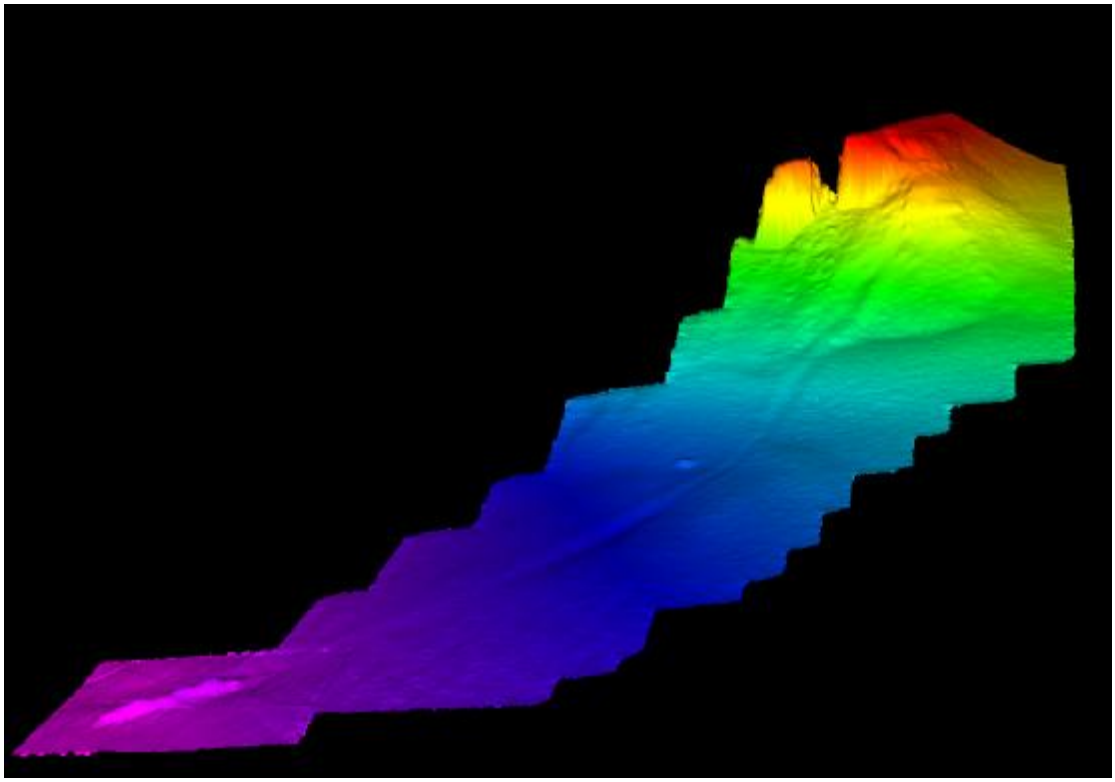
Sound of Mull Remote Sensing Project
Interim report for Historic Scotland



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Cover illustration: Simrad EM3002 multibeam sonar image of an undidentified site off Ardtornish Point, Sound of Mull. Data processed using Cfloor software.

Introduction

During June 2004, Aspect Surveys Ltd., and Kongsberg Maritime Ltd., carried out a remote sensing survey of the Sound of Mull on Scotland's north west coast. The project was funded and supported by a consortium of organisations including Historic Scotland, Centre for Digital Imaging DJCAD University of Dundee, Morvern Maritime Centre, and Lochaline Dive Centre as the "the Sound of Mull mapping consortium".

This report provides an account of the work undertaken to date as required by Historic Scotland (Historic Scotland, 1996a, 1996b). A description of the survey methodology (for a copy of the project design, see appendix) is followed by detailed analysis of results from the multibeam surveys funded by Historic Scotland. The report also incorporates analysis of the sidescan datasets (funded by other members of the consortium) for sites where post processing has been completed. However, considerable work remains to fulfil the archaeological potential of the entire dataset. Moreover, the interpretations arising from analysis of the data gathered may change as specialist analysis progresses. The report represents merely a first step towards full publication as part of a proposed monograph about the work of the Sound of Mull Archaeological Project (SOMAP) since 1994.

Licences

Details of sites listed in the report were obtained from research of local sources, the National Monuments Record of Scotland (www.rcahms.gov.uk), and from existing published sources. In the interests of brevity, descriptions from each site often refer to the NMRS listing where comprehensive citations and bibliographies on each site may be found.

Copies of Admiralty Charts used as base maps were derived in part from material obtained from the UK Hydrographic Office with the permission of the Controller of Her Majesty's Stationery Office and UK Hydrographic Office (www.ukho.gov.uk). This information is © British Crown and SeaZone Solutions Ltd, 2004, with all rights reserved and reproduced for this project under data licence No. 112004.005. It is not to be used for the purposes of navigation. The remote sensing data, images and maps remain © of Aspect Surveys Ltd., Kongsberg Maritime Ltd., Cfloor AS, and all other members of the Sound of Mull mapping consortium (Lochaline Dive Centre, Morvern Maritime Centre, Historic Scotland, University of Dundee, Cfloor AS). In recognition of the partnership philosophy of this project, all members of the consortium retain equal rights to use the data arising from this project without permission from other members of the consortium, with the proviso that any published versions of the data acknowledge the project's origins as follows: "data generated by Aspect Surveys Ltd., Kongsberg Maritime Ltd., and Cfloor AS, for the Sound of Mull mapping consortium (Historic Scotland, Centre for Digital Imaging DJCAD University of Dundee, Morvern Maritime Centre, and Lochaline Dive Centre,)".

. For this purpose, a disk accompanies this report and includes geotiff images of all multibeam survey files in addition to 3D visualisation images created in Cfloor (www.cfloor.no)

Study area

The Sound of Mull is a 31 km mile strait of water separating the island of Mull from the isolated mainland peninsula of Morvern, on Scotland's exposed north west coast. A glacial trough reaching 150 metres in depth in places cuts through the centre of the Sound. The Sound's southern entrance opens out onto the exposed waters of the Firth of Lorne and, to the north, the open sea of the Inner Minch via the Ardnamurchan peninsula. Within its confines, a limited onshore fetch and the wind shadow created by the hills of Mull and Morvern make the Sound of Mull a relatively sheltered coastal environment although at times, short, sharp seas can occur when wind counters tide. Average tidal currents run at 0.7knots at full flood or ebb (UKHO 1995) although localised currents around Ardtornish Point, Duart Point, Inninmore Point, Deirg Sgeir, and Rubh'ant Sean Chaisteil (close to the wreck of the Hispania) exceed published estimates at certain states of the tide. The Sound of Mull is sediment rich, bounded by two large sea loch systems Loch Linnhe, and Loch Sunart, the smaller Loch Aline, and numerous river sources. Loch Sunart is particularly influential because it drains sediment and heavy fresh water run-off at times of peak rainfall into the northern end of the Sound of Mull during the ebb-tide cycle (pers.comm.,George Forster).

Fig.1: project area location in Scotland (UK).

Project background

Since the 1980s, archaeologists have begun to document the maritime cultural landscape of the Sound of Mull. On the coastal fringe, they have revealed settlement of coastal lands dating to the Bronze Age, and a wide variety of site types including fish traps, harbours, bothies, quarries, kilns, and boathouses etc (Martin and Martin, 2004). Most of these sites may be traced to the 19th century. Work underwater on two 17th century warships (Martin, 1998) has illustrated the nature of conflict between armed warships and defended castles while also revealing the excellent preservation potential of the seabed sediments present at certain locations.

Since 1994, volunteers on the Sound of Mull Archaeological Project (SOMAP) have been working to record numerous other shipping related sites. But, progress by volunteer divers in surveying complex 3D structures, has been painstakingly slow. Nevertheless, work on the *SS Thesis* has revealed fairly rapid rates of deterioration (see fig.2). This picture is reinforced by observations gained over ten years from other wrecks in the area. However, most of these sites remain unrecorded, the rates of their deterioration un-quantified, and the factors conditioning their survival, complex and poorly understood.

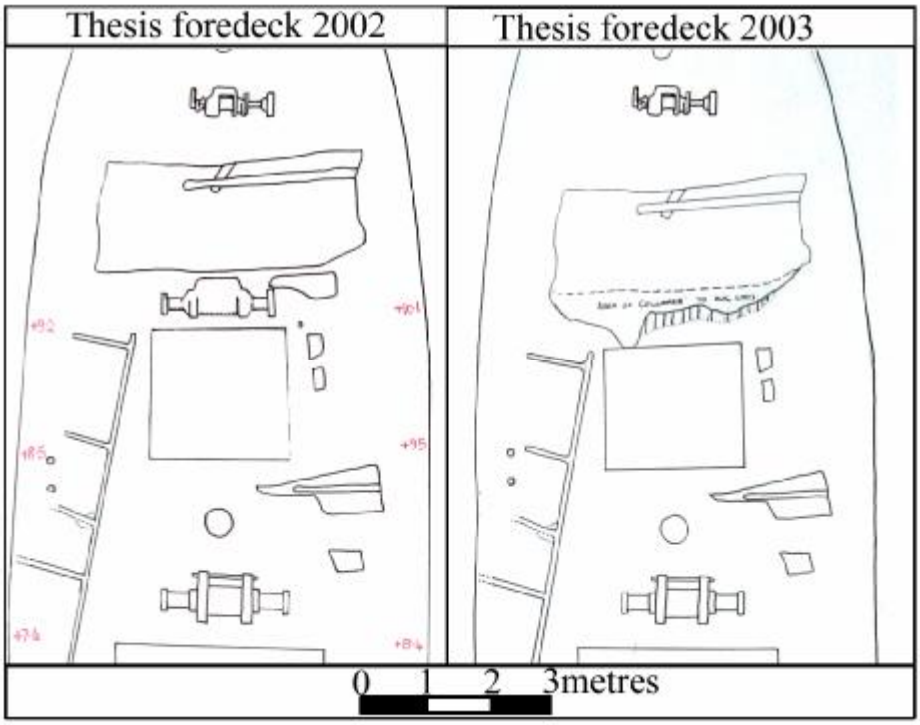

Fig.2 Comparisons of the foredeck of the *SS Thesis* from 2002 – 2003. Note the disappearance of one deck winch and surrounding deck plating. The deck winch now lies deep in the ship's holds.

The Sound of Mull faces a number of management conflicts. The pressures of dive tourism (circa., 4,000 visitors annually) have left their mark on the archaeological resource and there have been reports of damage caused by intermittent but heavy use of bottom trawling methods (nephrops trawls and scallop dredging). Despite these challenges, the sea remains a treasured environment for its many visitors, who contribute considerably to a fragile rural economy. These visitors would benefit from provision of high quality interpretation to inform them about the underwater cultural heritage. In addition, the Sound of Mull has been selected as a pilot area for the Scotland Sustainable Marine Environment Initiative (SSMEI) project

(Posford Haskoning and Nautilus Consultants, 2004: 17-19). This dataset will be passed on to the SSMEI team to aid in developing successful and sustainable management of the marine assets of this outstanding area for the future.

The challenge of recording so many complex sites persuaded the author to look towards the latest remote sensing techniques. Recent work elsewhere in the UK (eg., Forbes, 2003; Wessex 2003; 2004,) has demonstrated the potential of multibeam and side scan sonar as a method for carrying out rapid mapping and evaluation of complex archaeological sites with the potential to generate maps and reports quickly and accurately. And a survey of the Sound of Mull also provided an opportunity to evaluate remote sensing survey methodology and equipment against a large corpus of high quality survey data generated by archaeologists on at least four sites (*Swan, HMS Dartmouth, John Preston, SS Thesis*.)

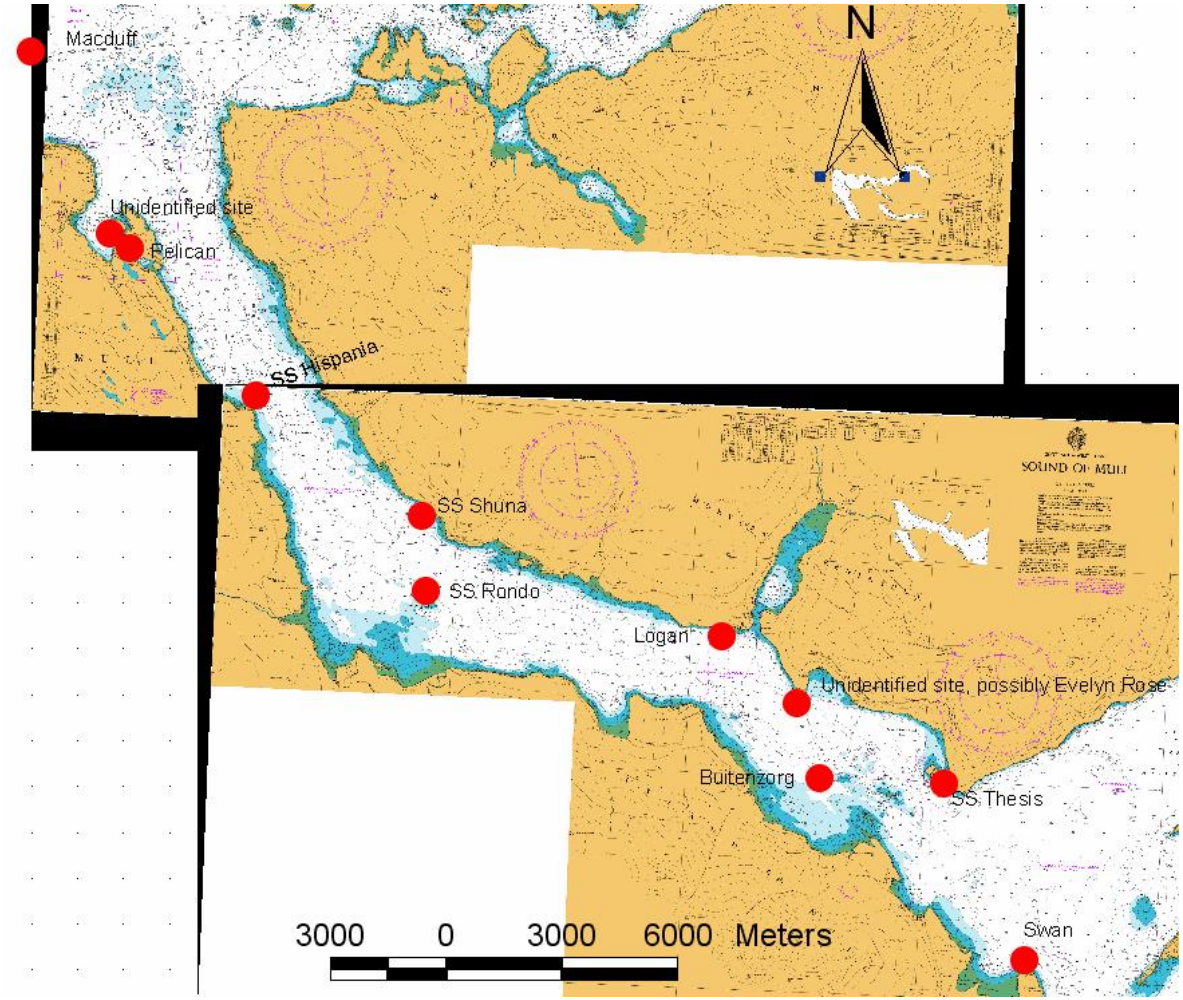

Fig.3: Location map of study area, showing the location of the known sites targeted for detailed survey work (The base map is © British Crown and SeaZone Solutions Ltd, 2004, with all rights reserved and reproduced for this project under data licence No. 112004.005)

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Fieldwork methodology

The remote sensing project utilised the latest in high resolution multibeam and digital sidescan sonar systems, deployed from the M/V Gaelic Rose, a 16 metre (m) ex- fishing boat chartered from Gaelic Rose charters, Lochaline. The Gaelic Rose offered a stable working platform able to cruise with ease at survey speeds of 4-6 knots and with ample computer working area providing an efficient platform for operations.

Fig.4: The MV Gaelic Rose at Lochaline. Note the purpose built, bow mounted pole for the multibeam sonar system, complete with position fixing antennae. The rig was welded to the hull and tensioned using webbing straps.

Multibeam sonar

The survey utilised a single sonar head Kongsberg Maritime EM3002 shallow water multibeam system, set to operate at a frequency of 293 KHz. A Kongsberg Seatex Seapath 200 Real Time Kinetic (RTK) system was installed on the vessel to provide high accuracy, real-time position, heading, velocity and attitude data. An AML sound velocity smart probe was deployed daily to obtain a speed of sound profile of the water column.

The sonar head and Seapath 200 motion sensor, Seatex MRU-5, were mounted close together on a purpose built aluminium vessel bow mount pole, tensioned with strapping to the hull of the vessel to ensure rigidity. The single sonar head EM3002 provides a swath width of 3-4 times the water depth (120^{o} coverage sector) and achieves optimum results in depths of 0.5 – 150 metres beneath the sonar head. The Seapath 200 RTK integrates both the motion and Global Positioning System (GPS) carrier-phase information in a Kalman filter within the system's processing unit to

measure vessel roll, pitch, heave, heading and position data required by the EM3002. Offsets between all of the sensors were carefully measured and standard hydrographic patch test and calibration procedures followed to minimize any integration or alignment errors. The EM3002 operator station using EM3002's operator software, Seafloor Information System (SIS), and the main data processing unit were used to digitally acquire data, to integrate data from the ancillary sensors, and store all raw data files. Although SIS can provide real time data cleaning, Kongsberg Maritime Ltd, processed the data using their Neptune post processing software to generate Ascii xyz data files.

Fig.5 The EM3002 single sonar head and ancillary systems mounted onto a purpose built pole.

The author carried out all further post processing work. Cfloor 6.3.1 (www.cfloor.no) was used to generate terrain models from the ASCII files. All models were formed using the seabed algorithm, without vertical exaggeration or supplementary data smoothing. The maps incorporated into this report consist of shaded relief images displayed as charts with Universal Transverse Mercator (UTM) coordinates (UTM Zone 30N), and high-resolution 3D images. Location maps have been produced from digitized raster Admiralty charts 2390 and 2394, georeferenced to World Geodetic System (WGS) 84 datum and also projected to UTM Zone 30 N. These were obtained from www.seazone.co.uk. Cfloor 6.3.1 was also used to produce Geotiff image files for use in Arcview GIS applications and as geo-referenced overlays within the base maps.

In addition, the project is working on the development of 3d fly throughs for individual sites using McCarthy' Taylor's LSS Vista 9.01 (www.mccarthytaylor.com), and through cooperation with consortium partners at the University of Dundee but this phase of the project is still to be completed.

Sidescan sonar

The project undertook a high-resolution side scan survey using the multi frequency Klein 3000 side scan sonar. This equipment operates on two frequencies,

100kHz and 500kHz. The system comprises a surface processing unit, a monitor and a towed 'fish'. Trimble RTK GPS was interfaced with the Klein software for accurate positioning. Antennae to fish 'lay-back' distances were calculated and keyed into the software, to enable accurate positioning of the 'fish'.

Post Processing was carried out using Klein Sonar Pro Software but much work remains on this aspect of the project. All results were logged on DVD Rom. Target images of potential sites and known sites have been saved as .tif files. No sonar mosaicing has been undertaken so far, but given the appropriate software, such mosaicing could be undertaken.

Position fixing

The on vessel position systems were set-up to receive DGPS RTK corrections from an onshore Seatex Searef 200 RTK base station. Aspect Surveys Ltd positioned the base station antenna coordinates using static GPS methods with accuracy of +/- 100mm. Fugro Seastar spotbeam DGPS corrections with sub-metric accuracy were also input to the Seapath system for use during periods when RTK reference station signals were unavailable (e.g in the vicinity of Tobermory).

Base station coordinates were levelled from ordnance datum benchmarks adjusted to chart datum using Admiralty Tide tables (NP 2001-04) and real time tidal levels were provided using a Valeport 740 digital tide gauge mounted on the west pier at Lochaline, and accurate to +/- 10mm.

Sidescan positions are given in lat/long but multi-beam positions are given in Universal Transverse Mercator projection (UTM Zone 30 N), both using World Geodetic System 84 datum (WGS84, the mathematical ellipsoid used by GPS systems since January 1987).

Fig.6 Setting up a Real Time Kinetic (RTK) shore station adjacent to the West Pier, Lochaline.

Fieldwork results – Site Surveys

The project completed surveys on twelve sites (some sites incorporate more than one wreck). These twelve sites represent most of the known wreck sites in the target area. However, a number of known sites were not covered by survey work. These include the *Avro Shackleton* airplane site (NMRS: NM64SE 8003), and sites with a foreshore element such as the wreck of a fishing vessel (NMRS: NM55SE 8002) charted by the Hydrographic Office (Admiralty chart 2390) close to Rhemore at Dun Ban (OSNGR: NM 5690 5036).

All site surveys have been plotted at 0.10m point resolution (i.e., one xyz point for every 10cm of seabed) to preserve the maximum amount of archaeological information within the dataset, within the constraints of hardware and time available to the project.

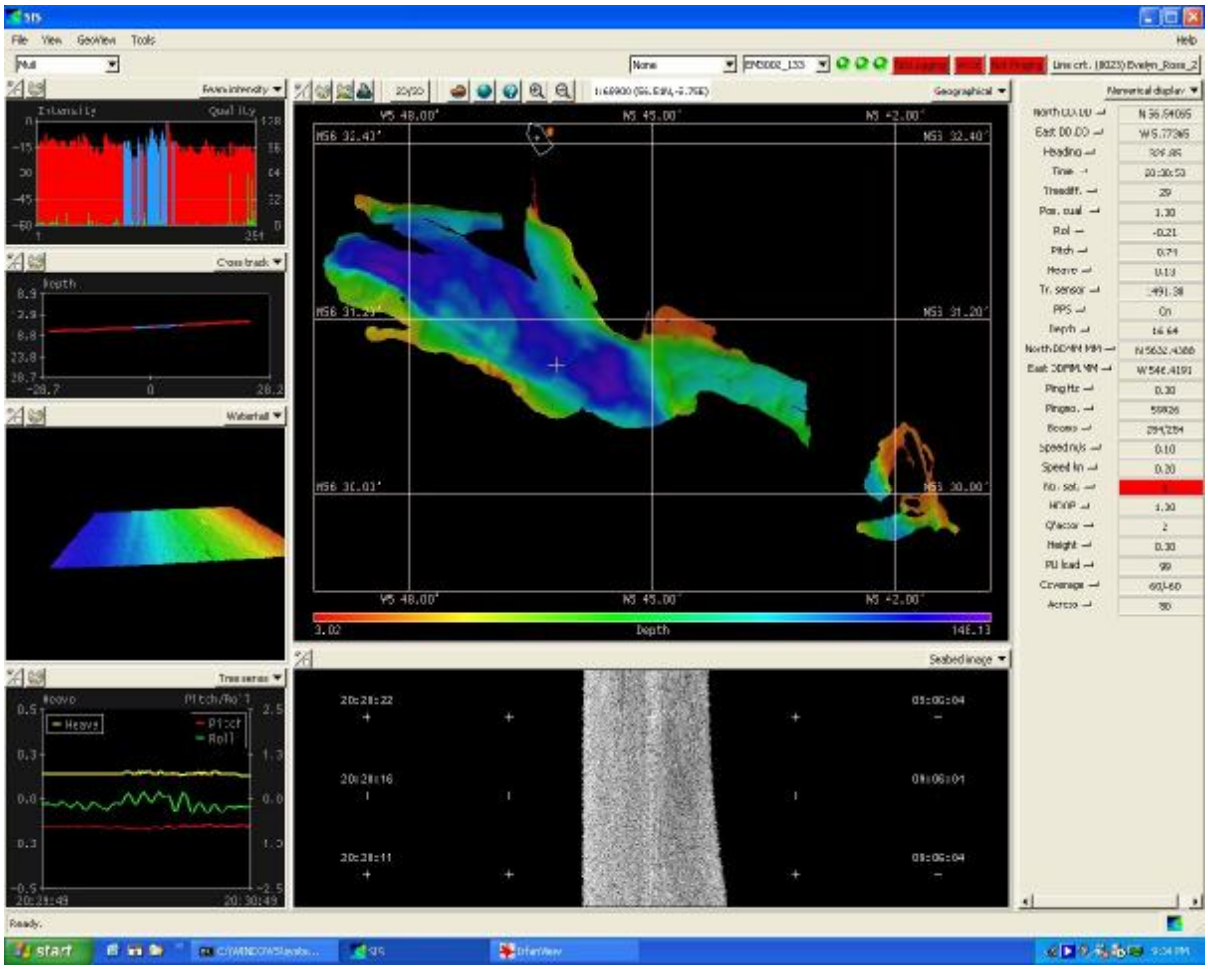


Fig.7 Screen capture of the EM3002 SIS data processing software.

Methodology test sites/site surveys

The existence of detailed datasets gathered by archaeologists over twenty years provided excellent baselines from which to test the accuracy and potential of multibeam and sidescan sonar as a survey tool. For this purpose, the project has attempted to draw objective comparisons between the two approaches, considering issues relating to survey accuracy, and archaeological benefit. It is hoped that the conclusions drawn from this exercise may be helpful when planning recording strategy in the future. At the same time, the project hoped to add data to already extensive archives on both test sites.

Swan

Site Location and Environment

Documentary sources (See Canmore, the public access system of the National Monuments Record of Scotland NMRS at www.rcahms.gov.uk: NMRS NM73NW8005) indicate the wreck of the *Swan* as being located against the rocky promontory of Duart Point, at the south eastern entrance to the Sound of Mull at N56' 27.45 W5' 39.32 (OS NGR: NM 7480 3546). The centre of the wreck was charted by remote sensing to be located at N56' 27.459N, W5' 39. 398 (WGS84). The seabed consists of coarse sands and gravels with larger boulders. The site is swept by currents through the ebb tidal cycle.

Survey and Research History

John Dadd discovered the *Swan* in 1979 and after the Archaeological Diving Unit's initial visit in 1991, the site has been thoroughly investigated by survey and excavation under the direction of Colin Martin, and comprehensively published. Detailed bibliographies, historical and archaeological summaries regarding the *Swan* (lost 1653) may be found on Canmore (See NMRS: NM73NW 8005).

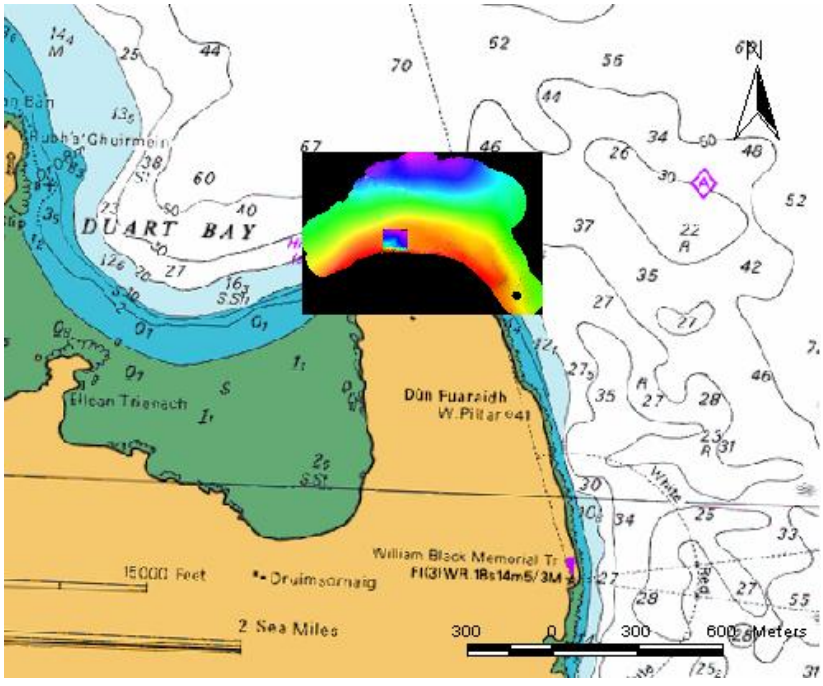


Fig 8: Location map of the Swan survey, the detailed site survey (fig.9) is shown inset within the area survey plot.

Fieldwork

A survey of the *Swan* provided an opportunity to test sidescan and multibeam sonar systems against a partially buried historic wreck recorded by diving archaeologists to the highest archaeological standards, using traditional techniques. The project also hoped to record the site within its wider environment and to enhance the licensee's already comprehensive dataset.

A multibeam and sidescan survey was undertaken (1,770585 xyz multibeam points) within the following area (see fig 9:

Latitude min N)	Latitude max (N)	Long. Min (W)	Long. max (W)
56'.27. 2604	56'.27. 2927	5' 39. 2733	5' 39.1309

In order to set the wreck of the Swan in its wider geographical context and to identify anomalies offshore, the seabed off Duart Point was surveyed using multibeam and sidescan sonar to a distance of 350m offshore within the following area:

Latitude min N)	Latitude max (N)	Long. Min (W)	Long. max (W)
56'.27. 1900	56'.27. 3847	5' 39. 445	5' 38.5373

The results have been processed at 0.5m point resolution (29312 xyz points.See fig.15)

Results

The multibeam dataset has identified the cast iron guns that are visible on the seabed but not the single anchor (figs 10; 11). It is also possible to identify the largest boulders, and twin ballast mounds, separated by a depression in the seabed that may be partly caused by excavation activity. It is possible to identify all large, exposed iron features on the sidescan dataset (see fig.12)

The images also indicate one other area of potential interest close to the site, but not yet investigated by archaeologists (fogs 10; 13; 14). This is a raised mound at a depth of 6-7m below cd of approximately 150sq.m, situated to 10m north west of the forward ballast mound. This may be of high archaeological potential, situated as it is just beyond the excavated confines of the ship's bow. However, it is possible that this mound is merely an extension of sediment accretion visible at the western end of Duart Point and arising from the strong ebb tidal sequence carrying sediment from Duart Bay. A build up of sediment may also be seen at the eastern end of Duart Point, deposited during the flood tide that is strongest on this point. Between the two areas of accretion, the seabed appears to be stable or possibly experiencing some erosion, with depths typically 1m deeper than in adjacent areas that are experiencing accretion. The wreck of the *Swan* lies on the boundary between these two distinct zones and the sediment build up may help to explain why the Swan has been survived so well.

Initial observations on the sidescan dataset suggest that there are several interesting anomalies that require checking by divers. The main objective of this would be to search for material evidence for the loss off Duart Point of two other vessels in 1653 (*Martha and Margrett of Ipswich,* and *Speedwell of Lynne),* and at least two other wrecks lost around Duart Point *(*NM73NE 8001; NM73NW 8012). On a positive note, the sidescan trace has not identified any obvious evidence of dredging activity within the target area.

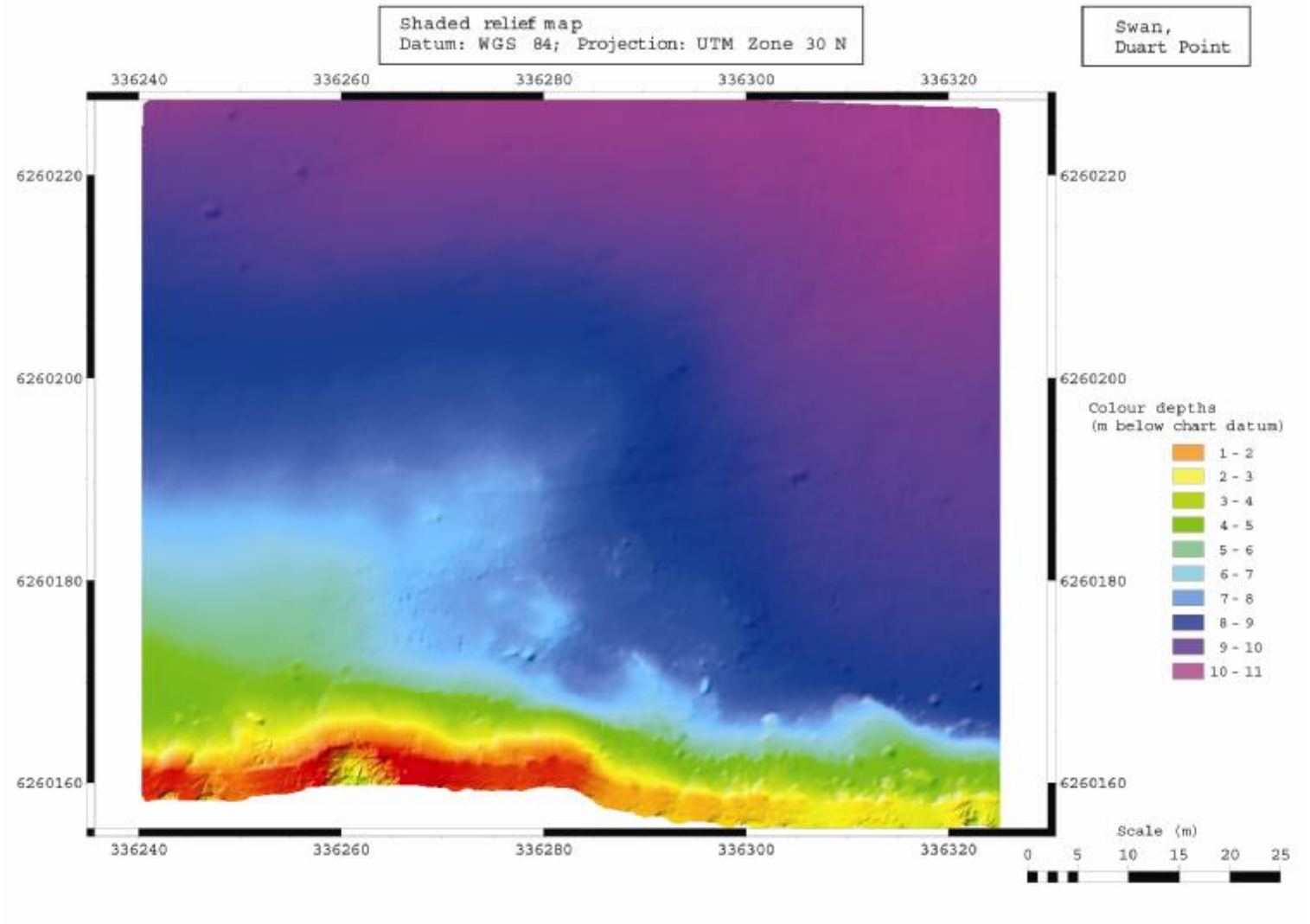


Fig.9 Multibeam site plan of the Swan site (processed at 0.1m point resolution)

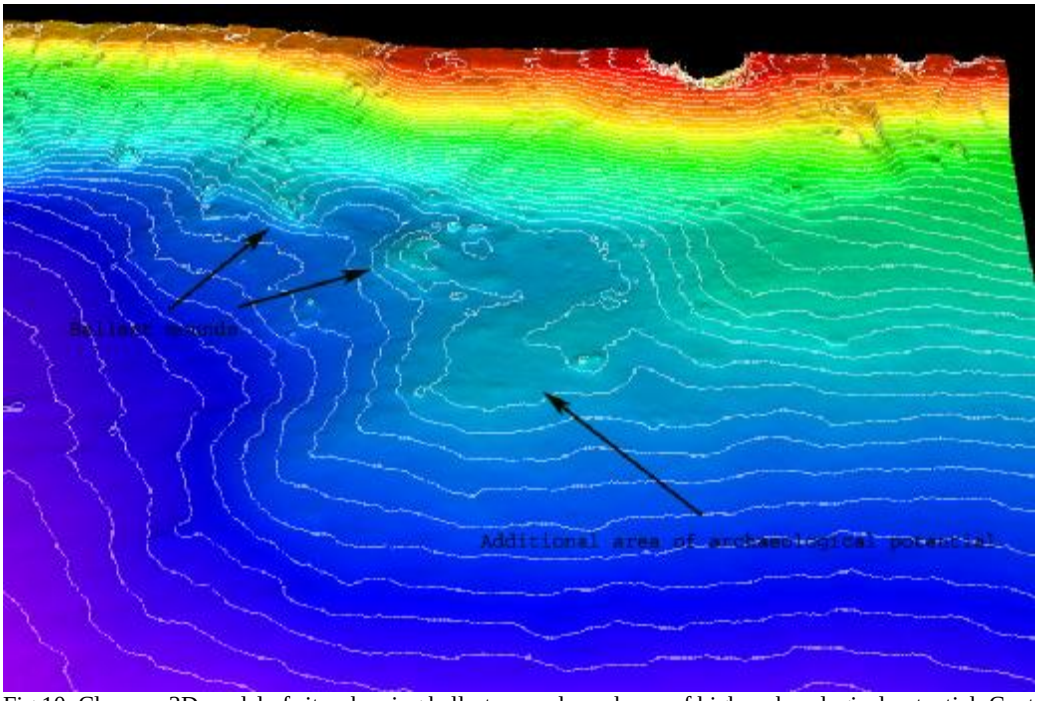


Fig 10: Close up 3D model of site, showing ballast mounds, and area of high archaeological potential. Contours are at 0.2 m intervals

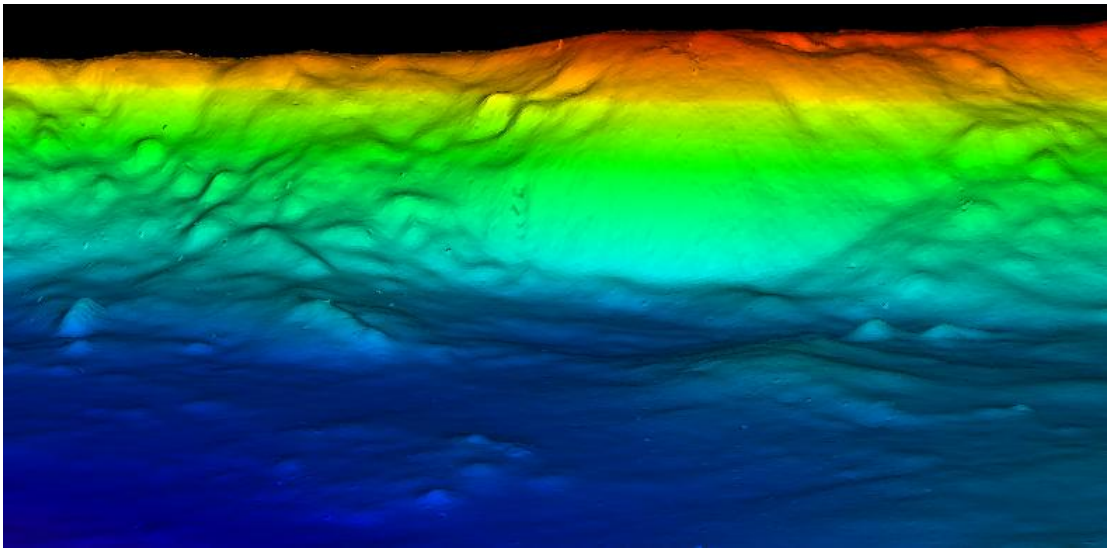


Fig.11: 3D terrain model of site showing guns, and ballast mounds.

