

Laos: Mystery of the Plain of Jars

# ARCHAEOLOGY

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A publication of the Archaeological Institute of America

January/February 2017

## TOP 10 DISCOVERIES OF THE YEAR

- World's Oldest Dress
- Salem Witch Trials
- The Dawn of War
- and more...

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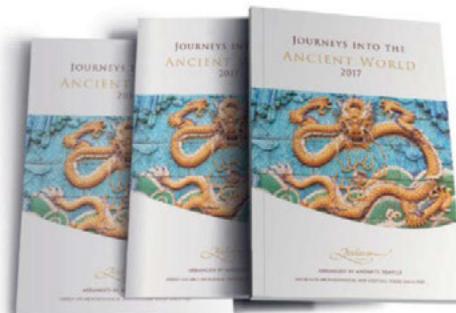
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**COVER:** Unearthed in Egypt in 1913, the "Tarkhan Dress," now securely dated to more than 5,000 years ago, is the world's oldest woven garment.

**PHOTO:** Courtesy Petrie Museum of Egyptian Archaeology

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## EDITOR'S LETTER

# THINKING BACK, LOOKING AHEAD

This year's "Top 10 Discoveries" (page 26) explores the vast array of human activity—from side-by-side native Taino and Christian inscriptions on Mona Island, Puerto Rico, to evidence of the true extent of Cambodia's Khmer Empire, and from 10,000-year-old signs of warfare at Lake Turkana, Kenya, to 400 wooden tablets containing the earliest written mention of London. ARCHAEOLOGY's editors have chosen these Top 10 finds as the best way to ring out the old year and welcome in a new one.

In that same vein, as ARCHAEOLOGY enters its 69th year, we want to renew our commitment to the magazine's future—and to you, our readers. Creative director Richard Bleiweiss has introduced a gentle change to the design of our pages to help us remain, as always, contemporary. What you will see are an enlivened palette and additional "breathing room" for our news stories and images. While we report on the past, our intention is to look ahead and to continue to bring you the incisive coverage of archaeology that you have come to expect in these pages, online, and in social media. We hope you like it!

Sometimes, the work of archaeology supports the recollection of events even as they begin to fade from memory. "December 7, 1941" (page 40), by deputy editor Samir S. Patel, covers the underwater archaeology efforts conducted at Pearl Harbor and around Oahu as the 75th anniversary of the attack there is commemorated. New details from that fateful day continue to emerge.

"Fire in the Fens" (page 34), by contributing editor Jason Urbanus, visits a British Bronze Age site that, but for a turn of luck, might never have been found. Must Farm, as it is called, contains evidence of the last day of a short-lived settlement that burned and fell, complete, into a slow-moving river, where it was preserved for three millennia.

Evidence of trade and diplomacy may seem like the last thing one would expect to discover at a Viking site. But "Hoards of the Vikings" (page 48), by senior editor Daniel Weiss, is the story of the "other" Vikings, who lived on the Baltic Sea island of Gotland. Theirs is a record of steady economic growth, trade, and independence—surely with ample amounts of aggression thrown in.

And don't miss "Letter from Laos" (page 55), by journalist Karen Coates, about the mysterious Plain of Jars. Happy reading, and a Happy New Year to all!

**USS Arizona Memorial**



**Claudia Valentino**

*Editor in Chief*

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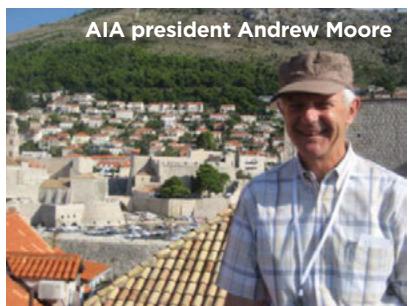


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## FROM THE PRESIDENT

# THE AIA TODAY AND TOMORROW

The Archaeological Institute of America (AIA) is the largest and oldest archaeological organization in North America. From its beginnings in 1879 it has supported excavations in the United States and abroad and has informed the wider world about the results of those investigations. *ARCHAEOLOGY* magazine is the AIA publication through which members of the general public learn of the work of archaeologists across the globe. More detailed, scholarly accounts appear in the AIA's highly rated *American Journal of Archaeology*, and in books published by the AIA. The AIA's national lecture program is carried out in 110 Local Societies, situated throughout the United States and elsewhere.



Renowned archaeologists themselves discuss their fieldwork and latest discoveries.

The AIA takes seriously its commitment to preserving the world's archaeological heritage. In recent years we have addressed the increasing need to speak out when archaeological sites and monuments are threatened. Whenever possible, we have joined forces with other organizations whose missions are similar to our own, in order to have the greatest possible impact. Our highly effective Site Preservation Program has helped ensure that archaeological sites, wherever threatened, receive the specialist care they need so that they may be conserved for the benefit of future generations. We have supported efforts to implement best practices in site management to set an example for all engaged in this vital work.

In the last two decades, under the leadership of successive presidents, the AIA has made great progress in fulfilling its mission. With the support of our loyal trustees and many generous members and friends we have increased our presence on all fronts. We devote considerable resources to training archaeologists and museum professionals. As a result, the AIA is admired as one of the world's leading archaeological heritage organizations. I have been proud to lead this vibrant organization, committed to increasing understanding of the importance of archaeology for us all. Archaeology tells us about the human past, certainly, but it can also help us address challenges in the present. This gives it special significance.

I will shortly step down as president of the AIA. My successor will be Professor Jodi Magness. She is an expert in the archaeology of ancient Palestine in the Roman, Byzantine, and early Islamic periods. Professor Magness is currently excavating a Late Roman-Byzantine synagogue with spectacular mosaics at Huqoq in Galilee. She brings to the presidency rich experiences of field research as well as an outstanding record of publication of both specialist materials and works intended for the broader public. I wish her well as she assumes the leadership of this outstanding archaeological organization.

**Andrew Moore**  
President, Archaeological Institute of America

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## LETTERS

# FROM OUR READERS

### REVISITING A ROYAL RESIDENCE

I was delighted to see the article on Gyeongju in South Korea ("Korea's Half Moon Palace," November/December 2016). I've had the pleasure of visiting the fascinating site of the old Silla capital. The entire area should be an archaeologist's dream, as there are many interesting facets of the site. I hope you will follow up with more on the unfolding picture now that the nation has begun to truly dig into their very interesting past.

Richard Underwood  
Urbana, IL

### ANCIENT ACOUSTICS

Thank you for the lovely feature "The Temple Builders of Malta" in your November/December 2016 issue. Having studied this subject for many years, I was delighted to find fresh coverage from a new perspective. Particularly interesting to read was Reuben Grima's informed idea about the intentionality of using natural fault planes in the cutting

ARCHAEOLOGY welcomes mail from readers. Please address your comments to ARCHAEOLOGY, 36-36 33rd Street, Long Island City, NY 11106, fax 718-472-3051, or e-mail letters@archaeology.org. The editors reserve the right to edit submitted material. Volume precludes our acknowledging individual letters.

of Malta's underground necropolis, the Hal Safieni Hypogeum. There is reason to believe that the space was also deliberately contrived to enhance eerie acoustic effects that occur there.

In 2014, the Old Temples Study Foundation organized a multidisciplinary evaluation of the Hypogeum, during which researchers in archaeo-acoustics measured the extraordinary sound behavior in the limestone chambers. Their findings include echoes that lasted as long as 13 seconds and impressive resonant frequencies at levels that are known to impact brain activity. I am convinced that sound played a large role in the ritual activity that took place there. With its fine reporting, ARCHAEOLOGY magazine helps meet the challenge of unraveling some of the mysteries.

Linda Eneix  
Myakka City, FL

### A RACE FOR THE AGES

I enjoyed the short article about the Roman horseracing mosaic found in Cyprus ("And They're Off," November/December 2016). Is it possible that at least one of the names in each group is that of the owner of the chariot team? It seems to me that the owners—undoubtedly wealthy folk of some importance—would be well known. Perhaps the mosaic is a depiction of a famous race that the villa owner's team

won? Thanks for a great magazine—I have subscribed for years and always look forward to the next issue!

Carole Graham  
Cortez, CO

### WHO(REALLY)DUNIT?

I enjoyed Samir S. Patel's article "Piltdown's Lone Forger" (November/December 2016). It jogged a long-forgotten memory and sent me searching my library for an article on Piltdown in the September 1983 issue of *Science*. This provided a new look at the most celebrated scientific hoax of all time and turned up a surprising suspect—Sir Arthur Conan Doyle, who understood chemistry and was himself a doctor, a fossil collector, a world traveler, and a known practical joker. The article stated that Doyle had visited the relatively unguarded location many times, on his own, at odd hours. It was thought provoking, and I want to thank Patel for the fine article.

Richard K. Smith  
El Cajon, CA

### Samir S. Patel responds:

Indeed, the author of *The Hound of the Baskervilles* has been implicated in the lore of Piltdown Man—motivated by revenge against the scientific community for shaming his spiritualist beliefs, it is said—but the evidence against Charles Dawson is quite compelling. We are glad to have reignited your interest.



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## PROTEINS SOLVE A HOMININ PUZZLE



Châtelperronian Neanderthal body ornaments

**A**round 40,000 years ago, modern humans made their way into Europe, sweeping through the continent and, eventually, driving to extinction our close relatives, the Neanderthals. Exactly how that process took place is still up for debate. Tangled up in that conversation are questions about the sophistication of Neanderthals, including whether they were capable of artistic expression, or made jewelry or complex stone tools.

Archaeologists agree that hand axes and scrapers were definitely part of the Neanderthal toolkit, and modern humans are credited with developing points made of bone and antler, as well as flint blades. But in between these two types of technology, chronologically, are the so-called Châtelperronian tools, characterized by sawtooth edges and knives with convex backs. Researchers are still unsure which hominin was responsible for them.

Scientists from the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, applied a relatively new technique—probing ancient bones for the remains of proteins—to solve the riddle at the Grotte du Renne, a cave located 150 miles southeast of Paris. Châtelperronian tools

were discovered there, mostly in the 1950s, in association with ornaments such as bead necklaces and pendants, as well as hominin remains. The jewelry implies the deposit was made by modern humans, but the bones appear to be those of Neanderthals.

Proteins are more robust than DNA, so they persist longer in bone, especially in warmer climates. The human and Neanderthal genomes—and, in turn, proteins—are nearly the same, so the team was on the hunt for small differences. “If you have a choice between DNA and proteins—with DNA around, you would want DNA,” says Matthew Collins, a professor of proteomics at the University of York and a collaborator in the new work. “If you want to push things further back in time, then no one’s really been looking at proteins.”

The research team analyzed 28 bone fragments found close to the Châtelperronian tools and screened them for preserved proteins. They recovered about 70. After eliminating several as stemming from possible contamination during handling, they analyzed the remainder. “There were a number that are only active in bone during the first one or two years of life,” says Frido Welker, a graduate student at the Max

## FROM THE TRENCHES

Planck Institute, who helped lead the research. Based on the presence of those proteins, Welker explains, and the size of the bones, the scientists concluded the remains were from the skull of a breast-feeding infant.

To figure out if it was a Neanderthal or human baby, they isolated sequences of amino acids, the building blocks of proteins, and compared them to sequences found in modern humans. They specifically looked for snippets that are either found in low frequencies in humans or show slight differences from typical human versions. If any of these were present, the bones were likely Neanderthal. They hit on one that tends



Grotte du Renne, France  
only to be found in human populations in Oceania—where modern humans carry more genetic material conserved from earlier hominin populations.

As another data point, analysis of

mitochondrial DNA later confirmed what the protein analysis suggested: The infant was Neanderthal. Radiocarbon dating of a section of skull put its age at roughly 42,000 years old. Thomas Higham, who runs a radiocarbon lab at the University of Oxford, and who had previously concluded that the finds at Grotte du Renne were jumbled together from two different time periods, called the new study “hugely exciting.”

“It looks as though the Châtelperronian is a Neanderthal industry,” he says. “I think it is quite possible that Neanderthals were capable of making and using personal ornaments.”

—NIKHIL SWAMINATHAN

## OFF THE GRID

*Rogers Island, in the middle of New York's Hudson River about an hour north of Albany, is part of a large eighteenth-century fort and supply base built by the British in 1755 and used throughout the French and Indian War (1754–1763). During that time, expansion of the fort—to accommodate at least 16,000 soldiers—made the island and the riverbank village of Fort Edward the largest city in colonial North America, after New York and Philadelphia. Many consider the fort to be the spiritual home of the U.S. Army Rangers, as that was where Major Robert Rogers wrote his 28 “Rules of Ranging” in 1757 to dictate principles of reconnaissance and guerilla forest warfare. (Number 21: “If the enemy pursue your rear, take a circle till you come to your own tracks, and there form an ambush to receive them, and give them the first fire.”) The tactics proved very effective and still appear in the U.S. Army Ranger Handbook. David Starbuck of Plymouth State University says, “Archaeology is now helping to develop trails and outdoor exhibits that will highlight daily life on the early American frontier. Unlike so many forts and battlefields, Rogers Island will tell the very human story of soldiers’ lives as they camped, drilled, and prepared to fight.”*

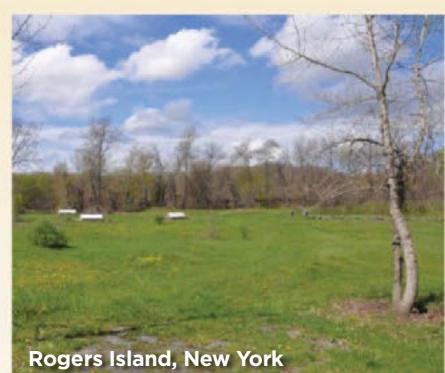
### THE SITE

Rich prehistoric sites have been found on the island and east bank of the river, where Native Americans hunted and fished from about 4000 b.c. until Europeans arrived in the eighteenth century. The fort and base spanned both the island and the

village on the bank. Some portions were built over—homeowners in Fort Edward have found military artifacts and bricks in their basements—but the southern half of Rogers Island was spared modern settlement and is one of the most intact sites from the French and Indian War. Excavations began in 1991 and continue, having investigated huts and barracks, the oldest smallpox hospital excavated in North America, and a merchant’s house. The visitors’ center on the island displays many of the artifacts that have been uncovered.

### WHILE YOU'RE THERE

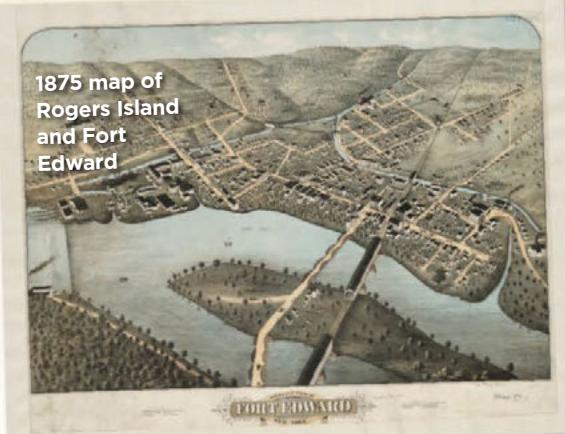
The Old Fort House Museum in Fort Edward is a complex of buildings with historical artifacts and reconstructions dating from



Rogers Island, New York

the 1770s to the 1940s. Fort William Henry, 13 miles away in Lake George, was, along with Fort Edward, a setting for James Fenimore Cooper’s *The Last of the Mohicans*, and features both a museum and living history exhibits. The lake is host to a variety of other recreational activities, including hot-air ballooning.

—MALIN GRUNBERG BANYASZ



## FROM THE TRENCHES

# A PHARAOH'S LAST FLEET

Over the past three years, archaeologists from the University of Pennsylvania Museum of Archaeology and Anthropology have been excavating an ancient Egyptian boat burial in Abydos. Although very little of the actual vessel survives, it was originally interred in a vaulted subterranean mudbrick building. The site dates to around 1850 B.C., and is believed to have been part of the elaborate funerary complex of the 12th Dynasty king Senusret III. "Boats were used during funerary ceremonies and took on a magical significance," says lead archaeologist Josef Wegner. "The boats used in this way were ritually buried as a means of emphasizing this symbolic connection with the deceased."

The team recently uncovered a decorative tableau that was incised into the white plaster walls along the interior of the boat building. The surviving scene extends for over 80 feet and depicts more than 120 ancient Egyptian watercraft, along with animals and floral motifs. The renditions of the boats range in size and complexity, with the largest measuring five feet



Funerary complex, Abydos, Egypt

long, with finely detailed masts, sails, rigging, and deckhouses. Researchers are still unsure who made these etchings, as the images do not compose a single unified scene, but appear to have been created by several different hands of varying talent. It is likely that the carvings were left by individuals who were involved in the funerary ceremonies and participated in depositing the boat.

