future work

Further investigations of the wreckage to the west of the Quadrant Rock are required to establish the full extent of this material. English Heritage have recommended to the DCMS that the *Royal Anne* designated area should extended from a radius of 100m to 200m centred at 49° 57.48' N 05° 12.99' W (WGS84), but excluding any part of that area which lies above MHWS, to afford protection to the material at the Quadrant site. It is hoped that this will encourage further investigation of this site, although this is likely to be difficult given the dense kelp cover and often adverse sea conditions.

Priorities

- Locate and measure the three extra guns recorded in the 1973 Bristol Survey but not located in 2004.
- Undertake a measured, georeferenced plan of the guns and anchors.
- Locate and record the reported guns on the inshore (east) side of the Quadrant to establish whether these are part of the *Royal Anne*.

6.8 Assessment of significance against non-statutory criteria

6.8.1 Assessment scale

In this section the significance of the *Royal Anne* is assessed against the non-statutory criteria used to judge the importance of historic wrecks or wreck sites under the 1973 Protection of Wrecks Act.

For each criterion, one of the following draft grades has been selected, following the trial methodology set out in Wessex Archaeology's report on the Quadrant Rock undesignated site (Wessex Archaeology 2005b) which was done on an experimental basis to help assess the relative importance of the criteria as they apply to different sites.

The following categories are 'scored' in accordance with the following scale:

- Uncertain - Insufficient evidence to comment;
- Not valuable - This category does not give the site any special importance;
- Moderately valuable - This category makes the site more important than the average wreck site, but not exceptional;
- Highly valuable - This category gives the site a high degree of importance. A site that is designated is likely to have at least two criteria graded as highly valuable;
- Extremely valuable - This category makes the site exceptionally important. The site could be designated on the grounds of this category alone.

6.8.2 Period

Highly valuable. Galley frigates were originally designed to combat Barbary Corsairs in the Western Mediterranean in the late 17th century. Although the current project has identified that there were at least twenty-five 17th and 18th century naval vessels specifically described as galleys, the *Royal Anne* is the only known, and only designated, example of a wreck of this type of ship in UK territorial waters. Most galley frigates were rebuilt or scrapped or ended their days as fireships or breakwaters. It is unlikely that another example of a wrecked galley frigate will be found in UK territorial waters. The build of the vessel is of interest within a national dimension as a Royal Naval warship with international use.

6.8.3 Rarity

Extremely Valuable. The survival of early 18th century shipwreck material *in situ* but with no evident intact ship structure is unusual but not particularly rare. What is particularly important about the *Royal Anne* is the spectacular collection of unusually rich high status objects that have been recovered from the site, with a bias towards the nobler metals that have survived better on the seabed.

6.8.4 Documentation

Extremely valuable. There is a considerable body of contemporary documentation held at the PRO regarding *the Royal Anne*; so much so that it is possible to trace her history from the time she was being built to the time when she was wrecked. The documentation links her with contemporary personages such as the Marquis of Carmarthen, Queen Anne, George I and Lord Belhaven and historical events such as the War of the Spanish Succession, the first Jacobite rebellion and the suppression of Atlantic piracy. Initials engraved on metalwork recovered from the wreck can be linked with historic personages such as Lord Belhaven. The loss of such an important figure would have had significant implications for the Royal Navy and colonial government of the day.

There is additional interest in the accounts of local plunder, the use of Captain Rowe's new diving engine on the *Royal Anne* and the body of secondary literature recording local traditions associated with the shipwreck and burial of the casualties

6.8.5 Group Value

Highly Valuable. The *Royal Anne* is one of 32 vessels known to have been lost at or off Lizard Point during the 18th century. There another designated site nearby at Rill Cove. The Lizard (and particularly Lizard Point) is a notorious and historic navigational hazard and recorded casualties begin as early as 1321; the site therefore forms a part of a very rich historic maritime landscape (Larn 1997; Wessex Archaeology 2005b).

In addition the *Royal Anne* is close to the undesignated Quadrant Rock site and the traditional burial place of most of the crew and passengers at nearby Pistol Meadow.

6.8.6 Survival / Condition

Uncertain. No part of the ship's structure has been located but there is some possibility that parts of ship structure may survive in the immediate vicinity of the two guns. Although the site has been partially excavated, it is almost certain that undisturbed contexts still exist and further field assessment is required to determine the extent and nature of undisturbed sediments and reliably assess this criterion. Surface finds are all heavily eroded.

6.8.7 Fragility / Vulnerability

Highly valuable. The site is located in a dynamic seabed environment so what remains is vulnerable to environmental a conditions and also, perhaps to unauthorised salvage. It is possible that there are still undisturbed contexts in gullies containing artefacts of historical importance that also have a significant salvage value.

6.8.8 Diversity

Valuable. Although there is unlikely to be any surviving structural or organic material an impressive range of artefacts have been recovered from the site. The score for this criterion would be significantly increased if it can be demonstrated that there are surviving parts of the ship's structure or proven that the crew and passengers are buried at Pistol Meadow

6.8.9 Potential

Highly valuable. The archaeological potential of the *Royal Anne*, in terms of artefactual material has been demonstrated to be high. So far only part of one gully has been excavated - there was no surviving ship structure in that part but, as no other parts of the site have been excavated, the nature and depth of sediments on the rest of the site are unknown. If there are deeper areas or pockets of sediment there could be survival of some parts of the ship's structure and this needs to be ascertained in order to form a proper opinion of the potential of the site.

Similarly, there is a need to establish the extent of the *Royal Anne* wreckage/debris trail, as only a small part has so far been investigated, and for further investigation to demonstrate that the Quadrant Rock site is part of the same wreck.

The site also has considerable potential for public education and increased awareness of the wreck.

Fig 27 Oblique view of the Royal Anne site looking north at The Lizard. This model is based on Intermap elevation data (© 2006 Intermap Technologies Ltd)

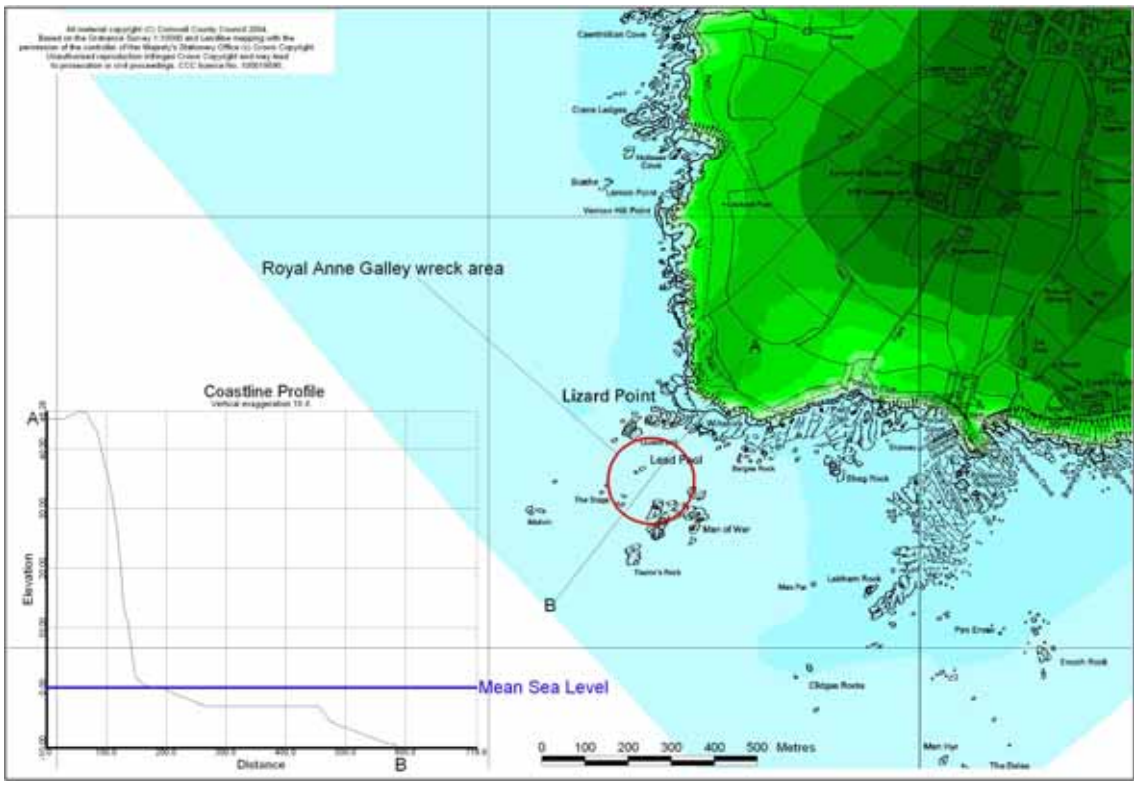

Fig 28 Coastline profile

7 Results of the environmental assessment

7.1 Assessment of the sources of environmental data

By Phillip Rees

7.1.1 Introduction

In this section the sources of environmental data are discussed in accordance with the project design (Camidge and Johns 2005). The data sources identified are listed above in Section 4.4.1 and represent the most important sources of environmental data that can be accessed for this location. However it should not be considered definitive but an illustration of the extent of information available.

The data sources often relate to surveys or studies that involve larger sections of the Cornish coastline which include references to the area of the Lizard Point. Examples of this were the Shoreline Management Plan (Halcrow Maritime 1999a) and JNCC Coastal Directories Series (Joint Nature Conservation Committee 1996).

The data was accessed in a range of formats from ring binder volumes typified by the Shoreline Management Plan, archive data retrieved from the UKHO, geological survey memoirs, to extracts from sophisticated interactive websites operated by BGS, BODC, POL etc.

It was noticeable that although the websites appeared to provide ready access to a wide range of data sources, the information that can be gleaned was dependent on the make up of the particular website and the form in which the data has been stored and classified. It was sometimes found that some of the websites were difficult to access, and required significant time and effort to extract the relevant data.

For instance, whereas the BGS website was able to provide site specific information of rock samples taken from close vicinity of the wreck site itself, it was not possible to identify any other website with site specific oceanographic data or water quality samples within several tens of kilometres of the *Royal Anne* Galley site.

Even in those instances where data was finally accessed, it was often found that no data had been retrieved at the time of the survey and hence had little or indeed any value.

As a consequence there appears to be a significant disparity in the nature and availability of different types of data for the study area. It should be recognised that the development and use of metadata in the marine environment is still at an early phase and hence sourcing any relevant data can often prove time consuming and often unproductive. There are however, indications that the leading authorities such as the Met Office, CEFAS and the Environmental Agency are combining their resources to improve the stewardship and access to marine data in order to enhance management of the sea around the UK.

The partnership and schemes which have been involved in supporting marine spatial data infrastructure are:

- The Integrated Coastal Hydrography (ICH) project, established by UKHO, EA, MCA, CEFAS and OS to develop a web-enabled database that would show the location of available coastal surveys around the UK. It also created a "discovery" portal to access the data – see www.coastalhydrography.com

A search was made in the discovery portal but no data was reported for the Lizard Point.

- Inter coastal zone mapping (ICZMap)

The inter-agency project known as ICZMap was funded by the Cabinet Office to develop an integrated approach to coastal management and aspects associated with data management. It was established between UK Hydrographic Office, the Environment Agency, Ordnance Survey and the Maritime Coastguard Agency (MCA) in order to resolve the issues surrounding the integration of existing terrestrial, hydrographic and geological spatial data in the coastal zone.

One of the important elements of the project was for the partners to agree on the methods to perform geodetic transformations of horizontal datums. The final report was issued in October 2003 and includes some important findings regarding procedures for data collection and reporting in the marine environment which should be adopted for this project. www.iczmap.com.

- Ocean Net – Marine Data and Information Partnership (MDIP)

OceanNET is the portal for the UK Global Ocean Observing System Action Group (GOOS-AG) Partners comprising Defence Science and Technology Laboratory (dstl), DEFRA, EA, Fisheries Research Services, Met Office, NERC and UKHO. www.oceannet.org

The UK GOOS Action Group is operated under the umbrella of the Inter-Agency Committee on Marine Science and Technology (IACMST).

The Marine Data and Information Partnership (MDIP) is a new initiative to provide a co-ordinating framework for managing marine data and information across the UK with the objective of improving the availability and access to marine data and information.

The IACMST has produced a number of reports in pdf and interactive formats including:

- UK Marine Waters 2004 – Marine Processes and Climate which summarises the available information on climate, physical and chemical oceanography, changes in sea levels in the form of an interactive web based database.

This represents a valuable data resource as it provides access to a whole range of environmental parameters albeit that the data sources still relies on historical datasets. There is however an initiative by DEFRA to create a new marine monitoring network which should be able to provide much improved time series data at more locations around the UK coastal regions.

In summary, there appears to be a significant disparity in the availability of physical and chemical oceanographic data for the area in the vicinity the Lizard Point compared to geological and marine habitat data. Whereas there is site specific data of geological mapping and rock classification, as well as relatively detailed habitat data, the data for the physical and chemical oceanography tends to be generic and extrapolated from datasets acquired from some considerable distances from the location of the *Royal Anne*.

7.1.2 The Shoreline Management Plan

The Shoreline Management Plan (SMP) was prepared for Cornwall County Council in collaboration with the local District Councils by Halcrow Maritime in 1999. The SMP is divided into three areas: Rame Head to Lizard Point (Halcrow Maritime 1999b), Lizard Point to Land's End (Halcrow Maritime 1999a) and Land's End to Hartland Point (Halcrow Maritime 1999b). As can be seen, the Lizard Point happens to lie at the interface of two of these three strategic areas

Whereas the Land's End to The Lizard report would have provided more relevant data, in that the wreck site of the *Royal Anne* Galley lies towards the west side of the Lizard, the data from this report is not as complete as the section from Rame Head to The Lizard

Point. This is because the section from Land's End to The Lizard SMP was part of a pilot study which was to be updated at a later stage, but unfortunately this was never undertaken. Whereas the other two SMPs each consists of four volumes - Volume 1 Strategy Document, Volume 2 Studies and Reports, Volume 3 Maps and Supporting Information and Volume 4 Updates to the SMP - the Lizard Point to Lands End SMP consists only of the Volume I Strategy Document.

Section 2 of SMP 6D/Volume 2/Physical Environment, reviews existing information relating to the area of coastline from Rame Head to The Lizard. This includes a summary on coastal hydrodynamics of reports and information of studies undertaken by the JNCC, Met Office and HR Wallingford which has relevance to the area of the Lizard Point (Section 2.2, 7-8).

The aspects discussed include reference to wave spectra, wind data, extreme water levels and tidal stream current data.

Of possible relevance are 5 data series held by BODC near the Lizard undertaken by the Marine Biological Association in 1978 and 1980 (total 63 days) and for MAFF in 1974 (total 35 days) www.bodc.ac.uk.

Reference is also made to the Tidal Stream Atlas of the Cornish Coast produced by the Institute of Marine Studies at Plymouth University – see section 3.2.6 of Volume 2 Studies and Reports (George 1990). A copy of this is held by HES at Truro.

As part of the Coastal Dynamics Appraisal (SMP 6D/Volume 2/Physical Environment), Halcrow purchased wind, wave and water level data to enable prediction of the environmental conditions at sites of interest around the coastline from Rame Head to Lizard Point.

This report provides a rigorous appraisal of the environmental parameters for 25 locations along the south coast of Cornwall, including sites at Coverack (6D-5-5), Downas Cove (6D-5-6), Kennack Cove (6D-5-7), Cadgwith (6D-5-8).

Of these sites, the data from Cadgwith is considered to provide the most useful background information for the wreck site of the *Royal Anne* Galley. It should be noted however that Cadgwith is sheltered from the south-west which represents the most significant wave climate by direction. It is therefore recommended that the SMP from The Lizard to Hartland Point is reviewed in order to identify if there are any sites which are more appropriate for the Lizard Point.

The following wind and wave data was purchased from the Met Office by Halcrow:

- frequency analysis (wind direction and wind speed) for July 1987 to June 1997 (10years) for Culdrose;
- three-hourly time series (wave height, wave period and wave direction for July 1992 to June 1997 (5 years) inclusive for 50.0° N 4.46° W (approx 18 nm east of the wreck site);
- frequency analysis (direction against wave height and wave period for 50.00° N, 4.46° W;
- extreme value analysis by direction (wave height and wave period) up to 1:200 year return period for 50.00° N, 4.46° W.

The following water level data was purchased from Proudman Oceanographic Laboratory (POL):

- time series of tide data at Newlyn (A class gauge) for July 1992 to June 1997 (5 years)

This data is still held by Halcrow but cannot be accessed for this study because of licensing restrictions. The reports are available in pdf format from CCC's Technical Library.

The transformation of the wave climate from the offshore point to the inshore point was conducted using Halcrow's refraction and shoaling programme (REFPRO) and shoreline and nearshore data system (SANDS) This enabled the inshore wave conditions for the period July 1992 to June 1997 to be determined at 3 hourly time steps, and extreme values to be produced at each location. The resulting inshore time series was analysed to produce frequency analysis and extreme wave conditions at the -2m CD contour. This is appropriate for the *Royal Anne* as the depth of water reported at the wreck site is less than 5 metres CD.

It should be noted that tide levels for Fowey and Lizard were predicted using Halcrow's TIDEANY analysis programme and that the tide levels given for Cadgwith agreed with the tide levels determined for the Lizard using the Admiralty Tide Table method for secondary ports.

Tidal state	water level (mOD)	water level (mCD)	return period	water level mOD
MHWS	2.40	5.30	1:200	3.11
			1:100	3.08
MHWN	1.30	5.20	1:50	3.05
			1:20	3.00
MLWN	-1.00	1.90	1:10	2.96
			1:5	2.91
MLWS	-2.30	0.60	1:2	2.83

Fig 29 The Water Levels at Cadgwith (OD to CD = -2.90 m) as taken from the SMP (6D-5-8)

The SMP predicted sea level rise based on published research into global sea level rise and isostatic uplift. The IPCC (1990) provides rates for global sea level rise from 1990 to 2030 and from 2030 to 2050. The combined global sea level rise and isostatic uplift (Shennan 1989) for the period 2000 to 2050 is 0.33m for the south coast of Cornwall.

This is in contrast to predictions by Carter (1988) which provides rates of recent sea level change for Newlyn which if applied over the next 50 years would see a rise of only 0.085m and is an illustration of the relative unknowns associated with predicting changes in sea level. It can be argued that the more appropriate action is to extrapolate the rise of sea level that has been observed from the tide gauge observations at Newlyn over the last 90 years.

In addition the Met Office has two time series wind data for the Lizard and Lizard Lighthouse www.badc.nerc.ac.uk

- Lizard Time Series 01/01/1904 to 31/12/1992 at 49.962° N, 5.207° W. 107 data files
- Lizard Lighthouse 01/01/1998 to current at 49.958° N, 5.201° W. 128 data file.

7.1.3 English Nature/JNCC

The English Nature representative for marine conservation from the Truro office advised that they do not hold any relevant documentation for the offshore areas of the Lizard Point but made reference to the Joint Nature Conservation Committee (JNCC).

The JNCC provided the following relevant information with regard to the *Royal Anne* Galley:

- A Marine Habitat Classification for Britain and Ireland. This provides a tool to aid the management and conservation of marine habitats. It is one of the most comprehensive classification systems currently in use. – see www.jncc.gov.uk/MarineHabitatClassification
- The area of the *Royal Anne* Galley is not a Marine Special Area of Conservation (SAC)
- The JNCC provide data files of Biotopes for the area off the Lizard Point which has been incorporated in the GIS database. The appendices list the descriptions of 50 biotopes lying at, or close to, the area of the designated protected wreck site.
- The JNCC website includes a MNCR Mermaid search engine relating to biotope site etc- www.jncc.gov.uk/mermaid/main.htm

The JNCC has also produced a Marine Monitoring Handbook (Davis (ed) *et al* 2001) which relates to The Habitats Directive concerning the management of a network of Special areas of Conservation (SAC's).

Whereas the Lizard Point is not a marine SAC, the handbook provides useful information concerning management of the marine environment and in particular studies in the vicinity of protected wrecks such as the *Royal Anne* Galley.

The Marine SAC website itself however – www.ukmarinesac.org.uk provides useful reference information on monitoring techniques in the marine environment; this includes discussions on the remote sampling, diving, towed underwater video, use of remotely operated vehicles (ROV's), and use of acoustic surveys such as RoxAnnTM which is a seabed discrimination system which has been used for biotope mapping.

7.1.4 The UK Hydrographic Office

The main function of the UK Hydrographic Office (UKHO) is to produce charts of the UK and areas overseas for use by the Royal Navy. The UKHO also becomes involved in projects such as the Integrated Coastal Hydrography (ICH) and ICZMap which is a partnership between the UKHO, The Environment Agency, Ordnance Survey and the Maritime and Coastguard Agency (MCA) to develop a methodology for definitive measurement of environmental data in shallow and coastal areas around the UK. see - www.coastalhydrography.com

The smallest scale hydrographic chart for the Lizard is Admiralty Chart 2345. This covers a number of locations along the south coast of mount's Bay including Lizard Point at a scale of 1:15000. The location of the wreck of the *Royal Anne* Galley is marked on this chart as an historic wreck with an exclusion zone extending towards the Quadrant, the Stags, and Man of War Rocks.

In order to source charts and records used in the compilation of this and previous charts, a visit was made to the Historical Archives and The Wrecks Section of the UKHO in Taunton on 24 October 2005. The various sources of material that were available are classified into three indexes based on the periods; pre-1930s, 1930 to 1979 and post-1979.

Although these dates may appear somewhat arbitrary, they relate to the techniques used to acquire soundings in those particular periods; hence pre-1930 would be confined to lead line soundings, the period 1930 to 1979 utilises echo sounding techniques, and post-1979 involves more sophisticated techniques using a combination of echo sounding, side scan sonar and other multi beam systems.

By examining the information in each of the Indexes it was possible to identify specific entries in the various ledgers which contained references to the sea areas around the Lizard Point. A number of charts were identified for closer examination; in all about ten different sources for all three periods were requested for close evaluation. Of these only two sources were considered as providing beneficial data for the *Royal Anne* DBA. These are the 1851 chart of The Lizard and Adjacent Rocks surveyed by Captain G Williams (L7989) and the 1973 chart from Marazion to The Lizard surveyed by Lieutenant Commander JD Pugh (K6859/1-2).

The 1851 Chart

The first chart covers an area from Cadgwith on the east to Rill Point near Kynance on the west, and for a distance of approximately one nautical mile offshore Lizard Light (Fig 30).

The chart is in A1 format at a scale close to 1:12,500 and displays a number of lead sounding lines into shallow water in and around the Stags and other outlying rocks called the "Man of War" Rocks.

The results from this detailed survey were used to prepare a hydrographic chart of the Lizard and Adjacent Rocks also dated 1851 (Chart 2447). This is a chart that could be used for navigation, albeit that similar to the fair chart, this also does not portray any co-ordinate graticules.

A further version of what appears to be sourced from this chart was originally published in May 1863 at a scale of 1:12,500 with small corrections in 1927, 1929 and 1930. This chart is referenced as OCB 147 B10 and is a chart which depicts sea areas along the South Coast of Cornwall and which does show latitude and longitude fiducial markings.

The 1973 Chart

The charts for Marazion to Lizard Point were surveyed by Lieutenant Commander J.D. Pugh using the survey vessel HMS *Woodlark* in the period 5th September to 8th November 1973 (Fig 31).

The survey comprised echo sounding lines run at approximately 200 metre line spacing using Hi-Fix Hyperbolic Radio Navigation System. It is noted in the attached survey report that an 18ft survey launch fitted with Hi-fix receiver was used to obtain soundings around Lizard Point, "on the infrequent occasions when sea conditions permitted". The soundings close inshore are plotted in tenths of a metre.

The soundings obtained are plotted in metres reduced to chart datum using observations at tide poles at Lizard Point (2.90m below OD Newlyn)

No sonar sweep or investigations were carried out because of faults with the side scan sonar.

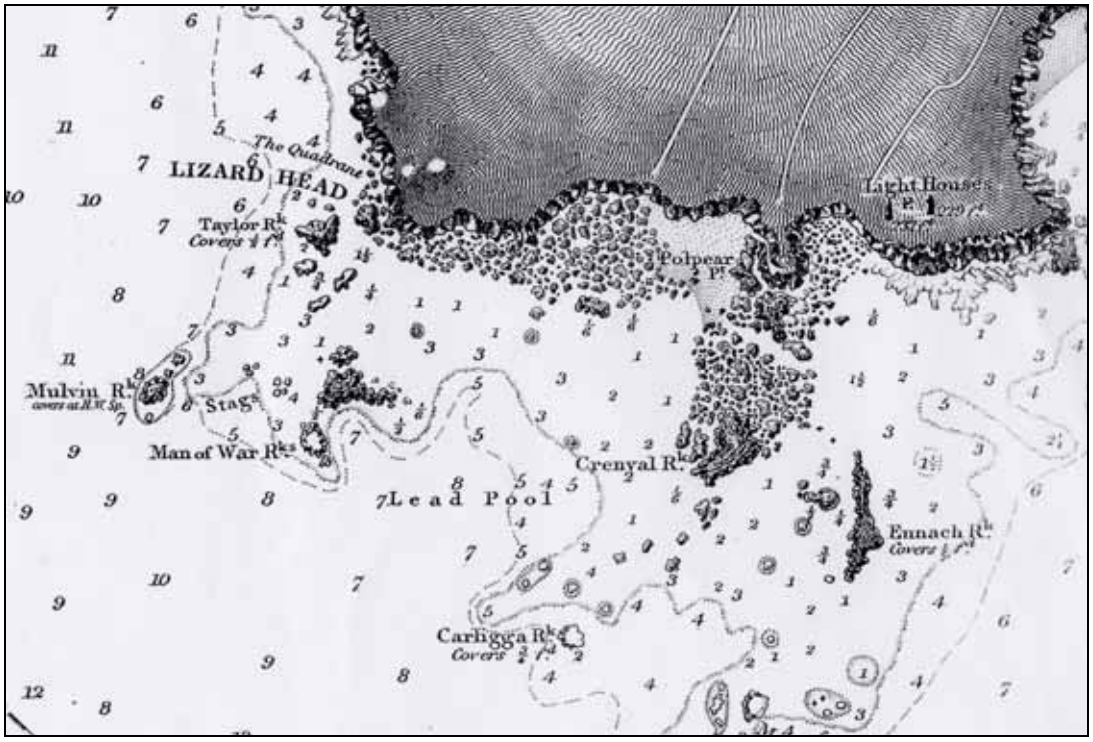

Fig 30 Detail from the 1851 Chart (UK Hydrographic Office)

A black and white copy of the Original/Master of the Survey was obtained on an A0 sheet at a scale of 1:25000. A further A3 copy of the original coloured sheet was also obtained for the Lizard Point area (Fig 30).

This survey represents the most definitive UKHO hydrographic survey of the Lizard Point and has provided the source material with amendments for current hydrographic charts 2345 which was used as the base chart for the desk based assessment.

Fig 31 Detail from the 1973 Chart (© UK Hydrographic Office)

Fig 32 Detail from Admiralty Chart 2345 showing the Royal Anne Galley *Designated Area*

Admiralty Tide Tables

In addition to hydrographic charts the UKHO is also responsible for compilation of the Admiralty Tide Tables, NP 201-06.,

The Admiralty Tide Tables (ATT) lists the predicted the times and heights of High and Low Water for Standard Ports around the UK. Each Standard Port is shown with a tidal curve for spring and neap tidal ranges. In addition the ATT provides the time and height differences for a number of secondary ports which enable the predicted times and heights to be derived.

Whereas the Standard Port nearest to the Lizard Point is Falmouth, Table V notes that tidal prediction for Falmouth are based on less than one year's complete observations.

The Introduction in the ATT provides an explanation of the various effects that can influence predicted tides and hence play a role in determining the observations of sea levels at the wreck site of the *Royal Anne* Galley.

Some of these effects can be quite significant and are summarised by the following:

- Meteorological Effects of Tides (low and high barometric pressure, wind induced and seiches)
- Negative surges which can result in abnormally low water levels
- Seasonal changes in Mean Level
- Seasonal Variations in Harmonic Constants
- Zone Time and Time Differences

- Tidal Stream and Currents
- Tidal Data on Admiralty Charts
- Datums of Tidal Predictions.

Table III identifies the height in metres of chart datum relative to ordnance datum in the United Kingdom. This shows that chart datum at the Lizard Point is -2.90 metres below OD Newlyn. (Ordnance Datum (Newlyn) is the datum of the land levelling system on the mainland of England, Scotland and Wales, and on some of the closer islands offshore; this datum is equivalent to the average value of mean sea level at Newlyn for a six year period 1915 -21. Due to subsequent rise in sea level this datum is now about 0.2 m below mean sea level at Newlyn).

Table V defines the various Tidal Levels (Chart Datum, HAT, MHWS, MHWN, MSL) all of which are used to report sea levels to suit different circumstances.

	Falmouth	**Plymouth**	**Lizard (secondary port)**
LAT	0.0m	0.0m	0.0m
MLWS	+ 0.8m	+ 0.8m	+ 0.6m (- 0.2)
MLWN	+ 2.1m	+ 2.2	+ 1.9m (- 0.3)
OD (Newlyn)	+ 2.91m	+ 3.22m	+ 2.90m
MSL	+ 3.21m	+ 3.22m	+ 3.05m
MHWN	+ 4.3m	+ 4.4m	+ 4.2m (-0.2)
MHWS	+ 5.4m	+ 5.5m	+ 5.3m)-0.2)
HAT	+ 5.8m	+5.9m	+ 5.7m (extrapolated

Fig 33 The Tidal Levels from Admiralty Tide Table V - (Supplementary Tables) for Falmouth, Plymouth and OD Lizard (extrapolated), shown in metres. Note: As previously advised the observations at Falmouth are insufficient for a complete year whereas Plymouth has 19 years of observations from 1981 to 2001. The variance in tidal heights of less than 0.1m between Plymouth and Falmouth provide reasonable confidence in the extrapolated levels for the Lizard Point as shown above. It should also be noted that the difference in levels between chart datum and LAT for Falmouth (+ 2.91 m) and The Lizard (2.90 m) is negligible at 0.01 m.

These tidal levels provide the basis by which it then becomes possible to determine the extreme water levels for the 1, 10, 50 and 100 year return period. – see section on extreme water levels.

In Part II - Time and Height Differences for Predicted Tides at Secondary Ports lists Lizard Point as Secondary Port with Falmouth are also shown above.

Photogrammetry and LIDAR

A check was made with the Imagery Section of the UKHO to determine whether any photogrammetry or LIDAR data was available for the Lizard Point. The UKHO reports that only limited surveys of the UK coast line have been undertaken to date and this does not include the area of the Lizard Point.

Airborne laser bathymetry represents a new technique which has the potential to acquire images of extremely high quality and definition in clear water to a depth of 30 metres. The UKHO has formed a joint venture with Airborne Hydrography AB to undertake surveys around the coastal waters of the UK

Admiralty Coastal Surveys intend to conduct trials in the south west early in 2006 and has indicated that they would be willing to over fly the wreck site with two runs and provide

processed data. As this would not be a commercial venture they could not accept any liability for the performance but suggested that the data could be improved if a broadcast differential signal could be obtained from the Trinity House Light at the Lizard Point. .Each pass would cover a swathe 100 m wide, hence two passes would cover the complete designated area of the wreck site, email to – p.hobson@admiraltycoastal.com

7.1.5 British Geological Survey

The geological resource material relating the wreck of the *Royal Anne* Galley can be separated into two elements: reports derived from investigations based onshore and investigations conducted by offshore sampling.

Onshore

This section describes the origin, and character of the geology of the reefs and skerries extending offshore from the Lizard Point and comments on the nature of the lithology, the presence of dykes and their possible influence on the location of artefacts from the wreck of the *Royal Anne* Galley.

The geology of the onshore areas of the Lizard Complex and more specifically the "Man of War" Gneiss where the *Royal Anne* foundered has been the subject of much evaluation and interpretation since the early work of De la Beche in the 19th century (1839) and Flett in the earlier 20th century (1946). Their significance lies in the nature and disposition of the "Man of War" rocks and the present domain of the wreck site.

The "Man of War" Gneiss represents the lowest unit of the Lizard Complex and as such represents a group of resistant rocks which have been eroded to form a sequence of low lying reefs at the extreme tip of the Lizard Complex.

The interpretation of the gabbro, amphibolite, serpentinized peridotite and associated rocks of the Lizard Complex has undergone radical re-appraisal since the pioneering work of the Geological Survey by Flett since the late 1940s. U-Pb dating of zircon from the Man of War Gneiss (Sandeman et al 1997) indicates that the magmas crystallized in the early Ordovician period (499 million years BP).

With increased knowledge of plate tectonics, the assemblage of rocks found in the complex is now recognized as a small sliver of oceanic crust which has been subject to extensive regional metamorphism. The current understanding of the processes that may have occurred has recently been summarised by JR Andrews (1998, 21-30).

Nevertheless it is considered that the Memoirs of the Geological Survey still provide the most detailed petrographic description of the geology in the area of the *Royal Anne* Galley (Flett 1946) and for archaeological purposes in general Flett's work has remained the standard reference work for the area (cf Quinnell 1987, 13).

Sir John Flett as Petrographer and Director of the Geological Survey undertook the initial survey published in 1912 and a subsequent re-examination of principal exposures and sections in the period 1937 -39 and was published in 1946. The memoirs are supplemented by Sheet 359 which is presented as two sheets at 6" to one mile.

The southernmost sheet (OCN 90 NE), which describes the geology of the extreme tip of the Lizard Point including the offshore reefs and skerries comprising the 'Man of War Rocks of The Old Lizard Head Series', is specifically referenced and annotated in Sir John Flett's own handwriting (Fig 34).

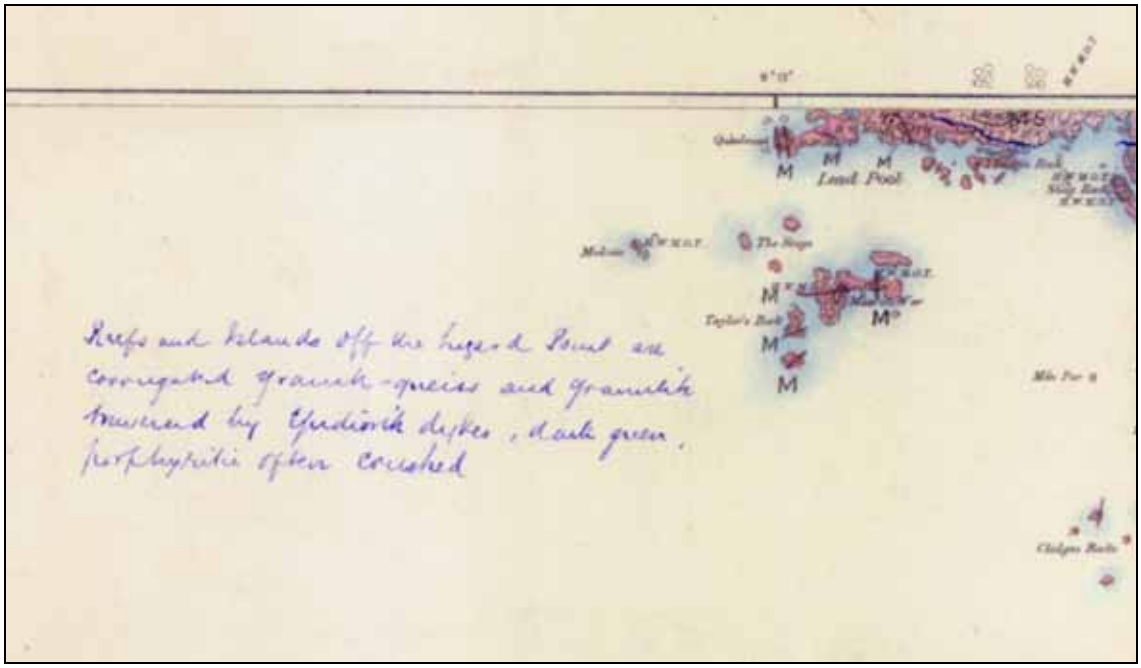

Fig 34 Explanation of Geological Sheet 359, 6" to one mile, annotated by JS Flett (© British Geological Survey)

It describes the group of tide washed reefs and skerries extending for nearly a mile from shore and known as the Man of War, Quadrant, Enoch Rocks, Vasiler etc. These reefs and islets consist of corrugated granite-gneiss and granulite traversed by epidiorite dykes, dark green, porphyritic often crushed.

The Man of War gneiss is a distinctive type of hornblendic gneiss which has been injected with veins and sills of fine grained granitic material. It forms a permeated zone of foliated schists and gneiss which is known to extend at least 270m offshore and can only be seen at extreme low tides. It does not occur on the mainland, although large blocks can be seen on the beach at nearby Polpeor Cove.

The indications are that the Man of War gneiss forms the seabed in the area of site of the *Royal Anne* Galley and extends over the whole of the protected designated area. These rocks are extremely hard and resistive to all forms of weathering, although the geological sheet shows a number of epidiorite dykes bisecting the Man of War reef itself which could form areas of differential weathering in the gneiss. These may have been preferentially weathered to form the shallow zawns or gullies in which the artefact material from the *Royal Anne* appears to have been preserved.

Terminology

Granite – Gneiss is a course grained granular rock in which foliation results from the alternating layers of light and dark minerals. Whereas gneiss is normally formed from regional metamorphism of granite the rocks, in this instance the rocks tend to grade to granite; hence the description is given as "granite –gneiss".

Granulites form the highest grade of metamorphic rocks, formed at close to melting point, which comprise characteristic minerals of pyroxene, sillimanite and garnet with little or no platy minerals left.

Epidiorites occur as narrow vertical dykes and contains hornblende formed from the thermal metamorphism of pyroxene.

