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Scapa Flow Underwater Salvage Sites Survey: Phase 2 Report



This report was compiled by SULA Diving and ORCA Marine (University of the Highlands and Islands) on behalf of Historic Environment Scotland.

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CONTENTS

FIGURESiv

PLATESv

ACRONYMSx

ACKNOWLEDGEMENTSxi

EXECUTIVE SUMMARYxii

1 INTRODUCTION 1

1.1 Salvage Background 1

1.2 Project Background 4

1.3 High Seas Fleet Salvage Sites: Phase 1 5

1.4 Summary of Phase 1 Results 5

2 AIMS & OBJECTIVES 6

3 METHODS..... 7

3.1 Archive research 7

3.2 Side Scan Sonar 7

3.2.1 Side scan sonar processing 8

3.3 Ground-truthing 8

3.3.1 Diving 9

3.3.2 Remote video 9

3.3.3 Shiptime project data..... 9

3.4 Geographical Information Systems (GIS) 9

4 RESULTS & INTERPRETATION 12

4.1 SMS *Moltke* 12

4.1.1 Salvage background 12

4.1.1 Ground-truthing..... 15

4.2 SMS *Kaiser*..... 27

4.2.1 Salvage background 27

4.2.2 Ground-truthing..... 29

4.3 SMS *Printzregent Luitpold*..... 36

4.3.1 Salvage background 36

4.3.2 Ground-truthing..... 37

4.4 SMS *König Albert*..... 44

4.4.1 Salvage background 44

4.4.2 Ground-truthing..... 45

4.5 SMS *Kaiserin*..... 49

4.5.1 Salvage background 49

4.5.2	Ground-truthing.....	52
4.6	SMS <i>Friedrich der Grosse</i>	58
4.6.1	Salvage background	58
4.6.2	Ground-truthing.....	59
4.7	SMS <i>Grosser Kurfürst</i>	64
4.7.1	Salvage background	64
4.7.2	Ground-truthing.....	64
4.8	SMS <i>Derfflinger</i>	69
4.8.1	Salvage background	69
4.8.2	Ground-truthing.....	70
4.9	SMS <i>Bremse</i>	81
4.9.1	Salvage background	81
4.9.2	Ground-truthing.....	82
4.10	SMS <i>S36</i>	89
4.10.1	Salvage background	89
4.10.2	Ground-truthing.....	89
4.11	SMS <i>B109</i>	93
4.11.1	Salvage background	93
4.11.2	Ground-truthing.....	93
4.12	SMS <i>V78</i>	96
4.12.1	Salvage background	96
4.12.2	Ground-truthing.....	96
4.13	Miscellaneous contacts.....	98
4.13.1	SS042 & SS049.....	98
4.13.2	SS101.....	99
4.13.3	Lyness contacts (SS112, SS113).....	99
4.13.4	Rinnigal contacts (SS114, SS115, SS116 & SS117)	103
4.13.5	Contact SS118	108
4.13.6	Contact SS119	108
4.13.7	Contact SS120	108
5	DISCUSSION.....	111
5.1	Phase 1	111
5.2	Phase 2	111
5.3	Project Overview.....	112
5.4	Future work.....	113
6	CONCLUSION.....	114

7	REFERENCES	115
8	APPENDICES	116
8.1	Appendix 1: Side scan sonar survey contact report.....	117
8.2	Appendix 2: Specifications of German vessels surveyed during Phase 2 (from Jung & Maass, 1990).	126

LIST OF FIGURES

Cover: Side scan of SMS *Kaiser* primary salvage site, and photo of SMS *Kaiser* forward mast splinter-proof control room

Figure 1: Salvage Sites Phase 2 with the 1923 chart as base map.11

Figure 2: Side scan coverage of the SMS Moltke with the 1923 chart as base map showing multiple sonar contacts..... 15

Figure 3: Side scan image SS003.....20

Figure 4: Scan image of spotting top (SS010).21

Figure 5: Side scan of SS014.....22

Figure 6: Side scan image of SMS Kaiser primary salvage site (SS044).29

Figure 7: SMS Prinzregent Luitpold primary salvage site (SS045, SS046 & SS047).....38

Figure 8: SMS König Albert primary salvage site (SS056, SS057 & SS058).46

Figure 9: SMS Kaiserin primary salvage site (SS053, SS054 & SS055).52

Figure 10: SMS Friedrich der Grosse primary salvage site (SS059, SS061 & SS062).....60

Figure 11: SMS Grosser Kurfürst primary salvage site.....66

Figure 12: SMS Derfflinger primary salvage site.....71

Figure 13: Side scan image of tertiary site (SS086, SS088, SS089, SS090).....75

Figure 14: SMS Derfflinger tertiary salvage site used 1939-1946 (UKHO Chart F083, 1940)..76

Figure 15: SMS Bremse, primary salvage site at Toyness marked on Admiralty Chart 3729 (1925) (top) and the side scan image of the area (SS127 & SS128) (bottom).84

Figure 16: Side scan image of SMS S36 wreck site to west of Cava.90

Figure 17: Side scan image of wreckage in Mill Bay, Hoy (SS105).....94

Figure 18: Side scan image of the V78 salvage site (left) and UKHO chart 3729 (1923) showing its original location on the north side of Fara (right).97

Figure 19: Side scan image of contacts SS112 and SS113 located off Lyness pier.102

Figure 20: Side scan contacts off Rinnigal pier, Hoy.104

Figure 21: Side scan image of the salvage barge (SS114) located east of Rinnigal pier.104

LIST OF PLATES

Plate 1: Air locks fitted to the hull of a sunken German vessel (C. Bullen Collection).....3

Plate 2: SMS Derfflinger breaks the surface in July 1939 after its hull was pumped full of air (C. Bullen Collection).3

Plate 3: The raised hull of a German vessel with air locks still attached (C. Bullen Collection). 4

Plate 4: SMS Moltke at Scapa Flow (B. Forbes Collection).12

Plate 5: Whaler on hull of SMS Moltke (H. Hadley Collection).13

Plate 6: SMS Moltke with SMS Seydlitz behind. (Left). Flag raised on SMS Moltke (Right). (B Forbes collection).13

Plate 7: Cutting up one of SMS Moltke’s 12-inch guns at Lyness from one of the two turrets left behind in Orkney (B Forbes Collection).13

Plate 8: Sonar images of Moltke contacts SS002 (top left) and SS021 (bottom left) with corresponding ground-truthing images at right.18

Plate 9: Schematic of the torpedo loading crane on SMS Friedrich der Grosse (left) and an image of a loading crane in operation (right) (G. Staff Collection).19

Plate 10: Diver photographs of SS003 showing timber members and steel end fittings (left) and brass sockets (right) from SMS Moltke gangway.20

Plate 11: Archive images of a gangway in use on SMS Moltke (G. Staff Collection).20

Plate 12: Images from the Shiptime Project ROV footage showing the remains of the spotting top (left) and of the mast support below where the crow’s nest would have been located (right).21

Plate 13: SMS Moltke forward mast spotting top and crow’s nest (G. Staff Collection).21

Plate 14: Remote video image of SS014.22

Plate 15: SMS Moltke samson post top. (G. Staff Collection).23

Plate 16: Mosaic image showing the section of armour plate, measured 2.9m x 2.2m and was 9” thick (inset) found on the site of SMS Moltke.24

Plate 17: Wing gun turret on SMS Moltke, showing armour plate detail (K. Heath Collection).24

Plate 18: Additional sections of armour plate (left) lying close to the piece of turret armour, with an example shown from HMS Lion (right).25

Plate 19: Circular artefact found at SMS Moltke site, lodged firmly in the seabed (left). The one shown on the right was recorded on the site of SMS Prinzregent Luitpold.25

Plate 20: Archive image of coal loading on the SMS Von der Tann (G. Staff Collection).26

Plate 21: SMS Kaiser in Scapa Flow, just starting to sink during the scuttling on 21st June 1919.27

Plate 22: SMS Kaiser, afloat after salvage in March 1929 (left) and one of its gun turrets ashore at Lyness (right) (B. Forbes Collection).28

Plate 23: Left, rangefinder located just off the primary salvage site of SMS Kaiser (Shiptime Project), with animated reconstruction of rangefinder (inset, image courtesy of M. Samuel).31

Plate 24: SMS Kaiser forward mast showing splinter proof control room (top) and underside of spotting top (bottom).32

<i>Plate 25: SMS Kaiser wreckage at base of forward mast comprising searchlight platforms (top) and bridge structure (bottom).</i>	33
<i>Plate 26: Boat supports found on the Kaiser primary salvage site (left) alongside an archive image (G. Staff Collection) of boat supports on the deck of a German battleship (right).</i>	34
<i>Plate 27: Gyrocompass remains found on the seabed to the south-east of SMS Kaiser's primary salvage site.</i>	35
<i>Plate 28: SMS Prinzregent Luitpold in Scapa Flow (B. Forbes Collection).</i>	36
<i>Plate 29: Prinzregent Luitpold primary salvage site, showing mixed wreckage (SS047) including a brass "room" (top) and repeater-type compass alongside an archive image of a German repeater compass (bottom).</i>	40
<i>Plate 30: Archive image of SMS Prinzregent Luitpold showing a room located behind the aft control tower (K. Heath Collection).</i>	41
<i>Plate 31: Prinzregent Luitpold primary salvage site, forward mast with splinter-proof spotting top (SS045).</i>	42
<i>Plate 32: Prinzregent Luitpold primary salvage site, forward searchlight platforms (SS045).</i>	42
<i>Plate 33: Prinzregent Luitpold, primary salvage site (SS046), diesel engine (image courtesy of I. Houston, OSAC).</i>	43
<i>Plate 34: SMS König Albert in Scapa Flow (B. Forbes Collection).</i>	44
<i>Plate 35: Shipbuilding and Shipping Record 1935 (T McKenzie) (C Bullen Collection).</i>	44
<i>Plate 36: SMS König Albert primary site, foremast remains (SS057).</i>	47
<i>Plate 37: SMS König Albert primary site, samson post boom (SS056) with coal winch on top.</i>	47
<i>Plate 38: SMS König Albert primary site, pinnace diesel engine (SS058) lying upside down on seabed.</i>	48
<i>Plate 39: SMS Kaiserin at Scapa Flow (B. Forbes Collection).</i>	50
<i>Plate 40: SMS Kaiserin following salvage, being towed through the Pentland Firth on route to Rosyth (Dundee Courier).</i>	51
<i>Plate 41: Drawing by diver of the position of the SMS Kaiserin, December 1935, showing the bent foremast protruding from seabed (Orkney Archive D1/59/1/1).</i>	51
<i>Plate 42: SMS Kaiserin primary site, wire on drum (SS055).</i>	54
<i>Plate 43: SMS Kaiserin primary site, samson post boom (SS055).</i>	54
<i>Plate 44: SMS Kaiserin primary site, samson post (SS055).</i>	55
<i>Plate 45: SMS Kaiserin primary site (SS054), aft mast protruding from seabed (image courtesy of B. Wade).</i>	55
<i>Plate 46: SMS Kaiserin primary site (SS053), aft searchlight platforms (image courtesy of B. Wade).</i>	56
<i>Plate 47: SMS Kaiserin primary site, brass pipe projecting from seabed (image courtesy of B. Wade).</i>	56
<i>Plate 48: SMS Kaiserin primary site, searchlight remains, partially buried with intact front grill with inset of (top) and iris (bottom). A similar searchlight unit from a German ship is also shown (top right) (G. Staff Collection).</i>	57
<i>Plate 49: SMS Friedrich der Grosse at anchor in Scapa Flow (B. Forbes Collection).</i>	58
<i>Plate 50: SMS Friedrich der Grosse primary salvage site, searchlight platforms adjacent to aft mast.</i>	61

<i>Plate 51: SMS Friedrich der Grosse primary salvage site, showing aft mast protruding from seabed.</i>	61
<i>Plate 52: SMS Friedrich der Grosse primary salvage site, sub-colibre liner casing.</i>	62
<i>Plate 53: SMS Friedrich der Grosse primary salvage site, boom sections.</i>	62
<i>Plate 54: SMS Friedrich der Grosse primary salvage site, forward mast and splinter proof control room.</i>	63
<i>Plate 55: SMS Friedrich der Grosse primary salvage site, forward mast, spotting top and splinter proof control room.</i>	63
<i>Plate 56: SMS Grosser Kurfürst.</i>	64
<i>Plate 57: SMS Grosser Kurfürst primary salvage site, aft searchlight platform with possible searchlight unit on seabed below.</i>	67
<i>Plate 58: SMS Grosser Kurfürst primary salvage site, forward mast spotting top and splinter proof control room.</i>	67
<i>Plate 59: SMS Grosser Kurfürst primary salvage site, forward mast crow’s nest, located below the main spotting top.</i>	68
<i>Plate 60: SMS Grosser Kurfürst primary salvage site, searchlight platform wreckage near the forward mast.</i>	68
<i>Plate 61: SMS Derfflinger at Scapa Flow, 1919 (K. Heath Collection).</i>	69
<i>Plate 62: The hull of SMS Derfflinger was taken to the River Clyde for breaking up in 1946 (B. Forbes Collection).</i>	70
<i>Plate 63: Enlarged view of the tripod mast on SMS Derfflinger,</i>	72
<i>Plate 64: Aerial image of SMS Derfflinger at tertiary salvage site, west of Rysa Little, with SS Cape Ortegal moored alongside prior to being deployed as a blockship (K. Heath Collection).</i>	76
<i>Plate 65: SMS Derfflinger, aft mast spotting top, primary salvage site (image courtesy of B. Anderson).</i>	77
<i>Plate 66: SMS Derfflinger, diesel pinnace engine, primary salvage site (image courtesy of B. Anderson).</i>	77
<i>Plate 67: SMS Derfflinger, top of tripod mast showing centre and side (port) leg, primary site. Starboard leg missing (image courtesy of W. Allen).</i>	78
<i>Plate 68: SMS Derfflinger, searchlight mount near top of tripod mast, primary site (image courtesy of W. Allen).</i>	78
<i>Plate 69: SMS Derfflinger, small forward-facing platform on middle leg of tripod mast, primary site.</i>	79
<i>Plate 70: SMS Derfflinger, underside of splinter proof control room, partially buried, primary site (image courtesy of W. Allen).</i>	79
<i>Plate 71: SMS Derfflinger, tertiary site, main anchor capstans (SS087).</i>	80
<i>Plate 72: SMS Bremse (K. Heath Collection).</i>	81
<i>Plate 73: SMS Bremse after its scuttling (left) and during salvage (right). B Forbes & K Heath collections.</i>	82
<i>Plate 74: SMS Bremse, primary salvage site, showing miscellaneous wreckage, deck plating and a small boiler (images courtesy of OSAC).</i>	85
<i>Plate 75: SMS Bremse, archive image showing the aft searchlight platform (top) and its remains on the salvage site (bottom).</i>	86

Plate 76: Remains of a night speed indicator (top) attached to the remains of the aft searchlight platform (top). A similar unit (arrow) installed on SMS Moltke is also shown (bottom) (images courtesy of OSAC and G. Staff).87

Plate 77: Night speed indicator signals and commands (Samuel, 2018).....88

Plate 78: Pathé newsreel clips of Destroyer S36 being sunk off Cava (copyright Pathé).90

Plate 79: SMS S36, hull plating on the seabed (image courtesy of BSAC).91

Plate 80: SMS S36, propeller shaft (image courtesy of BSAC).91

Plate 81: SMS S36 at Cava, bow steering gear remains (top, image courtesy of P. Balazy) and a schematic of the bow rudder arrangement (bottom).....92

Plate 82: Wreckage in Mill Bay, on incorrectly charted site of B109.....94

Plate 83: Electrical box with the wording “N&K Stromkr Lampen” at incorrectly charted site of B109 in Mill Bay.95

Plate 84: Telegraph on a German destroyer (left) and the telegraph from V78 after recovery in 1998 (right) (K. Heath Collection).97

Plate 85: Side scan images SS042 (top left) and SS049 (top right) proved to be isolated searchlight platforms. Photographs of SS042 show the platform (bottom left) and remains of a searchlight control (bottom right) (images courtesy of BSAC).98

Plate 86: Side scan contact 101 (image as inset) located in Gutter Sound was a samson post and boom (top) typical of Kaiser-class vessels. Samson post detail from Kaiser-class (left) and Bayern-class vessels (right) (B. Forbes Collection).100

Plate 87: Top of samson post showing tri-plate arrangement, Gutter Sound.....101

Plate 88: Remains of a mast section at SS112 (top) and the remains of a mast and mixed wreckage at SS113 (bottom).....102

Plate 89: Archive images (top) of the barge being sunk by Rinnigal pier in 1976 (Image courtesy of D. Campbell via Huskylan Charters). The pier can be seen in the top right image. Images of the barge in its current condition (bottom).105

Plate 90: Circular ring found off Rinnigal pier composed of steel (SS115).106

Plate 91: Turbine casings to the west of Rinnigal Pier (SS116).....106

Plate 92: Turbine casing (left) with plate clamp attached (SS116) and an example of a similar clamp (right).....106

Plate 93: Turbine casing (SS117, top) and non-ferrous turbine blades (bottom).107

Plate 94: SS118, isolated aft mast and crow’s nest (image courtesy of B. Anderson).109

Plate 95: SS118, still image of 3D mosaic (image courtesy of R. Priestly & A. Hatt).....109

Plate 96: Torpedo remains at SS119, showing detached air cylinder and warhead (left) and afterbody (right).....110

Plate 97: Still image of German pinnace diesel engine (SS120) taken from a 3D model (image courtesy of S. Brown, 3Deep).....110

ACRONYMS

ACoP	Approved Code of Practice
BSAC	British Sub Aqua Club
GIS	Geographic Information System
GPS	Geographic Positioning System
HES	Historic Environment Scotland
NRHE	National Record of the Historic Environment
OIC	Orkney Islands Council
ORCA	Orkney Research Centre for Archaeology
OSAC	Orkney Sub Aqua Club
ROV	Remotely Operated Vehicle
RoW	Receiver of Wreck
SCUBA	Self Contained Underwater Breathing Apparatus
SMR	Sites and Monuments Record
SMS	Seiner Majestät Schiff
SS	Side Scan
UKHO	United Kingdom Hydrographic Office
WGS84	World Geodetic System 1984

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EXECUTIVE SUMMARY

This project was undertaken by ORCA (University of the Highlands and Islands Archaeology Institute) and SULA Diving Ltd on behalf of Historic Environment Scotland (HES). It represents the second phase of work (see Henry *et al.* 2018 for the report on the first phase) to gather data on the seabed remains left behind following the salvage of the German High Seas Fleet, which was interned and subsequently scuttled in Scapa Flow, Orkney, in June 1919. The salvage process that followed the scuttling was an unprecedented achievement and represents another fascinating aspect of Scapa Flow's maritime heritage.

Phase 2 continued the ground-truthing process for the remaining sites detected in Phase 1 sonar surveys. Phase 2 ground-truthing surveys focussed on the remaining primary salvage sites associated with the following vessels:

- SMS *Moltke*;
- SMS *Prinzregent Luitpold*;
- SMS *Derfflinger*;
- SMS *Friedrich der Grosse*;
- SMS *Kaiserin*;
- SMS *Kaiser*;
- SMS *König Albert*;
- SMS *Grosser Kurfürst*; and
- Miscellaneous contacts, including a German diesel pinnace discovered in 2017 and subject since to disturbance (reported separately in SULA Diving, 2018), SMS *Bremse*, SMS *S36*, SMS *B109* and SMS *V78*.

The overall aim of the Scapa Flow Salvage Sites Project was to determine what remains of the many vessels of the German High Seas Fleet that were salvaged in the years that followed their scuttling in June 1919. Phase 1, undertaken over the winter of 2016/17, involved a side scan sonar survey of the main anchorages and other areas thought to have been involved in the salvage process. A process of ground-truthing the sonar contacts started in Phase 1 was completed in this Phase 2 project. The overall result of this process is that the vast majority of salvage sites in Scapa Flow have been located and the remains at each site have been directly investigated and recorded. Archive research throughout Phases 1 and 2 has underpinned both the approach to fieldwork and the interpretation of its results. The combination of side scan sonar with direct ground-truthing (by diver or remote video) worked effectively. The involvement of volunteer archive researchers and recreational volunteer divers brought added detail to the project, as well as engaging divers with the importance of the submerged historic assets. Salvage remains included a wide range of artefacts from vessels that have been long removed from Scapa Flow. It has been possible to dovetail the artefacts found at each site with archive accounts of the salvage, generally on a ship by ship basis. The original requirement to determine what remains of the salvage process has been successfully achieved and should help to protect these sites as physical reminders of the inter-war salvage effort, which is another important part of Scapa Flow's maritime history.

1 INTRODUCTION

This project was undertaken by ORCA (University of the Highlands and Islands Archaeology Institute) and SULA Diving Ltd on behalf of Historic Environment Scotland (HES). It represents the second phase of work (see Henry *et al.* 2018 for the report on the first phase) to gather data on the seabed remains left behind following the salvage of the German High Seas Fleet, which was interned and subsequently scuttled in Scapa Flow, Orkney, in June 1919. The salvage process that followed the scuttling was an unprecedented achievement and represents another fascinating aspect of Scapa Flow's maritime heritage¹.

The seven remaining ships of the High Seas Fleet, which were designated as Ancient Monuments under the Ancient Monuments and Archaeological Areas Act of 1979 Act in 2001, have seen Scapa Flow become one of the most well-known dive sites in the World. Those wrecks are still the primary focus of recreational divers but the remains of those vessels that were recovered and removed from the Flow have been a recognised diving resource for many years. Diving activity on these so-called salvage sites is increasing, partly because of a growing demand for new dive sites, but also due to an increasing interest in the High Seas Fleet as the centenary of its scuttling approaches. However, the exact extent and composition of these so-called salvage sites is unknown and they are at risk from disturbance due to a lack of statutory protection. There is a need therefore to carry out an assessment of the salvage sites, which will help to inform their protection in the future.

1.1 Salvage Background

The salvage of the German High Seas Fleet was an unparalleled achievement. It was initially said that the recovery of the larger German vessels was an impossible task given their sheer size and weight (some up to 28,000 tonnes displacement). The first salvage efforts focussed on the smaller destroyers², which at less than 2000 tonnes displacement were lifted relatively easily using barges. Divers passed wires under the hull of the sunken vessel and they were simply winched to the surface and taken away for breaking. A completely different and unique method was used by the main salvors Cox and Danks and later by Metal Industries Ltd to recover the larger vessels of the fleet, most of which, in contrast to the destroyers, were lying upside down on the seabed in depths up to 45m. The basic principle was simple - fill the vessels with air to the point that they floated to the surface. In practice, however, this was a difficult and risky procedure involving a huge amount of preparatory work to firstly access the hulls and then seal all routes that might allow air to escape. Access was achieved by fitting long tubes known as air locks to the hull of the upturned vessel. Divers installed these section by section until they broke the surface. Guy wires were fixed from the air locks back to the hull in order to keep them in an upright position and airtight hatches were fitted internally. This allowed air to be pumped into the tubes to displace the water. Salvage workers were then able to descend the air locks and cut through the hull of the vessel (if the divers had not already done this) and gain access to the inside (Plate 1). The work to seal the hull then ensued, pumping more air in when necessary to displace water and allow access further down the hull of the vessel. This

¹ An account of the scuttling and salvage were provided in the Phase 1 report (Henry *et al.*, 2018).

² Referred to as Large Torpedo Boats by the German Navy (Jung & Maass, 1990). For the purposes of this report, the term Destroyer will be used for consistency with the Phase 1 project.

was all done by shift workers “in the dry”, who were exposed to the same pressure as divers working outside the hull and who therefore had to be decompressed at the end of their shift as they ascended the air locks to the surface. When sufficient buoyancy had been achieved the hull would rise to the surface (Plate 2). This was not always a straightforward process of course and complications were met in some cases (as described later in the results section). However, 12 of the 16 largest vessels (displacement in excess of 20,000 tonnes) in the High Seas Fleet were raised in this way, *i.e.* using compressed air, and towed away for breaking (Plate 3). A more detailed account of the salvage methods and the challenges faced by the salvage teams can be found elsewhere (Bowman, 1964).



Plate 1: Air locks fitted to the hull of a sunken German vessel (C. Bullen Collection). Workers accessed the air locks by small boats and descended through them to the hulls on the seabed below.

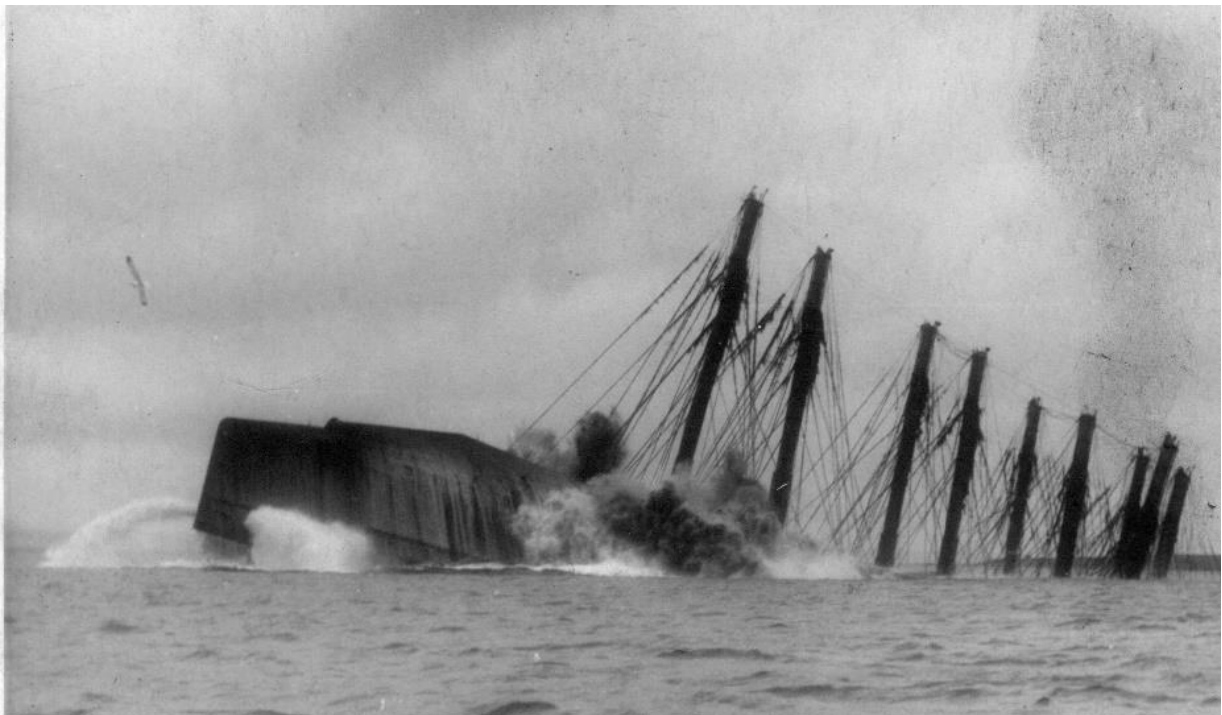


Plate 2: SMS Derfflinger breaks the surface in July 1939 after its hull was pumped full of air (C. Bullen Collection).

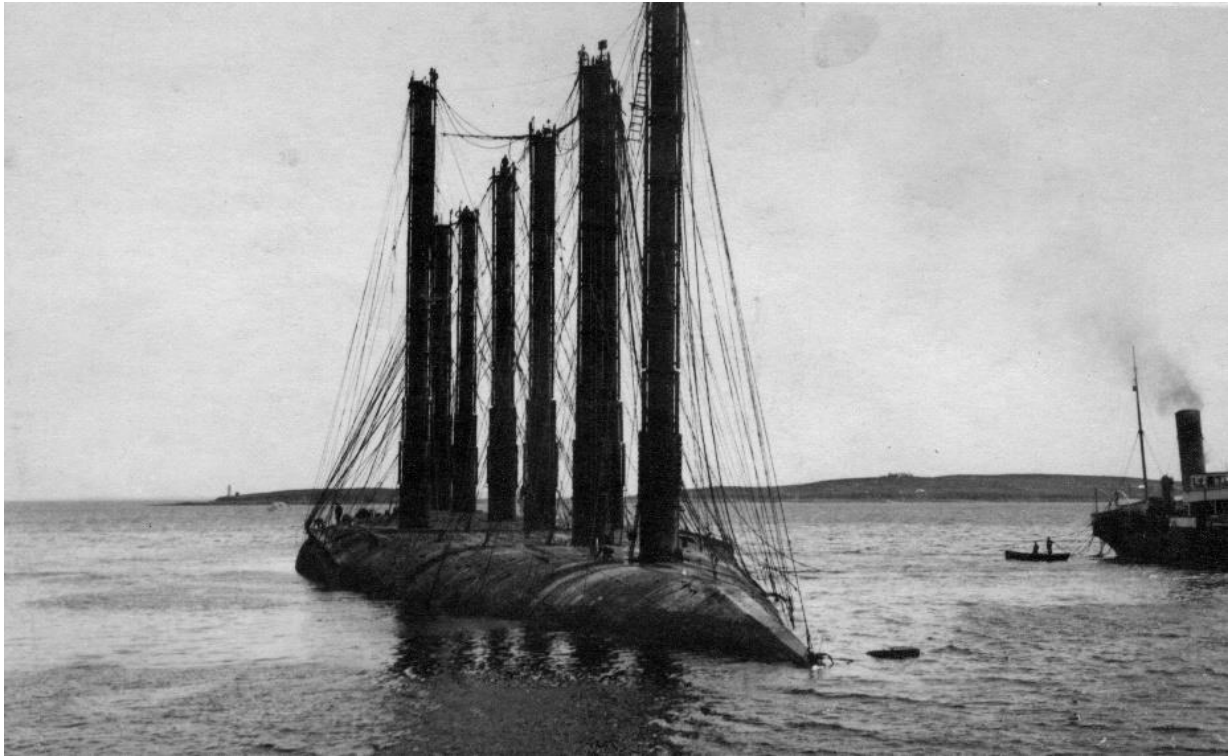


Plate 3: The raised hull of a German vessel with air locks still attached (C. Bullen Collection). Note the guy wires attached to the hull of the vessel to stabilise the air locks.

1.2 Project Background

This project builds on and complements previous projects undertaken and conducted that have cumulatively helped to map and record large extents of the cultural heritage resource situated on the seabed throughout Scapa Flow. These include:

- The HES-funded Scapa Map Project (Forbes, 2006) identified and recorded salvage sites, imaging the significant depressions and structural remains present at a number of the primary sites;
- HES-funded MBES surveys completed by Wessex Archaeology (WA) in 2011 to map the blockships in Burra Sound and other wartime wrecks (HMS *Strathgarry*; *UB116*; the *F2* and *YC21* barge; *S54*; *V83*; and *Dewey Eve*) (Dresch and McCarthy 2012);
- Desk-based assessment (DBA) work to improve the record of the marine historic environment conducted as part of HS and the Royal Commission for Ancient and Historic Monuments of Scotland (RCAHMS) Project Adair (Pollard et al. 2012);
- The Scapa Flow 2013 Marine Archaeology Survey 2013 (Christie, et al., 2013) recorded the SMS *Bayern* and SMS *Seydlitz* primary salvage sites, as well as the blockships at the Churchill Barriers and lesser known wartime wrecks around Scapa Flow;
- The Lost Aircraft of Scapa Flow project (Henry, et al., 2016) highlighted the extent of the secondary salvage sites that are present on the seabed in Orkney, during the investigation of aircraft remains; and
- The Scapa Flow Shiptime Project (Henry & Heath, 2017) was a multi-disciplinary collaborative project that gathered new data on the extent, survival and character of

submerged cultural heritage remains on the seabed around Orkney, including some of the wrecks of the High Seas Fleet and especially the Royal Navy vessels HMS *Hampshire*, HMS *Vanguard*, HMS *Pheasant* and HMS *Royal Oak*. This project was the source of some of the survey and ground-truthing data used in this Phase 2 salvage sites project.

1.3 High Seas Fleet Salvage Sites: Phase 1

The need to understand more about the location and composition of the salvage sites provided the context for the HES-funded Scapa Flow Salvage Sites Project. The work that resulted in the report titled “High Seas Fleet Salvage Sites Report”, also referred to as the Phase 1 Report, was carried out over the winter of 2016/17 (Henry, et al., 2018). Its main objectives were to:

- carry out a side scan sonar survey of the German fleet anchorages and scrap sites (excluding the area around the remaining seven wrecks of the fleet); and
- ground-truth the sonar contacts to identify, record and assess any salvage remains.

1.4 Summary of Phase 1 Results

The Phase 1 sonar survey covered all of the main anchorage areas, which amounted to an area of approximately 6.9km². The salvage sites within that area proved to be numerous and corresponded almost entirely to the larger vessels of the High Seas Fleet that were recovered, comprising 10 battleships, battle cruisers and cruisers (not including the remaining wrecks, those that were beached or those which have been previously surveyed³). While most of the salvage sites were located where the larger vessels were anchored (primary sites), Phase 1 pinpointed a number of shallower sites to where salvaged vessels were moved from their original locations. These secondary (and sometimes tertiary) sites were used to carry out more salvage work in easier (shallower) conditions or to prepare the vessel for a long sea journey south to Rosyth where they were scrapped. This extensive network of sites is spread over a wide area, providing a physical record of the remarkable salvage process that ensued in later years and has a collective historical significance that adds to the story of the scuttling of the Fleet.

The large number and complexity of the sites meant that only a limited amount of ground-truthing could be undertaken during Phase 1. This focussed on the primary salvage sites of SMS *Von der Tann* and SMS *Hindenburg* and a secondary salvage area on the east side of Rysa Little, where debris from several vessels was found. Dive surveys revealed a variety of artefacts at each site, comprising large masts, spotting tops, samson posts, davits and searchlight platforms, as well as smaller items like coal winches, compass stands, sub-calibre liners, searchlight remains and electrical cabling, boxes and switches. In the case of SMS *Von der Tann*, the sonar and diving surveys found an extensive salvage trail from its primary salvage site leading eastwards into shallower waters by the island of Cava. Very little remained of most of the fifty destroyers of the High Seas Fleet on the seabed at their original anchorage locations. A small

³ Three battleships (SMS *Margraf*, SMS *König* and SMS *Kronprinz Wilhelm*) remain on the seabed in Scapa Flow. SMS *Baden* was beached and refloated and the salvage remains of SMS *Bayern* and SMS *Seydlitz* were surveyed in 2013 (Christie, et al., 2013).

number of contacts were detected in the sonar survey but it is thought that most destroyers were raised and removed in their entirety, leaving little on the seabed. The hulls of only a few remain, such as the *V83* at Rysa, the *S36* at Cava and the *S54* in Hoxa Sound. Some of the others were re-purposed and used as aids in the salvage of larger vessels, such as SMS *Hindenburg*.

A large volume of new data on the salvage sites of the High Seas Fleet was collected during the Phase 1 project. The archive research conducted in parallel to fieldwork was able to provide context to the finds. This information has been disseminated widely to the diving and non-diving public to increase awareness of the salvage process and promote its historical significance. Phase 1 also identified the work that remains to be done to complete the examination of salvage remains and HES has driven this process towards completion by supporting the Phase 2 investigation. The final product will provide a detailed account of the physical remains at each salvage site in Scapa Flow. This will help to promote the salvage sites and their value not only as a diving resource, but also as another significant part of Scapa Flow's maritime heritage. Detailed survey information can also be used to better protect the salvage sites and some level of additional protection may indirectly be afforded to the remaining seven wrecks of the German High Seas Fleet, as the centenary year of their sinking approaches.

2 AIMS & OBJECTIVES

The broad aims of this project were outlined in the Phase 1 report and apply equally in Phase 2. They are:

1. to create a baseline database of the scrap sites of the High Seas Fleet in Scapa Flow, Orkney;
2. to establish the extent of the remains of the individual salvage sites in Scapa Flow, Orkney;
3. to locate, record and assess the condition of all salvage sites relating to the German High Seas Fleet;
4. provide information to aid HES in monitoring wartime heritage assets; and
5. ensure that the information collected is disseminated widely and made available for public study, appreciation and enjoyment.

The Phase 2 objectives were to complete the process by examining the salvage records and sites associated with the following vessels:

- SMS *Moltke*;
- SMS *Prinzregent Luitpold*;
- SMS *Derfflinger*;
- SMS *Friedrich der Grosse*;
- SMS *Kaiserin*;
- SMS *Kaiser*;
- SMS *König Albert*;
- SMS *Grosser Kurfürst*; and
- Miscellaneous contacts, including SMS *Bremse*, SMS *S36*, SMS *B109* and SMS *V78*.

The product of this process taken alongside the results of Phase 1 will be a detailed account of salvage remains at the main salvage sites in Scapa Flow, which will be completed in the period leading up to the centenary of the scuttling in 2019.

These aims and objectives fit within a wider strategy to promote and protect Scottish underwater wartime heritage, and dovetailing into *Scotland's Archaeology Strategy*, as detailed in the project's funding application to HES.

3 METHODS

The methodology used in Phase 2 comprised elements of archive research, field-based survey work (geophysics and ground-truthing), data analysis and presentation. The field-based survey work predominantly comprised ground-truthing the sites identified from the sonar surveys carried out in Phase 1. However, some additional side scan surveys were undertaken at specific sites to better inform the ground-truthing process.

3.1 Archive research

A number of sources were identified to collect historical data on the salvage operations of the scuttled High Seas Fleet, Scapa Flow, Orkney. This research informed on the vessels interned in Scapa Flow and the subsequent salvage operations along with the submerged cultural heritage assets that remain on the seabed today. These sources were as follows:

- Cox, E. F., 1932, *Eight years of salvage at Scapa Flow*, Proceedings Fifth Thomas Gray lecture, The Institute of Mechanical Engineers
- McKenzie, T., 1949, *Marine Salvage in Peace and War*, The Institute of Engineers and Shipbuilders in Scotland, Vol 93, Paper 1122
- Metal Industries Ltd Salvage Logbooks, D1/59 Orkney Library Archives
- Metal Industries Ltd records, D1/59 Orkney Library Archives
- The Orcadian, Orkney Library Archives
- United Kingdom Hydrographic Office (UKHO)
- Newspaper articles, sourced from www.britishnewspaperarchives.com.

A volunteer element to archive research was built into the project by holding regular archive sessions at the Orkney Library's Archive Rooms. Led by K. Heath (SULA), this directed volunteer researchers through the analysis of historical documents to extract data relevant to the project.

3.2 Side Scan Sonar

Although largely completed in Phase 1, a limited number of side scan sonar surveys were made during Phase 2 to help guide the ground-truthing process. As in Phase 1, the side scan sonar surveys were completed using a standard C-MAX Sonar CM2 Digital Towfish with depth sensor. A high frequency setting of 780kHz with a varied range setting 12.5m (25.4 pings per second); 25m (25.4 pings per second); 37.5m (17.8 pings per second); 50m (13.8 pings per second) was used. A medium frequency setting of 325kHz, with a varied range set of 50m (9.1 pings per second) and 75m (7 pings per second) was also used. The survey lines were conducted so that

each run overlapped with the water column of the previous run, to ensure complete coverage of the search area.

Spatial data was collected using an Evermore SA380 Marine GPS, attached to the portside of the survey vessel. A counter-pulley secured to a davit at the stern of the vessel calculated the layback of the towfish. The distance between the GPS and the counter pulley was used during post processing to determine the location of the towfish (and thus the site) relative to the boat. This had an accuracy of +/- 3m.

3.2.1 Side scan sonar processing

Side scan sonar data was post-processed using SonarWiz 7 following guidance in *Marine Geophysics Data Acquisition, Processing and Interpretation: Guidance Notes* (Plets, et al., 2013). SonarWiz 7 software allows other data such as basemaps in ESRI shapefile format to be viewed alongside the side scan sonar data. Additionally, it can be used to produce a mosaic of several survey transects achieving the best possible images of the sites. The data was processed with slant range correction (where the water column is removed during processing) to produce continual imaging of the seafloor.

The main criteria used to characterise an anomaly as representative of High Seas Fleet salvage remains were:

- locational: for example, if they were within the vicinity of primary and secondary salvage site areas;
- the nature of remains on the seabed: readily identifiable anthropogenic remains such as known wreck sites or boom buoys (rectangular boxes) were not taken into consideration during this project, except when located near a primary or secondary site; and
- anomalies located outwith the known salvage areas of a vessel (for example, parts of their superstructure were lost or dropped whilst being towed to secondary sites or Lyness) were ascertained as High Seas Fleet remains due to the high-resolution side scan data collected, aiding identification of the contact.