—JASON URBANUS

## THE CURSE OF A MEDIEVAL ENGLISH WELL

Archaeologists working near Liverpool, England, recently rediscovered a legendary medieval well. The shallow well was for centuries a popular destination for religious pilgrims, owing to its purported ability to cleanse one of sins and heal certain ailments. It was likely associated with St. Anne, whose cult became popular in England around 1400. By the late nineteenth century, the well was no longer in use and was gradually buried by plowing and other agricultural activity. Although archaeologists were aware of its general whereabouts, its exact location was unknown until recently.

The 6.5-by-6.5-foot well was con-

structed from local sandstone blocks, with three steps leading down to the water. In the sixteenth century, the structure was also at the center of a mysterious event. The well's many visitors made it lucrative, and it became the subject of a contentious ownership dispute between a local priest and an agent of a neighboring landowner. The priest ended up putting a curse on the well, only to have it backfire—he died three hours later. Things didn't go much better for the agent. A few months later, after some serious financial losses and the passing of his only son, he was found dead beside the well with his skull crushed in.

—JASON URBANUS



St. Anne's Well, Merseyside, England

## FROM THE TRENCHES

# DISCOVERING TERROR

In 1845, Sir John Franklin led an expedition that sailed from England in search of the Northwest Passage. The next year, both of its ships were abandoned in

Arctic ice, and the entire 129-member crew perished. For nearly 170 years, efforts to find the missing ships—HMS *Erebus* and *Terror*—fell short. Then,

in 2014, *Erebus* was discovered in Canadian waters by a team from Parks Canada (“Franklin’s Last Voyage,” July/August 2016), and now *Terror* has been found as well—around 60 miles north of its sister ship in the coincidentally named Terror Bay.

*Terror* was located in September 2016 by an Arctic Research Foundation vessel that detoured to the wreck’s location based on a report from an Inuit crewmember who recalled seeing a piece of wood that looked like a mast sticking out of the ice covering Terror Bay six years earlier. Divers found the ship 80 feet underwater and in extremely good shape. Two weeks later, Parks Canada confirmed the identification, opening a new chapter in the story.

—DANIEL WEISS



Ship's wheel, HMS *Terror*

## HUNGRY MINDS

**B**rain size has traditionally been seen as the best way of comparing the intelligence levels of human ancestors. Now a team of researchers believes it has found a more accurate gauge: cerebral metabolic rate, or the amount of energy consumed by the cerebrum, which can be estimated based on the amount of blood delivered to it. As a proxy for cerebral blood flow, they measured the size of openings in the base of the skull through which the internal carotid arteries pass.

The team studied 35 skulls from 12 hominin species, including *Australopithecus africanus*, *Homo erectus*, Neanderthals, and modern humans. They found that, over more than three million years of evolution, hominin brain size has increased 350 percent—while cerebral blood flow has increased 600 percent. “This suggests that brain metabolism was being very heavily selected for throughout our evolution,” says Vanya Bosiocic of the University of Adelaide, “and has probably played a very important role in contributing to our

intelligence.” The researchers believe that the brain’s growing demand for energy is most likely due to increased synaptic activity and interconnection among neurons.

—DANIEL WEISS



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Lindell has been featured on numerous talk shows, including Fox Business News and *Imus in the Morning*. Lindell and MyPillow have also appeared in feature stories in major magazines and newspapers across the country. MyPillow has received the coveted "Q Star Award" for *Product Concept of the Year* from QVC, and has been selected as the Official Pillow of the National Sleep Foundation.

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## FROM THE TRENCHES



## GUIDE TO THE AFTERLIFE

The Korean government recently designated as state treasures a group of sixth-century A.D. artifacts unearthed from a tomb dating to Korea's Silla Dynasty (57 B.C.–A.D. 935). The tomb, which is located in Yangsan, South Gyeongsang, was first discovered during an archaeological exploration in 1990. Inside, archaeologists found the artifacts that gave it its name—Geumjocheong, “Gold Bird Tomb.” The relics include two extraordinary gold accessories shaped like bird's claws, the first artifacts of this kind to be found in Korea. They are small, just over an inch long. The sharp claw tips, each a quarter-inch long, spread outward, as they would if a bird were about to take flight.

Researchers believe the claws were once connected to a figure of a bird's body through three holes at the end of each one. The body, it is thought, was probably made of wood and decayed. Some ancient records indicate that people were buried with bird's wings in their tombs, symbolic of the connection between this world and the next. Other relics from the tomb include a silver belt decorated with patterns of saw-toothed wheels, gold earrings with tortoiseshell designs etched on the surface, and a bronze pot used to boil or warm liquor, soup, or medicinal herbs.

—HYUNG-EUN KIM

# Do You Suffer From:

- Plantar Fasciitis
- Joint Pain
- Heel Pain
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- Arthritis
- Neuropathy



Nicole S.

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## FROM THE TRENCHES

# JAPAN'S EARLY ANGLERS

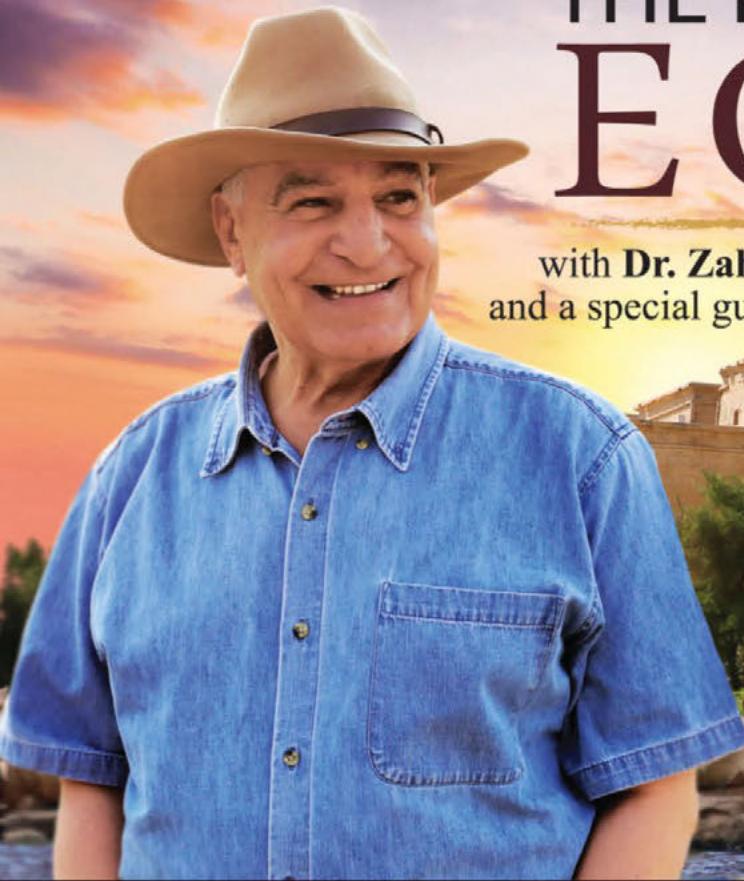
**A**rtifacts unearthed at Sakitari Cave in Okinawa, Japan, show that humans had successfully adapted to living in small island environments by 35,000 years ago—thousands of years earlier than previously thought. Among the finds were two of the world's oldest fishhooks, dating to 23,000 years ago, and the skeleton of a child. Except for some quartz flakes, most of the artifacts at the site, including beads and scrapers, were made from shells. Humans at that time had been taking long ocean voyages for tens of thousands of years, but learning to adapt to life on a small island was more challenging than living on the coast of a larger landmass, as the people at Sakitari could not count on inland food sources. Other Paleolithic sites on nearby islands indicate that by 30,000 years ago people had a well-established maritime lifestyle, which set the stage for moving out to more remote islands in the Pacific.

—ZACH ZORICH



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## FROM THE TRENCHES

# A REMOVABLE FEAST

Removal of plaster-covered roasting pit, Head-Smashed-In, Canada



Royal Alberta Museum archaeologist Bob Dawe recently returned to the scene of an unusual discovery he made in 1990. While excavating at Head-Smashed-In, a prehistoric buffalo jump in the foothills of the Rocky Moun-

tains, he uncovered an intact 1,600-year-old sandstone-lined roasting pit. Such archaeological features are often found near buffalo jumps and were probably used to cook large quantities of meat for celebratory feasts—but they are always

empty. This example was brimming with bones belonging to a buffalo calf, at least two adult buffalo, and a canine, probably a dog-wolf hybrid. The people who had hoped to dine on the meat, likely ancestors of today's Blackfoot, never retrieved it. Sensing excavation of the pit would be a complicated affair, Dawe covered it up and vowed to return when he had the time to investigate it properly.

Last summer, with the help of paleontologists, Dawe and his team dug around the roasting pit and encased it in a plaster jacket so they could lift it out of the earth intact. Dawe plans to methodically excavate the feature in the laboratory, and eventually put it on display, but he doesn't expect to ever find out just why the lavish banquet remained in the ground. "It would have been quite a feast," says Dawe, "so something drastic must have happened. Maybe there was a blizzard, or a prairie fire. Or maybe other people drove them away."

—ERIC A. POWELL

## BLUE COLLAR IN ANCIENT PERU

Indigo, the blue dye used in modern times to make the first blue jeans, may have been associated with ordinary folk in ancient Peru as well. Archaeologists led by Tom Dillehay of Vanderbilt University discovered textiles at the Huaca Prieta mound that date from as far back as 5,800 years ago and, after being washed by conservators, revealed a blue tint. Laboratory tests confirm the coloring is indigo, a dye made from the leaves of a shrub of the pea family, says Jeff Splitstoser of George Washington University, a textile specialist who conducted the tests with Jan Wouters of University College London. It is the

oldest known use of indigo in the world, he says. "Blue from sources other than indigo is rare, so it has always been assumed it was indigo, but until now we never had the proof." Huaca Prieta has been notable for its lack of high-class goods, a pattern that extends to indigo-dyed fabric, too, according to Dillehay. "I don't see its early use associated with elites or high-status people," he says. "In fact there is no evidence of artifacts or contexts of high-status people at Huaca Prieta. The data suggest egalitarianism."

—ROGER ATWOOD

Fabric scrap dyed with indigo



# THE MONKEY EFFECT



Bearded capuchin monkey

There are fancy obsidian blades from Mesoamerica and deftly knapped Clovis points, but many stone tools look, to the uninitiated, like ... well ... rocks. This is especially true of some of the simplest, oldest human-made artifacts. But there are reasons that a paleoanthropologist can pick up a seemingly random rock and say, "This was made by human hands." There's more or less no known natural mechanism that breaks certain kinds of rocks in a way that makes sharp edges, or knocks consistent flakes off a larger core. Spot those useful edges or flakes, and you almost certainly have an intentionally made tool. However, according to new research, that's no longer strictly true, thanks to some bearded capuchin monkeys in northeast Brazil.

Researchers from the University of Oxford's Primate Archaeology Research Group and the University of São Paulo recently found that these monkeys actually create "artifacts" that could be mistaken for human-made stone tools. The monkeys smack rocks together, for reasons that aren't clear, but may involve licking the broken surfaces for silicon, an essential trace nutrient. Sometimes the rocks break in ways that create flakes or leave the broken rocks with sharp edges suitable for cutting or scraping. The monkeys don't use them that way, but the researchers wrote that "the production of archaeologically identifiable flakes and cores, as currently defined, is no longer unique to the human lineage."

—SAMIR S. PATEL



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## FROM THE TRENCHES

# FIGURE OF DISTINCTION

In a Neolithic dwelling at the site of Çatalhöyük in southern Turkey, archaeologists have uncovered a limestone female figurine that is at least 8,000 years old. While many such figurines have been found there previously, most are made of clay. Further, few display the kind of high-quality craftsmanship and level of detail evident in this example, which, excavators

say, would have been executed by a skilled artisan using flint or obsidian tools. Interpretations of these robust female figurines differ. Some researchers consider them fertility goddesses, while others suggest they may represent older women of high status in the community.

—JARRETT A. LOBELL

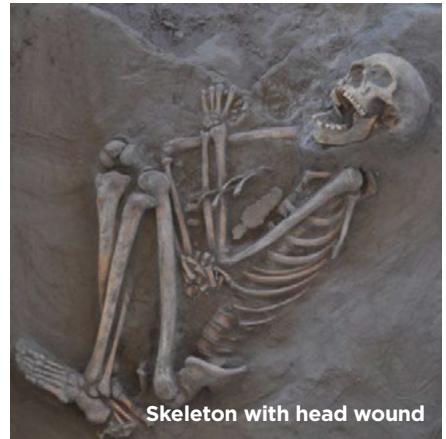
Neolithic figurine



# DEATH BY BOOMERANG

While on survey in a national park in southern Australia, archaeologists recently discovered a male skeleton eroding out of a riverbank. Dubbed Kaakutja, or “older brother” in a local language, the man had a fatal six-inch gash in his skull. When Griffith University paleoanthropologist Michael Westaway first examined the skull damage, he thought “it looked similar to steel-edged weapon trauma from medieval battles.” But radiocarbon dating of Kaakutja’s skeleton shows he died in the thirteenth century, well before Europeans reached Australia and introduced metal to the continent. Westaway concluded that the wound was likely caused by a heavy war boomerang or a sharp-edged club known as a *lil-lil*, both of which are depicted in Aboriginal rock art. “Kaakutja’s trauma is unique in that it is the first recorded case of edged-weapon trauma in Australia,” he says. The lack of defensive wounds to the man’s arms suggests he may have been attacked while he slept, which, according to nineteenth-century ethnographic accounts, may have been a common tactic in prehistoric Australian conflicts.

—ERIC A. POWELL



Skeleton with head wound

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## WORLD ROUNDUP BY SAMIR S. PATEL



**1. ALASKA:** Metal artifacts from a house site on the Seward Peninsula are the first evidence of trade

between the Thule, ancestors of today's Inuit, and Asia. The house is between 700 and 900 years old, constructed centuries before sustained trade with Europeans or Russians. The Thule did not smelt their own metals, and X-ray fluorescence shows that the artifacts, including a buckle and a bead, had been smelted—and the material resembles metals made in Asia at the time.



**2. MEXICO:** In a return to Lambityeco, a city occupied from A.D. 500 to 850 and first excavated in the 1960s, archaeologists discovered a massive carved stone crocodile. It is thought that it was once part of a temple's ceremonial staircase, but was moved to the ground and placed upside down. Experts think the move was part of a reconstruction of the ceremonial center that signaled a cultural break with the city's larger neighbor, Monte Albán.



**3. UNITED KINGDOM:**

According to rumor, World War I German

U-boat commander Captain Krech claimed that a "strange beast" with a "horny sort of skull" attacked his submarine, UB-85, on April 30, 1918, and this is why a British patrol boat captured his crew and sank the sub. Engineers laying undersea cable found the wreck of a sub that could be UB-85 in the North Channel of the Irish Sea. Historians think the boat was actually caught on the surface while charging its batteries.



**6. ARGENTINA:** Evidence continues to build that humans occupied the Americas well before the Clovis culture emerged around 13,000 years ago. At the site of Arroyo Seco 2, archaeologists have uncovered bits of stone tools and animal bones with telltale butchery marks dating to as long as 14,000 years ago. On the menu was a variety of extinct mega-fauna, including giant ground sloths, car-sized glyptodonts, and toxodons, rhino-like hooved animals with prominent incisors.



**7. SCOTLAND:** Analysis of remains from excavations conducted in the 1970s at Skara Brae, on the Orkney Islands off the country's northern tip, have provided the first evidence anywhere in Europe that Neolithic people ate rodents—in this case, voles. The bones had been charred, and were found alongside other food remains and even directly in a hearth. The rodents may have been brought to the islands intentionally, perhaps as food on long sea voyages.



**8. FRANCE:** Between 1803 and 1805, Napoleon stationed armies along the French, Belgian, and Dutch coasts for an invasion of Britain that was abandoned after he decisively lost the Battle of Trafalgar. Recent analysis of charcoal excavated from one of these camps shows that official supplies of firewood were apparently not enough to keep the soldiers warm and fed, perhaps because sources were overtaxed by the war. Rather, the men supplemented by collecting their own locally.



**4. DENMARK:** The smell must have been ... interesting. Some 3,000 years ago, someone at a Bronze Age settlement burned their cheese in a clay pot, which they then threw away, intact. Perhaps it was out of frustration, or to conceal the mistake, or simply because the pot was ruined. Scientists suspect that it was an attempt to make something like sweet, tangy Brunost, or Norwegian brown cheese, produced by boiling down whey. Researchers report it no longer smells.



**5. CHINA:** We can't say which side of the marijuana legalization debate the resident of a tomb in the Jiayi Cemetery would have been on, but it's clear that the plant carried special ritual or medicinal importance to his people. His body had been wrapped in a "shroud" of 13 cannabis

plants, fanning out across his torso, around 2,500 years ago. Most of the flowers had been removed, but those that remain suggest he was buried in the late summer.



**9. TANZANIA:** There are various places in Africa where ancient human footprints have been found, but none contain as many as the volcanic mudflat of Engare Sero, where researchers have recently catalogued more than 400 dating to between 10,000 and 19,000 years ago. Two individuals appear to have been jogging, and there were two groups of mostly women and children traveling in different directions. It's thought that even more footprints lie under nearby sand dunes.



