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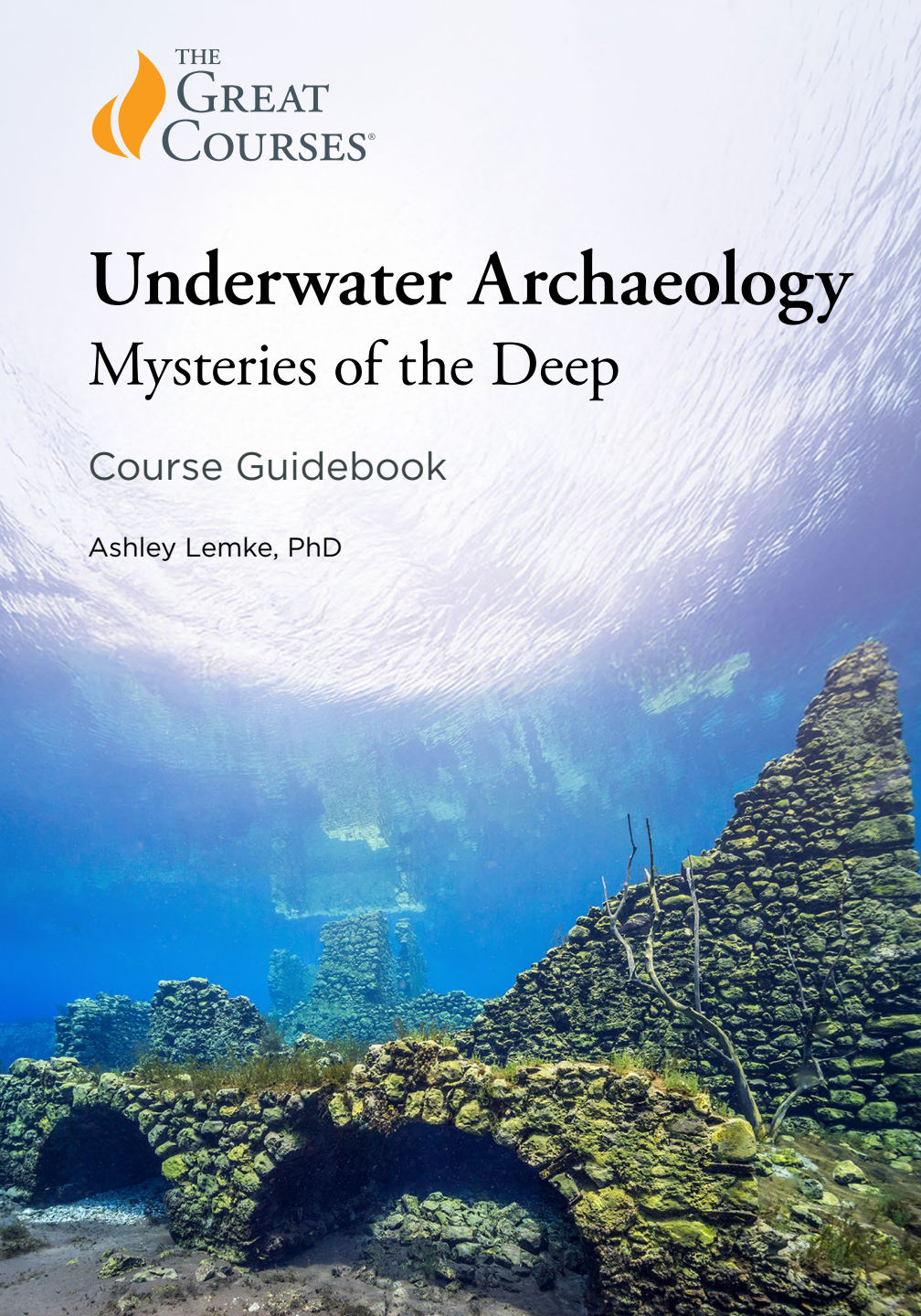
# Underwater Archaeology

## Mysteries of the Deep

Course Guidebook

Ashley Lemke, PhD



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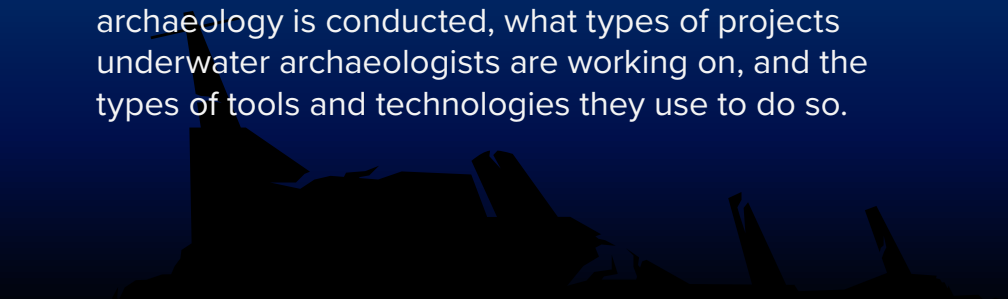
# How Underwater Archaeology Works

Archaeology is the study of the human past through material remains—artifacts left behind and the remains of people themselves—that can be investigated to discover something about human history and prehistory. Archaeologists work everywhere in the world to explore past human behavior. Anywhere that people have lived, there is a material record, and archaeologists use this material culture to explore what peoples' lives were like in the past. In this course, you'll explore underwater archeology, which is the study of the past through material remains in or adjacent to underwater environments. You'll discover how underwater archaeology is conducted, what types of projects underwater archaeologists are working on, and the types of tools and technologies they use to do so.



## Defining Underwater Archaeology

Underwater archaeology can be broken down into different areas of study, the first of which is maritime archaeology—the scientifically based study of past human life and activities in, on, or around the water. It is a broad field that investigates the physical remains of human interactions and relationships with the sea. It includes ships, boats, boat burials, abandoned wrecks, and so on as well as the infrastructure associated with life on the sea or on the coast, including ports, harbors, and docks.

Therefore, *maritime archaeology* is among the broadest terms because it deals with sites that are both terrestrial and underwater. Maritime archaeologists study whole landscapes, such as coastlines—including lighthouses on land and shipwrecks offshore. They explore the long history of maritime adaptations that date all the way back to the world's oldest boats and the last ice age.

Nautical archaeology as a whole fits within maritime archaeology and is the specialized study of ships, boats, and canoes by examining their material remains. It's more specific because it's a method for documenting ship manufacturing and technology and deals with the ships themselves and the economic processes of construction and shipping.

Similar to nautical archaeology is aeronautical archaeology—the study of aircraft crash sites and battlefields that are underwater. Numerous aircraft can be found in bodies of water all over the world, dating from different wars and battles or having been lost as part of training exercises.

Submerged site archaeology—the study of archaeological features or sites that were once dry land but are now completely or partially submerged—also falls under underwater archaeology. Both entire landscapes and submerged habitation sites like underwater cities are included in this type of archaeology. Submerged sites range in time, and the study of sites that date to a time before preserved written records is referred to as submerged prehistoric archaeology.

Because of the different kinds of underwater sites and their research questions, underwater archaeology is interdisciplinary—meaning that underwater archeologists work with collaborative teams with expertise in a range of sciences. To conduct cutting-edge research, they draw on techniques and specializations from fields such as anthropology, history, chemistry, geology, physics, paleoecological research, robotics, engineering, and scuba diving.

## The Importance of Underwater Archaeology

What can archeologists learn about the past from underwater sites? Individual shipwrecks can tell them about the historical importance of a particular time and place and reveal details about the magnitude of loss of life, the circumstances of the loss, and technological development at the time. The remains of sunken cities or drowned villages can inform archeologists about natural disasters and environmental changes and how people in the past coped with these issues. Underwater archaeology can also tell archaeologists about the world's first sailors and help them better understand human evolution. The stories that underwater sites can tell are so detailed in part because they often hold data that simply does not exist on land.

One of the most important parts of underwater archaeology is preservation. In this regard, different kinds of artifacts, materials, and objects—particularly things that are organic, such as bone, shell, antler, wood, plants, basketry, clothing, and textiles—preserve much better underwater than they do on land. The immaculate preservation provided underwater means that some types of sites only exist when they are submerged, and whole classes of data that are often missing on land, such as organic remains, are also present.

Ultimately, underwater sites often present a frozen moment in time. They have not been disturbed by farmers or the building of a skyscraper or parking lot—issues that plague archaeological sites on land. Instead, sites are generally protected by the underwater environment. Sometimes, archaeologists get very lucky, and the sites are completely undisturbed by human activity.

## The Development of Underwater Archaeology

Underwater archaeology is a cutting-edge field, but how did it begin? In 1775, the first underwater dig was conducted in Italy. In the Tiber River, English antiquarians sponsored an expedition to recover artifacts near Rome. Although this project was minimally successful and only recovered a few objects, it was the birth of an entire field of study that is one of the most exciting facets of archaeology today.

However, from a historical perspective, underwater archaeology had a rocky start. At first, it struggled to establish itself as bona fide archaeological research because of the difficulties in accessing sites underwater. While there were some early investigations, archaeologists only started systematically exploring below water once scuba became widely available. Early skeptics of underwater archaeology also asked if it was worth the time and money—as the difficulties of working underwater made it slower and more expensive than traditional archaeology on land.

Despite this rough start, there's no question today that underwater archaeology is an ethical practice that is conducted to the same standards as on land—and it contributes unique data to some of the biggest questions people have about the past.

Underwater archaeology developed rapidly in the 20th century. Within 100 years, the rate of change in technology is staggering, from the year 1900—when surface-supplied helmet divers worked at 55 meters to recover statuary from a Roman shipwreck carrying Greek art under the supervision of an archaeologist—to the year 2001, when the Massachusetts Institute of Technology deployed an autonomous underwater vehicle (AUV) to search for a Greek shipwreck in the Mediterranean.

Today, archeologists use the latest techniques in remote sensing and diving to go below the surface to find and record archaeological sites—just like they would do on land. They use tools like sonar and underwater robots to explore the deep past and cutting-edge technologies to help them map the seafloor and find shipwrecks and other archaeological sites.

For example, autonomous surface vehicles are robotic vessels that float on the water's surface and make detailed scientific measurements. They can be sent out on a research trip and map the seafloor using different kinds of sonar for more than a week at a time. Archaeologists also use AUVs, which slide below the surface to document the seafloor and—combining photography and sonar—create maps of archaeological sites using both light and sound. In addition, remotely operated vehicles (ROVs) can help archaeologists find and document sites before diving in themselves. ROVs are particularly useful in areas that are too deep for scuba divers, in addition to cold water or areas far offshore that are also challenging to dive. ROVs don't need oxygen and don't get cold, so they can stay down longer than divers and cover more ground.

## Diving to and Protecting Underwater Sites

While archaeologists are interested in and use a wide array of technologies, diving—either scuba or via surface-supplied air—plays a large role in underwater archaeology and goes hand in hand with many of the other methods, including robots and remote sensing techniques.

One of the pros of using divers in underwater archaeology is that it gives archaeologists the most immediate access to a site. It also provides the greatest flexibility in adapting to archaeological requirements. Scuba divers can swim, look at different areas, pick up objects, take photographs, and ultimately decide what needs to happen while they're at a site.

In terms of the cons of using divers, the equipment and logistics can be expensive. When scuba diving, underwater archaeologists can only be down for short periods of time in certain conditions. In addition, archaeologists need specialized training to be able to dive, and there are potential hazards to divers.

What underwater archaeologists are most worried about is that fragile and significant sites underwater are not plundered or destroyed—and that they are preserved and studied. In fact, the underwater archaeology record is so critical and the research so important that in 2001, UNESCO adopted its Convention on the Protection of the Underwater Cultural Heritage. Under this international legal framework, all traces of human existence underwater that are 100 years old or more are protected. This convention helps prevent destruction and loss or looting and salvage of these important archaeological sites and also provides guidelines and best practices for site conservation and protection.

Underwater archaeologists are on the frontier of researching the past. Although people have known about sunken ships and cities for centuries, only now are they able to leverage the latest developments in subsea technology and harness historical training to explore deeper depths and further back in time.

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# Sunken Cities of the Ancient Mediterranean

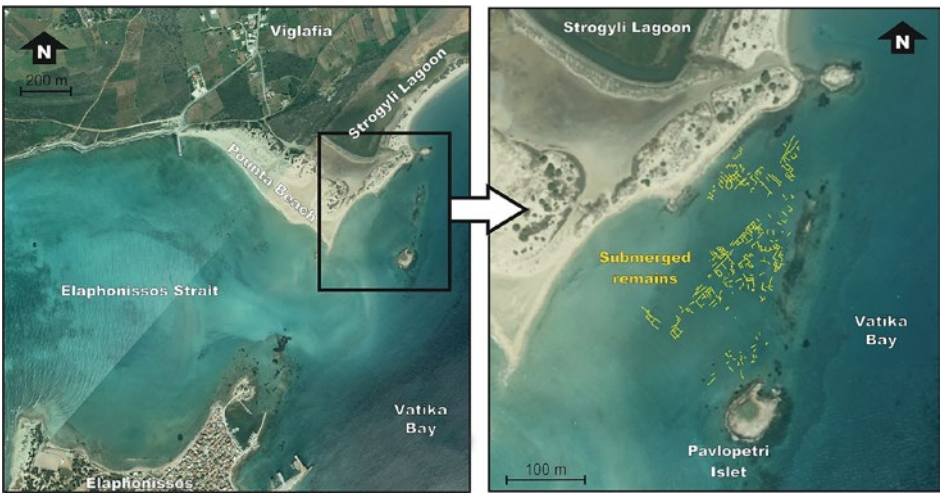
Though separated by time and space, cultures all over the world recount stories or histories of floods or of lower water levels and migrations. In addition, due to a range of natural disasters, numerous past towns and cities met a watery end. Each site has its own unique history of how it became flooded. Did it sink? Did the ground lower? Did water levels rise? Was there a tsunami or volcanic eruption? What processes sank these ancient cities? How did they become part of the underwater archaeological record? To answer some of these questions, you'll explore four lost cities of the ancient world in this lecture—all of which are in the Mediterranean Sea.