Images and position data were generated in contact reports for each anomaly and all identified contacts are provided in Appendix 1.

3.3 Ground-truthing

Side scan sonar data from Phase 1 provided location data and site imagery to guide the ground-truthing process. SCUBA diving (self-contained underwater breathing apparatus) was the optimum method for collecting high quality video and photography and was used to survey sites lying in up to 40m water depth. However, sites lying in excess of 40m depth precluded the use of SCUBA, due to limited bottom time and the increased safety risk of working at that depth. Consequently, a remote video system was used to survey those deeper sites. A detailed method statement and risk assessment for diving and remote video survey operations was carried out for the project (SULA ref 18-366). On each day of fieldwork the hazards, risks and risk controls were discussed and all members of the dive/survey team signed off a toolbox talk sheet.

3.3.1 Diving

SCUBA diving was the chosen method for diving operations and was conducted according to the *Scientific and Archaeological Diving Projects Approved Code of Practice (ACoP)*. This involved the use of a four-person dive team comprising a Diving Supervisor, a team of two divers and another diver acting as a surface assistant. Dives were carried out either by a buddy team of two divers, or by a single diver with a surface standby diver. Sites were marked by deploying a weighted and buoyed line at each site, using co-ordinates provided from the side scan sonar surveys.

Divers inspected each site and attempted to locate the objects evident from the sonar images. Video footage and photographs were taken of the key features at each site using a Nikon D7500 and/or GoPro Hero 4 or 6. This was subsequently reviewed by K. Heath (SULA Diving). Following experience gaining during Phase 1, the dive surveys were conducted in a two-stage process. For each site an initial series of dives were carry out in order to broadly survey the area. Video and photography were analysed and a series of specific objectives was compiled for a second survey of the site on a later date. This method aimed to minimise the number of unanswered questions that might remain after just visiting a site once.

3.3.2 Remote video

A Spyball remote video system (Submertec, 540TVL, min. illumination 0.02Lux) was used at the deeper sites (>40m) to assess the visible remains. A secondary video system (GoPro Hero 4/6) was also attached to the Spyball to gather still images or additional higher quality video. Remote videos were carried out during calm weather conditions to allow for maximum control over the direction of the video survey. Throughout the surveys, care was taken to avoid disturbing the sites. Spatial data was collected using an Evermore SA380 Marine GPS, providing accuracy of +/- 3m.

3.3.3 Shiptime project data

The Scapa Flow Ship Time Project (Henry & Heath, 2017), hereafter referred to as the Shiptime Project, was a multi-agency project as outlined in Section 1.2 above. Sonar data was made available from Phase 1 of the Salvage Site project and this was used to guide Shiptime Project ROV surveys of several salvage sites where video footage of remaining artefacts was recorded. This footage was then made available to Phase 2 of the Salvage Site project that allowed an element of ground-truthing that was particularly useful for the deeper sites where diving was not planned or unsafe. It also allowed for the more effective use of diving effort at the shallower sites, as ROV footage was sufficient ground-truthing on its own in some cases.

3.4 Geographical Information Systems (GIS)

A Marine Environmental Data and Information Network (MEDIN)-compliant ArcGIS Project was created using a WGS1984 geodetic datum projected to UTM Zone 30N. The acquired data and fieldwork results were entered into ArcGIS. ESRI's ArcGIS software was chosen as the most suitable program for use on this project due to its advanced tools, database connections and graphical output capabilities. A shapefile was created within an ArcGIS *.mxd project, ensuring

compatibility with the Canmore database and HES data management systems. Each asset in the GIS and the database has been assigned a Unique ID number allowing easy spatial querying of the GIS, enabling the auditing and assessment of the sites and anomalies.

Images, including side scan mosaics generated in both Phase 1 and 2, have been geo-rectified into the GIS where necessary and worldfiles created for appropriate image files such as TIFFs and JPEGs. Relevant datasets have been imported into this database, and have been linked to the mapped shapefiles of records within the GIS. These have been modelled closely on existing National Record of the Historic Environment (NRHE) and Orkney Sites and Monuments Record (SMR) databases and data fields allowing for easier integration.

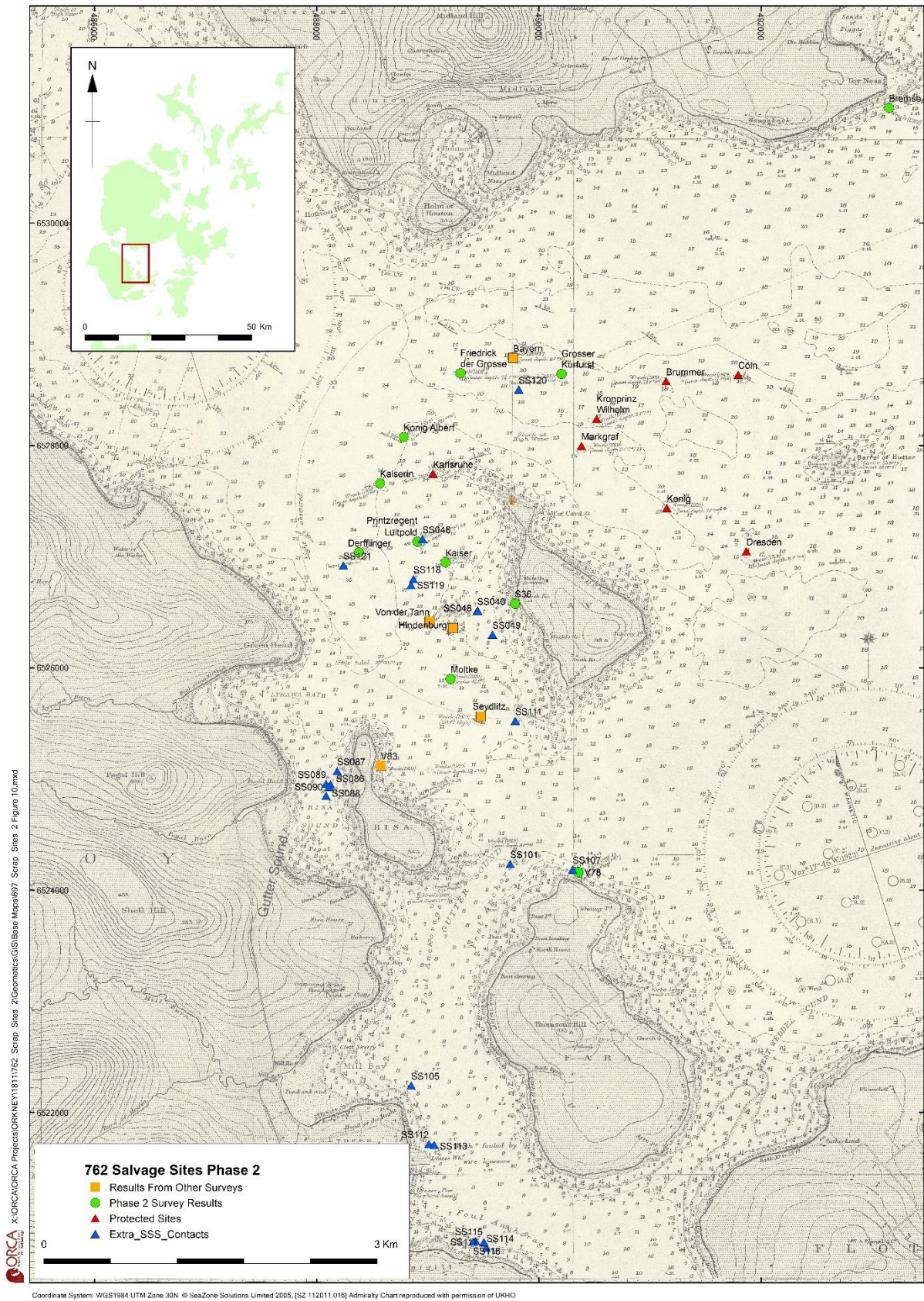


Figure 1: Salvage Sites Phase 2 with the 1923 chart as base map.

4 RESULTS & INTERPRETATION

The results are presented in relation to each vessel of the German High Seas Fleet examined in Phase 2 of this project, in order of their salvage (see Appendix 2). These include information on the scuttling and salvage of each vessel generated from archive research, site survey information gathered during the ground-truthing phase and a discussion of how the survey findings relate to archive research. Side scan sonar images generated during Phase 1 are also included in this section as they effectively illustrate the layout of each site. The results for a number of other miscellaneous contacts thought to be linked to the salvage process are also included for completeness.

4.1 SMS *Moltke*

4.1.1 *Salvage background*

During internment, SMS *Moltke* (Plate 4) was anchored to the west of the island of Cava, with SMS *Hindenburg* to the north and SMS *Seydlitz* to the south⁴. As it sank the *Moltke* capsized and settled upside down on the seabed in a depth of approximately 20m. At low water, her hull was exposed and two days after the scuttling on the 23rd June 1919, the whaler *Ramna* ran into the hull and was stranded on the ebbing tide (Plate 5).

The salvage of SMS *Moltke* was conducted by Messrs Cox and Danks in June 1927 with preparations to raise the vessel beginning in October 1926. An initial diver survey found the

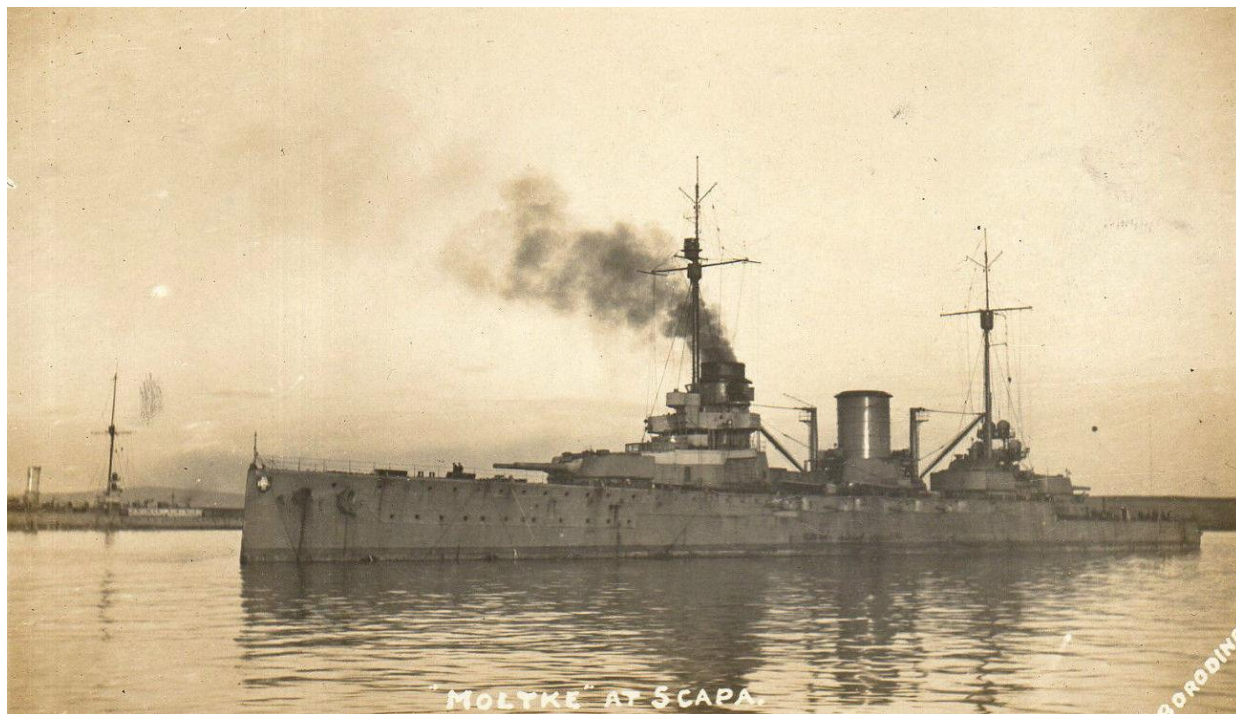


Plate 4: SMS *Moltke* at Scapa Flow (B. Forbes Collection).

⁴ One sailor, a died while the SMS *Moltke* was in Scapa Flow. Stoker Johannes Thill on the 2nd of December 1918. He is buried in the Royal Navy Cemetery at Lyness on Hoy. Grave number O 197.



Plate 5: Whaler on hull of SMS Moltke (H. Hadley Collection).



Plate 6: SMS Moltke with SMS Seydlitz behind. (Left). Flag raised on SMS Moltke (Right). (B Forbes collection).



Plate 7: Cutting up one of SMS Moltke's 12-inch guns at Lyness from one of the two turrets left behind in Orkney (B Forbes Collection).

vessel lying in 72 feet of water and resting on her gun turrets. The super-structure had been largely crushed by the weight of the vessel⁵. Over the next few months, holes were plugged with concrete before attempts were made to raise the vessel by pumping the hull full of air. Initial attempts to float her were unsuccessful, one problem being that the list in the hull would increase as it filled with air. To rectify this the hull of a German destroyer (the *G38*) was placed on the high side of the hull and filled with water to weigh it down. This succeeded in preventing the list and the vessel was raised successfully by the 8th June (Plate 6). One of the four 10-tonne propellers was missing. Accounts vary as to what happened to it. One source suggests it had broken off when the vessel sank and had been recovered (The Courier and Advertiser, June 20th 1927). Another account states that it had been cut off and removed during the winter of 1926/27 to help correct the list that was hindering the re-floating (George, 1973).

After she was re-floated, several attempts were made to move the *Moltke* eastwards towards Cava using tugs and winches⁶. Each attempt succeeded in moving the hull a short distance before elements of the superstructure would dig into the seabed and prevent further progress. Divers were able to clear an offending “bollard” on one such occasion and noted that the two large guns had dropped onto the seabed after their mountings had been crushed. After further progress towards shore, divers reported that the remaining superstructure had been crushed through contact with the seabed and was now hindering further movement (The Orcadian, 16th June 1927). After a final attempt to move the hull on the high tide it stuck again, “no more than a ship’s length off the beach”. It was found that her bridge had dropped and also one gun in the forward turret had dropped to what would have been its full elevation (if not upside down) and was digging in to the seabed. Her aft mast was still in place but “crumpled up”, while the foremast had been blasted off previously (The Courier and Advertiser, June 20th 1927).

At this location over the next few weeks, hundreds of tons of the outer casing, the remaining three propellers and other easily available metal had been salvaged. With winter approaching, it was decided that the hull should be re-floated and moved to a more sheltered location at Lyness, about three miles away. This occurred in late August and appeared to be a relatively straightforward process until the tow was halted 400 yards from the pier at Lyness as some of the remaining superstructure prevented further movement (Aberdeen Press and Journal September 1st 1927). These obstructions were cleared and the hull was brought into Lyness pier. On May 18th 1928, the SMS *Moltke* left Lyness under tow from three powerful tugs to be taken to Rosyth for breaking up⁷ (The Courier and Advertiser May 21st 1928).

⁵ A newspaper report from “The Scotsman” on 7th October 1926 states ‘one of the divers had a curious find last week when diving alongside the *Moltke*. He found on the bottom one of the battleship’s boats still attached to her by a rope. This boat had evidently been abandoned in the excitement at the time of the scuttling of the fleet. On being released the boat was hauled to the surface, and when bailed out she floated lightly. She is intact, except for the ravages of sea worms on all the elm work, but her oak planking is in perfect condition after being submerged for over seven years.’

⁶ Hawsers were run to the east and attached to large anchors. Winches on the upturned hull of the *Moltke* pulled against the anchors in the effort to move it shoreward (The Orcadian, 16th June 1927).

⁷ A report from a correspondent of the Scotsman newspaper took a tour of SMS *Moltke* once dry in the drydock at Rosyth. Walking under the vessel, he noted seeing six of the ten main armaments. The vessel was chocked with blocks of wood on the aft turret but describes the super turret behind as “broken off”, also, one of the wing turrets was missing (The Scotsman, Wednesday 06 June 1928). These may have been removed at Lyness to facilitate SMS

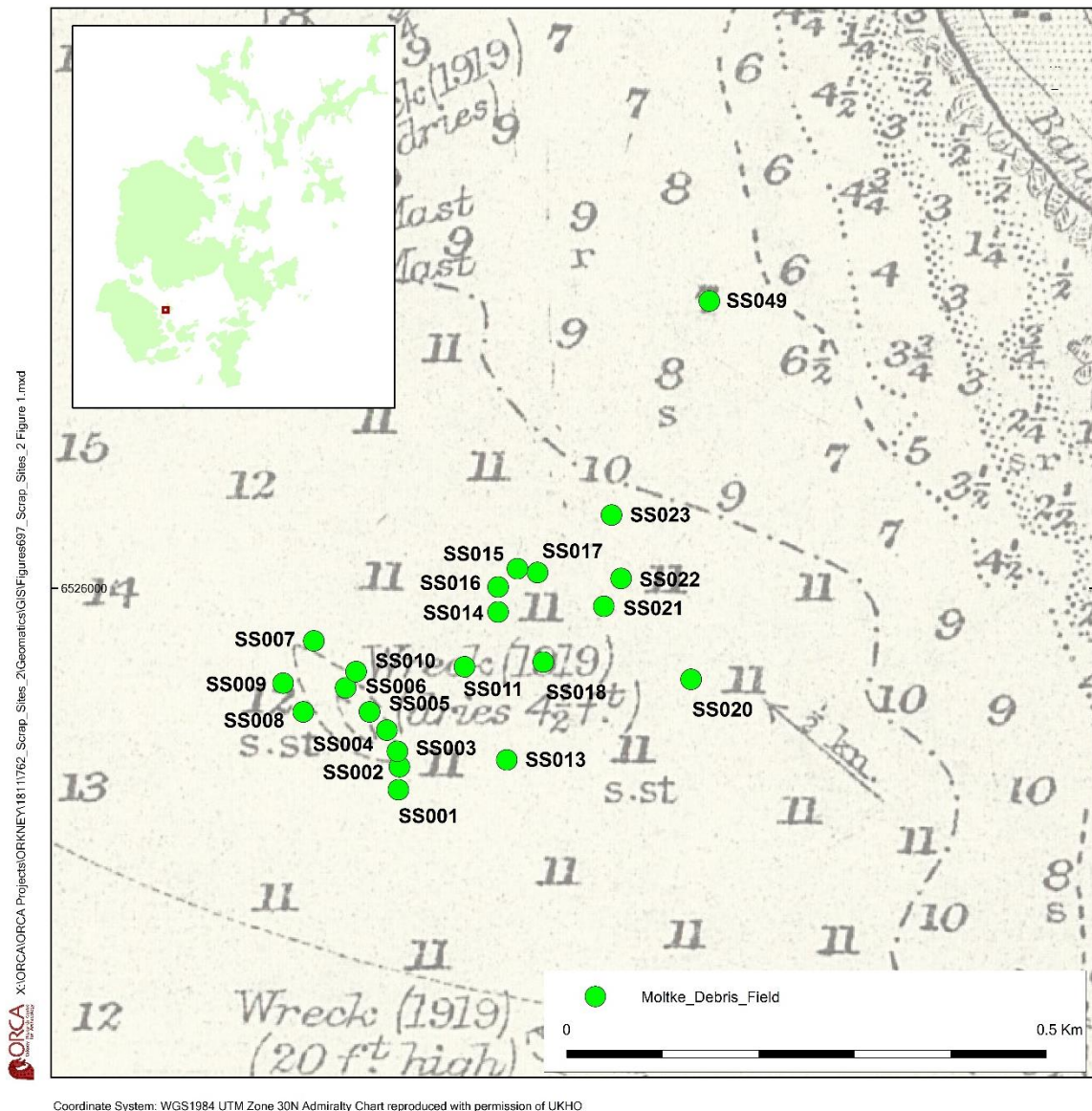


Figure 2: Side scan coverage of the SMS Moltke with the 1923 chart as base map showing multiple sonar contacts.

4.1.1 Ground-truthing

The side scan survey of the SMS *Moltke* site was carried out during Phase 1 and is shown below in Figure 2. As this proved to be such a large site, only the location of each contact is shown on the admiralty chart of the time. There were multiple sonar contacts in the area that could be divided into two broad groups, one corresponding to the primary salvage area and another group to the north-east. All of these contacts were relatively small and there were no obvious structures such as masts, which were seen at other sites. In addition, the sonar survey showed that there was no seabed depression at the *Moltke* site. This is probably due to the relatively hard nature of the seabed in this area. It was assumed that all debris in this area belong to SMS

Moltke fitting into the dry dock as this happened later with SMS *Kaiser* and other vessels, or may have been the “couple of large guns” that fell out when *Moltke* was raised in June 1927 as the mountings had been crushed by the weight of the vessel.

Moltke as no archive evidence of either primary or secondary salvage of other ships was found for that area. The Shiptime Project gathered ROV video footage on the original *Moltke* scuttling site in 29th July 2017 and this was reviewed initially to examine side scan targets SS001-SS010. These included a diesel engine from a pinnacle (SS001), a lattice type crane or boom (SS002), a gangway (SS003) and a spotting top with short mast section (SS010). It also recorded several other miscellaneous items including what appeared to be sections of armour plate which had not been detected during Phase 1.

Additional remote video surveys were carried out during Phase 2 on the 8th June 2018 to examine sonar targets to the north-east. These surveys found a second lattice crane/boom (SS021), miscellaneous wreckage and several small Danforth-type anchors which appeared to be between 1.5 and 2m in length. Sonar contact SS014 proved to be a samson post from a *Moltke*-class vessel (Plate 15). There was clear evidence of blasting on the lower end of the post.

Diving surveys of the *Moltke* sites were made on several occasions between 16th July and 3rd October 2018. The lattice type crane/boom was distinctive in shape and construction, being approximately 7m long and made of a steel lattice framework with diagonal cross members (Plate 8). The crane came to a point at one end with a single pulley wheel. Examination of the plans for SMS *Moltke* revealed a close match to the torpedo masts, of which the *Moltke* had two, that were used to lower torpedoes into the torpedo rooms below deck. An image of this operation is shown in Plate 9, where the distinctive loading mast is clearly visible. The gangway (SS003) identified in the Shiptime Project was also dived. It was of a timber construction with brass & steel fittings, which included the stanchion sockets that were used to confirm its identity. Images of the gangway remains (Plate 10) and an archive photograph of a similar gangway, possibly the same one, are shown below (Plate 11). The foremast (SS010) comprised a relatively short section of mast with a partially degraded upper spotting top (Figure 4, Plate 12 & Plate 13). Electrical wiring was present inside that probably supplied lights and communications to the spotting top. The lower crow's nest was fully degraded.

The Shiptime Project also recorded a number of other objects on the *Moltke* site that were too small to be distinguishable in sonar data collected during Phase 1. These included several pieces of armour plate that were investigated during the diving surveys. The largest section had a distinctive curved shape with a small aperture in one corner (Plate 16). It measured 2.9m x 2.2m with a thickness of 0.23m (exactly 9"). A review of historic photographs of the *Moltke* and its armour specification strongly suggest this is a section of the forward right armour on one of its main turrets (see Plate 17). Smaller pieces of plate lying nearby may also be turret armour, one of which (1.0m x 0.9m and 50mm thick) was shaped and possibly part of the shielding fitted around the gun barrel. Although no images could be found that show this armoured piece *in situ* on the *Moltke*, similar pieces were fitted to other battleships (Plate 18). Given that these sections of armour plate were found in the centre of the primary scuttling site, it is most likely that they originate from one of the two gun turrets that divers noted had been crushed and were left behind on the seabed after it was raised. They would almost certainly have been salvaged afterwards, but not completely, as these artefacts indicate.

There were numerous small items of wreckage in the vicinity of the armoured plate. These included coal winches, searchlight fragments (including a section of the brass iris) and heavy circular items, which appeared to be some type of lid or hatch (Plate 19). These were 630mm in diameter, approximately 100mm thick and comprised a heavy brass ring with a timber insert (these types of items were found at the salvage sites of several vessels in the course of Phase 2). The lid at the *Moltke* site was lying on its edge and partially buried. Given the relative hardness of the seabed in this location, it must have arrived in its present position with some force, perhaps dropping from height. After further reference to archive photographs of the *Moltke* and other ships in the fleet, it was determined that these lids were coal hatches, located in the deck and removed when coal was being loaded. Plate 20 shows an archive image of SMS *Von der Tann* where coal has been deposited on deck. Three round hatches can be seen which presumably have been removed from the deck in order to push the coal into the bunkers below. The brass ring around the lid would reduce the risk of sparks that could ignite coal dust occurring during its removal/fitting.

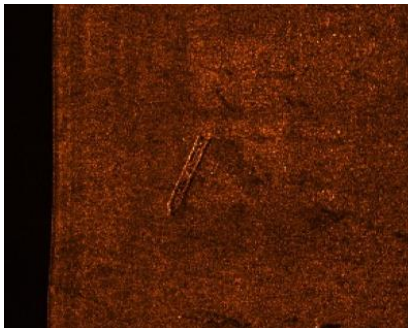
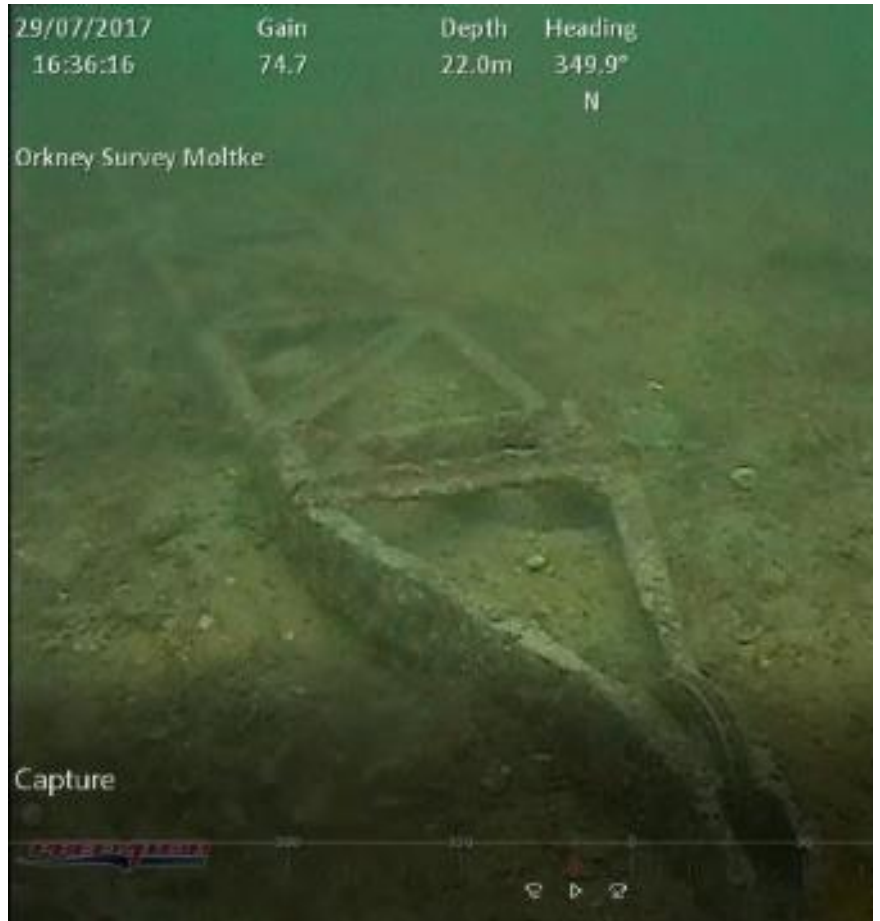
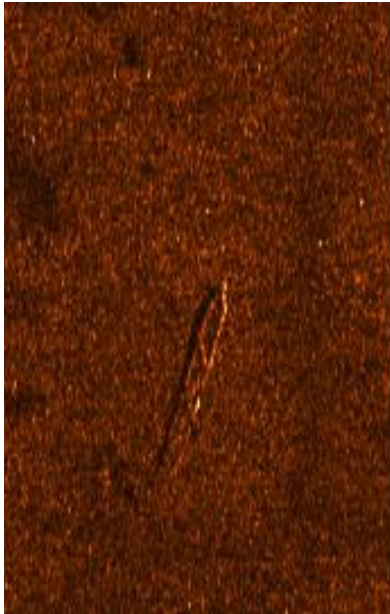


Plate 8: Sonar images of Moltke contacts SS002 (top left) and SS021 (bottom left) with corresponding ground-truthing images at right.

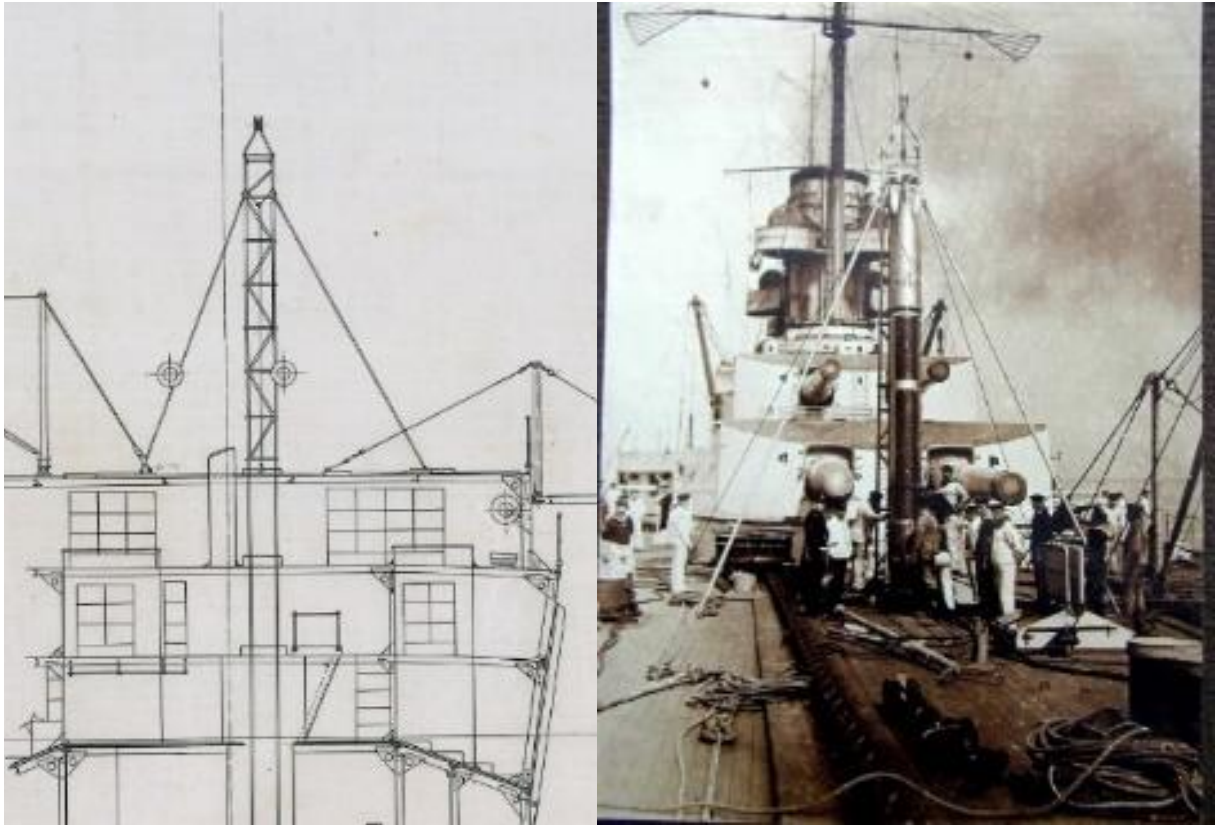


Plate 9: Schematic of the torpedo loading crane on SMS Friedrich der Grosse (left) and an image of a loading crane in operation (right) (G. Staff Collection).

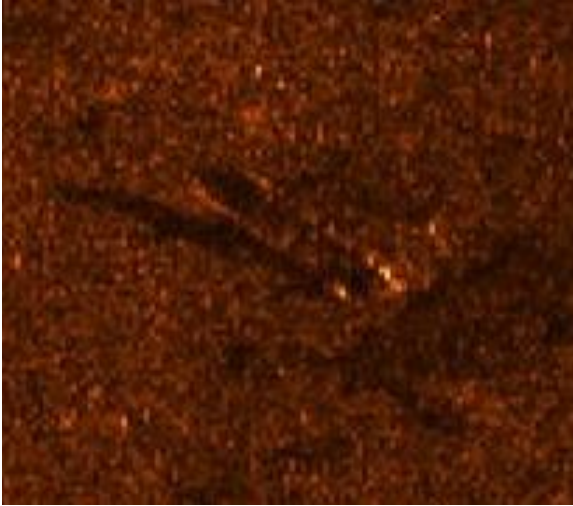


Figure 3: Side scan image SS003.



Plate 10: Diver photographs of SS003 showing timber members and steel end fittings (left) and brass sockets (right) from SMS Moltke gangway.



Plate 11: Archive images of a gangway in use on SMS Moltke (G. Staff Collection). Note The brass fittings at the top of each side member of the gangway (circled, left) and the brass sockets support for hand rail stanchion (right).

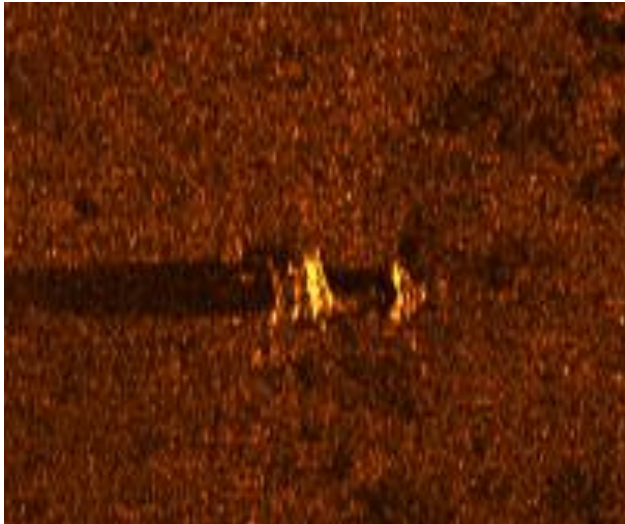


Figure 4: Scan image of spotting top (SS010).



Plate 12: Images from the Shiptime Project ROV footage showing the remains of the spotting top (left) and of the mast support below where the crow's nest would have been located (right).

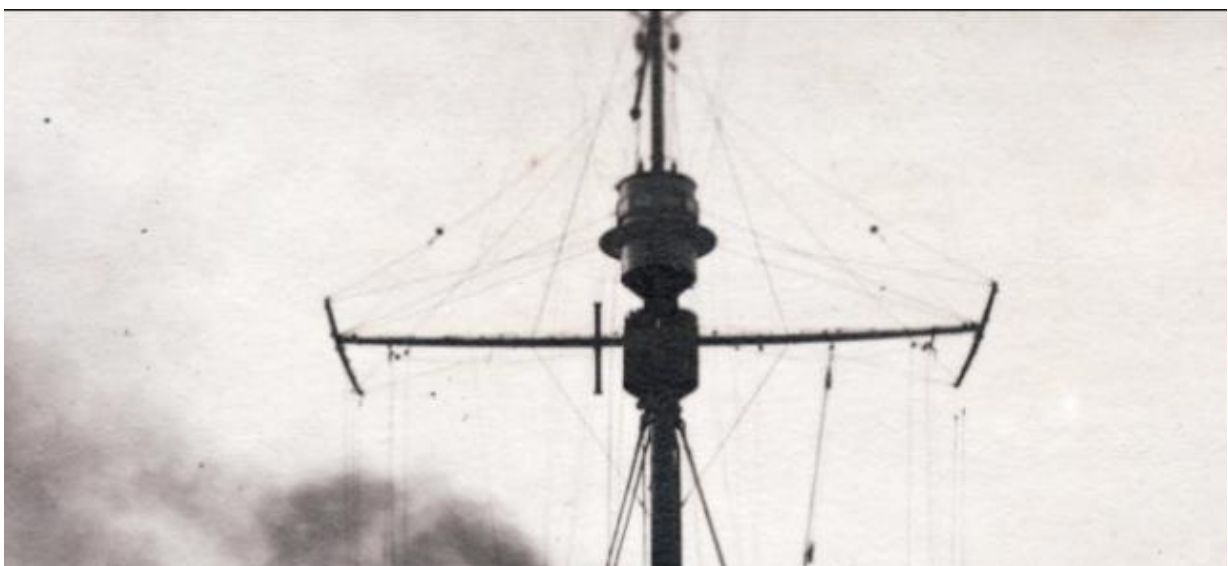


Plate 13: SMS Moltke forward mast spotting top and crow's nest (G. Staff Collection).

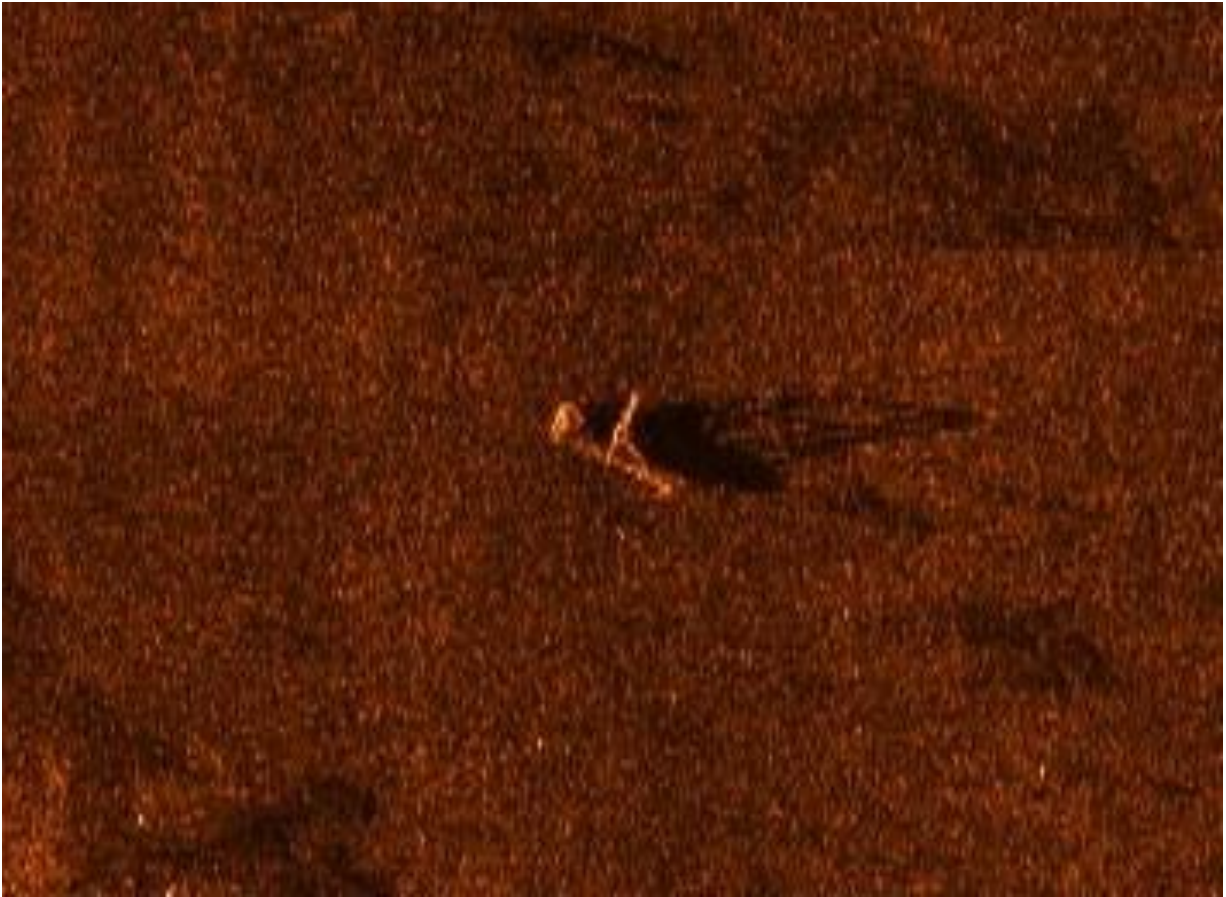


Figure 5: Side scan of SS014.



Plate 14: Remote video image of SS014.



Plate 15: SMS Moltke samson post top. (G. Staff Collection).