**10. MICRONESIA:** The ancient city of Nan Madol—composed of artificial basalt islands surrounded by canals, and called the "Venice of the Pacific"—was one of the first in Oceania to be ruled by a chief. Using uranium-thorium dating, researchers found that construction of a monumental tomb, the size of a football field, began there in 1180 and was completed by 1200. This pushes back the establishment of the capital and its chiefdom by 100 years.

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# TOP 10 DISCOVERIES OF 2016

**ARCHAEOLOGY's editors reveal the year's  
most compelling finds**





## LONDON'S EARLIEST WRITING

London, England

The largest and most significant collection of Roman waxed writing tablets is providing an intriguing glimpse into life in early Roman London. More than 400 wooden tablets were unearthed by archaeologists from Museum of London Archaeology (MOLA) during excavations at the site of the Bloomberg company's new European headquarters. Roman London (called Londinium) was founded around A.D. 50, and the recovered texts, written by ordinary residents, record various names, as well as events and transactions that took place during the settlement's first few decades.

The tablets, which began to be published in 2016, feature a once-popular method of Roman writing that involved using a pointed stylus to etch letters into a thin layer of wax that had been spread onto a small plank. Since tablets such as these were typically made of wood, they rarely survive. However, the Bloomberg excavation site is located along what used to be the Walbrook River. Most of the tablets discovered there were part of an ancient garbage dump that was used to fill in the wetlands to create buildable land during the Roman era. The muddy, oxygen-free conditions were instrumental in the preservation of the nearly 2,000-year-old tablets. Although the actual inscriptions in wax have long since disappeared,



A 1st-century A.D. wooden tablet (above) found at an excavation in London bears the earliest known reference to Londinium. Molten wax was applied to tablets using a spatula (top right), and a decorated stylus (top left) was used to inscribe text in it.

sometimes an overly aggressive scribe applied too much pressure and accidentally etched their writing into the wood beneath the wax.

"The collection is hugely significant," says MOLA archaeologist Sophie Jackson, "because the tablets date to the first few years of London. They provide new insights into the people who lived, worked, and traded there and administered the new city, and what social, economic, and legal structures were in place."

Thus far, 19 of the 405 tablets have been decoded through an exacting process that uses multidirectional photography and microscopic analysis. Among these are Britain's oldest handwritten document and the earliest known reference to Londinium. Some texts appear to be legal records and contracts, while others are correspondence. And one tablet, which simply contains the alphabet, may have been part of a school lesson.

—JASON URBANUS



## ANGKOR URBAN SPRAWL

Siem Reap Province, Cambodia

**R**esearchers in northwestern Cambodia have carried out the largest airborne laser-scanning archaeological project to date. They used lidar to survey 900 square miles of the densely forested Angkor region, revealing centuries-old cities that once belonged to the vast Khmer Empire.

The kingdom's provincial centers turn out to have many characteristics in common with Angkor, the metropolis surrounding the iconic Angkor Wat temple. All share a checkerboard of city blocks within a central moat, enormous reservoirs and canals used for water management, and mysterious mounds and "coiled" embankments built into the earth and seen at every eleventh- and twelfth-century temple site.

Archaeologist Damian Evans had spent a decade searching for evidence of an industrial city at a site east of Angkor called Preah Khan of Kompong Svay. When he looked at the new survey unobscured by vegetation, the three-mile-by-three-mile enclosed urban grid—the largest in Southeast Asia—appeared

Lidar scans have revealed the outline of an urban grid in the Angkor region of Cambodia.



in plain sight. "It reveals this degree of complexity—the scope and scale at which human beings adapted the environment," he says. "That's what lidar illuminated so beautifully in Cambodia."

—NIKHIL SWAMINATHAN

## REGIME CHANGE IN ATHENS

Athens, Greece



The remains of 80 men were discovered shackled together at the wrists in a mass grave at a necropolis near Athens.

**T**he end of the seventh century B.C. was a tumultuous period in Athenian history. Though once ruled by a king, the increasingly powerful region of Attica, home to Athens, had come to be presided over by aristocrats who maintained their hold on power through landownership and lifetime appointments. But as the century drew to a close, the political climate was primed for a new type of government—that of a single ruler, or tyrant. An evocative gravesite on the outskirts of Athens is a testament to this contentious moment in history.

to date the grave to the mid-to-late seventh century B.C., suggesting to project director Stella Chrysoulaki that the men were executed in the course of one of these attempts to gain political primacy. "For the first time," Chrysoulaki says, "we can illustrate historical events that took place during the struggle between aristocrats in the seventh century and led, through a long process, to the establishment of a democratic regime in the city of Athens."

—JARRETT A. LOBELL



## WORLD'S OLDEST DRESS

Tarkhan, Egypt

It's almost impossible to imagine that an item of clothing worn thousands of years ago has survived to the present day. But the "Tarkhan Dress," named for the town in Egypt where it was found in 1913, has endured—and has now been precisely dated using the latest radiocarbon dating technology. Researchers have determined that the very finely made linen apparel dates to between 3482 and 3103 B.C., making it the world's oldest woven garment. Alice Stevenson, curator at the Petrie Museum of Egyptian Archaeology, says, "The dress has provided people with a real sense of the antiquity and longevity of the ancient Egyptian state and society."

— JARRETT A. LOBELL



New radiocarbon dating finds that a dress discovered in Egypt is at least 5,100 years old.

Neanderthals are thought to have made ring-shaped structures out of whole and broken stalagmites deep in a French cave.



## EARLY MAN CAVE

Bruniquel, France

**A**fifth of a mile inside Bruniquel Cave in southwestern France, a chamber holds several enigmatic ring-shaped structures made from whole and broken stalagmites. Radio-carbon dating of a burned bear bone found among them initially suggested they date to around 47,000 years ago. But this year, uranium-thorium dating that focused on the stalagmite tips and deposits that accumulated on them after they were broken found the structures were actually built around 176,000 years ago. Researchers concluded that since

Neanderthals were the only humans living in the area at the time, they must have assembled them. "When we first got this date, I thought it was unbelievable," says Jacques Jaubert, an archaeologist at the University of Bordeaux. "We had no idea that Neanderthals were operating so deep inside caves at this time." While the structures also provide evidence of group collaboration, the reason they were built remains a mystery.

—DANIEL WEISS



## PERUVIAN WOMAN OF MEANS

Áspero, Peru

A prominent woman was buried 4,600 years ago in Peru along with accessories such as a bone brooch carved to resemble an Amazonian monkey.



The role of women in ancient cultures has received increased attention in recent years, from that of female pharaohs in Egypt to Viking wives in northern Europe. And now, archaeologists in Peru have found signs that women

there held positions of prestige at the earliest stages of civilization. At the site of Áspero, a female skeleton was found decorated with shells of the genus *Spondylus*, which come from hundreds of miles away in far northern Peru and were a sign of authority for centuries in Andean cultures.

About 45 years old when she died, the woman had clothing accessories made of bone carved in the form of seabirds and Amazonian monkeys, also status symbols, says archaeologist Ruth Shady Solís of San Marcos University. Most striking is the burial's age—some 4,600 years ago, near the dawn of the fishing and farming civilization

that thrived on Peru's coast. Shady Solís found sculpted female figurines dating from the same period—more proof, she believes, that women occupied prominent social positions.

—ROGER ATWOOD



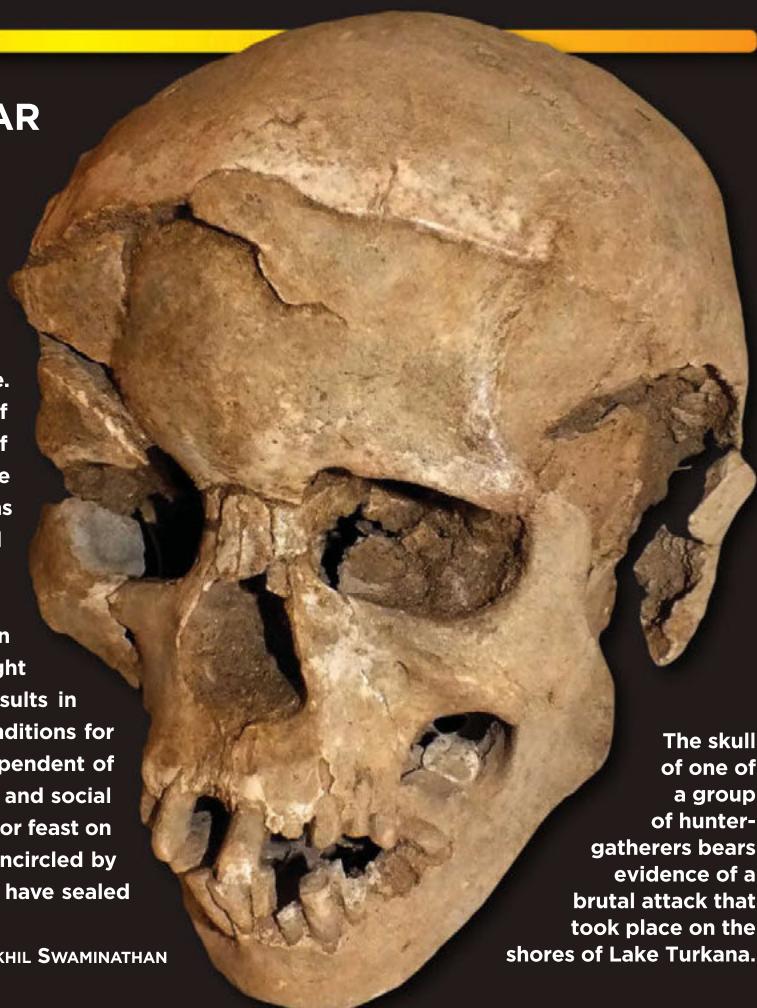
## 10,000-YEAR-OLD TURF WAR

Lake Turkana, Kenya

Organized aggression is typically associated with disputes over ownership of land or possessions. But the 10,000-year-old remains of 27 individuals discovered at what was once the southwestern edge of Kenya's Lake Turkana suggest that this may not always have been the case. The unburied bodies, found at a site called Nataruk, were of hunter-gatherers and were unaccompanied by evidence of settlements or valuables. Instead, they paint a picture of pure carnage: The bones of 21 adults and six children show lesions most likely resulting from arrows and clubs. Weapons found at the site were made from obsidian sourced from afar, indicating the attackers were not local.

University of Cambridge archaeologist Marta Mirazon Lahr believes that people have always been prepared to fight for what they want, and that the formation of groups results in cultural divisions, thereby justifying warfare. These preconditions for battle "have existed for a very long time," she says, "independent of the development of farming, material wealth, civilizations, and social hierarchies." Within this context, the simple choice to hunt or feast on the beach at Nataruk, a plum spot on a lake almost fully encircled by mountains, where animals came for food and water, could have sealed the deceased's fate.

—NIKHIL SWAMINATHAN



The skull of one of a group of hunter-gatherers bears evidence of a brutal attack that took place on the shores of Lake Turkana.



## SPIRITUAL MEETING GROUND

Mona Island, Puerto Rico

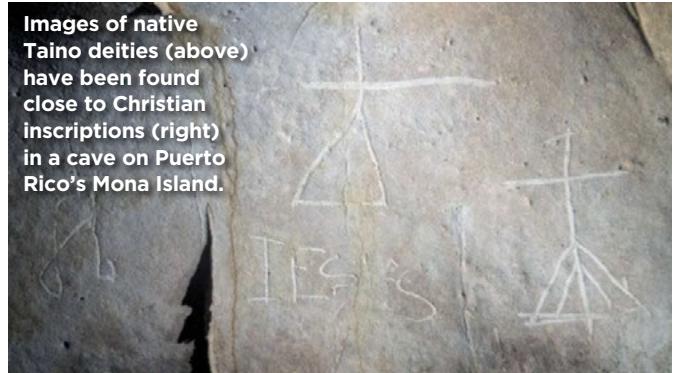
**S**ince at least the twelfth century, indigenous Taino people living on Mona, a small island west of Puerto Rico, ventured deep into its vast network of caves and left images of *cemies*, or deities, on the chambers' soft limestone walls. Now a team led by British Museum archaeologist Jago Cooper has found that one of the caves also contains markings left by sixteenth-century Spaniards. "The entrance to this cave is quite difficult to find," says Cooper. "So the Europeans were probably, at least initially, led there by Taino." The team has recorded more than 30 historic inscriptions, including crosses, Latin phrases from the Bible, and even the signatures of individuals, such as a sixteenth-century royal official named Francisco Alegre, who had jurisdiction over Mona at one time.

Cooper says that while the European inscriptions were placed close to the indigenous markings, they don't overlap, leaving the impression that the Spaniards were careful not to deface the Taino rock art. "It's as if the two traditions were in dialogue with one another," says Cooper, noting that it is also possible that Taino who had converted to Christianity made some of the crosses. "This is tangible evidence of how people, both European and indigenous, were forging new identities in the Americas. The cave embodies the personal experience of contact between these two cultures."

—ERIC A. POWELL



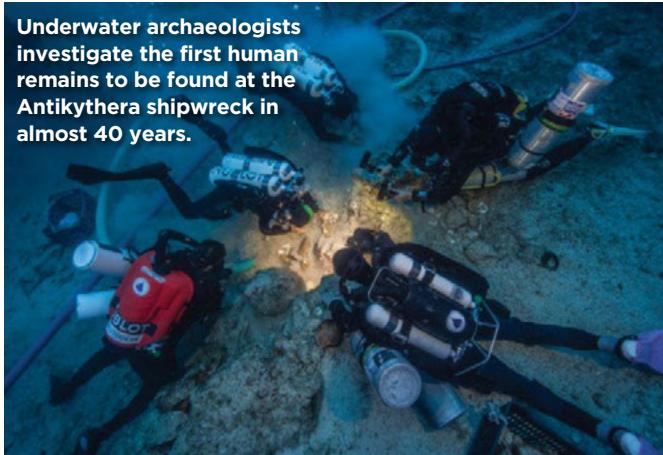
Images of native Taino deities (above) have been found close to Christian inscriptions (right) in a cave on Puerto Rico's Mona Island.



## ANTIKYTHERA MAN

Antikythera, Greece

The Antikythera shipwreck (circa 65 B.C.) is the ancient world's largest, richest, and perhaps most famous wreck. Discovered in 1900 off the Greek island of Antikythera, the site has yielded hundreds of treasures, including bronze and marble statues, as well as the Antikythera Mechanism, often referred to as the world's oldest computer. However, an



Underwater archaeologists investigate the first human remains to be found at the Antikythera shipwreck in almost 40 years.

important new discovery was made in summer 2016 when an international team recovered a human skeleton there. The remains, which include parts of the cranium, jaw, teeth, ribs, and long bones of the arms and legs, most likely belonged to a young male. Evidence of at least four other individuals had previously been found at the site, but the newly discovered remains are the first to be uncovered in almost 40 years—and during the age of DNA analysis. According to ancient DNA expert Hannes Schroeder, the discovery might provide the first opportunity to examine the genetics of an ancient mariner. "Human remains from ancient shipwrecks are extremely uncommon," he says. "DNA analyses can potentially provide fascinating new information on the crew's genetic ancestry and geographic origins."

Project codirector Brendan Foley suggests that the individual may have been trapped belowdecks when the ship smashed into the rocks and sank. Parts of the skeleton discovered in 2016 remain in situ and will be further excavated this summer. Foley believes that even more human remains may survive at the site along with other precious cargo.

—JASON URBANUS



A rocky outcrop called Proctor's Ledge (above and below) has been confirmed as the site where 19 people accused of witchcraft were hanged in Salem, Massachusetts.



## SALEM'S LOST GALLOWS

Salem, Massachusetts

**T**here are almost 1,000 surviving official documents and several contemporary histories from the Salem witch trials of 1692 and 1693. But little of this relates directly to the 19 hangings that punctuated the notorious period of hysteria and paranoia, and none of the documents record where the executions took place.

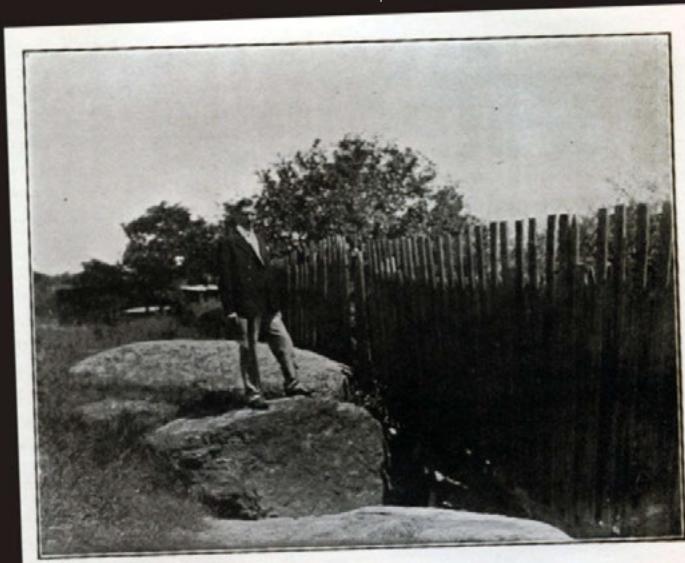
The site—long believed to have been somewhere on or near Gallows Hill—appears to have been forgotten by the early nineteenth century. In 1921, historian Sidney Perley theorized that the hangings took place at Proctor's Ledge, a rocky outcrop at the base of Gallows Hill.