# Pavlopetri

Pavlopetri lies off the coast of the Peloponnesian Peninsula in Greece and is a real-life Atlantis. It is an ancient site where people lived, worked, and played and which eventually became submerged below the Mediterranean Sea due to natural, geological forces.

Pavlopetri was discovered in 1967 by Nic Flemming, a world-renowned marine geoarchaeologist. Diving below the water, Fleming spotted the remnants of stone-walled buildings, foundations, and even tombs. The following year, he and archaeologists from the University of Cambridge mapped most of the city's streets, individual buildings, and tombs. Beginning in 2009, Pavlopetri was mapped in even more detail using digital methods, which revealed how accurate the first hand-drawn maps of the city were—an amazing feat accomplished by Flemming and his dive team.

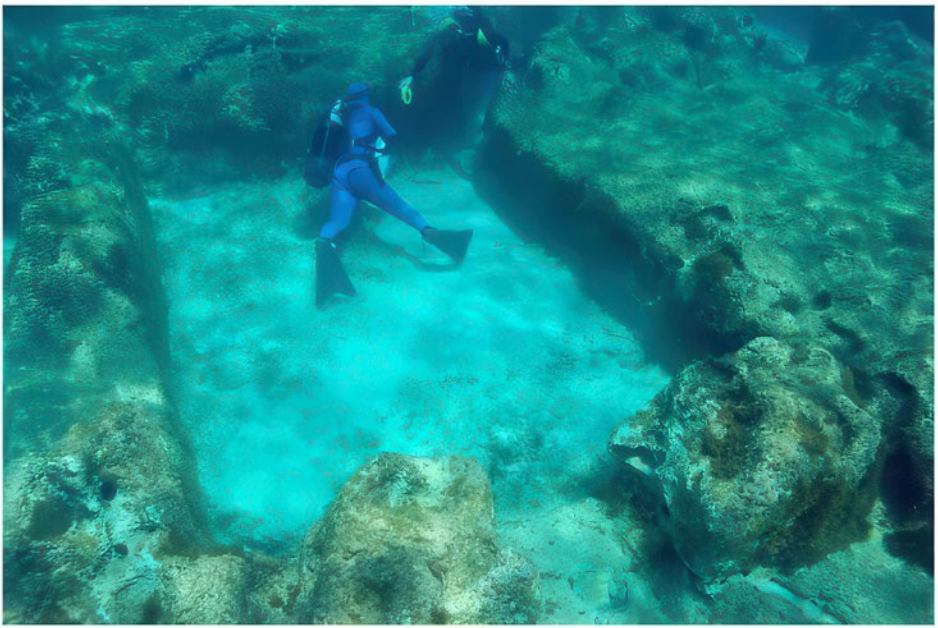
But how did Pavlopetri become submerged? The area around the site—as well as the town—used to be connected to the larger Peloponnesian Peninsula. Over time, earthquakes in the area pushed the city down, and the sea level rose. Researchers now hypothesize that the city submerged around 1000 BCE due to the first of three earthquakes in the nearby area.



Artifacts found at Pavlopetri date the occupation. Originally, it was thought to date to the Mycenaean period, which extends from about 1750 to 1050 BCE. However, ceramic styles have been recovered underwater that date to the Minoan Bronze Age, meaning they could be up to 4800 years old. Even earlier archaeological evidence at Pavlopetri dates to the Neolithic time period—5000 years ago.

## Apollonia

Apollonia, which is in modern-day Libya, was an important city and port in the southern Mediterranean. The oldest parts of the city—more than 2500 years old—are now underwater due to submergence from earthquakes and sea level rise. The part of the city that was the closest to shore subsided first and is now between 2 and 3 meters below water. Other parts of the city, particularly those that date to the later Byzantine Christian periods of Late Antiquity and the Middle Ages, are still above sea level and are dry land ruins.




Numerous structures are preserved underwater, though some pieces have toppled over. These pieces include a submerged tower that marked the north side of the harbor entrance, a submerged pier that is 90 meters long and made of stone blocks, and a submerged fish pool likely built during Roman times.

Apollonia is unique in that remains of its ancient port are preserved very well below water. Dating to the 6th or 7th century BCE, the port is one of the oldest complete ports ever found. The harbor has two basins, which were protected by islands, a natural reef, and a pier. It is likely that cargo vessels landed in the eastern basin, as two shipwrecks with ceramic amphorae have been found there. Partially submerged buildings at Apollonia have been interpreted to be ship sheds that were used for Greek military vessels.

While the site is underwater, which offers some protection from the erosion that impacts many of the ruins on land, some areas have still incurred damage. For example, in 1958—when Nic Flemming and his crew first visited and documented the site—some archways were already damaged, and divers that revisited the site in the 1980s said they were almost destroyed.

Additionally, one structure had a roof that was partially standing—the only known example of a standing roof at an underwater city—which has since collapsed. Apollonia is also susceptible to pollution from vessels and businesses in the area. However, it is hoped that the site will soon be the location of an underwater archaeological park.

## Baiae

The Phlegraean Fields region west of Naples is an area of volcanic activity, including bradyseismic phenomena. Bradyseismic activity involves magma chambers that are underground, part of Earth's crust. These chambers periodically fill with lava and then drain, causing either a gradual uplift in the land above them when they're full of lava or a gradual lowering of the land when they empty of lava.

Baiae, which is off the coast of Italy, was a resort town for the Roman aristocracy, particularly near the end of the Roman Republic. Due to bradyseismic activity, it began to sink into the water around the 3rd century CE. The ancient city, 40% of which is submerged, was famous for its luxurious villas, baths, shops, and other buildings.

The Baiae site extends more than 177 hectares (or 437 acres) and features many underwater buildings. Because this was a fashionable Roman resort town, beautiful and highly decorated villas abound, with marble floors and colorful mosaics still intact. The floors in the villas were also made from rich and multicolored marble. These floors and amazing mosaics are protected by a layer of sand that can be fanned away during archaeological research to reveal bright patterns and designs. The remains of the ancient city now range between 3 and 24 meters below water.

One of the most wonderful things about Baiae is that it's protected and preserved as an underwater archaeological park. Established in 2002, the Submerged Archaeological Park of Baia allows tourists to either snorkel or scuba dive at eight locations around the site, each of them between 3 and 15 meters deep. Visitors are given an archaeological presentation before each dive to teach them about the ancient remains they can then view firsthand.

Visitors can also take a boat with a transparent hull to see the sites below the water without even getting wet. The fairly clear water and shallow depths allow visitors to see these structures and mosaics clearly either from the boat or in the water.

## Thonis-Heracleion

Over 100 square kilometers of the Nile delta on the coast of Egypt—now underwater—was once dry land. Ancient Egyptians built cities and roads there and were living their day-to-day lives when a combination of factors, including sea level rise, soil subsidence, earthquakes, and tsunamis, led to flooding and sank these settlements.

One such site is Thonis-Heracleion. Now entirely underwater, the city is thought to have sunk in the 8th century CE. Today, it is 6.5 kilometers off the modern Egyptian coastline. Its archaeological remains lie in 10 meters of water, and an 11-by-15-kilometer area of the city has been mapped and researched thus far—a very large area for detailed archaeological research.

The city itself is not the only archaeological site. Nearby are hundreds of ancient ship anchors as well as almost 80 shipwrecks dating from the 6th to 2nd centuries BCE. Taken together, these sites reveal what an active port and harbor Thonis was—a central area for shipping and trade—while its sunken temples show it was a place of religious worship.

It's important to note that although the site is underwater, artifacts have not moved around drastically or rolled or washed away from their original places. In fact, up to 3 meters of intact deposits have been excavated at Thonis.

This type of deposit, where artifacts of different ages are sealed in intact layers, is called stratigraphy. Archaeologists carefully excavate each layer, whether it is found on land or below water. This stratigraphy and the overall context of each artifact provide the additional evidence needed to date and interpret the layers. Underwater excavations have recovered jewelry, coins, lead weights, and ceramics—all evidence of daily life.

## The World's Sunken Cities

These sites are amazing parts of the archaeological record, and many can be visited. The underwater archaeology park at Baiae has provided an example for other parts of the world to explore how visitors can see these sites firsthand and learn more about them.

Sunken cities that were close to the shoreline then are still very close to the shoreline now, but this also means they're susceptible to modern pollution, sea traffic, and looting. Hopefully, these sites will continue to be protected for future generations.

While Atlantis may not be real, these true stories about the past are just as fascinating—and they also show why myths live on and are embedded in the memory of many people, particularly when important cities were there one day and then submerged the next.

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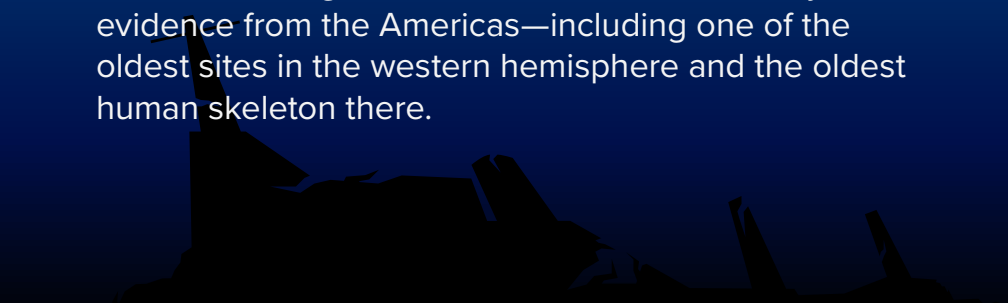
# 3

# Submerged Traces of Early Human Migration

When did humans first leave Africa? When did they get to Australia? How did they travel to the Americas? Ancient human migration remains one of the most enduring and controversial topics facing archaeologists today because the answers to such questions are a moving target. Every year, archaeologists are uncovering new—and older—evidence that overturns previous ideas. This topic is also significant for underwater archaeologists. In this lecture, you'll examine some of the archaeological evidence of these early journeys by exploring a few important underwater sites. You'll take in South Africa, new archaeological sites in Australia, and, finally, evidence from the Americas—including one of the oldest sites in the western hemisphere and the oldest human skeleton there.



## Early Human Migration

The world's oceans were much lower during the Pleistocene era, when Africa, Europe, Asia, Australia, and the Americas were first being inhabited by humans. Large areas of land on the continental shelves surrounding these landmasses would have been exposed dry land. This land is also right along the edges of the continents.

When ancient humans were migrating to a new place, such as Australia, the first thing they would have hit is the coast. But the coast then wasn't the coast now. It was much farther out. Therefore, underwater archaeologists play a crucial role in exploring early human migrations. They're the only people looking at where the oldest sites and the oldest evidence for this ancient human journey will be found.

Much of early human migration took place when the world looked very different than today. During the last ice age, large glacial ice sheets covered much of the northern hemisphere and high altitudes. Oceans were much lower, with the large amounts of water held frozen in those massive glaciers—and more land was exposed where peoples were living, hunting, and moving. These landscapes are underwater now, leaving critical evidence of early human migration submerged beneath the watery depths. In this regard, underwater sites tell the amazing story of ancient human migration—with each site and data point telling archaeologists more about human journeys in the deep past and what their lives were like.

## South Africa

Research in South Africa reveals some hints at the life of early human ancestors, living on landscapes that have since vanished underwater. For example, in 1995 and 1996 in Table Bay off the coast of South Africa, nautical archaeologists were researching and excavating two shipwrecks. While doing so, they made an amazing discovery: three ancient stone tools between 1.4 million and 300,000 years old that were made by *Homo erectus*—our human ancestors.

The three artifacts, known as Acheulean hand axes, seemed to be in their original position—what archaeologists call *in situ*. Such positioning is critical because it means they were used and left on Table Bay when it was dry land and the sea level was at least 10 meters lower than present. When water levels rose, the landscape became inundated, and the artifacts were protected until their discovery.

While the South African hand axes found underwater do not have precise dates, the youngest they could be is 300,000 years old. To date, these artifacts are by far the oldest to have ever been found underwater.

While these discoveries took place in the 1990s, current research done by the African Centre for Coastal Palaeoscience at Nelson Mandela University off the coast of South Africa is using sophisticated computer and environmental modeling to understand what that lost shoreline would have looked like and when it would have been dry land.

The Paleo-Agulhas Plain, as it's called, would have supported plants, animals, and human ancestors. In addition to this modeling, a lot of really amazing archaeology is taking place in caves on the present-day coast of South Africa.