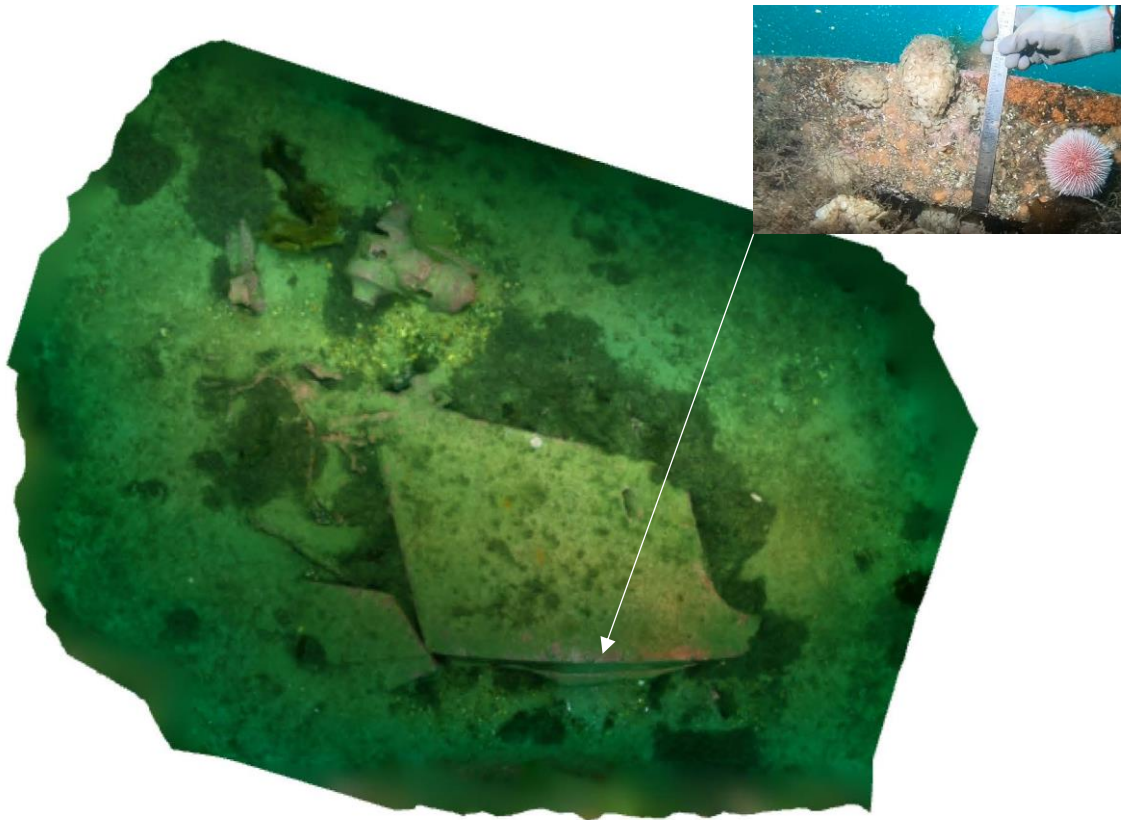


Plate 16: Mosaic image showing the section of armour plate, measured 2.9m x 2.2m and was 9" thick (inset) found on the site of SMS Moltke. The shape of the artefact matches that of the side armour plating on the gun turrets as shown below.

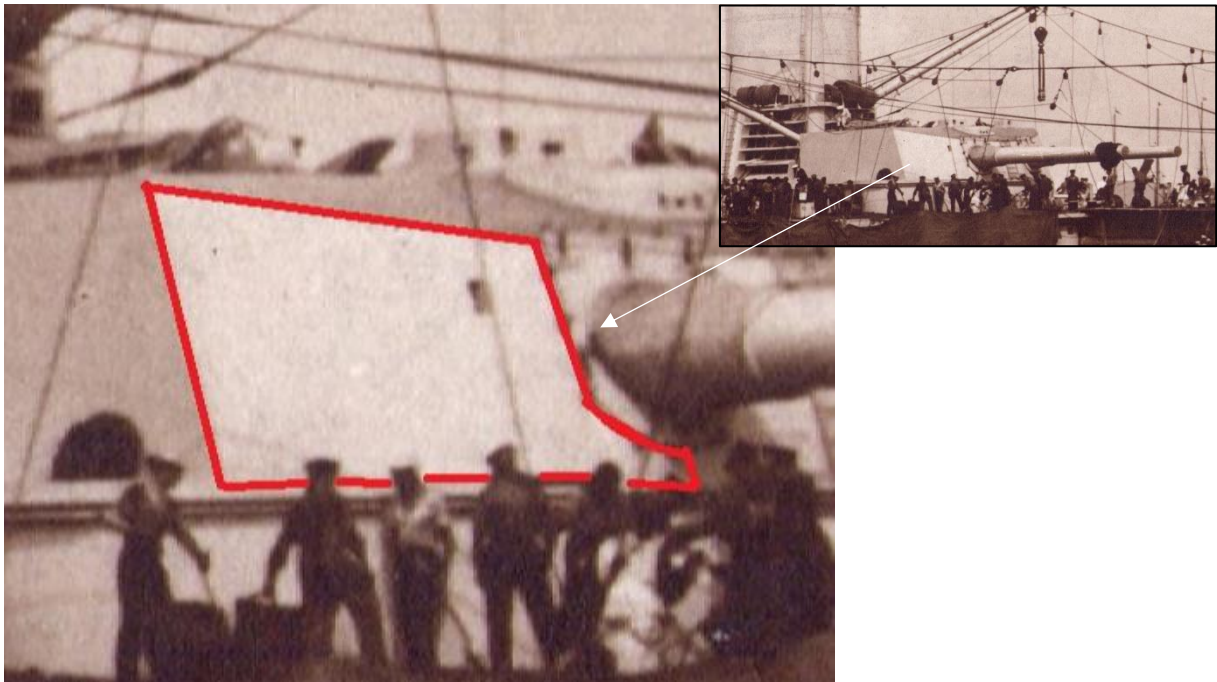


Plate 17: Wing gun turret on SMS Moltke, showing armour plate detail (K. Heath Collection). The highlighted section matches the shape of the armour plate found on the site of SMS Moltke. As well as the shape, note the small aperture at the top right of the plate.

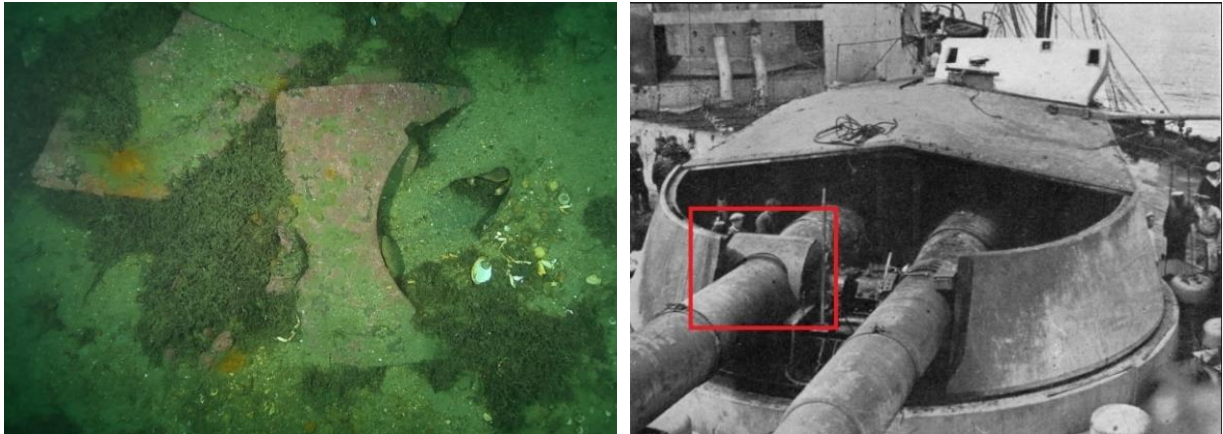


Plate 18: Additional sections of armour plate (left) lying close to the piece of turret armour, with an example shown from HMS Lion (right). These items may also have originated from the turret area, being similar in shape to small armour sections installed around the gun barrels.



Plate 19: Circular artefact found at SMS Moltke site, lodged firmly in the seabed (left). The one shown on the right was recorded on the site of SMS Prinzregent Luitpold. Circular artefacts, thought to be deck coal hatches, were found at several locations. They were constructed from a brass ring with a timber insert.



Plate 20: Archive image of coal loading on the SMS Von der Tann (G. Staff Collection). Note the three circular deck hatches (arrows) that would be lifted to allow coal to drop into the bunkers.

4.2 SMS *Kaiser*

4.2.1 *Salvage background*

During internment, SMS *Kaiser* was anchored to the west of the island of Cava, just to the south-east of SMS *Prinzregent Luitpold*⁸. The *Kaiser* capsized and settled upside down on the seabed in a depth of approximately 20m.

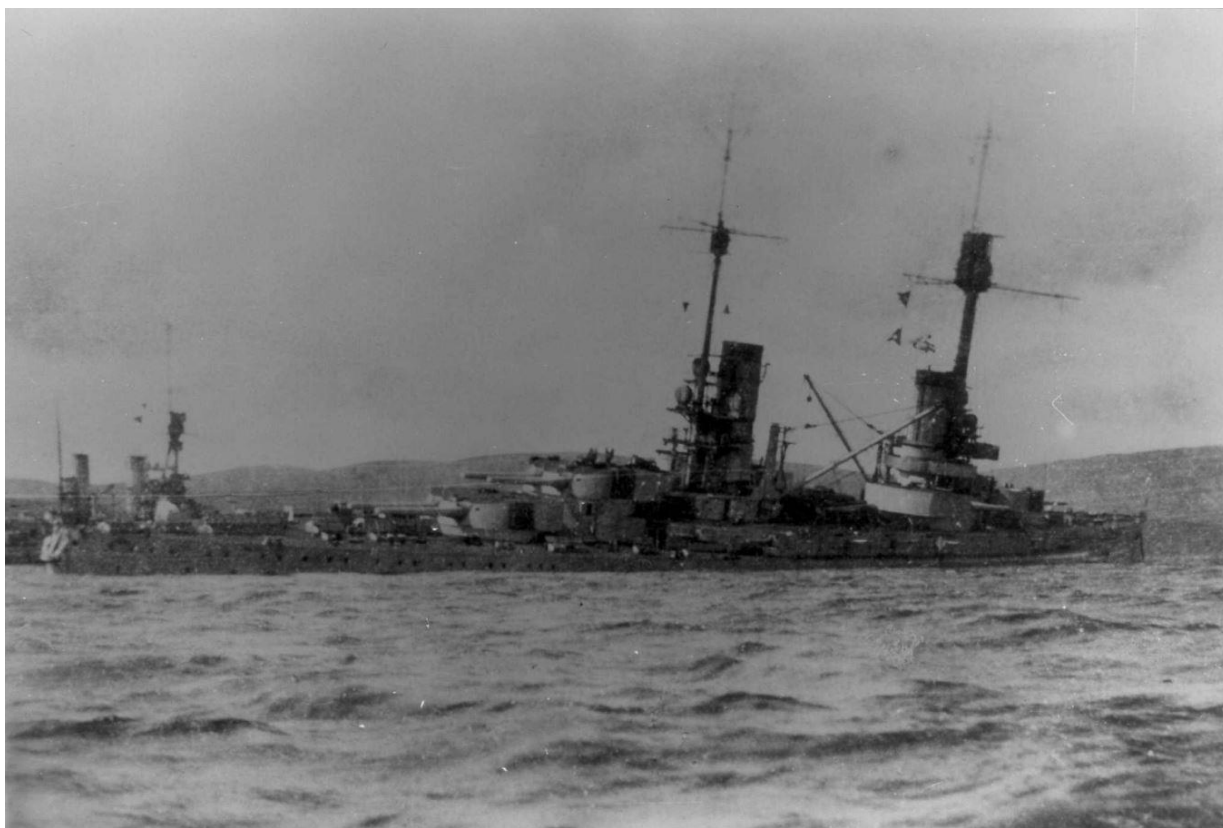


Plate 21: SMS *Kaiser* in Scapa Flow, just starting to sink during the scuttling on 21st June 1919.

SMS *Kaiser* was raised by Messrs Cox and Danks in March 1929 (Plate 22) with preparations beginning in summer 1928. Initial efforts to raise the vessel in February 1929 were unsuccessful, for while the bow rose to the surface the stern remain firmly on the seabed. However, by 21st March 1929 the hull was reported as being well above water with two propellers (one was missing) and the rudders in plain sight (Dundee Courier 22nd March 29th 1929). Divers reported that the mast and funnels had been crushed and what was left of the superstructure was hanging underneath the hull. Anything considered a hindrance to moving the vessel away from the site was blasted off with explosives in an operation which took two days (The Scotsman, 29th March 1929). The *Kaiser* was then towed to the south-east towards Cava and positioned over a sandbar located between the SMS *Hindenburg* (not raised until July

⁸ One sailor died while SMS *Kaiser* was in Scapa Flow. Stoker, Otto Hinte died on the 7th April 1919. He is buried in the Royal Navy Cemetery at Lyness on Hoy. Grave number D 228.

1930) and the shore. Here the vessel was prepared for onward towing to Lyness, a process that was described by Mr Cox:

“Between us and our objective-Lyness pier- is a sandbank on which there is only eight fathoms of water, so our task is to so reduce the Kaiser’s draught as to enable it to pass over that bank.”

The Orcadian, 4th April 1929

By sinking the hull over hard ground in shallow near Cava, the full weight of the vessel crushed any remaining superstructure and succeeded in pushing the conning tower up into the hull. The result was that the vessel came to rest on its fore and aft gun turrets. Once re-floated her draft had been reduced sufficiently and she was towed to Lyness in May 1929. Further materials were removed here⁹. It was known that the draft was still too much to enter the dry docks at Rosyth for breaking, so the salvors determined to remove the gun turrets, each of which weighed over 400 tonnes. The fastening clips on each turret were burned through, allowing them to drop to the seabed after which they were recovered and cut up onshore at Lyness (Plate 22). The hull was moved further into Ore Bay (to the south of Lyness pier) and sank once again on hard ground with the intention of pushing the conning tower further up into the hull in the absence of the gun turrets (Dundee Evening Telegraph, 27th June 1929).

On the 8th July 1929, an attempt was made to tow the *Kaiser* south to Rosyth but the conning tower dropped and caught on the seabed and brought the hull to a standstill. As the tide rose the vessel re-floated and was towed back to Lyness. Once back at Lyness the conning tower was positioned over the top of one of the gun turrets and sank, forcing the tower back into the hull (The Scotsman 15th July 1929). This did not work however, and the conning tower was removed with explosives (which had been initially ruled out), recovered and broken up at Lyness. The *Kaiser* left Lyness on the 20th July 1929 and was towed to Rosyth. (The Scotsman, 22nd July 1929).

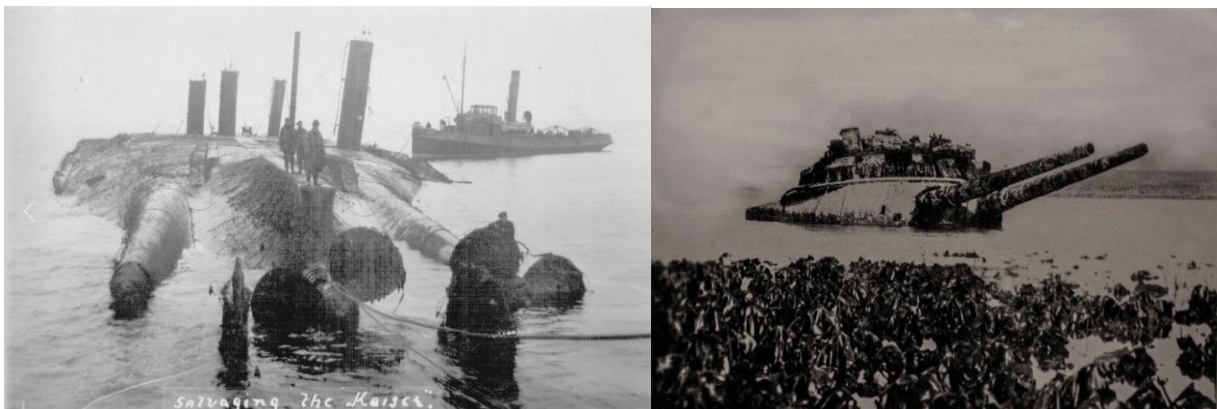


Plate 22: SMS Kaiser, afloat after salvage in March 1929 (left) and one of its gun turrets ashore at Lyness (right) (B. Forbes Collection).

⁹ On the 30th May, a diver named Herbert Sampson Hall (45) of Portsmouth died while working inside the hull at Lyness. (Dundee Courier 30th May 1929).

4.2.2 Ground-truthing

Ground-truthing focussed on the main salvage site located where the *Kaiser* was scuttled and subsequently raised. The side scan image (SS044) of the site collected in Phase 1 showed a number of masts and other wreckage (Figure 6). No evidence of a depression was observed in the sonar data, indicating a relatively hard seabed in this area.

The site was investigated by ROV during the Shiptime Project on 28th July 2017 and by divers on the 16th & 17th July 2018. ROV footage focussed on the largest feature on the site which proved to be the forward mast that included an armoured top compartment, collectively known as a splinter proof spotting top and control tower (Jung & Maass, 1990). A large area of

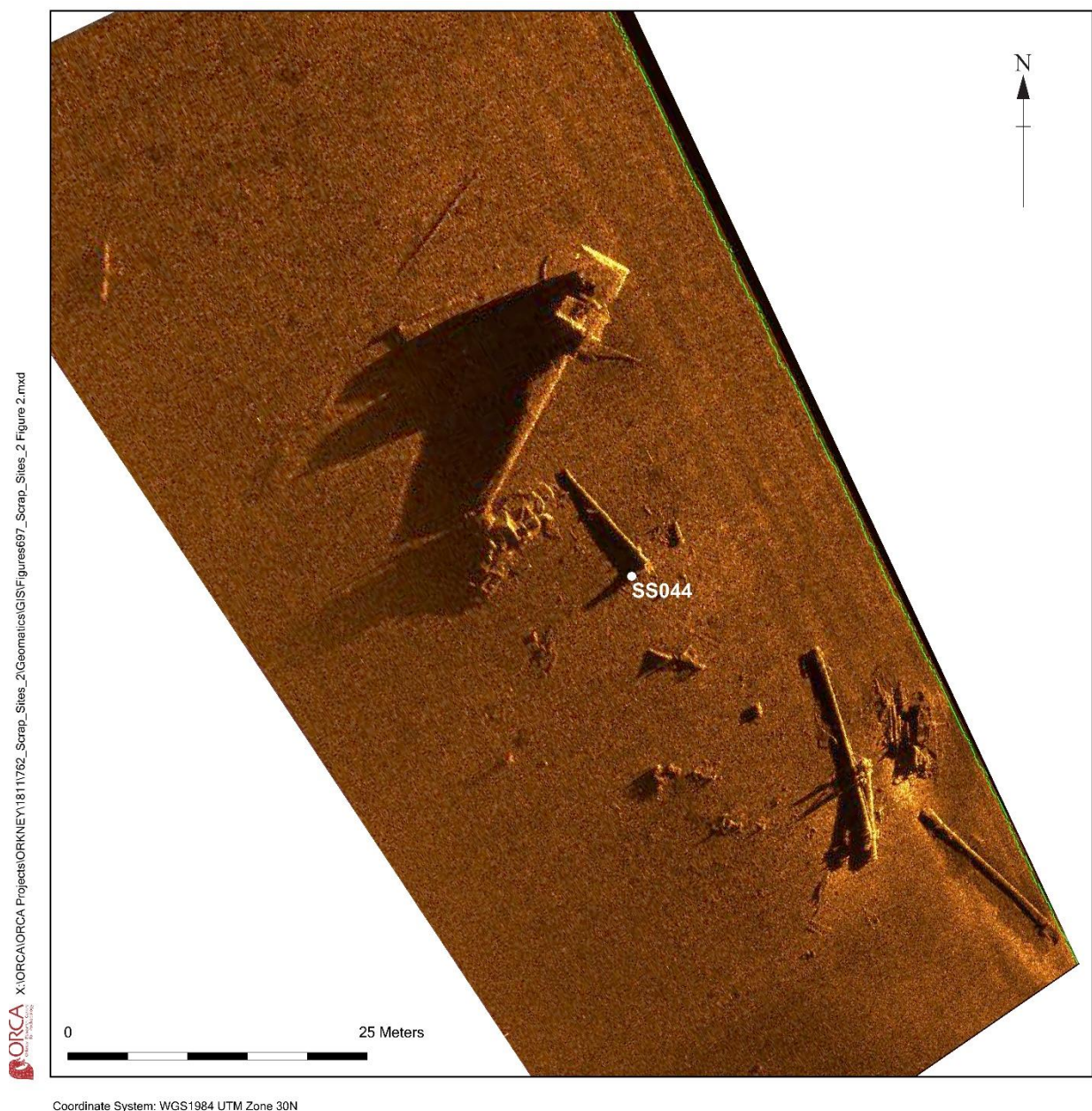


Figure 6: Side scan image of SMS Kaiser primary salvage site (SS044).

wreckage was located at the bottom of the foremast that comprised two searchlight platforms and the upper bridge works, the latter including a large platform and room. The ROV also located a rangefinder (Plate 23) and what appeared to be boiler wreckage to the north-west of the spotting top.

Dive surveys succeeded in mapping out almost the entire site and collected more detailed images of the forward mast and spotting top (Plate 24) and associated bridge and wreckage (Plate 25). The following additional items were observed (in the order of heading south-east from the foremast):

- A section of samson post boom, including the end pulleys;
- A complete samson post and boom, corresponding to the type on Kaiser-class vessels; and
- Aft mast with searchlight platforms, with searchlight debris including mounts and brass iris segments. Aft crow's nest severely degraded.

A number of other items were also recorded scattered around the area between the fore and aft masts. As well as uncharacterised wreckage, there were a number of coal winches including a group of three lying together, coal hatches and supports, most likely boat cradles (Plate 26). A gas cylinder was also recorded here, origins unknown.

A volunteer dive survey carried out on the 26th November 2018 investigated two additional sonar contacts lying to the south-east of the *Kaiser's* primary salvage site. SS129 proved to be the remains of a searchlight along with what appeared to be a large fairlead and probably originated from the *Kaiser*. SS124 was an anchor of Danforth-type anchor approximately 2m in length and is not thought to be linked to the *Kaiser*. However, the isolated remains of a gyrocompass were found to the north-east of the anchor in a location close to the route taken by the *Kaiser* when it was towed into Cava (Plate 27). The exact location of the gyrocompass remains was not recorded at the time of discovery.

The ground-truthing results broadly reflected the archive statements that anything which might have hindered the towing of the upturned vessel was removed at the primary salvage site, *i.e.* the forward and aft masts, bridge, searchlight platforms, samson posts and booms. The only large item not seen at the primary site was a second samson post. It is unlikely to be buried at the site (as stated earlier the seabed is relatively hard in this area) but could be obscured by other wreckage. It is also possible that the samson post was dragged away from the primary site and left elsewhere during the secondary salvage process or actually recovered by the salvors. An isolated samson post was located in Gutter Sound (see section 4.13.2) but this included a boom so cannot be from SMS *Kaiser* as both booms were accounted for at the primary site.

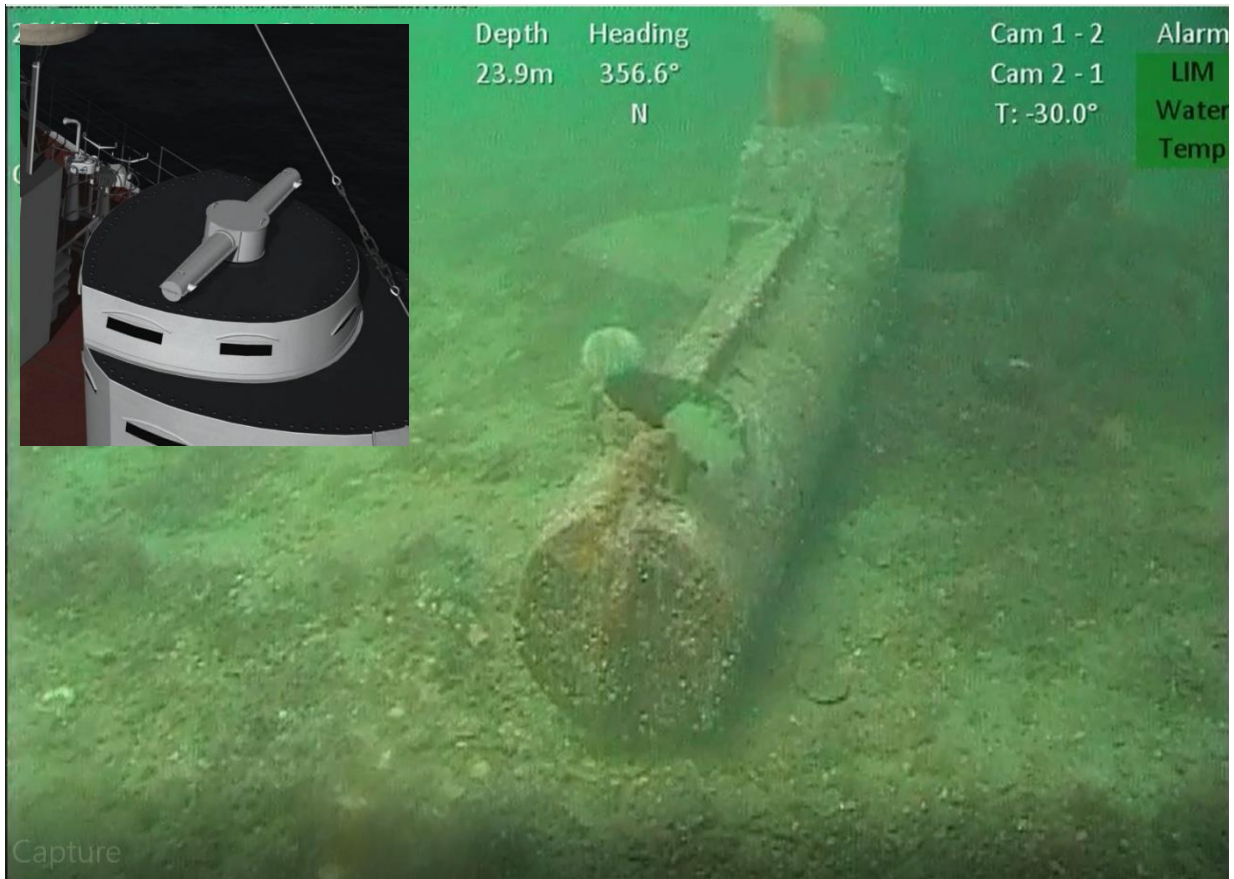


Plate 23: Left, rangefinder located just off the primary salvage site of SMS Kaiser (Shiptime Project), with animated reconstruction of rangefinder (inset, image courtesy of M. Samuel).



Plate 24: SMS Kaiser forward mast showing splinter proof control room (top) and underside of spotting top (bottom).



Plate 25: SMS Kaiser wreckage at base of forward mast comprising searchlight platforms (top) and bridge structure (bottom).

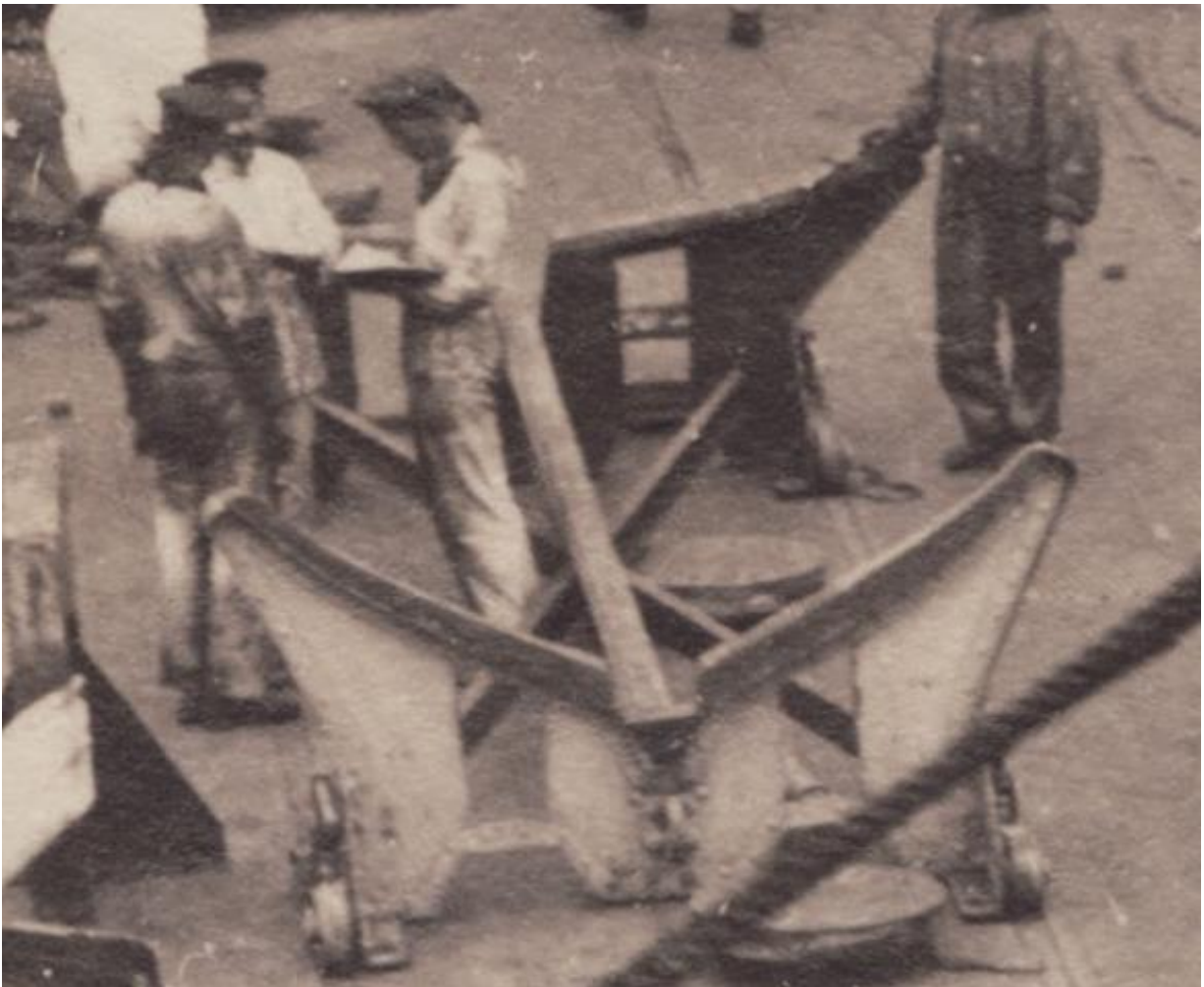


Plate 26: Boat supports found on the Kaiser primary salvage site (left) alongside an archive image (G. Staff Collection) of boat supports on the deck of a German battleship (right).



Plate 27: Gyrocompass remains found on the seabed to the south-east of SMS Kaiser's primary salvage site.

4.3 SMS *Prinzregent Luitpold*

4.3.1 *Salvage background*

SMS *Prinzregent Luitpold* was anchored to the west of Cava just the north-west of SMS *Kaiser*¹⁰ (Plate 28). She capsized and sank, coming to rest on the seabed in a depth of approximately 32m. In contrast to most of the other vessels that sank with their bows to the north-west, *Prinzregent Luitpold* sank with her bow pointing east, for reasons unknown.

The hull was raised by Messrs Cox and Danks in July 1931. Preparatory work began in February 1931 with divers inspecting the upturned hull to select positions for the air locks that had previously been used to raise SMS *Von der Tann* (raised in December 1930). Work to plug holes progressed smoothly although not without incident¹¹. In June 1931 she was partially raised but with a list and her stern remained on the seabed. The hull was allowed to sink again before another attempt was made later in June in which the stern was raised to the surface but air leakages, including through open portholes, caused the hull to sink once more. After further

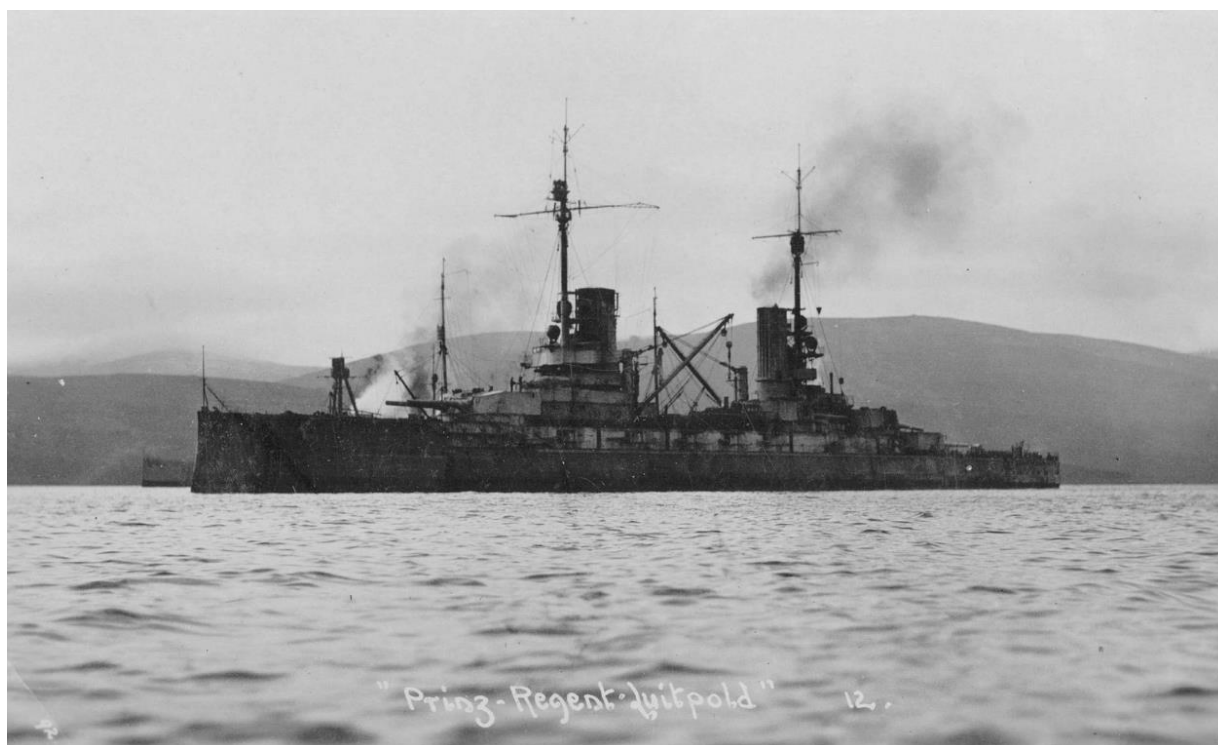


Plate 28: SMS *Prinzregent Luitpold* in Scapa Flow (B. Forbes Collection).

¹⁰ Two sailors from SMS *Prinzregent Luitpold* died while at Scapa Flow. Telegraphist Friedrich Bonneder died on the 4th of January 1919. He is buried in the Royal Navy Cemetery at Lyness on Hoy. Grave number D 226. Stoker Albert Hanshatter died on the 13th March 1919. He is buried in the Royal Navy Cemetery at Lyness on Hoy. Grave number D 227.

¹¹ In May 1931 there was an explosion when a lamp burst igniting gasses trapped within the hull. The workers in that compartment of the vessel rushed to get to the airlock as the blast had blown rivets and the water was rising. One of the workers, Wilfred Tait of Thurso, was missing and was later found drowned (Aberdeen Press & Journal, 28th May 1931).

work to seal leaks she was successfully raised on the 9th July 1931 and subsequently towed to the sandbank of Rysa where she was briefly “beached” (Dundee Courier, 17th July 1931), possibly to compress any remaining obstructions. One week later, the vessel was taken to Lyness where she stayed until May 1933 when she left Lyness in tow (by three German and one British tugs) for Rosyth¹². Afterwards, Mr Cox closed down his salvage operation in Orkney and sold his salvage equipment to the Glasgow firm Metal Industries Ltd.

4.3.2 Ground-truthing

The side scan sonar shows a discernible depression on the site orientated in an east-west direction (Figure 7). There were three main sonar contacts across the site that comprised two main areas of debris (SS045 & SS047) with a smaller contact 50m to the north east (SS046).

Ground-truthing data were obtained from the Shiptime Project on the 28th July 2017 as well as by remote video and diving surveys carried out during Phase 2. The Shiptime ROV footage focussed on sonar contact SS047, which comprised an area of non-descript wreckage, including a metal box and associated railings/ladders, small davit arms and deck supports, perhaps for sub-calibre liner boxes.

Diving surveys were carried out on the 13th & 16th July and again on the 12th November 2018. Further inspection of SS047 found searchlight platforms amongst the wreckage as well as a section of the aft mast with degraded crow’s nest remains, comprising just the floor and entry hatch. A large detached tube found by the mast may have been part of the spotting top but this is uncertain. Further inspection of the metal box recorded in the ROV survey found it to be a brass room with a door (possibly steel) on one side (Plate 29). The room measured 4m wide by 1.8m long and 2.0m high (it was lying partially buried, so length and height measurements were minimum estimates) and was lying upside down with cables present inside. A repeater compass was also found on the seabed nearby (Plate 30). An archive image of SMS *Prinzregent Luitpold* (Plate 30) shows a small room and repeater compass located on the platform behind the aft control tower, the only *Kaiser*-class vessel that appeared to have this feature. No evidence was found that definitively confirmed the room’s function but the fact it is made of brass suggests it may have been used to house compass equipment.

SS045 comprised the foremast with spotting top and two searchlight platforms (Plate 31 & Plate 32). The spotting top comprised a heavy enclosed compartment, most likely of the splinter-proof type, and was intact. The searchlight platforms were angled up into the water column and partly buried. Various searchlight components were present here, including brass iris segments and a base mount. A small pile of wreckage also lay to the south and included pulleys, a large block and wire, which may have been related to a samson post assembly. Also present on the seabed between SS045 and SS047 were several coal hatches, a coal winch and two deck stands shaped for a cylindrical item, possibly sub-calibre liners.

¹² A disaster almost occurred in the Pentland Firth where strong tides turned the hull around and the tugs were powerless for some time. Skilful navigation managed to bring the tow back under control, much to the relief of the crews and particularly of the 14 men who were camped on the upturned hull Aberdeen Press and Journal 8th May 1933).