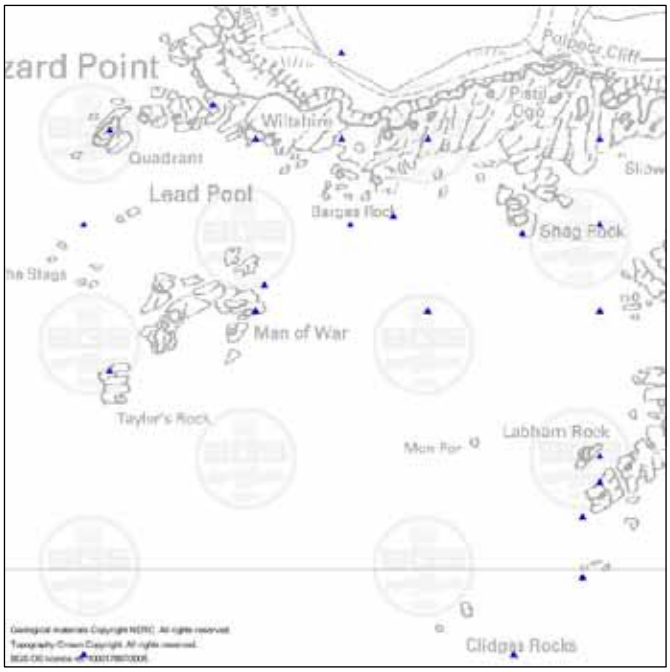

Fig 35 BSG sample locations

Easting	Northing	Precision	Locality	Rock Name	Comments
169120	11350	10 m	Mulvin	Man o' War gneiss amphibolitic	
169120	11350	10m	Mulvin	Man o' War gneiss amphibolitic	
169300	10900	100m	Man o' War Rock	Granulitic Gneiss	
169300	10900	100m	Man o' War Rock	Porphyritic Epidiorite	dyke in gneiss
169300	10900	100m	Man o' War Rock	Porphyritic Epidiorite	dyke in gneiss
169330	11230	10m	Taylor's Rock	Man o' War Gneiss amphibolitic	
169500	11300	100m	SW corner of Lizard Head +30ft HW	Gneiss	
169500	11300	100m	Quarry, SW corner of Old Lizard Head	Granulitic Quartzite	
169500	11300	100m	Quarry, SW corner of Old Lizard Head	Hornblende Schist (contorted)	fine grained
169500	11300	100m	Quarry, SW corner of Old Lizard Head	Quartzite & Hornblende Schist	
169510	11330	10m	Man o' War Rocks, N side	Man o' War gneiss intermediate	
169700	11300	100m	Pistil Ogo, Lizard	Granulitic Quartzite	
169700	11300	100m	Pistil Ogo, SW of waterfall	Hornblende Schist	fine grained
169700	11300	100m	Little Cove, S of Pistil Ogo	Muscovite, biotite Schist	quartzose
169800	10900	100m	Clidgas, outlying rock island, Lizard	Coarse Gneiss	
169810	11390	10m	Smag Rock	Man o' War Gneiss; Quartz Schist	

Fig 36 GeoIndex BSG rock samples

Offshore

The source material available of the offshore geology is more problematical, mainly as a result of the extreme nature of the environment at the Lizard Point. The primary source is The British Geological Survey Sea Bed Sediments Sheet of the Lizard (OCN 90 NE).

This is at a scale of 1:250,000 which equate to almost 4 miles to the inch hence the level of detail available are relatively poor. Whereas the sheet identifies the distribution of surficial sediments indicate that the seabed sediments are likely to be sandy gravels with areas of muddy sandy gravels, the area close in to the Lizard Point itself has not been mapped.

The map however shows that numerous sediment samples have been taken within the immediate vicinity of the Lizard Point, but unfortunately it has not been possible to obtain any further information on the nature and character of these seabed samples. It has however been possible to identify specific rock samples which have been taken within the immediate vicinity of the wreck site.

These are samples which have been taken from the rocks of Taylor's Rock, Man of War Rock and the Stags itself, see Fig 35 for sample locations.

The most relevant samples are from the Man of War Rocks and Taylor's Rock. The sample near the Stags at 169300 E, 11402 N appears to be absent. The petrographic descriptions as detailed confirm the findings of Flett's Geological Survey Memoirs.

7.1.6 British Oceanographic Data Centre (BODC)

The BODC holds publicly accessible marine data including current meter series, wave data, biological, chemical and geophysical data. A search was made by the BODC on our behalf of all of their data files including associated data sources. The results were disappointing because almost all of the files held were for locations which are some distance from the Lizard Point and hence are not considered relevant. The wave data sources were; Seven Stones, Eddystone and off the Isles of Scilly. The CTD (conductivity, temperature and depth) were restricted to a few locations some tens of nautical miles from the wreck site and hence have been essentially discounted.

The BODC did however provide a number of useful contacts, namely;

- recent wave data from the Seven Stones www.metoffice.org
- tide gauge data: www.bodc.ac.uk
- sea surface temperatures from Seven Stones www.oceannet.org/medag
- sea surface salinity from off Plymouth www.oceannet.org/medag
- biological data www.marlin.ac.uk

The United Kingdom Digital Marine Atlas (UKDMAP) published by the BODC at the POL (1998) is a reference work on the marine environment in the form of geographically database. The UKDMAP CD-ROM contains a total of 1,650 thematic charts on a wide variety of topics group under the following headings:

- General Reference
- Marine Geology & Geomorphology
- Heritage Information
- Marine and Coastal Parks, Reserves and Protected Areas

- Marine and Coastal Nature Conservation
- JNCC Coastal and Marine Datasets
- JNCC/ESAS seabird and cetacean Distribution
- Sea birds and mammals
- Marine biology
- Currents, tides & surges
- Winds, waves and weather
- Seawater temperature, salinity and nutrients
- Physical properties of the water
- Chemical distribution
- Exploitation of the marine environment
- Fishing areas and fish spawning areas
- Fishery statistics

Whereas it should be appreciated that the level of detail that can be shown is limited, the Atlas does provide useful information of tidal streams, winds and wave, seawater temperature, and salinity in the vicinity of the Lizard. These show indicative criteria at the Lizard Point for the following components:

- M2 max/min tidal amplitude of 50/10 cm per sec.
- Max/min air temperature over the sea of +25.0 and -4.0° C.
- Max/min sea water temperature of +22.0 & 3.0° C.
- Mean sea salinity in winter of 35.30 ppt at surface and 35.25 ppt at the bottom
- Sea salinity in summer of 34.50 ppt at surface and 35.25 ppt at the bottom

7.1.7 Proudman Oceanographic Laboratory (POL)

The Proudman Oceanographic Laboratory (POL) is one of the leading world centres on tidal prediction and also of modelling and forecasting shelf sea dynamics.

POL have developed modelling programmes which can be used to provide a wide range of parameters relating to sea levels, currents both tidal and non tidal otherwise known as surges. The POLPRED model which can be supplied under licence for use in a Windows environment can be used to produce one year of hourly tidal elevation, current speed and direction hindcast or forecast.

All models have depth average currents but some models can be used to provide data at the surface, depth averaged and at the bottom. Where necessary the standard time interval can also be varied.

The tidal regime statistics that can be derived include: HAT, LAT, MHWS, MHWN, MLWN, MLWS, maximum/minimum current speed/direction, current ellipse eccentricity.

In addition to other criteria the models are able to provide estimates of extreme surge levels or total water levels with return periods of 2, 5, 10, 20, 50, 100, 500, and 1000 years. This together with estimates of extreme tides/surges and total still water levels and depth

mean currents would offer a valuable resource to the understanding of the environmental climate at the wreck site.

It is worth noting that the POL website includes a real/near real time display of sea level networks around the UK. This shows the relationship between actual and predicted tides for the last 7 days or so. These tidal curves highlight the variation between the predicted and observed tide levels due to atmospheric and other effects.

The Applications Team at POL – Lisa Eastwood lac@pol.ac.uk identified that the team could provide a wide range of parameters relating to sea levels and currents including surges but do not have any data relating to waves or wave spectra.

The POLPRED software + model domain is £500, plus a licence fee of £300 subject to the coverage of the numerical model – see www.pol.ac.uk/appl/suppl.html

7.1.8 Environment Agency

The Environment Agency is responsible for maintaining and improving the quality of fresh, marine, surface and underground water in England and Wales. This includes responsibility for coastal water quality under the Water Framework Directive.

The Agency undertakes monitoring in coastal waters to assess water quality for national (NMMP) and international (EC Directives) purposes. The Agency has recently issued (November 2005) reports on:

- The state of the marine environment.
- Our marine strategy
- Working for a better marine environment

The aims of the NMMP are to detect long term trends in physical, biological and chemical variables at selected coastal sites to establish if regulatory measures are effective in protecting the marine environment. The NMMP was initiated in the late 1980s to co-ordinate marine monitoring in the UK between a number of organisations which include CEFAS. The mandate for marine monitoring was extended to include pollution monitoring known as MPMMG. For further information on MPMMG refer to CEFAS (section 7.2.10) These documents are available on the website in pdf format – www.environment-agency.gov.uk.

A request was made to the environment agency to provide any water quality data within 3 nautical miles of the *Royal Anne* Galley. The nearest available site that is available is Mullion Cove, 7 km away to the north-west.

7.1.9 Meteorological Office

The Meteorological Office develops and implements ocean modelling systems for wave forecasting and has been commissioned by DEFRA to develop a near shore wave monitoring network using HF radar techniques. A pilot project has been established for the Celtic Sea but as yet there is no HF data coverage for the south coast of Cornwall.

The wave data used for the SMP was supplied by the Met Office and was used by Halcrow Maritime to develop wave climate criteria for a number of near shore locations along the south coast of Cornwall.

The Met Office also acquires wind data from The Lizard Lighthouse, Culdrose and Camborne www.metoffice.gov.uk.

The data from Culdrose is detailed in the Section 1 of the SMP report (Halcrow Maritime 1999a).

7.1.10 Centre for Environment, Fisheries and Aquaculture Science (CEFAS)

CEFAS is a scientific research and advisory centre working in fisheries management, environmental protection and aquaculture and has an integrated programme to measure long term natural trends in physical, biological and chemical parameters at a number of coastal, offshore and estuarine locations around the UK.

The Marine Pollution Monitoring Management Group (MPMMG) is co-ordinated by CEFAS on behalf of DEFRA and is responsible for the National Marine Monitoring Programme (NMMP).

More information about the role and activities including sources of data can be found at:

www.defra.gov.uk/environment/marine/mpmmg/index.htm

www.marlab.ac.uk/

www.ospar.org

The nearest NMMP sampling station to the Lizard Point is station 585 which is located on the 50.00 degree parallel about 35 nautical miles east of the Lizard Point just south and west of the Eddystone Lighthouse. Water samples are being collected and analysed for organic compounds, dissolved oxygen, suspended solids, metals and chlorophyll a.

7.2 Summary of environmental data for the *Royal Anne* Galley site

This provides a framework for assessing the requirements of collecting further data but the summary should not be considered a definitive statement on environmental data at the wreck site.

7.2.1 Wind Climate

The frequency of the distribution of wind speed against direction as given in table 4.1 and 4.2 indicates that prevailing wind direction is south westerly and that the maximum recorded wind speed from 1987 to 1997 was 63 m/s (140 mph).

7.2.2 Wave Conditions

The offshore wave conditions at 50.00° N, 4.46° W, predicted by the Met Office Wave Model, indicates that the dominant wave direction is in the 210° N and 240° N sectors for over 60% of the time.

The most frequent wave condition is Hs = 1 m, which prevails for about 25% of the time. For 5% of occurrences the wave height exceeds Hs = 4 m.

The most extreme waves arrive from 210° with the 1:100 year conditions reaching Hs = 12 m and the 1:2 year conditions of Hs 8 m. The wave conditions for the second most severe sector, 240° N, tend to be consistently 1 – 1.5 m less than the 210° N direction.

7.2.3 Water Levels

The tidal range does vary significantly along the south coast of Cornwall, and is approximately 4.7 m on spring tides. The predicted 50 year return period storm surge along the south coast of Cornwall is 0.75 to 1.00 m (Pugh). For future planning, sea level rise must also be taken into account which is estimated to be 330mm over 50 years.

The 100 year return periods for 1990 using the joint probabilities method for Newlyn as determined by Dixon and Tawn in collaboration with POL on "Extreme Sea-Levels at the UK A – Class Sites is 6.43 metres. Because of the relative close proximity of Newlyn to the Lizard Point it is considered that this extreme sea level which is derived from a

combination of extreme still water and extreme waves can be applied to the site of ***Royal Anne*** Galley.

It is interesting to note that IACMST reports that whereas sea level trends show an increase in sea level of 100mm during the 20th century, the rate of sea level rise has decreased from the 19th into the 20th century. It is unfortunate that it was not possible to access the IACMST interactive database because it was not functioning when this section of the report was in preparation.

7.2.4 Water Temperatures

Annual sea surface temperature (sst) around the UK coastline has increased by about 0.5° C for the period 1871 to 2000, with most coastal sites showing a warming trend.

The nearest time series data to the Lizard Point is the Seven Stones data. This shows an increase in annual sea surface temperature from 12.0 to 12.5° over the period 1871 to 2000.

7.2.5 Salinity

Only a few long-term time series exist for UK waters and these do not indicate any overall trend.

There is no relevant time series data for the Lizard Point, with all the time series data being restricted to the North Sea.

7.2.6 Tidal Stream Currents

The SMP identified that the most definitive tidal stream atlas for Cornwall (George 1990). The information can be used subject to reservations and acknowledgement of the source of the material.

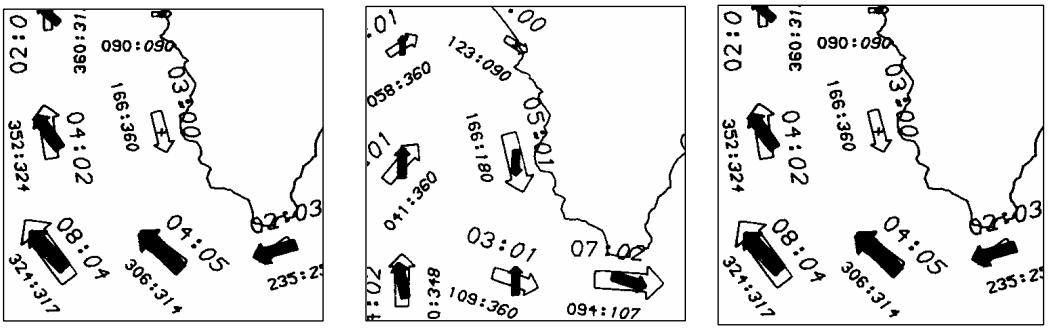

Fig 37 Detail from the Tidal Stream Atlas of the Cornish Coast, from left to right 5 hours, 4 hours and 3 hours before HW Devonport (reproduced courtesy of Plymouth University)

The atlas was produced using a traditional format for a semi-diurnal regime comprising 13 charts, one for each hour of tidal time. The arrows show the 'set' of the stream by direction and the 'rate' of the stream by magnitude. These show some interesting phenomena in the area around the Man of War Rocks. It is anticipated that the flows in the skerries in the vicinity of the ***Royal Anne*** site will not follow the normal pattern of flows due to reverse circulating currents caused by the localised nature of the seabed topography. For instance, the prediction at 6 hours before HW Devonport with a strong ebb tide flowing at up to 1.5 knots down channel shows a reverse current close inshore around the wreck site.

At 5 hours before HW Devonport this reverse circulating current has become more pronounced and formed a gyre centred on the area around the Stags. Over the next hour (4 hours before HW Devonport) the centre of this gyre has moved offshore creating stronger reverse circulating currents inshore. By 3 hours before HW Devonport this gyre

has completely disappeared, and the flows are all in a flood direction with relatively strong flows at the wreck site.

7.3 Summary comments on available data and recommendations

The UKDMAP issued by BODC in 1998 represents a useful graphical database but since it has not been updated it has now been superseded by the work undertaken by IACMST which has produced a number of reports and an interactive website that provides access to a range of chemical and physical oceanographic parameters.

Whereas a number of marine monitoring programmes have recently been initiated, they do are not sufficiently developed to provide any beneficial data for this DBA. It is however important to appreciate that if these programmes are successful then they should provide an effective means to source survey information and data at any given location around the UK coast line.

The SMP provides useful background information and analysis of the coastal dynamics along the south coast of Cornwall. But because the Lizard Point does not represent an area of strategic importance regarding coastal defence issues and because it lies on the interface of two study areas, the SMP does not unfortunately provide site specific data for the location of the wreck of the *Royal Anne* Galley. The SMP does however provide valuable wind and wave climate data that can be used for wave climate modelling at the wreck site.

It is interesting to note that perhaps the most relevant site specific data that is available was from the Geological Survey Memoirs dated 1911 which made direct reference to the Man o' War (Flett 1946).

Similarly, the data from the UKHO include charts from the survey undertaken in 1851 using lead soundings (UKHO L7989). The data from this survey is still used in the make up of chart 2345, and the UKHO stressed that as such the charting should be used with caution. It is noted that the soundings from the 1973 survey (UKHO L6859/1-2) were undertaken from a small craft during the late autumn, often in adverse sea state conditions and hence should also be used with some degree of caution.

It is for this reason that every effort should be made to not only corroborate the sounding charts but to provide more high definition data of the wreck site by acquiring LIDAR data of the offshore reefs.

It should also be appreciated that it is often easier to acquire offshore hydrographic and oceanographic data using a larger vessel to acquire good quality data sets than it is to operate close to the shore in shallow water.

In the instance of the wreck of the *Royal Anne* Galley, the location and operating conditions make it extremely difficult to acquire corroborative data using conventional techniques. It is therefore not altogether surprising that the availability of site specific data is limited to obtaining rock samples on the offshore reefs and to a habitat sampling programme which could be carried out by a marine biologist operating from a small craft.

It may therefore be worthwhile making an assessment to determine if a sequence of time series observations of a range of parameters taken at a prospective monitoring point relative near to the Lizard Point can be considered representative of the conditions at the wreck site. This would require observations to be correlated between the monitoring point and the wreck site, but would mean that the extended time series data from the monitoring point could then be applied to assessing conditions at the wreck site.

This approach would largely depend on the free access of data between the various groups and organisations. At the moment organisations such as the UKHO charge for their

services and issue data under a licence and hence there are issues with regard to free access to data when these organisations become part of a larger network.

Finally, it is considered that the review of data sources for the *Royal Anne* Galley at the Lizard Point have provided useful background information for the assessment of methods of data collection which are considered in the Section 9.

8 Coastal processes

By Jon Rees

8.1 Summary

The relatively sparse oceanographic data set from this region has resulted in a two stage modelling approach to determine the magnitude of coastal processes.

Firstly, a bed shear stress model has been developed in order to assess the importance of waves and currents in the inter-tidal zone. Secondly, a 2d depth integrated numerical model was used to predict the tidal ellipse and residual current direction at the *Royal Anne* Galley site. Results indicate that in the inter-tidal zone, where the *Royal Anne* lies, wave height and water depth are the controlling parameters in either dispersing artefacts from the site or sediment engulfing the site. However, in other deeper locations the relative balance between wave and tidal forces dominates. In the *Royal Anne* scenario, particle tracking experiments with the numerical model show the majority of particles remain close to the wreck site with a smaller population heading northwest. The lack of good quality wave and current data from the Lizard site results in low confidence in the predictions of the long-term fate of particles.

A methodology has been developed in which to integrate all the disparate oceanographic datasets in order to provide high quality, auditable advice to archaeological managers of protected wreck sites. In order to complete this process a structure decision tree program for management of protected sites is required.

8.2 Oceanographic theory

8.2.1 Currents

Currents around the UK are driven by three main forcing mechanisms – (i) celestial bodies (moon, sun, plants etc.), (ii) from density effects either associated with estuary systems where density (salinity variations) effects can occur or from the creation of seasonal temperature gradients that cause density stratification of the water column producing "jets" around cold water domes (Brown et al 2003) and (iii) from Meteorological forcing due to storms or hydrostatic effects. In order to assess the relative magnitudes of these forcing mechanism currents and tidal are measured for long periods (typically 28 days) of time using current meters. Figure 38 shows three different methods of displaying current data. Panel A shows 12 hours of data drawn from a central point and creates a tidal **ellipse** in which the tide rotates. The same data drawn along a horizontal axis (panel B) shows the variations over time in a **stick** plot. Finally, the individual data points, or vectors, can be drawn as a progressive vector diagram (or **PVD**). After plotting 12 hourly vectors the difference between the start and finish point is termed the **residual** current.

The residual current is sensitive to a whole range of different drivers and can change magnitude and direction on various timescales from hours to weeks. E.g. a storm may significantly change the residual direction for a short periods (days), variations maybe evident on spring-neap timescales (14 days) or on seasonal timescales (several months).

Moving the starting point can also significantly change the trajectory of the residual. In summary, residual currents and their PVDs are both spatially and temporally dependent.

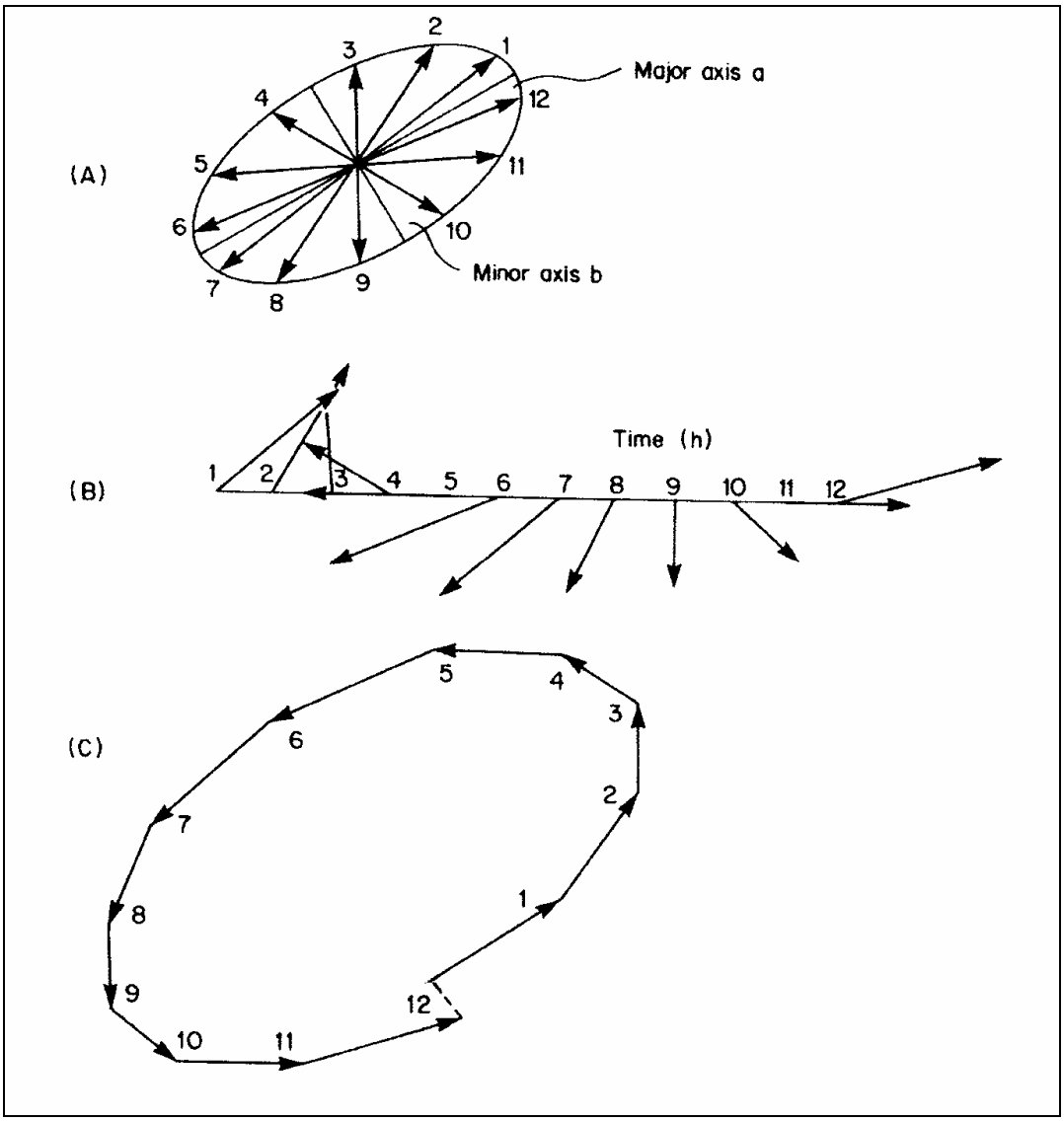

Fig 38 Tidal current vectors (from Dyer 1986)

8.2.2 Waves

Waves are generated by the action of wind on the surface of the sea. In deep water, wave height is controlled by three factors: wind strength, duration and fetch. The faster and more sustained the wind blows over a longer distance the greater the wave height and corresponding the wave period. Long period waves (greater than approximately 10 seconds) are normally associated with waves created potentially thousands of kilometres away. Conversely, locally generated waves tend to be of shorter wave period.

As waves propagate from deeper water to shallower water, wave heights will increase until the wave breaks. Waves will reflect off headlands and reefs, refract (turn into shallower water) and shoal around changes in bathymetry.

8.2.3 Sediment transport

Sediment transport is controlled by the forces acting upon the substrate. The non-linear combination of the wave and current forces will either transport sediment in suspension (within the water column) or as bedload (within the substrate). An intermediate state also exists where sediment can alternate between bedload and suspended sediment transport known as saltation. Generally, sediment is transported from *sources* of sediment e.g. eroding cliffs or river mouths to *sinks* of sediment e.g. estuaries or deep water. The timescale for these changes can take thousands of years with sediment moving in slow steps from one temporary reservoir of sediment to the next.

Sidescan sonar and swath bathymetry systems can be used to map the bedforms on the seabed which give an indication of the sediment transport direction. Note these "snap shoot" surveys give indications of the sediment transport direction when sediment last occurred. This may have been a few seconds before the survey, a month or several years ago and is dependent on the processes transporting sediment (in this instance tides, spring tides or severe storms respectively). Particle size and mineralogical analysis of the sediment can also help establish sediment transport patterns and pathways.

8.3 Lizard area data

An assessment of the available data is provided above in Section 7 and this section concentrates on modelling data and other data sources required for the bed shear stress analysis.

8.3.1 Currents

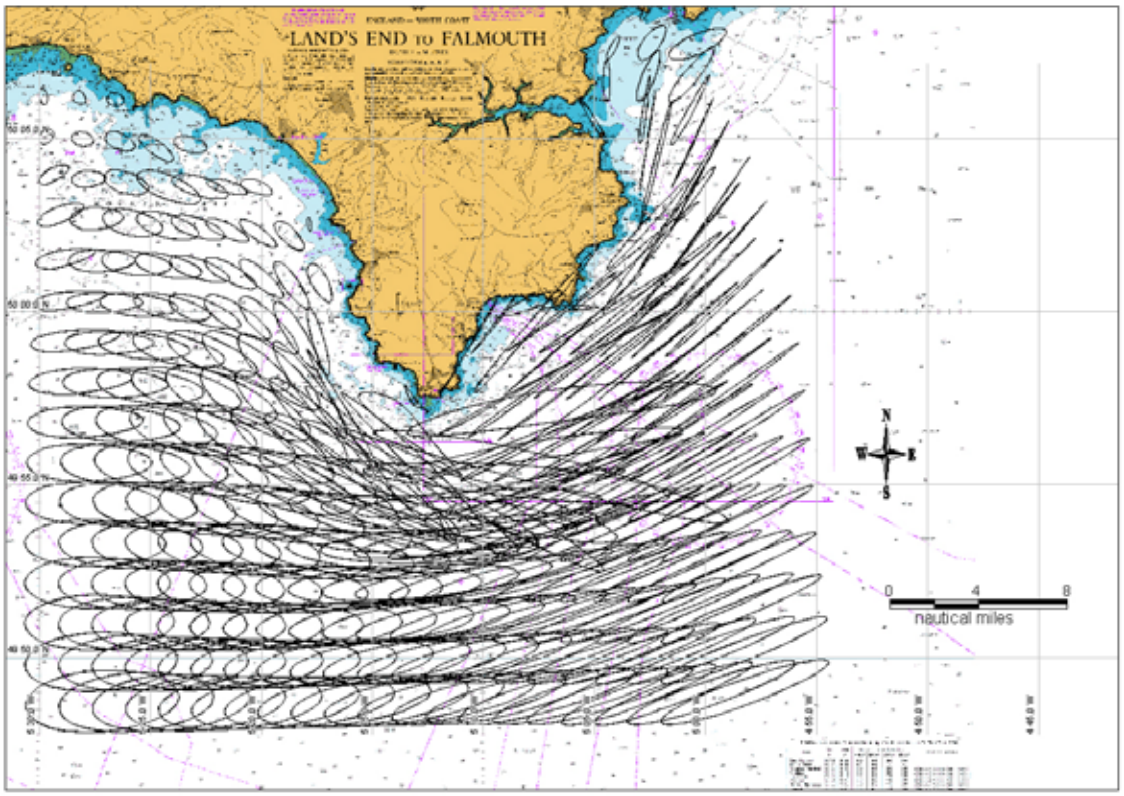

Fig 39 Spring Current ellipses around the Lizard (from CEFAS Plume model)

Figure 39 shows the tidal ellipses for the area around the *Royal Anne* Galley site and the Lizard peninsula. Within Mounts Bay, to the west of the region, the tidal ellipses are generally small and circular indicating weak and circular tidal currents. However, moving to

the east tidal ellipses getting significant larger and ellipsoid in shape around Lizard Point and even longer and more elongated or rectilinear on the east side of the Lizard.

The residual currents estimated by the model are shown in Figure 40 and indicate the eastward residual flow along the coast. Note that this model does not predict residual currents due to meteorological e.g. storms or from density effects. For instance, a strong easterly wind may change the direction of the residual to a westward direction. The strength of the residual also increases eastwards and shows a convergence zone to the south east of the headland. This maybe evidence of a gyre or eddy circulation commonly associated with the headland where an eddy is formed on the downstream side of the promontory.

The model needs to be calibrated and validated with wave and current data from the Lizard site in order to provide high confidence prediction of the fate of particles.

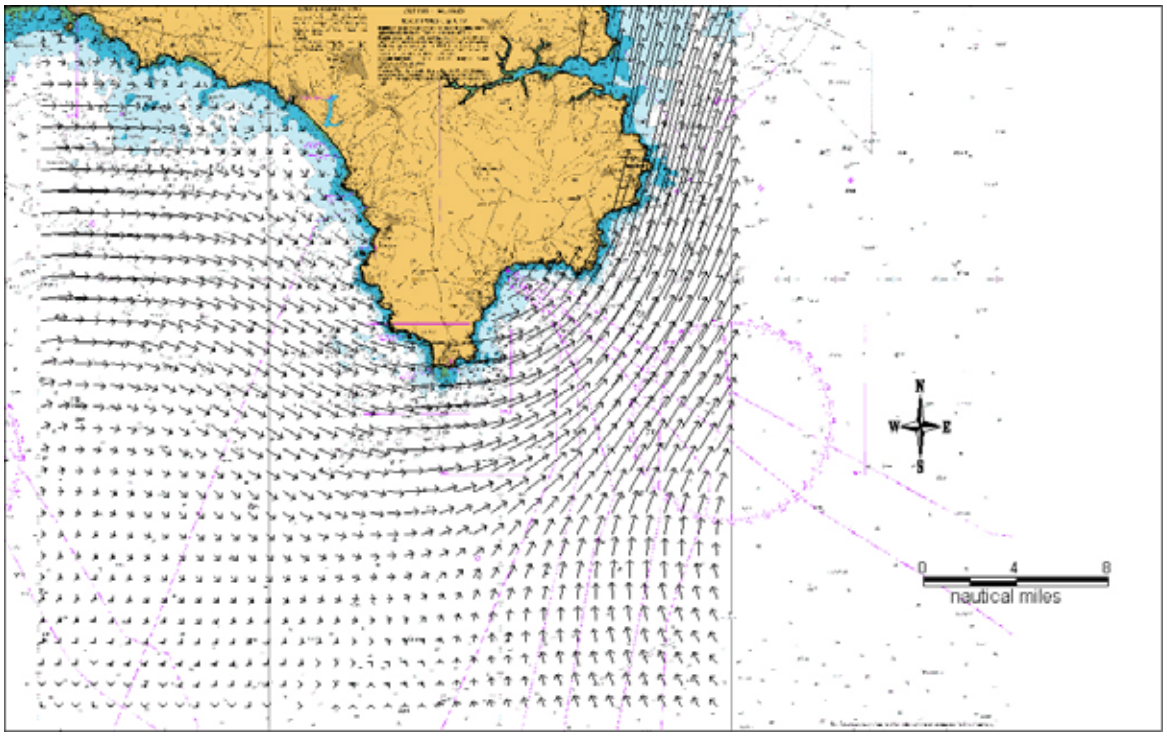

Fig 40 Residual current direction around the Lizard (from CEFAS Plume model)

8.3.2 Seven Stones data

The nearest source of high quality Oceanographic data is from the Seven Stones Met Office buoy, situated between Land's End and the Isles of Scilly and is available from the WaveNet System (Rees, 2003). Data from January 2003 to January 2006 is present (data from earlier is available for purchase from the Met Office) as shown in Figure 41 and shows wave heights up to 8m have been recorded with wave periods up to 20 seconds. Surface temperatures vary just under 20 °C in summer to approximately 10 °C in winter.

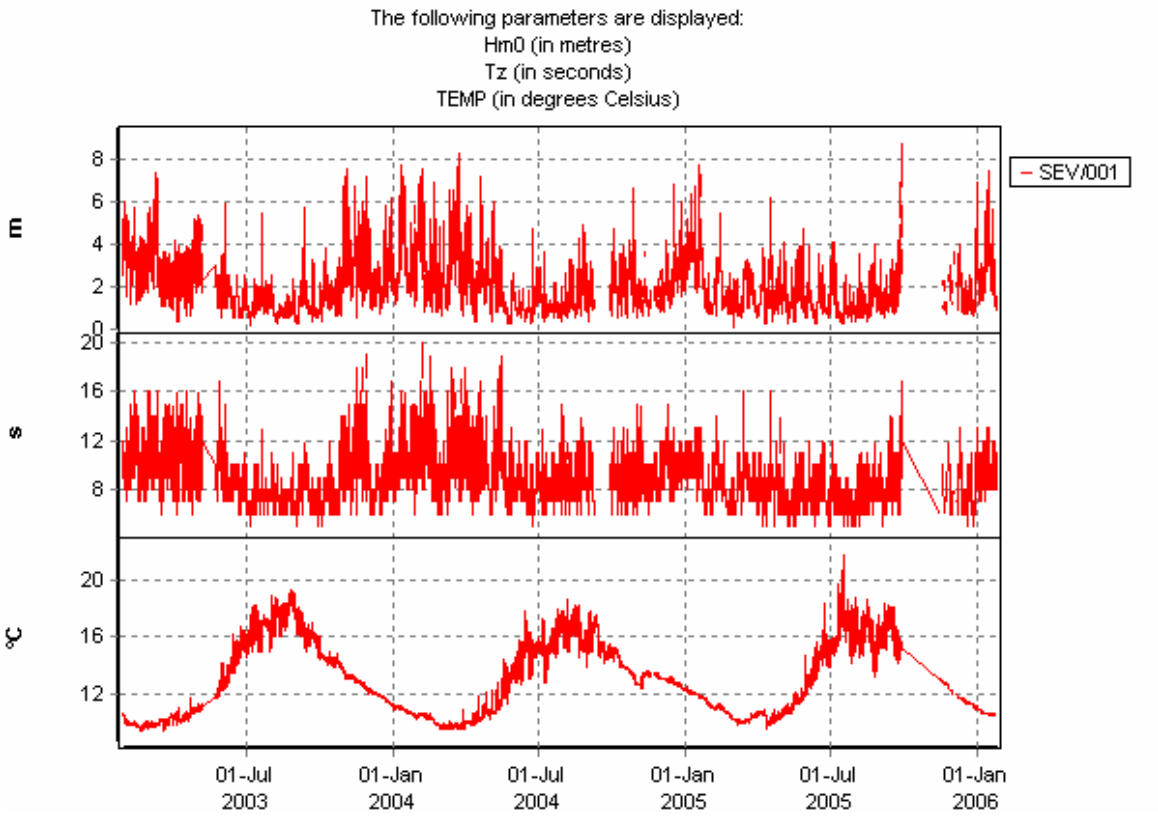

Fig 41 Wave Height (top panel), wave period (middle panel) and temperature (bottom panel) data from the Seven Stones Buoy for the period January 2003 to January 2006 (from WaveNet – www.cefas.co.uk/wavenet - data courtesy of the Met Office).

8.4 Numerical modelling

Two different approaches to modelling the site of the *Royal Anne* have been undertaken. Firstly, a bed shear stress model showing how the wave and current forces acting on the seabed vary with water depth etc. Secondly, the CEFAS sediment plume model (Aldridge 2002) has been used to produce predictions of tidal ellipses, tidal residues and trajectories of particles seeded into the flow field.

8.4.1 Bed shear stress modelling

In order to assess the resultant forces on the seabed from wave and currents, the bed shear stress from each component must be calculated individually and then combined using non-linear wave-current interaction (Soulsby 1997). Thus, the bed shear is a function of the water depth, wave height, wave period and current velocity) or

Bed Shear stress (τ) = f (water depth, wave height, wave period, current velocity)

In order to assess the importance of bed shear stress, one parameter will be altered each time with the remaining parameters constant. Figure 42 shows the bed shear stress with constant wave period and current (10 seconds and 1m/s respectively). As waves increase in wave height, they break in deeper and deeper water until the 12m wave does not break in 15m water depth. Note that the bed shear stress increases from 3 N/m2 (due to the background current) to a maximum of 23 N/m2.

