



Επιστημονικό Σωματείο,
Έτος Ίδρυσης 1982, έδρα:
Κάνιγγος 27, 106 82 Αθήνα
(Ένωση Ελλήνων Χημικών)
<http://archaeometry.org.gr/index.php/en/>

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Πληροφοριακό Δελτίο της Ελληνικής Αρχαιομετρικής Εταιρείας

- Ιούνιος 2018 -

**No human being will ever know the Truth, for even if they
happen to say it by chance, they would not even know they
had done so.**

(Xenophanes)

Newsletter of the Hellenic Society of Archaeometry

- June 2018 -

Nr. 207

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ΣΥΝΕΔΡΙΑ - CONFERENCES/WORKSHOPS
RESEARCH IN PROGRESS 2018 –
UNIVERSITY OF YORK, THE HUNTINGTON
ROOM, KINGS MANOR, YORK, TUESDAY 6TH
NOVEMBER 2018

The Department of Archaeology is delighted to host this year's Research in Progress at **The Huntington Room, Kings Manor, York on Tuesday 6th November 2018.**

This meeting is aimed at a wide variety of contributors, from historical and archaeological metallurgists to excavators, historians, and economists. If you are working, or have just finished working, on a project related to archaeological or historical metallurgy, we would like to hear from you. We are particularly interested in bringing together contract and public-sector archaeologists with academic researchers, and in fostering links between the different disciplines studying metallurgy and related activities. Whether you are a student, a researcher, an interested non-specialist, or a professional excavator, we invite you to meet others working in this field and present your research to an interested community.

A prize is awarded for the best presentation by a student (or recent graduate within 12 months of graduation) at the meeting as chosen by those members of HMS Council present.

NEW! In addition to the prize, The Historical Metallurgy Society is offering a small number of travel bursaries for students presenting papers. If you are a student and would like to be considered, please indicate with your submission.

Please send your abstract (250 words) to vrc505@york.ac.uk before the 22nd of June 2018. This year we will be offering a Poster Session, therefore please also indicate whether your submission is a paper or poster.

Registration and details to follow on our website <http://hist-met.org/meetings/research-in-progress-meeting-2018.html>

For further information, please email Vanessa Castagnino (vrc505@york.ac.uk).

THE PRELIMINARY SCIENTIFIC PROGRAM **FOR THE 2018 TRONDHEIM RADIOCARBON** **CONFERENCE**

The preliminary scientific program for the 2018 Trondheim Radiocarbon Conference is now online.

Go to <https://www.ntnu.edu/radiocarbon-2018/scientific-program> and click on the link at the right side of the screen.

I'm looking forward to seeing many of you in Trondheim next month.

Best regards,

Kim

Kimberley T. Elliott
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CALL FOR PAPERS, FIFTH INTERNATIONAL CONFERENCE ON THE ARCHAEOLOGY OF PAROS AND THE CYCLADES

**Η ΠΑΡΟΣ ΑΝΑ ΤΟΥΣ ΑΙΩΝΕΣ ΑΠΟ ΤΗΝ
ΠΡΟΪΣΤΟΡΙΚΗ ΕΠΟΧΗ ΣΤΟΝ 16ο ΑΙΩΝΑ μ.Χ.**

***PAROS THROUGH THE AGES FROM
PREHISTORIC TIMES TO THE 16th CENTURY AD***

Paroikia, Paros, June 2019

The Fifth International Conference on the *Archaeology of Paros and the Cyclades* (Paros V) will take place in Paroikia of Paros in June 2019. The Conference is dedicated to the history, archaeology, geology and natural environment of Paros from the prehistoric times down to the 16th century AD.

The Conference is the fifth in a series of International Conferences under the specific title *Paros*, organized by our Institute and held in Paroikia of Paros at periodic intervals. The First and Second International Conferences were dedicated to the Paria Lithos (Paros I) and to the great Parian poet Archilochos (Paros II) respectively. The Third and Fourth International Conferences were devoted to the famous Parian sculptor of the 4th century BC, Skopas, and his prolific work (Paros III) and to the colonies founded by Paros in the ancient world (Paros IV) correspondingly.

The Paros V Conference, including scientific announcements, cultural events and guided tours, is organized in collaboration with the *Municipality of Paros* and the *Cultural Association of Paros 'Archilochos'* based in Paroikia of Paros, and will be held in the Conference Hall 'Archilochos' located near the town centre of Paroikia.

Conference languages are Greek and English with simultaneous translation provided. Talks should not exceed the 15 minutes. All Conference participants (speakers and session Presidents) will stay at Paroikia and their hotel accommodations will be covered by the organizers.

CONFERENCE TOPICS:

The Conference will focus to:

1. History, Archaeology and Religion of ancient Paros
2. Geology and Natural Environment of Paros and the Cyclades

More specific topics include:

I. History and Archaeology

- relations/contacts of Paros with the Cycladic islands & Asia Minor
- history & historical personalities
- topography and transportation network
- coinage, economy and society
- trade and sea routes
- seafaring and mobility
- landscape archaeology and settlement pattern
- architecture, material culture and arts (sculpture, icons, wall painting etc)
- sculpture workshops & sculptors
- inscriptions and hagiography

II. Geology of Paros and the Cyclades

- Geodynamics, Structural Geology and Tectonics
- Physical Geography and Geomorphology
- Past sea level change
- Geoarchaeology
- Natural Hazards, Earthquakes, Tsunamis
- Geoparks and Geotourism
- Volcanology
- Hydrogeology and Hydrology

Especially on Parian Marble and Ancient Quarries

- Quarries and Geology
- Provenance Identification
- Quarrying Techniques
- Hazards and Preservation of Ancient Quarries
- Marble Properties

TITLE AND ABSTRACT SUBMISSION

Titles and abstracts of papers up to one page to be included in the volume of abstracts for the Conference, written in both languages (English & Greek) and including full information on authors (title, institution, post address, email address), can be sent as follows: **Titles** of contributions until the **end of June 2018** and **abstracts** until **November 10, 2018**:

For History, Archaeology and Religion of ancient Paros: From Prehistoric to Roman times to Organizer of the Conference Prof. Dora Katsonopoulou at paros.iapk@gmail.com

For History, Archaeology and Religion of ancient Paros: From Early Christian to 16th century AD to Coordinator of the Conference Dr. Konstantinos Roussos at roussos_kostas@hotmail.com

For Geology and Natural Environment of Paros and the Cyclades to Coordinator of the Conference Dr. Nikos Mourtzas at nikosmourtzas@gmail.com

A second Circular will be sent in early 2019 including the preliminary program of the Conference and accompanying social/cultural events.

With best regards,

For the Organizing Committee

Prof. Dora Katsonopoulou

President

<https://cornell.academia.edu/DoraKatsonopoulou>

ΑΝΑΚΟΙΝΩΣΕΙΣ - ANNOUNCEMENTS



Summer School in
Cultural Heritage Materials & Technologies



CultTech
Summer School

2018

DATE: 8-21 July

KALAMATA, GREECE

ORGANISATION

The program operates within the advanced natural and cultural environment of the Peloponnese and offers a creative mixing of archaeological science, archaeometry and Cultural Heritage technologies. It is oriented from the Department of History, Archaeology and Cultural Resources Management, University of the Peloponnese in collaboration with the Demokritos National Center for Scientific Research and the National Observatory of Athens.

PROGRAMME STRUCTURE

The program consists by a lecturing part (3 first days) on Archaeology and Cultural Heritage Technologies, field archaeology by visiting the Ancient Thouria excavation (4 days) a field-trip stay and practice to Pylos (4 days) and guided educational tours to historical sites, museums, monuments and leisure time at the city of Kalamata and nearby sites.

APPLY BY 15/06/2018

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THORIKOS PROJECT

The Belgian School at Athens has been granted a permit by the Greek Archaeological Service to start a new five-year project at Thorikos (Attica, Lavrion) under the direction of Prof. Roald Docter. As part of this project, investigation will resume on the upper slopes of the Velatouri, where settlement remains and monumental tombs dating to the Bronze Age were excavated in the 19th and 20th centuries. Where the Bronze Age occupation of the Velatouri is concerned, the objectives of the 2018 campaign involve 1) the study of excavated remains, 2) the cleaning and 3D documentation of old excavation trenches, 3) surface survey on the acropolis and eastern slopes of the hill, and 4) geophysical and geochemical prospections of targeted sectors of the site. We are looking for volunteers willing to join the team and participate in the 2018 campaign, which will take place from August 20 to September 14. Volunteers will be involved in the surface survey, the preparation of old excavation trenches for 3D laser scanning, the processing of the finds, and the geophysical prospection.

The project will cover accommodation (in shared rooms) during the four weeks of the project, in addition to light meal (on the site, at ca. 11.00 AM) and lunch (in a local taverna, at ca. 3.30 PM) on working days.

Deadline for application: June 5 – please, send a CV and a motivation letter.

Note that only applications from volunteers available for the whole duration of the campaign (i.e. 4 full weeks) will be considered.

For further information and application, please contact Sylviane Déderix (sylviane.dederix@gmail.com).

Robert Laffineur, Sylviane Déderix, Margarita Nazou, Nikos Papadimitriou

Dr. Sylviane Déderix
Humboldt research fellow
Institute of Classical Archaeology - University of Heidelberg

INTERNET SITES

ΕΙΣΑΓΩΓΗ ΣΤΗΝ ΠΟΛΕΜΙΚΗ ΤΕΧΝΟΛΟΓΙΑ ΤΩΝ ΑΡΧΑΙΩΝ ΕΛΛΗΝΩΝ

Αγαπητοί Φίλοι της ΕΜΑΕΤ,

Η παρουσίαση των κ.κ. Θ.Π. Τάσιου-Κ. Γιαννακού της 14ης Μαΐου 2018 με θέμα "*Εισαγωγή στην Πολεμική Τεχνολογία των αρχαίων Ελλήνων*" που μαγνητοσκοπήθηκε από το Ίδρυμα Μποδοσάκη "έχει ανέβει" στον ιστότοπο του Ιδρύματος Μποδοσάκη, στη διεύθυνση <http://www.blod.gr/lectures/Pages/viewlecture.aspx?LectureID=4100>. Οι ενδιαφερόμενοι μπορούν να την παρακολουθήσουν.

