

Stunning Views

The ADUS team at St Andrews and Dundee universities have been working on sonar visualisation technologies for some time. Now they have applied the technique to underwater wrecks and that's good news for divers in Scotland ...



the Karsruhe at Scapa Flow

Divers in Scotland will soon benefit from the latest sonar visualisation technology which provides accurate and detailed images of wrecks. Already some of Scotland's better known wrecks have had the sv treatment and the results are dramatic.

In this article Martin Dean, Mark Lawrence and Chris Rowland (ADUS) - www.adus.org.uk and www.wrecksight.com offer an insight into the new technology used by ADUS, a specialist wreck survey team based at the Scottish universities of St Andrews and Dundee.

Unlike the usual artistic impressions of well-known dive sites, these new sonar images reveal wrecks exactly as they are lying on the seabed, and in precise detail, offering an unprecedented level of information to divers. The current condition of the wreck is revealed and accurate coordinates of features on the wreck and significant pieces lying nearby are recorded to centimetric accuracy.

By making such wreck images and survey data available for the first time, and in a variety of formats, divers' experience and understanding of the wrecks can be enhanced. More efficient and safer dive planning becomes possible, and divers will at last have the opportunity to show their friends and family exactly what they've been diving on when they get home from a dive trip.

OVER THE LAST decade significant advances have been made in the technology used to map the seabed because of the demands of the oil and gas industries and the need for better information about what might lie in the way of marine developments such as windfarms. Divers are also very interested in the seabed and what might be lying on it, but have yet to benefit from the use of offshore technology in the same way as they have from recent advances in diving equipment.

This situation is now changing as ADUS, using specially developed WreckSight visualisation techniques and software, aims to provide recreational divers with very detailed still and three-dimensional moving images of popular wreck sites around the UK presented in formats specifically geared for their use. Visit www.wrecksight.com where you can download a special public preview of the WreckSight visualisation software. With it you will get a free dataset of the *Brummer*, one of the scuttled German High Seas Fleet. Please also take this opportunity to comment and share your thoughts and ideas with us.

ADUS was originally set up to research improvements in sonar surveying methodology. This led to high resolution sonar surveys being carried out on environmentally hazardous wrecks that were leaking oil or contained dangerous munitions.

The three members of the ADUS team have strong sport diving roots and they quickly realised that the quality of the imagery they were producing could be of interest to the recreational diving world. When the *Royal Oak* survey was commissioned and planned in the early summer of 2006, ADUS decided to undertake additional work in Scapa Flow and survey the wrecks of the German High Seas Fleet. Images from are shown here in **SCOTTISH DIVER**. It is planned to gather data on other popular dive sites around the UK in the near future. Shown here exclusively in **SCOTTISH DIVER** is an image of the well known Hispania wreck in the Sound of Mull which was surveyed by ADUS recently.

So how does it all work then?

The images shown here have all been produced using a multibeam sonar system. This collects accurate depth measurements beneath the survey boat using the same principle as a dive boat echosounder, but much more accurately and with much wider coverage of the seabed. Side scan sonar systems can also provide wide coverage but do not produce the millions of accurate 'pin-point' positions with heights necessary for three-dimensional visualisation.

A typical industry-standard multibeam system, the Reson SeaBat 8125, when linked to high-end positioning and motion compensation systems, takes accurate 'spot heights' at 240 adjacent points up to 40 times a second in a thin line under the survey boat at 90° to its track. As the boat moves forward, a swath of very precise bathymetric (XYZ) data is built up to produce a three dimensional model of the seabed and any wreck lying on it. Because of the accuracy of the survey, each swath can be stitched together to produce an accurate map of the wreck and surrounding area.

There are many factors that can affect the final results of each survey and ADUS continues to fine-tune its methodology each time to achieve the best possible results, and develop new ways of visualising them effectively.

While the conventional hull-mounted system is fine for shallow wrecks, ADUS has developed the use of the sonar head mounted on extendable frameworks, to get the sonar head just that little bit closer to the wreck. The laws of physics govern the definition achievable with sonar systems and we cannot get away from the fact that the closer the sonar is to the wreck, the better the definition possible.

