Archaeology of a Great War U-boat Attack Off Southern Portugal: Development and Adaptation of Methods and Techniques

Jorge Russo
CINAV - Portuguese Navy Research Centre, Portugal
russochief@gmail.com

Augusto Salgado
CINAV - Portuguese Navy Research Centre, Portugal
aaasalgado50@gmail.com:

Abstract

On 24 April 1917, the German U-boat U-35, commanded by Lothar von Arnauld de la Perière, halted, attacked and sunk one wooden sailing ship and three metal cargo steamers off the coast of Sagres and Lagos, Algarve, Portugal.

On the eve of the centenary of this Great War episode, a team from the Portuguese Navy Research Centre (CINAV) started a historical and archaeological project on the U-35's mission and these sunken ships.

The sailing ship was the first to be searched at a depth of more than 650m, in what was also the first Portuguese underwater archaeology mission on a large technical scale in Portugal. The location of one of the steamers has been clarified, and the identification of the other two was proven.

During our archaeological and historical research into the three steamers, we developed or adapted diverse methodologies in order to survey and record them, such as 3D printing, and to identify crewmembers in historic photographs, by using an advanced algorithm for biometric recognition.

Sharing these hopefully useful methodologies is the objective of this paper.

Keywords

U-35, Great War, 3D printing, biometric recognition

Introduction

On 24 April 1917, the German submersible U-35, of the U-31 class, commanded by the 'ace of aces' Lothar von Arnauld de la Perière, sunk four ships off Sagres and Lagos, on the south coast of Portugal. Germany had been officially at war with Portugal since 9 March 1916, after the Portuguese requisition of all German and Austro-Hungarian ships anchored in Portuguese continental, colonial or insular ports. This action was followed by the consequent German declaration of war.

From the War Diary (SM U-35 Kriegstagebuch, 1917), we know that U-35 left the Austro-Hungarian Adriatic naval base of Cattaro, today's Montenegro, on 31 March, heading to the west Mediterranean and the south of Portugal, aiming at the busy merchant lanes from and to the Mediterranean through the Straits of Gibraltar. Even with battery problems and a torpedo attack by a French submersible, de la Perière was able to safely cross the dangerous Otranto Strait and the Italian blockade. The U-35 then crossed the Mediterranean by way of Sicily and Sardinia and stopped at the African coast on 8 April. It crossed the Straits of Gibraltar to the west on the night of the 13 to 14 April.

During the two-week journey to the Atlantic, de la Perière halted and sunk several merchant ships, and exchanged gunfire with some of them. He reported in the War Diary an intense naval coastal patrol, off both the African and Spanish coasts, east of Gibraltar.

After engaging several merchant ships, where some were halted and others sunk, the U-35 positioned itself off Cape Saint Vincent, in Portuguese waters, on 24 April. Shots from U-35 actions were heard on the Portuguese coast and the small-armed tug *Galgo*, serving the Portuguese Navy, was sent to investigate. Armed with a 37mm Hotchkiss canon, *Galgo* engaged the German submersible, but the Hotchkiss 2nm range was no match for the 15nm 105mm gun of the U-35. After a short exchange of fire without consequences, the Portuguese Navy tug oriented its efforts on rescuing the men from the ships which had been sunk by U-35.

The first interaction with the merchant traffic occurred at 8.50am, when the Danish merchant steamer SS *Nordsoen*, heading from Scotland to Italy, under British charter, was halted. Its papers were confiscated, the crew released but the ship was sunk by explosive charges set by the submersible crew. Only 25 minutes later, the Norwegian merchant steamer SS *Torvore*, travelling from Swansea to Naples under British charter and loaded with 1667t of locomotive coal bricks, was sunk, also by explosives.

Now the U-35 headed east in the direction of Lagos, where it engaged the armed French merchant steamer SS *Caravellas*. The French Navy auxiliary ship was armed with 90mm guns, and fought the submersible for 30 minutes, firing 18 shells. The submersible fired five shells and stopped the pursuit because it was short of ammunition, allowing the French to escape heading east. Meanwhile, a previously halted ship was on hold, and was sunk after the fight by gunfire. She was the Norwegian 3716-ton merchant steamer SS *Vilhelm Krag*, formerly *Nordpol*, travelling in ballast but under British charter, between Genoa and Barry Roads.

