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March/April 2015

How Rome Became **ROME**

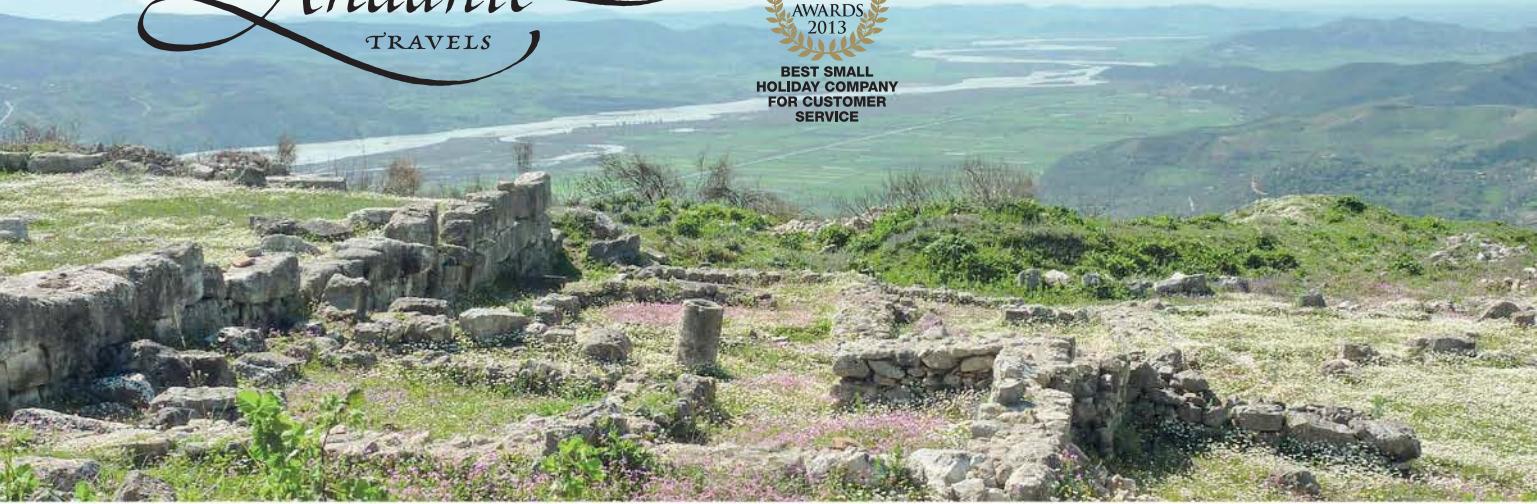
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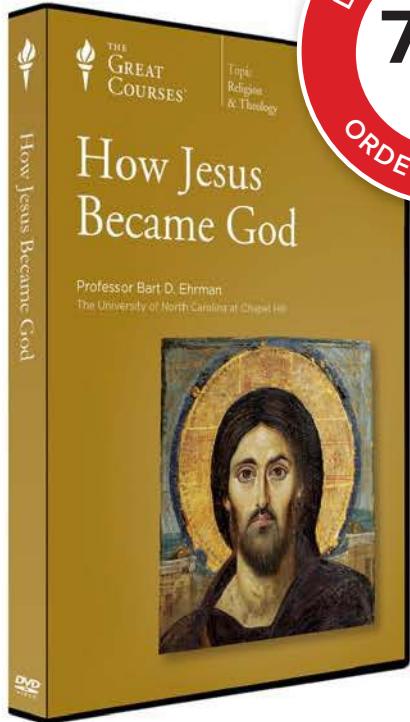
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Cover: The Colosseum, one of ancient Rome's greatest engineering and architectural achievements, was built during the first century of the empire, between the years A.D. 70 and 80.

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Assembling the Evidence

The archaeological record frequently offers impressive indications of the human impulse to move forward. It often is the details of those efforts that prove to be the most amazing. Such is the case with Portus, Rome's monumental Mediterranean port complex. Archaeologist and writer Jason Urbanus brings us "Rome's Imperial Port" (page 26), the story of the centuries-long progression from city to empire through the lens of one of the most impressive engineering and logistical projects ever undertaken.



500-year-old Liao Dynasty tomb painting

Much of what we think we know about the Viking presence in the British Isles comes from historical accounts that they arrived, bent on violence, in A.D. 793 and attacked the monastery at Lindisfarne. In "The Vikings in Ireland" (page 46), contributing editor Roger Atwood writes of new evidence coming from a handful of burials that opens the possibility that Viking families had actually arrived with the intention of settling down—much earlier than previously thought.

Iron smelting is believed to have begun in Egypt around 600 B.C. How, then, could researchers have discovered iron beads in a burial some 40 miles south of Cairo dating to 2,700 years earlier? Answers may be found in the laboratory. Journalist Kate Ravilious examines efforts by archaeologists and planetary scientists to discover the source of that iron, and to re-create the mysterious beads, in "Iron from the Sky" (page 36).

Cahokia, located at the confluence of the Mississippi and Missouri Rivers, near St. Louis, has long been recognized as a vast prehistoric urban complex—in fact the largest city of its time in the Americas north of Mexico. Nonetheless, the causes of its rise and rapid growth around A.D. 1050 have long been a source of speculation. In "City of the Moon" (page 40), science journalist Mike Toner investigates new research, conducted with assistance from astronomy, into the alignment of the site and others nearby indicating that Cahokia could have been the center of a lunar cult that attracted an enormous influx of immigrants and pilgrims.

"Letter from the Marshall Islands" (page 51), by archaeologist Michael Terlep, presents the steps he and other specially trained researchers and technicians are taking at Wotje Atoll in the central Pacific not just to record but also to render safe unexploded ordnance left over from World War II. Sitting beneath sand, blistering sun, and salt water, American and Japanese bombs pose an ongoing threat to residents and their environment, even as clues about WWII strategy and tactics are being revealed.

And don't miss "Packed for the Afterlife" (page 34), by executive editor Jarrett A. Lobell—an intimate glimpse of the care taken to provision a couple for their final journey some 500 years ago.

Claudia Valentino

Claudia Valentino
Editor in Chief

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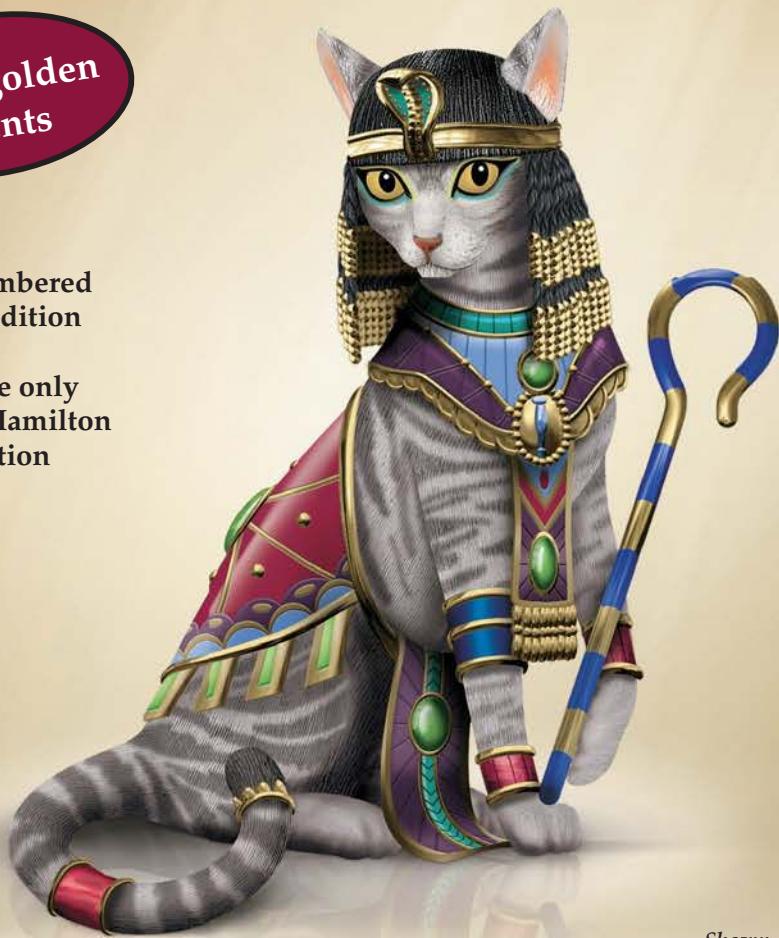
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Signs of Life

Techniques of scientific analysis, once considered outside the realm of archaeology, when applied to skeletal remains and to other organic materials, have opened a new chapter in our understanding of the human story. Sometimes the insights can be transformative.



A researcher at the Max Planck Institute examines Neanderthal DNA remains.

One of the most revolutionary discoveries occurred when recent studies of Neanderthal DNA revealed that they were genetically closer to modern humans than fossil evidence alone had indicated. This is the manner in which we learned, too, that Neanderthals and our modern human ancestors interbred. Thus, most people with origins in the Northern Hemisphere share part of their genetic inheritance with Neanderthals.

Historical archaeology has also been positively impacted by advanced DNA analysis. In no other way could archaeologists have confirmed that the skeleton found recently beneath a parking lot in Leicester, England, was the historical figure we know as King Richard III. While the skeleton had severe scoliosis—itself a telling indicator, as Richard III was often described as having a spinal deformity—it was DNA analysis that conclusively established his identity.

Archaeologists have long realized that in order to understand humanity's transition from hunting and gathering to an agriculture-based way of life—which, in turn, enabled the growth of cities and civilization—they needed to begin by determining when, where, and how plants and animals became domesticated. Until recently, we thought familiar crops such as wheat and barley, and animals, including sheep, cattle, and pigs, had probably been domesticated in the Middle East, and as single events, with the practice then spreading. So too, with domesticated rice in China, and with maize, beans, and potatoes in Central and South America. But, thanks to DNA analysis, the history of domestication is now seen as more complex. Several of the main species of crops and animals were domesticated in multiple events, often in locations thousands of miles apart.

The teeth and bones of prehistoric humans also have a deeper story to tell thanks to isotopic analysis. What has been learned is that people in the past migrated more often than previously believed. Further, isotopic studies show that migrating farmers carried the farming way of life that originated in western Asia into southern and central Europe.

These studies, and so many more, are enriching our understanding of the human past and bringing it to life in ways that speak directly to us today. All of this would have been beyond reach just a few years ago.

A handwritten signature in black ink that reads "Andrew Moore".

Andrew Moore
President, Archaeological Institute of America

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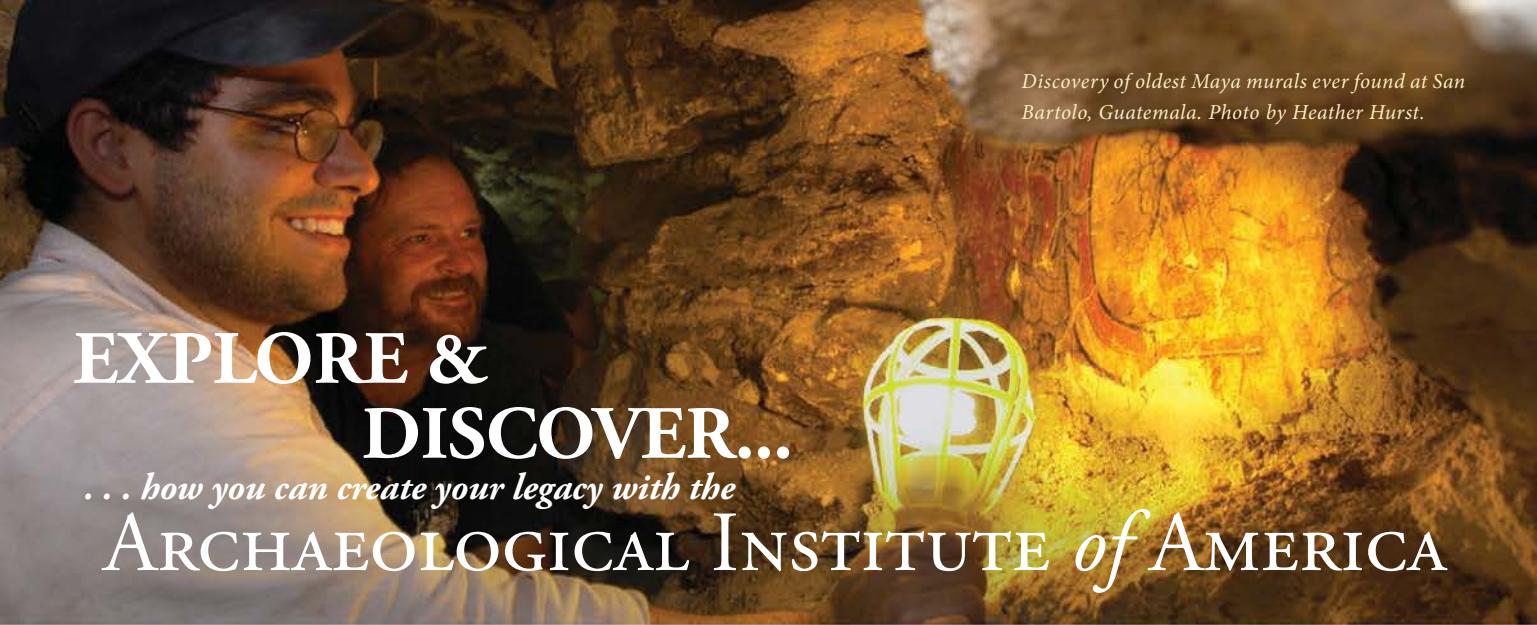
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Discovery of oldest Maya murals ever found at San Bartolo, Guatemala. Photo by Heather Hurst.

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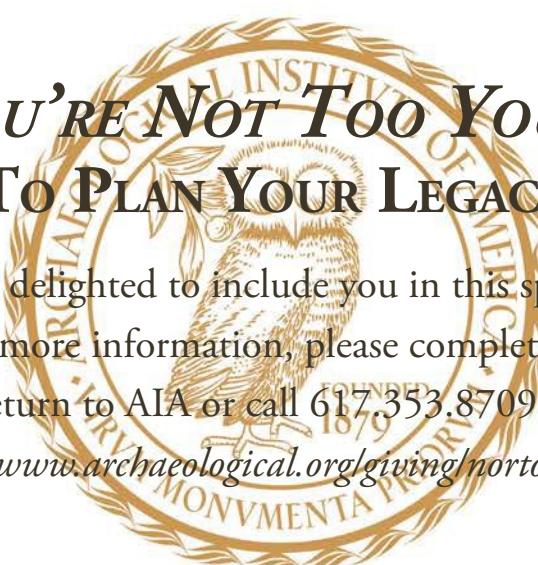
L-R: Eric Blind with Ellen and Charles S. La Follette in the archaeology lab in San Francisco's Presidio.

For Charles S. La Follette, creating a personal legacy through a planned gift in his will was a natural extension of his involvement with the Archaeological Institute of America and his commitment to archaeological research and education. "I joined the Norton Society to help the AIA continue its wonderful archaeological programs for generations to come," says Charles. With his bequest, he is confident that AIA will continue to provide professional archaeologists with resources critical to their work and lifelong learning opportunities for everyone.

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Spiked Heels

In "Fancy Footwear" ("From the Trenches," January/February 2015) the author states that the gilded shoes weren't for daily wear, but rather for burial ritual, but the main proof of this was not mentioned. All these artifacts



(17 pairs discovered in tombs) have highly decorated soles with patterns of stylized clouds, flames, lotus rosettes, and interconnected hexagons, and the most unique feature of these shoes is the fact that the soles are studded with spikes—the tips of several of these can be seen in the photograph. The thickness and length of these spikes differ somewhat from one pair to another, but they all have them, and they would clearly make it impossible for a person to actually wear these shoes. Scholars believe that these are "sky-walking" shoes to allow the deceased to ascend into the heavens, and are also possibly related to the shamanic role of the ruler as one who bridges the gap

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.

between the world of humans and the spirit world. This shamanic theme is also depicted in the branched "cosmic tree" of the gilt-bronze crowns that accompany many of these burials.

Stephen Garrigues
Daegu, South Korea

A Military Past

I found "America's First War" (January/February 2015) very interesting. I had previously heard of the Pequot War when reading information about my ancestor, George Denison, who fought in this conflict.

Judith Wells
McMinnville, OR

Neanderthal Art?

I take issue with the marks mentioned in "Symbolic Neanderthals" (January/February 2015) being called "art." They are virtually identical to those on both my workbench and saw horses. Yes, they are worn patterns from or for some repetitive process we do not know. However, to call them art or even symbols is attaching today's labels, values, justifications, and beliefs in an effort to "humanize" the mark makers. They may well have been marks from dulling an edge of a stone tool to keep it from cutting the user.

Davis Steelquist
Quilcene, WA

Family History

Your interesting article on archaeological exploration of Frenchman and Yucca Flats ("Dawn of a Thousand Suns," November/December 2014) brought back vivid images from my childhood, 200-plus miles away in

Pasadena. My bedroom window faced north, Nevada-wards, and I had an uncanny ability to awaken early in the morning just before a nuclear test, although we did not know the schedule. Suddenly the view would go from pitch-black to the mountains silhouetted for a few moments against an otherworldly ash-white sky. I will never forget that utterly colorless "color." Then one summer dawn, as we drove through the eastern Californian desert toward Idaho, we saw the color-devoid flash one last time, over the hills ahead of us. But this time we were so close that we could also see stark rows of crookedly vertical grey shock waves. It was so sobering that no one spoke for a long, long time.

Elizabeth Wayland Barber
Pasadena, CA

It was interesting to read "Dawn of a Thousand Suns" (November/December 2014). Besides being a great topic to read about, it was a bit personal as well. Within my family's history, my grandfather served in the Navy post-World War II on USS *Bowditch* in 1946. He was part of and witnessed the Able atomic bomb test on the Bikini Atoll, and we still have the pictures he took of the mushroom-shaped clouds coming off the test sites. This article allowed me to learn more about this event in history, and how it played a part in our family's own history. I was just so amazed to see the Able test mentioned in the magazine that I felt the need to get a hold of and thank the editors for publishing it.

Matt Rolfs
Cincinnati, OH



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From the Trenches

LATE-BREAKING NEWS AND NOTES FROM THE WORLD OF ARCHAEOLOGY

Seismic Shift

Sanxingdui was a Bronze Age civilization that flourished in China's fertile Sichuan Basin for several hundred years before mysteriously disappearing around 1100 or 1200 B.C. Around the same time, a similar civilization sprang up in Jinsha, some 30 miles from Sanxingdui. Experts generally accept that the Jinsha civilization is a continuation of the Sanxingdui culture, but have been puzzled by what prompted the move. War? Floods? Now, a Chinese scientist has argued that the actual cause was a massive earthquake that led to a landslide that diverted Sanxingdui's primary water source so that it flowed past Jinsha instead.

Much of what is known about Sanxingdui civilization comes from two pits dating



**Sanxingdui excavation pit,
Sichuan Province, China**

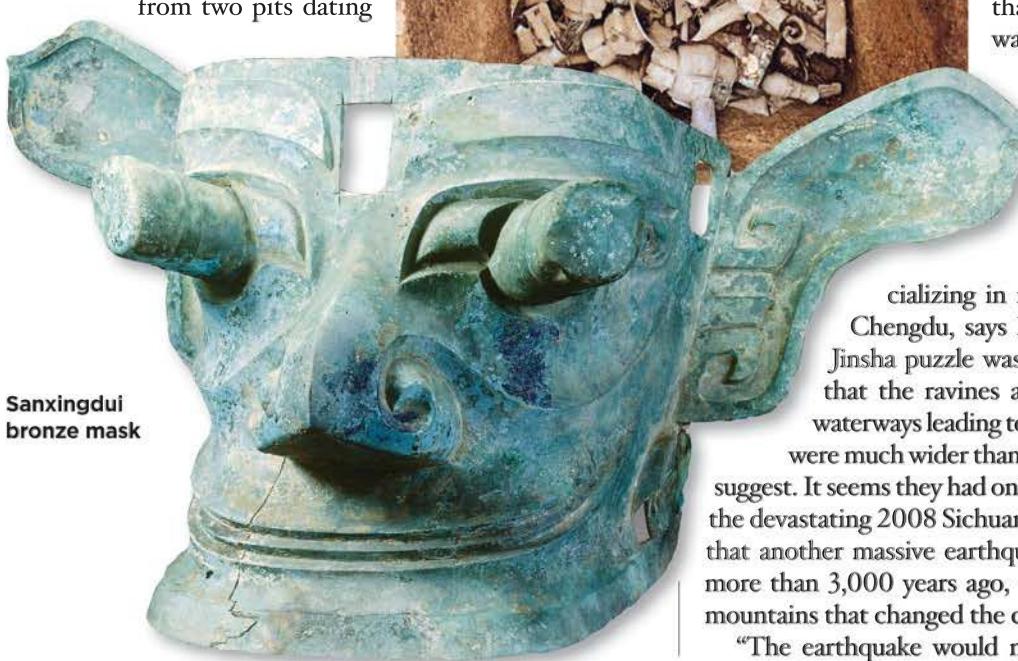
to around the time of its disappearance. The pits contained hundreds of jade, bronze, and ivory objects that had been ritually broken or burned and then buried, and their discovery in 1986 shook up the world of Chinese archaeology.