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ΝΕΕΣ ΕΚΔΟΣΕΙΣ – NEW PUBLICATIONS

A PORTABLE COSMOS. REVEALING THE ANTIKYTHERA MECHANISM, SCIENTIFIC WONDER OF THE ANCIENT WORLD, ALEXANDER JONES

New York: Oxford
University Press, 2017. Pp. xiv, 288; 8 p. of plates. ISBN 9780199739349. \$34.95.

Bryn Mawr Classical Review 2018.05.16

Reviewed by Alex Nice, Université Libre de Bruxelles/ University of the Witwatersrand
(alexnice@ulb.ac.be)

In June 1980, the Nobel prize winning physicist, Richard Feynman, visited the National Archaeological Museum in Athens. There, to the surprise of the museum staff, he expressed a particular interest in knowing more about object number 15087. An anomaly among the rich trove of sculptures, vases, and other decorative objects, the device which drew Feynman's attention was 'one thing so entirely different and strange that it is nearly impossible'.¹ This object with its gear trains ('very much like the inside of a modern wind up clock'), graduated circles, and Greek lettering, we now know as the Antikythera Mechanism.

Named for its discovery in an ancient shipwreck off the island of Antikythera (ancient Aegila) in 1900-1901, the Mechanism is unlike any other object recovered from an ancient context. Early investigators tried to relate it to other more familiar mechanical devices. Might it be an astrolabe? Or perhaps a planetarium? The turning point came in the late 1950s when the young physicist, Derek de Solla Price, recognised that the 'wondrous device' was a computer. But it is only in recent years that an international, multi-disciplinary research group (the aptly named Antikythera Mechanism Research Project or AMRP),² with the latest research and scientific techniques at their disposal has been able to unravel the deeper mysteries of the device and to demonstrate its importance for calculating a variety of astronomical data. In this volume, Alexander Jones addresses the current state of knowledge regarding the Mechanism: its discovery, origins, workings, and offers his own plausible hypotheses regarding its purpose and meaning.

Details of discovery and salvage are themselves as much of a detective exercise as the investigation into the Mechanism itself. The story of the accidental discovery of the wreck by sponge divers from Symi offers broad social insights into their culture and motivations for bringing it to the attention of the Greek authorities. Jones interweaves their salvage efforts with references to the contemporary newspaper reports. Anecdotal stories enliven the narrative. According to one account, while loading items onto the ship take the antiquities to Athens, only the action of an astute naval officer (Periklis Rediadis, later an important contributor to early knowledge about the Mechanism) prevented a crew member from throwing the Mechanism back into the sea. Fortune

continued to play a role in the discovery by finding a champion in the Minister for Education, Spyridon Stais. It was largely due to Stais' efforts that the 'inscribed slab' and other fragments of the Antikythera Mechanism were taken seriously by archaeologists.

Ever-diplomatic, Jones recalls those on whose shoulders he stands, acknowledging the importance of the early investigations and the limitations of scientific investigation, while eschewing stories of personal rivalries and fragile egos.³ This is as much the story of the development of modern archaeological techniques as it is the investigation into the Antikythera Mechanism. X-rays were the stimulus for Price's more mature work *Gears from the Greeks* (1974); linear tomography helped Bromley and, especially, Michael T Wright to produce a working reconstruction of the Antikythera Mechanism. Latterly, computerized tomography (CT) and reflectance transformation imaging (RTI) scans have permitted the AMRP team, with the elements contributed by Price and Wright, to publish a reconstruction of the gearing scheme of the Mechanism that is now generally accepted by the scientific community.⁴ Furthermore, CT and RTI imaging has led to improved readings of the inscriptions and a better understanding of the workings of the Mechanism. All of this, if not always explicitly stated, is a testament to the value of interdisciplinary and collaborative research which has subsequently led to 'a proliferation of the community of researchers' (p. 46).

The bulk of the book concerns the external and internal workings of the Mechanism. Generously illustrated with line drawings, photographs, and black and white plates (Figures M1-M8), the complexity of the Mechanism is laid bare. The front dial of the Mechanism consisted of a dial with an Egyptian calendar, zodiacal divisions, and represented 'the cosmos in motion' (p. 202) with pointers for the sun, moon, and other planetary spheres. Two dials were mounted on the back of the device. The upper consisted of a spiral Metonic dial, enclosing smaller Callippic and Games dials, and the lower the Saros dial, enclosing an Exeligmos dial, used for calculating eclipses. A back-cover inscription (Jones' BCI), now largely decoded and translated thanks to CT and RTI, described the Mechanism.

Within, to control the dials, were no less than some twenty-seven gears, able to execute uniform and nonuniform motion, essential for representing the direct and retrograde motions of the planets.

Differential gearing also allowed the device to display the different phases of the moon. These aspects, Jones is careful to point out, are not paralleled by any other devices known from antiquity (p. 223).

Ingenious though these aspects were, the Mechanism was not perfect.

Jones posits errors in the device's ability to measure single days with precision; the triangular teeth on the gears would have resulted in a certain amount of 'backlash'; and there were slight errors derived from the application of Greek astronomical theory, for example, there would eventually have been a noticeable error in the moon's phases.

Individual chapters explore the different aspects of the Mechanism in detail. Ancient concerns with the calendar and games, the stars, sun, and moon, eclipses, and the planets, provide a backdrop to the practical considerations of the Mechanism and its relative success in portraying these celestial phenomena on one device. These chapters range widely in time and space from Babylonian and Mesopotamian understandings of time and the cosmos, through the Egyptian calendar, the importance of the zodiac, ancient Greek and Roman understanding of solar and lunar eclipses. Interlaced, are references to

comparative material: the Greek calendar on the Little Metropolitan Church at Athens, a parapegma from Miletus, Babylonian omen texts and the Astronomical Diaries. But the Mechanism was only so accurate: the Saros and Exeligmos dials could only have accurately depicted eclipses within a narrow window of time; the portrayal of the planets (the ‘Wanderers’) was limited to the direction of the planets from Earth and their relative distances. Despite careful explanations, the reader unaccustomed to the language of astronomy and engineering may well feel a little overwhelmed. For here, ecliptic, synodic, and penumbral, nestle comfortably next to eccentric, epicyclic, and contrate. The detailed explanations of phenomena or mechanical operation often require careful reading and re-reading to comprehend fully the process or concept under examination.

Those in favour of an association with Archimedes or Syracuse may be disappointed. This, argues Jones, was a device made in Rhodes in the First Century BC and intended for a localised Epirote market.⁵ Clues are found in the inscriptions. There is a reference on the purely ‘symbolic’ Games dial to the Halieia, and to the Naa, local Rhodian and Epirote festivals respectively; the Metonic spiral contains Corinthian month names, which match almost exactly the month names used by localities in Epirus . Coinage provides a terminus post quem for the ship wreck: it can be no earlier than 76 BC; the provenance of the cargo, from Asia Minor and the Hellenistic world, including amphorae from Rhodes, suggests that the ship’s route was from East to West.

Jones further maintains that the Mechanism’s ultimate purpose was as a teaching, rather than a research, device. Such devices were undoubtedly rare but Geminus is frequently cited. He was the author of An Introduction to the Phaenomena, otherwise known as the Isagoge, who probably lived in Rhodes around 70 BC. There are close connections between the Isagoge with the calendrical functions of the Mechanism, its treatment of the Sun and Moon with their depiction on the Mechanism; the chapters on the rising and setting stars with the Parapegma inscription; and its discussion of eclipses with the Saros and Exeligmos dials (p. 238, table 9.1). Furthermore, from Cicero, we know that Posidonius, a Rhodian and contemporary of Geminus, had constructed a similar astronomical device (p. 94). The arguments are persuasive.

This is a remarkable book about a remarkable device. After reading A Portable Cosmos, the Antikythera Mechanism seems a little less ‘different and strange’, a little less ‘impossible’ but no less of an ancient wonder. In clear and lucid prose, Alexander Jones has successfully integrated all the necessary literary, archaeological, and forensic evidence relevant to the Mechanism. The result is a detailed, thorough, and perceptive analysis which will surely stand as the definitive handbook on the Antikythera Mechanism for some time to come.

Notes:

1. Feynman, R. (1980) What Do You Care What Other People Think? Further Adventures of a Curious Character New York, pp. 93-97.
2. See <http://www.antikythera-mechanism.gr/project/team>, Accessed May 2018.
3. Marchant, J. (2008) Decoding the Heavens. London.
4. Freeth, T., Bitsakis Y., Moussas X., Seiradakis J. H., Tselikas

A., Mangou H., Zafeiropoulou M., Hadland R., Bate D., Ramsey A., et al., (Nov. 2006) 'Decoding the ancient Greek astronomical calculator known as the Antikythera Mechanism' Nature 444, 587-591.

5. See Price, D. de Solla (1974) Gears from the Greeks. The Antikythera Mechanism, a Calendar Computer from ca. 80 BC Transactions of the American Philosophical Society, ns 64.7, 61-62. Philadelphia.



ARCHAEOLOGIA BULGARICA XXII 2018 #1

It has just been published.

Regards,

Lyudmil Vagalinski
editor

www.archaeologia-bulgarica.com

Archaeologia Bulgarica XXII 2018 #1

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EΙΔΗΣΕΙΣ - NEWS RELEASE

ARCHAEOLOGISTS UNCOVER REMAINS OF MAN CRUSHED AS HE FLED POMPEII, BY GIANLUCA MEZZOFIORE AND VALENTINA DIDONATO

A man managed to escape the first eruptive fury of Vesuvius in A.D. 79, only to be crushed beneath a block of stone hurled by an explosive volcanic cloud, new excavations at the site suggest.

Archeologists working at the ancient Roman city of Pompeii, Italy, found the man's remains almost 2,000 years after he died.

Stunning pictures from the scene show a skeleton pinned beneath the stone. The impact crushed the top of the man's body. His head might still be buried beneath the block of stone.

Lesions on the skeleton's tibia are signs of a bone infection that probably hampered the man's escape attempt, archeologists said.

Nonetheless, the man, who was at least 30 years old, survived the first phase of the eruption and fled along an alley, probably limping because of his infection.