Heading back to Cape Saint Vincent, de la Perière discovered that the charges that were placed earlier on the Danish ship had not exploded and that it was now aground on the Algarve's shore cliffs. He ordered his crew to place another set of explosives and, this time, the ship was sunk. Before returning to Cattaro, the U-35 sunk the 265-ton Italian brig *Bienaimé Prof. Luigi*, 10nm south-east off Cape Saint Vincent. The Italian vessel was heading from Fowey to Genoa with a cargo of China clay.

Between 25 and 26 April, U-35 crossed the Strait back into the Mediterranean, arriving at Cattaro safely on 6 May 1917, after a navigation of 36 days, travelling 2230nm on the surface and 321nm submerged. During this navigation, the U-35 sunk 24 ships, in a total of more than 80,000 tons, using all the nine torpedoes it carried, 541 of its 105mm grenades and 29 explosive charges.

Almost 100 years after the U-35's actions that brought the Great War to the continental Portuguese waters, far away from the Belgium trenches and the African remote territories, and out of history books, a team from the Portuguese Navy Research Centre (CINAV), supported by the Portuguese Great War Centenary Commission and Vila do Bispo Municipality, started Project U-35[1] (2014).

Project U-35 aims to research the history of the episode and to investigate the archaeology of the four ships sunk on 24 April 1917. The main objectives of the archaeological project were: to determine if the alleged U-35's wrecks were indeed the ships sunk by the submersible that day; to clarify the location of the Danish ship SS *Nordsoen*, which appeared in different spots, on different dive guides; and, to locate the Italian brig, more than 650m deep.

[1] http://projectu35.wixsite.com/projectu35

During the archaeological work, the team felt the need to adapt methods and techniques, and / or to develop and apply some that we had never tried before. For example, the archaeography around the SS *Torvore* lies more than 30m deep. In this wreck the use of multibeam echo sounder geophysics data, besides the obvious results, allowed the production of an analogical model of SS *Torvore* and SS *Vilhelm Krag*. On the human factor, the application of biometric algorithms helped to identify a crewmember from one of the sunken ships in historical photographs where he was not safely identified. The team also needed to find a way to enable the use of heavy and very expensive means for searching at that depth to find material evidence of the Italian ship. The project did not have the money for these costs, which are usually enormous.

Looking for the Italian brigantine *Bienaimé Prof. Luigi*, more than 650m deep

The U-35's War Diary indicates the sinking of the Italian sailing ship on a set of coordinates that puts her more than 650m deep, 10nm south-west of Cape Saint Vincent, perilously near to today's commercial navigation lanes. To conduct a scientific mission looking for an almost 100-year-old wooden wreck, at that depth, offshore, and near a commercial navigation lane, was outside the very small project budget. The project needed a seagoing oceanographic ship and a deep sea ROV. The team begin seeking alternative ways of achieving the needs of the project. The answer came in the form of a synergic collaboration, that was indeed symbiotic.

The Portuguese Task Group for the Extension of the Continental Shelf was setting off on a new mission to the Azores Islands. Each time, before they go on a mission, they need to do a test dive with their ROV *Luso,* not far from their base, in case an anomaly is detected. Having identified this opportunity, the project team provided them with an objective for their test dive—the position of the Italian sailing ship that is written in the U-35's War Diary. This was the first time the ROV and its pilots were involved in an archaeological task.

With all these issues considered, including the new field of research, we were allowed to use the only Iberian deep sea ROV and one of the Portuguese Navy's oceanographic ships—the NRP *Gago Coutinho*—on our search mission. It was a truly symbiotic collaboration that did not end there and is still continuing today.