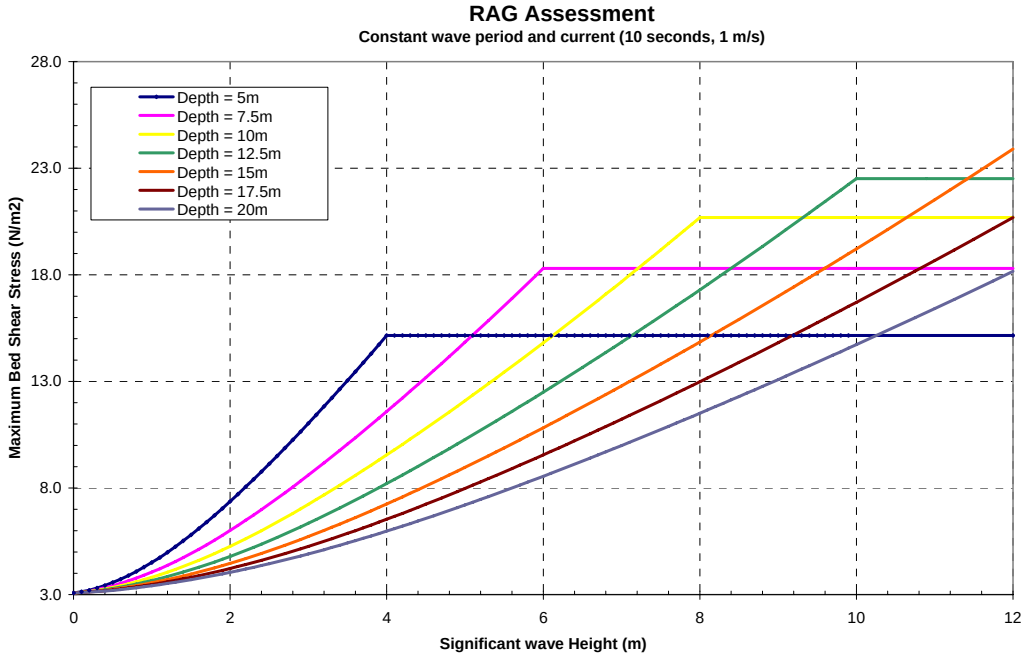

Fig 42 Bed shear stresses from various water levels (constant wave period and current velocity). The wave breaking arrangement is shown as the break in the curves

In the second arrangement, the water depth and current are keep constant (20m and 1m/s respectively) as shown in Figure 43. The importance of wave period is clearly demonstrated with longer period waves "penetrating" deeper and thus having significantly more effect on the bed shear stress.

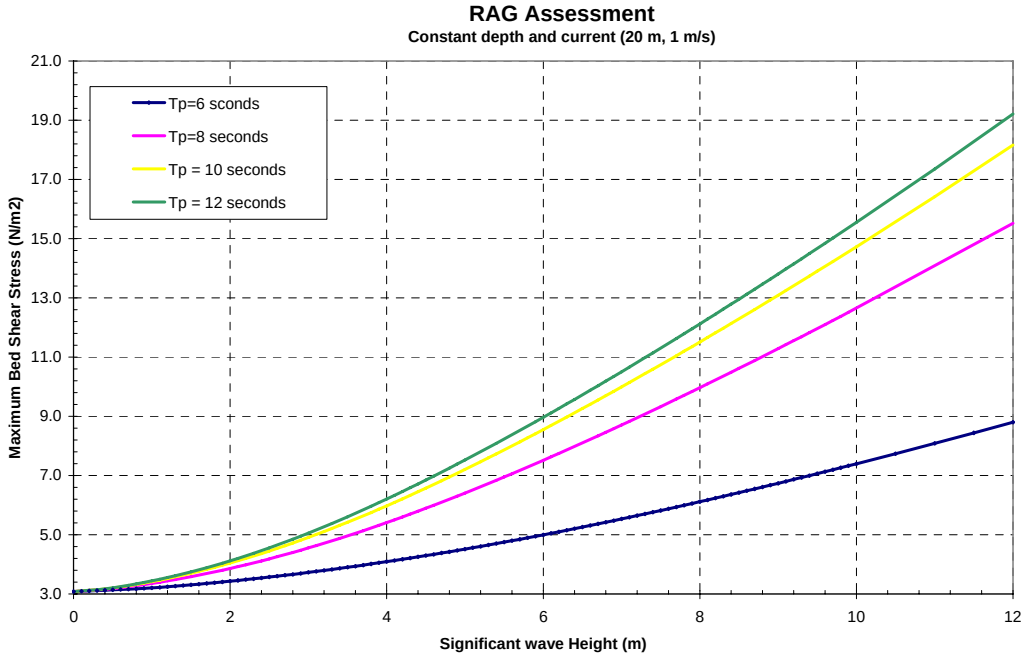

Fig 43 Bed shear stresses from various water periods (constant depth and current velocity)

In the third arrangement (Fig 44), the water depth and period are kept constant (20m and 10 seconds respectively) and the depth mean current varied. The zero current line shows

maximum bed shear stresses of approximately 15 N/m2. By increasing the current to 0.66 m/s (approx 1 knot) the maximum bed shear stress increases to 17 N/m2.

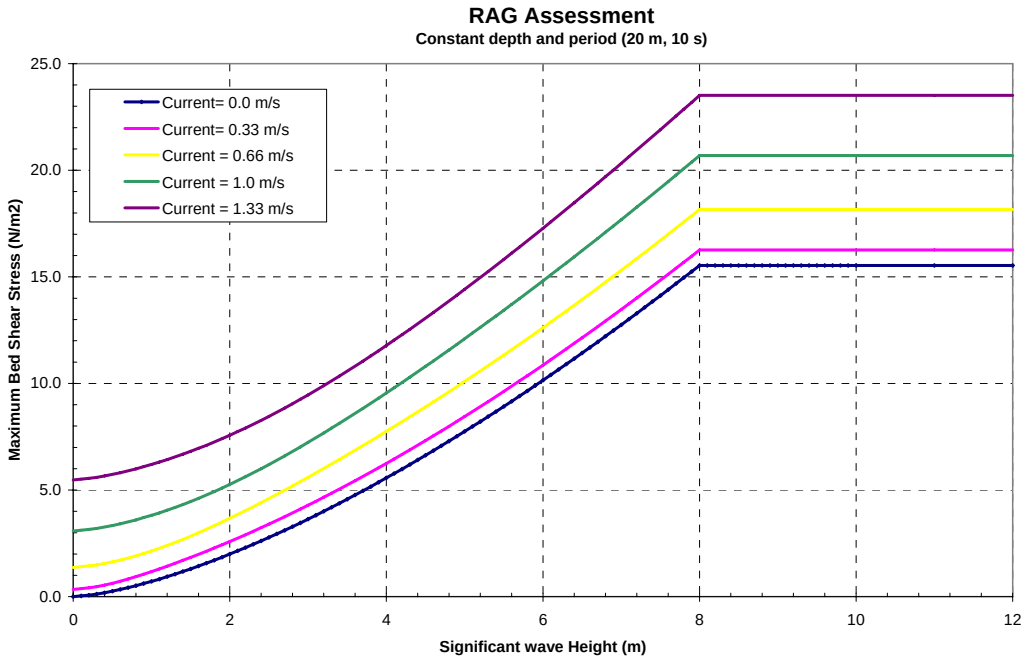

Fig 44 Bed shear stresses from various currents (constant depth and wave period)

The above diagrams show that the water depth and wave height are the most important parameters for controlling the bed shear stress at an inter-tidal site. Currents and wave period are of secondary importance in this locality. However, in deeper open water, this will be reversed and current will dominate for most of the time except for storm events. In these deeper waters, the relative energy balance between the strength, frequency and direction of storms versus tidal currents will become driver for sediment transport. It should be noted that these statistics may be effected by Climate Change.

8.4.2 Particle tracking

The CEFAS plume model (Aldridge 2002) has been used to map the current ellipse and residual current directions around the Lizard Point as shown in Figures 39 and 40. The model can be used to seed particles of various particle sizes and density into the model at any point within the model domain at specific times and at various tidal states.

Figure 45 shows the output of the model with 2500 points released at the *Royal Anne* site after 48 hours at a spring tide slack water. The typical particle size is 180 micron (fine sands). The main body of particles, in this scenario, is close to the initial release point, with a secondary group moving offshore and to the west. Relatively few particles move eastwards. It should be noted that the timing of the release is crucial in assessing the footprint and minor changes in the release time can result in significantly different particle footprints.

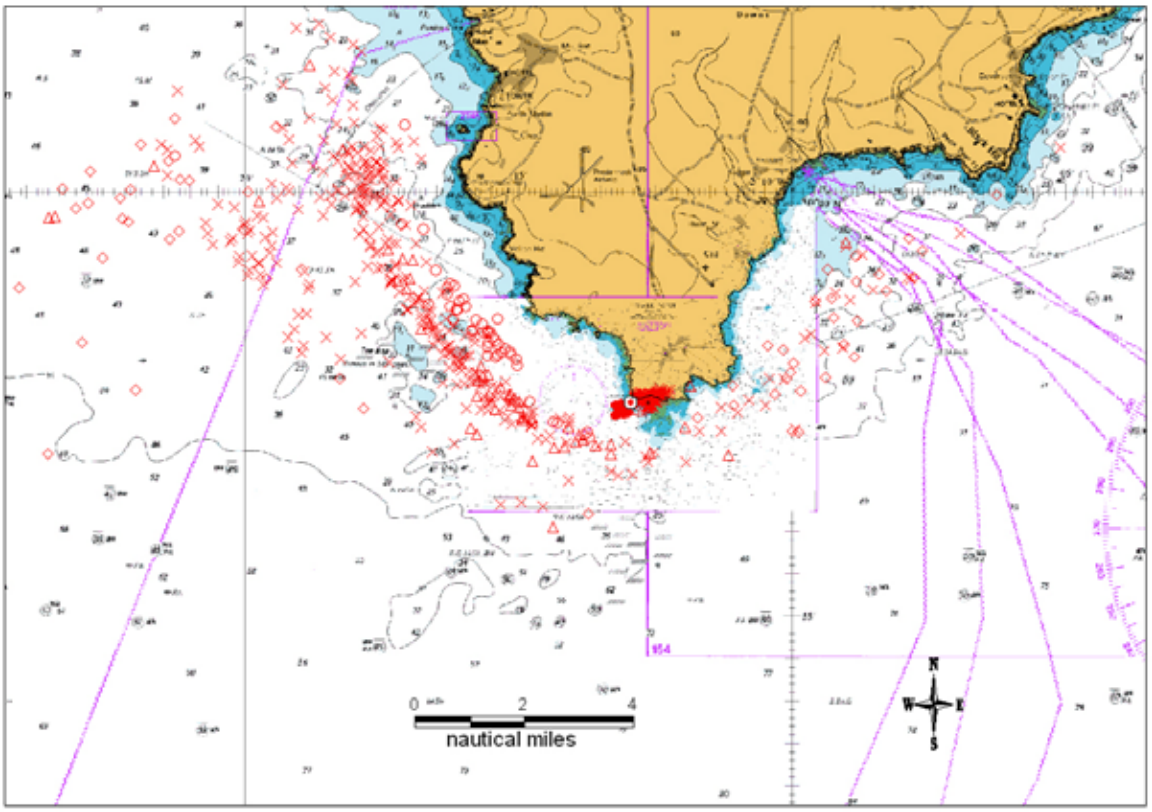

Fig 45 Dispersion of 2500 artificial particles (mean particle size 180 microns) in the CEFAS Plume model from the RAG site (after 48 hours on a spring slack water; symbol reflects height in the water column – circles (near surface), triangles (mid-depth), diamonds (near-bed, crosses (particles on the bed) at the end of the model run

Other scenarios with particles of 1000 microns and higher specific density (eg oak has a specific gravity of 1240 Kg/m3) have been run to test if different particle sizes have different trajectories and hence different long-term sinks. However, all other scenarios results in all the particles hitting the seabed close to the *Royal Anne* site. In other locations and in different wave/current regimes, different long-term sinks can be evident.

Note the CEFAS plume model does not include wave forcing as the model is based on a database of tidal constituents. Similarly, the bathymetry used to create these tidal constituents does not resolve the complex and uncharted inter-tidal zone.

8.5 Conclusions

This assessment of the coastal processes at the *Royal Anne* Galley site has shown the crucial requirement to preferably collect high quality oceanographic data (waves, currents and bathymetry) from the protected wreck sites. This is especially true for the *Royal Anne* site which lies in a generally data sparse region of the UK. However, there are locations around the UK where high quality datasets already exist or where calibrated and validated numerical models can provide good estimates of the wave and tidal regime.

Once wave and current data has been collected these can be combined to produce bed shear stress exceedance diagrams which archaeological managers can use to manage protected wrecks and marine landscapes. Appendix 13.2 shows how wave and current data from a site of the East Coast (Scroby Sands) can be used to create bed shear stress exceedance diagrams.

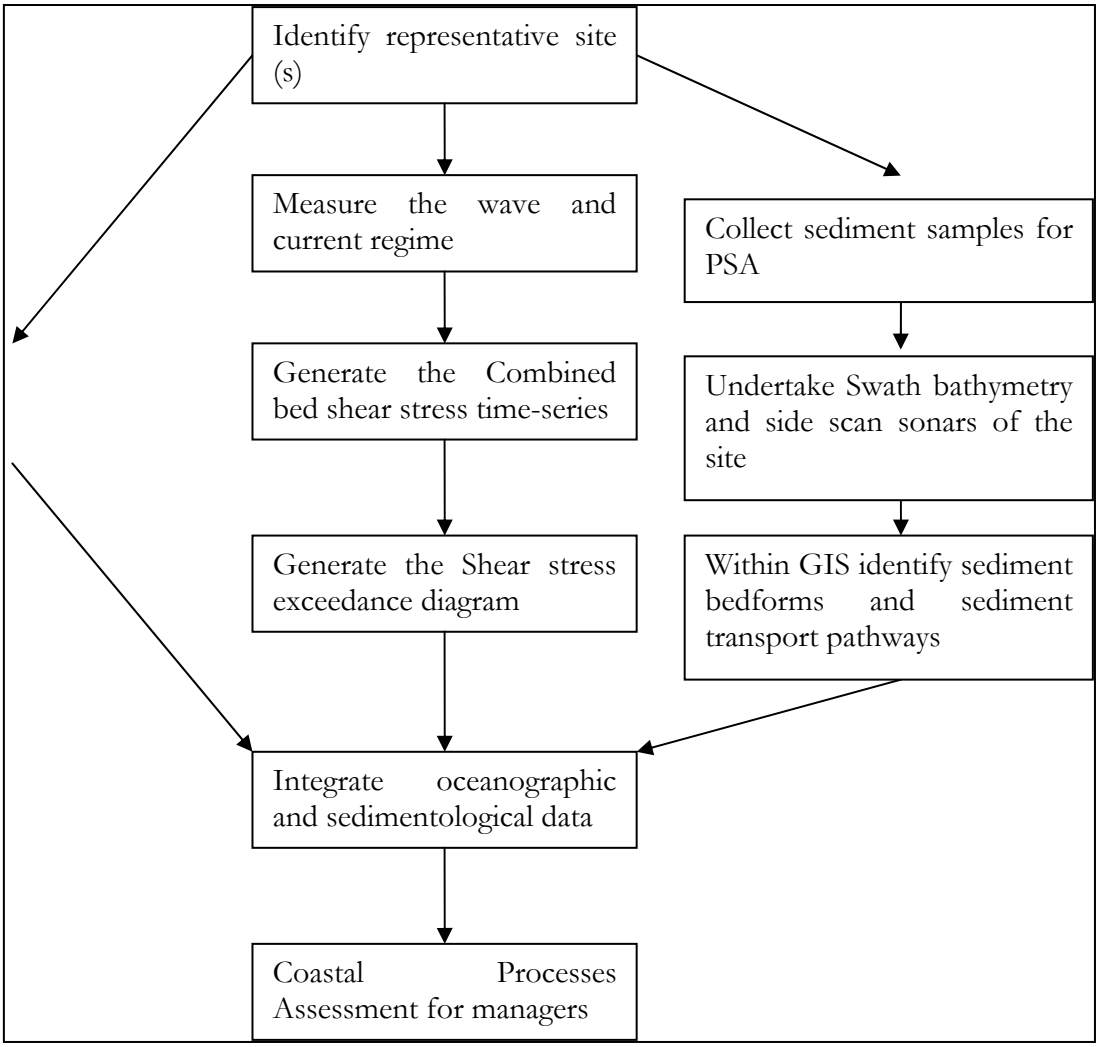

Fig 46 Flow chart for the assessment of coastal process at protected wreck sites

Figure 46 shows an information and process flow chart for integrating coastal processes data for providing advice to archaeological managers. Three streams of data are evident – water quality, oceanographic and sedimentological/bathymetric. Once each stream has been completed, the data could be entered into a structured decision tree programme which can integrate disparate data streams and provide a ranked risk based management matrix. Currently, this decision tree program does not exist for protected sites, but similar approaches have successfully integrated data for the identification and creation of new habitats for managed re-alignment sites commissioned by the Environment Agency (Parker 2005).

8.6 Recommendations

- In the inter-tidal zone the wave height and water depth are the controlling parameters for sediment transport and hence dispersion of artefacts from protected wrecks sites.
- In deeper water the relative balance of storms and tidal forces controls sediment transport.
- Wave and current measurements are essential for describing the sediment transport environment around a protected wreck site. In some instances, these data already exist from high quality measurements for other purposes eg windfarm and dredging area environmental impacts and

scientific research. However, in some areas, such as the Lizard, there are no high quality data sets of waves and currents, even from areas remote from the site and thus not representative and hence new datasets are required.

- Generation of bed shear stress exceedance diagrams allows managers of historic sites to firstly assess the potential transport mechanisms of artefacts and hence dispersion from the deposit site, and secondly to assess the likelihood of local sediment transport (eg sand waves) either engulfing a site or exposing a site. From these curves the probability of various scenarios can be judged on a case by case basis and hence management plans for each historic site created.
- In many of the UK's inter-tidal zones bathymetric records are either non-existent, are of poor quality or are sparsely populated. It is crucial to the success of the management of historic sites that the morphology of these areas is known in sufficient detail to manage the sites as:

(1) Bathymetric charts (to appropriate horizontal and vertical resolution, accuracies and coverage), allow correct plotting of the positions of artefacts in their correct oceanographic/sedimentological context. An assessment can thus be made of the oceanographic transport mechanisms in the vicinity and hence in a "hindcast" mode can allow various "wreck dispersion scenarios" to be tested.

(2) Bathymetric charts allow oceanographers to assess the bed shear stress from combined breaking waves and waves in the intertidal zone. Potential methods of acquiring this type of data include swath bathymetry from vessels and LIDAR from aircraft (MESH, 2005). Various data initiatives exist around the UK from this type of data eg UKHO, MDIP (www.oceannet.org/MDIP/Introduction_to_MDIP.html). Nationally with the UK, there are initiatives underway to survey the whole of the UK Continental Shelf using swath bathymetry for a variety of end users (Chris Vivian pers comm).

- A structure decision tree programme needs to be developed to integrate disparate data sets for Marine Environment Assessments of protected wrecks sites. This will create a risk based management matrix with which managers can administer a site. An audit trail is also created for future reference.

9 Assessment of methods of data collection and application

By Kevin Camidge

9.1 Physical oceanography

9.1.1 Waves

There are a number of commercially available instrumentation packages which collect this type of data.

Waverider buoys

These are often used in commercial projects where wave parameters need to be recorded. One of their principal advantages is ease of data telemetry. Because the device sits on the surface of the sea, data can be transmitted electronically to shore.

These devices do not, however, collect tidal stream data. Because we are also interested in collecting data on currents (tidal stream data) it will be more cost-effective to consider an instrument package which collects these data simultaneously.

As an indication of likely costs, the Axys Triaxys directional wave buoy system costs £165 per day to hire from GSE rentals. Deployment, maintenance, retrieval and insurance costs need to be added to this.

Combined Current Profiler / Wave Gauge

One such system is the Nortek AWAC system. This is not the only available instrument package but details of the AWAC will be given as an exemplar of what is available.

This instrument records data on current profile as well as wave height, period and direction. In addition, the unit records temperature and pressure (depth). The standard AWAC is installed on the seabed in up to 40m of water. The unit can be deployed for up to 8 months with lithium batteries and can operate online or as a stand-alone unit with internal data recorder and batteries. A data sheet for this unit is reproduced in appendix xx below.

To get a complete picture of the wave and current conditions on a site, data would need to be collected for a whole year. This would maximise the chances of recording the higher wave energies encountered during winter storms. However, on the more exposed sites this may pose a threat to the data collection unit. A minimum data collection period would be one complete tidal cycle (a month).

The cost of these units is relatively high. Rental charges quoted by GSE rentals for this unit are £60-70 per day. Transportation, insurance and deployment/retrieval costs would need to be added to this. If a full year's data were to be collected, then outright purchase might prove to be more cost effective.

9.1.2 Tidal stream

If for any reason current data is not collected using the combined AWAC wave and current instrument package as detailed above, then a stand-alone current measuring device will need to be deployed. Again, numerous commercially available devices exist. One such is the Nortek Aquadop acoustic current meter. This device needs to be installed on the seabed. This device collects simple wave data using a pressure sensor. This works in shallow water to a maximum depth of 15-20m. No wave direction data are recorded. A data sheet for this device is included below in Appendix 13.3.

As an example of likely cost, the Aquadop current meter costs £25-30 per day to hire from GSE rentals. Transportation, insurance and deployment/retrieval costs would need to be added to this.

9.1.3 Artefact distribution

Workers on historic wreck sites have often reported the movement or 'disappearance' of artefacts exposed on the seabed. A number of attempts to quantify and measure these phenomena have been attempted.

The usual technique is to place tracer objects on the seabed at known locations and to record their positions at set time intervals. At Kinlochbbervie, practice golf balls and halved tennis balls respectively weighted with washers and bolts were used. 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 wreck sites *Hazardous Prize* and St Peter Port Harbour. The bricks were of two types, 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 and personal correspondence). This work is ongoing 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 it could be used widely on historic wreck sites and direct comparisons of the forces acting at the seabed of each site made. More sophisticated techniques involving active electronic or acoustic tracking of the tracer objects have been suggested; while this would reduce the incidence of 'lost' tracers it would involve considerable extra cost. As an example, acoustic ID tags which are detectable using sidescan sonar exist – but these cost in the region of £300 for each tag.

Data from such dispersal trials would help considerably in validating existing object dispersal models such as the CEFAS sediment PLUME model for individual sites. They would also be of great value in corroborating the bed shear stress models discussed above in Section 8 'Coastal Processes'.

9.1.4 Temperature

Several of the instrument packages under consideration for monitoring other parameters on historic wreck sites also record temperature. Instruments used to record wave height, currents and sediment chemistry can all be fitted with water temperature sensors. This data is therefore probably best collected by the wave and sediment chemistry instrument packages. It is also relatively easy to collect temperature data from a small boat using a temperature probe which can be lowered into the water column. For this reason, it is probably worth recording the water temperature on site whenever other activity demands a presence on site. This can be done separately for sea surface and seabed at known locations.

9.1.5 Salinity

This refers to the concentration of inorganic dissolved solids in seawater. The salinity at a site is likely to be fairly constant. The salinity can be measured in a number of ways. One method is to measure conductivity and temperature; the salinity can then be calculated. Conductivity can be measured as part of an existing instrument package, such as a sub-sea datalogger. It can also be measured using a simple conductivity/temperature drop probe.

Another method is to measure salinity as part of the water sampling regime. Water samples can all include salinity as one of the analysed parameters.

9.2 Chemical oceanography

9.2.1 Redox

The Redox (Reduction-Oxidation) potential within seabed sediments could be determined either by direct measurement using a probe placed in the sediment, or by analysis at a laboratory of sediment samples.

Direct measurement

The use of data loggers to record Redox potential has been used on a number of sites, notably on the *Colossus* stabilisation trials and on the MoSS project (Camidge 2005; Gregory 2004). In both these cases an EauxSys data logger with probes attached by flying leads was used. Typically the Redox potential was logged by the instrument every hour for a period of three months. The Redox data from both projects exhibited problems - periods of malfunction and unrealistic values interspersed with periods of more credible values. These malfunctions may have been caused by fouling of the Redox sensors but could also have been caused by a flaw in the instrumentation itself. If datalogging is to be used then measures should be taken to protect the Redox probe from fouling, perhaps by refining the dip-wells used for the probes on the MoSS project.

EH already own an EauxSys data logger so presumably purchase cost would not be an issue. Calibration, possible modification, deployment and retrieval would, however, all be additional costs.

Sediment Analysis

Wood boring organisms and fungi are only active in aerobic conditions, so they only tend to attack wood exposed to open seawater. Aerobic sediments contain relatively high levels of molecular oxygen, nitrate and ferric ions. More deeply buried sediments exhibit much lower levels of these chemical species but higher levels of ferrous, sulphide and ammonium ions. 'These chemical changes with depth in the sediment are connected to a change in habitat conditions from aerobic to anaerobic' (Gregory 2000, 40). The relative proportions of these chemical species can therefore be used as Redox indicators. By analysing sediment samples taken from the vicinity of buried archaeological material, an indication of the ongoing chemical processes can be determined. For details see Sediment Chemistry below

9.2.2 Monitoring corrosion of iron

Iron on historic wreck sites is very common. In particular, many sites have cast iron guns, which are often the means by which the site was first recognised. Any consideration of the environment of the site must also consider the stability of these relatively large iron objects. In order to quantify the corrosion process in these iron objects David Gregory was asked to formulate a strategy for monitoring iron guns – this is reproduced in full in Appendix 13.1 below.

He has outlined a two part strategy: firstly, how to quantify the corrosion by measuring the corrosion potential and pH and secondly a method of stabilisation, using sacrificial anodes. Both techniques, if adopted, need to be implementing using divers.

9.2.3 Water quality

One litre samples are required and separate samples need to be taken from the water column at the surface and seabed.

The samples need to be taken and packed in sealed containers, stored in a coolbox with ice packs and transported to the analysing laboratory within 24 hours. Water samples would be analysed for pH, salinity, nitrates, phosphates and metals. The cost per sample (using a UKAS accredited laboratory) is likely to be in the region of £50-100 per sample. Additional costs will be incurred for specialist interpretation of the results.

9.2.4 Sediment chemistry

The sediment chemistry could be recorded in a number of ways. Time series data can be collected using sub-sea data loggers or sediment samples may be taken for analysis in the laboratory.

Data Loggers

Previous work such as the Moss Project and the *Colossus* Stabilisation Trial has used sub-sea data loggers to record sediment chemistry over a period of time, usually three months (Camidge 2005 & Gregory 2004). Both these projects used the same type of data logger, the EauxSys Waterwatch 2685. In both cases problems were experienced with some of the data collected, in particular the pH and Redox potential.

These instruments are capable of recording a number of parameters, at preset intervals over a period of months. On the *Colossus* project the instrument recorded pH, temperature, pressure, dissolved oxygen and Redox potential. On the MoSS project the same instrument was configured slightly differently and recorded temperature, pressure, dissolved oxygen, salinity, Redox, pH and turbidity (Total Suspended Solids - TSS). It is possible to deploy some sensors in the water column and others within the sediment (in dip-wells) at the same time. English Heritage currently owns the instrument previously used on the *Colossus* project.

The Waterwatch system costs in the region of £10,000, depending on what sensors it is equipped with. Alternative systems exist such as the Seabird (reputed to be more reliable – about £20,000) and the RBR-420 (about £15,000). Any of these instruments could be used to collect sediment chemistry and some water quality data simultaneously.

Sediment Sampling

Physical samples are taken from the sediment. A number of ways exist for collecting samples. Mechanical remote sampling methods such as grabs and trawls are probably inappropriate on protected historic wreck sites, in which case diver collected samples are probably the best option. The samples need to be taken and packed in sealed glass containers, stored in a coolbox with ice packs and transported to the analysing laboratory within 24 hours. Sediment samples should be analysed for pH, salinity, dissolved oxygen, nitrates, nitrites, sulphate, sulphide, ammonia, phosphate and ferrous ions. The cost per sample (using a UKAS accredited laboratory) is likely to be in the region of £50-100 per sample. Additional costs will be incurred for specialist interpretation of the results.

9.3 Seabed characteristics

9.3.1 Bathymetry

By recording the depth of the seabed on and around the site, it is possible to construct detailed contour maps as well as 3D digital terrain models. This will help to understand the site in the context of the surrounding seabed topography. It is important that bathymetric data is referenced to a recognised vertical datum, usually chart datum which is approximately LAT. A number of techniques exist for collecting bathymetric data. This data also needs to be collected for the oceanographic modelling.

Multibeam sonar

Multibeam sonar uses acoustic methods to measure depth in a swathe beneath and to either side of the survey vessel as it moves forward. This technique is widely used in hydrographic survey. The width of this swathe is determined by the depth of water under the survey vessel, but is typically two to four times the water depth (Green 2004).

The survey accuracy will be limited by the accuracy of the position fixing technique employed. High quality survey GPS units are required, utilising differential (DGPS) or RTK. In addition, the survey vessel needs a gyro compass and a motion reference unit. Set up and operation require an experienced engineer and operator, usually supplied by the equipment agents/manufacturers. Processing of the raw data requires proprietary software, usually with experienced operators (Wessex 2005c). All these factors combined make the use of multibeam very expensive. Operators cost in excess of £400 per day. Rental cost of all the equipment, operator and suitable survey vessel is unlikely to be less than £2000 per day and could be considerably more.

The other issue is access of the survey vessel to the site itself. Some historic sites are located very close to shore or are situated in navigationally hazardous locations. Successful multibeam surveys require that the survey vessel can access the site and manoeuvre around it easily. This is not always the case.

It should also be noted that reasonable sea conditions are also required for good quality results. Mobilising equipment, boat and personnel to coincide with suitable sea conditions can be difficult and expensive. Finally, there is the possibility that thick kelp growth on shallower sites may cause problems. It has not yet been established to what extent kelp affects the results. The acoustic signals may in fact be (at least partly) recording the top of the kelp rather than the seabed itself. Further research is required into this phenomenon.

Impressive looking digital terrain models of a number of wreck sites have been produced, especially using the RESON seabat multibeam system. Comparison of multibeam generated surveys with surveys of the same site produced by diver measurement has suggested a high degree of correlation (Dean & Frazer 2004).

Echo Sounder

Bathymetric data can be collected using a moderately-priced echo sounder. The quality of the GPS position needs to be considered as does the frequency/ beam width of the transducer. It is also quite time-consuming to collect sufficient bathymetric data to produce adequate contour or terrain plots. Readings are taken only under the boat and at about one reading per second. With care reasonable topographic maps can be made without the use of sophisticated and expensive survey equipment. However, the limitations of such surveys must be appreciated. The beam width of the transponder is rarely less than 10°, thus the minimum depth over a fairly large area is recorded (roughly a circle 3.5m diameter in 10m of water, and a 7m circle in 20m of water). Thus it is quite easy for this type of system to miss small features. The same reservations about kelp apply to this system as those outlined in the multibeam system above.

Airborne LIDAR

Airborne laser bathymetry represents a new technique which has the potential to acquire images of extremely high quality and definition in clear water to a depth of 30m. The system consists of aircraft mounted pulsed laser transmitters with green and infrared outputs. A receiver measures the time for the laser pulses to return and thus the distance is determined. The green laser penetrates clear water and is reflected from the seabed, while the infrared pulse reflects from the sea and land surface. One advantage of this system is

that above-water features such as the shoreline and rocks are also mapped at the same time. These out-of-water features are not mapped with traditional acoustic bathymetry. The typical coverage width of a LIDAR flight is about 100m. The level of detail obtained depends to some extent on water clarity, but in any case is probably currently not as good as the best multibeam surveys. However the costs are considerably less, said to be between a fifth and a half of the cost of comparative multibeam surveys (Guenther 2000). In very shallow water or where there are navigational hazards, LIDAR is likely to be the only viable option. Survey of a typical protected wreck site is likely to cost in the region of £1000-2000.

9.3.2 Sediment

Physical Composition

It is important to know the physical composition of the sediment both on and below the seabed. This is particularly important for understanding the likelihood of sediment transport on the site (see the section on coastal processes). Where possible, the stratification of the sediments around the archaeological material should be recorded. Some information may be available from previous intrusive work on the site. Where this data is not available, small test pits or cores should be considered as a means of gathering this data. This will usually require divers to gather the samples.

Samples should be taken from several locations around the known historic remains. The locations should be decided after the seabed surface has been studied to establish the apparent homogeneity of the visible sediments. Where there is buried archaeological material samples from sediments below the seabed surface should be considered. The decision must take into account the damage which may be caused to archaeological levels by intrusive sampling. Samples should be analysed for particle size, particle distribution and physical composition as well as shear strength. English Heritage Labs at Fort Cumberland have undertaken this sort of work in the past. However, if required, commercial labs could be used; cost is likely to be around £50-90 per sample. Where possible sediment samples for physical composition and chemical analysis should be taken at the same time.

Depth

Sediment depth can be ascertained in a number of ways. The method employed will be determined by the nature of the sediments on the site in question. Where relatively shallow sediments are present over bedrock, hand sampling by divers is probably the best technique. Where relatively deep, soft sediments (sand and silts) are present then coring may be an appropriate technique. The overall depth of soft sediments can easily be determined by probing (especially using a water-jet probe) but this does not give any information on the composition of the sub-seabed sediments.

Sub-bottom Profiler

These use sonar which penetrates beneath the surface of the seabed and produces a 2D section of the buried geological and sedimentary formations. They operate over a range of frequencies. The lower frequency types (boomers) give better sediment penetration but lower resolution, while the higher frequency profilers have poorer sediment penetration but better resolution. In certain conditions, sub-bottom profilers may be able to detect buried cultural material, but in a number of test cases (*Amsterdam* & *Mary Rose*) the results were not conclusive (Green 2004). However they do, in most cases, produce a good indication of the seabed strata.

Sub-bottom profilers are usually deployed towed behind the survey vessel. Good sea conditions and room for the vessel to manoeuvre are therefore required for successful

results. To achieve good results, a specialist operator is required for this equipment and a certain amount of post processing to render the data graphically. This type of survey is probably best entrusted to a specialist contractor and is likely to prove costly. As an indication only of likely costs, GSE rentals quote £90 per day for hire of a GeoAccoustics 5430 pinger and tow fish. To this would need to be added the cost of the survey vessel, insurance, operator and post processing.

9.4 Biological

9.4.1 Flora and fauna

Aims

To characterise and quantify the flora and fauna in the vicinity of the historic wreck site. This will enhance our understanding of the environmental conditions affecting the preservation of the archaeological material.

Area

The boundaries of the biological survey need to be rigorously defined. Exactly what these bounds are will be determined by the extent and nature of the site itself. In most cases however, an area of about 25 x 25m will probably suffice to characterise the flora and fauna of the site itself. In some cases it may be deemed advantageous to set this against the backdrop of the surrounding area. This will, of course, increase costs and therefore the likely information gains need to be carefully considered and set against the additional expense.

Time span

A single biological survey will provide data on the existing flora and fauna at that time. However, the nature and quantity of these organisms is likely to change seasonally. To fully document these variations, a number of surveys throughout the year would be required. At a minimum, this would consist of a summer and winter survey. A more comprehensive strategy would require four surveys at three-monthly intervals throughout the year. A balance might need to be struck between costs and data quality.

Options summary:

- Single flora and fauna survey – probably taken during settled weather conditions during the summer months.
- Bi-annual survey – a summer and winter survey (if possible) allowing the main seasonal variations to be recorded.
- Four surveys at three monthly intervals throughout the year – results in a fuller picture of the seasonal variations in the flora and fauna on the site.

Survey strategies

It is common practice in commercial environmental surveys to obtain infaunal samples by using remotely operated mechanical mechanisms. These typically consist of coring (vibrocore), grabs and trawl mechanisms. On protected wreck sites, these remote sampling methods are probably inappropriate because of the danger of damaging archaeological deposits. On historic wreck sites, diver-collected samples are probably to be preferred. Cost of sample collection could be minimised by incorporating the infaunal sampling into other programmes of diver activity.

Epifaunal survey data can collected in a number of ways (Davis 2001, 65-67):

- Quadrant sampling
- ROV
- Drop-down video
- Diver operated video

Whichever of these techniques is eventually adopted this is a specialist area and the involvement of a marine biologist at the design stage is essential. As with most data collection, the best value for money will be achieved when very clear objectives are defined from the outset. In other words, we need to decide what data we need and why we need it rather than simply gathering data because we can (or because we are 'ticking the boxes').

9.4.2 Monitoring biological degradation of timber

The majority of historic wrecks are mainly constructed with timber. For this reason, organisms which attack timber have particular significance for timber preserved within the sediments of the seabed. Only when conditions are hostile to these organisms will timber be preserved. One technique which has been used to monitor wood decay on a number of historic wrecks is the use of timber sample blocks (Camidge 2005, Cederlund 2004). In both these studies, blocks of pine and oak were used to simulate the common materials of historic ships. However it was clear from these studies that the difference in the rate of attack between pine and oak blocks was small. The use of pine blocks can probably be dispensed with, especially as this is not a common material in the fabric of most ships.

The timber sample blocks are deployed in the water column and buried within the sediments associated with the timber remains. They are retrieved typically at intervals of 3, 6, 12 and 24 months. Three different agents of timber decay can be monitored: wood boring organisms, bacteria and fungi. Over the limited timescale of these trials, the wood borers were seen to be the most significant in terms of timber damage. This technique gives some indication of the relative risks on a given site for wood exposed on the seabed and wood buried within the sediment. This can help to quantify the threat to wreck material where it is being exposed having previously been buried within the seabed sediments. For a full discussion of the techniques used see Camidge 2005 and Cederlund 2004.

Purchase and placement of these timber blocks is relatively inexpensive. The analysis is however, subject to large price differentials.

1. Weight Loss: Blocks can be weighed at standard moisture content prior to deployment. After retrieval they are brought to the same moisture content and then reweighed. The weight loss of the block indicates the amount of decay/attack which has occurred. This does not discriminate between the different types of attack but does quantify the level of decay. This type of analysis costs about £10 per sample block.
2. X-Radiography: The blocks are x-rayed and the number of tunnels caused by wood-boring organisms counted. The level of attack is quantified on the five point ASTM D 2481 rating scheme. This analysis does not differentiate deterioration caused by bacterial or fungal attack. The cost of analysis is about £100 per sample.
3. Scanning Electron Microscope: Timber samples are fixed and dried then examined using a scanning electron microscope. Bacteria and fungal hyphae are identified along with any decay caused to the timber. This process is relatively expensive and can cost as much as £1000 per sample.