Although some jade and stone artifacts had been found in the area in 1929, experts had thought that sophisticated Chinese civilization at the time was centered along the Yellow River in the distant Central Plains region. But the pits, which yielded expertly worked bronze items, including several giant masks with strangely distorted features, made clear that the Sanxingdui civilization was quite advanced as well. In

2001, the Jinsha site, discovered within the modern-day provincial capital of Chengdu, was found to contain bronze items that share a similar artistic vocabulary.

Niannian Fan, a scientist specializing in rivers at Sichuan University in Chengdu, says his interest in the Sanxingdui-Jinsha puzzle was first piqued when he noticed that the ravines and beds holding a number of waterways leading to and passing the Sanxingdui site were much wider than their current rate of flow would suggest. It seems they had once held much larger rivers. After the devastating 2008 Sichuan earthquake, Fan hypothesized that another massive earthquake had struck the same area more than 3,000 years ago, causing a landslide high in the mountains that changed the course of the Minjiang River.

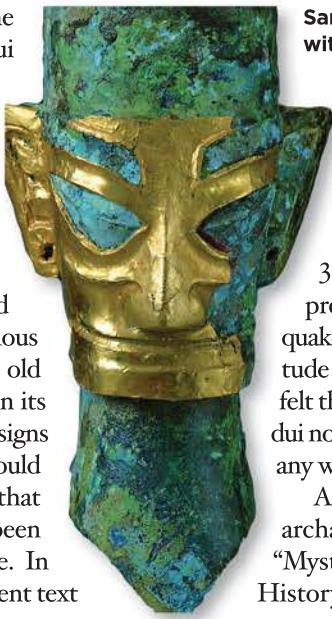
"The earthquake would not have destroyed Sanxingdui



**Sanxingdui
bronze mask**

directly," says Fan. "But the water level in Sanxingdui would have decreased sharply just one or two days after the earthquake."

Fan has gathered preliminary evidence to back up his hypothesis. Using Google Earth, he found that a stretch of mountainous terrain through which the old river would have flowed on its way to Sanxingdui lacks signs of glacial erosion that should be present, suggesting that this section may have been covered up by a landslide. In addition, he notes, an ancient text



Sanxingdui bronze head with gold mask

records that an earthquake occurred in 1099 B.C. in the capital of the Zhou Dynasty in Shaanxi Province. This is around 300 miles from what he presumes to have been the quake's epicenter, but its magnitude would have ensured it was felt there. (Neither the Sanxingdui nor the Jinsha civilization left any written records.)

Agnes Hsu-Tang, an archaeologist and host of the "Mysteries of China" series on History Channel Asia, believes

that Fan's hypothesis "is the most rational explanation [for the move from Sanxingdui to Jinsha] I have heard up to this point."

Still, the earthquake and landslide hypothesis can't explain why the broken and burnt objects were thrown into the pits at Sanxingdui around the time the site was abandoned. "These sacrificial pits might not have anything to do with the fleeing, but may have been a sacrificial ritual carried out regardless of the natural disaster," says Hsu-Tang. "There is evidence suggesting that they did not do it in a hurry, that it was very deliberate, and that the objects were not meant to be recovered. And that's what remains so mysterious."

—DANIEL WEISS

OFF THE GRID

Krakow, one of Poland's oldest cities, is well-known for its churches, but it also hosts the country's most significant collection of Jewish monuments and buildings. At the end of the fifteenth century, the city's Jewish population was driven out of the center and directed to settle in the district of Kazimierz. Known as the Oppidum Iudaeorum, or "Jewish City," it grew into a religious and cultural center for the region's Jews. By the 1930s more than 60,000 lived there, but the Nazi occupation rendered the district a virtual ghost town. Recently scholars, historians, and archaeologists have taken a new interest in the area. Dariusz Niemiec of the Institute of Archaeology of the Jagiellonian University and a team of students are excavating in and

around the Old Synagogue, the country's oldest standing example, in the heart of the Oppidum Iudaeorum. It has a long and storied history that follows the fortunes of Poland, from the building's initial construction in the Gothic style in the beginning of the fifteenth century, to its reconstruction in 1570 by the workshop of Renaissance architect and sculptor Mateo Gucci, to a visit from Tadeusz Kościuszko, who led a Polish uprising against Russian and Prussian rule in the late eighteenth century, to the twentieth century, when it was looted by the Nazis.

The site

The Old Synagogue is a rare surviving example of what is known as a "fortress synagogue," so called for its features borrowed from military architecture. Its windows, for example, are placed far above ground level, and its thick walls are buttressed to withstand assault. After restoration in the 1950s, the synagogue was opened as part of the Historical Museum of the



Courtyard excavation

City of Krakow. Niemiec's archaeological work is focused on the exterior courtyard and aims to identify the oldest parts of the foundation and the cultural layers associated with them. Visitors today can see exhibits on various aspects of Jewish life in Krakow, as well as Cracovia Iudaeorum 3D, a digital reconstruction of the history of the district

supplemented with archaeological finds, including ceramic vessels with Hebrew inscriptions.

While you're there

It would take weeks to visit all of Krakow's historical sites, but visitors should start with the city's Old Town, a UNESCO World Heritage Site brimming with cafes and shops and a main square that is the largest medieval square in Europe. The Wawel Royal Castle complex, overlooking the Vistula River, once a royal residence, today contains a priceless collection of sixteenth-century Flemish tapestries. More recent history is reflected at the site of the Płaszów concentration camp and Oskar Schindler's Factory, which houses a museum dedicated to the story behind Steven Spielberg's *Schindler's List*.

—MALIN GRUNBERG BANYASZ

Old Synagogue, Krakow, Poland





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Magnificat II and studied the escapement, balance wheel and the rotor. He remarked on the detailed guilloche face, gilt winding crown, and the crocodile-embossed leather band. He was intrigued by the three interior dials for day, date, and 24-hour moon phases. He estimated that this fine timepiece would cost over \$2,500. We all smiled and told him that the Stauer price was less than \$90. He was stunned. We felt like we had accomplished our task. A truly magnificent watch at a truly magnificent price!

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Treasure of Rathfarnham Castle



While undertaking restoration work at Dublin's Rathfarnham Castle, archaeologists recently discovered a "treasure trove" that offers a rare glimpse into life in seventeenth-century Ireland. The artifacts include a foldable toothbrush, clay pipes, jewelry, porcelain, coins, chamber pots, intact goblets, and early wine bottles. The items, among 1,700 other objects, had been left inside a wash pit and sealed beneath a stone floor that perfectly preserved them.

Exactly how the items got there is still being established. They may have been hidden when the castle was attacked, or placed there for washing and never retrieved. In any case, archaeologists believe that the artifacts belonged to a specific household, most likely that of Adam Loftus, grandson of Archbishop Adam Loftus, who served as Queen Elizabeth's chief envoy to Ireland and who originally built the castle. "These artifacts give us a rare and intimate insight into the lavish lifestyle of the

castle's residents at the time. What makes it all the more exciting is that most of the artifacts are high-end imported goods from as far away as China, which tells us that Ireland may have been more fashionable at the time than previously thought," says Antoine Giacometti, one of the chief archaeologists working on the project. Rathfarnham Castle will reopen to visitors in 2015 with the artifacts planned to go on public display.

—ERIN MULLALLY

History's Largest Megalith



A team of archaeologists at a 2,000-year-old limestone quarry in Lebanon's Bekka Valley recently excavated around a megalith weighing approximately 1,000 tons and dubbed Hajjar al-Hibla, or "stone of the pregnant woman." It was intended for the Temple of Jupiter, which sits on three limestone blocks of similar size at the nearby site of Baalbek. To the team's shock, they unearthed yet another block, this one weighing an estimated 1,650 tons, making it the largest known megalith. The German Archaeological Institute's Margarete van Esse says excavation was suspended when the trench became dangerously deep. "Hopefully in a following campaign we can dig down to the bottom of the block," she adds. The team wants to find clues there that will show how the megaliths were transported.

—ERIC A. POWELL

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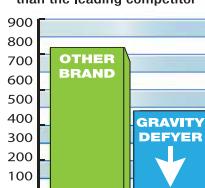
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Squaring the Circles



Stone circle, Jordan

Researchers from the Aerial Photographic Archive for Archaeology in the Middle East have brought renewed attention to an archaeological phenomenon known as "Big Circles." Spread across parts of Jordan and Syria, these manmade features have received

and possible date," says project director David Kennedy. The origin, function, and purpose of the circles remain a mystery, although Kennedy hopes that his work will provide a new perspective from which to analyze them.

—JASON URBANUS

Hidden in a Coin Hoard



Gold torque within Celtic coin hoard

Archaeologists separating the contents of the largest known Celtic coin hoard have uncovered a number of gold items mixed in with the coins. The hoard, which was found on Jersey in the British Channel Islands, consists of 70,000 coins estimated to weigh a half ton in all. The researchers have so far removed a shoebox-sized portion of the hoard, revealing one complete gold torque and parts of six others.

The hoard is thought to date to around 50 B.C., when the Romans, led by Julius Caesar, were advancing north through France conquering Celtic tribes as they went. "We think they were trying to get their wealth out of the way," says Neil Mahrer, a museum conservator with Jersey Heritage, "presumably with the idea of coming back for it later."

—DANIEL WEISS

Figurines of Novae

From the mid-first to the fifth century A.D., the site of Novae in the province of Moesia (now Bulgaria) served as a military outpost of the Roman Empire. Novae flourished throughout its history, with

all the trappings of a busy provincial camp, including workshops, a hospital, barracks, administrative buildings, latrines, temples, altars, and monumental defensive walls and towers. Over the last five decades, research-

ers have uncovered these structures and countless artifacts. Most recently, archaeologists from the University of Warsaw have been excavating in what may have been the house of the centurion (a Roman officer) of the Legion I Italica, first raised by the emperor Nero and deployed to Novae in A.D. 69. The team, led by Piotr Dyczek, uncovered three second-century bronze figurines, two depicting speakers dressed in togas and one of a comedic actor. According to Dyczek, the figurines may once have decorated pieces of furniture or been part of a household shrine in a home he describes as "very luxuriously equipped."

—JARRETT A. LOBELL



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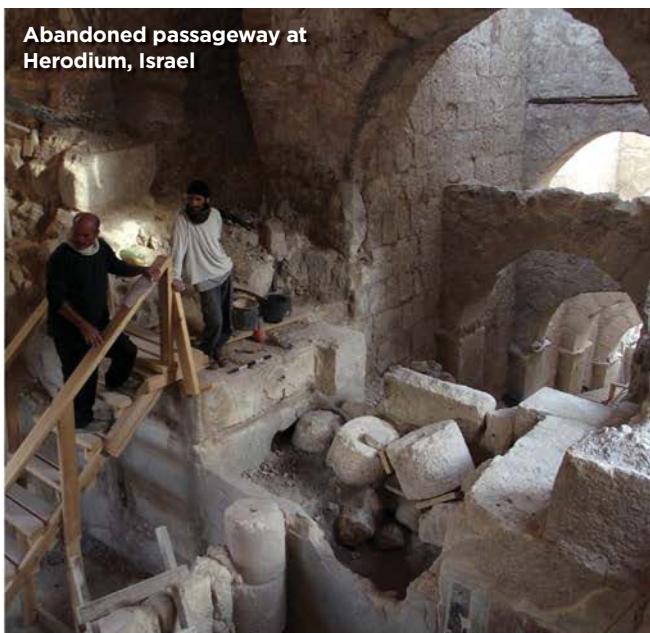
Autumn of the Master Builder

Herod, king of Judea from 37 to 4 B.C., has long been renowned as an architectural visionary, having overseen such projects as the reconstruction of the Temple of Jerusalem, the Masada palace complex, and the harbor and city of Caesarea. Now, archaeologists from the Hebrew University of Jerusalem excavating the king's palatial complex at Herodium have uncovered evidence that Herod sometimes sacrificed extensive work on one grand construction plan in favor of another.

Researchers discovered a large corridor in the upper palace at Herodium, apparently designed to allow the king and his entourage direct access to the palace courtyard. The corridor was at least 65 feet high and supported by a network of arches, but was left unfinished and partially filled in with rubble when the king decided to turn the hilltop into a giant cone-shaped monument. "This was a huge project being done just for the sake of preserving his name," says archaeologist Yakov Kalman. "This was probably done in the last 10 years of his life when Herod was not mentally stable."

—DANIEL WEISS

Abandoned passageway at Herodium, Israel



Aerial view, Herodium

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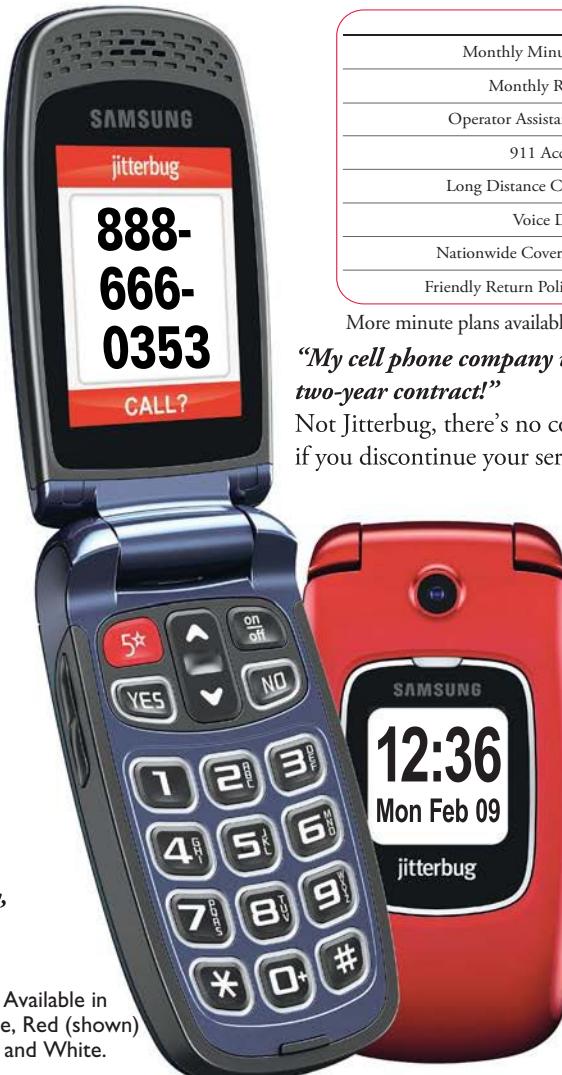
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Buried With Care



Medieval burials, Flers, France



Lead coffin with heart

The town of Flers in northwestern France has existed since at least the twelfth century. In the fifteenth century, the small rural village of about 500 inhabitants was centered around the Church of Saint-Germain. French archaeologists excavating the church cemetery in order to understand the building, its history, and changing burial practices over the centuries have recently uncovered hundreds of burials. The majority of these were simple, wooden coffins from the medieval period, but among them were two richer coffins, both made of lead, dating to the eighteenth century. One of them had a lead heart attached to it as well.

—JARRETT A. LOBELL

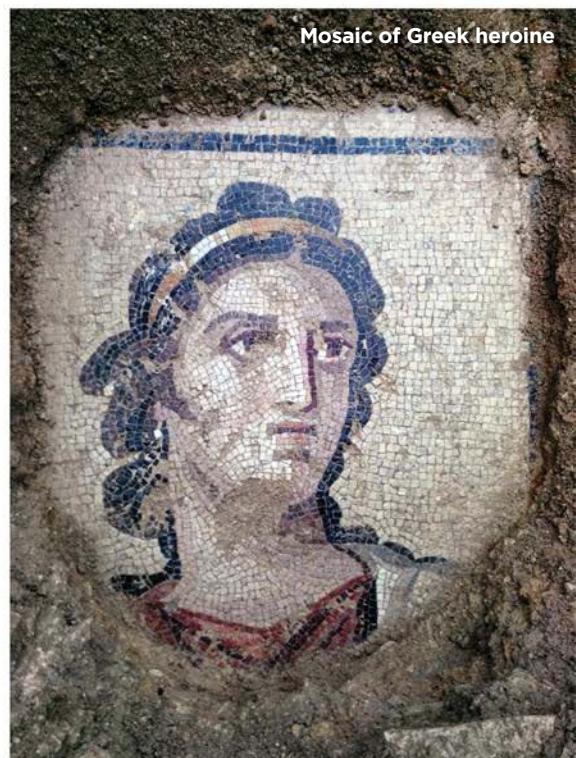
New Mosaics at Zeugma

Continuing excavations in the House of the Muses at Zeugma in southeastern Turkey have uncovered even more spectacular Roman mosaics, as well as more of the house's well-preserved architecture. In one of the newly discovered rooms, archaeologists uncovered a mosaic pavement depicting four young women framed by elaborate patterns. Although not identified by any inscriptions, the women may represent heroines from Greek mythology.

—KUTALMIŞ GÖRKAY



House of the Muses, Zeugma, Turkey



Mosaic of Greek heroine

Finding the Battle of the Ford of the Biscuits

In 1594, an army loyal to Queen Elizabeth marched along a road that led across the Arney River near the town of the same name, about 80 miles west of Belfast, in what is now Northern Ireland. Little did they know that they were walking into a large-scale ambush set by a group of Irish chieftains. The Queen's soldiers were slaughtered and the supplies they were transporting to nearby Enniskillen Castle were dumped into the river. The incident became known as the Battle of the Ford of the Biscuits, but after 400 years its location had become a matter of dispute. Scholars believed that the battle had taken place at the Drumane Bridge, about a mile and a half east of town,



**Lead shot,
Red Meadows, Northern Ireland**

but the local oral history maintained that it had occurred closer to town, at a site called the Red Meadows. This year archaeologists from the Northern Ireland Environment Agency (NIEA) worked with the people of Arney to investigate.

"To be honest, I wasn't that keen to look at [the Red Meadows]," says Paul Logue, an archaeologist with the NIEA. "But when we went, it actually started to seem quite promising." A closer examination of area maps showed that the Red Meadows was the only dry path through miles of bog, and that it led right to a ford in the river. It was a natural place

for an ambush. The team surveyed the Red Meadows with metal detectors and found huge numbers of lead bullets and shot in the ground, clear evidence that they had found their battlefield.

Logue and other archaeologists from the NIEA have been working with the local people for a year on a project called "Battles, Bricks, and Bridges," which

is examining the history of Arney. In a way, the project continues the local tradition of preserving history that has been going on at least since the time of the battle. "Oral history is a way of communities keeping their stories alive," says Logue, "and that is really what happened with this battlefield."

—ZACH ZORICH

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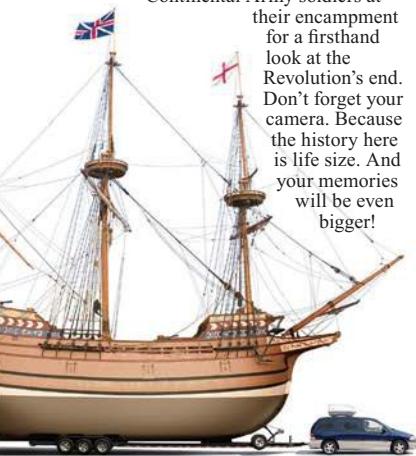
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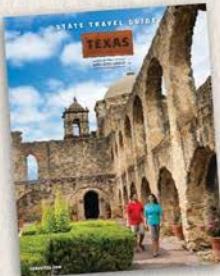
The family of mollusks known as shipworms are sometimes referred to as the “termites of the sea” because they bore through and eat submerged wood, including shipwrecks. Actual termites are able to digest wood because bacterial communities in their guts generate enzymes that break down wood fibers. But in a number of shipworm species, the cecum, or intestinal structure where they digest wood, doesn’t have a bacterial community to help out. Researchers have now found the missing microbes—living in specialized cells in shipworms’ gills. “I would say that this finding likely extends to many species,” says Dan Distel of the Northeastern University Marine Science Center. Useful enzymes then migrate to the cecum—scientists don’t know how just yet—where they break wood down into nutritious sugars, sugars that the shipworms then don’t have to share with a community of gut bacteria. This is the first time such an arrangement has been observed in the animal kingdom.

—SAMIR S. PATEL

Driftwood bored by shipworms



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Tomb of the Jealous Dog

Liao Dynasty tomb painting, Shanxi Province, China



Archaeologists have uncovered a Liao Dynasty (A.D. 907–1125) brick tomb in Datong City in northern China's Shanxi Province. The tomb had been looted, but only

valuable, portable artifacts were taken, which left its remarkable wall paintings intact. The murals cover more than 160 square feet and depict constellations, wooden architecture, travel, and daily

life. One panel shows servants standing around an empty bed while a cat plays with a silk ball and a dog, to the right, looks on, perhaps a bit jealously.

—JARRETT A. LOBELL

Shackled for Eternity

Archaeologists have recently uncovered a large Gallo-Roman necropolis in southwest France. Located just 800 feet from the Roman amphitheater in Saintes, the cemetery may have been the final resting place for many of the arena's victims. Several hundred graves dating to the first and second centuries A.D. were found, including many double burials, in which two bodies were interred in one trench, lying head to foot. The archaeologists also excavated at least five individuals—four adults and one child—who were still wearing riveted iron shackles around their wrists, necks, or legs. The graves were almost entirely devoid of artifacts, except for that of a young child who was buried with coins on his or her eyes and seven small vases.

—JASON URBANUS



Roman-era burial with neck shackle, France

Treason, Plot, and Witchcraft

Remember, remember, the fifth of November." In one of the United Kingdom's largest and most historic homes, archaeologists have found a lingering memory of the paranoia and angst that followed the Gunpowder Plot of 1605, when Robert Catesby and a group of Catholic conspirators (including Guy Fawkes) attempted to blow up both houses of Parliament and kill the Protestant King James I.



