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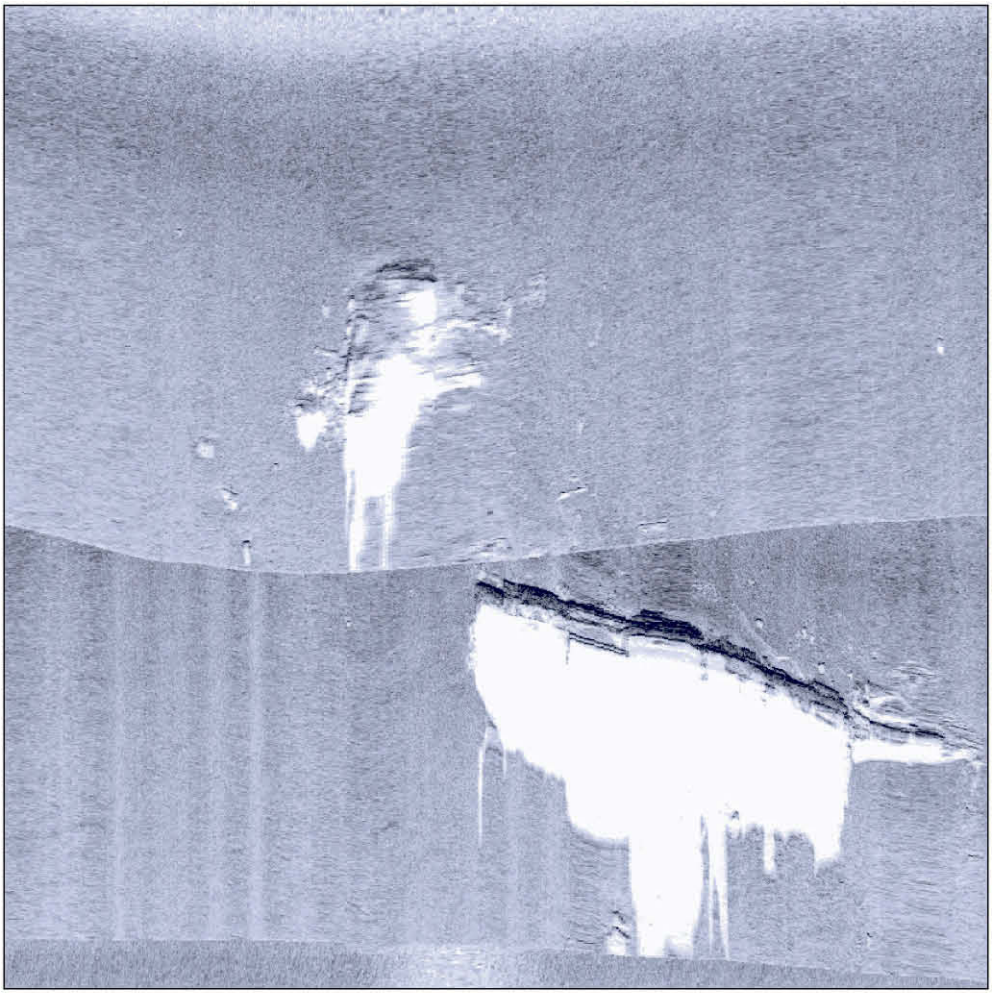
Archaeological Services in Relation to Marine Designation

UB-41 and *UB-75*, off Robin Hood's Bay

Marine Geophysical Survey Report



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Archaeological Services in Relation to Marine Designation *UB-41* and *UB-75*, off Robin Hood's Bay

Marine Geophysical Survey Report

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Summary

Wessex Archaeology was commissioned by English Heritage to carry out geophysical surveys and associated archaeological assessments of the wreck sites reported as those of *UB-41* (UKHO No. 62887) and the *UB-75* (UKHO No. 6438). Both are believed to be German submarine wrecks dating from World War I (WWI) recorded as being lost during 1917 and are located approximately 15km ENE of Robin Hood's Bay, North Yorkshire.

The geophysical data consisted of sidescan sonar and marine magnetometer data acquired by Wessex Archaeology during September 2013. The geophysical data interpretation was cross-referenced with historical records and descriptions provided by past dives at the site where possible.

Both of the targeted wrecks were identified at their given positions. *UB-41* appears generally intact, although a debris field along its eastern edge and other scattered individual pieces of debris suggest an amount of damage, probably due to the explosion that sank the vessel. The data could not be correlated with certainty with the description provided by a previous dive report, and the orientation of the vessel could not be determined. However, the dimensions of the wreck are similar to the known dimensions of *UB-41*, suggesting the current identification is correct.

UB-75 has been found to be in two separate, unequal pieces, with a large main structure and smaller additional separate piece to the NW. A previous dive report description indicates the bow of the vessel was missing, which is potentially the smaller separated part, and suggests the vessel is orientated with the bow to the WNW. The previous dive report also suggests the stern section of the vessel is missing, although this has not been identified. The dimensions of the wreck are similar to the known dimensions of *UB-75*, suggesting the identification is correct.

It is not precisely known what caused the vessels to sink, although correlation with historic mapping suggests they strayed into a British mine field and detonated mines. Circumstances of loss and definitive identification cannot be determined using geophysical data alone, and diver survey will be needed if these questions are to be answered.

During the survey, some tidal currents were experienced which reduced the accuracy of the sidescan sonar positioning. Acquiring multibeam bathymetry data over the sites would increase the confidence in the precise positioning of the wrecks.

Archaeological Services in Relation to Marine Designation *UB-41* and *UB-75*, off Robin Hood's Bay

Marine Geophysical Survey Report

Acknowledgements

This investigation was commissioned by English Heritage, using geophysical data collected by Wessex Archaeology.

The geophysical fieldwork was carried out by David Howell and Laura Andrews, both of Wessex Archaeology, with the assistance of the skipper and crew of the survey vessel *Humber Guardian*, operated by Briggs Marine. Wreck positions and information were provided by Mark Dunkley and Serena Cant of English Heritage, and their assistance is acknowledged in this respect. Additional information was kindly provided by Anthony Firth of Fjordr Ltd, in the form of minefield charts, and his assistance is also acknowledged.

The geophysical data were processed by David Howell, who also compiled this report with Paolo Croce. Quality control was provided by Dr Paul Baggaley and Dr Louise Tizzard, and the figures were produced by Kitty Brandon. The project was managed for Wessex Archaeology by Toby Gane.

Archaeological Services in Relation to Marine Designation *UB-41* and *UB-75*, off Robin Hood's Bay

Marine Geophysical Survey Report

1 INTRODUCTION

1.1 Background

1.1.1 Wessex Archaeology (WA) was commissioned by English Heritage (EH) to carry out geophysical surveys and associated archaeological assessments of the reported wreck sites of *UB-41* (UKHO No. 62887) and the *UB-75* (UKHO No. 6438). Both are believed to be German submarine wrecks dating from World War I (WWI) recorded as being lost during 1917.

1.1.2 The geophysical data consisted of sidescan sonar and marine magnetometer data acquired by WA during September 2013.

1.1.3 The wreck site of *UB-41* is located in the North Sea, approximately 14.5km ENE of the North Cheek headland, Robin Hood's Bay, North Yorkshire. The wreck site of *UB-75* is located in a similar area, approximately 2.5km SE of *UB-41* (**Figure 1**). The locations were provided to WA by EH as Latitude and Longitude co-ordinates, and then projected by WA to UTM Zone 30N:

Site	Latitude (WGS 84)	Longitude (WGS 84)	Easting (UTM 30N)	Northing (UTM 30N)
UB-41	54°27'.845 N	000°17'.723 W	675288	6038525
UB-75	54°27'.147 N	000°15'.715 W	677506	6037315

Table 1: Wreck locations provided in WGS84 and projected to UTM Zone 30N.

1.1.4 The survey consisted of a box-in of each wreck site. Four lines of data were collected around each recorded location, two orientated N-S and two E-W, with a line spacing of 50m. The vessel track plot is illustrated in **Figure 2**.

1.2 Aims and objectives

1.2.1 The aims of this assessment were to carry out an archaeological interpretation of the marine geophysical data acquired from the survey areas. This has resulted in an archaeological review of both of the wreck sites.

1.2.2 The objectives were as follows:

- *To acquire and interpret high resolution marine geophysical data suitable for archaeological interpretation from both wreck sites.*
- *To assess the current condition of the wrecks, and identify any surrounding material of possible archaeological potential in order to inform possible further studies.*
- *To cross-reference the results of the geophysical survey with any documentary evidence and information from any previous surveys at the site.*

2 METHODOLOGY

2.1 Data Sources

2.1.1 The geophysical data were collected by WA on board the survey vessel MV *Humber Guardian* on the 25th September 2013. The survey involved the acquisition of sidescan sonar and marine magnetometer data.

