

The 'Atlas' Survey Zone: Deep-sea Archaeology & U-boat Loss Reassessments

Axel Niestlé

Dabendorf, Germany

Between June 1944 and May 1945 the waters of the English Channel witnessed intense naval operations during the final phase of the German U-boat campaign against allied shipping. Operating close to shore and also the along the cross-Channel convoy supply lanes, German schnorkel-equipped U-boats suffered grievous losses with only moderate success. The majority was sunk with all hands while submerged. Official post-war loss lists were largely based on incomplete wartime signal intelligence derived from intercepted and decoded Axis radio communications. In the heat of battle, this historical documentation was often incomplete.

In July 2008 Odyssey Marine Exploration mounted an expedition designed to determine the formerly unknown or vague identities of six World War II German U-boat wrecks located in the Western English Channel and along the northern coast of Cornwall. The survey was conducted using the ROV Zeus launched from the *Odyssey Explorer*. Authoritative new evidence obtained during the survey has led to the definitive identification of the former German U-boats U 325, U 400, U 650, U 1021 and U 1208. Consequently, previous errors in the operational history of the German U-boat campaign in the Western English Channel have been corrected. The project serves as a positive example of how deep-sea wreck archaeology, working in tandem with historians, can access fresh data and rewrite major naval history.

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1. Introduction

In the heat of battle, historical documentation often remains necessarily incomplete. With naval history usually based on information found in official documents or oral recordings filed in archives or museums, the precision in the accounts of naval actions or operations decrease markedly in cases where contemporary records are lacking or incomplete. This lack of information has led sometimes to dreadful distortions in the true narrative of how historical events unfolded. The operational history of the German U-boat campaign during both world wars of the 20th century offers splendid examples of this deficiency. A high percentage of U-boats lost in combat went down with all hands under circumstances that even remain obscure today. Documentation of the German role in operations often remains fragmentary.

Modern deep-sea marine archaeology offers a completely new dimension for historians to investigate and reconstruct operational events in naval conflicts of the last centuries. Thanks to advanced manned or unmanned underwater vessels equipped with powerful lights and the latest sensors and cameras, numerous wrecks of sunken ships, formerly hidden in the darkness of the deep sea, can now be located and examined to learn more about their features and final fate. Some 60 years after the last war, many of the wartime wrecks are still preserved in surprisingly good condition.

Exploration and detailed documentation by experienced archaeologists and expert historians can result in successful wreck identification and a more precise understanding of events otherwise left obscured by the shadows of history. The search and detailed inspection of the famous German World War II battleship *Bismarck*, for instance (Ballard and Archbold, 1990; Garzke and Dulin, 1991), offer an excellent example of a collaborative effort by marine archaeologists and historians to rewrite history.

During the last two decades the wrecks of several formerly unrecorded World War II German U-boats were discovered off the south-west coast of Britain in locations where no wartime losses were recorded in the official list of German U-boat losses compiled during the war and published jointly by the British Admiralty and the US Chief of Naval Operations (CNO) in 1946.¹ Further, several of these U-boat wreck sites are substantially distant from known positions of allied anti-submarine attacks made during the war. Hence, these losses were probably caused by some other means, such as mining, marine accidents or malfunction.

The discovery of unexplained U-boat losses in this part of Britain's coastal waters did not come as a surprise. Between June 1944 and May 1945 the waters of the English Channel saw intense operations during the final phase of the German U-boat campaign against allied

shipping. Operating close to the coastline and along the cross-Channel convoy supply lanes, German schnorkel-equipped U-boats suffered grievous losses in exchange for moderate success. The majority was sunk with all hands while submerged, and evidence for their destruction was often limited to oil and debris observed rising from the depths. It is now known that official post-war loss lists were mainly based on incomplete wartime signal intelligence derived from intercepted and decoded Axis radio communications (Niestlé, 2008). The rapid disbanding of allied naval departments related to the assessment of German wartime U-boat losses after May 1945 left no opportunity for a thorough check of results with the help of German military records, which fell into allied hands at the end of the war. In September 1945 it was estimated that the translation and detailed analysis of every German U-boat log, together with correlation of all attacks reported therein with corresponding Allied attacks, would require the services of a significant-sized staff for the better part of a year.² With this work never initiated, the degree of error in the 1946 publication of the Admiralty and the US Chief of Naval Operations is evident from the fact that until today more than 150 losses have been re-assessed.

In July 2008 Odyssey Marine Exploration initiated an expedition to survey hitherto unidentified or vague

German World War II U-boat wreck sites in the Western English Channel and the north Cornish coast as part of its Atlas Shipwreck Survey Project (Fig. 1). The author was given the opportunity to join the expedition team as expert historian responsible for actual wreck identifications. A total of six dive target sites were selected, to be examined using the Remotely-Operated Vehicle Zeus based on the *Odyssey Explorer* research vessel. In the hands of experienced operators this multi-purpose vehicle offers optimum conditions for wreck surveys. The ambitious purpose of the expedition was to collect maximum information to form objective assessments about the identity of each wreck. As a precondition of success, close cooperation between the onboard Project Manager and the expert historian in planning every dive operation ensured that all sections and details of the wrecks helpful in the identification process were fully investigated and documented by high-definition video supported by the digital photography. While many wreck details were identified live during the underwater surveys, others only became apparent following numerous repeat viewings of the video footage.

In the following sections, the results of the individual wreck surveys are presented in combination with the 'forensic' interpretation of the available information in order to reveal the identity of the wrecks.

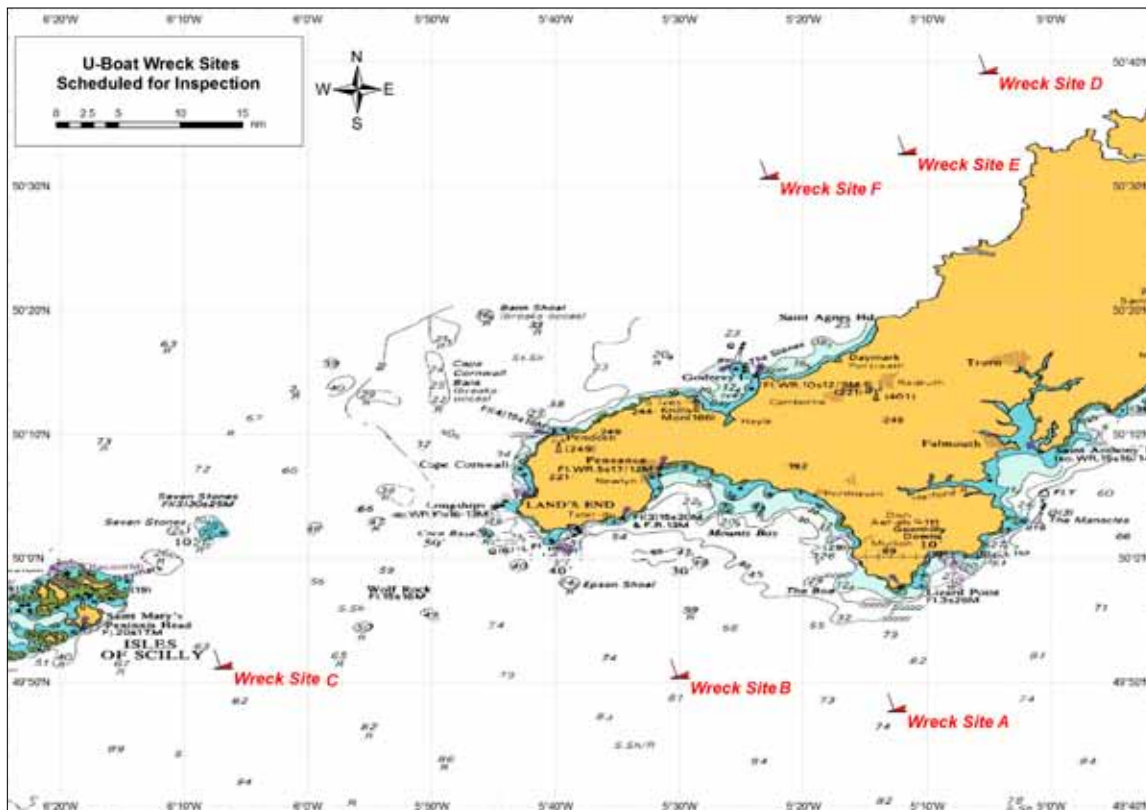


Fig. 1. Map of Odyssey's 2008 U-boat expedition area, denoting the locations of wreck sites visited.

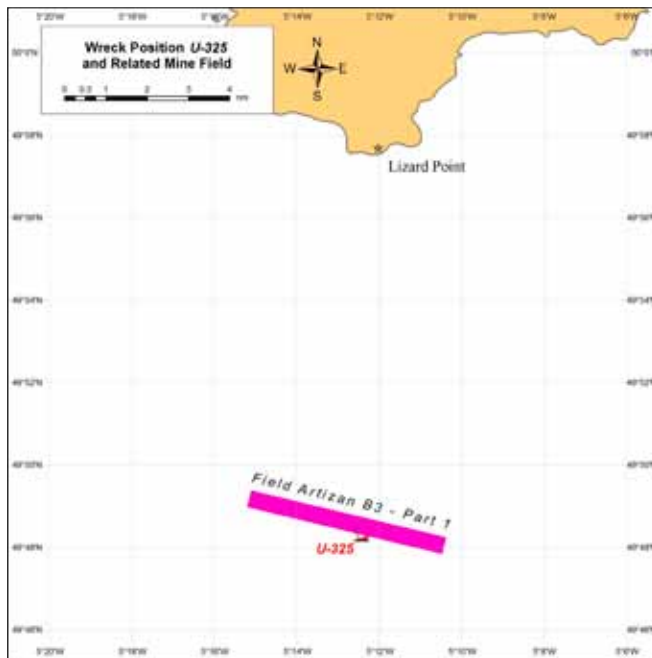


Fig. 2. Map showing wreck site U 325 alongside the English 1945 minefield location south of the Lizard.