Upper King's Room,
Knole House, England



Six-hundred-year-old Knole House in Kent was then owned by Thomas Sackville, Lord Treasurer. Sackville was having the home renovated to host the king himself, work that included creating the "Upper King's Room," where the monarch would have stayed (but never actually did). As part of a five-year project of study and conservation, researchers recently pulled up floorboards in the room and found what are known as apotropaic marks—also called "witchmarks" or "demon traps." These crosshatch patterns had been carved into beams around the fireplace and under the floor by the craftsmen working on the room, as protection for the royal occupant from witchcraft and demonic possession. Tree-ring dating of the beams reveals that the

marks were made just months after the Gunpowder Plot had been foiled.

In the hysteria that followed the plot, accusations of witchcraft and demonic activity were common, fueled in part by James' demonization of Catholics and his interest in the supernatural. Two years earlier he passed a law imposing death for those engaging in witchcraft, and

had once written a book, *Daemonologie*, supporting witch-hunting. According to James Wright of Museum of London Archaeology, which is working on the project, "These marks illustrate how fear governed the everyday lives of people living through the tumultuous years of the early seventeenth century."

—SAMIR S. PATEL

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With Dr. Enda O'Flaherty
July 17 - August 1, 2015

CHINA'S SILK ROAD

With Professor Johan Elverskog
August 9 - 26, 2015

PUB CRAWL OF ENGLAND

With Dr. James Bruhn
August 9 - 21, 2015

SRI LANKA

With Dr. Ruth Young
August 21 - September 7, 2015

SCOTLAND

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WORLD ROUNDUP



NEW JERSEY: While building a wall to protect coastline hit hard by Hurricane Sandy, workers encountered the remains of what appears to be a 19th-century shipwreck. Authorities have decided not to disturb the site further, but a telling artifact suggests that it might be the remains of *Ayrshire*, a Scottish brig full of Irish and English immigrants that went down in a storm in 1850. The artifact could be part of a locally invented pulley system—like an old-fashioned clothesline—that was used to rescue almost all the passengers.



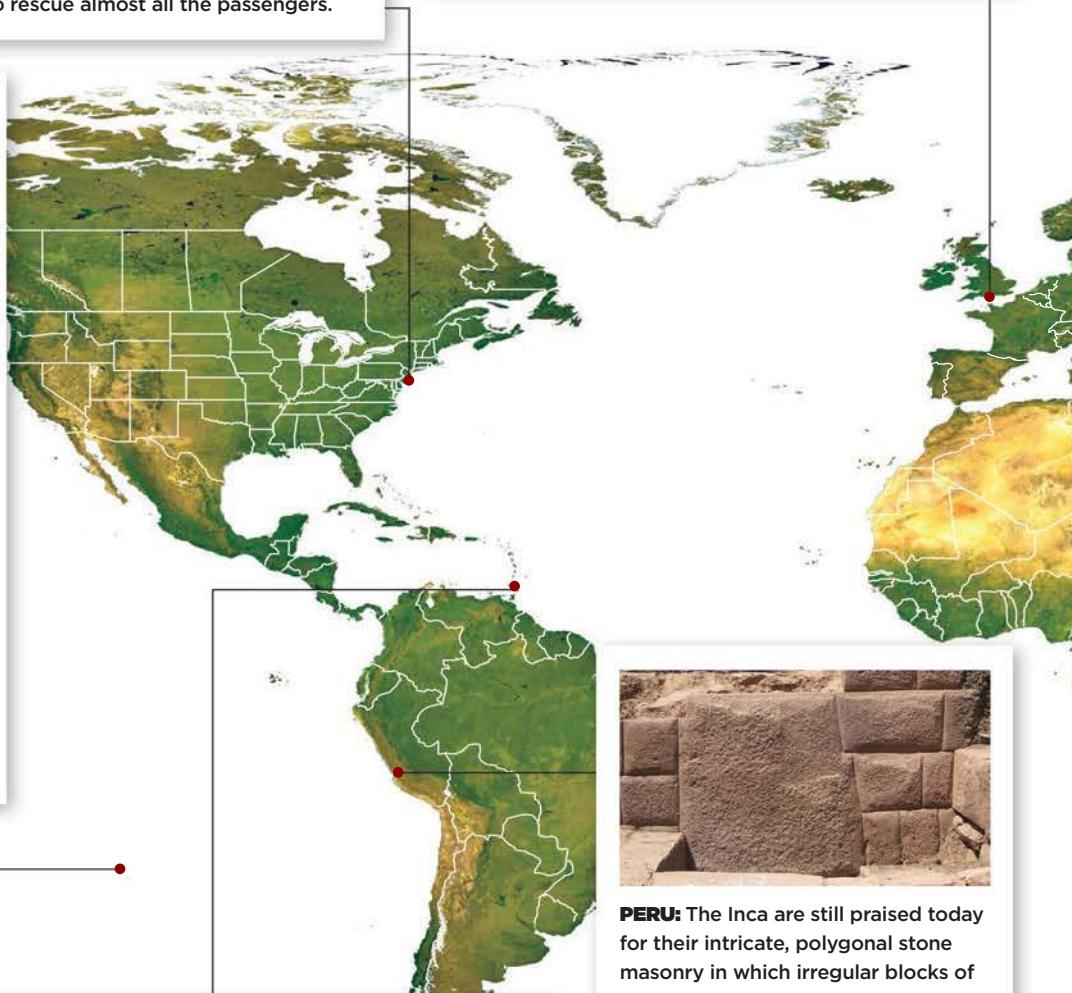
ENGLAND: In 1981, archaeologists excavating the remains of *Mary Rose*, the early-16th-century warship that sank near the Isle of Wight in 1545, found the remains of the ship's dog, which they nicknamed "Hatch." Because a penis bone was never found, it was assumed that Hatch

had been female, but new genetic analysis of material from one of the canine's teeth show that "she" was a "he"—and that he had brown fur and was related to modern Jack Russell terriers.



CHILE: The people of Rapa Nui (Easter Island) migrated to their remote South Pacific home from the west around A.D. 1200. Analysis of the genes of 27 descendants of those who created the famed moai statutes confirms Polynesian ancestry, and also reveals European and Native American genetic markers.

The European traits almost surely date to after European contact in 1722. The same may be true of the Native American genes, but statistical analysis suggests the Polynesian natives could have encountered Native Americans as early as 1280. This is the first human genetic evidence of such contact with the South American mainland.



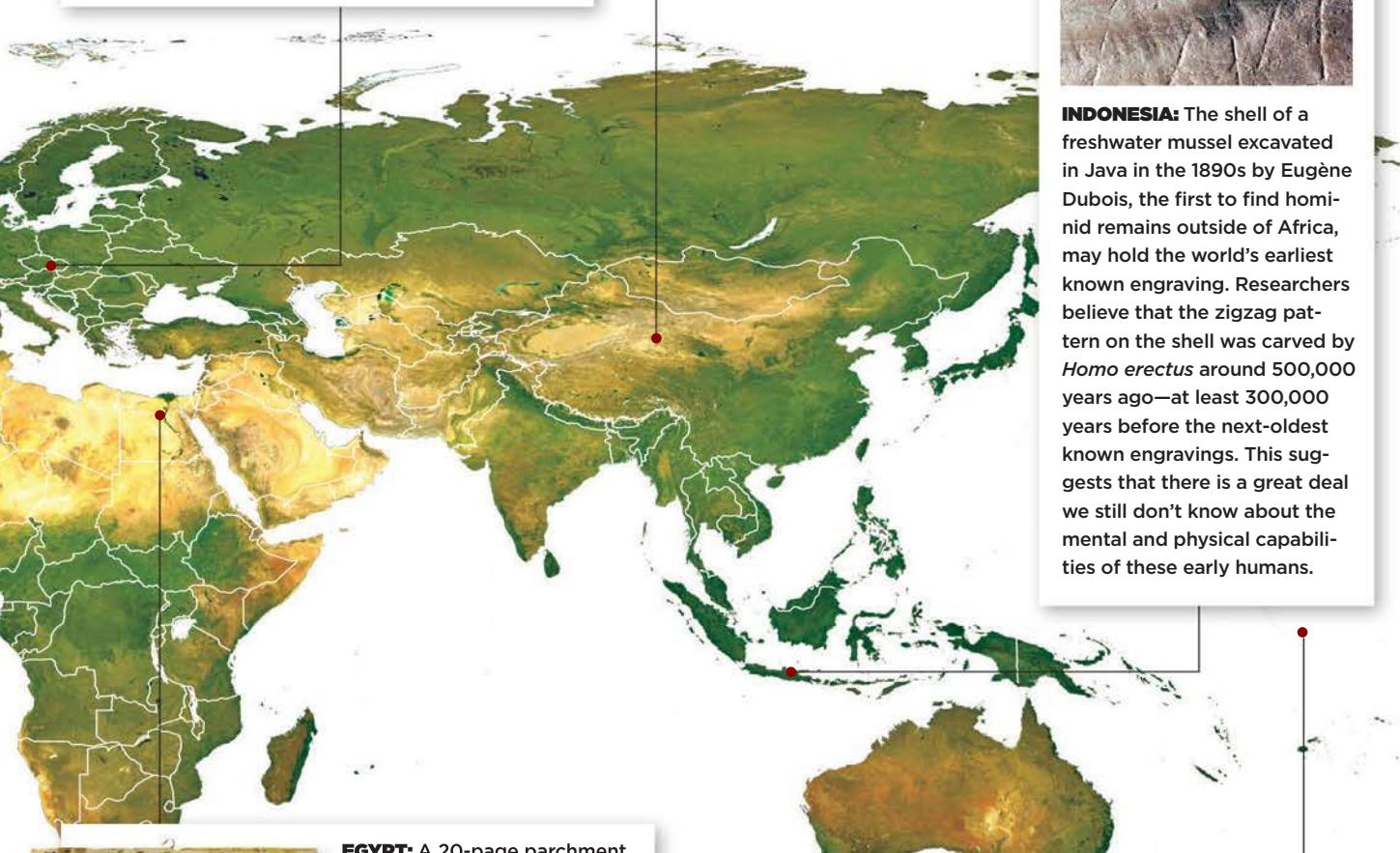
TRINIDAD AND TOBAGO: In 1677, the French and the Dutch fought over strategically important Rockley Bay in Tobago. By the time the smoke cleared, 2,000 men were dead and 14 ships sunk. Until now, not a single ship has been discovered there. Marine archaeologists looking for evidence of the battle have found a concentration of seven cannons, 72 clay pipes, four forks, and a Westerwald stoneware jug depicting Alexander, David, and Joshua. The evidence points to *Huis te Kruiningen*, a 130-foot-long Dutch warship that was scuttled to avoid capture by the French.



PERU: The Inca are still praised today for their intricate, polygonal stone masonry in which irregular blocks of stone were carved to fit together like a giant geometric puzzle. One of the most famous examples of this is the 12-angle stone on the side of a narrow street in Cusco, cut precisely to fit in among other stone blocks. Now, hundreds of miles away, it has been one-upped. A 13-angle stone has been found in a water and irrigation system in Huancavelica, southeast of Lima.



CZECH REPUBLIC: The people of the Upper Paleolithic settlement at Předmostí ate a lot of mammoth, according to a new study, and gave their dogs reindeer and musk ox meat. The work, which examined isotopes in bone collagen for clues to the diet of the Gravettian people 30,000 years ago, shows that carnivores, such as bears and wolves, also ate mammoth meat. Dogs, however, did not, which is a surprise, considering how much mammoth meat the people had around. This suggests that the dogs were restrained, and likely used more for transportation than hunting.



EGYPT: A 20-page parchment codex in a museum collection in Australia has been translated and found to contain a variety of spells. Written in Coptic 1,300 years ago, it contains a mixture of Orthodox Christian and Sethian traditions, the latter referring to a group that idolized Seth, the third son of Adam and Eve, and had died out by the time the codex was written. Among the spells: "Love charm: Say the formula on wine. Let them drink," and "Someone who is possessed: Say the formula on linseed oil and pitch. Anoint them."



CHINA: According to a new study of more than 50 sites across the Tibetan Plateau, barley was essential to life at high elevation. Nomadic people had traversed the region for thousands of years, and around 5,200 years ago they began to settle. But even then they did not live more than 8,000 feet above sea level. Around 3,600 years ago they moved to higher elevations, up to 11,000 feet. The researchers believe that the introduction of barley, which is frost-tolerant, was the key to living on the roof of the world.



INDONESIA: The shell of a freshwater mussel excavated in Java in the 1890s by Eugène Dubois, the first to find hominid remains outside of Africa, may hold the world's earliest known engraving. Researchers believe that the zigzag pattern on the shell was carved by *Homo erectus* around 500,000 years ago—at least 300,000 years before the next-oldest known engravings. This suggests that there is a great deal we still don't know about the mental and physical capabilities of these early humans.



KIRIBATI: Could a piece of aluminum finally crack one of the 20th century's greatest mysteries? In July 1937, famed pilot Amelia Earhart and navigator Fred Noonan disappeared over the Pacific Ocean without a trace. Various suggestive artifacts have turned up on uninhabited Nikumaroro Island, where Earhart and Noonan may have crash-landed. One of these items is a sheet of aluminum that some now think matches a patch that was put on Earhart's plane during a stop in Miami. More investigation of the island is planned.

Rome's Imperial Port

The vast site of Portus holds the key to understanding how Rome evolved from a mighty city to an empire

by JASON URBANUS

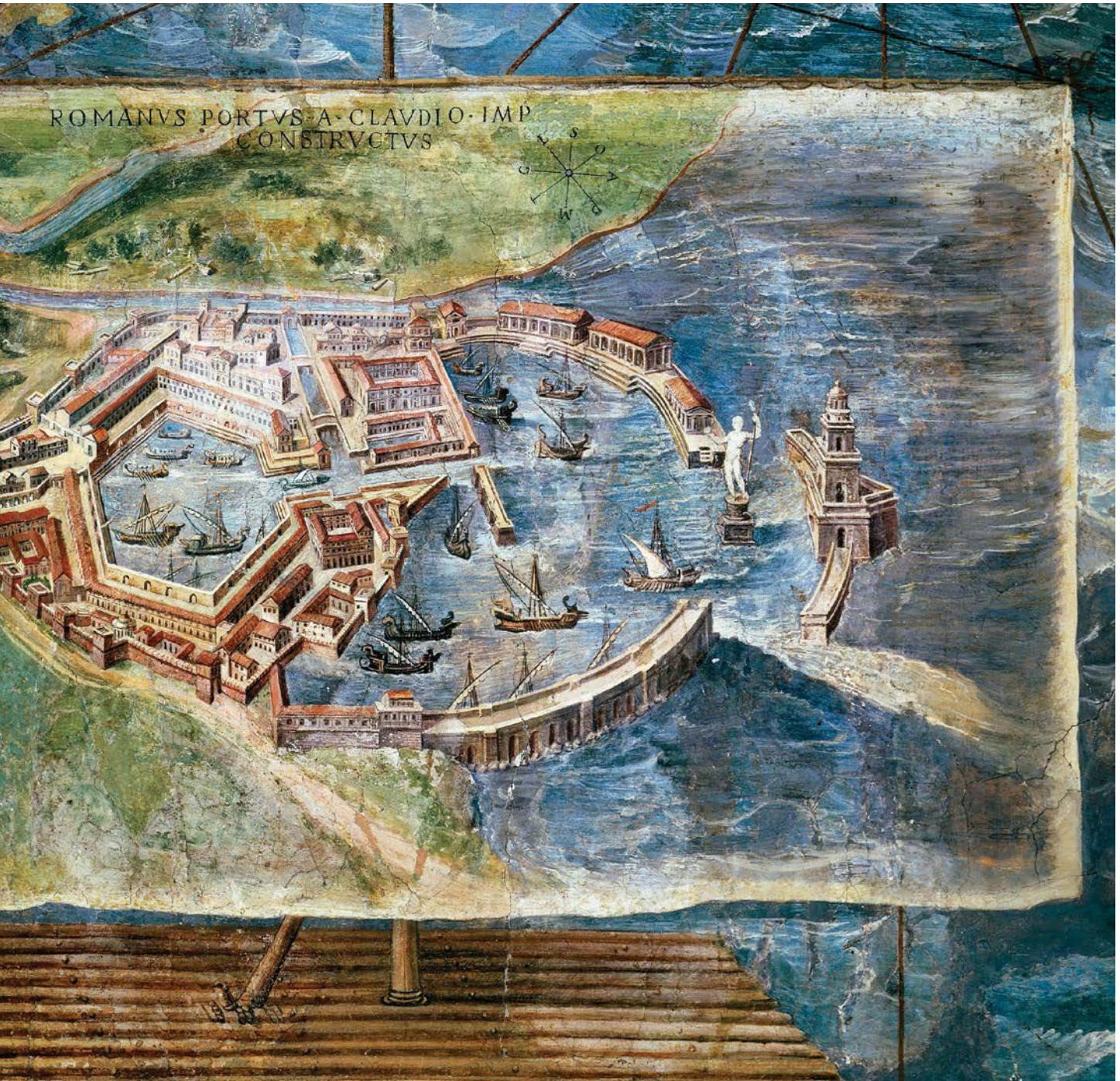


TWENTY MILES SOUTHWEST of Rome, obscured by agricultural fields, woodlands, and the modern infrastructure of one of Europe's busiest airports, lies what may be ancient Rome's greatest engineering achievement, and arguably its most important: Portus. Although almost entirely silted in today, at its height, Portus was Rome's principal maritime harbor, catering to thousands of ships annually. It served as the primary hub for the import, warehousing, and distribution of resources, most importantly grain, that ensured the stability of both Rome and the empire. "For Rome to have worked at capacity, Portus needed to work

at capacity," says archaeologist Simon Keay. "The fortunes of the city are inextricably tied to it. It's quite hard to overestimate." Portus was the answer to Rome's centuries-long search for an efficient deepwater harbor. In the end, as only the Romans could do, they simply dug one.

Although it had previously received little attention archaeologically, over the last decade and half Portus has been the focus of an ambitious project that is rediscovering the grandeur of the port, its relationship to Rome, and the unparalleled role it played as the centerpiece of Rome's Mediterranean port system. Keay, of the University of Southampton, is currently director of the Portus Project, now in its fifth year, but has been leading





fieldwork in and around the site since the late 1990s. He is part of a multinational team investigating Portus' beginnings in the first century A.D., its evolution into the main port of Rome, and, ultimately, the complex dynamics of the port's relationship with the city and the broader Roman Mediterranean. The multifaceted project involves a number of institutions, including the United Kingdom's Arts and Humanities Research Council, the British School at Rome, the University of Cambridge, and the Archaeological Superintendence of Rome.

One of the difficulties the team has faced in addition to the site's enormous size is its complexity. Portus encompasses not only two man-made harbor basins, but all of the infrastructure

Portus (left), now some two miles from the Mediterranean shoreline, was built by the Romans in the 1st century A.D. to be their main maritime port. Still visible today, its hexagonal basin and its adjacent canal facilitated the transfer of goods up the Tiber River to Rome. A 16th-century fresco (above) in the Vatican Palace shows an idealized reconstruction of Portus' grand architectural and engineering features.

associated with a small city, including temples, administrative buildings, warehouses, canals, and roads. Archaeologists have taken many approaches to investigating Portus. "Methodologically, the strategy has been to combine large-scale, extensive



An aerial photograph shows the ruins of the city of Ostia, founded at the mouth of the Tiber River in 386 B.C. Even after the construction of Portus, Ostia continued to function as part of the imperial port system.

work using every kind of geophysical and topographic technique, with excavation reserved for relatively focused areas,” says Keay. “The aim is to try and understand a key area at the center of the port, which could provide a point from which to understand how the port worked as a whole.” The current archaeological research is offering a new understanding of just how Portus’ construction enabled Rome to become Rome.

BY THE DAWN OF THE first century A.D., just before Portus was conceived, Roman territory stretched from Iberia to the Near East, enveloping all the coastal land bordering the Mediterranean Sea. Romans considered the Mediterranean such an innate part of Roman life that they often referred to it simply as *Mare Nostrum*, or “our sea.” However, paradoxically, as it was located nearly 20 miles inland, Rome was without a suitable nearby maritime port. This obstacle had periodically inconvenienced the city over the course of the previous millennium. In a sense, Rome’s growth had always relied on its capacity to connect with ever-broadening Italian and Mediterranean trade networks. The more Rome expanded, the more it turned to outside resources to feed its population. Throughout its history, Rome’s size and potential always seemed to be commensurate with—and limited by—its



One of the many techniques employed by the Portus Project was coring, here being undertaken near a Trajanic quay. This provided the team with a broad geomorphological history of the site, especially as it related to the Tiber River, canals, and various waterways.