2.1.2 The geophysical data used for this report were assessed for quality and their suitability for archaeological purposes, and rated using the following criteria:

Data Quality	Description
Good	Data which are clear and unaffected by weather conditions or sea state. The dataset is suitable for the interpretation of standing and partially buried metal wrecks and their character and associated debris field. These data also provide the highest chance of identifying wooden wrecks and debris.
Average	Data which are affected by weather conditions and sea state to a slight or moderate degree. The dataset is suitable for the identification and partial interpretation of standing and partially buried metal wrecks, and the larger elements of their debris fields. Wooden wrecks may be visible in the data, but their identification as such is likely to be difficult.
Variable	This category contains datasets with the quality of individual lines ranging from good to average to below average. The dataset is suitable for the identification of standing and some partially buried metal wrecks. Detailed interpretation of the wrecks and debris field is likely to be problematic. Wooden wrecks are unlikely to be identified.

Table 2: Criteria for assigning data quality rating

2.1.3 The sidescan sonar data have been rated as "Average" using the above criteria. Some snatching due to tidal currents and weather are visible within the data, but does not detrimentally affect the data to a large degree. The positioning accuracy of the towfish was poor due to the length of towed cable (due to water depth) and the strong tidal currents at the site. Positioning errors were partially rectified during data processing.

2.1.4 The marine magnetometer data have been rated as "Good" using the above criteria. The data were clear with very little spiking or background noise, however, some of the positioning uncertainties affecting the sidescan sonar also applied to the marine magnetometer. Again, these were rectified during processing.

2.2 Geophysical Data – Technical Specifications

2.2.1 The sidescan sonar data were acquired using a Klein 3900 system. The system was operated at 500kHz with a range of 75m per channel and a line spacing of 50m. Towfish positioning information was provided by a cable counter and applied as manual layback during processing. Data was recorded digitally using SonarPro software as *.xtf* files.

2.2.2 The marine magnetometer data were acquired using a Geometrics G-882 Caesium Vapour magnetometer operating at a frequency of 10Hz, towed directly behind the sidescan sonar fish on a 10m cable. The data was digitally logged in Geometrics MagLog Lite software as *.GEOMAG* files, and later converted to *.txt* files for processing and interpretation.

2.2.3 Positioning for the survey was provided by a Hemisphere R131 DGPS Receiver system, with the navigation data recorded using HyPack navigation software. All positions for the survey were recorded and expressed as WGS84 UTM30N.

2.3 Geophysical Data – Processing

2.3.1 The sidescan sonar data were processed by WA using Coda GeoSurvey software. This allowed the data to be replayed with various gain settings in order to optimise the quality of the images. The data were interpreted for any objects of possible anthropogenic origin. This involves creating a database of anomalies within Coda by tagging individual features of possible archaeological potential, recording their positions and dimensions, and acquiring an image of each anomaly for future reference.

2.3.2 A mosaic of the sidescan sonar data is produced during this process to assess the quality of the sonar towfish positioning. The survey lines are smoothed, and the navigation corrected by applying individual fixed laybacks as recorded during the survey. This allows the position of anomalies to be checked between different survey lines and for the layback values to be further refined if necessary.

2.3.3 The raw vessel position data recorded in HyPack were extracted, converted into Coda corrected navigation *(.cnv*) format, and then applied to the data within the Coda mosaic. Laybacks as recorded during the survey were then applied to the data. This is a less accurate method of positioning than using a USBL beacon or cross-referencing the sidescan sonar with multibeam bathymetry data, especially at site with >50m water depth where 150m – 200m of cable needed to be used. As such the positioning accuracy is considered to be +/- 20m.

2.3.4 The form, size, and/or extent of an anomaly is a guide to its potential to be an anthropogenic feature, and therefore of its potential archaeological interest. A single, small, but prominent anomaly may be part of a much more extensive feature that is largely buried. Similarly, a scatter of minor anomalies may define the edges of a buried but intact feature, or it may be all that remains of a feature as a result of past impacts from, for example, dredging or fishing.

2.3.5 The magnetometer data were processed using Geometrics MagPick software in order to identify any discrete magnetic contacts which could represent buried metallic debris or structures. The software enables both the visualisation of individual lines of data and gridding of data to produce a magnetic anomaly map.

2.3.6 The data were loaded into MagPick and laybacks added as with the sidescan sonar data. The data were then smoothed, a trend fitted to the results, and then the trend values subtracted from the smoothed values. This was carried out in an attempt to remove natural variations in the data (such as diurnal variation in magnetic field strength and changes in geology). The processed data were then gridded to produce a map of magnetic anomalies, and individual anomalies tagged and images taken in a similar process to that undertaken for the sidescan sonar data.

2.3.7 The form and size of a magnetic anomaly is a guide to its potential to be an anthropogenic feature. Generally single magnetic amplitudes of over 5nT identified along a short distance are interpreted to be of anthropogenic origin.

2.4 Geophysical Data – Anomaly Grouping and Discrimination

2.4.1 The previous section describes the initial interpretation of all available geophysical data sets. This inevitably leads to the possibility of any one object being the cause of numerous anomalies in different data sets and apparently overstating the number of archaeological features around the wreck sites.

2.4.2 To address this fact, the anomalies were grouped together, allowing one ID number to be assigned to a single object for which there may be, for example, a magnetic response and multiple sidescan sonar anomalies.

2.4.3 Once all the geophysical anomalies have been grouped, a discrimination flag is added to the record in order to discriminate against those which are not thought to be of an archaeological concern. These flags are ascribed as follows:

Non-Archaeological	U1	Not of anthropogenic origin
	U2	Known non-archaeological feature
	U3	Non-archaeological hazard
Archaeological	A1	Anthropogenic origin of archaeological interest
	A2	Uncertain origin of possible archaeological interest
	A3	Historic record of possible archaeological interest with no corresponding geophysical anomaly

Table 3: Criteria for discriminating archaeological importance of features

2.4.4 All the anomalies that have been identified from around the wreck sites are presented in **Appendix I** and discussed in this report.

2.4.5 The grouping and discrimination of information at this stage is based on all available information and is not definitive. It allows for all features of potential archaeological interest to be highlighted, while retaining all the information produced during the course of the geophysical interpretation for further evaluation should more information become available.

2.5 Sources of Information

2.5.1 A search for supporting information was made for relevant archaeological and related data in primary and secondary documentary sources. The principal sources consulted in this report are as follows:

- *Records of minefields laid in the vicinity of the targets' locations.*
- *Secondary published sources were also consulted such as dive guides.*

2.5.2 The primary data relevant for the study was found in Chart Z42 (UKHO 1918).

3 PROJECT BASELINE

3.1 Archaeological Baseline

UB-41

3.1.1 *UB-41* was a German Type UB-II torpedo attack boat that operated along the east coast of England and Scotland during 1916 and 1917. Built by Blohm & Voss at Hamburg in 1916, and launched the same year, the vessel measured 36.9m long, 4.26m wide and had a draught of 3.7m. She was armed with two bow torpedo tubes, one 88mm deck gun, and carried four torpedoes (Young 2003, Young & Armstrong 2006).

3.1.2 The vessel was reported missing on 5th October 1917 during her thirteenth patrol. On the same day a large explosion was observed from the coast at Scarborough, which is thought to have been that of *UB-41* either detonating a mine (Young 2003, Young & Armstrong 2006) or suffering an internal explosion (English Heritage 2013). If the cause was from detonating a mine, it is unclear whether it was one previously laid by *UC-55* on 9th July 1917 or whether she drifted into the extensive minefield laid by HMS *Angora* and

HMS *Abdiel* in September 1917 (Young 2003; Young & Armstrong 2006; Fjordr Ltd. in prep.) (**Figure 3**). After the observed explosion, the vessel sank with the loss of all hands.

3.1.3 The wreck of *UB-41* was initially located in 1989, and then confirmed as a wreck by survey in 1997, although not definitively identified at this time (English Heritage 2013). The site was dived and filmed at the recorded location in 2003 by Bob Jolley, who recorded a full description of the site (in Young and Armstrong 2006). It was noted that the wreck is broken into two sections with the main section lying over onto its starboard side at an angle of approximately 45 degrees. There were clear signs of damage where the vessel suffered an impact, probably the result of a mine detonation in close proximity, although many items of machinery and other equipment appeared to remain *in situ* within the vessel. The wreck was also noted to be covered and surrounded by a large amount of discarded lobster pots, nets, and other fishing equipment (a longer, more detailed description is given in Young & Armstrong 2006). Although this detailed description of the wreck has been provided, the site has not been fully surveyed since 1989. The geophysical survey that is the focus of the current investigation provided a larger scale site overview to the detailed dive description. *UB-75*

3.1.4 *UB-75* was a German Type UB-III torpedo attack boat that operated along the east coast of England during 1917. Built by Blohm & Voss at Hamburg in 1917, and launched the same year, the vessel measured 55.5m long, 5.82m wide and had a draught of 3.6m. She was armed with four bow and one stern torpedo tubes, one 88mm deck gun, and carried ten torpedoes (Young 2003, Young & Armstrong 2006).

3.1.5 The last firm report of *UB-75* was after she torpedoed the steamer *Venetia* off Whitby on 10th December 1917. Following this incident, all contact was lost and the vessel never returned to port (Young 2003, Young & Armstrong 2006). She was presumed lost in a minefield off Flamborough Head; however, the current wreck location suggests she strayed into the same minefield laid by HMS *Angora* and HMS *Abdiel* in September 1917 off Robin Hood's Bay (**Figure 3**). Although no explosion was observed at the time, the location suggests she struck a mine and sank resulting in the loss of all hands (as with *UB-41)*.