Where the effects of bacteria and fungi are to be studied it is recommended that a timescale longer than the 24 months used in the above mentioned trials is employed. However, in the majority of historic wreck sites the activity of the wood boring organisms is probably the most important biological agent, as these organisms, in the right conditions, will usually completely destroy timber within a few years.

10 Strategy for the Phase 2 assessment

10.1 Site characteristics

The designated site of the *Royal Anne* Galley lies off the Lizard Point where extremely dynamic sea conditions exist for most of the year. In addition the site sits within the 5m depth contour, surrounded by rocks, many of which are just submerged at high water.

The site is also subject to significant swells, which often make diving impossible even when sea conditions are benign elsewhere. It is subject to considerable tide, and diving operations are limited by a narrow 'tidal window'. Approach to the site in anything other than a small inflatable or RIB is extremely hazardous. Numerous visits by the ADU, and more recently by the diving contractor, have failed to deploy surface supply divers on the site. Finally, the number of days per year when conditions are suitable for diving on the site is limited to 20 to 30 days per year. It is not uncommon for conditions to be unsuitable for periods of 6-8 weeks, even in the summer.

For these reasons it will be extremely difficult to collect environmental data on this site. One of the most difficult problems will be mobilisation planning. Hiring of equipment, boats and divers all have to be pre-booked. But they also depend on predicting suitable conditions on site. It seems inevitable that considerable stand-by costs are likely to be incurred. Wherever possible, rapid deployment when suitable conditions present themselves will be the best option.

Diving on site will be a particular problem. At the project design stage it will be essential to hold detailed discussions with a diving contractor and the HSE to formulate an acceptable ACoP for the diving operations on this difficult site.

10.2 Wave and tide data

Real data applicable to the site is required to refine the tide and bed shear stress models. Use of a combined wave and tide data device such as the Nortek AWAC is recommended (see below Appendix 13.4). However, despite the desirability of collecting this data for a complete year, it is probably more practical to collect data for one complete tidal cycle (one month). By deploying the instrument for a month in the summer the risk of damage to the unit will be minimised. Even so, this will be a significant risk on this site. Unfortunately, this will mean that no data is collected for the significant storm events which are known to occur on this site, especially in the winter. It is difficult to see how quantitative data could be collected without risking the expensive instrumentation required to collect it. In the final analysis, only those commissioning the data collection can decide what level of risk they are willing to accept.

The unit needs to be installed on a clear, deeper part of the site such as that to the north-east of the guns (Black Weed Gulley). The recommended instrument package will also record water temperature (just above the seabed) and pressure (depth).

It is recommended that Jon Rees of CEFAS is retained as a consultant at the project design stage to fully integrate the data collection with the tidal residual and bed shear stress modelling.

10.3 Dispersal trials

It is recommended that artefact dispersal trials are conducted using bricks of various sizes and densities. The trials should be conducted in a similar manner to the trials currently being conducted on *Hazardous Prize* and St Peter Port Harbour by Sara Holland (Holland 2005). Additionally, the density (specific gravity) of the marker bricks should be recorded before deployment. It has also been suggested by Jon Rees of CEFAS that one additional ($0.05m^3$) size of brick is used to assist with his tidal residual modelling.

The marker objects should be placed around three of the existing control points (possibly A, I and Z1) as this will include the three main types of topography (gulley, reef and pinnacle). The markers should be monitored over two or three years. Their dispersion will help to quantify the winter storm surges, which would otherwise go unrecorded.

10.4 Water quality

The samples need to be taken and packed in sealed containers, stored in a coolbox with ice packs and transported to the analysing laboratory within 24 hours. Water samples would be analysed for pH, salinity, nitrates, phosphates and metals. It is recommended that a UKAS accredited laboratory is used to analyse the samples.

10.5 Corrosion monitoring of iron

Two iron guns are known on the seabed on the *Royal Anne* site. Corrosion monitoring will be undertaken to establish the stability of these guns (using the strategy described in Section 13.2). If they are found to be actively corroding it is recommended that anodic protection is undertaken.

Measurement of the corrosion potential can be achieved using commercially available equipment. The Buckley Bathycorrometer is designed for corrosion monitoring of sub-sea structures and costs in the region of £2000 (see Appendix 13.2). It is proposed that David Gregory be retained as a consultant to help with the design and interpretation of the iron corrosion monitoring programme.

Two options are available for recording the sediment chemistry on this site. A data logger such as the EauxSys Waterwatch system could be installed on the seabed and data collected over a preset time interval. The datalogger would need to be installed and retrieved by divers. There is also the risk of damage to the unit if storms occur during the deployment. Data from this type of unit collected on other sites has suffered from inaccuracies, possibly caused by fouling of the Redox and pH sensors. If such a unit is deployed on the site it should be deployed and retrieved at the same time as the AWAC unit to minimise mobilisation costs.

10.6 Sediment chemistry

Two options are available for recording the sediment chemistry on this site. A data logger such as the EauxSys Waterwatch system could be installed on the seabed and data collected over a preset time interval. The datalogger would need to be installed and retrieved by divers. There is also the risk of damage to the unit if storms occur during the deployment. Data from this type of unit collected on other sites has suffered from inaccuracies, possibly caused by fouling of the Redox and pH sensors. If such a unit is deployed on the site it should be deployed and retrieved at the same time as the AWAC unit to minimise mobilisation costs.

An alternative is to take sediment samples and have these analysed by a laboratory. The samples would need to be taken and packed in sealed glass containers, stored in a coolbox with ice packs and transported to the analysing laboratory within 24 hours. Sediment samples would be analysed for pH, salinity, dissolved oxygen, nitrates, nitrites, sulphate, sulphide, ammonia, phosphate and ferrous ions. This could only provide a snapshot of the sediment chemistry, but would be considerably cheaper than using a data logger.

10.7 Sediment depth and physical composition

Sub-bottom profiling is unlikely to be practical on this site due to the difficulties in accessing the site in a suitable survey vessel.

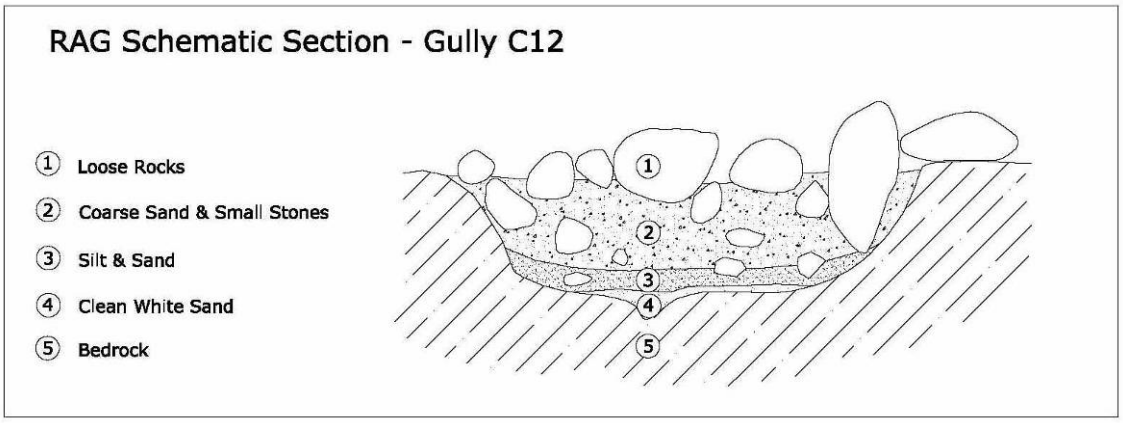

Fig 47 Section of sediments recorded during excavation of gulley C12

Records of the physical sediment and stratigraphy have already been made during excavations on the site. If further recording of sediment depth is deemed necessary, then hand excavation by divers is probably the most practical as the sediment is confined to gulley bottoms and is rarely more then 0.30m deep. In any case, samples need to be taken and analysed for particle size, particle distribution and physical composition as well as shear strength.

10.8 Bathymetry

This site is not suitable for multibeam survey due to access difficulties. It is proposed that an airborne LIDAR bathymetry survey is undertaken. It will be a good test of this relatively new technology for archaeological applications. The survey should include the current *Royal Anne* designation as well as the area around the Quadrant rock.

As mentioned above (Section 7.1.4), the UKHO has formed a joint venture with Airborne Hydrography AB to undertake surveys around the coastal waters of the UK Admiralty Coastal Surveys intend to conduct trials in the South West region early in 2006 and have indicated that they would be willing to over fly the site of the *Royal Anne* Galley with two runs and provide processed data. As this would not be a commercial venture they could not accept any liability for the performance but suggested that the data could be improved if a broadcast differential signal could be obtained from the Trinity House Light at the Lizard Point. Each pass would cover a swathe 100 m wide, hence two passes would cover the complete designated area of the wreck site.

If for any reason LIDAR proves unsuitable then an echo sounder bathymetric survey will need to be undertaken from a small boat.

10.9 Flora and fauna

As outlined above, this is a specialist area and it is intended that a qualified marine biologist is employed at the project design stage to assist in the formulation of the biological data collection. It will be necessary to have the area of the study precisely defined, in terms of the geographical and research areas required. Only then can an actual data collection strategy be formulated.

10.10 Monitoring biological degradation of timber

It is recommended that a limited number of oak sample blocks are installed in the water column and within the sediments of the *Royal Anne* site. Six blocks placed in the water column, to be retrieved after one and two years. Only one block from each of these retrievals will be analysed; the others are spares in case of loss. Similarly, eight oak blocks should be buried, 0.20m deep in the sediment contained within gullies on site. These should also be retrieved at one and two year intervals. They should be buried at two different locations (four blocks in each location). It will only be necessary to analyse four of these blocks.

Block No	Location	Interval (yrs)
1	Exposed on the seabed	1
2	Exposed on the seabed	2
3	Sediment – location A	1
4	Sediment Location B	1
5	Sediment – location A	2
6	Sediment Location B	2

Fig 48 Proposed sample block analysis

The blocks should be analysed by X-ray and tunnel count to quantify attack by wood boring organisms. This analysis will cost about £600. Analysis for bacterial and fungal attack is possible but will cost in the region of £6000 for the six samples proposed. The placement and retrieval of these timber sample blocks will be by divers.

10.11 Finds

Because the finds from the *Royal Anne* are in private ownership, and some might have been sold, it is recommended that the collection should be recorded, so that there is a proper record if the collection is dispersed.

10.12 Documentary research

There is scope for further documentary research in particular relating to

- the history and development of galley frigates in the late 17th and 18th centuries;
- the life of Lord Belhaven;
- circumstances of the wreck and aftermath.

10.13 Pistol Meadow

Pistol Meadow, the traditional burial site of the *Royal Anne's* crew, is now owned by the National Trust. The area does not yet have an archaeological survey and does not have a National Trust SMR number.

Pistol Meadow is potentially a site of national importance, containing as it might the remains of virtually the whole complement, passengers and crew, of an early 18th century warship, the wreck of which is a designated site. To contribute to the seamless management of the terrestrial and maritime archaeological resource a geophysical survey should be undertaken to attempt to detect the position of the grave pits (most of the meadow is down to short, coarse grass, grazed by ponies), further documentary research carried out to locate contemporary accounts of the burial and the site considered for protection through designation.

Fig 49 The Royal Anne designated area viewed from Polpeor, looking approximately west and shoeing conditions on a windy day (photo: © CCC)

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www.pro.gov.uk Public Record Office

http://www.lizarddiver.co.uk Royal Anne Galley and other historic wrecks

http://www.nls.uk/broadsides/broadside.cfm/id/155579 National Museum of Scotland's database of broadsides

http://48.1911encyclopedia.org/B/BE/BELHAVEN_AND_STENTON_JOHN_HAMILTON_ The 1911 Encyclopedia

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WaveNet- www.cefas.co.uk/wavenet

Links to Suppliers

Corrintec (suppliers of Rust Gun)

http://www.corrintec.co.uk/ (Contact technical manager Stephen Ellis)

Buckley's (suppliers of Bathycorrometer):

http://www.buckleys.co.uk/subsea.htm

Corrpro Europe Ltd: (suppliers of anodes):

http://www.corrpro.com/catalog/itm_idx/61.htm

Far West Corrosion control (suppliers of reference cells):

http://www.farwestcorrosion.com/fwst/refelect/gmc09.htm

12 Project archive

The HES project number is **2004091**

The project's documentary, photographic and drawn archive is housed at the offices of the Historic Environment Service, Cornwall County 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 2004091).
2. Copies of historic maps and charts stored in an A2-size plastic envelope (GRE 978).
3. Digital photographs stored in the directory ..\Images\Maritime\Royal Anne Galley 2004091
4. This report held in digital form as: G:\CAU\HE PROJECTS\SITES\MARITIME\ROYAL ANNE GALLEY 2004091\MEA REPORT.DOC

13 Appendices

13.1 Strategy for corrosion monitoring of iron cannon on the wreck of the *Royal Anne* Galley

By David Gregory

13.1.1 Introduction

The *in situ* measurement of electrochemical parameters such as surface pH and corrosion potential, E_{corr}, can be an invaluable tool in understanding the corrosion mechanisms of metals on marine archaeological sites. Furthermore, with the aid of such information it is possible to stabilise and start the conservation process of iron artefacts on the seabed with sacrificial anodes, which is advantageous, should it be decided to raise the artefacts at a later date. This section serves as a basic introduction to the corrosion of iron (cast) in the marine environment with particular focus upon the equipment and methods used for the in situ measurement of the corrosion of such artefacts and how they can be stabilised *in situ* with the aid of sacrificial anodes. A bibliography, pertaining to the most relevant literature and web links to suppliers of equipment is also given. The report is seen as an initial dialogue to enable Cornwall County Council's Historic Environment Service to design and accomplish a successful monitoring and stabilisation programme for the cast iron cannon preserved on the wreck of the *Royal Anne* Galley.

13.1.2 Corrosion of iron in the marine environment

When a metal, such as iron, is submerged in seawater it undergoes electrochemical corrosion. This corrosion involves the flow of electrons (which a carry a negative electrical charge), from one location to another. These electrons emanate from the atoms of the metal itself. They are released from the metal and enter the system at the anode and leave it by combining with other substances at the cathode; the complete system is called a corrosion cell. The reactions, which take place at the anode and cathode of a corrosion cell, are essentially the same for all metals. At what is termed the anode, electrons are released by the metal and give rise to an oxidation reaction (by chemical definition meaning the loss of electrons) to form an electrically charged atom, an ion. It is this process which results in the destruction of the metal. Metal ions carry a positive electrical charge and are called cations, for example:

$$\text{Metal} \rightarrow \text{Metal}^{2+} + e^- \qquad \text{Equation 1}$$

$$\text{Fe (Iron)} \rightarrow Fe^{2+} + 2e^-$$

The electrons, which are released as the metal corrodes, must be consumed in a complementary reaction, which is called reduction (or the gaining of electrons) and takes place at the cathode. Electrons become involved in one of two reactions according to whether oxygen is present or not. In seawater, where oxygen is freely available, the electron acceptor at the cathode is oxygen itself, where oxygen and water combine accepting electrons to form hydroxyl ions according to the following reaction:

$$O_2 + 2H_2O + 4e^- \rightarrow 4(OH)^- \qquad \text{Equation 2}$$

Oxygen Water Electrons Hydroxylions

This process is summarised in Figure 50.

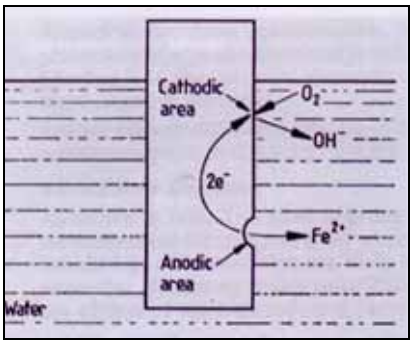


Fig 50 Anodic and cathodic reactions at metal surface in oxygenated and aqueous conditions (after British Standards Institute 1991)

The metal cations released at the anode have two options. First they may enter the environment as aqueous ions and precipitate away from the metal, which continues to corrode. Alternatively, and as commonly occurs in the marine environment, they may react with anions in the environment and form corrosion products (such as iron: carbonates, oxides, hydroxides and sulphates), which adhere to the surface of the metal and result in what is commonly called a concreted layer (concretion). These solid corrosion products, especially the carbonates and oxides typically found in the marine environment, may act to slow the corrosion process thus preventing further corrosion and preserving the bulk of the metal. The concreted layer acts as semi permeable membrane and results in increased concentrations of chloride and hydrogen ions at the surface adjacent to the corroding metal. If we consider the basic construction of a concreted artefact on the seabed, as shown in Figure 51, it can be seen that after many years' submersion, an acidic and chloride rich microenvironment surrounding the corroding metal is established. The acidity results from hydrolysis of the metal cations and, as corrosion proceeds, chloride ions from the surrounding seawater diffuse through the concretion to the corroded metal surface to achieve electrical neutrality of the corrosion products.

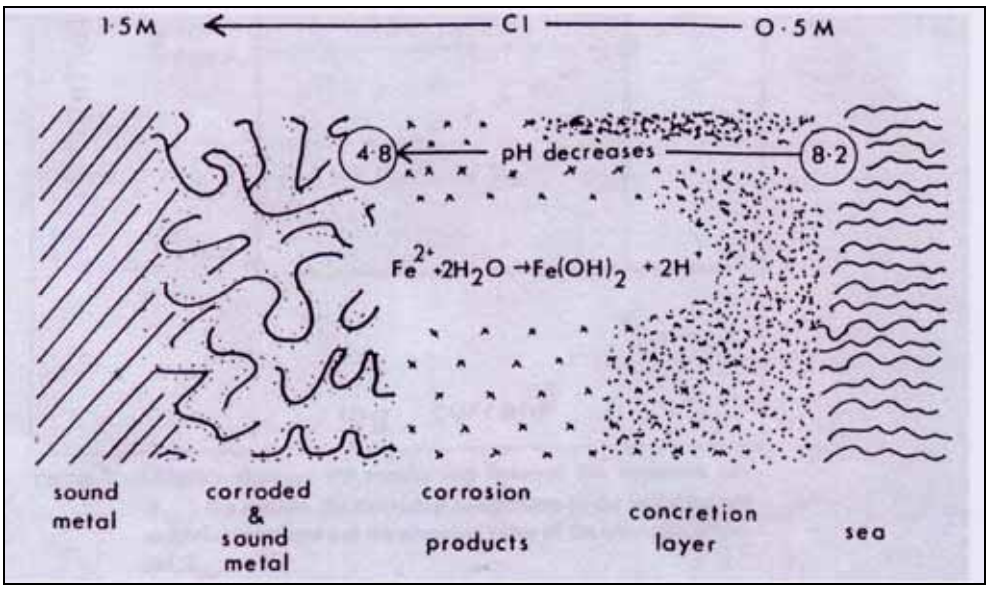


Fig 51 Schematic cross section of a concreted and corroded iron object in sea water (after MacLeod, 1989)

13.1.3 Active corrosion, passivation and immunity

In general, one of three situations develops:

1. Active corrosion whereby the metal forms soluble corrosion products that move away from the metal into the surrounding environment.
2. Passivation, whereby the metal forms solid corrosion products which adhere to the surface and prevent or at least restrict further corrosion
3. Immunity, in certain cases, such as in reducing environments and low pH, metal will not corrode and is thus said to be immune.

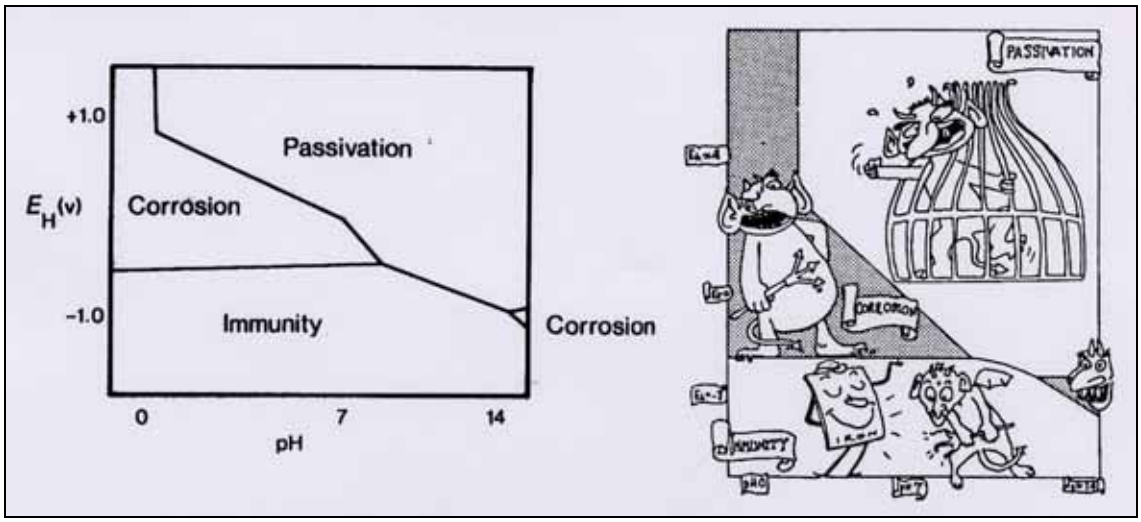


Fig 52 Pourbaix diagram of iron in seawater at 25ºC showing the conditions for corrosion, passivation and immunity.

Whether or not a metal corrodes away, is passified, or is immune to corrosion depends on a combination of: the stabilising effect of the corrosion products. The stability of the corrosion products themselves is dependent upon the local pH. In order to determine which of these scenarios will occur the corrosion potential (E_{corr}) and pH at the metal surface needs to be measured. E_{corr} is the electrical potential generated as a result of all the anodic (Equation 1) and cathodic (either Equation 2 or 3) reactions taking place at the same time on the metal surface. The pH is a measure of how acidic or basic a solution is. The combined effect of these two variables acting on a metal can be shown on a diagram referred to as a Pourbaix Diagram (Fig 52). These diagrams are thermodynamic stability maps that show whether a metal is in an active, passive or immune region, with regard to corrosion. It is important to state that these diagrams do not give any information as to the actual corrosion rate.

13.1.4 Cathodic Protection

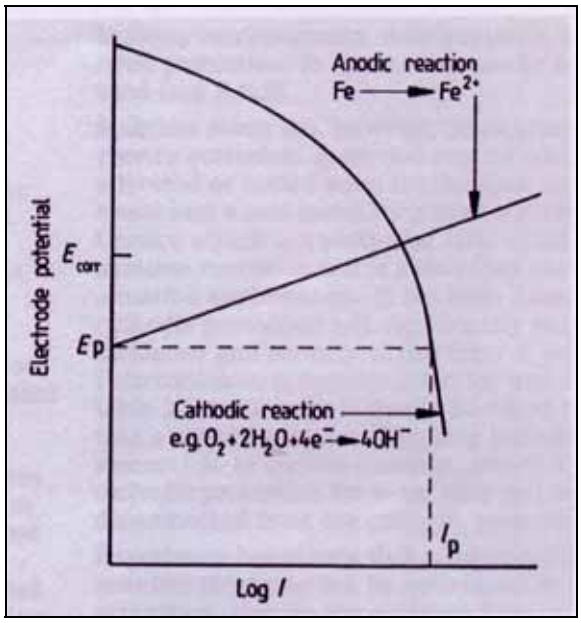


Fig 53 Relationship between polarisation and cathodic protection. E_{corr}: Corrosion potential; E_p: Protection potential; I_p: Protection current

This information can be used to not only understand the corrosion process, but perhaps more significantly in this instance, enable stabilisation of the cannon to be effected. As discussed, for corrosion to take place the existence of anodic and cathodic areas on the metal surface are required. If electrons are caused to flow into the metal from an external source, then the positive ions (cations) leave the metal surface less readily and the cathodic process is enhanced. Thus, as shown in Figure 53, if the potential of the metal is reduced by the external supply of electrons from E_{corr} to E_p then the anodic current, and hence the corrosion attack, will cease and cathodic protection will have been achieved. E_p is called the protection potential. The cathodic current (I_p) at the potential protection has to be sustained by the external source in order to maintain the cathodic protection. This can be achieved by connecting the metal to an auxiliary anode, which has to provide the necessary current density to all parts of the surface of the metal, which will then become the cathode. If the anode is a material such as zinc or aluminium, the current will flow because of the potential difference arising from the cell formed, and the auxiliary anode will be consumed. This type of anode is called a sacrificial anode (British Standards Institute, 1991). Effectively, the attachment of an anode will cause the corrosion potential (E_{corr}) of the metal surface to become more negative and lie within the immune area of the Pourbaix diagram.

13.1.5 Equipment for Corrosion Monitoring

Depending on the over goals of the project, *in situ* as opposed to assessing the corrosion processes ongoing, there are two options for the equipment required to monitor the cannon. In the first case, to simply ensure that the cannon are stabilised, through the addition of sacrificial anodes, measurements of the corrosion potential will suffice. This is because it only needs to be ascertained that the corrosion potential shifts from an area of active corrosion or passivation to that of immunity. The determination of corrosion otentials is effected by reading the voltage recorded by a digital multimeter (impedence $>10^{14}$ Ohms). The measured voltage refers to the difference in elepotential of a reference

electrode (typically silver / silver chloride in sea water) and a working electrode such as platinum or AISI 316 stainless steel. These metals are electrochemically inert, do not corrode in seawater and therefore the measured voltages refer to the object itself. These measurements can be achieved with the commercially available instrumentation such as the *Bathycorrometer* or *Rust Gun*. These types of instruments are relatively simple to calibrate and use and are very robust (Fig 54), although it has to be noted that the author has had limited use of these types of meter.

Fig 54 Bathycorrometer (©Buckleys' Ltd)

It is essential that an extra long stainless steel probe tip be fitted to these meters (rather than a standard version) so as to be able to measure through the concretion layer which potentially surrounds the cannon.

However, if more knowledge of the corrosion processes is desirable pH will also need to be measured. To the best of the author's knowledge commercially available equipment which measures both pH and corrosion potential is not available. The present author, as well as other archaeological and conservation scientists, have developed their own underwater systems to measure both corrosion potential and pH. The corrosion potential is essentially measured as above using a commercially available silver / silver chloride reference cell (and a custom made platinum working electrode both attached to a high impedance multimeter. pH is determined using a flat surface pH electrode connected to a small hand held laboratory pH meter. These instruments are then fitted into a custom made waterproof housing, the cables to the two meters passing through watertight cable glands (IP 67 rating). The type of equipment developed at the National Museum can be seen in Figure 55.

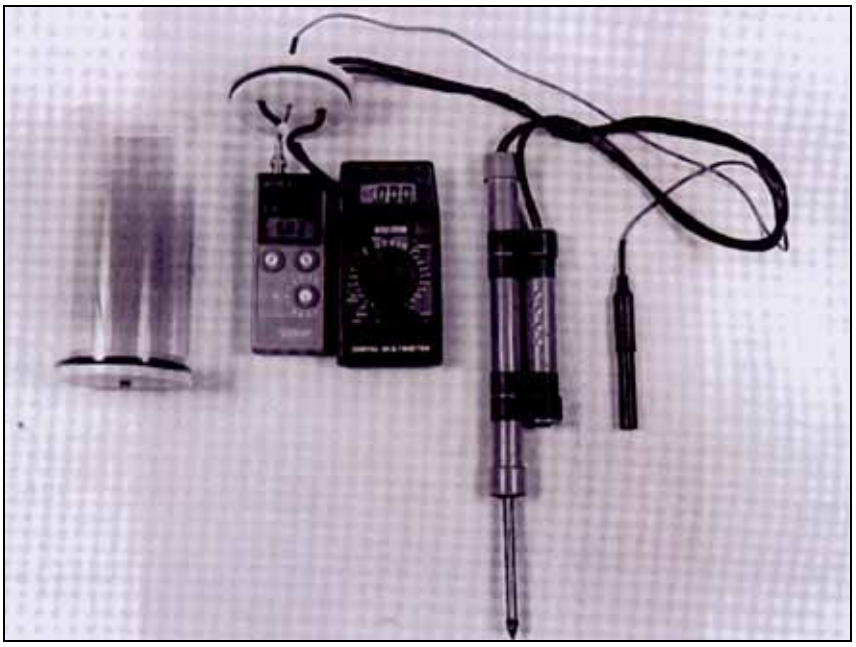


Fig 55 Equipment for determining surface pH and E_{corr}, showing from left to right: polycarbonate waterproof housing with o-ring seal, pH meter, high impedance multi-meter, working electrode (AISI 316 stainless steel) with attached reference electrode, and flat surface pH electrode. (© National Museum of Denmark)

13.1.6 Measuring in situ

As a starting point measurements should be taken near the cascobel, trunnions and muzzle of each cannon to check the variation in corrosion parameters. Drilling through marine concretions can be achieved either by using an old-fashioned breast drill – yet it can prove difficult to apply enough "weight" to the drill bit – especially if diving alone. Alternatively, a standard automotive pneumatic drill can be used – it should be noted that they should be seen as "consumables" as even with cleaning and rinsing with water dispersing agents (WD40) they have a limited lifetime after being submerged in sea water. The pneumatic drill is connected to a STAB jacket / dry suit feeder hose, which is in turn connected to the low pressure port of a standard SCUBA first stage. Drill bits designed for drilling masonry should be used for drilling the concretion, as these should not damage the metal surface too much when it is reached. As a hole of up to 15mm will need to be drilled, it often helps to drill a series of pilot holes in order for the larger drill bit to get a better grip. The largest drill bit should be at least 1-2 mm larger than the diameter of the largest of the measuring electrodes (normally the pH electrode). A typical set up is shown in Figure 56.

On drilling through the concretion, bubbles (primarily of hydrogen) will issue from the hole. On penetrating the concretion a space of between a few millimetres to a couple of centimetres is "felt" – this is the area, as shown in Figure 51, of the corroded and sound metal and non concreted concretion products. Often these will come out into the water as dense black clouds. At this point it should be possible to feel the metal surface – it is unmistakeable. If only corrosion potential is to be measured it would be worthwhile considering attaching measuring bolts to the cannon – as this would limit the need to drill to the metal surface every time. A bolt, made of AIAI 316 steel, could be drilled through the concretion and into the surface of the metal and left fixed. The shank of the bolt should be covered with shrink fit so that only the tip, which touches the metal of the

cannon, and the head being left exposed – simply placing the tip of the working electrode on the head of the bolt would give the corrosion potential.

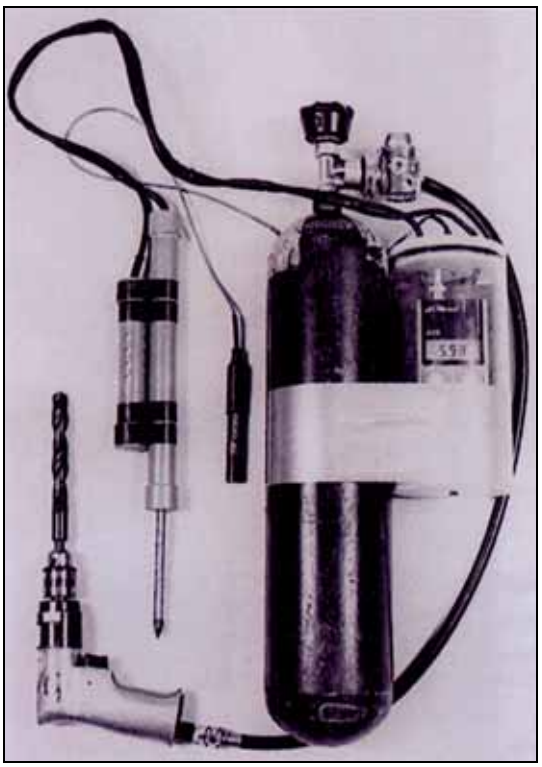


Fig 56 Equipment attached to a SCUBA cylinder with pneumatic drill ready for in situ measurements. (© National Museum of Denmark)

If measuring pH, the pH electrode should be quickly inserted into the hole and left to stabilise – this often can take up to a couple of minutes. The reading will more than likely decrease due to the acidity at the metal surface. Often once a low stable reading has been made it will start to increase again due to the inward ingression of seawater. The lowest measurement should be recorded. Having measured the pH the corrosion potential is taken by placing the working electrode into the hole and pressing it firmly against the metal surface. The corrosion potential reading will be instantly stable ± a few millivolts. It is often a good idea to check the reading before placing the working electrode in the hole (reading in seawater) to ensure that a good contact has been established. Typical corrosion potentials of iron in seawater will be between –0.5 and –0.6 Volts (versus the silver / silver chloride reference).

Further to these measurements the water temperature around the cannon should be measured as well as the water depth.

13.1.7 Processing of results

Corrosion potential measurements will have been made relative to a silver / silver chloride reference electrode. In order for them to be suitable for use on a Pourbaix diagram they will have to be converted to the Standard Hydrogen Electrode – this is a simple calculation and will be carried out, as part of the interpretation of the data after Phase II (Field Assessment) of the project is complete. pH values will be correct as the equipment will have been calibrated in pH units prior to its use. If it is decided to measure both corrosion potential and pH the National Museum of Denmark has the appropriate software and

expertise to construct these diagrams and data will be interpreted in terms of the likely mechanisms of corrosion. Although software is readily available commercially and it is certainly possible to obtain a Pourbaix diagram by clicking on various buttons within these packages, such software should be used with caution if the user is not familiar with the principles of thermodynamics.

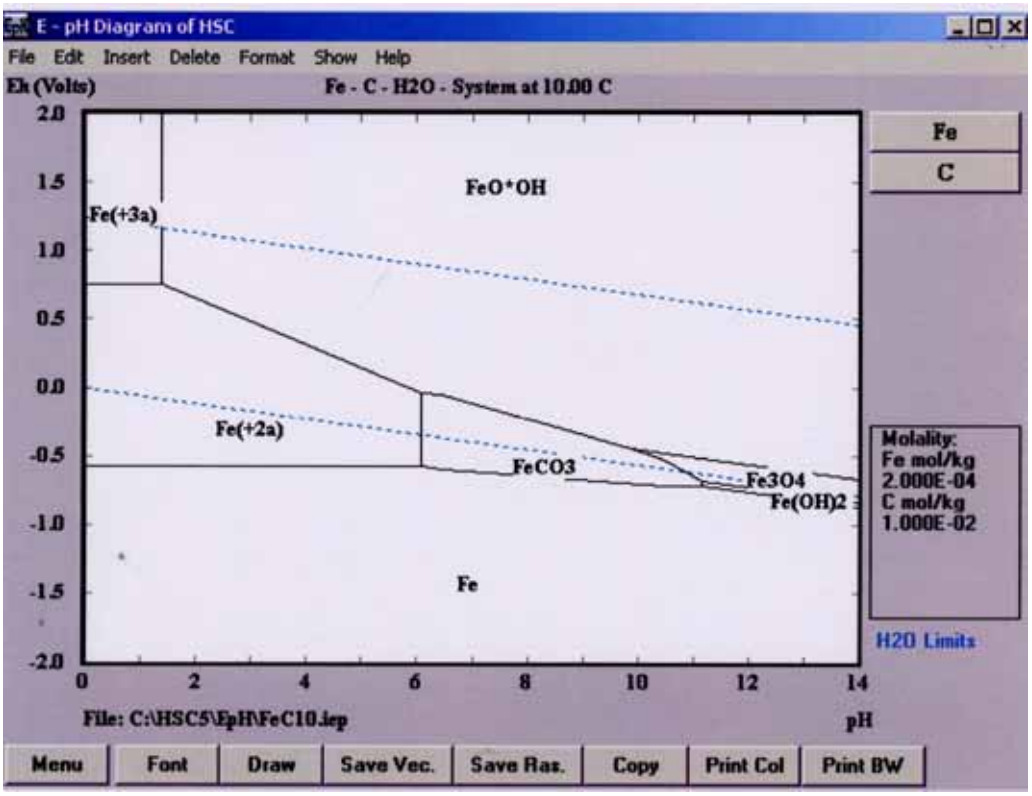


Fig 57 Example of Pourbaix diagram created for iron and carbon in aqueous solution at 25'C using HSc Chemistry

13.1.8 Stabilisation with sacrificial anodes

Although the use of sacrificial anodes on offshore structures is well established (Det Norske Veritas Industry A/S 1993; British Standards Institute 1991), this has been mainly for the offshore industry (pipelines, ships and offshore structures). It has been attempted on only relatively few archaeological artefacts and in these situations, more often or not, *ad hoc* measures have been taken in the type anodes used and subsequent monitoring of them. Nevertheless using offshore standards as a starting point and adapting these to the *Royal Anne* Galley is certainly feasible but there will undoubtedly be some "trial and error".

Alloys used for sacrificial anodes in the offshore marine environment are normally based on aluminium or zinc. When an anode has been attached a protection potential of –0.8V, relative to the silver /silver chloride/seawater (Ag/AgCl/seawater) reference electrode is generally accepted as satisfactory for protecting carbon steels and low alloy steels in aerated seawater. In anaerobic environments including typical marine sediments, a lower protective potential, -0.9V has widely been considered necessary to achieve efficient protection.

The optimal anode material to use is dependent upon the surrounding environment on the wreck site and the positions of the cannon. For example if the cannon are exposed to open seawater and there is little risk of the anodes being covered, due to sediment transport, then the anode material will be different to if the cannon were buried / partially buried and the anodes themselves were in risk of being covered. Figure 58 shows the composition of the various anodes typically used and the various environments they may be used in.

