

October 19, 2022 • Modern K'iche' Maya Long Count: 0.0.9.17.9 • 5 Muluc 2 Sac • G7

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**Preserving Underwater Maya Finds** 



Sharpened ends of building posts from the Paynes Creek Salt Works, preserved in mangrove peat below the sea floor. Check out: <u>www.underwatermaya.com</u> Photo by Heather McKillop.

As sea level rose during the Holocene, red mangroves (*Rhizophora mangle*) grew taller to keep their leaves above the shallow water along the coast of Belize. The mangrove prop roots trapped detritus, silt, and sediment, which created peat. This organic, oxygen-free sediment preserved the wooden building posts of hundreds of structures built by the Classic Maya as salt kitchens where brine was boiled in clay pots held up by solid clay cylinder supports over a fire. The water evaporated, leaving salt, a valued commodity in short supply at nearby inland cities. The loose salt was hardened over a fire to produce salt cakes transported by canoe along the coast and up rivers to marketplaces (McKillop 2019).

The abundant "briquetage" (salt-making pottery) at some of the Paynes Creek Salt Works indicates the pots were broken at the salt kitchens, similar to the salt industry at some modern highland villages near salt springs, such as Sacapulas (Reina and Monaghan 1981). In some cases, the



Jim Reed,

Editor



Heather, always happy to get wet!

pots, as documented by ethnoarchaeological fieldwork in the Philippines by Andrea Yankowski. Cynthia Robins found thousands of tiny salt sherds at Aventura site in northern Belize that she suggests may indicate transport of salt to the city in pots.

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### The Long Count of Bars and Dots by Edwin Barnhart

I can't remember the first time I met Sid, but by 2006, I was bringing students to his hacienda just outside Merida. With a dry erase board on his back patio, he'd dazzle them with his knowledge of Maya calendars and mathematics until their eyes crossed, then his wife. Feli, would serve a wonderful Yucatec lunch buffet by the pool. What were Sid's gualifications



The website introductory image. Go to: barsanddots.com

to teach Maya mathematics? He created the world's first Maya calendar conversion software, Bars and Dots.

Sometimes after those nights or when my travel courses were done, I'd return to Sid's place to talk about the Maya calendar. He would challenge me with Maya math puzzles and show me the latest software programs he was working on. Those little programs were child's play compared to the final version of his original program - Bars and Dots Pro. He wrote it in old DOS-based language and wasn't prepared to redo the thousands of lines of code it took to modernize the software. By 2007, he and I were scheming about how to make an updated version.

In 2008, I tried my hand at making a Maya calendar conversion iPhone app. With the help of software developer Michael Duatermann, I made a simple version and published it as "Maya Calendar" (it's still out there today). It had a fun new Maya birthday calculator, but its math was nothing like - as Sid liked to call it - BD Pro.

There were many other Maya calendar correlation softwares created over the years, but none quite as impressive as **Bars and Dots**. Yes, it could convert Maya dates to Christian dates and vice versa, but could also do so much more. You could input a calendar round and it would tell you all possible long count dates upon which it could occur. You could enter Maya distance numbers and add them up. It could break down a Maya date into its prime factors, search for even increments of important Maya numerological cycles, and tell you where it landed in the cycles of various celestial bodies. It tackled complex topics like the Dresden Codex Serpent Pages and the 819 Cycle. Perhaps most important of all, it allowed you to enter a partial date - like so many eroded monuments have - and provide a full list of possible solutions to complete it. The mathematical modeling that Sid had to understand in order to write that code is mind boggling!

Sid first created Bars and Dots in the early 1970s. By the 80s, it had become the go-to software for major Maya scholars like my mentor Dr. Linda Schele. She taught me how to use it, so I knew Bars and Dots before I even knew Sid. Unfortunately, as computer technology advanced and DOS operating systems became obsolete, Bars and Dots was collateral damage. Modern

computers wouldn't run the program anymore.

Sid and I just... talked about it. Wouldn't it be great to make a new version of Bars and Dots? Think of

how much more we could make it do now! But who could do the modern coding? And how would we find the money to hire them?

As Sid's years advanced and his health declined, I grew more determined to help him modernize his amazing software. Then in 2018, while talking with my math professor and friend Curt VanderVere, he offered to help me find a capable computer programming student at his college to help. Consulting with his colleague Rob Cooley, they suggested a sharp young programmer named Ethan Yoder. After a bit of correspondence between Ethan, Sid, and I, we agreed to work together. Maya Exploration Center would fund a two-week trip for Ethan to visit Sid in Yucatan. Sid would walk Ethan through the old DOS software and Ethan would code a new version as his senior research project at Pennsylvania College of Technology.