Stone might have been doorjamb

But there he was hit by the massive stone block -- perhaps a doorjamb -- possibly hurled at him by the force of the pyroclastic flow. That's the blazing-hot mixture of gas, lava fragments and other debris belched out by a volcano.

"This discovery has shown the leaps in the archeological field. The team on site are not just archeologists but experts in many fields; engineers, restorers and (have) the technical tools like drones and 3D scanners.

"Now we have the possibility to rebuild the space as it once was," said Massimo Osanna, general director of the Archeological Park of Pompeii.

"This is the first time an excavation happens with all of these tools.

In the 1800s and 1900s, they dug in the area where we found the skeleton, but they did not go as deep as we did. Because of the experts we had, we knew how to do it."

Please visit the site: <https://www.cnn.com/2018/05/29/health/pompeii-victim-crushed-rock-eruption-intl-trnd/index.html> [Go there for pix]

HORSES FOUND IN POMPEII MAY HAVE BEEN HARNESSSED TO FLEE ERUPTION

Several horses recently discovered in a 2,000-year-old stable appear frozen in a failed flight to safety from the eruption of Vesuvius.

After this horse died in the eruption of Vesuvius, its body was covered in ash. Over centuries, the remains decayed, leaving a void in the hardened ash that was subsequently filled with plaster and exposed.

A horse recently found trapped in the ashes of a suburban Pompeii villa was just the tip of the equestrian iceberg. Since that discovery was announced last week, archaeologists have revealed that at least three horses perished in the villa's stable during the volcanic eruption of Vesuvius that famously buried the ancient Roman town.

At least two of the animals were harnessed and possibly prepared for a frantic evacuation when they were hit with the lethal, pyroclastic flow that rushed through Pompeii and its surroundings after midnight in the summer of A.D. 79.

The stunning, complete plaster cast of one of the villa's horses is the first of its kind from Pompeii. When the volcano erupted, many of the town's residents and animals collapsed and died in place after being struck with waves of superheated poisonous gas and ash. Their decaying bodies then left hauntingly shaped voids in the hardened ash layer.

Learn how your family ancestry is connected to the human origin journey with National Geographic's Geno 2.0 DNA Ancestry Kit.

In the late 19th century, archaeologists developed a method of injecting plaster into these voids to capture more details about the dead. Since then, it's mostly been used on humans—and an infamous chained dog—but this was the first attempt on a large mammal.

The team also cast two legs from another horse discovered nearby, but the rest of the void left by that body had been destroyed by tomb robbers, known locally as tombaroli, who were tunneling around the walls of the ancient villa to steal artifacts they could sell on the black market.

The void and skeletal remains of a third horse were also almost completely destroyed by tombaroli, zooarchaeologist Chiara Corbino, who studied the horses, tells National Geographic.

Evidence for bits and bridles around the two cast horses suggests that they were harnessed by people trying to flee the eruption, says Massimo Osanna, general director of the Archaeological Park of Pompeii. The remains of the third horse are too incomplete to determine whether it was also harnessed at the time of death, says Corbino.

The villa, located in the Civita Giuliana area outside the walls of ancient Pompeii, was originally discovered at the beginning of the 20th century, then partially excavated in the 1950s and later sealed.

Investigators spotted the tombaroli tunnels last summer and alerted archaeologists from the Archaeological Park of Pompeii, who then excavated the previously unknown stable area.

Evidence for a leather bit and bridle decorated with metal ornaments was found around the head of the horse.

Italian authorities have since confirmed to National Geographic that the find is the result of a significant criminal investigation known as Operazione Artemide (Operation Artemis), led by Italy's national gendarmerie, the Carabinieri. This multi-year investigation took off in 2014, after thieves stole a frescoed depiction of Artemis, the Greek goddess of the hunt, from the walls of an ancient Pompeian house that is currently closed to the public.

By early 2015, the operation had swept up more than 140 suspects—tombaroli, illegal art dealers, and even some mafia members—in simultaneous dawn raids across 22 Italian provinces. Teams recovered some 2,000 ancient artifacts, including illegally excavated vases, coins, and architectural fragments.

According to Osanna, research at the villa has been concluded for the time being, but the archaeologists do not rule out continuing excavations in future, which might reveal yet more tragic moments frozen in time.

Dr. Robert Ballard found the RMS Titanic in 1985 with the help of imaging technologies designed by the National Geographic Society. For more than a century, a percentage of proceeds from National Geographic subscriptions has helped fund exploration around the world.

Between 1912 and 1915, a young National Geographic Society supported Hiram Bingham's excavation of the "lost" Inca city high in the Andes. Bingham's map-maker went on to become the first cartographer of the Society's new Cartographic Division.

One of the oldest and most complete human skeletons yet found in the New World was located by divers deep in a Yucatan cave in 2007. National Geographic helped fund archaeological training for the divers, who recovered the 12,000-year-old remains in subsequent years.

National Geographic partnered with the Smithsonian in the 1920s for the multi-year excavation of Pueblo Bonito, Chaco Canyon National Monument's most important ruin. The important technique of dendrochronology, which dates archaeological features using tree rings, was refined during the project.

A female victim of human sacrifice some 500 years ago, the mummified remains of the "Ice Maiden" were discovered on a Peruvian mountain by National Geographic Explorer Johan Reinhard in 1995. It was the first of a series of Inca mummy discoveries made by Reinhard that shed new light on their sacrificial rituals.

Now a World Heritage Site, this wealthy ancient Greco-Roman city has been the center of ongoing archaeological excavations since the 1960s.

National Geographic grants supported scientific research at Aphrodisias for more than two decades, from 1966 to 1988.

The remarkable discovery in 1987 of the Royal Tomb of Sipán may have been unwittingly aided by looters, but National Geographic supported its scientific excavation for the next four years. The richest pre-Columbian tomb ever found in the Americas, it contained numerous elaborate artifacts made from gold, silver, and semi-precious stones.

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Kristin Romey is an editor and writer covering archaeology and paleontology for National Geographic.

**Please visit the site: <https://news.nationalgeographic.com/2018/05/pompeii-horse-civita-giuliana-archaeology-science/> [Go there for pix]**

**THE SCIENTIFIC DETECTIVES, PROBING  
THE SECRETS OF ANCIENT ORACLES,  
GEOLOGICAL FEATURES, TOXIC FUMES,  
AND VISIONS OF THE FUTURE,  
BY KEVIN KRAJICK**

One hot spring day, two scientists began climbing a steep, boulder-strewn ridge near Selcuk, in southwestern Turkey. The few stunted pines sprinkled here and there offered little shade. “Don’t touch the rocks with your hands too much,” warned their guide.

“Scorpions.” Several hundred feet up, a dark, narrow opening pierced the slope. They climbed in and descended about 20 feet to the floor of a small, cool cavern. In the indirect sunlight, they could see stalactites lacing the walls, and curving passages, too small to enter, spiraling down. A newly shed snakeskin lay on the floor. At the rear, five natural steps led up to a rock formation resembling a tangle of human bones. They had found their quarry—an oracle of Cybele, earth goddess of Asia Minor, curer of disease, granter of fertility, seer of all things. From prehistoric times until 2,000 years ago, and perhaps longer, people came to this cave to ask Cybele the same questions we ask today. Whom should I marry? How can I make more money? How long will I live? Today, we have therapists and algorithms, risk analysts and actuarial charts. The ancients had oracles.

The scientists were John Hale, an archaeologist from the University of Louisville, and Jelle Zeilinga de Boer, a geologist from Wesleyan University. They had formed themselves into a sort of oracle detective team, seeking out the sites of these ancient prognosticators and attempting to figure out why they are located where they are and what role they played in the ancient world.

Around 50 B.C. the Roman politician Cicero wrote, “As far as I know, there is no nation whatever, how polished and learned, or however barbarous and uncivilized, which does not believe it is possible that future events maybe be indicated, and understood.” Oracles were the most famous and enduring institutions of the ancient world. The best known was Greece’s Oracle of Delphi, where, for at least 1,000 years, kings and common pilgrims visited a cave where a priestess leaned over a sacred spring and inhaled from it the breath of the god. Elsewhere, the future was divined via haruspicy, the reading of organs from sacrificed animals; empyromancy, the interpretation of flickering flames; or augury, which involved observing lightning flashes and other phenomena. At Dodona, priests of Zeus were said to hear the future in the rustling leaves of a sacred oak. At Sura, on the Turkish coast, it was in the patterns of fish congregating around a magical whirlpool. On earthquake-prone Mount Garganus in Italy, the method was incubation: A supplicant performed purification rituals, slaughtered a black ram, and slept on its skin in the sanctuary. That night’s dream held portents, interpreted by a resident priest. At the Cybele shrine visited by Hale and de Boer, divination apparently involved dice made from the knucklebones of sheep. Thousands have been found at its entrance, along with votive statues, coins, and other offerings.

Almost all these sites had one thing in common. They all were located upon or within extraordinary natural features—deep caverns, strange rock formations, bubbling springs, ancient groves—that apparently had something to do with their powers. Some researchers believe cults connected to some of these sites could go back to well before the rise of civilization, as far as 25,000 years. As religions and belief systems changed, some sacred sites went with them—Cybele shrines were renamed for more familiar Greek gods—at least until Christianity came to dominate the Mediterranean. That was when the Roman Emperor Theodosius declared Christianity the state religion, and outlawed oracles, in A.D. 385. Sites great and small were pillaged, repurposed, or just buried and forgotten. (One exception is the cave on Mount Garganus, now a sanctuary of the Archangel Michael of Mont Sant’ Angelo.) Sixteen centuries later, archaeologists started digging.

In the 1990s, looters rediscovered the cave of Cybele before archaeologists got there. Years later, Hale and de Boer were led there by the director of the Ephesus Museum in nearby Selcuk, Cengiz Icten. Outside the cave, Icten poked the dry ground with a walking stick and grinned. Suddenly, we saw what he was seeing. Everywhere in the loose soil were pottery sherds, shaped stones, even a corroded bronze coin, “It took many centuries for all this to build up,” he said. “This place goes back a long way.”

Hale and de Boer got their start in the oracle business at the famed Delphi itself. The archaeologist and geologist had met in 1995, while both were touring ancient ruins elsewhere. They became friends over a bottle of wine and their shared interest in the oracle—a space where their spheres of academic interest overlapped. That night they vowed to solve the mystery.