3.1.6 The wreck site was originally surveyed in 1997, although it was not definitively identified at this time (English Heritage 2012). As with *UB-41*, *UB-75* was dived and filmed at the recorded location in 2003 by Bob Jolley, who recorded a full description of the site (in Young and Armstrong 2006). It was noted that the main wreck was generally upright but leaning to port by about 20 degrees. The conning tower was still in place, as was the 88mm deck gun, and scatters of 88mm ammunition were identified around the wreck. The main observable recorded feature was that the front 10m or so of the vessel appear to be missing and were not observed, suggesting the wreck was broken in two after initiating the detonation of a mine. Similarly, a small section at the aft end was also recorded to be missing, suggesting the possibility of contact with two mines. As with *UB-41*, the wreck was also noted to be covered and surrounded by a large amount of discarded lobster pots, nets, and other fishing equipment (a longer, more detailed description is given in Young & Armstrong 2006).

3.1.7 Again, although this detailed description of the wreck has been provided, the site has not been fully surveyed since 1997. The geophysical survey that is the focus of the current investigation provided a larger scale site overview to the detailed description.

4 RESULTS

4.1 Seabed Features Assessment

4.1.1 Both of the targeted wreck sites were observed in the geophysical data sets around their given positions. Processing of the geophysical data indicated that tidal currents at both of the sites had resulted in the sonar towfish being pushed approximately 50m NW (**Figure 2**). As such, the geophysical data coverage is slightly offset compared with the planned lines, but both wreck sites were still fully imaged.

4.1.2 A number of other possible associated anomalies were identified along with the main wreck structures. For the purposes of this report, only anomalies interpreted as being directly related to the wreck sites have been recorded. All of the identified anomalies are described below and in **Appendix I**, the distributions illustrated in **Figure 4**, and the wrecks illustrated in **Sheet 1** and **Sheet 2**.

UB-41

4.1.3 A total of 36 sidescan sonar and 1 magnetic anomaly were identified at and around the *UB-41* wreck site. These were grouped to produce a list of 16 sites of potential archaeological interest, which were characterised as follows:

Archaeological Discrimination	Number of Anomalies	Interpretation
A1	12	Anthropogenic origin of archaeological interest
A2	4	Uncertain origin of possible archaeological interest
Total	**16**	

Table 4: Sites of potential archaeological interest at the *UB-41* site

4.1.4 Wreck *UB-41* is located in approximately 52m depth of water and has been found to be orientated approximately NE-SW (**Figure 4**, **Sheet 2**). The main body of the wreck (**7014**) appears relatively coherent and intact and measures approximately 26.4 x 6.3 x 2.5m, with significant height still visible although no detailed structural elements were identified. A large magnetic anomaly of 812nT has been observed associated with the wreck.

4.1.5 The wreck description from 2003 (Young & Armstrong 2006) suggests the wreck is in two parts. This has not been definitively identified within the sidescan sonar data, although it is possible that if the two sections are only separated by a small distance (of the order of a metre or two) this would not be resolved well in the data. An acoustic shadow is present approximately halfway along the structure, although whether this represents a break in the wreck or just the presence of a feature attached to the hull is uncertain. The identified length of the wreck (26.4m) is also significantly shorter than the original recorded length of the vessel (36.9m). This could be due to the wreck being partially buried at one or either end, that the ends are damaged to the point where the whole length has been reduced, or that the wreck itself is bent which would give the impression of it being shorter in the sidescan sonar data. However, the dimensions are similar enough to suggest the wreck is that of *UB-41*.

4.1.6 Despite the structure appearing generally intact, a spread of incoherent debris (**7015**) has been identified mainly concentrated around the SW end of the wreck. This spread of debris includes a possible single distinct piece larger than the rest, a second one of which has been identified outside the debris field approximately 10m to the W (**7006**). A linear feature (**7004**) has been identified extending 23.2m NW from the N end of the wreck, and

could either be cabling associated with the wreck or a length of snagged and abandoned fishing gear.

4.1.7 Approximately 30m ESE of the main wreck structure, a large, single piece of debris (**7007**) measuring approximately 7.8 x 4.2 x 1.2m has also been identified. This is possibly a more coherent piece of the structure that will have detached following the explosion that resulted in the sinking of the vessel. However, the wreck description from 2003 (Young & Armstrong 2006) suggests both the bow and stern of the vessel are still present on the main structure, so it is uncertain as to what this piece of debris could be. Also, at 30m away from the main structure, it is unlikely that it was identified during the 2003 dive.

4.1.8 Between **7007** and the main wreck structure (**7014**), five irregular dark reflectors with acoustic shadows have also been identified (**7008**, **7009**, **7010**, **7011** and **7012**), which are likely to be small pieces of debris associated with the wreck. A bright reflector ring (**7013**) has also been identified in this area, but the nature of this is uncertain and it could represent partially buried debris or an area of seafloor disturbance.

4.1.9 Three other smaller dark reflectors with acoustic shadows (**7002**, **7003** and **7005**) have been identified within a 50m radius of the main wreck structure, and are likely to be isolated pieces of associated debris. Two other pieces of debris (**7000** and **7001** have been identified further away, and as such it is uncertain as to whether these are directly related.

4.1.10 It is difficult from the data to determine which is the bow and stern of the vessel, as there are no distinct features identifiable in the data that can be cross-referenced with the dive report.

4.1.11 No scour has been identified associated with the wreck, and the surrounding seabed appears stable with no significant areas of mobile seabed sediment. This suggests the wreck is likely to be permanently exposed on the seabed, with little changes in burial of the main structure and associated debris. The seabed sediment at the wreck site is recorded by BGS as being sandy gravel (BGS 1986) and the Admiralty Chart records the seabed as sand, mud, pebbles, gravel and shell (UKHO, Chart 129, Edition 5, 2010).

UB-75

4.1.12 A total of 41 sidescan sonar and 2 magnetic anomalies were identified at and around the *UB-75* wreck site. These were grouped to produce a list of 14 sites of potential archaeological interest, which were characterised as follows:

Archaeological Discrimination	Number of Anomalies	Interpretation
A1	14	Anthropogenic origin of archaeological interest
A2	0	Uncertain origin of possible archaeological interest
Total	**14**	

Table 4: Sites of potential archaeological interest at the *UB-75* site

4.1.13 Wreck *UB-75* is located within approximately 54m of water and has been found to be separated into two distinct unequal sections (**Figure 4**, **Sheet 2**). The main body of the wreck (**7024**) is orientated WNW-ESE and measures approximately 47.8 x 7.2 x 5.2m. The structure appears relatively intact with significant height observed and some structural detail visible. An increase in observed height towards the centre of the wreck suggests the conning tower is still intact and that the vessel is relatively upright.

4.1.14 The second section of the wreck (**7019**) is located approximately 20m NNW of the NW end of the main section and is on a different alignment, orientated approximately N-S. This section is also significantly shorter, measuring approximately 17.4 x 8.3 x 4.6m, and appears less intact, but still shows significant height and some structure.

4.1.15 The description of the wreck from 2003 suggested that approximately 10m of the bow section of the vessel was missing, probably separated during the explosion that sunk the submarine (Young and Armstrong 2006). The geophysical data seem to support this, and if **7019** is the separated section of the bow it indicates that the vessel is orientated with the forward section to the NW.

4.1.16 The wreck description also notes that the stern ends 'abruptly', and that a small section from this part of the vessel may also be missing. This is not supported by the current geophysical data which suggests the stern is relatively intact, even though it does seem less well defined than the rest of the structure possibly indicating it is broken up to some degree. A second separate section of wreck has not been identified in this survey, although it is always possible that one could exist outside of the area covered by the geophysical data.

4.1.17 Debris fields have been identified either side of both **7024** (**7023** and **7025**) and **7019** (**7020** and **7021**), with the observed debris extending furthest to the north and east of each structure, respectively. Again referring to the wreck description in Young & Armstrong (2006), and assuming the bow of the vessel to lie to the NW, the debris field to the north of the main section of the vessel (**7023**) is likely to contain, among other things, 88mm ammunition shells and possibly sections of the outer hull which were reported as being missing from the starboard side of the structure.

4.1.18 At *c.* 8 m north to the structure, two elongated objects *c.* 2.5 m long might suggest the presence of two air cylinders within the debris field. Four air cylinders were reported to be on the top of the hull in 2003 (Young and Armstrong 2006). It is unclear whether the position of the two possible cylinders in the debris field is related to the probable explosion that occurred at the time of the sinking or whether the objects were dragged there from the original position by a post depositional event (i.e. fishing nets).

4.1.19 In addition to the debris fields in the immediate vicinity of the two wreck sections, eight other pieces of possible associated debris have been identified within 50m of the two wreck sections. Anomalies **7026**, **7027**, **7028** and **7029** have all been identified south of the main structure of the wreck, with **7029** representing two very distinct, adjacent square anomalies that may represent significant pieces of debris.

4.1.20 Anomalies **7016**, **7017** and **7018**, however, have been identified to the SW of the possible detached bow section and are much less distinct. They are a linear alignment of anomalies and, due to their proximity to the wreck, are also likely to represent associated debris. One final anomaly (**7022**) has been identified approximately 37m to the NE of the main wreck structure, and could be an isolated piece of debris.