The visit went well enough, and Ethan returned to Pennsylvania that fall to create the program. He had a good start, but then the problems began. In retrospect, trying to get two programmers together with a 50+ year age gap was a challenge I hadn't anticipated; Ethan wanted to make it open-source code, and Sid disagreed. Sid was his normal gruff and overly direct self, which Ethan did not respond well to. Ethan had ideas about a modernized look and feel, but Sid insisted that his original blue screen with yellow font were non-negotiable. In the end, Ethan had 90% of the program up and running, but there were some math errors and bugs that Sid couldn't live with. Sid outright refused to allow his name to be associated with the project, and Ethan said simply, "here's the program, don't contact me anymore." My dreams of a Bars and Dots reborn had crashed upon the rocks of bad communication.

I had just about given up, but fortune smiled down upon the project once more. In the summer of 2020





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### Preserving Underwater Maya Finds Using 3D Technology with Heather McKillop

Louisiana State University continued from page I

Wooden structures lacking stone foundations were preserved in mangrove peat below the sea floor in a coastal lagoon in southern Belize at the Paynes Creek Salt Works. What was preserved was the base of each post that had been dug into the ground when the buildings were constructed. A total of 4042 wooden posts were mapped, with many more discovered in water too deep or remote to map with a total station (McKillop 2019).

The significance of the discovery of the preserved wooden buildings (as well as wooden objects) is that wood normally decays in the tropical landscape at Maya sites. However, pole-and-thatch buildings were likely common for residences, workshops, storage, and other structures. The remains of wooden structures that have decayed are visible in the modern landscape from mounded remains of stone foundations and artifacts. At the Paynes Creek Salt Works, we have the actual buildings, which provide a model of ancient Maya wooden architecture for other sites.

The preservation of wood was a conservation nightmare, since the wood was salt-waterlogged. To prevent wood from drying and cracking when exposed to air, each post or wood object is kept in water. Even pottery is kept in water and desalinated, since the salt moves to the artifact surface as the object dries, cracking and exfoliating the surface. Some wood objects, including the Ka'ak' Naab' canoe paddle and the wooden handle with the jadeite gouge, were professionally preserved in the Preservation Lab at Texas A&M by C. Wayne Smith and Helen DeWolf (McKillop 2005, McKillop et al. 2019). Despite conservation, the Ka'ak' Naab canoe paddle continued to crack, from alternating dry and wet setting in antiquity! We filled the cracks with crazy glue, following advice from the lab.

Creating 3D digital images would be the solution to preserve a record of the salt-waterlogged wood and pottery. In 2009, I created the LSU DIVA Lab (Digital Imaging and Visualization in Archaeology) with funds from a Louisiana Board of Regents grant for 3D scanners, a 3D printer, and software. In January 2010, I made a 3D image of a stone adze using one of our new NextEngine 3D scanners and made a 3D-printed replica using our 300-lb Dimension Elite 3D printer. Twelve years later, in 2022, we are still using the same 3D printer, but have expanded our 3D technology.

Since 2011, we took NextEngine 3D scanners to image waterlogged finds at our field camp. Since 2019, we have used an Artec Space Spider in the field, with doctoral student Cher Foster doing a "scantastic" job of imaging huge wooden posts, ocarinas, and other decaying objects at our field camp from a gas-powered generator. The Space Spider, purchased on my current NSF grant ("Labor Relations in a Traditional Complex Society" with Dr. Cory Sills) is faster and more accurate, but an expensive piece of equipment.

The use of 3D technology has allowed the Underwater Maya team to make 3D-printed replicas of Maya artifacts for exhibits, outreach, and teaching. There are several



Modern Pole-and-Thatch buildings in a traditional Maya village. Photo courtesy of John Anderson, LSU Cartographic Information Center.



Exhibit featuring 3D printed replicas of artifacts and wood post samples from the Underwater Maya project at the Tourism Information Center, Punta Gorda, Belize, April 2012 (funded by a "Site Preservation Grant" from the AIA–Archaeological Institute of America. (left to right in the photo are Robert (administrator of the center), Heather McKillop, John Young (Boat charter/team member), and Cory Sills. Photo by Jill Planner, Punta Gorda.

advantages of using 3D-printed replicas instead of the actual artifacts! The 3D-printed artifact replicas have no monetary value on the International Antiquities market. There is no government permission required for exhibiting replicas, although I consult with the Belize Institute of Archaeology so they are aware of our outreach activities. Most importantly, the use of 3D-printed replicas of Maya artifacts makes "artifacts" accessible to a wide public audience.

With funding from a Site Preservation grant from the AIA (Archaeological Institute of America), we opened a permanent exhibit in Punta Gorda (above). At the request of the marine tour guides, we also opened an exhibit at the Ranger Station in Paynes Creek National Park. As the main users of the park for fly-fishing, the marine tour guides protect the site; they suggested the exhibit at the ranger station would add value to the tours they take. The DIVA lab scientists have done outreach at various venues, including over 5000 attendees at a Maker-Fair in Baton Rouge (page 6).



