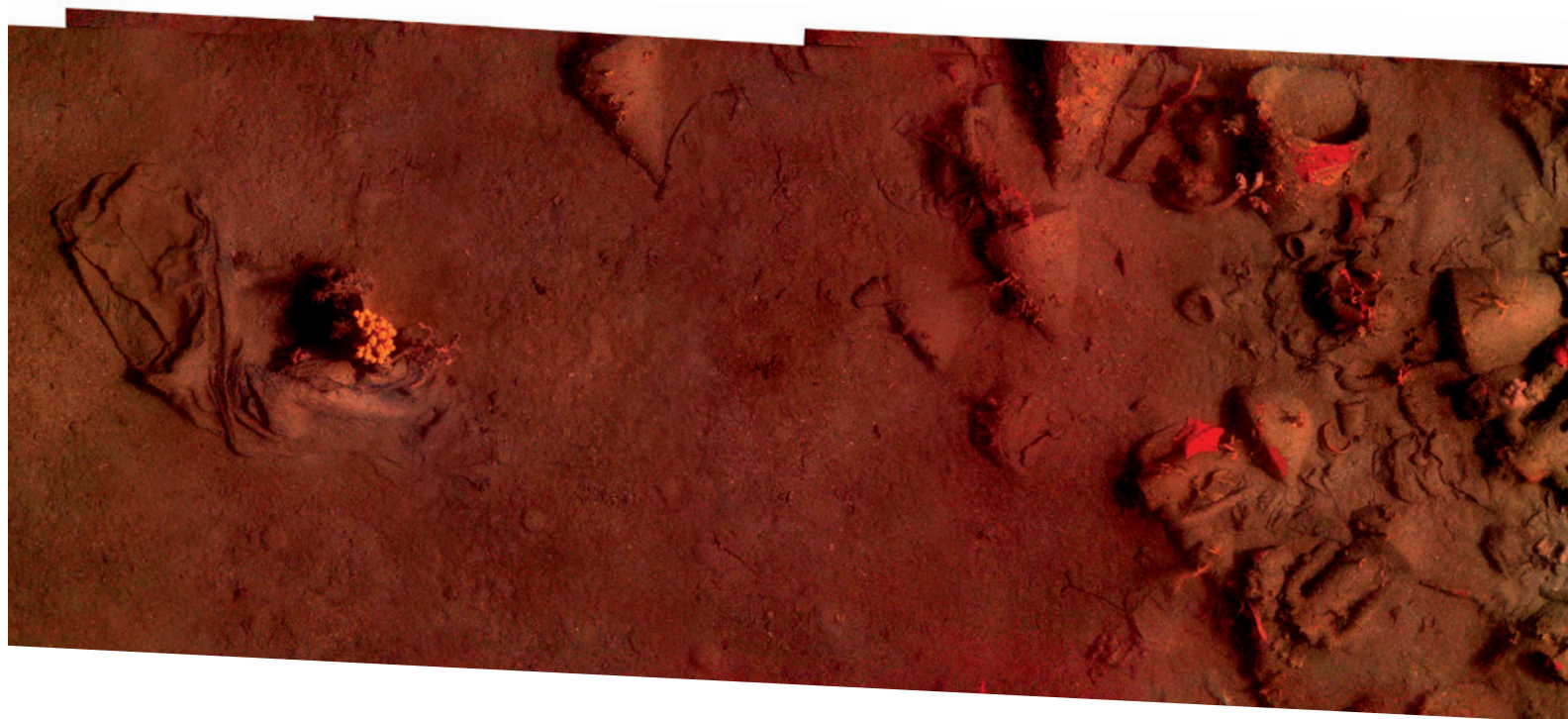
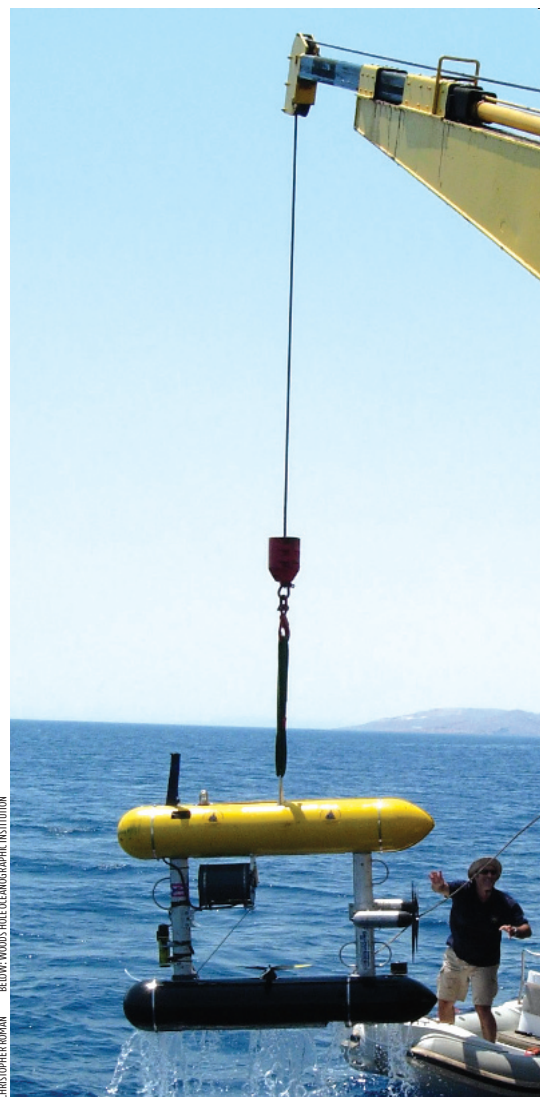