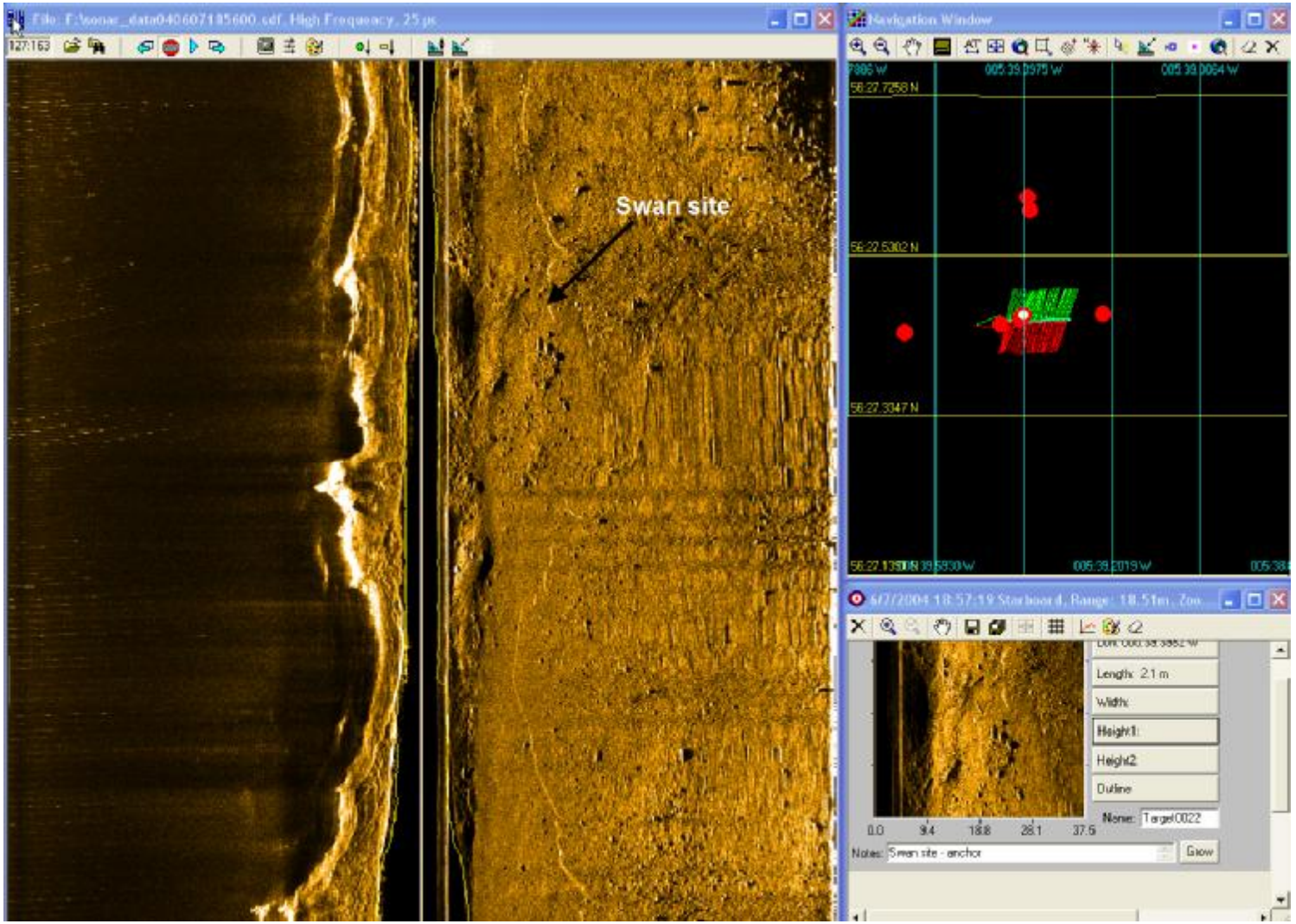


Fig. 12: Klein 3000 sidescan image of the Swan, with site location pointers, survey track and close-up targets as sub-windows

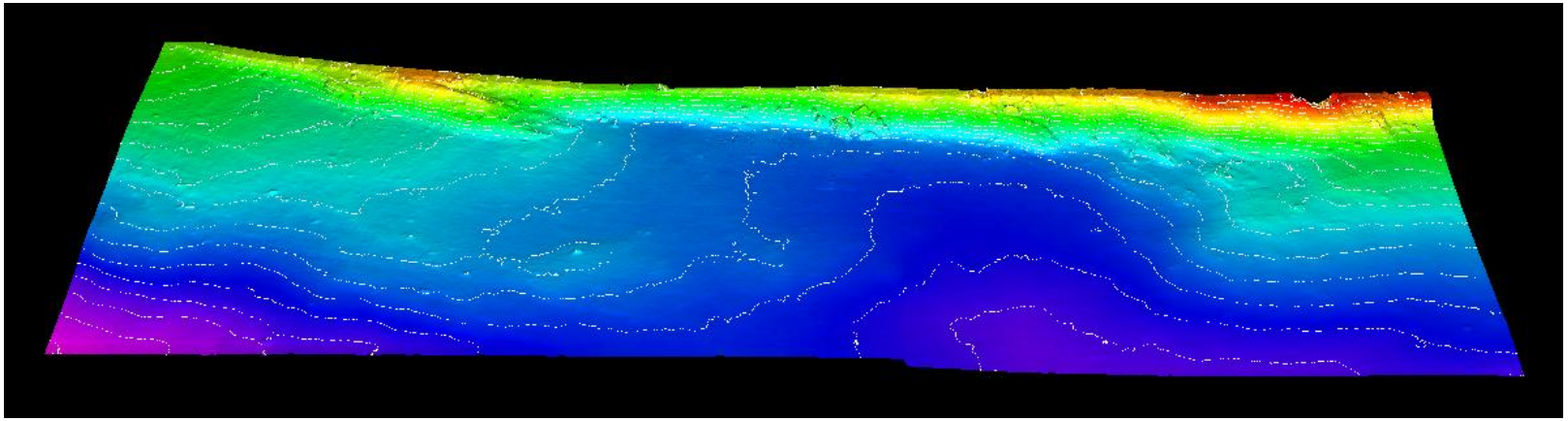


Fig. 13: Bathymetry plot of the Seabed off Duart Point. Contours are at 0.5m intervals. This is an oblique view of the seabed from a northerly direction.

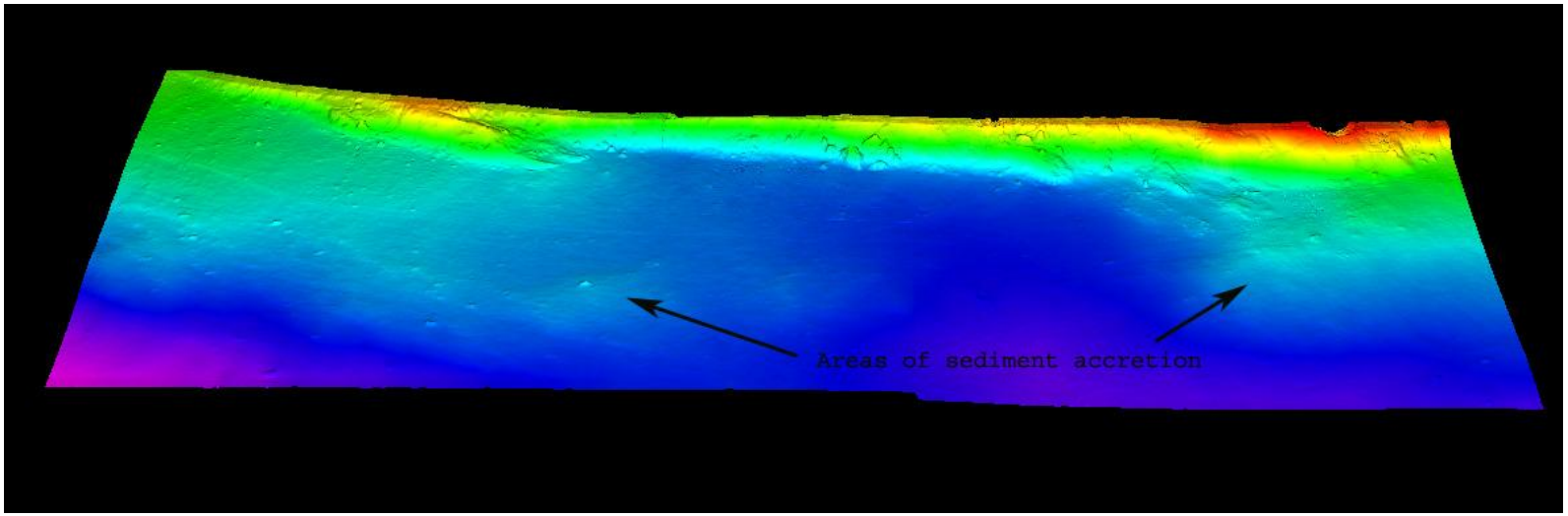


Fig. 14: relief plot of the Seabed off Duart Point viewed obliquely from the north. The site of the Swan may be seen towards the right of the image.

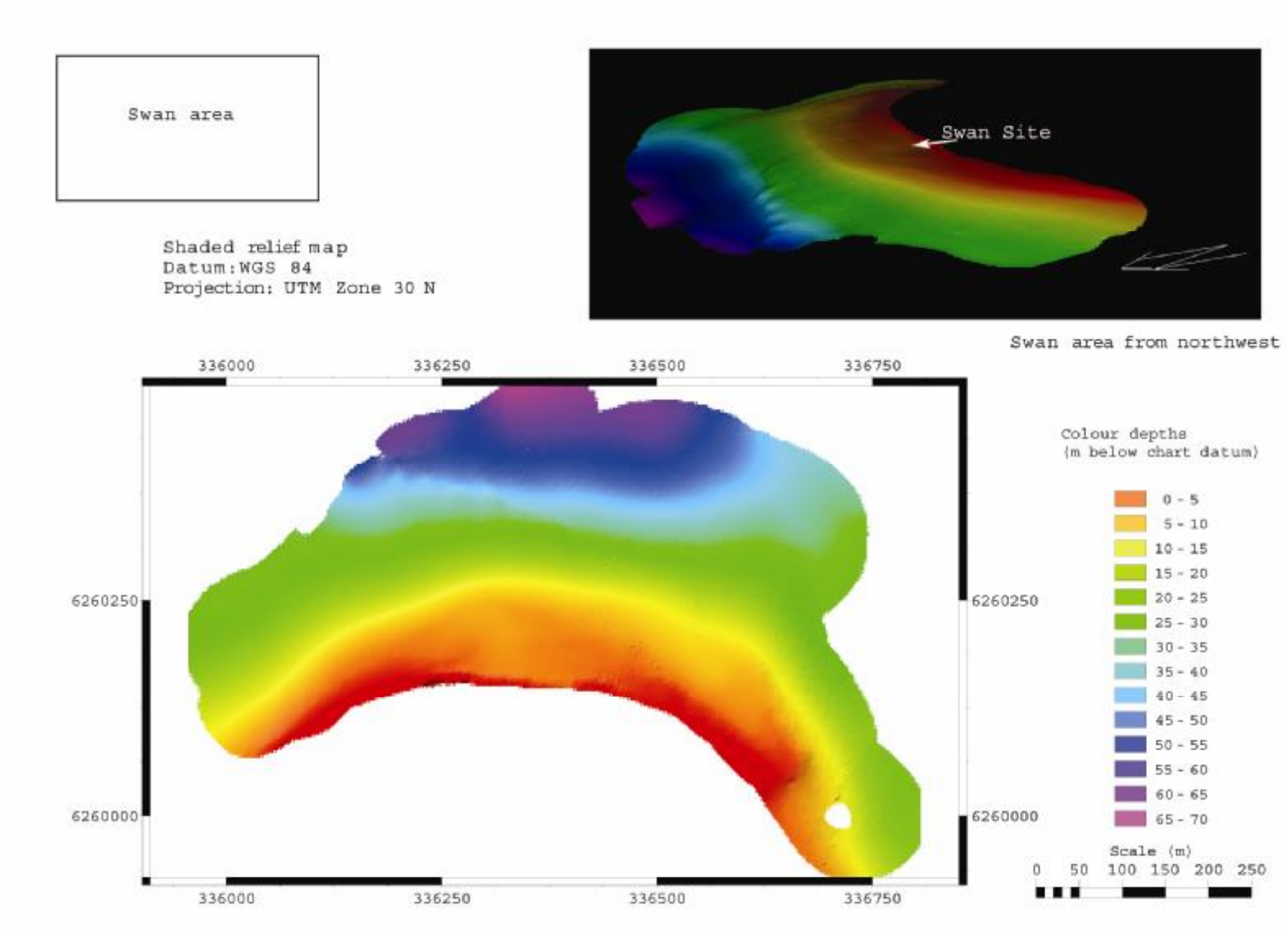


Fig 15: Multibeam plot of the Swan area survey, showing the shelf off Duart Point. Data processed at 0.5m point resolution

SS Thesis

Site Location and Environment

The wreck of the *SS Thesis* is situated on a gradually sloping seabed at OS NGR NM 7289 4036 or Lat/Long N56' 29.932 and W5' 41.515 (WGS84), close to *Rubha an Ridire or* Inninmore Point. Today, the hull is almost intact to deck level, canted over to port on a sloping seabed of gravel with the bow of the ship sitting on bedrock at 14m (below cd), and the stern, embedded into softer gravels at 31m (below cd). Only a skeleton of the ship's bow remains where plating no longer covers the hull frames.

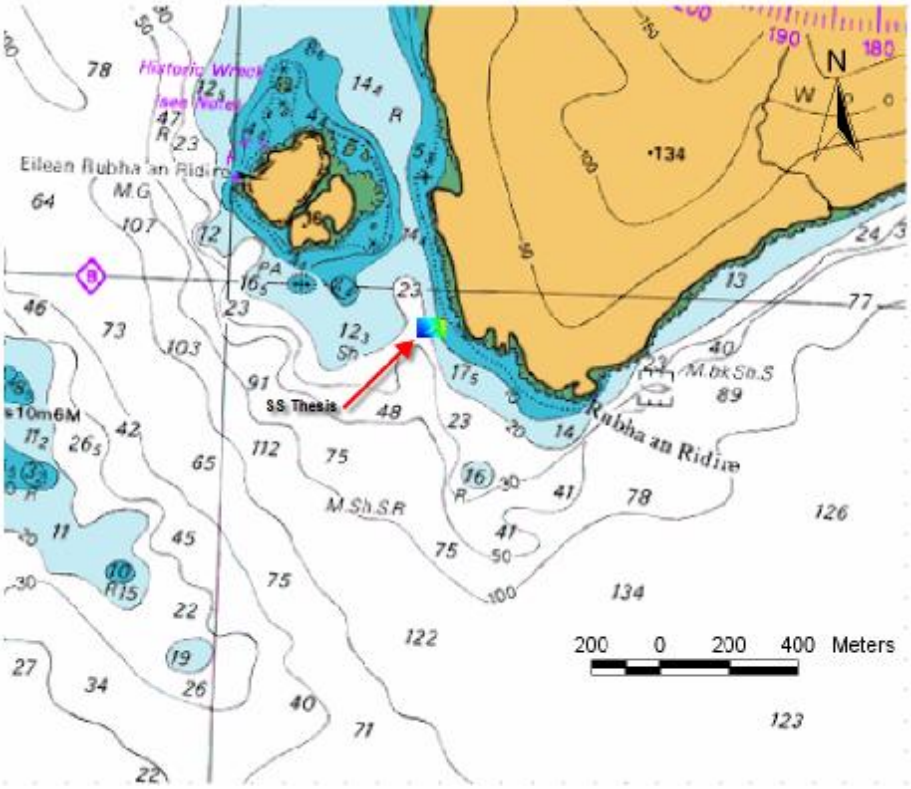


Fig 16. Location map of the *SS Thesis* close to Rubha an Ridire or Inninmore Point. This information is © British Crown and SeaZone Solutions Ltd, 2004, with all rights reserved and reproduced for this project under data licence No. 112004.005

Post loss history

Local scallop divers Mike Campbell and Richard Grieve (Salen, Mull) located the *SS Thesis* sometime during the late 1970's while working good scallop grounds close to Eilean Rubha an Ridire (*pers. comm*. Mike Campbell, and Richard Grieve). Campbell carried out some haphazard salvage work on her but the *SS Thesis* was subject to at least one other salvage episode. Neil Brown, a scallop diver operating out of Oban, worked the site intermittently for two years in 1979 or thereabouts, when scallops were thin on the ground (*pers. comm.*, Mike Campbell). By the early 1980's, the site was already popular with the growing number of sport divers visiting the area, as it remains today. Summary relating to the history of the ship, and investigations on it may be gained from the NMRS (See NM74SW 8001).

An initial inspection in June 2000 pinpointed signs of deck collapse towards the bow. This prompted SOMAP to undertake a more extensive survey. Volunteers spent an average of 10 days each year (2000-2004) recording the site and it was adopted by SOMAP under the NAS *Adopt A Wreck* scheme in 2001 (Kaye and Cook,

2002: 8-9). Compilation of a detailed deck plan and profile supplemented by multi-disciplinary scientific studies has provided a considerable insight into the design of the *SS Thesis* as well as the complex evolution of the site and its environment after the ship was wrecked while helping to document a well preserved example of a vessel type of which few examples remain (Robertson, in prep.)

Fieldwork

The remote sensing survey sought to test the accuracy of diver surveys and in particular, to establish whether a twist was indeed present forward of the bridge deck area. It sought also to establish the site within its environmental context and to record sedimentary regimes around the wreck. The survey of the *SS Thesis* consisted of several approaches to the wreck from different angles to enable the sidescan sonar system to record the wreck from different positions. The multibeam sonar system was running throughout the duration of this survey and recorded 448056 multibeam xyz points within the following area:

Latitude min (N)	Latitude max (N)	Long. min (W)	Long. max (W)
56' 29. 5477	56' 29.5663	5' 41. 3228	5' 41. 2734

Results

Diver surveys had indicated that there may be as much as a 0.5m twist of the hull to port, forward of the bridge deck area, possibly caused by impact damage exacerbated by collapse of the vessel's bow section. The sidescan and multibeam reinforce its existence but do not offer sufficient accuracy to corroborate or disprove the 0.5m estimate.

The sidescan surveys illustrate the degree to which the holes in the ship's deck have appeared, where heavy objects such as deck winches have fallen into the holds below (pers. comm., Roger Mathieson) The sidescan trace also illustrates the amount of hull plating that has fallen away from the ship forward of the bridge deck area, with some holes also visible at seabed level in the vicinity of the engines and boilers. The sidescan also offers excellent definition of aspects of the wreck, including the twin cylinder compound engine, and single Scotch type boiler.

Measurements drawn from one sidescan image (fig.19 top left image) have been compared with measurements taken by divers of the same features on the seabed (see table 1). The diver measurements have been drawn up at a scale of 1:50, with the accuracy of these measurements checked using Web for Windows and errors estimated at +/- 10cms. There are considerable but inconsistent discrepancies in the figures. For example, the Klein system has given a measurement 4m greater than the vessel's maximum breadth recorded by Lloyds (Lloyds Belfast Survey report 3303).

What measured?	**Diver measurement (cms)**	**Measurement taken off the Klein 3000 sidescan (cms)**
Width of vessel just aft of engine block	7.64 m (25ft) (Lloyds Belfast 1887)	1120cm
Length of boiler	295cm (diver measurement)	260cm
Length of engine block	268cm	240cm
Max width of engine block	119.5cm	220cm

Table 1: comparison of measurements taken using the Klein sidescan processing software with data from diver measurements or Lloyds Survey.

Diver surveys indicated that up to 2m of the stern may be buried in the seabed and that there may be some scouring of seabed sediments amidships on both sides. This sedimentary position is reinforced by the multibeam datasets although the degree of burial indicated at the stern seems to slightly over-emphasise reality. It is possible that the accumulation of sediments at the stern may contain material from the ship's poop which of which no material evidence has been found and as such, this area may be of considerable archaeological potential.

The presence on the sidescan of an exposed reef adjacent to the starboard stern quarter, and exposed areas too at the vessel's bow seem to suggest that the stern of the Thesis is trapping the natural movement of sediment in a south easterly direction with the ebb tide. This sedimentary picture broadly reflects models of sedimentary scour and accumulation experienced on other sites that angled at approximately 90 degrees to a strong unidirectional current (pers.comm., Justin Dix).

There appears to be some 'blurring' of the stern features that is not present on the seabed; the vessel's short raised quarter deck can not be made out and the trapezoidal shape of the void on this deck appears seems to have merged with hold aft of the engine room. Blurring is also present towards the bow and it is hard to differentiate between the holds, boilers and anchors, or indeed to make out the side of the vessel although these stand out clearly on the sidescan trace and on the seabed.

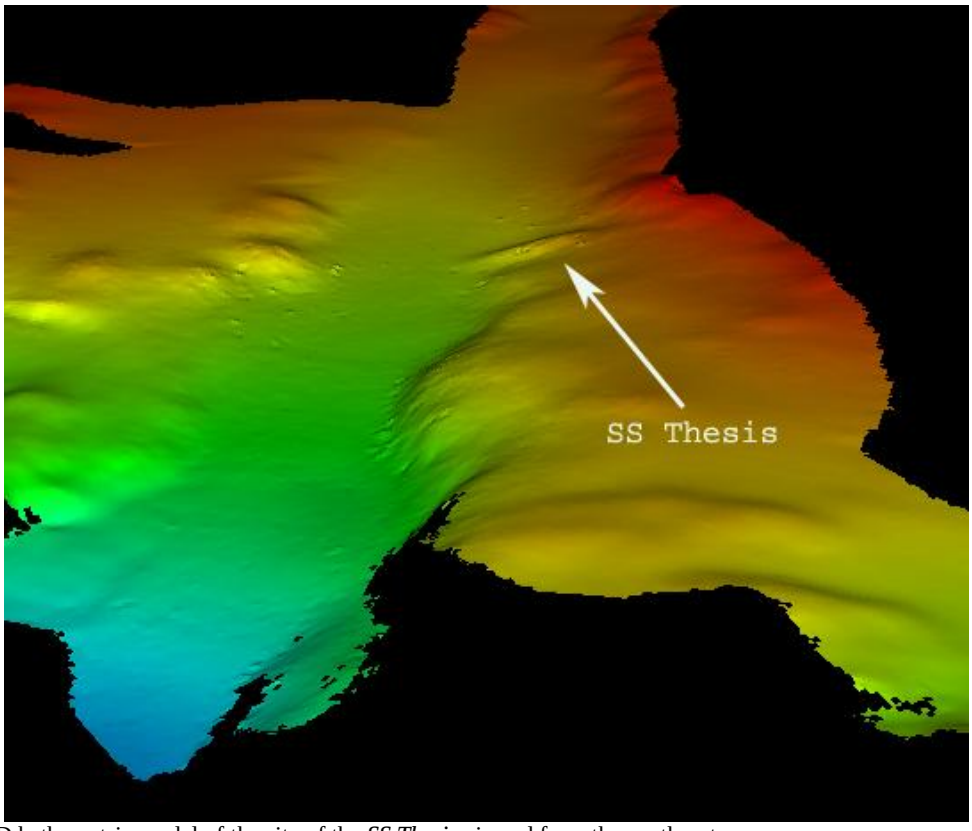


Fig 17, 3D bathymetric model of the site of the *SS Thesis* viewed from the southeast.

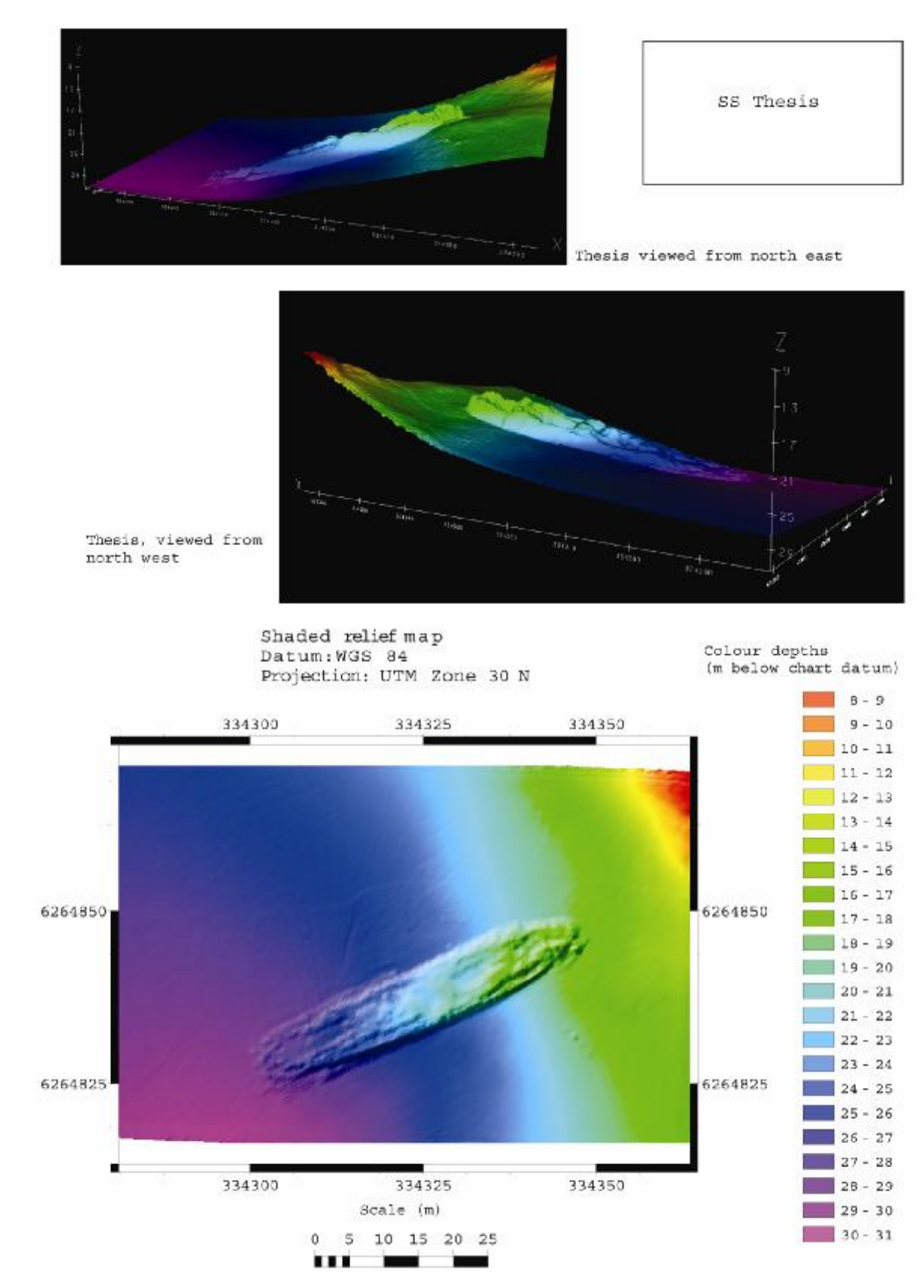
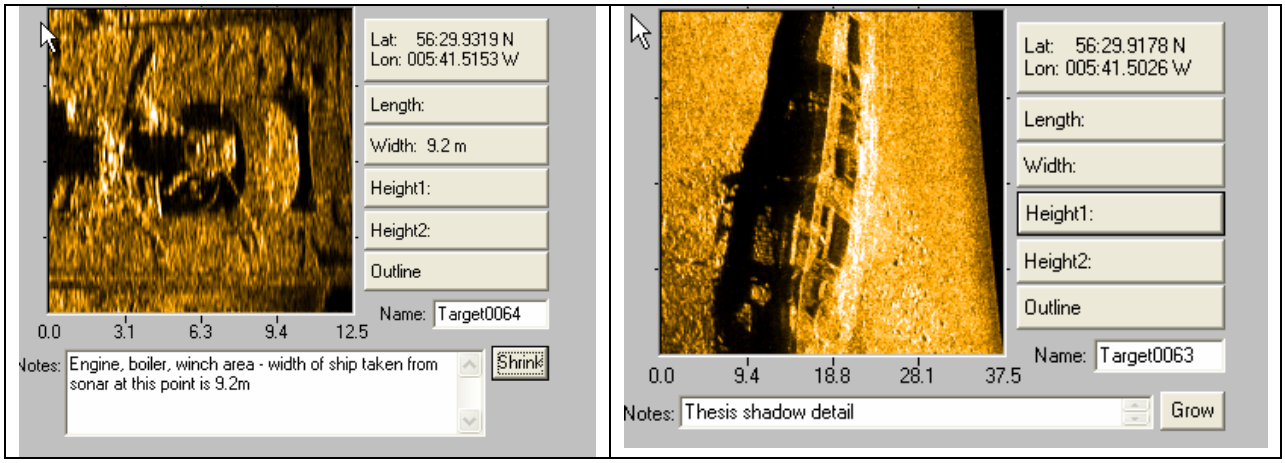


Fig 18 Shaded relief map of the *SS Thesis*, with colour depth banding, and 3D models



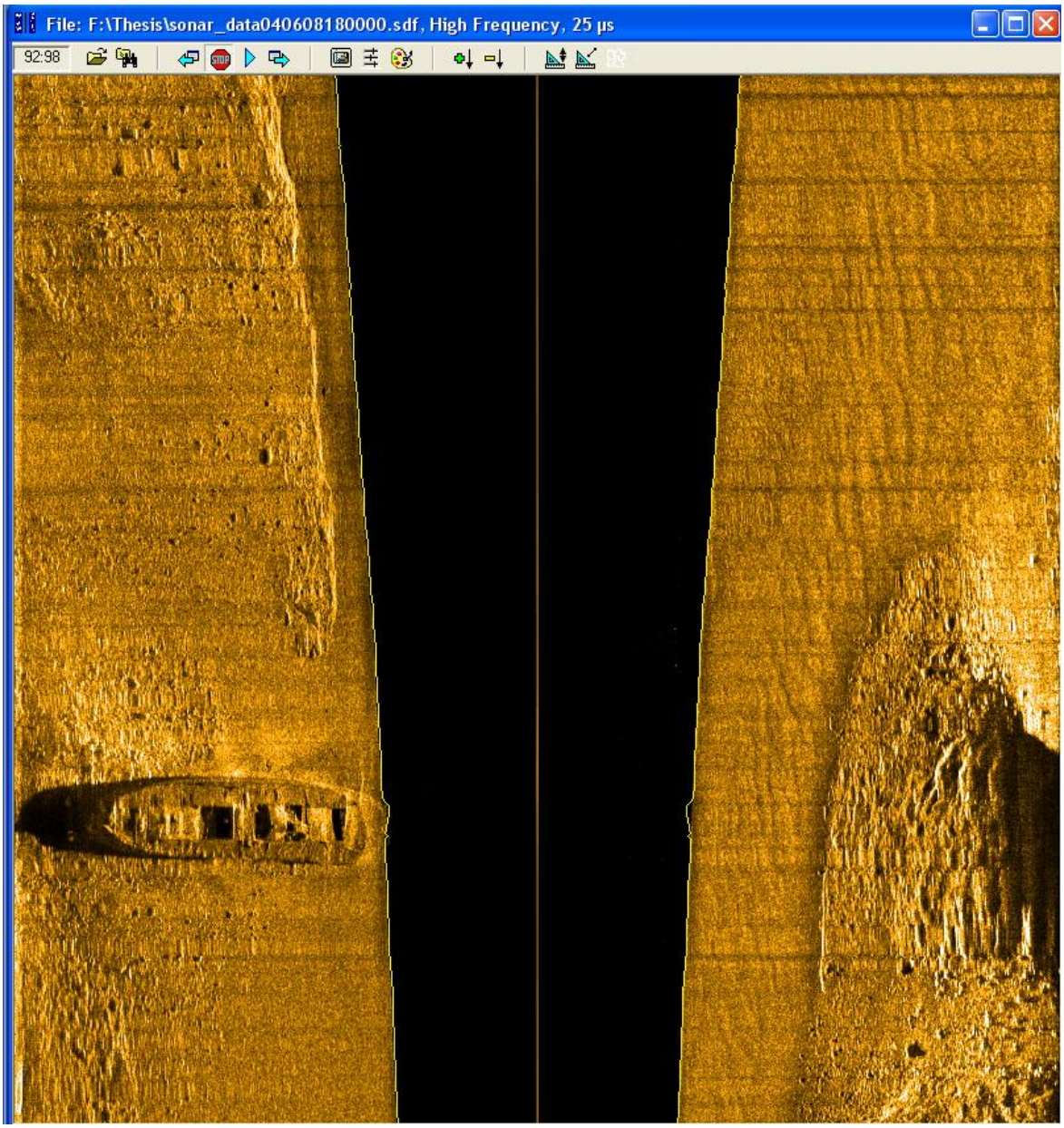


Fig 19 Sidescan images and close-ups of the *SS Thesis*. Note the presence of bedrock at the bow.

Conclusions

Data quality – *Swan*

Comparisons with up to date site plans (Colin Martin, pers.comm.,) demonstrate excellent cross correlation, suggesting that both recording methods offer high degrees of accuracy on this site. However, the absence on the multibeam image of certain seabed items known to be in existence (e.g. the anchor) tends to suggest partial 'blurring' of the sonar image. It is possible that this is due to problems during data processing. The sidescan dataset has provided excellent resolution quality, sufficient for undertaking a qualitative survey of the principal components on this site. However, as an aside it is hard to differentiate between geological features and cultural material on the basis of the multibeam and sidescan datasets and further fieldwork would certainly be required to identify the significance of individual anomalies relating to unknown sites.

On this site, the multibeam dataset processed at 0.1m point resolution does not offer anything like the recording resolution provided by traditional archaeological methodology. However, it is sufficient to identify major cast iron features on a partially buried historic wreck. That said, because of the amount of processing involved in reviewing the entire dataset, it is questionable whether it would be possible to identify manmade features of the size of a cast iron cannon from this dataset without prior knowledge of their existence and location without recourse to advanced pattern recognition systems of the sort being developed by the Universities of St Andrews and Edinburgh for English Heritage (Richard Bates, pers.comm.,). When processed at 0.5m point resolution, the datasets are sufficiently detailed to record principal bathymetric features and to establish a site within its wider geographical context. However, 0.5m point resolution is not detailed enough to enable detailed analysis of archaeological features on the seabed.

The multibeam dataset has been excellent in recording the wreck of the Swan within its wider 'seabed-scape', allowing specialists to identify patterns of erosion and accretion, and to define potential areas of archaeological significance. Such a wide area survey could not be accomplished easily using divers, and certainly not within reasonable time and cost scales.

Data quality - *Thesis*

The blurring discussed above is surprising, given that excellent resolution has been demonstrated on other similar sites within the SOMAP dataset. Although blurring of this sort might be explained by processing irregularities, the data gathering methodology on the *Thesis* site is more likely to have been at fault. Experience from other projects (Wessex, 2004,) has indicated that optimum resolution can be achieved from one very slow pass of a wreck site; the *Thesis* survey involved numerous passes from different angles and this may have caused blurring of the image due to minute changes in position fixing between each pass.

As a result, the *Thesis* dataset does not provide the same resolution provided by traditional archaeological techniques. Nevertheless, it still provides an excellent 3D model of the wreck within its environment, a task almost impossible using diver survey techniques alone. Although the multibeam has not provided much definition of features, the Klein 3000 sidescan images do provide excellent definition of individual components of the site. However, the magnitude of the errors in measurements taken off the Klein interface (when compared with diver measurements and original Lloyds

survey reports) suggests that the Klein system does not provide sufficiently repeatable accuracy to act as a standalone tool for accurate archaeological survey.

Site surveys

SS Rondo

Site Location and Environment

The wreck of the *SS Rondo* is located off the island of Deirg Sgeir, at N56' 32.275 W5' 54.6667 (OS NGR: NM 5956 4527). The vessel is poised precariously on a steep, rocky slope at an average angle of approximately 30 degrees (see fig 22). Her stern sits on bedrock at a depth of 4-6m below chart datum (cd) and her bow lies at the foot of the slope at a depth of 48-50m below cd. Tides at this point reach up to 2 knots at springs on the flood. However, the site is diveable right through the ebb tide, although current may be felt during the ebb particularly at depth.

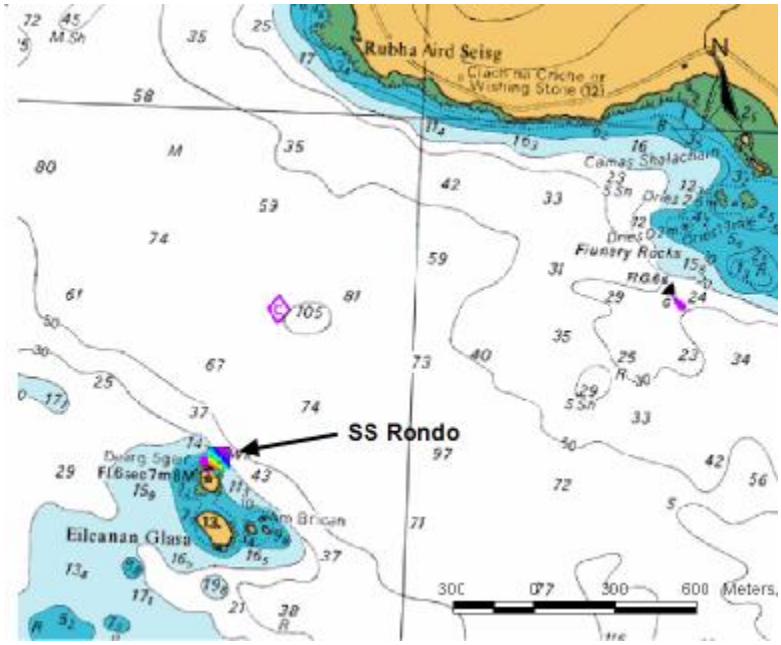


Fig 20: Location map of the *SS Rondo* close to Deirg Sgeir.

Survey and Research History

A summary of the history of the *SS Rondo* may be found on Canmore (NM54NE 8001 at www.rcahms.gov.uk). In brief, this general (dry) cargo steamship of 3500 tons dead weight tonnage (2363 gross tonnage) was built in 1917 in Tampa, Florida (in then-neutral America) under the name *War Wonder I* and to a standard design. The available photographs record a 'three island' ship of typical form for the period, of relatively full section and with a raised forecastle, a large superstructure amidships (housing a triple-expansion engine) and poop accommodation at the stern. Two masts and derricks are situated forward and aft respectively, apparently to serve four holds. The stem is straight or nearly so, and the vessel has a counter stern.

She was lost during the night of 25 January 1935, having broken her anchor cable while sheltering in 'Aros Bay'. The ship was in ballast at the time, and much of her gear was removed before she sank. No previous archaeological surveys of this wreck have been undertaken but documentary sources suggest that the vessel was

semi intact in 1973 when first visited by divers. Today, the *SS Rondo* (launched 1917), together with the *SS Thesis* (launched 1887) SS *Shuna* (launched 1909), and SS *Hispania* (launched 1912), forms the group of merchant steamships in the Sound of Mull that are visited (often on numerous occasions) by most recreational divers active in Scotland.

Fieldwork

A multibeam sonar survey of the *Rondo* was undertaken and recorded 695756 xyz points within the following area (see fig 23):

Latitude min (N)	Latitude max (N)	Long. min (W)	Long. max (W)
56'32. 1648	56'.32.1942	005' 44. 759	005' 44. 49

The sidescan survey was undertaken at the same time. The remote sensing data has been corroborated by recent correspondence from visiting divers and well known published sources (Liddiard, 2002)

Results

Both sidescan and multibeam datasets indicate that the slope consists of exposed bedrock, most prominent on the vessels port side. There appears to be more sediment cover on the starboard side of the vessel and it may be that this vessel is catching sediment carried by the flood tide. The bedrock appears to form steps, with different gradients of slope visible at different depths on the cliff. However, the overall gradient can be estimated to be 30 degrees. At the foot of the cliff (at a depth of 40m below cd), the sidescan signature suggests that there is considerable sediment cover, although bedrock outcrops appear close by. Divers have indicated that the seabed around the bow consists of coarse gravel and pebbles (Liddiard, 2002)

The presence of considerable sediment cover on the seabed explains how the bow of the Rondo has become embedded at the foot of the cliff. Both datasets seem to suggest that there is an accumulation of sediment around the outside of the bow, perhaps up to 3metres deeper than the surrounding seabed. The greater accumulations of sediment build up appear to be on the vessel's port bow. This accumulation of sediment may contain buried archaeological material. Wreckage at the bow may be exposed by as much as 1-2m proud of the seabed. Within the hull, there is some evidence for scouring and the plating, and inner frames exposed in places to a depth greater than surrounding seabed (see fig 21).