# The Long Count of Bars and Dots

### by Edwin Barnhart continued from page 2

a software developer from Seattle, Matt Neel, contacted me. Years earlier, I had helped him create a 3D model of Palenque's Temple of the Sun for a college assignment. He was writing to say thanks and see if he could repay my kindness with another 3D model. As we got talking, I realized that he also had a deep interest in the Maya Calendar. One thing led to another, and by that fall he was helping me fix and expand Ethan's program!

I told Sid about our plans and he was understandably skeptical, but as Matt knocked out problem after problem, Sid got excited again. Alas, his health continued to decline. His kidneys were failing and, at his age, doctors were reluctant to attempt the necessary surgery. On June 10, 2021, Sid emailed me this:

"Look, the project is yours. If you want to open it up for tests that's ok (sic) with me. Call it what you want, just mention something to the effect that it is your and your programmer's interpretation of with permission of SH. Final product and interpretation is solely Ed and Matt."

My final correspondence thread with Sid started over the 2021 Thanksgiving holiday with a cryptic email reading simply, "Am I believing my eyes? Is this the results of your programmer?"

Now with Sid, that could have been bad. But a follow-up call showed he was in fact very happy with all the work Matt had done. He started once again actively assisting me, sending screen shots annotated with

Sid alongside one of the carved/painted billars inside the recently excavated/consolidated Temple of the Tables, which is right next to the Temple of the Warriors, at Chichen Itza. March 24. 2006. Photo: courtesy of Evan J. Albright.



debugging advice. My last email from him was February 15, 2022.

As the IMS community knows well, Sid passed on May 19, 2022. I'm truly thankful that Matt and I secured his blessing to honor his legacy with a new version of Bars and Dots. It's up on the internet at:

#### www.barsanddots.com

free for all to use. Sid wouldn't have liked that part. He wanted me to monetize it and buy Feli a car! It's still a work in progress, but it has everything Sid's original program could do – plus, thanks to Matt, a bit more. We encourage the IMS community to give it a test drive and share any comments or suggestions they have. If you have anything to contribute, we welcome that, too.

Bars and Dots lives again! Matt and I are proud to stand on the mathematically genius shoulders of my friend, Sid Hollander. May he rest in peace and never be forgotten.

#### **Great Courses, Podcast, and So Much More!** featuring Edwin Barnhart Dr. Edwin Barnhart

Dr. Edwin Barnhart, director of the Maya Exploration Center, has over twenty five years of experience in Central, South, and North America as an archaeologist, an explorer, and an instructor. He is a widely recognized authority on ancient astronomy, mathematics, and calendar systems. During his over 20 years in Latin American archaeology, he has discovered the ancient city of Ma'ax Na in Belize, mapped over 4,000 ancient buildings, and published over a dozen articles and books. He has appeared in over a dozen documentaries and given presentations all over the world.

His involvement in Maya studies began in 1990 as an archaeological intern in the ruins of Copan, Honduras. In January of 1996, he was invited to return to Copan and help the University of Pennsylvania excavate the early acropolis and the tomb of the city's lineage founder. From 1992-1995 he studied art, iconography, and epigraphy (hieroglyphic translation) under the late Dr. Linda Schele at the University of Texas at Austin. During that same time, he worked across the state of Texas as a contract archaeologist.

Dr. Barnhart received a Ph.D. from the University of Texas at Austin in 2001 with his dissertation entitled ) 🗩 🌰 🜰 "The Palenque Mapping Project: Settlement

Patterns and Urbanism in an Ancient Maya City". Upon graduation, he and his colleagues established Maya Exploration Center (MEC) through which to continue and share their research. As of 2020, he has led and/or organized over 200 ancient



In 2012, he made his first lecture series for the Teaching Company's Great Courses entitled "Lost Worlds of South America". His second Great Course entitled "Maya to Aztec: Ancient Mesoamerica Revealed" was released in March of 2015. In 2018, his third Great Course was released, entitled "Ancient Civilizations of North America". His fourth and most recent production was a new concept - a travel series entitled "Exploring the Mayan World" released in July of 2020. All told, Barnhart now has 104 lectures/shows through Great Courses. Over



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### Preserving Underwater Maya Finds Using 3D Technology with Heather McKillop

Louisiana State University continued from page I

Since 2017, I have taught "3D Digital Imaging" at LSU with NextEngine 3D scanners purchased from the College of Humanities and Social Sciences (McKillop 2022).



My goal is to empower undergrads to learn 3D technology. I added a graduate "Advanced 3D Archaeology" course in 2021. In the fall of 2022, the students started using Artec Eva and Leo, with full-body imaging and scanning a car. We also use a variety of other 3D technologies, with the goal to use open source technology to make 3D scanning more accessible. We are using I-phone 14 with Lidar capability to scan complete ancient Maya wooden building posts.