Alloy	**Environment**	**Potential (Volts)**
Zinc:		
0.5% Al, 0.1% Cd	Sea water	-1.05 (vs silver / silver chloride)
Aluminium:		
0.4% Zn, 0.04% Hg	Sea water	-1.05 (vs silver / silver chloride)
5% Zn, 0.04 % Hg	Seabed - mud	-1.05 (vs silver / silver chloride)
3% to 5% Zn0.01 to 0.03% In	Sea water / seabed mud	-1.05 (vs silver / silver chloride)

Fig 58 Typical information for sacrificial anode materials (BS7361, 1991)

In general aluminium based alloys are preferred in seawater or seabed situations. Aluminium corrodes to form an oxide film, which is tightly adherent and causes rapid polarization. The addition of the various alloying elements leads to total breakdown of the oxide film (activation) and improves maintenance of the anodes. Apart from alloy type anodes come in various shapes and sizes, an "elongated flush mounted" type would at present seem the optimal type of anode to use which could be placed on the seabed adjacent to the cannon to be protected. These typically have lugs mounted on the ends to which a copper cable can be attached the other end can be attached to an AISI 316 bolt which can be fitted to the cannon. In this way it should be relatively simple to replace the anodes when they have been depleted. An example of a sacrificial anode system deployed at the Duart Point wreck site in Scotland can be seen in Figure 59 (cf MacLeod 1995; Gregory 1999).

At this stage it is too early to design a specific programme for the stabilisation of the cannon as there are too many unknowns presently. However, following an initial field assessment of the site and the cannon it will be possible to design a stabilisation plIn order to optimise this it will be essential to have the following parameters:

- General positions of the cannon (exposed, buried, partially buried)
- Sediment type and likelihood of seabed mobility
- Dimensions of the cannon

- An estimation of the dissolved oxygen content, salinity and average temperature of the water around the site.

Fig 59 Zinc anodes deployed on the cannon and anchor at the wreck of the Swan at Duart Point, Scotland

With this information it will be possible to determine the type and amount of anodes needed and make estimates as to their lifetime before they need to be changed and how often they will need to be changed.

13.2 Extreme event analysis, an example from the east coast of England

As an example of bed shear stress exceedance diagrams discussed above in Section 8, data from Scroby Banks on the east coast of England is presented in this appendix.

The current and wave height/period time-series from the Nortek AquaDopp current profiler (ADP) deployed on a CEFAS MiniLander has been converted initially into bed shear stress due to current and waves individually. This is then combined using non-linear wave-current interaction (Soulsby, 1997) to produce a time-series of Total bed shear stress as shown in Figure 60. As the waves are relatively small (Hsig 2.1m) and the water depth small (mean water depth 7m), wave stresses are high and thus the total bed shear stress is dominated by the combination of both wave and tidal forcing mechanisms. The time series of total bed shear stress is shown with the critical erosion stresses for various particle sizes in Figure 61. Bed shear stresses are capable of resuspend 2mm sand (τ_{cr} of approximately 3 Nm^{-2}) for sustained periods of time during peaks in bed shear stress.

An alternative method of showing this data is to use an exceedance diagram as shown in Figure 62. This shows the percentage of time that the total bed shear stress exceeds a certain value. Thus, for 10 % of the time the total bed shear stress exceeds 3 Nm^{-2}. The erosional bed shear stress for various particle size are also shown in Figure 61 and show that a 500 μm sand can be eroded for approximately 95% of the time.

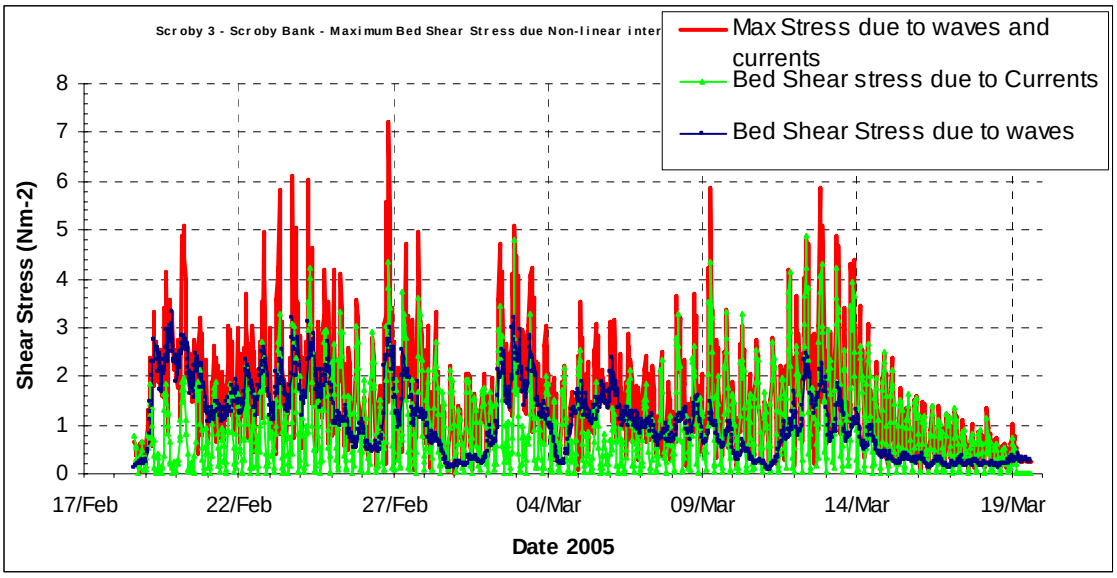


Fig 60 Time series of bed shear stress from waves, tides and total bed shear stress due to non-linear wave current interaction from Scroby Sands third deployment

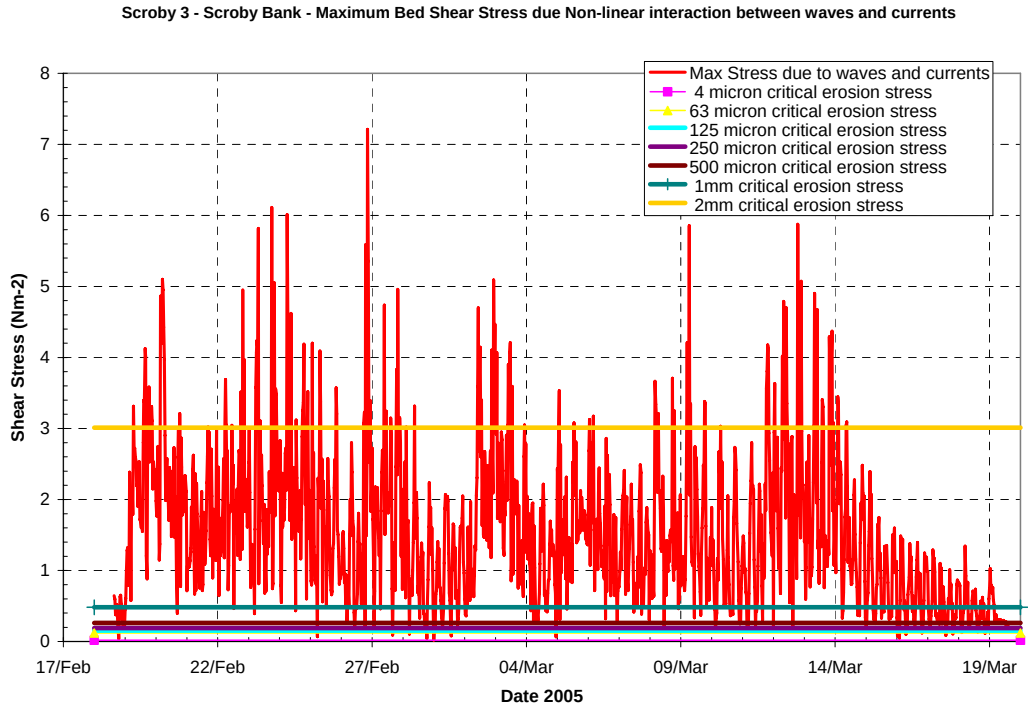


Fig 61 Total bed shear stress due to wave and tides from Scroby Bank. Also shown are critical erosion thresholds for various particle sizes

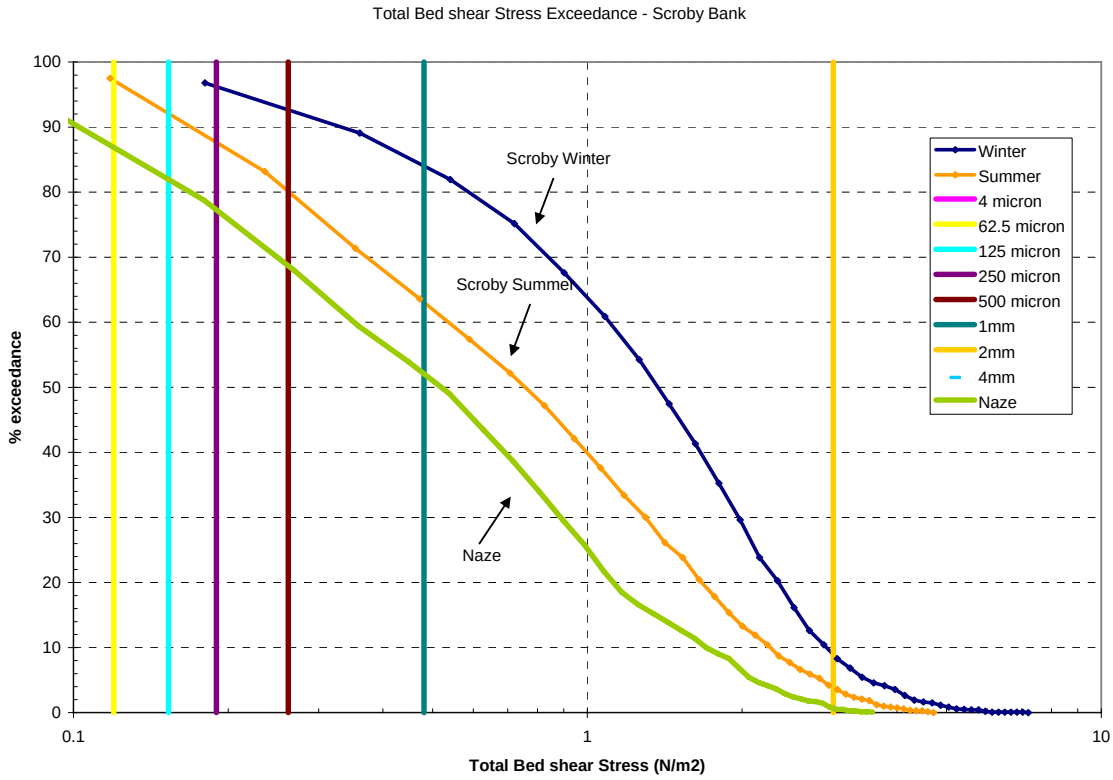


Fig 62 Total bed shear stress exceedance diagram for winter and summer on Scroby Bank as well as a site on the Naze for comparison. Also shown are the theoretical critical bed shear stress for various sizes of sand

If, a protected wreck site was situated on Scroby Bank, the curves show that in winter 10 % of the time, sediment of 2mm is capable of being moved. Thus, any artefacts which are close to being neutrally buoyant will be easily dispersed and it is likely that the site is repeatedly covered and uncovered with sediment (assuming no supply limitation). The archaeological manager would therefore be confident in that any artefact on the wreck site on Scroby will stay in that location and should stay covered with sand and hence protected from biological and chemical attack for long periods of time.

In contrast, the Naze site although relatively similar to Scroby, does show significant different characteristics. Sediment moves less than 1% of the time and thus if exposed, any artefacts will remain exposed for periods of time.

13.3 Recommended equipment for data collection

Nortek AWAC data sheet

AWAC™

- **Wave height and direction**
- **Full current profile**

...All with a single instrument

With the Nortek AWAC, you get a current profiler and a wave directional system in one unit. You can measure the current speed and direction in 1-m thick layers from the bottom to the surface and you can measure long waves, storm waves, short wind waves, or transient waves generated by local ship traffic.

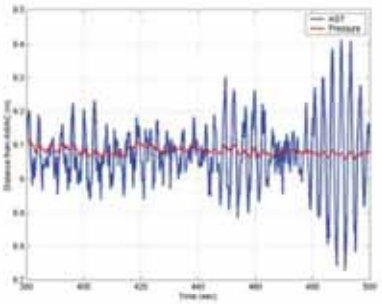
The 1 MHz AWAC is designed as a coastal monitoring system. It is small, rugged, and suitable for multi-year operation in tough environments. It can be operated online or in stand-alone mode with an internal recorder and batteries.

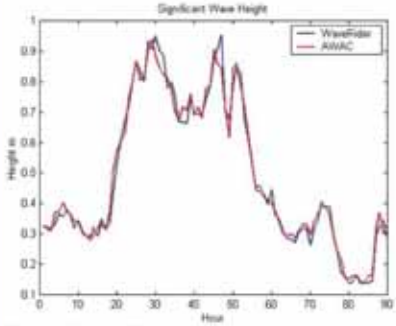
The sensor is usually mounted in a frame on the bottom, protected from the harsh weather and passing ship traffic.

The mechanical design is all plastic and titanium to avoid corrosion. Online systems can be delivered with protected cables, interface units on shore, and backup batteries and recorder. In stand-alone use, the raw data are stored to the internal data logger and power comes from an external battery pack. A variety of options are available with maximum deployment lengths of 4 months with hourly wave data (8 months with Lithium batteries).

AST breakthrough

With the optional Acoustic Surface Tracking (AST) firmware you can measure the long waves (swell), storm waves and the short waves generated from local winds. Moreover, the AST also gives you the ability to derive wave parameters based on *times series analyses*, which is a major advantage relative to the classical bottom mounted systems that derive the wave parameters from spectral estimates of pressure or velocity. This means that AWAC can directly measure wave parameters such as H_{max}, $H_{1/3}$, T_{max}, etc. which other bottom mounted systems simply cannot.





The AWAC with AST firmware option has been deployed for comparison with wave (directional) buoys all over the world. The short segment shows a test conducted by Nortek partner Thetis SA off the south coast of France.

Software

The AWAC software is used to configure the instrument for deployment, retrieve the data and convert all data files to ASCII, and view all the measured current profiles and wave data. In order to calculate the wave parameters, the non-graphical WaveExtract software will generate ASCII files with all the interesting wave parameters.

For long term projects with multiple deployments and/or multiple stations, please contact Nortek to receive the latest information on the Nordis generation software. For system integrators, individual DLL and ActiveX® elements are available for integration into Windows® or Windows® CE applications.

NORTEK AS

www.nortek-as.com

Specifications

System

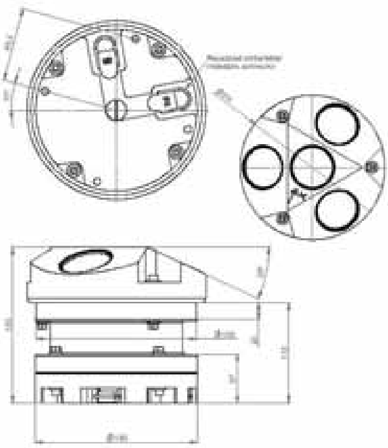
Acoustic frequency	1 MHz
Acoustic beams	4 beams, one vertical, three slanted at 25°
Operational modes	Stand-alone or long term monitoring

Current profile

Maximum range	30 m (depends on local conditions)
Depth cell size	0.4 – 4.0 m
Number of cells	Typical 20–40, max. 128
Maximum output rate	1 s

Wave data

Maximum depth	40 m
Data types	Pressure, one velocity cell along each slanted beam, distance to surface
Cell size	0.4 – 4.0 m
Sampling rate (output)	1 Hz/2Hz, 2Hz (4 Hz AST)
No. of samples per burst	512, 1024, or 2048



Velocity measurements

Velocity range	±10 m/s horizontal, ±5 m/s along beam (inquire for higher ranges)
Accuracy	1% of measured value ±0.5 cm/s
Doppler uncertainty	
- *Waves*	3.5 cm/s at 1 Hz for 2 m cells
- *Current profile*	1 cm/s (typical)

Sensors

Temperature	*Thermistor embedded in head*
	- Range: –4°C to 40°C
	- Accuracy/ Resolution: 0.1°C/0.01°C
	- Time constant: <10 min
Compass	*Flux-gate with liquid tilt*
	- Maximum tilt: 30°
	- Accuracy/Resolution: 2°/0.1° for tilt <20°
Tilt	*Liquid level*
	- Accuracy/Resolution: 0.2°/0.1°
	- Up or down: Automatic detect
Pressure	*Piezoresistive*
	- Range: 0-50 m (standard)
	- Accuracy/Resolution: 0.5% of full scale/ Better than 0.005% of full scale per sample

Data Recording

Capacity (standard)	2 MB, expandable to 26/82/152MB
Profile record	#cells×9 +120
Wave record	#samples×24 + 46

Data Communication

I/O	RS-232 or RS-422
Baud rate	300–115200
User control	Handled via "AWAC" software or ActiveX® controls

Power

DC input	10–16 ±10% VDC
Peak current	2A
Operating power consumption	1 W (typical)

Dimensions

Length, height, width	See drawing
Weight	5.8kg

Online applications

The AWAC is designed with long term monitoring in mind. The optional 48-Volt interface unit can be used to drive cables that are 5 km long and contains options for a variety of communication interfaces. This includes direct links using cable or radio as well as interfaces for GSM or analog telephone with automatic download from the internal recorder. Batteries and internal recorder can be used in conjunction with online systems for backup purposes.

Wave measurements

The AWAC provides three independent methods for measuring wave height and period. The three methods utilize the pressure, orbital velocity, and acoustic surface tracking (optional). These three independent measurements provide an internal check so that the processed estimates can be checked against each other.
Directional estimates are derived from the projected array of velocity measurement cells. The processing technique is known as the *Maximum Likelihood Method* (MLM). This advanced approach of estimating wave direction allows for wave events from independent directions to be resolved, unlike standard single point measurement methods.

Standard Output Parameters for systems with AST: $H_{1/3}$, $H_{1/10}$, H_{max}, $T_{1/3}$, $T_{1/10}$, T_{max}, T_{mean}, T_{peak}, $L_{1/3}$, $L_{1/10}$, L_{max}, Peak Direction, Mean Direction, Directional Spreading, Unidirectivity Index

Specifications:

Height Resolution:	1 mm
Height Accuracy:	1 cm
Height Range:	0–20 m
Period Resolution:	0.01 sec
Period Accuracy:	0.1 sec
Period Range:	0.5–100 sec
Direction Accuracy:	2°
Direction Resolution:	1°

www.nortek-as.com

NORTEK AS
Vangkroken 2
NO-1351 Rud
Norway
Tel: +47 6717 4500
Fax: +47 6713 6770
E-mail: inquiry@nortek.no

青岛诺泰克测量设备有限公司
[illegible]

NortekUK
Mildmay House, High St.
Hartley Wintney
Hants. RG27 8NY
Tel: +44-1428 751 953
Fax: +44-1428 751 533
E-mail: inquiry@nortekuk.co.uk

NortekUSA
Suite 400, 100 E. San Marcos Blvd
San Marcos, CA 92069
Tel: 760-510-5922
Fax: 760-510-5921
E-mail: inquiry@nortekusa.com

Nortek Aquadop Acoustic Current Meter

Aquadopp®

Open water 3D Current Meter

Imagine an ocean current meter without need for recalibration, without moving parts, with the ability to withstand fouling and with the sampling volume moved away from the mounting structure. These are among the factors making the Aquadopp® family the most versatile ocean current meters available. Leading oceanographers and engineers all over the world use the Aquadopp®. Typical applications are:

- ✓ Self-contained deployments
- ✓ Permanent monitoring stations
- ✓ Real time data collection on buoys, ROVs, offshore platforms, etc.

The Aquadopp® is usually configured from a PC, but it can be operated from any third-party controller using the RS232/RS422 interface (binary or ASCII) or analog outputs.

Software

The Aquadopp® comes standard with Windows® software both for real time data collection and for controlling autonomous deployments. Different views and menus guide you through the process from configuration to data conversion. The software has an extensive on-line help section and requires no special skills.

New firmware versions from Nortek can be loaded into the Aquadopp® using the standard software, removing the need for opening the canister and replacing components.

The effect of magnetic deployment frames can be eliminated in the on-line compass calibration procedure.

In the final analyses, the Aquadopp® offers great value through the combined use of advanced Doppler technology and a flexible system design.

The Aquadopp® has several significant advantages when compared to other open water current meters:

- ✓ All plastic and titanium parts stops corrosion
- ✓ Small and light weight (less than 3kg!)
- ✓ No moving parts that can be blocked or sensitive parts that are easily damaged
- ✓ Low power consumption for long deployments
- ✓ A variety of sensor heads and the ability to move the sampling volume away from the mounting structure assure undisturbed measurements in all situations.

Wave directional spectra

The Aquadopp®can be configured to collect wave directional data at the same time as it measures the mean current. Nortek provides postprocessing software that allows you to calculate the wave spectra from the raw data.

Diagnostic mode

The diagnostic mode is unique for Aquadopp®. It allows the user to intersperse the average data with periods of rapid sampling (1Hz). Diagnostic data are typically used to analyze mooring motion or to gather information about surface waves or internal waves.

NORTEK AS

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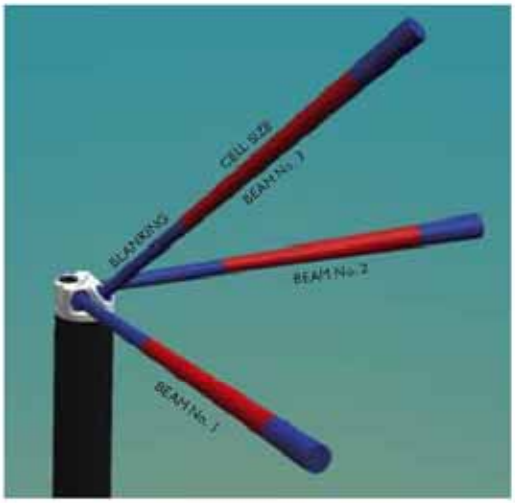
Aquadopp Head Configurations – collecti



A variety of sensor heads are available for the Aquadopp®. Each head is optimized for certain applications to ensure that you can collect data which you really want to.

The Aquadopp® measures the Doppler shift occurring when transmitting and receiving sound along two or more narrow acoustic beams. The Doppler shift is proportional to the velocity component along the beam. The data can be combined, using the exact geometry, to generate 2D (minimum 2 beams) or 3D velocity (minimum 3 beams).

Sampling Area, Blanking and Cell Size

The sampling area is determined by the blanking, cell size, and beam geometry, as shown in the above Fig. The parameters blanking and cell size are user selectable in software, whereas the geometry is determined by the orientation of the acoustic beams. The tilt and the compass sensor in the Aquadopp® work equally well whether it points up or down. Consequently, any head may be used up-looking just as well as down-looking.

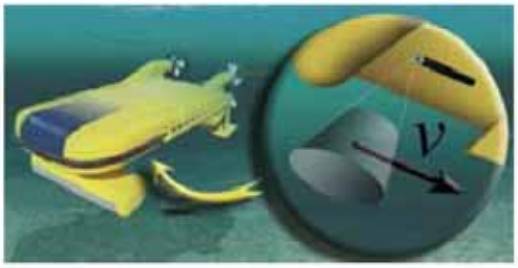
Custom Sensor Design

The Aquadopp® sensor head is made from a tough epoxy and polyurethane plastic materials suitable for molding. This allows us to design and construct new sensor heads with a lead time of four weeks or less. Contact Nortek or your local representative today if you have applications that may require a new sensor head design!

Other Sensors

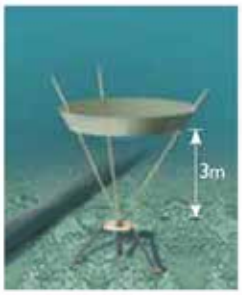
All heads have tilt and temperature sensors built in. Pressure sensor is standard for all heads except for the 2D side-looking head.

A typical application for the 2D side-looking sensor head is to measure 2D flow away from walls or boundaries. Shown here is an example of channel flow monitoring where the Aquadopp® is mounted on the channel wall, protected from floating debris, and the measurements are made in the free flow away from the wall.



A European military contractor has developed a system for mine hunting based on a powerful ROV. The ROV runs ahead of the ship at a distance of a few hundred meters, tracking targets as it goes. To measure the speed and direction, the vehicle is fitted with an Aquadopp® with right-angle sensor head to get accurate readings at 1-sec intervals.

An Aquadopp® with a symmetric sensor head can be used to measure at a fixed distance above the bottom.



AquaFin Deployment Fixture. *The AquaFin is designed for mooring an Aquadopp® Current Meter or a Current Profiler. It shackles into the mooring line and allows the Aquadopp® to swivel freely so that its beams always look into undisturbed flow. Choose non-magnetic stainless steel or titanium for mooring loads of 450, 900, and 1350 kg, respectively. Dimensions are: 414 mm × 684 mm (w × h). Fin alone is 306 mm wide.*

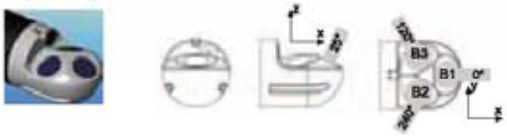
ing data undisturbed by flow interference

Head Configurations

Standard sensor head

The **Standard sensor head** is designed for mooring applications. The transducer orientation is optimized to give the best possible precision for the horizontal velocity. All three transducers are mounted on one side and the instrument should be mounted to assure that the beams are pointing into the undisturbed flow. In the case of a mooring line, this can be achieved by attaching a balancing fin to the Aquadopp® or by using the Aquafin.

Right angle sensor head



The **Right-angle sensor head** is used when it is important to give the instrument a low profile to minimize drag. Typical examples are bottom frames, ROVs, and applications where the Aquadopp® will be towed.

Symmetric sensor head

Symmetric sensor heads are designed to measure above or below the Aquadopp®. The most common application is Aquadopp® units mounted on bottom frames. In addition to measuring above the frame at a programmable distance, the vertical extent of the sampling volume is more precisely defined with the symmetric design than with the standard head, which is designed for mooring applications.

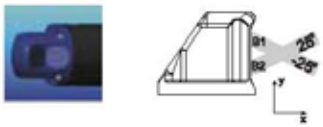
Asymmetric sensor head

The **Asymmetric sensor head** is used in situations where the sample area is best located above (or below) the instrument and out to the side. A good example is buoy mounted Aquadopp® units, where the measurement area should be positioned both below the hull and away from the anchor chain.

Hockey-puck-looking sensor head

The **Hockey-puck-looking sensor head** has all three beams in the horizontal plane. The sensor head can only measure 2D velocity, but has the advantage that one of the beams can be eliminated in the calculation of the horizontal velocity. This head can be used when making measurements close to the surface or bottom.

2D side-looking sensor head



The **2D side-looking sensor head** is used to measure 2D flow away from walls or boundaries. Typical applications include channel flow monitoring where the Aquadopp® is mounted on the channel wall – protected from floating debris – and the measurements are made in the free flow away from the wall.

Sensor head nomenclature. The acoustic beams are defined by their unity vectors Bi in the reference coordinate system XYZ. The reference system remains constant, regardless of the sensor orientation. The conversion from beam velocity to XYZ velocity is given by the inverse matrix generated from the Bi vectors.

Should none of these configurations fit your application, note that other head configurations are available on request.

Specifications

Water Velocity Measurement

Range	±5m/s (inquire for higher ranges)
Accuracy	1% of measured value ±0.5 cm/s
Maximum sampling rate (output)	1 Hz, 2 or 4 Hz on request
Internal sampling rate	23 Hz

Measurement area

Measurement cell size	0.75 m
Measurement cell position (user selectable)	0.35–5.0 m
Default position (along beam)	0.35–1.8 m

Doppler uncertainty (noise)

Typical uncertainty for default configurations	0.5–1.0 cm/s
Uncertainty in U,V at 1Hz sampling rate	1.5 cm/s

Echo Intensity

Acoustic frequency	2 MHz
Resolution	0.45 dB
Dynamic range	90 dB

Sensors

Temperature	Thermistor embedded in head
Range	–4°C to 40°C
Accuracy/Resolution	0.1°C/0.01°C
Time response	10 min
Compass	Flux-gate with liquid tilt
Maximum tilt	30°
Accuracy/Resolution	2°/0.1° for tilt < 20°
Tilt	Liquid level
Accuracy/Resolution	0.2°/0.1° for tilt < 20°
Up or down	Automatic detect
Pressure	Piezoresistive
Range	0–200 m (standard)
Accuracy/Resolution	0.5% / Better than 0.005% of full scale per sample

Analog inputs

Number of channels	2
Voltage supply	12V. Hardware can be modified to provide 5V or battery voltage.
Voltage input	16 bit A/D

Data Communication

I/O	RS232, RS422, or analog outputs Software supports most commercially available USB–RS232 converters.
Baud rate	300–115200
User control	Handled via WIN32® software, ActiveX function calls, or direct commands with binary or ASCII data output.

Software ("Aquadopp")

Operating system	Windows® 2000 & XP Functions Deployment planning, start with alarm, data retrieval, ASCII conversion. Online data collection and graphical display. Test modes.

Data Recording

Capacity (standard)	9 MB, expandable to 33, 89, or 161MB
Data record	40 bytes
Diagnostic record	40 bytes

Power

DC input	9–16VDC
Peak current	2A at 12VDC (user adjustable)
Max. consumption, 1Hz	0.2–1.0W
Avg. consumption	0.1 W (0.02Hz), 0.01 W (0.002Hz)
Sleep consumption	0.0013 W
Battery capacity	50 Wh. Extended 6000 m version has 2 battery packs (i.e. double capacity)
New battery voltage	13.5 VDC
Data collection (alkaline)	6 months at 10-min, ±1.5 cm/s noise
Data collection (lithium)	18 months at 10-min, ±1.5 cm/s noise

Connectors

Bulkhead (Impulse)	LPMBH-5-FS (bronze – titanium optional)
Cable	LPMIL-5-MP on 5m neoprene cable

From the year 2005 inline connectors type MCBH-8-FS will be used. This will cause the endbell to be somewhat longer than today.

Materials

Standard model	Delrin® and polyurethane plastics with titanium screws

Environmental

Operating temperature	–5°C to 45°C
Storage temperature	–15°C to 60°C
Shock and vibration	IEC 721-3-2
Pressure rating	300m for housing Pressure sensor OK to 1.5× range

Antifouling paint

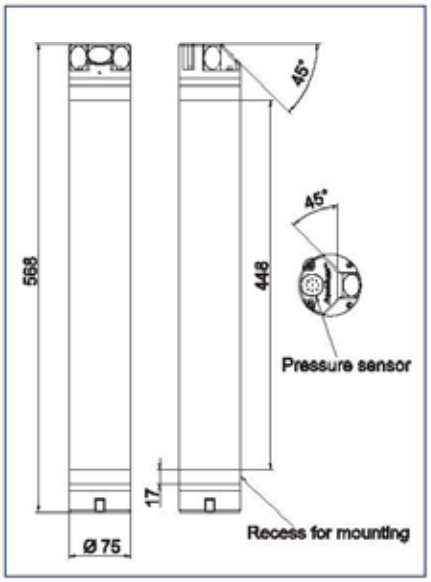
May be applied to all surfaces

Dimensions

Cylinder	See drawing below
Weight in air	3.5kg
Weight in water	Neutral

Options

Acoustic beams	Several different sensor heads available
Battery	Lithium or rechargeable Li-Ion batteries available
External battery	4 battery packs in 75 mm diameter, 500mm length. External canister
Connectors	LPMBH-8-FS with PLPMIL-8-MP on 10m polyurethane cable for optional RS422 or RS232 with analog input



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www.nortek-as.com

NORTEK AS
Vangkroken 2
NO-1351 Rud
Norway
Tel: +47 6717 4500
Fax: +47 6713 6770
E-mail: inquiry@nortek.no

青岛诺泰克测量设备有限公司
中国·青岛市海尔路29号海尔大厦
电话：0086-532-85017570 85017270
传真：0086-532-85017570
E-mail: inquiry@nortek.com.cn
www.nortek.com.cn

NortekUK
Mildmay House, High St.
Hartley Wintney
Hants. RG27 8NY
Tel: +44- 1428 751 953
Fax: +44- 1428 751 533
E-mail: inquiry@nortekuk.co.uk

NortekUSA
222 Severn Avenue
Suite 17, Building 7
Annapolis, MD 21403
Tel: +1 (410) 295-3733
Fax: +1 (410) 295-2918
E-mail: inquiry@nortekusa.com
www.nortekusa.com

Conductivity Sensor 3919/4119/4120

D344 - June 2005

These Sensors have a number of advantages over previous models:

- ***Improved depth rating of 6000 meters for 3919 and 4120***
- ***Real-time integrated calculation of salinity, density and speed of sound (see below)***
- ***Internal pressure never exceeds 1 bar therefore electronics and sensors are unaffected by sea depth***
- ***Rugged and Robust with minimal and simple maintenance needs***

Conductivity is a key parameter for in-situ determination of several fundamental physical properties of seawater. For seawater, the ability to conduct electrical current is mostly dependent on temperature and the amount of inorganic dissolved solids. This means that, together with temperature and depth information, a good estimate of the salinity may be determined.

Salinity is defined as the concentration of dissolved solids. Other important properties of seawater are again dependent on the salinity. Among these are the density and the speed of sound.

The Conductivity Sensors are based on an inductive principle. This provides for stable measurement without electrodes that are easily fouled and may wear out in the field.

Utilization of miniature components has made it possible to integrate all the required electronics. A digital signal processor calculates salinity, density and speed of sound. The salinity and density are calculated according to the UNESCO International Equation of State (IES 80).

The Conductivity Sensor 3919 outputs data in both RS-232 and Aanderaa SR10 format. 4119 outputs SR10/VR22 format, while 4120 has analouge output as well as RS232.

On the RS-232 output the Conductivity in mS/cm, as well as Temperature, Salinity, Density and Speed of sound may be presented.

Two SR10 channels are available; one of the SR10 outputs can be configured to present Conductivity, Salinity, Density or Speed of sound, while the other SR10 output presents the temperature measurement.The user may configure the range on both SR10 outputs. This allows for a possibility to zoom in on the range of interest.

Conductivity Sensor 3919 and 4120 are designed to operate down to 6000 meters, 4119 is designed to operate down to 1000m. The Conductivity Sensors are available for Recording Current Meters RCM 9, RCM 9 MkII, RCM 9 IW, RCM 9 LW and RCM 11, Recording Doppler Current Profiler RDCP 600 as well as an stand-alone RS-232 sensor for other applications.

AADI AANDERAA

AANDERAA DATA INSTRUMENTS • www.aadi.no *Reliable Solutions 1*

Our Products

3 Year Meter Warranty

Waterproof Hand-held Meters

CyberScan DO300 Waterproof Dissolved Oxygen Meter

- **Waterproof and Dustproof Housing** - IP67 rated, ideal for rugged harsh conditions. Plus it floats!
- **Automatically Compensates Salinity and Barometric Pressure** after manual input for increased accuracy
- **Independent 100% and Zero Adjustment Calibrations** give meter high accuracy across entire measurement range
- **No Meter Warm-up Required with Galvanic Cell** - takes measurements immediately and produces quick response
- **Displays Electrode Diagnosis** gives slope, zero offset and millivolt values to help determine when to service or replace electrode
- **Stability Indicator** prompts whenever reading stabilizes
- **Hold Function** momentarily freezes reading for easy viewing and recording
- **Auto-Power Off** saves battery power after non-use
- **Self-Diagnostic** with message codes for easy troubleshooting
- **Adjustable Backlit Display** for viewing readings conveniently in poorly lit places
- **Large, Easy-to-Read Custom LCD Display** with simultaneous readings provides optimum viewing with user-friendly icons
- **Rugged Carrying Case (Included)** provides handy on-site meter calibration and measurement

Applications

Aquacultural: Use to monitor oxygen levels in catfish and shrimp farming; game stocking ponds; ornamental fish tanks and ponds; and in other fish farming applications.

Industrial: Ideal for checks the quality of plant water intake and discharge, wastewater and water treatment, recirculating systems and industrial process systems.

Environmental: Use to test water quality, monitor health of aquatic ecosystems, survey surface and ground water drinking supplies, and meet EPA regulations.

Educational: Ideal for quick, accurate DO readings in laboratories and schools.

Specifications of CyberScan DO300 Meter

Product Code	EC-DOWP300
Dissolved Oxygen Range	0 to 19.9 mg/l or ppm
Resolution & Accuracy	0.01 mg/l, 0.1 ppm & ±1.5% Full Scale
% Saturation of Oxygen	0.0 to 199.9 %
Resolution & Accuracy	0.1 % & ±1.5% Full Scale
Temperature Range	0.0 to 100.0 °C (32.0 to 212 °F)
Resolution & Accuracy	0.1 °C (0.1 °F) & ± 0.3 °C (0.5 °F)
Salinity Correction	0.0 to 50.0 ppt
Barometric Pressure Correction	500 to 1499 mm Hg or 66.6 to 199.9 kPA
Method	Manual input for automatic correction
No. of DO Calibration Points	Up to 2 points; 100% in air and/ or 0% in known solution
Temperature Compensation	Automatic / Manual (0 to 100 °C)
Back-lit Display	Yes
Memory	50 data sets
Special Functions	Stability Indicator; Self-diagnostic; Electrode characteristics; Hold & Auto-Power Off after20 minutes
Power	4 'AAA' x 1.4V batteries

13.4 19th and 20th century literary sources relating to Pistol Meadow

CA Johns

Local legend, still current, has it that the bodies of those drowned in the wreck were buried on the north side of the valley at Pistol Meadow, above the nearest beach to the scene of the wreck and that 'Pistol' is haunted by their ghosts. The story was first recounted by the Revd CA Johns in 'a week at the Lizard', first published in 1848;

> 'Of all the tales of shipwreck told at the Lizard, the story connected with Pistol Meadow is the saddest and most frequently repeated. Its date I could not ascertain, but it must, I concluded, have taken place more than a century ago. A transport, having on board the governor of some distant colony, with his suite and 700 men, was driven on a group of rocks, still called from the incident the Man-of-War Rocks, and dashed to pieces. Two only of the whole company reached the shore alive, and these two, it is said, being well acquainted with the cost, had ventured to remonstrate with the captain for steering his course so near the dangerous headland. They were rewarded by being put in irons, and in irons they were washed ashore, to bear testimony to their captain's obstinacy. Two hundred dead bodies were subsequently washed on shore and buried in pits, containing from twenty to thirty each, in this meadow. Thirty years ago the fishermen said they could even then descry, with the help of their water-glasses, pieces of cannon lying at the bottom where the ship went to pieces; and they also averred that dogs of all kinds were held in great detestation in the parish because a great number of these animals assembled from all parts of he country to devour the dead bodies which were then washed ashore. Many persons in the parish are still afraid to pass through Pistol Meadow after dark' (Johns 1848, 73-4).