The Silt road

The tracks of Bronze Age merchants, ancient heroes and doomed civilisations lie strewn across the Mediterranean sea floor. At last we have the tools to uncover these riches, says **David Dobbs**

BELOW: WOODS HOLE OCEANOGRAPHIC INSTITUTION
CHRISTOPHER ROMAN





IT'S not every day someone toasts a robot with ouzo, and rare indeed that they do so on board a ship beneath Mediterranean stars. Last July, however, a team of archaeologists, oceanographers and engineers did just that. They stayed up deep into the night on the deck of their research vessel Aegaeo, drinking to the good health of a human-machine collaboration that is about to usher in a new era for marine archaeology.

The team, composed of Greek and American scholars and a robot called SeaBED, had just completed an expedition to explore a Roman-era shipwreck sunk in 60 metres of water off the Greek island of Chios. Though some of the humans were top-flight marine archaeologists, it was the robot – or to use its proper title, the autonomous underwater vehicle (AUV) – that really made the difference. SeaBED collected photos, sonograms and spectroscopic analyses that mapped the ancient wreck in unprecedented detail and precision in a time frame that no one had thought possible. The team accomplished in a few days what would previously have taken a decade.

"It worked better than we dared hope," says project leader Brendan Foley, an archaeologist and historian of science and technology at Woods Hole Oceanographic Institution. "You go on these missions with your list of things

you must do, your list of things you should do, and your list you sort of fantasise doing if you have time. We got them all done in three days. I am really excited about what we might be able to do working like this."

Having proved SeaBED's worth, the team now plans to spend the next decade uncovering the maritime networks that once fostered and knitted together the Mediterranean's early civilisations.

When it comes to investigating the Bronze Age Mediterranean (roughly 4000 BC to 1000 BC) – the seafaring world of the poet Homer's Iliad and Odyssey, from which Greece rose to become a birthplace of western civilisation – this effort promises to reveal much about how a scattered but increasingly connected maritime culture spawned the organised, literate and liberal society of Greece. "While the Egyptians were building pyramids, Greece was a backwater," says David Mindell, a professor of the history of engineering and technology at Massachusetts Institute of Technology and a key member of the team. "Yet it gradually comes to command the Aegean and Greek world that Homer writes about and spawn much of western civilisation and philosophy. How ▶

In a few seconds SeaBED (left) can create a photomosaic image of the sea floor, like the strip below showing a cargo of ceramic amphoras from a Bronze Age shipwreck





did that emerge from these islands?”

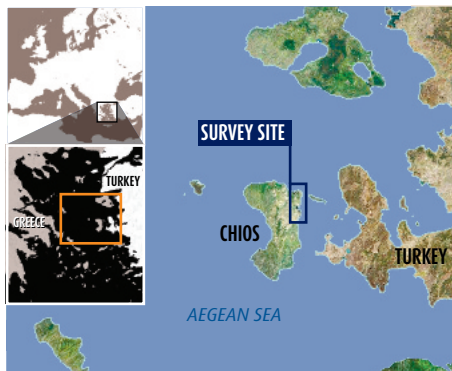
It clearly had a lot to do with boats. Ships are everywhere on the artefacts from these times – on rings, sarcophagi, everything – and obviously very much on people’s minds. However, we know almost nothing about these vessels, or their routes and likely cargoes. “The terrestrial remains those cultures left are probably the best studied in the world,” says Andrew Bevan, an archaeologist at University College London who specialises in the eastern Mediterranean Bronze Age. “But the sea, which is clearly so important to that era, is all but a blank.”

Until, that is, you get down to the bottom of the ocean. “Traffic on the sea leaves no tracks. You go by a spot, no one can tell the next day,” Mindell points out. “But over time there is a rain of signs – the wrecks, the garbage – that creates a pattern on the sea floor.” That pattern, Mindell hopes, will change our view of how those civilisations emerged. It might even solve mysteries such as the disappearance of certain key peoples (see “Fall of the Minoans”, opposite).