3D scan of an ancient Maya figurine from the Village Farm Site, Belize. For more information on the project, please see <u>www.underwatermaya.com</u>

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### Unbundling the Past: Events in Ancient and Contemporary Maya History for October by Zach Lindsey

**16 October 625 CE**: On 9.9.12.11.2 8 lk' 5 Kej G6, B'alaj Chan K'awiil was born. The victim of second son syndrome, B'alaj was sent away from his home at Tikal as a young person to rule far-away Dos Pilas. He watched from afar as his older brother Nu'n U Jol Chaahk prepared for the throne of Tikal. Eventually, their relationship deteriorated into civil war. When Calakmul invited (or "invited") B'alaj and his older brother Nu'n to give up the war and swear fealty to Calakmul, B'alaj did – but Nu'n rebelled, pitching Tikal into war with both Calakmul and Dos Pilas. This was too much for Tikal, and B'alaj defeated his brother, possibly killing him. B'alaj served as de facto ruler of Tikal, but the tables would soon turn once again when Nu'n's son became leader of the city. By the time B'alaj died, he saw Tikal rise again to defeat Calakmul. Sounds like a stressful life. Of course, after his death, his son seems to have defeated Tikal again, so I guess things worked out okay for him after all.

**26 October 709 CE**: On 9.13.17.15.12 5 Eb 15 Mak G6, Lady K'abal Xook and her husband, the lord of Yaxchilan, performed penance together. Later, they asked artist Mo' Chaahk to design lintels including the date for Yaxchilan



Yaxchilan Lintel 24 depicting Shield Jaguar with a torch over Lady K'abal Xook's bloodletting rite. Courtesy of: <u>latinamericanstudies.org</u>

Structure 23, their probable tomb. Mo' Chaahk created something that rings out through time. Lintel 24 depicts the lady as she draws a rope through her tongue while her husband holds a torch over her. It's one of the few Maya images to be taught in art history classes. It regularly appears in surveys of Precolumbian art. It has its own Wikipedia page and the Khan Academy discusses it in their section on Art of the Americas. And it should be. Mo' Chaahk was a master who created an image that didn't just honor a king and a queen – it has become a bridge between contemporary people and his vanished world.

# Wednesday, October 19 at 8 pm ET "Preserving Underwater Maya Finds Using 3D Technology"

### with Heather McKillop, Louisiana State University

Access this active hyperlink to join the event: <u>https://us02web.zoom.us/j/83799294545</u>



"Our lab at LSU looks like a Tupperware party," says McKillop of the various boxes and bags housing her Maya artifacts, most of which date back to the Classic period of Maya civilization, between A.D. 300 and 900. Photo by Collin Richie. Original article available here. <u>McKillop dives into new Maya discoveries</u>

**Heather McKillop** is the Thomas and Lillian Landrum Alumni Professor in the LSU Department of Geography & Anthropology and founderdirector of the LSU DIVA Lab, which stands for Digital Imaging and Visualization in Archaeology. She is best known for her research into ancient Maya coastal trade routes and for her related discoveries of a roughly 1,200-year-old wooden canoe paddle and jadeite scraping tool, both found underwater in a mangrove peat bog below the sea floor in Belize.

Of her current work, Heather notes, "We started taking 3D-scanners into the field in 2011 because the wood, as soon as you take it out of the water, begins to decay. And the pottery, if you let it dry, since it's saturated with saltwater, the salt comes to the surface, expands, and exfoliates and destroys everything. So, we keep everything in plastic bags filled with water and then transfer what we've found to plastic containers with water.

"We can then print replicas in our lab. Our 3D scans are precise replicas that we can study

for research, use in teaching, and share digitally or by 3D prints."



The DIVA lab scientists had an exhibit at the Maker-Faire at the main Baton Rouge library in October 2015. We think all 6500 registered visitors came by our tables! Here you see Jane Fiegel and Amelia Juneau (both LSU honors grads) showing visitors some 3D printed replicas. In the background Valerie Feathers (now Dr. Feathers) discusses the 3D printed replica of the ancient Maya canoe paddle (4'7") people came by to have photos taken with it! Kurt Dilores is (LSU MA grad) is also in the photo. Looking professional wearing our DIVA Lab polo shirts, with the logo designed by artist Mary Lee Eggart.



### Great Courses, Podcast, and So Much More! featuring Edwin Barnhart

the last decade, he has appeared multiple times on the History Channel, the Discovery Channel, Discovery Channel 3D, Canada's Religion Television, Japanese NHK Public Television, and an award-winning documentary entitled "2012: The Beginning". Dr. Barnhart is a Fellow of the Explorer's Club and leads travel courses for college professors on ancient astronomy, mathematics and sacred geometry through his private company Ancient Explorations, LLC.

#### ArcheoEd Podcast

Popular now is Dr. Barnhart's Podcast which releases new audio presentations on the first of every month. "ArchaeoEd" stands for archaeology education, but its also Ed talking about his 30+ years as an archaeologist. You can always hear it on <u>archaeoed.com</u>, but if you subscribe through your preferred podcast app, it will let you download all the episodes on to your phone for free and notify you as soon as new episodes are available.