The account in Joseph Polsue's parochial history of Landewednack, published in 1867, is obviously based on CA Johns' account (Polsue 1867 vol II).

Wilkie Collins

The Victorian novelist William Wilkie Collins visited the Lizard in 1850 , and his account of the shipwreck, published three years after Johns', adds some more detail to the story; 'Turning from the Lizard Head towards a cliff at some little distance, we passed through a field on our way, overgrown with sweet-smelling wild flowers, and broken into low grassy mounds. This place is called 'Pistol Meadow', and is connected with a terrible event which is still spoken of by the country people with superstitious awe.

> 'Some hundred years since, a transport-ship, filled with troops, was wrecked on the reef off the Lizard Head. Two men only were washed ashore alive. Out of the fearful number that perished, two hundred corpses were driven up on the beach below Pistol Meadow; and there they were buried by tens and twenties together in great pits, the position of which is still revealed by the low irregular mounds that chequer the surface of the field. The place was named, in remembrance of the quantity of fire-arms – especially pistols – found about the wreck of the ill-fated ship, at low tide, on the reef below the cliffs [CA Johns suggests that the place-name is a corruption of the ancient British *Pistyll*, a spout or cataract from the stream which flows through the meadow and falls down the cliff]. To this day, the peasantry continue to regard Pistol Meadow with feelings of awe and horror, and fear to walk near the graves of the drowned men at night. Nor have any of the inhabitants yet forgotten a revolting circumstance connected by traditional report with the burial of

the corpses after the shipwreck. It is said that when the dead bodies were first washed ashore, troops of ferocious half-starved dogs suddenly appeared from the surrounding country, and could with difficulty be driven from preying on the mangled remains that were cast upon the beach. Ever since that period, the peasantry have been reported as holding the dog in abhorrence. Whether this be true or not, it is certainly a rare adventure to meet with a dog in the Lizard district. You may walk through farm-yard after farm-yard, you may enter cottage after cottage, and never hear any barking at your heels – you may pass, on the road, labourer after labourer, and yet never find one of them accompanied, as in other parts of the country, by his favourite attendant cur' (Collins 1851, 69-70).

Walter White

'Then Pistol Meadow, so named from the number of pistols washed up there with two hundred dead bodies from a wreck on the Man-of-War Rocks, so long ago that no one remembers the date' (White 1855, 226).

Mrs Craik

In September 1881 Mrs Craik, the author of 'John Halifax, Gentleman', visited The Lizard with two of her daughters, her guide, a local fisherman named John Curgenven, pointed Pistol Meadow;

"Look up there ladies, that green slope is Pistol Meadow. Nobody likes to walk there after dark. Other things walk as well".

"What things?"

"'Two hundred or more of foreign sailors, whose ship went to pieces in the little cove below. They're buried under the green mounds you see. Out of a crew of seven hundred only two men were washed ashore alive, and they were in irons, which the captain had put on them because they said he was going too near in shore. It was called Pistol Meadow because most of 'em were found with pistols in their hands, which may be true or may not, since it happened more than a hundred years ago. However, there are green mounds, you see, and Lizard folk don't much like passing the place after dark" (Craik 1881, 19).

JC Trewin

The literary critic JC Trewin, who spent his boyhood at The Lizard in the early years of the 20th century, recalled the eeriness of Pistol Meadow in his autobiography;

'Beyond Maenheere the road ceased to be a road: it fell past the clitter of a narrow, ferny lane top the squarish pasture of Pistol Meadow, with a squelching trickle of stream, the tamarisk's overhang by the Polpeor path, and westward, the rough rise to Old Lizard Head. I would never venture through Pistol after dark. Even today, the mounded field, pungent with the scent of seaweed and camomile, has the same queerness. In Pistol I have always felt that other eyes were watching. Yet there has been nothing but rank grass, the rock-littered sea, and steps - steep, weedy stairs – to the least troubled of the Lizard coves: a sheer cliff of mesembryanthemum, a splatter of seaweed ribboned glossily across the pebbles, a cavern a natural arch, and a chain of brimming pools.

'The meadow's name belongs to legend. According to this, in the first half of the eighteenth century, a transport bearing more than 700 men was driven on the Man o'

War Rocks and driven to ruin. Two hundred dead bodies were washed ashore and buried in pits, each holding from twenty to thirty, on the rough summit of the cliff. So many firearms were picked up that the place became known as Pistol, and the name stuck…

'I can believe anything of this meadow, especially after a December sunset. It was in December that I had an odd experience, about four o'clock on a calm, dull afternoon during the Armistice autumn. In the narrows of the cliff path above Pistol I heard someone coming, a brisk patter of feet, and stood aside to let him pass. He was, as I remember, a shrivelled man in a nondescript blue Guernsey, torn badly at the collar. He had a fuzz of wiry, greying brown hair. Nothing else was noticeable but his eyes, deep black in the extreme pallor of his face. I said good afternoon. He brushed by me without answering. A few seconds later, not more, I heard steps again, and there, coming towards me, was without doubt the same man, though manifestly he could not have doubled around in so short a time and on so awkward a path. I stopped, more perplexed than frightened, and again said good afternoon; again there was no reply. And then a third time, I heard steps. Now nothing was in sight. I felt a quick stirring in the air, but no one passed me. Fear came, and I tore home through the darkening day…Nobody at home, where we knew most of the people at The Lizard, could identify the man, or anyone like him' (Trewin 1948, 21-2).

Daphne du Maurier

The story was further elaborated by the romantic novelist Daphne du Maurier;

'Both these wayfarers [Walter White (1855) and Alsphonse Esquiros (1865)] as well Wilkie Collins the novelist…were haunted by a story of shipwreck and death connected with a spot called Pistol Meadow. This gruesome tale, difficult to envisage on a day of high summer in the tourist season, is not too hard to reconstruct on a late afternoon in February, or better still December, when the sea, a sullen grey, lashes the rocks , and the cliff paths are muddied with winter rains.

'In the mid-eighteenth century a transport ship was wrecked on a reef off Lizard Point, and a couple of hundred corpses washed ashore in the stony cove beneath the westward cliff. The Lizard people found them at low tide, jammed into rock crevices, tangled up in seaweed, half hidden under stones, and scattered near to the reef where the hip had foundered a great quantity of firearms, mostly pistols. Above the cove a rough meadow sloped to the cliffs, good for little except grazing, and here the people dug the pits in which to bury the dead soldiers, carrying the bodies one at a time up the steep path from the cove. The task was hard, taking several days, and to the horror of the men who dug the pits and bore the bodies to them they found the shore invaded by a pack of hungry dogs, appearing not only from their own neighbourhood but from the outlying country, all seeking to prey upon the drowned. But at last there was not a single body left upon the shore; each poor soldier lay with his fellows in the common graves above, and forever after the place was known as Pistol Meadow…

'Visiting the scene some hundred years after Wilkie Collins, I looked uneasily about me for the sight of a mangy cur loping up the cliffs, and being pelted with stones by village boys, but all was orderly. Near to the lighthouse a man, painting the inside of a café, pointed out Pistol Cove west of the point, but the meadow was more difficult to place, for the cliff walk above the cove was bounded with wire for safety's sake – there had recently been a fall of earth – and then the path wound to the left to the

further headland and a look-out hut beyond. Here was no meadow with sweet-smelling wild flowers and waving grass blowing peacefully over the mounds of the dead, as described by Wilkie Collins. The rough ground sloped directly to the cliff, intersected by a stream, the mounds I trod were natural hillocks sprouting gorse, until . . . could this be it?

'A small enclosure, set about with stumpy willows [tamarisks] grotesquely shaped by the prevailing wind, the ground bussocky and rough. The whole enclosure, if dug, would not have covered more than fifteen to twenty square feet. Perhaps, as Wilkie Collins said, wild flowers grew here once, and in his day, before the stumpy willows formed, the mound of the pit would have shown, now sunken with a century of winter rains. It was peaceful, untroubled, better than many another resting-place for sleeping soldiers.

'Looking upon it, and then out to sea, I thought back some thirty-five years or more to a night spent in the Lizard hotel…and how I could not sleep because the lighthouse beam swept my window each minute. One, three, five, it was as if every other moment, with maddening persistence, someone entered the room and flooded it with light, then flicked it off again, while as the night lengthened and the weather worsened, the foghorn boomed. Two hundred years ago there were no beacons and no warnings, and all the soldiers of the transport heard was the sound of the sea breaking on the reef, while they waited, huddled on the decks, for the first tearing crash as the vessel struck, (Du Maurier 1967, 72-5).

13.5 List of documents held at the Public Record Office, Kew

Copies of documents collected by Mike Hall and Rob Sherratt were catalogued and indexed by Kevin Camidge. Further work at the PRO was undertaken by Kevin Camidge with Robin and Janet Witheridge. The 'RAG' numbers in the following tablesare reference numbers given to the documents by Kevin Camidge.

13.5.1 ADM 1/577-580 Letters from unemployed Admirals 1693-1804

Ref.	No	Loc	Date	From / To	Subject	Description
ADM 1/577	RAG022	KC	10-12-1709	Carmarthen to Admiralty	Ballast	RAG not to proceed until more ballast added. Also Carmarthen proposes masts altered at Sheerness. Carmarthen mentions his health twice?
ADM 1/577	RAG001 *	KC	27-1-1709/10	Carmarthen to Admiralty	Sea Trials	Carmarthen accepts temporary command of the *Royal Anne* Galley (for trials only) He wants a second Lieutenant - not normally allowed on a fifth rate on account of the RAG having 48 guns plus 12 'clear space ports' and 60 men over compliment (apparently to operate the 66 oars in the trials).
ADM 1/577	RAG004 *	KC	31-1-1709/10	Carmarthen to Admiralty	Sea Trials	Pleading against his refusal of a second Lieutenant. Says he only needs same for the trials of RAG. Reminds them that HRH promised him selection of RAG's officers.
ADM 1/577	RAG006 *	KC	24-7-1710	Carmarthen to Admiralty	Sea Trials	Carmarthen at Spithead with RAG & *Swallow* Prize. Says he will be ready to put to sea Tuesday but asks for an extra day to swap some of RAG's guns as he feels they are unsuitable. Also wants to swap some green men for 50 marines.
ADM 1/577	RAG024	KC	25-8-1710	Carmarthen to Admiralty	Sea trials	Part of letter "Came into Plymouth after the *Swallow* Prize, which I sent into harbour with a small prize I took the 23rd instant off of the Bass".
ADM 1/577	RAG021	KC	9-9-1710	Mynge (CIC ships at Spithead & Portsmouth) to Capt Trevor (RAG)	Orders	Trevor is ordered to discharge the 2nd lieutenant and all men above highest compliment (190) and put them on HM ship *Newark*. Note: *Newark* is listed as a 80-gun 3rd rate ship built in 1695 (Lavery 1989).
ADM 1/577	RAG009	KC	25-6-1716	Flag Officers ; Rates & Guns	Rates	List of Rates and Cannon size & Number : (Why is this filed with letters from retired admirals?). Single sheet NOT transcribed.
ADM 1/577			No date	Carmarthen to Admiralty	Building	Carmarthen asking for money for his work on RAG. First page only of letter.

Ref.	No	Loc	Date	From/ To	Subject	Description
ADM 1/577			No date	Carmarthen to Admiralty?	Crew & pay	Part of a letter about manning levels and pay for RAG.
ADM 1/577			No date	Carmarthen To Admiralty?	Sea trials?	Part of letter; Carmarthen talks of chasing French ships.

13.5.2 ADM 2/40 Orders and instructions

Ref.	No	Loc	Date	From/ To	Subject	Description
ADM2/40 page 107			20-6-1709		Orders	To fall down to Longreach and with all dispatch get aboard guns, stores and provisions and proceed to the Nore and remain there for further orders sending an account of your proceeding to my secretary for my information.
ADM2/40 page 265			24-8-1709	From Pembroke to Trevor	Orders	Notwithstanding the orders to proceed to Longreach you are required and directed to forebear doing the same until such time as she shall be gunned and fitted in all other respects as the Marquis of Carmarthen shall desire. Then you are to put my aforesaid orders into execution.
ADM2/40 page 373			1-10-1709		Orders	*Difficult to read* but seems to be an order to discharge all men who for whatever reason cannot be on board when the ship is sent to Lisbon. This message to several ships. Also ordered to take on board some officers needing passage to Lisbon.

13.5.3 ADM 2/41 Orders and instructions 9 November 1709 – 20 June 1710

Ref.	No	Loc	Date	From/ To	Subject	Description
ADM 2/41 (109)			7-12-1709	Admiralty to Captain Trevor	Orders	RAG to proceed to the Nore and from there to the Downs.
ADM 2/41 (127)			12-12-1709	Admiralty to Captain Trevor	Orders	RAG to remain at the Nore until further orders.
ADM 2/41 (177)			29-12-1709	Admiralty to Captain Trevor	Orders	To Captain Trevor instructing him to follow Carmarthen's orders.
ADM 2/41 (250)			17-1-1709	Admiralty to Captain Trevor	Orders	RAG ordered to Longreach.

Ref.	No	Loc	Date	From/ To	Subject	Description
ADM 2/41 (263)			24-1-1709	Admiralty to Captain Trevor	Orders	Orders to Captain Trevor. Guns, stores and provisions to be removed from the RAG prior to her refitting at Woolwich or Deptford.
ADM 2/41 (285)			2-2-1709	Admiralty to Captain Trevor	Orders	RAG to proceed to Woolwich to be cleaned and refitted.
ADM 2/41 (340)			20-2-1709	Admiralty to Carmarthen	Orders	RAG to be cleaned and tallowed and furnished with 6 weeks provisions. Then to the Nore and the Downs and wait for orders.
ADM 2/41 (429)			30-3-1710	Admiralty to Carmarthen	Orders	The Marquess Carnarthen, first captain of the RAG to get RAG ready for dock at Woolwich, then to Longreach to load guns and stores then to the Nore.
ADM 2/41 (431)	Photo		31-3-1710	Admiralty to Carmarthen	Orders	Telling Carmarthen (first captain of RAG) to order the second captain (Trevor) to take RAG to Woolwich with the guns in as requested.
ADM 2/41 (531)			3-5-1710	Admiralty to Carmarthen	Orders	Once RAG is fit guns to be loaded and RAG to proceed to the Nore.
ADM 2/41 (531)			19-5-1710	Admiralty to Carmarthen	Orders	Carmarthen captain of Rag to proceed to the Nore where he will have opportunity to 'try the qualifications' of the RAG. To take under his command the *Swallow* Prize. To make the best trial of RAG sailing and other qualities for 3 weeks or a month. Then repair to some port of the kingdom to wait for further orders.

13.5.4 ADM 2/42 Orders and instructions

Ref.	No	Loc	Date	From / To	Subject	Description
ADM2/42 page 18			28-6-1710	To Marquis of Carmarthen 1st Captain	Orders	Whereas we have given orders for the cleaning and tallowing of RAG and the *Swallow* Prize either at Portsmouth or Plymouth you are requested and required to carry this out and provisioning for 2 months with all possible dispatch after which, with no loss of time, you are to carry out our instructions regarding the trying of the qualifications of RAG.
ADM2/42 page 63			25-7-1710	to Captain Trevor 2nd captain	Orders	Whereas complaint hath been made with her Majesty that since your lordship did lately bring into Portsmouth two Swedish ships under suspicion of their being prizes you have caused the masters of them to be strictly confined on RAG and the Swallow prize and not permitted them to write or speak to any of their friends. Judge of the high court of admiralty having reported to the Queen that they should be examined before a Standing Commission at Portsmouth or sent up to the high court of the Admiralty here. Whereupon her Majesty's pleasure hath signified to the Duke of Queensberry (sec of State) that the same shall be complied with.. Your lordship is herby required and directed to cause them to be carried before the Standing Commission at Portsmouth or London if none exists in Portsmouth.
ADM2/42 page 198			29-8-1710	to Marquis of Carmarthen 1st Captain	Orders	to repair to town and attend her Majesty.
ADM2/42 page 210			30-8-1710	to Carmarthen from Mr Walker superintendent at Plymouth	Orders	you are hereby required and directed to give orders to Captain Trevor, second captain, of RAG now at Plymouth to make all possible dispatch in getting said ship ready for sea and then without loss of time to repair with her to Spithead with such trade as is bound his way and are ready to sail where he shall remain for further orders.
ADM2/42 page 223			7-9-1710	from Mr Ming superintendent at Portsmouth	Orders	to discharge her second lieutenant and such men who are above her highest complement (190) into the *Newarke* and advise who has been transferred.

Ref.	No	Loc	Date	From/ To	Subject	Description
ADM2/42 page 228			9-9-1710	To Mr Ming superintendent at Portsmouth	Orders	you are hereby required and directed to give orders to the Captain of the RAG which we are informed is now in Portsmouth to proceed with her out to Spithead without loss of time and that he remain there for further orders.
ADM2/42 page 232			9-9-1710	To Mr Ming superintendent at Portsmouth	Orders	to order her to Spithead and direct the first lieutenant of the *Newarke* to take the command of her upon him until her Captain returns from London.
ADM2/42 page 248			10-9-1710	To Mr Walker superintendent at Plymouth	Orders	upon RAG's arrival at Plymouth to send her to sea with the ships.
ADM2/42 page 253			10-9-1710	To Mr Ming superintendent at Portsmouth	Orders	RAG to go to Plymouth and follow Mr Walker's orders
ADM2/42 page 268			23-9-1710	To Mr Ming superintendent at Portsmouth	Orders	to send RAG to the Downs for further orders plus and take with her any trade wanting to go that way
ADM2/42 page 271			25-9-1710	To Mr Walker superintendent at Plymouth	Orders	to send her to the Downs
ADM2/42 page 345			20-10-1710	To Edward Whittaker Admiral of the White	Orders	To order RAG to proceed to sea in company with ships listed and look out for the Russia trade and return to Ough Bay
ADM2/42 page 622			16-1-1710	To Mr Juniper, Superintendent at Chatham	Orders	To orders RAG into Sheerness to be fitted for Channel Service thence to the Nore to remain there for further orders

13.5.5 ADM 2/43 Orders and instructions 19 January 1710 – 18 July 1711

Ref.	No	Loc	Date	From/ To	Subject	Description
ADM 2/43 (14)			23-1-1710		Orders	Alterations to be made to RAG, which the officers of Sheerness have proposed – these to be carried out at Chatham. When finished RAG to proceed to the Nore.
ADM 2/43 (153)			1-3-1710	To RAG at the Nore	Orders	RAG and 4 transports to take 3 regiments of Dragoons from Leith (in north Britain) to Holland.
ADM 2/43 (489)			21-5-1711	To RAG at the Downs	Orders	Orders for RAG to remain at the Downs
ADM 2/43 (491)			23-5-1711	To RAG at the Downs	Orders	Orders for RAG to remain at the Downs
ADM 2/43 (529)			2-6-1711		Orders	RAG to escort the Yacht *Mary* (with His Excellency onboard) from Holland to Harwich.

ADM 2/43 (543)			11-6-1711		Orders	Appointing the *Centurion* to perform the above escort duties if RAG not able.
ADM 2/43 (566)			15-6-1711		Orders	RAG ordered to the Downs.
ADM 2/43 (594)			26-6-1711		Orders	RAG to provision for a voyage to Russia.
ADM 2/43 (612)			3-7-1711		Orders	RAG to get new foremast at Harwich. Also to refit for channel service & victuals for 3 months. Then to return to the Downs.
ADM 2/43 (617)			5-7-1711		Orders	RAG to go to Harwich or Portsmouth (depending on wind) to refit for channel service, victuals for 3 months, cleaned and tallowed.
ADM 2/43 (618)			6-7-1711		Orders	To Captain Boyse in Sheerness. RAG to be taken along to Russia if ready in time. If not he is to take *Scarborough* instead.

13.5.6 ADM 2/44 Orders and instructions

Ref.	No	Loc	Date	From/ To	Subject	Description
ADM2/44 page 20			02-7-1711	To Thomas Hardy	Orders	To direct RAG to accompany the ship *Noore* to Norway and from thence to England for the better security of the trade.
ADM2/44 page 34			3-8-1711	To Thomas Hardy	Orders	to send her to the Downs and hence to Yarmouth roads to join the Russia trade with their convoy and proceed with them to ?? (difficult to read).
ADM2/44 page 52			9-8-1711		Orders	order to complete her provisions for 3 months.
ADM2/44 page 56			11-8-1711		Orders	the company of the *Royal Ann* Galley to proceed to Yarmouth Roads and convey the trade from thence to Norway and if there shall be any ship bound to Hambro (Hamburg) to see them as far as Helgoland
ADM2/44 page 56			11-8-1712		Orders	to follow the orders of Capt Hemming of the *Bristol*
ADM2/44 page 63			14-8-1711		Orders	orders to proceed to Ough Bay and take RAG with you if she is in the Downs
ADM2/44 page 70			17-8-1711		Orders	to proceed with the *Bristol* to Yarmouth Roads and thence to Norway
ADM2/44			??-8-1711		Orders	to put himself under the command of Capt Hannington and follow his orders for proceeding to Bristol

Ref.	No	Loc	Date	From/ To	Subject	Description
ADM2/44 page 325			1-11-1711	To Mr Juniper, Superintendent at Chatham	Orders	to send RAG into Sheerness to fit for Channel service and thence to the Nore (North Foreland).
ADM2/44 page 445			5-1-1711		Orders	to receive aboard the two ?? named (difficult to read).
ADM2/44 page 448			7-1-1711		Orders	to the Downs.
ADM2/44 page 457			11-1-1711		Orders	to receive aboard a ? and carry same to Lisbon (difficult to read).
ADM2/44 page 488			26-1-1711	To Mr Juniper, Superintendent at Chatham	Orders	to order RAG to convoy the Sheerness yacht to Ough Bay and then repair to the Downs.
ADM2/44 page 492			20-1-1711	To Mr Juniper, Superintendent at Chatham	Orders	To order RAG to stay at the Nore.

13.5.7 ADM 2/45 Orders and Instructions 10 March 1711 – 8 November 1712

Ref.	No	Loc	Date	From/ To	Subject	Description
ADM 2/45			10-3-1711		Orders	RAG ordered to the Nore. To wait there for further orders before proceeding to Holland.
ADM 2/45			12-3-1711		Orders	RAG ordered to Lisbon and to join with Captain Morrice of HMS *Canterbury.*
ADM 2/45			14-3-1711		Orders	RAG to call at Plymouth and if *?Winchester?* is there to proceed together.
ADM 2/45			17-3-1711		Orders	Take baggage on to Gibraltar.
ADM 2/45			24-4-1712		Orders	Take the consul from Gibraltar to Tunis.
ADM 2/45			20-8-1712		Orders	To RAG at Port Mahone (Minorca) to return to Great Britain with all the shipping under your command.

13.5.8 ADM 2/46 Orders and Instructions

Ref.	No	Loc	Date	From/ To	Subject	Description
ADM2/46 page 18			19-11-1712		Orders	Her Majesty has been informed that the Rovers of Sally in the dominions of the emperor of Morocco have seized some English vessels which ran ashore on their coast and imprisoned some of their persons. Orders to proceed with the *Port Mahon* in search of the *Sally Rover* (the Rovers of Sally) to protect said vessels.

ADM2/46 page 69			10-12-1712		Orders	orders relating to the cessation of arms.
ADM2/46 page 127			9-1-1712/13		Orders	The moors cannot be prevailed upon to keep the truce and that they have several of her Men as slaves in Mequinez. Orders To keep the subjects of Emperor of Morocco in safe custody until the slaves are released.
ADM2/46 page 137			17-12-1713		Orders	to repair to Lisbon and convey from thence to Port Mahon several merchant ships laden with naval stores for Sir John Jennings squadron.
ADM2/46 page 155			17-2-1712/13		Orders	orders to RAG and ships under her command to follow orders received from Captain Paddon commander of the *Ruby*.
ADM2/46 page 283			21-5-1713	to Cap Paddon of Ruby	Orders	to repair with ships under his command to GB and call for orders in Plymouth and if none are there to return to the downs.
ADM2/46 page 439			12-9-1713		Orders	to deliver the Queens presents to the Emperor of Morocco according to the orders direct from Her Majesty's and to the last ships remaining to consult with the governor of Gibraltar about bringing officers and soldiers from thence to Great Britain.
ADM2/46 page 585			23-3-1713/14		Orders	to reduce his men to the lowest complement.

13.5.9 ADM 2/48 Orders and instructions

Ref.	No	Loc	Date	From/ To	Subject	Description
ADM2/48 page 303			29-7-1715	From Byng	Orders	To hasten to the Downs as soon as possible.
ADM2/48 page 348			26-9-1715		Orders	to put the ships under his command to whole allowance of all species of provisions the first day of next month 1st October.
ADM2/48 page 353			5-10-1715		Orders	with the ships under his command to assist the Duke of Argyll, General of her Majesty's forces in North Britain either in transporting troops, arms or ought else.
ADM2/48 page 361			13-10-1715		Orders	To take on board two months dry provisions and whole allowance for 420 men + water + proceed to the Road of Leith give it to said vessels and return to the Nore.
ADM2/48 page 365			10-10-1715		Orders	to seize or destroy all vessels in the rebels custody or within their reach.

Ref.	No	Loc	Date	From / To	Subject	Description
ADM2/48 page 368			19-10-1715		Orders	to take under his command the *Drake* and *Sharke* Sloops.
ADM2/48 page 561			9-11-1715 (noted down as 16 needs checking against log)		Orders	to refit in Woolwich.
ADM2/48 page 567			16-4-1716		Orders	to go to short allowance of flesh on the 1st May next.
ADM2/48 page 606			1-6-1716		Orders	with the *Queenborough* to convey the trade from Newcastle to the Baltic.
ADM2/48 page 630			2-7-1716		Orders	to go to Margate roads under command of commander in chief of fleet.

13.5.10 ADM2/49 Orders and instructions

Ref.	No	Loc	Date	From / To	Subject	Description
ADM2/49 page 19			15-8-1716		Orders	with the *Phoenix* to cruise till 20th Sept between Shetland and Stadtland for the protection of the Archangel trade.
ADM2/49 page 50			21-9-1716		Orders	to repair to the Nore.
ADM2/49 page 54			2-10-1716		Orders	with the *Diamond* to cruise off Bucharest? for the Russia trade till 20th Oct and then return to the Nore.
ADM2/49 page 55			2-10-1716		Orders	to seize Swedish privateers.
ADM2/49 page 72			31-10-1716		Orders	to refit in Sheerness.
ADM2/49 page 95			3-12-1716		Orders	to follow Mathew Alymer's orders attending the King from Holland.
ADM2/49 page 152			9-2-1716		Orders	to proceed to the coast of Gollenburgh? for intelligence on what ships to take under his command.
ADM2/49 page 154			12-2-1716		Orders	to call in at some other port in Norway inhabited by the Danes to gain intelligence on what preparations the Swedes are making at Gollenburgh?
ADM2/49 page 157			14-2-1716		Orders	to repair to the Nore with the ships under RAG's command.
ADM2/49 page 168			19-2-1716		Orders	to proceed with them to the coast of Norway and send the *Charles* Galley to the Nore if he sees occasion.
ADM2/49 page 220			23-4-1717		Orders	to repair to the Nore.
ADM2/49 page 230			15-5-1717		Orders	to reduce men to middle complement and refit at Chatham.

Ref.	No	Loc	Date	From/ To	Subject	Description
ADM2/49 page 257			14-6-1717		Orders	to cruise for one month between England and Holland and call in at Yarmouth in 10 or 12 days.
ADM2/49 page 207			23-7-1717		Orders	to come to the Nore to be laid up and paid off at Sheerness.

13.5.11 ADM 2/50 Lords letters: Orders & instructions 1719 -1723

Ref.	No	Loc	Date	From/ To	Subject	Description
ADM 2/50 (127)	RAG026	KC	21-8-1719	Admiralty to Willis	Orders	Captain Willis is appointed to the command of RAG at Sheerness. The officers and company of *Deal Castle* to be transferred to RAG. RAG to be fitted out for channel service, cleaned and graved with white stuff. Victualled for 4 months at highest compliment .
ADM 2/50 (129)			29-8-1719		Orders	RAG (and many other named ships) are not to attack Swedish ships.
ADM 2/50 (139)			30-9-1719		Orders	RAG to go onto 'whole rations of flesh'.
ADM 2/50 (154)	RAG025	KC	20-11-1719	Admiralty to Willis	Orders	Orders to Captain Willis at the Norre to proceed to the coast of Guinea, Cape Verde and Africa (Sierra Leone) with the *Lynn*. Rations for 8 months at whole allowance for highest compliment. Both ships to hunt Pirates.
ADM 2/50 (158)			20-11-1719	Admiralty to Willis	Orders	RAG and *Lynn* to call at Mederas for wine instead of beer for the crew.
ADM 2/50 (163)			30-11-1719	Admiralty to Willis	Orders	RAG and *Lynn* at the Nore, all supernumeris to be discharged (same letter to 10 other ships).
ADM 2/50 (164)			2-12-1719	Admiralty to Willis	Orders	RAG to take charge of merchantmen on voyage – also to call at Plymouth for any merchantmen bound their way.
ADM 2/50 (385)			24-4-1721	Admiralty to Willis	Orders	Willis to sort payments to *Anna Transport* for carrying bread for Hampshire .
ADM 2/50 (386)			27-4-1721	Admiralty to Willis	Orders	RAG ordered to Longreach, guns stores and provisions offloaded then RAG to Deptford to be surveyed.
ADM 2/50 (400)	RAG028	KC	10-6-1721	Admiralty to Willis	Orders	To Willis, RAG Deptford Orders to fit out RAG for a voyage to West Indies. RAG to be sheathed & graved with white stuff. Stores and victuals for 8 months at full rations for highest compliment. Accommodation for the Governor of Barbados.
ADM 2/50 (413)			26-7-1721	Admiralty to Willis	Orders	RAG to take midshipman John Graydon, (left behind by the *Faversham*) to rejoin his ship.

Ref.	No	Loc	Date	From / To	Subject	Description
ADM 2/50 (419)			22-8-1721	Admiralty to Willis	Orders	RAG to take onboard guns, stores and provisions, then to Spithead. Take onboard Lord Belhaven, governer of Barbados with his retinue and equipment. Remain at Spithead until further orders.
ADM 2/50 (430)	RAG027	KC	12-9-1721	Admiralty to Willis	Orders	Orders to Captain Willis at Spithead for his proceeding with the Lord Belhaven, his servants and equipage to Barbados. From there to the Leeward Islands, Jamaica. To take, sink, burn or otherwise destroy Pirates around Barbados. Then to deal with Pirates in the Leeward Islands. Then to Jamaica to put himself under the command of the captain of ships there. Then to convoy home ships from there via the windward passage. Then along the coast of North America from N Carolina to Newfoundland. Again hunting Pirates. Then back to England by late next summer.
ADM 2/50 (434)			12-9-1721	Admiralty to Willis	Orders	RAG to call at Medeira for wine instead of beer for the ship's company.

13.5.12 SP 54 Secretaries of state: State papers Scotland series II

Ref.	No	Loc	Date	From / To	Subject	Description
SP 54/9/31			10-10-1715	Burchette to Townsend	RAG off Scotland?	NOTE: Need to check that this is RAG [Josiah] Burchette to Secretary Townshend. Enclosing copy letter from Capt James Stewart, of the Royal Ann, on his actions in Cromarty: he cannot send boats or men ashore without fear of them being seized by the Jacobites. 1715 Oct 10
SP 54/9/51E			11-10-1715	Captain Stewart to Burchett	RAG off Scotland?	NOTE: Need to check that this is RAG Capt Stewart of the Royal Ann to Burchett. Following news of the rebels advance to Burntisland, he is sailing to join the *Pearl* and *Portmation* in Leith Road; if the rebels should take Leith his ships will have nowhere on the coast to get food and water, or communicate with London . [1715 Oct 11]

13.5.13 ADM 3/24,33 Admiralty Board Minutes, Secretariat

Ref.	No	Loc	Date	From / To	Subject	Description
ADM 3/24	RAG02 *	KC	12-11-1709	Admiralty Office minutes	Building	Allowance to be made to Marquis Carmarthen for his 'directions' relating to the building of RAG.
ADM 3/33	RAG003	KC	15-11-1721	Admiralty Office minutes	Salvage	Resolved that orders be given to Cap. Rowley of *Lively* to proceed from Plymouth to the Lizard to save what he can of the wreck of RAG.

13.5.14 ADM 7/377

Ref.	No	Loc	Date	From / To	Subject	Description
ADM 7/337	RAG023	KC	19?-6-1709	Admiralty Office	Guns & men	Proposed complement and guns for RAG built at HM yard Woolwich. Also list same for 8 6th rates. HIGH MID LOW MEN 190 160 130 GUN DK 20x9lb 20x9lb 18x9lb UPPER DK 20x6lb 20x6lb 18x6lb
ADM 7/337	RAG020	KC	14-10-1709	Admiralty Office	Building	Carmarthen directed construction of a fifth rate as an experiment. Carmarthen to be allowed 40/- per day for his attendance at Woolwich.

13.5.15 ADM 33/271 Pay Lists

Ref.	No	Loc	Date	From / To	Subject	Description
ADM 33/271	RAG011 *	KC	Last entry 25 Oct 1721	Pay Lists	Ship	List of those on board with details of pay and to whom payment was made on loss of RAG. Interesting header showing allowances of provisions. Note at top shows changing compliment.

13.5.16 ADM 39/2273 Muster Lists

Ref.	No	Loc	Date	From / To	Subject	Description
ADM 39/2273	RAG018	KC	10-4-1721	Muster table	Crew	Single page showing summary of crew. Runs from 12 May 1721 (181 born, 109 mustered) to 15 August 1721 (186 born, 106 mustered)

ADM 39/2273	RAG010	KC	16-08-1721	Muster Lists	Crew	Muster list headed 16 Aug 1721, last entry shown 14 Aug 1721. The list is not complete (See pay list RAG011). A list of ships crew. Heading states complement as 190 men.
ADM 39/2273	RAG019	KC	16-8-1721	Willis	Repair?	37 men belonging to HM yard at Deptford were victual onboard RAG. Presumably repairs to ship.
ADM 39/2273			May 1721		Movements	Heading of muster list shows recent movements of RAG. Recently returned from Guinea. 8th May Longreach 10th May Woolwich 11th May Deptford.

13.5.17 ADM 7 Miscellaneous

Ref.	No	Loc	Date	From / To	Subject	Description
ADM 7/337	RAG023	KC	19?-6-1709	Admiralty Office	Guns & men	Proposed compliment and guns for RAG built at HM yard Woolwich. Also list same for 8 6th rates. RAG HIGH MID LOW MEN 190 160 130 GUN DK 20x9lb 20x9lb 18x9lb UPPER DK 20x6lb 20x6lb 18x6lb
ADM 7/337	RAG020	KC	14-10-1709	Admiralty Office	Building	Carmarthen directed construction of a fifth rate as an experiment. Carmarthen to be allowed 40/- per day for his attendance at Woolwich.
ADM 7/655		KC			Captains of the Royal Anne Galley	Robert Trevor 2nd March 1708 – 16th November 1714. James Stewart 26th July 1715 – 8th August 1717. Frances Willis 25th August 1719 – 10th November 1721. Note the gaps – these gaps are reflected in the captain's logs. RAG may have been layed up for these dates.

13.5.18 ADM 51/791 Captain's logs

Ref.	No	Loc	Date	From/ To	Subject	Description
ADM 51/791			1-3-1710		Ballast	RAG at Nore – took on 40 tons of ballast and some dry provisions.
ADM 51/791			21-3-1710			RAG in Yarmouth Roads.
ADM 51/791			26-3-1710			RAG in the Humber.
ADM 51/791			6-4-1710			RAG at Leith.
ADM 51/791			12-5-1710			RAG at Sheerness.
ADM 51/791			18-5-1710		Repairs	RAG in dock.
ADM 51/791			11-7-1710			Portsmouth.
ADM 51/791			21-1-1711		Anchored	Nore..
ADM 51/791			8-3-1711		Moored	Portsmouth.
ADM 51/791			23-4-1712		Anchored	Gibraltar.
ADM 51/791			13-6-1712		Anchored	Lisbon.
ADM 51/791			23-7-1712			Lisbon to Gibraltar with *Lynn* and *Ludlow Castle.*
ADM 51/791			30-11-1712		Anchored	Gibraltar
ADM 51/791			28-1-1713		Anchored	Lisbon
ADM 51/791			7-2-1713		Anchered	Gibraltar Bay
ADM 51/791			15-8-1713			Tangiers
ADM 51/791			1-9-1713			Lisbon
ADM 51/791			1-3-1714		Anchoed	Lisbon
ADM 51/791			21-3-1714		Anchoed	Spithead
ADM 51/791			26-7-1715		Moored	Chathem
ADM 51/791			18-8-1715			Sheerness
ADM 51/791			4-9-1715			Leith

Ref.	No	Loc	Date	From/ To	Subject	Description
ADM 51/791			21-9-1715			Cromarty
ADM 51/791			23-9-1715		Ballast	Long boat employed fetching extra ballast for the RAG
ADM 51/791			1-10-1715			Cromarty
ADM 51/791			3-10-1715		Scotland	Stopped a ship after 2 shots fired. Got her to pay for the second shot.
ADM 51/791			5-10-1715			Cruising between St Abbs and Montrose.
ADM 51/791			16-11-1715			Anchored in Firth of Forth.
ADM 51/791			19-3-1715			At the Nore/
ADM 51/791			15-4-1716		Refit	Medway anchored in Galleon's Reach for reballast, caulking. Then to Woolwich for rigging repairs/
ADM 51/791			3-6-1716			At the Nore
ADM 51/791			9-6-1716			Off Flamborough Head to pick up a convoy of 46 ships bound for the Baltic.
ADM 51/791			17-6-1716			Anchored Elsonore, Copenhagen.
ADM 51/791			21-6-1716			Sails for England.
ADM 51/791			11-7-1716			In the Downs.
ADM 51/791			12-9-1716			Off Shetland.
ADM 51/791			28-9-1716			In the Downs.
ADM 51/791			14-11-1716			In Dock.
ADM 51/791			12-12-1716			Anchored at the Nore
ADM 51/791			8-3-1716			Stavern, Norway
ADM 51/791			28-4-1717			At the Nore
ADM 51/791			14-6-1717			At the Nore
ADM 51/791			25-6-1717			Flamborough Head
ADM 51/791			19-7-1717			At the Nore

13.5.19 ADM 51/4315 Captain's Logs

ef.	No	Loc	Date	From/ To	Subject	Description
ADM 51/4315			25-8-1719			At the Nore.
ADM 51/4315			10-12-1719			Nore.
ADM 51/4315			28-12-1719			Plymouth.
ADM 51/4315			14-2-1719			Teneriffe.
ADM 51/4315			22-2-1719			Buried Mr Henry Walter, the surgeon.
ADM 51/4315			31=3-1720			At sea, Cape Mount. Fired 2 shots to bring a Bristol ship to..
ADM 51/4315			10-4-1720			Cape Formosa.
ADM 51/4315			30-7-1720			Princes Road.
ADM 51/4315			27-8-1720			RAG took onboard mutineers from *Adventurer* Galley, Captain Hudson.
ADM 51/4315			13-10-1720			Bass Island.
ADM 51/4315			29-4-1721			Plymouth Sound.