There may be one item of debris (approximately 4m in length) lying c.10m adjacent to the vessels starboard forward quarter that requires checking by divers. Another target that requires further investigation may be seen on the sidescan sonar trace (fig. 24 top image) approx 110 m from the bow of the *Rondo* at a bearing of 69degrees (target 0022) at N56' 32.3264, W5' 54.6259.

Amidships, up to 2 m of the side of the ship close to the turn of the bilge, overlies the steep bedrock slope. Much of the hull structure above this point was salvaged. Here external plating above the turn of the bilge appears to be intact but twisted inwards, and frames are visibly exposed in places on starboard side towards the stern (frames appear to be at c.0.30m spacings). Within the hull structure, the multibeam dataset offers insufficient resolution to identify individual components but the remains of the stern tube (up to 7m in length) is visible on the sidescan trace, and the remains of what may be a deck support, winch on supported deck plating, or 'A' frame mast appear to protrude up to 1.5m off the ground amidships. Diver reports

indicated that this 'A' frame mast was no longer standing upright in 2002. In the shallows, the remains of the sternpost remain intact (the propeller has long since disappeared) although it is impossible to predict for how long this will remain so. Neither datasets illustrate the gaps between the keel and bedrock that remained intact in at least two places in January 2002 (Liddiard, 2002)

There is considerable evidence for heavy dredge or nephrops trawl activity in the vicinity of Deirg Sgeir with the closest dredge marks within 200m of the wreck. However, it is thought that the position of the *Rondo*, so close into the foot of the Deirg Sgeir cliff must reduce the threat of dredge impacts to the wreck.

Conclusions

The heavy salvage that took place prior to the ship's sinking has removed much of the potential importance of this site. The sinking has been followed by an era of removal of souvenirs by visiting divers since 1973. Both factors have taken their toll on this wreck. However, much of the rapid deterioration evident on this wreck must be put down to its precarious position on a steep slope within a dynamic tidal environment.

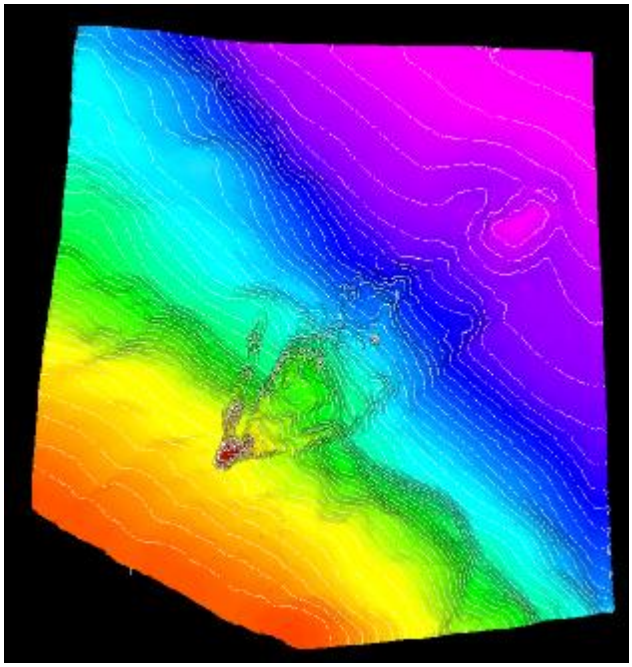


Fig 21: aerial bathymetry plot of the *SS Rondo* (contour lines are in 1m increments)

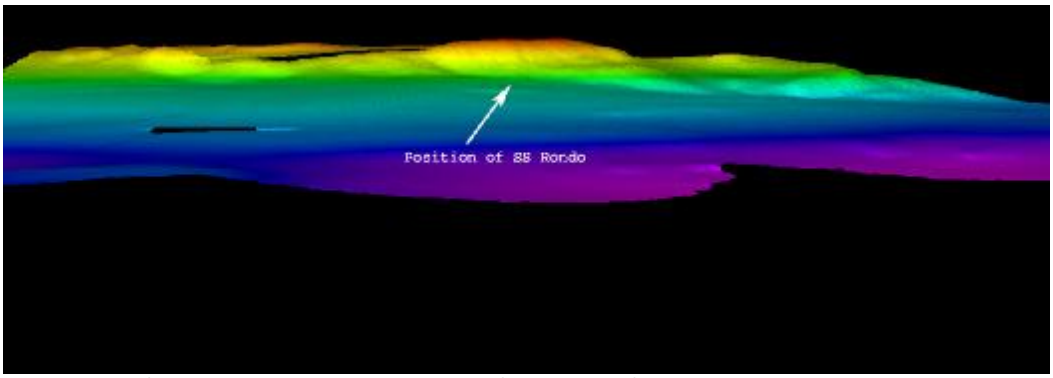


Fig 22: view of the seabed surrounding the island of Deirg Sgeir from the north east showing approximate position of the *SS Rondo*.

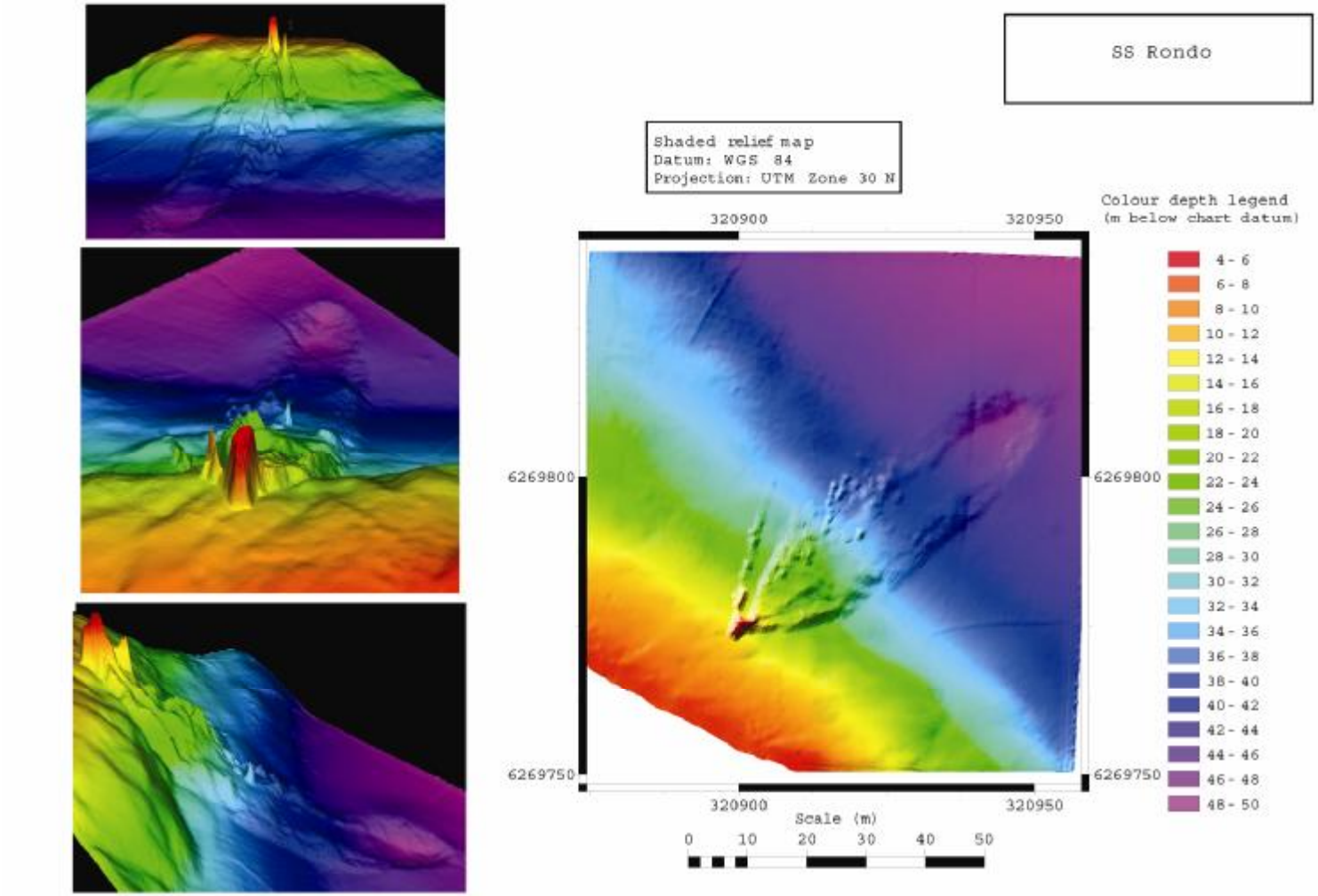
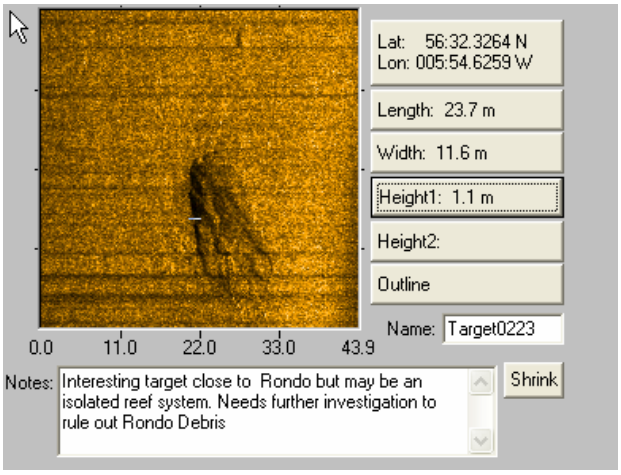


Fig 23: multibeam map of the *SS Rondo*



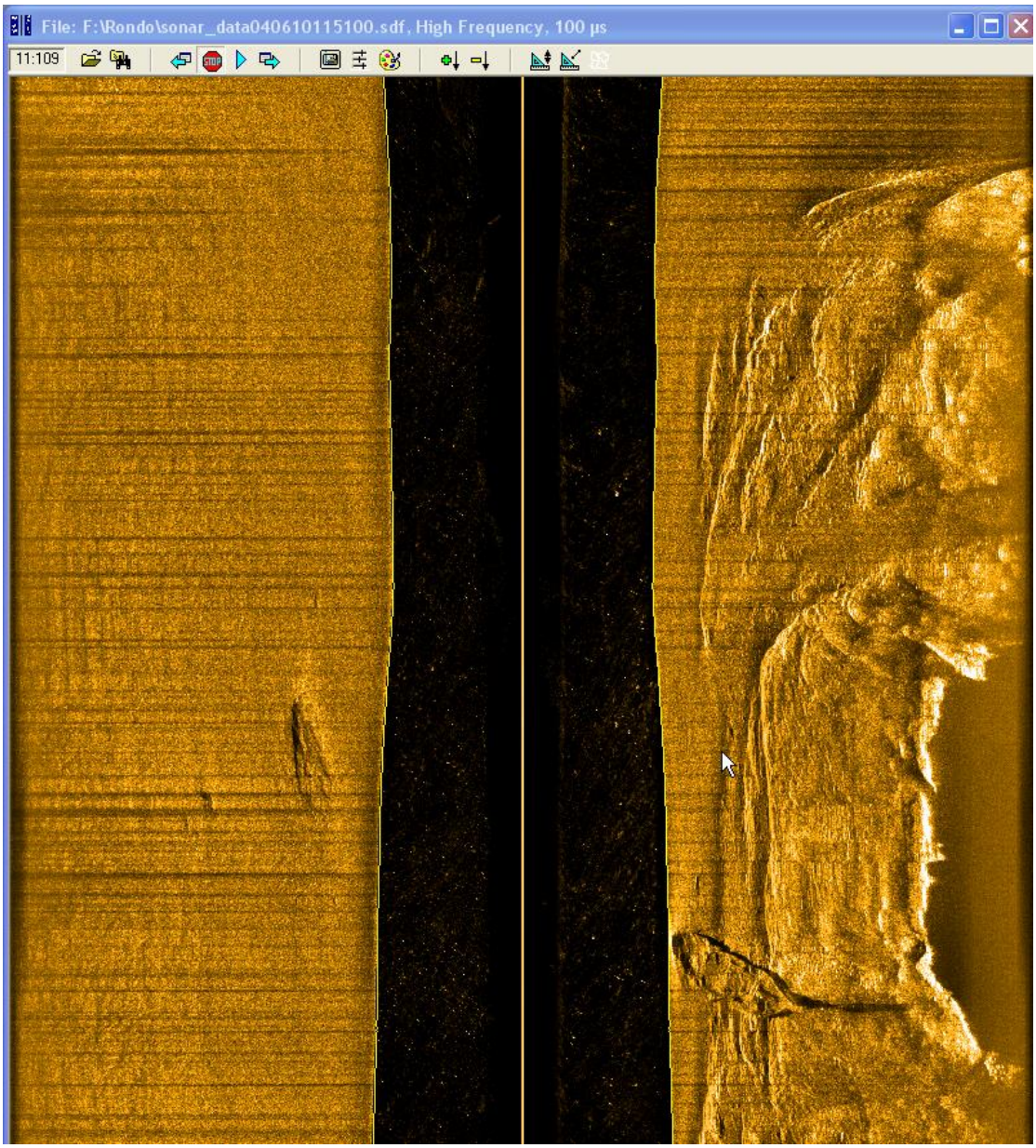


Fig 24: Sidescan images of the *SS Rondo*

SS Hispania

Site Location and Environment

Documentary sources (NMRS: NM55SE 8005) chart the wreck of the Swedish steamer *SS Hispania* as being located on a shelving seabed at N56' 34.9 W5' 48.5 (OS NGR: NM 5519 5043). The centre of the wreck was charted by remote sensing to be located at N56' 34.9260, W5' 59.22W (WGS84). The vessel displays a pronounced list to starboard that has been increasing in recent times, with her bows pointing towards the Mull shore. At the vessel's stern the seabed depth is below cd, and at the bow 24-26m below cd. The top of the superstructure amidships, and in places on the vessel's port side, was charted at below 14-16m below cd. The seabed at this point consists of gravely sand with rocky outcrops and the vessel sits on a shelf, close to the edge of a drop-off into the glacial trough to a depth in excess of 90m (see fig. 27).

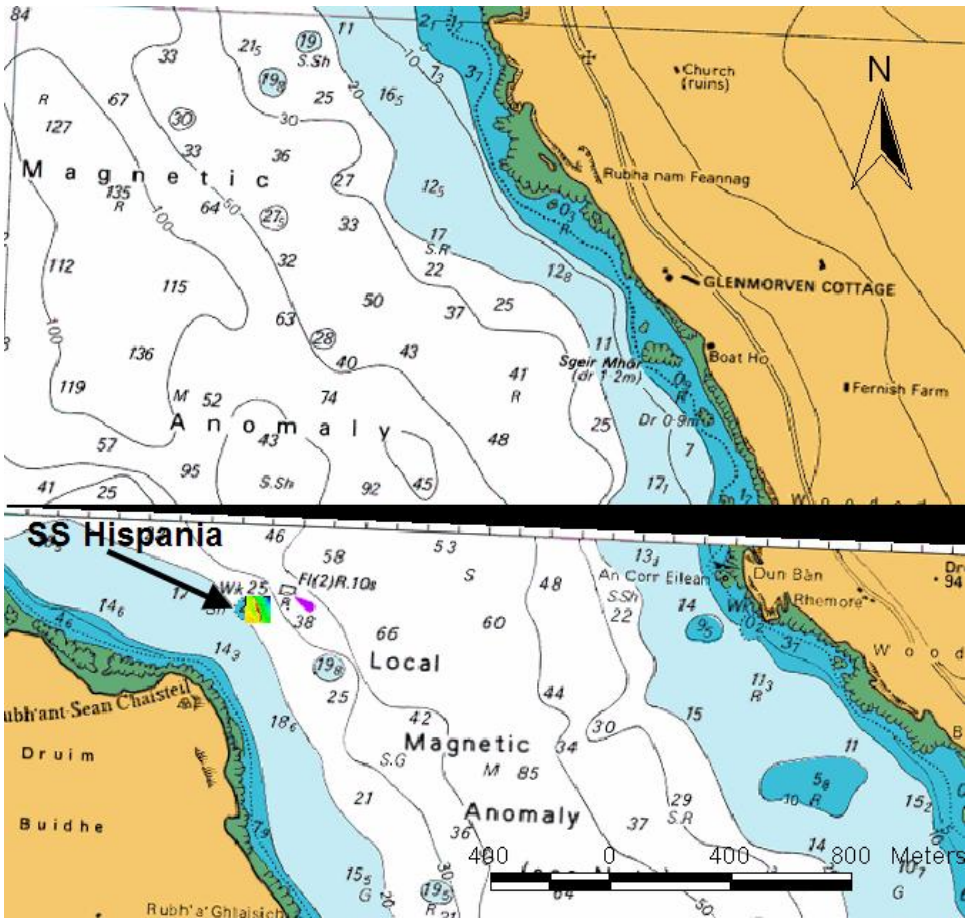


Fig. 25: Location map of the wreck of the *SS Hispania*. The basemap is © British Crown and SeaZone Solutions Ltd, 2004, with all rights reserved and reproduced for this project under data licence No. 112004.005 (NB: - the black banding on the charts is due to the altered chart projection to UTM30N)

Survey and Research History

A summary of the history of the *SS Hispania* may be found on Canmore (NM55SE 8005 at www.rcahms.gov.uk.) In brief, this Swedish general cargo steamship was built in 1912 and wrecked in the Sound of Mull on 18 December 1954 after leaving Liverpool with a cargo of steel, asbestos, rubber and fishing line, bound for Sweden. She navigated through the Sound of Mull to escape bad weather but hit

the reef of Sgeir Mor and sank soon afterwards. The site was salvaged during the 1950's by members of Scarborough Sub Aqua Club (Pete Lassie, pers.comm.), and its popularity with sport divers has resulted in the removal of all non-ferrous artefacts from the wreck. Prior to SOMAP's involvement, no archaeological surveys of the site had been undertaken.

Fieldwork

A multibeam and sidescan sonar survey of the *SS Hispania* was undertaken and recorded 742553 xyz points within the following area:

Latitude min (N)	Latitude max (N)	Long. min (W)	Long. max (W)
56' 34. 5406	56' 34.5706	5' 59.1492	5' 59.0976

Some preliminary diving surveys have also been undertaken by SOMAP on this site and observations from these surveys are included in the text below.

Results

The multibeam dataset have produced a cross section through the bridge structure of the *SS Hispania*. This section suggests a list to starboard of 30 degrees off the horizontal. A 30 degree estimate was also provided by SOMAP divers during June 2001. The bathymetry plots (fig. 26) suggest that a scour pit is opening up amidships close to the hull on the vessel' s starboard side and the section confirms this (see fig 29). The middle point of the scour pit is located at 316552.650E, 6274856.705N (UTM30N) and the seabed depth is 24.824m below cd. At this point the scour pit is up to 0.70m deeper than the adjacent seabed. Bedrock outcrops, extending up to 10m away from the starboard side of the vessel provide a fringing reef around this scour pit. Monitoring by SOMAP since 2000 and numerous discussions with visiting divers confirms the noticeable increase in the vessel's list to starboard as she leans into this pit. By contrast, on the port side of the vessel and at either end, there is some evidence for accumulation of sediment that may also be a relevant factor. It is most likely that a stronger ebb tidal current and eddies created on the flood tide are interacting with the wreck and surrounding bedrock outcrops to cause these effects.

The *SS Hispania*'s five holds are all visible on the sidescan trace as are her forecastle and poop. The poop accommodation block is collapsing badly now but in 1999, only the roof had rotted away (Liddiard, 1999). On the sidescan trace, the floor frames are visible within the holds suggesting that little cargo remains. The superstructure (aft of no. 3 hold [when counted from the stern]) has lost its funnel, but the engine room roof frame appears to remain substantially intact (although the plating has mostly disappeared). A masts or kingpost between holds 1 and 2 is partially collapsed with fresh damage visible during monitoring SOMAP monitoring visits in 2001. It appears intact in sport diver guides written in 1999. Other features identifiable on the seabed and sidescan traces include the counter stern and rudder (fig.33), while divers have recently commented that auxiliary steering gear (aft), a spare propeller (secured to the forward side of the poop accommodation block), and an anchor lying on the seabed off the starboard bow all remain in situ.

In November 1999, a scallop dredger caught its gear in the superstructure, possibly causing minor scrape damage to the hull and laying one of the masts over on its side. This mast may be seen on the multibeam and sidescan trace (see fig 31 forward of number 4 hold (holds counted from the stern). Additional signs of damage viewed by SOMAP during June 2001 included newly corroding impact scrapes on the

port side about 7m from the bow (measuring about 2m across), and on the starboard side of the deckhouse aft of the engine.

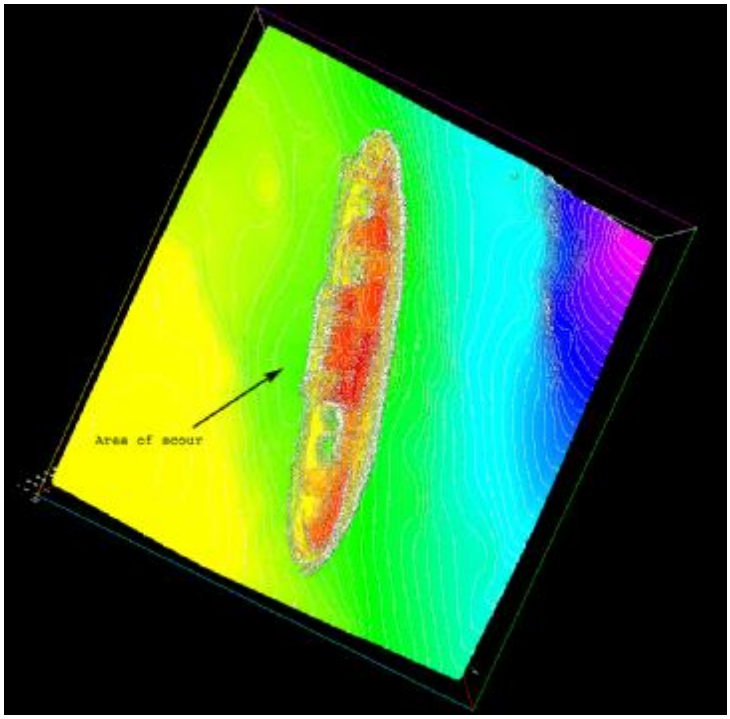


Fig 26: Bathymetry plot of the *SS Hispania* with pointers delineating area of scour (contour increments are 0.25m)

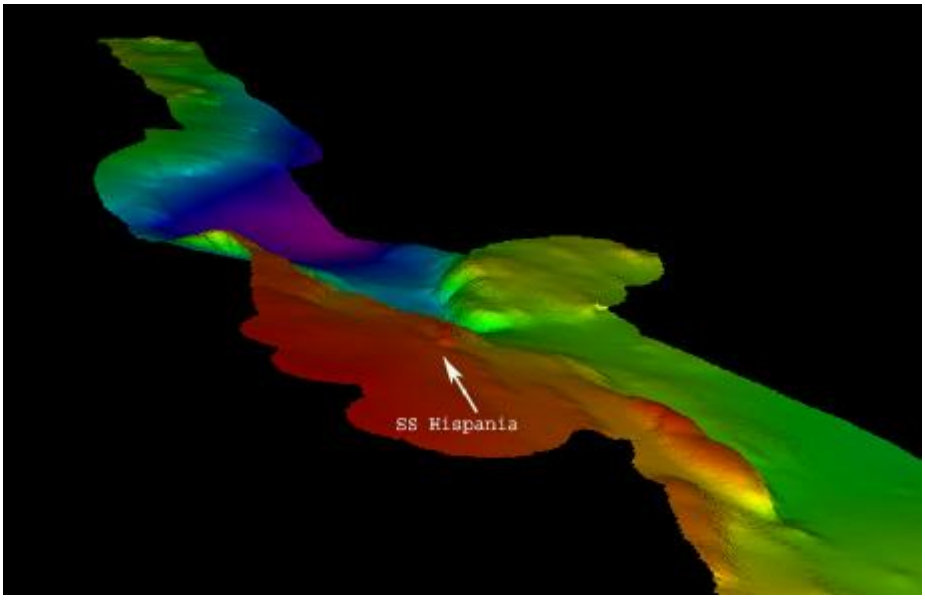


Fig 27: Area view from a southerly direction of the ledge, wreck location, and glacial trough.

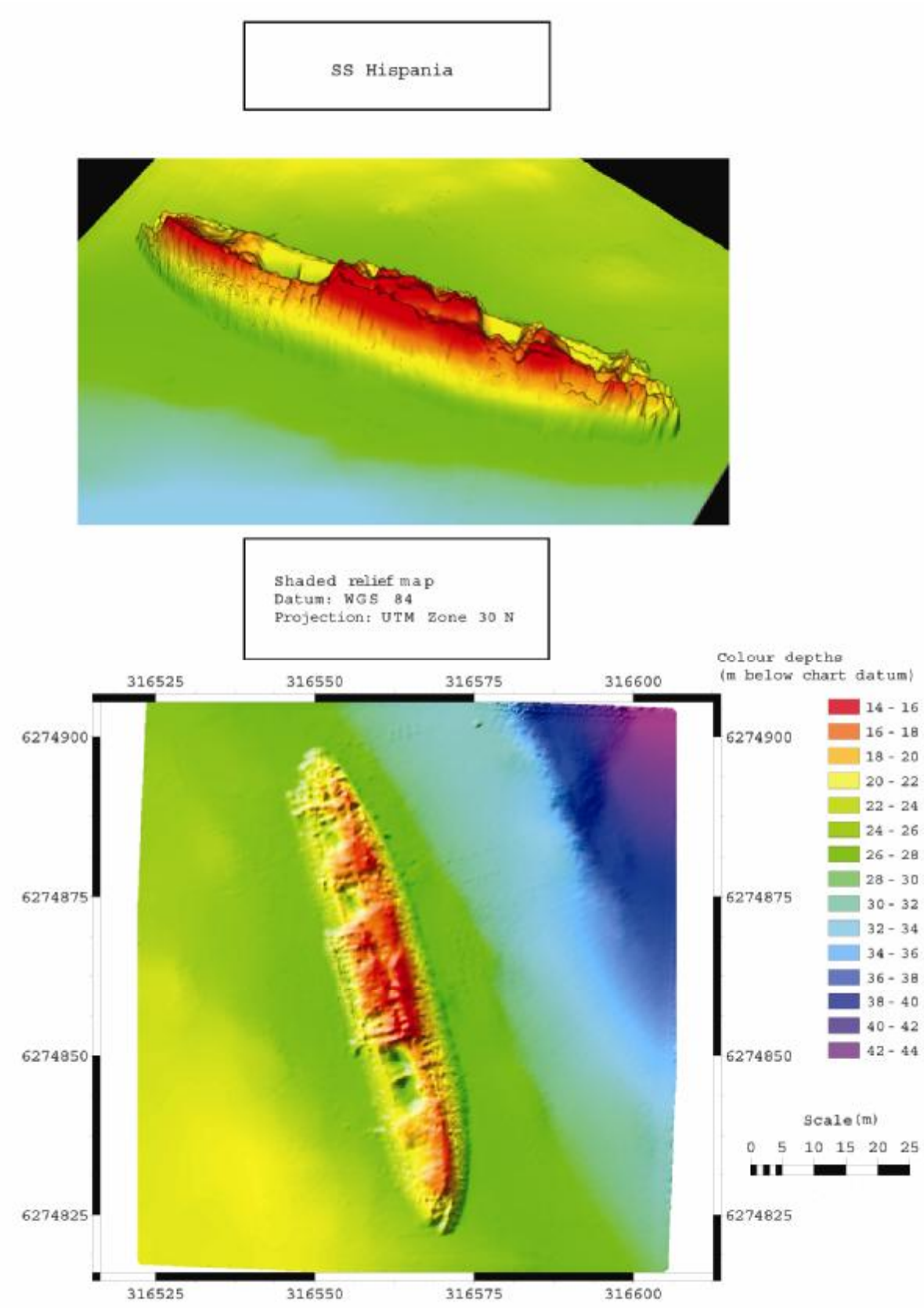


Fig 28: multibeam map of the *SS Hispania*

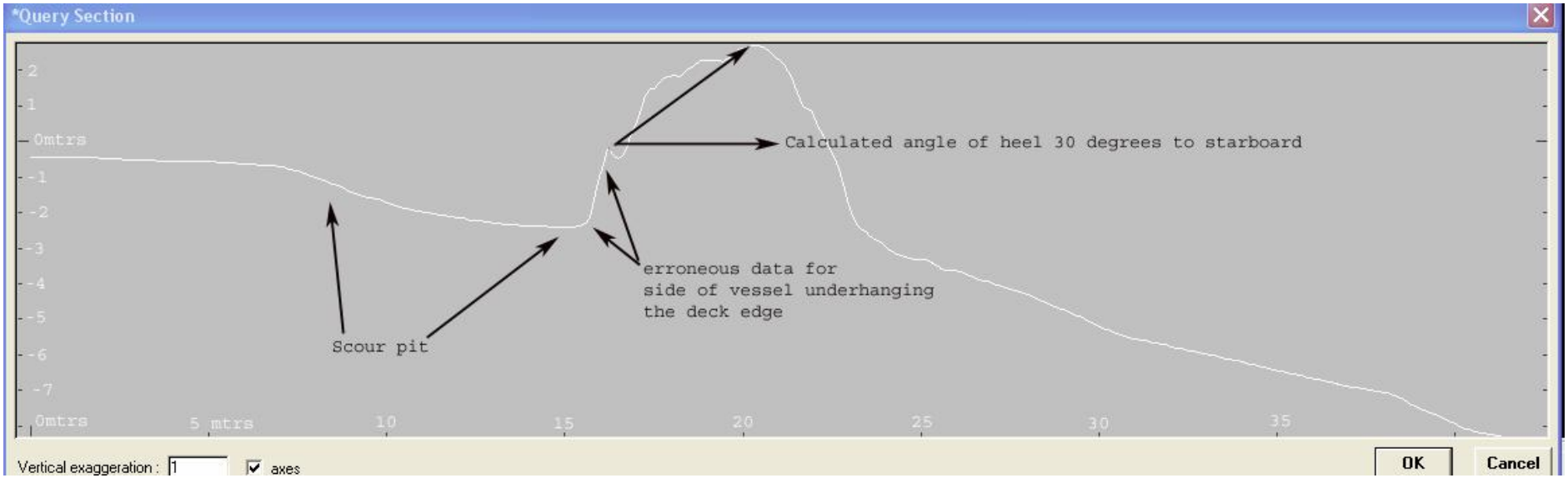
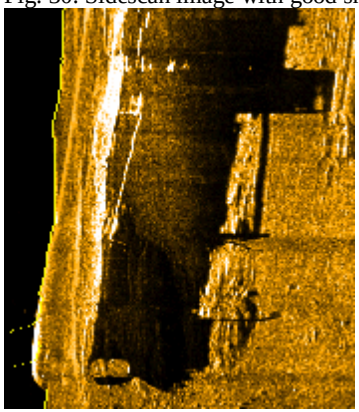


Fig. 29: Cross section viewed from the south east of the seabed and bridge structure of the *SS* Hispania, based on multibeam data processed using LSS Vista software. X axis increments are 5m. Y axis increments are 1m. Note the scour pit on the vessel's starboard side.

Fig. 30: Sidescan image with good shadow detail of the stern of the *SS Hispania showing* poop deck structure, counter stern and rudder in position



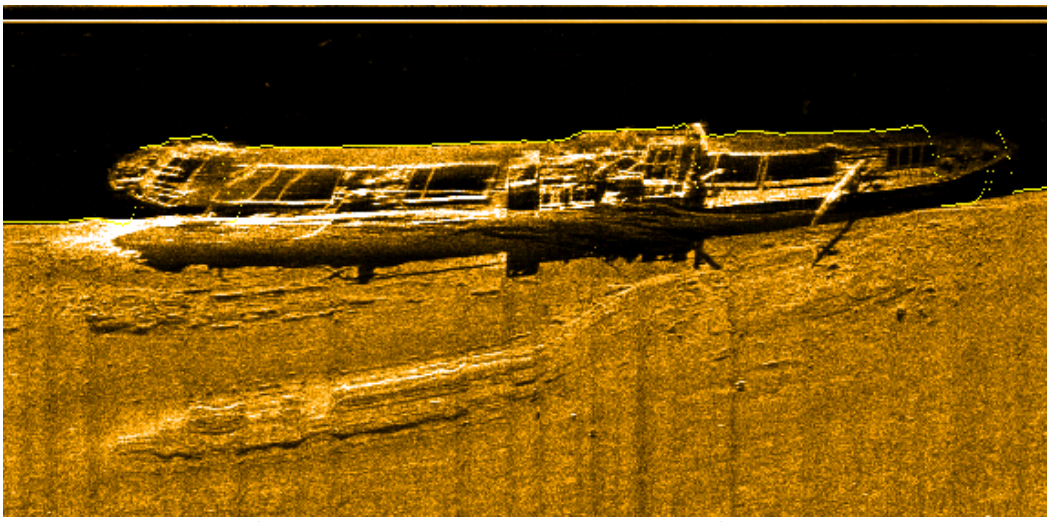


Fig. 31: Sidescan image of the vessel's starboard side. Note the collapsed forward mast.

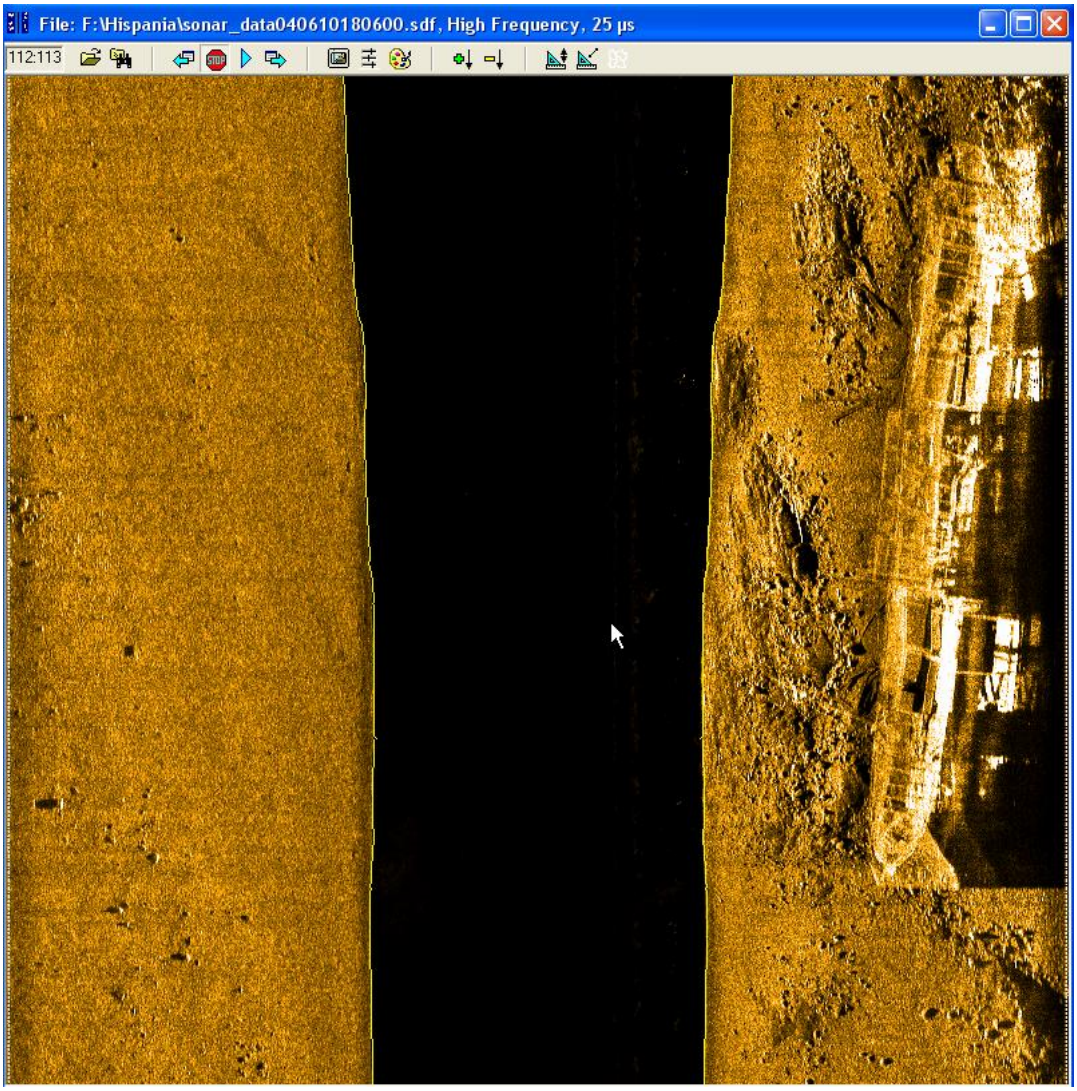


Fig. 32: Sidescan image of the surrounding seabed and port side of the wreck. Note the superstructure detail and hold areas.

SS Shuna

Site Location and Environment

Documentary sources (NMRS: NM54NE 8004) indicate the wreck of the Scandinavian Steamship Company's *SS Shuna* as being located on a gradually sloping seabed at N56' 33.4 W5' 54.8 (OS NGR: NM 5955 4736). The centre of the wreck was charted by remote sensing to be located at N56' 33.380N, W5' 54.840 (WGS84). The highest points of the ship's superstructure at the raised forecastle and bridge deck lie at 20-21m depth below chart datum (cd). The seabed depth at the stern on the vessel's starboard side is 30-31m below cd and on the port side is 28m below cd. This wreck is subject to currents that typically run in a north west, south east direction but never at speeds of greater than 0.5knots; the site is diveable at all states of the tide.