2. Wreck Site A – U 325

In 2007 the wreck of a German World War II Type VIIC U-boat was discovered by Scuba divers off Lizard Point in the English Channel at coordinates 49°48.283N, 05°12.383W. No German wartime U-boat loss has been documented as existing in this position (Niestlé, 1998). Similarly, no anti-U-boat attack was ever recorded at or close to the present wreck location. Examination of all German U-boat losses in the general area revealed that U 399 and U 1018 lay closest to the wreck's position. However, although both boats were sunk, survivors picked up afterwards created a trail of positional data. Their wrecks have since been discovered by Scuba divers close to the recorded historical loss position of these boats (McCartney, 2003: 28-30).

On 17 July 2008 wreck site A was located at a depth of 84m, listing 80° to portside. Most of the former upper deck structure above the pressure hull, which had previously formed the outer lines of the vessel above the water line, is no longer intact. All pressure hull hatches are closed with both periscopes down. Forward hydroplanes show a 5° tilt upwards, while the aft hydroplanes are in a neutral position. The outer hatches of forward torpedo tubes Nos. II, III and IV are closed, while that of tube I is half open with a loaded torpedo still inside. At the extreme stern of the boat the forward part of a heavily crushed torpedo, formerly loaded in the aft torpedo tube (No. V), is sticking out of the remaining part of the tube, bent down towards port. The presence of live ordnance indicates a formerly unidentified wartime loss.

Visible battle damage to the wreck, apart from destruction caused by corrosion and obvious extensive post-war fishing activity, is limited to a semi-circular destruction area aft at the extreme end of the pressure hull, including a large hole in the pressure hull itself on the starboard side in front of the stern bulkhead (Fig. 3). The outer hull of the extreme stern with the two rudders attached is completely separated from the rest of the hull, lying just astern on the sea bottom. Battle damage on the wreck offers sufficient evidence to suggest that mining was the most plausible explanation of this submarine's loss.

In fact the British Royal Navy laid down various minefields in the general area during 1945. To counter the increasing number of schnorkel-fitted U-boats in UK coastal waters, on 15 January 1945 the First Sea Lord ordered a heavy anti-U-boat mining program to be undertaken in the Western Approaches, Plymouth and Portsmouth Commands. Three days later the Commander in Charge at Portsmouth and Commander in Charge at Plymouth were requested to prepare an agreed program for the laying of deep minefields in the English Channel on the assumption that 10,000 mines were available for the task. On 9 February 1945, the Plymouth's naval Commander-in-Charge forwarded to the Admiralty a plan for deep minefields in his Command, which would necessitate the expenditure of 3,600 mines. Mines were to be laid at a depth of 60ft in two parallel dog-legged lines, 5 and 7 miles seaward of the coastal convoy route and in conformity with it. Fields were to be completed first off Wolf Rock (Serial 'A': 800 mines), followed by the area off Lizard Head (Serial 'B': 1,400 mines) and finally off Start Point (Serial 'C': 1,400 mines). On 26 February 1945 the Admiralty approved the plan.

With priority given to the laying of the new fields in the Portsmouth Command, work on fields in the Plymouth Command, code-named operation 'Artizan', only started on 3 April 1945. Contrary to the initial plan, mine laying started with the fields of Serial 'B' off Lizard Head. Up to 30 April 1945, nine different fields (Serial B1, part 1 to 4, Serial B2, part 1 to 4, and Serial B3, part 1), comprising 900 mines, were laid. On 6 May 1945, following the German surrender, operations on the remaining fields was suspended.³

Comparison between the exact coordinates of the individual mine fields with the nautical position of the U-boat surveyed by Odyssey in 2008 revealed that the wreck's position is a near perfect match to field B3, part 1 (Fig. 2). This field was laid by the coastal minelayer HMS *Plaver* escorted by the minesweepers HMS *Ilfracombe* and HMS *Shippigan*. After leaving Portsmouth at 16.12hrs on 29 April 1945, the mines were laid at a depth of 60ft

between 08.14 and 08.42 the next day using 100 Mk XVII/XVII(8) units, along a line extending for 3.3 miles in a direction $283\frac{1}{2}^{\circ}$ from position $49^{\circ}48'03''N$, $05^{\circ}10'26''W$. At 22.26hrs on the same day the ships returned to Portsmouth.⁴ From the evidence reported above it is beyond all doubt that the U-boat in question was in fact lost to the secretly laid allied minefield, which remained unknown to German U-boat Command for the duration of the war.

With the minefield laid as late as 30 April 1945, only four German U-boats then designated for operations in the Channel area, and recorded as lost during the final days of the war, emerge as likely candidates for the wreck. The four boats in question are U 325, U 398, U 1017 and U 1055, all belonging to the famous Type VIIC, which was modified in 1944 with schnorkel equipment for continuous underwater operations (Niestlé, 1998: 228, footnote 46; 234, footnotes 110 and 115).

The survey of technical features on this first submarine wreck revealed the fitting of a Type 2 folding schnorkel installation in combination with a ring-float schnorkel valve and 'Jaumann'-type anti-radar coating above the exhaust outlet (Köhl and Niestlé, 1989: 35-6; Niestlé, 1994: 444-46; Figs. 4-5). In the area of the former upper deck in front of the conning tower only two compressed air bottles, fitted onto the pressure hull, were found. Pressure-tight containers holding five-men life-saving

rubber dinghies, formerly fitted in the upper deck on the fore ship, were discovered on the sea bottom close to their former position. A Type LM42U mount of the 3.7cm anti-aircraft gun, originally located on the lower anti-aircraft gun bandstand aft of the conning tower, is clearly visible among the residual pile of debris from the former bridge construction on the port side of the wreck (Fig. 6). The outer hull at the forward end of the keel was not modified for the late-war balcony array of the multi-unit listening gear.

Although no direct identifying marks were found on the wreck, comparison of individual features with available information on the contemporary fittings of the four likely U-boats eventually led to the conclusion that the wreck must be U 325. Each of the other three boats in question could be positively excluded from the list on account of the wreck features described above. U 325 is known to have been fitted with the same schnorkel installation, including schnorkel valve and a type of anti-radar coating, as was found on the wreck.⁵ The other wreck features are also identical to those present on U 325.

U 325 (Oberleutnant zur See Erwin Dohrn: Senior Lieutenant, U-boat commanding officer) left Trondheim in Norway on 20 March 1945 for its second war patrol in British inshore waters. On 29 March 1945 U-boat Command ordered the boat to occupy naval grid square



Fig. 3. Mine damage at the after end of the pressure hull, just forward of the stern bulkhead on the wreck of U 325, with a bent-up starboard propeller shaft underneath. The shape of the stern torpedo tube is faintly visible in the upper left corner.



Fig. 4. Schnorkel head lying on the deck of wreck of U 325, with the cylindrical part covered with Jaumann-type anti-radar camouflage.



Fig. 5. View of the ring-float schnorkel head installed on U 637 taken post-war at Lisahally, Northern Ireland, displaying a Jaumann anti-radar absorber used to camouflage the schnorkel head against radar detection, comparable to that installed on U 325. The layered absorber measured about 7cm in thickness. On top of the schnorkel head the 'Bali I' -detector antenna, used against metric radar sets, can be seen, which, however, were hardly in use any more in 1945.



Fig. 6. A Type LM42U gun mount, complete with 3.7cm M42U AA-gun, lying on the seabed beside the wreck of U 325. The gun mount is upside down with both sides of the hinged protection shield folded back. The circular object on the right is the bottom of a pressure-tight ready-ammunition container formerly fitted to the gun platform.

BE 3531 (50°03'N, 13°25'W) with an operational radius of 30 nautical miles. This order was however cancelled the next day and on 31 March 1945 the boat was advised to continue its southward passage west of Ireland as far as the latitude of naval grid square BE 31 (50°33'N). On 7 April 1945 U 325 sent a routine passage report from naval grid square AL 61 (55°47'N, 19°45'W), indicating that the boat had hauled far to the west on its outbound route. Three days later U-boat Command ordered U 325 to operate on the coastal convoy route on both sides of Lands End from Bull Point to Lizard Head. At the time of the cessation of hostilities, U-boat Command considered U 325 to be still operational. When U 325 thereafter failed to enter base or to show up at one of the Allied assembly points, its loss became apparent. No information about the cause of its loss was then available to U-boat Command.⁶

After the war the allied anti-submarine assessment committee attributed the loss of U 325 to a series of depth charge attacks by the destroyers HMS *Hesperus* and HMS

Havelock on 30 April 1945 in position 53°42'N, 04°53'W. When fresh information on U 325's actual operational area became known from German records during the 1950s, the Naval Historical Branch of the British Ministry of Defense revised the original assessment. Now allocating the destruction of U 242 to the action on 30 April 1945, U 325 was then considered to have been lost to an unknown cause in the absence of any specific explanation.

Following the discovery of three hitherto unknown German World War II U-boat wrecks off the Cornish Coast between 1990 and 2001, the author believed that U 325 could be one of them, based on the fact that the position of the wrecks was situated well within its operational area. However, insufficient information on individual wreck features then available allowed any definitive interpretation (Niestlé, 2004). In light of the new information obtained during the 2008 Odyssey survey and presented above, previous conclusions about the likely wreck location of U 325 can no longer be retained.