Over the last five years, a research team has reviewed Perley's findings. They have

also applied new technology to pinpoint the site.

With the help of both a piece of overlooked testimony and a geographic information system that determined what could be seen from where (known as a viewshed analysis), researchers concluded in 2016 that Perley had been right. Proctor's Ledge is indeed the spot where the accused met their ends. The team, led by Salem State University historical archaeologist Emerson Baker, also conducted geophysical testing and found no human remains or evidence of a gallows at the site. "This finding is in keeping with oral traditions," Baker says, "that the families of the victims came under cover of darkness to recover loved ones and rebury them in family cemeteries."

—SAMIR S. PATEL



THE CREVICE



The remains of a 3,000-year-old village were recently discovered in a clay quarry called Must Farm in eastern England. The wooden houses were destroyed by fire, and the charred timbers gradually sank to the bottom of an ancient riverbed.

A short-lived settlement provides an unparalleled view of Bronze Age life in eastern England

by JASON URBANUS

# FIRE IN THE FENS



**S**OME 3,000 YEARS AGO, throughout Britain, broad changes in settlement patterns, society, and technology were slowly bringing an end to what archaeologists call the British Bronze Age (2500–800 B.C.). In the coming centuries, the Iron Age would emerge. But in the wetlands of East Anglia, referred to as the Fenland, a transformation of another sort, both more conspicuous and tangible, was taking place. Climate change was gradually causing water levels to rise, and, as marshland increased, vital dry land became scarcer. The solution for one small settlement was to build its homes on pylons directly above the water. However, by some twist of fate, shortly after the new settlement was built, it was destroyed by fire—whether deliberate or accidental is not known. The conflagration caused the houses and their contents to collapse into the shallow river below. There, extraordinary circumstances led to their preservation and eventual discovery. Recent excavations of this Late Bronze Age village are providing archaeologists with as yet unmatched insights into the lifestyle and day-to-day lives of Britons three millennia ago. It is considered one of the most important discoveries in the history of British archaeology.

The site, called Must Farm, is named after and located in a modern-day clay quarry outside the town of Peterborough. Until now, much of what is known about Bronze Age Britain has stemmed from investigations of specialized sites such as burial mounds, megalithic monuments, or ritual deposits of bronze weapons. While these types of finds have value, they offer archaeologists little information about ordinary people and everyday life. Even when Bronze Age houses and settlements have been identified, they have yielded scant material evidence.

Thousands of artifacts have been unearthed at Must Farm—from bronze axes to balls of thread. It is, however, not

just the sheer volume of ancient material that makes Must Farm unique. It is also how those objects retrieved there relate directly to daily life in the Late Bronze Age, and expressly to one particular, fateful day. “So often in archaeology we see settlements going out of use, we see evidence of destruction,” says Selina Davenport from the Cambridge Archaeological Unit (CAU) at the University of Cambridge. “But at [Must Farm] we see a moment of use and it’s a moment of life. The fire and the silt together have created an almost complete snapshot of the life of the settlement.”

**I**N PREHISTORIC TIMES, the Must Farm site was part of a low-lying fen connected by the River Nene to the North Sea around 30 miles away. Human activity in the area dates back to the Neolithic period, and settlements there thrived, particularly during the Bronze Age. But waters rising over thousands of years submerged the landscape beneath thick deposits of sediment, clay, and peat, while transforming the entire area into a vast marshland. This process gradually buried archaeological sites deep within the terrain, and the Fenland environment enabled their remarkable preservation.

Beginning in the seventeenth century, engineers started to drain the wetlands to create farmland. In the late nineteenth century, companies began digging into the area around Must Farm for its fine-quality Oxford Clay, on a scale that no archaeological excavation could have matched. In some places, quarrying reached a depth of 100 feet. (Some of Britain’s most important dinosaur fossils were unearthed there by nineteenth- and early twentieth-century antiquarians.) This quarrying process would later create an almost perfect set of conditions for the CAU as they undertook the first extensive archaeological investigation into the deep Fenland. “What made Must Farm different was the nature of the brickworks

there,” says the CAU Site Director Mark Knight. “The large-scale extraction of clays meant that we were able to look beneath the thick blanket of peat and for the first time investigate the deeply buried sediments of the Fenland basin—and look what we found!”



Among the hundreds of domestic items discovered are a variety of different-sized ceramic bowls and storage vessels, some with their contents remaining.

**T**HE RECENT STORY of the ancient settlement at Must Farm began in 1999. An amateur archaeologist walking along a previously abandoned section of the quarry noticed some peculiar wooden logs protruding out of the water in a vacant pit. Having spent some time at excavations in the area, including at the famous nearby Bronze Age site of Flag Fen, he recognized the unusual age of the posts and contacted authorities. Archaeologists confirmed that the wooden timbers



Archaeologists found an assortment of metal tools and weapons from various Must Farm households, including spearheads (right), swords, and sickles. Some socketed bronze axes (above) even had their wooden hafts still attached.

dated to between 1000 and 800 B.C. Over the next decade, material recovered during periodic and brief investigations began to intimate that something larger and more significant might be buried beneath the pit. Forterra, the brick-making company that owns Must Farm, planned to reopen that section of the quarry—and, in fact, to build a road over what archaeologists had by then identified as a Late Bronze Age site—creating the first opportunity for researchers to investigate on a larger scale.

In 2015, the CAU, with funding from Forterra and Historic England, began extensive exploration around the ancient wooden timbers. For 10 months they labored at a stressful and quickened pace in order to excavate, document, and remove the massive amounts of material before the site was due to be handed back to Forterra. It soon became evident that beneath the waterlogged sediments was an entangled mess of wooden beams buried in more than six feet of silt and peat. However, some semblance of organization began to become apparent amid the seemingly chaotic array of blackened timbers, and archaeologists ultimately realized that what they were looking at were the remains of several circular houses. This discovery itself was almost unprecedented within British Bronze Age archaeology. When evidence of Bronze Age houses can be found, it usually only consists of postholes and soil imprints, which is all that remains after the wood, brush, and other materials decay. Must Farm's anaerobic conditions, however, preserved these building materials.

Initial excavations revealed at least five houses, each of which averaged around 20 to 25 feet in diameter, built close together. A semicircular defensive palisade surrounded the entire



complex. Scholars estimate that the small settlement probably consisted of eight to 10 roundhouses within an oval enclosure, but half the site was wiped out by quarry activity in the 1960s. A site of this size may have been home to an extended family unit of perhaps 60 people. Overall, a staggering 5,000 pieces of timber, from thick beams to wood chips, have been recovered. Some of the palisade posts are in such good condition that they look as though they could have been purchased at the modern building supply store down the street. And the cut marks made during the sharpening and shaping of the posts 3,000 years ago are so easily discernable that the CAU researchers are hoping to match individual cuts with specific axes that were also retrieved from the site.

What makes the discovery of these rare houses so astounding is the realization that this settlement had been built directly over an ancient waterway. The houses once stood atop large wooden stilts driven into the river bottom so that each structure hovered about three feet above the water's surface. Narrow gangways connected individual houses. "It was originally thought that people were only living on the dry land," says Davenport. "They might occasionally hunt along the fen edge but never live in the middle of the fen. But that's what we are seeing now—a settlement right in the center of the fen."

Must Farm is the first example of this type of Bronze Age settlement ever found in England.

This way of living may have been the community's solution to the changing climate conditions that were causing dry and habitable land to become ever scarcer. The remaining pockets of dry land within the fen landscape were essential both for farming and as grazing land for domestic animals, so something had to give. Instead of moving to another location, the settlement simply adapted. "The little islands of dry land are shrinking, and you need those for farming, so you live on the water," says Davenport. "There is a long history [in the Bronze Age] of building across the fen, so the skills are already there."

Knight, though, offers an additional theory and suggests that the unusual placement of the settlement at Must Farm was, possibly, a strategic defensive and economic move for the community. "In a world before roads and major forest clearance, the waterways were the thoroughfares connecting people and materials. He says, "The flow of metalwork, for example, would have depended on these channels. By positioning themselves directly on top of the watercourse, the inhabitants of Must Farm were able to exert control over the movement of things, and, at the same time, it gave them a heightened sense of security." This decision, though, may also have led to the community's demise.

**Must Farm yielded the finest collection of Bronze Age textiles ever recovered. Researchers have uncovered artifacts tied to every aspect of the weaving process, from balls of thread (below) to finely woven garments (left).**

from the rafters. And some activities seem frozen in time. Archaeologists discovered a bowl that still has porridge and a spoon in it, and a garment in the process of being woven.

A great number of high-quality textiles were found, some of which are made from thread as thin as a human hair. They are considered the finest collection of British Bronze Age fabrics ever discovered, and archaeologists remain stunned by their condition. “At the first bit of textile that one of the archaeologists

found, she immediately stood up to make sure it hadn’t been torn from her trousers,” jokes Davenport. “It looked that good.”

Although the Must Farm residents lived on the water, evidence found at the site suggests that they enjoyed a rich and varied diet and retained a vital connection to dry land.

Metal farming implements, as well as the preserved remains of porridge made from wheat and barley, confirm that agriculture was a major component of Bronze Age life. However, sheep and cattle bones, along with those of red deer and wild boar, indicate that animal husbandry and hunting also played a major role in the food supply.

Overall, the Must Farm excavations reveal a vibrant, sophisticated Late Bronze Age community. Although its inhabitants may seem to have been living in isolation within a vast wetland, they were highly mobile, both on land and water. They would have been capable of traveling on the river both inland and toward the sea. The evidence of hunting and farming, the presence of timber, and the discovery of a large wooden wagon wheel attest to their ability to navigate their terrestrial surroundings. Artifacts made from jet and amber hint at the settlement’s connections with broader trade networks. At least 18 green and blue glass beads discovered within the ruins originated in Turkey or Syria.

So, how did this seemingly thriving community come to be destroyed? It is apparent that the settlement was consumed by fire, but it is not yet entirely clear how that fire started. Some of the evidence found so far points to arson. Forensic archaeologist Karl Harrison is currently examining the timbers and other available clues. Using modern forensic techniques on a 3,000-year-old, water-saturated site is not without its difficulties. But Harrison is hoping to determine whether the fire began in a single structure and then spread, or whether all of the houses ignited at the same moment. “If each property con-



**A**T SOME POINT, when the settlement was still probably less than a year old, it was destroyed by fire. This catastrophe is evident in the blackened beams and ubiquitous charred debris. As the houses fell into the river they settled gradually, thanks to the rather stagnant current, and became embedded in the river bottom. For the first time, archaeologists have learned that the basic framework for each house was provided by three concentric circles of wooden posts, mostly oak, which supported the roof, walls, and floor. These provided the infrastructure to which the woven, wattle-like, paneled walls and floors were secured. The long roof timbers, which formed the conical roof, were covered in a combination of thatch, turf, and clay.

Along with the houses, all of the inhabitants’ household belongings were deposited along the river bottom. As archaeologists gradually began to remove the top layers of burnt house timbers, they were confronted by an extraordinarily rare collection of artifacts preserved within the ruins. These everyday objects, from weapons to tweezers, had been in use right up until the moment the settlement was destroyed, and provide a comprehensive picture of life at Must Farm 3,000 years ago. “When compared to other, later, Bronze Age sites in Europe, Must Farm represents a highly amplified example,” says Knight. “It is our [best] chance to answer questions about lifestyle, appearance, and taste at the end of the Bronze Age.”

The assemblage of artifacts found from house to house was incredibly consistent. They all contained a nearly identical set of objects, permitting archaeologists to create a kind of inventory of a Late Bronze Age household. Each home had a set of various sized pots and storage vessels, wooden furniture, saddle querns, weaving paraphernalia, and metal tools such as axes, hammers, sickles, and spears. Cured legs of meat hung



tains indications of the development of an internal fire, then this begins to look much more like an intentional event," he says. Thus far, analysis of the charred remains seems to favor the theory that all of the structures were lit simultaneously and, thus, purposely. Additionally, the rather young age of the timbers and the damp conditions of the environment suggest that the roundhouses would not have easily caught fire without some additional assistance. As to motive, Davenport imagines that the location of the Must Farm settlement in the middle of the river may have caused some inconveniences for other local communities. "The river is the only route through the fen, so it is amazing that these people built their houses right in the middle," she says. "You can't easily sail your boat down the river with a bunch of houses in the way." To clear the waterway, perhaps zealous neighbors took matters into their own hands. Still, if the Must Farm settlement were intentionally torched, it does not necessarily signify actions of a nefarious sort—it could have been part of an elaborate religious cleansing ritual.



Numerous jet, amber, and glass beads (top) were unearthed, some of which were manufactured thousands of miles away in the Near East. A 3-foot-diameter wooden wheel (above), likely under repair or construction, is the most complete example ever discovered in Britain.

Although the Late Bronze Age inhabitants of Must Farm appear to have left behind all of their belongings, surprisingly, there is no evidence of the people themselves. No human remains associated with the fire have been found at the site. "It seems the occupants left and did not return," says Knight. "Maybe they were chased out or compelled to leave? The presence of weapons could suggest a violent end."

**F**OR WHATEVER REASONS, the Must Farm community abandoned its Fenland location after the fire. Today the site is notable for its unique characteristics, the quantity and quality of its artifacts, and for the expanded vision of Bronze Age Britain that it allows. The main conundrum facing archaeologists in the future is determining whether Must Farm is actually unique or just the result of a unique set of circumstances. It is the first time that a settlement of its kind has ever been discovered in Britain, but it is also the first time that archaeologists have been able to search so deeply and extensively within a wetland environment. Perhaps communities frequently built their houses above the Fenland waterways, but are buried so far beneath the modern landscape that no evidence of them has yet come to light.

Mark Knight is one who believes that, given the opportunity, and under the right conditions, it may be possible to find sites similar to Must Farm all over eastern England. "We believe the Must Farm pile dwelling is representative of the rest of Fenland. The very fact

that the first time we go deep in Fenland we find a site like this establishes emphatically that there are many more 'Must Farms' out there waiting to be unearthed," says Knight. "And that truly creates an extraordinary new image of life in Britain 3,000 years ago." ■

Jason Urbanus is a contributing editor at ARCHAEOLOGY.



**Smoke pours from USS Arizona on Battleship Row during the attack on Pearl Harbor. Also visible are USS California, listing at left, USS Maryland, right of the plume, with the capsized USS Oklahoma directly beside it, and USS Neosho at right.**

## A DATE WHICH WILL LIVE IN INFAMY

**3:33 a.m.**

Five Japanese midget subs take positions around 10 miles from Pearl Harbor.

Minesweeper USS Condor spots a submarine south of the Pearl Harbor entrance.

**3:42 a.m.**

Cargo ship USS Antares spots a submarine conning tower in the Defensive Sea Area.

**5:45 a.m.**

First attack wave—183 planes—begins takeoff from Japanese aircraft carriers.

**5:50 a.m.**

# DECEMBER 7, 1941

## The underwater archaeology of the attack on Pearl Harbor

by SAMIR S. PATEL

**T**HE TWO HOURS OF the attack on Pearl Harbor on December 7, 1941, might be the most heavily documented and studied in history. There are eight official investigations, from a Naval Court of Inquiry to a Joint Congressional Committee, reams of records, and enough books, oral histories, documentaries, and feature films to fill a library. Yet there are still things that can be learned about the morning when 350 Japanese warplanes killed 2,403 Americans, wounded another 1,104, and sank or severely damaged 21 ships in a coordinated attack on military sites around Oahu, Hawaii.

A number of factors have obscured details—big and small—from that day. For example, the surprise of the attack complicated eyewitness accounts. Secrecy shrouded the active war effort on both sides. And, in the aftermath, the United States rushed to rebuild its naval power in the Pacific with the greatest maritime salvage project in history, which returned all but three of the damaged ships to service. This effort begins to explain why there are few archaeological sites directly tied to December 7.

In 2016, the National Oceanic and Atmospheric Administration (NOAA) and the Bureau of Ocean Energy Management completed the first database of submerged cultural resources in the main Hawaiian Islands. Of 2,114 entries, just five come from the attack: two battleships in the har-

bor, two Japanese submarines in deep water, and a lone American seaplane. All were spared salvage—and in some cases discovery—for decades by some combination of depth, damage, and respect for the dead.

For the United States, Pearl Harbor stands alongside Yorktown, Gettysburg, Little Bighorn, and other iconic battlefields as a crucible of American identity. But it is different in both its freshness in memory and its inaccessibility, since most of the surviving remnants lie underwater, within active military installations, or both. It was 40 years before the underwater sites became the subject of archaeological inquiry. “We’re gaining a much more detailed understanding of the battlefield and all of its nuances,” says James Delgado, director of maritime heritage for NOAA’s Office of National Marine Sanctuaries, who has been directly involved in several of the archaeological projects at Pearl Harbor. “Seventy-five years on, the view is far more comprehensive and three-dimensional, not just in terms of the major events, but also individual experiences.”