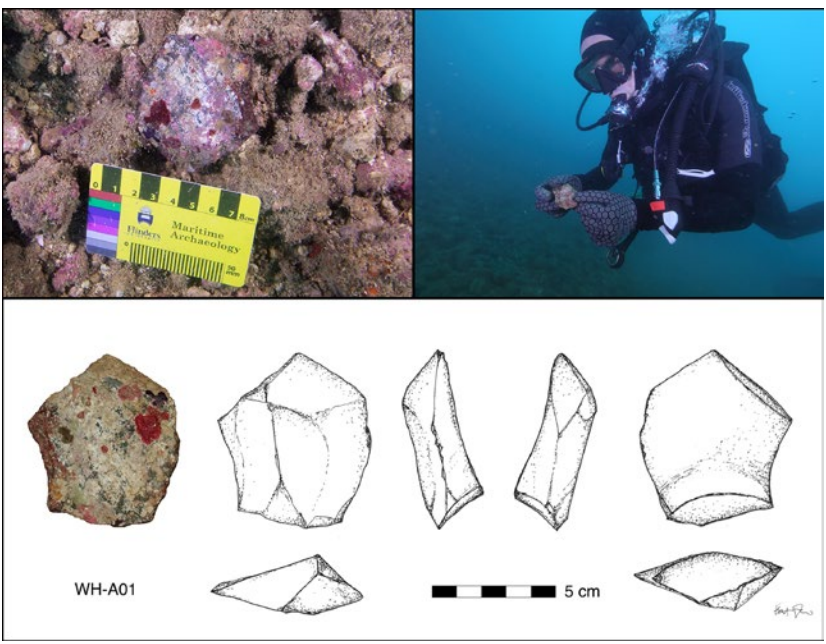
On land, the oldest archaeological site is 3.3 million years old, but there is likely even older archaeology offshore of some of the world's coastlines. *Homo erectus* were living there, but what else may archaeologists find when they dive into the waters and explore further? They will need to do much more work underwater to find additional evidence from earlier time periods.

## Australia

Australia used to be much larger—so much so that during times of lower sea level, it was connected to Tasmania, New Guinea, and the Aru Islands, forming a paleocontinent called Sahul that is now partially flooded. So far, the earliest time for the human occupation of Australia is 65 to 50,000 years ago, but even older evidence is likely to exist underwater, on the shores of Sahul. Indigenous peoples in Australia have detailed oral history accounts that tell of times of lower water levels. They can pinpoint islands that used to be there, and the names of these places are still known.

One can't even talk or think about the peopling of Australia without considering the underwater record because the continent today is not the continent it was then. It was a completely different shape and size and had a different coast and a different environment when people first arrived. In fact, the search for sites on Australia's continental shelf is critical because 2 million square kilometers of land would have been available during the last glacial period—and that is all underwater now.

Underwater archaeologists from Flinders University in South Australia, led by Jonathan Benjamin, are targeting the Dampier Archipelago—also known as Murujuga—to seek evidence of Sahul's ancient inhabitants. This group of islands would have been connected to the mainland when water levels were lower, as it's part of the Sahul landmass. Research here is ongoing, and in 2020, the team reported 7000-year-old artifacts discovered underwater.




DAMPIER ARCHIPELAGO ARTIFACTS

The wonderful thing about this project is how it employs a variety of different techniques and technologies to model the past landscape and pinpoint areas to look below water. Using a combination of Lidar—a method that uses lasers to map the land surface—and various types of sonars, the team gets a detailed view of the ancient land surface.

## The Americas

Compared to other parts of the world—such as Europe, Asia, and Australia—the peopling of the Americas happened relatively late, but when exactly humans first set foot there is still unclear. This area comprises another place and time period where the underwater record is key.

The first models had people coming over land by foot across Beringia, or the Bering Land Bridge—a massive continental landmass connecting Asia to the Americas—up until around 12,000 years ago when water levels were lower. Another hypothesis is that people would have used boats to travel along the shoreline of Beringia and then into the Americas.

Both of these routes took place when the continental shelves were exposed, meaning that the coastlines such peoples would have been inhabiting are now underwater. Every year, there seems to be new data, pushing the arrival of humans to the Americas back thousands of years.

While archaeological projects on these continental shelves have taken place, very little data has been recovered to date, mostly because this is a very challenging place to work. Cold water in the north and tectonic activity further south make studying and understanding the past landscape difficult. Archaeologists and geologists are working on those problems. Meanwhile, some of the most fantastic evidence comes not from the oceans but from sunken sinkholes and caves.

One such place is the Aucilla River in Florida, which is a large inland waterway that ultimately empties into the Gulf of Mexico. Part of a karstic—a limestone-eroded—landscape, the river has underground caves and sinkholes that provide a wealth of archaeological sites.

At sites such as Little Salt Spring and Warm Mineral Springs, these inland river settings have preserved human remains, stone tools, and animal bones. Page-Ladson is one of the most significant sites in the Aucilla River due to the role it plays in research on the peopling of the Americas.

The site reveals that 14,000 years ago, when water levels were lower, the sinkhole was still partially filled and acted as a watering hole for animals and people. Getting fresh water is a critical part of life, and many animals spent a lot of time around such places. It's likely that humans were hunting mastodons and other animals right at this strategic spot. The evidence from this spectacular site therefore pushed back how long archaeologists knew humans occupied North America by about 1500 years.

## Human Remains in Hoyo Negro

In 2007 in Mexico, a team was working underwater in Hoyo Negro—a 150-foot-deep underground cavern and cave system filled with water. At the bottom, divers found a large number of bones, including those of many ice age animals. But it was the discovery of the bones of Naia, a 15- or 16-year-old girl, that provided an amazing new look into early peoples in the western hemisphere.

Naia is the oldest human skeleton found thus far in the Americas, dating between 12,000 and 13,000 years old. Her skeleton is also nearly complete, and her genetic information was extremely well preserved by the underwater environment.

Genetic analyses show that Naia has similarities with all Native American groups that were compared to her, indicating that she is an ancestor to many indigenous peoples in the Americas. At the time of her death, most of the cave system would have been dry, but a part of Hoyo Negro was always an area of deep water. It appears that Naia was in the caves and then fell more than 30 meters into a pool of water on the floor of Hoyo Negro and eventually drowned. It is likely that the animals in Hoyo Negro suffered the same fate, and the site is basically a pile of bones from different species.

Hoyo Negro is an amazing site, and given its depth and the challenges of exploring submerged caves, it's also a difficult place to research. Technical divers have documented the bones underwater, and the research team has developed amazing high-resolution mapping techniques so that other specialists, such as biological anthropologists who study human bones, can collect all the data they need—even though they themselves may not be certified for technical diving. Instead, the dive team records everything in excruciating detail, and 3D maps allow others to experience Hoyo Negro via virtual reality on dry land.

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4

# Pirates, Plunderers, and Mutineers

Piracy is the unlawful taking of ships, cargos, sailors, and passengers for profit, and it has long been considered the scourge of maritime trade and travel. Although it's almost universally condemned, piracy has flourished in various parts of the world and continues today. In this lecture, you'll examine some of the evidence from the underwater archaeological record of piracy and focus on two sites from the Golden Age of Piracy between 1650 and 1750: the remains of Port Royal and the wreck of the *Queen Anne's Revenge*. Lastly, you'll explore a shipwreck off the coast of Australia that was followed by a mutiny, a series of murders, and a rescue—the *Batavia*.

## Port Royal

The colonization of the Americas led to numerous conflicts, including between Britain and Spain for control over territories and goods. The Spanish Main—the parts of the Spanish Empire that were on the American mainland—produced gold, silver, gemstones, spices, wood, and other valuable goods that were shipped from the mainland back to Europe. This fact made ships frequent targets for pirates, privateers, and countries at war with Spain, including Britain.

Due to its central location in the Caribbean, large population, and booming economy, Port Royal in Jamaica was a strong strategic location for the British. But because sufficient British warships were not available to protect the area, the governors of Port Royal were forced to rely heavily on the famous Henry Morgan and other privateers. In this regard, the British government would award official contracts to individuals to raid Spanish, Dutch, and French ships throughout the Caribbean. While part of the bounty from these ships was reserved for the British Crown, the rest flowed into Port Royal. After this type of privateering was ended by the 1670 Treaty of Madrid, it was replaced by piracy—which continued into the 18th century.

On the morning of June 7, 1692, an earthquake rocked Jamaica. The sand spit that the city of Port Royal was built on liquefied. During this earthquake, three violent shocks were followed by a tidal wave. Buildings slid and disappeared below the sea within minutes. Thirty-three acres—or 66% of the town—sank into Kingston Harbor. Twenty acres and their buildings sank in just 3 meters of water right offshore, and another 13 acres slid into waters some 10.7 meters deep.

The remains of the town could be seen below water in Kingston Bay, but the first systematic survey didn't take place until 1959. Corresponding archaeological research was also done on land in the 1970s and included excavations of houses that produced thousands of artifacts. However, the most extensive research was conducted by Donald Hamilton and the Institute of Nautical Archaeology, cooperating with Texas A&M University, and began in 1981. The underwater excavations continued until 1990, in collaboration with the Jamaica National Heritage Trust.

Between the wealth of historical documents and the detailed archaeological remains preserved underwater, archaeologists have a very good understanding of life in the 17th-century English colonial port city. Thousands of artifacts have been recovered from the site, including a large amount of local and imported pottery but also wrought iron tools, clay objects, and tobacco pipes. The ceramic assemblage includes tin-glazed earthenware—the first white pottery ever manufactured in England. So much of the pottery exists at Port Royal that it's clear this type of ceramic was readily available in the colonial settlement.

During underwater investigations, the remains of three children who had perished during the earthquake were found. There are also the remains of a ship that ripped through the walls and floors of some of the rooms due to the tidal wave that followed the earthquake. The shipwreck has also been excavated, and artifacts from it include iron and lead shot, tobacco pipes, glassware stem fragments, ceramics, and other tools. Overall, the research at Port Royal has illuminated 17th-century architecture, city planning, trade, and diet.

While ancient cities were built, renovated, changed, and rebuilt over maybe hundreds of years, British Port Royal stands as a unique archaeological site because it was only in existence for 37 years before it sank, leaving it remarkably intact and an effective snapshot of daily life. As such, the archaeologists who work at Port Royal have dubbed it a catastrophic site—a place where a disaster has preserved archaeological remains and materials frozen in time. Port Royal is also unique because it's the only sunken city in the western hemisphere.

It's often said that Port Royal met its fate because of its supposed wickedness. Despite research demonstrating the effects of the earthquake, the legend of places like Port Royal being punished endures. Similar to Baiae in Italy, stories about party towns sinking live on. These types of places and events keep the Atlantis myth alive.

## *Queen Anne's Revenge*

The famous pirate Blackbeard is still something of an enigma. He likely served as a privateer during Queen Anne's War in North America, which was part of the larger War of the Spanish Succession that was taking place in Europe and spilled over into colonial territories in the western hemisphere.

Shortly after this conflict ended, Blackbeard turned to piracy. Late in the fall of 1717, he made his way to the Caribbean—where he intercepted a French ship carrying enslaved peoples, *La Concorde*. Blackbeard took control of the ship and renamed it *Queen Anne's Revenge*. Although he used the ship for less than a year, Blackbeard captured many prizes with it, and it looms large in the tales of piracy in the Northern Atlantic.

As the flagship of Blackbeard's fleet, the *Queen Anne's Revenge* sailed from the Caribbean, throughout the Bahamas, and up the North American coast, capturing other ships, crew, and valuables. In 1718, at the height of his power, Blackbeard blockaded the port of Charleston for almost a week, but soon after, off the coast of North Carolina, the *Queen Anne's Revenge* was grounded on a sandbar and abandoned. Just 6 months later, the pirates met an armed contingent of the Royal Navy, and Blackbeard was killed during the combat.

Today, the ship lies in 7 meters of water, in Beaufort Inlet, off the coast of North Carolina. It was discovered in 1996 by an independent firm—Intersal Inc.—which received a permit from the North Carolina Department of Natural and Cultural Resources to conduct the work. Some of the first evidence recovered included a cluster of cannons and anchors as well as a bronze bell with the date of 1705 on it—proving that the wreck was from the early 18th century.

The site was threatened largely due to hurricane activity, and to protect the wreck and study it, the underwater archaeology branch of the North Carolina Office of State Archaeology began research at the site and excavation underwater in 1997. The underwater investigations of the ship have recovered more than 400,000 artifacts from the wreck.

Larger artifacts include some of the pieces of the boat itself but also numerous cannons manufactured in different countries, which indicates a pirate ship: cannons from all over, stolen off of prizes and other ships during many different raids, making it well armed for its next hunt. In addition to the cannons, other artifacts—including arms, navigation and medical equipment, personal possessions, pieces of clothing, tools and dishes, ceramic storage jars, and cooking ware—have been recovered from underwater.

## The *Batavia*

The *Batavia*—a Dutch East India Company boat—was built in 1628. On its maiden voyage, it set out toward its namesake, Batavia, capital of the Dutch East Indies, in present-day Jakarta. However, on June 4, 1629, the *Batavia* wrecked on Morning Reef near Beacon Island, 60 kilometers off the western coast of Australia. Only 300 of the 341 passengers made it to shore, the others having drowned.

THE *BATAVIA* REPLICA

Faced with being stranding on a small, uncharted island off the coast of the Australian mainland—with limited food and no fresh water—the captain of the ship, Francisco Pelsaert, made the decision to sail for Batavia in one of the long boats recovered from the wreck. The plan was to seek help and return to rescue the survivors.