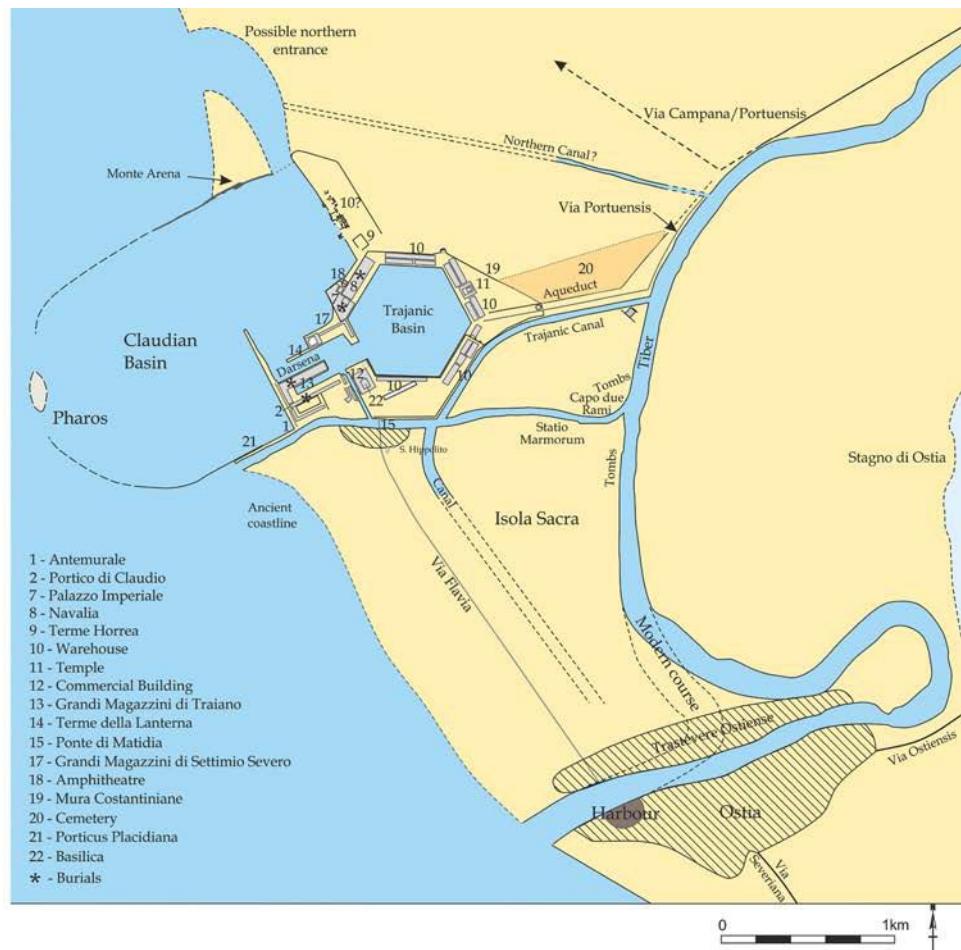
A map created by the Portus Project shows Ostia and the port complex at Portus, and many of its major features around the 5th century A.D., shortly before maritime activity there began to decline.

port capabilities. During the first half of the first millennium B.C., the early Roman settlement relied on a small river harbor at the foot of the Capitoline, Palatine, and Aventine Hills, where a near-90-degree bend in the Tiber River created a small plain and natural landing for boats. Known as the Forum Boarium and the Portus Tiberinus, the site was also where two important ancient Italic trade routes crossed. This river port was, at this early juncture in Rome's history, the heart of its supply, communication, and redistribution activities. Archaeological evidence found there, among the earliest ever discovered in Rome, indicates that even during the city's early days, Romans were interacting with foreign travelers and importing goods from across the Mediterranean ("A Brief Glimpse into Early Rome," May/June 2014). By the fourth century B.C., as Rome was expanding

beyond the site of the original seven hills and into central Italy, it began to outgrow its limited river port. Although Rome was connected to the sea via the Tiber River, seagoing ships and boats of substantial size could not safely maneuver up the river's course to the city.

A significant step was taken in 386 B.C. when Rome founded the colony of Ostia at the Tiber's mouth, some 20 miles away, not only to help supply the growing city with grain and other foodstuffs, but to enhance its connections with the Mediterranean. While Ostia eventually became a significant Roman city and played a major role in imperial Rome's multifaceted port system, it proved insufficient as the city's sole port. Although adjacent to the Mediterranean Sea, the site had geographical drawbacks. "Ostia could never handle massive numbers of ships," says Keay. "It's a river port, and the river itself is no good. It floods, it's treacherous at the river mouth, and it's not really deep enough."

Still limited by its lack of a deepwater maritime port, the Romans began to look southward. By the second century B.C., Rome controlled most of the Italian peninsula, as well as parts of Iberia,



Greece, and North Africa. Roman ships were now bigger and were sailing farther abroad more frequently. The river port of Rome, Portus Tiberinus, even when combined with Ostia, couldn't meet the increasing demands of an expanding Mediterranean-wide trade network. The establishment of Puteoli (modern Pozzuoli) on the Bay of Naples formed part of the solution. At Puteoli, the Romans finally had a natural maritime harbor that could accommodate ships of all sizes as well as increased traffic. Puteoli evolved into the principal port of the Roman Republic, and remained so for two hundred years. But Puteoli itself was not without its limitations: Rome's greatest commercial harbor was located more than a hundred miles south of the capital. Goods arriving on large ships had to be offloaded at the Bay of Naples and carted up to Rome overland, or transshipped onto smaller boats and ferried up the coast to Ostia, a three-day sail away. "It's not ideal," says Keay, adding, "The Romans realized this and toyed with the idea of building a port closer to Rome, an anchorage that would speed up the whole process and make it more efficient."

By the beginning of the



A 2nd- or 3rd-century A.D. fresco shows merchants unloading grain.



Enormous warehouses, such as those built by the emperor Trajan (top) and in the later 2nd century A.D. (above) were constructed throughout Portus in order to store the massive quantities of goods arriving at the port.

empire at the end of the first century B.C., the population of Rome and its environs had reached well over a million people. The lack of a nearby maritime port was beginning to make supplying the city a nearly impossible task. With its territory now spread from one end of the Mediterranean to the other, resources from every region sailed to Rome. Olive oil, wine, *garum* (a popular fish sauce), slaves, and building materials were shipped from places such as Spain, Gaul, North Africa, and the Near East. However, the most important responsibility of the Roman emperor was ensuring the steady and continuous flow of grain.

Grains and cereals were the staple of the Roman diet, either

consumed in bread form or served as a porridge. It has been estimated that a Roman adult consumed 400 to 600 pounds of wheat per year. With a population of more than a million, this required Rome to stock a staggering 650 million pounds annually. Throughout Rome's history, shortages in the grain supply led to riots. The city's food supply was frequently interrupted by storms and bad weather, and grain ships could be lost at sea. Any such delay or loss created civil unrest.

From the second century B.C. onward, the Roman government took an increasingly active approach to monitoring and controlling the grain supply. First, the government began to regulate and subsidize the price, ensuring that grain remained affordable to the masses at all times. By the Augustan period, the emperor was doling out as much as 500 pounds of grain per head to as many as 250,000 households. The emperors realized that the key to Rome's stability was keeping its population well fed.

Yet, by the first century A.D., Rome could no longer be sustained by Italian harvests alone. It began to exploit its newly annexed fertile provinces, especially North Africa and Egypt, which soon became the largest supplier of Roman grain. It took as many as a thousand ships, constantly sailing, just to support the demand for grain in the city. With large grain ships typically capable of hauling more than 100 tons, and sea transport at least 40 times less expensive than land transport, Rome desperately needed a deepwater port close to home.

AT ABOUT THIS SAME TIME, Roman engineering was beginning to manifest its unparalleled capabilities. The emperor Claudius concluded that the time was right to build an artificial port within Rome's environs, one large enough to accommodate the demands of an ever-growing city. Portus was built from scratch, a couple of miles north of Ostia, along a coastal strip on the Mediterranean near the mouth of the Tiber River. It would become the linchpin in a new imperial port system that enabled Rome to be continuously and efficiently supplied for the next 400 years.

The enormous engineering project was begun by Claudius

around A.D. 46 and took nearly 20 years to complete. It was the largest public works project of its era. At its center was an artificial basin of nearly 500 acres, dug out of coastal dunes. A short distance from the mouth of this harbor were two extensive moles, or breakwaters, constructed to protect it from the open sea. A small island with a lighthouse stood between the two moles and guided ships as they approached. With a depth of 20 feet, the Claudian basin was large enough, deep enough, and sheltered enough to provide ample anchorage for large seafaring ships heavily laden with as much as 500 tons of cargo.

In addition to the large basin, this early stage in Portus' construction involved other facilities such as a smaller inner harbor known as the *darsena*, and various buildings associated with the registration, storage, and distribution of goods. The harbor complex was connected to the Tiber River two miles to the south via a network of canals, the largest of which measured nearly 100 yards wide. This greatly expedited the whole process of bringing goods from cargo ships to Roman households. Enormous warehouses were built at Portus that were capable of storing many months' worth of grain. Portus became not only the place through which foodstuffs entered Rome, but also where they were stored.

The construction of Portus brought great renown to Claudius and, later, to his successor Nero, who saw it to completion. Portus was commemorated on coins issued by the emperors and on a monumental arch erected by Claudius at the site. "There is an element to the port of Claudius that makes it clear that it is a vanity project," says Keay, "and there is also an element that reflects the rhetoric of empire. The emperor is the great provider, who overrides nature in order to feed his people."



Portus' most distinguishing feature is the surviving hexagonal artificial basin (left, and below in a reconstruction), built by Trajan in the 2nd century A.D. Each side was more than a thousand feet long, providing ample space for berthing ships and transferring cargo.

The establishment of Portus by Claudius was just the first step in a process that led to the continual expansion and enhancement of the site over the next two centuries. In the early second century A.D., as Rome grew to its greatest territorial extent, the emperor Trajan was responsible for a massive enlargement and reorganization of Portus. Trajan, whose building projects were transforming the city of Rome,

turned his architects toward the redevelopment of the existing harbor. As with many Trajanic projects, the goal was not only to provide new functional facilities, but ones that also symbolically celebrated the power and glory of his empire.

At the heart of Trajan's new harbor was another artificially dug basin just east of the existing Claudian basin. Its hexagonal shape, which has become Portus' most iconic feature, sur-

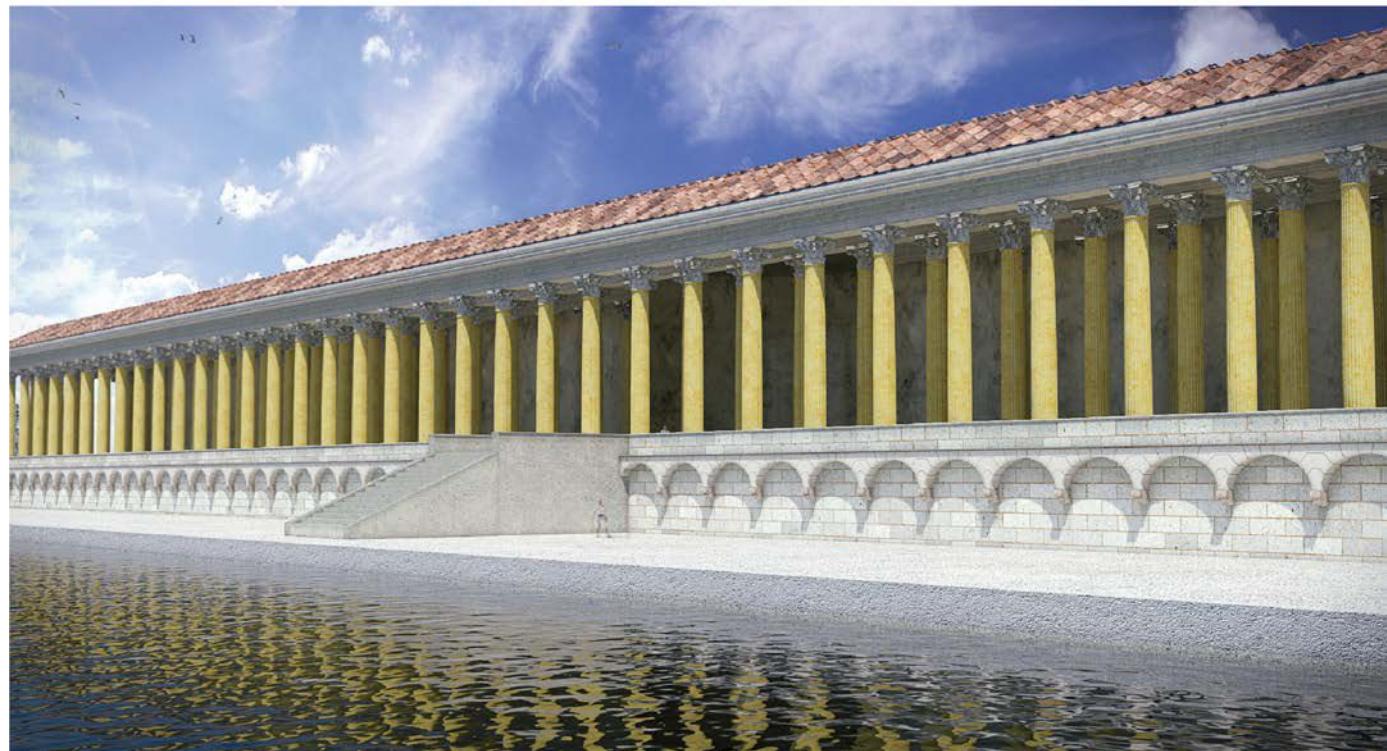


Archaeologists have recently uncovered the remains of a sixty-foot-high building, seen here in a reconstruction, that functioned as a shipyard for the dry-docking and maintenance of ships.

vives today as a private lake for fishing on the estate of Duke Sforza Cesarini. The unusual design, which had no precedents in Roman harbor construction, provided increased functionality, as well as a unique aesthetic signature. The hexagonal basin not only increased Portus' overall protected harbor space by nearly 600 acres, but the six sides of the new basin expedited the docking and unloading processes. Each of its sides, at a length of almost 1,200 feet, provided ample quay-side space for berthing ships and handling cargo.

The process could not have been more streamlined. The new Trajanic harbor could accommodate about 200 ships, in addition to the 300 anchored in the Claudian basin. Rome had at last created a port suitable to its far-reaching Mediterranean maritime empire. If Claudius' Portus was a statement of Rome's

ability to alter natural topography, Trajan's harbor was a celebration of Rome's design and construction capabilities. Each side of the hexagonal basin was adorned with new monumental buildings designed so that any traveler sailing into the harbor would be immediately confronted with the grandeur and power of Rome. Sightlines from the harbor led straight to impressive porticoes, temples, warehouses, and even a statue of Trajan, all framing the waterfront. In addition to its functionality, Portus was designed to deliver the message that Rome reigned supreme. "Portus is a statement about imperial power—it controls not just the Mediterranean but nature itself. It's really the only time that the Mediterranean has been controlled by a single political power, and this port played a key role in enabling its authority to be maintained; only the Ottomans come close," explains Keay.

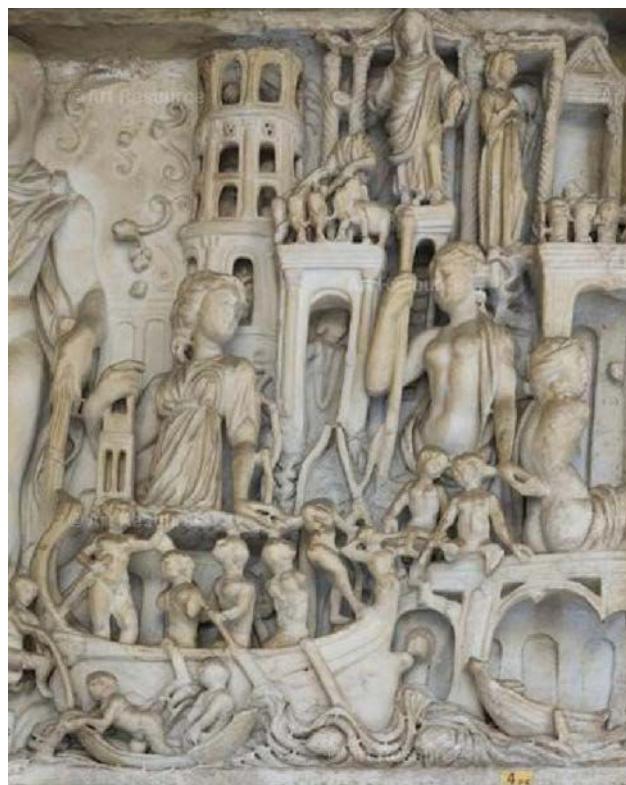


One of the major buildings at Portus was the so-called Imperial Palace, seen here during geophysical survey (top left), after excavation (top right), and in a digital reconstruction (above). This huge and lavish structure was used by government officials and administrators responsible for overseeing the port's activities, and may have also functioned as a residence for the emperor himself.

OVER THE LAST FEW years, the Portus Project has been working on what would have been a thin isthmus of land between the Claudian and Trajanic harbors. There the team has uncovered the foundations of what Keay refers to as a shipyard—a massive warehouse-type structure associated with the dry-docking and maintenance of ships. The 780-by-200-foot building is believed to have stood nearly 60 feet high. Its facade was divided into a series of arched bays, some 40 feet wide, that opened onto the hexagonal basin. Keay thinks that the structure could also have some association with Roman naval activity. “Portus is the place from which the emperor sails out, and it’s the place from which new governors go out to their provinces,” he says. “There was a security issue at Portus, and it makes sense that there was a naval detachment here. I think our big building is part of that in some way.”

There is also some evidence that the emperor himself maintained a presence at the site. Near the shipyard, the Portus Project has also investigated the so-called *Palazzo Imperiale* (Imperial Palace). This multifunctional complex covered nearly seven and a half acres, with prominent views across both basins. The three-story structure contained all of the appurtenances of a wealthy Roman villa—porticoes, mosaics, peristyles, and ornamental dining rooms, but also contained storerooms, offices, and production areas. Recently it was discovered that a small amphitheater was even added to the complex later in the third century. While the lack of epigraphic evidence makes it impossible to associate the building directly with the emperor, Keay believes it certainly would have been used by high-ranking government officials and representatives of the emperor who oversaw all aspects of port activity.

At its height, Portus may have catered to a seasonal population of 10,000 to 15,000 people, although it was not primarily a residential site. Its bustling crowds would have consisted of merchants, shippers, dockworkers, administrators, and government agents, many of whom commuted from larger cities such as Ostia or even Rome. The traffic to and from the harbor is estimated to have been several thousand seagoing ships annually, as well as hundreds of smaller boats and barges that maneuvered around the various basins and canals and up the Tiber River. Once a ship entered Portus, it might temporarily anchor in either the inner or outer harbor basin as it awaited a berth quayside or for smaller boats to transship its cargo. After freight was registered and recorded, it was loaded into warehouses or onto smaller barges to be



A marble relief from a 3rd-century A.D. sarcophagus gives an impression of the bustling activity and crowded conditions at Portus, which not only had dockage, warehouses, and administrative buildings, but also residential and religious structures.

brought along the various canals and towed up the Tiber to Rome. Insight into the organization of the importation process and the procedures Roman officials followed has been uncovered at Monte Testaccio in Rome, where transport amphoras were discarded (“Trash Talk,” March/April 2009). Some of the amphoras bear small *tituli picti*—painted notations that record information about the type of product, its weight, origin, destination, merchant, or shipper. The *tituli*

picti demonstrate how thoroughly each product was examined and the painstaking measures employed for each shipment of goods. “I think there’s an unimaginable complexity to the registration of cargo. The person responsible for the port needs to know where to assign ships, where particular cargoes belonging to particular merchants go, how material gets from one storeroom to another and then onto the boats that go up the Tiber,” says Keay. “It’s highly complex.”

Ports all over the Mediterranean, including Carthage, Ephesus, Leptis Magna, and Massalia, as well as those in Italy such as Puteoli, Ostia, and Centumcellae, formed the extensive network that allowed the Romans to bring the resources of foreign lands to Rome. Many of the goods brought to Portus were destined for the capital, while others were immediately redistributed to other ports in the Mediterranean. Portus, as the primary port of Rome itself, was the cornerstone of that system.

WRITING IN THE SECOND century A.D., the famed Greek orator Aelius Aristides marveled at the scope and efficiency of Rome’s maritime capabilities. “Here is brought from every land and sea, all the crops of the seasons and the produce of each land. The arrivals and departures of the ships never stop, so that one would express admiration not only for the harbor, but even for the sea. Everything comes here, all that is produced and grown ... whatever one does not see here, it is not a thing which has existed or exists.” As the centerpiece of Rome’s grand shipping network, Portus allowed the city to enjoy all the resources of the known world—and left foreigners such as Aristides in wonder and amazement. ■

Jason Urbanus has a Ph.D. in archaeology from Brown University.

Packed for the Afterlife

The remarkably well-preserved contents of a Ming Dynasty tomb

by JARRETT A. LOBELL

IN AN ANCIENT CITY near Taizhou, at the confluence of the Yangtze River and the Grand Canal in eastern China's Jiangsu Province, two sturdy wooden coffins were placed side by side inside a tomb. To prepare for the burial, a six-foot-deep pit had been dug, wooden panels had been laid down to reinforce the walls and floor, and a slurry of lime and sticky rice, which would dry and harden, was poured in. The coffins were then lowered, porcelain vessels were placed at the heads, more slurry was added, and the hole was filled in with dirt.

When archaeologists from the Taizhou Municipal Museum excavated the 500-year-old tomb, they moved the coffins to the museum, where they were carefully opened, exposing

their red lacquered interiors. Inside the coffins, which they determined belonged to a husband and wife named Wang and Xu, they found few bones, but more than two dozen artifacts, including textiles and personal effects. According to the researchers, the artifacts' incredible state of preservation is a result of the dry, oxygen-depleted environment inside the tomb, which had been created by the hardened slurry. Sealed from the elements and from microbes penetrating from the outside, and protected by the low-moisture, hypoxic environment inside, the wooden objects and satin, silk, linen, and cotton textiles buried with Wang and Xu survived the centuries. ■

Jarrett A. Lobell is executive editor at ARCHAEOLOGY.