Hale brought a deep knowledge of ancient history, languages, mythology, and architecture. De Boer supplied expertise in the even more ancient: the origins of rocks, the mechanisms of earthquakes, the workings of volcanoes. He had surveyed the area around Delphi in 1981 for a study of Greek earthquake hazards. “Geology is at the ground level of everything, whether it’s biological, archaeological, anthropological or ecological,” he said.

“It’s my hope,” Hale said, “that by learning about the past, one might find some inspiration about how to live today.”

Delphi sits on the slopes of Mount Parnassus, about 75 miles west of Athens. It is thought to have originated as a sanctuary of Gaia, the pre-Greek earth goddess. The Greeks later said it was where Zeus had placed the center of the world. It was also the main abode of Apollo, god of the sun and of prophecy, near where he slew the giant serpent Python. By the fifth century B.C., it hosted an elaborate complex of ritual buildings. Over the colonnade of Apollo’s temple was carved “γνώθι σεαυτόν.” “Know Thyself.”

According to Greek writer Plutarch (A.D. 46–120), inside the temple a small, dimly lit underground sanctum enclosed a cleft in the bedrock. The feature exuded a sweet-smelling vapor—the pneuma, or “breath of the god.” The pneuma, he wrote, was produced by “natural underground forces,” and was emitted “as if from a spring.” Once a month, a priestess, or Pythia, went through elaborate purification rituals, sat in a special

chair, and hung her head over the chasm to inhale the pneuma. Then she began speaking in a strange, disembodied voice. Questioners were admitted.

The Pythia's answers could be cryptic or unwelcome, but they were always taken seriously. Matters of business, marriage, treaties, and wars were undertaken on her counsel. In legend, it was the Pythia who told Oedipus he would kill his father and marry his mother. Some time before 399 B.C., one Chaerephon asked the Pythia if anyone was wiser than his friend Socrates. "No," said the oracle—either confirming either the philosopher's greatness or denying the very existence of human wisdom. According to fourth-century B.C. historian Herodotus, in 546 B.C., the Lydian king Croesus sacrificed 3,000 animals, burned piles of valuables, and sent a huge treasure to honor the oracle. Then he sent a messenger to ask whether he should attack his rival, Cyrus of Persia. The priestess replied that if he did, he would "destroy a mighty empire." Croesus attacked and was defeated. By some accounts, he was given a last-minute reprieve from being burned alive, and sent a messenger to the oracle to ask why it had betrayed him. The Pythia replied: "Croesus ought, if he had been wise, to have sent again and inquired which empire was meant, that of Cyrus or his own; but if he neither understood what was said, nor took the trouble to seek for enlightenment, he has only himself to blame for the result." Her message was simple. Know thyself.

What kept people coming back to oracles—outside, of course, of the universal desire for certainty about the future? Perhaps the seers did, indeed, have a good track record in predicting the future. One reason for this could be that oracles were the greatest intelligence-gathering and -disseminating agencies of their day. According to a 1956 history of oracles by historian H.W. Parke, temple officials often subjected powerful people to days or even weeks of questioning before allowing them to consult the oracle. This meant that those officials had deep access to political developments, military strategies, and economic trends—sometimes from opposite sides of a conflict. This may have helped them make informed judgments that they could pass on to the priest or priestess. Another factor is that oracles often favored the most generous tippers—who were, thanks to their wealth, probably more likely to prevail in an economic or military conflict anyway. Croesus notwithstanding.

Then, there is the third theory: the uncanny. "There is a hell of lot more around us than we know about," said de Boer, a die-hard scientific empiricist with little patience for speculation. "When people ask me, 'Do you know how it all worked?' I have to say no. There are some things we will never know."

It should be noted, though, that something can seem extra-natural without being outright supernatural. The investigation of many such phenomena is often known as geomythology, or the study of how natural processes—from earthquakes and volcanic eruptions to floods and eclipses—get encoded in religious stories, mythology, and folklore. In the case of Delphi, it had been speculated that the pneuma was some gas or vapor, emitted from a natural chasm or spring, with psychoactive effects.

"Present-day humans are pretty arrogant when they think the ancients could not have observed things clearly."

In the late 19th and early 20th centuries, Delphi was rediscovered by archaeologists. At the time, scholars denounced the whole idea of the pneuma, supernatural or geological,

as a myth or even a hoax. Excavation of the ruins revealed no obvious cleft or cave where the oracular sanctum might have been. There was also no obvious sign of volcanism that would account for the release of gases. According to Parke, some researchers believed that the priestess was inspired by sitting over a hole filled with burning marijuana. Another, more recent, theory has it that the Pythia was high from chewing the toxic leaves of the oleander tree, or inhaling their smoke.

De Boer, however, had examined the area closely in his initial survey, with a geologist's eye. To the east of Delphi, he spotted an earthquake fault exposed by a modern road cut, and followed it on foot to near the temple complex. "It was beautifully expressed on the surface," he said. To the west lay a known fault, striking in the same direction. And if you connected the ends, the thread clearly ran under the temple, though that part was obscured by rocky debris and the buildings themselves. De Boer had read Plutarch, and connected that cleft with what he saw in the ground. It was not a geological smoking gun, exactly, but it was a geomythological lead. "Present-day humans are pretty arrogant when they think the ancients could not have observed things clearly," he said.

Later, in the late 1990s, de Boer and Hale visited Delphi together and, among other things, dug up Greek government geological maps showing that the limestone in the area was laced with tarry petrochemicals. There was no evidence of geothermal features, but a slow slippage of the fault could create enough heat to vaporize those deposits. They also found traces of a second fault, almost perpendicular to the first, also below the temple floor. This intersection would have created an ideal vent for underground gases. There was no spring, as Plutarch suggested, but Hale and de Boer found evidence of a drain, and, uphill, some still-running spring water. They sampled this water and chiseled out pieces of travertine, a chalky rock that forms when chemical-laden spring waters react with air. In both they found traces of hydrocarbon gases.

One of the gases in the flowing water is ethylene, a substance used in the early 20th century as an anesthetic, and still widely used in the chemical industry. In small doses, it is said to induce an out-of-body euphoria and a release of inhibition. In the interest of science, of course, Hale and a couple of friends in Louisville got hold of a tank of ethylene, opened the valve in a backyard garden shed about the size of the alleged inner sanctum, and took turns, well, huffing it. Hale is pretty sure this was legal. They lost the feeling in their hands and feet, and began seeing the world as if from outside. "Very strange, but not scary," said Hale. The next logical step? Predicting the outcome of the next Kentucky Derby.

Starting in 2001, the team published a series of scientific papers laying out the case that the Delphic Oracle operated exactly as described, and that much of it could be explained scientifically. Though not everyone bought into all their conclusions, many scholars were converted. Modest fame followed, and a book. There was just one problem. Every garden-shed prediction about the Kentucky Derby was dead wrong.

Hale likes pointing out that the Greek words for "prophet" and "madness"—*mantos* and *mania*—come from a common root. "When Plato considered the Delphic Oracle, he said that the priestess was never of any use when she was in her right mind. But when she was mad, she benefited all mankind," said Hale. "That is a beautiful thought. It tells us that there are special places on Earth that shape human belief."



Emboldened by their work at Delphi, Hale and de Boer looked farther afield. Southwest Turkey was a logical starting point. In the centuries before Christ, the Greeks had colonized the region. At other times there were Hittites, Lydians, Persians, and Romans. There are multicultural ruins all over the place, including the oracular Greek temples of Klaros and Didyma, nearly as important as Delphi in their time, if not quite as well known. According to inscriptions dating back as far as 600 B.C., rulers from as far away as present-day Russia and Mauritania consulted these oracles about plagues, labor disputes, and religious crises. Locals asked about planting crops, money matters, or, in one case, whether to embark on piracy. (Didyma approved.) So one spring they set out to explore as many of them as they could, gather samples, and devise, if possible, a unifying theory of ancient oracles.

To reach Klaros, we drove through wooded hills and farmland near the Aegean coast to a small valley, where we followed a dirt road through the lemon groves. The road entered a swampy area and dead-ended against a rocky wall. From out of high reeds rose a set of broad steps leading to a great stone platform. Only a few columns and walls still stood, but in the remains of the sanctuary were fragments of a sculpture of Apollo said to have once been over 20 feet high. Countless names and inscriptions had been carved into the ruins—possibly the greatest surviving collection of ancient Greek inscriptions in a single place. Artifacts found around the temple foundations date at least as far back as 1200 B.C. “People obviously sensed early on that there was something special about this place,” said Hale.

The stone slabs that once formed the main temple floor had been hauled away. This had exposed a basement labyrinth once hidden within the platform—and, Hale and de Boer suspected, Klaros’s oracular secrets. The labyrinth, excavated by French archaeologists in the 1980s, led from the front steps to two chambers in the rear, all now filled waist-deep with stagnant water.

I tried not to think too hard about what else might be down there, rubbing against our legs.

According to an A.D. 18 description by Roman aristocrat Tacitus, prophecies here were offered only on certain nights: “A priest, after hearing merely the number and names of the clients, [went] down into a cave; there he [drank] from a secret fountain.” The priest went into a trance, and then cried out his prophecies from an unseen corner. About 50 years after Tacitus, Pliny the Elder noted that these priests served only one-year terms—possibly, he noted, because the fountain “inspires wonderful oracles, but shortens the life of the drinker.”

For decades prior to the site’s excavation, researchers had looked for such a cave in nearby hillsides. The discovery of the labyrinth and these chambers suggested that the oracular cave was, in fact, embodied by the temple itself. It even looked like the structure had been repeatedly expanded and elaborated around it, much like at Delphi.

“Let’s try and get a feel for the oracular experience,” said Hale. In bathing suits and water shoes—we knew ahead what to expect—we descended four steps into the watery labyrinth entrance. The water was warm, opaque with algal scum, and alive with frogs and turtles. I tried not to think too hard about what else might be down there, rubbing against our legs. We waded through six turns to reach the chambers. At least we had the

open sky above us. The experience would have been a lot spookier for ancient pilgrims following the priest. It would probably have been pitch black, the tunnel barely shoulder-wide with the ceiling at head-height. At the end of the labyrinth, we came to a room covered with surviving stone arches, and with stone benches along the walls. Here questioners must have waited to hear prophecies.