Unfortunately, a senior Dutch East India Company official, Jeronimus Cornelisz, had already been planning a mutiny before the ship had wrecked. Cornelisz worked with other mutineers to stockpile all the supplies and arms salvaged from the wreck. Then, over the course of several weeks, they murdered approximately 125 of the survivors, which included men, women, and children.

After Pelsaert returned with a rescue vessel, Cornelisz and many of the mutineers were convicted and executed. The wreck itself was discovered in 1963, and archaeological research on land and underwater over 2 decades revealed further details about the tragic events. On land, evidence of Dutch artifacts was found in the graves of people murdered during the mutiny. Over the course of four seasons beginning in 1972, underwater investigations were conducted at the site, including a complete excavation of the stern portion of the ship.

The site was a challenging area to work, as it's open and exposed to extremely unpredictable weather—likely one of the reasons why the ship wrecked there in the first place. On average, for every 1 good day of diving conditions, there were 3 days where diving was impossible. Despite this, the divers excavated many finds from the boat, including cannons, pottery, cannonballs, pipes, spoons, bowls, coins, and even fragments of rope and fabric.

Excavations of the *Batavia* shipwreck and the settlements made by the survivors helped establish many heritage laws in Australia, as well as some of the best practices for recording archaeological sites—such as detailed mapping—and collaborative work between the material archaeological record and historical documents.

All of these sites illustrate how underwater archaeology can reveal striking details of the past. Both Port Royal and the wreck of *Queen Anne's Revenge* provide a window into the Golden Age of Piracy, showing the day-to-day life of a captain and his pirates. Port Royal also highlights the other side of pirate life on land—offering a sense of what happened with the goods raided from ships along the Spanish Main—while the *Batavia* provides evidence of a murderous mutiny.

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# Viking Ships and Stone Age Danes

From the 8th to 11th centuries, Vikings—seafaring peoples from Scandinavia—spread from Northwestern Europe to the Mediterranean, North Africa, the Middle East, and all the way across the Atlantic to North America. One of the best sources for learning about the Vikings is archaeology, and in this lecture, you'll explore some of the underwater archaeology of the Viking Age. Then, you'll turn to the underwater archeological record to examine a time before Vikings, before kings, even before agriculture to see how people were living in the Mesolithic Period in Europe.

## The Skuldelev Viking Ships

During the late Viking Age, between 1070 and 1090, five Skuldelev Viking ships were filled with stone and sunk to create a barrier on the Roskilde Fjord that blocked the sea channel from invaders. Time passed, and these ships were nearly forgotten. However, fishermen in the area knew about a shipwreck, and pieces of sunken ship fragments were recovered and brought to the attention of the National Museum of Demark.

Nearly 1000 years after the Viking ship barrier was created, a cofferdam was driven into the seafloor around the ships. A cofferdam is a walled area built in a body of water that creates a space from which water can then be pumped out, effectively creating a dry spot on the seafloor. Overall, the archaeological team at Skuldelev worked for 12 weeks straight to carefully excavate and remove the ships.

The slow excavation done at Skuldelev allowed the wood to remain wet so that it wouldn't warp or crack. Instead, the ships have been preserved in their immaculate state, and each piece retains its original shape. Artifacts must be kept wet, and once they're brought to the surface, they need to be stabilized and conserved so that they don't deteriorate. At Skuldelev, this situation was even more complicated because of the rocks and stones that were inside the ships. If all the water had been drained out right away, the weight of the stones—without the buoyancy provided by the underwater environment—would have crushed the fragile wooden timbers of the boats. Therefore, the excavation within the cofferdam was done very slowly.

The conservation process involves slowly removing the water in a careful, systematic, laboratory-controlled process and replacing it with something else—often polyethylene glycol—that causes water retention and helps maintain the original shape of the wood. Once conserved, wooden ships and artifacts can be displayed in museums.

The excavations at Skuldelev were revolutionary in terms of developing methods for working within a cofferdam. For example, during excavation, archaeologists lay on wooden bridges over the tops of the shipwrecks. These wooden bridges did not touch the soft shipwrecks, and the archaeologists could move around and slowly uncover the wrecks—rather than standing on or walking over them. This careful excavation recovered five amazing ships that tell archaeologists about Viking shipbuilding, maritime lifeways, trade, and warfare.

Because of the preservation provided underwater, archaeologists know many details about each individual boat. The five ships include an ocean-going cargo ship, a longship, a coastal trader, a small longship, and a fishing boat. Skuldelev II is a warship, and because of its design, archaeologists know that it was built for high speeds and carrying large groups of Viking warriors.

With preserved wood, archaeologists can conduct numerous analyses, including using the tree rings to identify the type of tree the ship was built from. As such, archaeologists know that Skuldelev II was built near Dublin, Ireland—which speaks to the far-reaching territories inhabited and used by the Vikings. Tree rings can also be used to determine how old the ships are, and the warship was dated precisely to the year 1042. Archeologists can learn this type of detail from individual shipwrecks by conducting analyses on timbers.

Furthermore, thanks to the underwater preservation and careful removal of the timbers, all five of the Skuldelev boats have been reconstructed. At the Viking Ship Museum in Denmark, shipbuilding teams built sea-going replicas of the original ships using Viking Age methods, and now, all these boats are located in the museum's harbor. Overall, the different types of watercraft sunk at the fjord tell archaeologists about the diverse lives of Vikings, as skilled traders, explorers, and warriors who specialized their shipbuilding for different uses.

## Tybrind Vig

The Mesolithic Period in Europe—from 10,000 to 5000 years ago—followed the Paleolithic Period, or Old Stone Age. Understanding the Mesolithic in Denmark requires moving on from Skuldelev to even older archeological sites in the waters off the coast. One of the most famous is called Tybrind Vig. Located 300 meters off the Danish coast, Tybrind Vig is an extensive late Mesolithic settlement that is in 3 meters of water. As with many archaeological discoveries, clues are found and then further explored.

In 1957, the first artifacts were located from 500 meters to the south of the site by amateur archaeologists and scuba divers. It wasn't until the early 1970s that large-scale excavations took place at Tybrind Vig. This was the first systematic large-scale underwater excavation of a submerged prehistoric site—and it was excavated between 1978 and 1988.

Originally, Tybrind Vig was a coastal village, but due to geological tilting along the southwestern part of Denmark, the prehistoric coastlines of the country are now underwater. With this tilting and a gradual rise in sea level, some of the settlement was heavily eroded, but some areas were more protected by flooding and preserved very well.

Due to the wet, oxygen-free, and buried context, many organic remains have been recovered from the archaeological site. While the central portion of the site eroded away in the past, many objects were deposited along the end of the settlement in a midden—a dump site for domestic waste. Objects like animal bones, plant remains, potsherds, stone tools, and other artifacts are often found in middens. These garbage heaps contain a lot of data for understanding how past peoples lived.

The data from Tybrind Vig tells archeologists that the area around the site was an ecotone—a place along the border of many different kinds of ecological habitats, which is a great place to live even today because it provides access to numerous and diverse resources. In addition to the coast right near the village, there was also a forest of lime, oak, and elm trees, as well as thickets of hazel.

During sea level rise, when some of the land was eroded, many of these trees fell into the water and have been preserved. The tree-ring dating of the sunken trees at Tybrind Vig reveals that the settlement was occupied for about a 1500-year time span. In addition to the forest, an area in front of the site that would have been the coastline seems to have served as a very productive fishing ground. Many artifacts here speak to this use, and it's likely that fishing was one of the reasons people chose to settle at this site.

Artifacts recovered from the midden give archaeologists a detailed look into the diet of Mesolithic people 6000 years ago. Hundreds of animal bones have been recovered, mostly from fish and different kinds of sea animals. Bones from terrestrial animals were also found, revealing that people were targeting a range of different animal species.

The types of animals that have been found at the site indicate that people occupied the area all year long. It wasn't just a seasonal fishing camp or a summer beach haven. Instead, it was a permanent village where people lived full time. The bones also reveal that different forest animals were hunted and trapped for their fur. Overall, the animal bones, fishing equipment, and isotopic studies (analyses that identify chemical markers of certain foods in teeth and bones) demonstrate that people living there ate a mostly marine diet.

The artifacts at the site are exceptional, and they include many wooden items often not seen in sites of this age in northern Europe. More than 60% of the artifacts that have been found at Tybrind Vig are organic. The artwork, particularly wooden paddles, is another extraordinary find from the site because it's been preserved.

## Archaeology in the North Sea

There's even more to the Mesolithic world underwater to explore, particularly in the North Sea. For example, in 1931, a British fishing boat called the *Colinda* was working 40 kilometers off the Norfolk coast of England, and one of its fishing nets pulled a large chunk of peat up from the seafloor.

Pilgrim Lockwood, the skipper of the boat, cut into this block of peat with a shovel to break it up and throw it overboard. But his shovel hit something solid right in the middle. It turned out to be a 22-centimeter-long carved barbed-edge harpoon—a prehistoric tool that dated thousands of years ago to the Mesolithic Period.

The *Colinda* harpoon and the peat it was encased in became the first evidence of Doggerland, an area of dry land that would have connected Great Britain to continental Europe. Following the discovery of the harpoon, other fishing nets dredged up further archaeological evidence, such as stone tools and other bone and antler artifacts.

Researchers now know that areas below the North Sea—and also below the Baltic Sea—used to be dry land where people, animals, and plants were living. Fishing nets have brought up even older remains, such as mammoth tusks and even part of a Neanderthal skull.

Research in this area is challenging, mostly because it's such a huge place to map. In the North Sea itself, thousands of years ago, 100,000 square kilometers of land would have been above water. Hunter-gatherers—the peoples that were living on Doggerland and on the landscapes below the Baltic Sea—didn't live in large cities with stone architecture. Instead, they lived in smaller settlements like Tybrind Vig, and these types of sites are harder to find—mostly due to their small size. But research is ongoing. Ultimately, it's a very exciting time for underwater archaeology all over the world but particularly in northern Europe, where archaeologists know that these vast landscapes underwater are just waiting for them to dive in and see what else might be found.

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# Cold Water Archaeology

When you think of scuba diving, you probably think about colorful coral reefs, tropical fish, and warm waters. However, many sites around the world, including some of the best preserved, are in cold waters. In this lecture, you'll explore three shipwreck sites at either pole of our planet. In the Arctic, you'll examine the remains of two ships from John Franklin's lost expedition. Then, you'll jump to Antarctica to explore the recent discovery of Ernest Shackleton's ship—the *Endurance*—which was lost for more than 100 years. Finally, you'll also explore much older archaeology preserved in the North American Great Lakes, where the remains of an ice age culture are preserved on the bottom of Lake Huron.

## Excavating the *Terror* and the *Erebus*

John Franklin was a British Royal Navy officer and an Arctic explorer. He is most famous for leading a doomed expedition attempting to traverse the Northwest Passage. After two successful expeditions to the Arctic, his third expedition ended when the ships became trapped in ice off of King William Island in what is now Nunavut. The ships were abandoned 1.5 years later, and the entire crew eventually perished from a combination of starvation, hypothermia, and scurvy.

For many years, numerous ships were dispatched to try to find the crew and understand what had happened. The perilous voyage had two ships, the HMS *Erebus* and the HMS *Terror*, which were both lost in the 1840s. But after many years of searching, the *Erebus* was discovered in 2014. And in 2016, the *Terror* was found in Terror Bay, Nunavut, near where the ship was reported to be abandoned.

Of the two wrecks, the *Terror* is in better condition, with the decks and the interior spaces of the ship largely intact. Research on both vessels is still ongoing. Numerous scientific dives have been conducted at the sites, including searching the interior of the *Terror* with an ROV—which was used to penetrate the wreck to see what condition it was in, where the artifacts were, and what types of artifacts were preserved. The video and images captured by the ROV then helped plan future areas for the scuba diving archaeologists to go in and map the shipwreck and record and recover artifacts.

During excavations of both wrecks, the exact position or the context of artifacts is recorded. Context is extremely important for archaeologists—the exact position of an artifact in 3D space. It's often combined with its provenience or provenance, which is exactly where the artifact was found. Context is critical because it allows archeologists to understand the spatial organization of the objects at an archaeological site, as well as how the artifacts were used and how they were made.

Therefore, it is vitally important to leave artifacts in place, and it's equally important for archaeologists to make detailed recordings of all the spatial information about those artifacts before they are removed for scientific study.

## Preservation and Protection of Archeological Sites

After archaeologists remove artifacts from their preservational environment and bring them to the surface, the artifacts are exposed to oxygen, which can lead to chemical and physical reactions. So, careful conservation work is completed to ensure the artifacts are stabilized and don't corrode or degrade away. After being underwater for more than 100 years, archeologists want to make sure that once the items are brought to the surface, they're still preserved in their original state—or as close to their original state as possible—so that they can be studied and then eventually shown to the public.

The artifacts that have been recovered from both these shipwrecks are amazing because of the cold water preservation. They include navigational equipment, individual utensils for eating, objects for recording expedition notes, and even some personal effects.

Another interesting aspect of these wrecks—in addition to the artifacts they preserve—is the legal case concerning who owns these vessels and the objects that are found within them. These were British flagged ships, but after retaining repatriation rights for any human remains that were found and some of the first artifacts recovered, the British government gifted the two ships to Canada and the Inuit—in care of the Inuit Heritage Trust.