From the fact that U 325 passed a transit report from the area west of Ireland and the absence of any promising Anti-Submarine attacks along its expected route or in its assigned operational area, it is most likely that U 325 arrived in its assigned operational area on or around 17 April 1945. Equipped with fuel and provisions for a patrol length of at least ten weeks, theoretically U 325 should have left its operational area for return to base no later than about 9 May 1945. Nothing is known about the final movements of U 325, but the wreck's position is within its assigned operational area, although at its eastern limit. German U-boats still at sea around Britain at the time of the German surrender started to surface from 9 May 1945 onwards in accordance with radio orders, with U 249, then also operating in the Channel, being the first German U-boat to surrender to allied forces on the same day. It is therefore reasonable to assume that U 325 would have acted accordingly or at least would have finally left its operational area at that time in order to commence return to base. Hence, it is assumed that U 325 was sunk with all hands between 30 April 1945 and 9 May 1945 by mining on the British field 'Artizan B3, part 1' in position 49°48.283'N, 05°12.383'W.

3. Wreck Site B – U 650

In 1976 the Risdon Beazley salvage company reported the discovery of a submarine wreck at coordinates 49°51.25'N, 05°29.86'W, which was confirmed in 1997 by a local Scuba diver. The presence of ferrous propellers pointed to the presence of a late World War II U-boat (McCartney, 2003: 27). On 17 July 2008, Odyssey surveyed the wreck of a German Type VIIC U-boat at a depth of 79m at position 49°51.061'N, 05°29.971'W. The hull is heavily corroded and lies with a 75° list to port side on a flat, sandy bottom.

Almost all of the superstructure has disintegrated, with just piping and compressed air bottles left undisturbed. Periscopes and a Type 1 schnorkel mast with a ball float head are in a lowered position. The 3.7cm model LM42U anti-aircraft gun mount has fallen off its foundation and is lying on the seabed. The conning tower hatch is shut, while the forward torpedo hatch and galley hatch aft are open. Torpedo tubes II and V were found empty, the condition of tube IV remains unclear, and tubes I and III are inaccessible owing to accumulations of debris. Four life-saving rubber dinghy containers were found on the sea bottom below the fore ship. A modified ('Atlantic') bow is fitted without a towing eye conversion for underwater refueling. However,



Fig. 7. The massive gun mount for the 8.8cm deck gun features prominently on the wreck of U 650. Beneath is the lower part of the schnorkel mast lying on the deck. The circular opening of the pressure flange connecting to the fresh air intake tube, characteristic of the older Type 1 schnorkel installation, is partly obscured by the rectangular wooden deck cover of the former 8.8cm ready ammunition store located just behind the gun mount.

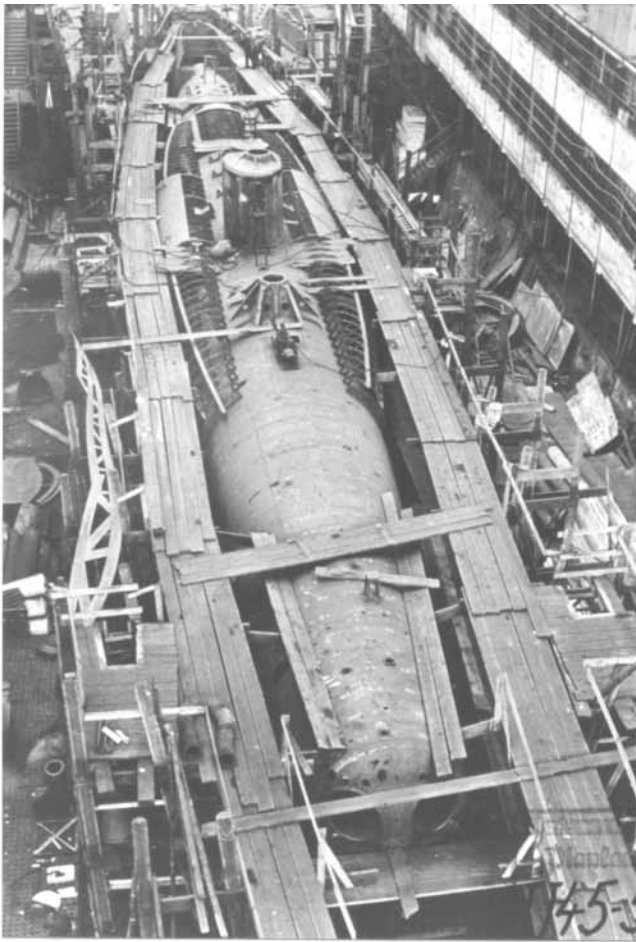


Fig. 8. Bow view of U 53 during building at Kiel, with the massive deck gun mount clearly visible on top of the pressure hull in front of the conning tower behind, which was technologically similar to U 650.

the most interesting and unusual feature of the wreck is the presence of the original 8.8cm deck gun platform in front of the conning tower (Figs. 7-8).

Battle damage to the wreck is apparently limited to a small breach in the pressure hull on the starboard side of the forward torpedo room (Fig. 9). From the interpretation of the wreck details it is evident that the U-boat was cruising submerged or had bottomed on the seabed when an explosion ruptured the pressure hull. The damage appears consistent with the destruction caused by a direct hit from a contact-fused hedgehog projectile, carrying a 35lb Torpex explosive charge. From the relative position of the damage it can be expected that large amounts of air must have escaped from inside the boat through the hole in the pressure hull. However, as no fuel oil tanks were located near the damage area, the submarine is expected to have only discharged small amounts of oil, if any at all. As a result of the structural damage all compartments forward of the control room are likely

to have been flooded instantly, making any attempts to surface the vessel impossible. The open hatches may implicate a possible attempt by surviving crew members to escape from the boat. Post-war, the upper structure disintegrated, probably by a combination of corrosion and fishing impacts.

From all German schnorkel-equipped U-boats directed to operate in the English Channel during the period June 1944 to May 1945, and presently recorded as missing or whose fate remains open to question, only U 650 fits the reported wreck details. The crucial wreck features underlying this conclusion was the installation of the original 8.8cm deck gun platform in front of the conning tower in combination with the presence of dinghy containers on the fore ship. None of the other U-boats presumed lost in the English Channel carried this fitting. With the wreck identified as U 650 without doubt, the reason for its loss still remains open to question.

U 650 (Oberleutnant zur See z.V. Rudolf Zorn: Senior Lieutenant, U-boat commanding officer) left Bergen/Norway on 9 December 1944 to continue its sixth patrol. Having initially sailed from Bergen on 26 November, the patrol had to be aborted north of the Shetlands owing to technical failures, returning to Bergen for repairs on 3 December. Shortly before midnight on 9 December 1944, U 650 was released by its escort V 5116 near the small island of Hellisoey at the northern end of the Fedjefjord. According to the daily log of U-boats on patrol kept at U-boat Command, the boat was instructed to travel through the Shetland-Faroe passage into the Atlantic, heading for a preliminary steering area west of Ireland. On the outbound trip U 650 kept strict radio silence in accordance with standing orders during November/December 1944, which instructed outbound boats to report positions only upon direct request. When U-boat Command assumed that the boat must have almost reached its preliminary steering area, U 650 was directed on 20 December 1944 to continue into the English Channel as its operational area, concentrating on attacking cross-Channel shipping off Cherbourg and Seine Bay. Together with U 325 and U 905, the boat was intended to be a replacement for U 322, U 485, U 486 and U 680, then operating in the Channel. On 30 December 1944 U-boat Command informed U 650 that its arrival in the allocated operational area was expected on or after 31 December 1944.

In the following weeks U-boat Command believed that the boat would continue to operate within its assigned area until the exhaustion of fuel and provisions forced it to commence the return voyage to Norway. When no status report was received by 5 February 1945, U-boat Command sent a reminder signal on the same day. In a

further signal on 9 February 1945 the boat was ordered to head for the port of Stavanger in Norway. In the absence of any report from U 650 after its departure from Bergen on 9 December 1944, and its failure to reach a German base, U-boat Command eventually posted U 650 as missing in the English Channel with effect from 7 January 1945. The given date for its loss was necessarily somewhat arbitrary in the absence of any clue about its loss, but clearly indicates that U-boat Command assumed that the boat reached its assigned operational area before disappearing.⁷

From Ultra signal intelligence the British U-boat tracking room at the Admiralty Operational Intelligence Centre was aware that U 650 had ceased patrols, although the exact date of the boat's departure could not be established. Also U-boat Command's operational order of 20 December was duly intercepted, but could not be read owing to the newly introduced special one-time pad cipher system in German U-boat radio traffic. Only from U-boat Command's signal of 30 December 1944 did it become known that U 650 was bound for operations in the Channel. However, similar to the situation on the German side, the tracking room had no clue about the whereabouts of U 650 in the following months, except for the fact that it did not return to base. On 5 March 1945 the boat was eventually recorded as lost to unknown causes sometime during January 1945.

After the war the allied assessment committee similarly felt unable to attribute the loss of U 650 to any known anti-submarine attack carried out along its outbound route or in the English Channel during the given period when the boat supposedly disappeared. Therefore, the loss of U 650 remained unexplained and the boat was recorded as 'lost to unknown cause' in the joint official list on the assessment of German U-boat losses during World War II.⁸

Following the daily plot kept by U-Boat Command, it is reasonable to assume that its loss must have taken place sometime during January 1945. No anti-U-boat attack took place during the war at the present wreck location. A detailed examination of all anti-submarine attacks during January 1945 in the general area of the wreck site revealed two anti-submarine incidents in the general area (Fig. 10):

- On 15 January 1945 by the frigates HMCS *Saint John* and HMCS *Port Colborne* in position 49°54'N/05°40'W.
- On 21 January 1945 by the corvette HMS *Dahlia* in position 49°56'N/ 05°35'W.