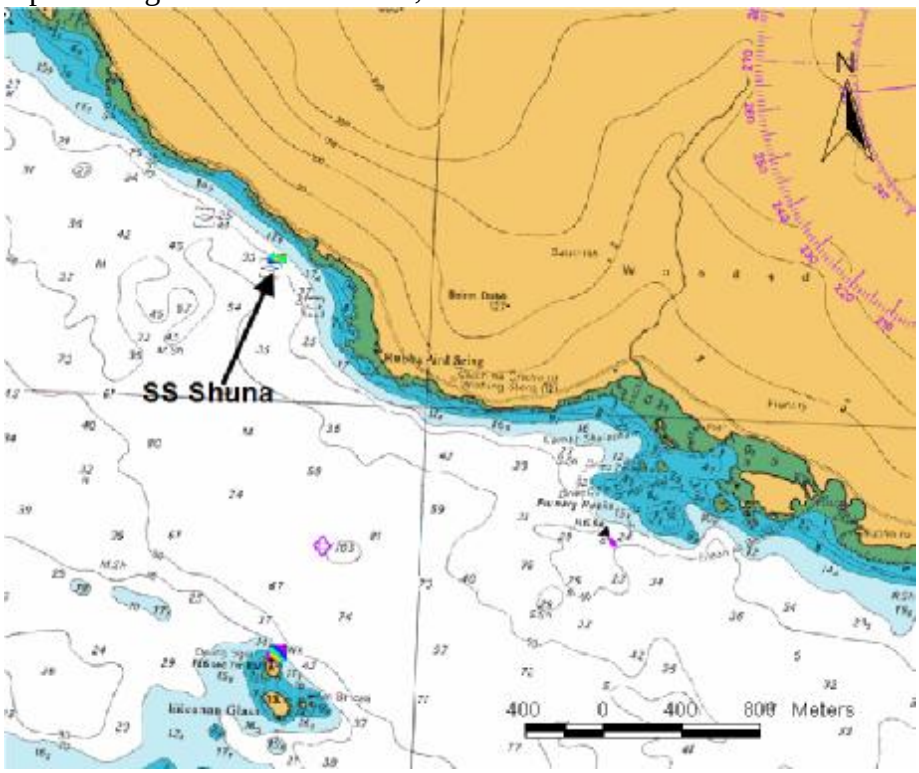


Fig. 33: Location map for the *SS Shuna*. . The basemap is © British Crown and SeaZone Solutions Ltd, 2004, with all rights reserved and reproduced for this project under data licence No. 112004.005

Survey and Research History

A detailed summary of the history of the *SS Shuna* may be found on Canmore (NM54NE 8004 at www.rcahms.gov.uk.). In brief, the *SS Shuna* was owned by Scandinavian Shipping Company and managed by Messrs Glen & Co., Glasgow, was en route through the Sound of Mull with a cargo of coal and iron from Glasgow to Gothenburg. She struck on the Grey Rocks [Eileanan Glasa: NM 595 450] in the Sound of Mull and was forced to beach on the Morvern shore, before sinking on 8 May 1913. This vessel is a steamer with engine amidships, a poop deck flush with the quarter deck, and a raised forecastle.

Fieldwork

A multibeam and sidescan sonar survey of the *SS Shuna* was undertaken and recorded 480003 within the following area:

Latitude min (N)	Latitude max (N)	Long. min (W)	Long. max (W)
56'32. 2202	56' 33.2382	005' 54.5339	005' 54.4775

Some preliminary diving surveys have also been undertaken by SOMAP on this site and observations from these surveys are included in the text below. Additional descriptions of the site by John Liddiard, (following site visits during autumn 2002) may be found at http://www.divernet.com/wrecks/wtour480203.htm .

Results

The bow of the *SS Shuna* is oriented towards east southeast and the vessel lies upright on a fairly featureless, sloping gravelly seabed (fig.34). There are signs of a tightly confined but limited debris field at the bow. It was possible to define one object (c. 2.3m in length) positioned c. 23m off the starboard bow. Three objects with lengths exceeding 2m are located within 10m of the stern. Clear evidence of nephrops trawl or scallop dredging marks were identified within 50m of the wreck. Although the tidal regimes on this site do not prevent diving at any time, there is tentative evidence for some scouring of sediments on the vessel's port side, forming pits up to 1m deeper than the surrounding seabed (it is just possible that this phenomenon is actually due to data errors and this requires re-checking), as well as signs of sediment accretion at the bow. This fits with the *SS Shuna's* reputation amongst visiting divers as a 'silty' wreck.

The sidescan sonar has recorded length measurements of 67.5 - 69.3m in length and both datasets clearly demonstrate a steamer with engine amidships (figs. 36; 37). Much of the bridge deck structure and companionways remain intact with the exception of the roof that has mostly rotted through. The funnel has gone from above the boiler cavity, and the triple expansions engine cavity lies exposed just to the stern of steel footings that probably mark the original location of a wooden deck-house that has disintegrated (fig.37).

The *SS Shuna* has an impressive raised forecastle (2-3m off the deck) equipped with anchor winches and the like (fig.34). Four cargo holds (two either side of the bridge deck) with high hatch comings that, like the stanchion plating and bulwarks, remain mostly intact. Twin winches and a mast were used to handle cargo from each set of holds and can be found between the two sets of holds. The winch and masts appear semi-intact. Much of the coal cargo remains within the holds of the *SS Shuna*. Both the ships counter stern and rudder intact with the propeller still in place (the propeller appears to have a radius of c. 4.3m). A spare propeller may be seen on the flush stern deck where many mooring fittings remain.

Conclusions

Despite the heavy souvenir hunting that deprived the *SS Shuna* of all non ferrous fittings within months of her discovery by divers during 1980's, the *SS Shuna* remains the best preserved of the Sound of Mull's sunken merchantmen. She may therefore be the most archaeologically important. Her coal cargo has not (yet) been targeted by salvors despite several expressions of intent. The proximity of scallop dredgers working this site and the existence of a nearby fish farm site operated by Scottish Sea Farms, Connel, have concerned the diving fraternity. Claims of reduced visibility, altered current regimes, and accumulation of silt from the fish farm remain unproven and these factors may be beneficial anyway. In practice there have been few instances of conflict and relations with the fish farm remain cordial. For instance, divers working for Scottish Sea Farms have assisted SOMAP by gathering monitoring video footage to supplement the SOMAP archive.

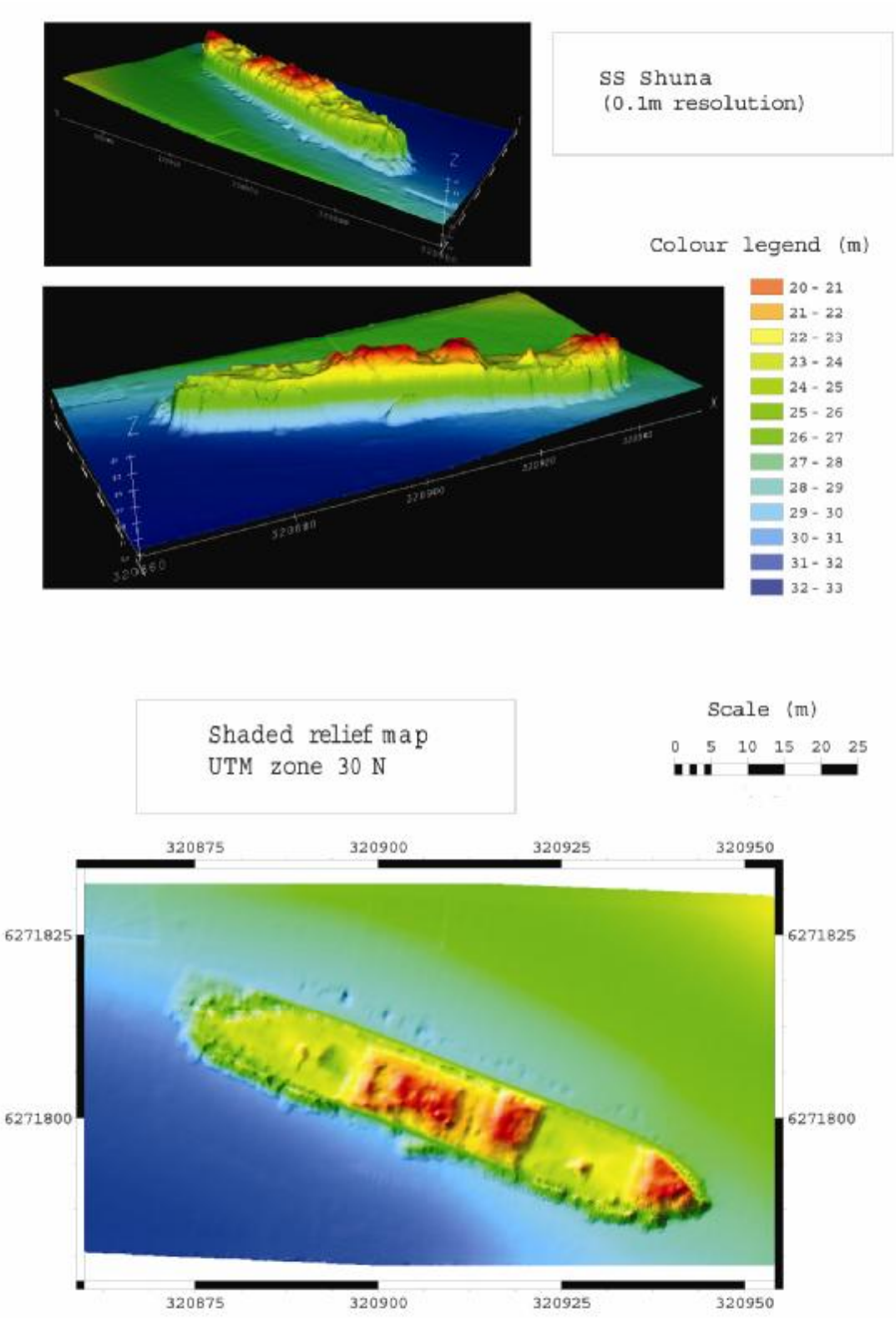


Fig.34: Multibeam map of the *SS Shuna*

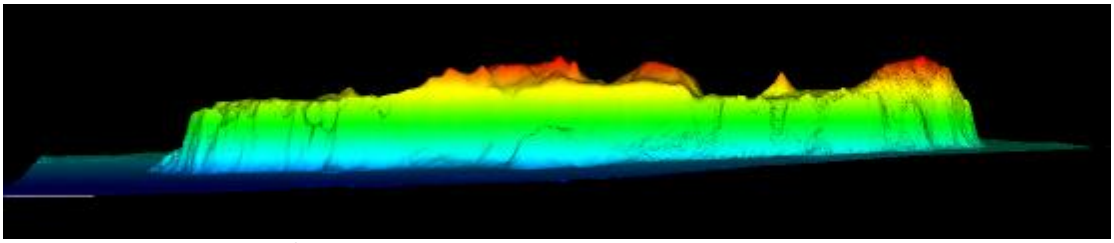


Fig. 35: Starboard elevation of the *SS Shuna* using multibeam sonar.

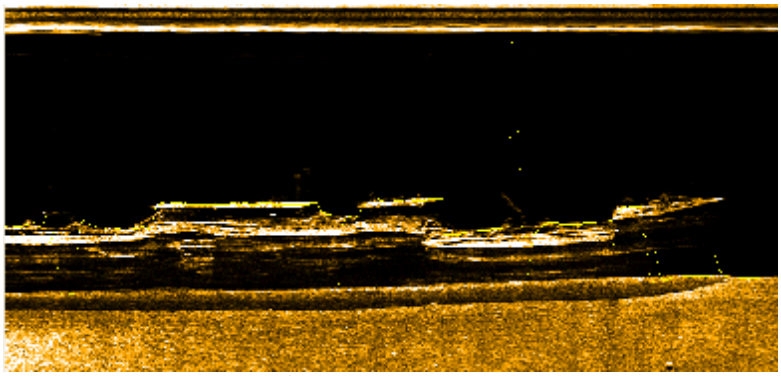
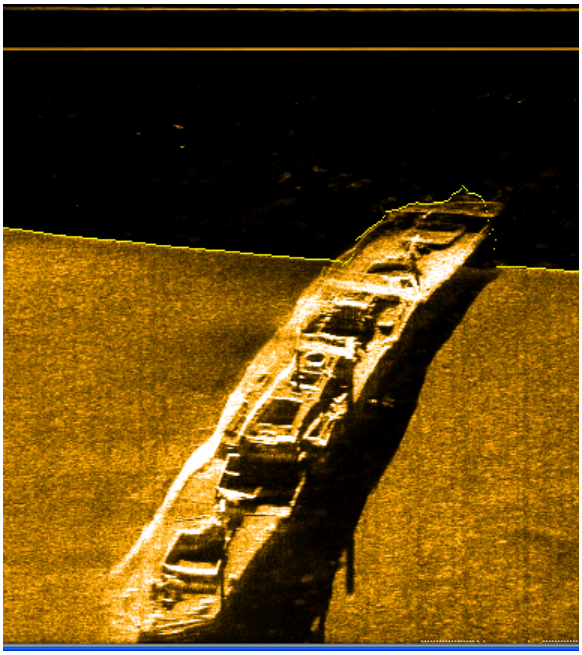


Fig 36: Starboard elevation of the *SS Shuna* using sidescan



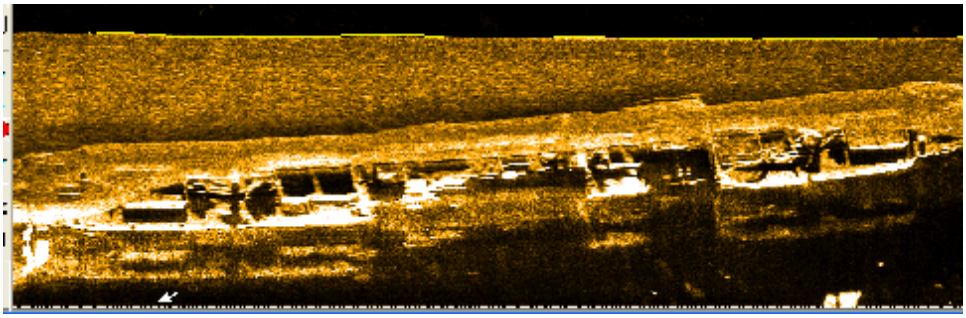


Fig. 37: Deck detail on the *SS Shuna*

SS Buitenzorg

Site Location and Environment

Documentary sources (See NMRS Reference NM64SE 8002), record the wreck of the *SS Buitenzorg at* N56' 30.25, W5' 44. 4667. The midship section of the wreck was charted by remote sensing at location N56' 30.2618 , W5' 44.4068 (WGS 84). The wreck lies upright on a gradually sloping seabed of sand and mud with the bow pointing in a northerly direction (the NMRS indicates an orientation of 315 degrees). Seabed depths at the vessel's stern vary from 81-83m (below chart datum), and exceed 90m (below chart datum) at the bow. Depths of the ship's structure vary from 76m below cd (amidships) to 79m below cd (on some of the topmost deck structures) and 80-85m in some of the hold areas.

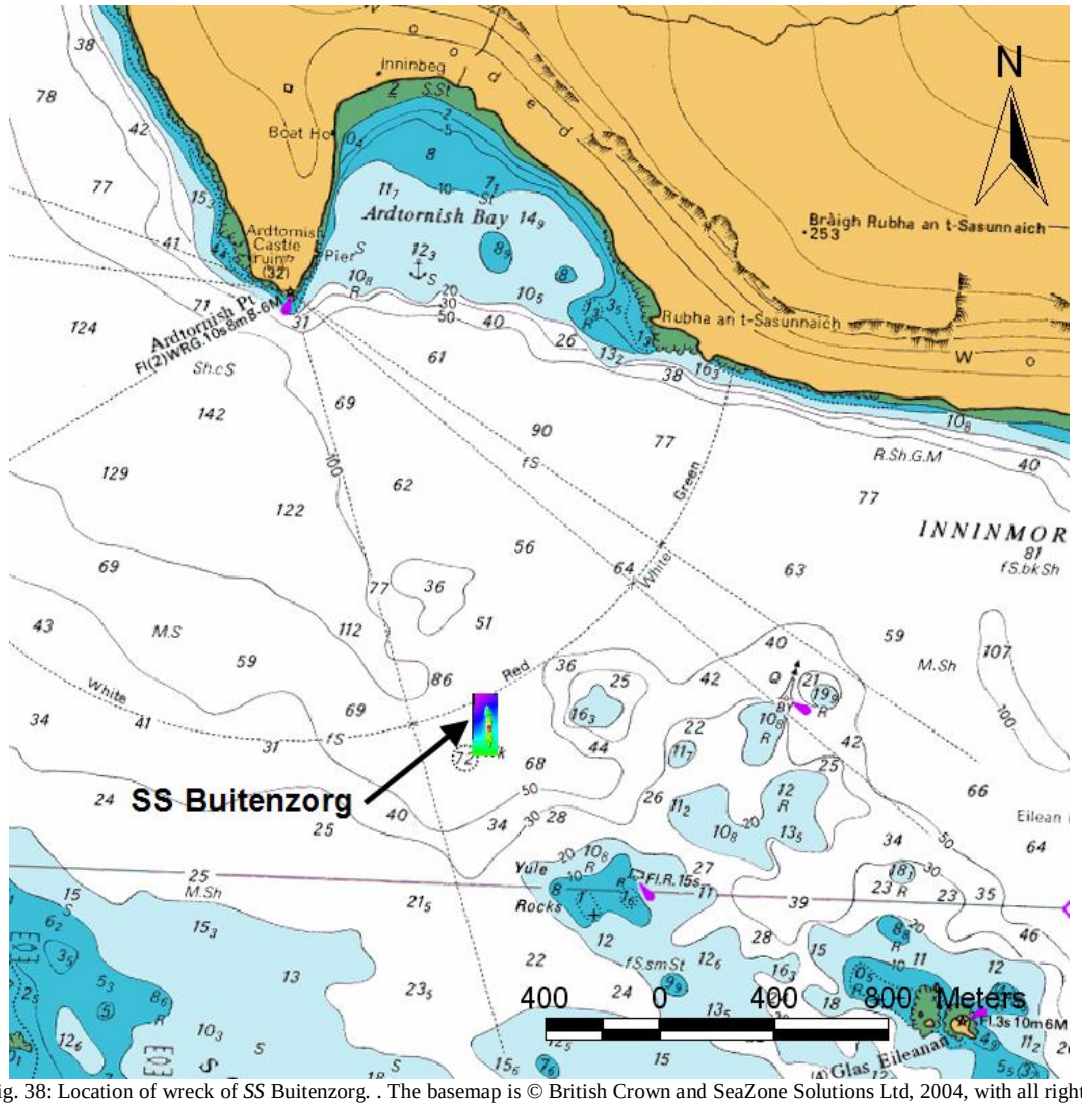


Fig. 38: Location of wreck of *SS* Buitenzorg. . The basemap is © British Crown and SeaZone Solutions Ltd, 2004, with all rights reserved and reproduced for this project under data licence No. 112004.005

Survey and Research History

According to documentary records, the site of the SS Buitenzorg was salvaged using remote grabs and divers sometime between 1977 and 1983, by Kilburn Salvage Co. Ltd, Newport and Tay, and by Aberdeen Diving Services (see NMRS Reference

NM64SE 8002). The vessel, with her cargo of rubber, tea and tin, bound from Calcutta to Dundee, had made a convoy rendezvous in the Firth of Lorne before heading northwards through the Sound of Mull towards the open Atlantic. Reports suggest that the ship was scuttled for fear of further U-boat threat offshore. Despite the ship's depth, technical divers have conducted some photographic recording of the wreck on several occasions.

Fieldwork

The site of the *SS Buitenzorg* was recorded with multibeam sonar (1,885,000 xyz points) over the target area between:

Latitude min (N)	Latitude max (N)	Long. min (W)	Long. max (W)
56' 30.1384	56' 30.2092	5' 44 3201	5 44 2623 W

A sidescan survey of the site was also undertaken but no diving fieldwork has so far been undertaken on the *SS Buitenzorg* due to its depth.

Site description

The structure of the *SS Buitenzorg* remains largely intact, lying upright on the seabed. The hull remains semi intact, with substantial raised forecastle and poop structures, four or five holds with associated winches, and intact masts, cranes or davits. The midships bridge and engine superstructure remain semi intact.

The wreck lies within a small debris field. There is evidence of wreck debris up to 40m from the starboard side of the vessel but no evidence for debris to port covered by a sonar shadow. The starboard debris includes one large object 5.3m in length (and 1.5m off the seabed). A possible debris object was also identified 45m off the port bow.

There is evidence of salvage impact targeting the contents of the forward hold, where use of grabs has ripped a large hole (3-5m wide) out of the port hand side of the vessel. This hole may also extend to the starboard side at the same point as documentary sources indicate a breach in the starboard side (See NMRS: NM64SE 8002). There is some evidence for distortion of the bow of the vessel forward of this impact damage (or approximately 2 degrees to port) but it is uncertain what might have been the cause of this.

There is clear evidence of salvage related damage to this site but no evidence of any scallop dredge marks in the close vicinity of the *SS Buitenzorg* although dredging does target the wider area. Both the sidescan and multibeam sonar traces indicate a degree of seabed scouring of up to 2m in depth around the stern of the vessel, with tentative evidence for some accretion of sediments towards the bow.

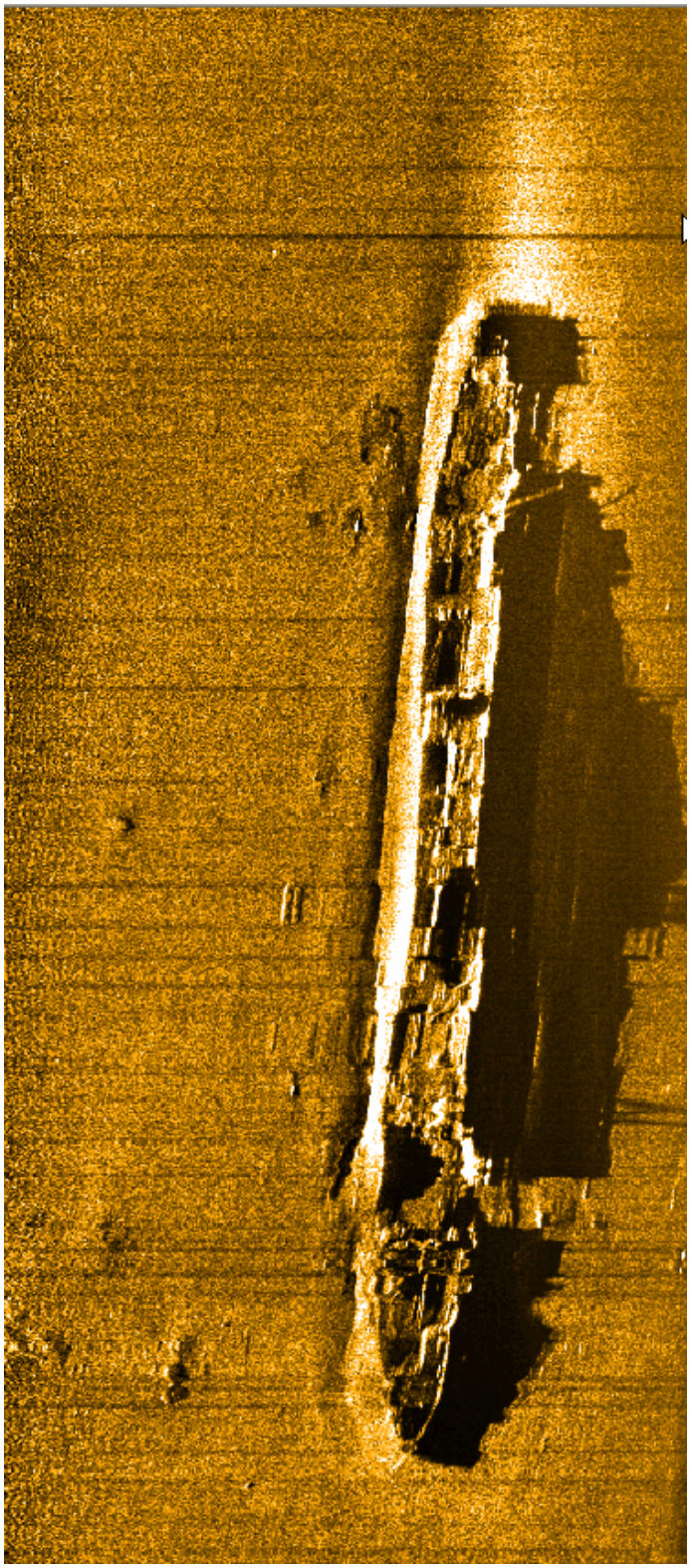


Fig: 39: Sidescan image of *SS Buitenzorg. (*The vessel's bow is at the bottom of the picture).

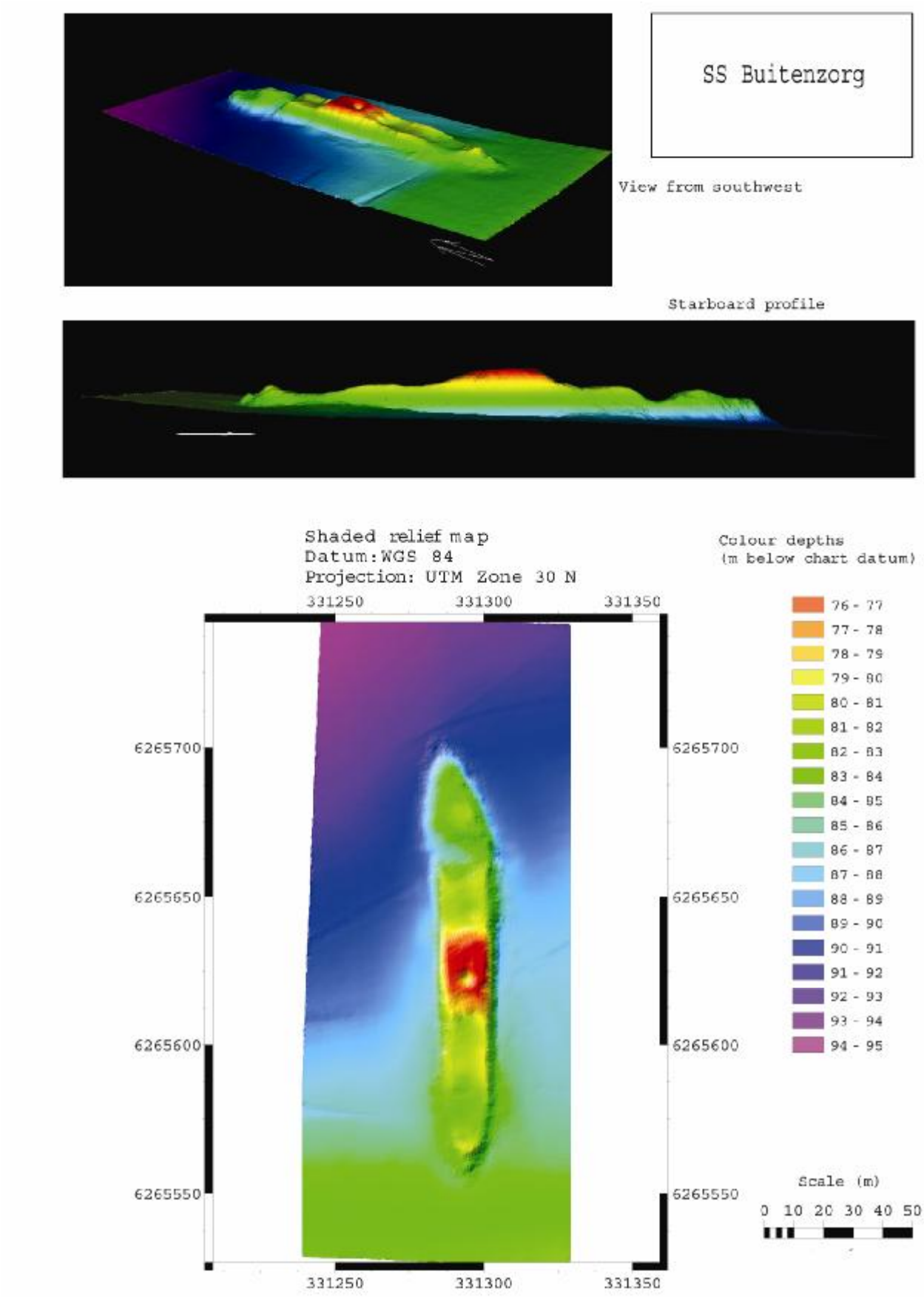


Fig. 40: Multibeam map of *SS Buitenzorg*

Unidentified site, possibly the wreck of the steam trawler Evelyn Rose

Site Location and Environment

A previously unrecorded wreck was located 330m south of Artdtornish Point at N56' 30.910, W5' 45.340 (WGS84). Features associated with this wreck were also identified between the wreck and the base of a steep underwater cliff off Ardtornish Point at 45m below cd. The seabed around the wreck slopes at between 115-130m below chart datum. This is an extremely tidal location with currents of up to 3 knots on the ebb tide close to Ardtornish Point, and possible down currents observed on the flood tide close to Ardtornish Point.

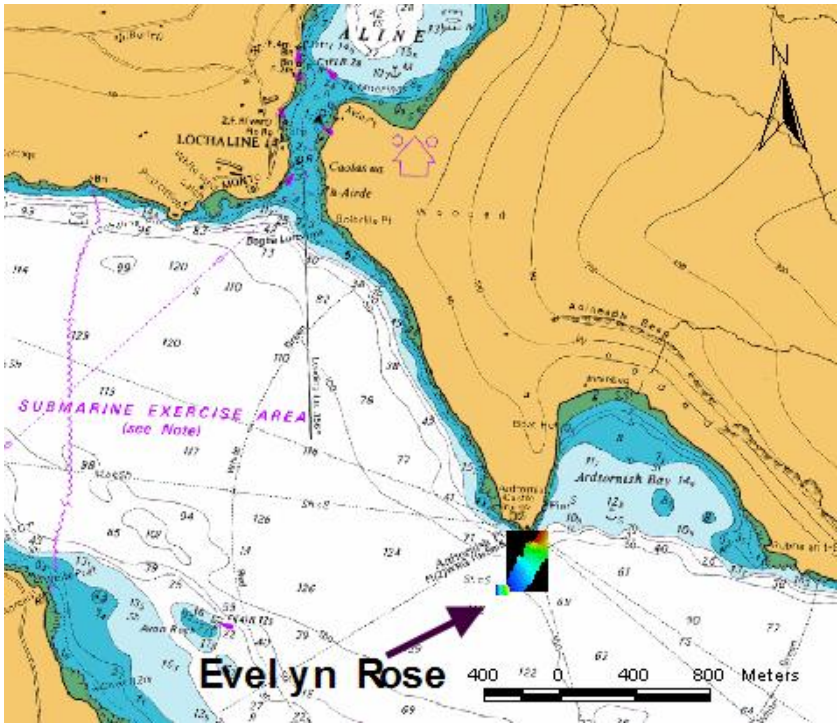


Fig. 41: Location map for the unidentified site off Ardtornish Point. The basemap is © British Crown and SeaZone Solutions Ltd, 2004, with all rights reserved and reproduced for this project under data licence No. 112004.005

Survey and Research History

Recorded losses in the vicinity of Ardtornish include the tall ship Annihetta (NM64SE 8010) lost near Ardtornish in 1815, and the 327 ton steam trawler, Evelyn Rose, commanded by skipper W.Dawson of Fleetwood. She was registered in Grimsby, and operated from Fleetwood, owned by the Cevic Steam Fishing Co. of Fleetwood. (Oban Times, 8 January 1955). She was lost on 31st December 1954 after hitting Ardtornish Point. Ten of her twelve man crew were lost. The documented position of the Evelyn Rose is given as N56' 31.1 W5' 45.1 (OS NGR: NM 692 425. See (NMRS Reference: NM64SE 8004). The author has been unable to test the veracity of rumours from visiting divers, each claiming the discovery of the Evelyn Rose wreck, apparently close in towards Ardtornish Point (in the 60-80m depth range).

Fieldwork

This site was recorded with sidescan and multibeam sonar (559070 xyz points) over the target area between:

Latitude min (N)	Latitude max (N)	Long. min (W)	Long. max (W)
56’ 30.5364	56’ 31.503	005’ 45 2252	005 45. 0522W

Results were plotted at 0.1m point resolution. Associated features were recorded using sidescan and multibeam sonar (152680 xyz points) between an area:

Latitude min (N)	Latitude max (N)	Long. min (W)	Long. max (W)
56’ 30.5423	56’ 31.503	005’ 45 1933	005 45. 0526W

No diving fieldwork has so far been undertaken due to the depths on this site.

Results

Despite extensive searches of the Ardtornish Point and Bay area no significant anomalies were identified close to shore. However, the multibeam has identified a linear shaped mound on the seabed (fig.42), approximately 40m in length and c. 8m wide (the sidescan trace suggests a mound of 35-37m in length). At the northeastern end of this mound, the seabed depth is 115m below cd. At the southwestern end of this mound, the seabed depth is 125-130m below cd. At its highest point (towards the northeastern end of the mound), this feature stands c.4m off the seabed. A linear feature, possibly 5-10m in length and akin to a small mast, appears to be resting on the seabed but remains attached to the mound on its eastern side.

It is likely that this mound represents a wreck as opposed to a geological feature. This hypothesis is strengthened by the presence of an item of debris and a curved track (figs.43; 44), approximately 330m in length between the mound (115 m below cd) and the foot of the underwater cliff off Ardtornish Point (45m below cd). This track appears to be of similar width to the mound but it is not possible to define the depth of this indentation.

There is also an item of debris at position Eastings 330584.166, northings 6266949.789 (Projection UTM30 N, and WGS84 datum), and at a depth of 97.091mtrs below cd (figs.43; 44) this feature appears to be c.5m in width and is protruding c. 0.5m off the seabed. While this could be of geological origin, its position, some 10-15m from the indented track, points to this being debris from a wreck that hit Ardtornish Point, before careering down a steep slope to rest some 330m offshore.

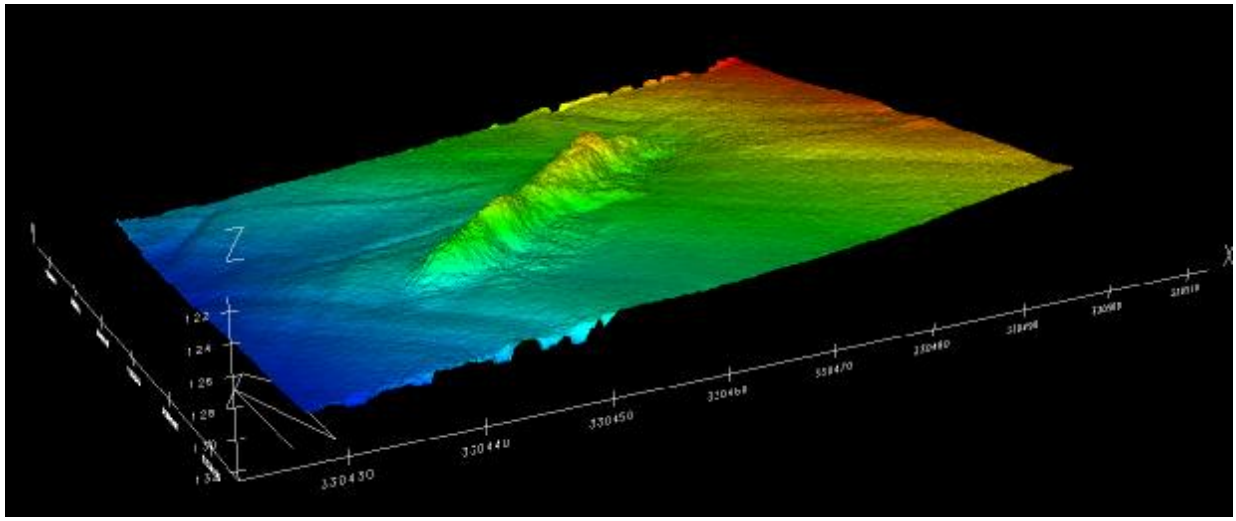


Fig. 42: 3D model of the unidentified site off Ardtornish Point.

Conclusions

The size of this feature corresponds closely with documented measurements for the steam trawler *Evelyn Rose.* However, without verification by ROV, it is impossible to test this hypothesis. Without further research of the seabed morphology on this site, it is impossible to suggest whether the vessel's track is etched into rock signifying that the track could date to the original sinking of the ship in 1953. If the seabed is comprised mostly of soft sediments, it seems unlikely that a track would remain so well defined a half-century after the original loss of the ship. In this case, it is possible that the ship came to rest at closer towards the base of the cliff (where it may have been dived on at one time) before moving further out from the point at a later date.