We departed the Lisbon naval base on the morning of 27 May 2014 and headed south to Cape Saint Vincent. After a night of sailing and an echo sounder beam survey, the *Luso* ROV commenced the long descent down to the acquired targets and the historical coordinates we had. The team was very excited; the hours spent in the dark control room in front of dozens of television screens

Figure 1. ROV control room, with screen showing the wooden plank.

seemed like minutes. Suddenly a small dot appeared on the ROV's sonar. The ROV pilot headed to the spot and minutes later, a wooden object appeared from the darkness of the abyss (Figure 1).

It was the only object the team found from all the targets investigated; and, we did not find any convincing evidence relating that wooden plank to the Italian brigantine. However, the size of the slow growing corals on it, suggests at least the possibility.

Was Hans Johan Larson on two historic group photos?

The application of biometrics

Hans Johan Larson (1885–1925) was born in Bergen, Norway, on 15 January 1885, and died on 12 August 1925 (pers. comm., Nielson 2015). He obtained his navigation certificate at the age of 23 and was part of the SS *Nordpol*'s crew as foreman, for eight months in 1906/1907, and again as second pilot, until 1911. His last job was at the port of Bergen.

Larson would have his share of the war when one of the ships he sailed on was torpedoed off Murmansk, in Russia. He was sent to a hospital in Arkhangelsk, Russia, where he stayed for some time in the company of a helmsman from the same ship. In the last four years of his life, as an employee of the port of Bergen, he was always very sick, suffering from back problems, rheumatism, kidney failure and heart. He died in 1925 from a heart attack.

In 2015, Larson's grandson, Hans Nielson, contacted the project, informing us his grandfather was a former crew member of the SS *Nordpol*. It happens that Larson's SS *Nordpol* was our SS *Vilhelm Krag*, sunk by the U-35 as a result of gunfire, on 24 April 1917. German submersibles, thus, constituted a conceptual link, which bound this Norwegian man, not only to our SS *Vilhelm Krag,* but also to the submarine warfare on the merchant navy during the Great War, and the neutral victims.

Hans Nielson gave the team all the information he knew about his grandfather, along with an impressive set of historic photographs. Amongst them was an image of the SS *Vilhelm Krag* as SS *Nordpol*, which had never been published before. He also gave the team some photographs of his grandfather. In these photographs, there were two group photographs, one with the crew of the SS *Nordpol*, on board the ship, and another in what appears to be a marriage. Nielson's mother claimed that Larson was in these group photographs, but as Nielson did not recognise him in any of them, he did not believe that Larson was included.

The project had gained a new objective: to determine if Hans Larson was in the group photos. The question was: how was this to be achieved?

The team began by considering who had the ability to identify specific persons amongst groups of people: security agencies! Airports are a good example as they largely use biometrics for face recognition. The team then looked into companies that develop and build biometric systems for airports. We discovered that the world leader in this field is Portugal (Vision-box[2]), and that their head office is in Lisbon. We contacted the office immediately, and after some short briefings, they accepted the challenge and agreed to assist the team. They adapted some of their biometric algorithms and tested the two single photos of Larson against both group photographs.

What the algorithm delivers is the number of times the facial recognition fails to identify someone specific, in this case, Larson in the group photos—comparing his notable facial features with those of everyone else in these photos. From the Vision-box perspective, the curve that characterises the algorithm that was chosen for this evaluation relates the number of false acceptances as a function of the value to the match scores obtained. A score of 44, meaning around 0.070% of false recognitions every 100 positive tests, is acceptable to claim a positive correspondence. The test resulted in 36.25 in the crew photo and over 44 to the marriage photo.

So, even without 100 % certainty, the method and the test resulted in a very strong claim that Hans Johan Larson was in fact in both group photographs; and, that this method can work and be applied to identify people in historic photographs (Figure 2).

[2] http://www.vision-box.com/

Figure 2. Application of biometrics on facial recognition in the identification of Hans Johan Larson in historic group photographs.