Both attacks were apparently not examined by the U-boat assessment committee because no report could be located in the official archives. The Report of Proceedings of

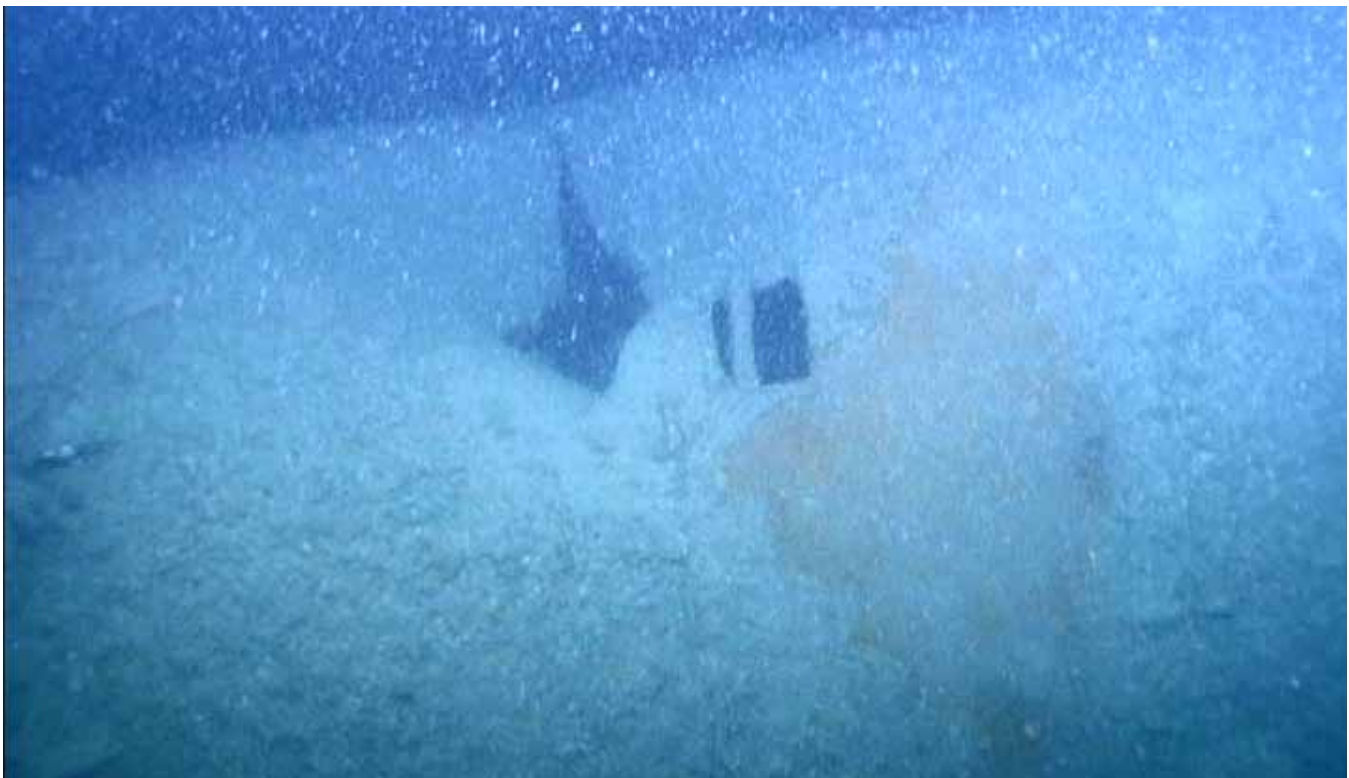


Fig. 9. Battle damage on the wreck of U 650, displaying a dent in the forward part of the pressure hull level at the after end of the forward torpedo room. The size of the opening compares to the open rectangular battery-loading hatch, measuring 70 x 45.6cm. Battle damage is consistent with the destruction expected by a direct hit from a contact-fused projectile fired from a Mk 10 Hedgehog A/S mortar used during World War II.

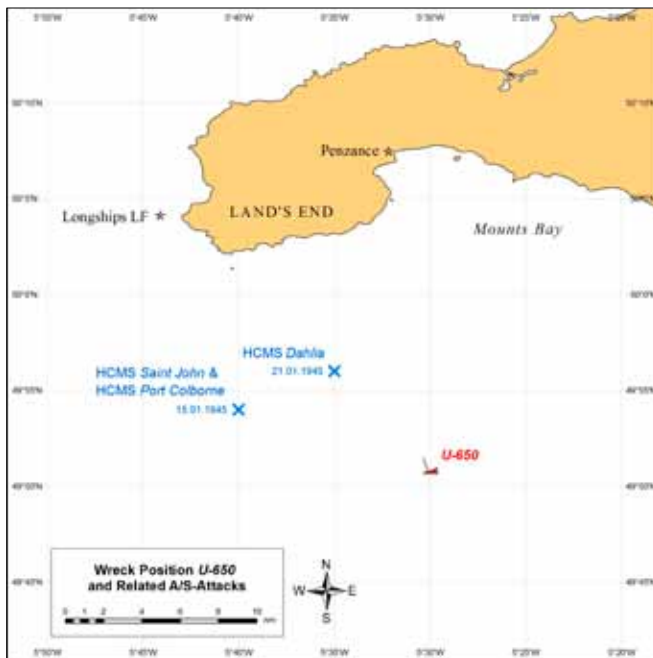


Fig. 10. Map showing wreck site U 650 in the Western English Channel in relation to known Allied anti-submarine attack positions.

Escort Group 9 for the period between 29 December 1944 and 25 January 1945 merely mentions that on 15 January 1945 several Anti-Submarine contacts were investigated and attacked in the vicinity of Wolf Rock, which were all finally classified as wrecks or non-subs.⁹ More substantial information is documented in the diaries of the commanding officer of HMCS *Saint John* (Whitby, 2005: 268):

“Monday, January 15 – At Sea

A quiet fairly undisturbed night. We arrived back off the Lizard at about 0800 and turned round to the W. once more. As soon as it was properly light I turned to 310° to sweep up to the E. of the Wolfe. At about 1030 [GMT] P.C. [*Port Colborne*] got contact and we had to go and investigate it. A bottom contact of indefinite proportions and not previously plotted and so I decided to attack. It was difficult to hold and after 2 H/H [Hedgehog] attacks we lost it and spent some time bumming round. P.C. then got off on yet another echo while we at last regained the first one and attacked it again twice. Nothing but fish and a wisp of oil and so classified it wreck.”

From the description in the diary the result of the attacks was inconclusive. Although the damage on the wreck of U 650 could well have resulted from a hedgehog projectile exploding on the deck casing, the apparent absence of any air bubbles coming to the surface indicates that the target attacked on 15 January 1945 was probably one of the non-submarine objects located frequently by the ships of Escort

Group 9 during their patrol in January 1945. Moreover, a list of all new non-submarine contacts obtained by ships of Escort Group 9 between 29 December 1944 and 25 January 1945, appended to the Report of Proceedings, records no position at or close to the reported wreck position.¹⁰

The attack by HMS *Dablia* on 21 January 1945 took place nearest to the wreck. The present site location is about 7 nautical miles bearing 130° true away from *Dablia*'s historical attack position. Unfortunately, no report of her attack could be found among allied records. Therefore, information remains somewhat enigmatic. What is clear is that while escorting the eastbound nine-ship coastal convoy BTC-44, the corvette obtained a submerged contact on her asdic. The war diary of Plymouth Command contains the following entry for 21 January 1945:¹¹

“At 0859 this morning HMCS [sic] *Dablia*, escorting convoy BTC 44, attacked a firm contact in position 140 deg Longships 10 miles; *Icarus* and *Duncan* of the 14th Escort Group, were despatched to take over from *Dablia* but at 1000 the latter decided her target to be non-sub and proceeded to re-join her convoy.”

The report of the Convoy Commodore for BTC-44 mentioned the incident in a single sentence (but without disclosing the identity of the escort): “Escort dropped D/Cs [Depth Charges] off Bute Head. No results observed.”¹² It should be noted that the reported nautical coordinates for the attack place it in a position about 13 nautical miles bearing 130° from Longships, which slightly differs from the information recorded in the war diary of Plymouth Command cited above. Moreover, with the actual wreck position about 21 nautical miles bearing 130° from Longships, its bearing is identical to that calculated for *Dablia*'s attack. No information is available to assess the navigational accuracy in the positioning of the attack under the prevailing conditions. HMS *Dablia*, like other Flower-class corvettes in 1945, was fitted with depth charge throwers and a Mk 10 hedgehog mortar. Therefore, it is possible that hedgehog projectiles were fired in the attack. It is regrettable that no other information on the action of HMS *Dablia* on 21 January 1945 appears to have been preserved. In the absence of data it is impossible to reach a final conclusion about the identity of the contact and the result of her attack on this date.

Based on the information given above a final decision about the cause of U 650's loss is considered impossible at present. Nevertheless, it is proposed to correct the record of how U 650 was lost during January 1945 with the conclusion that its demise was caused by a hedgehog attack by an as yet unidentified allied vessel in the position 49°51.061'N, 05°29.971'W.

4. Wreck Site C – U 1208

On 24 February 1945 a German U-boat was sunk in a series of attacks by the frigates HMS *Duckworth* and HMS *Rowley* of the British Escort Group 3 south-west of Lands End at position 49°55'N, 06°08'W. Following the torpedoing of the British freighter *Oriskany* in convoy BTC.78 early on the morning of 24 February 1945, the ships of Escort Groups 3 and 15 started to search for the attacker. After six hours *Rowley* made an asdic contact at 10.20hrs on a U-boat contact steering south-west and just under the surface of the sea. Following several unsuccessful attacks, oil was observed on the water's surface after a hedgehog attack carried out by *Duckworth* at 12.25hrs. Further attacks against the now bottomed contact resulted in conclusive evidence for the destruction of a U-boat. At the time the action was assessed as "U-boat probably sunk" (Young and Armstrong, 2009: 334-8).

On 27 March 1945 the British U-boat tracking room at the Admiralty Operational Intelligence Centre tentatively identified U 480 as the attacked and sunk boat, probably based on pieces of very thin synthetic rubber picked up from the scene afterwards. U 480 was known to have been covered with rubber sheets (codenamed 'Alberich') as a counter measure against allied sonar detection.¹³ After the war the allied assessment committee felt no reason to question the wartime tracking room allocation.