4.1.21 No scour has been identified associated with the wreck, and the surrounding seabed appears stable with no significant areas of mobile seabed sediment. This suggests the wreck is likely to be permanently exposed on the seabed, with little changes in burial of the main structure and associated debris. The seabed sediment at the wreck site is recorded by BGS as being gravelly sand (BGS 1986) and the Admiralty Chart records the seabed as mud, sand, stones, broken shell and rock (UKHO, Chart 129, Edition 5, 2010).

5 DISCUSSION

5.1.1 Both of the submarine wrecks were identified at their recorded locations and in general match the wreck descriptions recorded after the sites were dived in 2003. *UB-41* was recorded as being in two separate pieces, but appears as mainly a single structure within the sidescan sonar data. This could be due to the two separate sections being very close together.

5.1.2 One larger separate piece of debris has, however, been identified (**7007**) although, given that it is located approximately 30m from the main structure, it is unlikely that this was identified during the 2003 dive. The dive report suggests that both the bow and the stern of the wreck are relatively intact, so it is uncertain as to which part of the vessel this could represent.

5.1.3 The scatter of debris around the vessel suggests that it is partially broken up, which may be the result of an explosion in proximity to the vessel. However, debris resulting from an explosion would appear the same within geophysical data as that resulting from other means (e.g. vessel hitting rocks, trawler damage) and so this can only be confirmed by diver survey. The description from the dive in 2003 suggests there is clear evidence of implosion of the hull on the port side forward of the conning tower, suggesting the cause of loss was a mine strike. However, this detail could not be resolved within the geophysical data.

5.1.4 Definitive identification of a vessel is not possible using geophysical data alone, although the dimensions of the wreck correlate approximately with the known dimensions of *UB-41*. The dimensions recorded here are shorter, although this could be due to breaking up and/or twisting of the wreck, and possible partial burial. The nearest charted wreck is over 1.6km away. On balance, it is considered likely that the correct attribution (*UB-41*) has been applied to this wreck site.

5.1.5 The presence of two bow torpedo tubes in the *UB-41* wreck site description given by wreck diver and underwater photographer Bob Jolley (in Young and Armstrong 2006) is consistent with a UB II type which was fitted with a stern tube and two bow torpedo tubes and not with UB III type which was fitted with one stern and four bow torpedo tubes. The description reports "proceeding over a bit of open seabed to your left, you come to the two bow torpedo tubes, the first thing you see is the heavy outer doors; moving across the doors and down the bottom tube, you arrive at the open hull".

5.1.6 The diver observations (in Young and Armstrong 2006) that the rear periscope is extracted and the forward one "must have been extended because it is actually snapped off", together with the explosion detonation witnessed by Scarborough station watchers might point to a periscope depth explosion.

5.1.7 *UB-75* is a more complex site. The approximately 10m of missing bow recorded from the 2003 dive (Young & Armstrong 2006) has been identified approximately 20m away from the main section of the wreck on a different orientation. However, the possible missing stern section has not been identified. It is possible that this may lie outside of the area covered by the geophysical data, or that it is badly broken up and no longer survives as a coherent section.

5.1.8 As the wreck is in two sections surrounded by scattered debris, it is possible that *UB-75* was also lost due to an explosion. However, as with *UB-41*, the exact cause of loss cannot be determined by the geophysical data. No definite features suggesting an explosion appear to have been identified during the dive in 2003, though it is suggested

that a single mine hit aft (Young & Armstrong 2003). However, given that it is the bow section that is most clearly separated, it is also possible that a mine could have hit further forward on the structure.

5.1.9 It is likely that *UB-75* has been lost while submerged because the conning tower hatch is reported as "firmly closed" at the time of the discovery (Young & Armstrong). Furthermore, the fact that of two periscopes one is fully retracted while the other protrudes just slightly from the conning tower could suggest that they were not fully deployed at the time of the sinking. The absence of detonations heard from the Scarborough signal station watchers around 13th December could possibly further support the theory of an explosion at depth.

5.1.10 The presence of four bow torpedo tubes in the *UB-75* wreck site description given in Young 2006 is consistent with a UB-III type which was fitted with one stern and four bow torpedo tubes. Also the mention of missing "part of the outer casing" and references to the round inner hull that "can be clearly observed" there suggest a double hull construction which is a constructional characteristic pertinent to UB-75 rather *UB-41*.

5.1.11 As with *UB-41*, definite identification of the wreck cannot be achieved using geophysical data, although the recorded dimensions correlate approximately with the known dimensions of *UB-75*. The nearest charted wreck is over 800m away. On balance, it is considered likely that the correct attribution (*UB-75*) has been applied to this wreck site.

5.1.12 As has been previously noted, it was found during data processing that tidal currents had pushed the geophysical equipment to the NW during the survey. Additionally, towfish positioning was difficult to achieve due to the relatively deep water at the sites and the correspondingly large amount of cable out used. Survey of the sites by multibeam bathymetry would help remove any positioning uncertainty in the data.

5.1.13 Diver survey is recommended if the wrecks are to be definitively identified and the exact circumstances of their losses and conditions are to be determined.

5.1.14 The relationship of the wreck sites with the plotted mine barrage of 1917 strongly suggests that the U-boats both fell foul of a British minefield, with the dates correlating to support this theory (**figure 3**). The error of six or seven hundred metres between the plotted minefield and the wreck sites could be accounted for by inaccuracies in positioning the minefields when they were laid. In 1917 it is likely that a sextant was used for position fixing. The best possible accuracy that could be achieved using this technique was 0.1 nautical miles (200m) (Dunlap and Shufeldt 1972) and therefore a difference in accuracy of several hundred metres would not be unusual. Add to this the unavoidable errors in layback and in the georeferencing of historic charts, and the differences can be considered typical.

6 REFERENCES

British Geological Survey, 1986. Sea Bed Sediments and Quaternary Geology 1:250,000 Map Series, Sheet 54°N - 02°W (Tyne-Tees). Crown Copyright.

Dunlap, G.D. and Shufeldt, H.H. eds. 1972, *Dutton's Navigation and Piloting*, 12th edition. Naval Institute Press

English Heritage 2012, *English Heritage Monument Record, UB-75*, English Heritage National Record of the Historic Environment Monument Record 1570561, accessed online via PastScape on 25th October 2013 http://www.pastscape.org.uk/hob.aspx?hob_id=1570561

English Heritage 2013, *English Heritage Complete Monument Report, UB-41*, English Heritage National Record of the Historic Environment Complete Monument Record 1570506

Fjordr Ltd. in prep., East Coast War Channels in the First and Second World Wars, English Heritage Report Ref: 6586, Fjordr Report Ref: 16131

UKHO 2010, 129 - Whitby to Flamborough Head, Edition 5 dated 2010, United Kingdom Hydrographic Office

UKHO 1918, Z42 – Flamborough Head to River Tyne: East Coast Mine Barrage – Dated 16 August 1918, United Kingdom Hydrographic Office Archive

Young, R. 2003, *The Comprehensive Guide to Shipwrecks of the East Coast, Volume One (1766 – 1917)*, Tempus Publishing.

Young, R. and Armstrong, P. 2006, *Silent Warriors, Submarine Wrecks of the United Kingdom, Volume One*, Tempus Publishing

APPENDIX I – ANOMALIES OF ARCHAEOLOGICAL POTENTIAL

UB-41

WA_ID	Classification	Easting	Northing	Archaeological Discrimination	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Notes
7000	Debris	675351	6038555	A2	0.6	0.5	0.9	-	Distinct dark reflector with shadow; no identified magnetic anomaly though the anomaly from nearby wreck *UB-41* could mask any signal. Possible piece of debris, possibly related to wreck *UB-41* though it is located approximately 70m away so this is uncertain.
7001	Debris	675322	6038458	A2	1.3	0.8	0.7	-	Distinct dark reflector with shadow; no identified magnetic anomaly though the anomaly from nearby wreck *UB-41* could mask any signal. Possible piece of debris, possibly related to wreck *UB-41* though it is located approximately 75m away so this is uncertain.
7002	Debris	675251	6038528	A1	3.8	0.6	0.5	-	Elongate dark reflector with shadow, no identified magnetic anomaly though the anomaly from nearby wreck *UB-41* could mask any signal. Possible piece of debris, possibly related to wreck *UB-41*.
7003	Debris	675254	6038515	A1	4.1	0.2	0.2	-	Elongate dark reflector with shadow, no identified magnetic anomaly though the anomaly from nearby wreck *UB-41* could mask any signal. Possible piece of debris, possibly related to wreck *UB-41*.
7004	Rope / Chain	675275	6038551	A2	23.2	0.1	0.0	-	Linear dark reflector with small shadow extending NNW-SSE from the northern edge of wreck *UB-41*. Possible length of rope or chain associated with the wreck, though could be a piece of fishing gear attached to the structure.