Beyond this room was a rectangular inner chamber where archaeologists had found a circular hole in the floor, containing water—the secret fountain, apparently. Perhaps the water source had shifted and begun to overflow, or maybe rain had filled the old basement. In any case, we could not see the hole and had to feel for it with our feet—carefully. A caretaker had warned us it went down at least 20 feet. Off to one side, we finally felt it. It was covered by what felt like a modern metal grate.

Hale and de Boer suspected this spring was effervescing hydrocarbon gases like those at Delphi—maybe even a lot more potent, if the priests were dying prematurely. “In a closed space, it would be like sniffing gasoline, only worse,” suggested de Boer. “Of course, not very healthy.”

By feel, we fed a long, plastic hose down through the grate. A big plastic syringe was attached to the other end, and we sucked up water samples from the depths. These samples would go back to de Boer’s lab.

Our next target would be Didyma.

Pilgrims originally reached Didyma by walking 10 miles from the coastal city of Miletus along the Sacred Way, a stone path flanked by sphinxes, fountains, and tombs. Remnants of it can still be seen from a parallel, far less impressive asphalt road. The temple lies on the outskirts of the small village of Didim, where a century of excavations has revealed a stupendous building with a multistory central court, much bigger than Klaros—much bigger than the Parthenon, actually, which would fit comfortably inside it. Like Delphi, Didyma is said to have featured a spring above which a priestess sat. The spring is thought to have dried up after Persian invaders burned and looted the place in 493 B.C. It miraculously returned, supposedly, after Alexander the Great passed through some 150 years later. Today its exact location has been lost.

When we arrived the place was crawling with tourists. This didn’t bother Hale or de Boer. They were looking for something very specific: the site of a now-vanished little house in the center, where a priestess “receive[d] the god by imbibing the vapor of the water,” according to the fourth-century A.D. writer Iamblichus. In the courtyard, we spotted three round, well-like structures, all currently dry. Any of them could have been the spring. De Boer speculated that they all could have been the spring; maybe it had dried up and popped up elsewhere periodically, he said, due to natural shifts in underground waterways. “They must have moved the well from time to time to keep up,” he said.

In the absence of any water within the temple itself, de Boer went to a well in front, where pilgrims are thought to have purified themselves before entering. It held plenty of water, as well as coins that people had tossed much more recently. We poked the hose down and sucked up some water. “Second or third best, but better than nothing,” said de Boer.

Some months later, de Boer called me with the results: The water at both Klaros and Didyma contains ethylene, along with other hydrocarbon gases including methane and ethane. Ever the cautious scientist, he said he needed to go back for more investigation.\* But, he said, “This gives us a good indication that a similar process was going on at all these places.”

We tried to investigate other oracular haunts over the next few days, but time had shifted the landscape and muddled evidence at many. Patara, once a seaside city said to host an oracle of Apollo, was sunken into silt and underbrush, leaving little to see. At Sura, ancient people had once bought kebabs that they tossed into a strange whirlpool—possibly a freshwater spring blending with the sea below the tide line—and priests told the future by observing the fish that gathered for the feast. We found the ruins of the temple there and a nearby spring, but the shoreline had long since receded, and the site itself was mired in a swamp. We hunted for Acharaca, a long-lost cave dedicated to the god of the underworld Pluto and his queen Persephone. There, sacrificial bulls led in were said to simply drop dead. Near the rumored site, we sniffed hydrogen sulfide—a sign that perhaps the bulls were victims of volcanic gases. Locals told stories of collapsed underground vaults, and warned of venomous snakes. Hale and de Boer, patient but weary, resolved to return some other time.

We also ventured to the ancient town of Hierapolis, whose ruins sprawl out over a mountain slope. Pure white terraces, formed of travertine-type minerals precipitating from dozens of chemical-laden springs, mantle the mountainside. The waters, used as a spa in ancient times and still available for wading or swimming, are said to treat high blood pressure, skin disease, rheumatism, and eye problems.

In the ruins above the spa was the place de Boer and Hale had come to see: a small oracle called the Plutonium. “It was supposedly an entrance to hell,” said Hale. Ancient authors write of a dense, deadly vapor issuing from it. Sacrificial animals such as sparrows were thrown in and quickly died. “Mysteriously taken by the god,” said Hale. The apparent portal is a tiny arched doorway cut into a cliff next to the ruins of a modest Apollonian temple. Except for a head-size gap, the door was closed off with a recent-looking block-and-mortar job. On a nearby wall was a partly obliterated Greek inscription. Hale struggled to make it out: “dreams ... earth ... oracle ...”

As we approached, we were struck with a terrible stench. It was hard to say if this came from the cave or two small dead porcupines on the marble pavement nearby. An elderly lady was sweeping up a pile of dead birds with a broom, like it was her regular job.

De Boer said that in the 1980s Turkish scientists had shown the vapor to be largely carbon dioxide, which can come from volcanic sources. Heavier than air, it can kill by displacing oxygen wherever it pools. They also identified whiffs of sulfuric acid and a few other asphyxiants and poisons. Ancient accounts said that while the sacrificial animals died in the Plutonium, the priests could go in and out unscathed. “I believe they had bladders of air under their robes,” said de Boer. “It must have made people really afraid.” Since our trip, German scientists have shown that carbon dioxide around the Plutonium tends to pool up in the cool of the night, creating a lethal layer a couple of feet thick. The concentration of the gas falls rapidly with height—so it could quickly suffocate animals close to the ground, while humans could wade through, safe and unperturbed.

In poking around before the trip, I had come across a vaguely sourced article in Omni magazine that asserted that two vacationing Australians had entered the Plutonium recently and disappeared. An equally vague website claimed, “Many people throughout history who went past the mouth of the cave never returned.” We were undeterred as we eyed that head-sized gap.

I volunteered. “Promise you’ll wave or something, if you’re passing out,” said Hale, as I prepared to look in. “Oh, sure. If I look like I’m slumping, just grab my legs and pull,” I said.

My head just fit through. A hot, humid billow burned my eyes. I held my breath and blinked as my vision adjusted to the darkness. In a cell-like room, a square shaft descended about six feet down, where a narrow black cleft curved to the right and out of sight. A dark shape lay on the floor, unidentifiable. Gasping for air, I pulled my head out.

Later, Fettah Anli, the friendly owner of the nearby Hal-Tur Hotel, told us he had grown up playing among the ruins. He was quite sure no one had ever disappeared in the Plutonium, but he did say that locals had once hung a sign over the door saying “Devil’s Hole,” and lowered small dogs and other unfortunate animals to their deaths for the entertainment of paying visitors.

Fifteen years ago, he went on, a tourist from New Zealand—he remembered the man’s name was Thomas—went swimming in a mineral-water pool nearby, and decided to explore a narrow underground feeder channel. “After he swam in, his wife kept waiting for him,” said Anli.

“But he did not come out. Then she started screaming.”

It took three days for a backhoe to reach Thomas’s body. He had become wedged in a tight spot 40 feet into the cave, and apparently drowned. It seemed that repeated retellings of the story had morphed his journey to the underworld into yet another myth.

\* This, sadly, would not happen. Jelle Zeilinga de Boer passed away before he got a chance to go back.

**Please visit the site: <https://www.atlasobscura.com/articles/where-are-the-greek-oracles> [Go there for pix, caps, and better format]**

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## **ANCIENT ROME’S COLLAPSE IS WRITTEN INTO ARCTIC ICE, BY ROBINSON MEYER**

Scientists can finally track the civilization’s economic booms and recessions—thanks to the exhaust of its massive coin-making operation, preserved for centuries in Greenland’s ice sheet.

On March 15, some time ago, several dozen famous politicians—sturdy men, duly elected senators who claimed to love their republic—attacked their chief executive while he walked into the Senate. They stabbed Gaius Julius Caesar 23 times, as he fell to the floor, defenseless, and bled to death, setting off a chain of wars that formally ended the Roman Republic and initiated the Roman Empire.

Some 2,062 years have passed since that day, but we haven’t stopped arguing about it. From Central Park productions of Julius Caesar to op-ed accusations of “Caesarism,” the Roman dictator—and the world he inhabited—still looms in our political conversation. Even the architecture of Washington, D.C., suggests that it is a kind of New Rome.

But for all those years, the source material for the arguments have remained largely the same. Archaeologists can locate new sites and excavate for coins, plates, or jewelry; scholars can read and reread Roman writers like Cicero, Sallust, and Catullus, who all documented Caesar. These have been the techniques for learning about Rome for centuries, and they are indispensable. But lately, they have been joined by something new.

On Monday, scientists announced the discovery of an entirely new resource that has the potential to remake some of those centuries-old arguments over Roman politics and history. A team of archaeologists, historians, and climate scientists have constructed a history of Rome’s lead pollution, which allows them to approximate Mediterranean economic activity from 1,100 b.c. to 800 a.d. They found it hiding thousands of miles from the Roman Forum: deep in the Greenland Ice Sheet, the enormous, miles-thick plate of ice that entombs the North Atlantic island.

In short, they have reconstructed year-by-year economic data documenting the rise and fall of the Roman Republic and Empire. The first news of the record was published Monday afternoon in Proceedings of the National Academy of Sciences.

Why does the amount of lead in the atmosphere tell us something about the Roman economy? “It’s a proxy for coin production. That’s the biggest thing,” said Seth Bernard, a professor of ancient history at the University of Toronto. When the Roman government needed to pay for something, it ordered the creation of new silver coins. These coins were produced, in part, in mines on the Iberian peninsula. But these mines didn’t excavate pure silver: Instead, they unearthed an ore of silver, lead, and copper that had to be smelted into silver. This process filled the air with lead pollution.

Once in the air, these lead emissions did not stay in one place. Instead, it wafted with the winds, eventually blowing into squalls and storms over Greenland. When these storms deposited lead-tainted snow or sleet over the Arctic

island, the precipitation fused with the ice sheet and became its newest layer. Century upon century of snow and ice fell on the ice sheet, burying but never disturbing that old layer of ice—until 1999, when climate scientists began coring the ice sheet at the NGRIP site. Four-inch tubes, documenting those ancient layers of snow and sleet, were hauled to the surfaces and pristinely preserved.