Today there are very few survivors of the attack, and fewer each year. The sites discussed here will soon be the only primary sources about an event that changed the course of the twentieth century. They are being studied not out of historical curiosity, but to ensure their stewardship for the future.



Sunken battleships leak oil three days after the attack. USS *Arizona* is at bottom right.

6:37 a.m.

Destroyer USS *Ward* fires on and sinks the submarine spotted by *Antares*. These are the first shots and casualties of the Pacific War.

Two American privates at the Opana Mobile Radar Station report a signal indicating a group of 50 planes or more.

7:02 a.m.

7:15 a.m.

Second attack wave—167 planes—begins takeoff.

7:33 a.m.

American code breakers determine that Japanese diplomats have been told to break off talks with the U.S.

## THE BATTLESHIPS

USS Arizona and USS Utah  
PEARL HARBOR

**T**HE BROKEN REMAINS of the battleship USS *Arizona*, in shallow water off Ford Island, are a war grave, a pilgrimage site, a potential environmental nightmare, and a focal point for the study of shipwrecks around the world and the archaeological landscape of World War II. *Arizona*, commissioned on October 16, 1916, was the second and last battleship in the Pennsylvania “super-dreadnought” class: 608 feet long, 33,000 horsepower, armed with 12 14-inch guns and around 30 smaller ones, and with armor up to 18 inches thick. It saw little action before it entered Pearl Harbor for the last time on December 6, 1941, and docked in berth F-7, where the repair ship USS *Vestal* pulled alongside it.

*Arizona* began to take fire almost as soon as the attack began, and men scrambled across the teak deck fighting fires. There are reports that its bottom was blown out by a torpedo that slid in under *Vestal*, around the same time that a torpedo fatally struck USS *Utah*, an older battleship used for anti-aircraft training. Then, at 8:10 a.m., crack Japanese bombardier Noburo Kanai loosed a 1,760-pound armor-piercing bomb that penetrated *Arizona*’s deck beside the No. 2 turret and detonated the forward magazine, killing 1,177 men. At 10:32 a.m., 30 minutes after the attack ended, the ship was declared untenable and abandoned. It burned for days.



**USS Arizona burns following the explosion of its forward magazine. On the left, USS Tennessee sprays water to force away burning oil.**

Within a week, Navy divers were examining *Arizona*, and over the next two years they removed turrets, sensitive material, live ammunition, machinery, the masts—and 105 bodies, though those efforts were stopped due to manpower limitations, safety concerns, and the emotional toll on the divers. In December 1942 *Arizona* was struck from the books of commissioned ships, its remaining casualties declared buried at sea. It was one of the three ships damaged in the attack that did not return to service, along with *Utah*, which still sits in the harbor, and USS *Oklahoma*, which was refloated but sold for scrap and lost in a storm in 1947. Dave Conlin, chief of the National Park Service (NPS) Submerged Resources Center (SRC), has led recent studies of the wreck and says, “Had *Arizona* not been so catastrophically wounded by the attack, or *Utah* been righted like they were trying to do, there would be almost no indications of what happened here.”

Once the salvage ended, no one systematically examined the wreck until NPS took over management of the site in 1980. Its condition at the time, according to a later NPS report, was “riddled with contradiction and mystery.” The SRC (then called the Submerged Cultural Resources Unit) and the Navy Mobile Diving and Salvage Unit One planned a series of dive seasons. The project began in 1983 with an unexpected revelation. It had been thought that all four of *Arizona*’s turrets had been removed or destroyed. But just aft of the explosion damage, divers found the No. 1 turret—intact. “Three battleship guns in a turret as big as a Greyhound bus, at a depth of 29 feet. How is it that they didn’t know about that?” says Conlin. “Everyone thought all the turrets had been removed. Unbelievable.”

The next year, NPS and the Navy began a foot-by-foot inspection and mapping project to assess the wreck and look for evidence of undocumented operational modifications, battle damage, and salvage efforts. This had never been attempted on a wreck of this scale. There were no guidelines to follow, no relevant experience or technology, save string, clothespins, measuring tape, plastic protractors, and some electronic measuring tools. But they had some expertise, particularly that of NPS’s Larry Nordby, whose work measuring cliff dwellings in the Southwest helped them adjust for the curvature of the ship. Those original measurements, according to Scott Pawlowski, chief of cultural and natural resources at the World War II Valor in the Pacific National Monument, “were just damn good.” They found that the hull plates had ripped outward 20 feet at the point of the explosion like an over-pressurized tin can. They retrieved potentially explosive

**7:48 a.m.**

First attack wave strikes the Naval Air Station at Kaneohe Bay and destroys its long-range reconnaissance planes.

General attack is signaled on Pearl Harbor and nearby airfields.

**7:50 a.m.**

Commander Mistuo Fuchida signals “Tora! Tora! Tora!” (“Tiger! Tiger! Tiger!”) to indicate maximum surprise was achieved.

**7:53 a.m.**

Commander Logan C. Ramsey sends a base-wide message: “AIR RAID, PEARL HARBOR. THIS IS NOT A DRILL.”

**7:58 a.m.**



The No. 1 turret of *USS Arizona*, thought to have been removed decades before, was first found to be intact in the 1980s.

materials, observed items from dishes to a Coke bottle to a fire hose, and could not find evidence of a torpedo strike. Of diving on the wreck during this time, when he was with NPS, NOAA's James Delgado says, "It connects you to the human events that happened, those details that are intimate and personal, beyond the iconic image of a burning battleship."

The project continued in the following years with the mapping of *Utah*, an often-forgotten casualty of the attack, and an unsuccessful scan for crashed aircraft and submarines. Of major concern were *Arizona*'s structural integrity and the estimated 500,000 gallons of bunker C fuel oil inside. Around a gallon a day still leaks from the wreck, a bright sheen visible to every visitor to the memorial. Another phase of research began around 2000 and applied the latest technology and modeling to understand how the ship is changing. *Arizona* has since become the best-characterized metal wreck in the world.

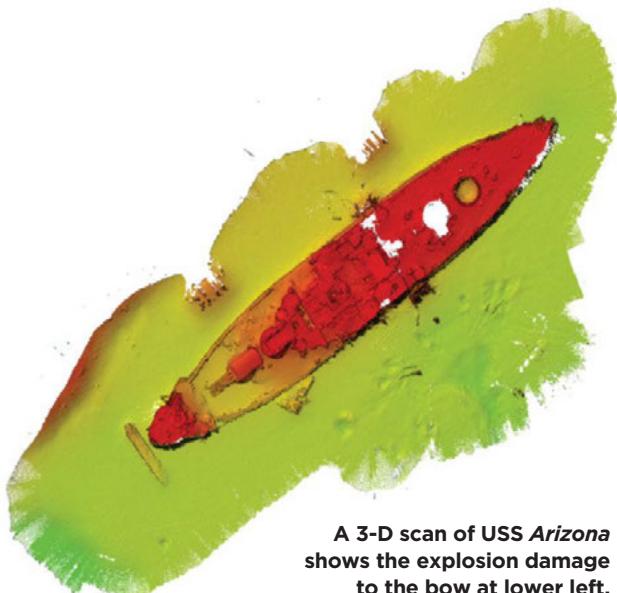
Working with the Navy, National Institute of Standards and Technology, University of Nebraska, U.S. Geological Survey, and other partners, NPS

created a detailed model of the stresses on the ship. They have studied the microbes, chemical decay products, water flow, the sediment and rock beneath it. They're using sonar, 3-D imaging, hyperspectral cameras. "We're bringing all these data sets together," says Pawlowski.

"What we learned is that, yes, *Arizona* is corroding. Yes, *Arizona* is rusting. And yes, *Arizona* is changing," says Conlin, "but it's changing very, very slowly, and the best science that we have tells us that *Arizona* will still have significant structural integrity for at least another 150 years." The risk of a catastrophic spill is low, he adds. Battleships don't hold oil in a single tank, but in hundreds of cells. A recent SRC study found that, of the several places where oil emerges from the wreck, only one appears to be closely connected to a fuel storage area. The rest of the leaking oil follows a circuitous path through interior spaces, which suggests that it is distributed around the ship. Furthermore, it is thought that the oil inside inhibits the degradation of the metal and provides a buoyant force for its structure. And there's no way to remove the oil without deeply impacting or damaging a war grave. "We are getting smarter about how we can understand *Arizona*," Conlin says, "and also how we can manage *Arizona*."

Another recent project has involved entering the wreck with an innovative new remotely operated vehicle developed by the Advanced Imaging and Visualization Lab at Woods Hole Oceanographic Institution, which will be used to create

3-D models of some interior spaces of the ship, measure sediment accumulation, and collect microbial communities from inside. Such sensitive work, Conlin explains, is not undertaken lightly and is not just to feed curiosity, but is in service of preservation and stewardship of the wreck and others like it. "What started as an iconic battleship, the way it was in the 1980s, becomes something more," says Delgado. "The development of the field of marine, maritime, and nautical archaeology—you can really see it in a microcosm with the way work on *Arizona* has advanced."



A 3-D scan of *USS Arizona* shows the explosion damage to the bow at lower left.

8:01 a.m.

A torpedo strikes the port side of *USS Utah*. The battleship capsizes in minutes.

8:10 a.m.

USS *Arizona* is hit and explodes, killing 1,177. President Roosevelt is informed of the attack.

8:30 a.m.

Destroyer *USS Zane* spots a submarine inside the harbor. Within minutes, *USS Monaghan* rams and sinks it.

First attack wave ends.

8:45 a.m.

## THE SUBMARINES

Type A Kō-hyōteki  
DEFENSIVE SEA AREA

**T**HE FIRST SHOT OF the Pacific War was not fired from a Japanese fighter, but from an American destroyer, more than an hour before the attack began. At 5:45 a.m., the cargo ship USS *Antares* spotted an object that might have been a submarine in the Defensive Sea Area outside Pearl Harbor. The destroyer USS *Ward* fired on it twice around 6:37 a.m. The second shot found its mark, and the object sank beneath *Ward*. On board this secret Japanese submarine, two young operators became the first casualties of the Pacific War.

Sub sightings continued throughout the attack, on both sides of the harbor entrance and even within it, where at around 8:30 a.m. the destroyer USS *Monaghan* rammed and sank another. Early the next morning, a small sub and a surviving crewman, Ensign Kazuo Sakamaki, washed ashore on the east side of Oahu. Sakamaki became America's first prisoner of war, and the Navy got a close look at what they had been firing at.

The subs are known as Type A Kō-hyōteki-class subs, and it is now known that five were deployed in the attack. Just 81 feet long and 6 feet in diameter, with a crew of two and a 600-horsepower electric motor, each "midget" sub was transported, piggyback, on a larger submarine. They fanned out around 10 miles from the harbor entrance early on the morning of December 7. Their plan was to enter the harbor one by one, wait out the attack, and then fire their torpedoes that night. Though their role in the attack was lauded in Japan, they weren't successful in this particular mission.

The fates of some of these subs have been a mystery. Sakamaki's is now on display at the National Museum of the Pacific War in Fredericksburg, Texas. The one rammed by *Monaghan*



A submarine wreck was found in three pieces between 1992 and 2001.

was raised and buried at Pearl Harbor in 1942. In June 1960, another was found by a Navy diver at Keehi Lagoon, east of the harbor entrance. The bow was removed and dumped, and the rest sent back to Japan, where it was restored and put on display at the Naval Academy at Etajima (now the Naval History Museum). That left two: the one sunk by *Ward* and another that may or may not have made it into the harbor.

Concerted searches for the subs began in the 1980s. Most were conducted by the Hawaii Undersea Research Laboratory (HURL), which operates two submersibles that ferry scientists and filmmakers to the deep ocean. Before each season, the subs do a series of dives to test their equipment. Since the early 1990s, HURL's chief submersible pilot Terry Kerby has used the dives to search for wrecks, the midget subs in particular. "If we could use those test dives in an area where we might find something," he says, "then we would do it." They have made dozens of finds this way, from an old Studebaker to a Japanese aircraft-carrying submarine.

In 1992, HURL found the stern section of a midget sub, followed by the midsection in 2000 and the bow in 2001. This sub was not identified at the time, but became known as the "three-piece." In 2002, while investigating a sonar target just outside the Defensive Sea Area, HURL found another sub, intact. They saw, just where the conning tower meets the hull, the hole made by the first shot of the war. Survey showed that *Ward*'s shot struck a support frame and deflected downward, creating a vent hole in the bottom of the sub, which explains why it didn't implode as it porpoised to a soft landing a mile from its fatal encounter. "It took 10 years, but we finally found it," says Kerby. "It was in perfect condition."

That left the three-piece. One theory about this sub is that it made it into the harbor, all the way to the backwater called West Loch, where it fired its torpedoes and set off its scuttling charge. Then, following the West Loch disaster, a massive accidental explosion in 1944, it was picked up, cut into pieces, and disposed of. A new analysis by NOAA and HURL, which returned to examine the sub in 2013, proposes an alternate explanation. The cruiser USS *St. Louis* reported that as it exited the harbor at



A Japanese midget submarine washes up on the east side of Oahu the morning after the attack. Five were used in the offensive.

8:50 a.m.

Second attack wave begins and encounters heavy anti-aircraft fire from the Navy dry dock yard.

Under heavy fire, Lieutenant Commander J.F. Thomas grounds USS *Nevada* to avoid blocking the channel.

9:10 a.m.

10:00 a.m.

Japanese fighters and bombers depart Oahu and return to their carriers.

As USS *St. Louis* pulls out of the harbor, two torpedoes are fired at it but detonate on a reef.

10:04 a.m.

the end of the attack, two torpedoes were fired at it but struck a reef. NOAA's James Delgado and his team found a new piece of evidence to support this—a report that a 1950–1951 marine science expedition led by George Vanderbilt III stumbled across a midget sub, blown in half, near where *St. Louis* had been fired upon. The report, sent to *LIFE* magazine by an intelligence officer named Captain Roger Pineau, stated that the sub was

hauled up, cut further, and dumped. The remains of a Japanese serviceman were found nearby a few days later. Delgado and his coauthors conclude that the three-piece is indeed the final sub from the attack, but that it probably never made the difficult journey into the harbor. It was likely waiting next to the harbor entrance—like the one discovered on the other side in 1960—to block it by sinking ships as they fled the attack.

## THE SEAPLANE

PBY-5 Catalina  
KANEOHE BAY

**I**N THE ATTACK, 75 percent of the U.S. planes sitting at airfields near Pearl Harbor were damaged or destroyed. For all the aircraft lost—the Japanese lost 59—there is one that can be linked to that morning. Very few people can gain access to it, and even then only with a military escort, since it lies in the water just off Marine Corps Base Hawaii at Kaneohe Bay, on the east side of Oahu. During the war, this was the location of a Naval Air Station for PBY-5 Catalina seaplanes, long-range reconnaissance craft.

The Japanese knew that these planes could track them to their carriers north of the island. The PBY-5s had a range of almost 1,500 miles and could be in the air in minutes. So, just before the general attack, at 7:48 a.m., attacking planes strafed the Naval Air Station with 20 mm incendiary rounds and bombs. Of the 36 planes there, three were out on patrol, six were damaged, and the rest were destroyed. Servicemen at Kaneohe Bay scrambled to put out fires and salvage what they could.

In the 1980s, the mooring area was used for training mine-detecting dolphins. That could be when the battered wreck of one of the PBY-5s was first identified. In 1994, students and archaeologists from the University of Hawaii and East Carolina University surveyed the remains. "It was a good start on the submerged story," says Hans Van Tilburg, who was on that team and is now a maritime heritage coordinator with NOAA. In 2000, the University of Hawaii returned to the site for surveys that turned up aviation-related scraps, but no other planes. It's possible that the others had been salvaged or drifted into deeper, murkier water. "Our desire is to get back to the bay and continue looking in deeper water," says Van Tilburg.

The remains of the plane consist of the forward portion of its fuselage, including the cockpit and turret, which lies on its starboard side in about 30 feet of water, the starboard half of the 105-foot parasol wing, and the fragmented remains of the tail



Servicemen attempt to save a burning seaplane (above) at Kaneohe Bay. In the cockpit of one (left), the throttles suggest takeoff had been attempted.

30 feet away. It is likely that fuel tanks in the center of the wing exploded, but the wrecked seaplane holds telling details about the frantic eight minutes of that initial Japanese attack.

There is a large gash in the port side, just where a propeller would have been. Inside the cockpit, the port throttle is in the forward position. Yet the plane is still attached to its mooring line. This all suggests that an attempt was made to scramble at least one of the planes—but that it didn't get far. The wreck does not provide evidence of what happened to the pilot, or just how many planes were moored at Kaneohe that morning. Some sources say three, others four, and there are six in a drawing by a Japanese pilot. "Every eyewitness account contradicts the other accounts," says Van Tilburg. "It's still a bit of a mystery. But this might be the only plane we know of that we can point to and say, 'This is a December 7 casualty.' ■

Samir S. Patel is deputy editor at ARCHAEOLOGY.