In this wonderful and unique situation, governments and indigenous communities are working together to jointly manage, protect, and research these two sites. Both the *Erebus* and the *Terror* are listed as National Historic Sites of Canada.

## The *Endurance* and Cold Water Preservation

From 1914 to 1917, Sir Ernest Shackleton led the *Endurance* and its crew of 27 men on an Imperial Trans-Antarctic Expedition. In a fate similar to that of the *Erebus* and *Terror*, the *Endurance* became trapped in ice and eventually sank. Thankfully, all crew members were eventually rescued. On March 5, 2022, the *Endurance* was discovered lying in more than 2743 meters of water, making this site one of the coldest and deepest.

The expedition to find the *Endurance* was organized by the Falklands Maritime Heritage Trust. It used the last known coordinates of the boat from the recovered notes from Shackleton and his crew and employed ROVs to search for 2 weeks before finding the wreck. The research thus far has documented the wreck, which is protected as a historic site and monument under the Antarctic Treaty System.

Several unique environmental features make the Arctic and Antarctic ideal for preservation. The *Endurance* is in an amazing state of preservation, highlighting how well wooden vessels are preserved in cold water, where the rate of decay and corrosion is reduced.

Water at a certain depth can remain liquid at temperatures below freezing. In addition, the poles have a lack of natural light due to ice cover and weaker sunlight in this part of the world, with even less light penetrating deep into the water. This lack of light leads to less decay. Deep, cold waters also contain less oxygen than warmer water, further stunting degradation and corrosion. In the Arctic, a thin layer of sediment covers the artifacts, so they are not exposed to currents or wave action. Together, all these factors helped preserve the ship in a frozen-in-time state.

Due to the cold water in both the Arctic and Antarctic, there is also a lack of shipworms—mollusks known as the termites of the sea. These creatures bore into wood submerged in seawater, including docks and piers, but also plague wooden shipwrecks. Fortunately, no shipworms exist in Antarctic waters, so they have not impacted the *Endurance* at all. In addition to all these preservation factors, the deeper a wreck is, the more protected it is. With increasing depth, waves become less of a factor in wreck breakage and decay.

## The Great Lakes

Overall, while cold water is very good, cold fresh water is even better for preservation. It allows shipwrecks to preserve even longer than they would in oceans because in salt water, metal objects tend to corrode very quickly. There's also a lack of coral, which can impact archaeological sites in saltwater contexts; finally, fresh water does not have the shipworms commonly found in warm seawater.

Researchers have estimated that 8000 shipwrecks are in the North American Great Lakes. While the cold freshwater immaculately preserves wooden shipwrecks, what's unique about Lake Huron in particular is that it also preserves a record of an ice age culture of hunter-gatherers—people without agriculture that were hunting caribou. Their archaeological sites and artifacts are preserved in the middle of Lake Huron. This type of archaeology is different from that concerning shipwrecks, but it's the cold freshwater environment that's responsible for the preservation of ancient environments.

At the end of the last ice age, there were extreme fluctuations in the lake levels of all five of the Great Lakes. During the Pleistocene glacial epoch, the waters in the Great Lakes were much higher than they are today. Then, toward the end of that period, as the environment became more arid and as water outlets changed and shifted and glaciers retreated, water levels in the Great Lakes around 9000 years ago became much lower than they are today.

LAKE HURON

A geological feature called the Alpena-Amberley Ridge is in the middle of Lake Huron; it would have been a dry land bridge connecting modern-day Michigan to Ontario. There's archaeological evidence of people living out on this feature when it was exposed.

The ridge preserves paleo-environmental materials—environmental records that date to ancient time periods. Within the context of this wonderful environmental preservation are archaeological sites, including stone-constructed features that were used to hunt caribou. The remains of these hunting features have been documented using a range of different sonar techniques to map the seabed or lake bottom.

Under Lake Huron, in the context of hunting sites, there are stone tool flakes—small debris left over from making a larger stone tool—that are made of obsidian. Obsidian is a volcanic glass, and because it only comes from volcanoes, it has a very specific geochemical signature that archaeologists can use to trace it to the exact volcanic source it came from.

Two very small flakes of obsidian that were found at an archaeological site in 30 meters of water on the bottom of Lake Huron are 9000 years old, and they are traced to Oregon. This is a distance of more than 4000 kilometers, telling archeologists that people in the past were capable of great trade and exchange networks. Before social media, planes, or a lot of the modern technologies and techniques that exist to make connections, people in North America at the end of the last ice age had trade and exchange networks that cut across the continent.

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# Ritual Sites and Votive Offerings

Some of the most intriguing and valuable goods found underwater were put there on purpose. Votive or ritual offerings are placed in water and are not meant to be returned to, retrieved, or used for anything else. Such offerings then become fossilized in the archaeological record. Where objects have been discovered, they can connect archeologists to peoples from the past and perhaps allow them to gain insight into their hopes for the future. In this lecture, you'll explore a few of these artifacts before considering peat bogs and human burials in water—including evidence of a water mortuary cult in the American southeast.

## Lake Titicaca

While it's likely that many people made offerings to the ocean, the ocean is a big place—and very little of it has been examined by archaeologists. Good evidence for ritual water offerings in the past comes from smaller lakes and other bodies of water that have been more thoroughly investigated.

One such place is Lake Titicaca, at high altitude in the Andes Mountains between Bolivia and Peru. There are 16th- and 17th-century documents stating that Inca peoples made offerings to bodies of water, and archaeological evidence of these acts has been found at Lake Titicaca.

One of the most recent and spectacular finds is a carved stone box with a stone lid that was placed on one of the reefs. Once it was recovered and opened, inside was a small carved shell llama and a rolled piece of gold. When artifacts like this are found, archaeologists can investigate their origin and source the materials used to make them.

For example, the type of shell the llama is made out of is not local to the Lake Titicaca area. The small llama is carved out of spondylus shell, and the closest place to find such shells is on the coast of Ecuador. Therefore, either goods were traded back and forth over long distances, or peoples themselves were coming long distances and bringing these items with them to place them in the lake.

For a long time, archaeologists thought that all the objects found in Lake Titicaca were from the Inca time period. However, it has also been discovered that older Tiwanaku peoples also made offerings to the lake. Found near the Bolivian side of the lake, these pre-Inca offerings include ceramic vessels, incense burners, gold objects, and shells. In addition to these items, evidence also exists of animal sacrifice, as the bones of young llamas have also been found and seem to be part of the ritual behavior.

However, offerings are not the only artifacts in Lake Titicaca—refuse from daily life has also been found in the lake, meaning that not everything was ritually deposited. Archaeologists have found evidence of past settlements that date to time periods when the water levels were lower. Over time, the water rose and submerged these sites, a process seen all over the world on the continental shelves.

The underwater record in Lake Titicaca has a wealth of data and a complicated story to tell, as archaeologists are finding both ritual deposits but also evidence of day-to-day life from settlements that were abandoned after they were flooded.

## The Cenote at Chichén Itzá

Chichén Itzá is a famous archaeological site—a city built by the Maya civilization. At the site, there is a cenote—a large natural pit or sinkhole formed by rock dissolving and limestone collapsing. Thousands of artifacts that were ritually deposited into the cenote's water have been recovered.

Many of these objects were recovered from 1904 to 1907 by Edward Herbert Thompson. Using a bucket attached to a pulley system that was then lowered into the water, more than 30,000 Maya artifacts from the cenote at Chichén Itzá were brought up to the surface. Among these finds are gold objects, items made from obsidian, a volcanic glass, jade figurines, and many others. Thanks to underwater preservation, a lot of organic objects were also recovered—shell, wood, rubber, and even cloth.

The artifacts from the cenote provide archeologists with a picture of Maya life they would otherwise never see. This is not a situation like some other underwater archaeological sites—where people were living there on dry land and then water rose and submerged the site. Water was always present in this cenote, and all of the objects in it are ritual deposits. Because of this, the cenote at Chichén Itzá is often called a sacred cenote—or sometimes the cenote of sacrifice.

## Draining the Cenote

Investigating cenotes is a fascinating story about the development of underwater archaeological methods. Because of the spectacular finds recovered using the bucket and pulley system, it was clear that many more objects were in the cenote. To recover these artifacts, researchers tried to drain all of the water out of the cenote so that they could excavate it like a dry land site.

Although damming off a site makes it easier to excavate, archeologists still have to keep the site and objects wet. In the case of cenotes, when attempts were made to drain them, the pumps were unable to keep up with the amount of water pouring into the cenote from the groundwater. They managed to lower the water but never empty it entirely. When the pumps did lower the water, archaeologists went into the cenote and excavated.

In addition to these challenges, archaeologists always want nice, clean layers of sediment and artifacts. That way, they can date objects relative to each other and see which ones were deposited first. Such a situation is called the law of superposition, where the artifacts in the bottom-most layer are the oldest—the first deposited. Each layer above that is younger in age.

However, because people were putting things into the water in cenotes over and over again, and the artifacts were tumbling down the steep sides in the cenote, there was no clear stratigraphy. Instead, the deposit is what archaeologists call a palimpsest—a big pile of artifacts from many different times periods—which makes it difficult to say what ones were put there first. The important part is that despite this lack of stratigraphy, a lot of data has still been recovered, telling archeologists more about Maya ritual behavior.

One of the significant things was the amount of gold in the cenote. Gold in general is fairly rare in Maya tombs or caches on land, but quite a bit of it is in the cenote. The raw material can be traced to different regions. For example, some of the gold objects in Chichén Itzá came from Costa Rica and Panama, indicating that objects came from far and wide to be sacrificed in the cenote.

While archeologists do not always have written records that accompany sites and artifacts, they do have documentation from the Maya time period. They know that cenotes were an important part of Maya cosmology. The idea is that cenotes act as a portal between the earthly plane—where people were living—and the underworld. Cenotes were clearly important for Maya religion, which is likely why many different people offered so many objects over time.

## Peat Bogs

While rivers, lakes, and cenotes hold fascinating clues about religious life in the past, there are many interesting archaeological sites with votive offerings in peat bogs—wetland areas with soft, spongy ground that is largely composed of living and decaying plant matter, such as moss. They are well known for many discoveries. For example, the famous bog bodies from Europe are naturally mummified by the peat, with their facial features, hair, and sometimes clothing preserved.

While one doesn't have to use scuba gear to explore a peat bog, it is still an underwater environment; it is waterlogged and marshy, so the same rules about preservation apply as at all underwater sites—and the preservation is very good and often unmatched on land.

In certain cases, entire ships were placed as offerings into peat bogs. One such bog in Denmark—Nydam Mose—has been studied and excavated for a long time. Many of the artifacts found there are thought to be the possessions of conquered enemies that were placed into the bog in thanks to the gods for a successful battle. Three boats have been preserved in Nydam.

While one may assume that wooden objects would rot in a bog, it's actually quite the opposite—the lack of oxygen and being completely waterlogged keep these objects from deteriorating. On land, wood tends to break down

and decay when it is wet, dry out, and become wet again. This constant back and forth erodes organic materials quickly, whereas completely wet environments aid preservation.

What is interesting is that a lot of the items ritually deposited into bodies of water were first broken intentionally. Evidence exists of bowls that have a hole in the bottom, swords that have been bent, and other objects that have been burned. The idea was likely that since these are offerings, they were not meant to be used again. Once deposited in a bog, they could no longer be seen; no one could get them, and even if someone did, they would be broken anyway, so they would not be useful.

## Underwater Human Burials

Sometimes, people themselves were laid to rest in peat bogs. One of the most famous sites of a water mortuary cult is Windover in Florida. Here, 7000 years ago, deceased persons were bundled in cloth and placed below water in peat bogs. Wooden stakes were driven into the peat around the bodies to pin the cloth and anchor them in the water.

Peat is extremely good at preserving organic remains. At Windover, even the organs of these individuals—including stomachs and brains—have been recovered. While Windover was excavated in the 1980s, sites of this same type have been found all over Florida. Most recently, one was even discovered under salt water in the Gulf of Mexico.

At times of lower water levels, much of the continental shelf below the Gulf of Mexico was dry land. The environment was much the same, with swampy peat bogs, and individuals were buried there. These once freshwater bogs are now covered in seawater, and human burials have been recorded offshore at the site of Manasota Key. This site is actually being eroded away, so archeologists and local peoples, including indigenous tribes, are working together to save it before it's lost forever.

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# Shipwrecks and Nautical Archaeology

Shipwrecks are largely accidents—either a collision, a grounding, or a ship that caught fire and sank. They are the result of chance or catastrophe. Due to the nature of catastrophic wrecks, many shipwrecks contain the remains of those who went down with the ship. Such events are central to the field of nautical archaeology, which studies boat construction and design and is a critical component of underwater archaeology overall. In this lecture, you'll examine several examples of famous shipwrecks, how underwater archaeology is conducted at these sites, and the types of questions and issues that archaeologists are interested in.

## The Importance of Nautical Archaeology

Nautical archaeology is a historical science. It relies on a deep understanding of ship design and construction as well as an organized approach to wreck sites. Nautical archaeologists have to ask what factors led to the loss of a vessel and what factors have affected the condition and distribution of the materials at the site since it went down.