“There isn’t anything close to this detailed” documenting the Roman economy, said Joe McConnell, a professor of hydrology at the Desert Research Institute and one of the authors of the paper. “Our record is dramatically different both in its temporal resolution and in its dating precision.”

“The paper speaks for itself,” said Seth Bernard, who had early access to its findings but did not work on the research. “It feels sort of like we’ve discovered the Americas. There was another continent over there, that was always there, that we can see now. And I think that continent is scientific approaches.”

The new paper contains findings that Roman historians can already apply to their work. It finds that Rome’s economy waxed and waned, following well-documented events in its history, including wars and plagues. In 218 b.c., for instance, when Rome fought with Carthage in the Second Punic War, lead pollution appears to fall—and then it rises, abruptly, as Roman soldiers seized Carthaginian mines in southern Spain and put them to use. It also detects nonviolent events: When Rome debased its currency, reducing the amount of silver in each denarius coin in 64 a.d., lead pollution in the air fell.

And it provides crucial economic context for some of the most pivotal events in Roman history, including the death of Julius Caesar (and the birth of Jesus of Nazareth). The Crisis of the Roman Republic—the series of civil wars and political strife, spanning 134 b.c. to 27 b.c., that brought the Roman Republic to an end— were associated with a broad period of economic stagnation and disintegration, the study finds. And the early Roman Empire—especially the Pax Romana, the 206 years of mostly uninterrupted peace throughout the Mediterranean—were accompanied by an economic boom. When compared with other studies, research suggests that Western Europe may have seen higher lead emissions during the Pax Romana than at any time prior to the Industrial Revolution, nearly 1,800 years later.

This finding reverses a widely cited study from the 1990s that reached almost exactly the opposite finding. That paper, which used a similar but rudimentary technique to pull lead emissions out of the Greenland ice, argued that Roman economic productivity peaked during the late Republic, then stagnated throughout the entire Roman Empire. But that study drew from 18 data points; this new research made 25,000 different measurements of the ice core.

### **How Lead Emissions Align With Roman and Mediterranean History**

There’s a lot going on in this chart. It shows the varying amount of lead pollution in the air, as measured from an ice core taken from the NGRIP site in northeastern Greenland. It augments this timeline with major events in Roman history and, after 300 B.C., the silver content of Roman coinage. The letters at the very top signify individual historical events, as follows: A: the Punic Wars, B: the Sertorian War, C: the Civil Wars, D: the final pacification of Gaul and Spain,

E: the Antonine plague, F: the Plague of Cyprian, G: the Roman abandonment of Britain, and H: the collapse of the Western Roman Empire. (McConnell, et al. / PNAS) “Lead pollutants have become enormously important because they give us information that we don’t get from literary sources. The one chart that’s there—I can already see that chart being produced in 50 articles over the next 10 years,” said Bernard about the above graph.

“It’s great stuff.”

Lead emissions are not a perfect record of Roman prosperity, however, because scholars still don’t know how Rome thought about its economy.

Coins were clearly important: At the height of the Roman Empire, coins were so standardized that the same money could theoretically be used to buy goods, services, and slaves across modern-day Syria, Spain, Italy, and Turkey.

“The size of this integrated monetary zone is unparalleled,” said Bernard. “And the volume of coinage seems larger than any time before or afterward—it really shows the integration of the Roman economy and the level of trade that was going on.”

Yet for all these coins, it remains unclear how Rome managed its money in a modern sense. “What we’d love to have is a document that says Rome had a state monetary policy,” said Bernard. But none have ever been found. So scholars have argued about whether Roman leaders ignored liquidity or inflation, simply ordering a new round of coins whenever the government faced a large expense; or whether leaders managed money more strategically. Nero’s order to debase the currency in 64 a.d. suggests that the Empire, eventually, did see some value in increasing the amount of money in circulation.

The study would not have been possible without three methodological advances, researchers told me.

First, computer models of the atmosphere have significantly improved over the last two decades. These simulations allow scientists to estimate how air from the Iberian peninsula—air that, in Roman times, would have been full of lead pollution—wafted up to the Greenland ice sheet. It also allowed them to distinguish between air from the Iberian peninsula specifically and ambient air from farther east in Europe. This has its historical uses, too: The study documents a rise in ambient lead quality starting in 800 b.c., which coincides with the expansion of the wealthy Phoenician civilization into the western Mediterranean.

Second, chemists and hydrologists have become more adept at finding trace amounts of mineral in the ice core. In the 1990s, researchers could only analyze the pollution in ice cores by peeling tiny shavings of ice off of them. Now, labs use highly sensitive mass spectrometers to measure the presence of 35 different elements and chemicals at once.

These techniques are constantly improving. The new study uses more than 25,000 observations of the ice core across 2,000 years of time.

Alexander More, a climate scientist and a historian at Harvard University, told me that another team is working on a technique that can generate 2 billion data points across a 2,000-year ice core—and do it without destroying the ice in any way.

Finally, researchers have gotten better at precisely tying each of those observations to a specific year. Over the last decade, scientists have worked together across fields—including climate science, geochemistry, and volcanology—to unify the “dating” of important climate records. Most importantly, they have learned the precise year that every major volcanic eruption in the last 2,500 years occurred and identified these eruptions in a wide set of natural climate records. Ice cores from Greenland and Antarctica, as well as tree rings from around the world, all show a distinct chemical signature left behind by the eruption of the massive Indonesian volcano Samalas in 1257. Using that eruption and others, as well as a number of other anomalies, scientists can “count backward” in ice cores and tie each layer in the ice to a specific year.

“We think the uncertainty in our age scales is about one to two years, even in antiquity,” said McConnell, an author of the paper. “And that’s pretty good. It’s a lot better than what archaeologists are used to, I can tell you that.”

This specificity allows them to find precise political events in the ice. For instance, even though Rome took over Iberian mines after the Second Punic War, the peninsula saw revolutions and uprisings for centuries. Only in 19 b.c. did Rome’s first emperor, Caesar Augustus, conquer the rest of Gaul and place the entire colony under a new administration.

“The big increase [in lead pollution] corresponds exactly—and I mean exactly—to the pacification of Iberia and Gaul by Caesar Augustus. And [Iberia and Gaul] are where this pollution was coming from, so it all makes sense,” said McConnell.

That said, the lead record does not seem to mark a few major events in Roman history. The Plague of Justinian, which may have killed half the population of Europe in 541 and 542 a.d., does not seem to feature prominently in the record. Nor does the record encompass the full scope of the Roman coin-minting operation: Many important silver mines sat near Greece and the eastern Mediterranean, and their emissions probably did not make it to Greenland.

Alexander More, the Harvard researcher who was not affiliated with the research, said that even in this study, he remained “interested in knowing how the air [from Iberia] got over to Greenland.” His team’s own analysis of climate models suggests that air masses tend to travel from Europe’s northwest to its southeast, which is the opposite journey that these lead emissions would need to have made. “So there might be input from China here, we don’t know,” he said. “These are all things that need to be considered.”

But above all, he said that he was “very happy” to see the new work.

“We are very heartened by the fact that historians and climate scientists and archaeologists are working together to produce interdisciplinary research of this kind,” he said.

According to some scientists, lead poisoning played a role in the demise of Rome. So it’s ironic that lead provides its own record of what devastated the empire. Starting in 165 a.d., a plague swept out of the east and into the Roman world. The disease, dubbed the Antonine plague, caused fever, diarrhea, and skin pustules. (Some scholars believe it may have been smallpox.) It killed millions of Romans, and it devastated the Roman army in particular.



Solving the Mystery of an Ancient Roman Plague The Roman economy never recovered. Lead emissions plunged that year, hitting a new baseline that persisted for several centuries. Only in the late fourth century, when a Germanic tribe overthrew the last Western Roman emperor, did emissions fall even lower.

It is a new input in an argument—did plagues doom the Roman empire?—so careworn that even the 18th-century historian Edward Gibbon, who wrote 4,000 pages on Rome’s decline, wearied of debating it. And like the rest of the study, it will change how classicists like Seth Bernard go back to the primary sources.

“How we read Cicero, how we read our historical sources of the Gracchi—it does feel like we have new material that we’ve never had access to before,” he told me. “The opportunity lies in taking this new data and rethinking what we have.”

And it “all makes sense” that ancient historians would find succor in climate science, he said. “We’ve known for a very long time that if you’re in a world that relies on human power, and calories, and energy—and thus the sun—then what the sun is doing, and what climate is doing, matter a lot,” he said.

To that, I would add only: You do not need to return to Catullus and Caesar, Cicero and Catiline, to find a civilization that ran on calories and human power, that relied on the sun and the stable climate. Nor was ancient Rome the only civilization that scattered its exhaust to every corner of the Earth, leaving a record of itself that would have been unimaginable to its own citizens. If you wish to seek out such a civilization, then congratulations: You are living in one right now.

**Please visit the site: <https://www.theatlantic.com/science/archive/2018/05/scientists-reclaim-the-long-lost-economic-history-of-rome/560339/>**

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## **DID SYRIA CREATE THE FIRST SONG? BY LEILA MOLANA-ALLEN & LIZZIE PORTER**

Syria's musical traditions show histories and cultures that transcend contemporary politics and war. This is a country that gave the world song.

In Syria, music runs deeper into the fabric of the place than anywhere else in the world.

Long before the modern state was formed in 1946, Syria had developed rich musical traditions over thousands of years. The diverse religions, sects and ethnicities that inhabited and travelled across the country over the millennia – Muslims, Christians, Jews, Arabs, Assyrians, Armenians and Kurds, to name but a few – all contributed to this eclectic musical heritage.

### **Songs of ancient Syria**

In the 1950s, archaeologists found 29 3,400-year-old clay tablets in a small cubicle – likely a library – in the ancient port city of Ugarit on Syria's Mediterranean coast. They were mostly broken into tiny fragments, but one, which came to be known as H6, remained in larger pieces. Inscribed on it were lyrics, and underneath them is what researchers believe is the earliest example of musical notation anywhere in the world.

These shards of clay are the beginnings of an incomparable musical heritage.

Academics have spent years literally piecing together the tablets, trying to work out what was written on them, what it meant and how the musical notation might sound were it to be played again. The text is in Babylonian cuneiform script, a system of writing that spread throughout the region several millennia ago.