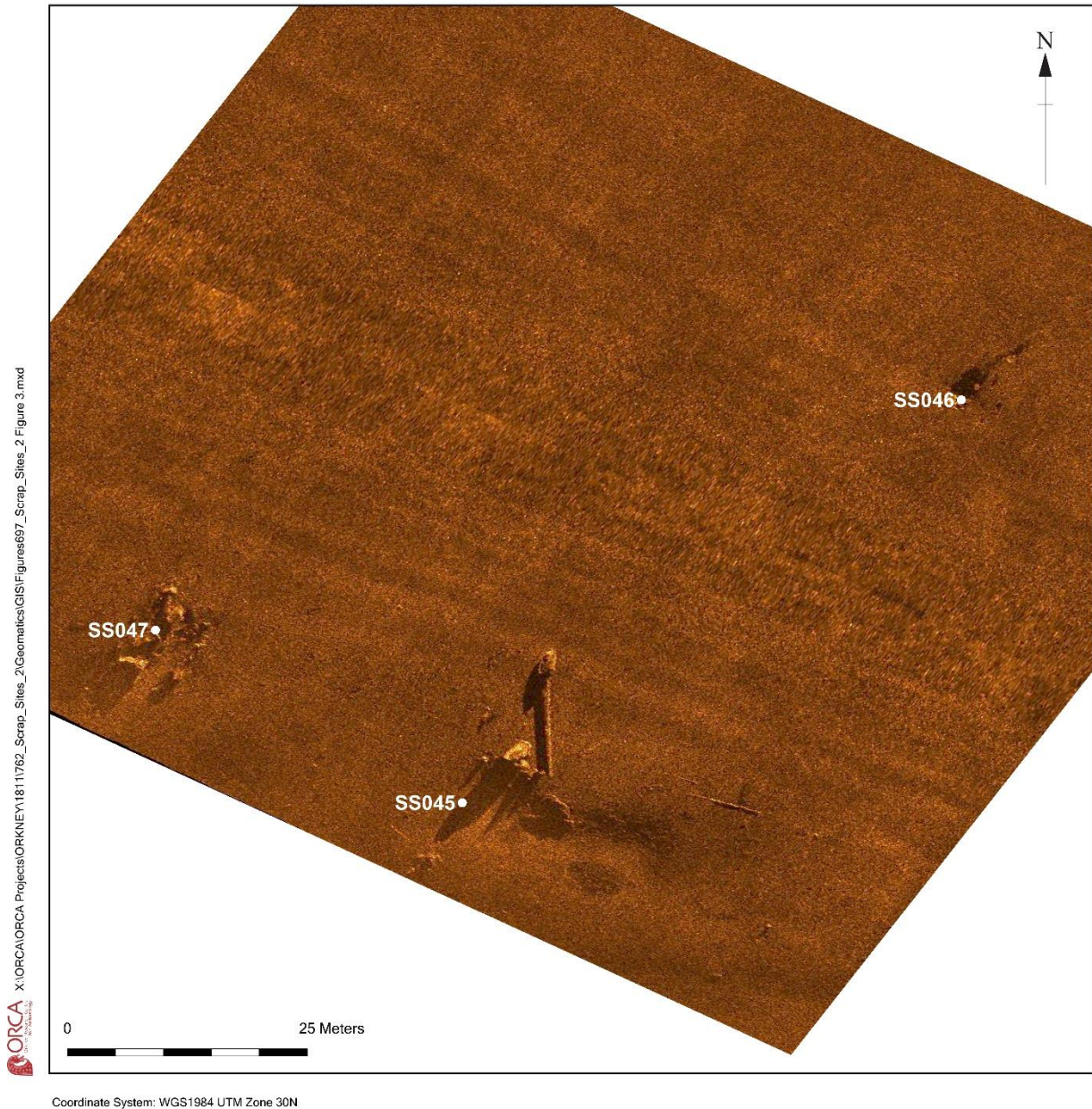


Figure 7: SMS *Prinzregent Luitpold* primary salvage site (SS045, SS046 & SS047).

A remote video assessment of SS046 was made on the 7th June 2018. The main sonar contact at this location was a small diesel engine with associated debris, including a circular brass fuel tank (Plate 33). The engine was upright on the seabed and due to its relatively large size was probably from a diesel pinnace and probably from SMS *Prinzregent Luitpold* given its proximity to the primary salvage site. A subsequent inspection of the site by divers on the 11th November 2018 provided more detailed video footage of the engine and remains.

The ground-truthing results showed a number of artefacts left behind on the seabed at the primary salvage site, with the presence of the brass room and repeater compass being noteworthy. Apart from a small amount of wreckage to the south of the forward mast, no other evidence of samson posts or booms was found at the site. It is possible that they were still attached to the hull when it was towed away from the site and could have been removed or

fallen off elsewhere. Contact SS066, located to the north-east of Rysa, was investigated in Phase 1 and comprised the remains of two samson posts and one boom from a *Kaiser*-class vessel. It is thought more likely those remains originated from SMS *König Albert*, but further investigations may be required to confirm this.



Plate 29: Prinzregent Luitpold primary salvage site, showing mixed wreckage (SS047) including a brass "room" (top) and repeater-type compass alongside an archive image of a German repeater compass (bottom).



Plate 30: Archive image of SMS Prinzregent Luitpold showing a room located behind the aft control tower (K. Heath Collection). This also shows a repeater compass located on the starboard side of the room.



Plate 31: Prinzregent Luitpold primary salvage site, forward mast with splinter-proof spotting top (SS045).



Plate 32: Prinzregent Luitpold primary salvage site, forward searchlight platforms (SS045).

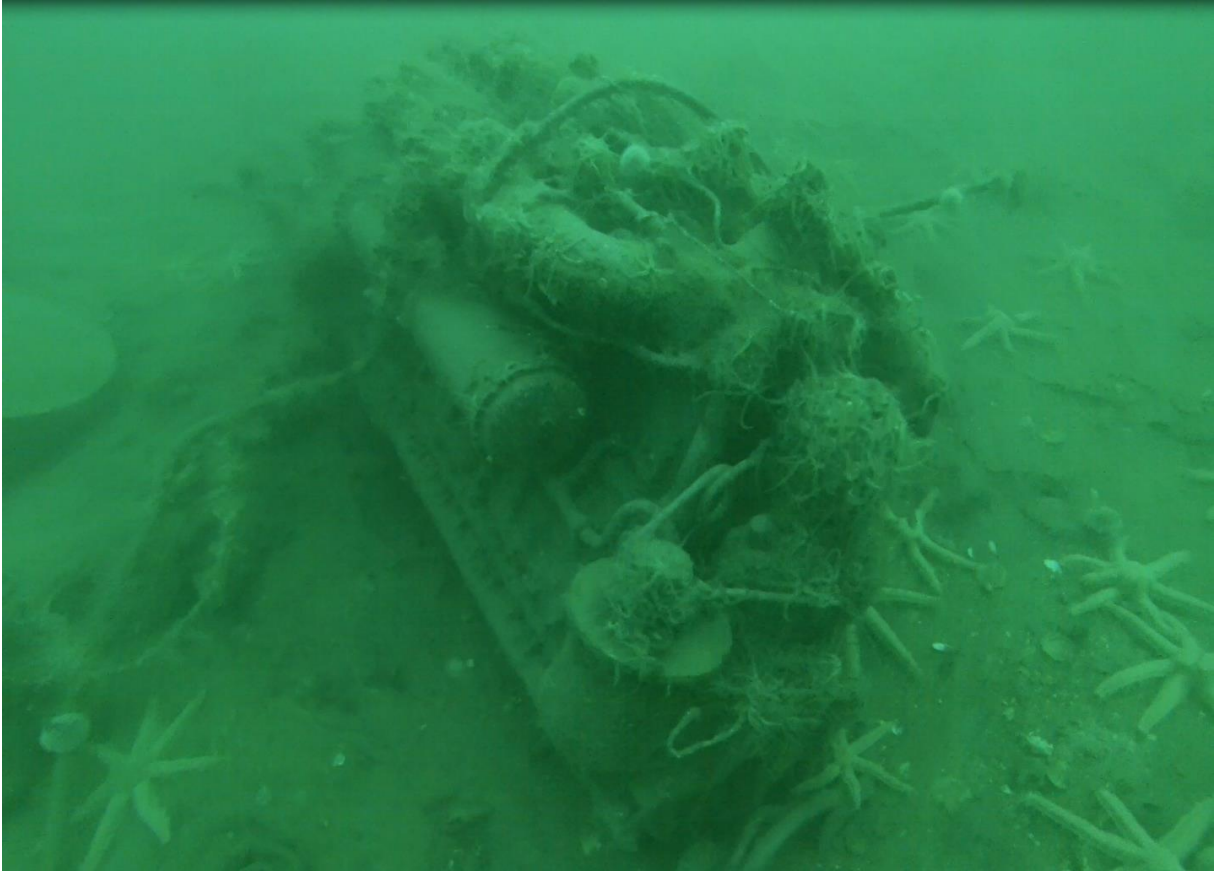


Plate 33: Prinzregent Luitpold, primary salvage site (SS046), diesel engine (image courtesy of I. Houston, OSAC).

4.4 SMS *König Albert*

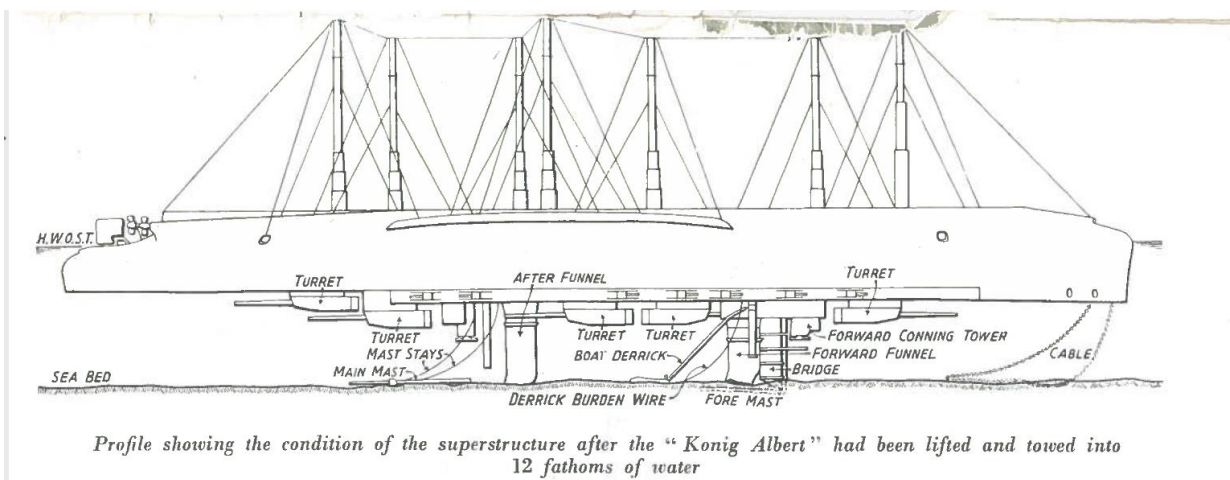
4.4.1 Salvage background

SMS *König Albert* was anchored to the north-west of Cava and north of SMS *Karlsruhe* and SMS *Kaiserin* (Plate 34). She capsized and sank in a depth of approximately 42m with her bows to the north-west.

SMS *König Albert* was the second ship to be raised by Metal Industries Ltd, the first being SMS *Bayern* in 1934. Less archived information is available for those ships raised by Metal Industries, as they tended not to submit reports to the press. Preparatory work began in October 1934 and diver surveys indicated that the vessel lay upside down on a slope, with a port list of nine degrees, and with the stern in slightly shallower water at 21 fathoms (38.4m).



Plate 34: SMS *König Albert* in Scapa Flow (B. Forbes Collection).



Profile showing the condition of the superstructure after the "König Albert" had been lifted and towed into 12 fathoms of water

Plate 35: *Shipbuilding and Shipping Record 1935* (T McKenzie) (C Bullen Collection).

Probably due to the soft muddy seabed, all gun turrets and the superstructure were reported to be completely buried under the hull. The first airlock was fitted on 29th November 1934 and the final (eighth) one was fitted at the end of April 1935. The vessel was reported raised by the start of August, having come up initially at the bow, followed by the stern the next day (The Orcadian, 1st August 1935). Divers cleared wreckage hanging under the hull before she was towed to Rysa Little, where further debris was cleared before being towed onwards to Lyness. After some salvage works, the vessel was towed to Rosyth, leaving Orkney on the 1st May 1936 in the tow of three Dutch tugs.

An interesting sketch of the *König Albert* salvage is shown in Plate 35, which illustrates the condition of the vessel after she was raised and towed into shallow water off Rysa. It shows that many of the structures that were removed from other ships before leaving the primary salvage site were in fact still in place on SMS *König Albert*. The image also gives some insight into the scale of the undertaking that faced the salvage divers who were tasked with removing the structures that impeded the tow into shallower water.

4.4.2 Ground-truthing

The side scan image collected in Phase 1 shows a depression on the seabed in a WNW to ESE orientation and relatively few objects were visible across the site (Figure 8). Ground-truthing data was limited to remote video surveys carried out on the 3rd July and 28th September 2018 (the Shiptime Project did not survey the SMS *König Albert* site) and found three main features on the site. The first appeared to be the remains of a mast and spotting top (SS057), most likely from the forward mast (Plate 36). The spotting top appeared to be crushed and lying upside down with just the floor still attached to a short (1-2m) section of mast protruding up off the seabed. The second object was a long tubular structure that formed the most obvious sonar contact (SS056). It carried no external fittings or rigging, which suggested it may have been a samson post boom (Plate 37). A coal winch was found lying on top. The third main target was a diesel engine (SS058) lying upside down on the seabed (Plate 38). This was probably from one of the *König Albert*'s diesel boats that, given its orientation, was still attached to the deck when it sank. Other small targets seen in the area included coal hatches and other small items of non-descript wreckage.

The lack of artefacts described above was partly the result of being limited to remote video to ground-truth the site, resulting in some smaller items being missed. However, it was also a reflection of the fact that many of the structures typical of primary salvage sites, e.g. masts and samson posts, were still in place on *König Albert* when she was towed away from the primary salvage site to Rysa, neatly illustrated by the sketch shown in Plate 35. This was typical of Metal Industries Ltd, which used the Rysa site to carry out clearance work, in contrast to Cox and Danks, who either cleared obstructions while the vessel was still on the primary salvage site (e.g. SMS *Kaiser*), or moved them into shallow water on the west side of Cava (e.g. SMS *Moltke*, SMS *Von der Tann*). A single boom present on the site also agrees with the sketch that shows that a boom was missing on arrival at Rysa. Sonar contact SS066, a short distance north-east of Rysa and investigated in Phase 1, comprised two samson posts, a boom, searchlight platforms and a section of mast. It is thought very likely that these are from SMS *König Albert*, although further investigation might be required to confirm this.

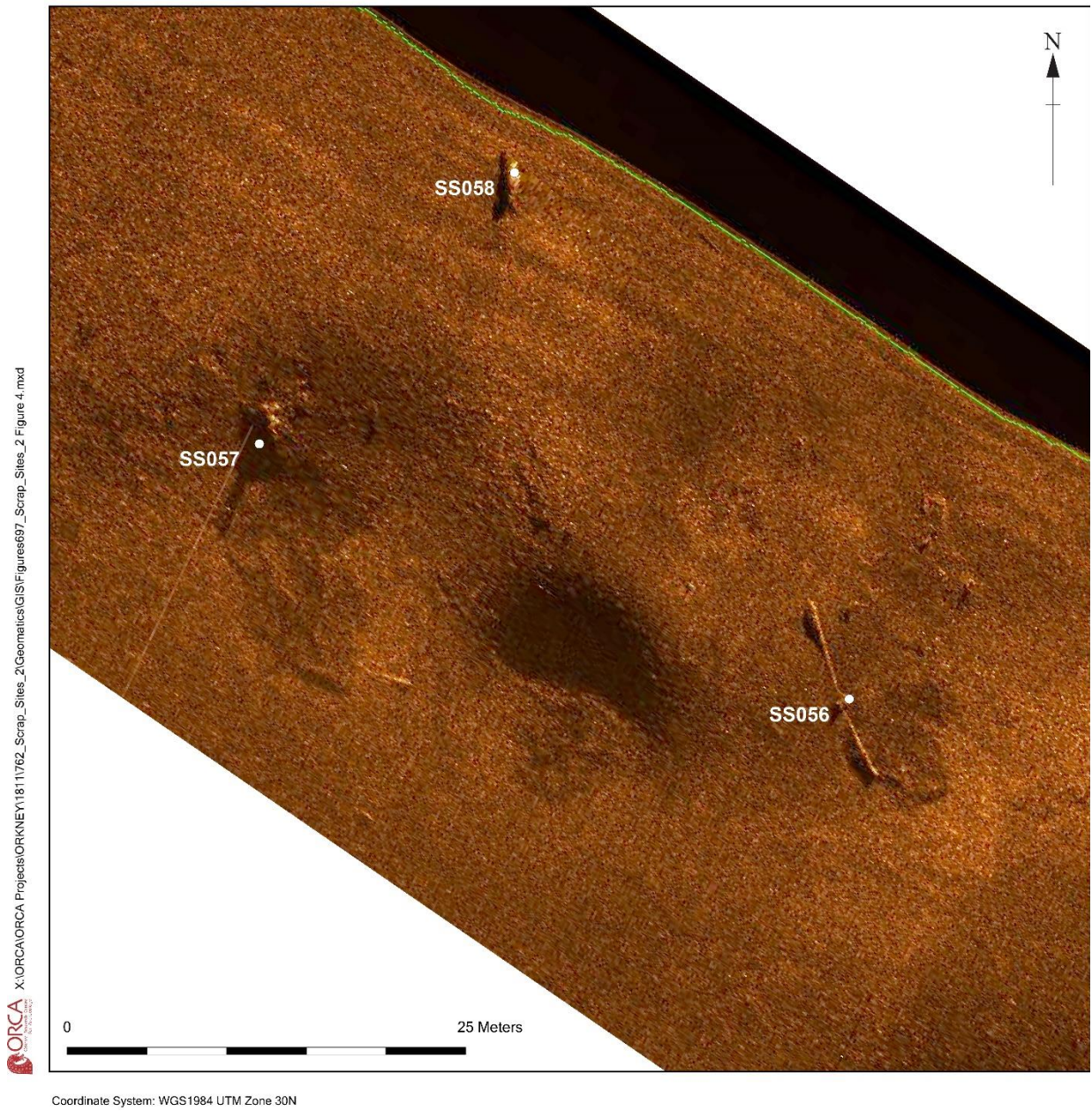


Figure 8: SMS König Albert primary salvage site (SS056, SS057 & SS058).



Plate 36: SMS König Albert primary site, foremast remains (SS057).



Plate 37: SMS König Albert primary site, samson post boom (SS056) with coal winch on top.



Plate 38: SMS König Albert primary site, pinnacle diesel engine (SS058) lying upside down on seabed.

4.5 SMS *Kaiserin*

4.5.1 Salvage background

SMS *Kaiserin* was anchored to the north-west of Cava, approximately 500m west of SMS *Karlsruhe* (Plate 40). She capsized and sank, coming to rest on the seabed in a depth of approximately 34m with her bows to the north-west. However, she reportedly lay only 15 feet from the surface and a trawler grounded on her in 1920¹³.

SMS *Kaiserin* was raised by Metal Industries in May 1936. An initial diver survey and accompanying sketch carried out on 11th December 1935 (Plate 41) described the vessel as “upside down resting and resting on its superstructure with an 11° list to starboard. The forward mast bent 15 feet from the deck and the rest of the mast is sticking out of the mud with the fighting top clear of the seabed” (Orkney Archive D1/59/1/1). She was finally raised on 14th May 1936 after eight months of work and further dive surveys of the floating hull were carried out over the following days. Orkney Archive excerpts detail the work undertaken on each survey (Orkney Archives D1/59/1/4):

- 19th May: Divers Survey.
Forward bridge 15’ below conning tower – little holding.
Foremast broken off short.
Forward & aft Samson posts intact.
Forward funnel crushed to deck.
Aft funnel broken away at louvers.
Mainmast 5’ below aft conning tower.
Portion aft bridge structure hanging, but little holding.
Blasting forward 1 -7 pm.
Forward Bridge practically adrift.
Forward Samson post less than half-cut.
- 20th May: Weather – Fresh N/NW wind. Sea moderate.
Diving – Blasting carried out aft only owing to the weather, aft mast blasted away (carried away at deck level whilst being blasted lower down).
Blasting aft bridge completed.
Samson post approx. ½ cut round.
- 21st May: Weather – Light N/NE wind. Sea calm.
Diving - Blasting aft Samson post completed noon.
Forward bridge now adrift.

¹³ *Trawler damaged at Scapa Flow.* “The Grimsby trawler *Cecil Coombes* stranded on the deck of the scuttled German battleship *Kaiserin* at Scapa Flow, and put into Aberdeen for repairs. The *Kaiserin* lies about 15 feet under water, and the trawler stuck fast on the vessel. The force of the shock hurled overboard a member of the crew, who was rescued with some difficulty. The crew were ordered to take to the boats, and after breaking three hawsers a government tug succeeded in pulling the trawler clear. Extensive damage was caused to her plates.” (Portsmouth Evening News 29th January 1920).

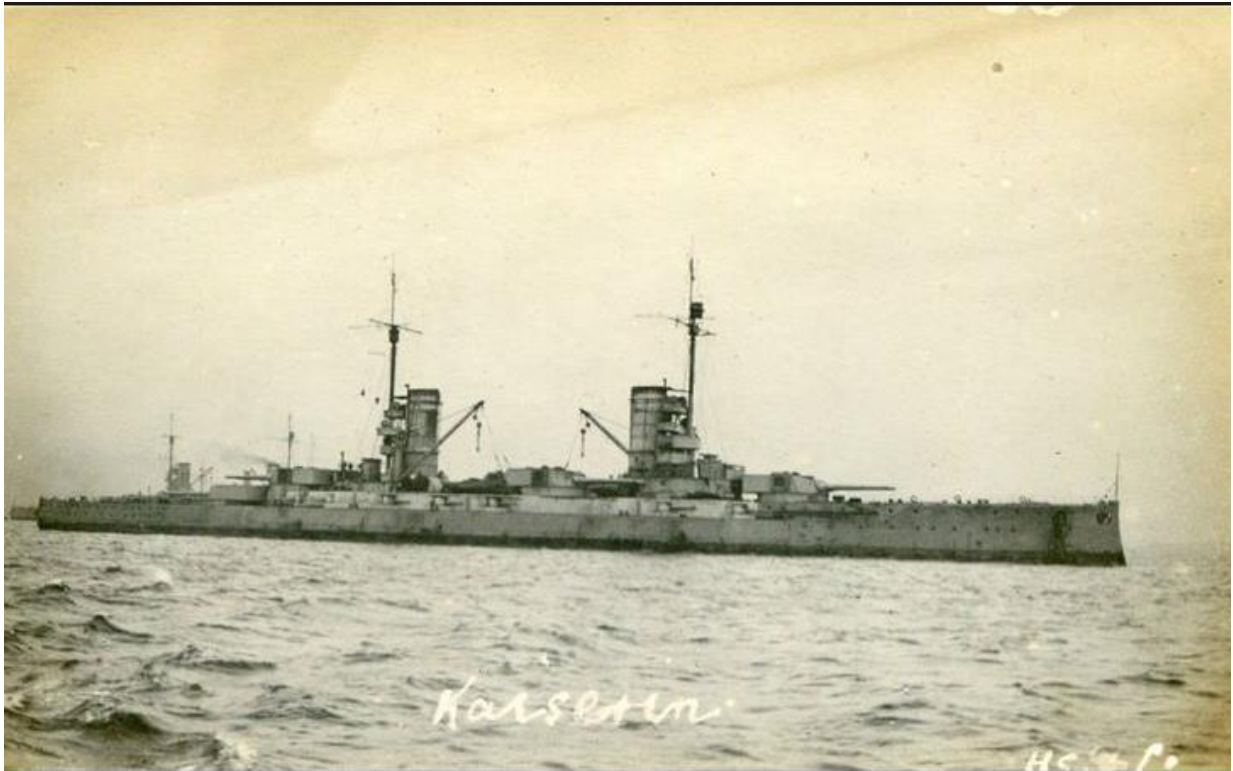


Plate 39: SMS Kaiserin at Scapa Flow (B. Forbes Collection).

Blasting forward Samson post contd. Post cut completely round but portion still holding by rivets to casing. Hanging about 10' down. A start will be made at 6am tomorrow in order to clean in time for morning tide.

22nd May: Diving – (From 7 am to clean for towing at morning tide). Forward Samson post found to have fallen away during night. Small portion of forward bridge still hanging by a few angles shot away. Light anchor cleared. Wreck towed to bank on tide.

The hull was initially towed into Rysa, where further works may have occurred, before being towed to Lyness then onwards to Rosyth, leaving Orkney in October 1936.



Plate 40: SMS Kaiserin following salvage, being towed through the Pentland Firth on route to Rosyth (Dundee Courier).

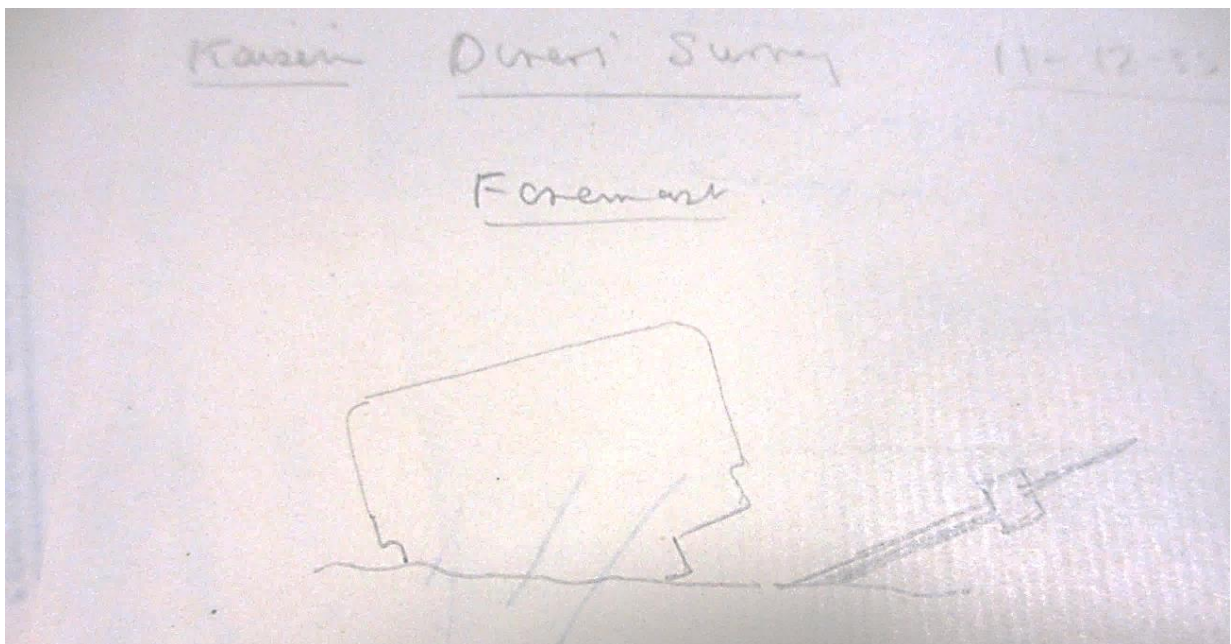


Plate 41: Drawing by diver of the position of the SMS Kaiserin, December 1935, showing the bent foremast protruding from seabed (Orkney Archive D1/59/1/1).

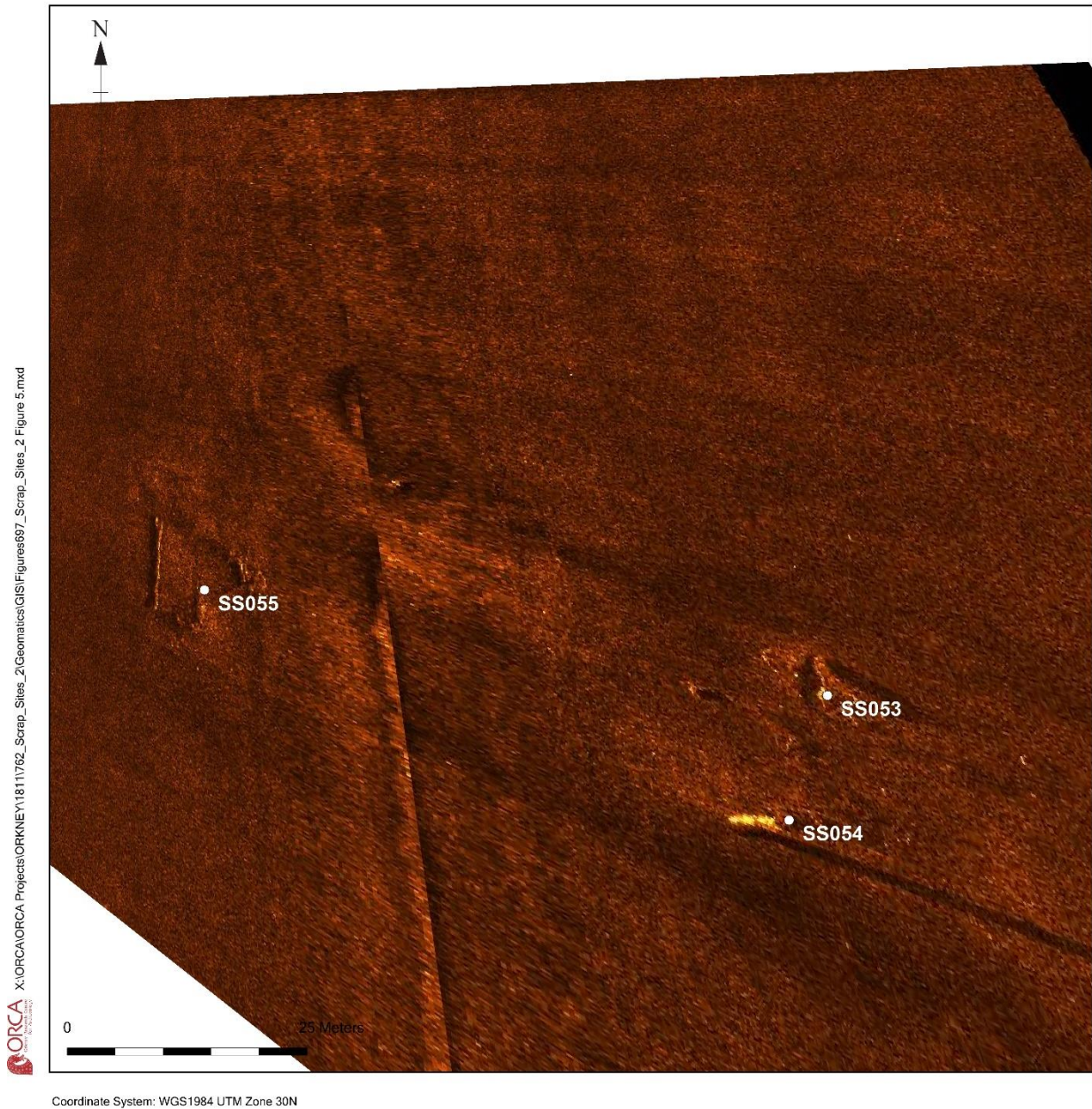


Figure 9: SMS Kaiserin primary salvage site (SS053, SS054 & SS055).

4.5.2 Ground-truthing

The side scan image of the primary salvage site of SMS *Kaiserin* shows a seabed depression orientated in a WNW to ESE direction (Figure 9). Several sonar contacts were evident (SS053, SS054 & SS055), some of which appeared to be masts or booms as well as other indistinct objects spread through the site.

Ground-truthing was carried out during the Shiptime Project on 28th July 2017 and later by remote video during the Phase 2 project. The Shiptime survey inspected the two main groups of contacts evident in the sonar survey. The contacts to the north-west (SS055) were most likely the forward structures and included a long tubular structure lying flat on the seabed, a pile of mixed wreckage (including a heavy spool of wire) possibly from the bridge, the remains

of a samson post (most likely the forward post) and a small mast or davit (Plate 42, Plate 43 & Plate 44). The tubular object was initially thought to be the forward mast, however the ROV footage showed no features that would be associated with a mast, e.g. rigging attachment points, rungs, spotting top, brackets, etc. Alternatively, it may be a boom, given that a samson post was located a few meters away. However, none of the terminal features of a boom were present either and as such its origin remains uncertain without additional survey work.

The aft wreckage to the south-east (SS053 & SS054) included another long tubular artefact that was protruding out of the seabed and several meters up into the water column (Plate 45). Again, its origin was uncertain as it had no features that would identify it as a boom or mast. No samson post was observed in this area. Underneath lay a pile of twisted metal framework. A short distance away were two searchlight platforms where searchlight mounts, wiring and brass pipes (possibly voice pipes) were also present (Plate 46). Several smaller items were scattered around the searchlight platforms, including a coal winch, a coil of wire on a drum, a brass tube sticking out of the seabed with shaped end pieces. Perhaps the most interesting feature was the remains of a searchlight with an intact front grill that lay partially buried in the seabed (Plate 48). The ROV survey also located a torpedo mast, lying some way off the forward wreckage to the west.

A remote video survey carried out on 28th September 2018 did not improve the ground-truthing data for the area described above. However, a volunteer diving survey was carried out on the 28th July 2018 and the video footage made available to the project (courtesy of B. Wade). This provided more detail and clearer footage of the aft mast area where small fragments of coal and wood were scattered across the seabed. Two brass pipes were found, one being almost buried next to the one seen during the ROV survey. Inspection of these pipes found that they were 300mm in diameter and that they both had similarly shaped end pieces. The pipe section protruding from the seabed was measured at approximately 1.5m but the total length was unknown. A section of ladder was also seen partially buried in the seabed.

Ground-truthing results generally corresponded to the salvage archive for SMS *Kaiserin* that indicated that the remains of the bridge structure (forward and aft), foremast, samson posts and aft mast were removed from the hull at the primary salvage site. There were some anomalies however. Only one samson post was found on the site and the presence of the foremast on the site was also uncertain. The diver's sketch from the archive suggested the foremast was sticking out of the seabed with spotting top intact. It would be easy to assume that the long structure protruding from the seabed to the south-east of the site was the foremast depicted in the diver's sketch. However, no evidence of a spotting top was observed and its location on the site makes it more likely that this was the aft mast. The mast-like structure to the north-west of the site is in the correct area but a lack of distinguishing features prevents a certain identification. It is possible that despite the foremast being snapped, it was still attached by guy wires and subsequently dragged away when the vessel was towed from the site. A relatively interesting assemblage of artefacts remain at the site, with the searchlight remains being the most noteworthy.



Plate 42: SMS Kaiserin primary site, wire on drum (SS055).

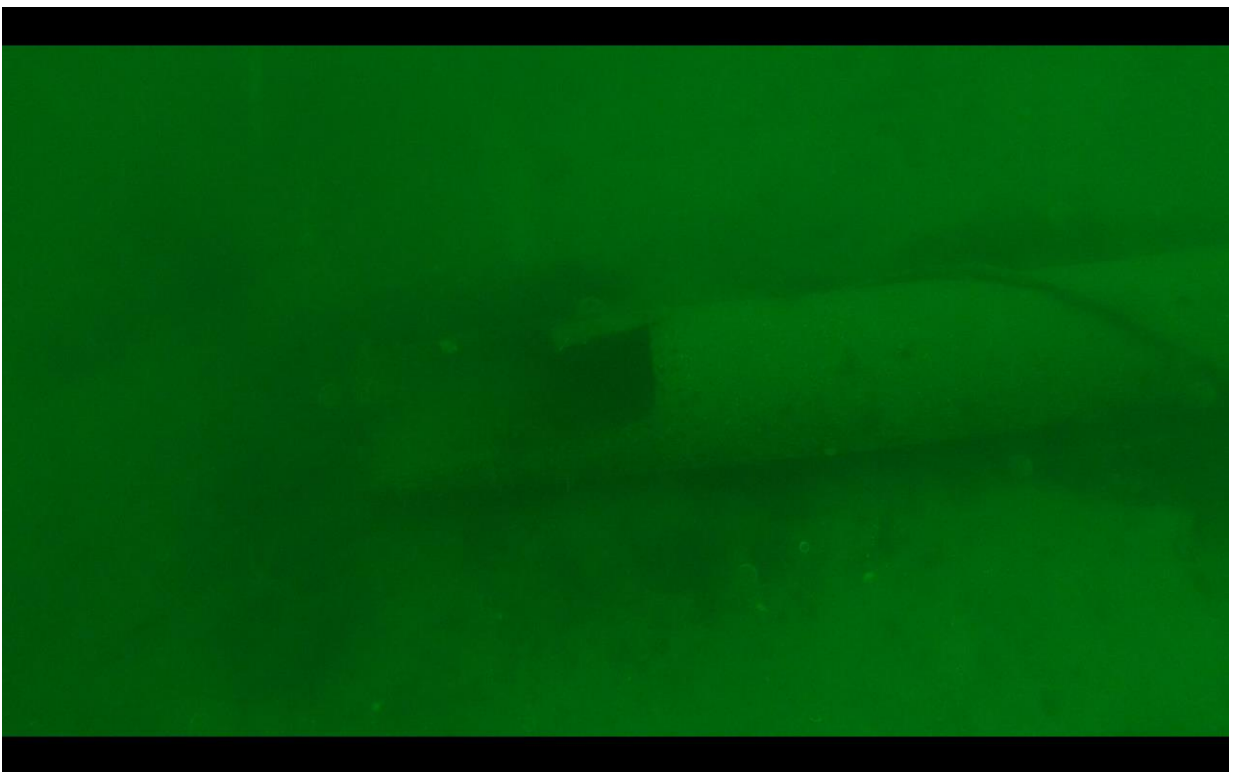


Plate 43: SMS Kaiserin primary site, samson post boom (SS055).



Plate 46: SMS Kaiserin primary site (SS053), aft searchlight platforms (image courtesy of B. Wade).



Plate 47: SMS Kaiserin primary site, brass pipe projecting from seabed (image courtesy of B. Wade). A second similar pipe, which was almost entirely buried, can just be seen in background.



Plate 48: SMS Kaiserin primary site, searchlight remains, partially buried with intact front grill with inset of (top) and iris (bottom). A similar searchlight unit from a German ship is also shown (top right) (G. Staff Collection).

4.6 SMS *Friedrich der Grosse*

4.6.1 Salvage background

SMS *Friedrich der Grosse* was anchored to the north of Cava just to the west of SMS *Bayern* (Plate 49). She capsized and sank with her bow to the north-west in a depth of approximately 33m.



Plate 49: SMS *Friedrich der Grosse* at anchor in Scapa Flow (B. Forbes Collection).

She was raised by Metal Industries Ltd in April 1937 in stages: the bow was raised on the 28th and the stern on the 29th. On the 30th April, she was towed from the primary site and anchored at Rysa. A subsequent diver's report stated that both samson posts were intact but the derricks (booms) had "slipped", both masts were adrift and lying on the seabed, the stern was slightly crushed and the hull was resting on the turrets at low water with samson posts sticking into the seabed. Blasting to remove the forward and aft superstructure and samson posts was completed by the 6th May 1937, after which she was towed to Lyness¹⁴ and then onwards to Rosyth, leaving Orkney on 31st July 1937.

¹⁴ While at Lyness pier she was used in the recovery of the salvage steamer *Metinde*, which sank in a gale in January 1936 (Aberdeen Press & Journal, 9th July 1936).

4.6.2 Ground-truthing

The side scan image for the *Friedrich der Grosse* primary salvage site is shown in Figure 10. This shows a depression in the seabed orientated north-west to south-east. Multiple contacts are evident in the area that are mostly indistinct, apart from a relatively obvious mast and spotting top structure to the north-west of the site and what may be searchlight platforms to the south-east.

Ground-truthing of the site was carried out during the Shiptime Project on the 30th July 2018 and later by remote video survey during the Phase 2 project. The Shiptime survey¹⁵ focussed on the group of targets (SS062) to the south-east of the site. The presence of searchlight platforms here was confirmed with at least two platform sections seen lying together along with extensive cabling and control mechanisms (Plate 50). A short distance away to the north-east a tubular structure, at least 6m in length, was found sticking out of the seabed at an angle of approximately 30 degrees (Plate 51). The origin of this artefact was unclear as it carried no distinguishing features. It may be one of the samson post booms (the salvage diver reported that both booms had “slipped” prior to arrival at Rysa (Metal Industries Ltd Salvage Logbook D1/59/2/3) or a section of the aft mast. The ROV moved west from the platforms and located a sub-calibre liner box, partially buried in the seabed (Plate 52). At this point the ROV returned to the searchlight platforms and the survey was terminated after its umbilical became snagged in wreckage.

A remote video survey was carried out on 3rd July 2018 and covered the north-west area of the site. Starting in the same area that was covered in the Shiptime survey, the remote video worked in a north-west direction, passing two metal beams projecting from the seabed before coming to another tubular structure sticking out of the seabed (SS061). This artefact had broken off about 1m above the seabed and its main length (several meters) was lying on the seabed (Plate 53). The absence of features along its length suggest this was a samson post boom. Further to the north-west, the large diameter forward mast was found lying half buried including a well-preserved spotting top and armoured control tower (SS059) (Plate 54 & Plate 55). There was a small amount of debris around the base of the mast, which had ragged edges indicative of blasting. A number of small indistinguishable items were seen on the seabed.

The ground-truthing data recorded at the primary salvage site of SMS *Friedrich der Grosse* show that a large amount of wreckage was left on the seabed after she was raised, in contrast to other sites where very few remains were found, *e.g.* SMS *König Albert* (both vessels were towed away from the primary site without any clearance work taking place). The data also conflict with the archive salvage report that stated that both masts were “adrift and lying on the seabed” on arrival at Rysa. The forward mast and spotting top are clearly on the primary salvage site. The aft mast could not be positively identified at the site – a large tubular artefact was found sticking out of the seabed, but this may have been a boom, both of which were reported to have “slipped” when the vessel was inspected on arrival at Rysa. Several

¹⁵ Note that the Shiptime ROV video footage for SMS *Friedrich der Grosse* is incorrectly labelled “Grosser Kurfürst”. Similarly, the video for SMS *Grosser Kurfürst* is incorrectly labelled with “Friedrich der Grosse”.