Building an analogical 3D model from multibeam echo sounder geophysics x, y, z data

Conducting geophysics on submerged heritage, including wrecks, is today quite commonplace and almost mandatory in any archaeological survey. Multibeam echo sounder is one of the methods employed, and the project conducted, in 2015, a multibeam survey field season on the three steamers sunk by U-35 off Sagres and Lagos.

We always look to our data acquired during field seasons and ask ourselves what uses we can apply it to, besides the obvious. Reusing data, or using it for several objectives and for different purposes, is a way of making it less expensive. The answer to this question came in an analogical 3D model of the wrecks on the SS *Torvore* (30m+) and SS *Vilhelm Krag* (40m+).

The process was very simple. We transformed the x,y,z data from the multibeam echo sounder survey data to a STL file,[3] that is, printable on any common 3D printer.

With the 3D model printed, we looked for lost information that came from resolution problems, and add them to the model. After that, the model was undercoated with a neutral colour, and hand painted to simulate rust, concretions and biological life (Figure 3).

We understand the subsequent analogical 3D model has a considerable and serious amount of interpretation, but it revealed itself to be a very useful tool to brief and debrief the team's divers; and, to explain to people

[3] The STL file format is the most commonly used file format for 3D printing.

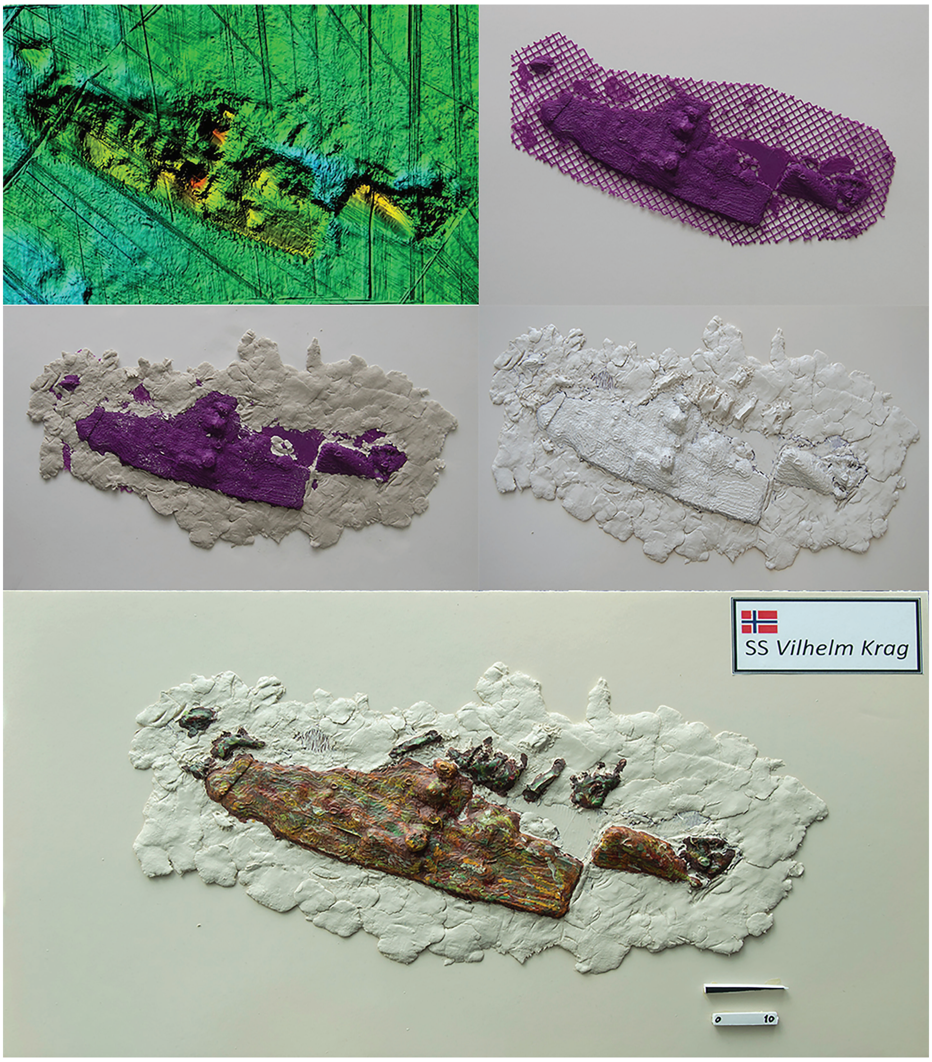

Figure 3. Analogic 3D model of the SS *Vilhelm Krag*'s wreck.

about features of the wreck, especially those who had never visited the wreck, or never will.