We could read the script... but we didn't have any idea what it meant

“The problem with this tablet is that – we could read the script because it was written in Babylonian cuneiform, and we know the value of the signs – but we didn't have any idea what it meant,” said Richard Dumbrill, professor of archaeomusicology at Babylon University in Iraq, who has worked on the Ugarit tablets for more than two decades.

Dumbrill described how he attempted on many occasions to reconstruct the Ugarit tablets in order to translate the text and music inscribed on them: “I took photographs and I tried to build them as a puzzle, but some had been damaged beyond reconstruction.”

The translation difficulties were a product of the text being written in a language known as Hurrian from the north-east Caucasus, probably in modern-day Armenia, but which ended up in Syria's fertile lands.

“These people migrated towards north-west Syria – it took them a good couple of thousand years – and decided to use the Babylonian signs to write their text and their music,” Dumbrill said. “So it was extremely difficult to translate. However, I managed to find out that the text below the two lines were musical names that were Hurrianised –

that is, they were Babylonian but had been transformed on contact with the Hurrian people. And I could find out that it was a melody. It took me about 20 years to translate.”

So what does the earliest musical composition tell us about the people who lived at that time? From Dumbrill’s translations, he believes they had catalogues of songs for occasions of all sorts and moods, not just hymns for religious events.

One song details a bar girl selling beer to her clients, but the tablet known as H6 details a more sober story.

“It’s about a young girl who cannot have any children; she thinks that the reason is because she misbehaved in some way, which is not mentioned,” Dumbrill said. “And from what we can understand of the text, which is quite limited, she goes at night to pray to the goddess Nigal, who was the goddess of the moon. She brings a little pot of tin with sesame seeds or sesame oil in it, which she offers to the goddess, and that’s all we know about the text.”

### **An ancient musical workshop**

But Syria did not produce only the earliest melody. Over time, a rich array of musical instruments on which to play them also formed across the region, such as the lyre, a stringed musical instrument with a yoke and a crossbar, and lutes, which evolved into the modern Arabian oud, a teardrop-shaped plucked string instrument that produces one of the most evocative sounds in the region.

At Mari, an Early Bronze Age city-state on the banks of the Euphrates river in eastern modern-day Syria, researchers in the 20th Century uncovered a number of records detailing the musical instrument-making business of the time.

“There in the palace [at Mari] we discovered a huge number of tablets which were mainly letters and receipts of material from artisans who were requesting leather, raw hide, wood, gold and silver for making instruments,” Dumbrill said. “Therefore we have a very good idea about the instruments that were made about 4,000 years ago. We knew the names of the artisans, we knew the type of instruments they made. They were already influenced by instruments which were not Syrian,” he added, citing the Iranian parahshitum as an example, a type of lyre that became very popular among the girls of the harem at Mari.

Production of musical instruments continued to flourish in Syria over the centuries, and many are preserved in collections open to visitors today.

At the Debbané Palace in the Lebanese coastal city of Saida, for example, a collection of Ottoman-era musical instruments, dating from around the 19th Century, gives visitors an insight into the traditions present across both Lebanon and Syriabefore the formation of the modern states. Pieces from Syria include ouds and bouzouks (a small lute with a long, slim arm) inlaid with wood and ivory.

“People [visiting] ask, why are there so many musical instruments?” said Ghassan Dimassy, a guide at the Debbané Palace. “We tell them that this is an Ottoman house and the women used to sit and sing.” He mimicked the women playing a musical instrument

and the men lying back and relaxing; here, music was the essential backdrop to any leisure occasion.

### **A music in exile**

Last year, Syrian authorities launched a bid to have Aleppo, Syria's second city, added to Unesco's Creative Cities Network as a 'City of Music' to commemorate its heritage. During the 17th Century, Aleppo was renowned for its muwashshah, a form of music combined with lyrics from Andalusian poetry, classical Arabic poetry, or, later on, Syrian or Egyptian conversational Arabic. Muwashshah are performed by a band playing the oud and qanun (a horizontal board with strings plucked to produce a haunting sound like trickling water), as well as the kamanja (a violin-like instrument), a darabukkah (drum), and a daf (tambourine). The form thrived in the city, where it was embraced by both Muslim and Christian populations.

However, significant efforts to preserve Syria's musical traditions are now also found outside this country, which has entered its eighth year of conflict and where civilians have in large part been forced to focus attention on survival rather than exploring their cultural heritage. Some Syrian youth are making the best of a difficult situation and are bringing Syria's rich musical history into the limelight.

Long an incubator of creative talent, Beirut has become a crucible for preserving Syrian musical heritage. Me'zaf, an organisation founded in the Lebanese capital in 2015, aims to innovate, promote and preserve authentic music from not just Syria, but the Levantine region as a whole, showing how the Middle East's rich musical traditions precede the modern nation-state borders introduced in the 20th Century.

"A lot of forms were created in Damascus or Aleppo and were taken to Cairo, then forms were created in Cairo and performed in the Levant," explained Ghassan Sahhab, a Me'zaf leader and Lebanese musicology teacher, composer and qanun player. "We have a rich culture and we have to appreciate it and know our history in order to continue. At the moment, it's a case of preserving heritage and culture."

Another musical troupe that formed in Beirut is Assa'aleek, which consists of five Syrians and a Norwegian. The band's name means 'the ragamuffins' or 'the vagabonds' in Arabic, and refers to a group of self-proclaimed Robin Hood-type characters who lived during the pre-Islamic era in the Arabian Gulf and tried to change the ways of the ruling class.

"We are similar to the Assa'aleek: we were forced out of our communities and homeland for many reasons," said Abodi Jatal, percussion player in Assa'aleek.

"It is important to preserve ancient Syrian music because this is our identity, it is history and it is civilisation, after all. This is what we have. This is what we are," said Assa'aleek vocalist Mona Al Merstany. "It's not just about a normal country – it's one of the most ancient countries. It is important to show such things because all people have the right to see beauty."

It is important to preserve ancient Syrian music because this is our identity

They see music as a way of fighting the injustices faced on a daily basis by people in the region.

“Our lyrics and songs, this is what they are built on,” Jatal said.

“We wanted to fight against bad habits, such as harassment against women, and we saw that this is really similar to what the Assa'aleek did, so that's why we used the name.”

As well as new songs, the band has been performing Syrian folk music since 2013, bringing music from across Syria's diverse landscapes and communities to audiences in Lebanon.

Syrian music heritage has come a long way since the melody found on the clay tablets at Ugarit. Today, bands such as Assa'aleek are reinventing the definition of Syrian music, bringing it to new audiences.

Over time, a rich array of musical instruments formed across what is now Syria (Credit: Leila Molana-Allen)

Meanwhile, they are developing the sounds that museoarchaeologists of the future might one day find, stored on computers, in files or drawers, in Aleppo, Damascus or Beirut, or even Paris, London or Berlin.

Al Merstany sums it up well: “When someone asks me what is Syria, this is what I have to say: the music, the art.”

**Please visit the site: <http://www.bbc.com/travel/story/20180424-did-syria-create-the-worlds-first-song> [Go there for pix]**

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## **HOW A BACKYARD PENDULUM SAW SLICED INTO A BRONZE AGE MYSTERY - RESEARCHER'S SWINGING BLADE OFFERS GLIMPSE INTO HOW ANCIENT MYCENAEANS BUILT PALACES, BY BRUCE BOWER**

Nicholas Blackwell and his father went to a hardware store about three years ago seeking parts for a mystery device from the past. They carefully selected wood and other materials to assemble a stonecutting pendulum that, if Blackwell is right, resembles contraptions once used to build majestic Bronze Age palaces.

With no ancient drawings or blueprints of the tool for guidance, the two men relied on their combined knowledge of archaeology and construction.

Blackwell, an archaeologist at Indiana University Bloomington, had the necessary Bronze Age background. His father, George, brought construction cred to the project. Blackwell grew up watching George, a plumber who owned his own business, fix and build stuff around the house. By high school, the younger Blackwell worked summers helping his dad install heating systems and plumbing at construction sites. The menial tasks Nicholas took on, such as measuring and cutting pipes, were not his idea of fun.

But that earlier work paid off as the two put together their version of a Bronze Age pendulum saw — a stonecutting tool from around 3,300 years ago that has long intrigued researchers. Power drills, ratchets and other tools that George regularly used around the house made the project, built in George's Virginia backyard, possible.

“My father enjoyed working on the pendulum saw, although he and my mother were a bit concerned about what the neighbors would think when they saw this big wooden thing in their backyard,” Blackwell says.

Anyone walking by the fenceless yard had a prime view of a 2.5-meter-tall, blade-swinging apparatus reminiscent of Edgar Allan Poe's literary torture device.

No one alive today has seen an actual Bronze Age pendulum saw. No frameworks or blades have been excavated. Yet archaeologists have suspected for nearly 30 years that a contraption capable of swinging a sharp piece of metal back and forth with human guidance must have created curved incisions on large pieces of stonework from Greece's Mycenaean civilization. These distinctive cuts appeared during a century of palace construction, from nearly 3,300 years ago until the ancient Greek society collapsed along with a handful of other Bronze Age civilizations. Mycenaeans built palaces for kings and administrative centers for a centralized government. These ancient people spoke a precursor language to that of Classical Greek civilization, which emerged around 2,600 years ago.

In Blackwell's view, only one tool — a pendulum saw — could have harnessed enough speed and power to slice through the especially tough type of rock that Mycenaeans used for pillars, gateways and thresholds in palaces and some large tombs.

Kings at the time valued this especially hard rock, known as conglomerate, for the look of its mineral and rock fragments, which form colorful circular and angled shapes.

In the early 20th century, archaeologists excavating a Mycenaean hill fort called Tiryns first noticed curved cut marks on the sides of pillar bases and other parts of a royal palace. The researchers assumed that ancient workers sliced through conglomerate blocks with curved, handheld saws and a lot of elbow grease.

Some investigators still suspect that handheld saws make more sense than a swinging pendulum blade. But scholarly opinions began to change as similar marks were found on stonework at other Mycenaean sites, including the fortified town and citadel of Mycenae. Separate reports in the 1990s by German archaeologists proposed that a pendulum device produced curved Mycenaean masonry marks. One of the researchers estimated that a pendulum saw would have needed to swing from a massive arm, between 3 meters and 8 meters high, to create the observed curved cuts. His calculations rested on an assumption that the curved saw marks represented segments of perfect, geometric circles, which in some cases would have required the wide arc of an especially tall pendulum.