The factors leading to the loss of the vessel are called predepositional—events that happened before an archaeological site was created. Factors that have affected the wreck since its sinking are referred to as postdepositional, or events that happened after the archaeological site was created.

Understanding ship construction is important because it provides an understanding of the function of a vessel. It can reveal cultural design and decision-making that determines why ships are made certain ways and why they look the way they do. Archaeologists can explore the evolution of naval warfare and ocean-faring technology over time by examining wreck sites and investigating the specific details of how they were constructed.

Overall, understanding ship construction and exploring the anatomy of a wrecked vessel go hand in hand—especially for identifying a shipwreck. In addition, the careful process of wreck identification is critical for matching archaeological sites with historical details and documents.

But what about ships that are so old they predate written records? A forensic investigation using archaeological methods can reveal how the vessel might have sunk, what it was constructed to do, and how it was used before it eventually wrecked.

## The Uluburun Ship

The Uluburun ship is a shipwreck that was discovered off the coast of Turkey in 1982 by a Turkish sponge diver. Underwater archaeologists from the Institute of Nautical Archaeology, led by George Bass, excavated this shipwreck over 11 field seasons from 1984 to 1994, with more than 22,000 dives in excess of 46 meters.

Due to careful excavation and research that was conducted at the site, the Uluburun ship was identified as a Late Bronze Age shipwreck from the 14th century BCE. She was carrying a shipment of elite goods, including exotic and valuable items, which were likely exchanged by kings, heads of state, and wealthy merchants throughout the Mediterranean. Luxury items were also recovered from the shipwreck, including carved ivory containers, gold jewelry that was set with precious stones like agate and carnelian, and trade goods from all over the Mediterranean, such as unworked elephant tusks, ostrich eggshells, faience beads, and glass ingots. Utilitarian items were also recovered, including weapons, balance weights, and stone anchors.

The remains of the hull of the ship and the stone anchors tell archaeologists about ancient shipbuilding techniques and their historical development. From studying the Uluburun ship, it's clear that there were many connections—social, political, and economic—across the Mediterranean and that these connections were forged by intense maritime activity. The Uluburun ship and a number of other shipwrecks in Turkey are very important for nautical archaeology specifically and for the field of underwater archaeology more generally because they were among the first systematically and scientifically excavated archaeological sites underwater.

THE ULUBURUN SHIP

George Bass and his team of archaeological pioneers experienced unique problems that archaeologists had never faced before—such as wooden shipwreck timbers beginning to float away once excavated from the seafloor. In solving such issues, they demonstrated that archaeology could be conducted underwater to the same standards as on land.

## The *Vasa*

The *Vasa* was the world's most advanced warship when she set sail in 1628. Many people gathered to watch her historic launch. But just 20 minutes into her maiden voyage and after sailing only 1300 meters, a gust of wind caused this massive Swedish warship to sink entirely below the surface. But what caused her to capsize?

Researchers now consider it likely that the gun deck of the ship was far too heavy. Although she was designed to carry 36 guns, she was sent out with more than twice that number. Overall, it appears that the emphasis during construction was given to the ship's elegance and firepower rather than the critical aspects of stability and seaworthiness.

The *Vasa* is a world-renowned example among underwater archaeologists for its preservation. The cold and oxygen-poor waters of the Baltic served to protect the wreck with less bacteria and wood-eating organisms than other areas of the world, and it's estimated that 95% of the *Vasa*'s wood is intact. Having sunk during its maiden voyage and its immaculate preservation make the *Vasa* a perfect time capsule of a 17th-century warship. The *Vasa* herself is no longer an underwater archaeological site—she was raised in her entirety from the watery depths.

Archaeological research after the ship was raised began in April 1961 and required carefully digging through the black sediment that filled the ship. More than 30,000 artifacts were recovered, including more than 4000 coins, pewter plates, hunting rifles, barrels of salted meat that were reduced to bones, chests of the sailors' belongings, and even the remains of at least 11 individuals themselves who had gone down with the ship.

THE *VASA*

A taphonomic study of the *Vasa* focused on iron artifacts and wood carvings. Taphonomy in archaeology is the study of processes that have affected artifacts and other remains found at archaeological sites. For example, when archaeologists find animal bones, there might be marks on the bones, and taphonomic studies attempt to discern how those marks were made, uncover the true story behind the artifacts, and correctly interpret human behavior in the past.

The *Vasa* is a wonderful ship for such studies because archaeologists can observe the effects of water on a wooden boat, knowing the exact amount of time it was underwater. After 330 years on the seafloor, some evidence of erosion exists, and parts of the ship exposed to currents saw some deterioration—with different objects faring better or worse underwater. For example, iron bolts rusted away completely, but large objects, such as cast-iron cannonballs, remained. Organic items, including the ornate wooden carvings, fared better; however, some were worn down by being exposed in the water column.

## *La Belle*

In 1684, Louis XIV of France sent explorer René-Robert Cavelier, sieur de La Salle, across the Atlantic with four ships and 400 people; the ultimate goal was to fortify French land in North America. This entire enterprise was a failure, with ships lost to pirates and other disasters, including being wildly off course and hundreds of miles from their intended landing point. In 1686, the last remaining ship of the mission, *La Belle*, sank in a storm off Matagorda Bay, along the coast of Texas, and lay undisturbed for 300 years. In 1995, archaeologists located the ship and started conducting research at the site.

Although the ship rested in less than 4 meters of water, the murkiness caused by sediment, minerals, and other organic matter in the water column severely limited the visibility and ability of archaeologists to conduct research in a detailed, systematic manner. So, the decision was made to form a cofferdam around the site.

The cofferdam was a double-walled steel structure, and rather than excavating underwater or using scuba and other techniques, archaeologists instead drained the water and worked more like a terrestrial archaeological dig. However, great care had to be taken to ensure that the fragile artifacts—including the wood in the hull of the ship—were slowly dried out so that they would not warp or begin to decay after being preserved underwater.

Archaeologists worked to systematically excavate the ship, with a crew of 20 people working 7 days a week for 8 months straight. After excavation came the long, slow process of conserving and studying the recovered artifacts from the shipwreck—over 1.6 million in total.

The artifacts tell the story of 17th-century French sailors and colonists as well as of the regional indigenous native communities that they encountered. The site was covered in mud beneath the water, so the artifacts are amazingly well preserved and include a bronze cannon that has dolphin-decorated handles, brass candlesticks, muskets, and more than 21,000 pounds of gunpowder.

Trade goods accounted for most of the ship's cargo and included more than 1500 rings, 17,000 brass pins, and hundreds of axe heads and knives. One box contained 600,000 individual beads for trading that were all strung together and organized by color.

## Forensic Underwater Archaeology and Shipwrecks

The shipwrecks of the Uluburun ship, the *Vasa*, and *La Belle* highlight two archaeological problems. First, how do materials pass from a dynamic context, where they're part of a living behavioral system, into the static archaeological record? And second, what happens to these material and their spatial relationships between the time of the wreck and when they're recovered by archaeologists? Every wreck and their artifacts are unique, and each can be investigated to reveal the cause of the sinking and any changes to the artifacts from their original forms and positions.

Archaeologists have to ask themselves what portion is preserved. Have there been any modifications of the deposit? Has there been scavenging or recycling? Most often, archaeologists don't have a whole ship, so it's important to study these wrecks almost as forensic sites, painstakingly piecing together all the data, excavating the artifacts, and recording their spatial relationships so that they can understand exactly what tales these boats have to tell about the past and what scholars can learn from some of their failures.

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# Sunken Warships: Treasure Troves of History

One of the most significant parts of nautical archaeology involves ships that were sunk during times of war. Thousands of ships were sunk all over the world during conflicts. These warships reveal details about the past that archaeologists can't get from historical documents alone. Instead, they must dive below the waters and see the evidence of these conflicts and battles for themselves. In this lecture, you'll explore two sites from the American Civil War and a naval battle that occurred during World War II.

## The *Monitor*

One of the most iconic shipwrecks in the United States is the USS *Monitor*. Built during the American Civil War, the *Monitor* was the first ironclad ship commissioned by the Union Navy, a revolutionary design for ships at the time—complete with revolving turret, low draft, and sleek profile, as well as thick iron sides that served to protect the vessel in several battles.

In March 1862, the *Monitor* was heading south to support Union forces but was unfortunately caught in a storm off Cape Hatteras on New Year's Eve at the end of 1862. While the crew worked to pump out water flooding in during the storm, the ship was eventually lost, with 16 of her crew going down with it. Today, the *Monitor* lies in 70 meters of water in the Atlantic Ocean, off the coast of North Carolina.

Discovered in 1973, almost 111 years after sinking, the *Monitor* was found to be resting upside down on the ocean floor. Since 1977, research at the *Monitor* site has included detailed mapping and the recovery of artifacts, including the human remains of two sailors. Additional studies made clear that the wreck was deteriorating at an alarming rate. Because of this, the National Oceanic and Atmospheric Administration created several detailed plans for the conservation of the *Monitor* and recovery of artifacts from this historic vessel.

Eyewitnesses who watched the *Monitor* sink below the water during the storm stated that they saw a red distress lantern burning on top of the turret. This red distress beacon was the last visible sign of the *Monitor* before it sank—and it was the first artifact recovered from the wreck site. Since that first discovery, more than 250 artifacts have been excavated and brought to the surface. These items include the anchor, the steam engine, personal effects—like a leather boot—and many tools, such as a hammer and a powder scoop for the guns.

Because of the rate of deterioration underwater, given the corrosive nature of salt water and metal, the entire gun turret of the *Monitor* has been raised to be preserved for future generations. *Monitor* artifacts and the turret are conserved and displayed at The Mariners' Museum and Park in Newport News, Virginia.

## The *Hunley*

Another vessel that changed the history of naval warfare was the *H. L. Hunley*, a Confederate submarine. On February 17, 1864, the *Hunley* sank the USS *Housatonic*, a 16-gun, 1240-ton sloop of war that was patrolling on blockade duty 4 miles from the entrance of Charleston Harbor in South Carolina. Afterward, the *Hunley* unexpectedly vanished beneath the Atlantic. No one knew exactly what happened after she delivered the fatal blow to the *Housatonic*—she simply sank beneath the waves and wasn't seen again for more than a century until 1995, when the National Underwater and Marine Agency discovered the wreck.

Once she was raised, the *Hunley* was conserved and excavated and revealed to be a striking time capsule, telling the story of what happened to her and her crew. The research on the *Hunley* was extensive and included 3D scanning the exterior surface of the vessel, removing pieces of the ship for conservation treatment, submerging the entire submarine in sodium hydroxide to conserve the iron, and cleaning the interior and exterior. The ship was encased in a layer of sand, sediment, rust, and silt—what archeologists call concretion—and that concretion had slowly built up during her time underwater.

Concretions can be removed slowly and delicately, and eventually, this process was done on both the interior and the exterior of the *Hunley* to expose the original surfaces of the vessel. Even with the hull plates removed, the vessel remained intact and sturdy enough that archaeologists could then explore the remains inside and begin the slow, careful excavation of the vessel.

The scientific and forensic work at *Hunley* helped archeologists learn her fate. Eventually, each of the seven hand cranks were excavated—which showed where each member of the crew had sat, working the cranks to propel the submarine.

The complete remains of all eight crew members were found during excavation. Research was done to 3D scan the crew members' remains, and DNA tests were conducted to identify them. All the evidence suggests that the crew died very rapidly while still manning their stations. While the spar torpedo was at a fixed distance from the *Hunley*, it's speculated that the concussive force of the torpedo explosion caused the crew to die instantaneously and the ship to sink.

## World War II Shipwrecks

The most explosive period of naval battles globally was World War II. It is estimated that around the globe, 15,000 ships were lost during the war—accounting for more than 500,000 servicemen killed in the conflict and 43 million tons of iron sunk beneath the world's oceans.

Two wrecks from this time period were lost during the Battle of the Atlantic—which began mere hours after Britain declared war on Germany in September 1939 and lasted for the duration of the war until Germany's surrender in 1945—and are found off the coast of North Carolina.

On July 14, 1942, the KS-520 convoy, comprising 19 merchant ships and 5 escorts, left Hampton Roads, Virginia, on its way to Key West, Florida, with a planned 7-day journey through waters rife with German U-boats.

A German U-boat—*U-576*—had been operating off Cape Hatteras, North Carolina, and had sustained damage in an earlier skirmish. It was heading back to France for repairs. But on the afternoon of July 15, the paths of the KS-520 convoy and *U-576* intersected. The U-boat fired four torpedoes into the convoy. Two rocked one boat in the convoy, another hit the convoy flagship, and a fourth struck the freighter *Bluefields* on its port side and sank it. Although the *Bluefields* went down rapidly, all of her crew escaped.

Moments after firing these four torpedoes, the German U-boat suddenly surfaced in the middle of the convoy. US Navy Armed Guards on a merchant ship opened fire on the U-boat, and two US Navy Kingfisher aircraft laid depth charges on either side of the submarine, sinking her with all 45 hands.

Both ships now rest 213 meters apart on the ocean floor, 228 meters below water. These sites are a memorial and a historic snapshot of this engagement. Before the remains of the KS-520 convoy battle were discovered in 2014, after years of searching, neither ship had been seen since 1942.