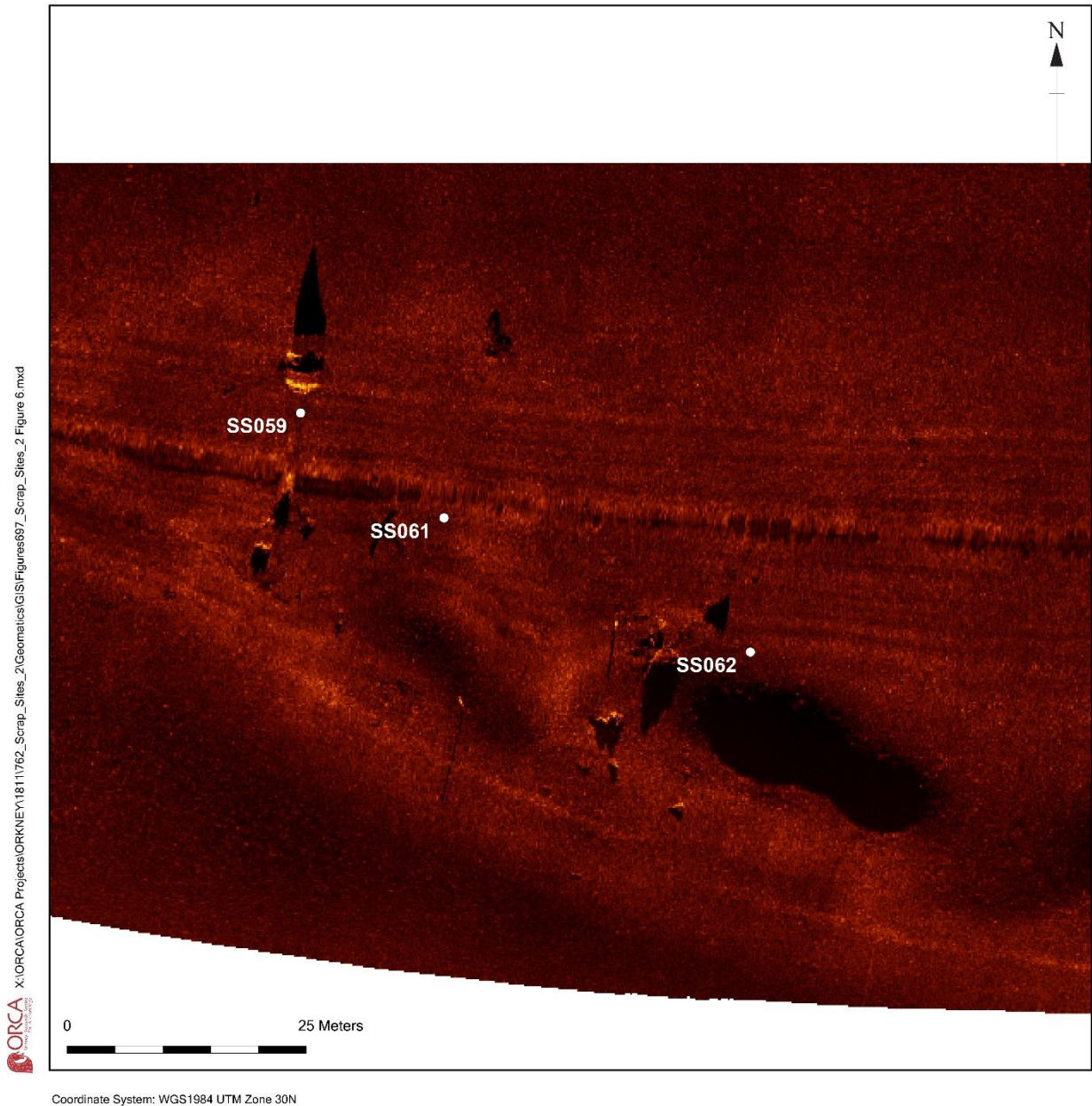


Figure 10: SMS *Friedrich der Grosse* primary salvage site (SS059, SS061 & SS062).

structures evident on the sonar image, particularly to the south-east of the site, remain to be identified however, so the extent of the primary salvage site is not yet fully understood, making it a candidate for further investigation.

The exact location of the secondary salvage site at Rysa is difficult to pinpoint. A site surveyed in Phase 1 (SS068) comprised two samson posts, one of which was sticking into the seabed, reflecting the description contained in the secondary salvage report, a possible aft mast and extensive non-descript debris. It is very likely that the remains at SS062 belong to SMS *Friedrich der Grosse* but again, further investigations might be required to establish this.



Plate 50: SMS Friedrich der Grosse primary salvage site, searchlight platforms adjacent to aft mast.



Plate 51: SMS Friedrich der Grosse primary salvage site, showing aft mast protruding from seabed.

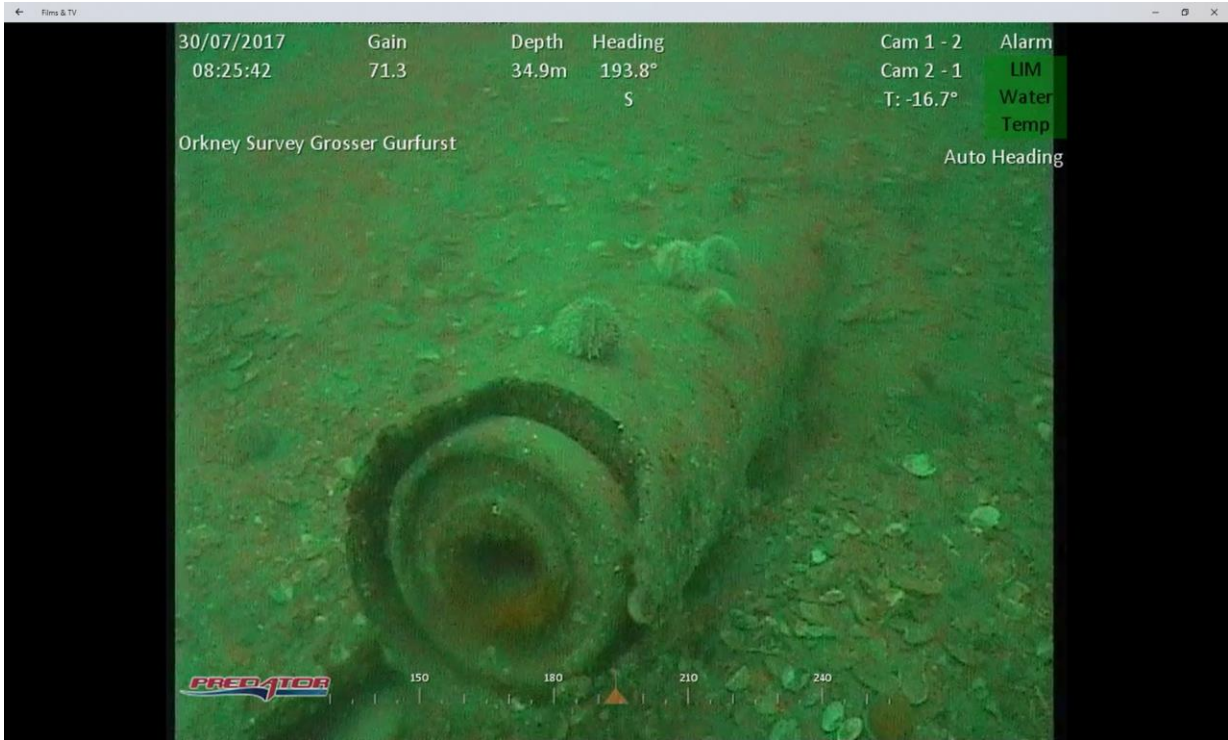


Plate 52: SMS Friedrich der Grosse primary salvage site, sub-colibre liner casing.



Plate 53: SMS Friedrich der Grosse primary salvage site, boom sections.



Plate 54: SMS Friedrich der Grosse primary salvage site, forward mast and splinter proof control room.



Plate 55: SMS Friedrich der Grosse primary salvage site, forward mast, spotting top and splinter proof control room.

4.7 SMS *Grosser Kurfürst*

4.7.1 Salvage background

SMS *Grosser Kurfürst* was anchored off the north side of Cava, just to the east of SMS *Bayern*. She capsized and sank in a depth of approximately 32m with her bow to the north-west.

The vessel was raised by Metal Industries in April 1938. After lifting, she was taken into shallow water at the bay at Rysa, referred to as Kirkaldy [sic] Bay in the Metal Industries salvage logs, and moored to four anchors. Here, work began to decrease her draft so that she could be dry-docked at Rosyth. The initial diver report from Rysa stated that her derricks were touching the seafloor with the rest of the vessel sitting clear of the seabed. The following day, blasting commenced and her starboard derrick was dropped. Works then focused on the aft funnel, bridge structure and port samson, followed by the forward funnel and bridge structure. On May 15th, *Grosser Kurfürst* was towed to Lyness (Metal Industries Logbook D1/59/3/5; The Scotsman 6th May 1938).

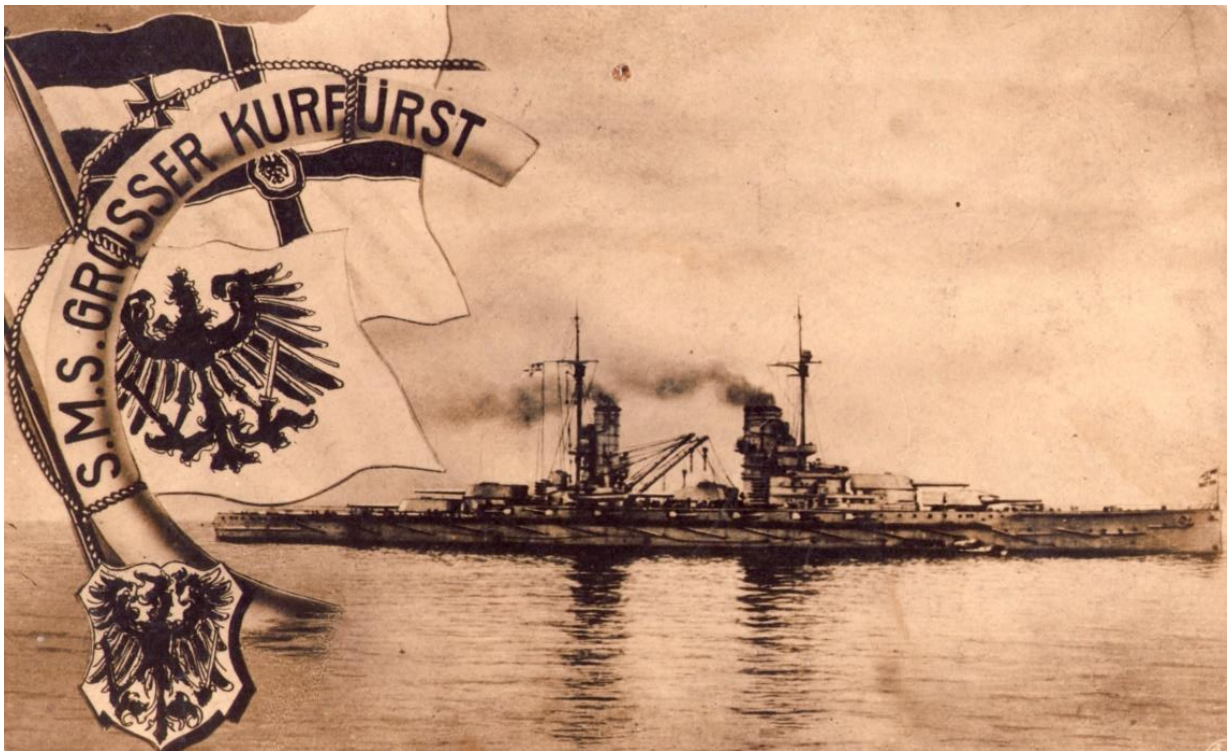


Plate 56: SMS *Grosser Kurfürst*.

4.7.2 Ground-truthing

The side scan image of SMS *Grosser Kurfürst* primary salvage site (Figure 11) shows a seabed depression orientated in a west to east direction. Relatively few sonar contacts were detected in the area, the most obvious being an area of wreckage to the west of the site that appeared to include a mast-like contact with spotting top.

Ground-truthing of the site was carried out during the Shiptime Project on 30th July 2018 and later by remote video survey during the Phase 2 project. The Shiptime ROV¹⁶ survey found the remains of a searchlight platform protruding into the water column (Plate 57). A circular object on the seabed underneath the platform may have been an intact searchlight unit. In the area surrounding the platforms there was other miscellaneous metal wreckage, metal beams projecting from the seabed and a long section of metal tube lying partially buried on the seabed. The ROV then heads on a north-west, then west direction and comes across several pieces of metal wreckage, before arriving at a more extensive area of wreckage. This included the forward mast complete with splinter-proof spotting top and control tower (Plate 58). Lower down the mast, a smaller crow's nest compartment was found, corresponding to archive plans for SMS *Grosser Kurfürst* (Plate 59). A large area of wreckage was present at the base of the mast that included the remains of searchlight platforms, control mechanisms, a searchlight base (Plate 60) and bridge structure. An extensive trail of cables led from the base of the mast into the wreckage nearby.

Additional remote video surveys were carried out on the 14th July and 28th September 2018 and covered a similar area to the Shiptime survey. The buried tube was inspected and the presence of some fittings indicated that it may have been a section of the aft mast, but this was uncertain. A coal hatch was seen on the seabed in the vicinity of the forward mast and an additional inspection of the wreckage around the base of the forward mast found what appeared to be a small diesel engine lying on the seabed alongside. Archive research indicated

¹⁶ Note that the Shiptime ROV video footage for SMS *Grosser Kurfürst* is incorrectly labelled "SMS *Friedrich der Grosse*". Similarly, the video for SMS *Friedrich der Grosse* is labelled with SMS *Grosser Kurfürst*.

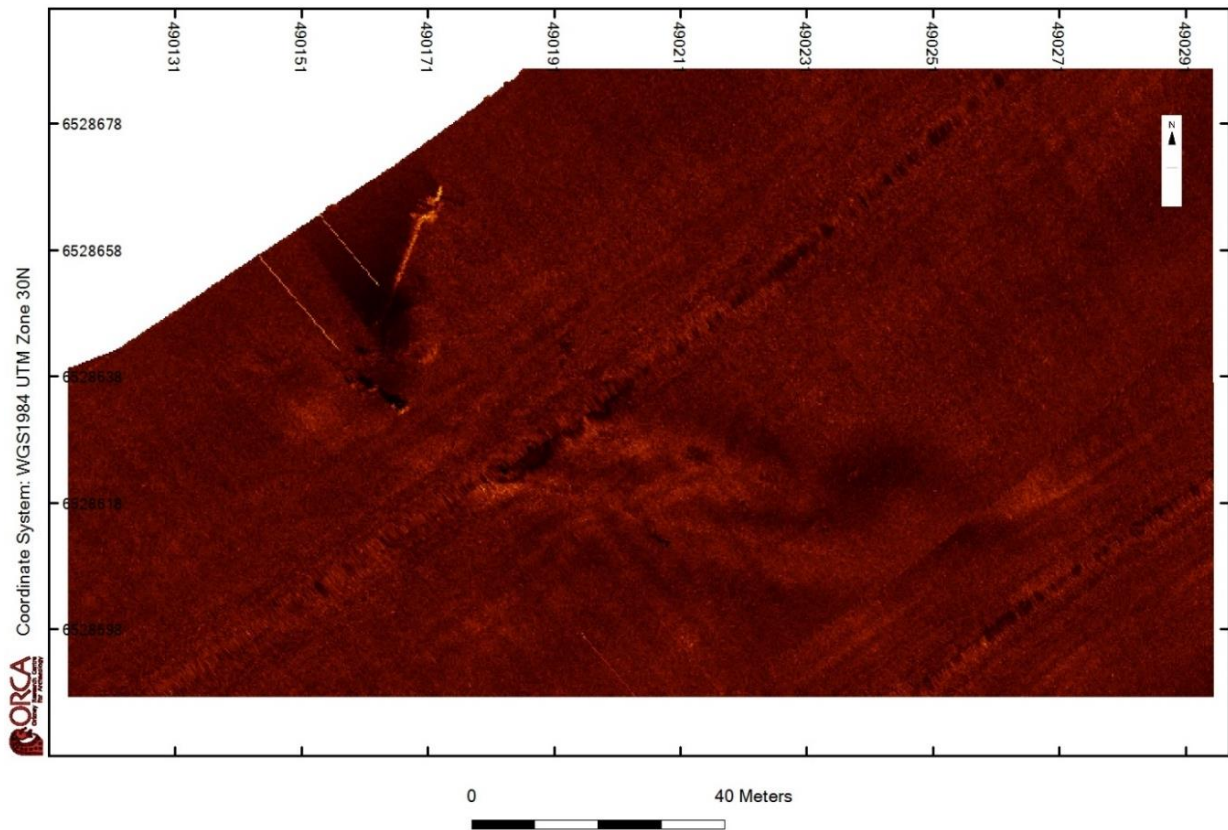


Figure 11: SMS *Grosser Kurfürst* primary salvage site.

very clearly that much of the superstructure and other fittings of the *Grosser Kurfürst* were still attached when she was towed away from her primary salvage site. It is likely that the artefacts that remain there were simply left on the seabed after she was raised rather than removed by the salvage divers. As it was not possible to survey this site by diving it is possible that some details of what remains there were missed and further investigations might be worthwhile.

The secondary salvage site (SS080) for *Grosser Kurfürst* at Rysa was surveyed by diver in the Phase 1 project. Both samson posts and booms were found there and it was their layout on the seabed, with the derricks and samson posts lying side by side, as well as their design that suggested they originated from a *König* class battleship, on which these structures were arranged on either side of the forward funnel. The *Grosser Kurfürst* was the only ship with this samson arrangement that had a secondary salvage site at Rysa. A large amount of other wreckage was also found here including funnel debris, bridge structure, searchlight platforms and a mast section.

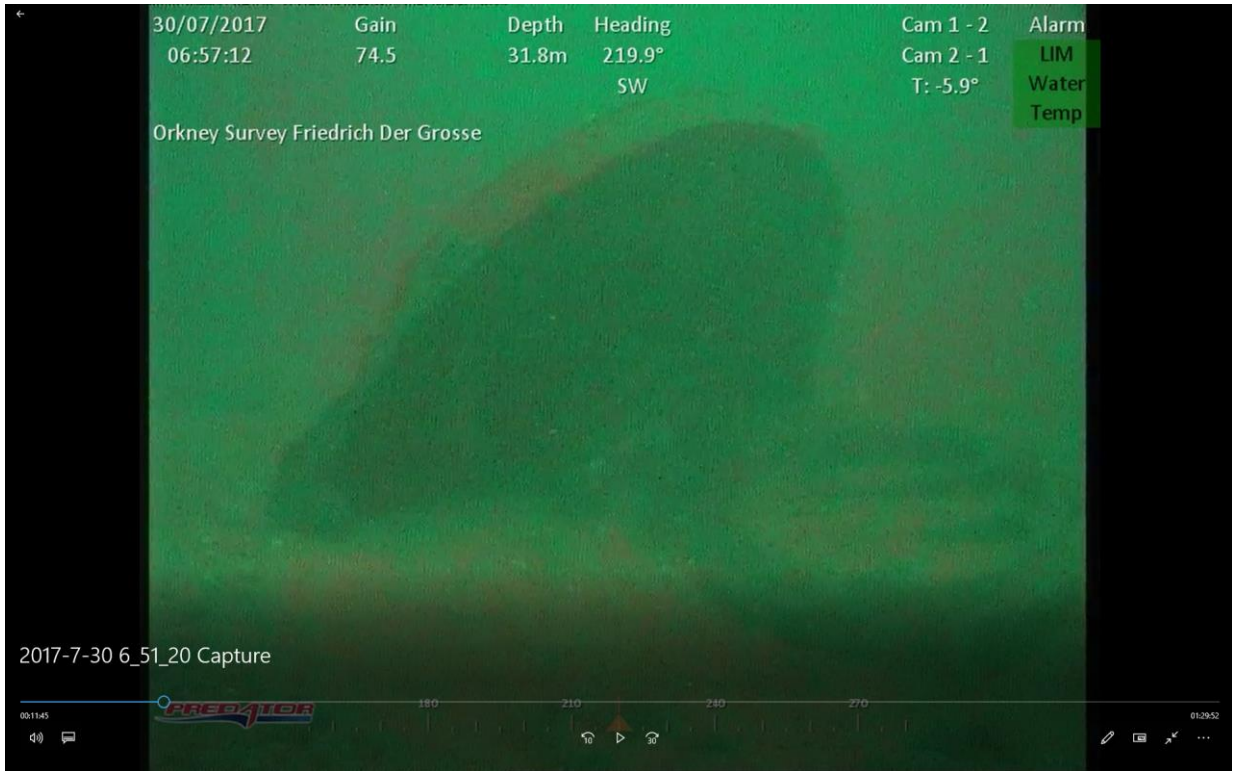


Plate 57: SMS Grosser Kurfürst primary salvage site, aft searchlight platform with possible searchlight unit on seabed below.



Plate 58: SMS Grosser Kurfürst primary salvage site, forward mast spotting top and splinter proof control room.



Plate 59: SMS Grosser Kurfürst primary salvage site, forward mast crow's nest, located below the main spotting top.



Plate 60: SMS Grosser Kurfürst primary salvage site, searchlight platform wreckage near the forward mast.

4.8 SMS *Derfflinger*

4.8.1 *Salvage background*

SMS *Derfflinger* was anchored to the west of Cava and was the furthest west of the battleships and cruisers (Plate 61). She capsized and sank in a depth of approximately 45m with her bows to the north-west.



Plate 61: SMS *Derfflinger* at Scapa Flow, 1919 (K. Heath Collection). Note the distinctive tripod mast.

After more than a year of preparatory work, SMS *Derfflinger* was raised by Metal Industries on 25th July 1939. The following day her tripod and aft masts were blasted off before she was towed to the east side of Rysa where clearance work continued on her superstructure. The after and forward funnels, bridge, mast, control room, portside ventilator, starboard air intake casing, samson posts and miscellaneous components of superstructure hanging below deck level were removed there. The original intention of towing her south to Rosyth was abandoned as too risky due to the onset of World War 2, so on Friday 25th August 1939, *Derfflinger* was moved around to the west side of Rysa, where cleaning of light gear was continued, along with the blasting of remaining portions of funnels and ventilators. On the 5th September 1939, she was moved further inshore so she rested on the bottom at all states of the tide, with the *Cape Ortegat* moored alongside prior to deployment as a blockship (MacKenzie, 1949; Metal Industries Ltd Records D1/59/4/1; The Orcadian 27th July 1939). *Derfflinger* was unable to be taken to Rosyth as the Admiralty required use of the dry dock there so staying at Rysa for seven years. It was often reported that she spent more time floating upside down than upright. In

1946 she was raised and taken briefly to Lyness before being towed south to Faslane on the River Clyde for scrapping¹⁷ (Plate 62) (Buxton, 1992; Pottinger, 1974).

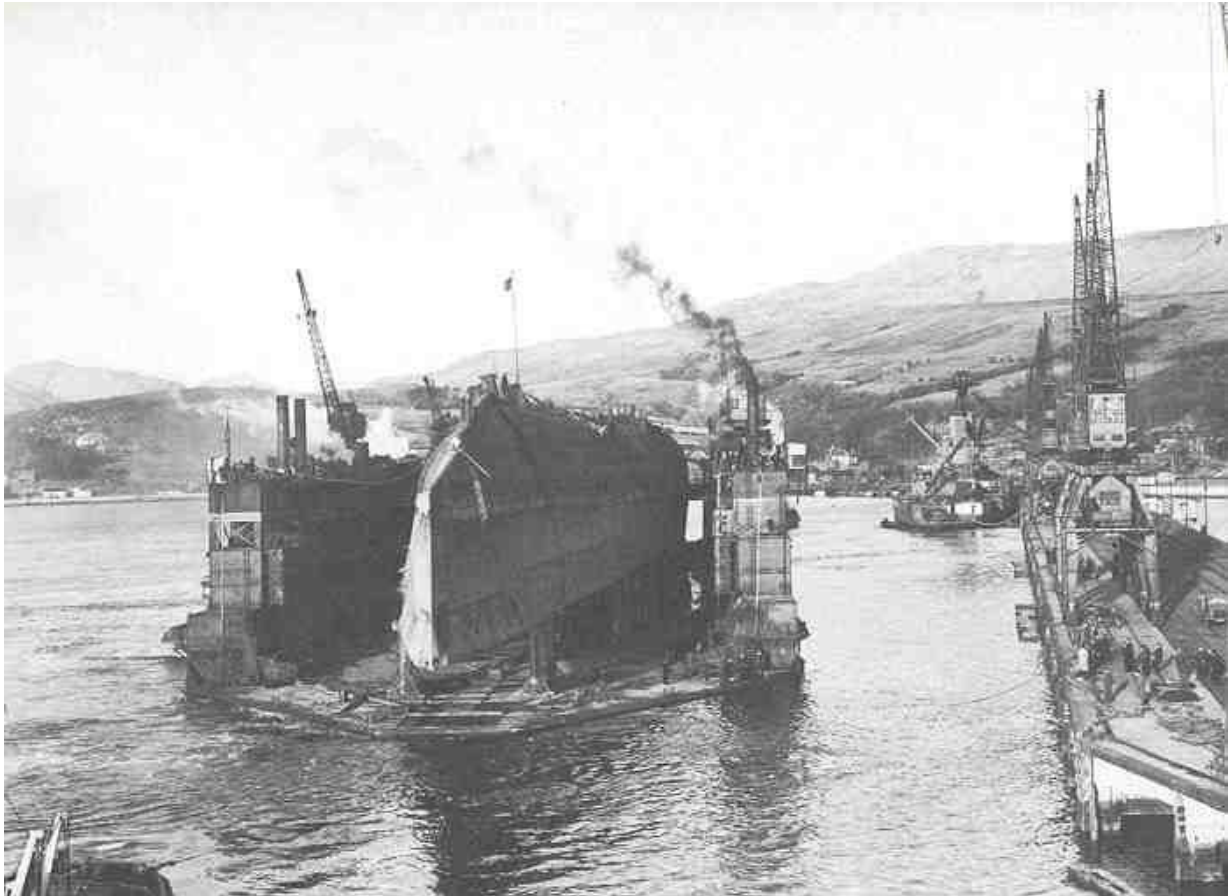


Plate 62: The hull of SMS *Derfflinger* was taken to the River Clyde for breaking up in 1946 (B. Forbes Collection). As the water depth was too shallow the hull was placed on a barge before being towed upstream.

4.8.2 Ground-truthing

The side scan image of SMS *Derfflinger*'s primary salvage site (

Figure 12) shows a shallow depression orientated in a WNW to ESE direction. Several long mast-like contacts were evident along with other smaller items spread across the site. The side scan image of her tertiary salvage site is also shown in

Figure 12 and shows non-descript objects scattered across a wide area. Note that her secondary salvage site on the east side of Rysa was surveyed in the Phase 1 project.

Ground-truthing of the primary site was carried out during the Shiptime Project and by remote video survey in this Phase 2 project. Further information was also contributed by volunteer

¹⁷ There was interest at one time in using the hull of SMS *Derfflinger* as a blockship at the eastern entrance of Skerry Sound (an eastern entrance to Scapa Flow) after the SS *Cape Ortegai*, which had been briefly stored next to *Derfflinger* before being placed as a blockship, rolled over and broke up in a storm but the Admiralty purchased the SS *Ilsestein* instead.

divers in November 2018. The Shiptime survey was carried out on 28th July 2017 and focussed on the contacts in the eastern area of the site. It initially located a large Danforth-type anchor

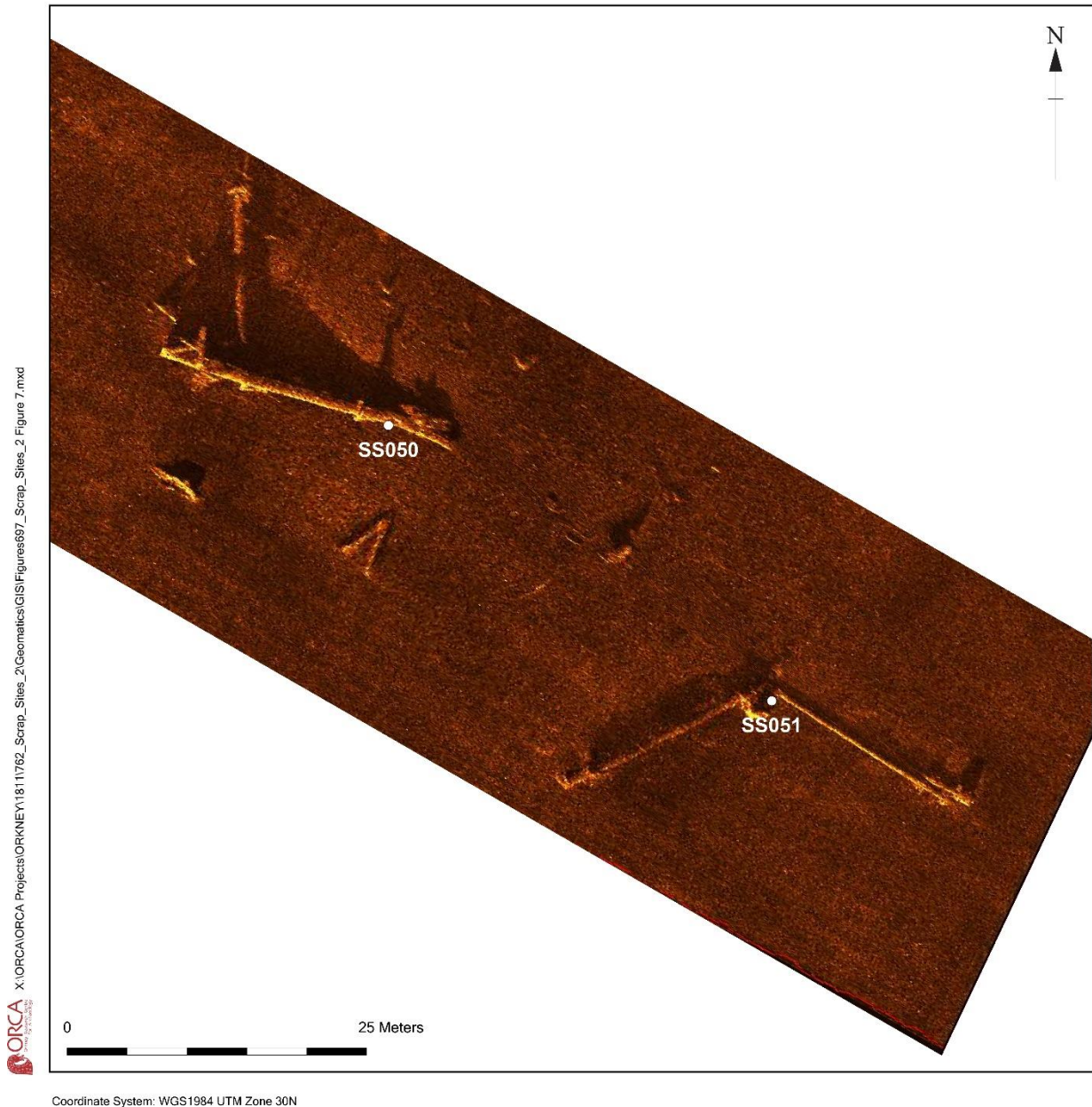


Figure 12: SMS Derfflinger primary salvage site.

(SS122) that most likely belonged to SMS *Derfflinger*. The survey then moved in a north-westerly direction, passing a concrete block, possibly used during salvage operations, and a torpedo mast lying on the seabed, before coming to the aft mast and spotting top (SS051; Plate 65). Inside the spotting top were a number of electrical cables and junction boxes. Lying beside the aft mast was another large tubular artefact. The initial interpretation was that this was part of the aft mast, but further investigation indicated that it was in fact one leg of the forward tripod mast that was fitted to SMS *Derfflinger* (see Plate 63).

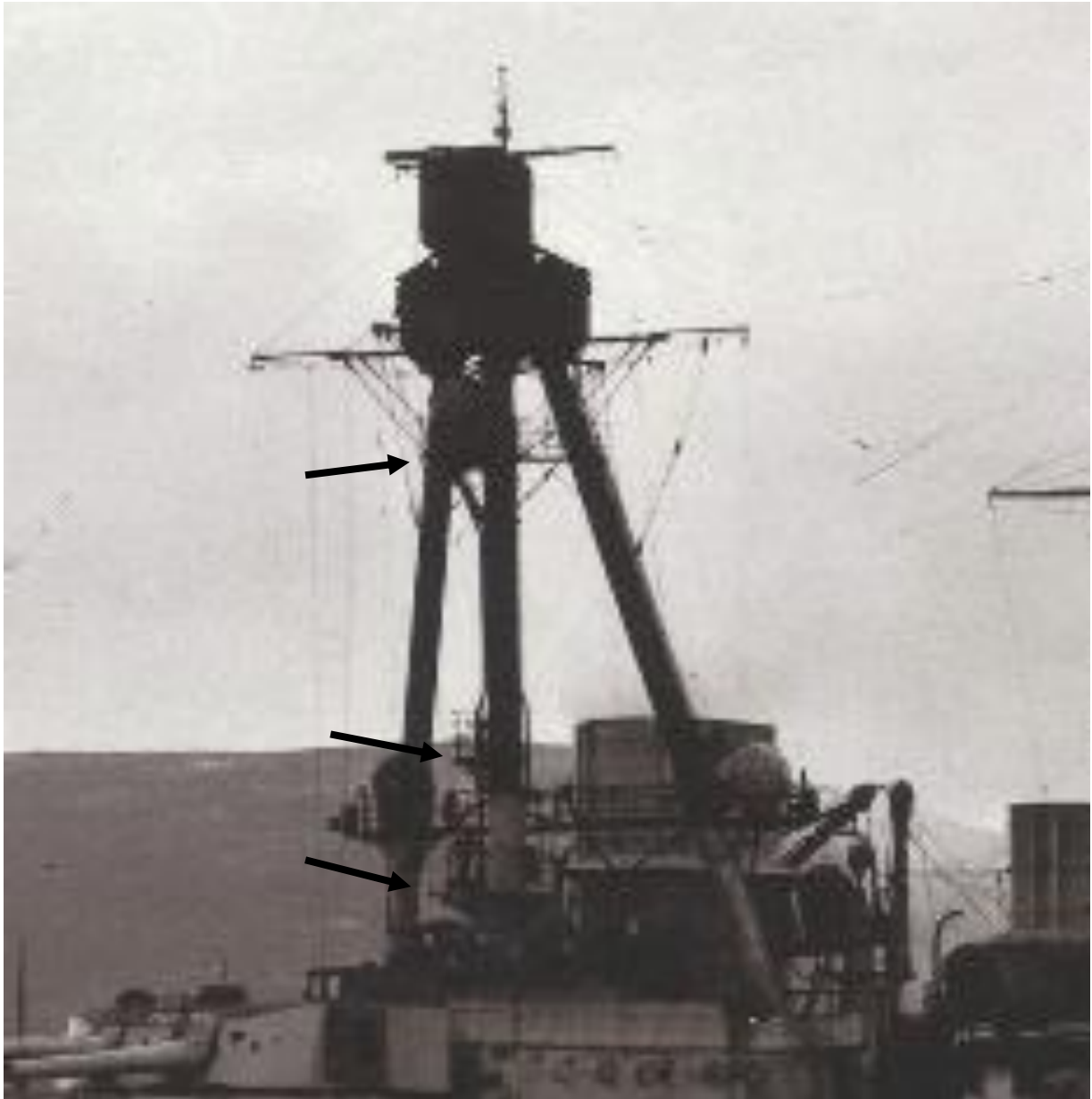


Plate 63: Enlarged view of the tripod mast on SMS Derfflinger, showing the ship-wide searchlight platform supported by the side legs spanning the side legs and the three small platforms located below the spotting top on the centre mast (arrows). Note the searchlight on the upper platform, just below the spotting top.

Moving further north-west the ROV then located a large diesel engine, lying upside down on the seabed, most likely from one of the large diesel boats kept on the deck (Plate 66). West of this, a V-shaped piece of steel wreckage was found, function unknown, which was also evident from the sonar survey. The ROV inspection ceased at this point.

Remote video (7th June and 28th September 2018) and volunteer diving surveys (5th & 6th November 2018) provided more information on the contacts to the north-west of the site. The main constituent of this group was the remains of the forward tripod mast that was characteristic of SMS *Derfflinger* (SS050). The tripod mast was installed during repair works following the Battle of Jutland (Staff, 2014) and comprised a vertical centre mast with a substantial spotting top and two supporting legs that sloped slightly backwards as they ran

down to deck level on either side of the ship. The salvage remains at this site comprised the centre mast and one supporting leg, most likely the port side leg (Plate 67). The other leg was absent. Initially, there was no sign of the large spotting top, although the supporting structure was present near the top of the centre mast along with a small section of floor. Other features of the centre mast were recorded that matched archive pictures. Near the top of the mast (but below the base of the spotting top) were the remains of a single searchlight platform, along with a searchlight mount (Plate 68). Lower down were the remains of a further two platforms, one small one approximately half way down (Plate 69) and another larger one at the bottom of the mast. These were simple, forward-facing platforms surrounded by waist-height railings (Plate 63) that appear to be covered in canvas in some archive images. Small deck mounted objects can be seen on both platforms in certain archive images but what function these objects served, and the purpose of the platforms, is unknown at present.

The supporting leg still attached to the centre mast was bent outwards and lay on the seabed at right angles. The main feature on the supporting leg was the remains of a platform at its lower end. These most likely correspond to the ship-wide platform that was installed between the two supporting legs of the tripod mast, just behind the centre mast. One searchlight was located at either end of the platform (port and starboard) and, like the small platforms on the centre mast, were guarded by railings that were sometimes covered in canvas. As noted above, the other supporting leg (starboard) was found some distance away by the aft mast. Its identification was also made possible by platform remains at one end, reflecting those found on the other supporting leg. How the starboard leg arrived in its present location is unknown.

The remote video survey also recorded the aft mast and observed the small spotting top and the remains of a lower platform that may have supported a searchlight platform. Smaller items seen around the forward mast included what appeared to be a sub-calibre liner and case (round type) and a small boiler, possibly from a steam pinnace.

Considering the substantial spotting top that was present on SMS *Derfflinger's* forward tripod mast, the apparent absence of any remains on the primary salvage site was unusual. Only a section of flooring appeared to remain of the lower spotting top structure, still attached at the top of the centre mast. However, a volunteer diver survey in November 2018 located what was thought to be the splinter-proof control room, lying just to the south of the forward mast (Plate 70). It was upside down and largely buried in the soft seabed, but the robust construction and shape was characteristic. Vestiges of a structure were attached to the underside of the control room and these, along with what was still attached to the centre mast, may be all that remain of the lower compartment. Although it was larger than the control room, its construction would have been lighter in comparison and therefore would have degraded more significantly over the years. The tripod mast has clearly suffered major disturbance either during the scuttling or the subsequent salvage process, so it is possible that the lower compartment was broken up at the same time and scattered across the site. The diver survey also recorded detailed images of the forward mast, aft mast and diesel engine.

Archive research indicated that much of the superstructure, e.g. samson posts and booms, was removed when SMS *Derfflinger* was taken to its secondary salvage site at Rysa. Phase 1 survey work at Rysa could not positively identify any remains at Rysa as belonging to *Derfflinger*, so

further work would be required to achieve this. None of the isolated samson posts found during Phase 1 and 2 correspond in design to those of a *Derfflinger*-class vessel.

The side scan image of SMS *Derfflinger*'s tertiary salvage site (Figure 13) located to the west of Rysa (Figure 14) shows two main areas of debris located approximately 50m apart. Ground-truthing of the tertiary salvage was carried out by dive survey on the 17th July 2018. The site is located between a salmon farm and the west shore of Rysa, extending from a muddy seabed at a depth of approximately 15m up into the shallow rocky subtidal area. Artefacts were scattered across a relatively wide area as indicated from the sonar survey of the site. A dive at the north end of the site (SS086) corresponding to her bow area found a variety of miscellaneous wreckage, including wires, metal sections with weight saving apertures, small davit arms and stays, brass voice pipes, ladder like framework and other objects that were not readily identifiable. The most notable artefacts at this location were a pair of anchor capstan winches that would have been mounted on the foredeck (Plate 71). A large amount of heavy wire hawsers was also evident, which are more likely to be associated with salvage activity. A dive on the site further south (SS088) found a similar collection of miscellaneous wreckage.