WA_ID	Classification	Easting	Northing	Archaeological Discrimination	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Notes
7005	Debris	675284	6038544	A1	1.4	0.8	0.4	-	Small, elongate dark reflector with small shadow; no identified magnetic anomaly though the anomaly from nearby wreck *UB-41* could mask any signal. Possible piece of debris, possibly related to wreck *UB-41*.
7006	Debris	675271	6038523	A1	4.8	2.2	0.7	-	Elongate dark reflector with shadow, no identified magnetic anomaly though the anomaly from adjacent wreck *UB-41* could mask any signal. Probable piece of debris; located at the south-western end of wreck *UB-41* and probably related.
7007	Debris	675318	6038518	A1	7.8	4.2	1.2	-	Large, irregular dark reflector with large shadow; no identified magnetic anomaly though the anomaly from nearby wreck *UB-41* could mask any signal. Located approximately 30m ESE of the main structure of wreck *UB-41*. Possibly a separate coherent section of the wreck that could have detached when the vessel experienced an explosion.
7008	Debris	675311	6038523	A1	1.4	0.8	0.9	-	Dark reflector with shadow, located a short distance (approx. 8m) NW of the separate section of wreck *UB-41* **7007**. Possible piece of debris associated with the wreck.
7009	Debris	675304	6038528	A1	1.0	0.3	0.4	-	Dark reflector with shadow located directly to the southeast of the main structure of wreck *UB-41*. Probably associated debris.
7010	Debris	675302	6038521	A1	0.8	0.2	0.3	-	Dark reflector with shadow located directly to the southeast of the main structure of wreck *UB-41*. Probably associated debris.
7011	Debris	675301	6038517	A1	0.6	0.4	0.5	-	Dark reflector with shadow located directly to the southeast of the main structure of wreck *UB-41*. Probably associated debris.

WA_ID	Classification	Easting	Northing	Archaeological Discrimination	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Notes
7012	Debris	675299	6038517	A1	1.6	0.5	0.6	-	Dark reflector with shadow located directly to the southeast of the main structure of wreck *UB-41*. Probably associated debris.
7013	Bright Reflector	675295	6038514	A2	6.3	2.3	0.0	-	Bright reflector identified as a ring on the sidescan sonar, located directly to the southeast of the main structure of wreck *UB-41*. Possible partially buried debris associated with the wreck, though could be an area of seafloor disturbance.
7014	Wreck	675290	6038527	A1	26.4	6.3	2.5	812	Main structure of the wreck of *UB-41*, identified orientated approximately NE-SW. Appears generally intact though a scatter of debris (**7015**) has been identified surrounding the south-western end, along with other individual pieces of debris already described. A larger piece of debris (**7007**) has been identified approximately 30m ESE of the main structure, and could be a separate coherent piece of the vessel that detached during the reported explosion. No real structural detail has been identified, though the wreck does still exhibit significant height and has been associated with a large magnetic anomaly. No scour has been identified, and the surrounding seabed appears stable with no evidence for extensive areas of mobile seabed sediment.
7015	Debris Field	675282	6038524	A1	17.9	17.4	0.0	-	Area of irregular dark and bright reflectors surrounding the south-western end of wreck *UB-41*. Probable scatter of associated debris. No separate magnetic anomaly identified due to proximity of the main wreck, though debris is likely to be ferrous.

UB-75

WA_ID	Classification	Easting	Northing	Archaeological Discrimination	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Notes
7016	Debris	677471	6037338	A1	0.8	0.7	0.4	-	One of a linear alignment of three irregular dark reflectors with shadows located 10m - 15m southwest of a separate section of wreck *UB-75* (7019). No identifiable magnetic anomaly, though the signal from the nearby wreck is likely to mask any anomaly that would be present. Possible debris, probably associated with wreck *UB-75*.
7017	Debris	677473	6037333	A1	1.5	0.2	0.3	-	One of a linear alignment of three irregular dark reflectors with shadows located 10m - 15m southwest of a separate section of wreck *UB-75* (7019). No identifiable magnetic anomaly, though the signal from the nearby wreck is likely to mask any anomaly that would be present. Possible debris, probably associated with wreck *UB-75*.
7018	Debris	677475	6037329	A1	1.5	0.7	0.4	-	One of a linear alignment of three irregular dark reflectors with shadows located 10m - 15m southwest of a separate section of wreck *UB-75* (7019). No identifiable magnetic anomaly, though the signal from the nearby wreck is likely to mask any anomaly that would be present. Possible debris, probably associated with wreck *UB-75*.

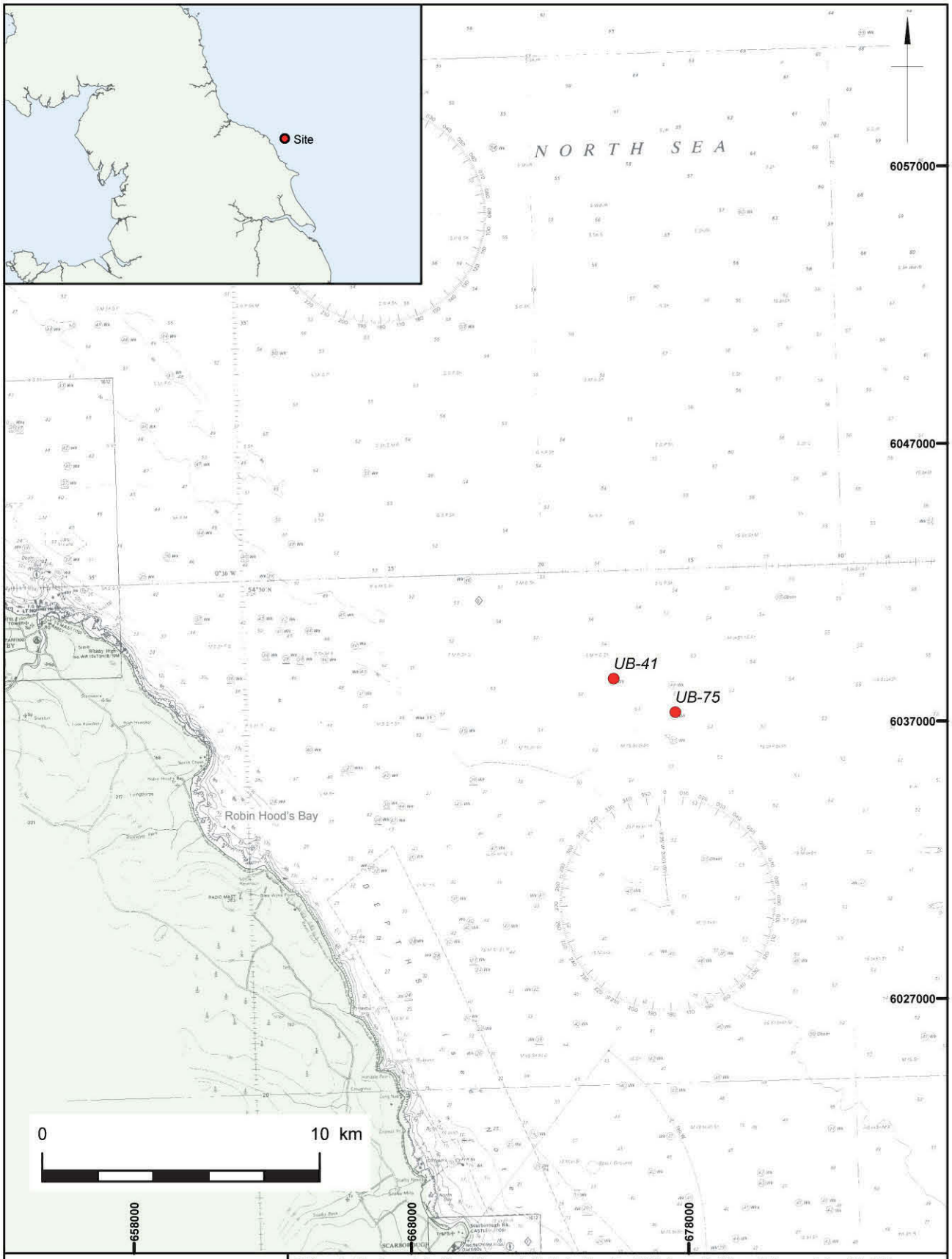
WA_ID	Classification	Easting	Northing	Archaeological Discrimination	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Notes
7019	Wreck	677487	6037347	A1	17.4	8.3	4.6	2486	Large dethatched section of wreck *UB-75*, distinctly separate from the main wreck structure (7022) and located approximately 20m to the north northwest. Main part is elongated along a NNE-SSW orientation, and shows some structure and significant height. Small debris fields (7020 and 7021) have been identified to the east and west. Previous dive reports indicate the forward section of the vessel is missing. It is likely that this is the foreword section, which separated after detonation of a mine.
7020	Debris Field	677481	6037343	A1	14.6	4.9	0.0	-	Area of irregular dark and bright reflectors to the west of the smaller section of wreck *UB-75* (7019). Possible debris field, probably associated with this section of the wreck.
7021	Debris Field	677494	6037345	A1	20.2	6.7	0.0	-	Area of irregular dark and bright reflectors to the east of the smaller section of wreck *UB-75* (7019). Possible debris field, probably associated with this section of the wreck.
7022	Debris	677535	6037347	A1	0.7	0.4	0.4	-	Dark reflector with shadow, no identifiable magnetic anomaly though the signal from the nearby wreck is likely to mask any anomaly that would be present. Possible debris, possibly associated with wreck *UB-75*.
7023	Debris Field	677511	6037324	A1	49.1	15.8	0.0	-	Area of irregular dark and bright reflectors along the northern side of wreck *UB-75*. Probable scatter of associated debris. No separate magnetic anomaly identified due to proximity of the main wreck, though debris is likely to be ferrous.