## THE NEXT DAY

10:32 a.m.

USS Arizona is abandoned.

Japanese fleet turns for home.

1:00 p.m.

12:29 p.m.

President Roosevelt addresses the nation and calls December 7, 1941, "a date which will live in infamy."

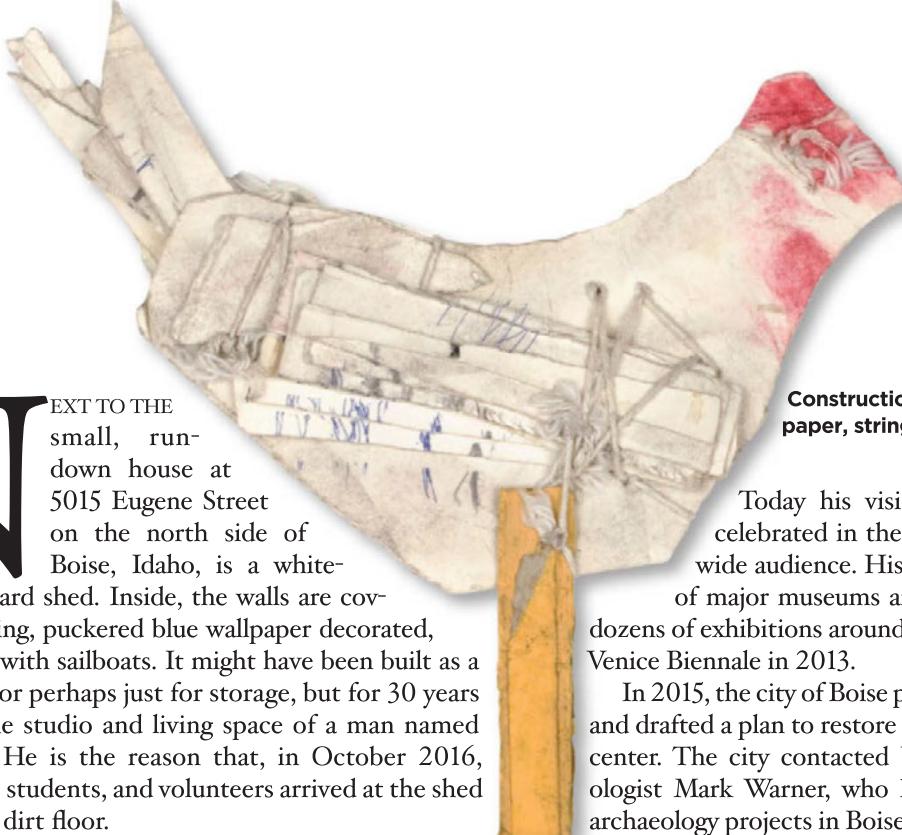
1:10 p.m.

The United States declares war on Japan, signaling its official entry into World War II.

# Seeing Beauty in the Mundane

**Looking for traces of a celebrated but unusual artist in suburban Idaho**

by SAMIR S. PATEL



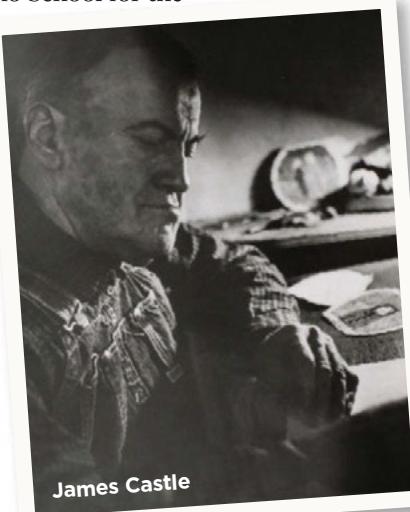
**Construction by James Castle made of paper, string, and soot**

**N**EXT TO THE small, rundown house at 5015 Eugene Street on the north side of Boise, Idaho, is a white-washed clapboard shed. Inside, the walls are covered with peeling, puckered blue wallpaper decorated, incongruously, with sailboats. It might have been built as a chicken coop, or perhaps just for storage, but for 30 years it served as the studio and living space of a man named James Castle. He is the reason that, in October 2016, archaeologists, students, and volunteers arrived at the shed to excavate its dirt floor.

Castle was born in 1899 in the remote town of Garden Valley, in the mountains north of Boise, to a large, hardworking Irish Catholic farming family. He was profoundly deaf from birth, and despite five years at the Idaho School for the Deaf and Blind, Castle never learned to communicate in any traditional way. It was a time when an impairment like his could result in institutionalization, but the Castles were protective and encouraged his predilection for art from a young age. Castle scavenged discarded paper, mail, and food wrappers, and made his own ink. When the family moved to the Eugene Street house in the 1930s, he began to live and work in the 12-by-12-foot shed. Day after day, decade after decade, until his death in 1977, Castle spent almost all of his time drawing and piecing together abstract constructions of paper, string, and wire.

Today his vision and resourcefulness are celebrated in the art world and admired by a wide audience. His works are in the collections of major museums and have been the subject of dozens of exhibitions around the world—including at the Venice Biennale in 2013.

In 2015, the city of Boise purchased the house and shed and drafted a plan to restore and preserve them as an arts center. The city contacted University of Idaho archaeologist Mark Warner, who has conducted other public archaeology projects in Boise, to lead an excavation. Over a week, Warner and his team dug 80 percent of the shed's dirt floor and some areas outside of it. They were able to learn a number of things about the shed that will help in its preservation and also discovered evidence of Castle's unorthodox artistic toolkit.



**James Castle**

**S**ELF-TAUGHT ARTISTS—variously identified as outsider, visionary, or naive artists—are a heterogeneous group. The term applies to those who create their work outside the mainstream of art schools, galleries, and museums. The one thing they have in common, according to Nicholas R. Bell, a curator at the Mystic Seaport Museum who studies self-taught artists, is “an overwhelming drive to express themselves.” Castle stands out among them because of his inability to communicate, and therefore some think he represents



Interior of the shed where Castle lived and worked for 30 years

**T**O INFORM THE preservation and restoration project, one of the goals of the excavation was to understand the shed itself. No one knew, for example, whether the dirt floor had ever been covered with floorboards, until the excavation found floor joists. According to Rachel Reichert of the Boise City Department of Arts and History, the city is planning to stabilize the building, move it, and then re-place it on a proper foundation. The dig also uncovered a variety of objects from Castle's day-to-day life. There were containers, including a small jar and a can, which chemists are testing to

a kind of unfiltered, innate creativity. Of Castle's artistic evolution, "the truth of it is that we know very little," says Bell. "He arrived in the public consciousness as a fully fledged visionary of sorts."

Through poverty and preference, Castle used found materials in his art. He drew on discarded envelopes, boxes opened flat, his siblings' homework, and food packaging, including vanilla ice cream cartons scraped free of their wax coating. He sometimes whittled his own drawing instruments. He made his ink from spit mixed with soot gathered from wood-burning stoves, and created pigments by soaking and squeezing out pieces of colored paper. He filled books with sketches, letters, and symbols, clearly fascinated with the visual representations of language. "His work seemed to employ what I call a kind of 'field expediency,'" says Jacqueline Crist, managing partner of the James Castle Collection and Archive, who helped bring his work to wide recognition in the 1990s. "These are the materials I have, and this is what I can do with them."

Castle's drawings of buildings, interiors, and farm scenes are notable both for his grasp of perspective and their level of detail. "We get a strong sense of the vernacular of the time in the small community where he lived his entire life," says Crist. But he also had a talent for what would be called, if he were a traditional artist, surrealism and abstract expressionism. People appear with square heads, ducks wear boots, and anomalous columns rise from farmscapes. He had a facility for this kind of representation, says Bell, honed by years and years of work and experimentation. "Nearly everybody, including myself, who comes to him sees what they want to see," says Bell. "He's not there to contradict you."



Drawing by Castle of a studio filled with artwork

determine whether they contain soot or other art materials. Two wadded pieces of fabric were likely used as daubers to apply his homemade ink. There were also three sticks of lead or graphite, one of his hand-whittled drawing tools, and a circular lens he might have looked through to alter the way he saw the world. Says Warner, "I'm comfortable saying these are the tools of Castle's artwork."

For Warner, the site offers a subtle lesson about archaeological interpretation. At first glance, the assemblage could easily be underestimated. But a pile of household items doesn't necessarily tell a mundane story. "We tend to wallow in the functional," he says. "But things get repurposed. What Castle did helps us remember that." ■

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Samir S. Patel is deputy editor at ARCHAEOLOGY.

**Evidence of trade,  
diplomacy, and  
vast wealth on an  
unassuming island  
in the Baltic Sea**

by DANIEL WEISS



# HOARDS OF



This array of silver coins, bracelets, and other forms of Viking wealth typifies the hoards found deposited at numerous sites across the island of Gotland.

# THE VIKINGS

**T**HE ACCEPTED IMAGE of the Vikings as fearsome marauders who struck terror in the hearts of their innocent victims has endured for more than 1,000 years. Historians' accounts of the first major Viking attack, in 793, on a monastery on Lindisfarne off the northeast coast of England, have informed the Viking story. "The church of St. Cuthbert is spattered with the blood of the priests of God," wrote the Anglo-Saxon scholar Alcuin of York, "stripped of all its furnishings, exposed to the plundering of pagans....Who is not afraid at this?" The Vikings are known to have gone on to launch a series of daring raids elsewhere in England, Ireland, and Scotland. They made inroads into France, Spain, and Portugal. They colonized Iceland and Greenland, and even crossed the Atlantic, establishing a settlement in the northern reaches of Newfoundland.

But these were primarily the exploits of Vikings from Norway and Denmark. Less well known are the Vikings of Sweden. Now, the archaeological site of Fröjel on Gotland, a large island in the Baltic Sea around 50 miles east of the Swedish mainland, is helping advance a more nuanced understanding of their activities. While they, too, embarked on ambitious journeys, they came into contact with a very different set of cultures—largely those of Eastern Europe and the Arab world. In addition, these Vikings combined a knack for trading, business, and diplomacy with a willingness to use their own brand of violence to amass great wealth and protect their autonomy.

Gotland today is part of Sweden, but during the Viking Age, roughly 800 to 1150, it was independently ruled. The accumulation of riches on the island from that time is exceptional. More than 700 silver hoards have been found there, and they include around 180,000 coins. By comparison, only 80,000 coins have been found in hoards on all of mainland Sweden, which is more than 100 times as large and had 10 times the population at the time. Just how an island that seemed largely given over to farming and had little in the way of natural resources, aside from sheep and limestone, built up such wealth has been puzzling. Excavations led by archaeologist Dan Carlsson, who runs an annual field school on the island through his cultural heritage management company, Arendus, are beginning to provide some answers.

Traces of around 60 Viking Age coastal settlements have been found on Gotland, says Carlsson. Most were small fishing hamlets with jetties apportioned among nearby farms. Fröjel, which was active from around 600 to 1150, was one of about 10 settlements that grew into small towns, and Carlsson believes



**At Fröjel, a Viking Age site on the west coast of Gotland, archaeologists search for evidence of a workshop that included a silver-smelting operation.**

that it became a key player in a far-reaching trade network. "Gotlanders were middlemen," he says, "and they benefited greatly from the exchange of goods from the West to the East, and the other way around."

**S**ITUATED BETWEEN THE Swedish mainland and the Baltic states, Gotland was a natural stopping-off point for trading voyages, and Carlsson's excavations at Fröjel have turned up an abundance of materials that came from afar: antler from mainland Sweden, glass from Italy, amber from Poland or Lithuania, rock crystal from the Caucasus, carnelian from the East, and even a clay egg from the Kiev area thought to symbolize the resurrection of Jesus Christ. And then, of course, there are the coins. Tens of thousands of the silver coins found in hoards on the island came from the Arab world.

Many Gotlanders themselves plied these trade routes. They would sail east to the shores of Eastern Europe and make their way down the great rivers of western Russia, trading and raid-

ing along the way at least as far south as Constantinople, the capital of the Byzantine Empire, via the Black Sea. Some reports suggest that they also crossed the Caspian Sea and traveled all the way to Baghdad, then the capital of the Abbasid Caliphate.

Entire Viking families are believed to have made their way east. "In the beginning, we thought it was just for trading," says Carlsson, "but now we see there was a kind of settlement. You find Viking cemeteries far away from the main rivers, in the uplands." Other evidence of Scandinavian presence in the region is plentiful. As early as the seventh century, there was a Gotlandic settlement at Grobina in Latvia, just inland from the point on the coast closest to Gotland. Large numbers of Scandinavian artifacts have been excavated in northwest Russia, including coin hoards, brooches, and other women's bronze jewelry. The Rus, the people that gave Russia its name,



Brooches found in a graveyard in Visby, Gotland's largest town, were used by Viking women to hold their clothing in place.

were made up in part of these Viking transplants. The term's origins are unclear, but it may have been derived from the Old Norse for "a crew of oarsmen" or a Greek word for "blondes."

To investigate the links between the Gotland Vikings and the East, Carlsson turned his attention to museum collections and archaeological sites in northwest Russia. "It is fascinating how many artifacts you find in every small museum," he says. "If they have a museum, they probably have Scandinavian artifacts." For example, at the museum in Staraya Ladoga, east of St. Petersburg, Carlsson found a large number of Scandinavian items, oval brooches from mainland Sweden, combs, beads, pendants, and objects with runic inscriptions, and even three brooches in the Gotlandic style dating to the seventh and eighth centuries. Scandinavians were initially drawn to the area to obtain furs from local Finns, particularly miniver, the highly desirable white winter coat of the stoat, which they would then trade in Western Europe. As time went on, Staraya Ladoga served as a launching point for Viking forays to the Black and Caspian Seas.

These journeys entailed a good deal of risk. The route south from Kiev toward Constantinople along the Dnieper River was particularly hazardous. A mid-tenth-century document by the Byzantine emperor Constantine VII Porphyrogenitus tells of Vikings traveling this stretch each year after the spring thaw, which required portaging around a series of dangerous rapids and fending off attacks by local bandits known as the Pechenegs. The name of one of these rapids—Aifur, meaning "ever-noisy" or "impassable"—appears on a runestone on

Gotland dedicated to the memory of a man named Hrafn who died there.

People from the East may have traveled back to Gotland with the Vikings as well. At Fröjel, Carlsson has uncovered two Viking Age cemeteries, one dating from roughly 600 to 900, and the other from 900 to 1000. In all, Carlsson has excavated around 60 burials there, and isotopic analysis has shown that some 15 percent of the people whose graves have been excavated—all buried in the earlier cemetery—came from elsewhere, possibly the East.

**I**N THEIR VOYAGES, the Vikings of Gotland are thought to have traded a broad range of goods such as furs, beeswax, honey, cloth, salt, and iron, which they obtained through a combination of trade and violent theft. This activity, though, doesn't entirely account for the wealth that archaeologists have uncovered. In recent years, Carlsson and other experts have begun to suspect that a significant portion of their trade may have consisted of a commodity that has left little trace in the archaeological record: slaves. "We still have some problems in explaining what made this island so rich," says Carlsson. "We know from written Arabic sources that the Rus—the Scandinavians in Russia—were transporting slaves. We just don't know how big their trading in slaves was."

According to an early tenth-century account by Ibn Rusta, a Persian geographer, the Rus were nomadic raiders who would set upon Slavic people in their boats and take them captive. They would then transport them to Khazaria or Bulgar, a Silk Road trading hub on the Volga River, where they were offered for sale along with furs. "They sell them for silver coins, which they set in belts and wear around their waists," writes Ibn



Combs such as this one, excavated at Fröjel, were made locally of antler imported from mainland Sweden.



Silver arm rings with a zigzag pattern, believed to have been manufactured on Gotland, are part of an enormous hoard unearthed on the island.

Rusta. Another source, Ibn Fadlan, a representative of the Abbasid Caliph of Baghdad who traveled to Bulgar in 921, reports seeing the Rus disembark from their boats with slave girls and sable skins for sale. The Rus warriors, according to his account, would pray to their gods: "I would like you to do me the favor of sending me a merchant who has large quantities of dinars and dirhams [Arab coins] and who will buy everything that I want and not argue with me over my price." Whenever one of these warriors accumulated 10,000 coins, Ibn Fadlan says, he would melt them down into a neck ring for his wife.

It is unclear whether the Vikings transported Slavic slaves back to Gotland, but the practice of slavery appears to have been well established there. The *Guta Lag*, a compendium of Gotlandic law thought to have been written down in 1220 includes rules regarding purchasing slaves, or thralls. "The law says that if you buy a man, try him for six days, and if you are not satisfied, bring him back," says Carlsson. "It sounds like buying an ox or a cow." Burials belonging to people who came from places other than Gotland are generally situated on the periphery of the graveyards with fewer grave goods, suggesting that they may have occupied a secondary tier of society—perhaps as slaves.