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For most people, Indiana Jones is the archetypal archaeologist. But is he? Indie is a lot of things, but a good archaeologist isn't one of them! Join Dr. Ed as he separates fact from fiction. <u>Dr. Jones I Presume?</u>



The world's oldest team sport played on a formal, stone built ballcourt. Where was it invented? Ancient Mesoamerica! Join me as I explain what we think we know about it and the modern versions that I keep running into. *The Mesoamerican Ballgame* 

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with **Dr. Damien B. Marken** Commonwealth University of Pennsylvania

### Commonwealth Oniversity of Femily Ivalia

### Living Under the Canopy: Lowland Maya Urban Studies in the Age of Lidar

Red Relief Image Map of the El Perú-Waka' urban core. View from the northwest. Lidar data courtesy of NCALM. Image by L.Auld-Thomas, 2018. Courtesy of PACUNAM.

Access and download this active hyperlink: https://us02web.zoom.us/j/8848707

The explosion in lidar surveys in archaeology over the last decade has dramatically altered how scholars view Lowland Maya cities, both literally and conceptually. No longer limited to pedestrian survey blocks and transects or opportunistic reconnaissance, archaeologists can now analyze the relationships between settlement, topography, and resources across complete swaths of the ancient Maya world. With these new perspectives, the debate over whether the Maya were urban or not is over. But what comes next?

Archaeologists of the Proyecto Arqueológico Waka' (PAW) have spent the last twenty years investigating the ancient Maya city of El Perú-Waka', Peten, Guatemala, mapping its structures, studying its water management systems, and excavating its buildings, large and small. This lecture will synthesize a portion of this research, combining lidar and archaeological data to document processes of urbanization at Waka', including its occupational histories, shifting

settlement form and dynamic resource management practices. What we see is a city in constant flux, with residents continuously adapting to changing ecological and historical circumstances. So, while Waka' exhibited features that we often would consider "typical" of a Maya city, its local history and physiogeography resulted in an unique expression of Lowland urbanism.

Damien B. Marken is Assistant Professor in the Departments of Anthropology, Criminal Justice, and Sociology at Commonwealth University of Pennsylvania. In 2011, he received his PhD in anthropology from Southern Methodist University. A National Geographic Society grantee and Explorers Club Fellow, he has actively participated in field studies across the Maya lowlands at the sites of Palenque, Chiapas, Mexico, (1997-2002), and El Perú-Waka' (2004-present) and La Corona (2005-2009) in Petén, Guatemala. He has published several studies of Classic Maya urbanism, settlement patterns and landscapes, architecture, and political organization, and is the editor of Palenque: Recent Investigations at the Classic Maya Center (AltaMira, 2007), co-editor of Classic Maya Polities of the Southern Lowlands: Integration, Interaction, Dissolution (with James L. Fitzsimmons, University Press

of Colorado, 2015), Building an Archaeology of Maya Urbanism: Flexibility and Planning in the American Tropics (with M. Charlotte Arnauld, in press), and Kingdom of the Centipede: New Archaeological Perspectives on the Classic Maya Center of El Perú-Waka' (with Keith Eppich and David Freidel, forthcoming).



Dr. Marken excavating a cached ceramic vessel from the El Perú-Waka' hinterland settlement T19-1, Tres Hermanas District. Photo by D. Menéndez, 2019.



Damien B. Marken

# Filled to the Brim: Improving Classic Maya Reservoir Capacity Estimates

by Damien B. Marken, Matthew C. Ricker, and Robert Austin

Our study reports water capacity estimates for four reservoirs within the Classic Maya (250-900 CE) city of El Perú-Waka', Guatemala. Combining field survey, soil analysis, and a variety of GIS interpolation methods, it illustrates ways to more fully quantify a challenging resource - water - and its availability using an interdisciplinary approach. This is accomplished by comparing surface interpolation methods for estimating reservoir capacities to demonstrate that most provide reliable estimates. Reported estimates are further enhanced by analyzing internal reservoir soil morphology to better understand and quantify formation processes and refine estimates from field survey. These analyses document a multiscalar organization to water management within the Waka' urban core that likely ran the gamut from individuals up to civic and state institutions. Although intricacies remain to be fully elucidated, this example offers an alternate path to theorizing about water management practices from traditional binary approaches.

Whether for drinking or for sustaining critical plant and animal resources, monitoring and managing available water resources is especially fundamental to the survival and longevity of complex societies (Scarborough 2003, 2015). For archaeologists studying prehistoric cultures, water can be a particularly tricky resource to calculate (e.g., Aiuvalasit 2017; Benson et al. 2014; Huckleberry et al. 2016; Murrell and Shelley 2009; Neely et al. 2015; Wright 2006). Precipitation rates have changed substantially over the centuries and present physical land cover does not necessarily reflect past surface conditions, making it challenging to quantify water availability. This is especially true in places such as the Maya lowlands, where regionally there is plenty of water, but it is not uniformly everywhere nor in every month.