However, in 1997 the wreck of a German Type VII C U-boat with an 'Alberich' rubber anti-sonar coating was found by Scuba divers in the English Channel to the south-west of Portsmouth at position 50°22'04"N, 01°44'10"W. With U 480 known to have been the only 'Alberich'-coated U-boat lost in the Channel area, the identity of this wreck must in fact be U 480. Hence, the identity of the U-boat sunk by the frigates of Escort Group 3 on 24 February 1945 off Lands End became again open to question (McCartney, 2003: 99-100).

On 18 July 2008 ROV Zeus located the wreck of a German Type VII C U-boat in 81m of water at position 49°51.783'N, 006°06.750'W (site C, Fig.1). The hull is heavily corroded and lying with a 45° list to portside on a flat, sandy bottom. The wreck displays widespread battle damage, especially forward of the conning tower, where large sections of the pressure hull are missing or stove in (Fig. 11). Almost all of the superstructure has disintegrated, only with piping and air flasks undisturbed. The periscopes are in a lowered position. Most of the schnorkel installation is missing owing to battle damage forward. No anti-aircraft guns were observed, partly due to heavy fishing netting across the port mid-ship section of the hull, which made ROV inspection impossible. The modified 'Atlantic' bow is fitted with a towing eye conversion for underwater

refueling (Figs. 12-13). No balcony array for the multi-unit listening gear was observed at the forward end of the keel. The extensive wartime damage is evidently the result of numerous 'tin-opener' depth charge attacks, which were carried out by various allied escort vessels in the days after the sinking in an effort to secure evidence from inside the hull leading to a positive identification of the sunken U-boat.

According to operational orders signaled from U-boat Command to boats on frontline patrol up to 24 February 1945, a total of six German U-boats may have been operating in the English Channel on that date. Of these, only U 1004 and U 1203 returned from patrol while U 927, U 1018, U 1208 and U 1279 went missing. From those lost on patrol, only U 1018 is now recorded as known sunk on 27 February 1945 by ships from Escort Group 2 in position 49.56'N, 05.20'W, with two survivors being picked up from the sea. No conclusive information about the fate of the other three boats has been obtained so far. Already during the war the British U-boat tracking room at the Admiralty Operational Intelligence Centre became aware of their loss from Ultra signal intelligence. However, similar to the situation on the German side, the tracking room had no exact clue as to the whereabouts of these three boats in the following months, except the fact that they never returned to base. Based on available information about allied anti-submarine attacks along their outbound track, or within the assigned operational areas, eventually their losses were tentatively allocated to the following attacks:

- U 927: air attack by Warwick 'V' of RAF Squadron 179 on 24 February 1945 in the Channel at position 59°54'N, 04°43'W.
- U 1208: depth charge attack by the sloop HMS *Amethyst* on 20 February 1945 south of Ireland at position 51°48'N, 07°07'W.
- U 1279: depth charge attack by the frigates HMS *Bayntun*, HMS *Braithwaite* and HMS *Loch Eck* on 3 February 1945 north-west of Bergen in position 61.21'N, 02.00'E.

A new investigation by the British MoD/NHB-FDS in 1991 revealed that the U-boat sunk by HMS *Amethyst* was in fact U 1276, based on a name label of a crew member from U 1276 attached to articles of clothes picked up after the attack. Hence, the fate of U 1208 again became open to question.

U 1208 (Korvettenkapitän Georg Hagene) left Kristiansand on 14 January 1945 for its first patrol. At 20.13hrs on 31 January 1945 the boat sent a routine passage report from naval grid square AM 4855 (54°09'N, 13°45'W). In return, U-boat Command directed the



Fig. 11. An example of the massive, widespread battle damage visible on the forward part of U 1208's pressure hull, caused by numerous depth charges dropped on the bottomed wreck ('tin-opener' attacks) after its sinking in order to obtain evidence for the boat's identity from paperwork and other material that would hopefully float to the surface.

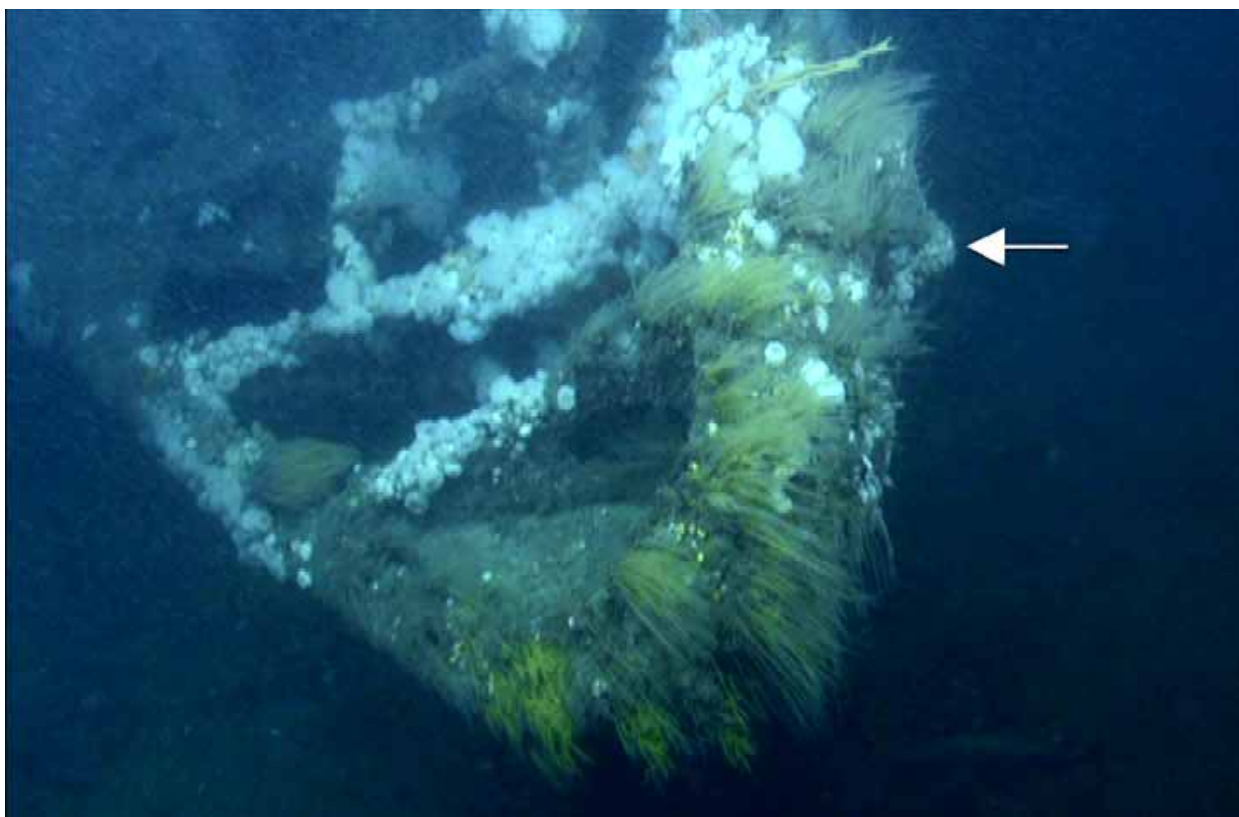


Fig. 12. The bow of U 1208's wreck, with an arrow pointing to the fastener for the antenna cable. Its sister ship, U 1206, was the first boat of the building yard Danziger Werft to be completed with this new design.

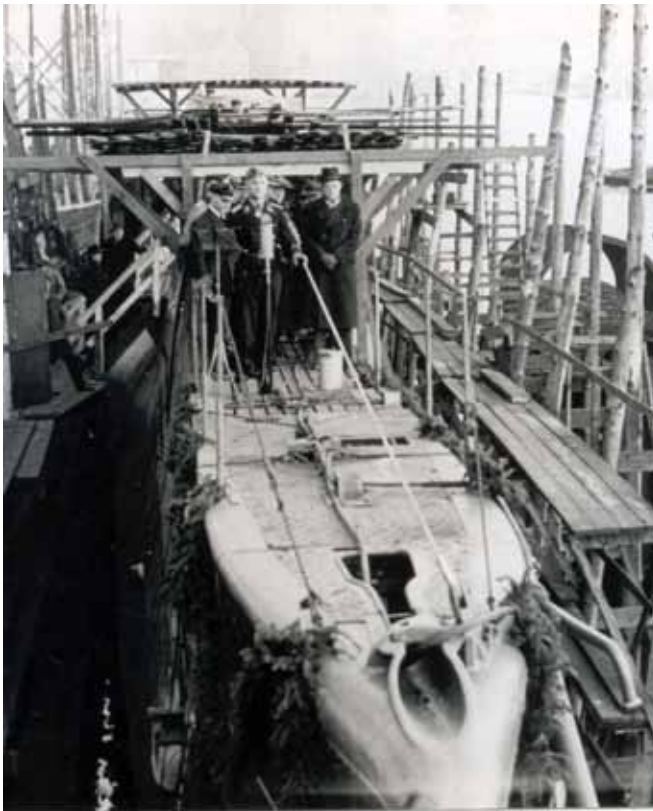


Fig. 13. U 1056 during its launching ceremony in April 1944 at the building yard of Germaniawerft AG Kiel, showing the enlarged Atlantic bow of U 1208 type and towing eye conversion for underwater refuelling. The radio antenna cable is fixed to a fastener visible on the right side of the towing eye. A number of different designs to fix antenna cables were used by U-boat building yards or on individual batches of newly built U-boats.

boat on 1 February 1945 to patrol against shipping at the western exit of the English Channel. On 5 February U-boat Command granted freedom to all boats then operating in the Channel to leave their assigned operational area towards the middle of the Channel or towards the coastal convoy route under the British coast between Brighton and Lands End in case no traffic was encountered in the erstwhile area. U 1208 should have arrived at the western exit of the Channel on or about 8 February. Having acquainted itself with the conditions inside this area, it is perfectly plausible that U 1208 closed the traffic focal point at Lands End. No further message was received from the boat after its last signal on 31 January 1945. When the boat later failed to return to Bergen, U-boat Command posted it as missing in its operational area effective from 5 March 1945.¹⁴

Comparison of the individual wreck features found during Odyssey's 2008 survey of the wreck, and a subsequent examination of available video footage, produced sufficient evidence to define its identity. Crucial features leading to the identification were the absence of the

balcony array for the multi-unit listening gear and the presence of the 'Atlantic' bow with towing eye conversion for underwater refueling. These observations thus excluded U 927 and U 1279 from the list of likely candidates, leaving U 1208 as the only other possible alternative for this particular U-boat wreck. The identity of the U-boat sunk on 24 February 1945 by the two frigates of Escort Group 3 has thus been established without doubt as U 1208, which was lost with all 49 men on board.