WA_ID	Classification	Easting	Northing	Archaeological Discrimination	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Notes
7024	Wreck	677512	6037317	A1	47.8	7.2	5.2	1024	Main structure of the wreck of *UB-75*, identified orientated approximately WNW-ESE. The wreck is separated into two distinct and unequal parts, with this being the main body of the vessel. The second section (7019) is possibly the bow of the vessel which, according to divers' reports, is missing from the main body of the wreck, likely due to separation after the vessel detonated a mine. The main section appears generally intact though a large scatter of debris (7023) has been identified along the northern side, and a smaller scatter of debris (7025) has been identified at the south-western edge. Some structure is visible, and differences in shadow height along the length of the wreck suggest the conning tower is still in place and exhibits significant height. Associated with a large magnetic anomaly.
7025	Debris Field	677498	6037315	A1	14.0	5.2	0.0	-	Small are of irregular dark reflectors at the south-western side of wreck *UB-75* (7024). Probable scatter of associated debris. No separate magnetic anomaly identified due to proximity of the main wreck, though debris is likely to be ferrous.
7026	Debris	677537	6037304	A1	2.9	0.6	0.1	-	Elongate dark reflector with small shadow identified close to the south-eastern end of wreck *UB-75*. No identifiable magnetic anomaly, though the signal from the nearby wreck is likely to mask any anomaly that would be present. Possible piece of associated debris.

WA_ID	Classification	Easting	Northing	Archaeological Discrimination	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Notes
7027	Debris	677516	6037304	A1	0.6	0.5	0.5	-	Dark reflector with shadow, no identifiable magnetic anomaly though the signal from the nearby wreck is likely to mask any anomaly that would be present. Possible debris associated with wreck *UB-75*.
7028	Debris	677522	6037307	A1	0.4	0.3	0.3	-	Dark reflector with shadow, no identifiable magnetic anomaly though the signal from the nearby wreck is likely to mask any anomaly that would be present. Possible debris associated with wreck *UB-75*.
7029	Debris	677506	6037295	A1	2.6	1.8	1.1	-	Two adjacent square dark reflectors with large shadows, no identifiable magnetic anomaly though the signal from the nearby wreck is likely to mask any anomaly that would be present. Possible debris associated with wreck *UB-75*.

Notes

1. Co-ordinates are in WGS84 UTM30N
2. Positional accuracy estimated ±20m



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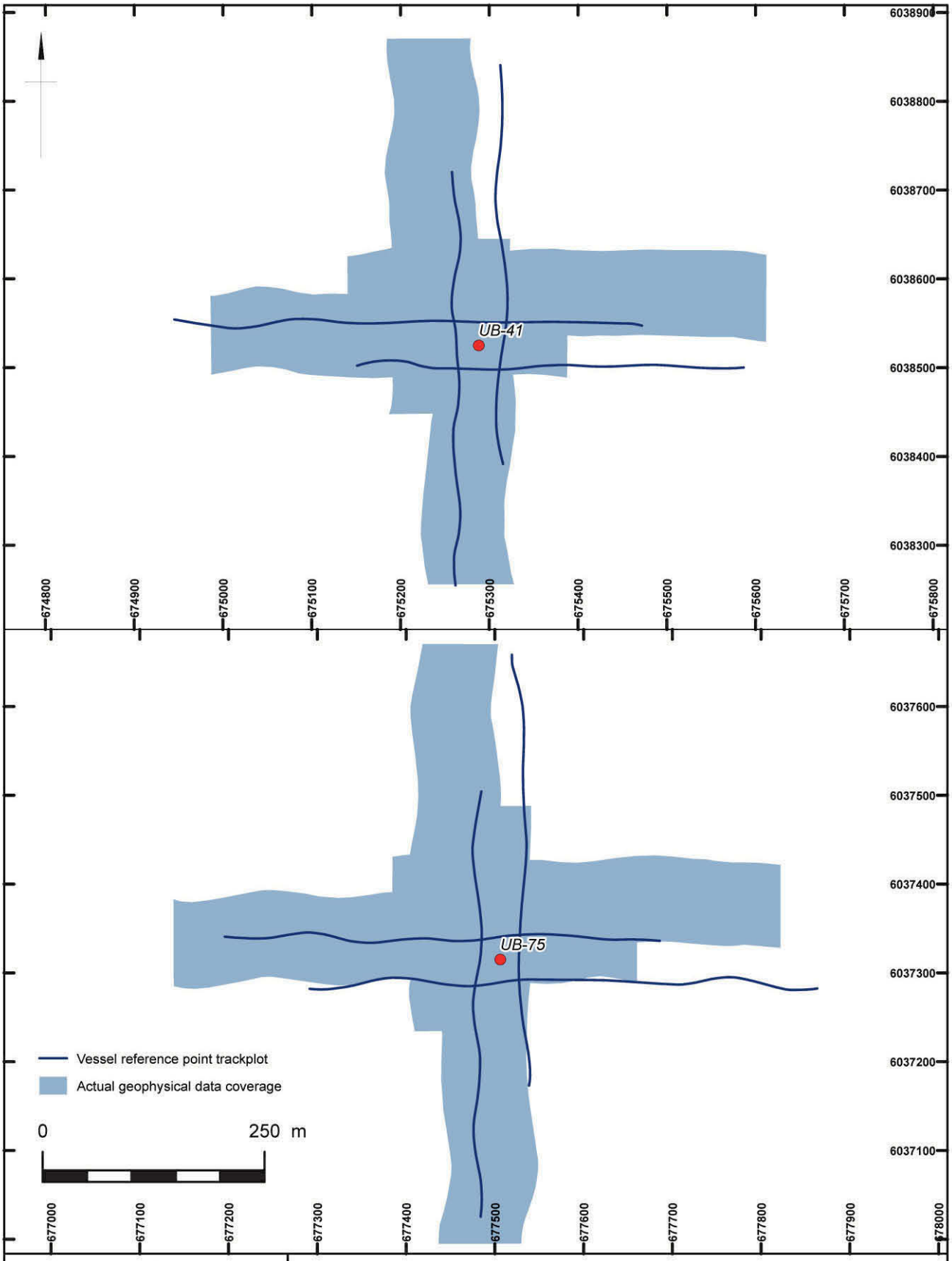
Study Area locations

Figure 1



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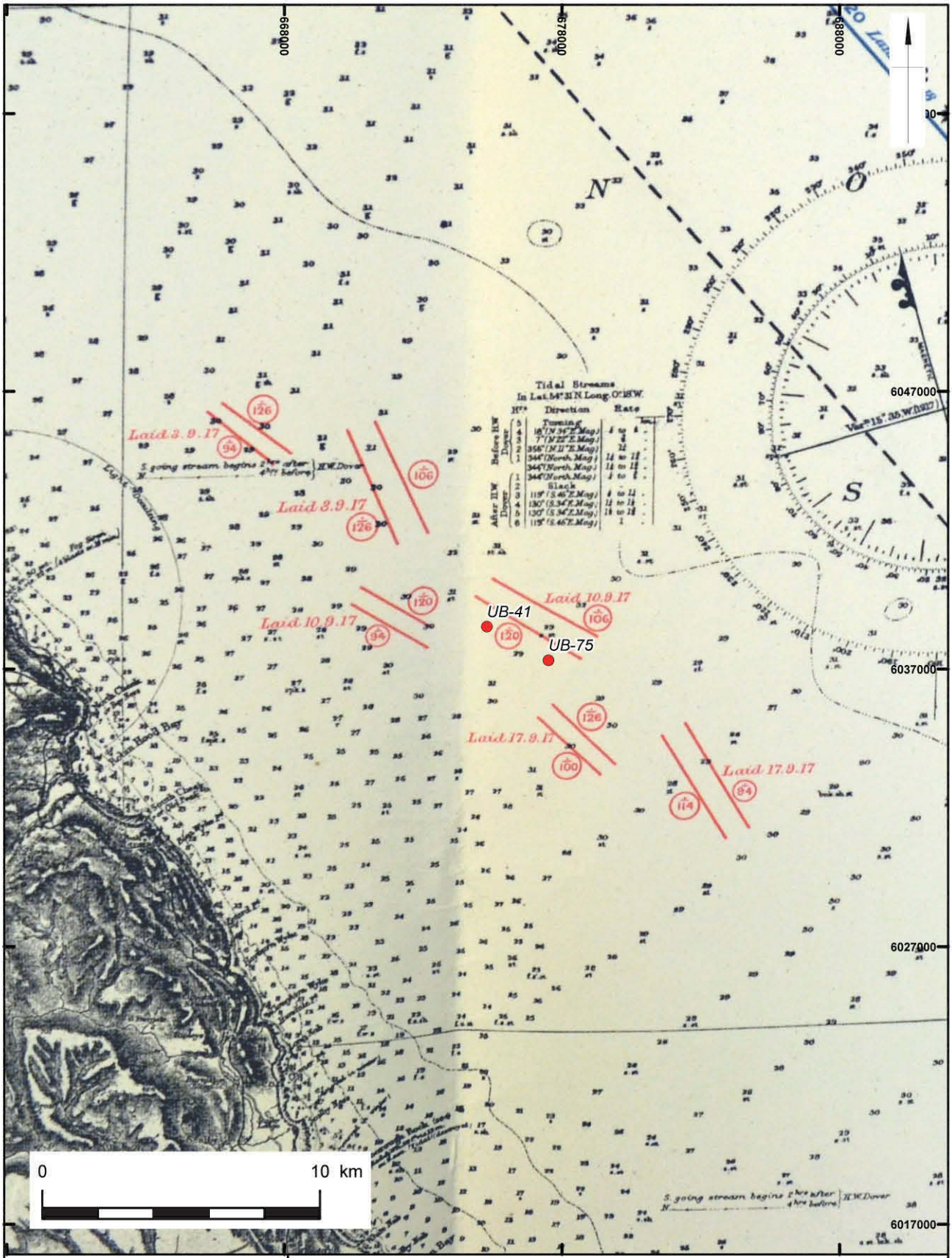
Vessel track plot and geophysical data coverage