Given the great depth of the shipwrecks, an AUV was required to map them, along with two Triton manned submersibles. These methods allowed the research team to collect multibeam sonar of the area, laser line scanning data of both wrecks, video, and photographs. A complete downward-looking laser scanning survey was completed for both the U-boat and the *Bluefields*, with models of both sites accurate down to 1 millimeter. A nearly complete

photogrammetric model was also collected of the U-boat. Photogrammetric models are an overlapping series of photographs that create a 3D rotatable mosaic of a site.

During the research, it became clear that both boats had become part of the underwater ecosystem. The shipwrecks had formed a reef on the bottom that was used by many different species of fish for protection and food.

## Polluting Wrecks

Many wrecks around the world have become safe havens for fish and are teeming with wildlife. But many shipwrecks, particularly those from World War II, are also potentially threatening and a source of pollution in global waters. These shipwrecks contain thousands of tons of oil, as well as bombs and chemical weapons.

Each shipwreck is different. Some were sunk by torpedoes, while others were blown apart. Still others were torn in half during battle or scuttled intentionally. Each wreck lies differently on the bottom, and each presents a different level of risk.

World War II ship hulls were typically 25 millimeters thick, and the rate of corrosion on a sunken vessel is between a tenth and two-tenths of a millimeter per year. So, a shipwreck that went down in 1942 would be about 30% weaker today than it was when it was built. Plus, those that are in shallow water are more impacted by sunlight and are degrading faster due to this exposure. They're also more likely to be jostled by storms and waves. And all shipwrecks, regardless of depth, are susceptible to earthquakes that could disturb them.

Unfortunately, fears of polluting wrecks have already been realized. For example, in 2001, a tropical storm rocked the resting place of the USS *Mississinewa*, an oil tanker sunk by a Japanese torpedo in the Federated States of Micronesia in 1944.

Lying 40 meters underwater and 640 kilometers southwest of Guam, the tanker leaked 24,000 gallons of oil in just more than 2 months before it was plugged in 2002 and eventually drained of oil in 2003. Another very famous

shipwreck, the USS *Arizona*—now a memorial in Pearl Harbor—has leaked oil for decades. It's estimated that it will continue to leak at a rate of 9 quarts per day for the next 500 years.

Remediation and salvage of oil from shipwrecks is a challenging, time-consuming, and expensive process. For example, the cleanup of the *Mississinewa* cost $6 million. Underwater archaeologists and environmentalists alike are well aware of the issues with potentially polluting wrecks, and they use different models and studies to forecast and prioritize cleanup based on the risks they pose.

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# Sea Level Rise and Submerged Villages

During the Last Glacial Maximum, between 24,000 and 19,000 years ago, the sea level rose rapidly, increasing at an average rate of 10 millimeters per year. When water levels rose like this, they flooded vast amounts of coastal landscapes. In this lecture, you'll look at water-level rise both on a global level and a local scale. You'll explore an ancient village off the coast of Israel that was flooded by sea level rise at the end of the last ice age. Then, you'll look at a series of archaeological sites that are lake dwellings and examine how underwater archaeology can illuminate past life around and in lakes.

## Atlit Yam

One of the oldest and largest submerged village sites—and one of the most important—is Atlit Yam, off the northern coast of Israel. This 40,000-square-meter Neolithic village is 8000 years old and now rests 6 to 12 meters below the Mediterranean Sea. Atlit Yam was submerged due to eustatic or global sea level rise at the end of the last ice age. At the time of occupation, the coast was a kilometer west of the modern shoreline, an indication of how much land has been lost over the last 8000 years.

The site has been so well preserved on the sandy seabed that human burials have been excavated from undisturbed graves. The site is also among the oldest known agropastoral fishing communities. Its inhabitants were not only hunting but were also herding domesticated animals, farming domesticated plants, and fishing—so they had an extremely diverse economy and a rich diet.

One of the most remarkable discoveries at the site are the stone wells. Three stone-built circular structures at the site were excavated and have been interpreted to be wells tapped into underground aquifers. These are the oldest constructed wells in the world.

The underwater environment at the site creates an anaerobic—or oxygen-free—environment that is perfect for preserving plant and animals remains. In fact, 91 individual species of plants have been identified at the site, including domesticated crops such as wheat, barley, lentils, and flax but also wild plants such as almonds, figs, and grapes.

In terms of animal remains, more than 8000 bones were excavated, include domesticated goats, sheep, cattle, pigs, and dogs. Wild animals found there include boar, gazelle, fallow deer, and red fox. Many of the animal bones have marks on them, and some are burned, telling archeologists that people butchered the animals and either cooked meat with the bone in or used the bones as fuel.

Perhaps some of the most evocative remains at the site are the human burials. An estimated 63 people were buried there. Graves were simple pits dug into the clay, and there were no headstones—although some stones were found on top of the graves, perhaps to mark them. Fifteen of the burials contained grave offerings—artifacts that were intentionally buried with the deceased individuals.

Analysis of the human remains shows some pathologies. This type of research is called bioarchaeology and paleopathology. A quarter of the male skeletons had an ear pathology that indicates diving or frequent swimming in cold water, which makes sense for a coastal community.

Overall, these finds off the coast of Israel are extraordinary. They show that people living on the Carmel coast had a sophisticated way of life and lived in a coastal community. There's even a structure with standing stones that might have been a place of ritual activity, but this needs to be confirmed by more research. Archeologists have this unique data and a window into life 8000 years ago due to the preservation provided underwater and global sea level rise that flooded this village.

## Pile Dwellings

While sea level rise is a well-known phenomenon, it should be noted that smaller bodies of water, such as lakes, also experience changes in water levels. How did people in the past live in areas that might have experienced local flooding?

High in the Alps is an extremely rich archeological record of pile dwellings. These are essentially stilt houses—raised platforms supported by wood beams—and there's more than 1000 of them in Switzerland, Germany, Austria, France, Italy, and Slovenia. They're found along lakes, rivers, and wetlands, and they represent sophisticated constructions of raised houses that could remain dry in wet areas.

Pile dwelling sites in the Alps were discovered during times of very low water levels, which revealed the piles that had been hidden below water. After discovery, some pile dwelling sites were excavated as early as the 1840s. In fact, the world's first archaeological dive team worked to excavate the remains of a pile dwelling in Lake Zürich in 1854. The remains of pile dwellings could even be seen on early aerial photographs.

Since the bottom sections of the piles or stilts have been preserved underwater, it was first thought that these dwellings were built over the water. However, it's now known that most of the sites were located in marshy areas near the lakes and that water levels have risen to completely submerge them. Dating to between 5000 and 500 BCE—between the Neolithic and Bronze Age in Alpine Europe—artifacts are also preserved underwater from many different time periods when people lived in the dwellings and objects were dropped and lost. The sites are well known for the preserved plant remains, wooden artifacts, bone, and textiles found there.

Excavations at some of these sites have revealed trade routes for exchanging items such as stone, shell, gold, amber, and pottery, and evidence also exists of dugout canoes and wooden wheels, including a two-wheeled cart with complete axles dating to around 3400 BCE. The latter are among the oldest preserved axles anywhere in the world. Europe's oldest textiles have also been recovered from pile dwellings in the Alps dating to 3000 BCE.

Archaeological research of pile dwellings has provided information about the development of agriculture, animal husbandry, and metallurgy over 4000 years. Because the wooden piles can be dated precisely using dendrochronology—tree-ring dating—such sites provide a detailed view into construction techniques and how the spatial layout and organization of villages changed over time. Due to the rich archaeological heritage preserved at these sites, more than 100 of them together have been designated as a UNESCO World Heritage site.

## Crannogs in Scotland

Another form of lake dwelling was invented and common for thousands of years in Scotland, Ireland, and Wales: the crannog. This unique form of building is vaguely reminiscent of the pile dwellings, but instead of stilts, crannogs are partially or completely artificial islands built up on stacked wood—and sometimes stones—over lakes. Crannogs primarily date to between the Late Bronze Age and the Middle Ages, although historical evidence indicates that they were used up into the 17th century.

Underwater excavations of crannogs reveal that the sites are complex and long-lived. For example, archaeological research at the Ederline crannog in Loch Awe, Scotland, shows that it was occupied in the 4th-century Iron Age as well as the Early Historic Period, between the 6th and 8th centuries. It remained in use for more than 900 years.

To excavate at Ederline, a scaffold was constructed above the crannog to hold equipment and provide a platform for divers to enter the water and an area for a safety diver to be stationed at all times. Once delicate archaeological layers were encountered, they were excavated with the aid of a water dredge to remove the dirt as the archaeologists worked.

With the dirt removed, artifacts could be mapped in place. At Ederline, timbers that have evidence of shaping and cutting were recorded, as were the remains of meals eaten by those living in the crannog, including cut and burned bones of cattle, pigs, deer, sheep, and goats.

Ceramics and plant remains were also recovered. Waterlogged barley and other seeds show that people at Ederline were both processing plants and eating them at the site. There are at least 20 crannogs in Loch Awe, which is the longest and third-largest body of fresh water in Scotland.

Loch Awe is not the only body of water in Scotland that preserves crannogs. In Loch Tay, Oak Bank crannog has been excavated with modern archaeological techniques, and the finds there include the structural timbers that created the crannog itself, plant remains, and artifacts.

Oak Bank crannog had a framework of foundation timbers that supported a platform with a 15-meter diameter roundhouse, as well as a walkway around the roundhouse and a gangway to shore. The site now lies in between 1 and 5 meters of water, and a range of extremely fascinating artifacts have been recovered, including a dairying dish that had remnants of the dairy food product still in it, a small iron dagger, and a perfectly preserved wooden whistle. There's also a piece of wool textile dating to 400 BCE.

## Digging Deeper

Overall, humans have come up with sophisticated ways to deal with fluctuating water levels, and interestingly, changes in water level are still revealing traces of the past. During low tide at the Severn Estuary in the United Kingdom, footprints dating to the Neolithic can be seen.

These footprints were created on a beach that is now underwater due to sea level rise—it's only during times of lower water that these pathways of ancient humans appear. Even older footprints have been found in the United Kingdom on the shore at Happisburgh, dating to nearly 1 million years old. These may be the footprints of early human ancestors—*Homo antecessor*.

Footprints like these provide archaeologists with a trail to follow into those deeper waters and to dive a little bit further and see the amazing remains that are left over from times of lower sea level. Humans have lived along ocean and lakes shores for millennia—and exploring these types of archaeological sites underwater requires sophisticated techniques for the careful recovery of fragile remains. Just as the sea level rose in the past, the sea level is rising again today.

Archaeologists can start to make connections between these ancient sites and modern places that will soon be inundated. While it's fascinating to explore the world below the waves and look at evidence of past life, perhaps these sites also hold lessons for the future.

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# In Search of Ancient Seafarers

Who were the first mariners? What is the oldest boat in the world, and what does it look like? Archaeologists have been attempting to answer questions like these for decades, largely because they know that the world's oceans are such an important part of contemporary lives today. Think of how much global shipping takes place over the world's oceans and seas, how much travel is done, and all the recreation that occurs. But when did all this start? When did humans start having this relationship with the sea, and what were ancient seafarers really like? In this lecture, you'll investigate the history and prehistory of humans at sea.

## Neanderthals as the First Mariners

Neanderthals were a subspecies of modern humans that existed in Europe and Asia between 300,000 and 24,000 years ago. Known Neanderthal technology—called Mousterian technology—consists of distinctive artifacts that have been found in Europe and Asia. Mousterian technology has also been found on islands in the Mediterranean Sea, which suggests that Neanderthals traveled there by boat. If this is the case, then Neanderthals were the first mariners—before *Homo sapiens sapiens*.

The Greek island of Crete offers some intriguing evidence in this regard. Even with lower water levels during the Pleistocene era, Crete was an island some 40 kilometers from the mainland—too far for any hominid to swim to. However, stone tools including quartz hand axes dating to 170,000 years ago have been found within deposits on Crete—so did Neanderthals boat there?

It's useful to think about why the earliest seafaring may have taken place in the Mediterranean. Neanderthals may have just been at the right place at the right time. With lower sea levels, the Greek mainland and the Ionian Islands likely formed an almost continuous landscape. The short gaps between islands would have been fairly accessible.

Currents and winds in the Mediterranean would also have made travel between these islands easier. Short distances could be traversed in a day, and greater visibility between islands would provide a clear path for a safe return voyage. It's likely that all of these factors created what archaeologists call voyaging nurseries—places that were ideal for experiments in sea travel and early boating technologies. However, since this is all indirect evidence, the idea still hasn't been widely accepted.

The biggest lesson about Neanderthal seafaring is that archaeologists need to conduct more research, both on land and underwater, to gather additional evidence. But even in the absence of direct evidence, the indirect evidence makes a strong case that Neanderthals could have been using some sort of watercraft to get to far-flung islands and to explore the world around them.

## Kozushima

Moving on from Neanderthals, how did early humans travel the world in the past? Before airplanes, trains, or domesticated horses, did the first humans leave Africa and walk to Europe, Asia, Australia, and the Americas? Some of these areas would be inaccessible without boats.

Kozushima is an island off the coast of Japan that provides strong, indirect evidence for human seafaring. The distance from mainland Japan to this island today is 54 kilometers—definitely too far to swim—and it crosses over water up to 200 meters deep. Even when the sea level was the lowest it's ever been, Kozushima was still 30 kilometers from land. That is, Kozushima was always an island—even in times of lower sea level.