13.5.20 W047/20B Minutes: Series I 1722 Jan-Oct

Ref.	No	Loc	Date	From / To	Subject	Description
WO47/20B			08-03-1721		Salvage	See note on dates – read as 1722 'And to Mr Dixon Storekeeper at Plymouth to acqt Mr James Bovey of St Mawes that if he will undertake y salvage of y RAG Gunns lost on y Lizard he will be allow'd y full price viz' Serv^{ble} 4 } Iron Gunns…. } Pr tonn Uns^{ble} 2 [This is probably pounds per ton?]

WO47/20B			7-5-1722		Salvage	'And to Capt Holman at Plymouth approving his agreement with James Bovey for the salvage of RAGs gunns lost near Lizard viz' Servicables at 50s per tonn Unservicables at 25s per tonn He is asked how they are to be got to Plymouth.
WO47/20B			10-05-1722		Salvage	'To Capt Holman not withstanding the orders sent to him 7th instant to agree with Wm Stephens, Roger James and Joseph Richards for the salvage of the gunns of RAG for £1/17/6 pr. Tonn…. And make them some further allowance for transporting them to Plymouth instead of Flushing Key…'
WO47/20B			02-08-1722		Salvage	'A letter to Mr Pearce storekeeper at Pendennis to pay the undertakers for salving the gunns of HM late ship the RAG £39/15/7 they having delivered 20 of her iron ordinance at Flushing quay according to agreement; and desire they'll be expeditious in getting the rest'.
WO47/20B			21-8-1723		Salvage	Accwpted Mr Richard Pearces bill of exchange date ? present for £39/15/7d payable 10 daya after sight to Mr William Spry or order being for the salvage of part of the guns lately belonging to HM Ship *Royal Ann* Galley.

13.5.21 ADM 106 Letters to navy board and by that board to the admiralty

Ref.	No	Loc	Dated	From / To	Subject	Description
ADM 106/648			21-3-1709	R Stacey to Comm of the navy	Building	Carmarthen visited the yard and wanted more hands employed on building of RAG
ADM 106/648			28-3-1709	Master shipwright at Woolwich to Comm of the navy	Building	St Michael instead of 'Lyon' in head. & other changes from normal practice. Shipwright asking if Carmarthen's orders are to be followed "..but whether it be intended by you I should comply with what may in some measure deviate from the practice of the navy…"
ADM 106/648			29-3-1709	R Stacey to Comm of the navy	Building	Water damaged copy of the above – not slightly different date.
ADM 106/648			5-4-1709	R Stacey to Comm of the navy	Building	Carmarthen is pressing for the men to work 2 tides per day on RAG. He also wants then to work through breakfast and dinner. Stacey says it is light from 4.30 to 7.30 now and asks for permission to work 2 tides per day.

Ref.	No	Loc	Dated	From / To	Subject	Description
ADM 106/648			27-4-1709	R Stacey to Comm of the navy	Building	Signed by Stacey and two others. Gives table of guns and men. Highest complement. Gun deck 20 9lb. Upper deck 20 6lb. Men 190. Middle compliment. Same guns but 160 men. Lower compliment 19 9lb 19 6lb Men 130 Says the compliment is higher than other ships as she is contrived to row with 66 oars.
ADM 106/648			6-6-1709	R Stacey to Comm of the navy	Delay of building	Delay of the new 5th rate (named as RAG) due to other orders.
ADM 106/648			6-6-1709	R Stacey to Comm of the navy	Building	Stacey says that Carmarthen is very pressing to have the new 5th rate in the water – he hopes to have it in Monday or Tuesday next.
ADM 106/648			9-6-1709	R Stacey to Comm of the navy	building	Reports that he is unable to work on other ships as the hands are fully employed with *August, Royal Ann* Galley, *Dunwick* and *Diligence* Galley. He says that the *Diligence* Galley is due to be launched next Friday. RAG not yet launched. "…afterwards rebuilt on y RAG's slip when she is off"
ADM 106/648			11-6-1709	R Stacey to Comm of the navy	Building	Reporting that Carmarthen wants the great cabin painted in veined marble, the balcony in vermillion and the quarter and poop decks laid with painted canvas. Also some panes of stone ground glass to be larger than contract. Stacey asks for directions.
ADM 106/648			26-6-1709	R Stacey to Comm of the navy	Building	Stacey states what guns should be suitable for the ***Queen*** *Anne* Galley (mistake or different ship?) (Eight?) Mon? Ten Minion Two Falcon The letter is co-signed, but the signature is illegible
ADM 106/743			12-09-1721	Captain Willis to Comm of the navy	Aground & Collision	Reports RAG run aground (South Break Head, on the Downs) by his 'pylott'. Then in collision with Virginian ship *Spolswood* - master TURNER.
ADM 106/743			31-10-1721	? to Comm of the navy	Repairs	Five illegible signatories from a ?boatyard in Portsmouth? This is a bill for work on RAG after her collision with the *Spolswood* for £104=6=2 and details of the repairs made.

Ref.	No	Loc	Dated	From / To	Subject	Description
ADM 106/743			21-11-1721	Perry of the SPOLSWOOD to comm of the navy	Collision	Titled "Damage done his ship *Spolswood* by RAG falling ab'd her in the Downs" Micajah Perry (*Spolswood*) about the collision with RAG in the Downs. Says he can not pay damages and claims it was not all his fault either. Appends a list of damage Total £134=12=0.
ADM 106/743	P McBride notes *		24-11-1721	Soton (or Loton) and Thomas Netherton to comm of the navy	Salvage	Sent to save what they can of the RAG stores. There is a list of what is on shore, much of it very damaged. Some discussion of how much to pay for salvage – the locals want half the value. Small boats at work on the site.
ADM 106/748			28-01-1721	Dove to comm of the navy	Salvage	Enclosing a letter from Mr Netherton 'our purveyor' regarding complaints about payment for stores from RAG salvaged. Mentions Penbroke 5th rate lost at Lizard 'some years past'
ADM 106/748			03-02-1721/2	Hazard? (Plymouth Transport at Helford) to comm of the navy	Salvage	[Very hard to read] Reports it is very hard to get the salvaged goods from RAG without order or payment. Mentions 'Mr Hicks agent to y engineers' also Mr Hoskins, Mr Sandys, Mr Netherton and Squire Robinson. Also Dutchman ran aground at Mullion.
ADM 106/748	RAG017	KC	24-02-1721	Plymouth transport to ?	Salvage	Part of letter Salvage of stores

Ref.	No	Loc	Dated	From / To	Subject	Description
ADM 106/748			03-08-1722	Dove to comm of the navy	Salvage	'..following paid for salvage of RAG stores' John Potter 4 - 2 - 10 ¾ Mr Hoskin } 2 - 7 - 4 ½ Mr Sandys 16 - 12 - 0 ¼ Mr Bovey } 3 - 12 - 9 ¾ Birn Richards 0 - 16 - 2 ¾ John Richards Esq Robinson 15 - 1 - 1 ¼ Rich Richards 30 - 3 - 5 ¼ Tho Thomas 5 - 10 - 6 ½ R Richards Walter Rowe 1 - 15 - 10 Tho Thomas 3 - 11 - 7 ½ TOTAL 103 - 13 - 6 ½ 'This is the full account of everything that has been brought hither saved from the wreck of the RAG' Also says that Plymouth Transport will be sent to collect 5 anchors taken up from RAG
ADM 106/748	RAG005		10-08-1722	Dove to comm of the navy	Salvage	*Plymouth Transport* sailed for the Lizard to collect the RAG anchors
ADM 106/752			26-03-1722	D West to Comm of the navy	Salvage	Mentions 'Capt Rowes invention for fishing on wrecks'. He recovers about 1.5 tons of cable from RAG – he wants paying
ADM 106/754	RAG008		02-05-1722	Lizard fishermen to Comm of the navy	Salvage	Seeking payment for salvage of 26 Cwt anchor recovered from wreck of RAG. They claim they also recovered 21 Guns which it is implied they were paid for.
ADM 106/754	RAG007		26-05-1723	Mr Dove to Comm of the navy	Salvage	Dove receives petition from 3 Fishermen who salvaged Guns and an anchor from RAG - claiming they have been defrauded of the salvage by John Sandy Deputy Vice Admiral for Cornwall.

Ref.	No	Loc	Dated	From / To	Subject	Description
ADM 106/765			24-07-1724	George Robinson to Comm of the navy	Salvage	Complaining of damage to his estate by salvage of RAG. 'The great concourse of people that attended on that occasion'. And 'That what was taken up by the fishing boats and others amounted to the value of £300'

13.6 Secondary sources & background

Ref.	No	Loc	Subject	Description
BM Library *Ancient songs and modern* Roxburgh Collection Vol 3 No 593	RAG013 *	KC	Wreck	Song/ballad the unhappy voyage describing the loss of RAG
Gwyn's Book of Ships Dingley, E.A. In Mariner's Mirror Vol 7 pp 46-52	RAG029	KC	Similar vassals	Drawing and description of a frigate with oars
Fairbairns Book of Crests of the Families of Great Britain and Ireland	RAG030	KC	Belhaven	Belhaven crest and Motto 'Ride through'
Mariner's Mirror Vol XI p185	RAG031	KC	Similar vassals	Inception of the galley frigate 1676. Mentions *Charles* Galley, *James* Galley & *Mary* Galley
Brief Historical Relation of State Affairs from Sept 1678 – Apr 1724 Luttrell, N. Oxford 1857 rep 1974 Vol V	RAG032	KC	Launch of RAG	"Tuesday was launched at Woolwich the Royal Ann Galley, of a new invention, under direction of the Marques of Carmarthen, carrying 40 guns, being the finest that ever was built" The previous two entries are headed "Thurs 30 June" and "Sunday Night". This would make the launch of RAG Tuesday 5th July (old date).
Mariner's Mirror Vol 7 1921 p122	RAG033	KC	Similar Vassals	Galleys mentioned including RAG, *Adventurous* Galley (Captain Kidd) 34-guns, *Mary* Galley 40-guns & 190 men, 6th rate *Dursley* Galley 20-guns & 130 men. 5th Aug 1704 "three new galleys building at Blackwall and Woolwich each with 40-guns". 9th Nov 1704 16 each of 16 oars.
A Treatise on Practical Seamanship Hutchinson W 1777 rep London 1979	RAG034	KC	Rowing Ships	About rowing ships with oars. Mentions *Liverpool* privateer of 22 oars. Oars joined by rope to aid synchronous rowing.
Mariner's Mirror Vol 10 1924 - Queries	RAG35	KC	Salvage	Cites Plymouth Weekly Journal 12-1-1722 : *Jolly Bachelor* & *Henrietta Yacht* going down to Lizard with newly invented diving engine to fish on the wreck of RAG.

Ref.	No	Loc	Subject	Description
Peter the Great's English Yacht – Admiral Lord Carmarthen and the Russian Tobacco Monopoly Ryan, W.F. in Mariner's Mirror Vol 69 1983 pp65-87	RAG036	KC	Carmarthen's ship designs	*Royal Transport* (6th rate)Built – Chatham by Robert Lee Launched – 11 Dec 1695Gun deck 90', Breadth 23' 6", Depth 9' 9"Men 100, 220 tons, 18-guns Presented by William III to Peter the Great in 1697. Wrecked on the Swedish coast 1715. Model and painting show RT to be schooner rigged (very early for this rig) "Much the fastest and best hatch then in England, built frigate fashion (flush decked) carrying 24 guns and contrived by Lord Carmarthen on purpose for the King's own use" Quotes Carmarthen "…craft of my invention was designed … so that it should be faster and more powerful than other ships exceeding it in size" Also mentions the Peregrine Galley to be built at Chatham under Carmarthen's direction. Says of Carmarthen "in 1710 is flying his flag in the RAG, a ship he had himself designed"
The fourth Journal of Jeremy Roch in *Three Sea Journals of Stuart Times* ed Ingram, B.S. London 1936	RAG037	KC	Rowing Ships	Jeremy Roch commanded the *Charles* Galley in 1688 *Charles* Galley 4th rate 32-guns, 42 oars, 125' by the keel, 220 men "Now having little wind I had a mind to try how the galley would row … and ran out all our oars, being 42 and put 3 men to each oar and found we could row 3 miles an hour". Included are two illustrations of the *Charles* Galley, one with oars in action
The Royal Yachts under George I Mariner's Mirror Vol 68 pp69-70	RAG038	KC	Similar Vessels	A list of Royal Yachts including *Peregrine* Galley 193 Tons, built 1700. Rebuilt 1715-16 as *Carolina*. Designed by Carmarthen. Rebuilt 1733 as *Royal Caroline* by R Stacey at Deptford.
Sailing Ships – Their History & Development pt II Laird-Clowes, G.S. London 1952 pp38-39	RAG039	KC	Rowing Ships	Referring to the model of a 20-gun ship 1719 "The sweep ports, 18 a side on the lower deck, recall the fact that oars were then commonly used in a great number of the lighter vessels … sweep ports did not finally disappear from the smaller frigates until the early years of the nineteenth century" Referring to a drawing of Mary Galley, 40 guns 1727 "At this period the smaller 5th rates of 30 guns and 6th rates of 20 guns were all normally fitted with oars and oar ports, but in the large ships of 40 guns this arrangement was uncommon. In fact the RAG, *Charles* Galley and *Mary* Galley were the only 40 gun ships of the early eighteenth century to have a complete set of oars. The last *Mary* Galley was built in 1744"
A New Universal Dictionary of the Marine Falconer, W.A. London 1815	RAG040	KC	Galley	Entry in Frigate-built "Implies the disposition of the decks … as to have a decent of 4 or 5 steps from quarter-deck and forecastle into the waist, in contra distinction to those where decks are in a continued line for the whole length of the ship, which are called galley-built"
The Royal Yacht Caroline 1749 Bellabarba, S. & Osculata, G.CMP 1989	RAG041	KC	Peregrine Galley	1697 – *Peregrine* Galley 190 Tons, 20-guns, designed by Carmarthen. Rebuilt 1716 as the Carolina. Rebuilt 1733 as the *Royal Caroline*.

Ref.	No	Loc	Subject	Description
The Ship of the Line Vol 1 Lavery, B. CMP 1995		KC	Royal Anne	NB There is also a ship called *Royal Anne* Originally built as the *St Andrew* in 1670 96-guns Rebuilt as the *Royal Anne* in 1703 100-guns, broken up in 1757.
Shipwreck Index of the British Isles Vol 1 Larn, B & R. 1995		KC	Wreck	Listed as *Royal Anne* NB this is RAG not *Royal Anne* Gives details of the loss from The London Journal 25.11 & 02.12.1720 (note date). RAG Date of loss 10.11.1721. 5th rate of 42-guns L 38.71 B 9.45m Built 1709 Stacey Woolwich
Rings, Symbols of Wealth, Power and affection. pp85-91 Scarisbrick, D. 1993	RAG042 *	KC	Mourning Rings	Mourning rings
Finger Rings from Ancient Egypt to the Present Day Taylor, G. & Scarisbrick, D. Oxford 1978	RAG043 *	KC	Mourning Rings	Mourning rings
The Ring from antiquity to the twentieth century Ward, A. et al 1981	RAG044	KC	Mourning Rings	Mourning rings
British Rings 800-1914 Oman, C. London 1971	RAG045	KC	Mourning Rings	Mourning rings (chapter 9)

13.7 Newspaper Accounts

Ref.	No	Loc	Date	Subject	Description
Gazette 2-12-1721 Page 2096	RAG012 *		27-11-1721	Wreck	Account by the three survivors of the wreck. Thomas Goodall, William James and Robert Wilson. Gives account of the ship's loss.
The Daily Post No 674	RAG014 *		27-11-1721	Wreck	Account of the wrecking. Names the three survivors as Thomas Goodall, Wm James & Robt Wilson.
The Daily Journal	RAG015 *		27-11-1721	Wreck	Account of the wrecking. The survivors are not named – just '3 men'
The Daily Courant No 6274	RAG016 *		29-11-1721	Wreck	Very full account of the loss – very similar to RAG012 – The three survivors are listed as Thomas Goodall, William James and Robert Wilson.

Plymouth Weekly Journal and General Post			5-12-1721	Pay	Hand written sheet Wages of the widows of the RAG ordered to be paid forthwith
Plymouth Weekly Journal and General Post			2-1-1722	Salvage	The JOLLY BACHELOR and HENRIETTA YACHT are going down to Lizard with a newly invented diving machine to fish upon the wreck of the RAG.

NOTES

DATES

In England the new year began on 25th March from the early 13th century until the Gregorian calendar was adopted on 1st January 1752. However documents of 18th century may use either 25th March or 1st January as the start of the New Year.

RAG has been used to stand for *Royal Anne* Galley throughout this index. Sources spell this in a number of ways – for example in RAG021 (orders to the captain) as "Royall ann Gally"

***** Means the document has been transcribed

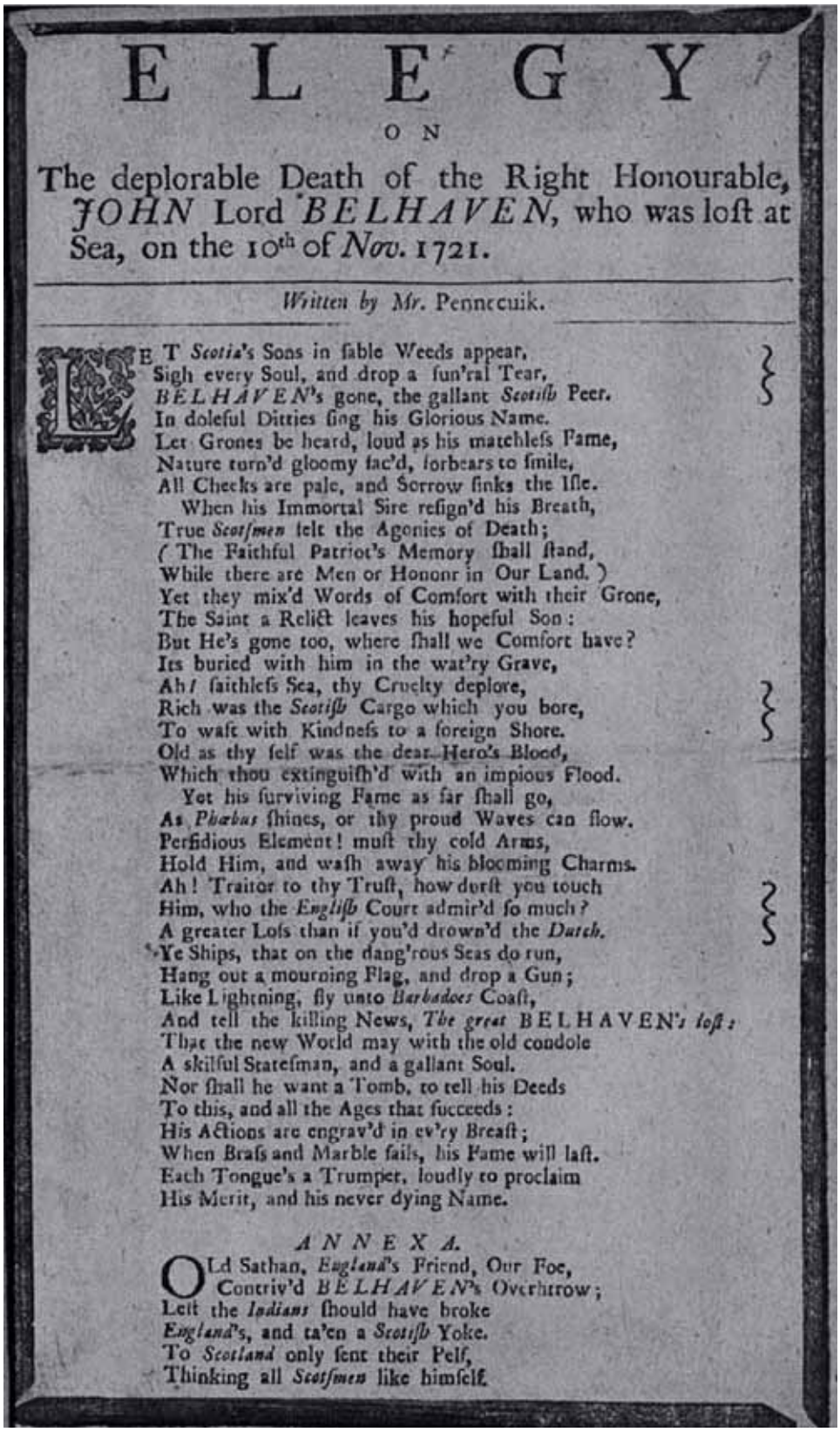
Loc Shows who holds photocopies of the document

KC Kevin Camidge

RS Robert Sherratt

MH Mike Hall

13.8 Elegy on the Death of Lord Belhaven



ELEGY

ON

The deplorable Death of the Right Honourable, *JOHN* Lord *BELHAVEN*, who was loſt at Sea, on the 10th of *Nov.* 1721.

Written by Mr. Penneeuik.

LET *Scotia*'s Sons in ſable Weeds appear,
Sigh every Soul, and drop a ſun'ral Tear,
BELHAVEN's gone, the gallant *Scotiſh* Peer.
In doleful Ditties ſing his Glorious Name.
Let Grones be heard, loud as his matchleſs Fame,
Nature turn'd gloomy fac'd, forbears to ſmile,
All Cheeks are pale, and Sorrow ſinks the Iſle.
When his Immortal Sire reſign'd his Breath,
True *Scotſmen* felt the Agonies of Death;
(The Faithful Patriot's Memory ſhall ſtand,
While there are Men or Honour in Our Land.)
Yet they mix'd Words of Comfort with their Grone,
The Saint a Reliſt leaves his hopeful Son:
But He's gone too, where ſhall we Comfort have?
Its buried with him in the wat'ry Grave,
Ah! faithleſs Sea, thy Cruelty deplore,
Rich was the *Scotiſh* Cargo which you bore,
To waſt with Kindneſs to a foreign Shore.
Old as thy ſelf was the dear Hero's Blood,
Which thou extinguiſh'd with an impious Flood.
Yet his ſurviving Fame as far ſhall go,
As *Phœbus* ſhines, or thy proud Waves can flow.
Perfidious Element! muſt thy cold Arms,
Hold Him, and waſh away his blooming Charms.
Ah! Traitor to thy Truſt, how durſt you touch
Him, who the *Engliſh* Court admir'd ſo much?
A greater Loſs than if you'd drown'd the *Dutch*.
Ye Ships, that on the dang'rous Seas do run,
Hang out a mourning Flag, and drop a Gun;
Like Lightning, fly unto *Barbadoes* Coaſt,
And tell the killing News, *The great* BELHAVEN's *loſt*:
That the new World may with the old condole
A skilful Stateſman, and a gallant Soul.
Nor ſhall he want a Tomb, to tell his Deeds
To this, and all the Ages that ſucceeds:
His Actions are engrav'd in ev'ry Breaſt;
When Braſs and Marble fails, his Fame will laſt.
Each Tongue's a Trumpet, loudly to proclaim
His Merit, and his never dying Name.

ANNEXA.

OLd Sathan, *England*'s Friend, Our Foe,
Contriv'd *BELHAVEN*'s Overthrow;
Leſt the *Indians* ſhould have broke
England's, and ta'en a *Scotiſh* Yoke.
To *Scotland* only ſent their Pelf,
Thinking all *Scotſmen* like himſelf.

National Museum of Scotland

13.9 Droits for the *Royal Anne* Galley

Note: 'Droits' are the forms for reporting wreck and salvage to the Receiver of Wreck.

Droit number	Salvor name	Description	File ref
358/01	Robert Sherratt	21 x musket shot; 7 x pistol shot; 9 x assorted pieces of Pb sheet; 1 x unknown Cu object; 1 x Cu alloy thin sheet; 1 x Cu alloy object with hole in centre; 1 x glass stopper with globular head; 6 x fragments of heavily eroded & encrusted glass; 3 x fragments of wine glass stem; 1 x Portuguese reis of 1702; 1 x Portuguese reis of 1716; 1 x Portuguese reis of 1706; I x Cu nail; 1 x pistol trigger guard; 2 x sherds of glazed ceramics; 3 x fragments of glass bottle; 8 x fragments of bent Pb sheet; 1 x two-ended pestle, one square end, one circular; 1 x Portuguese reis of 1715 1 x steelyard weight?; 1 x concretion with hole at one end; 3 x Cu nails, 1 x Cu hook; 1 x abraded coin, no visible details; various unidentified CU and Pb objects.	Open
B186/94/95	Robert Sherratt	Various artefacts from the TROyal anne Galley described on sheets attached to the droit	Closed
307/02	Robert Sherratt	1 x part of bell? - corroded & worn Cu alloy; 1 part of trigger guard? – very corroded & worn Cu alloy, 1 x nail?	Open
B635/97	Robert Sherratt	Various items (249)	TCA7/5/11

13.10 List of finds box numbers

(held by Robert Sherratt)

Box 1 Au

Box 2 Ag

Box 3 Pb – Smaller Objects

Box 4 Cu Alloy – Larger and poorer objects

Box 5 Cu Alloy – Smaller and finer objects

Box 6 Glass – General

Box7 Large objects – Mainly Pb

Box 8 Other metals

Box 9 Glass – Finer pieces

Box 10 Ceramics

Box 11 Composite metals

Box 12 Wood

Box 13 Fe

Fig 63 Golden guinea from the Royal Anne Galley dated 1719, find no 388 (photo: Kevin Camidge

Fig 64 Copper alloy bowls, find nos 259 and 264 (photo: Kevin Camidge)

13.11 List of finds from the *Royal Anne* site

No	Fdate	Grid ref	Nos	Material	Object Type	Description	Dimensions (mm)	Weight (g)	Location	Box No	Dated
1	01/01/1991	ZZ	1	Ag	Cutlery	Knife handle only, Belhaven crest, some corrosion	100x25		RS	2	
2	01/01/1991	ZZ	1	Ag	Cutlery	Knife, handle only, Belhaven crest, very corroded	100x25		RS	2	
3	01/01/1991	ZZ	2	Ag	Cutlery	Knife, handle pieces, very corroded, handle filling exposed	75x25		RS	2	
4	01/01/1991	ZZ	1	Glass	Jewellery?	Faceted stone, green	9		RS	9	
5	01/01/1991	ZZ	2	Cu alloy	Dividers	Navigational, with small detachable piece, initial "J D" some corrosion	100		RS	5	
6	01/01/1991	ZZ	1	Ag	Cutlery	Fork, heavily abraded, corroded	190x21		RS	2	
7	01/01/1991	ZZ	1	Ag	Cutlery	Fork, heavily abraded, corroded	190x22		RS	2	
8	01/01/1991	ZZ	1	Fe	Munitions	Shot, round, cannon	38 Ø		RS	13	
9	01/01/1991	ZZ	9	Pb	Munitions	Shot, ball, musket	17 Ø		RS	3	
10	01/01/1991	ZZ	18	Pb	Munitions	Shot, ball, musket	17 Ø		RS	3	
11	01/01/1991	ZZ	6	Pb	Munitions	Shot, ball, musket	17 Ø		RS	3	
12	01/01/1991	ZZ	1	Pb	Munitions	Shot, ball, musket, holed	18 Ø		RS	3	
13	01/01/1991	ZZ	1	Pb	Munitions	Shot ball, musket, damaged	15 ?		RS	3	
14	01/01/1991	ZZ	1	Pb	Munitions	Shot, ball, musket	13 Ø		RS	3	
15	01/01/1991	ZZ	1	Au	Jewellery	Ring, mourning, stone setting cracked	21.4 Ø		RS	1	
16	01/01/1991	ZZ	1	Cu alloy	Dividers	Navigational	102x13		RS	5	
17	01/01/1991	ZZ	1	Cu alloy	Small arms	Guard, trigger	113x22		RS	5	
18	01/01/1991	ZZ	1	Fe	Munitions	Shot, round, cannon	100 Ø		RS		
19	01/01/1991	ZZ	1	Ag	Coin	English, crown, William & Mary, heavily abraded	37.5 Ø		RS	2	
20	01/01/1991	ZZ	2	Cu alloy	Miscellaneous	Moulded, bell shaped2 halves/pair ?	57 Ø		RS	5	

No	Fdate	Grid ref	Nos	Material	Object Type	Description	Dimensions (mm)	Weight (g)	Location	Box No	Dated
21	01/01/1991	ZZ	1	Ag	Cutlery	Fork, heavily abraded	176x21		RS	2	
22	01/01/1991	ZZ	1	Ag	Cutlery	Spoon, handle only, heavy abrasion	130x15		RS	2	
23	01/01/1991	ZZ	1	Cu alloy	Miscellaneous	Moulded finial or knob	50x25		RS	4	
24	01/01/1991	ZZ	1	Cu alloy	Barrel Stop ?	Both ends broken	105		RS	4	
25	01/01/1991	ZZ	1	Cu alloy	Dividers	Navigational, heavy corrosion	81x18		RS	5	
26	01/01/1991	ZZ	1	Cu alloy	Miscellaneous	Moulded flat with slot, raised holed end	58x15		RS	5	
27	01/01/1991	ZZ	1	Cu alloy	Buckle	Centre bar, Broken	35		RS	4	
28	01/01/1991	ZZ	1	Pb	Miscellaneous	Spoon handle shaped	54		RS	3	
29	01/01/1991	ZZ	1	Cu alloy	Nail	Square section, tapered, pointed, flattened head	160		RS	4	
30	01/01/1991	ZZ	2	Ag	Coin	Heavy corrosion, no detail	32		RS	2	
31	01/01/1991	ZZ	1	Cu alloy	Miscellaneous	Flat strip - musket plate?	121x40		RS	4	
32	01/01/1991	ZZ	1	Ag?	Miscellaneous	Ring, split	33 Ø		RS	2	
33	01/01/1991	ZZ	1	Cu alloy	Nail	Part of	62		RS	4	
34	01/01/1991	ZZ	3	Ag?	Miscellaneous	Small broken pieces	30x20		RS	4	
35	01/01/1991	ZZ	1	Pb	Lead	Sounding, 5kg	330		RS	7	
37	01/01/1991	ZZ	1	Cu alloy	Coin	No detail, very badly abraded	27		RS	4	
38	01/01/1991	ZZ	2	Cu alloy	Nail	Sheathing	30		RS	4	
39	01/01/1991	ZZ	4	Glass	Miscellaneous	Clear, flat, pieces, broken	46x23		RS	6	
40	01/01/1991	ZZ	1	Pb	Lead	Fishing type	56		RS	3	
41	01/01/1991	ZZ	1	Pb	Disc	Flat bottom, rounded top edge	86		RS	7	
42	01/01/1991	ZZ	1	Pb	Lead	Boat type	85		RS	3	
43	01/01/1991	ZZ	1	Ag?	Miscellaneous	Fragment, Decorative, moulded	50		RS	2	
44	01/01/1991	ZZ	1	Fe composite	Nail	Cast of - some organic remains (rope?)	7x7		RS	12	

No	Fdate	Grid ref	Nos	Material	Object Type	Description	Dimensions (mm)	Weight (g)	Location	Box No	Dated
45	01/01/1991	ZZ	1	Pb	Munitions	Shot, cartridge, (modern ?) c 100 small balls	5		RS	3	
46	01/01/1991	ZZ	1	Cu alloy	Munitions	Cartridge, base of (modern ?) round	25x5		RS	5	
47	01/01/1991	ZZ	2	Glass	Miscellaneous	Handle, part of, clear	55x25		RS	6	
48	01/01/1991	ZZ	2	Glass	Drinking?	Stem? part of, clear, broken, abraded	55x30		RS	6	
49	01/01/1991	ZZ	4	Glass	Drinking?	Stem/stopper? clear, pieces, abraded	35x12		RS	6	
50	01/01/1991	ZZ	7	Glass	Drinking?	Stem/stopper? Clear, round, heavy pieces, abraded	50x35		RS	6	
51	01/01/1991	ZZ	5	Glass	Miscellaneous	Clear, pieces, curved, abraded	35x35		RS	6	
52	01/01/1991	ZZ	8	Glass	Miscellaneous	Clear, pieces, small	20x15		RS	6	
53	01/01/1991	ZZ	1	Glass	Bottle	Base, green	65x45		RS	6	
54	01/01/1991	ZZ	1	Glass	Miscellaneous	Green blue, piece	64x45		RS	6	
55	01/01/1991	ZZ	8	Ceramic	Miscellaneous	Earthenware, red	100x100		RS	10	
56	01/01/1991	ZZ	13	Glass	Miscellaneous	Green, fragments, very abraded	90x51		RS	6	
57	01/01/1991	ZZ	4	Cu alloy	Sheathing	Pieces	173x120		RS	4	
58	01/01/1991	ZZ	13	Glass	Miscellaneous	Green, pieces	52x40		RS	7	
59	01/01/1991	ZZ	5	Pb	Sheathing	Pieces	140x100		RS	3	
60	01/01/1991	ZZ	1	Pb	Sheathing	Piece	100X100		RS	3	
61	01/01/1991	ZZ	10	Pb	Sheathing	Fragments	80x45		RS	3	
62	01/01/1991	ZZ	10	Pb	Sheathing	Fragments	55x30		RS	3	
63	01/01/1991	ZZ	13	Pb	Sheathing	Fragments	30x20		RS	3	
64	01/01/1991	ZZ	3	Pb	Sheathing	Thin fragments	35x15		RS	3	
65	01/01/1991	ZZ	1	Pb	Sheathing	Flat	48x38		RS	3	
66	01/01/1991	ZZ	1	Ag?	Miscellaneous	Fragment	85		RS	2	
67	01/01/1991	ZZ	1	Cu alloy	Wheel	Spoked remains of (spur wheel?)	28 Ø		RS	5	

No	Fdate	Grid ref	Nos	Material	Object Type	Description	Dimensions (mm)	Weight (g)	Location	Box No	Dated
68	01/01/1991	ZZ	1	Cu alloy	Miscellaneous	Fragment shaped, hole at one end	46x15		RS	4	
69	01/01/1991	ZZ	1	Cu alloy	Miscellaneous	Fragment	35x35		RS	4	
70	01/01/1991	ZZ	1	Cu alloy	Miscellaneous	Nail like object, hole inside head end	55		RS	4	
71	01/01/1991	ZZ	1	Ceramic	Pipe stem	Clay	21		RS	10	
72	01/01/1991	ZZ	1	Cu alloy	Bar	Very corroded	70		RS	4	
73	01/01/1991	ZZ	1	Cu alloy	Miscellaneous	Fragment, very corroded	36		RS	4	
74	01/01/1991	ZZ	1	Pb	Washer	Bottle seal?	40 Ø		RS	3	
75	01/01/1991	ZZ	1	Pb	Seal	Cap - sand sprinkler?	55 Ø		RS	3	
76	01/01/1991	ZZ	30	Glass	Miscellaneous	Broken pieces	c50x50		RS	6	
77	01/01/1991	ZZ	11	Pb	Munitions	Shot, ball, musket	17.5 Ø		RS	3	
78	01/01/1991	ZZ	1	Cu alloy	Pin	Bent	330		RS	4	
79	01/01/1991	ZZ	1	Pb	Lead	Cylinder shape, 4.5kg	190		RS	7	
80	01/01/1991	ZZ	1	Ag	Cutlery	Fork, engraved Belhaven crest	195		RS	2	
81	01/01/1991	ZZ	3	Au	Watch	Pocket parts of	36.5 Ø		RS	1	
82	01/01/1991	ZZ	2	Au	Miscellaneous	Connecting links	16		RS	1	
83	01/01/1991	ZZ	1	Au	Chain	Braided, with wire clasp, broken	220		RS	1	
100	01/01/1994	ZZ	1	Pb	Weight	Conical	70		RS	3	
101	01/01/1994	ZZ	1	Pb	Weight	Conical	65		RS	7	
102	01/01/1994	ZZ	1	Pb	Weight	Cylindrical	70		RS	3	
103	01/01/1994	ZZ	1	Fe	Munitions	Shot, round, cannon, corroded	38		RS		
104	01/01/1994	ZZ	1	Pb	Sheet	Flat, worn	110x70		RS	3	
105	01/01/1994	ZZ	3	Pb	Munitions	Shot, ball, musket	17 Ø		RS	3	
106	01/01/1994	ZZ	1	Ceramic	Miscellaneous	Red earthenware	90x75x20/30		RS	10	
151	09/08/1997	D12	1	Cu alloy	Miscellaneous	Thin plate, slight oval shape, mould marks, worn	48x5		RS	5	