As the project progresses, SeaBED will be customised and upgraded with new instruments

SUNKEN TREASURE

The robot explorer SeaBED made its surveying debut in the waters off Chios and could now survey at least 30 more ancient wrecks in the surrounding area



There is certainly good reason to hope for some quick answers. So far, marine archaeologists have excavated just two major undisputed Bronze Age shipwrecks, yet these alone have already had a major impact on our understanding of that era. The Gelidonya and the Uluburun, named after spots on the Turkish coast off which they were found – both date from around 1200 BC, and the cargo they held strongly suggests that the boats came from Phoenicia, in what is now Lebanon and Syria.

Already that radically alters our dating of Homer’s life. He was long placed in the 8th century BC because historians thought that the Phoenician sailors he mentions so often had not sailed extensively until around

800 BC. The discovery of this clear evidence that Phoenicians sailed far and wide as early as 1200 BC suggests Homer might actually have lived as early as this. For Homeric scholars, that means rethinking their whole analysis. Who knows how much other classical history is waiting to be rewritten? “With only two Bronze Age wrecks done so far, almost anything we find has the potential to add to our understanding,” Foley says.

Katerina Dellaporta, director of the Ministry of Culture’s Ephorate of Underwater Antiquities, has already compiled a shortlist of some 30 ancient shipwrecks for SeaBED to investigate. The institute is charged with both exploring and preserving the country’s underwater heritage, and for several years Dellaporta has been pushing Greece’s Ministry of Culture for cash and time to explore deep-water sites in the Aegean and Mediterranean. The collaboration with MIT and Woods Hole, supported by the Hellenic Centre for Marine Research, which supplied the Aegaeo as well as a wealth of detailed data about wreck sites, is now making this possible.

Deep and dangerous

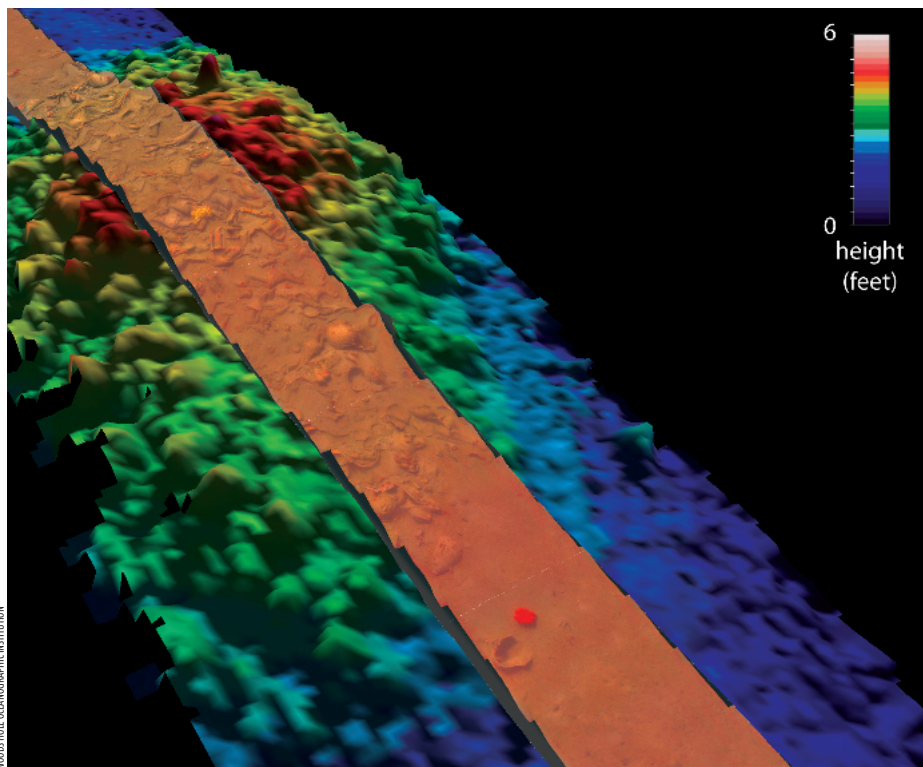
Until now, there have only been two ways to go and study a wreck – or whatever remains of it that hasn’t been rotted by salt-laden, bacteria-infested seawater. First there are the hugely expensive submarines and remotely operated vehicles (ROVs) used to explore sites like the Titanic. The second option is by diving.

However, excavation by scuba dictates an agonisingly slow pace: in deep water divers can only work a site for around half an hour at a time lest they get the bends. Mapping a wreck usually involves years of laborious work, laying out a grid with poles and string. It takes about a decade to work a single wreck, and there is a depth limit of just 50 metres, which sets 98 per cent of the ocean off limits. That’s part of the reason archaeologists have examined only two of the thousands of Bronze Age wrecks that the Mediterranean is likely to hold.