Detailed surface topographic data were collected using a total station and then processed as if collected for a post-occupancy civil engineering survey. Multiple interpolation methods were employed to estimate reservoir storage capacities using detailed topographic data collected with a total station. Comparison of the estimates indicates that although differing interpolation methods produce a range of variation in estimated water capacities, how reservoir margins and depths are defined have a substantially greater impact on capacity calculations. To further improve reservoir capacity



Topographic map of the northern urban core of El Perú-Waka' with the four investigated water storage features. Figure by Robert Austin. Courtesy of PAW.

estimations, the degree of post-abandonment slope wash within each catchment feature was modeled and removed using subsurface elevation data from soil cores and excavation locales across the four features. The combination of detailed topographic surface data and targeted subsurface data presents an effective methodological improvement to field investigation and data processing of managed water resources in the lowlands. More accurate data and methods on lowland Maya reservoir capacities are necessary to better understand how the coupled processes of surface hydrology, water storage, soil formation, and human intervention impacted and constrained urban water availability and quality maintenance.

#### The Classic Maya City of El Perú-Waka'

The ancient city of El Perú-Waka' (hereafter, Waka') is located in the southwestern corner of the Classic Maya heartland, with its urban core perched at the edge of the escarpment that forms the southern and western limits of the Petén Karst Plateau (Marken 2011; Figure 1). Its defensible location atop an 80m high escarpment and advantageous position near the juncture of the Río San Pedro Mártin and its Río San Juan tributary likely fostered the city's role in both east-west and north-south overland trade during the Classic period (Eppich et al. 2012). This combination of geographic factors may have also contributed to the historical importance of the city as one of the first places visited by Siyah K'ak' in the Early Classic and whose dynastic loyalty was highly contested during the Late Classic regional conflicts between the dynasties

of Tikal and Calakmul (Freidel and Escobedo 2014; Freidel et al. 2007). *continued on next page* 



## Filled to the Brim: Improving Classic Maya Reservoir Capacity Estimates

### by Damien B. Marken, Matthew C. Ricker, and Robert Austin (continued)

The most striking aspect of Waka' as a Maya city, however, is the dense clustering of its residential surface remains (Marken 2015; Marken and Maxson 2017; Marken and Pérez 2018); few Classic Maya sites exhibit such a high structure density (Canuto et al. 2018). Moreover, a variety of landscape features, as identified by archaeological survey and mapping, spill out from the urban core and clearly integrate the city's hinterland settlement into the urban fabric of Waka' (Marken 2015). Looked at broadly, Waka' is an excellent example of Classic Maya low-density, agrarian urbanism (Fletcher 2012; Isendahl and Smith 2013).

Survey data describe a mid-size monumental core embedded within a dense residential matrix, enveloped by a ring of periurban settlement and basins, and surrounded by a broader area of dispersed rural upland settlement dotted by satellite centers of mid- to small-sized monumental architecture (Marken, Ricker, et al. 2019). This general characterization of the regional settlement is confirmed by ground verification of a recent lidar survey of the area (Canuto et al. 2018; Marken et al. 2020). Recent fieldwork has investigated the coupled nature of how this modified ecological landscape developed through the combined study of topography, archaeological stratigraphy, and soil morphology within nonarchitectural landscape features, particularly where water collects, as suggested by hydrologic analysis of water flow - that is, reservoirs (Marken, Ricker, et al. 2019; Maxson and Marken 2018).

These dual goals were accomplished by acquiring data from (1) detailed topographic mapping with a Total Station, (2) soil core transects and test excavations within six previously identified reservoirs, and (3) archaeological excavation of engineering features adjacent to these reservoirs (Marken 2011; Marken, Austin, et al. 2019; Marken and Cooper 2018; Marken and Ricker 2018; Ricker et al. 2017, 2018, 2019).

#### Reservoirs Within the El Perú-Waka' Urban Core

The Waka' urban core sits atop the edge of a limestone escarpment that provides defensive security but severely limited local access to potable water resources. The karstic landscape atop the escarpment is porous, with no known natural freshwater resources in the form of springs, rivers, lakes, or swamps. Even regionally, freshwater resources are lacking; the lagoons 1.5 km to the east and the occasional springs that feed into the San Juan River to the south are brackish. The nearest major natural source of potable water is the large, spring-fed swamp, known locally as a cival, below the escarpment 3.5 km to the southeast. With no easily accessible natural potable water resources to support the 2,800-4,500 people living within the Classic period Waka' urban core (Marken 2011; Marken et al. 2020), inhabitants modified naturally occurring karst depressions across their urban landscape into reservoirs to capture



rainwater for household and community use. Surface hydrology indicates that an additional



Map of El Perú-Waka'. Drawn and compiled by D. Marken, 202 I

management function of this built landscape was to prevent the flooding of public and residential spaces during periods of intense rainfall by engineering urban surfaces to direct rainwater either into these catchment features or out of the city core entirely (Maxson and Marken 2018). Indeed, both surface and excavation data indicate that excess surface water from rainfall (flooding), not scarcity, was a primary guiding concern in the design of Waka's urban water management landscape. Some form of release or spillway system was built into every catchment feature to prevent overflow (Marken and Ricker 2018).