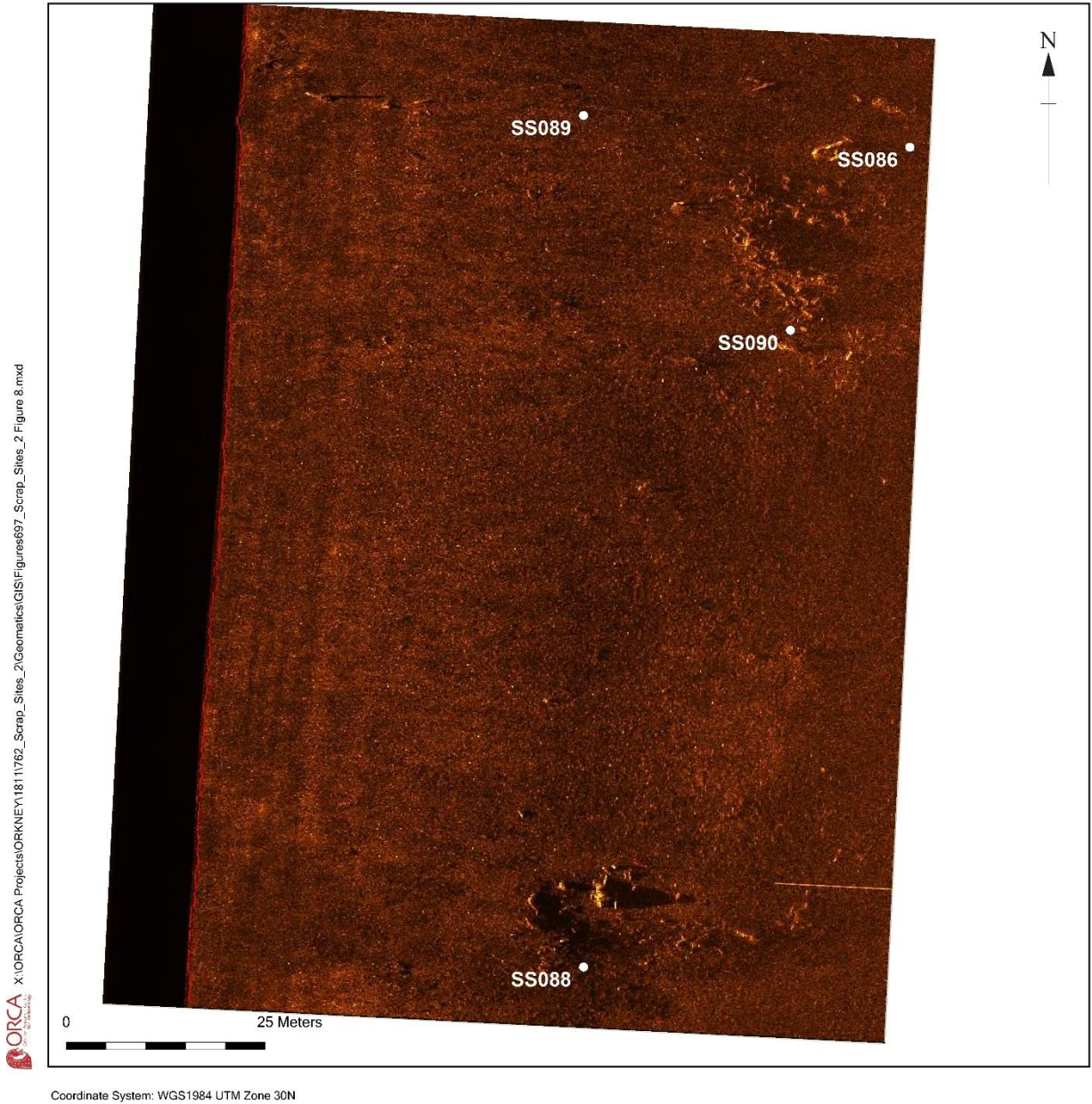


Figure 13: Side scan image of tertiary site (SS086, SS088, SS089, SS090).

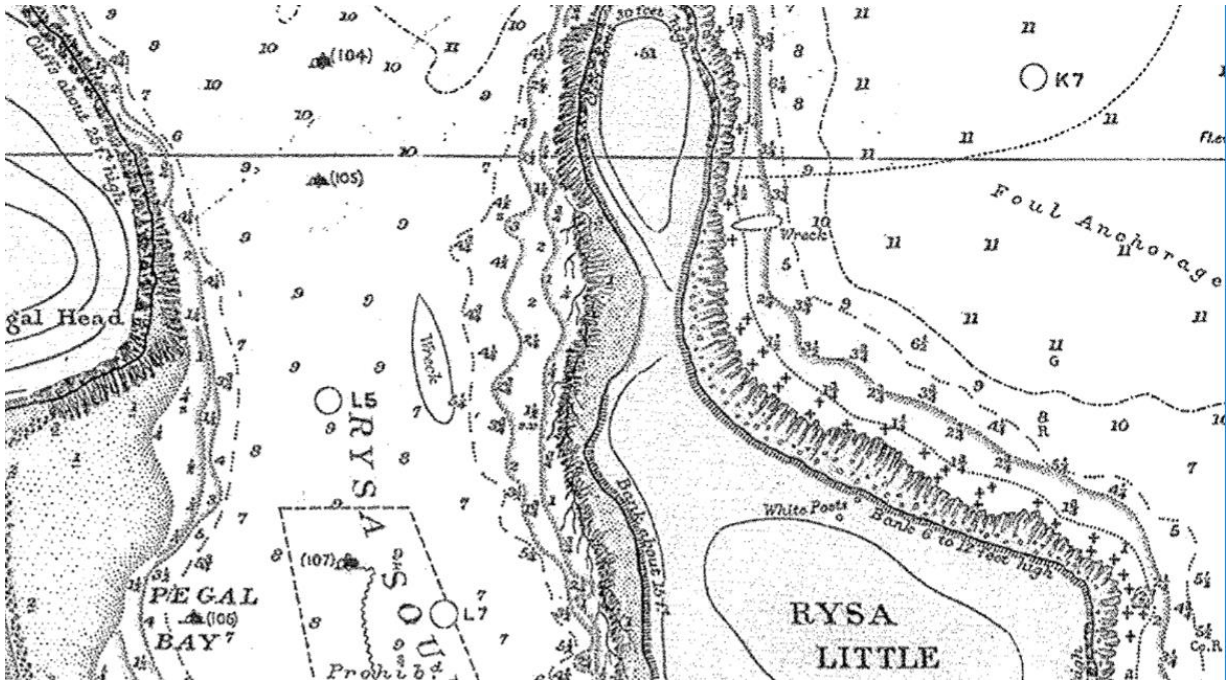


Figure 14: SMS Derfflinger tertiary salvage site used 1939-1946 (UKHO Chart F083, 1940).



Plate 64: Aerial image of SMS Derfflinger at tertiary salvage site, west of Rysa Little, with SS Cape Ortegál moored alongside prior to being deployed as a blockship (K. Heath Collection).



Plate 65: SMS Derfflinger, aft mast spotting top, primary salvage site (image courtesy of B. Anderson).



Plate 66: SMS Derfflinger, diesel pinnace engine, primary salvage site (image courtesy of B. Anderson).



Plate 67: SMS Derfflinger, top of tripod mast showing centre and side (port) leg, primary site. Starboard leg missing (image courtesy of W. Allen).



Plate 68: SMS Derfflinger, searchlight mount near top of tripod mast, primary site (image courtesy of W. Allen).



Plate 69: SMS Derfflinger, small forward-facing platform on middle leg of tripod mast, primary site.



Plate 70: SMS Derfflinger, underside of splinter proof control room, partially buried, primary site (image courtesy of W. Allen).



Plate 71: SMS Derfflinger, tertiary site, main anchor capstans (SS087). The chain pipe cover is visible in the foreground of the lower image.

4.9 SMS *Bremse*

4.9.1 *Salvage background*

SMS *Bremse* was anchored on the north side of Scapa Flow at the mouth of Swanbister Bay. During the scuttling an attempt was made to save SMS *Bremse* by towing her north towards shore. She was beached on a steep slope but capsized and sank, leaving her bows clear of the water.



Plate 72: SMS *Bremse* (K. Heath Collection).

SMS *Bremse* was raised by Messrs Cox and Danks in November 1929 and broken up entirely in Orkney. Preparations began in August when the salvors initially aimed to remove a portion of the forward superstructure, which was landed on the pier as scrap so that the hull could be turned completely upside down. Two floating docks, towed to the site from Lyness, were placed alongside the hull to help achieve this (The Scotsman, Monday 19th August 1929). However, the initial attempt resulted in the hull toppling over onto her opposite side. The floating docks were removed and air locks fitted along the exposed portion of the hull with a view to removing the vessel's upper works and improving its stability. It was also reported that the contents of a fuel tank were set alight to get rid of the oil, which had proved troublesome to the men at work inside the vessel (The Scotsman, Friday 20th September 1929).

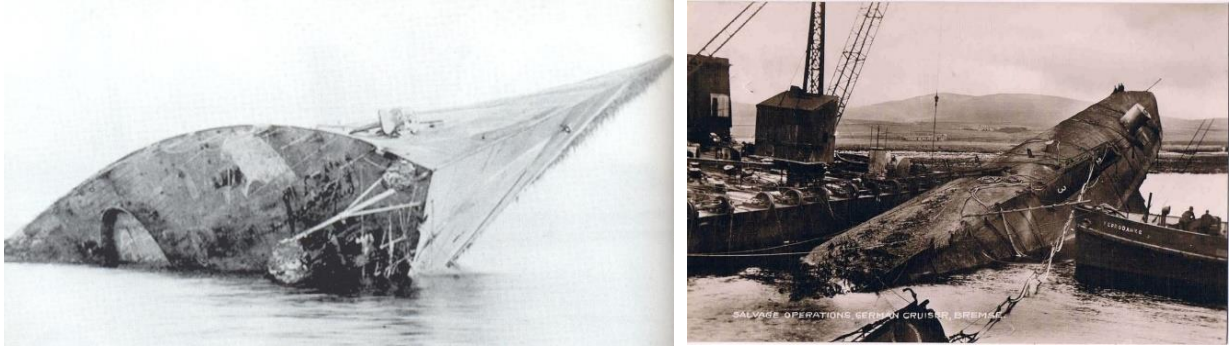


Plate 73: SMS Bremse after its scuttling (left) and during salvage (right). B Forbes & K Heath collections.

After some obstructions were blasted away, including the forward mast, the ship was ready for towing. This was delayed by bad weather that caused the hull to move and lose buoyancy (Dundee Courier, 2nd December 1929). She was successfully towed to Lyness shortly after this, as reports describe her being resting upside down at Lyness pier on concrete supports after salvors had removed her two propellers, each weighing 22 cwt (1.1 tonnes). Breaking work was delayed for Christmas and was scheduled to recommence in 1930 (Dundee Courier, 24th December 1929). By March 1930, the *Bremse* had been floated further inshore in order to access the lower levels of the engine rooms (The Scotsman, 26th March 1930).

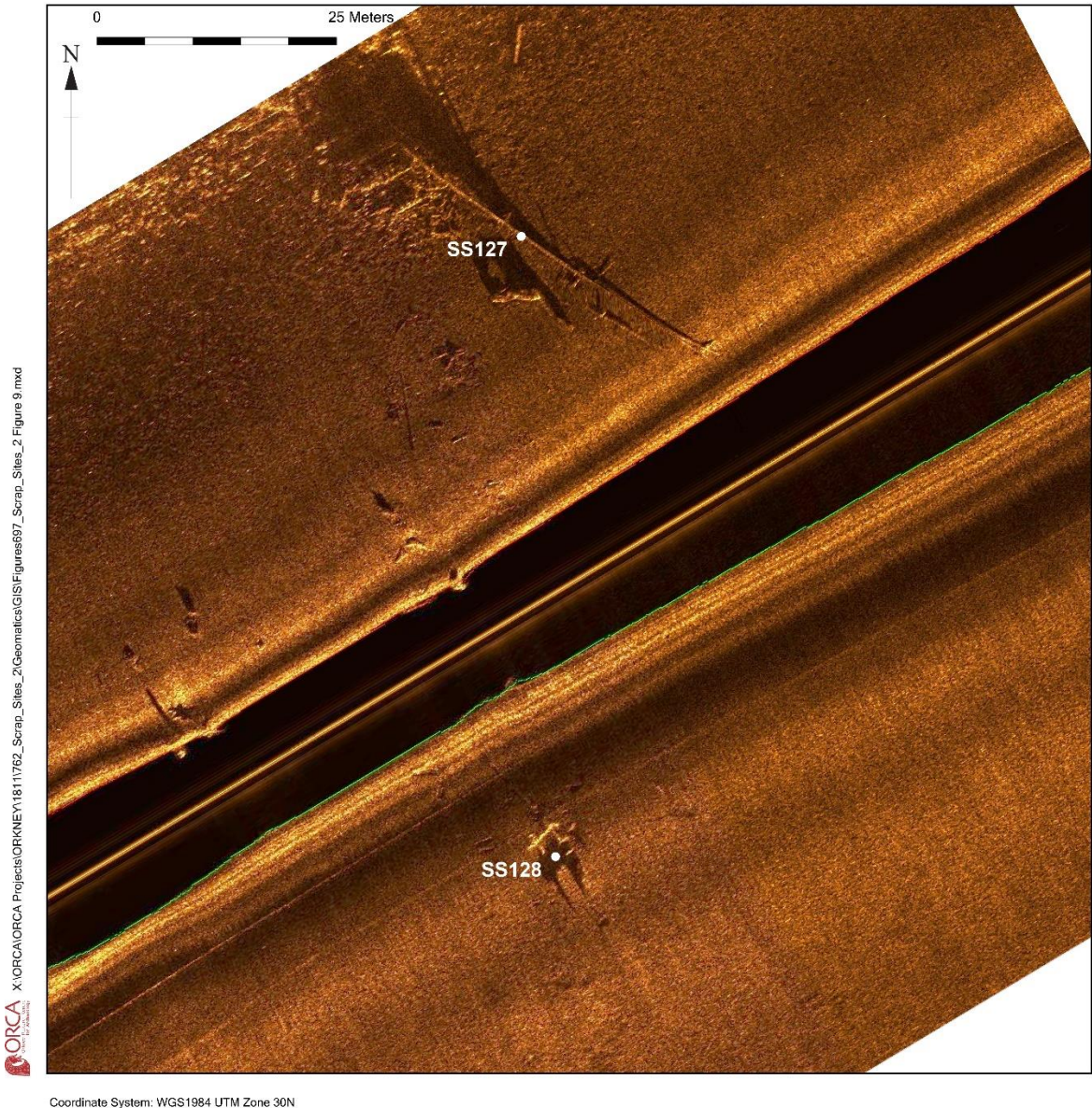
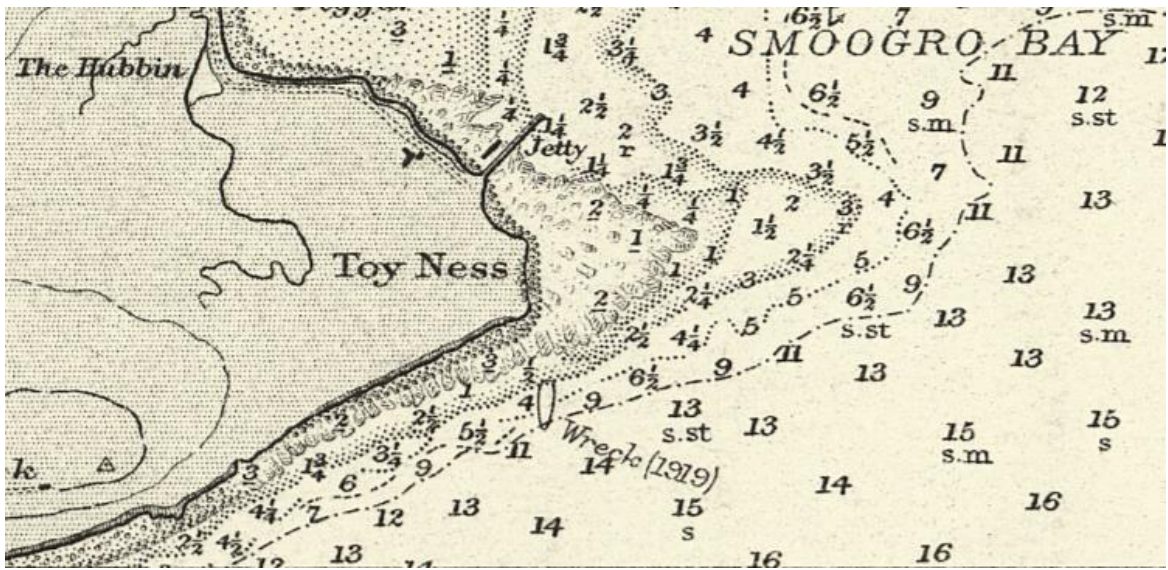
4.9.2 Ground-truthing

A side scan image of the *Bremse* site is shown in Figure 15. The main feature of the site is an area of indistinct wreckage that includes what looks like a mast. Various other smaller objects are scattered around the site.

Ground-truthing material was submitted by members of the OSAC, who dived the site in May 2014. This shows a large area of non-descript wreckage in the area of the mast, of which only the shoreward (bottom) end was recorded (SS127). Away from this main area a variety of large and small pieces of debris were scattered across the seabed to the east and south (Plate 74). This included some large areas of decking, one of which provides a “swim-through”, remains of the forward capstan winch, a small boiler, a lifeboat davit and an artefact that appeared to be the remains of an aft platform with a searchlight base unit (Plate 76). Also associated with this platform was a circular metal frame with a cross on the inside.

The site of SMS *Bremse* is relatively extensive with a variety of interesting artefacts. As noted above, the *Bremse* was accidentally rolled over onto her other side during the salvage process, which may have dislodged some of the artefacts that are on the site today. The forward mast was a particularly interesting feature of the side scan survey, but unfortunately no video footage of it was available. The isolated searchlight platform (SS128) was of a different type to that seen on the larger vessels and correlated closely with the aft platform in the archive image of SMS *Bremse* (Plate 75). In the same image, a small object can be seen on the aft end of the platform. It is likely that this feature was a night speed indicator (‘Nachtfahrtanzeiger’ in German) and was used to order speed changes to the fleet sailing inline ahead formation during the hours of darkness (Plate 76). The circumference and cross members of the frame were

lined with small bulbs which could be illuminated in different sequences corresponding to different commands. They were rear facing to be visible to following ships only and therefore could not be seen by enemy ships (Samuel, 2018). Different lighting configurations are shown in (Plate 77). This was the only example of its type in the salvage site project.



X:\ORCA\ORCA Projects\ORKNEY\18111762_Scrap_Sites_2\Geomatics\GIS\Figures\97_Scrap_Sites_2\Figure 9.mxd

Coordinate System: WGS1984 UTM Zone 30N

Figure 15: SMS Bremse, primary salvage site at Toy Ness marked on Admiralty Chart 3729 (1925) (top) and the side scan image of the area (SS127 & SS128) (bottom).



Plate 74: SMS Bremse, primary salvage site, showing miscellaneous wreckage, deck plating and a small boiler (images courtesy of OSAC).

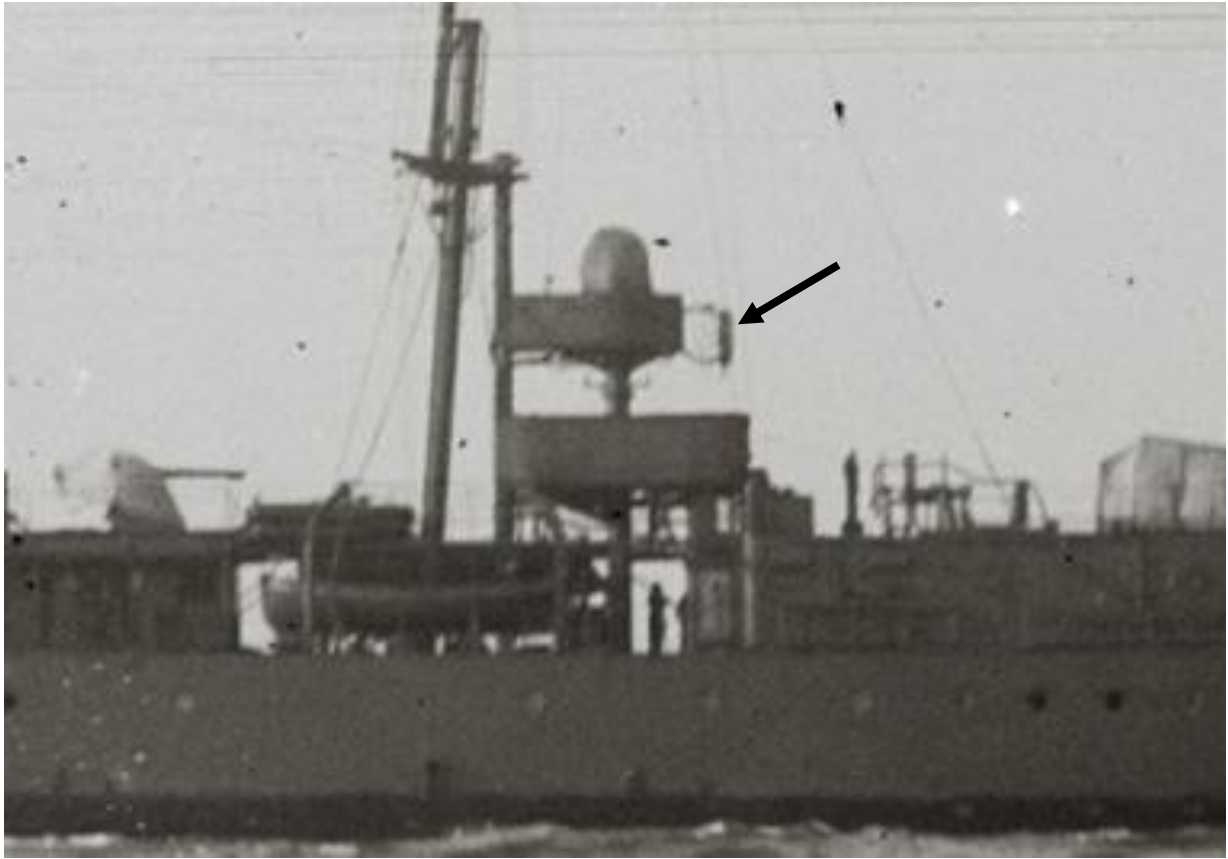


Plate 75: SMS Bremse, archive image showing the aft searchlight platform (top) and its remains on the salvage site (bottom). Note the structure in place on the aft end on the searchlight platform in the archive image (arrow).

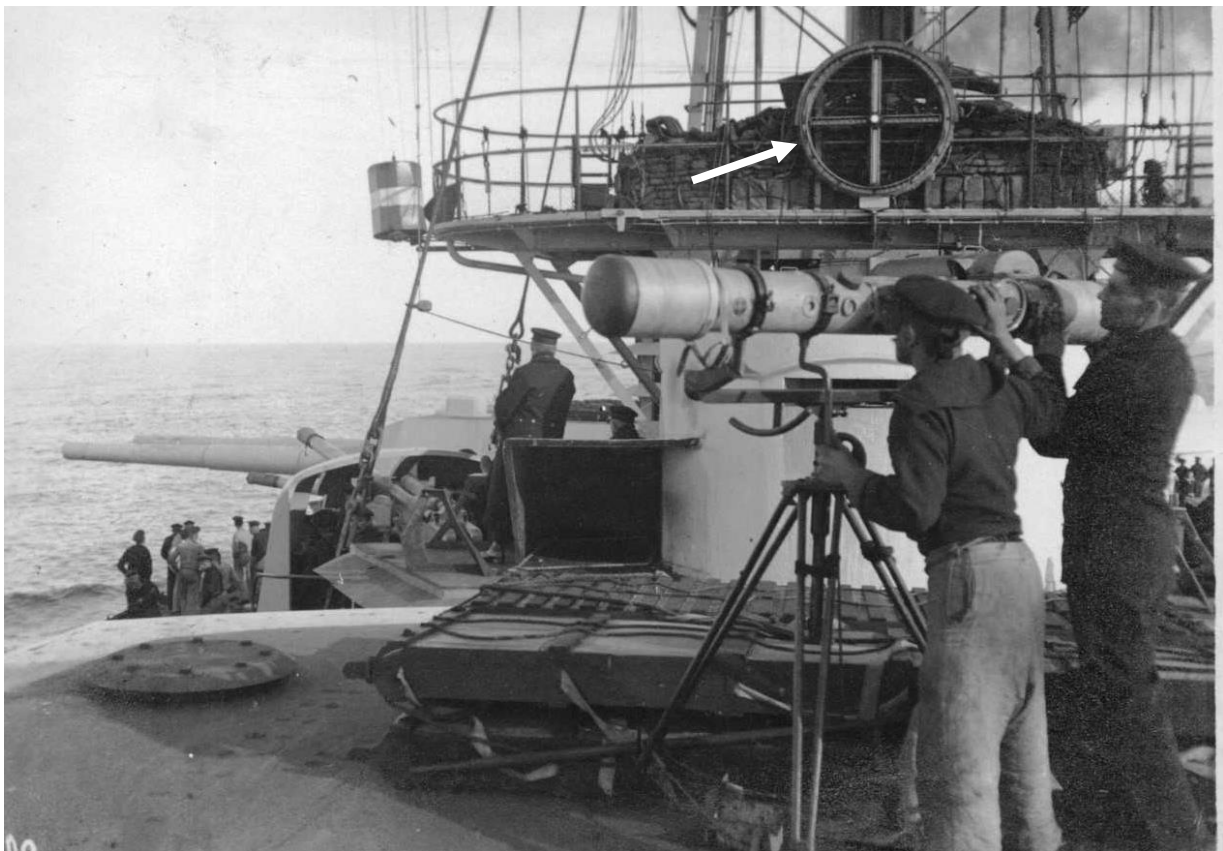


Plate 76: Remains of a night speed indicator (top) attached to the remains of the aft searchlight platform (top). A similar unit (arrow) installed on SMS Moltke is also shown (bottom) (images courtesy of OSAC and G. Staff).

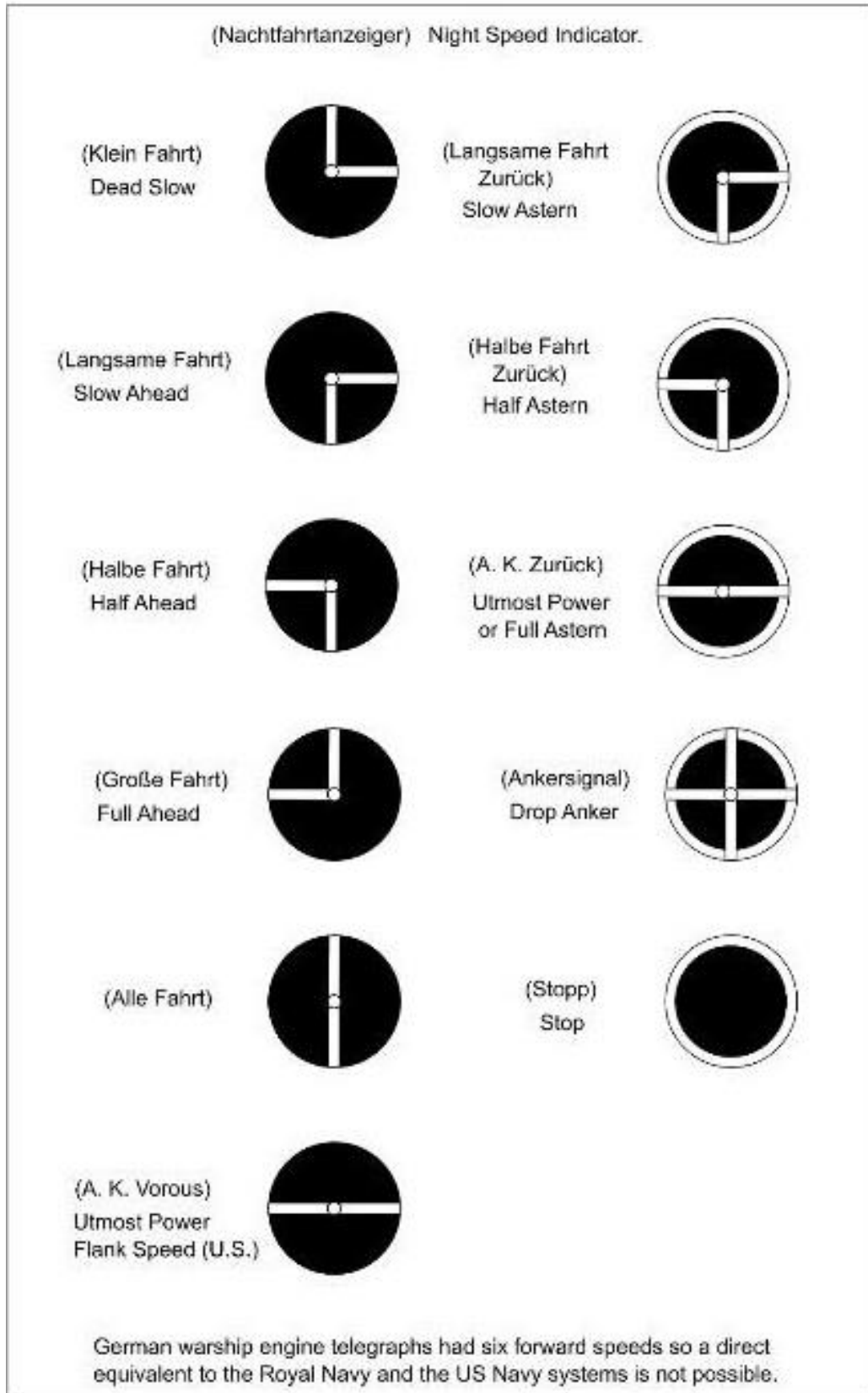


Plate 77: Night speed indicator signals and commands (Samuel, 2018).

4.10 SMS S36

4.10.1 Salvage background

The destroyer *S36* was anchored in Gutter Sound to the north-west of Fara. She sank in a depth of approximately 20m. She was raised in April 1925 by Messrs Cox and Danks. Initial dive inspections found that she was lying on her side. As was usually the case for destroyer salvage, barges were positioned on each side of the vessel from which wires were deployed under the hull of the target vessel. The *S36* was righted, lifted and moved to Lyness over a period of six days, despite a major fire breaking out on one of the lift barges during the recovery. Further inspection revealed that the *S36* was badly holed and the decision was made to keep her at Lyness for breaking (The Scotsman, 20th April 1925). Rather than being completely broken up however, the hull of the *S36* was left more or less intact and towed to the west side of Cava later in 1925¹⁸. Here she was sunk in shallow water with the specific intention of using her as an anchor in the planned salvage of SMS *Hindenburg*, which occurred the following year. The deployment of *S36* and the subsequent salvage was documented in a Pathé newsreel clip titled “A Colossal Task. The raising of sunken German Flagship ‘Hindenburg’” (Plate 78). This was one of many examples of destroyer hulls being re-purposed by Cox and Danks to aid in the recovery of the larger German ships. Two other destroyers (one being the *G38*) were used as breakwaters during the later stages of the *Hindenburg* salvage. *V70* was converted to a floating workshop and a section of the destroyer *S136* was used in the salvage of SMS *Seydlitz*.

4.10.2 Ground-truthing

The side scan image of the *S36* (Figure 16) site shows a large deposit of indistinct wreckage located in shallow water on the west side of Cava. A ground-truthing survey was carried out by a team of volunteer divers from BSAC on the 13th April 2018. Video footage taken during the survey shows the wreck to be well broken down with only a couple of pieces of wreckage standing higher than 2m off the seabed (Plate 79). The hull appears to have been completely stripped of all fittings apart from through hull valves which would have been left to maintain watertight integrity for towing to final sinking position. All engines and boilers had been removed, as had the propellers, although both propeller shafts were still in place (Plate 80). Numerous deck fittings including bitts and cleats were also present. This class of destroyer was fitted with a bow rudder, and the steering mechanism and a section of the bow is exposed at low water (Plate 81).

¹⁸Two UKHO wreck numbers exist for the *S36*. The UKHO wreck number 1073 records that: in 1925 it was reported that “S 36 BEACHED ON W SIDE OF CAVA”; in 1975 the identity of the wreck was changed to SMS “Nurnburg”* by a group of divers from RAF Lincoln; that this identification was formed “FROM LOCAL INFORMATION & BOOK ‘JUTLAND TO JUNKYARD’ BY S C GEORGE”; the wreck was described as “only a bow section remains, and what remains of that is considerably broken up”; in March 2009, UKHO reverted the name to S 36 Bow section after discussion with K Heath 20.2.09. The wreck is still listed as Nurnburg in the Canmore database. The UKHO wreck number 1010 record does not relate to the charted wreckage at Cava, but is the *S36* original report from 1919 until the lift in 1925, including a reference in the survey details to “WORK OF GUTTING S 36 COMPLETED. SHELL TO BE USED ON HINDENBURY[sic]. CP17774/28 SALVAGE REPORT. CP22830/28 & CP27298/29 BEACHED ON W SIDE OF CAVA.”

*SMS Nurnburg was beached on Cava during the scuttling in June 1919. She was subsequently refloated in July 1919 and used as a target off the Isle of Wight where she sank in 1922.



Plate 78: Pathé newsreel clips of Destroyer S36 being sunk off Cava (copyright Pathé).

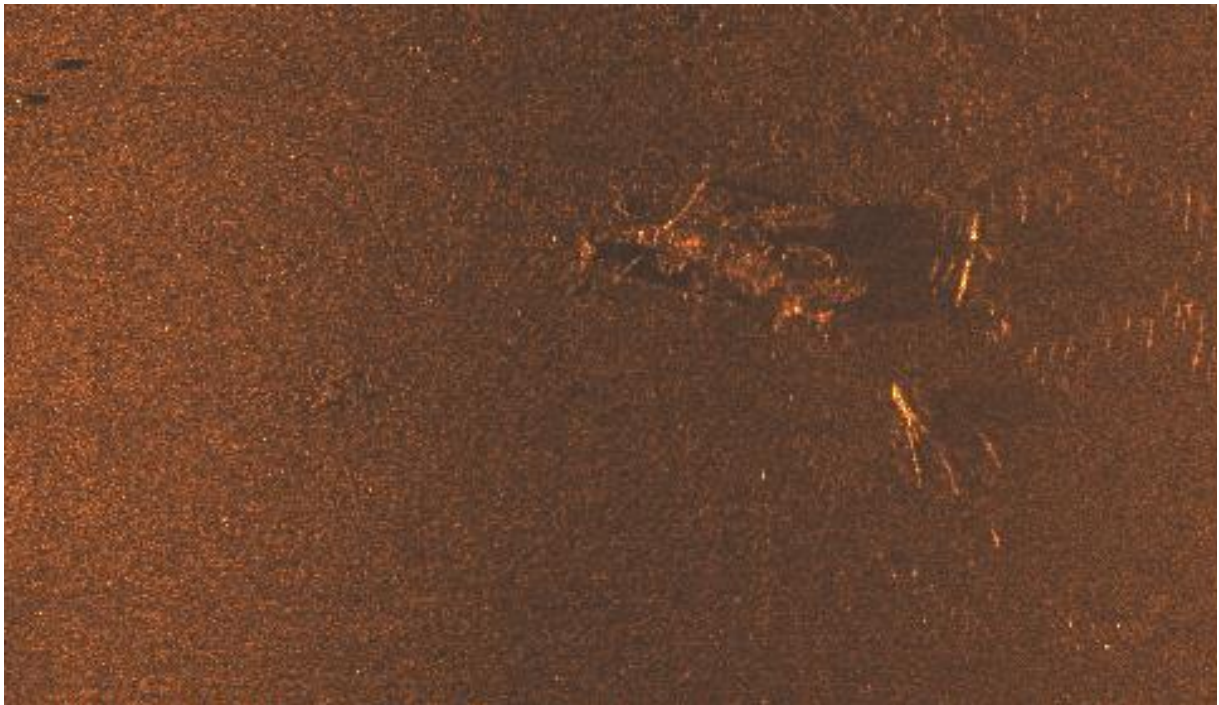


Figure 16: Side scan image of SMS S36 wreck site to west of Cava.



Plate 79: SMS S36, hull plating on the seabed (image courtesy of BSAC).



Plate 80: SMS S36, propeller shaft (image courtesy of BSAC).

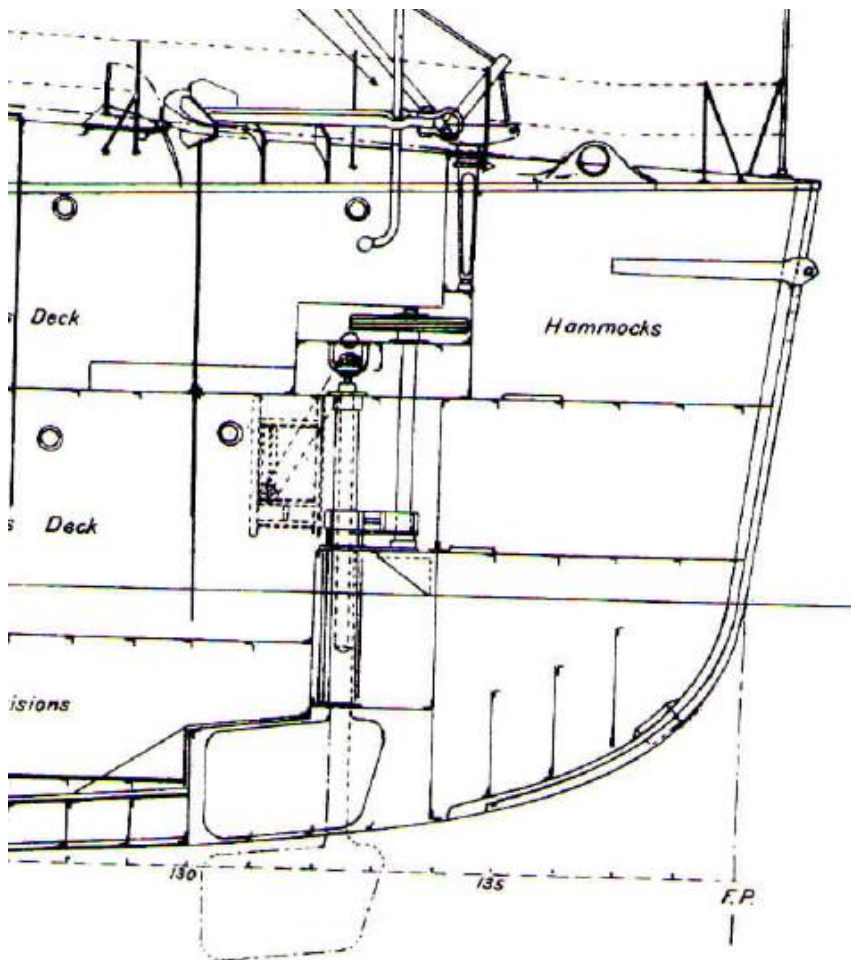


Plate 81: SMS S36 at Cava, bow steering gear remains (top, image courtesy of P. Balazy) and a schematic of the bow rudder arrangement (bottom).

4.11 SMS B109

4.11.1 Salvage background

The destroyer SMS *B109* was also anchored, like *S36*, in Gutter Sound to the north-west of Fara. It is thought the *B109* was raised by Messrs Cox and Danks in March 1926. The mid-section of *B109* is reported by the UKHO as being re-sunk just north of Lyness at the mouth of Mill Bay, for unknown reasons. The identity of this charted wreck is questionable however, as other records indicate that the *B109* was sold along with the *G101* and *G104* to the Alloa Shipbreaking Company in June 1926 for a total price of £1800 and was taken to Rosyth on 25th June, where breaking up commenced on 10th July 1926 (Buxton, 1992).