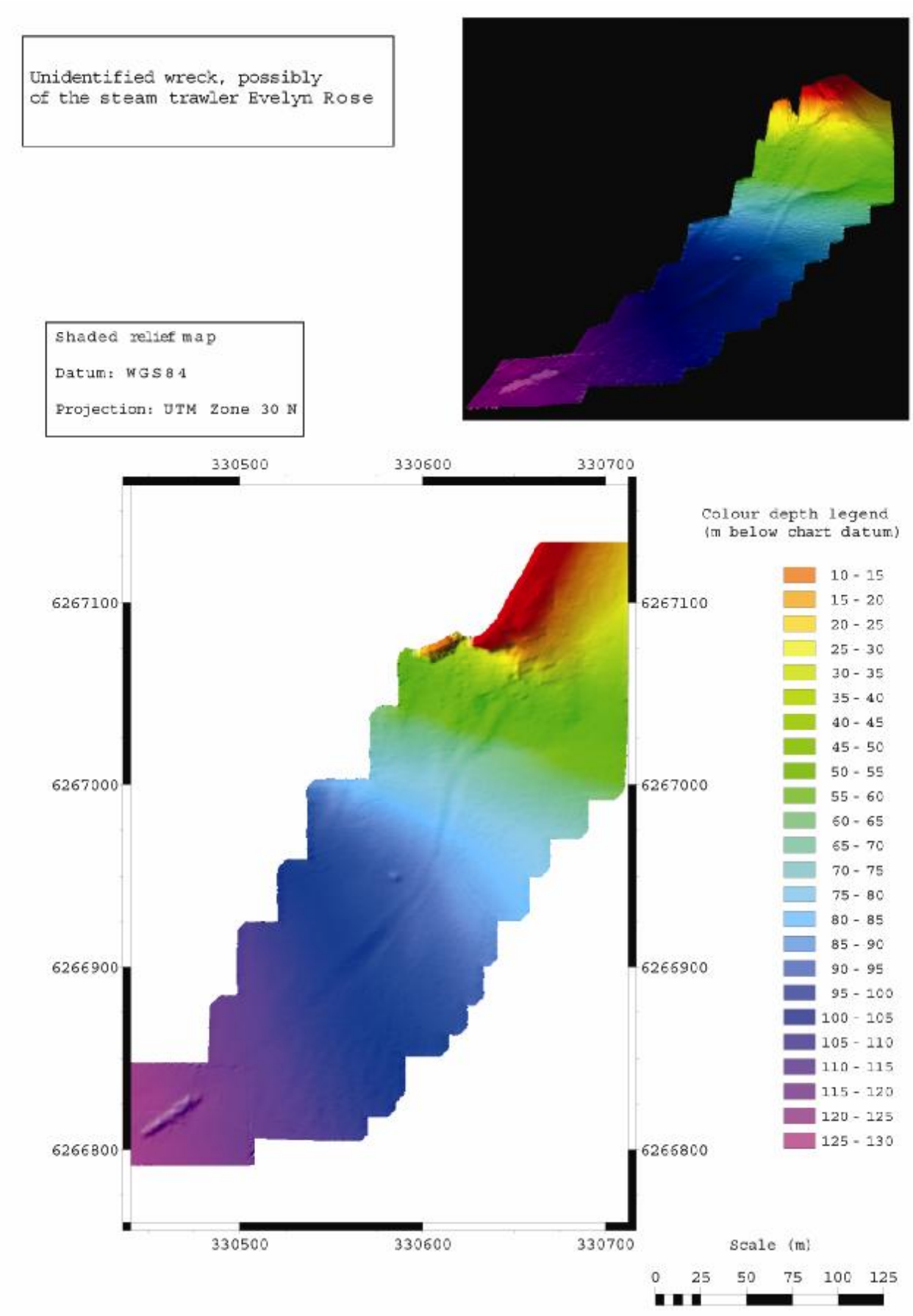


Fig.43: Multibeam map of an unidentified site off Ardtornish Point

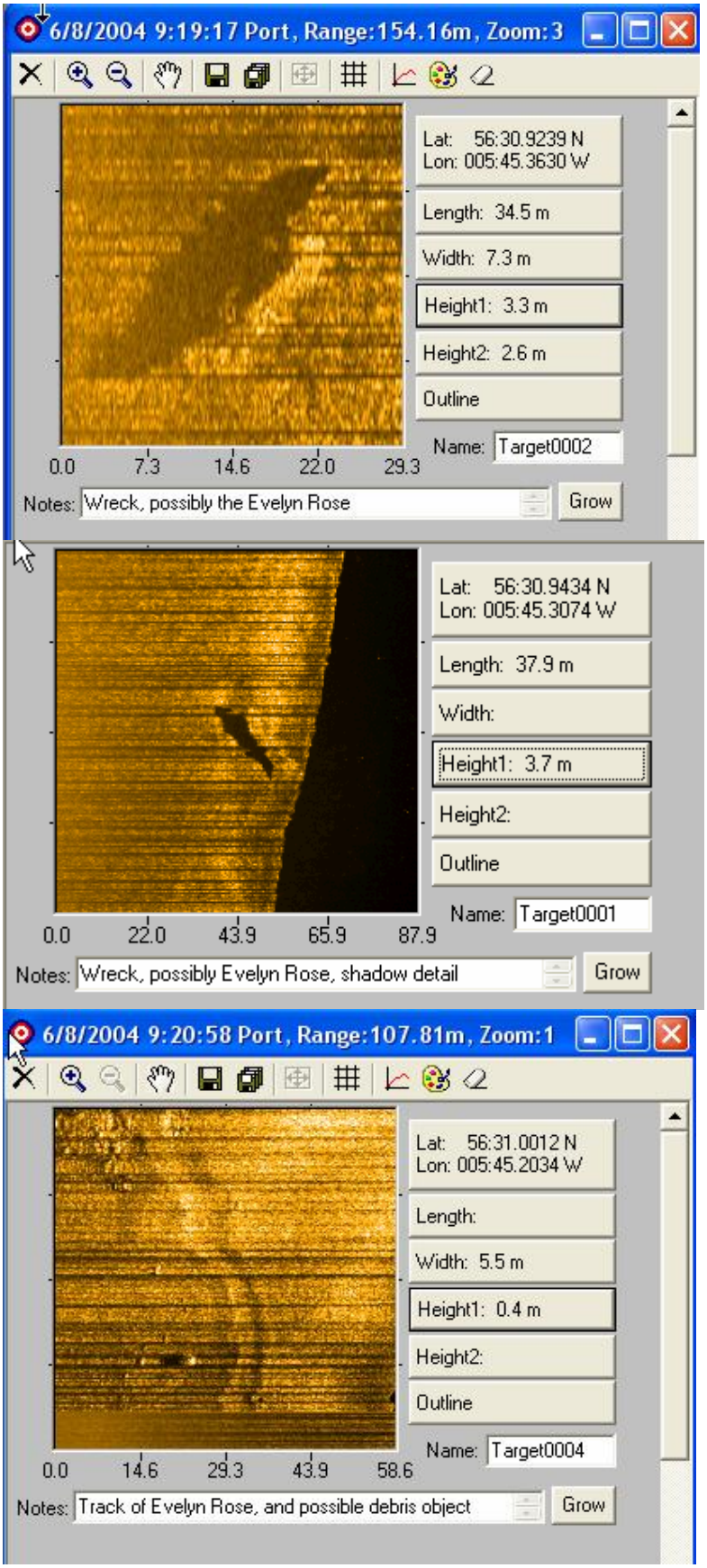


Fig. 44: Sidescan imagery of the unidentified site off Ardtornish Point.

PS Pelican and debris

Site Location and Environment

Documentary sources (NMRS: NM55SW 8009) indicate the wreck of the David Macbrayne's ex paddle steamer *Pelican* as being located close to the western shore of Calve Island at N56' 36.9333 W6' 2.4667 (OS NGR: NM 5209 5436). The centre of the wreck was charted by remote sensing to be located at N56' 36.8993, W6' 2.4930 (WGS84). The highest points of the ship's superstructure at the bow lie in 10-12m below chart datum (cd) and at the stern, 18-20m below cd. The seabed depth at the stern on the vessel's starboard side is 22-24m below cd and at the bow, 16-18m below cd. This wreck is not subject to currents is seldom undiveable.

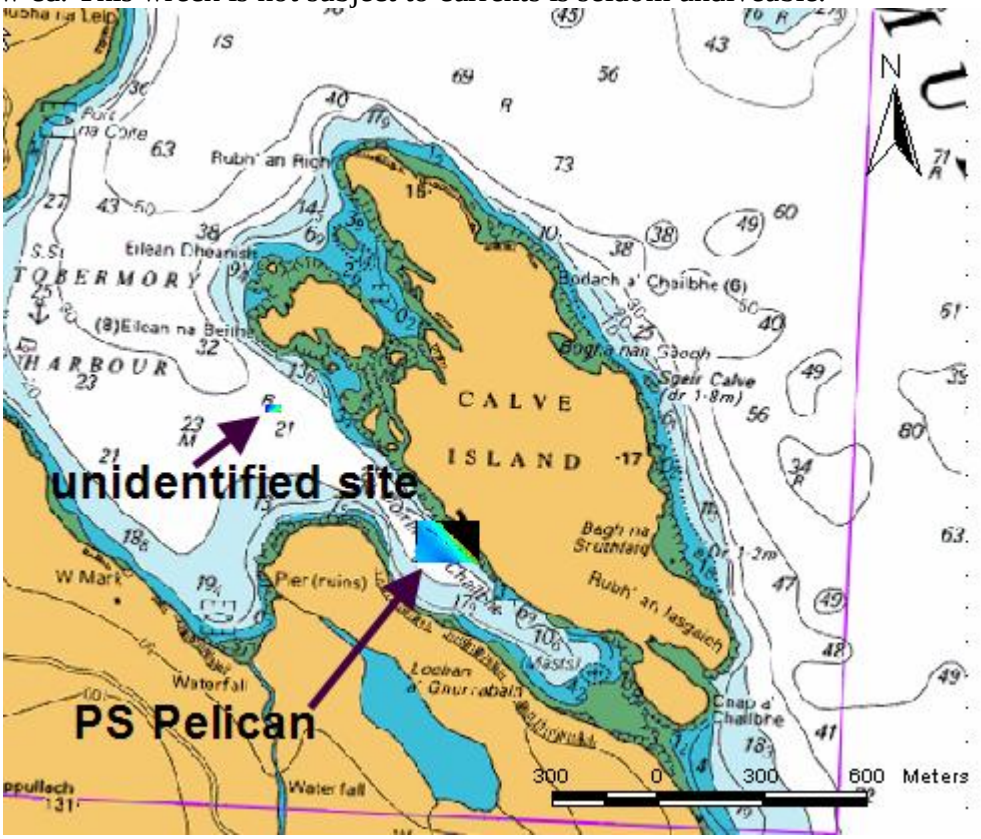


Fig. 45: Location map of Pelican, and unidentified site. This basemap is © British Crown and SeaZone Solutions Ltd, 2004, with all rights reserved and reproduced for this project under data licence No. 112004.005

Survey and Research History

A detailed summary of the history of the *Pelican* may be found on Canmore (NM55SW 8009 at www.rcahms.gov.uk.). In brief, the *Pelican* was in use as a coal hulk in Tobermory Bay, after many years in service as a steam packet for the Cork Steampacket Company, and then for David Macbrayne on his Scottish west coast ferry routes. The vessel was then stripped of her engines and paddles etc., and ended her days as a coal hulk at Portree, then Tobermory. She was driven aground in a storm on 5 December 1895.

The wreck has become a popular, sheltered dive attraction when poor weather prevents diving within the Sound of Mull.

Fieldwork

This site was recorded with sidescan and multibeam sonar (1445784 xyz points) over the target area between:

Latitude min (N)	Latitude max (N)	Long.min (W)	Long.max(W)
56’ 36.5254	56’ 36.5674	6’ 02 3722	6’ 02.2638

Results from the multibeam survey were plotted at 0.1m point resolution. The description below has been enhanced by observations and measurements provided during preliminary diver surveys undertaken by SOMAP during June 2003.

Results

The multibeam and sidescan datasets depict a semi intact hull structure within a tightly confined debris field. The ***Pelican*** has a clipper shaped bow, and iron hull. The length of visible remains may be estimated at approximately. 62.5-65m in length. Divers confirmed a maximum beam of 8.50m (across a central bulkhead beam 13 when counted from the bow). The vessel is orientated with its bow facing in a southeasterly direction. Remains of the wooden deck may be seen semi intact for a section of approximately 10m in length aft of the bow. Identifiable features at the bow include navel pipes, and anchor chain to the seabed at the starboard bow. The remains of a foredeck hatch (approx 110 by 85cm square) and forward cargo hatch (approx 205 by 210 square) may still be seen but are obscured on the sidescan trace amidst scattered iron debris. Large frames ends are visible on the sidescan trace, as are the main deck beams, and bulkheads of which divers measured two, at 11.8m and 20.65m [see also beam 13 above] respectively from the bow. Divers have observed vertical splits in the hull towards the bow on the port side and a large boulder underpinning the bow on the starboard side, forward of a capstan. The sides of the vessel also appear to lie at different angles, with the starboard side leaning inwards. All these observations may suggest that the ***Pelican*** has fractured low down towards the keel.

The iron plating appears to be mostly intact with the possible exception of a void at the port stern quarter and at the starboard stern quarter (where plating lies on the seabed). However, at the ship’s stern, there is a confused area of twisted metal and debris presumably from the ship’s collapsed superstructure and remaining machinery. This obscures much of the inside of the vessel at this point. Nevertheless, a heavily constructed sternpost and remains of the rudder are quite impressive.

There appears to be some debris on the vessel’s starboard side, mostly linear shaped objects within 10m distance from the ship. However, there is nothing on the sidescan trace to match the two features visible on the multibeam sonar scan to the stern of the main Pelican site (fig.51). It is likely that these have resulted from errors during processing, as these features don’t appear on the raw multibeam screen captured images and puzzled the local *cognoscenti*.

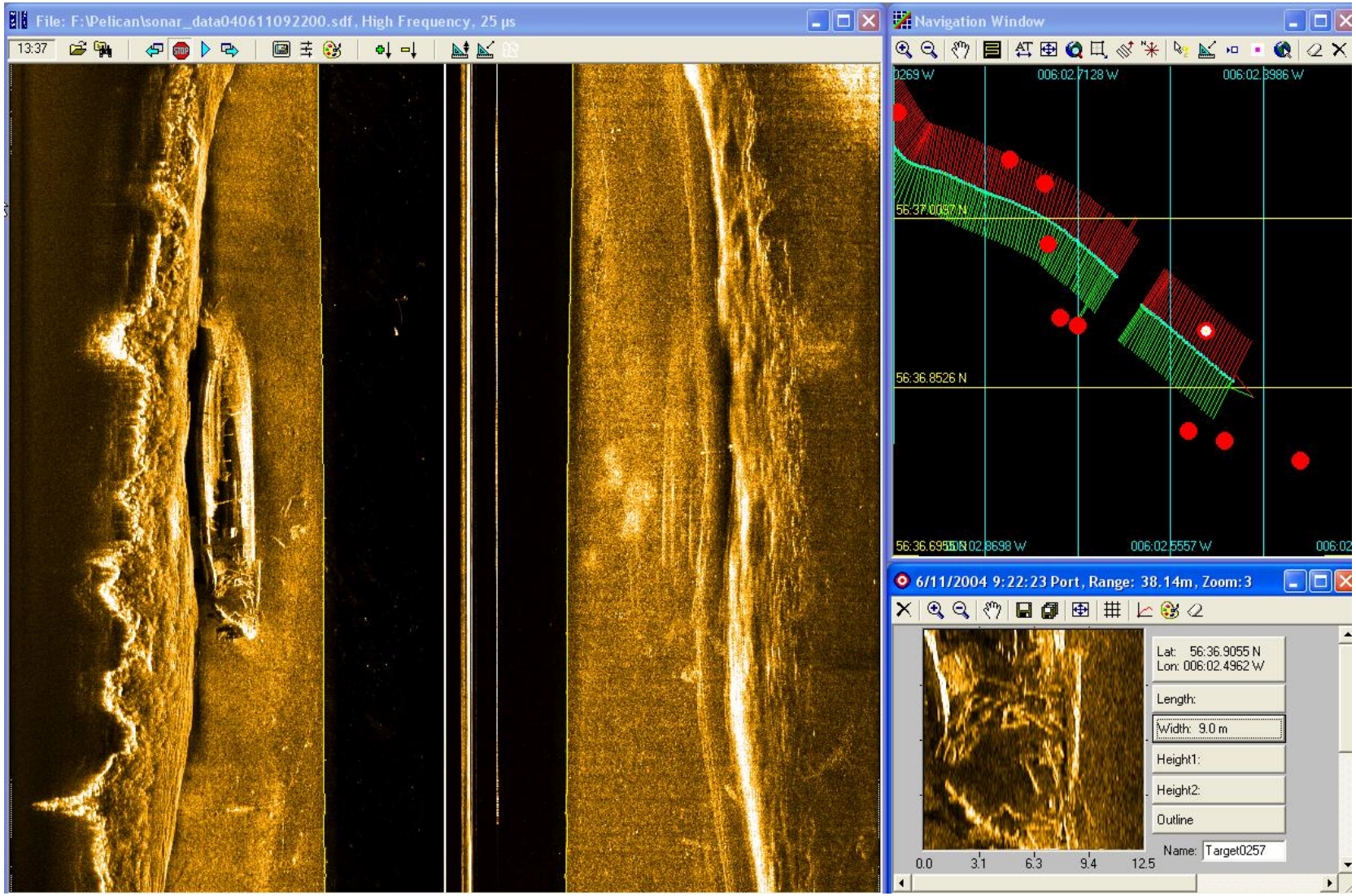


Fig.50: Sidescan image of the Pelican. Note the absence of anomalies present on the multibeam image.

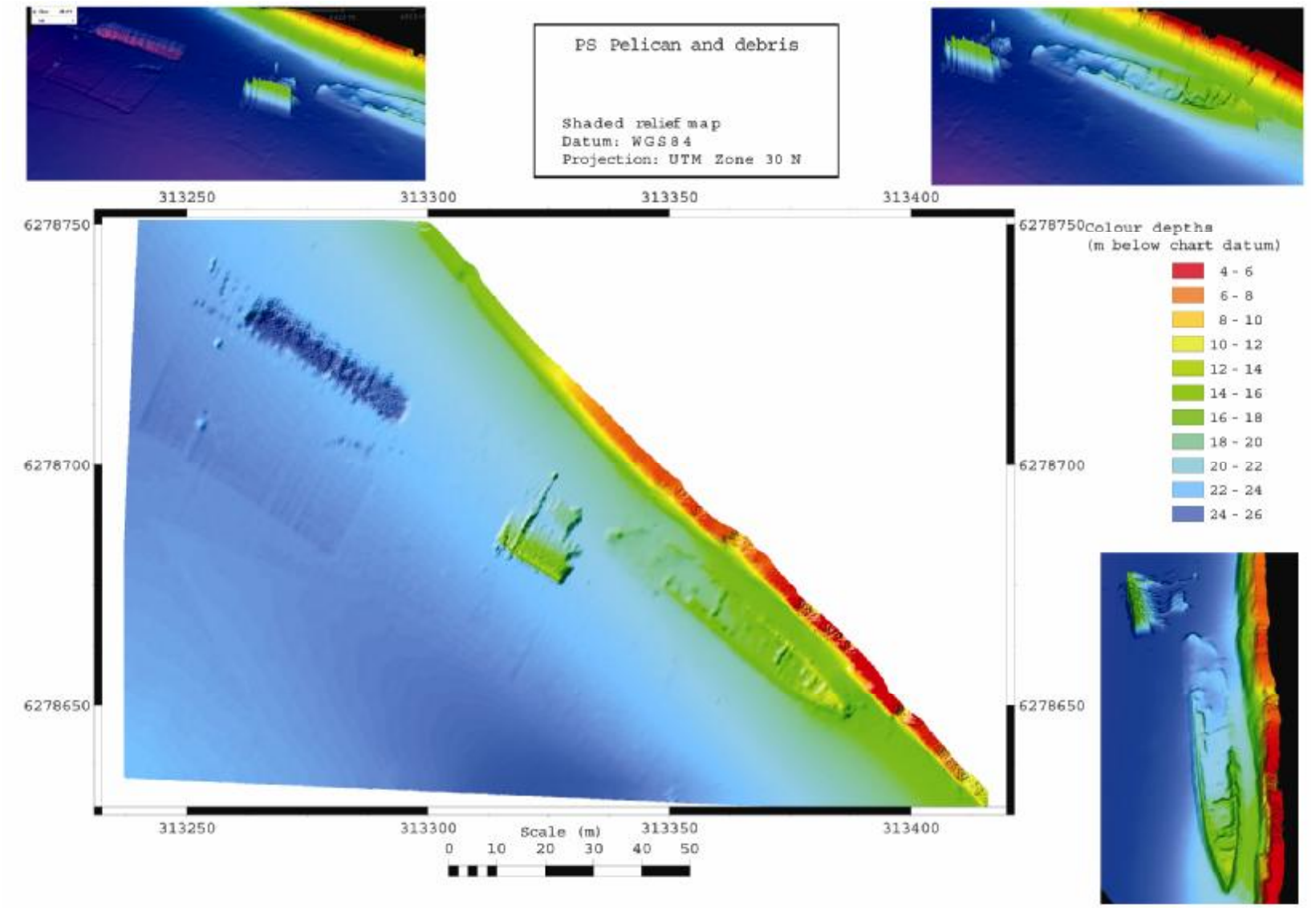


Fig.51: Multibeam map of the Pelican. Note anomalies to the stern that may be erroneous.

Conclusion

Puffer Logan

Site Location and Environment

Documentary sources (NMRS: NM64SE 8006) indicate the wreck of the Alexander Mcneil's puffer *Logan* as being located 240mtrs south west of the West Pier at Lochaline at N56' 31.863 W5' 47.243 (OS NGR: NM 6712 4408). The wreck was charted by remote sensing to be located at N56' 31.8540, W5' 47.220 (WGS84). The author does not know tidal conditions on the site.

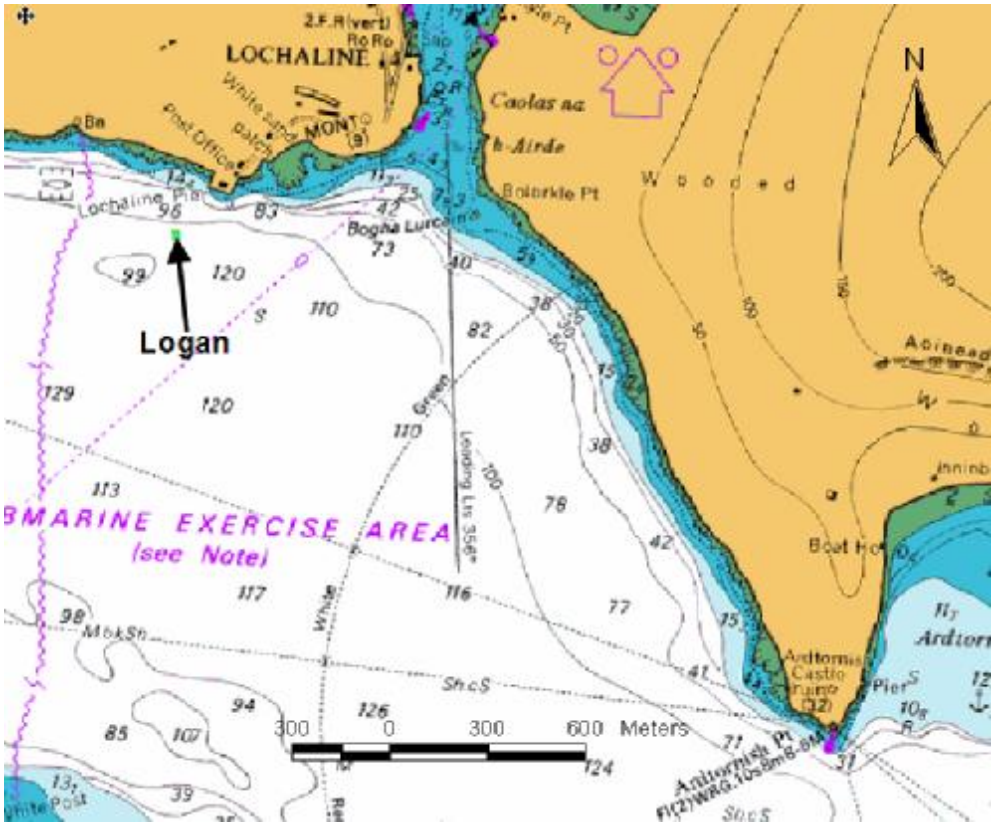


Fig.52: This basemap is © British Crown and SeaZone Solutions Ltd, 2004, with all rights reserved and reproduced for this project under data licence No. 112004.005

Survey and Research History

A detailed summary of the history of the *Logan* may be found on Canmore (NM64SE 8006 at www.rcahms.gov.uk.). In brief, this broadly typical west highland puffer sank off Lochaline's west pier after springing a leak while en route to from the Clyde to Skye with a cargo of coal. Despite her depth and distance offshore from the West Pier, rebreather divers visiting Lochaline have begun to dive on this site (see Canmore reference) describing a puffer with coal cargo in twin holds, lying intact and upright on the seabed, with her stern pointing towards the north (D.Greig, pers.comm.) No other survey work has been undertaken.

Fieldwork

This site was recorded with sidescan and multibeam sonar (3332 xyz points) over the target area between:

Latitude min (N)	Latitude max (N)	Long.min (W)	Long.max(W)
56’ 31.5072	56’ 31.5183	005’ 47.1455	005 47.1308

Results from the multibeam survey were plotted at 0.5m point resolution.

Results

This survey was at the operating limits of the Kongsberg Simrad EM3002 multibeam system and this site has yielded fairly poor resolution. Nevertheless, some useful bathymetric data has been gained. The highest points of the ship’s superstructure towards the stern (possibly the deckhouse) lie in 105.890m below chart datum (cd). At the ship’s bow, the seabed depth is 109m below cd. The wreck mound has a maximum width of 8.6m wide, and a maximum length of 19.19m, figures that considerably exceed diver generated estimates of 13-15m in length by 4-5m in breadth.

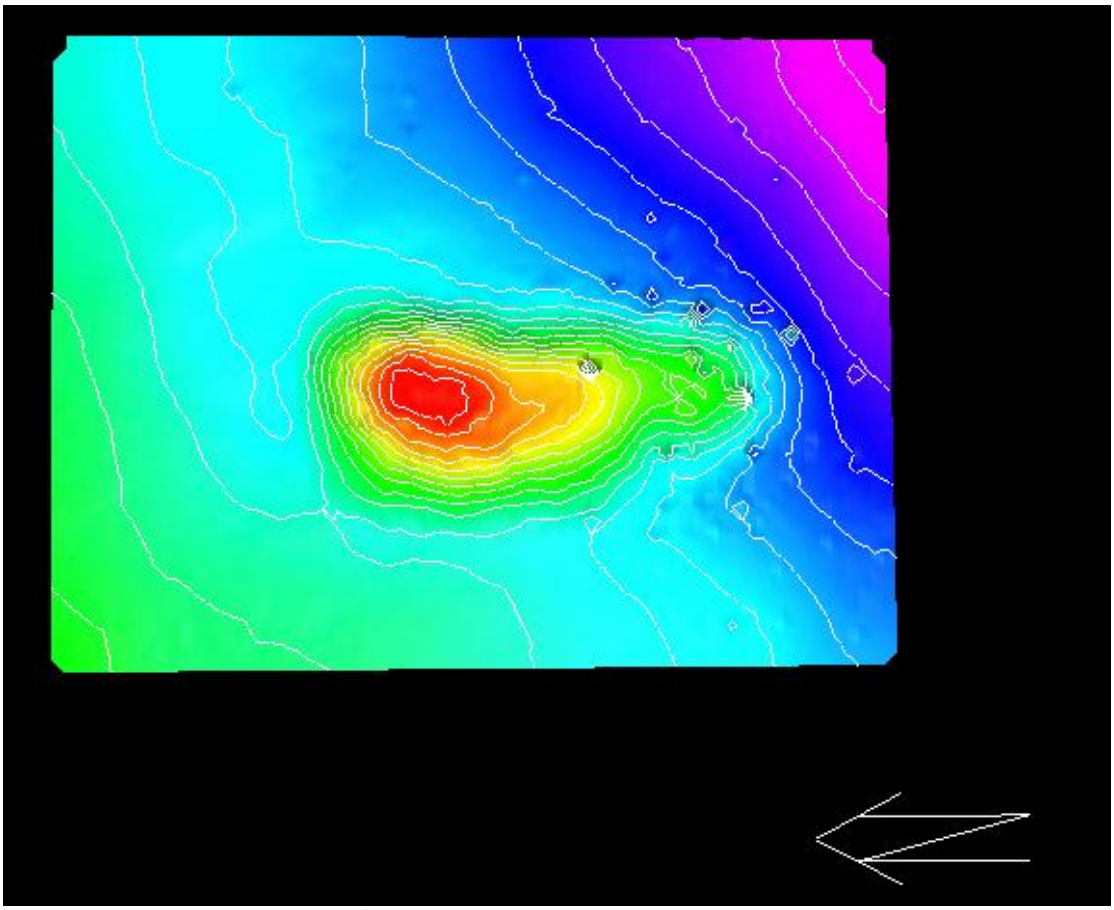


Fig.53: Multibeam bathymetry plot of the Logan site. The mound is 19.19m in length with the stern vessels stern orientated to the north.

Macduff

Site Location and Environment

The previously unrecorded site of a semi intact wreck was found and charted by remote sensing at N56' 39.6124N, W6' 5.2809, a position 4km north north west of the entrance to Tobermory harbour, and 2.26km from the charted position of a green navigation buoy marking the southern boundary of the New Rocks reef. However, the positional accuracy of this position may be suspect because the sidescan has provided three positioned images within a 70m target area.

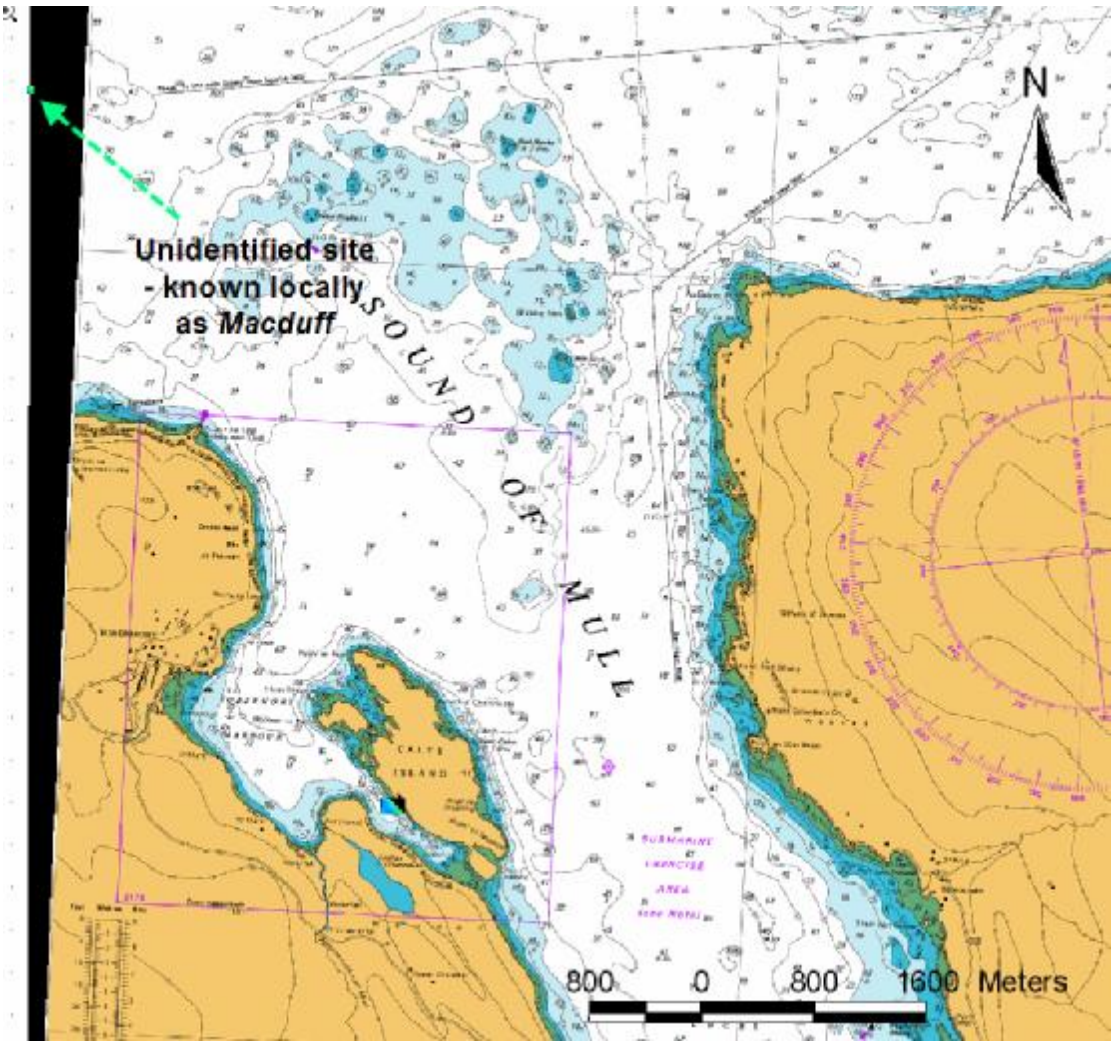


Fig.54: Location map of the *Macduff* site. This basemap is © British Crown and SeaZone Solutions Ltd, 2004, with all rights reserved and reproduced for this project under data licence No. 112004.005

Survey and Research History

Little is recorded about this site although the wreck is thought by charter boat skippers to be the puffer Macduff. The NMRS lists the *Macduff* as being lost in 1908 off Ardmore Point, Mull at an indeterminate location of N56' 39 W6' 8 (See NMRS: NM45NE 8004) but provides no details of the ship. Whittaker (1998, 291) lists a steamer of 56 net tons, carrying a cargo of salt and lost on 20th July 1908.

No survey work has been carried out prior to this project and the wreck is seldom dived on.

Fieldwork

This site was recorded with sidescan and multibeam sonar (3332 xyz points) over the target area between:

Latitude min (N)	Latitude max (N)	Long.min (W)	Long.max(W)
56’ 39.3490	56’ 39.3677	006’ 5.179	006 5.1483

Results from the multibeam survey were plotted at 0.5m point resolution.

.9

Results

The multibeam sonar datasets indicate seabed depths at this point of 53-55m below chart datum. The sidescan sonar images indicate a vessel of approximately 20m in length and 6-7m in width, with a fairly pointed bow and a semi intact hull and stern. It is difficult to decipher more from the sidescan image due to disturbance caused by sea swell during the survey of this more exposed site.

The multibeam datasets are of insufficient resolution to be instructive and do not compare favourably with the sidescan imagery.

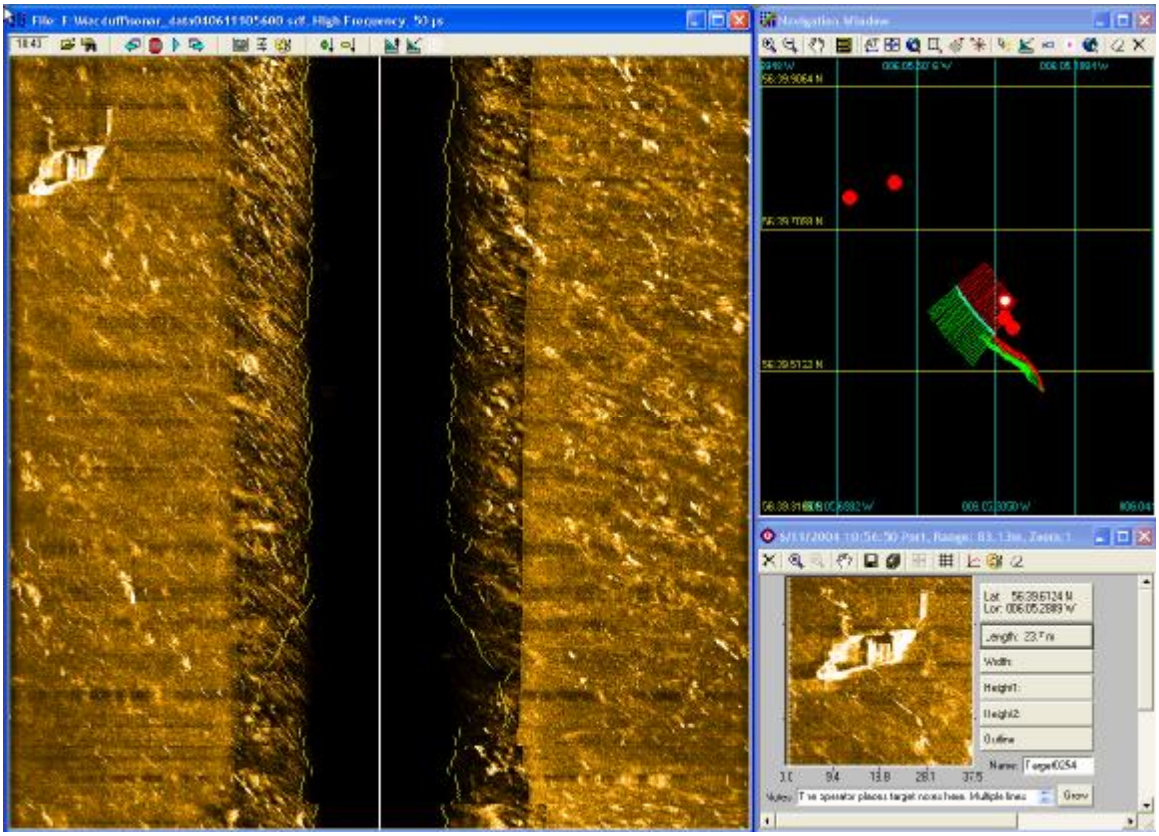


Fig.55: Sidescan image of the *Macduff* . Note warping due to wave action during the survey.

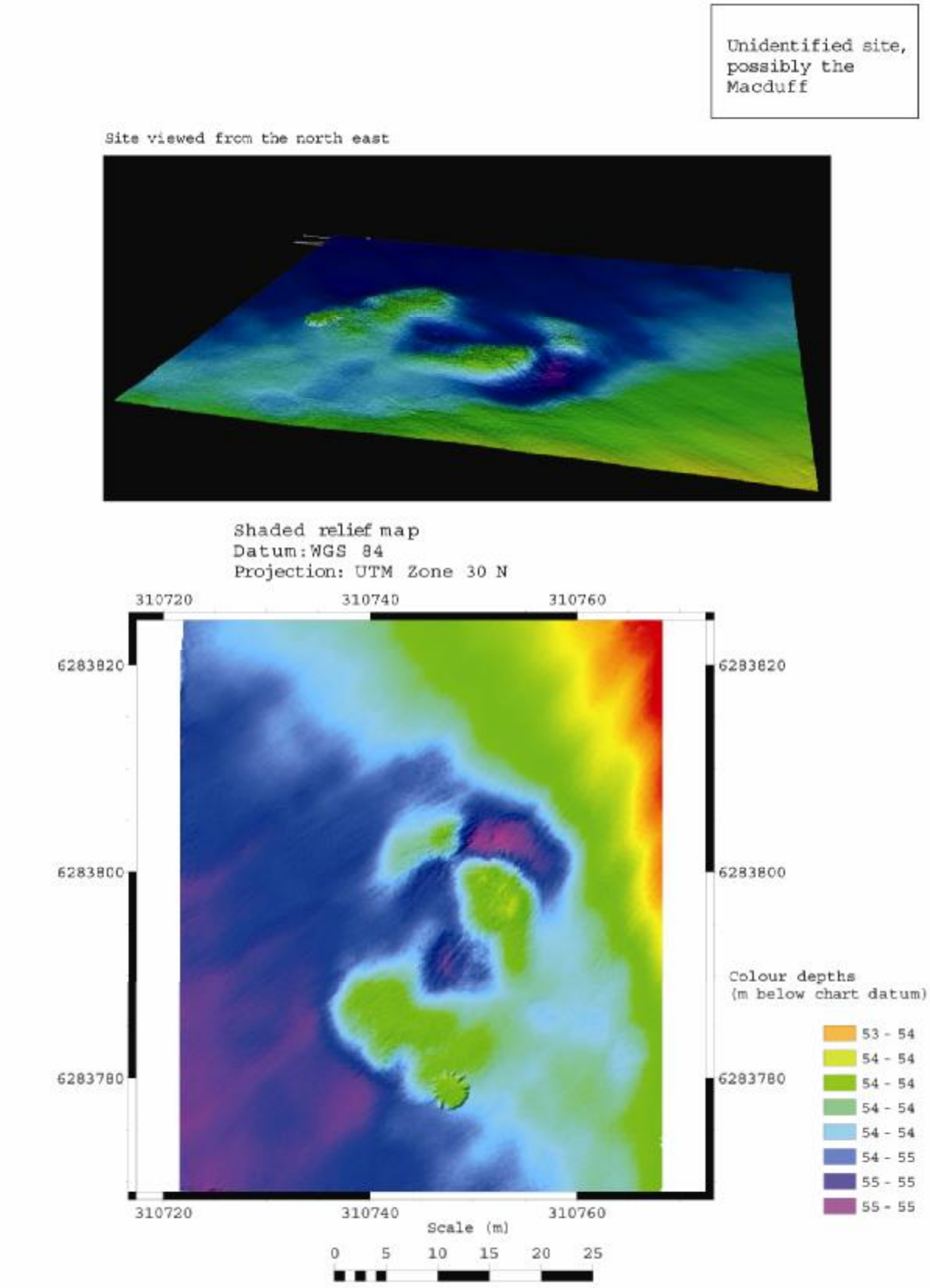


Fig.56: Multibeam map of the *Macduff* site.

Unidentified site in Tobermory Bay

Site Location and Environment

The previously unrecorded site of a semi intact wreck was found and charted by remote sensing at N56' 37.1102, W6' 3.0416, a position 220m WSW of a small bay at the north western end of Calve Island.