But SeaBED has leapfrogged these limitations. It was designed and built by Hanu Singh of Woods Hole, with navigation and control systems created by Mindell. Its main data collectors are a small mass spectroscope fashioned by Rich Camilli, also of Woods Hole, which allows non-intrusive chemical analysis of many artefacts on the seabed (a key to identifying dates and cultures), and an off-the-shelf high-resolution digital camera.

According to Mindell, SeaBED is not particularly elegant: its two hulls look “like two torpedoes connected by vertical braces”. The upper “torpedo”, which holds the controls





WOODS HOLE OCEANOGRAPHIC INSTITUTION

SeaBED's 3D maps of the sea floor can be used to interpret images (central strip) captured by its camera

SeaBED can go deep – 3000 metres or more, opening up 98 per cent of the ocean to examination. In her wish list, Dellaporta has already identified wrecks at depths as great as 550 metres that are just waiting to be explored. It's an enticing prospect because the deep, open waters often hold the wrecks of ships travelling longer distances, whose cargoes may differ from short-run freights found closer to shore. Depth also makes for well-preserved, easy-to-explore sites, with minimal turbulence and low sedimentation rates. And of course, deep-water sites are safe from pillage by treasure-hunting divers – a major problem at shallow-water sites.

Watching SeaBED pace out its slow and dead-steady course above a wreck offers a certain beauty, Foley says. There is grace in this contraption following its course in such a leisurely yet exact manner, firing its camera flash every 3 seconds. Making its passes over the wreck at Chios, it took more than 7000 photographs and mapped and imaged the site so thoroughly the archaeologists were simply stunned. At the end of the first day, a few hours after they pulled SeaBED up, the wreck veterans aboard the Aegaeo looked over the first photomosaics of the site in disbelief. "Collecting this information by scuba would have taken us seven years," Dellaporta told Foley and Mindell.

This is only the beginning. Over the coming decade, Mindell, Dellaporta and the rest of this transatlantic collaboration will try to reproduce the success and euphoria of this summer's test run. The project – which still has no official name – has been given use of the Aegaeo for 12 days this summer, and they are tentatively targeting three wreck sites thought to be of Bronze Age vintage.

As the summers pass, Foley and Mindell hope to add 3D subsurface sensing to their AUV tool kit, so that they can "see" objects buried beneath up to 2 metres of sea-floor silt. They also want their craft to be able to delicately extract any important artefact that resists remote analysis. With SeaBED and its successors they hope to cut through the sea's present opaqueness to reveal an increasingly coherent picture of its human past. ●

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and navigational equipment, is buoyed with foam, while the lower hull, parallel to the upper hull and separated from it by two braces about 1.5 metres long, is ballasted with the batteries that power the camera, spectroscope and other sensory equipment. This arrangement keeps the vehicle in a stable vertical position. A small propeller atop the lower tube controls vertical movement, while propulsion and steering come from two small props mounted at either end of a horizontal strut attached to the rear vertical brace.

SeaBED may be inelegant, but it is a precision navigator. It can hold the straightest of lines or turn 180 degrees on the spot as if

stuck on a pin. It has a top speed of 4 knots, but generally operates at around 1.5 knots – a very slow walk. The contraption is guided by a sophisticated GPS-enabled system that is recalibrated at each site to account for the water's acoustic and other properties, and then creates a three-dimensional map of the site (see above) that is accurate to the cubic centimetre. What's more, Foley, Mindell and their Greek colleagues consider SeaBED a work in progress, with many changes and improvements to come.

Of course, the other immense advantage that an AUV like SeaBED provides to marine archaeologists is access to deep-water wrecks.

Fall of the Minoans

Prosperous and cultured, Minoan civilisation boasted an early written form of Greek, organised trade, theatre and beautiful architecture. Nonetheless it suddenly collapsed in around 1400 BC, and no one is yet sure why.

The Minoan civilisation based on Crete lasted from around 3000 to 1400 BC. Crete is the second largest island in the Mediterranean, a large, fertile oblong at a maritime crossroads between Egypt to the south, present-day Syria and Israel to the east, and Turkey and Greece

to the north and west. The Minoans served as a sort of transition from the Egyptian and Semitic cultures that were the most notable and organised of the 5th and 4th millennia BC to the Greek and Roman empires.

Theories about the collapse of the Minoan civilisation abound. One prominent idea is that a cataclysmic volcanic explosion at Thera around 1600 BC sent a tsunami across the water to Crete, or perhaps devastated the local climate. However, that was around

150 years before the collapse, and no one has yet managed to explain this time lapse or firmly link the two events.

Another theory holds that relations between the Minoans and other cultures deteriorated, severing the trade links that made them wealthy. The mystery involves nothing less than the progenitor of the west's most influential civilisation, and because Minoan culture was first and foremost maritime, the answers probably lie on the ocean floor.