5. Wreck Sites D, E & F – U 1021 & U 400

Between the years 1990 and 2001 Scuba divers discovered three wartime wrecks of German World War II Type VIIC U-boats off the Cornish coast (sites D, E and F). Previously, no German U-boats at all had been recorded as wartime losses in these waters. A thorough examination of all German U-boat losses in historical records revealed that all boats recorded as lost up to the end of November 1944, having been directed to operate off Cornwall, are known to have sunk in other areas. After November 1944 several more Type VIIC boats received explicit orders to operate in the general area off the Cornish coast between Lands End and Milford Haven. Of these, U 400, U 1021 and U 325 never returned. Thus, it was assumed that these three U-boats had to be identical to the three wrecks in question. Based on somewhat incomplete wreck information obtained during former Scuba dives, a first guess about their individual identities was made in 2004 (Niestlé, 2004).

Previous research had also established that all three U-boats were lost to mining on secretly laid allied minefields, which remained unknown to German U-boat Command for the duration of the war. At the end of October 1944 intercepted 'Ultra' intelligence exposed the German intention for a probable renewal of U-Boat operations between Lands End and the Bristol Channel from Norwegian bases. On 29 October 1944 U-boat Command radioed a situation report for the Bristol Channel area to all boats at sea, which was to be kept permanently by the boats in their situation report files. Accordingly, it clarified that the limits of Britain's declared mine area were as follows: 52°10'N, 06°15'W and 52°00'N, 07°35'W through 51°35'N, 06°15'W and 51°00'N, 07°15'W to 51°01'N, 04°31'W and 50°33'N, 05°01'W. Noting that British authorities last mentioned the area in relation to naval warfare at the beginning of 1943, the boats were informed that otherwise no evidence was available that mines were still there. It was assumed that the minefields had not been renewed, so there would no longer be any danger to the boats.

The German situation report further provided the coordinates of the English convoy route along the Channel as operating at 51°05'N, 04°43'W as far as 51°02'N, 04°32'W to 50°33'N, and 05°02'W as far as 50°35'N, 05°15'W. Boats were informed to expect around three convoys steaming for the Channel ports daily from and to the Bristol Channel, passing Lands End at night, as well as war and merchant vessels sailing singly. On 18 November 1944 the Bristol Channel situation report was amended so that it now assumed the presence of minefields inside the declared area, to which the U-boats were reminded to pay attention. However, U-boat Command gave assurances that English convoy shipping routes radioed in were mine-free. Four days later U 680, which had left Bergen on 13 November 1944 for a patrol in British coastal waters, was directed to become the first boat to occupy the area cited in the Bristol Channel situation report as an attacking area. However, following a promising situation report from the English Channel area by U 978, U 680 was redirected to the latter area on 2 December 1944. Only two days latter U 400 received the order to patrol off the Cornish coast as a replacement for U 680.¹⁵

Through Ultra decrypts the British Admiralty was well

and timely informed about all of the above-mentioned German situation reports and operational intentions. On 15 November 1944 the Admiralty issued a policy signal to the Commander in Charge of the Western Approaches, stating that:

“...further consideration has been given to the relative importance of anti-U-boat minefields in the NW and SW Approaches. Routing of ocean convoys south of Ireland not only renders this the more attractive area but U-boats’ course of action can to some extent be anticipated. In the NW Approaches, mine-laying operations must follow rather than anticipate U-boat activities... Consider therefore as a matter of policy that mine-laying operations should be concentrated in the SW Approaches.”

In pursuance of their stated policy, and to meet the expected concentration of U-boats in the southwestern Approaches, the Admiralty ordered by signal on 25 November 1944 that the minelayer HMS *Apollo* should lay three lines of deep mines off Trevoze Head before cleaning boilers and making good defects at Plymouth. Operation ‘HW’ was to be conducted by the Commander in Charge of Plymouth and it was anticipated that the minelayer HMS

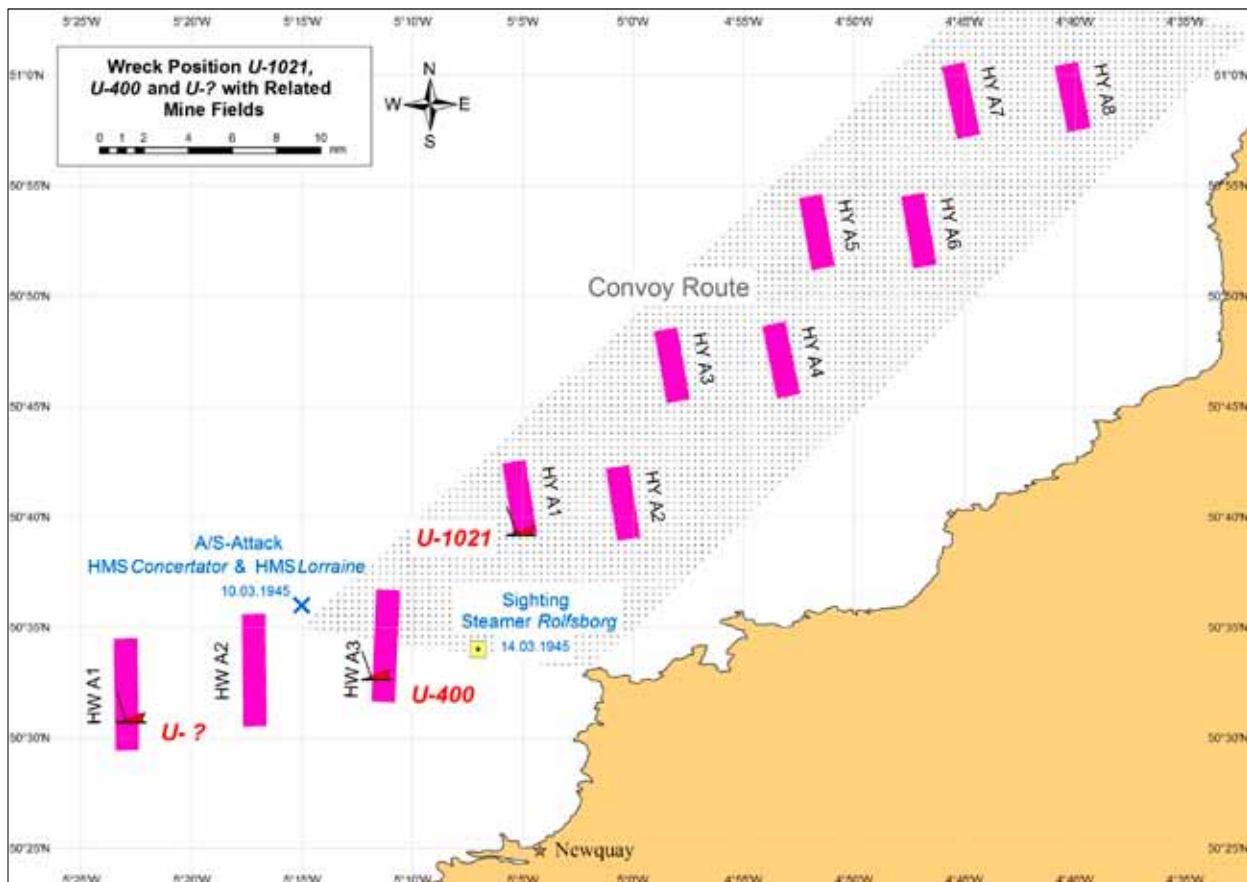


Fig. 14. Map showing the locations of wreck sites off the Cornish coast in relation to British mine field positions.

Plover would be available at the beginning of December to continue establishing these fields along the swept channel between Trevoze Head and Hartland point in operation 'HY'. Between 29 November 1944 and 3 January 1945 the two minelayers laid over 1,200 Mk XVII moored mines in 11 'deep fields' across the coastal convoy route along the north coast of Cornwall.¹⁶ Moored mines were used because ground mines sensitive enough to catch slow-moving U-boats would also have posed a threat to Allied surface ships. It should be noted that these mines were placed exactly within the area U-boat Command had explicitly declared mine-free in its amendment to the Bristol Channel situation report of 18 November 1944. Being aware of this advice, the British Admiralty set a well placed mine trap.

Comparison of the exact geographical coordinates of the individual minefields with the nautical positions of the three German U-boat wrecks revealed that each of the wreck positions is a near-perfect match with one of the above-mentioned minefields at sites D, E and F (Fig. 14):

- Site D (50°39'48"N, 05°05'04"W) rests in the southern half of field 'HY A1' laid by *Plover* on 12 December

1944. Consisting of 100 Mk XVII (39)/XVII units, it spread along a line extending for 3.3 miles in direction 171° from position 50°42.5'N, 05°05.4'W at a depth of 70ft. Two surface failures were reported during laying.