4.11.2 Ground-truthing

The side scan image for the *B109* site in Mill Bay, Hoy is shown in Figure 17. It shows a distinct wreck site 11m long and standing 3.1m off the seabed. The site was ground-truthed by diving on the 3rd October 2018. The wreckage was degraded and appeared to comprise only a section of a vessel (Plate 82). It was determined to be German in origin, identified by writing on some electrical junction boxes (Plate 83). The wreckage included a chain locker, which was full of chain, but chain was also found running over the deck and passing through two deck fairleads. It is possible this is a steering mechanism and the stern section of a destroyer. It is unlikely however, to be a part of *B109* as this vessel was recorded as being raised complete before being towed to Rosyth and scrapped, as noted above.

A number of destroyers were used by Cox and Danks for various projects and these were cut up and modified at Lyness. *V70* was turned into a floating workshop and sections of others were used in the salvage of the SMS *Hindenburg*. It is likely that this wreckage is part of a different German destroyer (as yet unidentified) that was cut up for such use.

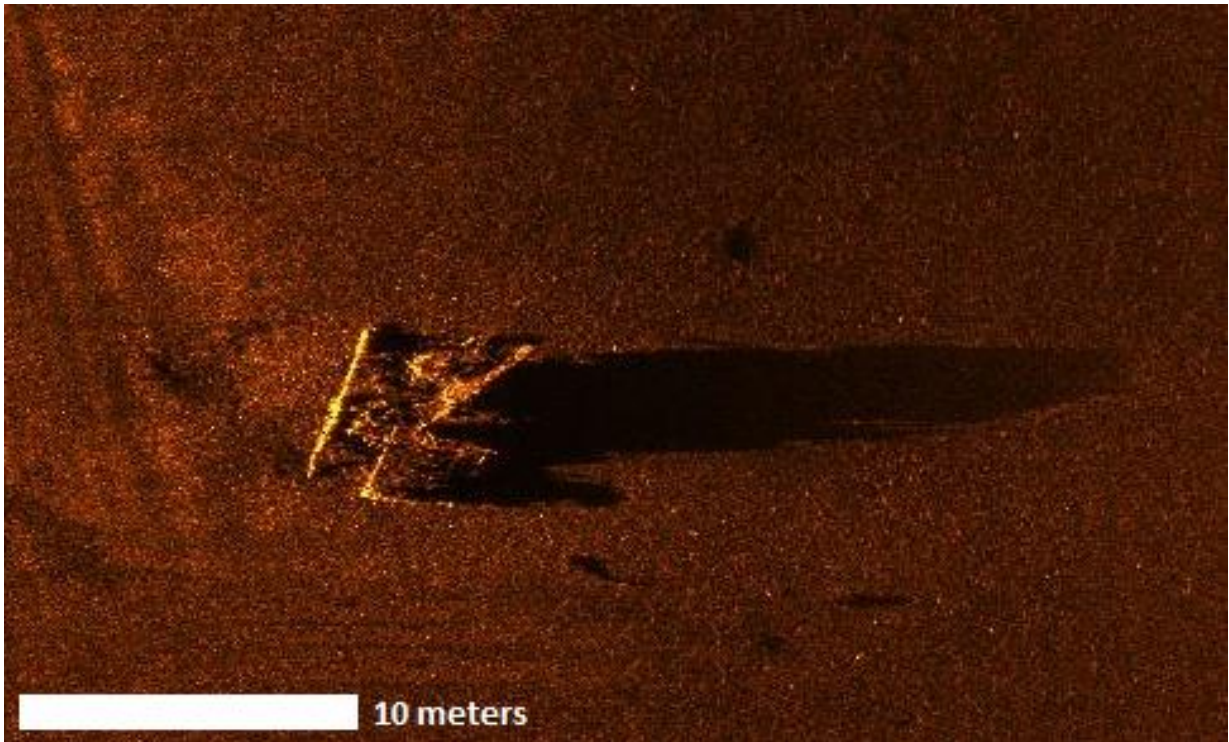


Figure 17: Side scan image of wreckage in Mill Bay, Hoy (SS105). It is thought that the chart entry for the site, which states it is the remains of B109, is incorrect.



Plate 82: Wreckage in Mill Bay, on incorrectly charted site of B109.



Plate 83: Electrical box with the wording "N&K Stromkr Lampen" at incorrectly charted site of B109 in Mill Bay.

4.12 SMS V78

4.12.1 Salvage background

The destroyer SMS V78 was anchored close in to the north-east shore of Fara and was raised by Messrs Cox and Danks on 7th September 1925. In terms of destroyer salvage, the V78 proved a difficult task, as it lay upside down and partially buried in sand. After floating docks were positioned over the wreck, divers used water jets to blow channels through the sand so that 9-inch wire hawsers could be passed under the deck of the ship. Further work was required to seal part of the hull so that air could be pumped in to assist the lift. The lift was eventually successful and the upturned hull was taken to Mill Bay, just north of Lyness, where it was lowered to the seabed again and turned upright, while still in its lifting cradle. From start to finish the operation took 14 days, seven of which were lost due to bad weather. After righting, the vessel was taken to Lyness and broken up (The Scotsman, 9th September 1926).

4.12.2 Ground-truthing

The side scan image for the V78 site is shown alongside the corresponding section of the Admiralty chart for 1923 (Figure 18). UKHO Wreck card number 1027 (created in 1919) related to V78 and its salvage in 1925. The wreck was deleted from hydrographic charts in 1930, although the wreck card entry was only amended to “DEAD” in 1965.

In 1975, a new wreck card (1034) was produced for the V78 site that reads as follows:

“H1287/75 16.10.75 POSN 585130N, 030935W. LIES IN APPROX 10MTRS, MTB VERY BROKEN UP. MENTIONED IN 'JUTLAND TO JUNKYARD' BY S.C. GEORGE. NOT SHOWN ON COMPUTER PRINTOUT OR CHARTS. (CPO DUNFORD, RAF LINCOLN, LTR DTD 15.8.75)”.

This card was created following the “discovery” of a wreck by members of RAF Lincoln Dive Club. It is unclear where the term MTB (motor torpedo boat) comes from because George (1973), the source referred to on the wreck card, lists the wreck in that location as a “VTB”, possibly meaning a V-class torpedo boat. Several dive guides published since 1975 that have used UKHO information extensively have repeated the reference to the remains of an MTB in this location (Ferguson, 1985; Macdonald, 1990). Despite this rather confusing background, it is clear that the remains referred to on wreck card 1034 are those of the V78.

No ground-truthing was carried out as part of this project. The area was dived in 1998 by one of the authors of this report, and the remains of a funnel and a base of the bridge section were found hard pressed into the sand. A ship’s telegraph was recovered (Plate 84) marked V-78 and is now in a museum in Stettin, Germany (RoW Droit number 754/99). Only very small items are thought to be present on the site, including a large number of brass flag Inglefield clips, most likely from the signal room.

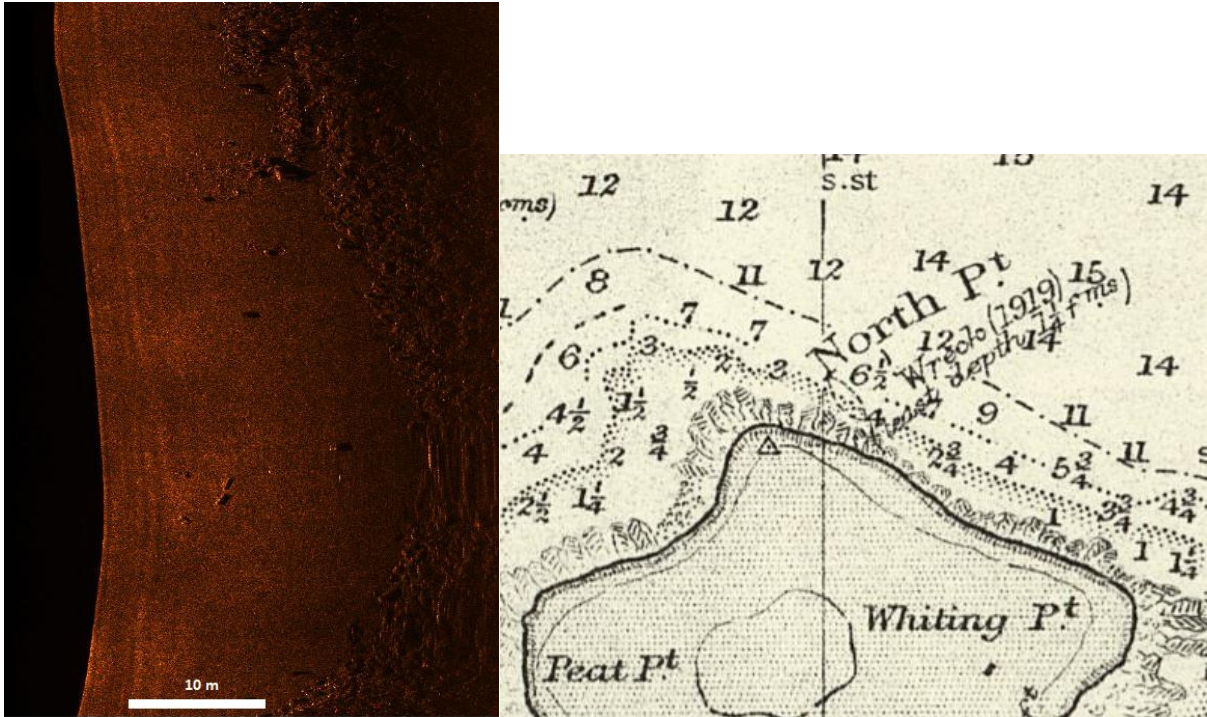


Figure 18: Side scan image of the V78 salvage site (left) and UKHO chart 3729 (1923) showing its original location on the north side of Fara (right).

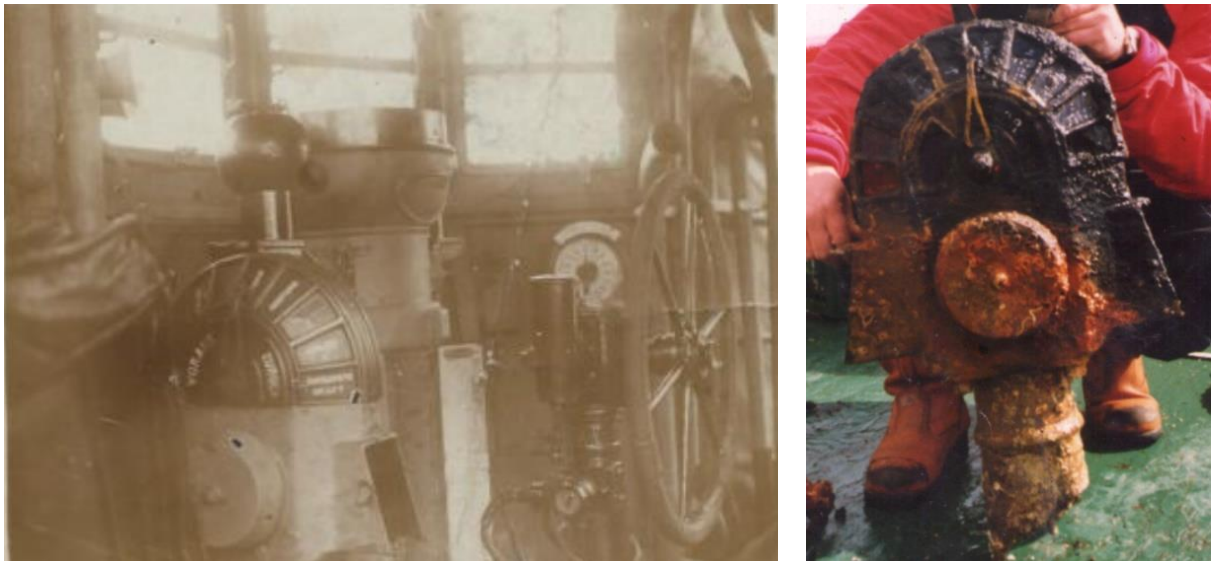


Plate 84: Telegraph on a German destroyer (left) and the telegraph from V78 after recovery in 1998 (right) (K. Heath Collection).

4.13 Miscellaneous contacts

During the side scan survey for Phase 1 of the Salvage Sites Project, a number of contacts were located away from the main areas where the ships were scuttled or the secondary sites. It was decided to look at these sites in Phase 2 to establish if these were connected to the salvage operations on the German Fleet.

4.13.1 SS042 & SS049

A side scan images of SS042 & 049 are shown in Plate 85. Both sites were ground-truthed by volunteer divers who were attending the European Scientific Diver Conference in April 2018. Contact SS042 was found to be searchlight platform lying upside down on the seabed. One set of gears for operation of the searchlight was present but no searchlights were attached to the platform. Due to its location it is probable this was from SMS *Kaiser*, which was initially towed to this location before being taken to Lyness. SS049 also proved to be a searchlight platform with remains of controls present. Its location suggests that the platform most likely originated from SMS *Moltke*, which was beached in this location (off Cava) prior to being taken to Lyness.

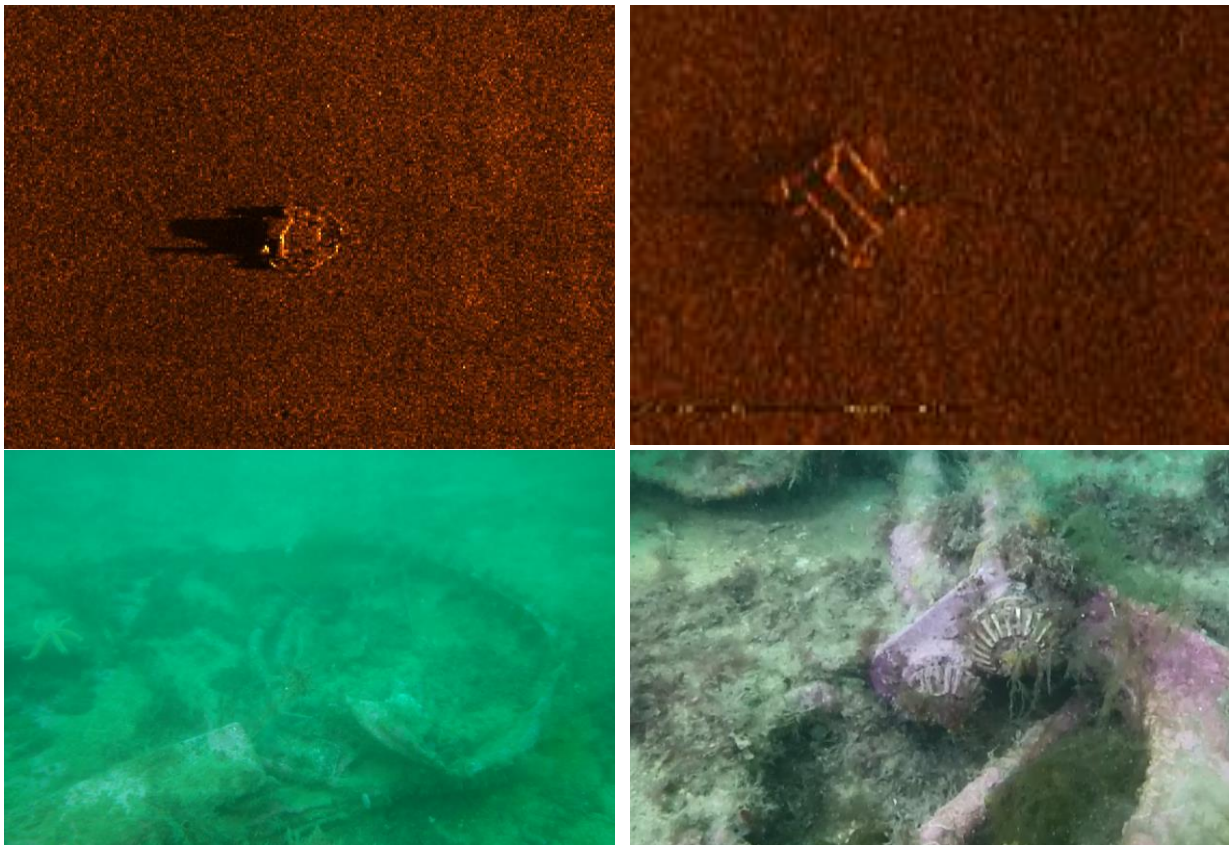


Plate 85: Side scan images SS042 (top left) and SS049 (top right) proved to be isolated searchlight platforms. Photographs of SS042 show the platform (bottom left) and remains of a searchlight control (bottom right) (images courtesy of BSAC).

4.13.2 SS101

This isolated contact was located at the northern end of Gutter Sound on the “sandbar” often referred to in the salvage reports. The salvaged vessels had to be able to clear this feature in order to reach Lyness and, consequently, some work was done here to remove further any obstructions. It was surveyed by remote camera and subsequently by divers on the 9th October 2018. A samson post complete with boom was found at the site, with no other wreckage visible, which is shown alongside the side scan sonar image in Plate 86. The post showed clear evidence of blasting.

Although material from several different ships may have been left here, including from SMS *Bayern*¹⁹, further investigation showed that the style of samson post found at the site was typical of a *Kaiser* class vessel, as the arrangement at the head of the post is different to the *Bayern* class vessels (Plate 86 & Plate 87). As noted above, samson posts were missing from the primary salvage sites of SMS *Prinzregent Luitpold* and SMS *Kaiserin* (those from SMS *König Albert* are thought to be accounted for elsewhere) and this artefact may belong to one of those two vessels.

4.13.3 Lyness contacts (SS112, SS113)

Two sonar contacts were detected just off Lyness pier (Figure 19) and were surveyed by divers on the 3rd and 9th October 2018. The closest one to the pier (SS112) was a mast section while the contact further out (SS113) comprised an area of metal debris consisting of a small platform, electrical wires and a short section of mast (Plate 88). As Lyness was a focal point for much of the salvage work after the ships had been raised and cleared of any obstructions that would prevent towing, it is almost impossible to say which vessel these artefacts might have originated from. Several other sonar contacts were detected nearby had been previously investigated and found to be funnel remains (Christie, et al., 2013). SMS *Moltke* was known to have caught some of its remaining superstructure on the seabed just off Lyness pier that halted the towing operation (Aberdeen Press & Journal, 1st September 1927).

¹⁹ “The 28,000-ton battleship Bayern, which was raised by salvage men in Scapa Flow during the week-end has been towed to within a mile of Lyness. The ship now rests on a sandbank in 60 feet of water. It is intended to blast away wreckage from the decks, and with the spring tides next week complete the towing to Lyness.” (Coventry Evening Telegraph 4th September 1934).

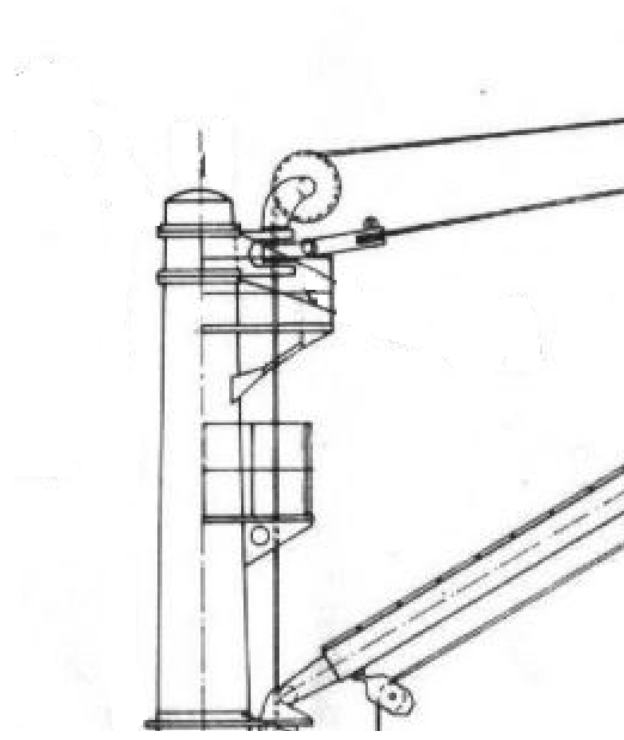
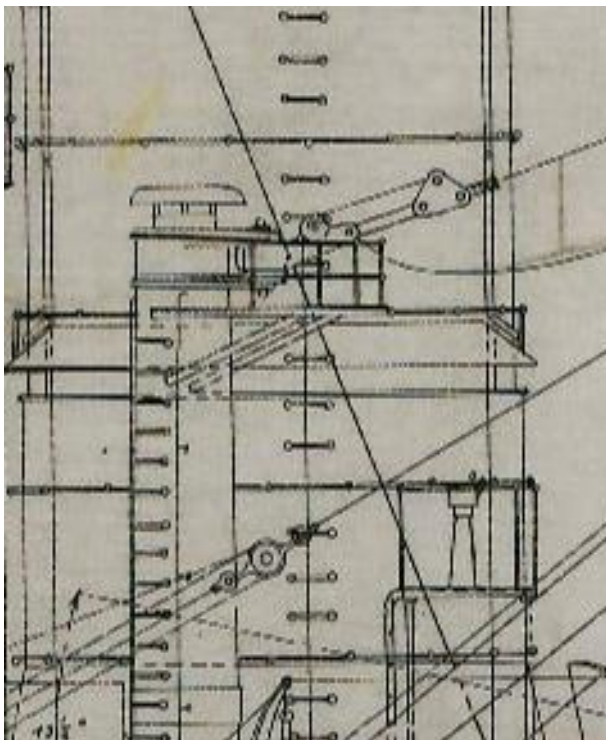


Plate 86: Side scan contact 101 (image as inset) located in Gutter Sound was a samson post and boom (top) typical of Kaiser-class vessels. Samson post detail from Kaiser-class (left) and Bayern-class vessels (right) (B. Forbes Collection).



Plate 87: Top of samson post showing tri-plate arrangement, Gutter Sound.

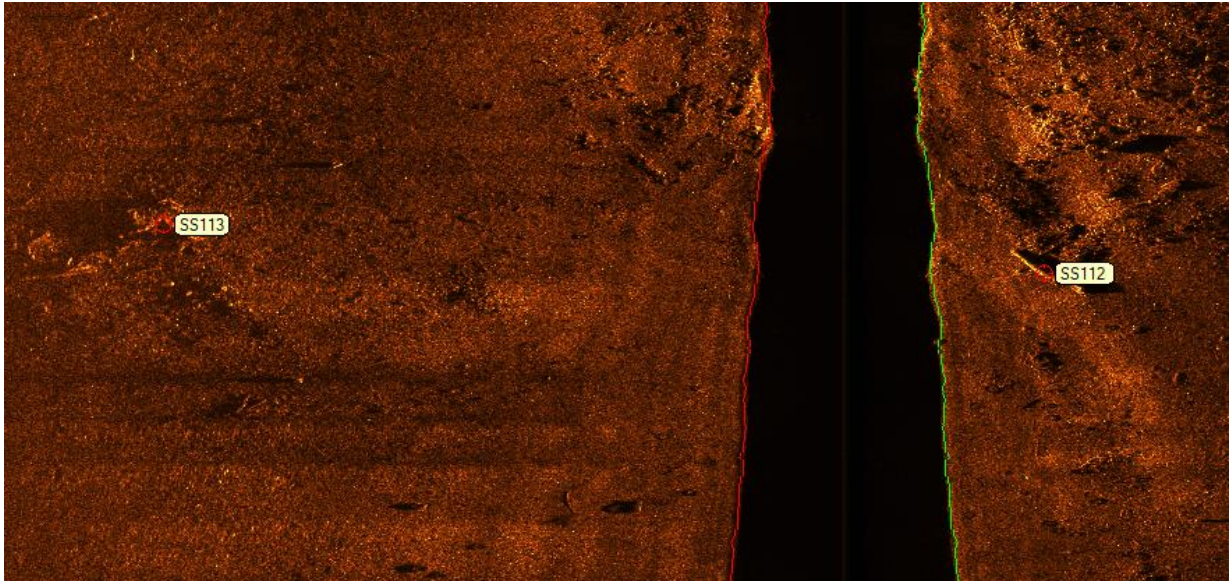


Figure 19: Side scan image of contacts SS112 and SS113 located off Lyness pier.



Plate 88: Remains of a mast section at SS112 (top) and the remains of a mast and mixed wreckage at SS113 (bottom).

4.13.4 Rinnigal contacts (SS114, SS115, SS116 & SS117)

Several sonar contacts were recorded off Rinnigal pier, located across the mouth of Ore Bay to the south of Lyness (Figure 20 & Figure 21). Although Rinnigal pier was built during World War Two by the Navy to supply its operations on Hoy, the pier and adjacent area was used subsequently by various salvage companies that worked both the German fleet and HMS *Vanguard*.

The sites were inspected by diving on the 23rd May 2018. SS114 was a previously known barge and not related to wartime activities, but is included here for completeness. It was used in the construction of the Flotta oil terminal in the 1970s and was one of two barges that sank in a gale in January 1976. The Scapa Flow Salvage Co Ltd, which at the time was undertaking salvage works on some of the remaining vessels of the High Seas Fleet, received the contract to raise both barges and hired in the German lifting barge *Roland* to do the lift. One of the barges was found to be badly damaged and a large section of this was taken to Rinnigal and sunk close to the shore to the east of Rinnigal Pier. Images of the barge taken during its salvage and of its present condition on the seabed are shown in Plate 89.

Contact SS115 was located within 5m of the end of Rinnigal pier. It was found to be a 3m diameter thin steel ring standing approximately 0.4m off the seabed (Plate 90). It is considered to be relatively modern and probably not debris from the salvaging of the German ships.

SS116 was an area of debris to the west of Rinnigal Pier and mainly comprised broken-up outer casing from turbines, which were salvaged from German vessels and cut up to access the non-ferrous turbine blades (Plate 91). The origin of this debris is unknown. One piece of casing still has some of the original salvage equipment attached: a plate clamp which was most likely used to recover this debris but was lost (Plate 92).

Contact SS117 was found to be half a turbine casing with most of the turbine blades still in place (Plate 93).

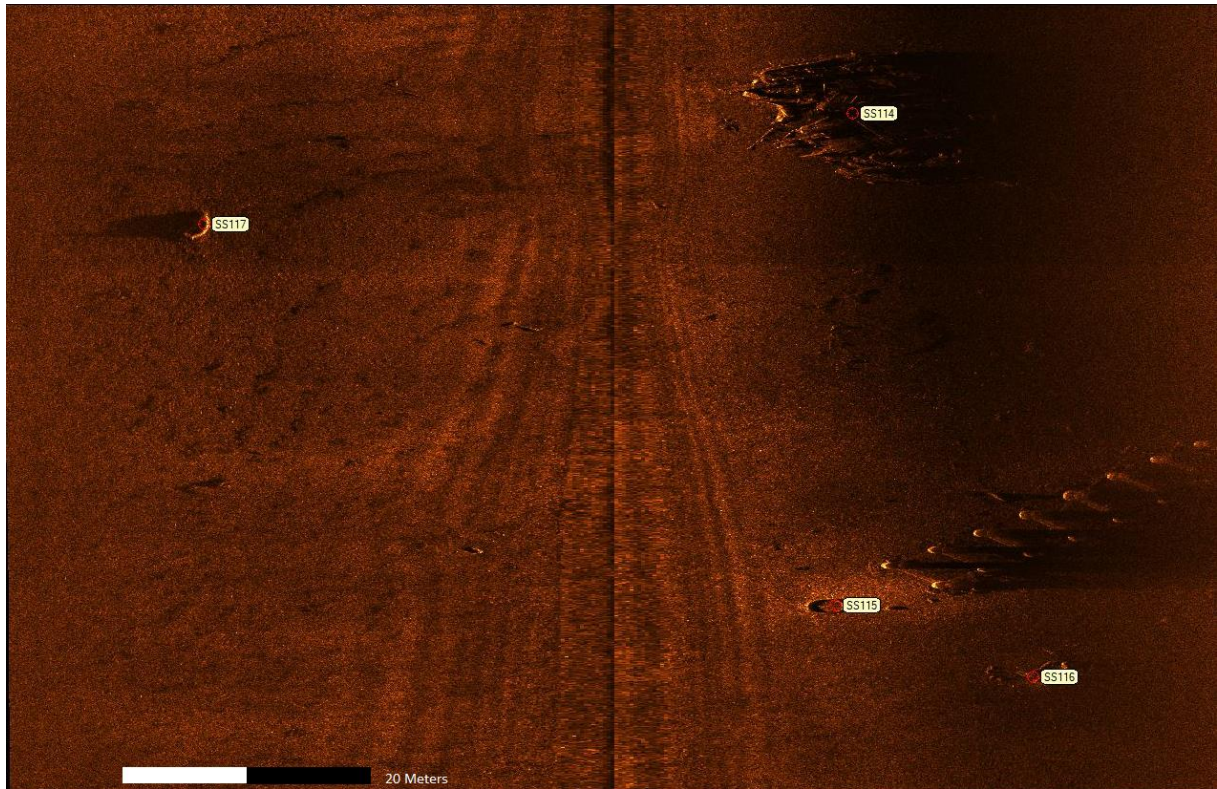


Figure 20: Side scan contacts off Rinnigal pier, Hoy.

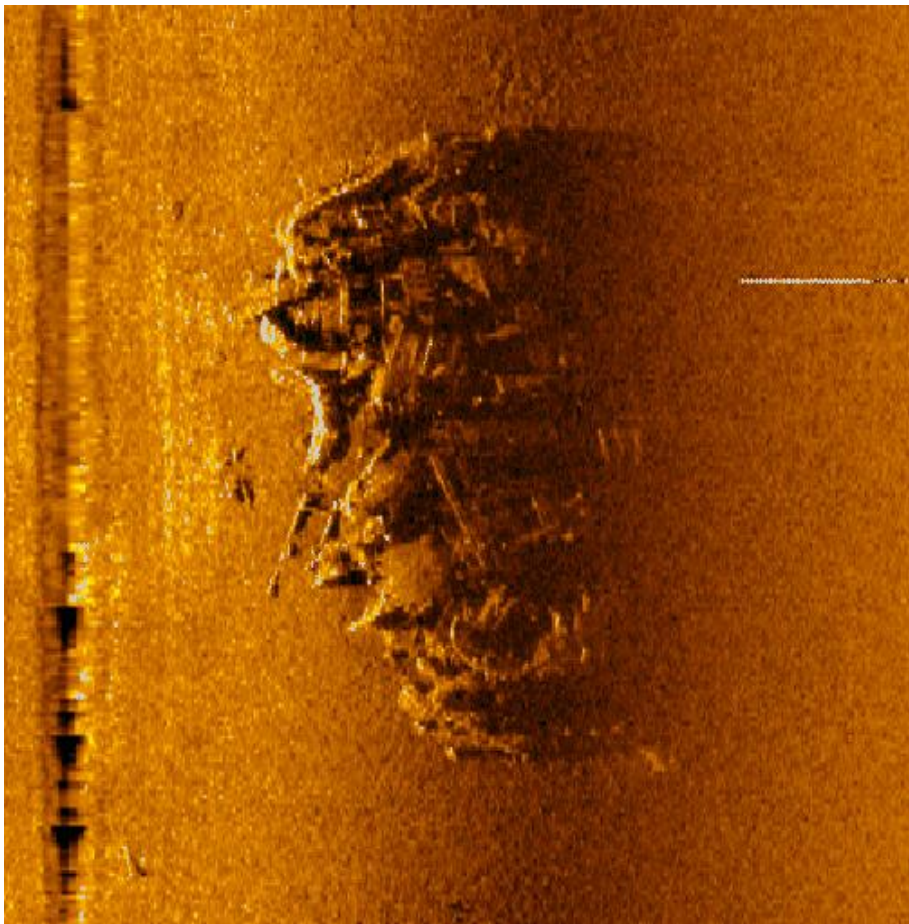


Figure 21: Side scan image of the salvage barge (SS114) located east of Rinnigal pier.

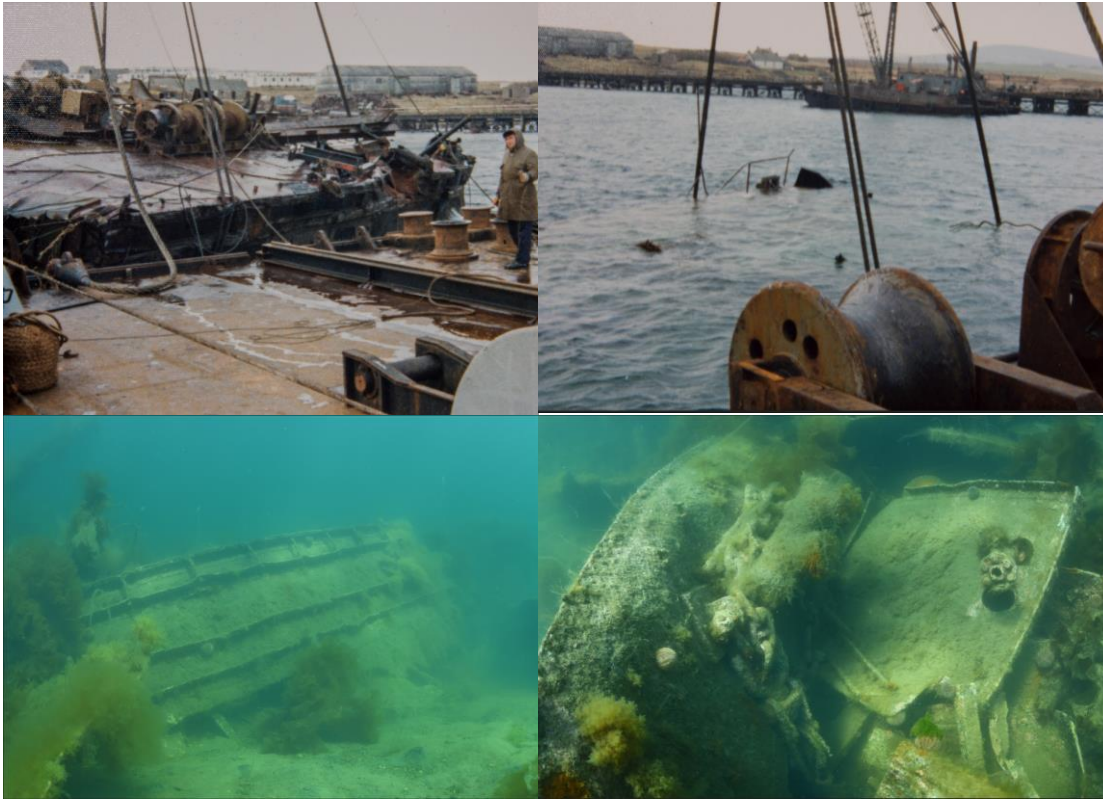


Plate 89: Archive images (top) of the barge being sunk by Rinnigal pier in 1976 (Image courtesy of D. Campbell via Huskylan Charters). The pier can be seen in the top right image. Images of the barge in its current condition (bottom).



Plate 90: Circular ring found off Rinnigal pier composed of steel (SS115).



Plate 91: Turbine casings to the west of Rinnigal Pier (SS116).



Plate 92: Turbine casing (left) with plate clamp attached (SS116) and an example of a similar clamp (right).

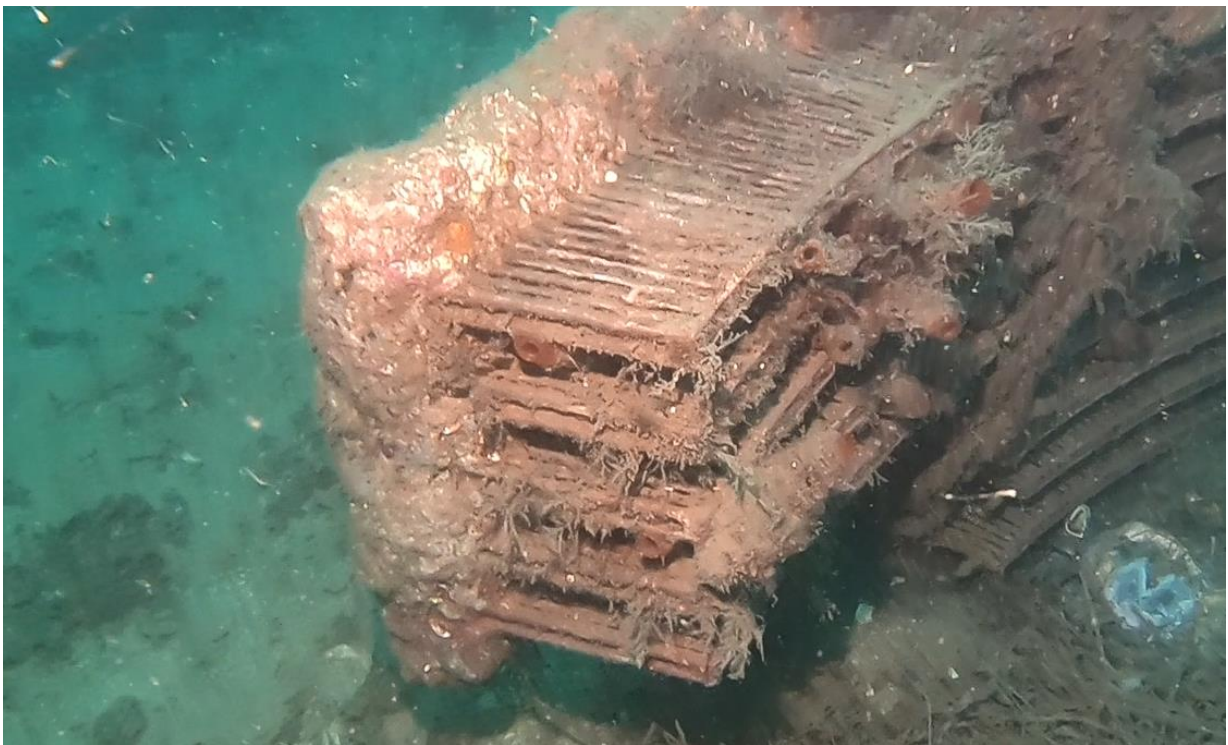
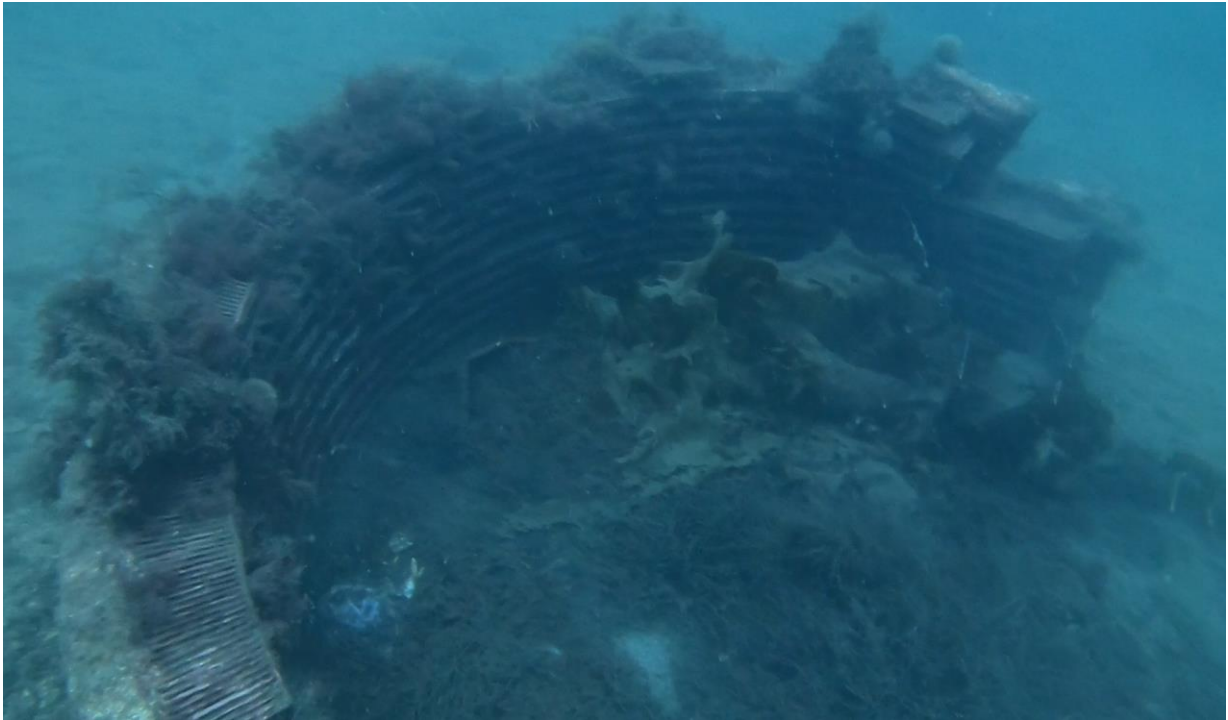


Plate 93: Turbine casing (SS117, top) and non-ferrous turbine blades (bottom).