The model proved extremely useful especially in the case of SS *Vilhelm Krag*. The Norwegian 3700-ton ship that is now a large and horizontal metal parallelepiped on the bottom, where only the boilers stand out, makes navigation and archaeography, particularly at that depth, not an easy task. Divers, briefed on the model, stated that after the very first dive, they had no problem navigating the wreck site, immediately finding the boilers and other features, as if they already known the wreck by diving it. The analogical 3D model, produced by printing a STL file made from the x,y,z multibeam echo sounder data, increased the safety and the diving team efficiency.

The archaeography of a 72m long metal wreck

Our main archaeography objective for the wreck of the SS *Torvore* was to record the outline of the hull, location of the engine room with its boilers and steam engine, as well as starboard and port profiles. The issues were the depth (more than 30m), a short field season available, the large extent of the wreck (more than 70m), and a diving team consisting mainly of non-archaeologist divers who had either a brief or no experience in archaeography. Other important aspects to consider were the desire to involve the local diving community in the project, on a long-term basis.

With these conditions, it was necessary to define the methodology to perform the archaeography of this specific wreck, given the objectives outlined and considering the need for it to be feasible for an inexperienced team of non-archaeologists to undertake it. The diving team was made up of non-archaeologists, who were nonetheless very experienced and competent technical divers, with closed circuit (rebreathers) set up, including plans for decompression dives with 90' bottom time, implicating long 150' total run time dives, including decompression.

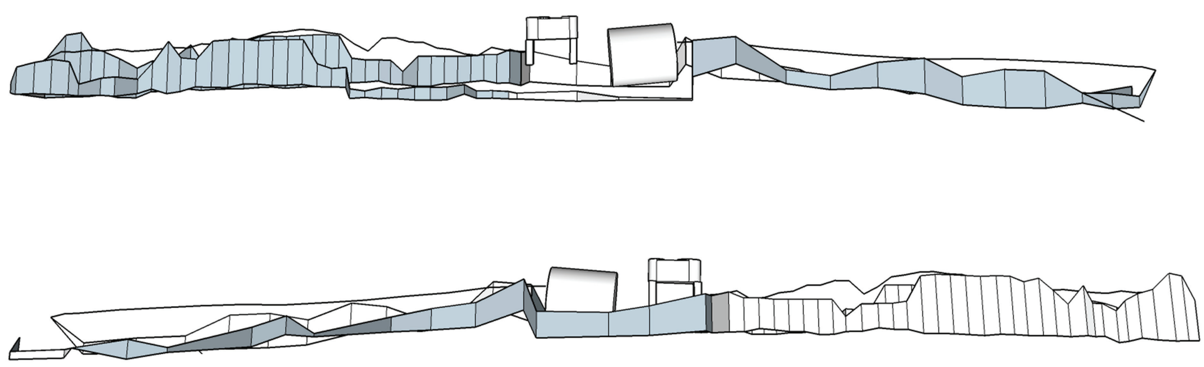

Figure 4. SS *Torvore*´s wreck archaeographic profiles.

With two teams of two divers each, we designed, implemented and tested the traditional baseline-offset method. In this case, we set two baselines, one from the stern to the engine, and other from the boiler to the bow. The stern baseline was marked at every metre, and the bow baseline every 3m. The objective of different markings was to test the outcome of the two resolutions (1m and 3m). Divers measured direct distances, from the baseline to the starboard and port outline of the wreck, using fibber measuring tapes, and depths between the outline of the wreck, on the points where the direct distances were measured, and the perpendicular respective point on the bottom, to record the wreck profiles (Figure 4).