- Site E (50°33'16"N, 05°11'37"W) is situated in the southern half of field 'HW A3', laid by *Apollo* between 01.31 and 01.56hrs on 3 December 1944. Consisting of 156 Mk XVII (39)/XVII units, it spread along a line extending for 5 miles in direction 182.5° from position 50°36.7'N, 05°11.1'W at a depth of 70ft. One possible failure was observed during laying.
- Site F (50°32'24"N, 05°23'12"W) lays at the southern end of field 'HW A1', laid by *Apollo* between 01.31 and 01.56hrs on 29 November 1944. Consisting of 156 Mk XVII (39)/XVII units, it spread along a line extending for 5 miles in direction 179° from position 50°34.5'N, 05°23.0'W at a depth of 70ft.

Initially Odyssey anticipated surveying all three U-boat wrecks in the area to obtain new and comparative infor-



Fig. 15. A late-war Type LM43U gun mount, complete with a 3.7cm M42U AA-gun lying on the seabed beside the wreck of U 1021 (site D). The gun mount is inverted with the gun breech present just above the sandy sea bottom. The crew protection shield has already fallen off.



Fig. 16. The schnorkel top on U 1021 and its ring float valve. Contrary to the same installation shown in Figs. 4-5, this example is covered with Wesch-type anti-radar camouflage, displaying a thin plastic layer with a waffle-like surface. Normally only applied to the curved structure of ball-float schnorkel heads, it was occasionally also fitted to other head types. Incidentally, the supporting ring at the lower end of the head valve, designed to back the more bulky Jaumann-type absorber, is clearly visible on U 1021's schnorkel head.

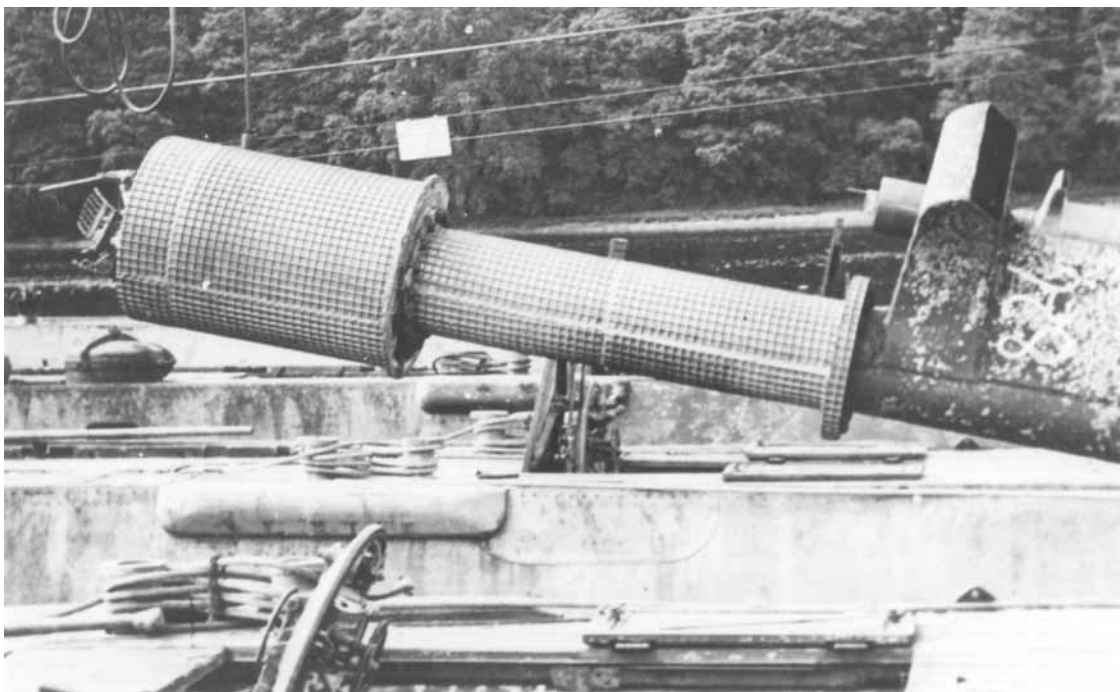


Fig. 17. The ring-float schnorkel head installed on U 826 (similar to U 1021), taken post-war at Lisahally, Northern Ireland, displaying a Wesch-type anti-radar absorber to camouflage the schnorkel head against radar detection. Like the Jaumann-type absorber, it was glued onto the metal surface of the head valve and the smaller stem tube below, above the exhaust outlet to the right. The latter should be submerged when the U-boat proceeded at correct schnorkel diving depth.



Fig. 18. Cover grating on U 1021 in the former location of the deck gun mount, which was no longer fitted in newly commissioned U-boats from 1944. Alongside, the type 1 schnorkel installation with its circular pressure flange is visible in the recess of the upper deck plating.

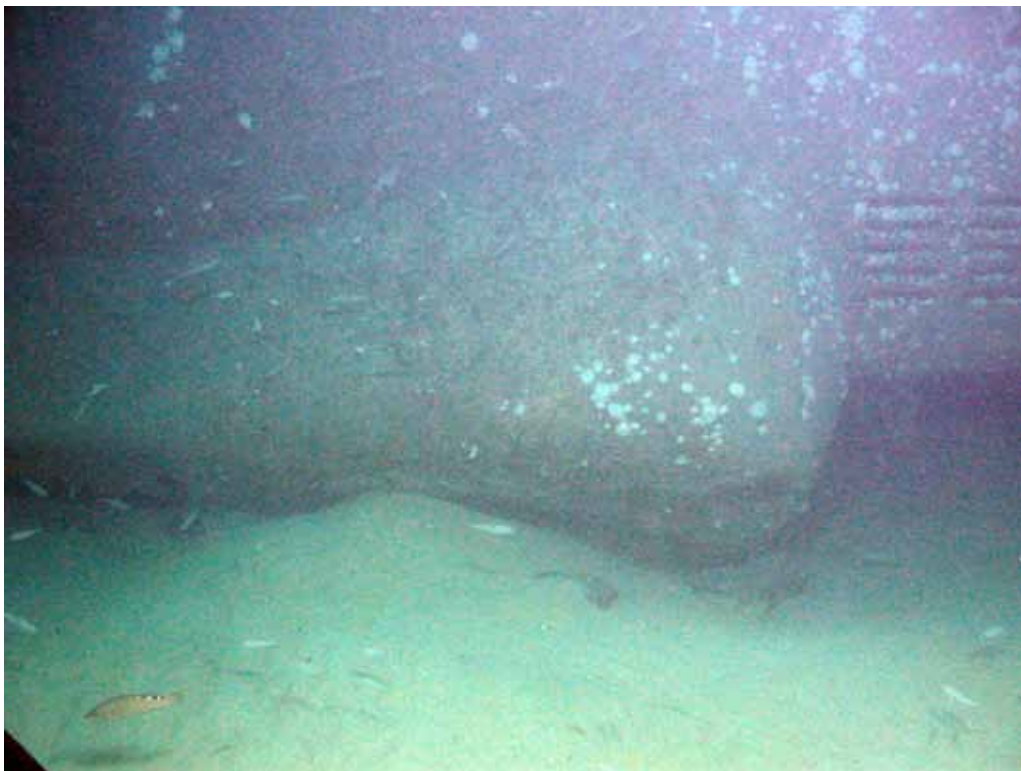


Fig. 19. The late-war balcony microphone array for the multi-unit listening gear at the forward end of the ship's keel on the wreck of U 1021. This improved installation allowed the passive detection of shipping noise from ships and convoys well beyond the horizon. Due to the difficult situation at building and repair yards in Germany since the end of 1944, only a few sets were installed on frontline U-boats before the end of the war.



Fig. 20. Crew members taking a meal on the deck of U 1021 (front) alongside a sister boat from the same building yard in harbour while working up in the Baltic Sea, presumably at Pillau during autumn 1944. The crew members are sitting on top of the schnorkel tube laid down on deck. The cooking pot forward left is standing on the cover grating shown in Fig. 18.



Fig. 21. The upper deck in front of the conning tower on the wreck of U 400 (site E). The pressure flange on the schnorkel mast serves as a comparison point to U 1021. Instead of the steel grating visible on U 1021, some boats like U 400 were fitted with a pressure tight Marcks-type life-raft container in that position, which could be opened from inside the boat in case of emergency.

mation. Owing to unexpected changes to the expeditions time schedule, eventually only two dives could be realized. Site D was first dived on 19 July 2008 and the U-boat hull was discovered in excellent visibility at a depth of 50.2m on a flat, sandy bottom. With the general condition of the wreck surprisingly good, much of the upper superstructure aft and forward of the conning tower is still in place. Battle damage caused by the explosion of the mine on contact at starboard in the area of the Petty Officer's living quarters, aft of the control room, is clearly apparent but localized. The force of the explosion formed a semi-circular destruction area measuring about 10m in diameter and caused a massive breach in the pressure hull. The complete superstructure in that area is now lying to starboard next to the hull on the sea bottom.

Among the debris a late-war Type LM43U gun mount with part of its 3.7cm M42U anti-aircraft gun still attached was discovered (Fig. 15). The boat is fitted with the old Type 1 folding schnorkel installation, which was installed up to autumn 1944, with a half-height pressure flange connection to the diesel air intake tube along the port side of the conning tower casing, in combination with a ring-float schnorkel valve with 'Wesch'-type anti-radar coating on the circular stem tube between the exhaust outlet and

the ring-float head (Figs. 16-17). No anti-radar coating was found on the drum-shaped ring-float head. A circular grating in place of the deck gun platform in front of the conning is clearly visible (Figs. 18, 20). The extreme bow superstructure has collapsed and the towing eye is visible on the seabed. A balcony array for the multi-unit listening gear is fitted at the forward end of the keel (Fig. 19).