A gown found in the man's coffin made of damask woven with a pattern of lotus, peony, and chrysanthemum flowers interspersed with coins, banana leaves, and silver bullion



A pair of shoes found in the woman's coffin



A two-piece damask skirt from the woman's coffin decorated with a pattern of flowers and insects



A *mingjing*, or a brocade scroll, found covering the man's coffin lid



A wooden picture frame called a *huasha*, from the woman's tomb, made in three pieces, with the top intended to resemble a mountain



Damask pillowcases found in the man's coffin with the phrases, "Early fly to heaven" and "To be born in the next life in the western world" outlined in silk thread and filled in with gold powder



The bamboo ribs of a fan with metal fan nails from the woman's coffin

AROUND 5,300 YEARS AGO, someone was interred in a sandy grave in the Gerzeh cemetery, 40 miles south of modern Cairo, Egypt. Clearly an important member of the community, he or she was buried with valuable goods, including an ivory pot, a stone palette for grinding cosmetics, a copper harpoon, and beaded jewelry. In among the gold and carnelian beads were some made of iron, a material that, while considered mundane today, must have been regarded as very precious at the time. A total of seven of these tubular iron beads were found in two Gerzeh tombs in 1911 by archaeologist Gerald Wainwright. Iron smelting, the extraction of metal from ore, is thought to have emerged in Egypt around 600

B.C. The beads therefore pose an archaeological conundrum because they were made more than 2,000 years earlier. They come from a time about which little is known, before Egyptian writing and the rule of the pharaohs. The source of the iron and the manner in which it was worked have become subjects of great speculation.

From the whole of pre-Iron Age Egypt, some 20 iron artifacts have been found and dated, including the Gerzeh beads and several fine items from the tomb of Tutankhamun, who died ca. 1323 B.C. The metal was rare, but definitely present. Was someone in ancient Egypt working iron far earlier than once thought? Was the iron an accidental by-product of copper smelting? Did it arrive from a precocious, unidentified iron industry elsewhere or—as Wainwright and his colleagues

Archaeologists and planetary scientists experiment with meteorites, ancient Egypt's first source of precious iron

by KATE RAVILIOUS

Iron from



suggested—from outer space, in the form of meteorites? And, in the case of the Gerzeh iron beads, how were such small, delicate beads made before experience working with the material had become widespread? Now a team of scientists has revisited the Gerzeh beads and, with a mix of new and old technologies, is providing some conclusive answers to these questions.

DIANE JOHNSON, A PLANETARY scientist at the Open University in Milton Keynes, England, developed a passion for Egyptian archaeology during a trip to the country five years ago. She enrolled to study for a certificate of higher education in Egyptology at the University of Manchester, where she met Egyptologist Joyce Tyldesley and first heard about the mystery of the Gerzeh iron beads. “Both of us are fascinated by ancient riddles and we couldn’t resist the temptation to investigate further,” explains Johnson.

Early analysis of the Gerzeh beads, published in 1928, revealed that they are rich in nickel. This was considered conclusive evidence that they came from meteorites. Johnson

says, which tend to contain more nickel than terrestrial iron sources. But by the 1980s, metallurgists threw doubt on this conclusion, and suggested that the beads could have been made from a nickel-rich iron ore known as laterite, or from material that was produced accidentally during copper smelting.

Johnson’s expertise on meteorites—she has collected them since childhood—and access to modern analytical equipment brought a fresh perspective to the problem. Her first step was to examine the four Gerzeh beads held in English institutions: three at the Petrie Museum of Egyptian Archaeology at University College London and one at the Manchester Museum. “I saw that they were all corroded and highly oxidized, and I realized that analyzing them wouldn’t be a trivial task,” she says. Undeterred, Johnson began her examination of the Man-

An inch-long bead found in a 5,300-year-old grave at Gerzeh in Egypt is made of iron, a rare and prized material at the time. Notes from the original 1911 excavation of the site (bottom right) note the presence of such beads and other precious materials.

the sky





Scans of one of the Gerzeh beads reveal traces of flax fiber upon which it was threaded, and high nickel content, suggesting meteoritic origin.

chester bead with photos and then a scanning electron microscope (SEM) at the Open University. The SEM bombarded the small bead (less than an inch long) with electrons. The resulting scatter of particles revealed detailed information on surface structure and chemistry without damaging the bead, resolving features just one micron wide, the width of a strand of spider silk. Johnson was able to direct the electron beam at the freshest bits of metal shining out from underneath the corrosion, which revealed iron containing an average of 4.8 percent nickel by weight. “This made me feel confident that it probably was meteoritic iron, but there was still a chance it could be made from naturally occurring nickel-rich iron ore,” says Johnson. The next step was to look at the crystal structure. Using the X-ray computed tomography imaging facility at the University of Manchester, Johnson and Tyldesley created virtual slices of the bead, which show that it is a hollow tube containing woven strands of flax fiber in the center. “This was almost certainly the string that the beads were threaded upon,” says Johnson. Zooming in further, she observed the classic meteoritic signature—intersecting fingers of long nickel-iron crystals, known as the Widmanstätten pattern. “It takes millions of years of cooling to produce crystals of this size, and the only place we see these kinds of crystals today are in meteorite samples,” she says. Using similar techniques, Thilo Rehren from University College London and Hamad bin Khalifa University in Qatar, along with his colleagues, has shown that the three Gerzeh iron beads at the Petrie Museum display the same crystal structure. The beads are definitely made from meteoritic iron, but that does not explain how the Egyptians worked the raw material into such fine decorations.

BACK AT HER LAB at the Open University, Johnson examines the results of a series of experiments to answer this question. The product is a tubular iron bead that looks like a stunning iridescent jewel, shimmering blue, green, and orange. “These beads are exquisite when they are fresh,” says Johnson, who wears her handmade meteorite beads on a necklace. Using her own precious collection of meteorite fragments, Johnson started to experiment with making beads. First, she used a modern saw to cut a thin layer of metal, which she then hammered to make it thinner, thin enough to roll into a bead. Disaster struck fairly quickly. “As soon as I hit it, the metal fractured and broke apart. This suggested to me that cold-working wasn’t the way to go,” says Johnson.

She used a furnace to heat the metal up to 200°C—approximately the temperature the Egyptians would have used to work copper at that time—and tried again. Once again it fractured, and Johnson realized that she needed to find a new approach. She studied the way that the metal had fractured and saw that

it was cracking along the crystal grains. So she cut her next slice parallel to the natural layers between the crystals, akin to sawing along the grain of a piece of wood, rather than across it. She also decided to turn the furnace up to 800°C (a very high but plausible temperature for ancient Egyptians, used to make Egyptian marl ware pottery) to see if the extra heat would help.

Finally, success. She hammered out a thin layer of metal and used pliers to bend it into a tubular bead (which she then toasted in a 400°C flame to achieve the color effect). Johnson had established the proof of concept, but to truly re-create the process by which the beads were made, she would need to



The distinctive crystal structure known as the Widmanstätten pattern (seen here in an unrelated sample) can take millions of years to form. It is a clear marker of meteoritic metal, and is present in the Gerzeh beads.

use tools and materials available at the time. She headed back to the Petrie Museum and found what she was looking for in a storage drawer: a stone tool with a groove across the end and a small, bent copper rod. Both are from Egypt and date to before the Gerzeh beads, though there is no evidence that they had been used in bead production. “They didn’t look like anything interesting, but after my metalworking experiments I realized that these could have been the kind of tools used to make beads,” she says.

Johnson made replica tools and coaxed another thin layer of meteoritic metal from her collection. (Again she used a modern saw, but is still experimenting with means to split meteoritic iron with stone tools). She bent it by placing it between a copper rod and a grooved lump of granite, and hammering gently while turning the rod. Rehren’s analysis of the Petrie Museum beads confirmed that the Gerzeh beads were rolled from thin sheets of meteoritic iron in the same way—a surprisingly sophisticated process for the time. “Forming such rolled-sheet beads out of coarse-grained and rather hard and brittle meteoritic iron would have required very careful hammering of the metal, most likely with intermittent annealing

[heating and slow cooling] to first create and then roll the sheet without cracking it,” says Rehren. “This demonstrates a very high level of skill of the predynastic smiths.”

Placing her own newly minted beads in the SEM, Johnson compared the structure with that of an unworked piece of iron meteorite. She could immediately see that the warming caused the nickel to migrate, creating nickel-rich bands. “This makes the metal stronger and less friable,” she explains. And once the meteoritic metal had been hammered into a bead, the nickel-rich bands became wavy in appearance.

Under the SEM, the Gerzeh bead had the same nickel-rich bands. In addition, the spacing between them is indicative of the type of meteorite the metal had come from. “The distance between these nickel bands in the Gerzeh bead fit with it coming from an octahedrite meteorite—a type that was once the core of a small planet or large asteroid,” says Johnson.

EACH YEAR, AROUND 40,000 tons of meteorite material enters Earth’s atmosphere, but most burns up before reaching the ground. Almost all of the interstellar lumps that survive the atmosphere are primarily “stony”—less than 10 percent are iron meteorites. It certainly is a rare material, but one that would be easy to spot in Egypt, where the dark, shiny metal stands out against desert sands. In 2008, geologists discovered an iron meteorite impact crater in the desert at Gebel Kamil in southern Egypt that dates to within the last 5,000 years. “The crater is around 45 meters [150 feet] in diameter and it would have been a significant event to witness,” says Johnson, “a massive fireball in the sky and a sonic boom as it arrived, perhaps similar to the Chelyabinsk meteor, which struck the Ural region of Russia in February 2013.” However, the fragments of meteorite from the crater don’t match the structure or chemistry of the Gerzeh beads.

Though this meteorite likely wasn’t the source of the Gerzeh beads, it may have brought metallic iron into the ancient Egyptian lexicon and imagination. The Egyptians already had a general term for “iron,” which possibly represented

After some trial and error, researchers were able to make beads from meteoritic iron, almost entirely with techniques that would have been available to ancient Egyptians. The color comes from toasting in a 400°C flame.



iron-related materials (such as hematite, an iron oxide) or any material that had a visual resemblance to fresh or weathered iron. But there was no term for metallic iron until around 1295 B.C., when *bia-n-pt*, which literally translates as “iron from the sky,” first appeared in Egyptian texts. “This word was applied to all metallic iron from this time onwards, and its sudden emergence in the language could be connected to a major event, such as a large impact or shower of meteorites,” says Tyldesley.

While it is only Tyldesley’s speculation, the Gebel Kamil meteorite might have been seen falling from the sky, suggesting that the metal from it—so unlike any other known material at the time—could have been regarded as a “gift from the gods.” Indeed, almost all known pieces of early iron in Egypt are symbolic or ritual artifacts. For example, Tutankhamun was buried with a dagger with a sharp iron blade (which could have been ritual, practical, or both), a miniature model headrest made from iron, and an iron amulet on a gold bracelet, as well as 16 small models of chisels with iron blades. Most of these items are thought to be made of meteoritic iron, except for the dagger, which may have been smelted elsewhere and imported as part of a royal dowry. “They were all recovered from graves and therefore were likely to have had some connection with the funeral and/or rebirth of the deceased,” explains Tyldesley.

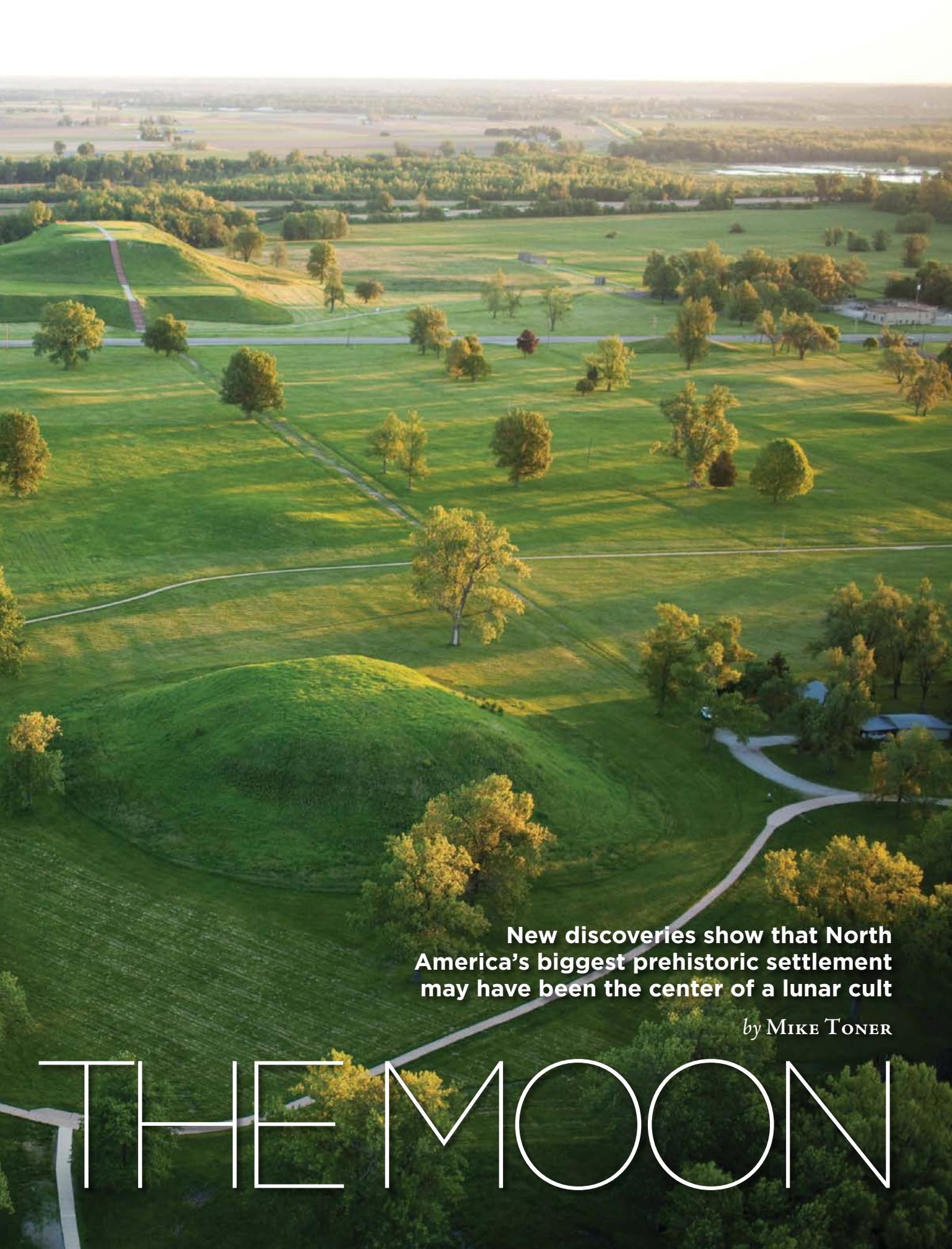
Furthermore, evidence so far suggests that only the most highly regarded people were buried with meteoritic iron. “The context in which the iron beads were found at Gerzeh clearly indicates that this was considered to be an exotic, special material,” says Alice Stevenson, curator at the Petrie Museum. One of the graves there, which contained two iron beads, also held an impressive diversity of valuable materials: lapis lazuli from Afghanistan and obsidian from Turkey or Ethiopia. It is likely that whoever was able to trade for and accumulate such material had a significant social profile and connections, and may have been considered to have specialist, esoteric knowledge. “The collection of such materials would also have been visually impressive to others, inspiring awe,” adds Stevenson. “Lapis being a vibrant blue, obsidian a glossy black, and the iron beads, as Johnson’s new work is showing, being iridescent and striking in color and pattern.”

We’ll probably never know why two special people were buried at Gerzeh with iron beads, but Johnson and her colleagues are still investigating the Egyptian iron mystery. Now they are analyzing the composition of other known iron artifacts and delving deeper into the written record in order to gain a greater understanding of the perception of iron in ancient Egypt. “We want to know if iron was rarely used because it was considered a gift from the gods, or because it was merely difficult to work compared to bronze,” explains Johnson. They also hope to document when iron went from being symbolic, ceremonial, and prized to useful, functional, and utilitarian. ■



Cahokia's central precinct, seen here from the air, was part of an urban complex that first rose at the confluence of the Mississippi and Missouri Rivers near modern-day St. Louis around A.D. 1050.

CITY OF



New discoveries show that North America's biggest prehistoric settlement may have been the center of a lunar cult

by MIKE TONER

THE MOON

ONCE IN A GENERATION—every 18.6 years to be exact—a rare full moon rises above Illinois’ Looking Glass Prairie and casts its pale glow across a carefully arrayed ancient tableau, one that has been there for a thousand years. As the moon, having arrived at the most northerly position of its multiyear cycle, rises above a distant hill, it lines up almost perfectly with a flat-topped earthen pyramid, three parallel rows of small circular mounds, and—beneath the soil—the spot where a young woman was ritually buried sometime around A.D. 1100.

Recent excavations suggest that these earthworks, located near present-day Lebanon, Illinois, and known today as Emerald Mound, are one of several sites on the fringes of the ancient city of Cahokia that have a distinctly lunar orientation. It’s a discovery that suggests to some archaeologists that America’s

premier prehistoric center may have had, or may have even begun with, a lunar cult.

“We have evidence—in the form of foreign pottery—that people came along a great road to Emerald and other nearby sites en route to Cahokia,” says University of Illinois archaeologist Timothy Pauketat. “Religious temples and mounds aligned to these rare moonrises lead us to suspect that thousands of people came here to venerate the moon and other deities at great ceremonial gatherings.”

At its height, Cahokia was the largest city in the Americas north of Mexico. The sprawling urban complex of 200 earthen mounds and pyramids rose at the confluence of the Mississippi and Missouri Rivers near modern-day St. Louis. A thousand years ago it was the site of a cultural convergence that preceded the spread of a new way of life across the country—what Pauketat calls the “big bang” of North American

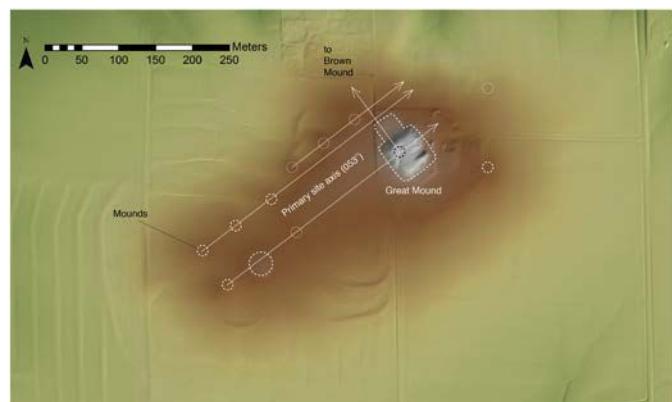
prehistory. “Cahokia was a unique place with a unique history that altered the histories of other Midwestern peoples,” he says. Before Cahokia’s dramatic growth around 1050, small agrarian villages had been the norm. In the centuries that followed, the eastern third of the country saw the rise of scores of mound-building chiefdoms—hierarchical societies that archaeologists now refer to collectively as Mississippian—which were all modeled on a way of life that began at Cahokia.

Despite a century of investigation, however, the city’s origins and the reasons for its astonishingly rapid growth and its equally swift demise continue to puzzle archaeologists. Some questions

may never be answered: More than a third of Cahokia’s earthen pyramids, along with uncounted plazas, temples, and houses, were wiped out by urban development in the St. Louis area before the advent of modern archaeology. Losses to urban sprawl continue to this day. Despite such setbacks, however, recent discoveries at Cahokia—from its “downtown” to its outlying precincts such as the Emerald, Copper, and Pfeiffer mound complexes some 15 miles distant—are spurring a flurry of new insights into the rise and fall of America’s first city.

“We’ve done so much archaeology in recent years, and have amassed so many big data sets that we can finally begin to put together a more complete picture of Cahokia,” says Thomas Emerson, director of the Illinois Archaeological Survey, which has been coordinating much of the research. “It’s making us rethink what we thought we knew.”

CAHOKIA WAS LONG CONSIDERED to have been relatively homogenous, but a new study shows that many Cahokians came from elsewhere. It appears to have been



The Emerald site (top), 15 miles east of Cahokia, consisted of a great mound, seen in the background, now overgrown with trees, as well as smaller temples and mounds that are no longer standing. As a plan of the site based on a lidar image shows (above), the structures were aligned on a 53-degree angle from true north, to the point on the horizon where the moon reaches the most northward position in its 18.6-year cycle.

a cultural melting pot, much like modern cities. “Cahokia could not have grown as fast as it did by birthrate alone,” says Emerson. “Like other early centers around the world, it grew by immigration.” Hard evidence of that, he says, is preserved in the tooth enamel of human remains unearthed over the years at various sites throughout greater Cahokia.

Naturally occurring ratios of strontium isotopes in soils vary widely from place to place, leaving a chemical signature in the water, plants, and animals of a locale—and in the teeth and bones of the people who consume them. According to Emerson, variations in the ratio of those isotopes reveal that fully one-third of the people who died in Cahokia were born somewhere else. “We can now definitely say that much of Cahokia’s population was made up of outsiders,” Emerson says. “Migration probably fostered new ways of living, new political and social patterns, and perhaps even religious beliefs.” Researchers don’t yet know where these immigrants came from, but by building a profile of strontium soil ratios in other locations they hope to find out.