4.13.5 Contact SS118

This isolated mast-like structure located west of Cava was inspected by volunteer divers in October 2018. Video footage confirmed it to be a mast and crow's nest, with the remains of a wooden top mast, most likely the aft mast of a *Kaiser*-class battleship (Plate 94 & Plate 95). Masts were usually left at the primary salvage sites, either having snapped off when the vessel settled upside down on the seabed, or later removed by divers as it would have impeded towing. As seen in the case of SMS *König Albert* however, it was possible for detached masts to remain attached to the ship by wire stays, and therefore be dragged away with the vessel. It is possible therefore that this mast may have become detached from a vessel while in tow, since it is located on the route that would have been taken from the primary salvage sites to Rysa and/or Lyness. There was no indication at the site which vessel the mast may have come from. The aft mast/crow's nest remains for most vessels included in both Phase 1 & 2 projects can be accounted for, either at their primary or secondary salvage sites. However, only a short section of aft mast was identified at the SMS *Kaiserin* primary site. It is possible therefore that the mast at SS118 is from the *Kaiserin* and could have been dragged to its present location during its tow to Rysa but further work would be required to establish this for certain.

4.13.6 Contact SS119

This contact was located west of Cava close to SS118, and inspected by remote video on the 31st October 2018. It was found to be the remains of a torpedo, with afterbody, air cylinder and what appeared to be a live warhead all lying in a detached state (Plate 96). No further survey work was conducted on the site and the matter was immediately reported to the Harbour Authority (OIC Marine Services) to deal with.

4.13.7 Contact SS120

Contact SS120 was dived by volunteer diver Simon Brown off MV *Valkyrie* in May 2017 and was found to be the remains of a German diesel pinnace (Plate 97). Although broken down, all of the fixtures and fittings were laying loose around the wreck site, including half the wooden ships wheel, the brass wheel hub, six portholes, two of which had fallen into the engine, and the prop shaft (but no propeller). A brass shell case was also found nearby but it was not clear if this was associated with the pinnace.

Following a report that some items had been taken from this site since it was discovered, HES commissioned SULA Diving to undertake a fresh survey of the site, which was done on 31st May 2018. The survey found that the portholes, filler cap, the shell case and some fittings off the engine had been removed from the site. An enquiry was made to the Receiver of Wreck but no items from Scapa Flow had been declared in the last year. A full report of the survey findings was made separately to HES (SULA Diving, 2018).



Plate 94: SS118, isolated aft mast and crow's nest (image courtesy of B. Anderson).



Plate 95: SS118, still image of 3D mosaic (image courtesy of R. Priestly & A. Hatt)



Plate 96: Torpedo remains at SS119, showing detached air cylinder and warhead (left) and afterbody (right).

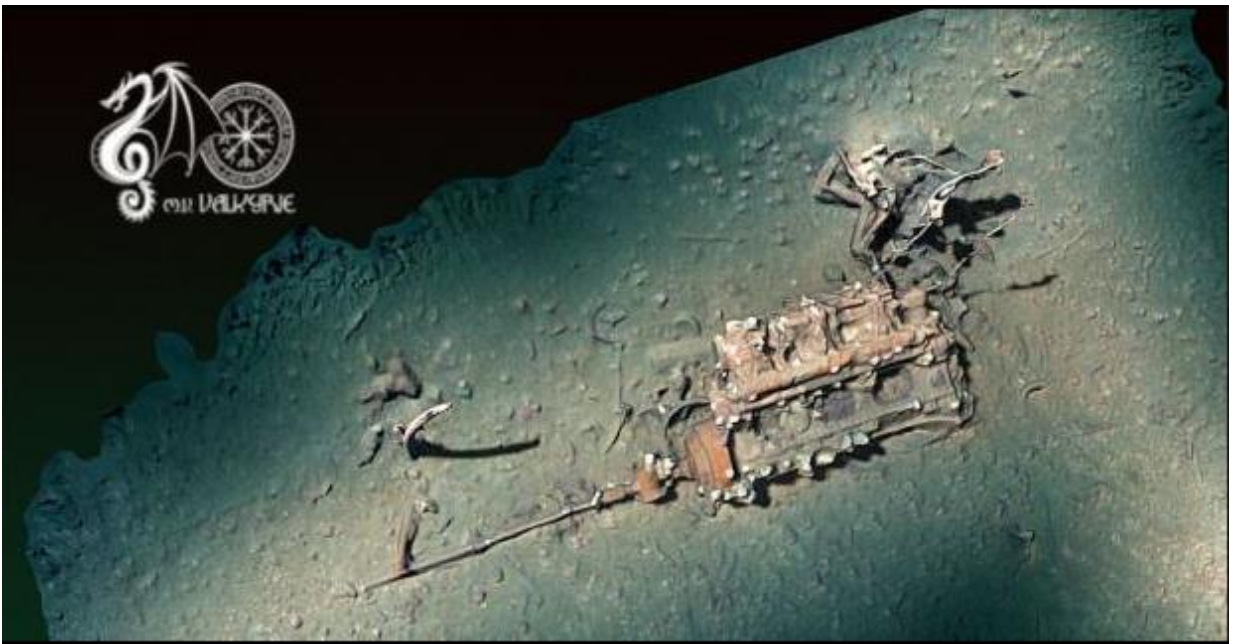


Plate 97: Still image of German pinnace diesel engine (SS120) taken from a 3D model (image courtesy of S. Brown, 3Deep).

5 DISCUSSION

The aims of the Scapa Flow Salvage Sites Project were to:

1. create a baseline database of the scrap sites of the High Seas Fleet in Scapa Flow, Orkney;
2. establish the extent of the remains of the individual salvage sites in Scapa Flow, Orkney;
3. locate, record and assess the condition of all salvage sites relating to the German High Seas Fleet;
4. provide information to aid HES in monitoring wartime heritage assets; and
5. ensure that the information collected is disseminated widely and made available for public study, appreciation and enjoyment.

These aims have been met by the work undertaken in Phases 1 and 2 of the project, as detailed below.

5.1 Phase 1

The Phase 1 project proposed a methodology involving three elements to achieve the aims set out above. These were archive research, side scan sonar survey, and finally ground-truthing (with remote video or diving). It was recognised early in this process that a phased approach would be required, given the likely volume of work entailed and so Phase 1 was planned to include archive research, a complete sonar survey with as much ground-truthing as possible. Sonar work revealed very limited remains from the destroyers of the High Seas Fleet, but an extensive network of sites associated with the larger (>20,000 tonne displacement) battleships, battle cruisers and cruisers. Limited ground-truthing was possible with the time and budget available but diver investigation of the primary salvage sites associated with SMS *Von der Tann* and SMS *Hindenburg* were achieved, along with a survey of secondary salvage sites on the east side of Rysa.

5.2 Phase 2

Phase 2 continued the ground-truthing process for the remaining sites detected in Phase 1 sonar surveys. Phase 2 ground-truthing surveys focussed on the remaining primary salvage sites associated with the following vessels:

- SMS *Moltke*;
- SMS *Prinzregent Luitpold*;
- SMS *Derfflinger*;
- SMS *Friedrich der Grosse*;
- SMS *Kaiserin*;
- SMS *Kaiser*;
- SMS *König Albert*;
- SMS *Grosser Kurfürst*; and
- Miscellaneous contacts, including SMS *Bremse*, SMS *S36*, SMS *B109* and SMS *V78*.

Ground-truthing revealed that in most cases, salvage remains were largely confined to the primary salvage areas and generally included large items such as forward and aft masts, forward and aft bridge structures, searchlight platforms, samson posts and booms. Their presence reflected the salvage methods employed on the larger ships, where their upturned hulls were raised to the surface, followed by the removal of anything left underneath the ship (on the deck) that would have been an obstruction to towing, before towing the vessel away from the site.

Masts and samson posts/booms were generally found with wires, pulleys and other rigging. Bridge structures comprised mixed metal framework. Searchlight platforms included searchlight remains, particularly the base mounts and extensive cabling and gears that were used to control them. Searchlight fragments were found, but only one intact unit was found, on the primary salvage site of SMS *Kaiserin*.

Large items such as those noted above were sometimes missing from the primary sites. Archive research was often able explain the absence of these large items, many of which were tracked down at Rysa. For example, most of the large deck structures on SMS *König Albert* and SMS *Grosser Kurfürst* were removed at secondary salvage sites at Rysa and were found during Phase 1 ground-truthing surveys. As well as the large items that were blasted off, a number of other smaller items were found that were more likely to have fallen off the deck, e.g. diesel boat remains (usually engines and boilers), boat supports, sub-calibre liners, coal hatches, miscellaneous boxes, coal winches and torpedo cranes. Not many other items might be expected, as most loose materials would have been stored below deck.

In other cases, e.g. SMS *Moltke*, a trail of salvage debris was found over a large area of seabed (a similar trail of debris was found on the salvage site of SMS *Von der Tann*, which was described in the Phase 1 report). While the remains of an aft mast and samson post were found, most were smaller items including coal winches, coal hatches, torpedo cranes, a gangplank and other pieces of non-descript wreckage. Perhaps the most unusual items were several sections of armour plate belonging to one of SMS *Moltke*'s 28cm guns. At 9 inches thick, they were the only pieces of heavy armour plate found during in both phases of the project and were likely overlooked during the salvage of the two large guns that were crushed under the weight of the vessel. Archive research was crucial to understanding the *Moltke* site, as it demonstrated that no other vessel had been salvaged in the same area or the area to the north-east. Previously, little was known of the salvage of SMS *Moltke* and it is rarely visited by recreational divers probably because, as these results demonstrate, its remains are dispersed over such a wide area and could not until now be confidently linked to any particular vessel.

5.3 Project Overview

The Phase 1 & 2 Salvage Site Projects focussed on 11 of the 13 largest vessels in the German High Seas Fleet that were salvaged in the inter-war years (the remaining two, SMS *Bayern* and SMS *Seydlitz* were surveyed previously (Christie, et al., 2013). An extensive dataset now exists that details the precise location, nature, extent and condition of each ship's primary salvage site and of the major secondary sites, fulfilling the aims of the project. The artefacts remaining on each site have been described in detail. This has been complimented with archive research that helped to interpret the remains at each site and was particularly useful when trying to

determine which ships the salvage remains at the secondary sites belonged to. It is likely that some artefacts have been missed but continued investigations, for example through engagement with the recreational diving sector, can help to fill in any missing details.

The methodology employed in the project was effective. Side scan surveys were able to effectively cover the large area of seabed involved in a relatively short timescale and provide the direction required for more time-consuming site investigations. The combination of remote and diver survey was also effective, although the most detailed information and best images were collected during the diver surveys. Remote video was most useful to investigate the deeper sites safely. The inclusion of the recreational diving sector in the project worked well and this relationship will likely be developed in the future.

Archive research was a vital part of the project and was also able to draw in volunteer support. Cox and Danks in particular made use of the press during their salvage activities in Orkney and the numerous newspaper articles held by the Orkney Library and Archives provided a great amount of detail on the salvage process for each ship. This was perhaps unsurprising, considering the nature of the undertaking. Press reports however were much rarer in the period that followed the departure of Cox and Danks, when Metal Industries Ltd took over. Metal Industries involved the press less often and most material was obtained from the written records of one manager, whose logbook is held in the Orkney Library and Archives.

5.4 Future work

The submission of this report and the subsequent steps that are taken to disseminate the results in the public domain will complete the fulfilment of the Project's aims. The data will aid HES in the monitoring of protected wartime heritage assets in Scapa Flow. The High Seas Fleet salvage remains are important as they represent the only remaining physical evidence of the High Seas Fleet vessels that were removed from the Scapa Flow and also the immense and unique salvage effort that occurred in the inter-war years. Consequently, there is good justification for their protection in the future. Effective dissemination of this project will help to raise awareness of the salvage sites and the history behind them, particularly in the recreational diving sector, as has volunteer diving and archive engagement. While some salvage sites have been regularly dived in the past, the more extensive information now available on the contents and layout of the sites, particularly from the sonar images, interest in diving more of the sites and more often may increase. Of course, this may bring added risk of damaging 'salvage' activities, but it is hoped that the process of information dissemination following this project will help to encourage a collective understanding that the sites should be left undisturbed. Added dive volume may also help to ease pressure on the seven scheduled wrecks that exist in Scapa Flow, although they are always going to be the main draw for recreational divers.

Dissemination of project results will allow the non-diving public to engage with the story of the salvage process in a way that was not possible before. The completion of this project is also timely for two reasons 1) as the centenary of the scuttling of the High Seas Fleet approaches in June 2019 and 2) as HES consults on the future management of Scapa Flow's historic maritime sites. As stated earlier, further work to map and monitor salvage remains should continue, through engagement with the recreational diving sector who will undoubtedly dive these sites,

and the non-diving public in the form of continued archive research, based on the foundations laid down by this project.

6 CONCLUSION

The overall aim of the Scapa Flow Salvage Sites Project was to determine what remains of the many vessels of the German High Seas Fleet that were salvaged in the years that followed their scuttling in June 1919. Phase 1, undertaken over the winter of 2016/17, involved a side scan sonar survey of the main anchorages and other areas thought to have been involved in the salvage process. A process of ground-truthing the sonar contacts started in Phase 1 was completed in this Phase 2 project. The overall result of this process is that the vast majority of salvage sites in Scapa Flow have been located and the remains at each site have been directly investigated and recorded. Archive research throughout Phases 1 and 2 has underpinned both the approach to fieldwork and the interpretation of its results. The combination of side scan sonar with direct ground-truthing (by diver or remote video) worked effectively.

The collaborative involvement of volunteer archive researchers and recreational volunteer divers brought added detail to the project, as well as engaging both divers and non-divers with the importance of the submerged historic assets and their vulnerability. This has not only deepened the wider community's understanding of their underwater heritage, but also created a trained human resource for the future.

Salvage remains included a wide range of artefacts from vessels that have been long removed from Scapa Flow. It has been possible to dovetail the artefacts found at each site with archive accounts of the salvage, generally on a ship by ship basis. The original requirement to determine what remains of the salvage process has been successfully achieved and should help to protect these sites as physical reminders of the inter-war salvage effort, which is another important part of Scapa Flow's maritime history.

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8 APPENDICES

8.1 Appendix 1: Side scan sonar survey contact report

Full list of contacts from Salvage Site Phase 1 Project with ground-truthing details completed following Phase 1 & 2 investigations.

SULA Diving and ORCA, UHI Archaeology Institute

Identifier	X_UTM30N	Y_UTM30N	Description	Interpretation	L (m)	W (m)	H (m)	Shadow(m)
SS001	489258	6525790	Sub rectangular feature aligned SW-NE	<i>Moltke</i> diesel pinnace engine	2.9	0.4	2.0	4.0
SS002	489259	6525814	Linear feature aligned almost N-S, ending in wedge shape to S	<i>Moltke</i> torpedo loading mast	7.7	0.8	0.1	0.3
SS003	489257	6525830	Linear feature aligned W-E	<i>Moltke</i> gangway	4.7	1.0	0.0	0.0
SS004	489246	6525852	Collection of linear anthropogenic features aligned predominately N-S		12.9	8.0	0.0	0.0
SS005	489228	6525871	Miscellaneous collection of anthropogenic features extending from SW to NE	<i>Moltke</i> debris	24.9	5.3	0.0	0.0
SS006	489203	6525896	Linear feature aligned N-S	<i>Moltke</i> mast portion	5.6	0.6	0.5	1.6
SS007	489170	6525945	Miscellaneous anthropogenic feature		5.4	2.0	0.0	0.0
SS008	489159	6525871	Linear feature aligned SW-NE with linear elements leading off of it	Rock ledge	4.2	2.0	0.0	0.0
SS009	489138	6525901	Linear feature aligned SW-NE with broader elements at various stages along its length, increasing in width to NE	Rock ledge	5.1	1.7	0.0	0.0
SS010	489214	6525913	Miscellaneous collection of anthropogenic features	<i>Moltke</i> spotting top foremast	5.1	2.1	1.4	6.6
SS011	489327	6525918	T-shaped feature, with long leg of T aligned E-W	Anchor	3.0	1.8	0.0	0.0
SS012	489176	6526214	Linear feature aligned almost N-S, ending in wedge shape to S		2.3	0.8	0.3	1.1
SS013	489371	6525821	Miscellaneous collection of anthropogenic features	Rocks and rope	7.7	3.9	0.0	0.0
SS014	489362	6525975	Feature consists of linear elements arranged around a prominent T shape	<i>Moltke</i> head of a samson post	3.9	2.0	1.9	8.6
SS015	489403	6526016	Miscellaneous collection of anthropogenic features		28.4	6.6	0.0	0.0
SS016	489362	6526001	Linear feature aligned NW-SE	Boulder and wreckage	2.4	0.9	0.7	1.5
SS017	489382	6526020	Sub rectangular feature aligned N-S		0.8	0.8	1.0	2.3
SS018	489409	6525923	Linear item, aligned NW-SE	Rocks	1.4	0.5	0.4	1.1
SS019	489677	6525762	Linear elements aligned NW-SE.	Rocks	5.9	2.5	0.5	3.4
SS020	489563	6525905	Linear feature aligned NW-SE	Anchor and rocks	3.9	1.3	0.5	2.2

SULA Diving and ORCA, UHI Archaeology Institute

Identifier	X_UTM30N	Y_UTM30N	Description	Interpretation	L (m)	W (m)	H (m)	Shadow(m)
SS021	489472	6525981	Linear feature , aligned S-N ending in wedge shape to N	<i>Moltke</i> torpedo loading mast	9.1	0.8	0.0	0.0
SS022	489490	6526010	Feature made up of cylindrical items	Anchor	2.4	2.1	0.4	1.1
SS023	489480	6526076	Linear feature aligned NW-SE	Possible mast element	19.3	0.6	0.2	1.7
SS024	489709	6525833	Linear feature aligned SW-NE. Curves round to N.	Possible mast element	3.0	1.7	2.2	10.7
SS025	489245	6526285	Anthropogenic structures	Destroyer sections, filled with concrete bags and bound by chains. Wedged against the port and starboard side of <i>Hindenburg's</i> stern (Diver Survey)	29.9	7.2	2.9	22.4
SS026	489225	6526342	Sub oval feature, aligned NW-SE	Buried platform of sub-oval shape (Diver Survey)	3.8	2.4	0.0	0.0
SS027	488928	6526369	Miscellaneous collection of anthropogenic features	Superstructure platform, probably lost during scuttling of from blasting activity when lifted (Diver Survey)	13.3	6.2	0.9	1.5
SS028	488989	6526358	Miscellaneous collection of anthropogenic features	Platform with interior pole, two coal winches, a metal box and electrical and steel debris (Diver Survey)	10.3	4.5	1.1	3.8
SS029	488967	6526407	Linear feature aligned W-E	Heavily built oval platform with piping and bronze gear wheel, and remains of repeater compass (Diver Survey)	4.0	0.8	0.3	0.5
SS030	489114	6526398	Miscellaneous anthropogenic features although possibly rocks	Possibly geological	18.5	2.7	0.9	2.2
SS031	489198	6526363	Linear feature aligned NW-SE	Davit spar with rigging (Diver Survey)	10.6	0.0	0.0	0.0
SS032	489173	6526344	Miscellaneous collection of anthropogenic features	Heavily corroded rectangular platform (Diver Survey)	5.0	0.0	0.0	0.0
SS033	489205	6526348	Miscellaneous collection of anthropogenic features	Rectangular box structure, possible forming part of a ventilation system (Diver Survey)	2.4	1.3	0.0	0.0
SS034	489190	6526404	Miscellaneous collection of anthropogenic features	Debris representing movement of <i>Von der Tann</i> after towing into Cava (Diver Survey)	34.6	30.2	0.0	0.0
SS035	488965	6526320	Circular feature	Upper foremast section and spotting top of <i>Van der Tann</i>	1.6	1.6	1.9	3.3

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Identifier	X_UTM30N	Y_UTM30N	Description	Interpretation	L (m)	W (m)	H (m)	Shadow(m)
SS036	488975	6526335	Circular feature	Small pinnacle boiler standing on its funnel (Diver Survey)	1.5	1.6	0.0	0.0
SS037	489214	6526447	Miscellaneous collection of anthropogenic features	Heavily riveted samson post (Diver Survey)	3.6	1.3	0.5	3.7
SS038	489225	6526436	Linear feature aligned NW-SE	Derrick arm (Diver Survey)	11.4	0.0	0.0	0.0
SS039	489246	6526509	Linear feature aligned NW-SE		3.1	1.2	0.0	0.0
SS040	489445	6526512	Rectangular anthropogenic features aligned NW-SE	Possible plating	5.8	2.1	0.6	4.7
SS041	489200	6526393	Miscellaneous collection of anthropogenic features	Searchlight platform (Diver Survey)	5.6	3.6	0.7	3.7
SS042	488925	6526379	Rectangular feature aligned NW-SE, with linear element protruding from SE end	Upturned platform with steel girders and wires (Diver Survey) Possible <i>Kaiser</i> debris	6.0	4.0	0.5	0.0
SS043	489289	6526596	Linear feature aligned NW-SE, with semi-circular element at its SE end	Anchor	3.5	2.4	0.0	0.0
SS044	489170	6526947	Miscellaneous anthropogenic features with prominent linear features aligned SW-NE	<i>Kaiser</i> main site containing complete foremast with spotting top and control room, aft mast, Samson post and boom, range finder and other miscellaneous items	0.0	0.0	0.0	0.0
SS045	488900	6527116	Miscellaneous anthropogenic features with prominent linear features aligned SW-NE and SW-NE	<i>Prinzregent Luitpold</i> main site including forward mast, spotting top and miscellaneous structure items	0.0	0.0	0.0	0.0
SS046	488952	6527158	Rectangular and miscellaneous anthropogenic features aligned SE-NW	Small diesel boat with cylindrical copper fuel tanks off <i>Prinzregent Luitpold</i> main site	9.1	3.9	0.0	0.0
SS047	488868	6527134	Miscellaneous anthropogenic features	2nd element of <i>Prinzregent Luitpold</i> main site, smaller mast items and aft structure elements	16.6	11.2	0.0	0.0
SS048	489450	6526514	Sub oval feature aligned NW-SE	Possible searchlight platform	6.3	2.6	0.8	4.7
SS049	489582	6526299	Miscellaneous anthropogenic features	Superstructure elements and platforms. Possible <i>Moltke</i>	10.4	6.4	0.0	0.0
SS050	488481	6527063	Miscellaneous anthropogenic features including prominent linear features aligned SE-NW and S-N	<i>Derfflinger</i> tripod mast. Two legs. Third leg and spotting top missing.	23.3	1.4	0.0	0.0

SULA Diving and ORCA, UHI Archaeology Institute

Identifier	X_UTM30N	Y_UTM30N	Description	Interpretation	L (m)	W (m)	H (m)	Shadow(m)
SS051	488513	6527040	Miscellaneous anthropogenic features including prominent linear features aligned SE-NW and SW-NE	<i>Derfflinger</i> aft mast	22.7	0.0	0.0	0.0
SS052	488436	6527099	Linear feature aligned NW-SE	Part of <i>Derfflinger</i> main site	5.3	0.0	0.0	0.0
SS053	488612	6527645	Miscellaneous anthropogenic features	<i>Kaiserin</i> mast and superstructure elements	0.0	0.0	0.0	0.0
SS054	488608	6527632	Miscellaneous anthropogenic features	<i>Kaiserin</i> mast and superstructure elements	7.8	0.0	0.0	0.0
SS055	488547	6527656	Miscellaneous anthropogenic features	<i>Kaiserin</i> mast and superstructure elements	0.0	0.0	0.0	0.0
SS056	488798	6528083	Miscellaneous anthropogenic features including prominent linear features aligned SW-NE and depression aligned SE-NW	<i>König Albert</i> amson post boom	12.8	0.0	0.0	0.0
SS057	488761	6528099	Miscellaneous anthropogenic features	<i>König Albert</i> superstructure element	3.6	2.0	1.4	6.6
SS058	488777	6528116	Miscellaneous anthropogenic features	<i>König Albert</i> possible mast element	3.8	0.7	1.4	2.6
SS059	489279	6528648	Miscellaneous anthropogenic features including prominent linear features aligned S-N	<i>Friedrich der Grosse</i> spotting top	25.8	0.0	1.2	4.2
SS060	489265	6528705	Linear feature aligned S-N	<i>Friedrich der Grosse</i> mast	11.4	0.0	0.0	0.0
SS061	489294	6528637	Miscellaneous anthropogenic features including prominent linear features aligned SW-NE and depression aligned SE-NW	<i>Friedrich der Grosse</i> mast and superstructure elements and main depression	5.9	2.6	3.3	19.9
SS062	489326	6528623	Miscellaneous anthropogenic features including prominent linear features aligned SW-NE and depression aligned SE-NW	<i>Friedrich der Grosse</i> main site	0.0	0.0	0.0	0.0
SS063	490172	6528667	Miscellaneous anthropogenic features including prominent linear features aligned S-N and depression aligned E-W	<i>Grosser Kurfürst</i> spotting top and mast	25.3	3.2	3.3	11.6
SS064	490202	6528615	Linear feature aligned NW-SE and depression aligned E-W	<i>Grosser Kurfürst</i> aft mast	13.0	0.7	0.4	1.1
SS065	488757	6525698	Oval feature and linear features (aligned NW-SE) and miscellaneous anthropogenic features	Top searchlight platform, boom arm, samson post and lower searchlight platform from a <i>Kaiser</i> class battleship probably <i>König Albert</i> (Diver Survey)	19.3	9.5	1.5	3.4

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Identifier	X_UTM30N	Y_UTM30N	Description	Interpretation	L (m)	W (m)	H (m)	Shadow(m)
SS066	488767	6525642	Linear feature aligned NE-SW	Samson post, remains of searchlight and deck mounted winch from a <i>Kaiser</i> class battleship probably <i>Konig Albert</i> (Diver Survey)	13.7	0.0	0.0	0.0
SS067	489012	6525417	Linear feature and associated items aligned E-W with sub rectangular feature 19.36m to the SW	Possible mast elements and searchlight platform (Diver Survey)	9.8	4.7	0.0	0.0
SS068	489011	6525464	Miscellaneous anthropogenic features including linear feature aligned SW-NE	Two samson posts and a mast with a small crow's nest, possibly <i>Fredrich der Grosse</i> (Diver Survey)	35.5	22.6	1.8	8.7
SS069	488967	6524839	Miscellaneous anthropogenic features including sub oval feature	Searchlight platform (Diver Survey)	0.0	0.0	0.0	0.0
SS070	488953	6524842	Linear feature aligned SW-NE	8.8cm L/45 gun	0.0	0.0	0.0	0.0
SS071	488944	6524872	Miscellaneous collection of anthropogenic features	Searchlight control platform (Diver Survey)	0.0	0.0	0.0	0.0
SS072	488779	6524960	Rectangular feature aligned W-E with portions at different levels of elevation	Miscellaneous wreck items associated with salvage operations at Rysa	4.1	3.0	0.9	5.3
SS073	488633	6525105	Anthropogenic structure aligned E-W	V83 stern	0.0	0.0	0.0	0.0
SS074	488689	6525108	Sub circular feature		0.0	0.0	0.0	0.0
SS075	488628	6525146	Linear feature aligned NW-SE	Miscellaneous wreck items associated with salvage operations at Rysa (Diver Survey)	6.3	0.0	0.9	3.3
SS076	488921	6524937	Two rectangular features	Wooden boxes for anchor boom nets	5.1	2.4	0.7	1.3
SS077	488989	6524922	Miscellaneous collection of anthropogenic features	Miscellaneous wreck items associated with salvage operations at Rysa	5.7	3.6	0.7	2.1
SS078	489102	6524847	Miscellaneous collection of anthropogenic features including linear features aligned NW-SE and rectangular features	Heavily corroded funnel plating and bands with extensive grating, wires and a possible searchlight platform (Diver Survey)	25.4	12.0	0.0	0.0
SS079	489100	6524877	Miscellaneous collection of anthropogenic features including linear features aligned NW-SE and rectangular features	Funnel grating and a brass doorframe (Diver Survey)	27.0	17.5	0.0	0.0

SULA Diving and ORCA, UHI Archaeology Institute

Identifier	X_UTM30N	Y_UTM30N	Description	Interpretation	L (m)	W (m)	H (m)	Shadow(m)
SS080	488990	6524949	Linear features aligned NW-SE	Samson posts that formed part of derricks for lifting <i>Grosser Kurfürst's</i> pinnaces	0.0	0.0	0.0	0.0
SS081	488864	6525068	Rectangular feature aligned N-S	Wooden boxes for anchor boom nets	5.0	2.7	0.9	2.4
SS082	488887	6525066	Linear feature aligned NW-SE	Possible mast element	6.4	0.5	0.9	3.6
SS083	488818	6525086	Linear feature aligned NW-SE	Possible mast element	4.5	0.8	1.0	1.8
SS084	488869	6525047	Rectangular feature aligned W-E	Wooden box for anchor boom nets	6.1	2.7	0.0	0.0
SS085	488965	6524980	Miscellaneous collection of debris	Bridge structure cabin with heavily corroded surrounding platform (Diver Survey)	18.8	10.2	0.0	0.0
SS086	488124	6524952	Miscellaneous collection of debris including circular features and linear features aligned N-S	Identified as a <i>Derfflinger</i> site	0.0	0.0	0.0	0.0
SS087	488184	6525071	Miscellaneous collection of debris including linear features align N-S and sub oval features	<i>Derfflinger</i> debris including two anchor capstans	3.3	0.8	0.6	6.1
SS088	488083	6524849	Miscellaneous collection of debris	<i>Derfflinger</i> debris and wire	15.0	7.8	0.0	0.0
SS089	488083	6524956	Miscellaneous collection of debris	<i>Derfflinger</i> debris and wire	0.0	0.0	1.8	5.0
SS090	488109	6524929	Miscellaneous collection of debris including linear feature align NW-SE	<i>Derfflinger</i> debris and wire	26.7	7.6	0.0	0.0
SS091	489563	6523810	Sub rectangular feature		2.5	1.5	1.0	1.9
SS092	489086	6523332	Linear feature aligned NW-SE with additional elements on NW terminus	Possible anchor	3.9	0.0	1.1	4.6
SS093	488660	6522939	Anthropogenic structure sub oval in shape aligned NW-SE, cylindrical object 11.97 metres from SE end	Shipwreck HM Drifter <i>Dewey Eve</i>	29.6	11.8	3.5	15.9
SS094	488642	6522749	Linear feature aligned W-E with additional elements on E terminus	Possible anchor	4.1	0.0	0.0	0.0
SS095	489072	6521489	Sub Circular features	Funnel elements as identified in Christie <i>et al.</i> , 2014 (Canmore ID 102248)	20.0	6.3	1.3	0.0
SS096	489108	6521471	Sub Circular features	Funnel elements as identified in Christie <i>et al.</i> , 2014 (Canmore ID 102248)	4.4	0.0	1.5	0.0
SS097	488941	6522863	Shipwreck aligned N-S, possible starboard propeller shaft visible	Shipwreck MV <i>Mara</i>	23.9	7.1	3.3	22.3

SULA Diving and ORCA, UHI Archaeology Institute

Identifier	X_UTM30N	Y_UTM30N	Description	Interpretation	L (m)	W (m)	H (m)	Shadow(m)
SS098	489253	6523938	Linear feature aligned W-E, with possible rope attachment leading off from E end	Possible anchor	4.0	2.4	0.0	0.0
SS099	489487	6524058	Linear feature aligned W-E	Possible anchor	5.1	2.2	0.5	2.0
SS100	489659	6524092	Rectangular feature aligned N-S	Unknown- block	2.6	1.0	0.0	0.0
SS101	489741	6524235	Linear feature aligned N-S with sub oval feature at N end	Samson post	4.4	12.4	0.0	0.0
SS102	489813	6524296	Linear feature aligned SW-NE		2.7	1.0	0.8	2.9
SS103	489971	6524317	Rectangular feature aligned SW-NE. In elevation sonar shadow reveals curved profile on NE end		2.2	1.2	1.1	2.6
SS104	489407	6524029	Two linear features aligned W-E. Lower feature appears to have some rock attached to eastern end	Two possible anchors	5.4	0.4	0.1	0.4
SS105	488851	6522243	Anthropogenic structure aligned SW-NE	UKHO wreck number 1114 listed as portion of <i>B 109</i>	15.3	4.7	2.8	18.7
SS106	488841	6522919	Anthropogenic structure aligned SW-NE	Wreck of the WW2 German Destroyer <i>F2</i>	0.0	0.0	0.0	0.0
SS107	490304	6524186	Miscellaneous anthropogenic features aligned NW-SE	Debris from <i>V 78</i>	23.8	12.2	0.0	0.0
SS108	489035	6526281	Linear feature aligned N-S	<i>Von der Tann</i> lower foremast section with crow's nest (Diver Survey)	12.0	0.8	0.0	0.0
SS109	489049	6526281	Rectangular feature aligned W-E and miscellaneous debris	<i>Von der Tann</i> pinnacle with small engine, copper pipes and fittings (Diver Survey)	3.2	1.5	1.0	2.6
SS110	489076	6526292	Miscellaneous anthropogenic features aligned SW-NE	Identified as geological (Diver Survey)	11.0	1.0	0.5	1.9
SS111	489748	6525521	Debris	Possible remains of mooring buoy	2.0	1.2	1.0	2.5
SS112	489009	6521717	Linear feature	Section of mast	10.0	0.8	0.7	
SS113	489057	6521709	Area of debris	Debris from possible bridge or searchlight platforms with electrical cables and a short section of mast	11.0	6.0	0.4	
SS114	489527	6520782	Large area of debris	Wreck of barge (Diver Survey)	31.2	10.9	1.4	
SS115	489430	6520843	Circular feature		5.0	5.0	0.5	
SS116	489407	6520836	Area of debris	Wreckage from salvage. Turbine casings	15.0	8.0	0.4	

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Identifier	X_UTM30N	Y_UTM30N	Description	Interpretation	L (m)	W (m)	H (m)	Shadow(m)
SS117	489505	6520834	Isolated curved feature	Turbine casing and turbine blades	8.3	1.2	0.8	
SS118	488871	6526798	Linear feature	Aft mast and spotting top from probably a <i>Kaiser</i> class battleship (drop camera survey, Diver footage)	15.3	2.6	1.2	
SS119			Three short linear features	Live torpedo	6.0	4.0	1.0	
SS120	489818	6528503	Small area of debris	German diesel pinnace	9.0	4.0	1.2	
SS121	488240	6526921	Large anchor.	Possible <i>Derfflinger</i> anchor (1). (Dived by divers off MV <i>Valhalla</i> .)				
SS122	488602	6527124	Large anchor and chain.	Possible <i>Derfflinger</i> anchor (2). (ROV footage Shiptime Project.)				
SS123	490278	6528214	Anchor. Stock standing upright out of seabed.	Possible <i>Kronprinz Wilhelm</i> anchor. (Dived by Simon Brown.) 3D model made.				
SS124	489072	6526623	Anchor.	Possible <i>Hindenburg</i> anchor.				
SS125	488437	6527694	Anchor. Possible <i>Kaiserin</i> .	Possible <i>Kaiserin</i> anchor (Drop camera footage).				
SS126	488782	6525747	Anthropogenic features.	Aft mast with degraded spotting top. Brass recess for wooden topmast. Related to contacts SS065 & SS066 (Diver Survey)	14	1.0	90	
SS127	493190	6531041	Long linear contact running 90 deg from rocky shoreline.	<i>Bremse</i> forward mast. (Diver survey, OSAC)	41			
SS128	493176	6530990	Framework	<i>Bremse</i> aft searchlight platform (Diver Survey, OSAC)	4.2	2.6	1.32	
SS129	489259	6526886	Isolated anthropogenic feature	<i>Kaiser</i> searchlight base and fairlead (Diver Survey)	2.3	1.5	0.64	

8.2 Appendix 2: Specifications of German vessels surveyed during Phase 2 (from Jung & Maass, 1990).

Vessel	Class	Type	Launched (L) / Commissioned (C)	Dimensions	Displacement (tonnes)	Top speed (knots)	Armaments
MSM <i>Moltke</i>	Moltke	Battle cruiser	7/4/1910 (L)	Length 186m Beam 30m Draft 9.2m	25,400	25.5	10 x 28 cm guns in five twin turrets, 12 x 15 cm guns, 12 x 8.8 cm guns, 4 x 50 cm torpedo tubes
SMS <i>Kaiser</i>	Kaiser	Battle ship	22/3/1911 (L)	Length 172.4m Beam 29m Draft 9.1m	27,000	23.4	10 x 30.5 cm guns, 14 x 15 cm guns, 12 x 8.8 cm guns, 5 x 50 cm torpedo tubes.
SMS <i>Prinzregent Luitpold</i>	Kaiser	Battle ship	19/8/1913 (C)	Length 172.4m Beam 29m Draft 9.1m	27,000	21.7	10 x 30.5 cm guns, 14 x 15 cm guns, 12 x 8.8 cm guns, 5 x 50 cm torpedo tubes.
SMS <i>König Albert</i>	Kaiser	Battle ship	27/4/1912 (L) 31/7/1913 (C)	Length 172.4m Beam 29m Draft 9.1m	27,000	22.1	10 x 10.5 cm QF L/50 guns, 14 x 15 cm QF L/45 guns, 8 x 8.8cm L/45 QF guns, 4 x 8.8cm L/45 semi-automatic anti-aircraft guns, 5 x 50cm submerged torpedo tubes.
SMS <i>Kaiserin</i>	Kaiser	Battle ship	11/11/1911 (L) 14/5/1913 (C)	Length 172.4m Beam 29m Draft 9.1m	27,000	22.1	10 x 10.5 cm QF L/50 guns, 14 x 15 cm QF L/45 guns, 8 x 8.8cm L/45 QF guns, 4 x 8.8cm L/45 semi-automatic anti-aircraft guns, 5 x 50cm submerged tubes.
SMS <i>Fredrich Der Grosse</i>	Kaiser	Battle ship	19/6/1911 (L) 15/12/1912 (C)	Length 172.4m Beam 29m Draft 9.1m	27,000	22.4	10 x 10.5 cm QF L/50 guns, 14 x 15 cm QF L/45 guns, 8 x 8.8cm L/45 QF guns, 4 x 8.8cm L/45 semi-automatic anti-aircraft guns, 5 x 50cm submerged tubes.
SMS Grosser Kurfürst	König	Battle ship	5/5/1913 (L) 19/8/1914 (C)	Length 174.7m Beam 29.5m Draft 9.2m	28,600	21.2	10 x 30.5 cm QF L/45 guns, 14 x 15 cm QF L/45 guns, 6 x 8.8cm L/45 QF guns, 4 x 8.8cm L/45 semi-automatic anti-aircraft, 5 x 50cm submerged tubes.
SMS <i>Derfflinger</i>	Derfflinger	Battle cruiser	1/7/1913 (L) 8/1914 (C)	Length 210.4m Beam 29m Draft 9.2m	31,200	25.5	8 x 30.5 cm SK L/50 guns, 12 x 15 cm SK L/50 guns, 4 x 8.8cm/45 QF guns, 2 x 8.8cm/45 semi-automatic anti-aircraft guns, 4 x 50 cm submerged tubes.

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SMS Bremse	Brummer	Light cruiser (minelayer)	11/3/1916 (L) 1/7/1916 (C)	Length 140.4m Beam 13.2m Draft 6m	5,856	28.0	4 x 15 cm guns, 2 x 8.8 cm AA guns, 2 x 50 cm torpedo tubes, 400 mines.
SMS S36	1913 type	Large Torpedo Boat	17/10/1914 (L) 4/1/1915 (C)	Length 79.6m Beam 9.3m Draft 2.8m	971	33.5	3 x 8.8 cm guns, 6 x 500mm torpedo tubes, 24 mines.
SMS B109	B97	Destroyer	11/3/1915 (L) 8/6/1915 (C)	Length 98m Beam 9.35m Draft 3.4m	1,843	36.0	4 x 8.8 cm guns, 6 x 50cm torpedo tubes.
SMS V78	V25	Torpedo Boat	1916 (L)	Length 84.6m Beam 8.3m Draft 3.4m	1,188	36.0	3 x 8.8 cm guns, 6 x 500mm torpedo tubes, 24 mines.