FOR THE GOTLAND Vikings, accumulation of wealth in the form of silver coins was clearly a priority, but they weren't interested in just any coins. They were unusually sensitive to the quality of imported silver and appear to have taken steps to gauge its purity. Until the mid-tenth century, almost all the coins found on Gotland



came from the Arab world and were around 95 percent pure. According to Stockholm University numismatist Kenneth Jonsson, beginning around 955, these Arab coins were increasingly cut with copper, probably due to reduced silver production. Gotlanders stopped importing them. Near the end of the tenth century, when silver mining in Germany took off, Gotlanders began to trade and import high-quality German coins. Around 1055, coins from Frisia in northern Germany became debased, and Gotlanders halted imports of all German coins. At this juncture, ingots from the East became the island's primary source of silver.

Interestingly, when a silver source from the Arab or German world slipped in quality, Jonsson points out, and the Gotlanders rapidly cut off the debased supplies, their contemporaries on mainland Sweden and in areas of Eastern Europe did not. "Word must have spread around the island, saying, 'Don't use these German coins anymore!'" says Jonsson. To test imported silver, Gotlanders would shave a bit of the metal with a knife so its contents could be assessed based on

color and consistency, says Ny Björn Gustafsson of the Swedish National Heritage Board. He notes that many imported silver items found on Gotland were "pecked" in this way, and that Gotlanders may also have tested imported coins by bending them. By contrast, silver items thought to have been made on Gotland—including heavy arm rings with a zigzag pattern pressed into them—were not generally pecked or otherwise tested. "My interpretation," Gustafsson says, "is that this jewelry acted as a traditional form of currency and was assumed to contain pure silver."

These arm rings are among the most commonly found items in Gotland's hoards, along with coins, and experts had long assumed they were made on the island, but no evidence of their manufacture had been found until Carlsson's team uncovered a workshop area at Fröjel. "We found the artifacts exactly where they had been dropped," says Carlsson. There are precious stones: amber, carnelian, garnet. There are half-finished beads, cracked during drilling and discarded. There is elk antler for crafting combs. There is also a large lump of iron, as well as rivets for use in boats, coffins, and storage chests. And, providing evidence of a smelting operation, there are drops of silver.

Researchers found that the metalworkers of Fröjel used an apparatus called a cupellation hearth to transform a suspect source of imported silver, such as coins or ingots, into jewelry or decorated weapons with precisely calibrat-

A silver coin from the early 10th century (obverse, far left; reverse, left) is one of tens of thousands excavated on Gotland that had originated in the Arab world.

ed silver content. They would melt the silver source with lead and blow air over the molten mélange with a bellows, causing the lead and other impurities to oxidize, separate from the silver, and attach to the hearth lining. The resulting pure silver would then be combined with other metals to produce a desired alloy. The cupellation technique is known from classical times, says Gustafsson, but so far this is the first and only time such a hearth has been found on Gotland. Only one other intact example from the Viking Age has been found in Sweden, at the mainland settlement of Sigtuna.

Traces of lead and other impurities were found embedded in pieces of the cupellation hearth among the material excavated from the workshop area at Fröjel. The hearth has been radiocarbon dated to around 1100. Also unearthed from the workshop area were fragments of molds imprinted with the zigzag patterns found on Gotlandic silver arm rings, establishing that they were, in fact, made on the island—and that the workshop was the site of the full chain of production, from metal refinement to casting. “We have these silver arm rings in many hoards all over Gotland,” says Carlsson. “But we never before saw exactly where they were making them.”

**D**URING THE VIKING AGE, Gotland seems to have been a more egalitarian society than mainland Sweden, which had a structure of nobles led by a king dating from at least the late tenth century. On Gotland, by contrast, farmers and merchants appear to have formed the upper class and, while some were more prosperous than others, they shared in governance through a series of local assemblies called *things*,



This imported silver piece found on Gotland shows signs of “pecking,” where a bit of metal was gouged out to test its purity.

which were overseen by a central authority called the Althing. According to the *Guta Saga*, the saga of the Gotlanders, which was written down around 1220, an emissary from Gotland forged a peace treaty with the Swedish king, ending a period of strife with the mainland Swedes. The treaty, believed to have been established in the eleventh century, required Gotland to pay an annual tax in exchange for continued independence, protection, and freedom to travel and trade.

Stratification did increase on the island as time passed, though. Archaeologists have found that, throughout the ninth and tenth centuries, silver hoards were distributed throughout Gotland, suggesting that wealth was more or less uniformly shared among the island’s farmers. But around 1050, this pattern shifted. “In the late eleventh century, you start to have fewer hoards overall, but, instead, there are some really massive



An example of one of the earliest silver coins minted on Gotland (obverse, top left; reverse, bottom left) dates from around 1140.

hoards, usually found along the coast, containing many, many thousands of coins,” says Jonsson. This suggests that trading was increasingly controlled by a small number of coastal merchants.

This stratification accelerated near the end of the Viking Age, around 1140, when Gotland began to mint its own coins, becoming the first authority in the eastern Baltic region to do so. “Gotlandic coins were used on mainland Sweden and in the Baltic countries,” says Majvor Östergren, an archaeologist who has studied the island’s silver hoards. Whereas Gotlanders had valued foreign coins based on their weight alone, these coins, though hastily hammered out into an irregular shape, had a generally accepted value. More than eight million

of these early Gotlandic coins are estimated to have been minted between 1140 and 1220, and more than 22,000 have been found, including 11,000 on Gotland alone.

Gotland is thought to have begun its coinage operation to take advantage of new trading opportunities made possible by strife among feuding groups on mainland Sweden and in western Russia. This allowed Gotland to make direct trading agreements with the Novgorod area of Russia and with powers to the island’s southwest, including Denmark, Frisia, and northern Germany. Gotland’s new coins helped facilitate trade between its Eastern and Western trading partners, and brought added profits to the island’s elite through tolls, fees, and taxes levied on visiting traders. In order to maintain control over trade on the island, it was limited to a single harbor, Visby, which remains the island’s largest town. As a result, the rest of Gotland’s trading harbors, including Fröjel, declined in importance around 1150.

**G**OTLAND REMAINED A wealthy island in the medieval period that followed the Viking Age, but, says Carlsson, “Gotlanders stopped putting their silver in the ground. Instead, they built more than 90 stone churches during the twelfth and thirteenth centuries.” Although many archaeologists believe that the Gotland Vikings stashed their wealth in hoards for safekeeping, Carlsson thinks that, just as did the churches that were built later, they served a devotional purpose. In many cases, he argues, hoards do not appear to have been buried in houses but rather atop graves, roads, or borderlands. Indeed, some were barely buried at all because, he argues, others in the community knew not to touch them. “These hoards were not meant to be taken up,” he says, “because they were meant as a sort of sacrifice to the gods, to ensure a good harvest, good fortune, or a safer life.” In light of the scale, sophistication, and success of the Gotland Vikings’ activities, these ritual depositions may have seemed to them a small price to pay. ■

**Daniel Weiss** is a senior editor at ARCHAEOLOGY.

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Ancient stone vessels of various sizes typify the thousands that are spread across more than 80 different sites on the Plain of Jars in northern Laos.

## LETTER FROM LAOS

# A SINGULAR LANDSCAPE

**New technology is enabling archaeologists to explore a vast but little-studied mortuary complex in war-damaged Laos**

by KAREN COATES

In the landlocked Southeast Asian nation of Laos, thousands of massive stone jars dot the Xieng Khouang Plateau. Scattered across 2,100 square miles of steep slopes, grassy fields, and forested foothills, these ancient megaliths create an archaeological landscape known as the Plain of Jars. The jars, more than 2,000 in all, are distributed across at least 80 sites—some with just a few, others with nearly 400. Most jars sit on mountain slopes, and the largest, which can be as much as nine feet tall and six feet in diameter, are found in highland locations above 3,600 feet. The majority are carved from

sandstone, and geologists estimate the heaviest weigh 25 tons or more. One of the biggest assemblages is found at a location called Site 1, where 344 jars sit in wide-open spaces on the windswept plains outside the town of Phonsavan, the capital of Xieng Khouang Province.

Intriguingly, almost nothing is known about the people who created the jars 1,500–2,500 years ago. They left no written texts, inscriptions, domestic structures, or habitation sites. Few excavations have been conducted, and not many bodily remains have been found, compounding uncertainty about their identity, beliefs, and practices.

Now, a newly formed five-year project funded by the Australian Research Council, Unraveling the Mysteries of the Plain of Jars, has come to northern Laos and is combining traditional archaeological excavations with new research technologies to create a picture of the people who have remained such an enigma for so long.

In February 2016, the team conducted its initial digs at Site 1 during an unusually frigid stretch of winter weather. One windy morning, archaeologist Louise Shewan of Monash University crawled across the ground,

## LETTER FROM LAOS



still damp after a drenching rain, into a pit only 6.5 by 6.5 feet. She grabbed a trowel and began to work beside two Polish researchers, one of whom was Joanna Koczur from the University of Szczecin. "Please don't rain," said Koczur. "Yesterday it was just crazy—it was like a swimming pool in here."

The three scraped away the red earth using brushes and tiny picks designed for precision. Their work centered on a round object on the packed dirt floor, which Koczur had found the day before. They worked meticulously to reveal more of what lay beneath. At first the object resembled a rock, smooth on top and caked with mud on the underside. But it was not a rock at all; rather, it was a small orb of bone, part of a fragile human skull, which they later named "Burial 5." The skull was surrounded by other bits of bone, so maneuvering around the trench among the delicate remains was difficult and physically demanding. "After five minutes in the same position, you are so stiff you can't move," said Koczur, who was dressed in layers of hats and jackets. Later that day, the team uncovered fragments from a second skull, and skull fragments and the mandible of a child. "Multiple burials in the same place are pretty fascinating," says project director Dougald O'Reilly of the Australian Research Council, especially when up to this time scholars studying



At Site 1 on the Plain of Jars (top), archaeologists recently excavated the skull of what they believe is a woman (above) associated with one of the jar burials.

this area had found so few.

By the end of the first season, more bones and numerous teeth had been uncovered from at least six burials of three types: primary burials, where the location is the original burial spot; secondary burials, a common form of burial rite often associated with megaliths, in which the remains have been reinterred; and, finally, inhumation jars, which are buried ceramic vessels containing bones. This variety adds to the complexity of the site and offers researchers the opportunity to consider questions they had never been able to examine before: Were the burial types

contemporaneous? How long was Site 1 used as a mortuary landscape? Do the different types of burials belong to different segments of the society? Is this variation repeated at other sites across the plain? Were the people who carved the jars local, or were they visitors from a faraway place?

While many of the bones are in poor condition and extremely brittle, the teeth, which are in better shape, can be very useful in beginning to respond to some of these questions. Shewan intends to conduct isotopic analysis of the teeth to determine whether the people who created the jars came from

the area. By comparing the strontium isotope ratio in the teeth with that of the local soil, plants, and water in the region, and in animal teeth from nearby archaeological deposits, researchers can tell if a person had obtained their food and resided locally.

Twenty years ago, the Plain of Jars was even less accessible than it is now. Back then, travelers—few and far between—arrived on noisy, old Soviet twin-turboprop Anatols, or on all-day overland rides through the twisting, precipitous mountainous terrain outside Phonsavanh, about five miles

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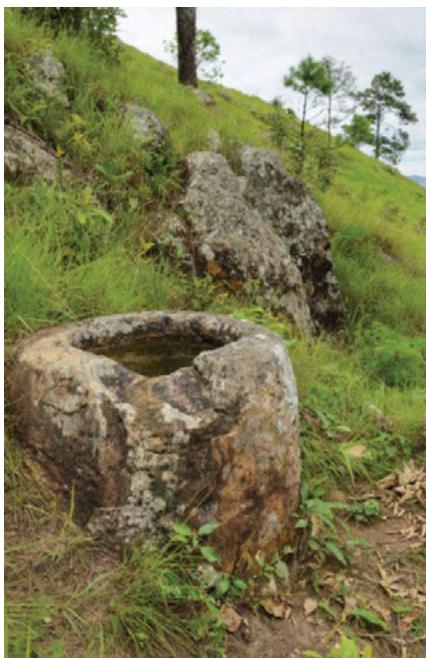
## LETTER FROM LAOS

from Site 1. For years, Phonsavanh was a rough, dusty town that went to sleep by 10 p.m., when the electricity quit. Today it's still a small city of about 37,000 people, but power stays on 24 hours a day, ATMs dispense Lao currency, trucks and motorcycles roar through the streets and stop at newly installed traffic lights, and most people have access to the Internet. There are also more visitors now, with restaurants, bars, and hotels catering to them.

Yet Phonsavanh still doesn't attract the influx of tourists seen at the Lao capital, Vientiane, or at the ancient city of Luang Prabang, a UNESCO World Heritage site known for its gilt Buddhist temples. "It astounds me how few people know about this fantastic archaeological landscape," says Julie Van Den Bergh, a Belgian archaeologist who spent years working with UNESCO and the Lao government to protect the area's cultural heritage and to prepare it for World Heritage status and sustainable tourism.

Only a very few archaeologists have ever excavated on the Plain of Jars and, therefore, precious little is known about the people who inhabited the plain. Yet, piece by piece, scientists have begun to assemble the story of how they were honored in death. Scholars now agree that the Plain of Jars is a prehistoric mortuary landscape composed of the burials of people who likely lived during Southeast Asia's Iron Age, between 500 B.C. and A.D. 500.

However, it is not just the scarcity of remains or the poor condition of the few bones that have been found that has hindered investigation. Research has long been hampered by the extreme remoteness of the jar sites, as well as the danger in reaching them. The Plain of Jars has, at times, been called the world's most dangerous archaeological site. In the 1960s and 1970s, during the Vietnam War, the area was pummeled with American-made bombs. It was a prime target



Stone jars dot the hillside at the location known as Quarry Site 2 on the Plain of Jars outside of the small city of Phonsavanh.

during the U.S. bombing campaign in Laos, when Xieng Khouang was ground zero in the fight between the North Vietnam-backed Pathet Lao communist insurgency and the United States-backed Royal Lao Government.

From 1964 to 1973, more than two million tons of bombs (including more than 270 million cluster bombs) were dropped on Laos, more than on all of Europe during World War II. An estimated 80 million of those bombs did not explode when they fell, and they continue to imperil the lives of people throughout the country. Of the millions of bombs remaining in the soil, the majority are small submunitions, often called "bombies," which are about the size of baseballs—but deadly nonetheless. They frequently look like rocks, indistinguishable from the surrounding terrain. Bomblets make digging, both for farmers and for archaeologists, very dangerous. "It's hard to even comprehend the scale of destruction that was wrought here," O'Reilly says. "You can still see bomb craters in the ground.

And many of the jars were blown over or smashed by the bombing. Fortunately, though, the majority of the jars weren't destroyed." Every day in Laos, people still find bombs. And every year, dozens of Laotians are injured or killed by them. "We don't have any interest in working at sites that haven't been cleared," O'Reilly says. "It's just too dangerous. It's frightening. You have to be vigilant and stick to the paths." Xieng Khouang remains one of the most heavily contaminated provinces, and the presence of so many bombs continues to be one of the greatest challenges both to further study and development throughout the region.