As it was not possible to establish straight and levelled baselines due to wreck debris, both baselines were, in fact, a group of baselines set together (1m or 3m long). The Pythagorean Theorem was used to determine real distances between the baseline and the wreck outline selected points. As we were using depths, to determine real distances and record profiles, during very long dives over several days, we had to consider tides and the need for depth calibration.

To calibrate depths, we set a control point (P0) in the overpressure valve of the high-pressure cylinder cover of the steam engine, as the first task of the first dive. The dive running time of the P0 first measurement was recorded in order to calibrate it to the Lowest Astronomical Tide (LAT). With the P0 LAT calibrated, we just had to measure the depth on P0 at the beginning of every dive and add or subtract the difference to the depth registered with every measurement made during the dive. We could even measure P0 depth immediately after the last depth measurement, as the last task, to introduce the tide weight during the dive bottom time in the calibration process, to increase accuracy. All depths were considered as the Average Depth, meaning the average value derived from the maximum and minimum recorded depth, for each depth measured (AD = (Pmax+Pmin)/2).

To calibrate P0 depth to the Lowest Astronomic Tide, we used the rule of twelfths. In a simple and short explanation, we start with Tide Tables that gives us low and high tide levels, for a specific port, day and time. Using the rule of twelfths on the local tide table, we were able to determine the Lowest Astronomical Tide for our specific time, day and port, knowing that tides evolve the following way: 1/12 on the first hour, 2/12 on the second, 3/12 on the third, 3/12 on the fourth, 2/12 on the fifth, and 1/12 on the sixth hour.

In this specific case, this was the calculation used to LAT calibrate SS *Torvore*'s P0:

To Sagres and Lagos, we needed to use the Tide Table for the port of Lagos (Table 1), on 1 September 2014, 10h55 UTC+1, when we first measured P0 depth.

Table 1. Tide Table for the port of Lagos on 1 September 2014.

Date: 2014-09-01	**Port: Lagos**	
Summer Legal Hour (UTC +1)	(m)	
Monday, 2014-09-01 00:42	1.09	Low-tide
Monday, 2014-09-01 07:04	2.87	High-tide
Monday, 2014-09-01 13:04	1.18	Low-tide
Monday 2014-09-01 19:28	2.80	High-tide

At the start of the first ever dive (Run Time = 08h04), P0 depth was:

P0 Max = 24.9m
P0 Min = 25.0m
Average P0 = 24.95m

The difference between high-tide and low-tide was **2.87m – 1.18m = 1.69m**
Using the rule of twelfths:
08h04, one hour after the Low-tide = **1/12**
09h04, two hours after the Low-tide = **2/12**
10h04, three hours after the Low-tide = **3/12**
11h04 (10h55 is closer to 11h04 than to 10h04), four hours after the Low-tide = **3/12**
Total = 9/12
So:
09/12 = 0,75 x 1,69m = 1.2675m
We then should subtract **1.2675m** from the Low-tide value of **2.87m** = **1.6025m**
As **P0** was recorded **24.95m (Average P0) – 1.6025m** = **23.348m**

Reference LAT Calibrated P0 = 23.348m

From this point onwards, any depth will be subtracted or added with the difference between the **P0** measured at the beginning of the dive, and the **Reference LAT Calibrated P0** (**ΔP0**).

After only three dives, the team managed to fully record the outline of the wreck, position of boiler and engine (Figure 5), and profiles. In reviewing the results, the divers observed that it looked like what they remembered seeing on the bottom. And, to verify accuracy, we decided to overlapped the record with the multibeam echo sounder record (Figure 6).

Obviously there were issues, easily corrected in a subsequent field season, but the method proved to be sufficiently accurate for the objective we had, and perfectly feasible for teams of non-archaeologist divers with minimal experience in archaeological recording and survey.