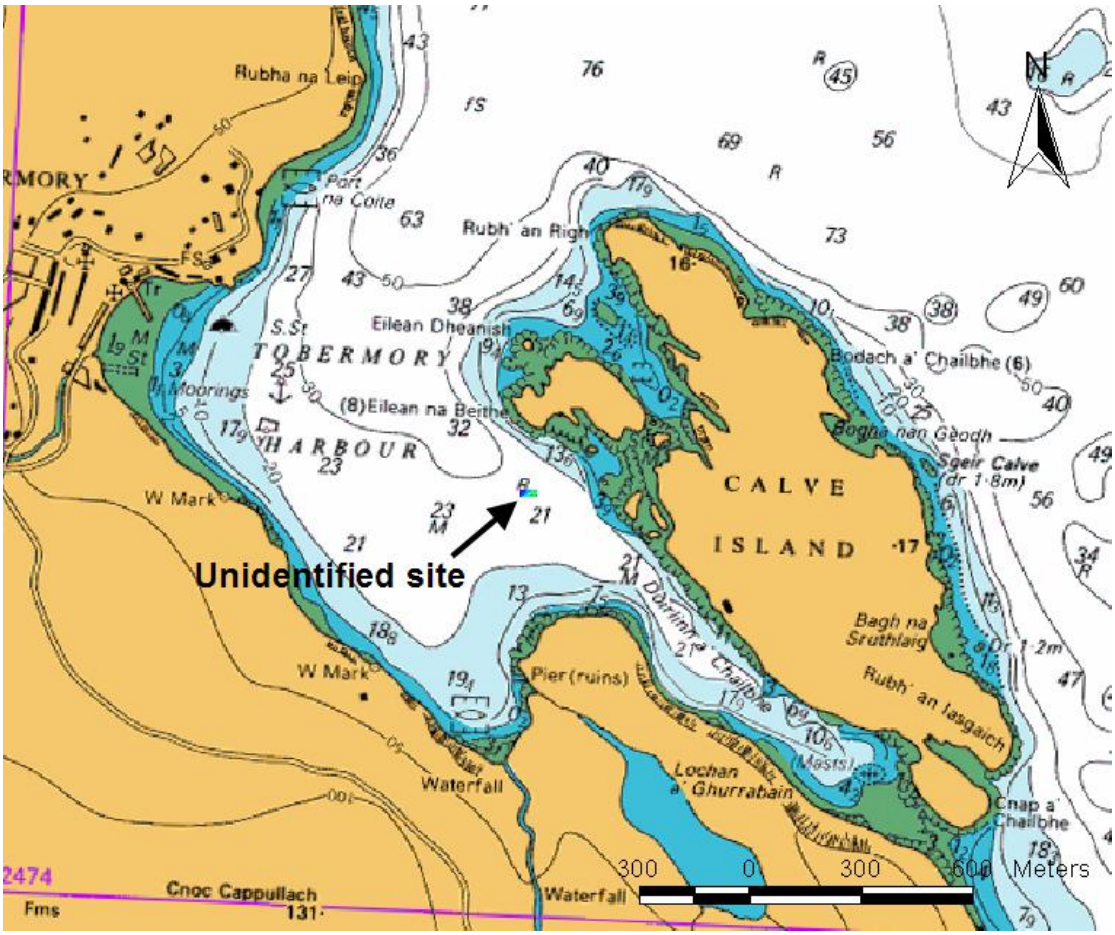


Fig.57: Location map of an unidentified site in Tobermory Bay. This basemap is © British Crown and SeaZone Solutions Ltd, 2004, with all rights reserved and reproduced for this project under data licence No. 112004.005

Survey and Research History

The NMRS does not list any site in this location. However, there were several shipping losses within Tobermory Harbour and the narrows separating Calve Island from the mainland, *Doirlinn a Chailbhe.* Potential candidates include the *Lohada* or a small motor launch reported in 1980 to lie astern of the Pelican and opposite the slipway (both sites mentioned under NMRS: NM55SW 8009). It is thought that several small hulks may be seen on the foreshore of the small bay identified above. No previous archaeological surveys have been undertaken.

Fieldwork

This site was recorded with sidescan and multibeam sonar (95612 xyz points) over the target area between:

Latitude min (N)	Latitude max (N)	Long.min (W)	Long.max(W)
56’ 37.580	56’ 37.653	006’ 33.299	006 30.540

Results from the multibeam survey were plotted at 0.1m point resolution.

Results

The sidescan trace indicates a vessel of 20.3m in length and 4-5m width lying upright on the seabed. The vessel appears to be double ended, and either open decked (or with the decking collapsed with the exception of some deck beams visible for and aft). She lies orientated in an east west direction on a gradually sloping seabed with a depth of 23-25m below chart datum. The structure at the eastern end and western ends of the wreck may protrude approximately 2m and 1.2m off the seabed respectively. A further anomaly may be identified approximately 12m WSW from the western end of the site. It appears as a pit on the multibeam trace and a hard reflector surface on the sidescan. It is worth noting that the seabed to northwest of this point is heavily disturbed in a manner consistent with moorings/anchor use and this feature may represent mooring debris.

It is not possible to identify this site from the remote sensing datasets. Ground truthing by divers will be required to identify the wreck, to verify aspects of the structure on the seabed and outlying anomaly.

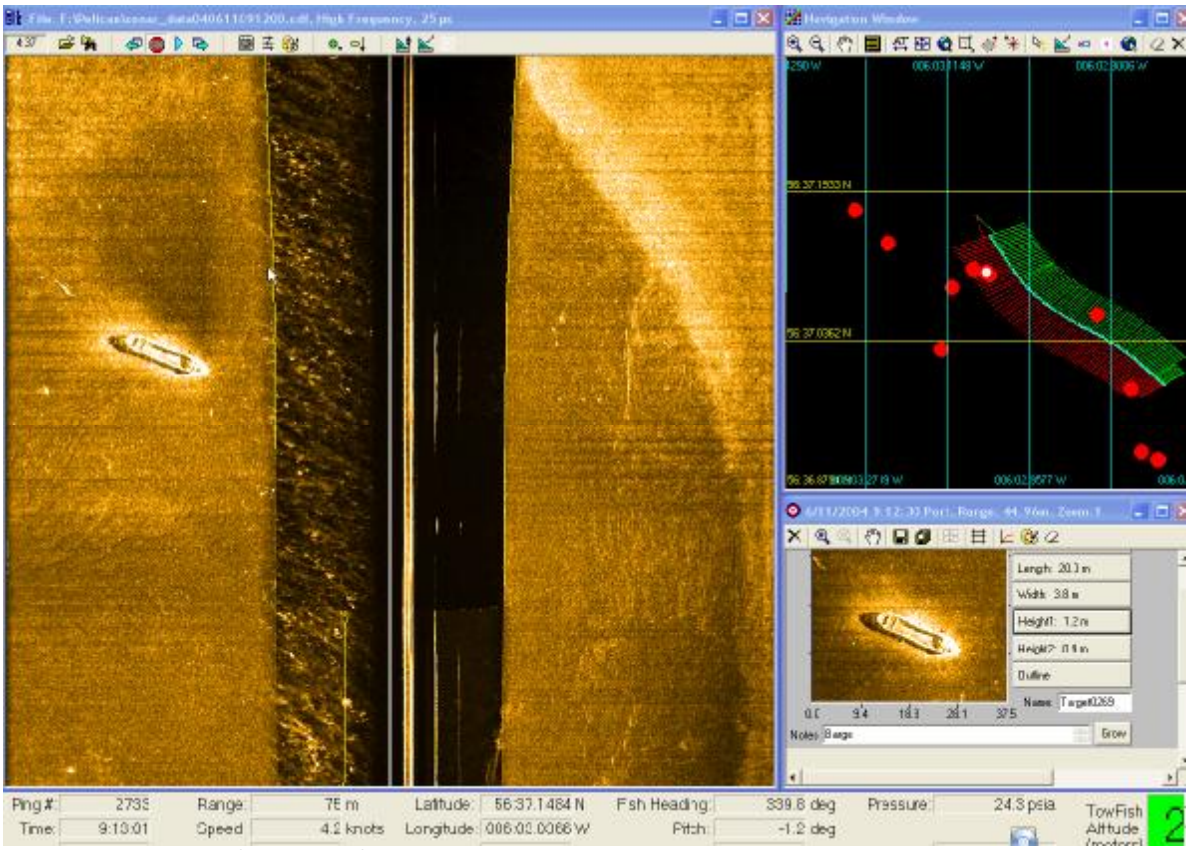


Fig.58: Sidescan trace of an unidentified site in Tobermory Bay

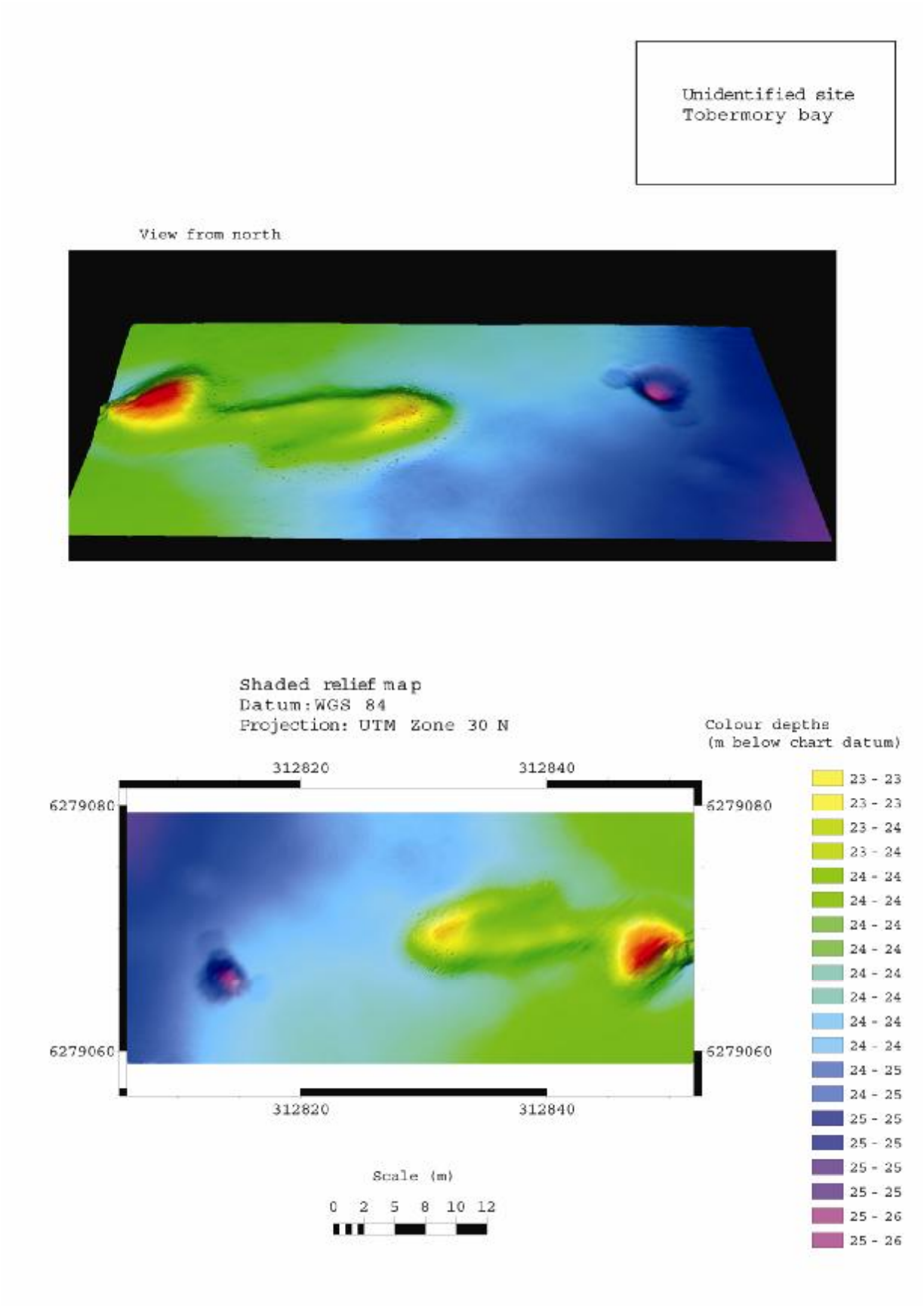


Fig.59: multibeam map of the unidentified site in Tobermory Bay

Strathbeg

Site Location and Environment

Documentary sources (NMRS: NM55SW 8004) indicate the wreck of the small fishing vessel *Strathbeg* as being located close to the islet of *Cnap a Chailbhe* at N56' 36.7, W6' 1.8 (OS NGR: c. NM 527 539). The site was charted by side scan sonar at location N56' 36.7450 W6' 2.1064 (WGS84). A listing on Admiralty Chart 2390 suggests that this vessel's masts were exposed at low water in 1976 and possibly at the charts amendment date in 1991.

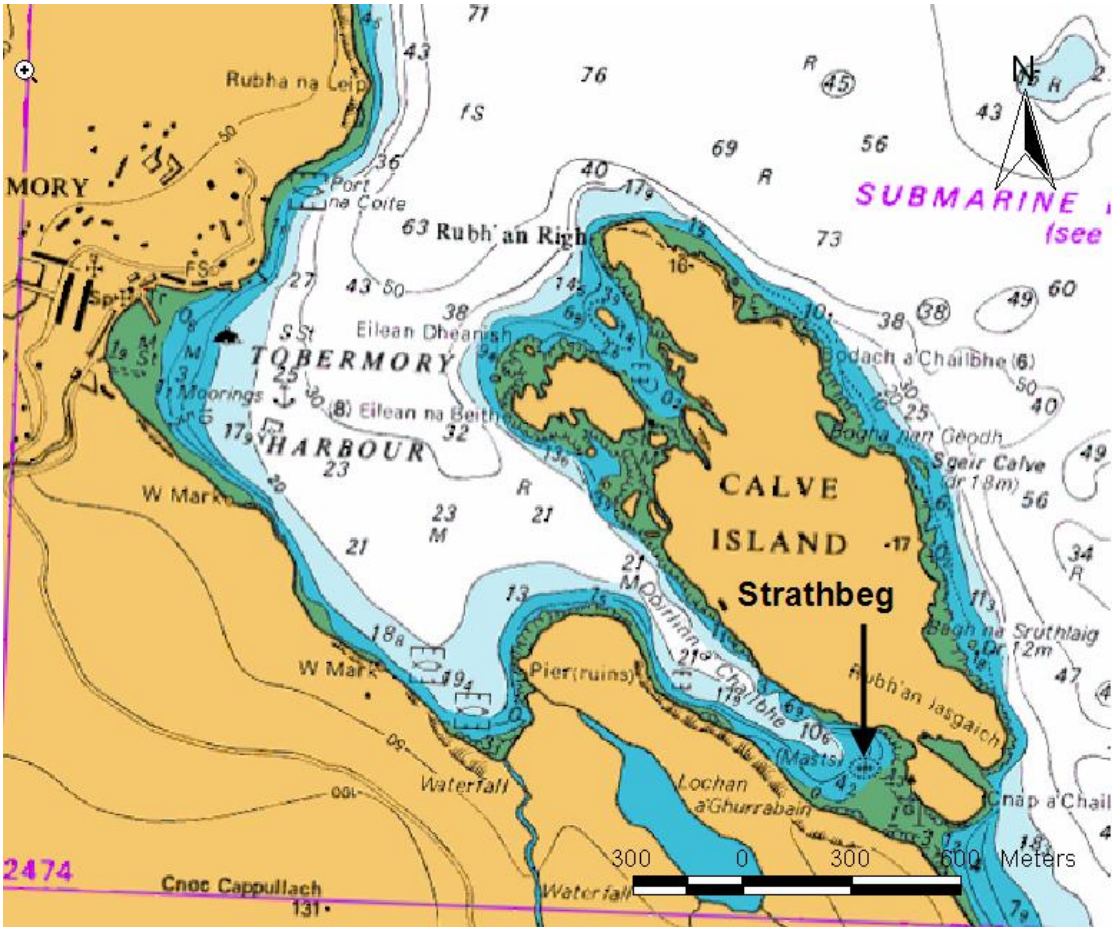


Fig.60: Location map of the *Strathbeg*. This basemap is © British Crown and SeaZone Solutions Ltd, 2004, with all rights reserved and reproduced for this project under data licence No. 112004.005

Survey and Research History

The NMRS includes a brief description of the location of this wreck but no details on the site, although it is described as a fishing vessel, lost at its moorings on 3rd May 1984 by Whittaker (1998, 293).

Fieldwork

The site was surveyed by sidescan and multibeam. However, no processing of the multibeam images on this site has been undertaken, and only the sidescan results are presented in this report.

Results

The sidescan shows a vessel listing to starboard with its hull orientated SE/NW. The vessel appears to be approx 21.7m in length, 5.2m breadth, and a substantial hull structure protrudes c. 3.1m above the seabed. This signature is consistent with a small fishing vessel. The hull has a lightly constructed deckhouse forward and open holds aft possibly containing machinery. Light framework exposed around the stern and holds. There is no sign of the *Strathbeg*'s masts still being in place and some evidence may be seen of debris off the stern possibly relating to a stern anchor or similar.

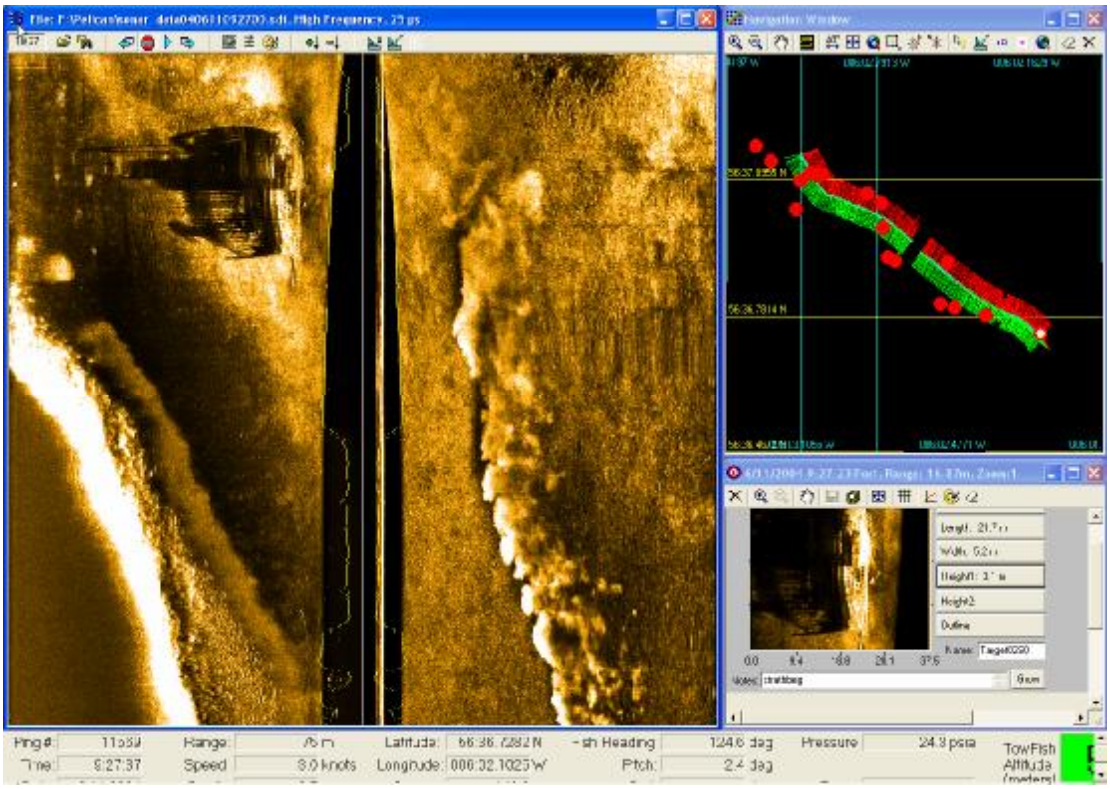


Fig.61: sidescan image of the *Strathbeg*.

Fieldwork results - area surveys

The programme of five days of survey completed area surveys covering an area totalling 25,703, 738 sq m (25.704 sq km). These were plotted at 0.5m point resolution while and an overall swathe bathymetry chart of the covered area was plotted at 10m point resolution.

During pre project planning, documentary research has identified several target areas perceived to be of high archaeological potential. Some were thought so because they appear frequently in documentary records relating to shipping losses; others may be important because they fulfilled a special function: for instance Scallastle Bay is denoted as an Admiralty Anchorage area in Admiralty Charts. In the case of Ardtornish Bay, the project aimed to clarify the archaeological potential of the bay, probably used in connection with Ardtornish castle (NMRS: NM64SE 1) since the late 13th century.

The area surveys identified approximately 100 anomalies that require further analysis and subsequent evaluation. However, much of the analysis of the sidescan data for this aspect of the project remains to be completed, and with some exceptions, the results that follow are largely confined to a display of the multibeam maps, along with some initial observations relating to selected areas.

Northern Sectors 1,2, and 3

Surveys of Sectors 1,2, and 3 included coverage of reef systems north north west of Tobermory Harbour (Northern area sector 1 and, see site survey of unidentified site that may be the *Macduff)*, the seabed surrounding Calve Island (Northern area sector 2), and some of the glacial trough and ledges in the vicinity of the *Hispania* (Northern area sector 3).

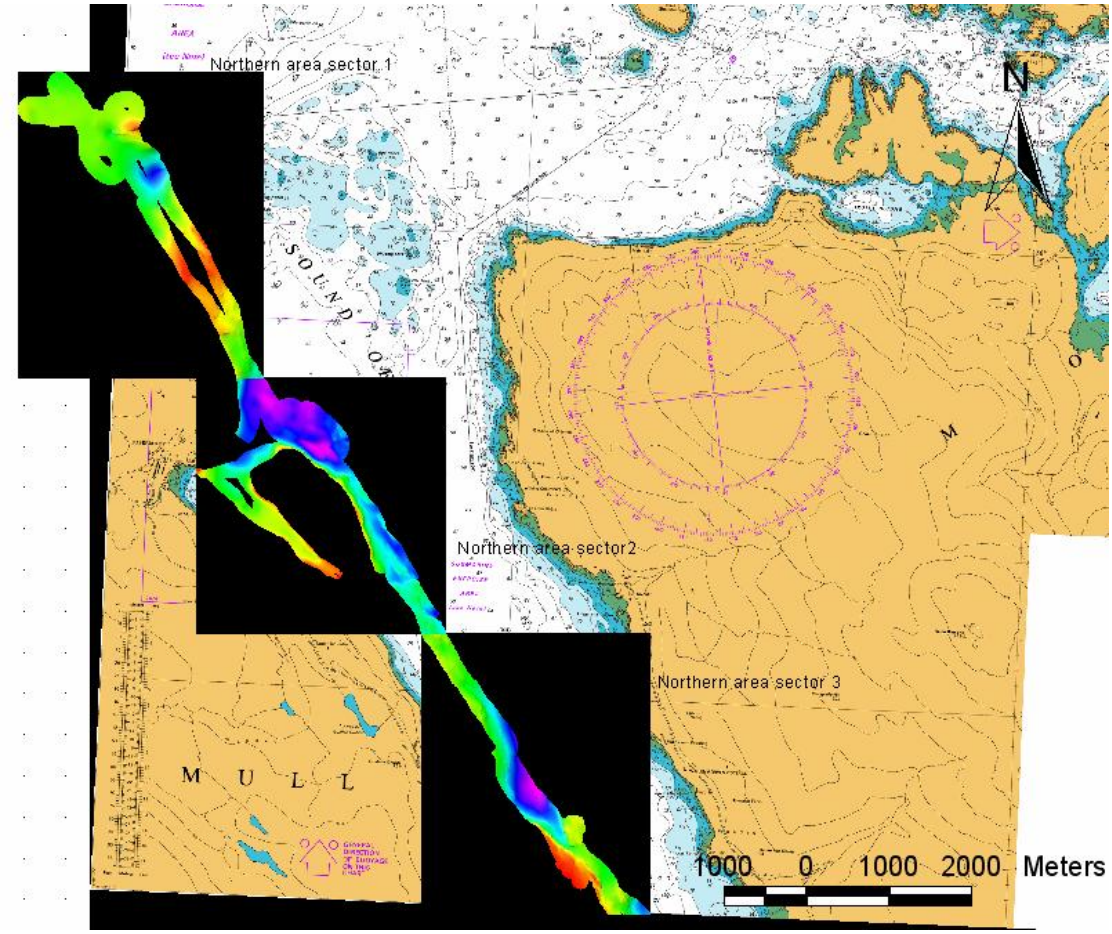


Fig.62: Location map of northern area sectors 1,2, and 4. This basemap is © British Crown and SeaZone Solutions Ltd, 2004, with all rights reserved and reproduced for this project under data licence No. 112004.005

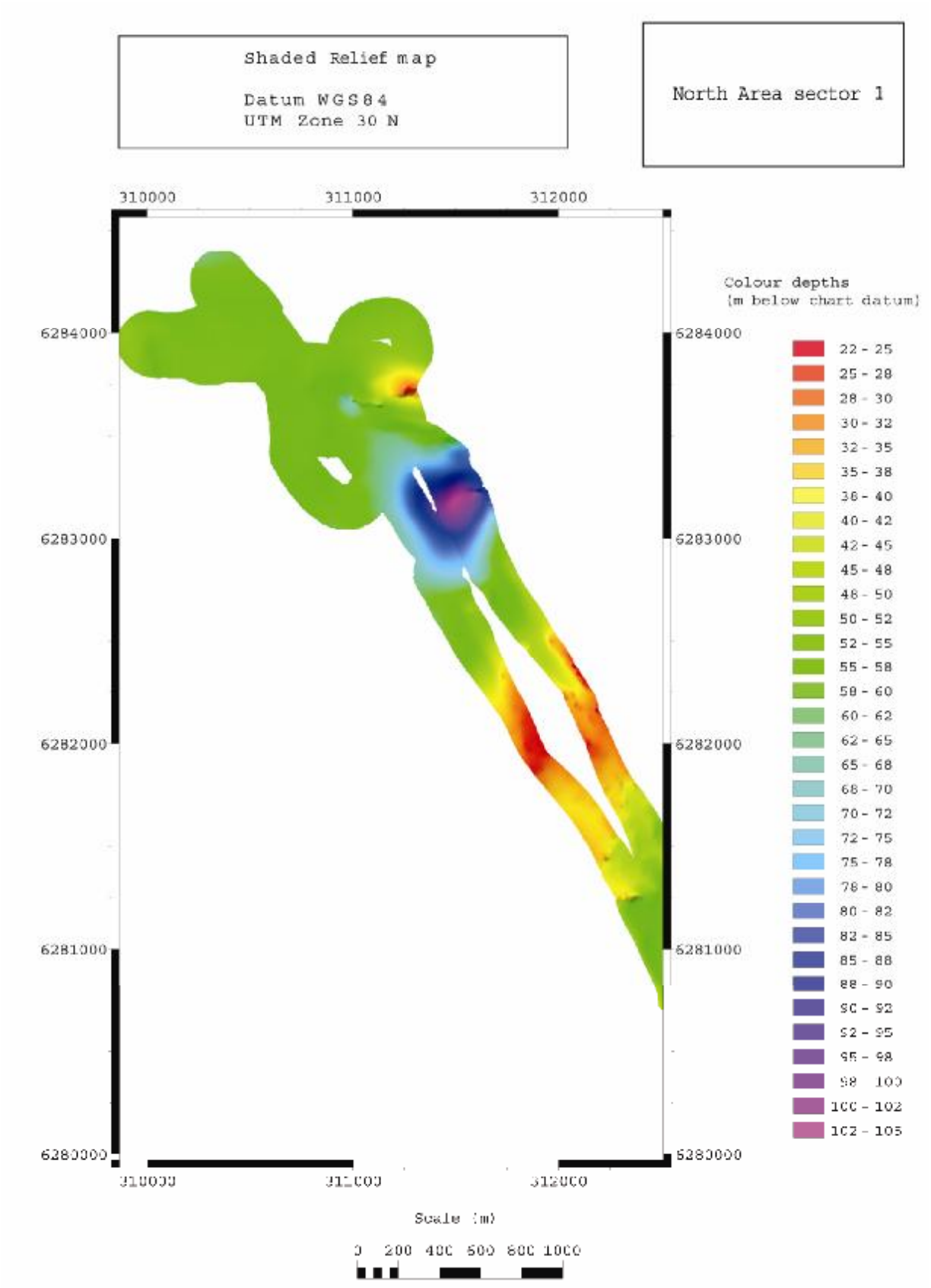


Fig.63: Multibeam map of Northern area sector 1.

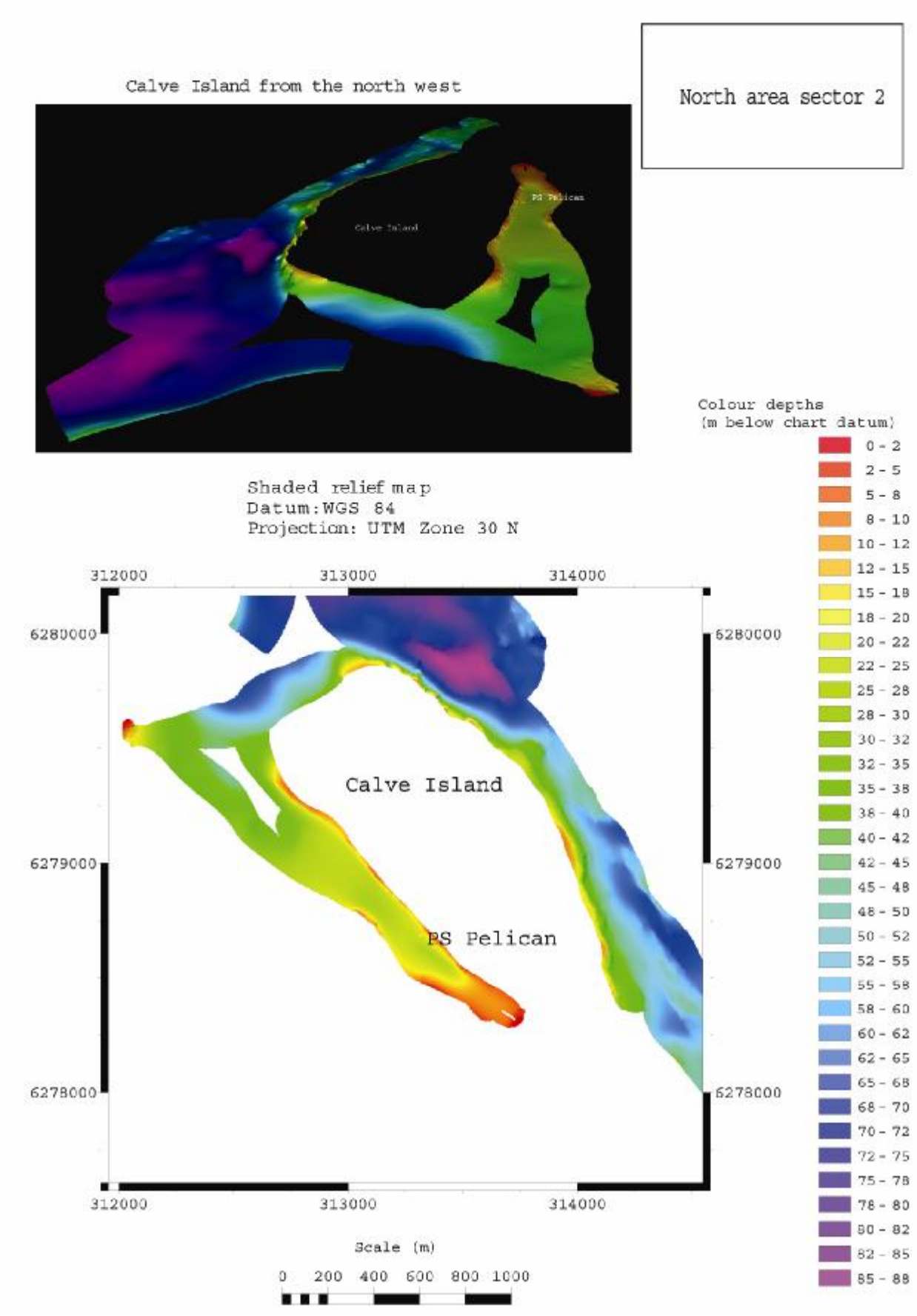


Fig.64: Multibeam map of Northern area sector 2.

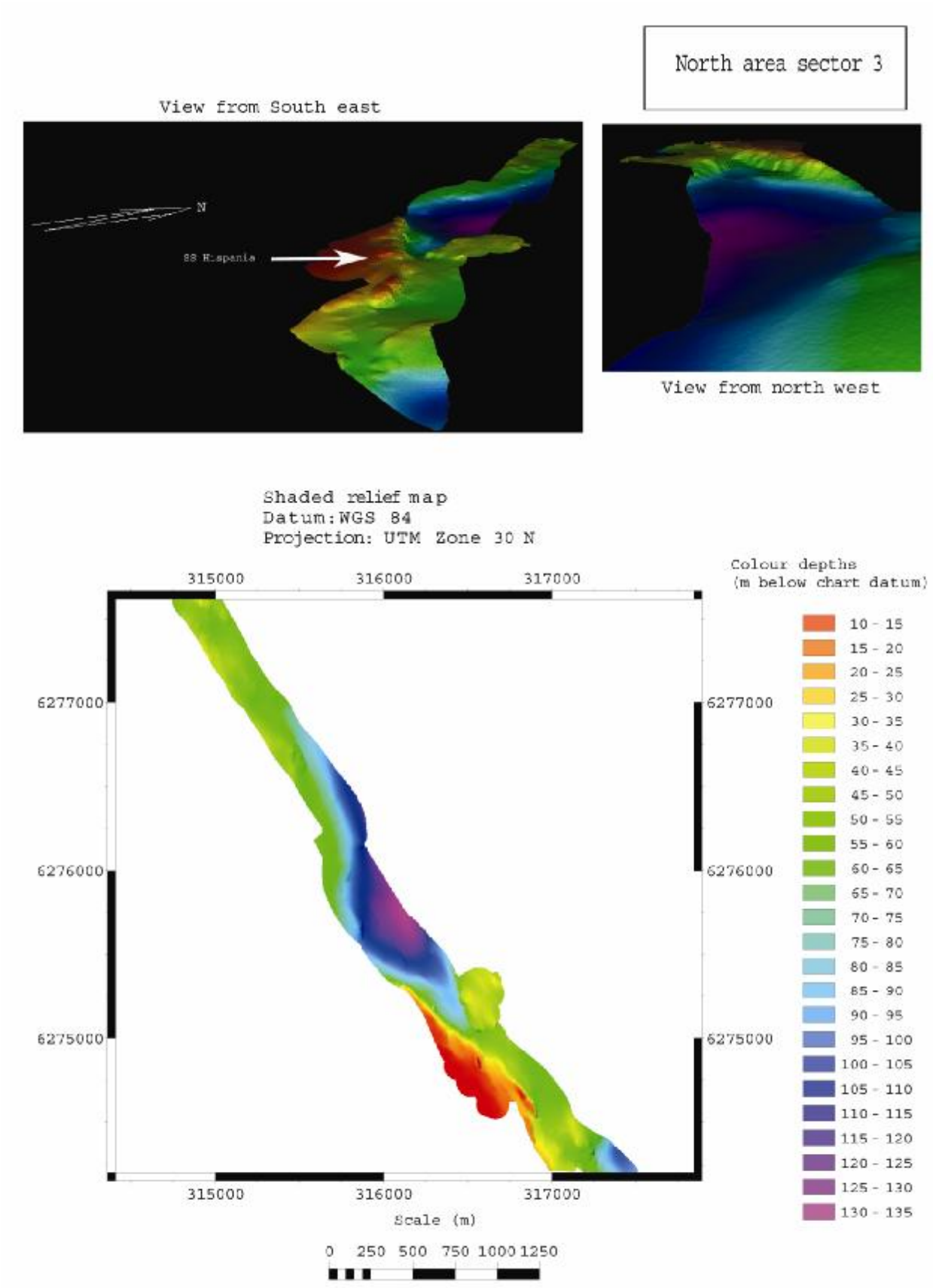


Fig.65: Multibeam map of Northern area sector 3.

Northern Sectors 4,5 and 6

Surveys of Sectors 4,5, and 6 included coverage of round the peninsula of Caisteal nan Con (Northern area sector 4) which has provided extensive sidescan data yet to be analysed, shelving seabed close to the wreck of the *SS Shuna* and the steep glacial trough north east of Dearg Sgeir (Northern Area Sector 5). Northern area sector 6 included the seabed shelf west of Ardness Point, and a transit towards Loch Aline.

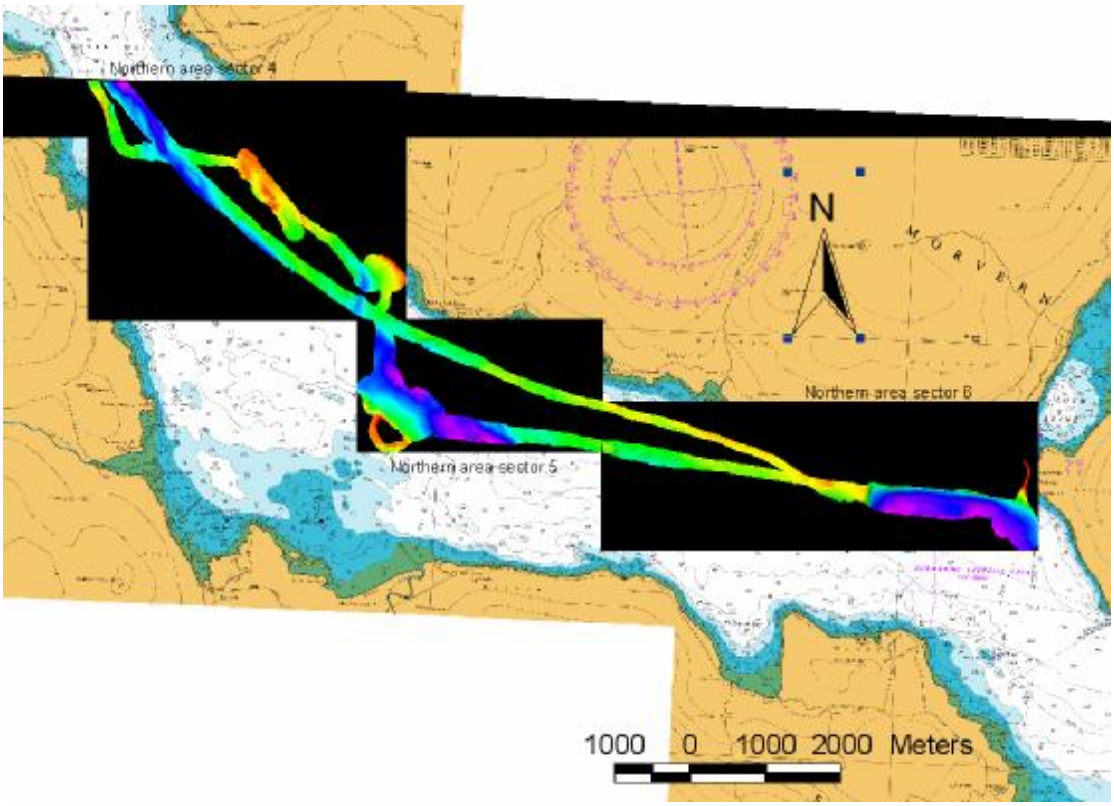


Fig.66: Location map of northern area sectors 4,5, and 6. This basemap is © British Crown and SeaZone Solutions Ltd, 2004, with all rights reserved and reproduced for this project under data licence No. 112004.005

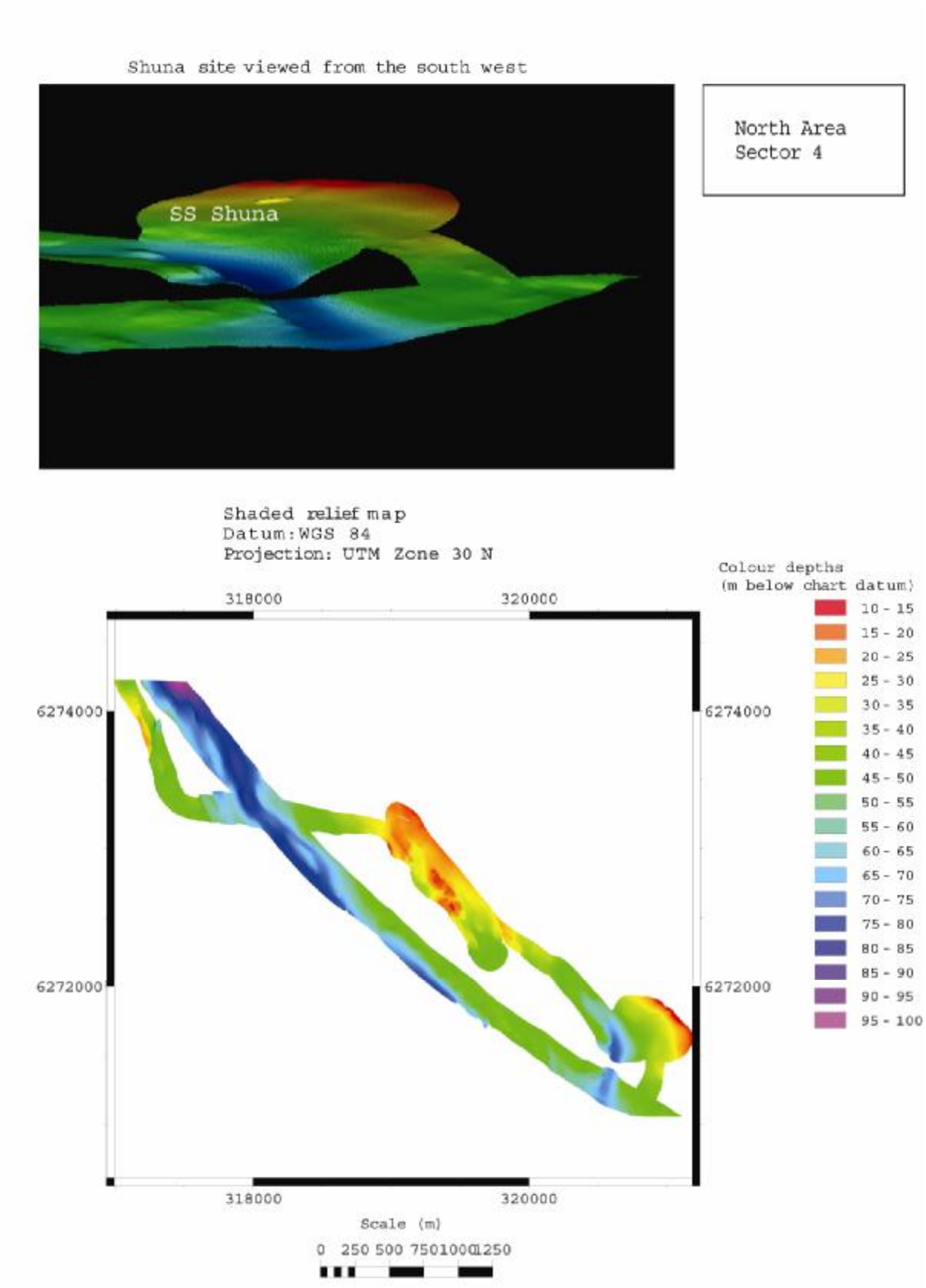


Fig.67: Multibeam map of Northern area sector 4.