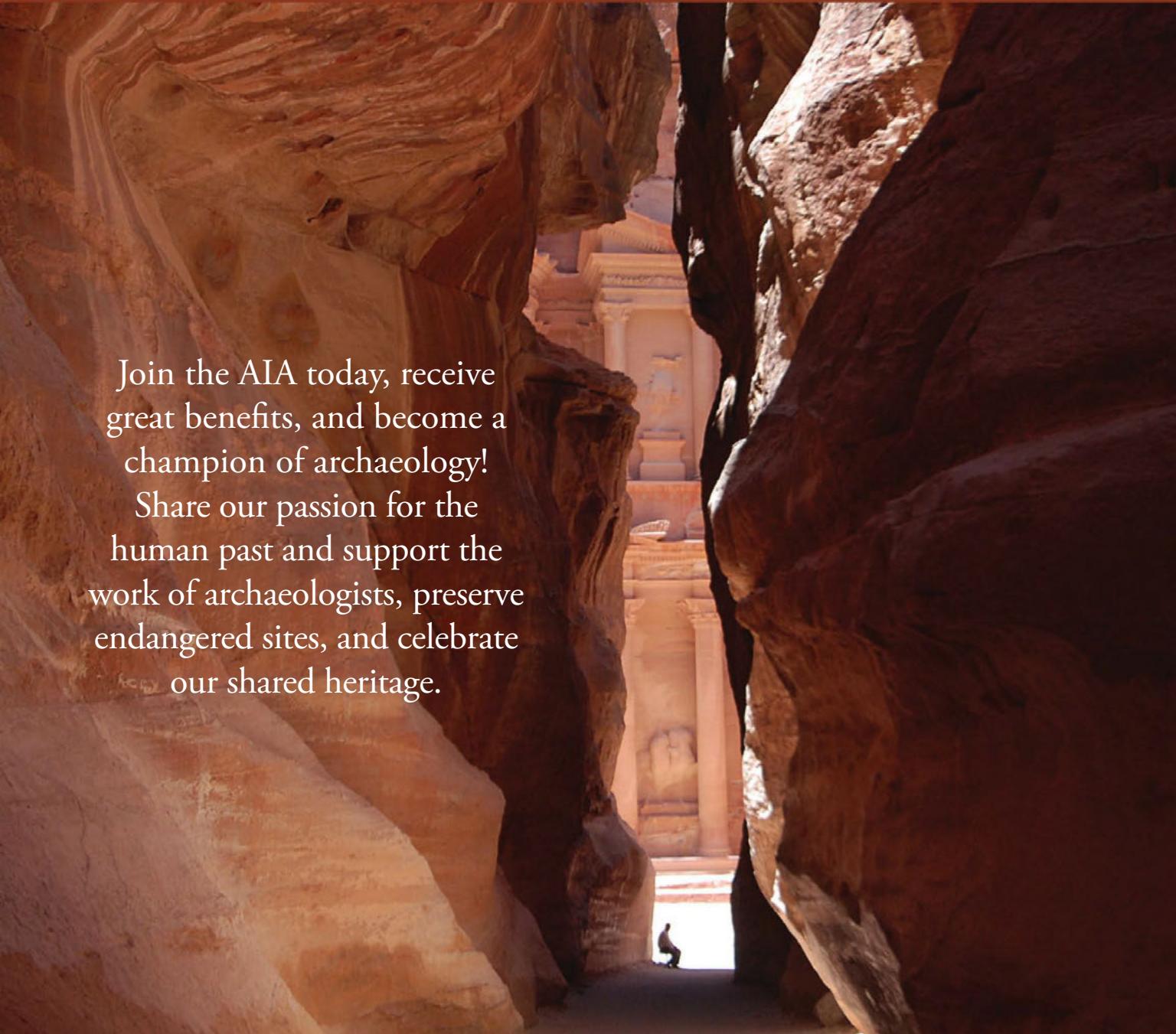
When Van Den Bergh worked on the Plain of Jars between 2001 and 2010, she did so alongside the Britain-based Mines Advisory Group, which cleared bombs from seven of the sites with the greatest potential for tourism. Although she spent several years in Xieng Khouang, Van Den Bergh was not able to excavate because her project was classified as research, and she didn't have government permission to dig at the time. However, her team was able to map more than 80 jar sites using tape measures, compasses, and handheld GPS devices, and to make traditional paper surveys. "Most of our photographs are pre-digital, too," she says.

The team began by visiting villages across the province and asking whether locals knew of any jars. Every time someone said "yes," team members surveyed the site. The results, Van Den Bergh says, pushed researchers to view the bigger picture and recognize the individual sites as components of a whole. "Jar sites are mainly on the edge of the central plateau and on the slopes of the inland valleys connecting to east, west, and south," she explains. When taken together, the seemingly disparate sites on the Plain of Jars appear to form a complex interconnected landscape.

(continued on page 62)



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## LETTER FROM LAOS

(continued from page 58)

Today, Shewan and O'Reilly, along with Thonglith Luangkhoth, their partner from the Department of Heritage at the Lao Ministry of Information, Culture, and Tourism, are conducting extensive research using more technologically advanced tools than were previously available to examine another mystery—how the massive jars were created and then set in place. “The jars themselves are quite impressive,” says O'Reilly. “You can't even get your arms around them.”

Geological research conducted by Van Den Bergh suggests the jars were carved from existing blocks of stone in quarries close to each jar site. Eight years ago, a British geologist named Jeremy Baldock, who was recruited to help Van Den Bergh's project, took measurements on a shady ridge called Phou Hin Moung, several miles southeast of Site 1 near a village called Ban Buatai. His aim was to create a 3-D model of the quarry in order to estimate the possible number of blocks that could have been taken from the site. Baldock determined that the quarry could have been the source for 57 blocks that were used to fashion 37 jars found in the nearby village, along with eight others scat-

tered around the area.

During this work, Van Den Bergh and Baldock also learned that the jar makers understood geological principles such as tectonics and sedimentation. “They approached areas of bedrock that had naturally fractured in large rectangular blocks,” says Van Den Bergh. “This might mean that the size of the jars is likely less an expression of status than of the size of available blocks.” Still, it's clear to researchers that the jars reflect importance in some manner. “The logistic and time investment alone—for jars of all sizes—indicates how people felt about their community and the importance of mortuary ritual,” Shewan says. “People are consciously ascribing significance to their burial landscape.”

The quarry nearest the team's initial excavation pits at Site 1 is about five miles away from the Site 1 jars. Investigating how the jars were moved will be a focus of upcoming seasons. “The jars may have been dragged or rolled—we don't know,” Shewan says. “However, the logistics required to shift up to 25 tons of carved rock must have had an impact on the landscape somewhere.” She hopes to use lidar in the future to virtually strip away the tree canopy and grass to look for drag marks or

gouging in the topography and to map possible transportation routes. Being able to examine the ground free of growth—a task that, in the past, required local volunteers with machetes—will allow her to look for evidence that would indicate where or how the jar people could have lugged multi-ton rocks across miles of downward-sloping terrain between quarry sites and jar sites. “It must have required a huge amount of effort to produce them and bring them from the quarry,” O'Reilly adds. “It's an incredible feat.”

Ever since pioneering French archaeologist Madeleine Colani first explored the region in the 1930s, many sites on the Plain of Jars have become even more inaccessible to scientists. But today, technology enables what was previously inconceivable. “We are fortunate to have a suite of recording methodologies and innovative analytic tools,” Shewan says. “Colani's corpus of research is truly inspiring; it makes you realize what we take for granted.” In addition to the isotopic analysis of skeletal remains from Burial 5 and the child found nearby, the team is geo-mapping every jar and every associated archaeological feature to create an extensive and expandable GIS database.

They are also using drones to design an interactive 3-D presentation for a Monash University–funded project called CAVE2. The CAVE2 room consists of a curvilinear wall with 80 high-definition screens, a high-powered computer that enables 30-frames-per-second playback of 84-million-pixel images, delivering one trillion computations per second for each of the 80 screens. Visitors wear lightweight 3-D glasses to explore all of the team's digital data. “You can actually walk through the landscape,” Shewan says. “Being in

**A massive stone jar lies half-buried in an area where the surrounding ground was contaminated with unexploded bombs from the wars of the 1960s and 1970s.**





A local villager totes bundles of firewood past the Plain of Jars Site 3.

CAVE2 places you right in the middle of the Plain of Jars, excavating alongside us at Site 1. We can measure distances between the jars, walk amongst them, step into the excavation trench to continue our research, and zoom in to areas of interest. We can watch the removal of each 10-centimeter layer, revealing the artifacts and burials as each layer is peeled away.” The best use of CAVE2 is yet to come, says Shewan, when drones will gather data from bomb-riddled sites too dangerous to explore in person.

In February 2017, the Unraveling the Mysteries team will return to Laos, to the high-elevation Site 52. It’s about 20 miles from Site 1 as the crow flies, but twice that distance by vehicle or foot. “Site 1 is the anomaly,” Shewan says, “being on a flat, cleared plain.” Site 52 sits near a modern-day Hmong village called Ban Pakeo. Only six years ago, the trek to Ban Pakeo took most of a day of hiking on a steep trail that branched off an old road. Now a new road brings visitors much closer. Van Den Bergh and her team previously measured and mapped the jars there, but no one has ever excavated. “Site 52 is untouched by any researchers, so it’s going to be quite exciting,” Koczur says.

The site encompasses four known jar groups, the largest of which contains at least 371 fine-grained sandstone jars, as well as a number of stone discs of the type often found at jar sites. “Sometimes those stone discs are said to be lids,” says O’Reilly, “but I don’t believe that they are. I think they are burial markers.” The team will also be looking for any skeletal material for DNA comparisons and isotopic analysis, as well as grave goods such as tools, beads, or ceramics that might be evidence of trade.

Despite all this—new research tools and technologies, better access to sites, and the somewhat decreased threat of unexploded ordnance—so many questions remain. But stand on a mountaintop or fly over Xieng Khouang, and it’s easy to see—the ancient jars will remain a defining presence across this land. ■

**Karen Coates** is a senior fellow at Brandeis University’s Schuster Institute for Investigative Journalism. Her latest book, with Jerry Redfern, is *Eternal Harvest: The Legacy of American Bombs in Laos*. For a video of the Plain of Jars, go to [archaeology.org/jars](http://archaeology.org/jars). To read the author’s earlier article on the site, go to [archaeology.org/jars](http://archaeology.org/jars).

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# Dispatches from the AIA

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## AIA Invites You to the 118th AIA-SCS Joint Annual Meeting in Toronto

Toronto, Canada



THE ARCHAEOLOGICAL Institute of America and the Society for Classical Studies are hosting their 118th Joint Annual Meeting in Toronto, Canada, from January 5 to 8, 2017. The annual event is the largest gathering of archaeologists and classical scholars in North America. The meeting will feature 72 academic sessions, including six workshops and 28 colloquia, and several special events such as an opening night lecture and reception and the annual awards ceremony. Registration and hotel information and rates, along with the program and other meeting-related items, are available at

[archaeological.org/annualmeeting](http://archaeological.org/annualmeeting).

The opening night lecture on Thursday, January 5, features renowned maritime archaeologist James P. Delgado, director of maritime heritage for the National Marine Sanctuaries program. Over the course of his career, Delgado has led numerous nautical expeditions, and served as chief scientist for the first full, 3-D mapping of *Titanic*. Delgado is the author of numerous articles and books and was the host of *The Sea Hunters*, a documentary series that aired on the National Geographic and History Channels from 2001 to 2006. In Toronto, Delgado will discuss

several major discoveries of lost ships in a presentation titled "The Great Museum of the Sea: A Global Tour of Some of the World's Most Important Shipwreck Archaeological Sites." The featured Bronze Age wrecks, classical shipwrecks, ships lost in early Islamic trade, the fabled lost fleet of Kublai Khan, the wrecks of explorers, lost ships of war, and *Titanic* speak to humanity's ongoing interaction with the sea and how archaeology is unlocking the secrets of the past, at times from the deepest parts of the ocean.

On Sunday, January 8, the AIA will host a special session highlighting the

James P. Delgado



incredible work being conducted by archaeologists in Toronto. The program will include the joint effort by the City of Toronto and cultural heritage consulting firm ASI to manage archaeological resources there—a program that won the AIA's 2016 Conservation and Heritage Management Award. The session will include presentations on the archaeology of Toronto's first general hospital, the work done at what used to be known as the Ward, exploration of Toronto's waterfront features, including the Queen's Wharf and an early nineteenth-century schooner, the Thornton and Lucie Blackburn Site—Toronto's first cab company and a safe terminus for the Underground Railroad—and 50 years of archaeology at Old Fort York.

The Third Annual Educators' Conference for teachers and educators interested in archaeology and heritage education will be held on Saturday, January 7. The program for the conference includes a workshop for training teachers, a follow-up discussion on evaluation and publication over the last year, and the ever-popular show-and-tell. In addition, we are excited to feature two sessions focused on heritage in Canada. The first, "Seeking Evidence in Alternative Spaces: The Case Study of the Black Church in the Ward District of Toronto," discusses the archaeology of marginalized groups in Toronto, specifically black Canadians in one of the poorest urban neighborhoods of

Canada from the mid-nineteenth to mid-twentieth centuries. The session will describe how teachers have been trying to incorporate this new, and at times controversial, material into their curricula. The second session, "Seeking to Contextualize First Nations Curricula through Archaeology," is concerned with the sensitive issue of dealing with archaeological material that still has meaning for descendant communities.

## International Archaeology Day Continues Rapid Growth

OCTOBER 15, 2016, WAS International Archaeology Day (IAD). The rapidly expanding annual celebration of archaeology featured more than 700 events and 600 Collaborating Organizations around the world. Early indications are that 2016 participation numbers will far exceed

2015's estimated 100,000 participants. We are especially pleased to see that several countries are now hosting their own national archaeology days, and we look forward to coordinating our efforts with those of our international colleagues as we work to focus public attention on global archaeology and its discoveries.

The U.S. National Park Service (NPS) once again joined the AIA as a partner and sponsor of IAD. Other federal agencies, including the Bureau of Land Management, partnered with the AIA to promote the event across the United States.

In recognition of the centennial of the NPS, IAD's ArchaeoMadness—an online competition in which 32 archaeological sites are pitted against each other in a single elimination tournament—featured 32 national parks to see which would emerge as the crowd favorite. Each day, participants vote for their favorite out of two sites. The winning site from each matchup moves on to the next round. The winner of the final matchup is crowned ArchaeoMadness Champion. This year, after

The graphic is a promotional poster for International Archaeology Day. At the top, the words "ARCHAEOLOGICAL INSTITUTE of AMERICA" are written in a blue serif font. Below this, the words "INTERNATIONAL ARCHAEOLOGY DAY" are written in large, bold, blue and brown letters. The background features a stylized illustration of green grass blades. In the bottom right corner, there is a white illustration of a trowel digging into the ground. At the bottom of the poster, the date "October 21, 2017" is written in a large, green, sans-serif font. Below the date, the website "www.archaeologyday.org" is also written in a green, sans-serif font.

several weeks of campaigning and voting, Tuzigoot National Monument in Arizona was declared the winner.

IAD 2016 also featured the 10th Annual AIA-MOS Archaeology Fair. This ongoing collaboration between the AIA and Boston's Museum of Science is a perfect example of a successful IAD event. The Archaeology Fair is attended by thousands of people, including students, teachers, and families. Over the course of the two-day event, attendees can participate in more than a dozen interactive, engaging, and informative activities presented by organizations from around New England. At the 2016 AIA-MOS Fair, children and adults had a great time exploring multiple aspects of archaeology and participating in archaeological digs,

making tools, exploring shipwrecks, and much more. Presenters at the fair were a mix of local historical and archaeological societies, museums, private archaeological firms, and city, state, and federal agencies such as the Boston City Archaeology Program, Boston National Historical Park, Concord Museum, Massachusetts Board of Underwater Archaeological Resources, New Hampshire Department of Transportation, Plimoth Plantation, Robert S. Peabody Museum of Archaeology, Stellwagen Bank National Marine Sanctuary, and the Public Archaeology Laboratory. With a regular annual attendance of between 5,000 and 6,000 people, the AIA-MOS Fair is the AIA's largest public outreach event. To find out more about the fair, and to join next year's festivi-

ties, visit [archaeological.org/fairs](http://archaeological.org/fairs).

International Archaeology Day 2017 will be October 21. Sign up today to become a Collaborating Organization and plan a public event in celebration of archaeology. We encourage anyone who is interested in joining next year's activities to visit our website, [archaeologyday.org](http://archaeologyday.org). It's never too early to begin planning!

## Hear about the Latest Archaeological Discoveries at an AIA Lecture

THE 121ST YEAR OF the AIA's popular Lecture Program is in full swing. More than 100 archaeologists are delivering lectures to audiences at AIA Local Societies across the United States and Canada. The wide range of topics featured this year includes ancient Babylonian instructions for building an ark, Athenian naval bases, and Neolithic Orkney, to name just a few. To find a lecture near you, visit [archaeological.org/lectures](http://archaeological.org/lectures).

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The 10th Annual AIA-MOS Fair held at the Museum of Science in Boston



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The most important thing when going for a hike is to be prepared—don't forget to bring a decent map, drinking water, extra food, a hat and gloves, and to dress in layers. And if you're planning to hike in snowy mountain passes, it's best to wear snowshoes. Discovered at an altitude of more than 10,000 feet on the Gurgler Eisjoch Glacier, the world's oldest snowshoe has recently been radiocarbon dated and found to be more than 5,500 years old. But according to archaeologist Catrin Marzoli, director of the Office of Cultural Heritage of the Autonomous Province of Bolzano, the technology hasn't changed much over the millennia. "This Late Neolithic snowshoe is of a very simple, yet effective construction," she says. "Until a few decades ago, in rural areas, snowshoes of this shape and material have been produced and used."

Like their modern counterparts, the Neolithic inhabitants of this Alpine region were quite comfortable traversing what might seem to be a harsh and inhospitable landscape, although archaeologists are unsure why they would have undertaken these journeys. It may have been to hunt, to locate pastureland, to travel to neighboring areas, to flee from their enemies, or even to celebrate religious ceremonies, explains Marzoli. Yet whatever their reasons for venturing into the rugged terrain, this snowshoe demonstrates that they were properly equipped—at least in part—for winter on Europe's high-altitude glaciers.

WHAT IS IT
Snowshoe
CULTURE
Neolithic
DATE
3800–3700 B.C.
MATERIAL
Birch, twine
FOUND
Gurgler Eisjoch Glacier, Dolomite Mountains, Italy
DIMENSIONS
12.59 inches in diameter





## caravan

• Daystop   1 Overnight   2 Two Nights



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**Capuchin Monkey**

**Morpho Butterfly**



**Three-toed Sloth**



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Cicero 106 – 43 BC



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