ADUS is also working in partnership with the UK MoD's Salvage & Marine Operations team to mount multibeam systems on remotely operated vehicles (ROVs) so that similar quality images to those shown here will be achievable in much deeper water. Recent trials have been undertaken at the Underwater Centre in Fort William and in

the Sound of Mull. This will be of benefit not just to Government departments responsible for wrecks with problematic materials on board, but also to more technically driven divers as clear images become available of those wrecks in ever deeper waters.

In fact ADUS has recently been contracted by UK MoD to undertake a survey of the Russian nuclear submarine K-159 which lies 250m underneath the Barents Sea off the Kola Peninsula in the far north of Russia. The K-159 sank on August 30, 2003 killing 9 of its 10 crew members while being towed to a naval scrapyard for dismantling. More details about this submarine can easily be found online.

So how might divers use this sonar data?

The sonar images are made up of a cloud of millions of surveyed points, each one very accurately positioned in three dimensions. This means that in addition to producing printed two-dimensional images of the wrecks on paper, as shown here, the data can be used to create virtual 'fly-arounds' using computer software, enabling the wreck to be viewed from any angle.

Using such software, the user can move around the wreck image at will using the computer's mouse to zoom in on any features. Additional functions, such as measurement of distance from one point on the wreck to another, or the absolute depth of the wreck at any one point, are all available to the user. The ability to annotate the wreck images with the shot-line position, diver's observations, the route taken or planned by a diver, even to add the diver's own digital stills or video at the appropriate location on the wreck, are all possible.

This sort of functionality presents a very useful dive planning aid. It allows those who want longer dives to plan a track linking shallower features, while those who do not mind the depth penalty, can devise a deeper dive route. Such a planning aid could also be valuable on those sites in less clear waters.

It is one thing to plan the dive, but discipline is always needed to dive the plan. In the commercial world acoustic ROV and diver tracking is an everyday feature, but it has yet to enter the sport diver world, largely because of cost. At some point in the future though it will be possible to track a diver's position overlaid on sonar images of the wreck, like the ones shown here, on a hand-held display or head-up display, telling the diver where to move on to next - a sort of underwater Tom Tom device if you like.

THE WRECKS

In 2001, the 7 main wrecks of the German High Seas Fleet scuttled in Scapa Flow in 1919 were scheduled as monuments of national importance under the Ancient Monuments and Archaeological Areas Act 1979. Divers do not require a special license to visit these wrecks but it is a criminal offence to damage a scheduled ancient monument.

Whilst the *Royal Oak* (because of its special status) remains off limits to sport divers, the other Scapa wrecks have been the focus of a great deal of diver attention

for many years. In the past the only images generally available of the whole wreck have been artists impressions based on diver observations. It will be a surprise to many to see the current state of the German wrecks, since they are in a worse condition than the artistic impressions have shown. It is hoped that not only will these images provide divers with good information about the wrecks they dive, it will also allow an accurate assessment of any changes to each wreck in the years to come.

Royal Oak

The *Royal Oak* is a war grave and so sport diving is prohibited. The sonar imagery reveals clear evidence of four torpedo impacts from the 7 fired by U47. The first hit the *Royal Oak* in the bows and blew the forefoot off. About 12 minutes later, three torpedoes hit in close succession on the starboard side, each one penetrating the protective torpedo bulge and at least two reaching magazines. The ship rolled over to starboard and, as the weight of the vessel bore on the fore and main masts, these were broken off or bent to port. These now lie on the seabed and stick out from under the inverted hull. 833 men lost their lives in the sinking.

Koenig

The sonar image reveals the *Koenig* to be virtually upside down with her starboard side only a few feet above the seabed. The *Koenig* has been extensively salvaged and the access made by salvors through the bottom of the hull is clear to see.