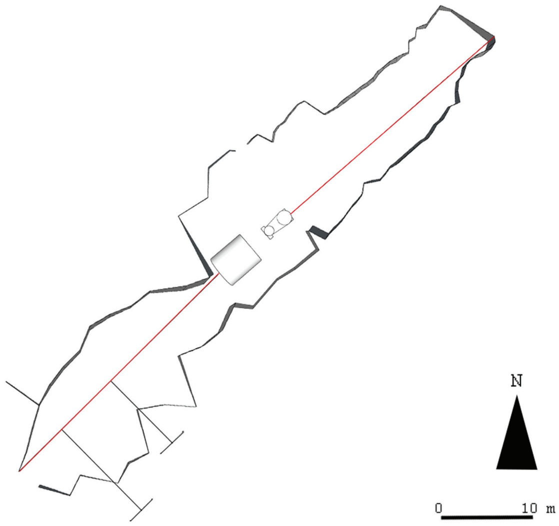

Figure 5. SS *Torvore´s* wreck archaeographic outline.

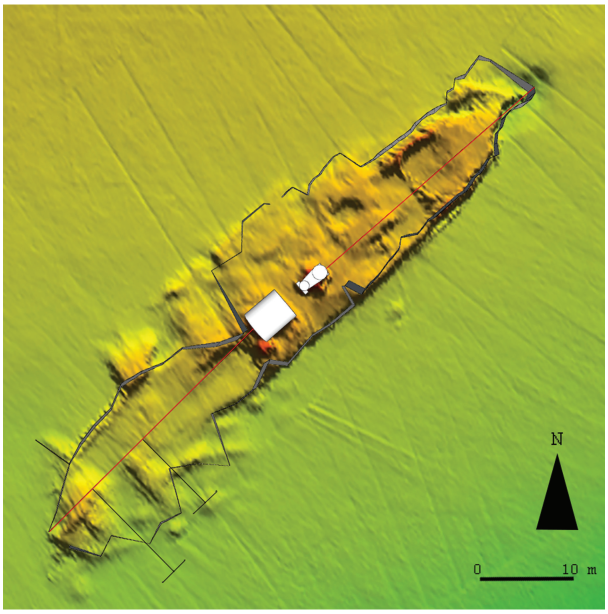

Figure 6. SS *Torvore´s* wreck archaeographic outline and geophysics comparison.

Conclusion

In conclusion, we have tried to demonstrate how a very low budget maritime archaeology project, around a Great War episode, almost unknown in the history books, was successfully conducted and concluded.

The success of the project and its results were critical, we believe, for rethinking some classical archaeological methods and adapting others, developing methods according to the project's needs, and building close and strong symbiotic relationships. This approach allowed us to use highly technical and expensive logistics and technology, and to involve non-archaeological divers.

The adaptation of the classical baseline and offset method allowed us to successfully record a 70m long metal wreck which is 30m deep, with a team of four divers, and in only three days. The use of simple depth measuring and Lowest Astronomical Tide calibration methods allow us to record, with the desired accuracy, both the port and starboard hull sections, within the same framework and team.

The use and adaptation of state-of-the-art biometric algorithms designed and developed for airport security facial recognition allowed us to identify a crew member related to the historic episode, from simple to group historic photographs, and to prove the applicability of this methodology in similar cases.

This was possible due to a symbiotic relationship with technology world leader Vision-box, as was the case with the symbiotic relationship with the Portuguese Task Group for the Extension of the Continental Shelf, that allowed the project to look for the Italian brigantine *Bienaimé Prof. Luigi*, more than 650m deep, with an oceanic hydrographical vessel and a 3000m deep operation with an ROV.

The involvement of non-archaeologist divers with technical diving skills, allowed us to conduct our tasks in a deep environment, proving the feasibility of carrying out important archaeological tasks in a successful way with recreational divers and enabling us to assess what is critical if we want to involve local communities in safeguarding underwater heritage.

Reference

SM U-35 Kriegstagebuch, (Manuscript). 31 Mar-06 May 1917, Bundesarchiv, Freiburg, Germany.

Further Reading

http://projectu35.wixsite.com/projectu35.