Figure 2



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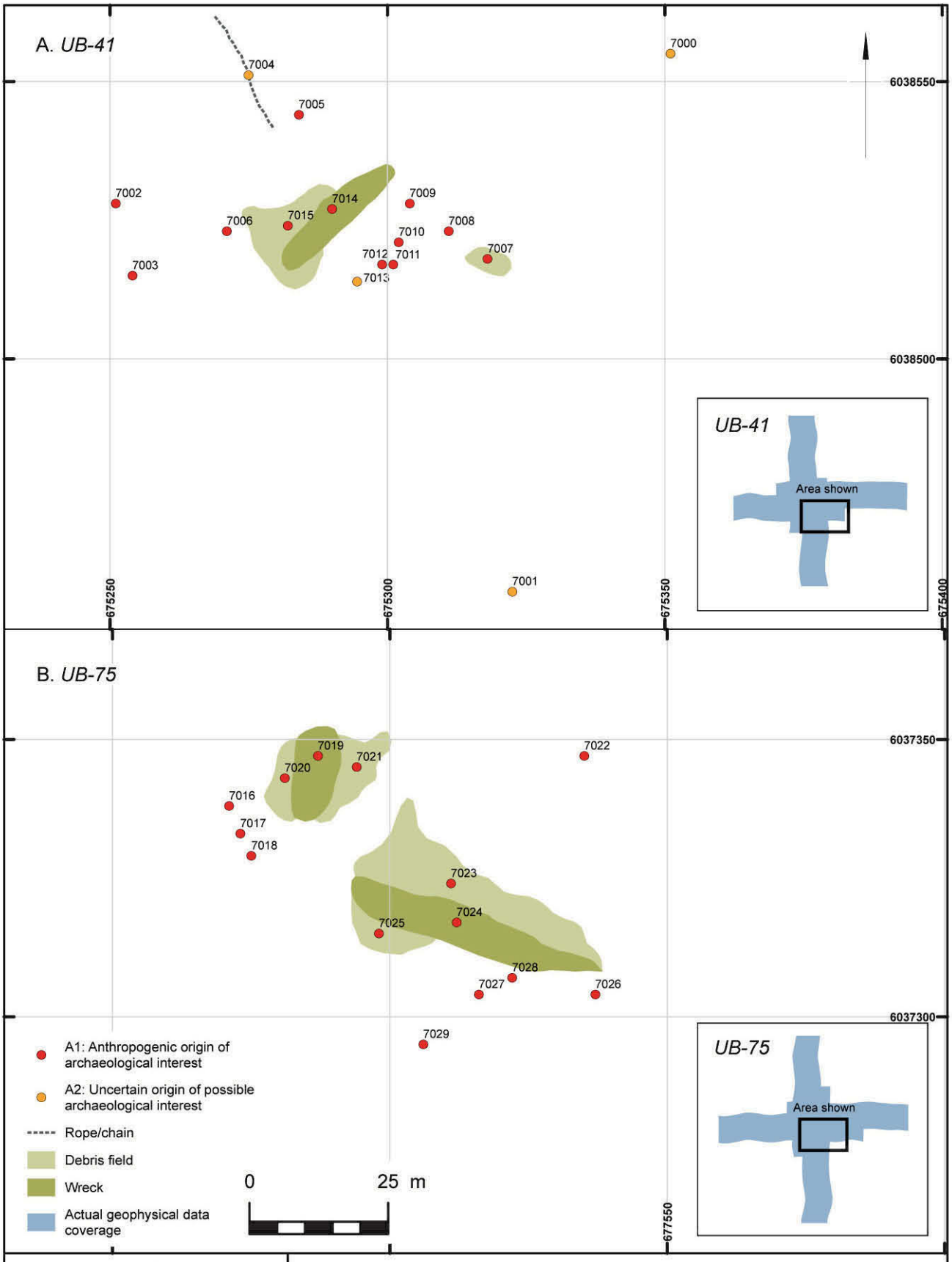
Wreck locations relative to known minefields

Figure 3



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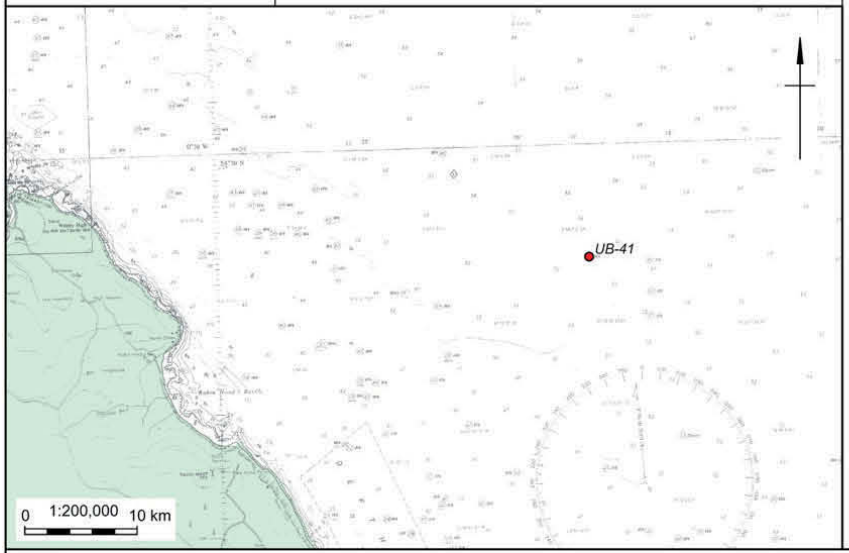
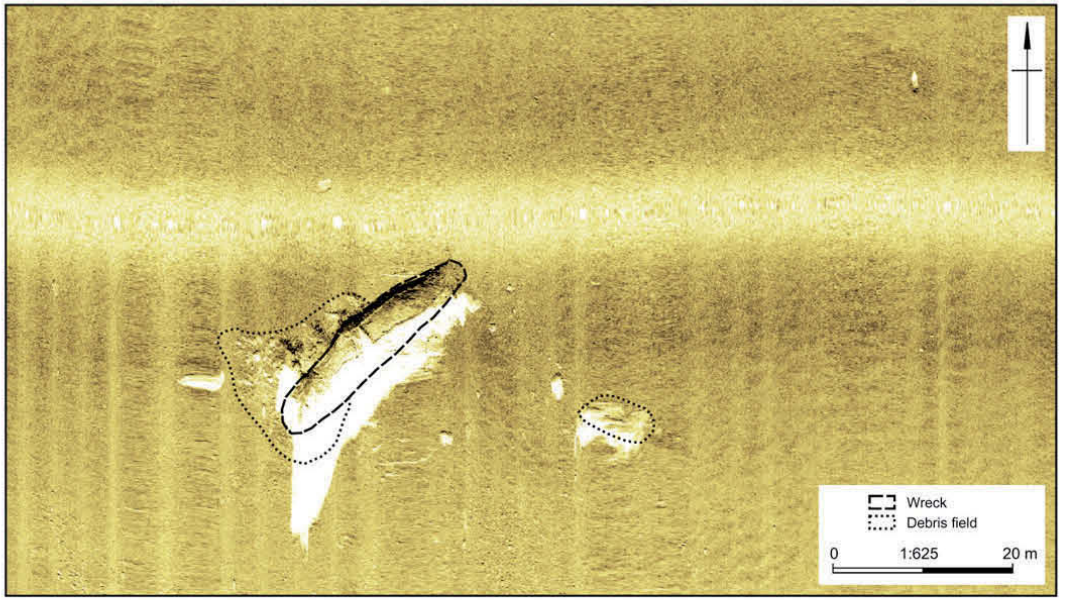
Seabed anomalies of archaeological potential