Why these far-flung people were attracted to Cahokia in the first place is another question. The fertile soils of the region were ideally suited for agriculture. Traditional thinking has



A 2012 excavation of a temple at the Emerald site revealed that its earthen floors were sealed with yellow clay, which may have been meant to evoke the glow of the moon.



In pits below the temples’ floors, archaeologists have found pottery from southern Indiana and southern Missouri, suggesting that people, perhaps immigrants to Cahokia, came from long distances to participate in ceremonies at the site.

assumed that as the scattered villages of the Mississippi River Valley became larger and more dependent on agriculture, their chiefs centralized political and economic control at Cahokia, which grew into a megacity of as many as 30,000 people. Now, however, excavations by Pauketat and Indiana University archaeologist Susan Alt, in the uplands east of Cahokia—once thought to be little but outliers of the urban core—have found tantalizing evidence that religion may have played a key role in the growth, and perhaps even in the founding, of Cahokia.

The most recent excavations by Pauketat and Alt at the Emerald site, for instance, have identified the outlines of several small temples, all oriented to lunar events in a way that closely matches the layout of structures at the nearby Pfeiffer mound complex and other upland sites. The temples have earthen floors that have been ritually—and repeatedly—sealed with thick yellow clay. It is possible, they say, that the yellow coloration was meant to evoke the light of the moon. Beneath the temple floors, sunken pits contain offerings of burned fabric, basketry, and large amounts of pottery—including varieties from southern Indiana and southern Missouri. “People were obviously coming here from distant locations,” says Alt. “The key locations of the temples define them as exceptional buildings. They were built, rebuilt, ceremoniously closed, reopened, and used for special offerings.”

At Emerald, the natural ridge on which the main temple, or acropolis, stands shows signs of having been partially reengineered to have it more closely conform to the horizon’s 53-degree azimuth, the angular offset from true north (just east of northeast

Red stone figures from Cahokia are thought to depict fertility deities associated with the moon, the underworld, and serpents. A woman (right) with a hoe in her right hand kneels on the back of a serpent and appears to be cultivating it. Another figure (below) holds stalks of a plant that run up the sides of her body.

on a compass) where the moon reaches the most northerly point in its 18.6-year cycle.

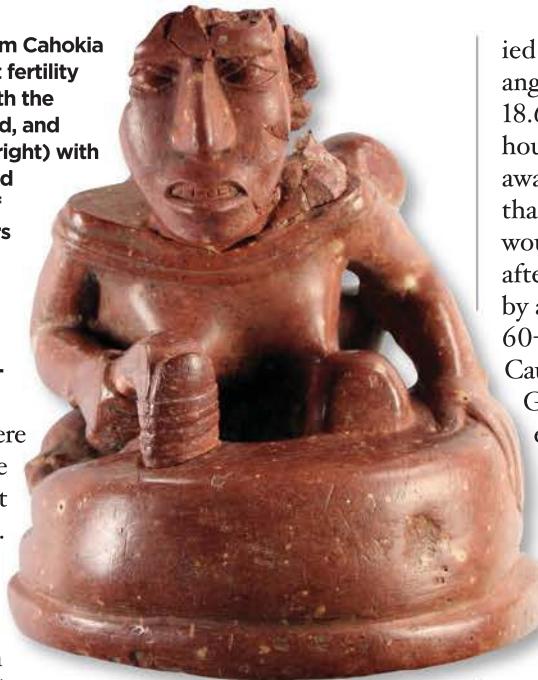
"The acropolis itself is naturally pre-aligned to the maximum northern moonrise," says Pauketat.

"It appears to have been purposely cut and filled by laborers to accentuate the 53-degree axis, then later expanded and surrounded by pole-and-thatch ceremonial structures and short-term habitations." Pauketat thinks that the readily visible, repeated alignment of so many structures and landforms to the same angle is too pronounced to be coincidental. "Emerald was a place where people aligned themselves to the moving cosmos, especially the moon," he says.

A number of small carved red stone figures—goddesses carrying medicine bags, women emerging from a basket of ancestral bones, and women with squash and maize growing from their hands—have been unearthed in and around Cahokia. Scholars believe they are suggestive of the moon's close association with female deities, the night, fertility, and the underworld. Pauketat says the relative scarcity of tools and other everyday artifacts at Emerald suggest it was a pilgrimage site, thinly populated for most of its existence and used by large, transient populations who came to venerate the moon. Recently, in fact, the archaeologists have identified, from soil resistivity measurements, traces of an ancient causeway, more than 150 feet wide and bounded by ditches on both sides. Quickly dubbed Emerald Avenue, the road enters the site from the southeast and then turns toward the west in the direction of Cahokia proper.

Emerald was drawing crowds before Cahokia reached its height, as evidenced by the dating of ceramics and temple structures, says Alt. "Emerald was built and utilized as a site of intensive religious activity before 1050." Alt believes the timing was critical. "The mingling of these diverse people may be one of the factors that fueled the 'big bang.' Emerald may have been foundational to the city of Cahokia."

The fixation with things astronomical is apparent in downtown Cahokia, too. At Mound 72 in central Cahokia, archaeologists unearthed the remains of 53 females, all bur-



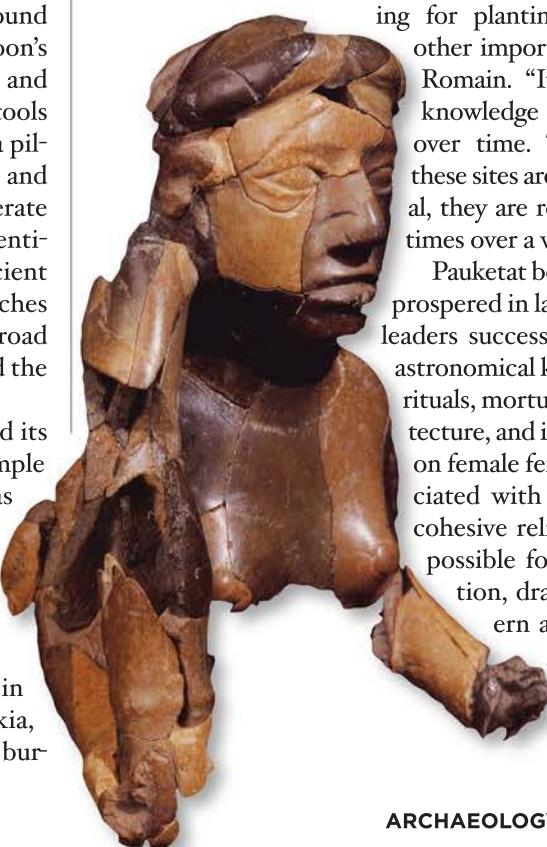
ied to conform to another lunar alignment—the 130-degree angle of the rising moon at the southernmost point of its 18.6-year cycle. Some theories even suggest that the mounds, households, temples, and plazas of Cahokia itself reflect an awareness of solar cycles. The entire city was built on a grid that is offset five degrees from true north, an orientation that would have aligned it directly with the sunrise on a day just after the autumnal equinox, a date that was likely marked by a harvest festival. A recently rediscovered half-mile-long, 60-foot-wide, raised ceremonial road, dubbed Rattlesnake Causeway, also runs along this five-degree axis from Cahokia's Grand Plaza through the heart of the city to two of its largest mortuary mounds.

WHERE AND HOW CAHOKIANS acquired their knowledge of such a complex lunar cycle is unknown, but Pauketat says it may be rooted in the Hopewell tradition, a series of cultures that prospered in the Northeast and the Midwest from 200 B.C. to around A.D. 500. One of the Hopewell's best-known earthworks, the 50-acre Octagon near Newark, Ohio, appears to have been a carefully planned lunar observatory, oriented to the same 18.6-year cycle that Pauketat and Alt see at the Emerald site.

"The expression of lunar consciousness that we see at Emerald—and its associations with the night, the lower world, the female, and fertility—is the same as what we see at Hopewell and at many other sites before and after Cahokia," says William F. Romain, research associate at Ohio State University's Newark Earthworks Center.

The moon's significance would also have had a practical dimension to the ancient Cahokians. "As societies became increasingly agricultural, the lunar cycle marked the timing for planting, harvesting, and other important activities," says Romain. "It seems likely that knowledge was passed down over time. The alignments at these sites are not only intentional, they are repeated in different times over a wide area."

Pauketat believes that Cahokia prospered in large part because its leaders successfully blended their astronomical knowledge and their rituals, mortuary practices, architecture, and iconography—heavy on female fertility symbols associated with the moon—into a cohesive religion. This made it possible for a diverse population, drawn from Midwestern agricultural villages, to coalesce into an urban complex unprecedented in its day.





A black tarp covers the remains of more than 20 buildings, including two temples and more than a dozen possible temporary buildings unearthed at the Emerald site in 2014.

Cahokia's lunar cult seems to have even had "missions" to spread its influence. At Trempealeau, Wisconsin, 500 miles upriver from Cahokia, the architecture and artifacts of a complex of platform mounds bear clear evidence of Cahokian culture. There too, Pauketat says, the site has a lunar alignment like that at Emerald.

"Our point really is that religion created Cahokia, and it was intimately part of everything everyone did and thought, enmeshed and entangled so completely in daily living that everything was religion," says Alt. "This Mississippian religion that began at Emerald and Cahokia was a new way of life."

"Something clearly set Cahokia apart from the world in which it formed," agrees University of Tennessee archaeologist David Anderson. "But if it was religion that held the people together, we also need to explain why it all fell apart after only 300 years."

Two recent research reports suggest that more down-to-earth causes may have contributed to Cahokia's decline and eventual abandonment sometime around 1350. A new analysis of sediments from a lake adjacent to Cahokia shows evidence of a major flood in the Mississippi bottomlands around 1200, just as the city was at its height. Geographer Samuel Munoz of the University of Wisconsin-Madison says pollen deposits

in the sediments also record an increase in cultivated crops, primarily corn, and rapid deforestation that peaked at about the same time—followed by a decline in farming, which essentially ceased around 1350.

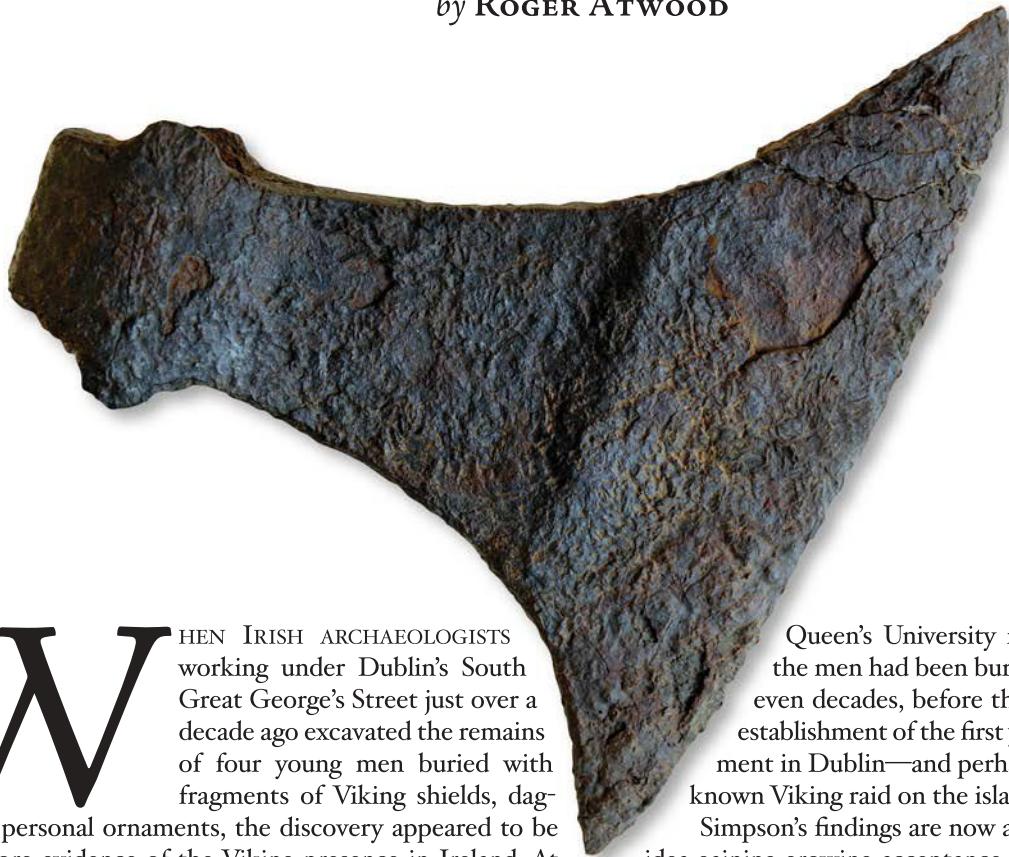
If not by flood, Cahokia's demise may also have been hastened by fire. Evidence of a huge conflagration came to light during a multiyear effort to salvage what was left of Cahokia's archaeological traces in East St. Louis before being obliterated by a new interstate highway bridge linking Missouri and Illinois. The 34-acre excavation by the Illinois Archaeological Survey found that sometime around 1200, a large section of Cahokia's administrative core—a walled compound containing more than 100 wood-and-thatch houses—was destroyed in a single massive fire. The area was never rebuilt. Researchers say they don't know whether the fire was the result of an accident, an act of aggression, or some kind of ritual cleansing, but they do know that in the years that followed, Cahokia was clearly in decline. By 1400, the city's lunar cult and whatever other unifying forces held it together were spent, and Cahokia was totally abandoned. ■

Mike Toner is a freelance writer and former science writer for The Atlanta Journal-Constitution.

THE VIKINGS IN IRELAND

A surprising discovery in Dublin challenges long-held ideas about when the Scandinavian raiders arrived on the Emerald Isle

by ROGER ATWOOD



WHEN IRISH ARCHAEOLOGISTS working under Dublin's South Great George's Street just over a decade ago excavated the remains of four young men buried with fragments of Viking shields, daggers, and personal ornaments, the discovery appeared to be simply more evidence of the Viking presence in Ireland. At least 77 Viking burials have been discovered across Dublin since the late 1700s, some accidentally by ditch diggers, others by archaeologists working on building sites. All have been dated to the ninth or tenth centuries on the basis of artifacts that accompanied them, and the South Great George's Street burials seemed to be four more examples.

Yet when excavation leader Linzi Simpson of Dublin's Trinity College sent the remains for carbon dating to determine their age, the results were "quite surprising," she says. The tests, performed at Beta Analytic in Miami, Florida, and at

Queen's University in Belfast, showed that the men had been buried in Irish soil years, or even decades, before the accepted date for the establishment of the first year-round Viking settlement in Dublin—and perhaps even before the first known Viking raid on the island took place.

Simpson's findings are now adding new weight to an idea gaining growing acceptance—that, instead of a sudden, cataclysmic invasion, the arrival of the Vikings in Ireland and Britain began, rather, with small-scale settlements and trade links that connected Ireland with northern European commerce for the first time. And, further, that those trading contacts may have occurred generations before the violent raids described in contemporary texts, works written by monks in isolated monasteries—often the only places where literate people lived—which were especially targeted by Viking raiders for their food and treasures. Scholars are continuing to examine these texts, but are also considering the limitations of using them to understand the historical record. The monks were devastated by the attacks on their homes and institutions, and other contemporaneous events may not have been

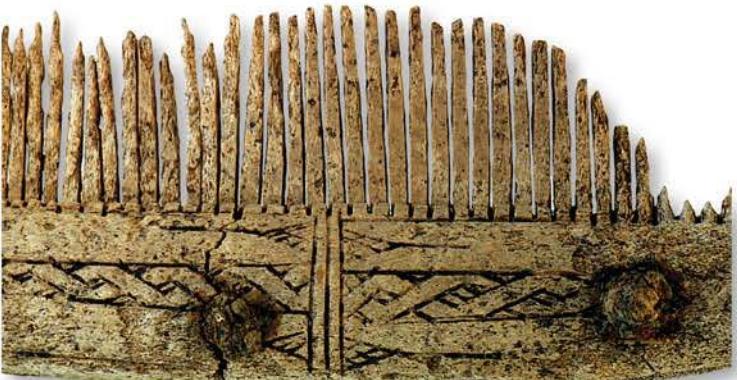
An impressive ax head is one of hundreds of Viking artifacts found during excavations under the streets of Dublin.



All across Dublin at sites such as South Great George's Street (above), archaeologists have uncovered dozens of Viking burials. These graves are now contributing to a picture of the city as a successful trading outpost of the Viking world.

recorded because there was no one literate available to do so. "Most researchers accept now that the raids were not the first contact, as the old texts suggest," says Gareth Williams, curator of medieval coinage and a Viking expert at the British

A decorated comb made of deer antler was found lying on the shoulder of one of the Vikings in the South Great George's Street excavation.



Museum. "How did the Vikings know where all those monasteries were? It's because there was already contact. They were already trading before those raids happened."

THE BEGINNING OF THE Viking era in Britain was long thought to have been June 8, A.D. 793, the day when seaborne Scandinavian raiders appeared on the horizon and attacked a monastery on the island of Lindisfarne, off the east coast of England. Population pressures at home, a thirst for wealth and adventure, and improvements in boat-building techniques all propelled the Vikings out of their chilly realm in search of conquest. In 795 they reached Ireland with an attack on Rathlin Island, where the monastery was "burned by the heathens," according to the Annals of Ulster, the longest and most detailed of the medieval texts that historians have relied on to chronicle the period. At the time, Ireland had been Christian for at least three centuries, and its monasteries were its wealthiest and most powerful institutions. Early medieval texts refer to the Vikings as simply "the heathens," stressing the religious, rather than ethnic, differences between them and the Irish.

The Annals describe hordes of Vikings plundering the



Unlike the Christian populations they encountered—and sometimes conquered—Vikings often buried their dead with treasured objects such as this late 9th- to early 10th-century zoomorphic iron figurine found in a grave in the Dublin neighborhood of Islandbridge.

landscape and battling the feuding warlords who ruled Ireland. One entry, from 798, says the pagan invaders stole cattle tribute from chieftains, burned their churches, and “made great incursions in Ireland and also Alba [Scotland],” painting a picture of widespread chaos and destruction. Another entry records the arrival of a flotilla of 60 Viking ships in 837 at the mouth of the Boyne River, 30 miles north of Dublin. Within weeks, the Annals say, the Vikings had won a battle “in which an uncounted number [of people] were slaughtered.” Recent excavations in Ireland tend to confirm the account the texts depict. “They came, they saw the lay of the land, and then came the catastrophic invasions described in the Annals,” Simpson says. “Considering the weapons buried with these guys, and all the Viking cemeteries discovered in Dublin, I don’t think the Annals were exaggerating. It must have been a very violent time.”

By 841, Vikings had established a year-round settlement around a timber-and-earth fort known as a *longphort* at the confluence of the Liffey and Poddle Rivers, in the heart of modern Dublin. This date has long been taken to be the beginning of the Vikings’ permanent settlement in Ireland. Through alliances, conquest, and intermarriage with local kings, their power waxed and waned over the next two centuries until they were expelled by celebrated Irish warlord Brian Boru in the Battle of Clontarf in 1014. In recent years the

story of that battle has also been revised, with modern scholars seeing it more as a clash for control of Dublin’s port than the shining moment of Irish nationalism of lore. Nonetheless, it meant the end of the Vikings’ presence. Unlike in England and northern France, where they created new cultural orders and royal lineages, the Vikings left little permanent imprint on Ireland, and there are few Viking place names there or Norse words in its language.

SINCE THE 1960s, archaeologists have been gathering information about the mid-ninth-century *longphort* that lay under the pubs and sidewalks of Fishamble Street in Dublin. “The Vikings started with sporadic summer raids, but after some years they decided, ‘This is lucrative, let’s stay,’ and so they built settlements to stay over the winter,” says Ruth Johnson, Dublin’s city archaeologist. Although the earlier dates for a Viking presence in Dublin that have been identified by Simpson and independent archaeologist Edmond O’Donovan differ from the later, established dates by only a few decades, when combined with other evidence, they are challenging the chronology of Viking settlement in Ireland.

Carbon dating, which measures the age of organic materials based on the amount of radioactive carbon 14 remaining in a specimen, usually gives a range of likely dates at the time of death. The older the material, the wider the range. In the case of the four individuals excavated under Dublin’s South Great George’s Street, Simpson found that two of them had a 95 percent probability of having died between 670 and 880, with a 68 percent probability of between 690 and 790. Thus, the entire most likely range was before the first documented



The bones of a Viking warrior in a grave in South Great George’s Street were discovered partly covered by the boss of his iron shield.



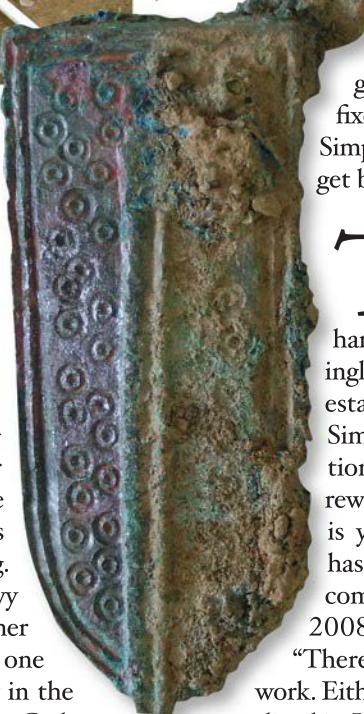
Archaeologists Edmond O'Donovan (left) and Linzi Simpson (right) excavate human remains and artifacts, including this decorated belt ornament (below), at a Dublin site called Golden Lane.

arrival of Vikings in 795. A third individual lived slightly later, with a 95 percent probability of having died between 689 and 882, with a 68 percent probability of between 771 and 851. "I expected a later range of dates, safe to say," says Simpson. "These dates seem impossibly early and difficult to reconcile with the available historical and archaeological sources."