Kronprinz Wilhelm

The *Kronprinz* lies on her starboard but almost upside down, with most of her superstructure embedded in the seabed. The sonar imagery demonstrates, this wreck is large and the tangle of wreckage is confusing. The seabed around the wreck is littered with debris. However there are a number of landmarks visible to the diver - notably the two masts can still be seen as they stretch out away from the wreck, the four bilge keels on the hull and the rudders at the stern.

Dresden

As one of the more completely intact of the wrecks the *Dresden* is an excellent dive. The whole superstructure together with the mainmast is relatively intact. She lies on her port side but is heeled over somewhat with the deck overhanging the seabed. The sonar image shows clearly how the armoured deck at the bow is peeling away



the Koln at Scapa Flow

from the hull plating, revealing more of the interior. Significant salvage damage is apparent in the vicinity of the engine room.

Koln

The *Koln* (image shown this page) is in very good condition, and lies on her starboard side with the deck almost vertical. The only significant area of salvage damage is the engine room area. A few notable features easily identifiable on the sonar imagery are the intact masts and the guns toward the stern. The knife-edge bows are impressive.

Karlsruhe

The *Karlsruhe* (image shown facing page) is the shallowest of the German wrecks and lies on her starboard side. The hull has significant areas of damage and is virtually severed in two where the engine room salvage has taken place, as the sonar images graphically reveal.

Brunner

The *Brunner* lies on her starboard side with her bows shallower than her stern. Clearly visible on the sonar image, the bridge and mainmast structure is fairly intact and just aft of the bridge the mid 6 inch gun with its barrel facing astern is easy to spot. From amidships aft there is significant salvage damage, providing access to the interior. The rudder can be seen clearly on the sonar image, lying on the seabed.

Markgraf

Like all the battleships, the *Markgraf* lies virtually upside down. The hull is heeled over slightly on her port side and is the deepest of the German wrecks (at approx 45m to seabed). Extensive salvage damage is obvious both at the forward end and aft of the midships area.

Bayern turrets

These four turrets fell out when the upturned hull was salvaged, and they now lie upside down on the seabed. The large dent in the seabed next to the turrets is where the hull was accidentally dropped during the salvage operations in 1933.

Hispania

This Swedish merchant vessel (644 net tonnes) sank in 1954 (image shown this page). The wreck remains fairly intact, and although she is gradually disintegrating with time, she remains one of Scotland's finest wreck dives. This wreck was originally much more upright but is now leaning a fair way over on its starboard side - you can now swim along the top of the keel on the port side in fact. The fore mast is lying parallel to the seabed these days too. A notable feature visible in the image is the spare propeller still present in its purpose built compartment toward the stern.

ADUS

ADUS was founded by two former members of the Archaeological Diving Unit, based at the University of St Andrews between 1986 and 2002. ADUS was setup in 2005 specifically to undertake research into high-resolution surveys of wrecks, and its principal clients are Government departments and agencies. Research into digital visualisation at the University of Dundee became essential to the work of ADUS which has now become a joint venture between the two. Further information about ADUS can be found at www.adus.org.uk also www.wrecksight.com If you found any of the information or images interesting or have any comments or observations, then please get in touch at info@adus.org.uk.

The ADUS team:

○ Martin Dean is a Senior Research Fellow at the University of St Andrews. He started

sport diving in 1967 before combining this with work to become the marine archaeologist at the National Maritime Museum at Greenwich in 1981. He then moved to St Andrews in 1986 to set up the ADU. His ambition is to sonar survey the Titanic! ○ Mark Lawrence is the owner of Lochaline Dive Centre on the Sound of Mull www.lochalinedivecentre.co.uk which many readers will be familiar with, as well as a co-researcher at the University of St Andrews. Mark learnt to dive in 1979 and

after studying Maritime Archaeology at university, took up a career in the subject specialising in the application of remote sensing equipment to archaeological sites underwater.

○ Chris Rowland is a Senior Lecturer in digital imaging at the University of Dundee. A keen wreck diver, he combined work with pleasure when he joined ADUS last year. He is actively involved in research to improve the visualisation of the high definition sonar data from wrecks.



the Hispania in the Sound of Mull

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