Figure 4

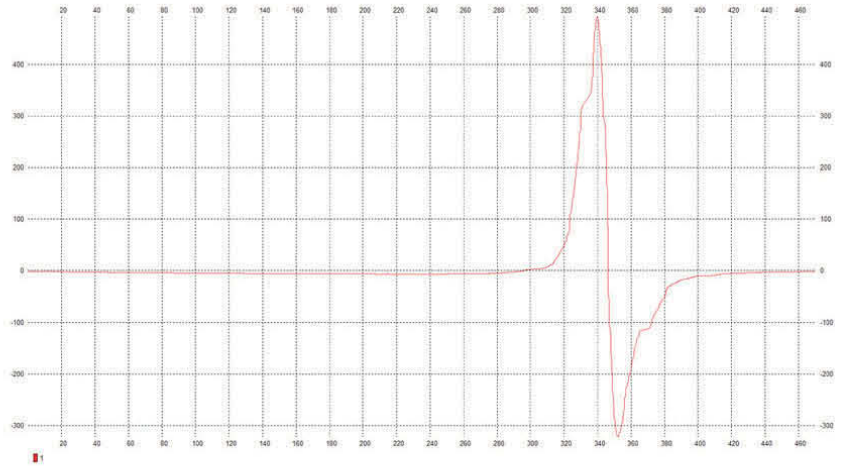
WA ID 7014 - *UB-41* - UKHO 62887

Location		675290 E, 6038527 N (UTM30N)
Archaeological Importance		High
Geophysical survey dimensions and notes		Dimensions: 26.4m x 6.3m x 2.5m. Main structure of the wreck of *UB-41*, identified as a distinct elongate structure orientated approximately NE-SW. Appears generally intact, though no real structural detail has been identified and some surrounding anomalies are likely to be scattered debris. The wreck does still exhibit significant height and has been associated with a large (812nT) magnetic anomaly. No scour has been identified, and the surrounding seabed appears stable with no evidence for extensive areas of mobile seabed sediment.
Build	**Type**	German Type UBII Submarine
	Construction	Steel hull, single saddle tank design; Two 142ps Körting diesel engines, two 140ps electric motors, two bronze propellers; Two bow torpedo tubes, one 88mm deck gun.
	Dimensions	36.9m x 4.37m
	Shipyard	Blohm & Voss, Hamburg
Loss	**Cause**	Sunk offshore Robin Hood's Bay on 5th October 1917, either after suffering an internal explosion or detonating a mine within the minefield laid by HMS *Angora* and HMS *Abdiel* in September 1917.
Extent of Survival		The geophysical data indicate the wreck is relatively intact, though with some surrounding debris fields and isolated pieces of debris. Dive reports from 2003 indicate the wreck is in two pieces, though the data do not support this. However, this could be the case if the two sections are very close. Dive reports also indicate the vessel is leaning approximately 45 degrees to starboard. The lack of mobile sediment indicates the wreck is permanently exposed, though the lack of scour indicates it is not being eroded away at present.





Sidescan sonar image



Magnetometer profile

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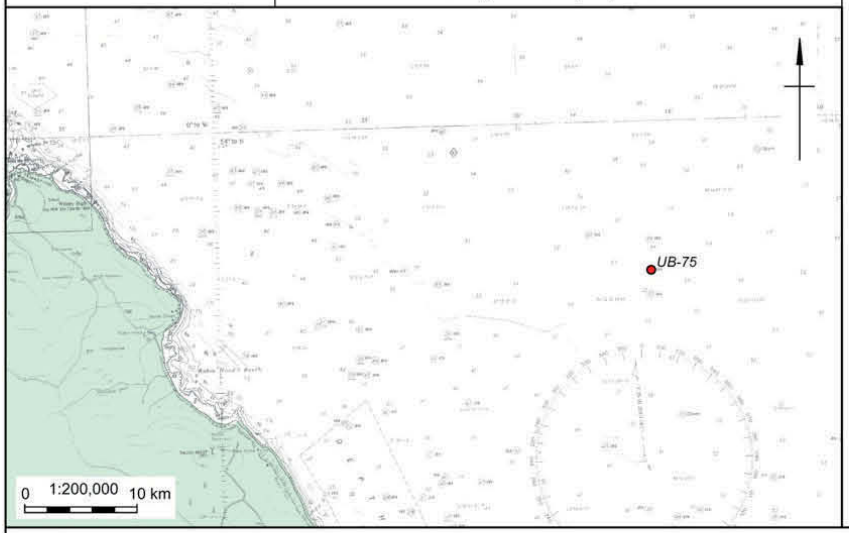
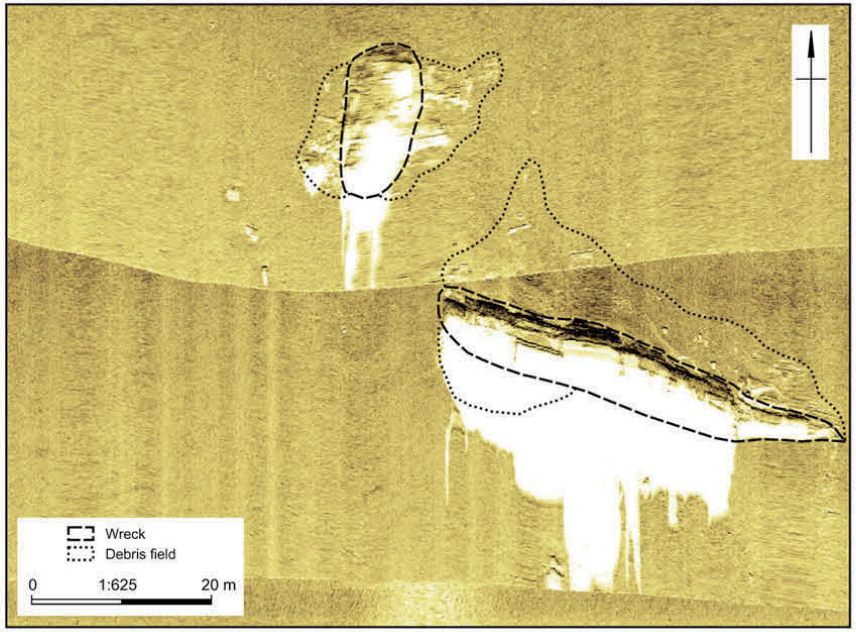
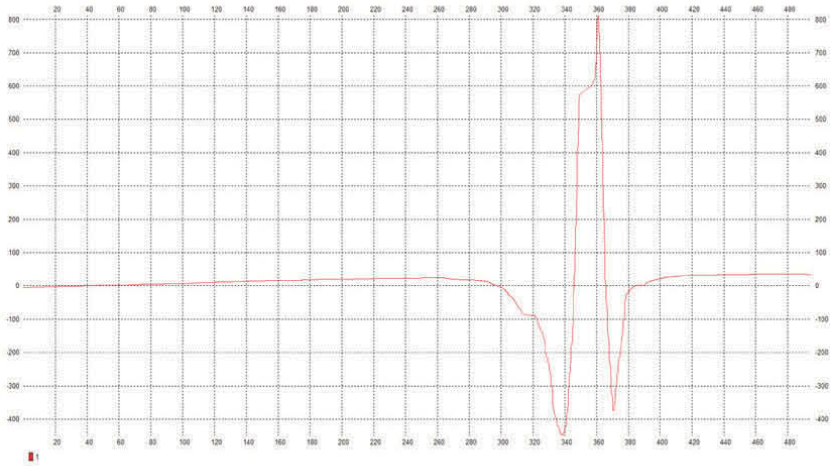
WA ID 7019 & 7024 - *UB-75* - UKHO 6438

Location		677512 E, 6037317 N (UTM30N)
Archaeological Importance		High
Geophysical survey dimensions and notes		Dimensions: 47.8m x 7.2m x 5.2m. Main structure of the wreck of *UB-75*, identified orientated approximately WNW-ESE. The wreck is separated into two distinct and unequal parts, with this being the main body of the vessel. Appears generally intact, with some structural detail being identified, though some surrounding anomalies are likely to be scattered debris. The wreck still exhibits significant height and is associated with a large (2486nT) magnetic anomaly. A second large anomaly approximately 20m away is interpreted as a second section of the wreck (measuring 17.4m x 8.3m x 4.6m) surrounded by associated debris.
Build	**Type**	German Type UBIII Submarine
	Construction	Double steel hull; Two 550ps MAN diesel engines, two 394ps electric motors, two bronze propellers; Four bow and one stern torpedo tubes, one 88mm deck gun.
	Dimensions	55.3m x 5.82m
	Shipyard	Blohm & Voss, Hamburg
Loss	**Cause**	Sunk offshore Robin Hood's Bay around 13th December 1917. Precise cause of loss unknown, though likely detonated a mine within the minefield laid by HMS *Angora* and HMS *Abdiel* in September 1917.
Extent of Survival		The geophysical data indicate the wreck is in two distinct and unequal sections with some surrounding debris fields and isolated pieces of debris. Dive reports from 2003 indicate the main section of the wreck is missing approximately 10m of the bow, in which case the second smaller section is likely to be the bow. The dive report also suggests a small section is missing from the stern, though this has not been identified. The lack of mobile sediment indicates the wreck is permanently exposed, though the lack of scour indicates it is not being eroded away at present.





Sidescan sonar image



Magnetometer profile

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