The fourth Viking excavated at South Great George's Street was the most intact of the group and revealed the most about their lives and hardships. A powerfully built man in his late teens or early 20s, he stood five foot seven—tall by the day's standards—with the muscular torso and arms that would come from hard, oceangoing rowing. His bones showed stresses associated with heavy lifting beginning in childhood. Unlike the three other men, he was not buried with weapons. He and one of the other men shared a congenital deformity in the lower spine, perhaps indicating they were relatives. Carbon dating gave a wider range for his lifetime, showing a 95 percent probability that he died between 786 and 955.

In 2005, O'Donovan found two Viking burials under Dublin's Golden Lane of similar ages to Simpson's, with a 94 percent probability of death between 678 and 870 for both individuals. One of the burials was an elderly woman, suggesting that Viking family groups, a telltale sign of permanent settlement, were likely established in Dublin earlier than medieval texts had indicated, and perhaps even before the establishment of the longphort. In a separate excavation under Ship Street Great, a few blocks away, Simpson found a Viking corpse with a 68 percent chance of dating from 680 to 775—again, before historical sources say Vikings had even set foot in Ireland. "We know that Vikings started staying over the winter in 841. But now these findings are showing dates before that, and people are starting to wonder what's going on," explains Johnson. "They weren't supposed to be here yet."

Tests done at the University of Bradford in England on the four South Great George's Street men's isotopic oxygen levels, which indicate where an individual spent childhood based on a chemical signature left by groundwater in developing teeth, told yet another story. The results showed that the



two men with the spinal deformity had spent their childhood in Scandinavia, though the tests were not precise enough to show where exactly. However, the other two had spent their childhoods far from the Viking homeland, in Ireland or Scotland, another sign of permanent settlement by families, and not just summertime raids by Viking warriors.

"You've got these four guys, with a mixed geographic origin, and closely associated with fixed settlements, with fires and postholes," says Simpson. "They didn't just come here and die and get buried. They were amongst the living."

THE EVIDENCE OF AN earlier-than-expected Viking presence in Ireland, based as it is on forensic tests conducted on a handful of burials, may seem slight. But seemingly small pieces of evidence can overturn well-established conventions in archaeology. Both Simpson and Johnson stress that more excavations and tests will be needed before anyone can rewrite the history of Viking settlement, and that is years away. Archaeological work in Ireland has been starved of funds and nearly stopped completely after the country's economic crash of 2008, and it is only now reviving. Williams adds, "There are two possibilities raised by [Simpson's] work. Either there was Viking activity earlier than we've realized in Ireland, or there is something in the water or soil in Dublin skewing the data, and both possibilities need further research."

Nevertheless Williams agrees with Simpson and others that the chronology of the Viking presence in Britain and Ireland is in flux, and that they were likely trading or raiding in Britain, and perhaps Ireland as well, before 793. "Most archaeologists would accept that there was extended contact in Britain with the Vikings from the late eighth century or earlier, and there is no reason to think that contact would not extend around Scotland and down into Ireland, especially in a natural landing place like Dublin," says Williams. Other finds support this: For example, the discovery at the port of Ribe, Denmark, of Anglo-Saxon artifacts dated to the eighth century and recent carbon dating of Viking remains in the Orkney Islands of northern Scotland from the same period all suggest fluid trade before raids began, he explains. "It's a poorly documented part of history," he says. "But before there was Viking settlement, there was this big trading zone in the North Sea. Did it extend to the Irish Sea? We don't have any evidence to say that, but it could be just a question of time." ■

Roger Atwood is contributing editor at ARCHAEOLOGY.

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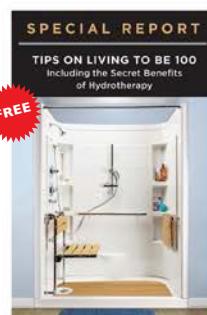
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LETTER FROM THE MARSHALL ISLANDS

A corroded bomb sits near a WWII Japanese pillbox on Wotje Islet in the Marshall Islands. Such unexploded ordnance presents risks to locals, but also provides undocumented information about warfare in the Pacific theater.



Defuzing the Past

Unexploded ordnance from WWII is a risk for the people of the Marshall Islands—and a challenge for archaeologists

by MICHAEL TERLEP

Crystal-clear water laps the white sands of Wotje Atoll in the Republic of the Marshall Islands, roughly halfway between Hawaii and Australia in the Pacific Ocean. Up the beach, a line of coconut palms provides much-needed refuge from the blazing sun. It is, by any definition, a tropical paradise. Yet in the sand and scrub of these islands, being slowly revealed by wind, waves, and the daily activities of the Marshall

Isele people, are dozens upon dozens of unwieldy metal cylinders. Many of these objects are breaking down and cracking open, and leak a lurid yellow powder. In the middle of the twentieth century, during World War II, the atolls in the Marshall Islands formed part of the eastern defensive line of the Empire of Japan. The metal objects are unexploded bombs and projectiles from that time—dropped, buried, or hidden, and forgotten by

the outside world—known as explosive remnants of war (ERW). Time and the tropical climate have left the ERW deteriorating, toxic, and volatile. Accidental detonation and chemical leakage pose serious threats to islanders and to local historic sites.

When discovered, ERW must be carefully rendered safe and/or removed by ordnance professionals. Yet the bombs and projectiles are still historical artifacts, and the sites



around them provide important context. To remove or destroy these historic bombs without studying them first is to remove pieces of a story, a story that can reveal aspects of warfare and of life in wartime that went undocumented at the time. Although the safety of the Marshallese people is always the first priority, a careful balance of caution and inquiry has made it possible both to learn a great deal from ERW and to help restore places such as Wotje.

On a Saturday in February 2014, a small aircraft makes a rattling landing on the grass-covered Japanese-era airstrip on Wotje Islet in Wotje Atoll. I've come to the island as chief archaeologist with the Marshall Islands Historic Preservation Office (HPO) to assist two representatives from the ERW disposal company Cleared Ground Demining, Steve Ballinger

Wotje is one of the 29 coral atolls and five coral islands that make up the Marshall Islands in the central Pacific. During WWII they were of critical strategic importance.

and Morgan Matsuoka, in a survey of World War II ordnance contamination. Wotje looks like any other small village in the Marshalls. Extended families live in Western-style houses with outdoor cooking areas along the lagoon shore. Small stores near the center of the island sell rice, flour, ramen, and, on lucky days, ice-cold Cokes. A single motorized vehicle, a beat-up pickup truck, is the only way to transport supplies around the half-mile-wide island.

Explosive ordnance survey and disposal has become one of the primary objectives of the Marshall Islands HPO. In 2012, the mayors of several atolls voiced their concerns to the national parliament, and with funding assistance from the Australian and U.S. governments, the island nation launched a multiyear campaign to render the atolls ERW-safe. As part of this effort, the HPO assists disposal teams with historical reports and photographs, and joins them to collect data, work with local communities, and ensure no historical or traditional sites are damaged during removal. When possible, the HPO works with

the ordnance teams to preserve ERW in situ as artifacts on a historic landscape. There have been only sporadic attempts to clear ERW in the past, but since 2012, six surveys and two large-scale disposal operations have taken place on Mili, Maloelap, Wotje, and Jaluit Atolls, with more planned for 2015 and 2016.

An older man and a couple of teenagers serve as our guides and first sources for identifying ordnance sites. They lead us to the island's single diesel generator, at the base of a crumbling Japanese seaplane ramp next to the twisted and bent engines of a Japanese Kawanishi H8K "Emily" plane. There, we find two American eight-inch, high-capacity projectiles, and one five-inch projectile. Ballinger takes a closer look and notes the deeply grooved rings that formed at the base of each explosive as they were propelled from massive U.S. naval guns. The projectiles failed to detonate on impact, leaving them, even today, extremely volatile. Heat, friction, or shock could cause a detonation that would destroy part of the generator, not to mention maim or kill anyone unfortunate enough to be nearby. This unpredictability makes ERW a source of much anxiety. Several accidental detonations have occurred in the Marshalls over the last decade, with one resulting in the death of a 12-year-old boy.

Moving slowly from one explosive to the next, Ballinger, Matsuoka, and I take notes, photographs, and measurements to help us identify the types of projectiles and explosive fillers—and possibly even which ship the explosives came from. In the following days, we will load the ERW onto the padded bed of the island pickup for transport to an uninhabited area for eventual disposal.

The history of the Marshall Islands reads like an adventure novel: gold buried beneath beaches, ships seeking safe harbor after mutinies, brutal conflicts between locals and Europeans. Early



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One five-inch and two eight-inch American projectiles rest near the remains of a Japanese Kawanishi H8K "Emily" plane.

Marshallese, a Micronesian people who settled the 29 coral atolls and five coral islands of the archipelago around 2,000 years ago, made the most of scarce resources. They farmed, fished, and created a vibrant culture visible in their traditional dances, pandanus fiber mats, and outrigger canoes. Traditional life in the central Pacific region drastically changed with the arrival of Europeans in the sixteenth century.

By the mid- to late nineteenth century, Europeans had laid claim to much of the Pacific. In the Marshalls, the Germans began the production of coconut oil. Large swaths of land became copra plantations, massive oceangoing vessels anchored in lagoons, and missions and trading stations rose.

In 1914, at the dawn of World War I, the Japanese navy seized control of Micronesia, but it wasn't until the late 1930s that they sought

to fortify paradise. The Japanese strategically constructed seaplane and naval bases and airfields on Kwajalein, Enewetak, Wotje, Jaluit, Mili, Maloelap, and Majuro Atolls. On February 1, 1942, the U.S. military began a campaign in the Marshall Islands with one of the first attacks on Japanese forces following Pearl Harbor. For months, U.S. forces bombarded Japanese bases, and, in early 1944, successfully invaded Majuro, Kwajalein, and Enewetak Atolls.

Dirk Spennemann, associate professor of cultural heritage management at Charles Sturt University in Australia, reports that the United States directed a minimum of 15,000 tons of high-explosive bombs, napalm,



The United States heavily bombarded Japanese installations on Wotje Atoll during WWII. Here, an aerial photograph shows the smoke of burning ammunition and fuel dumps in February 1942.

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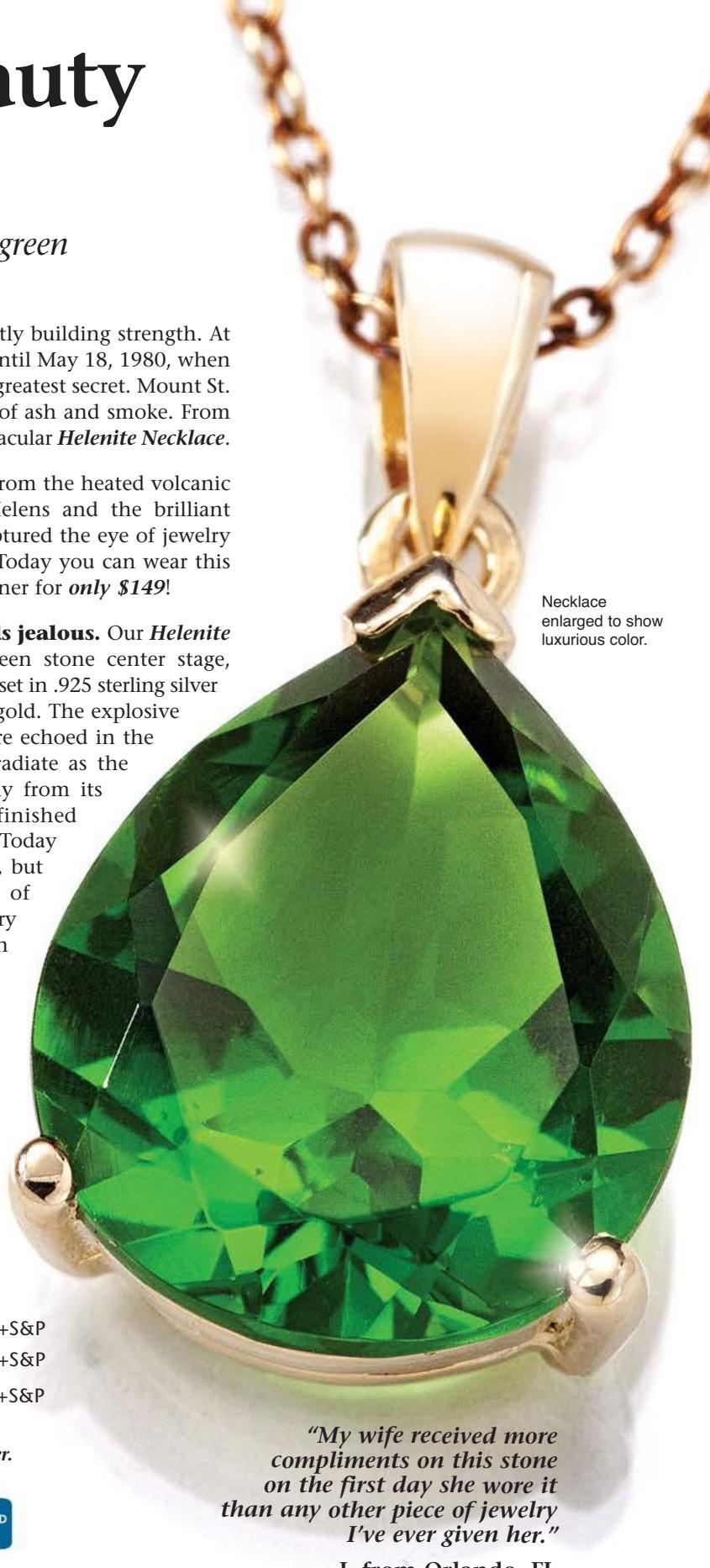
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rockets, and naval shells at targets in the Marshalls, an estimate that does not include invasion bombardment at Kwajalein and Enewetak. By December 1943, Mili Atoll had received more tonnage of U.S. explosives than any other target in the war to date—Berlin included. U.S. intelligence reports, Japanese accounts, and historical research conducted by Spennemann further suggest that as many as 50 percent of naval shells, and some other U.S. ordnance, failed to detonate on impact. In addition, countless tons of Japanese bombs and projectiles were stored on the islands as counterinvasion measures. There is currently no way of telling how many tons of these explosives remain on the former bases. By the end of the war, the once-lush tropical atolls were left hellish, with hundreds of Americans, Japanese, and Marshallese dead, vegetation burned, and thousands of pounds of explosives scattered across islets and vivid blue lagoons.

Once the soldiers had moved on, vegetation and the Marshallese moved back in. Ferns and vines now weave through the rusting and crumbling remains of coastal defense cannons, aircraft wreckage, barracks, and bunkers. In many cases, residents have resettled in old bases and repurposed military structures. Bunkers are now homes with wood frame additions, gun emplacement wells are pigpens, and machine guns hold shed

Several Type 97 No. 6 Japanese land bombs were found by archaeologists along Wotje Islet's runway. Puzzlingly, they were buried with only their fuzes exposed.



Buildings from WWII, including these remains of a Japanese air raid shelter on Maloelap Atoll, dot the Marshalls, and in many cases have been repurposed by islanders.

doors closed. Residents have even found a use for bomb craters: as pits for the production of taro, a starchy staple of Pacific cuisine. However, while clearing vegetation, building homes, or farming, accidental detonation of deteriorating ERW remains a serious threat.

After we examine the projectiles near the generator, our guides take us to a beach along the lagoon between a collapsed antiaircraft emplacement and a massive circular blockhouse at the northern tip of the island. The building is riddled with bullet holes. During the

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Reported by J. Page

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On Mili Atoll, archaeologists and bomb disposal technicians found five 650-pound Japanese Type 3 No. 25 bombs, which were carefully transported to uninhabited portions of the island for disposal.

war, U.S. pilots strafed the installation to silence the 13 mm machine guns firing through its narrow ports. In the sand at the base of the blockhouse, within the tidal area, are two cylindrical steel bombs. Decades of resting partially submerged along the shore have left the bombs deformed; large coral and sand encrustations bulge from the corroded shells. We delicately brush back rust to reveal the riveted construction characteristic of Japanese Type 97 No. 6 land bombs. The Type 97s resemble the stereotypical finned bombs seen in dozens of WWII movies. However, these are Japanese bombs, lying in the open a quarter-mile from the airstrip. They are unlikely to have been dropped here like the American ordnance. Rather, they appear to have been purposely placed on the beach.

We follow the shore to the ocean side to examine where Japanese forces constructed heavy fortifications. As the team approaches a Japanese pillbox, I spot another partially buried Type 97 bomb. The explosive is dug into the sand at a slight angle, with its nose—where the fuze, or detonation mechanism, is housed—pointed

skyward. There are more. By the end of the day we have had the sobering experience of identifying a dozen others down the beach in front of Wotje High School, and along either side of the airstrip our plane landed on. Each bomb is partially buried, with the fuze above the surface. The locations and orientations of these bombs present significant risk and also hint at the anxiety that must have permeated the months of waiting and bursts of violence that defined WWII in the Pacific theater.

Bombs like the ones across the Marshalls were dangerous from the moment they were built, and, in the seven decades they have spent in the humid salt air of the Pacific, have only grown more so. Corrosion of the metal shells or degradation of explosive components increases the potential for detonation or chemical contamination. Munitions remain unexploded today for a number of reasons. Perhaps the ordnance was never prepped for detonation, or failed to initiate on impact due to a production error or a loss of inertia too gradual to trip the fuze.

The cause of the failure or the degradation of components is rarely visible, so we must assume that the slightest movement could set them off.

Len Austin, the chief of explosive ordnance disposal for Golden West Humanitarian Foundation, based in Woodland Hills, California, says, “Some fuzes, fired or unfired, that are in the munitions, will degrade over so many years. The primers and detonators may break down to an even more sensitive state. Springs may have rusted or worn down, allowing for the movement of the firing pin. The explosive fillers may have degraded, or even undergone a chemical change due to heat, moisture, or reacting to the metals within the ammunition. So any movement or disturbance in its orientation could cause an old munition to detonate.”

Golden West and the Marshall Islands HPO recently dealt with just such a chemical change on Mili Atoll. Crews were attempting to dispose of five 650-pound Japanese Type 3 No. 25 bombs found buried near the island’s village. Similar in appearance to Type 97s—but much larger—these bombs were likely buried by U.S.

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troops or disposal teams shortly after the war. In three of the five bombs the explosive filler, 60 percent TNT and 40 percent hexanitrodiphenylamine (a highly toxic explosive compound), had decomposed into a tar-like sludge due to intense heat from brush fires. The cores of the bombs remained intact, and the decomposition created pressure that could have resulted in spontaneous detonation. The resulting explosion would have consumed the other four bombs and portions of the village.

Even if the bombs don't detonate, their chemical components can leak, creating health hazards. During archaeological expeditions to Mili, Wotje, and Maloelap Atolls, profes-



Five Japanese bombs on Mili Atoll have been moved to an uninhabited area for safe disposal.

sionals with HPO identified several Japanese explosives leaking picric acid, a mustard-colored compound of sulfuric acid and phenol. When dampened, picric acid forms highly explosive, impact-sensitive crystals. The compound is also very toxic and can lead to kidney failure if ingested. Matt Riding, the HPO anthropologist, says, "Chemicals from ERW are leaking into wells, rain catchments, and animal drinking



Bombs that have been cut in half for disposal reveal their intact interiors, as well as traces of yellow in the explosive filler, an indication of the formation of picric acid, a toxic and explosive by product.

water. Fish are ingesting the chemicals from submerged bombs in the lagoon and, in turn, local populations eat the fish. Residents have stopped fishing in some places, stating that the fish in those locations are no good. Underwater surveys of these areas often identify ERW."

Japanese records for the Marshall Islands are difficult to access and do not necessarily address specific events or details. All of the material remains of the war have the potential to provide new information. Archaeologists who encounter ERW collect data on the traits, modifications, and condition of the bombs, as well as their placement, orientation, and association with other artifacts and buildings. Through these data, the HPO hopes to develop a more accurate idea of Japanese military tactics and life on their bases before, during, and after battle.

According to Jim Christensen, senior archaeologist with ACR Consultants, a cultural resource management firm based in Sheridan, Wyoming, that employs archaeologists cross-trained as unexploded ordnance technicians, "The study of ERW helps address a

number of research questions. For example, what was the practical accuracy of bombsights versus propaganda reports on bombsight accuracy? What was the actual failure rate of U.S. ordnance and how did this affect wartime production, supply, and overall mission success and strategy? What can ERW tell us about Japanese wartime production and the Japanese conscription of indigenous groups to assist with the war effort?"

The Type 97 bombs found lining the runway and beaches on Wotje would, under normal circumstances, have been dropped from aircraft onto land-based targets. The detonation process for these 130-pound munitions requires the removal of a safety pin and the application of pressure on the nose, usually upon impact. On Wotje, however, the bombs were curiously not found near where aircraft and their armaments were stored.