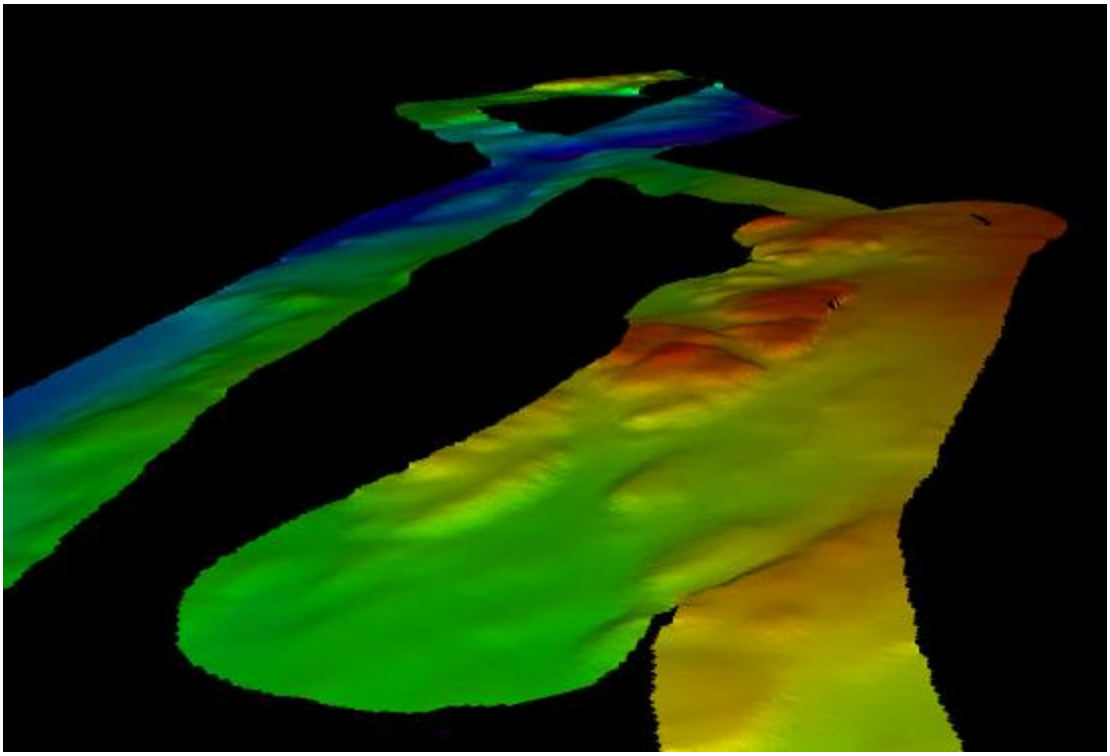


Fig.68: Multibeam image of the seabed around the peninsula of Caisteal nan Con castle, Killundine, viewed from the south east.

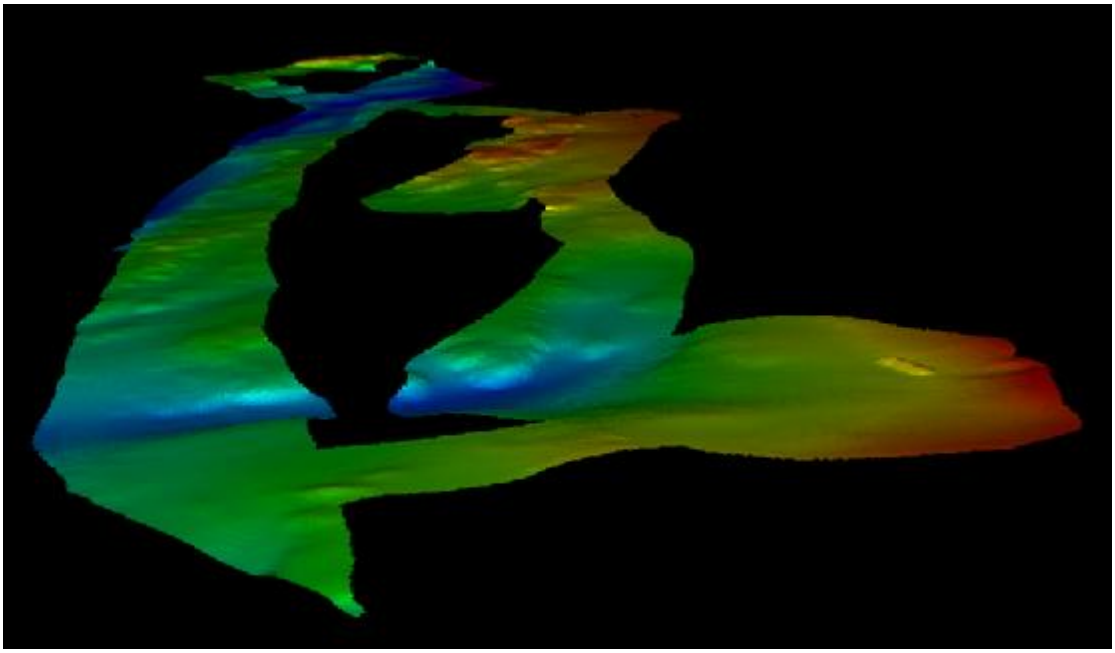


Fig. 69: View from the south east of the bay north west of Rubh'Aird Seisg, and towards Caisteal nan Con. Note the wreck of the *SS Shuna* on the extreme right of this image.

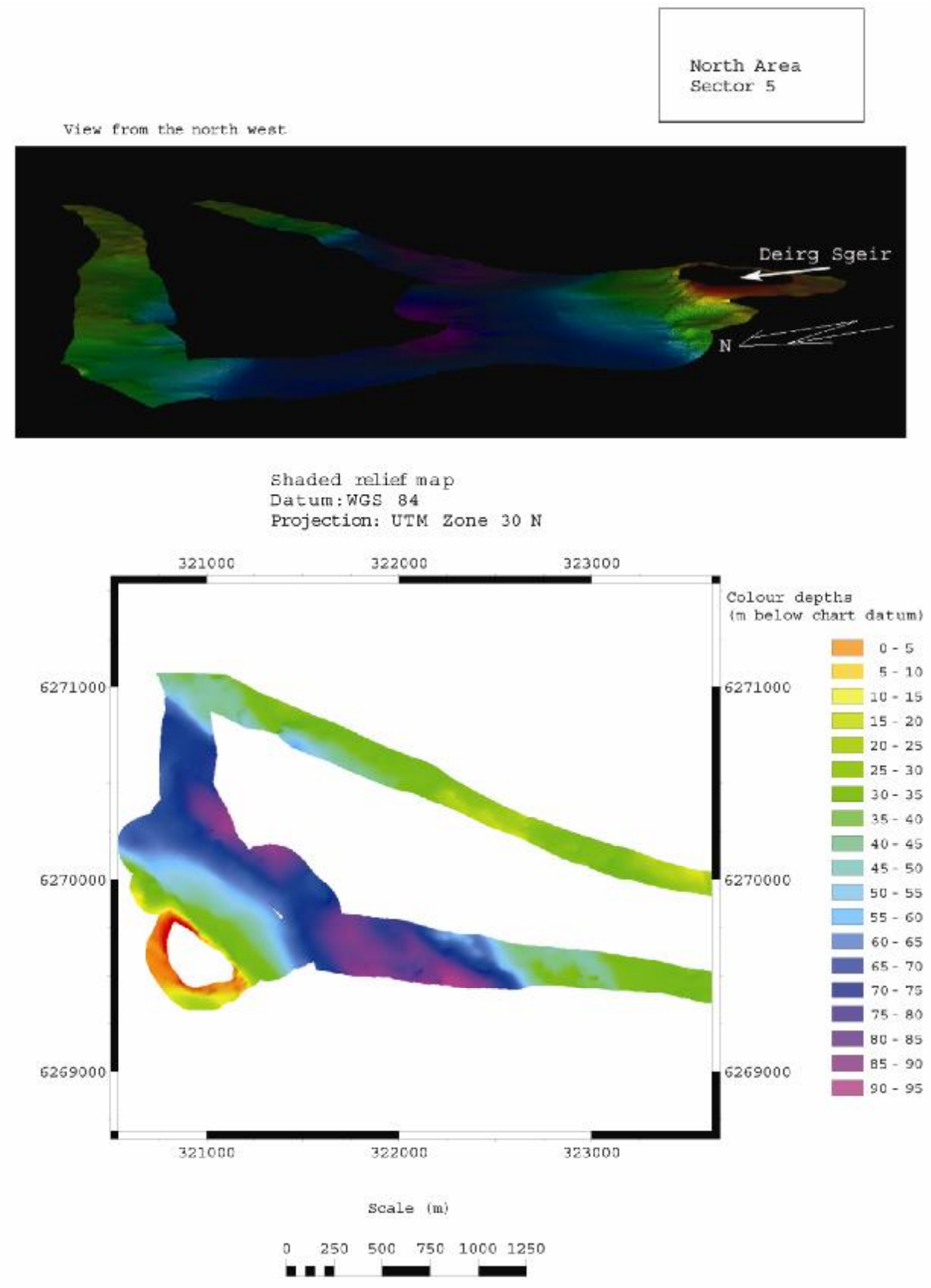


Fig.70: Multibeam map of Northern area sector 5.

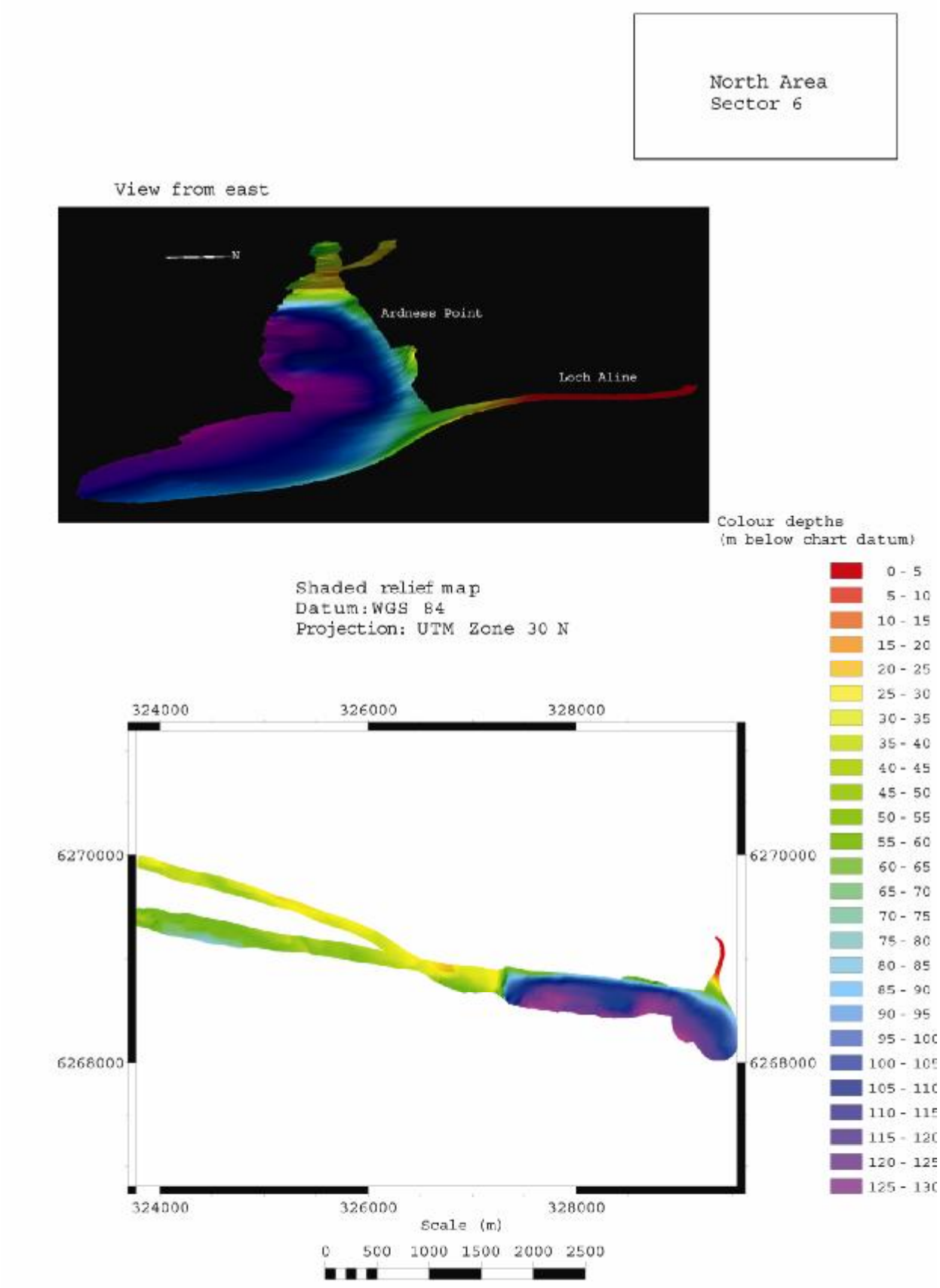


Fig.71: Multibeam map of Northern area sector 6.

John Preston, and Ardtornish Bay areas

Surveys of the John Preston area covered almost the entire width of the Sound of Mull from Ardness Point to an area east of Loch Aline. The gap in the John Preston area coverage is due to errors during processing.

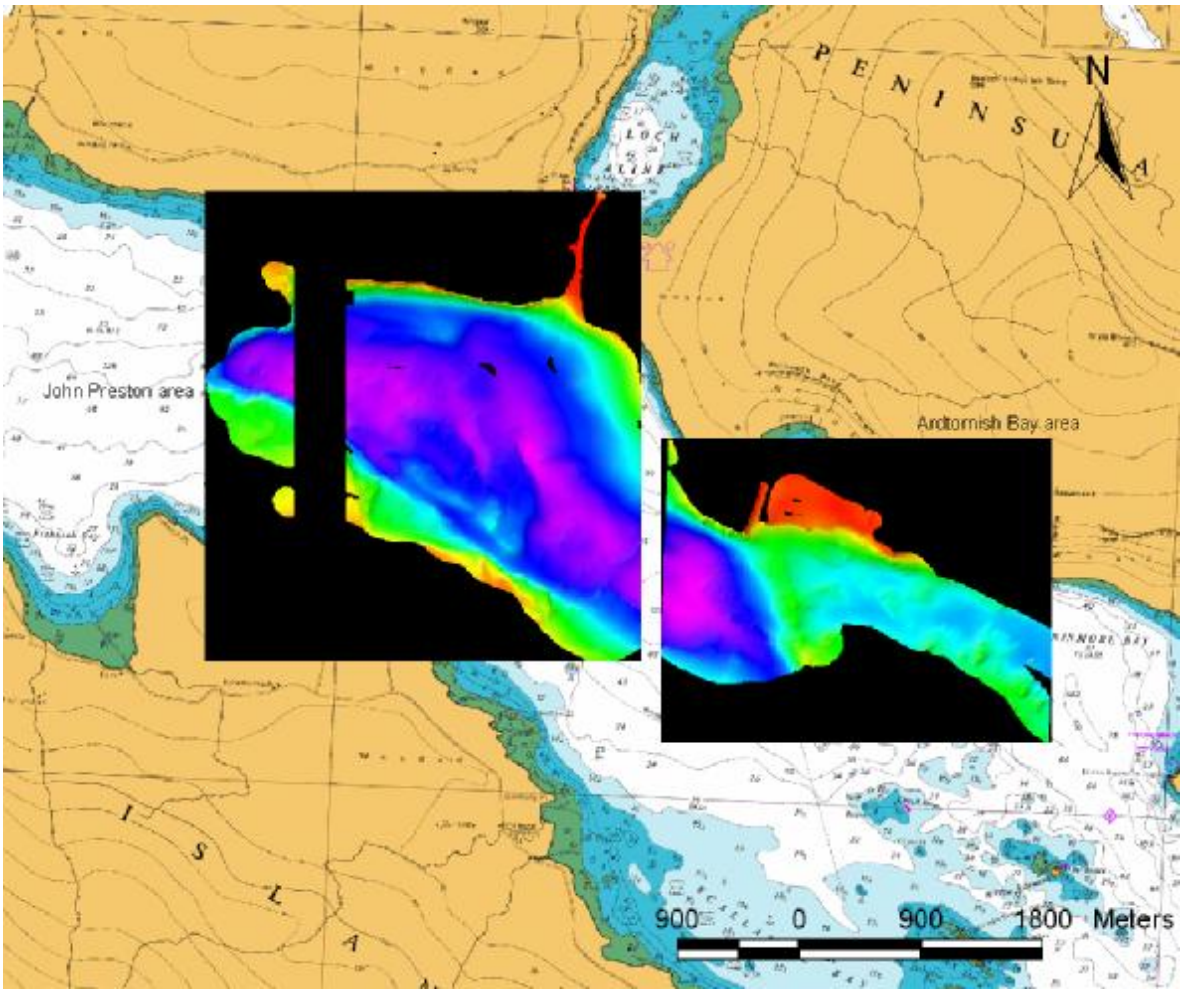


Fig.72: Location map of John Preston and Ardtornish Bay area surveys. This basemap is © British Crown and SeaZone Solutions Ltd, 2004, with all rights reserved and reproduced for this project under data licence No. 112004.005

The John Preston area survey has succeeded in recording the wreck of the 19th century slate schooner *John Preston (*recorded by SOMAP divers between 1994-9 see NMRS: NM64SE 8005). The site does not show up on the multibeam data at 0.5m point resolution but the site was charted by multibeam at N56' 31.99 W5' 48.20 (WGS84). The keelson and slate mound are visible on the sidescan trace; many other features such as iron pump pipes, anchor winches, ship's oven are not. The sidescan does illustrate the context of the *John Preston* on a narrow ledge midway down a steep cliff but there is nothing on the trace to indicate the presence of significant debris features at the foot of this cliff.

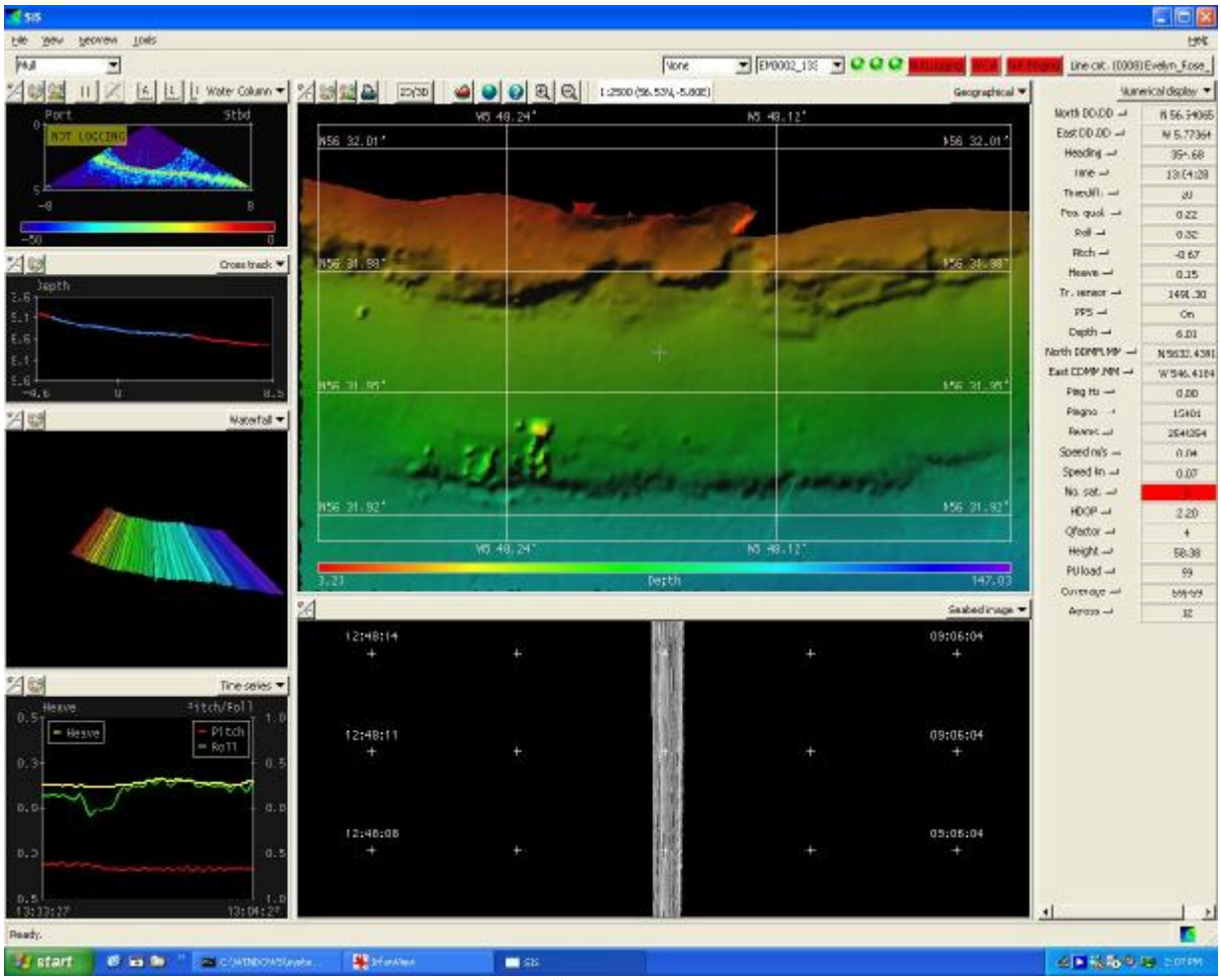


Fig.73: Sidescan screen capture of the cliffs on the *John Preston* site.

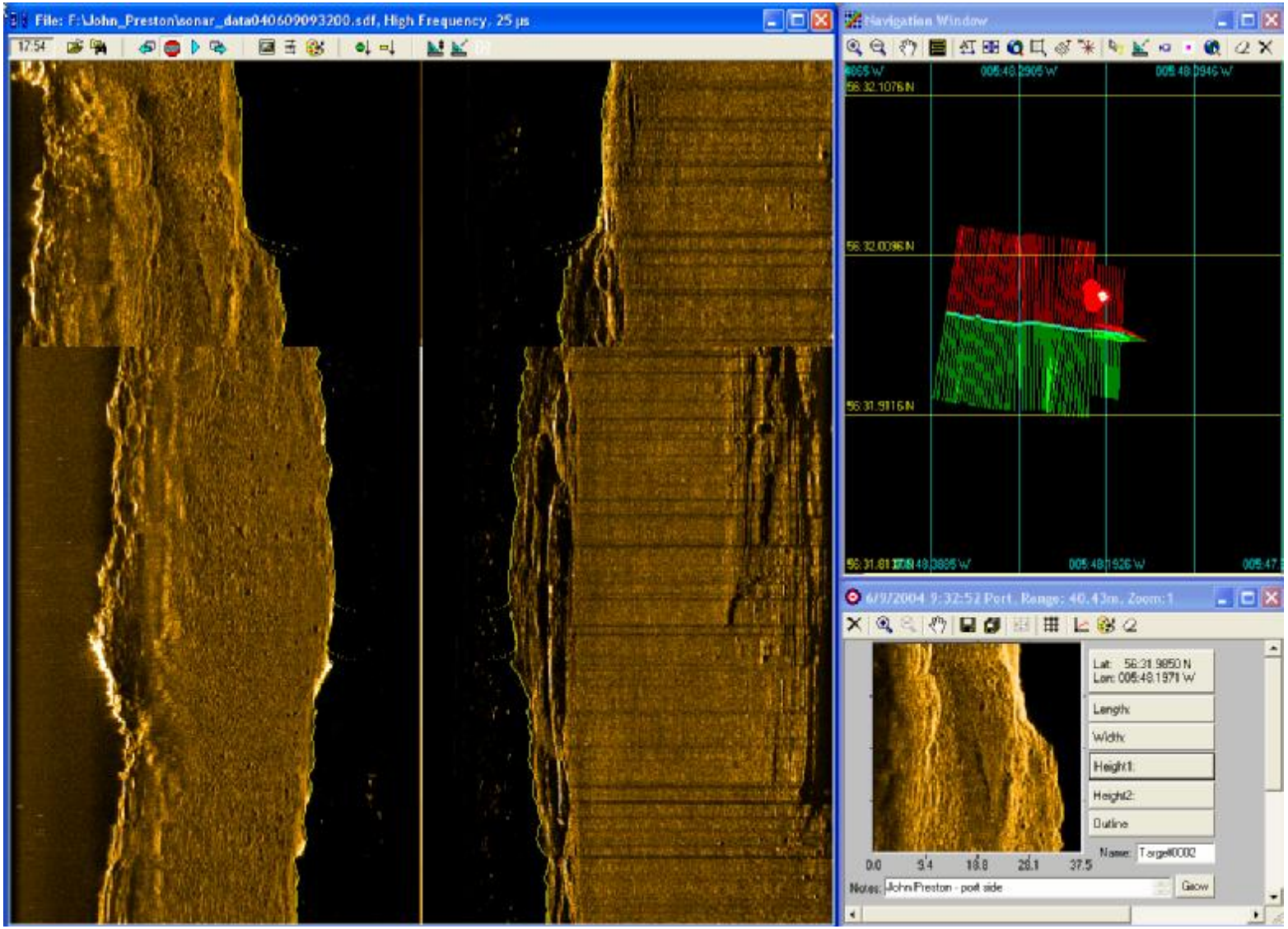


Fig.74: sidescan image of the *John Preston* site. Note the close up window with keelson visible

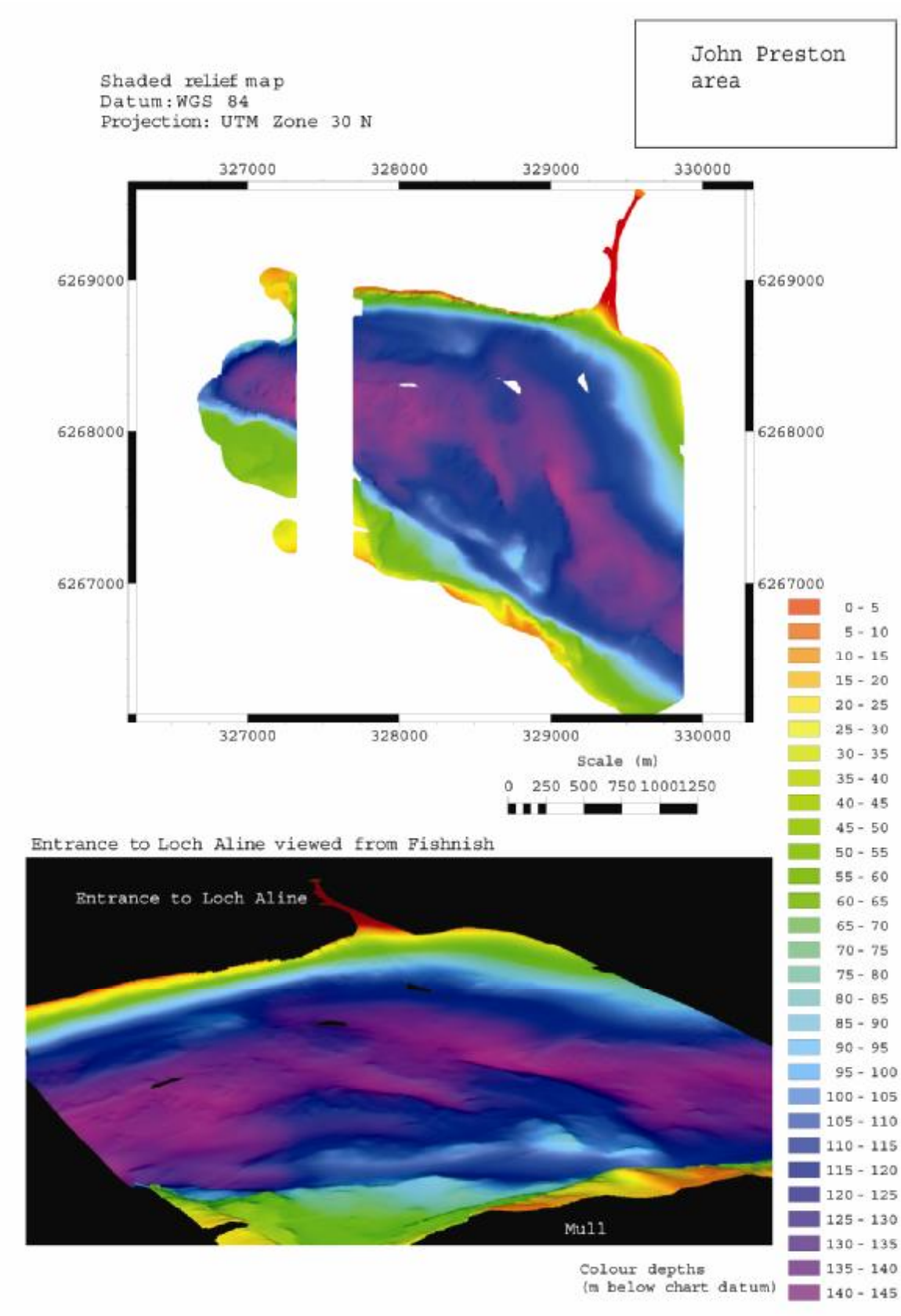


Fig.75: Multibeam map of John Preston area survey

The Ardtornish Bay area survey covered Ardtornish Bay and the reef systems offshore. Some preliminary analysis of the Ardtornish Bay dataset has been undertaken. The seabed in Ardtornish Bay appears to be fairly flat gravely sand, with bedrock outcrops. Evidence for dredging activity in the bay can be found on the sidescan trace, and several anomalies have been identified but it is likely that these represent isolated objects of little archaeological significance. Further remote sensing of the buried seabed layers using gradiometry or a sub-bottom profiling system would be required to identify the presence of buried archaeology of potential significance.

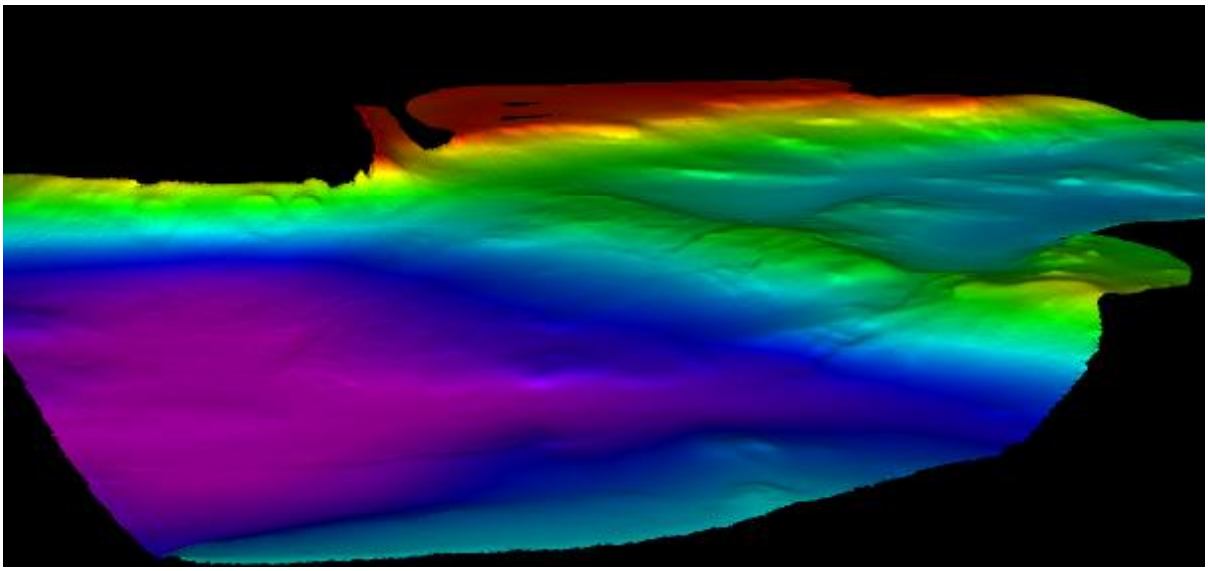


Fig.76: 3D image looking from Mull towards Ardtornish Point. Ardtornish Bay can be seen coloured red.

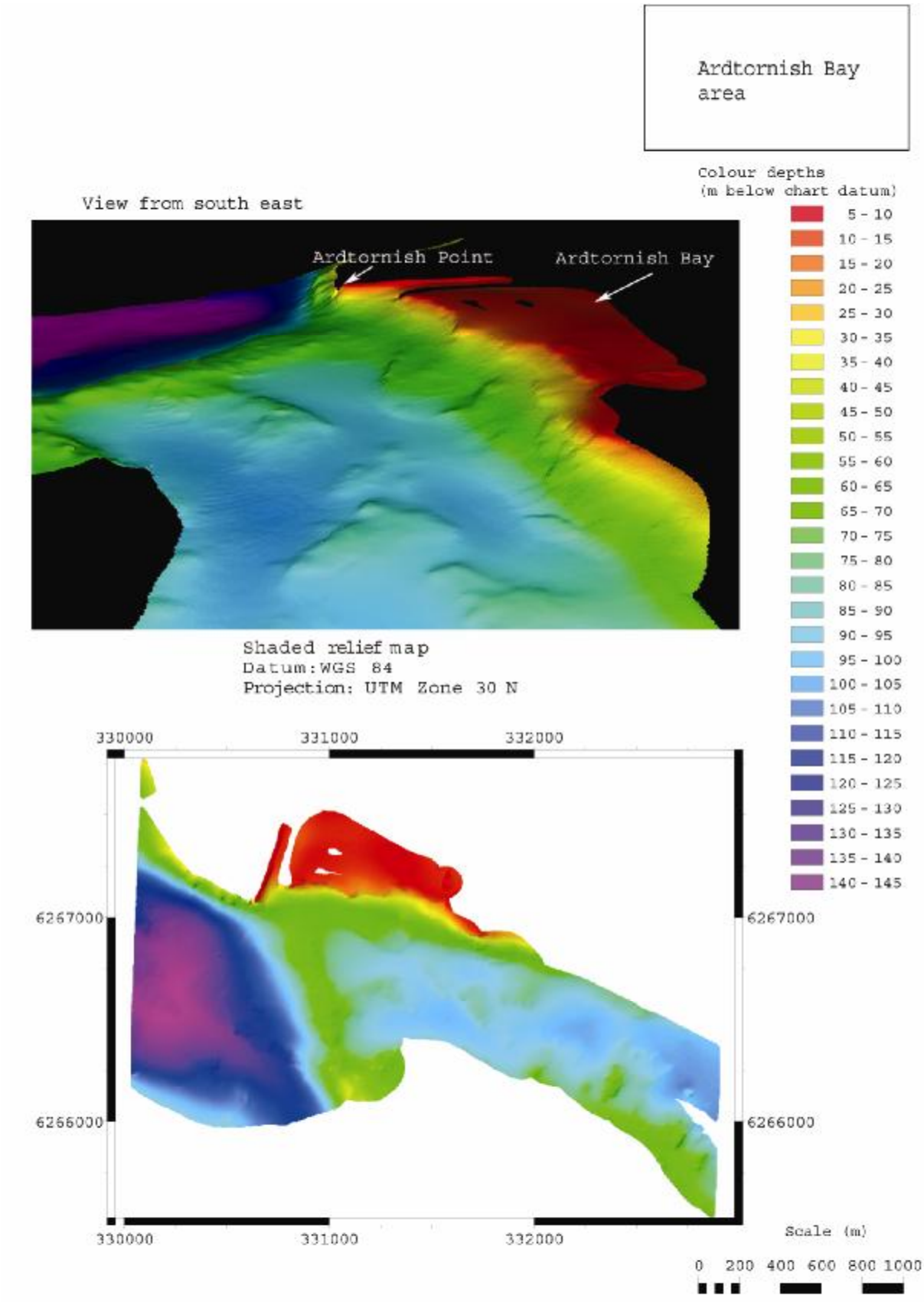


Fig.76: Multibeam map of Ardtornish Bay area

Scallastle Bay, Buitenzorg, Thesis areas.

Scallastle Bay is designated as an anchorage on Admiralty Charts and ships still anchor there during bad weather. The NMRS lists 13 wrecking incidents within the bay but only three sites are known to SOMAP. The survey of Scallastle Bay aimed to record an area surrounding the site of a collection of cast iron cannons recorded by SOMAP divers during 1995-7 (see NMRS: NM63NE 8005). The survey also aimed to record the seabed around a large pile of coal possibly from the wreck of the *Jane Shearer* (NMRS: NM63NE 8004) close to the cannon site.