Stone tool artifacts found on the island indicate that people were living there 38,000 years ago, but what's so unique about these stone tools is that they're made of a type of volcanic glass called obsidian. Obsidian is a unique type of rock. Prehistoric peoples loved it because it's sharp, it breaks effectively, and it makes efficient cutting tools.

Archaeologists love finding it because it comes from volcanic sources, and therefore, there are only a few places in the world where it can come from. Researchers can use geochemical techniques to trace its exact source, and in this case, rocks found on Kozushima that were shaped by human hands 38,000 years ago came from a source on mainland Japan. People were certainly not swimming that distance. It's clear in this case that boats were helping people transport themselves and obsidian from mainland Japan to Kozushima 38,000 years ago.

## Mesolithic Canoes

To date, the earliest types of boats that have been found anywhere in the world are dugout canoes. These are logs that were dug out—or sometimes burned out—to remove a middle section. The oldest is the Pesse canoe. Discovered in the Netherlands in 1955 during construction of a road, it was encased in a peat bog.

After its discovery, it was freeze-dried to preserve it, and it's now on display at the Drents Museum in Assen, Netherlands. Three meters long, it was crafted from a single scotch pine log. Tool marks from digging out the center of the log are still visible. Radiocarbon dating of the log dated it to the early Mesolithic Period (between 8200 and 7600 BCE).

In 2001, an exact replica of the canoe was crafted and successfully used as a boat by an individual paddler. This experimental archaeology technique provided further evidence that the Pesse canoe really is the world's oldest-known boat.

Experimental archaeology is a field of study that essentially tries to test archaeological hypotheses by running experiments. Sometimes, archeologists make their own stone tools or bronze swords. Such experiments help archeologists to better understand the artifacts and sites they're finding in the archaeological record.

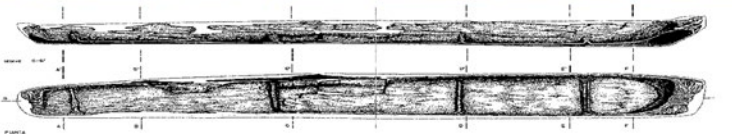
Canoes of similar age from the Mesolithic Period have also been recovered from France, Germany, two other sites in Denmark, and Slovenia. All of the Mesolithic canoes are monoxylous, which means they were dug out from a single trunk. They range in size from 3 to 10 meters and date from 8000 to 4100 BCE. They were made from various types of wood, including pine, poplar, oak, alder, and lime.

## Neolithic Canoes

La Marmotta is a submerged Neolithic site in Lake Bracciano, which is connected to the Mediterranean by the Arrone River. It was first discovered in 1989 and was excavated between 1992 and 2006, with another small excavation completed in 2009.

What's most interesting about the canoes at La Marmotta are their specific features. The largest canoe at the site—Marmotta One—is made of oak, and it's more than 10 meters long, more than 1 meter wide at the stern, and just about 1 meter wide at the bow. Transverse supports were built into the canoe to reinforce it and improve the durability of the hull and its maneuverability.

One of the most interesting parts about this particular canoe and some of the others are T-shaped wood pieces with holes in them attached along the rail of the canoe. These were inserted at similar distances and heights along the sides of the ships and were likely used for attaching a line, perhaps for sails or a stabilizer, or even to connect the canoe to another boat to form a catamaran. All of these possibilities would have improved the safety and stability of the boat and provided greater capacity for people, animals, and goods.



Over the course of the Neolithic, within just a few millennia, humans occupied the whole of the Mediterranean, from Cyprus to the Atlantic seaboard of the Iberian Peninsula, and boats likely aided them in this journey. The canoes from La Marmotta, including their specialized accessories, indicate that a level of sophistication and major technological development for sailing was in place as early as the Neolithic. Boats allow for the rapid movement of people, ideas, and goods, and their use facilitated migrations and the exchange of items not just within the Mediterranean but also beyond.

## The World's Oldest Shipwreck

The Black Sea was a hot spot for early seafarers. Underwater archaeologists from the University of Southampton conducted a survey project called the Black Sea Maritime Archaeological Project (MAP) and recorded more than 60 shipwrecks, including Roman and Ottoman ships.

While archaeologists know that shipwrecks underwater preserve well, they preserve even better in the Black Sea due to a low-oxygen environment. At certain depths, the Black Sea is anoxic, with no oxygen whatsoever—a perfect environment for preserving wooden vessels. The lack of oxygen means that no shipworms live there, so the Black Sea wrecks are even more intact than other underwater sites around the world.

In 2018, 80 kilometers off the coast of Bulgaria, the Black Sea MAP discovered the world's oldest intact wreck—a 2400-year-old Greek trading vessel, currently resting at a depth of 2 kilometers below the surface. The 23-meter-long ship and its hull are intact. Its rowing benches, mast, and rudder are all still in place. The vessel was too deep for scuba divers, so researchers used an ROV to 3D-model the shipwreck. Before this discovery, archaeologists had to rely on drawings found on ceramics to know what ships of this age would have looked like.

While a sample of the ship's timbers was brought to the surface for radiocarbon dating, it would be expensive and challenging to bring the entire ship up. In fact, resting below the Black Sea is the best place for this wreck. It's already been preserved there for more than 2000 years, and it will very likely keep being preserved for another 2000 or more.

Unless archaeological sites or artifacts are in immediate danger, smaller samples that are brought to the surface will suffice for all the scientific testing that needs to be done. The majority of the remains can be mapped and studied in place—in their original context and original environment. Areas like this are known as underwater museums, and leaving boats *in situ* is the best practice most of the time.

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# The Future of the Underwater Past

In this lecture, you'll explore an underwater site that touches on the importance of representation in archaeology and learn about two organizations—Diving With a Purpose and the Slave Wrecks Project—that are helping to bring underwater archaeology into the future. They are dedicated to researching the history of underrepresented groups, including Black pilots and enslaved Africans, as well as training the next generation of underwater archaeologists. Though still evolving, these projects are focused on untold aspects of history and the details that remained hidden underwater up until recently.

## Tuskegee Airmen

Before World War II, no African American had been a US military pilot. After decades of racially motivated rejections, Congress passed the Appropriations Bill Public Law 18 in 1939, finally allowing African Americans to be trained as fighter pilots. The Tuskegee Airmen—initially trained in Tuskegee, Alabama, at a segregated airfield—became the first all-Black fighter squadron in the United States serving during World War II.


On April 11, 1944, Frank Moody—a 22-year-old Tuskegee Airman—was on a training mission when his plane crashed into Lake Huron in the United States. Moody's body was recovered on shore about 2 months later, but his P-39 Airacobra plane remained hidden below water for 70 years, when it was discovered by a father-and-son dive team in 2014.

Archaeologists began mapping the wreck and bringing pieces of the plane up to the surface. Because this was a crash site, the plane was not intact. It didn't just simply sink below the waters. Instead, it's what archaeologists call disarticulated, meaning that most of the pieces are not in their original orientation. The plane broke apart on impact, and pieces of the wreck are spread out over almost half a mile on the lake bottom. The engine of the plane was one of the first artifacts discovered. The wings, tail, and propeller, as well as more than 600 artifacts, have also been recovered.

The Tuskegee Airmen were left out of history books and documentaries about World War II, but over time, many historians have recognized their vital role and sought to discuss racism and discrimination in the US military. Despite being war heroes who flew successful campaigns overseas in Sicily and North Africa in World War II, they dealt with discrimination and racism. With updated histories and underwater investigations like these, important stories are coming to light. The underwater discovery of Moody's plane has helped spur even greater interest in the Tuskegee Airmen, and it's helping to tell the tale of these brave pilots.

## Diving With a Purpose

Research at the Lake Huron site is continuing, as is the hunt for other plane wrecks known to have gone down there. At least three other Tuskegee Airmen planes are still lost below Lake Huron, according to Diving With a Purpose, which is a nonprofit group that focuses on protecting, studying, and conserving maritime history—particularly history that's associated with African Americans.

Founded in 2005, Diving With a Purpose is dedicated to locating and documenting shipwrecks, especially those associated with the transatlantic slave trade. The group offers several programs for divers, including training for adults and youths in maritime archaeology. These courses teach the basics of underwater archaeology and reinforce the precision that archaeologists use to map and excavate wreck sites through both classroom lectures and activities done on land first before entering the water.

One of the most important training courses conducted by Diving With a Purpose is a week-long workshop hosted in Biscayne National Park in Florida, just south of Miami. While at least 75 archaeological sites are submerged in the park's waters, there's often only one site National Park Service archaeologist on staff. Diving With a Purpose helps the National Park Service by providing expertise and volunteers to document the archaeological sites that it's responsible for.

Most shipwrecks are actually scattered debris fields. It's not common for a ship to sink peacefully and gently below the waves and remain intact on the ocean floor. When a ship or plane first wrecks, a number of factors can damage it and break it apart, including the impact. In the case of collisions, for example, the ships are already broken before they go down.

Many artifacts or parts of a ship can be found far from the original site, and locating all these remains is an important part of nautical archaeology. Once a wreck and its artifacts are located, they need to be mapped. Preserving and protecting wrecks is a critical aspect of the work that Diving With a Purpose is doing, and the organization trains divers in the fundamental methods used for documenting shipwrecks.

The type of research and collaboration projects done by Diving With a Purpose are helping to locate and better understand archaeological sites while also training students and members of the diving community to better understand and take part in preserving maritime history.

One of the most important aspects of Diving With a Purpose is its mission to reach out to and train a diverse audience and citizen scientists and to research the sorts of history that have too often been left behind. Diving With a Purpose received the 2022 Sanctuary Wavemaker Award from the National Marine Sanctuary Foundation, which recognized dedicated citizens who are advocates and ambassadors for the national marine sanctuaries in the United States.

## The Slave Wrecks Project

Another group that is seeing what shipwrecks can tell people beyond written records is the Slave Wrecks Project—an international network of researchers and institutions hosted by the National Museum of African American History and Culture in Washington DC. The project searches for slave ships one at a time using maritime archaeology and documentary research to take a new approach to the study of the transatlantic slave trade.

Between 10 and 12 million enslaved Africans were trafficked to the Americas between the 16th and 19th centuries, and the effects of this massive forced movement of people are still seen today. Researchers believe that more than 1000 ships carrying enslaved peoples wrecked during this period, and the Slave Wrecks Project is working to locate these lost ships.

Since 2013, the project has rediscovered and systematically investigated the *São José Paquete d'Africa*, a Portuguese slave ship. Carrying stolen peoples from Mozambique and sailing around South Africa on its way to Brazil, the *São José* crashed on rocks 100 meters from shore off of Cape Town on December 27, 1794. The captain, crew, and half of the enslaved peoples aboard the ship were rescued, but the rest of the Mozambican captives were lost at sea.

The research at *São José* is the first archaeological documentation of a vessel that foundered and was lost while carrying enslaved peoples. Matching the wreck site to the *São José* took careful research and persistence.

In 2014 and 2015, the first artifacts—including iron ballast and ship's timbers—were brought to the surface by archaeologists. Ballast and timbers are important artifacts because they can help archaeologists determine the size of the ship that wrecked. They can then compare these measurements to historical records to further match a wreck with its name.

Other artifacts recovered from the wreck include copper fasteners, a pulley block, several cannons and cannonballs, and even shackles. These shackles were particularly important in helping confirm the identification of the ship.

## Maritime Archaeology and Representation

The *São José* shipwreck is historically important, as it's one of the earliest voyages that brought East Africans into the slave trade and to the Americas; in addition, it shows the global scope of the slave trade and its enduring legacy. Historical documents can only go so far. It's one thing to read about the slave trade and quite another to see the actual shackles used in these vessels. Archival research and archaeology can work together to reveal the full story and understand the ultimate fate of the ship and what happened to the people on board—enslaved people who were often only recorded as a number. Underwater, archeologists can see tangible evidence of the lives they were living, the type of treatment they endured, and maybe even more than some of the history books want them to see.

The Slave Wrecks Project teaches a course for Africans and people of African descent that includes the basics of underwater archaeology methods. This program was first piloted in Senegal in 2022. The project also has the Crossroads Initiatives—to develop public exhibits, publications, and educational programs for local communities—and a program that trains local residents in scuba diving, cultural heritage, and ongoing community engagement. Since this training began in 2016, 17 local Mozambicans have become scuba certified.

Projects and organizations like Diving With a Purpose and the Slave Wrecks Project—as well as the excavation of Frank Moody's airplane—are moving the field forward. In the United States and United Kingdom, fewer than 1% of professional archaeologists are Black. The number of Black maritime archaeologists is even smaller. There are numerous barriers to participation in archaeological projects, and organizations like these are making research more accessible.


Representation is important in archaeology today, and archaeologists are increasingly seeking to work with local communities and indigenous peoples to better understand sites that are preserved below water. For example, in Wisconsin, archaeologists are working with indigenous peoples, including the Ho Chunk Nation and the Bad River Band of Lake Superior Chippewa, to investigate dugout canoes that have been found in Lake Mendota. Up to 11 canoes have been discovered. One such canoe, made of elm, is 4500 years old—the oldest ever found in the region.

Working with Native American nations to explore the canoes and the surrounding areas is providing a picture of the ingenuity of past peoples in the region and the physical remains to accompany vast oral historical traditions. The canoes will be preserved for many future generations. This collaboration is just one example of how working with Native American and indigenous communities is essential to keep pushing forward archeologists' understandings of the past.

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