Site E was dived next on the same day. The wreck is sitting upright on a hard, flat sea bottom at a depth of 52.3m. Aft of the conning tower the complete hull and its superstructure remain in place, except for the wooden planking. This includes the hydroplanes, rudders, shafts, propellers and aft torpedo tube V at the extreme stern. The rudders and planes are in a neutral position. The after torpedo hatch and galley hatch are both shut. The hatch cover to the conning tower is missing, lying to one side on the sea bottom. Both periscopes are down. The former bridge structure has collapsed and slid down onto the seabed with a Type LM43U gun mount for the 3.7cm anti-aircraft gun lying inverted alongside the hull. Forward of the conning tower a 'Marcks' liferaft container has been fitted in place of the deck gun plate (Figs. 21-22), together with the old Type 1 schnorkel installation with a ball-float schnorkel valve and a 'Wesch'-type anti-radar coating on



Fig. 22. U 400 during its commissioning ceremony at the building yard of Howaltswerke Kiel on 18 March 1944. The Marcks-container positioned in front of the conning tower is clearly visible.

the schnorkel head. Battle damage is obvious just forward of the schnorkel head. The forward torpedo hatch is dislodged, with a large crack in the pressure hull running diagonally along its perimeter. The forward bow section with torpedo tubes has been completely separated from the rest of the hull by the force of the mine's explosion. Four pressure-proof dinghy containers formerly located on the forward deck now lie on the seabed.

The identification of U-boat wrecks depends to a high degree on finding key identification marks on hulls, which may lead to identification when compared with fitting features known to have been carried during the war on individual boats. Although U 400 is known to have carried one of the first Type LM43U anti-aircraft gun mounts for frontline testing, this item offers no help because this type of gun mount is present on both wrecks sites. Instead, other features proved to be the crucial factors. Site D is characterised by a circular grating in place of the deck gun plate in front of the conning tower, while site F had a 'Marcks' liferaft container fitted at that location.

By comparing war-time photographs it was observed that the circular grating plate, whose appearance on previous, low power lighted video footage had resembled that of a deck gun plate (Figs. 18, 20), was never fitted onto U 400 and her late-war sister boats built at the yard at Howaldtswerke Kiel. Instead, these boats did carry the 'Marcks' liferaft container in that location, which was moved to that position in order to free its original place for the cut in the upper deck required to insert a schnorkel. Correspondingly, U 1021 was fitted with a grating plate and very probably also with a modified balcony array for the multi-unit listening gear at the forward end of the keel present at wreck site.

Based on the available evidence it is now proposed to amend the historical records so that we can conclude that U 400 was mined on field 'HW A3' (site E). According to U-boat Command's daily plot, U 400 was expected to arrive in its operational area on or shortly after 14 December 1944. Thus, it is entirely plausible that U 400 met its fate only days after the new anti-submarine minefield was laid.

U 1021 was lost in field 'HY A1' (site D). This U-boat is expected to have arrived in its operational area on or about 10 March 1945. That appears to coincide with the sighting of a suspected periscope on the afternoon of 10 March 1945 by the minesweeping trawlers HMS *Concertator* and HMS *Lorraine* at position 50°36'N, 05°15'W. The trawlers carried out an attack, expending their full outfit of eight depth charges, without result. On the afternoon of 14 March 1945 the north-bound British steamer *Rolfsborg*, a straggler from convoy TBC-95, heard a heavy explosion when at a location 294° and 4 miles off Trevoze Head, which converts

to approximately 50°34'N, 05°07'W. Patches of oil were later observed on the surface of the sea. At the time of the incident there were no other surface vessels in the area. In light of this evidence it is possible that U 1021 met its end on that day.

It is most regretful that there was no opportunity to inspect the third U-boat wreck in position 50°32'24"N, 05°23'12"W (site F), previously misidentified as U 325, but with its identity now again open to question following the confirmed discovery of that U-boat off Lizard Head. This mystery will be solved hopefully by choosing the site as a dive target during a future expedition.

6. Conclusion

In 2008 Odyssey Marine Exploration mounted an expedition to determine the hitherto unknown or vague identities of World War II U-boat wrecks in the Western English Channel and north coast of Cornwall. The five wreck sites visited showed different levels of preservation due to wartime damage, natural degradation and the detrimental impact of bottom fishing trawling. Visual site reconnaissance was achieved using the Remotely-Operated Vehicle Zeus on board the research vessel *Odyssey Explorer*. Close cooperation between various specialists both before and during the dive operations ensured that key wreck features essential for successful forensic wreck examination were pre-selected.

Based on authoritative evidence obtained during the ROV surveys, the wrecks were eventually identified as the former German U-boats U 325, U 400, U 650, U 1021 and U 1208 (Fig. 23). Of these, U 325 and U 650 had been recorded as missing on patrol without any further information about their fate being available since the end of World War II. Offering fresh information on the boats' final patrols and fates, the 2008 Odyssey expedition results have now corrected previous errors in the operational history of the German U-boat campaign in the Western English Channel during the final phase of the war. The survey project stands out as a fine example of successful teamwork between marine archaeologists and historians rewriting naval history. Further expeditions could lift the secrets of the fate of many more known, but as yet unidentified U-boat wrecks strewn across the seabed around Great Britain and Atlantic waters.

Apart from the historical results achieved by the expedition, and the realization that high-tech ROV techniques in marine archaeology offer great potential for future survey options, it should not be forgotten that the wrecks visited during the expedition are the final resting place of 241 German submariners, who paid the ultimate price in loyal

service for their country. Even after more than 60 years having passed since the fateful days of World War II, those killed on board are not forgotten by their families and relatives. There are no roses on a sailor's grave, but remembrance to those killed has now at least become a clear focal point in an underwater space. Odyssey Marine Exploration and the whole expedition team take special pride in this achievement of the expedition.

Acknowledgements

Results presented in this report would have been impossible without the initiative and support of Odyssey Marine Exploration. Special thanks go to Tom Dettweiler and Mark Martin as on-site Project Managers, Neil Cunningham Dobson and Hawk Tolson as Directors of Field Archaeology, and to the whole expedition team on board the *Odyssey Explorer*. John Oppermann helped greatly with support and encouragement. Gerhard Seiffert deserves special credit for producing the wreck site maps. Sean Kingsley, the Director of Wreck Watch International, kindly edited the manuscript for publication. This project would have been impossible without the support of Jason Williams, JWM Productions and the Discovery Channel, to whom I am extremely grateful for permission

to produce some images used in this report. Last but not least, I would like to add to the credit numerous Scuba divers, especially my fellow researcher Innes McCartney, for their long-term help and courage shown in the past during their innumerable deep dives in the waters around Britain to uncover the secrets of German U-boat wrecks hidden in the darkness of the sea.

Notes

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3. *British Mining Operations, 1939-1945, Naval Staff History, BR 1736(56), Vol. I* (London, 1973), 250-52
4. Supra Note 3, 262-63. Times are given as Central European Time (GMT+1).
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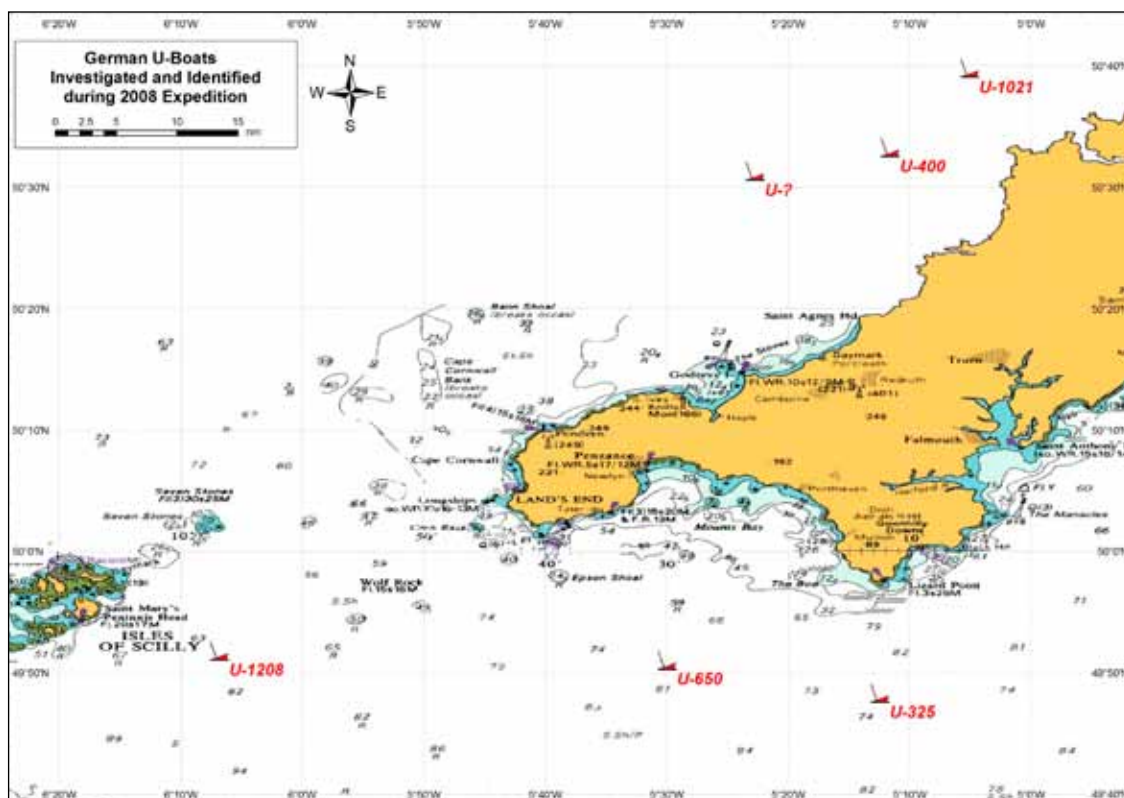


Fig. 23. Map of Odyssey's 2008 U-boat expedition area, correlating the locations of wreck sites with reassessed U-boat losses.

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 10. See Note 9, attachment list of wrecks and non-submarine contacts.
 11. TNA, ADM 199/1442, Plymouth Command: War Diaries 1945.
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