The methods described here can be used to better study tropical water management and more accurately estimate the water storage capacities of lowland Maya urban landscapes, and they could be easily adapted to in-filled – yet visible – water collection features elsewhere (e.g., Fletcher et al. 2008). Soil core transects provide a rather efficient means of acquiring subsurface topographic data, although the models here would be improved by additional coring along reservoir margins. When available, stratigraphic data from test and trench excavations along margins were key to improving subsurface coverage.

In quantifying a challenging and hard-to-model resource through a multiscalar and interdisciplinary approach that combines field surveys and soil analyses into multiple GIS surface and subsurface models, this research informs previous water management studies in tropical lowlands. Soil stratigraphy and morphology, in particular, improve estimates derived from modern surface topography alone (e.g., Brewer et al. 2017; Murrell and Shelley 2009). Visual and statistical *continued on next page* 

### Filled to the Brim: Improving Classic Maya Reservoir Capacity Estimates

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comparisons of the four interpolation methods used indicate that "brim" height and area definitions are the primary drivers in archaeological estimations of water storage capacity, not method of interpolation. This recognition will be vital to accurately estimating future reservoir capacities, even beyond the Maya area.

#### Conclusion

By combining field survey, soil analysis, and a variety of GIS interpolation methods in a multiscalar and interdisciplinary approach, a challenging resource - water and its availability can be more fully quantified. This is accomplished by comparing interpolation methods for estimating reservoir capacities to demonstrate that most do in fact provide reliable estimates. Reported estimates are further enhanced by analyzing internal reservoir soil morphology to better understand and quantify formation processes and sharpen estimates from field survey. These analyses document a multiscalar organization to water management within the Waka' urban core that likely ran the gamut from individuals up to civic and state institutions. Although some infrastructural landscape features within Classic Maya cities may have, at times, been regulated by "centralized" authorities, many others were built and managed, in practice, by households and local communities that maintained and managed their own resources in response to local needs (e.g., Ersten 2010; see also Chase 2016; Evans et al. 2021). Although its intricacies remain to be fully elucidated, this example offers an alternate path to theorizing about water management practices from traditional binary approaches.

The field data reported here were collected under permits by the Instituto Nacional de Antropología e Historia of Guatemala to the Proyecto Arqueológico Waka' (PAW), directed by Juan Carlos Pérez Calderon and David Freidel in 2016-2017 and Pérez Calderon and the senior author in 2018.

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El Perú-Waka' hinterland settlement

T19-1, Tres Hermanas District. Photo by D. Marken, 2019.



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### An Artistic Eye for the Maya with artist Steve Radzi

**Uaxactun**: "Eight Stones," is an important Middle Preclassic (800-300 BCE) archaeological zone located north of the city/state of Tikal. This was one of the earliest sites to be professionally investigated and reported on.

Astronomical complexes were first identified at Uaxactun and are identified throughout Mesoamerica as "E-Groups." These structures were long thought to be used to observe astronomical events such as the solstices and equinoxes, though archaeologist Ivan Šprajc has recently called this into question.

The oldest group at Uaxactun is Group E. This area dates back to the Preclassic, around 600 BCE, with continued building and expansion through the Early Classic Period.

**Steve Radzi** has been illustrating Maya sites for many years. The original black and white illustrations were created in 1995 for an exhibition at the Miami Museum of Science. In recent times, Steve has colored them, bringing them to life. These illustrations have not been published before. We shall feature his work in this and upcoming issues. Enjoy. You may visit Steve's site for more of his work. <u>www.mayavision.com</u>



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### Among the Ancient Maya, Cacao Was Not Exclusive to the Elite, but Was Important – and Common – to All by Shelly Leachman, featuring Dr. Anabel Ford

It was the money that grew on trees. Said to be a gift from the gods, cacao for the ancient Maya was considered sacred, used not only as currency, but in special ceremonies and religious rituals. It's the progenitor plant of chocolate, and notions of luxury are embedded in its lore.

The prevailing belief: Cacao was more available to, even controlled by, the society's very upper echelons, royalty. Past efforts to identify



Archaeological ceramic sherds tracked back to the Late Classic Maya were analyzed for biomarkers of cacao.

cacao in ceramics focused on highly decorative vessels associated with elite ceremonial contexts – think ornate drinking vases – leading to assumptions about how cacao was distributed and who could access it.