No	Fdate	Grid ref	Nos	Material	Object Type	Description	Dimensions (mm)	Weight (g)	Location	Box No	Dated
152	09/08/1997	D12	1	Au	Watch ?	Pocket, part of, thin flat disc, centre hole, inscription D.HUBERT, fine	16 Ø		RS	1	
153	10/08/1997	D12	1	Cu alloy	Tag?	Flat plate hole at one end, slight taper, corroded	45x21		RS	5	
154	25/08/1997	D12	2	Ag?	Miscellaneous	Thin flat, moulded design, broken, worn	25x20		RS	2	
155	25/08/1997	D12	1	Au	Coin	Portuguese, 4000 reis, bent	30 Ø	10.675	RS		1719
156	25/08/1997	D12	1	Au	Coin	Portuguese, 4000 reis, bent	30 Ø	10.65	RS		1704
157	25/08/1997	D12	1	Cu alloy	Buckle	Divers fin buckle, modern	35x28		RS	4	
158	25/08/1997	E12	1	Pb & Cu alloy	Weight?	Steel Yard, door knob shaped, lead encased in brass,, corroded	60x50		RS	11	
159	25/08/1997	E12	2	Cu alloy	Miscellaneous	Thin plate, oval, moulded, worn	48x27		RS	4	
160	25/08/1997	E12	1	Ceramic	Pottery	Earthenware, red, thick coarse, some glaze one side, worn	70x62		RS	10	
161	25/08/1997	E12	1	Pb	Sheet	Thin, 1 straight edge, corroded, worn	52x52		RS	3	
162	25/08/1997	E12	1	Pb	Sheet	Thin, folded, corroded, worn	100x73		RS	3	
163	07/09/1997	D12	1	Au	Coin	Portuguese, 4000 reis, damaged, bent	30 Ø	10.63	RS		1714
164	07/09/1997	D12	1	Au	Coin	Portuguese, 4000 reis, bent	30 Ø	10.45	RS		1715
165	07/09/1997	E12	1	Au	Coin	Portuguese, 4000 reis, damaged edge	30 Ø	10.46	RS		1719
166	07/09/1997	E12	3	Pb	Munitions	Shot, ball, musket, mould marks, good	25 Ø		RS	3	
167	07/09/1997	E12	2	Pb	Munitions	Shot, ball, musket, riser mould mark, good	25 Ø		RS	3	
168	07/09/1997	D12	1	Pb	Munitions	Shot, ball, musket, damaged, poor	25 Ø		RS		
169	07/09/1997	D12	1	Pb	Munitions	Shot, ball, musket, damaged, poor	20 Ø ?		RS	3	
170	07/09/1997	D12	1	Pb	Munitions	Shot, ball, musket, ball, damaged, poor	12 Ø ?		RS	3	

No	Fdate	Grid ref	Nos	Material	Object Type	Description	Dimensions (mm)	Weight (g)	Location	Box No	Dated
171	07/09/1997	D12	1	Pb	Munitions	Shot, ball, musket, damaged, good	5 Ø		RS	3	
172	07/09/1997	E12	1	Cu alloy	Coin ?	No detail, corroded, worn	25 Ø ?		RS	5	
173	07/09/1997	D12	1	Pb	Nail	Dome head, worn	25x1		RS	3	
174	07/09/1997	D12	1	Glass	Miscellaneous	Clear, flat, worn	23x20x3		RS	6	
175	07/09/1997	D12	1	Glass	Miscellaneous	Green, curved cup shaped	20x10x3		RS	6	
176	07/09/1997	D12	1	Cu alloy	Miscellaneous	Concave/ convex, pear shape, broken end	27x20x4		RS	4	
177	07/09/1997	D12	1	Cu alloy	Hinge ?	Spindle hole one side, styled, broken/worn end	76x18x2		RS	5	
178	07/09/1997	D12	1	Sn alloy?	Miscellaneous	Pewter ?curved cup shape, corroded	32x25x4		RS	4	
179	07/09/1997	D12	1	Cu alloy	Miscellaneous	Thin, dagger shape	38x7		RS	4	
180	07/09/1997	D12	3	Wood	Miscellaneous	Slivers	45x4		RS	12	
181	07/09/1997	D12	1	Pb	Ink well ?	Base only, hollow box shape, bent	45x40x40		RS	7	
182	07/09/1997	D12	1	Pb	Sheet	Thin, folded, corroded, worn	62x45		RS	3	
183	07/09/1997	D12	1	Pb	Sheet	Thin, folded, corroded, worn	40x30		RS	3	
184	07/09/1997	D12	1	Pb	Sheet	Thin, corroded, worn	27x17		RS	3	
185	07/09/1997	D12	1	Pb	Sheet	Thin, hole in centre, square, folded	35x23		RS	3	
186	07/09/1997	D12	1	Pb	Miscellaneous	Flat, chunky, with cut	42x13		RS	3	
187	07/09/1997	E12	1	Fe	Munitions	Shot, round, cannon, moderate/poor	98 Ø		RS		
188	07/09/1997	D12	1	Fe	Munitions	Shot, round, cannon, moderate/poor	99 Ø		RS		
189	07/09/1997	D12	1	Fe	Munitions	Shot, round, cannon, moderate poor	99 Ø		RS		
190	07/09/1997	G10	1	Fe	Munitions	Shot, round, cannon, moderate/poor	100 Ø		RS		
191	07/09/1997	G10	1	Fe	Munitions	Shot, round, cannon, poor	100 Ø		RS		
192	07/09/1997	D12	1	Fe	Munitions	Shot, round, cannon, moderate/poor	85 Ø		RS		

No	Fdate	Grid ref	Nos	Material	Object Type	Description	Dimensions (mm)	Weight (g)	Location	Box No	Dated
193	07/09/1997	G10	1	Fe	Munitions	Shot, round, cannon, not complete, very poor,	-		RS		
194	07/09/1997	D12	1	Au	Jewellery	Ring, mourning, skeleton design, stone setting, engraved	20 Ø		RS	1	1721
195	07/09/1997	D12	1	Au	Pendant ?	Attachment loop, signet? stone setting missing	25x14		RS	1	
196	07/09/1997	D12	1	Au	Chain	Braided, wire looped ends	32x5		RS	1	
197	07/09/1997	D12	1	Au	Chain	Braided, wire looped ends	102x5		RS	1	
198	07/09/1997	D12	1	Glass	Miscellaneous	Clear, oval handle shape, broken, worn	32x18		RS	6	
199	09/09/1997	D12	1	Glass	Jewellery	Green, faceted stone, flat base, dome top, chipped, worn	9x2		RS	9	
200	09/09/1997	B13	1	Ag	Cutlery	Spoon, handle only, tapered, corroded	129x14		RS	2	
201	09/09/1997	B13	1	Pb	Sheet	Thin, corroded, worn	29x20		RS	3	
202	09/09/1997	B13	1	Pb	Sheet	Thin, bent, corroded, corroded	48x30		RS	3	
203	09/09/1997	C13	1	Pb	Sheet	Thin, corroded, worn	22x19		RS	3	
204	09/09/1997	C13	1	Sn alloy?	Plate?	Rim? moulding, broken, corroded	78x30		RS	8	
205	09/09/1997	C13	1	Pb	Sheet	Thin, bent, corroded, worn	29x18		RS	3	
206	09/09/1997	C13	1	Pb	Sheet	Thin, folded, corroded, worn	49x23		RS	3	
207	09/09/1997	C13	1	Pb	Sheet	Thin, corroded, worn	30x17		RS	3	
208	09/09/1997	C12	1	Pb	Sheet	Thin, folded, worn	65x23		RS	3	
209	09/09/1997	C12	1	Pb	Sheet	Thin, holed, folded, corroded, worn	38x34		RS	3	
210	09/09/1997	C12	1	Pb	Sheet	Thin, folded, corroded, worn	33x32		RS	3	
211	09/09/1997	C12	1	Pb	Sheet	Thin, bent, corroded, worn	56x17		RS	3	
212	09/09/1997	C12	1	Pb	Sheet	Thin, folded, corroded, worn	90x35		RS	3	
213	10/09/1997	B12	2	Glass	Bottle	Worn frags of bottle glass	50x30		RS	6	

No	Fdate	Grid ref	Nos	Material	Object Type	Description	Dimensions (mm)	Weight (g)	Location	Box No	Dated
214	10/09/1997	C12	1	Sn alloy?	Plate?	Pewter? flat, rim? broken, corroded	72x32		RS	8	
215	10/09/1997	C12	1	Sn alloy?	Miscellaneous	Broken, corroded, worn	52x19		RS	8	
216	10/09/1997	C12	1	Sn alloy?	Miscellaneous	Broken, corroded, worn	44x23		RS		
217	10/09/1997	C12	1	Glass	Miscellaneous	Clear, flat, broken, worn	50x48x5		RS	6	
218	10/09/1997	C12	1	Glass	Miscellaneous	Clear, flat, broken, worn	39x20x4		RS	6	
219	10/09/1997	C12	1	Glass	Miscellaneous	Clear, flat, broken, worn	37x22		RS	6	
220	07/09/1997	D12	1	Ceramic	Tile	Earthenware, red, coarse, concave/convex, broken, worn	135x105		RS	10	
221	07/09/1997	D12	1	Ceramic	Miscellaneous	Earthenware, red, coarse, broken, very worn	64x38		RS	10	
222	07/09/1997	D12	1	Glass	Miscellaneous	Green, concave/convex, broken, worn	38x33		RS	6	
223	07/09/1997	D12	1	Glass	Miscellaneous	Clear, flat, broken, worn	25x18x4		RS	6	
224	07/09/1997	D12	1	Glass	Miscellaneous	Clear, flat, broken, worn	17x10x4		RS	6	
225	07/09/1997	D12	1	Glass	Miscellaneous	Clear, flat, broken, worn	16x12x6.5		RS	6	
226	07/09/1997	D12	1	Glass	Miscellaneous	Clear, convex/concave, broken,	14x8x1.5		RS	6	
227	07/09/1997	D12	1	Cu alloy	Rivet	Dome head, flat base, broken	10x6		RS	4	
228	07/09/1997	D12	1	Cu alloy	Disc	Centre hole, clean	5.5{19 Ø]		RS	5	
229	07/09/1997	D12	1	Pb	Miscellaneous	Sliver	40x4x2		RS	3	
230	07/09/1997	D12	1	Sn alloy?	Plate?	Broken, corroded	50x29		RS	8	
231	07/09/1997	D12	1	Cu alloy	Coin?	No detail, corroded, worn	19x16		RS	4	
232	07/09/1997	D12	1	Glass	Stopper?	Clear, tapered, broken	26x17		RS	6	
233	07/09/1997	D12	1	Au	Coin	English, guinea, George III	25.5	8.29	RS	8	1716
234	07/09/1997	D12	1	Au	Coin	Portuguese, 4000 reis	29.7	10.575	MH *	10	1720
235	14/09/1997	C10	1	Pb & Cu alloy	Weight?	Steel yard, door knob shaped, lead encased in brass, number on top	70x50		RS	11	

No	Fdate	Grid ref	Nos	Material	Object Type	Description	Dimensions (mm)	Weight (g)	Location	Box No	Dated
236	14/09/1997	C12	1	Au	Coin	Portuguese, 4000 reis	29.7	10.51	RS		1719
237	14/09/1997	C12	1	Au	Coin	Portuguese, 4000 reis	29.7	10.55	RS		1714
238	14/09/1997	D12	1	Fe	Munitions	Shot, round, cannon, moderate, poor	100		RS		
239	14/09/1997	D12	1	Cu alloy	Disc	Flat, wheel shape, groove on outer edge, raised centre hole See 296	42x5		RS	5	
240	14/09/1997	D12	1	Glass	Miscellaneous	Clear, fragment	25x25		RS	6	
241	14/09/1997	C12	4	Pb	Sheet	Thin, corroded, worn	39x27		RS	3	
242	14/09/1997	C12	2	Pb	Rivet	Nail shaped	24x23		RS	3	
243	14/09/1997	C12	1	Pb	Disc	ladle melt?	100x30		RS	7	
244	14/09/1997	C12	1	Cu alloy	Sheet	Thin, corroded, worn	45x29		RS	4	
245	14/09/1997	C12	1	Glass	Miscellaneous	Light green, concave/convex, broken, worn	43x19		RS	6	
246	23/09/1997	C12	1	Cu alloy	Candle Snuffer	Broken handle, scissors shape, worn/corroded	138x25		RS	5	
247	23/09/1997	C12	9	Pb	Sheet	Various pieces, thin, worn	50x30		RS	3	
248	23/09/1997	C12	5	Glass	Miscellaneous	Green, broken, Worn	40x28		RS	6	
249	23/09/1997	C12	8	Pb	Nail	Dome head, corroded, worn	25x2		RS	3	
250	23/09/1997	C12	5	Pb	Munitions	Shot, ball, musket, mould marks, clean	19 Ø		RS	3	
251	23/09/1997	C11	1	Cu alloy	Candle Stick?	Part of, hollow stem, corroded, worn, broken	65x25		RS	4	
252	23/09/1997	C12	8	Cu alloy	Rivet	Dome head, flat base	8x11		RS	4	
253	23/09/1997	C12	1	Sn alloy?	Miscellaneous	Rim, corroded, worn, broken	50x15		RS	8	
254	23/09/1997	C12	1	Glass	Drinking?	Stem? base, broken	33x30		RS	6	
255	23/09/1997	C12	1	Au	Jewellery	Ring, mourning, with damaged stone, thistle design, inscribed	19x5		RS	1	16 May 1719
256	23/09/1997	C12	1	Au	Coin	Portuguese, 2000 reis	24 Ø	5.33	MH		1715

No	Fdate	Grid ref	Nos	Material	Object Type	Description	Dimensions (mm)	Weight (g)	Location	Box No	Dated
257	23/09/1997	C12	3	Fe	Munitions	Shot, round, cannon, 1 good, 2 moderate, worn	100		RS		
258	23/09/1997	C12	1	Fe	Munitions	Shot, round, cannon, in caustic	100		RS		
259	23/09/1997	C12	1	Cu alloy	Pot	Concave/flat base, tapered sides - mortar	50x27.5		RS	5	
260	25/09/1997	C11	1	Cu	Nail	Square, flat head, tapered, corroded, worn	90x12		RS	4	
261	25/09/1997	C11	1	Cu alloy	Miscellaneous	Cog/knurl on spindle, hollow centre, broken, worn	24x23		RS	5	
262	25/09/1997	C11	1	Pb	Sheet	Corroded, worn	35x20		RS	3	
263	25/09/1997	C11	1	Sn alloy?	Miscellaneous	Flat, nail shape, broken, corroded	30x10x6		RS	8	
264	25/09/1997	C10	1	Cu alloy	Pot	Concave/flat base, tapered sides	110x71		RS	5	
265	25/09/1997	D11	2	Glass	Miscellaneous	Green, broken, worn	33x25		RS	6	
266	25/09/1997	D11	2	Pb	Sheet	Thin, corroded, worn	33x28		RS	3	
267	25/09/1997	D11	1	Pb	Sheet	Thin, folded, corroded, worn	66x28		RS	3	
268	25/09/1997	D11	1	Glass	Miscellaneous	Clear, flat, broken, worn	50x35		RS	6	
269	25/09/1997	D11	1	Glass	Stopper	Clear, round base, flat top	35x20		RS	9	
270	25/09/1997	D11	2	Glass	Drinking?	Stem? part of, clear, tapered, broken, worn	40x22		RS	6	
271	25/09/1997	D11	1	Glass	Drinking?	Stem? clear, moulded, tapered, broken, worn	30x18		RS	6	
272	25/09/1997	D11	1	Glass	Stopper?	Clear, tapered base, round top, broken, worn	35x20		RS	6	
273	25/09/1997	D11	1	Glass	Miscellaneous	Green, pot, shape, broken, worn	47x47		RS	6	
274	25/09/1997	D11	1	Glass	Miscellaneous	Clear, concave/convex, broken, worn	35x25		RS	6	
275	25/09/1997	D11	3	Glass	Miscellaneous	Clear, flat, broken, worn	45x20		RS	6	
276	25/09/1997	D11	2	Fe	Munitions	Shot, round, cannon, 1 good. 1 poor	100 Ø		RS		

No	Fdate	Grid ref	Nos	Material	Object Type	Description	Dimensions (mm)	Weight (g)	Location	Box No	Dated
277	25/09/1997	C11	2	Fe	Munitions	Shot, round, cannon, 1 moderate. 1 poor	100 Ø		RS		
278	28/09/1997	C11	1	Ag	Cutlery	Fork, three prong, moderate condition, some corrosion	194x23		RS	2	
279	28/09/1997	D11	1	Pb	Sheet	Folded, corroded, worn	70x60		RS	3	
280	28/09/1997	D11	1	Pb	Nail	Dome head, corroded	25x2		RS	3	
281	28/09/1997	D11	1	Glass	Miscellaneous	Green, bowl shape with part rim, broken	64x55		RS	9	
282	28/09/1997	C11	1	Glass	Bottle?	Green, broken, worn	40x30		RS	6	
283	28/09/1997	C11	1	Pb	Sheet	Corroded, worn	25x25		RS	3	
284	03/10/1997	E11	1	Cu alloy	Miscellaneous	Notch on side, corroded, worn	120x20		RS	4	
285	03/10/1997	E11	1	Cu alloy	Barrel Stop	Tapered stem, ring handle	77x38		RS	5	
286	03/10/1997	E11	1	Ceramic	Pipe stem	Clay	50x8		RS	10	
287	03/10/1997	E11	1	Cu alloy	Coin?	No detail, corroded, worn	28 Ø		RS	5	
288	03/10/1997	E11	2	Pb	Munitions	Shot, round, cannon, corroded, worn	28 Ø		RS	3	
289	03/10/1997	E11	1	Ag?	Jewellery?	Design on both sides, concave/convex, broken, corroded	38x20		RS	2	
290	03/10/1997	E11	1	Cu alloy	Sheet	Corroded, worn	50x40		RS	4	
291	03/10/1997	E11	1	Ceramic	Tile?	Earthenware, red, broken, worn	45x40		RS	10	
292	03/10/1997	E11	4	Pb	Sheet	Corroded, worn	63x18		RS	3	
293	03/10/1997	E11	2	Fe	Munitions	Shot, round, cannon, parts of	-		RS		
294	03/10/1997	E11	3	Glass	Miscellaneous	Green, broken, worn	38x34		RS	6	
295	03/10/1997	G12	1	Cu alloy, Pb	Pendulum?	Round with spur, convex, lead one side, corroded, worn	83 Ø		RS	11	
296	03/10/1997	G12	1	Cu alloy	Disc	Flat wheel shape, groove on outer edge, raised centre hole See 239	39 Ø		RS	5	

No	Fdate	Grid ref	Nos	Material	Object Type	Description	Dimensions (mm)	Weight (g)	Location	Box No	Dated
297	03/10/1997	G12	1	Ceramic	Tile?	Earthenware, red, thick coarse, concave/convex, broken, worn	100x50		RS	10	
298	03/10/1997	G12	1	Cu alloy	Miscellaneous	Flat base, dome top, corroded	15 Ø		RS	5	
299	03/10/1997	E11	1	Au	Coin	English, guinea, George I	36 Ø	8.275	RS		1715
300	03/10/1997	E11	2	Pb	Munitions	Shot, ball, musket, corroded, worn	18 Ø		RS		
301	03/10/1997	F11	2	Au	Chain	Fine braided, looped end with looped wire/looped end	40x4		RS	1	
302	03/10/1997	F11	1	Au	Chain	Braided, looped end with looped wire/looped end	50x4		RS	1	
303	03/10/1997	F11	1	Au	Wire	Looped	13x1.5		RS	1	
304	03/10/1997	F11	1	Au	Coin	English, guinea, George I, damaged, bent	17 Ø	8.28	RS		1715
305	03/10/1997	F11	1	Cu alloy	Disc	Flat, small raised centre piece with hole at top, corroded, worn	53 Ø		RS	5	
306	03/10/1997	F11	1	Ceramic	Miscellaneous	Earthenware, red, thick, coarse, broken, worn	55x45		RS	10	
307	03/10/1997	F11	3	Glass	Drinking?	Stem? clear, tapered, broken, worn	60x36		RS	6	
308	03/10/1997	F11	1	Glass	Stopper?	Clear, tapered, round top, broken, worn	50x20		RS	6	
309	03/10/1997	F11	2	Glass	Stopper?	Clear, ringed design, broken, worn	30x30		RS	6	
310	03/10/1997	F11	2	Pb	Munitions	Shot, ball, musket, damaged, corroded, worn	18 Ø		RS	3	
311	03/10/1997	F11	6	Glass	Miscellaneous	Green, 1 clear, broken, worn	25x19		RS	6	
312	03/10/1997	F11	1	Cu alloy	Buckle	Centre bar missing, some, light corrosion, worn	30x22		RS	4	
313	03/10/1997	F11	1	Cu alloy	Miscellaneous	Concave/convex, broken, light corrosion	18x17		RS	4	
314	03/10/1997	F11	1	Cu alloy	Miscellaneous	Melted? long tear drop, corroded	60x10		RS	5	

No	Fdate	Grid ref	Nos	Material	Object Type	Description	Dimensions (mm)	Weight (g)	Location	Box No	Dated
315	03/10/1997	F11	2	Pb	Wire?	Corroded, worn	65x5		RS	3	
316	03/10/1997	F11	2	Glass	Jewellery	Green, faceted stone, round, flat base, dome top, chipped, worn	9 Ø		RS	9	
317	04/10/1997	F12	1	Cu alloy	Dividers	Type? heavy corrosion, worn	82x10		RS	5	
318	04/10/1997	F12	1	Glass	Miscellaneous	Green, concave/convex, broken, worn	40x20		RS	6	
319	04/10/1997	G12	2	Pb	Sheet	Folded/flat, corroded, worn	63x42		RS	3	
320	04/10/1997	G12	2	Glass	Drinking?	Stem? clear, tapered, broken, worn	70x22		RS	6	
321	04/10/1997	G12	6	Glass	Miscellaneous	Green, concave/convex, broken, worn	62x35		RS	6	
322	04/10/1997	G12	2	Fe	Munitions	Shot, round, cannon, moderate/poor, worn	100 Ø		RS		
323	04/10/1997	F12	3	Fe	Munitions	Shot, round, cannon, 2 moderate/poor, worn, 1 part of	100 Ø		RS		
324	04/10/1997	D10	1	Fe	Munitions	Shot, round, cannon, poor	-		RS		
325	04/10/1997	D10	2	Cu alloy	Miscellaneous	Snake shape, interlocking pair, pin & loop one end, loop other Specs?	72x5		RS	5	
326	04/10/1997	D10	2	Glass	Miscellaneous	Green, broken worn	52x38		RS	6	
327	04/10/1997	D10	1	Glass	Drinking?	Stem? brown, clear, tapered, broken, worn	50x32		RS	6	
328	04/10/1997	D10	1	Pb	Sheet	Corroded, worn	31x20		RS	3	
329	04/10/1997	D10	1	Ag	Coin	English, William III? Worn	24 Ø		RS	2	
330	04/10/1997	D12	1	Au	Watch Part	Thin flat disc, centre hole, inscription "colston, London" fine	19 Ø		RS	1	
331	05/10/1997	B12	1	Glass	Drinking?	Stem? clear, moulded, tapered, broken, worn	28x20		RS	6	
332	05/10/1997	B12	1	Glass	Drinking?	Stem? clear, tapered, broken, well worn	50x20		RS	6	
333	05/10/1997	B12	1	Glass	Drinking?	Stem? clear, broken, worn	40x15		RS	6	

No	Fdate	Grid ref	Nos	Material	Object Type	Description	Dimensions (mm)	Weight (g)	Location	Box No	Dated
334	05/10/1997	B12	1	Pb	Munitions	Shot, ball, musket, worn	16 Ø		RS	3	
335	05/10/1997	B12	1	Pb	Sheet	Thin, bent, corroded, worn	28x27		RS	3	
336	05/10/1997	B12	1	Cu alloy	Buckle	Broken, corroded, worn	30x23		RS	4	
337	05/10/1997	B12	1	Glass	Miscellaneous	Green, broken, worn	28x15		RS	6	
338	05/10/1997	D10	2	Pb	Munitions	Shot, ball. musket, damaged, corroded, worn	19 Ø		RS	3	
339	05/10/1997	D10	3	Pb	Munitions	Shot, ball, musket, corroded, worn	18 Ø		RS	3	
340	05/10/1997	D10	1	Pb	Sheet	Oblong patch? corroded, worn	160x65		RS	3	
341	05/10/1997	D10	4	Pb	Sheet	Thin, corroded, worn	35x25		RS	3	
342	05/10/1997	D10	1	Glass	Miscellaneous	Green, flat, broken, worn	47x37		RS	6	
343	05/10/1997	D10	1	Ceramic	Pipe stem	Broken, worn	55x{12 Ø]		RS	10	
344	05/10/1997	D10	1	Cu alloy	Tube	Thick walled, tapered? broken, worn	53x16{11 Ø}		RS	4	
345	05/10/1997	D10	2	Cu alloy	Miscellaneous	Concave/convex, raised boss with centre hole	36x18		RS	4	
346	05/10/1997	D10	1	Fe	Munitions	Shot, round, cannon, moderate/ good, worn	100 Ø		RS		
347	05/10/1997	D10	1	Glass	Stopper	Clear, tapered, round top with cut away waist	60x38		RS	6	
348	05/10/1997	D10	1	Glass	Miscellaneous	Green, flat broken worn	30x28		RS	6	
349	05/10/1997	D10	1	Glass	Miscellaneous	Clear, flat, broken, worn	40x37		RS	6	
350	05/10/1997	C10	1	Ceramic	Miscellaneous	Earthenware, red, flat, well worn	40x33		RS	10	
351	05/10/1997	C10	1	Ceramic	Miscellaneous	Red with green glaze concave side, broken, worn	40x33		RS	10	
352	05/10/1997	C10	1	Ag	Cutlery	Spoon, handle only, well worn	130x13		RS	2	
353	05/10/1997	C10	1	Cu alloy	Sheathing?	Thin, worn	25x19		RS	4	
354	05/10/1997	D10	1	Pb	Sheet	Corroded, worn	34x15x1		RS	3	
356	05/10/1997	D10	1	Glass	Miscellaneous	Clear, broken, worn	25x17		RS	6	

No	Fdate	Grid ref	Nos	Material	Object Type	Description	Dimensions (mm)	Weight (g)	Location	Box No	Dated
357	05/10/1997	D10	2	Glass	Miscellaneous	Light green, concave/convex, broken, well worn	40x29		RS	6	
358	05/10/1997	D10	6	Glass	Miscellaneous	Green, concave/convex, broken, well worn	48x22x8		RS	6	
359	04/10/1997	G12	1	Pb & Cu alloy	Weight?	Steel yard, door knob shaped, lead encased in brass, number on top	63x53		RS	11	
360		F10	1	Au	Coin	English, guinea, Ann I	25 Ø	8.28	RS		1711
361		F10	1	Au	Coin	English, guinea, Ann I	25 Ø	8.3	MH		1711
362		F10	1	Au	Coin	English, guinea, William III	25 Ø	8.22	RS		1701
363		F10	1	Au	Coin	English, guinea, William III	25 Ø	8.22	MH *		1698
364		F10	1	Au	Coin	English, guinea, George I	25 Ø	8.305	MH *		1716
365		F10	1	Au	Coin	English, guinea, William III	25 Ø	8.25	RS		1701
366		G11	1	Au	Coin	English, guinea, James II	26 Ø	8.17	MH		1685
367		G11	1	Au	Coin	English, guinea, Charles II	25 Ø	8.3	MH		1684
368		G11	1	Au	Coin	English, guinea, William III	26 Ø	8.225	RS		1698
369		G11	1	Au	Coin	English, guinea, Charles II	25.5 Ø	8.15	RS		1684
370		G11	1	Au	Coin	English, guinea, George I	26 Ø	8.31	RS		1715
371		G11	1	Au	Coin	English, guinea, Charles II	25 Ø	8.125	RS		1679
372		G11	1	Au	Coin	English, guinea, William & Mary	26 Ø	8.275	RS		1692
373		G11	1	Au	Coin	English, guinea, Charles II	24.7 Ø	8.18	RS		1680
374		G11	1	Au	Coin	English, guinea, Charles II	25 Ø	8.18	RS		1672
375		G11	1	Au	Coin	English, guinea, James II	25.5 Ø	8.23	RS		1685
376		G11	1	Au	Coin	English, guinea, William & Mary	25 Ø	8.21	MH		1694
377		G11	1	Au	Coin	English, guinea, William III	25.4 Ø	8.025	MH		1700
378		G11	1	Au	Coin	English, guinea, William III	25 Ø	8.225	RS		1700
379		G11	1	Au	Coin	English, guinea, William III	25.3 Ø	8.175	RS		1695

No	Fdate	Grid ref	Nos	Material	Object Type	Description	Dimensions (mm)	Weight (g)	Location	Box No	Dated
380		G11	1	Au	Coin	English, guinea, Ann	25 Ø	8.29	RS		1714
381		G11	1	Au	Coin	English, guinea, George I	25.3 Ø	8.325	MH		1716
382		G11	1	Au	Coin	English, guinea, George I	25 Ø	8.325	RS		1720
383		G11	1	Au	Coin	English, guinea, William III	25.2 Ø	8..29	RS		1701
384		G11	1	Au	Coin	English, guinea, George I	24.6 Ø	8.325	RS		1720
385		G11	1	Au	Coin	English, guinea, George I	25.5 Ø	8.325	RS		1719
386		G11	1	Au	Coin	English, guinea, George I	25 Ø	8.265	RS		1715
387		G12	1	Au	Coin	English, guinea, Charles II	24.5 Ø	8.225	RS		1668
388		G12	1	Au	Coin	English, guinea, George I	25.5 Ø	8.34	RS		1719
389		G12	1	Au	Coin	Portuguese, 4000 reis	29.6 Ø	10.61	MH		1714
390		G12	1	Au	Coin	Portuguese, 4000 reis	29.2 Ø	10.5	RS		1715
391		G12	1	Au	Coin	Portuguese, 4000 reis	29.2 Ø	10.55	RS		1710
392		G12	1	Au	Coin	Portuguese, 4000 reis	29.5 Ø	10.55	MH *		1709
393		G12	1	Au	Coin	Portuguese, 4000 reis	29 Ø	10.55	RS		1714
394		G12	1	Au	Coin	Portuguese, 4000 reis	30 Ø	10.56	MH *		1719
395		G12	1	Au	Coin	Portuguese, 4000 reis	29 Ø	10.61	RS		1708
396		G12	1	Au	Coin	English, 1/2 guinea, George I	21 Ø	4.15	MH		1719
397		G12	1	Au	Coin	Portuguese, 4000 reis	30 Ø	10.6	RS		1720
398		G12	1	Au	Coin	Portuguese, 4000 reis	30 Ø	10.65	MH		1718
399		G12	1	Au	Coin	Portuguese, 4000 reis	30 Ø	10.56	RS		1712
400		G12	1	Au	Coin	Portuguese, 4000 reis	30 Ø	10.625	RS		1705
450	29/07/2001	E12	5	Pb	Shot	Musket shot	17 Ø		RS	3	
451	29/07/2001	E12	2	Pb	Shot	Pistol Shot	12 Ø		RS	3	
452	29/07/2001	F12	9	Pb	Sheet	Assorted small pieces of lead sheet	av 50 x 50 x 1		RS	3	
453	29/07/2001	F12	1	Cu alloy	Object	Some corrosion	118 x 16 x 4		RS	4	
454	29/07/2001	F12	1	Cu alloy	Sheet	Thin plate	72 x 36 x 1		RS	4	

No	Fdate	Grid ref	Nos	Material	Object Type	Description	Dimensions (mm)	Weight (g)	Location	Box No	Dated
455	29/07/2001	F12	1	Cu alloy	Object	Hole in centre 7 Ø	80 x 8 x 2		RS	4	
456	29/07/2001	F12	1	Glass	Stopper	Glass stopper, globular head - abraded	68 x 34 Ø		RS	9	
457	29/07/2001	F12	6	Glass	Fragments	Fragments of heavily eroded and encrusted glass	av 20 x 30 x 3		RS	6	
458	29/07/2001	F12	3	Glass	Wineglass	Fragments of wineglass stems	av 50 x 20 Ø		RS	6	
459	29/07/2001	F12	1	Au	Coin	Portuguese, 4000 reis 1702	29 Ø		RS		1702
460	29/07/2001	F12	1	Au	Coin	Portuguese, 4000 reis 1716	29.5 Ø		RS		1716
461	29/07/2001	F12	1	Au	Coin	Portuguese, 4000 reis 1706	29 Ø		RS		1706
462	30/07/2001	F12	1	Cu alloy	Nail	Square section	140 x 10 x 10		RS	5	
463	30/07/2001	F12	1	Cu alloy	Trigger Guard	Quite small possibly from a pistol	75 x 10 x 4		RS	5	
464	30/07/2001	F12	2	Ceramic	Pottery	Small glazed shards	35 x 25 x 4		RS	10	
465	30/07/2001	F12	3	Glass	Bottle?	Very abraded possible bottle shards	20 x 20 x 5		RS	6	
466	30/07/2001	F12	7	Pb	Shot	Musket shot	17 Ø		RS	3	
467	30/07/2001	F12	4	Pb	Shot	Pistol shot	12 Ø		RS	3	
468	30/07/2001	F12	1	Pb	Shot	Pistol shot with small hole	12 Ø		RS	3	
469	30/07/2001	F12	8	Pb	Sheet	Small fragments of bent Pb sheet	60 x 20 x 1		RS	3	
470	30/07/2001	F12	1	Cu alloy	Pestle	Two ended pestle. One end square the other circular	111 x 15 Ø		RS	5	
471	30/07/2001	F12	1	Au	Coin	Portuguese, 4000 reis 1715	29 Ø		RS		1715
472	30/07/2001	F12	1	Cu alloy	Object	Small 'fitting' with hole at one end	70 x 42 x 3		RS	5	
473	30/07/2001	F12	1	Pb	Weight	Steel-yard weight?	32 x 19 Ø		RS	3	
474	30/07/2001	F12	1	Cu alloy	Object	Small strip with hole at one end	45 x 17 x 2		RS	3	
475	30/07/2001	F12	1	Pb	Object	Concretion and lead obj	30 x 24 x 10		RS	3	
476	30/07/2001	F12	3	Cu alloy	Nail	square sectioned, abraded	25 x 3 Ø		RS	4	
477	30/07/2001	F12	1	Cu alloy	Object	Strip, part corroded away	44 x 10 x 1		RS	4	

No	Fdate	Grid ref	Nos	Material	Object Type	Description	Dimensions (mm)	Weight (g)	Location	Box No	Dated
478	30/07/2001	F12	1	Cu alloy	Hook	Exactly like modern cup-hook	38 x 3 Ø		RS	5	
479	30/07/2001	F12	1	Cu alloy	Object	Circular hole in centre, much corroded	16 x 7 x 7		RS	5	
480	30/07/2001	F12	1	Cu alloy	Coin	Heavily abraded - no visible detail	30.5 Ø		RS	5	

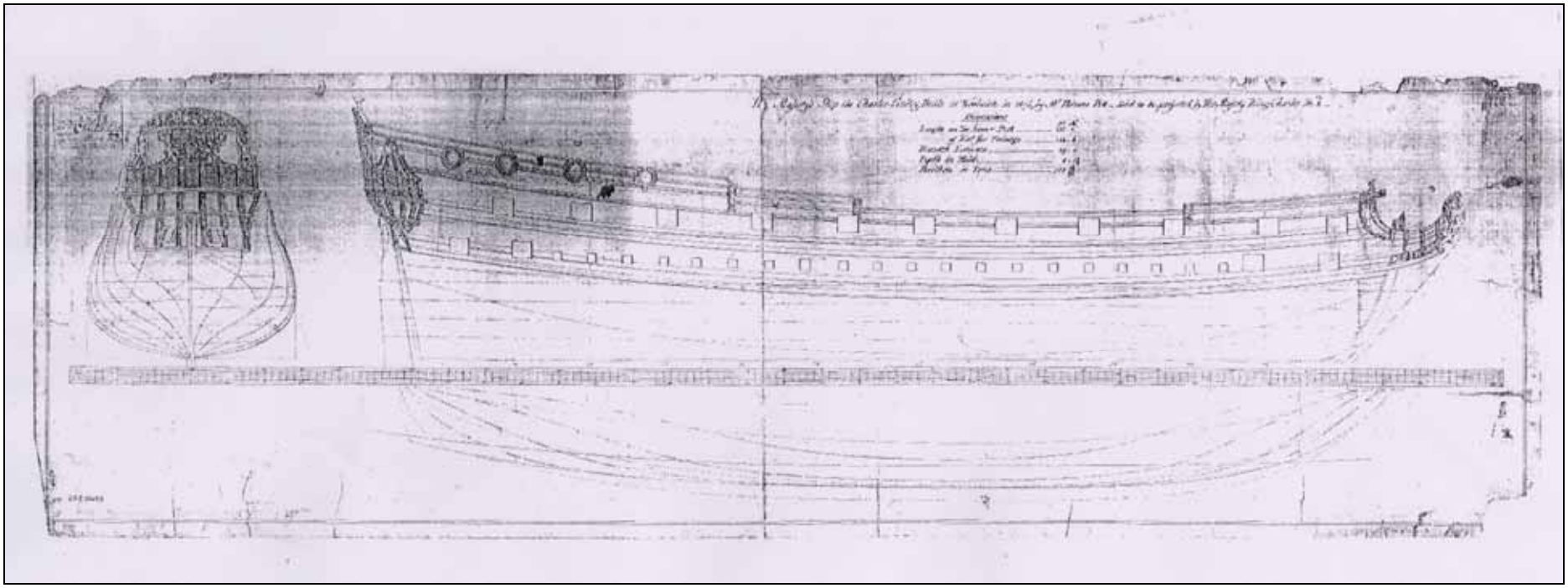


Fig 65 'Lines' plan of the Charles Galley (National Maritime Museum)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