Blackwell doubted that Mycenaeans used pendulum saws as tall as 8 meters, the equivalent of about 2½ stories. But there was only one way to find out. His experiments, described in the February *Antiquity*, indicate that a wooden contraption supporting a blade-tipped swinging arm had to reach only about 2½ meters high to create stone marks like those at Tiryns and Mycenae.

The Indiana researcher's homemade pendulum saw "is the most persuasive reconstruction of a Mycenaean sawing machine that was used to cut hard stones, especially conglomerate," says archaeologist Joseph Maran of the University of Heidelberg in Germany. Only one other life-size model of a pendulum saw exists.

### **Swing time**

Blackwell's experimental cutting device swung into action in December 2015 right where it was built, in his parents' Virginia backyard.

Positioned on opposite sides of the apparatus, Blackwell and his brother-in-law, Brandon Synan, pulled the sawing arm back and forth with a rope. A metal blade bolted to the bottom of the arm sliced into a limestone block. Unlike the type of conglomerate used in the Mediterranean region, limestone was readily available. The two tested four types of saw blades in the initial trials and again in February 2017.

Blackwell reviewed seven previously published designs and the one actual model of a pendulum saw that may have been used by a nearby Bronze Age society; they offered little encouragement. No consensus existed on the best shape for the blade or the most effective framework option. Designers were most notably stumped by how to build a pendulum that adjusted downward as the blade cut deeper into the stone.

Blackwell decided to build a device with two side posts, each studded with five holes drilled along its upper half, supported by a base and diagonal struts. A removable steel bar ran through opposite holes on the posts and could be set at different heights. In between the posts, the bar passed through an oval notch in the upper half of a long piece of wood — the pendulum. The notch is slightly longer than a dollar bill, giving the steel bar some leeway so the pendulum could move up and down freely while sawing.

Finally, the apparatus needed a tough, sharp business end. A Greek archaeologist that Blackwell met while working at the American School of Classical Studies at Athens from 2012 to 2015 put him in touch with a metalsmith from Crete. The craftsman fashioned four bronze blades with different shapes for testing on the pendulum saw: a long, curved blade; a triangular blade with a rounded tip; a short, straight-edged saw and a long, straight-edged saw with rounded corners. During tests with each blade, Blackwell added water and sand to the limestone surface every two minutes for lubrication and to enhance the saw's grinding power.

Blackwell suspected the triangular blade would penetrate the limestone enough to produce the best replicas of Mycenaean's arced cuts. He was wrong. Putting that blade through its paces, he found that only the tip creased the stone as the pendulum swung. The triangular blade yielded a shallow, wobbly groove that would have sorely disappointed status-conscious Mycenaean elites.

The short, straight blade did even worse. It repeatedly got stuck in the stone block during trials.

But in a dramatic showing, the long, curved blade left three concave incisions that looked much like saw marks at Tiryns. It took 45 minutes of sawing to reach a depth of 25.5 millimeters, a partial cut by Mycenaean standards. Blackwell and his brother-in-law took short breaks after every 12 minutes of pendulum pulling. "It takes a lot of physical effort to use a pendulum saw," Blackwell says.

The elongated, straight blade with rounded corners proved easiest to use. It made one Mycenaean-like cut after only 24 minutes of sawing. Either the straight or the curved blade could have fit the bill for Mycenaean stoneworkers.

Close inspection of successful experimental cuts showed that Blackwell's pendulum saw created curved incisions that were not segments of perfect circles. So an actual Mycenaean pendulum saw need not have been as tall as those earlier calculations had called for.

Blackwell suspects that Mycenaean masons tied or glued blades to one side of a pendulum's arm. After sawing deep enough so that the pendulum's wooden end hit rock, a worker chiseled and hammered off stone on one side of the incision so that the blade could be lowered for deeper sawing. Repeating those steps several times eventually left a flat face at the incision.

A half-finished pillar base from Mycenae preserves evidence of this procedure, Blackwell says. The stone displays a long, curved cut on a flat, vertical surface near one



of its sides. The cut abruptly stops partway down. At that level, stone abutting the incision shows signs of having been pounded off.

### **Ghost saw**

Even after Blackwell's hands-on experiments, the Mycenaean pendulum saw remains an archaeological apparition. Some researchers believe it existed. Others don't.

"Pendulum saws could have been a solution to Mycenaeans' specific problem of having to work with conglomerate," says archaeologist James Wright of Bryn Mawr College in Pennsylvania. Mycenaean conglomerate is considerably harder and more resistant to cutting than other types of rock that were available to the Mycenaeans and neighboring societies.

Blackwell's successful experimental incisions in limestone "conform with cut marks on Mycenaean stones," Wright adds. The next step is to see how Blackwell's pendulum saw performs on the tougher challenge of slicing through conglomerate.

While Blackwell's experimental device produces Mycenaean-style curved cuts, that doesn't mean Mycenaeans invented and used pendulum saws, contends archaeologist Jürgen Seeher of the German Archaeological Institute's branch in Istanbul. Seeher built and tested the only other reconstruction of a pendulum saw.

In a 2007 paper published in German, Seeher concluded that there was a better option than his pendulum saw: a long, curved saw attached to a wooden bar and pulled back and forth by two people, like a loggers'

saw. A loggers' saw could have produced curved marks on palace stones of ancient Hittite society, which existed at the same time as the Mycenaeans in what is now Turkey.

Unlike their Greek neighbors, Hittites did not construct pillars and gateways out of conglomerate. But a handheld, two-man saw would have enabled something a pendulum saw could not: precise cutting of conglomerate blocks from different angles, Seeher says.

"A handheld saw moved by two men is much more under control than a free-hanging pendulum," he says.

Seeher has archaeological evidence on his side. Double-handled loggers' saws have been excavated at sites from the Late Bronze Age Minoan society on Crete. Hittites and Mycenaeans, contemporaries of the Minoans, could easily have modified that design to cut stone instead of wood, Seeher proposes. They would have had to substitute rock-grinding straight edges for wood-cutting serrated edges.

Blackwell disagrees. He is convinced that Mycenaean craft workers trained for years to operate pendulum saws, just as skilled artisans like his dad go through a long apprenticeship to learn their trade.

Mycenaeans may have worked in teams that took turns using pendulum saws to cut conglomerate into palace structures, he speculates. Those workers probably used highly abrasive emery sand from the Greek island of Naxos to amplify the grinding power of their swinging saws, Wright adds.

Blackwell worked with his own family team to create a rough approximation of what a Mycenaean pendulum saw may have looked like and how it was handled. His father's construction expertise was crucial to the project. But those teenage summers doing scut work at building sites probably didn't hurt, either.

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This article appears in the April 28, 2018 issue of Science News with the headline, "Making the cut: Swinging blade slices into Bronze Age mystery."

#### Citations

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**Please visit the site: <https://www.sciencenews.org/article/how-backyard-pendulum-saw-sliced-bronze-age-mystery>**

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## **NEW SURVEY CONFIRMS NO HIDDEN NEFERTITI CHAMBER IN TUTANKHAMUN'S TOMB**

The result of a third radar survey show conclusively that there are no hidden chambers in the tomb Nevine El-Aref

After almost three months of study, a new geophysics survey has provided conclusive evidence that no hidden chambers exist adjacent to or inside Tutankhamun's tomb in the Valley of the Kings.

Mostafa Waziri, secretary general of the Supreme Council of Antiquities, announced the results, adding that the head of the Italian scientific team carrying out the research,

Francesco Porcelli of the Polytechnic University of Turin, is to provide all the details of the ground penetrating radar (GPR) studies during his speech to be delivered on Sunday evening at the ongoing Fourth Tutankhamun International Conference.

Waziri said that a scientific report was submitted on Sunday morning to the Permanent Committee for Ancient Egyptian Antiquities by Porcelli and his team, which included experts from the nearby University of Turin and from two private geophysics companies, Geostudi Astier (Leghorn) and 3DGeoimaging (Turin), who collected GPR data from the inside of Tutankhamun's tomb in February 2018.

According to the report, which Ahram Online has obtained, Porcelli said that the GPR scans were performed along vertical and horizontal axes with very dense spatial sampling. Double antenna polarisations were also employed, with transmitting and receiving dipoles both orthogonal and parallel to the scanning direction.

Porcelli asserted that the main findings are as follows: no marked discontinuities due to the passage from natural rock to man-made blocking walls are evidenced by the GPR radargrams, nor there is any evidence of the jambs or the lintel of a doorway.

Similarly, the radargrams do not show any indication of plane reflectors, which could be interpreted as chamber walls or void areas behind the paintings of the funerary chamber.

“It is concluded, with a very high degree of confidence, that the hypothesis concerning the existence of hidden chambers or corridors adjacent to Tutankhamun's tomb is not supported by the GPR data,” Porcelli said in the report.

This is the third GPR survey to be conducted inside the tomb in recent years. It was designed to stop the controversy aroused after the contradictory results of two previous radar surveys to inspect the accuracy of a theory launched in 2015 by British Egyptologist Nicholas Reeves, who suggested that the tomb of queen Nefertiti could be concealed behind the north and west wall paintings of Tutankhamun's burial chamber.

The theory was supported by former minister of antiquities Mamdouh Eldamaty, who agreed to conduct two GPR surveys. The first was conducted by a Japanese professional who asserted with 95 percent certainty the existence of a doorway and a hall with artefacts.

The second radar survey was carried out with another high-tech GPR device by an American scientific team from National Geographic, who rejected the previous Japanese results and asserted that nothing existed behind the west and north wall of Tutankhamun's burial chamber.

To solve the difficulties encountered by the two preceding surveys and provide a conclusive response, the current antiquities minister, Khaled El-Enany, who took office in March 2016, decided to discuss the matter at the second International Tutankhamun Conference, which was attended by a group of pioneer scholars and archaeologists who decided to conduct a third GPR analysis to put an end to the debate.

**Please visit the site:**

<http://english.ahram.org.eg/NewsContent/9/40/298932/Heritage/Ancient-Egypt/New-survey-confirms-no-hidden-Nefertiti-chamber-in.aspx>

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