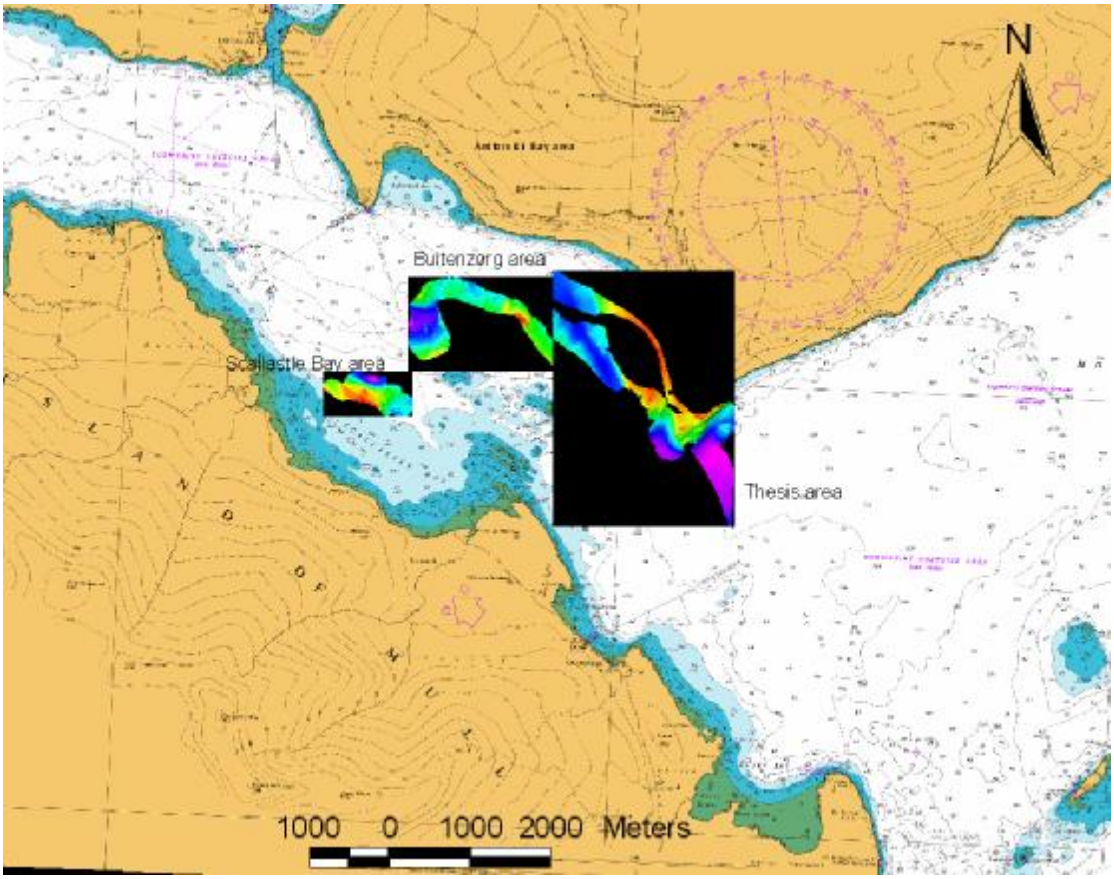


Fig.77: Location map of Scallastle Bay, Buitenzorg and Thesis area surveys. This basemap is © British Crown and SeaZone Solutions Ltd, 2004, with all rights reserved and reproduced for this project under data licence No. 112004.005

The cannon site could not be identified on the multibeam dataset at 0.5m point resolution. However, the site was identified by sidescan and charted at N56' 29.7869 W05' 44.8989. It is possible to identify three of the guns, including the two that are sticking breech end into the seabed. It is not possible to identify the others but they were partially or wholly buried during the last monitoring visit in 2002. Evidence for heavy nephrops trawl or scallop dredging activity is visible within 15m of this site and trawl activity may help explain the strange orientation of two of the guns on site. The sidescan has also identified numerous anomalies that require checking by divers. Possible sites of interest include a possible anchor 150m from the cannon site, charted at position N56' 29.6968, W5' 44.9203, at a bearing of 195 degrees from it.

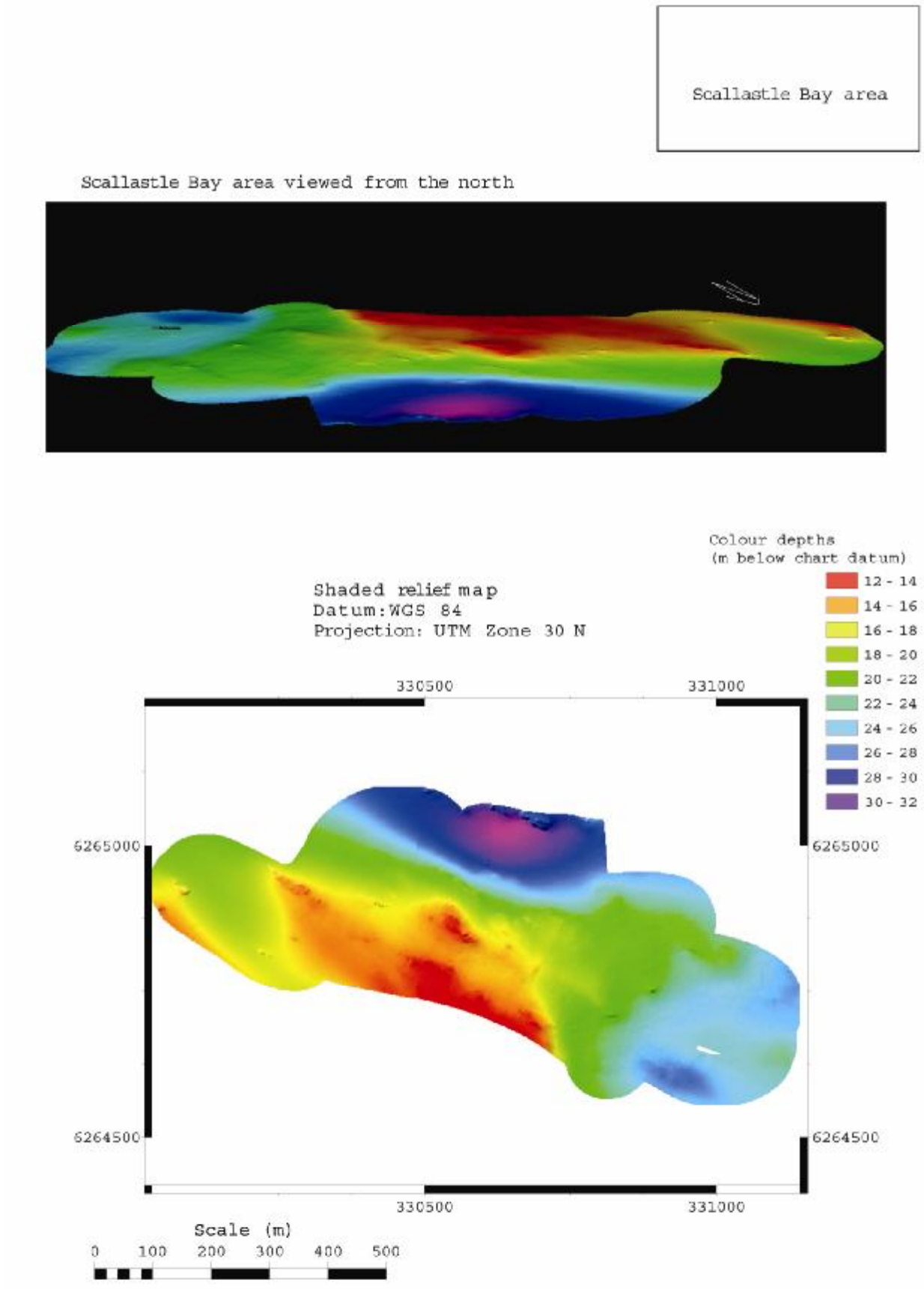


Fig.78: Multibeam map of Scallastle Bay area

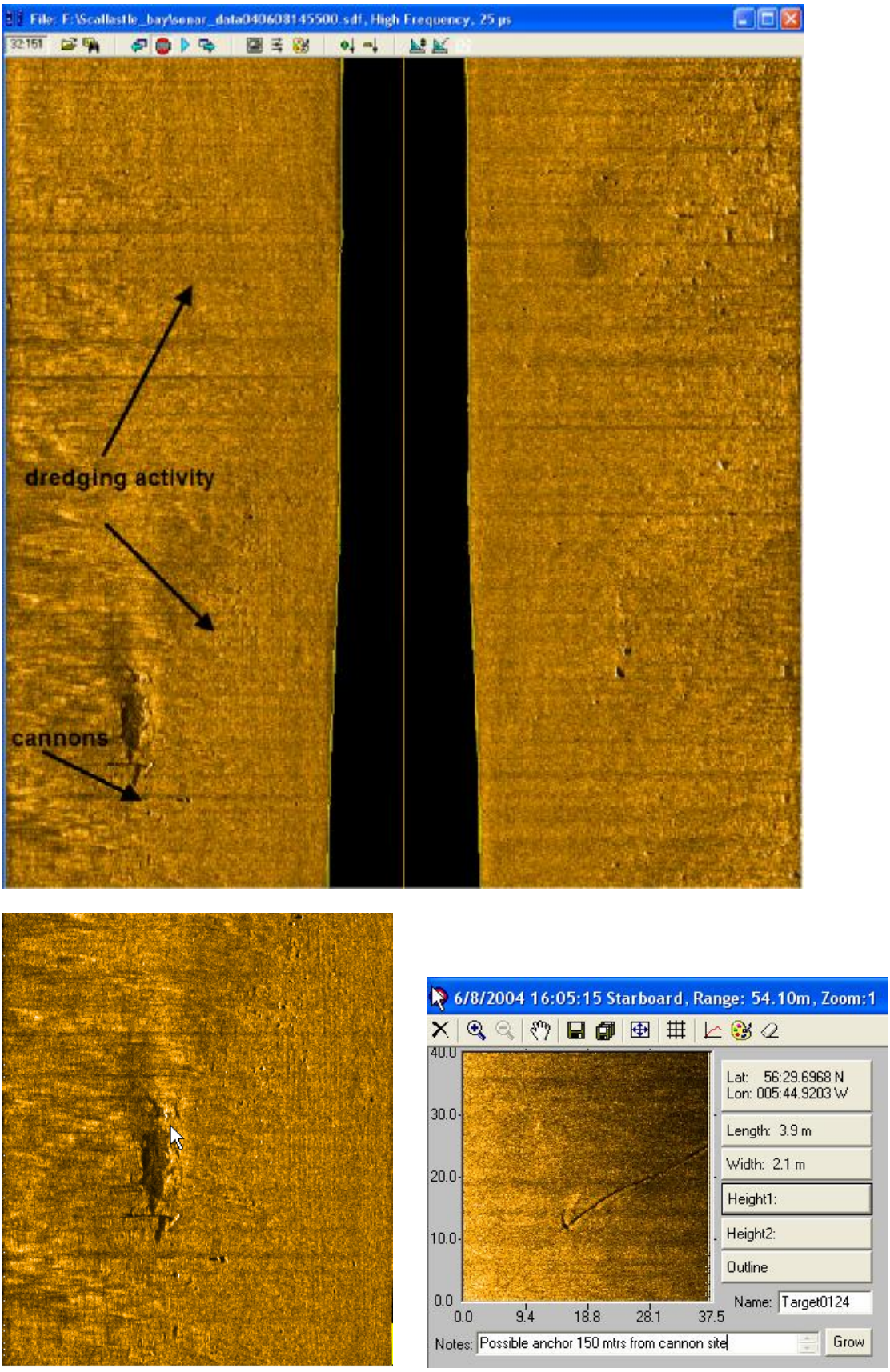


Fig.79: Sidescan images of cannon site and possible anomalies nearby (see inset target).

The Buitenzorg area survey covered a sector of seabed surrounding the wreck of the SS Buitenzorg, with the aim of attempting to identify any debris from the wreck or any other sites in the vicinity. Only preliminary analysis of the sidescan dataset has been undertaken and this confirms that the debris field surrounding the wreck if the Buitenzorg is close to the ship. No major anomalies were identified away from the vessel but a number of smaller items may require groundtruthing by divers.

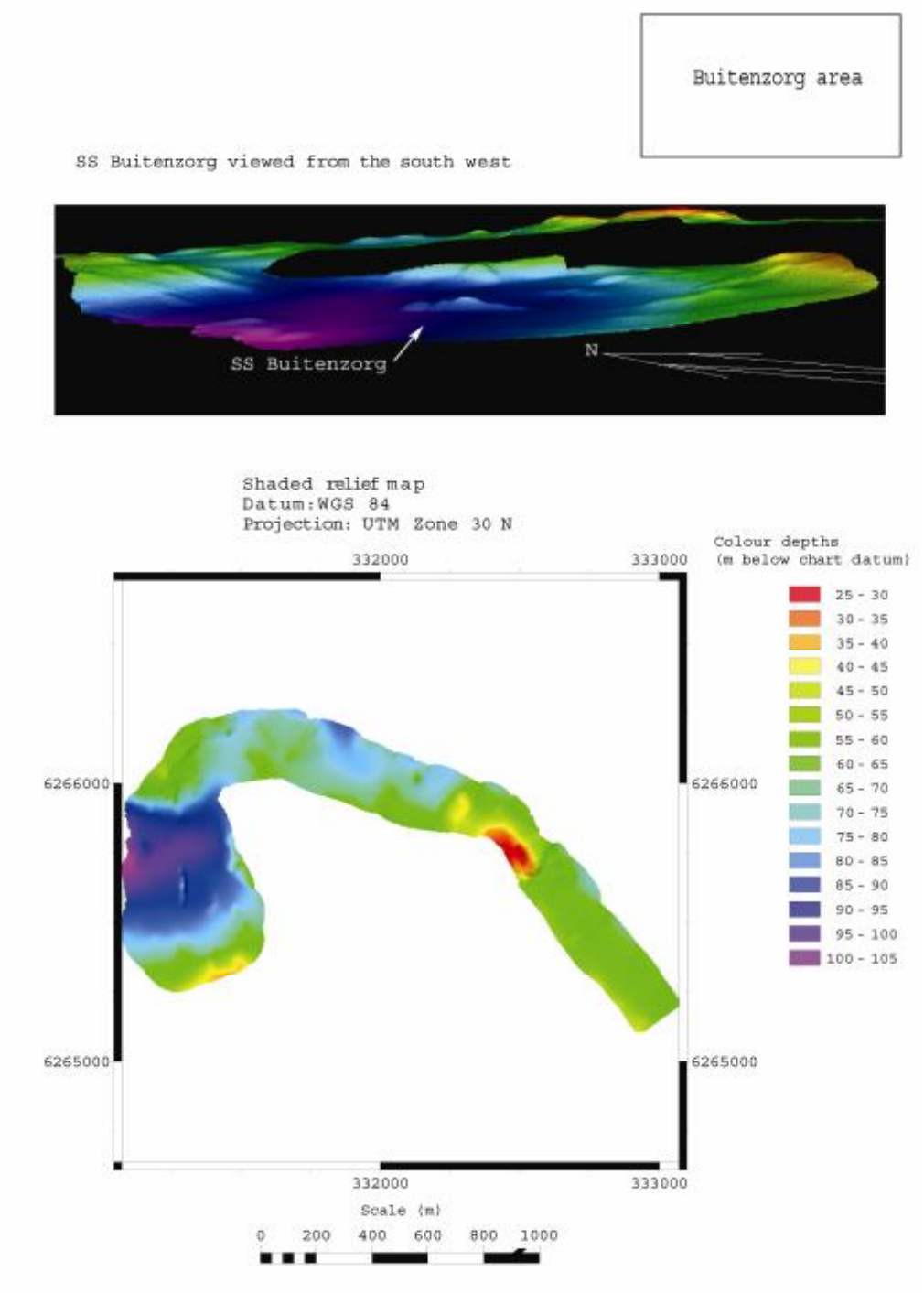


Fig.80: multibeam map of the Buitenzorg area survey.

The Thesis area survey targeted the islands of Eilean Rubha an Ridire, and the small channel between that island and Inninmore Point on the Morvern peninsula. The NMRS lists six wrecking incidents on the shores of Eilean Rubha an Ridire of which the 17th century frigate *HMS Dartmouth* (NMRS: NM74SW 8002) and the steamer *SS Ballista* (NMRS: NM74SW 8003) are the most significant. Neither the Dartmouth nor Ballista are visible on the multibeam trace at 0.5m point resolution. However, both sites are visible on the sidescan trace.

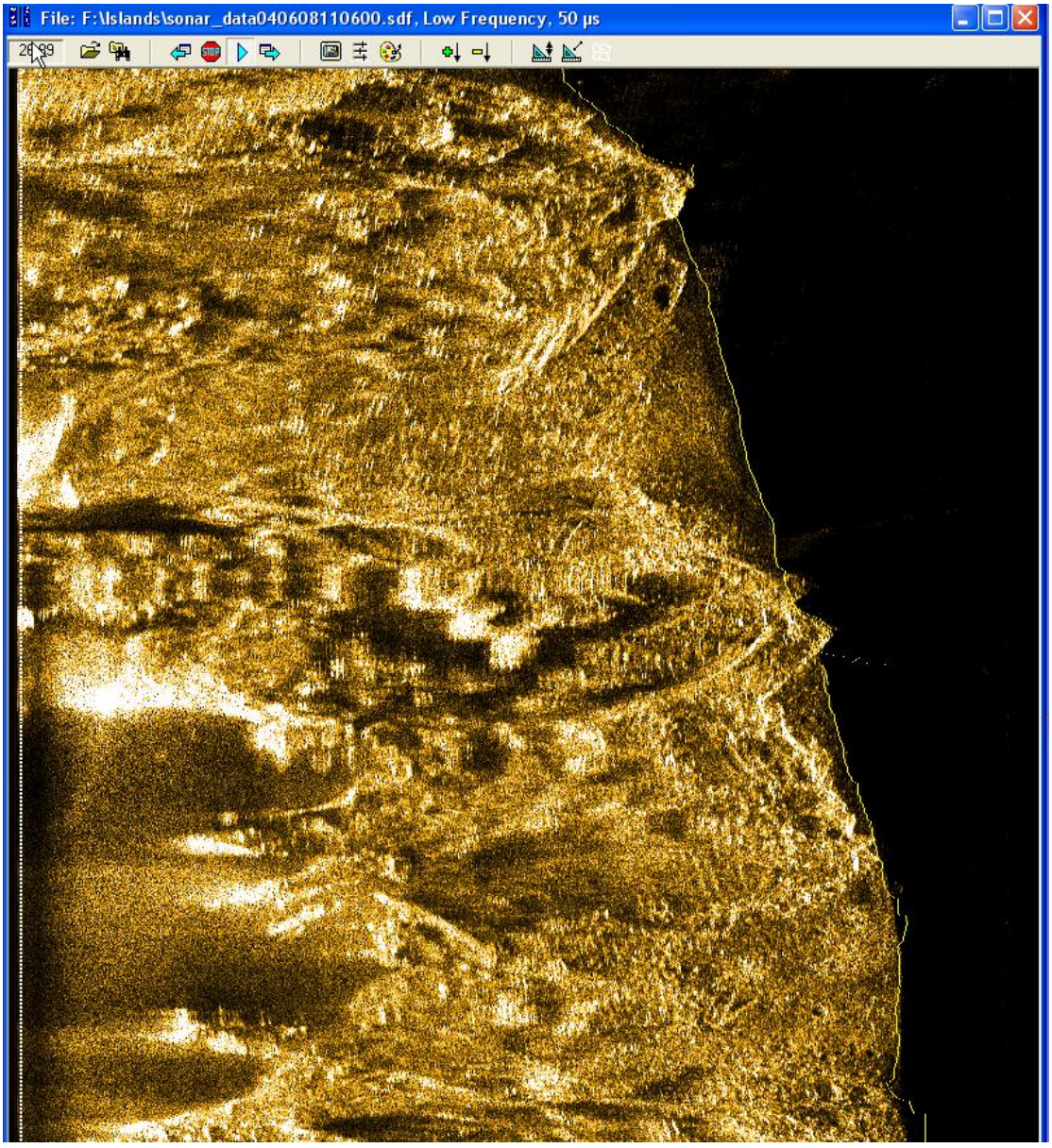


Fig.81: Sidescan survey of the *HMS Dartmouth* site. The ship's main anchor may be seen towards the bottom of the image which is blurred due to sea swell.

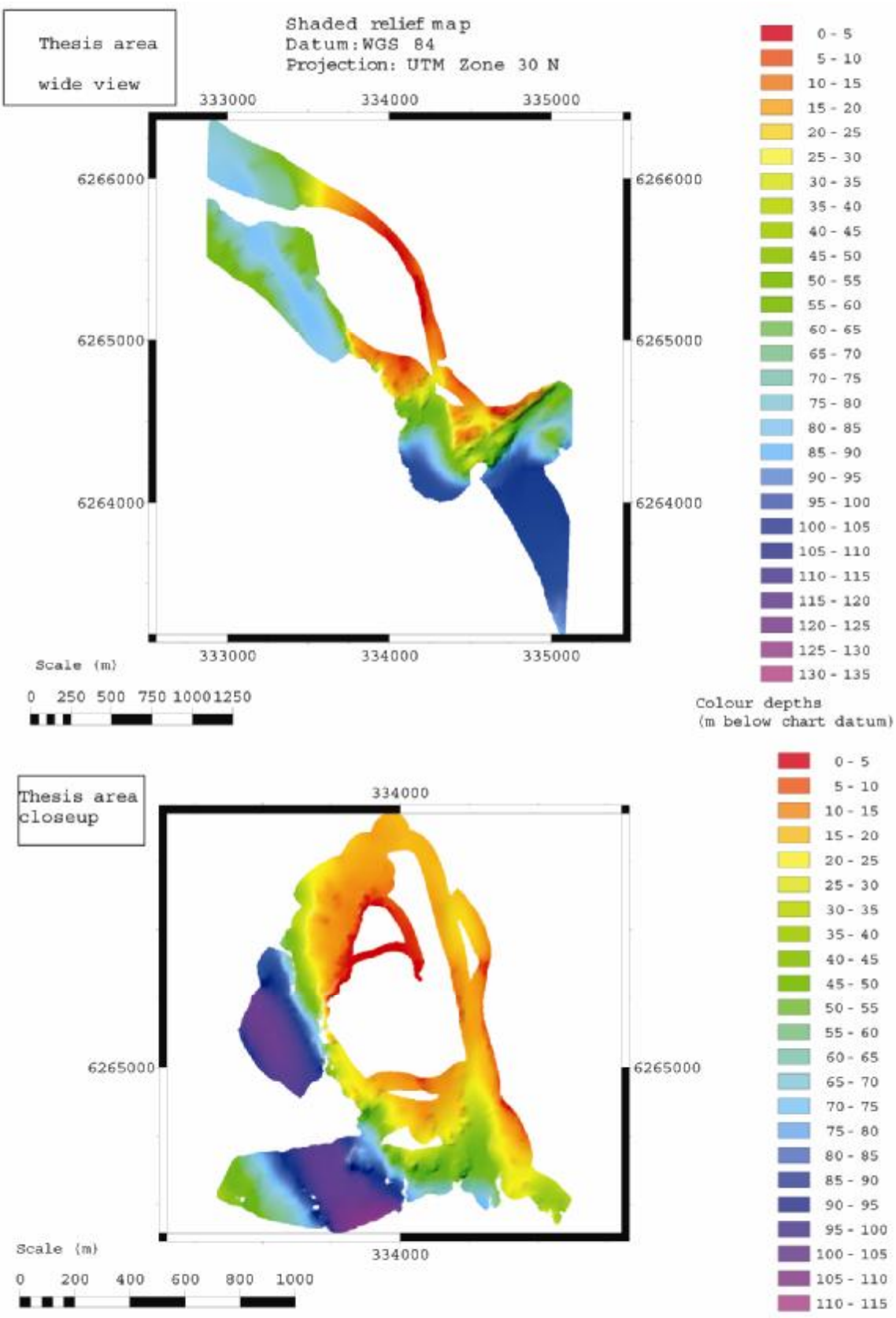


Fig.81: Multibeam maps of the Thesis area survey.

Survey name	Xmin	Xmax	Ymin	Ymax	Zmin	Zmax	Latitude min	Latitude max	Longitude min	Longitude max	Number of points
Sound_of_Mull_10m All	309862.9	336804.6	6259929.7	62844396.9	0.772774	147.077	56 26.4374	56 40. 3055	-06 6.978	-05 38.5373	247211
North Area											
North_Area1	309862.9	312829.9	6280698.4	6284396.9	24.6135	103.213	56 37. 5458	56 39. 5823	-06 6. 978	-06 6.978	222997
North_Area2	312015.1	315037.5	6277605.9	6280712	1.60723	86.3681	56 36. 1773	56 38. 238	-06 03.5386	-06 00.4877	228622
North_Area3	314742.9	317508.1	6274204.8	6277617.6	14.005	135.655	56 34. 3179	56 36. 2592	-06 16.05	-05 55.8155	149473
North_Area4	316990.5	321184.8	6271054.9	6274225.4	10.9478	97.3752	56 32. 5323	56 34. 4145	-05 58.4579	-05 54.3246	251202
North_Area5	320540.7	323796.2	6269318.3	6271069.3	4.48882	99.8347	56 32. 206	56 33. 5550	-05 55.1016	-05 51.555	210809
North_Area6	323769.8	329546.7	6268018.4	6269989.7	0.81574	126.84	56 31. 2486	56 32. 3581	-05 51.5869	-05 46.1623	211975
South Area											
Buitenzorg	331073.4	333070.2	6265106.2	6266263.9	25.173	102.737	56 30. 003	56 30. 3999	-05 44.4289	-05 42.4355	86534
Scallastle Bay	330033.5	331143	6264555.2	6265098.5	13.2898	31.1893	56 29. 4088	56 29. 5987	-05 45.4092	-05 44.3484	1353393
John_Preston/ Ardtornish Bay	326669.6	336116.9	6260448.1	6269594.5	0.688126	144.125	56 27. 2379	56 32. 3145	-05 49.0818	-05 39.3504	1199543
Thesis area	332872.4	335131.3	6263188	6266360.2	0.475235	13.197	56 29. 037	56 30. 4572	-05 42. 58	-05 40.3878	258333

Table.2: Multibeam coverage during area surveys.

Discussion

Project methodology

In summary, the project has achieved data quality sufficient to facilitate evaluation level surveys of all target sites and to establish these sites within their seabed scape. Processing at 0.1m point resolution has proven adequate for detailed evaluations of both scattered wooden wrecks (e.g. Swan) and intact sites. However, processing at 0.5m point resolution has proven to be suitable only for measuring bathymetry and establishing a wider environmental context to an archaeological site. The entire dataset demonstrates the advantages of combining use of multibeam sonar with a sidescan system such as the Klein 3000. While the EM3002 has proved excellent for modelling complex 3D structures and topography, the Klein system provides optimum resolution of detailed seabed features aiding identification and analysis and unlocking the potential of the multibeam dataset. However, measuring inaccuracies within the Klein interface software were noted. However, as the sidescan system costs only a fraction of the multibeam set-up, a combined approach of this sort is eminently sensible.

The data quality over the entire dataset is somewhat variable. Seabed swell and vessel roll on exposed sites (e.g. *Macduff*) has affected sidescan data quality. On sites where RTK position fixing was not available (e.g., sites in the lee of Calve Island, Mull), the drop-off in position quality appears to have resulted in glitches within the multibeam dataset and inconsistencies between positions generated by the sidescan and multibeam systems.

Faults in data gathering may have adversely affected the quality of sidescan data caused by the survey vessel changing course during a survey run. Data gathering methodology may have affected the quality of multibeam data on certain sites (e.g., *SS* Thesis) where the survey was undertaken by a sequence of several runs at 5 knots. In this respect, lessons learned from this project reinforce the findings of other researchers in the field (e.g. Wessex, 2004). Perceived wisdom suggests that optimum quality may be achieved from one slow run over a site, as opposed to multiple quick runs (where even the tiniest of position fixing errors can cause blurring of a sonar image).

Problems with the *SS Thesis* dataset, and the inconsistencies evident on the *Swan* dataset (where some cannons show but others do not) may have been caused during the post-processing phase. Experience from other researchers in the field (e.g., Wessex 2004) has demonstrated that processing multibeam data can eradicate evidence of the very features that archaeologists are interested in! With this in mind, previous methodological studies have recommended that any project archive retains copies of raw multibeam data, and that project designs make provision for appropriate processing hardware, software, time and expertise to work alongside archaeologists during post processing with the aim of maximising the quality of the dataset for archaeological purposes.

The existence of this dataset provides SOMAP with major challenges for the future. Where previously, volunteers have carried out surveys of complex 3D structures from scratch, effort will now be placed on more targeted recording of detailed aspects of particular vessels to complement the multibeam and sidescan plans. The sidescan datasets have also provided a long list of geo-referenced anomalies that require to be checked by divers. These tasks should keep the next generation of SOMAP volunteers happy for years to come.

Sound of Mull research

Despite the many problems identified and lessons learned, this project has provided a wealth of new information into the submerged cultural heritage of the Sound of Mull.

With the growth in mercantile trade around the coasts of the UK during the 18th and 19th centuries, the Sound of Mull witnessed a considerable increase in shipping traffic. Blessed with deep navigation channels and open anchorage areas (e.g., Scallastle Bay), a route through the Sound of Mull provided ships with a sheltered, coastal route away from exposed Atlantic shores. These factors were favoured particularly during bad weather, and during wartime.

Despite advances in navigation, lighthouses and the like, many vessels met their end in the Sound of Mull. This survey has recorded aspects of at least 28 of the 100+ potential sites. The discrepancy in numbers suggests that some of the recorded losses were subsequently salvaged; that wooden wrecks located in areas of soft sediment may be partially buried and difficult to locate by divers and seabed surface remote sensing techniques; and that more sites remain to be discovered, particularly in deeper locations as the availability of remote sensing equipment increases and advances in deep diving technology bring previously inaccessible depths within reach.

Many of the vessels identified were using the Sound of Mull simply as a transport route by British and European coasters. However, vessels such as the *Pelican* (local coal storage hulk), and *Logan* (supply of coal to Skye) were engaged in the everyday economic fabric of rural highland life. The loss of the *SS Buitenzorg*, scuttled after meeting other merchant ships at a convoy rendezvous spot in the Firth of Lorne prior to onward voyage northwards, reflects the danger and proximity of the U-boat threat to the Atlantic coasts of Scotland during wartime.

The sites identified include fishing vessels, coastal puffers, sailing merchantmen, steam coasters (small and large) dating to the 19th and 20th centuries, and encompassing many of the major vessel types that evolved around in northern Europe around the time of the Industrial Revolution. The sheltered waters of the Sound of Mull have helped to preserve many of these in remarkably good condition.

- The wooden vessels appear to be best preserved where soft sediments have partially buried their hull structures (e.g. *Swan*, *HMS Dartmouth*, and *John Preston*).
- On the whole, the metal wrecks are structurally intact but with the possible exception of the *Evelyn Rose* and the *SS Buitenzorg* (too deep for all but the most extreme technical divers), devoid of all non ferrous items due to the effects of souvenir hunting and salvage. The *SS Shuna* is the best preserved of the popular quartet (*Rondo, Hispania, Thesis and Shuna)*. The *SS Shuna* was the last big wreck to be discovered. Moreover, the wreck is located within a less tidally dynamic environment and has not been targeted by salvage interests (her coal cargo is still in place) despite several expressions of intention.

Deterioration evident on the *SS Thesis* and *SS Hispania* might suggest that many of the sites surveyed are in a phase of rapid evolution and interaction with a chemically and mechanically challenging environment. The remote sensing datasets hint at the importance of currents and sediment regimes as factors in this process:

noticeable scouring and sediment accretion patterns have been seen on the *SS Thesis*, *SS Hispania,* and *SS Buitenzorg*, and the *Swan,* with lesser effects also evident on the wreck of the *SS Shuna*. However, the exact mechanics and significance of these findings are poorly understood and this project intends to seek expert advice on the dataset from experts in Oceanography at Southampton University.

The project has documented evidence of heavy scallop or nephrops trawl dredging in the vicinity of archaeological sites in Scallastle Bay, Ardtornish Bay, and close to the wrecks of the *SS Buitenzorg, SS Shuna, SS Hispania* and *SS Rondo*. The datasets have catalogued evidence of actual damage to the wreck of the *SS Hispania* caused directly by impacts from scallop dredging equipment. There is also some evidence to suggest that where partially buried wooden wrecks are located within heavy scallop dredging areas (e.g. Scallastle Bay), that bottom trawling fishing methods may hasten the dispersal of exposed archaeological material. The project has also documented the impact of commercial salvage to the wrecks of the Sound of Mull. Salvage work has been undertaken on the wrecks of the *John Preston*, *SS Hispania*, *SS Rondo*, *SS Thesis*, but the impacts are most evident on the wreck of the *SS Buitenzorg*. The effects of casual souvenir hunting are undetectable on the project datasets though become self evident during diving surveys.

Conclusions

The Sound of Mull has provided an important seaway for shipping since early times. Its sheltered waters have also provided an excellent burial environment for a diverse range of archaeological sites. The demonstrated potential of a sheltered seaway such as the Sound of Mull may also be reflected in other coastal locations within Scotland such as the Clyde and Forth, where even greater concentrations of diverse archaeology (resulting from coastal settlement since early times and heavy shipping activity) may be found underwater in environments that are also conducive to the long term survival of archaeological remains.

The project has hopefully achieved evaluation level recording of a collection of diverse, but structurally well preserved merchant vessels of 19th to 20th century date within a reasonable timescale and budget. There is clear evidence of deterioration to many of the sites resulting from natural and manmade factors. While research initiatives into site formation processes may help to inform heritage managers of the environmental triggers involved, further research needs to be done into the effects of bottom trawl fishing on archaeological sites in the marine environment.

While this project has assisted in documenting human impacts with archaeological sites on the seabed of the Sound of Mull, it must be reiterated that scallop dredging, salvage work and souvenir hunting is carried out largely to the letter of the law. For, with the exception of the *Swan* and *HMS Dartmouth*, the law does not protect any of the wrecks of the Sound of Mull. Yet, as a group, these sites reflect an important but perhaps undervalued facet of industrial archaeology. Vessels like the *SS Shuna* and *Thesis* may be of some illustrative importance given that unaltered examples of comparable vessels are poorly represented within maritime museums (see Brouwer, 1999).

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Appendix – Brief summary of the project design

Aims and objectives

The project aimed to further knowledge about the archaeology of the Sound of Mull by carrying out preliminary recording of known sites and searching for others. The project also aimed to investigate the condition of sites and the factors affecting their long-term survival, and to raise awareness of the importance of recording and conserving the historic environment of the Sound of Mull.

With this in mind, a number of objectives were drawn up:

- Collation of existing, publicly accessible remote sensing data on the Sound of Mull.
- Commissioning a side scan and multi beam survey of the Sound of Mull (approx. 145 sq.km of seabed) including high resolution recording of known sites. The objectives of this were to:
    - enable preliminary recording of known archaeological sites
    - to search for additional sites in areas perceived to be of high archaeological potential where documented losses have occurred.
- Utilising remote sensing techniques on a selection of test sites where high quality diver generated data already exists, as a way of testing the effectiveness of multibeam and side scan sonars in the recording of archaeological material underwater.
- Processing all data and coordinating the production of identified deliverables.

The following deliverables were envisaged by the project:

- A CD ROM with a GIS project containing geotiff images georeferenced to WGS84 datum and projected to UTM Zone 30 N.
- Hard copy maps and .pdf digital maps of individual site surveys as high-resolution images, and in a 3D visualisation format using CFloor.
- Survey archives to national and local historic inventories (RCAHMS, and Highland Council Archaeology Service)
- Results of the survey (incl.maps) will be made available online at low resolution for the purposes of public access.
- Report to Historic Scotland and published versions.
- Public talks and articles in the diving press.

The perceived benefits of the project include:

- Baseline mapping of known archaeological sites to complement an existing programme of diver based surveys for use in monitoring significant change.
- Location and preliminary evaluation of unknown archaeological sites including wrecks that may benefit diver tourism in the area.
- Baseline mapping to indicate the extent of scallop dredging in the Sound of Mull and the potential threat posed to the cultural heritage.
- Provision of high quality research data to inform coastal zone management projects in the future.

- Enhancement of historic/nature conservation inventories with useful data.
- Promotion of conservation minded public access via a range of innovative interpretative strategies.

Data licences

In recognition of the partnership philosophy of this project, all members of the consortium (Aspect Surveys Ltd., Kongsberg Maritime Ltd., Lochaline Dive Centre, Morvern Maritime Centre, Historic Scotland, University of Dundee) retain © to the data, and equal rights to use the data arising from this project without permission with the proviso that any published versions of the data acknowledge the projects origins as follows: “data generated by Aspect Surveys and Kongsberg Simrad for the Sound of Mull mapping consortium (Historic Scotland, Centre for Digital Imaging DJCAD University of Dundee, Morvern Maritime Centre, and Lochaline Dive Centre”.

Table 3 – list of sites for survey

Site name	Map ref.	Depth	Notes	Approximate sq. area of survey	Description
General	N/a	< 250 metres deep	To cover as much of the Sound of Mull as possible within budget	Approx. 145 sq.km	Bathymetric survey of the Sound (as much as can be achieved within budget)
Rondo	3	Stern in 7 metres and bow in 50 metres	Survey of wreck and surrounding seabed	15,000 sq.metres	Intact shipwreck lying on steep gradient slope close to shore
Evelyn Rose	10	Uncertain. Possibly 60-80 metres	Search for wreck	40,000 sq. metres	Intact wreck, exact location unknown
Thesis	15	Bow in 15 metres, stern in 32 metres	Survey of wreck and surrounding seabed	15,000 sq.metres	Upright intact shipwreck lying on shallow gradient slope close to shore
Buitenzorg	Close to 12	Depth 70-90 metres	Survey of wreck and surrounding seabed	30,000 sq.metres	Upright intact shipwreck lying in deep water
Logan	7	Depth 105 metres	Survey of wreck and surrounding seabed	15,000 sq. metres	Upright intact shipwreck lying in deep water
Swan	16	Depth 10-12 metres	Survey of wreck and comparison with diver survey techniques	10,000 sq. metres	Broken shipwreck partially buried lying close to shore
Dartmouth	13	Depth 5-10 metres	Site survey/ comparison with existing surveys	10,000 sq.metres	Partially buried, scattered wreck
Ballista	14	Depth 5-10 metres	Survey of wreck and surrounding seabed	10,000 sq.metres	Upright intact shipwreck shows at low water
John Preston	6	Depth 16-18 metres	Survey of wreck and comparison with diver based survey techniques	10,000 sq.metres	Broken shipwreck partially buried lying close to shore
Pelican	Not shown	20 metres	Survey of wreck and surrounding seabed	15,000 sq.metres	Semi intact shipwreck lying close to shore in Tobermory Bay
Shuna	2	36 metres to the deck	Survey of wreck and surrounding seabed	30,000 sq.metres	Intact wreck lying on a flat seabed
Hispania	1	20 metres to the deck	Survey of wreck and surrounding seabed	30,000 sq.metres	Intact shipwreck lying semi upright on a flat seabed.

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