The bombs were deliberately buried vertically—noses pointing up—with only their fuzed caps exposed. At several locations, the bombs were buried within a few feet of each other, which would allow for a chain reaction if one detonated. The Wotje Type 97s appear to have been used as

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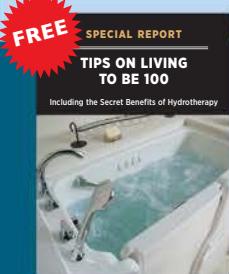


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A Japanese coastal defense gun on Mili Atoll is one of countless remaining military installations across the low-lying atolls of the Pacific.

impromptu land mines. The bombs buried along the ocean-side beach were intended to protect against an amphibious U.S. attack. More alarmingly, the bombs along the sides and end of the runway could have been used to prevent U.S. aircraft from landing, or to deliberately damage the runway if the Japanese troops began to lose control of the island.

The adaptation of aircraft bombs as land mines is not unique to the Pacific, but Wotje is the only known site in the Marshalls where it was done on such a scale. This demonstrates that life was not the same on all Japanese bases. Forces adapted to local conditions and concerns. On Wotje, fear of an invasion was likely higher than on other island bases, possibly due to the almost-daily U.S. bombardments. The U.S. invasion never happened, and the safety pins on the bombs are in place, but they are thin and rusting. The bombs remain dangerous, which makes everyone anxious. Despite our fascination with the military tactic, the bombs must be moved and disposed of.

We excavate around each bomb while avoiding direct contact, documenting everything we can. Then we attempt to move the bombs away

from inhabited areas. Unfortunately, two bombs on the beach are too volatile to move and may need to be heavily sandbagged and blown in place. That, and the safe detonation of the others, will have to wait until funds are secured to hire Cleared Ground, Golden West, or another explosive ordnance disposal team. Safe ERW disposal in such a remote part of the globe can be prohibitively expensive.

By the end of our three-day survey, Ballinger, Matsuoka, and I have documented and moved nearly three tons of explosives, including 14 Japanese Type 97s, 15 Japanese projectiles, three American general-purpose bombs, and 12 American projectiles, as well as dozens of pieces of small-round ammunition.

The Marshall Islands are, unfortunately, not alone in the concern about ERW. The Republic of Palau, due west of the Marshalls near the Philippines, is also engaged in a campaign to remove ERW. On the island of Peleliu in southern Palau, intense ground combat left countless volatile explosives in caves, valleys, and waters. In Belgium, No Man's Land,

an international group of archaeologists, historians, artists, and other professionals, is studying a World War I battle site at Ypres Salient, where small ammunition, mines, shrapnel shells, and grenades lie among other military artifacts. And in European cities, including Paris and Berlin, large unexploded bombs seem to appear regularly during construction and public works, often necessitating mass evacuations.

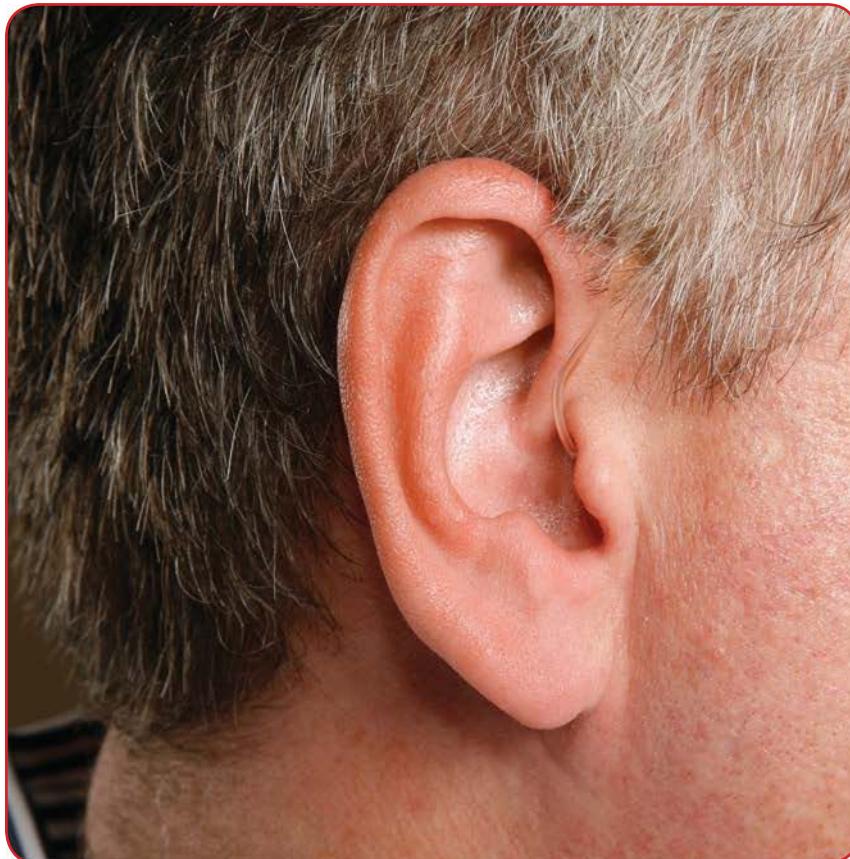
In the Marshalls, the job of dealing with ERW will continue for many years, and it will reveal much more about how war was waged on the Pacific's low-lying atolls. Archaeologists will continue to document, but also, where possible and safe, preserve the unexploded ordnance as artifacts of Marshall Islands history. For 70 years, the threat of detonation and contamination has plagued the people of the islands. In the coming years we hope to transform that threat into a historical resource and a reminder of everything the Marshallese culture survived. ■

Michael Terlep is chief archaeologist with the Marshall Islands Historic Preservation Office.

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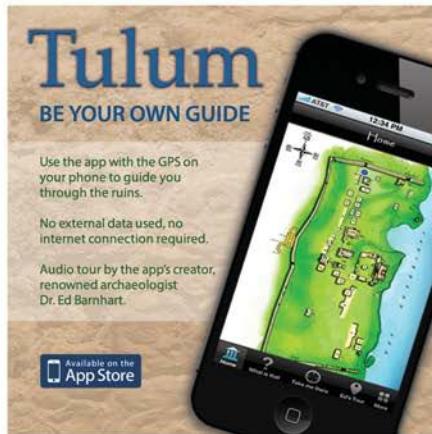
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Dispatches from the AIA

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EXCAVATE, EDUCATE, ADVOCATE

2,600 Archaeologists and Classicists Meet in New Orleans for AIA-SCS Meeting



THE 116TH JOINT ANNUAL Meeting of the Archaeological Institute of America (AIA) and the Society for Classical Studies (SCS) brought together more than 2,600 archaeologists, classicists, educators, and exhibitors for a four-day extravaganza of presentations, discussions, and opportunities for networking and socializing. With more than 100 colloquia, workshops, and roundtables, the 2015 meeting featured the largest academic program in the long history of the event. The program was notable for the breadth and diversity of its session topics, ranging from human evolution to the effect of current conflicts on cultural and material heritage.

Several sessions and workshops focused on the role of technology in archaeological research, including the opening night public lecture presented

by Miriam Stark of the University of Hawaii. Her talk, "Imagining Angkor: Politics, Myths, and Archaeology," focused on the ways remote sensing

techniques are changing the way we visualize and understand the ancient city of Angkor, capital of the Khmer Empire from the ninth to the fifteenth

Annual Meeting App Introduced in New Orleans



THE AIA AND SCS released a dedicated meeting app at the New Orleans meeting. The app, available for iOS, Android, and web, enabled meeting attendees to navigate the program and create customized schedules. The app included both the AIA and SCS programs, venue maps, information about the exhibit hall, messaging capabilities, and general information about the conference. Feedback from meeting attendees was overwhelmingly positive. If you were unable to attend but would like to get a detailed look at the meeting's offerings, the app remains live and can be accessed at www.archaeological.org/meeting/app

centuries A.D. Other lectures focused on the use of digital tools to curate archaeological data and the use of 3-D imaging as a way to digitally preserve and interpret archaeological heritage. These techniques and tools are making archaeological information available to anyone, anywhere, with access to a computer and the Internet.

Each year, the Annual Meeting provides an opportunity for archaeologists to present recent discoveries and new interpretations of the archaeological record. It also provides a setting in which to examine important current issues and challenges. At the Presidential Plenary Session, researchers discussed the latest findings from the site of Dmanisi in Georgia and their



Guests at the Opening Night Reception being entertained by a traditional New Orleans brass band.

impact on our perception of early human movement out of Africa. Other lectures touched on major concerns such as threats to archaeological sites and museum collections in areas of conflict and archaeologists' responses to those threats.

Special events included a lightning session for undergraduate presentations, the meetings of affiliated societies, networking receptions, and, for the first time, a conference for archaeology and heritage educators from around the United States and Canada. Representatives from AIA Local Societies congregated at the Society Representatives Breakfast to review the past year, recognize outstanding programs and individuals, share ideas, and socialize.

The Annual Meeting is the Institute's largest academic event and an opportunity for archaeologists to

exchange knowledge and information with their peers. Each year the meeting grows larger, with more sessions, attendees, and special events. If you missed the 2015 meeting, please join

us next year in San Francisco, January 6–9, 2016, for the 117th AIA-SCS Joint Annual Meeting. Visit the AIA website, www.archaeological.org, to find out how you can participate.

AIA Hosts First-Ever Conference for Archaeology Educators in New Orleans

MORE THAN 40 PEOPLE, including museum specialists, K–12 teachers, and federal employees from around the country participated in the AIA-organized conference for archaeology and heritage educators, "Building a Strong Future for Archaeological Outreach and Education." The two-day conference was created to allow these dedicated and enthusiastic professionals to evaluate the current state of heritage education and plan for the future.

The idea for the educators' conference emerged out of discussions held at various events, including the meeting of the Society for American Archaeology (SAA), meetings of the SAA's Public Education Committee, and an AIA-organized education summit at Boston University. The main goals of the conference were to create a network of archaeology and heritage educators who can work in a supportive and collaborative manner to build a strong future for archaeology, make

educators aware of what their peers are doing and what resources are already available, and connect newcomers to archaeological education with their more experienced colleagues.

Forgoing the traditional conference format of paper presentations, the program instead was interactive, consisting of panel discussions, roundtables, and workshops. Topics included establishing ethical guidelines for outreach programs and the diversity of state and regional approaches to outreach, evaluation, marketing, and sustainability. Topics were chosen through a survey of more than 100 educators from around the country. The conference proceedings are currently being compiled and will be made available online.

We plan to make the AIA educators' conference a regular event and have already begun planning the 2016 meeting. By providing a forum for these conversations, the AIA reaffirms its commitment to informing and educating the public about archaeological heritage.



Participants in the Educators Conference break into small groups for discussion.

AIA Awards Recognize Outstanding Individuals and Groups

EXCEPTIONAL WORK IN archaeology and archaeological education is highlighted each year at the AIA Awards Ceremony. The individuals and groups invited to the ceremony are recognized for their efforts to further the discipline of archaeology, educate both professionals and laypeople, and safeguard cultural heritage. These award winners inspire their peers, students, and the public, and demonstrate best practices in the field. The 2015 winners included

C. Brian Rose, University of Pennsylvania, Gold Medal Award for Distinguished Archaeological Achievement for his work in the field at Troy, the Granicus River Valley Survey Project, and Gordion; his visionary and energetic efforts to provide cultural heritage training to the members of the U.S. military serving in Iraq and Afghanistan; and his highly influential role as an educator, formerly at the University of Cincinnati, and currently at the University of Pennsylvania.



AIA President Andrew Moore (right) with Gold Medal recipient, C. Brian Rose.

T. Douglas Price, University of Wisconsin, Pomerance Award for Scientific Contributions for his influence on the field of archaeological science, including research that has revolutionized our understanding of the European Mesolithic, the transition to agriculture, and human migration throughout the world.

Connie Rodriguez, Loyola University, Martha and Artemis Joukowsky Distinguished Service Award for 25 years of dedication to the AIA and the AIA Local Society in New Orleans and her invaluable assistance each time the AIA Annual Meeting has



AIA Award winners gather after the ceremony.

been held in New Orleans (1992, 2013, and 2015).

Elspeth Dusinberre, James R. Wiseman Book Award for *Empire, Authority, and Autonomy in Achaemenid Anatolia* (Cambridge University Press, 2013), an insightful interpretation of the material evidence that addresses core issues of Persian control in Anatolia.

Allan Meyers, Felicia A. Holton Book Award for *Outside the Hacienda Walls: The Archaeology of Plantation Peonage in Nineteenth-Century Yucatán* (The University of Arizona Press, 2012), an exemplary statement on how archaeology can be used to support modern historical and ethnological research.

Nancy T. de Grummond, Florida State University, Excellence in Undergraduate Teaching Award for over 30 years of dedicated teaching that brings the immediacy of new ideas and discoveries directly into the classroom and instills in her students a passion for original research.

Elizabeth Pye, University College London, Conservation and Heritage Management Award for her groundbreaking efforts in transforming the field of objects conservation into a science-based discipline, and for over four decades of teaching, mentoring, and inspiring hundreds of students from around the world.

Temple of the Winged Lions Cultural Resource Management Initiative, Best Practices in Site Preser-

vation Award for designing a project to stabilize, conserve, and protect the monumental temple and its precinct; rehabilitate the surrounding landscape; develop and implement a comprehensive presentation strategy for the building and its environs; publish the data derived from both the original excavation and the new project; develop guidelines and manuals for different aspects of cultural resource management work; and build local capacity for undertaking CRM efforts.

Gregory Annenberg Weingarten, Annenberg Foundation, Outstanding Public Service Award for his extraordinary efforts in acquiring, protecting, and returning sacred artifacts to the San Carlos Apache and Hopi tribes.

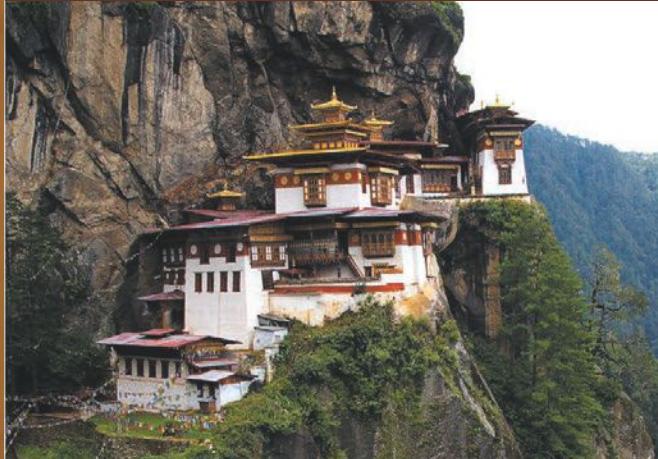
The Ancient World Online and **Charles E. Jones**, Pennsylvania State University, Outstanding Work in Digital Archaeology Award for work on open-access material relating to the ancient world and for presenting archaeological information to more than 1.1 million unique visitors to the site, ancientworldonline.blogspot.com, since its inception in 2009.

Christopher Hale, University of Melbourne, Graduate Student Paper Award (presented at the 2014 Annual Meeting) for "Central Greek and Kean Interconnections during the Middle Bronze Age: The Evidence from Mitrou, East Locris." Hale's paper delivers significant insights regarding trade in the Middle Bronze Age Aegean.

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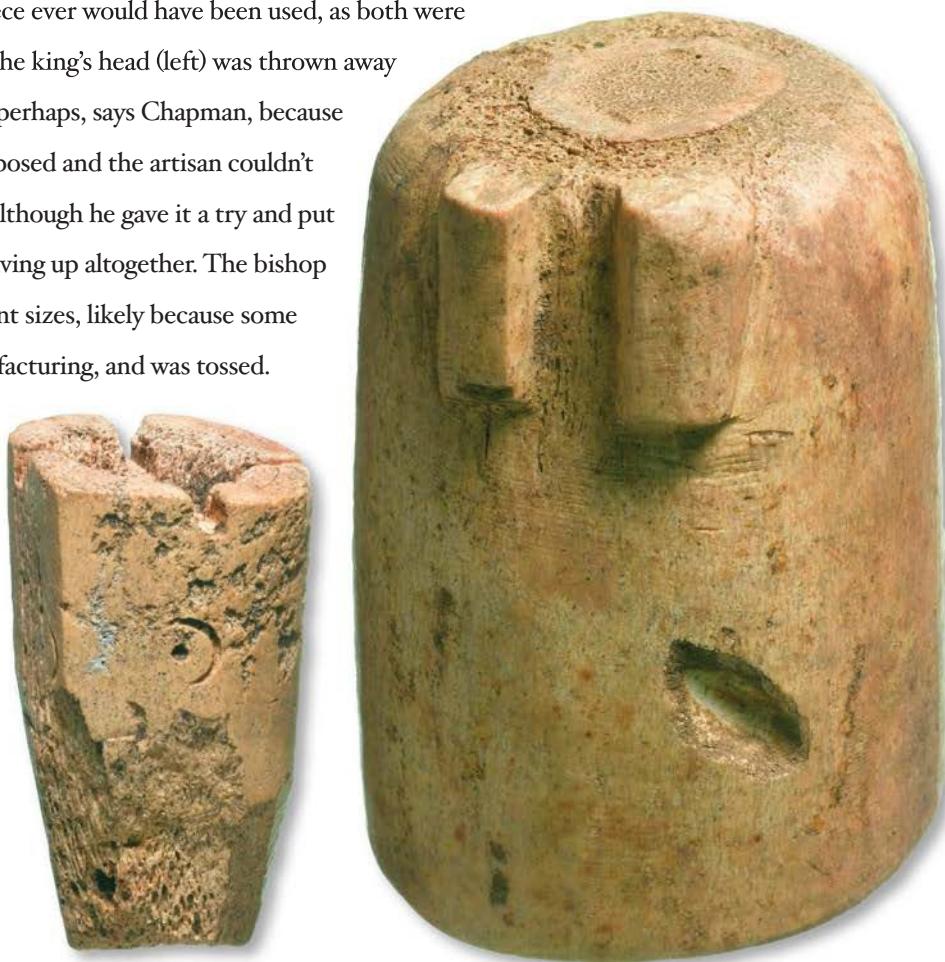
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ARTIFACT

Soon after it came to Europe from the Arab world in the twelfth century, chess became immensely popular among the upper classes. Kings, queens, nobles, and monks would pass their leisure time playing the game using finely carved pieces of elephant or walrus ivory that depicted characters from medieval court life.

Game pieces used by the less well-off, including these two found recently in Northampton, were fashioned of less lavish materials, such as antler and bone, and were less ornate. "These simple chess pieces followed the basic Arabic forms, where anthropomorphic figures were prohibited," says archaeologist Andy Chapman of Museum of London Archaeology Northampton, who is studying the artifacts.

According to Chapman, single stylized chess pieces, 70 of which have been found in Britain, are usually located in domestic contexts. But these two were unearthed in what archaeologists believe was a workshop where chess pieces were being manufactured—several red and fallow deer antlers were also excavated—making this the first time such a shop has been identified. It doesn't appear, however, that either piece ever would have been used, as both were discarded during production. The king's head (left) was thrown away before it was set onto its body, perhaps, says Chapman, because the antler's spongy core was exposed and the artisan couldn't place the right eye correctly—although he gave it a try and put one in the wrong spot before giving up altogether. The bishop (right) had two heads of different sizes, likely because some antler broke away during manufacturing, and was tossed.

**WHAT IS IT:**

Chess pieces

CULTURE:

Medieval European

DATE:

Late 12th century A.D.

MATERIAL:

Antler

FOUND:

Northampton, England

DIMENSIONS:

King's head (left): About 1 inch long and up to half an inch in diameter.
Bishop (right): 1.6 inches long and 1.1–1.2 inches in diameter

Archaeological Tours

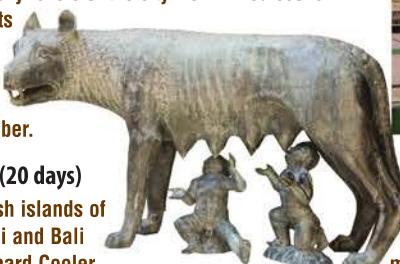
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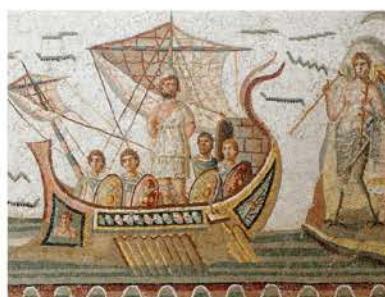
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Foss, DePauw U. Beginning with five days in Tunis, we visit Carthage, the Bardo Museum's fabulous mosaic collection, Thuburbo Majus and Punic Kerouane. Tour highlights include the Roman Dougga, Sheitla and El Jem, the underground Numidian capital at Bulla Regia and Kairouan. We will also visit underground cities, fortified granaries, Berber troglodyte villages and exotic bazaars.



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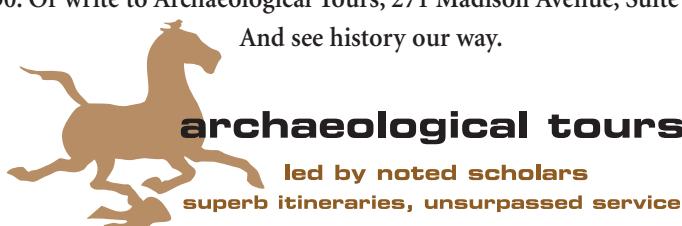


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