What about the farmers who grew cacao and the communities of people who lived amongst these orchards? What of the general populace?

A new study by UC Santa Barbara researchers Anabel Ford and Mattanjah de Vries asks these questions – and answers them – by examining cacao residues from ancient ceramics. Their results, published in the *Proceedings of the National Academy of Sciences*, demonstrate that cacao was, in fact, accessible to the general populace and was used in celebrations at all levels of society.

"It had long been assumed that cacao for the Maya was an elite exclusive," said Ford, an anthropologist and director of the MesoAmerican Research Center at UC Santa Barbara, who for 40 years has been conducting research on the ancient Maya city of El Pilar. "We now know this is not the case. The imbibing of cacao was a luxury accessible to all. The importance is that it was a requirement of the rituals associated with it."

To test the exclusivity of cacao use, the work examines 54 archaeological ceramic sherds. Originating from El Pilar – located on the border between Belize and Guatemala – the sherds can be traced to Late Classic period civic and residential contexts, representing a cross-section of ancient Maya inhabitants. The study includes a chemical analysis of these sherds – specifically of the biomarkers for cacao: caffeine, theobromine and theophylline.

"The discovery of chemical signatures of cacao made the investigation possible, but the main active ingredient, theobromine, it turns out is not sufficiently discrete to be certain of the cacao attribution," said Ford. "Mattanjah de Vries and his students, in their chemical research, encountered the possibility of detecting theophylline,



a specific component of cacao that could not be confused with anything else. He saw the potential for an interdisciplinary project." De Vries is a distinguished professor and department chair of chemistry and biochemistry at UC Santa Barbara. "At some point, I realized that some of the compounds we had been studying in this origin of life chemistry project occur in cacao, and thus can serve as biomarkers for cacao," de Vries said. "Since we had already investigated the spectroscopy of these compounds in great detail, this presented an opportunity to apply that



**Dr. Anabel Ford** 

expertise to detection of these biomarkers for archaeology.

"We can find a needle in a haystack, provided we know what the needle looks like; in this case the target molecule was a certain biomarker for cacao," he added. "That ability is what made this analysis possible."

In their selection of ceramics to test, Ford and de Vries prioritized the vases from which cacao was likely drunk. They also tested bowls, jars and plates. All vessel types had evidence of cacao.

"This was a surprise at first," Ford said, "but giving thought to the presence and understanding of their uses, bowls would be good for mixing, jars would be right for warming the drink (a traditional cacao preparation) and plates appropriate for serving food with sauces that can contain cacao (such as *mole poblano*).

"Now that we know that the presence of cacao is in all vessel types, we need to understand the greater distribution and use of these important household forms," Ford added. "What is critical in our work is that the data I collected in the El Pilar-Belize River area emphasizes the ordinary households and not just the elite center. Our research thus breaks ground on the identification and the distribution."

Source: The University of California – Santa Barbara "The Current" website, here: <u>Not Just for the Gods</u>

# Share What You Know About the Maya! 2022 Institute of Maya Studies Essay Contest

Are you an Undergrad who has written about the Maya for school or taken a trip to the Maya region?

You could win money telling us about your research or adventures!



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We'll publish your winning essay in the Institute of Maya Studies (IMS) *Explorer* newsletter! Membership in the IMS includes a newsletter subscription.



One winner will receive \$100 and a two-year membership to the Institute of Maya Studies; two others will receive \$100 and a one-year membership. All three will be published in our monthly newsletter and on our website, and we'll promote the winners on various social media pages. This will also get you exposure in the field.

Send an email to the address below. Include an essay of 1,500 words or fewer, along with a short bio. If you have images to accompany your submission, the more the better, but not required. The subject must be relevant to the Maya.

We mostly cover the ancient Maya culture, from 1500 BCE to 1500 CE, but an anthropological article about the contemporary Maya would be more than welcome. We recommend sending stories about field experiences or shortened versions of essays you've written for class. Our newsletter is for both academic and "regular" folks, so your essay needs to be conversational, not stuffy. If you win, you will also be asked to create a short video for YouTube describing your article. We will eventually need that video if you're notified that you are among the winners. Deadline: October 31, 2022.

# 2022 Institute of Maya Studies Essay Contest

### Send your essay to: Zac Lindsey at: *lindseyzj@gmail.com*

For your bio: Include your affiliation. Demographic information such as ethnoracial category or gender is not necessary, but important if it helps distinguish you and your point of view from others.

#### IMS September Second Wednesday Zoom: "The Second-Most Popular Maya Art in Ancient Times (Right after Cooking!)" with Mark Van Stone, Ph.D., G.F.

Recording now on the IMS website: <u>Maya Mold Made</u>



In 2014, Mark Van Stone discovered a rich collection of 208 ancient Maya molds in the Ruta Maya Foundation collection. Along the way, he has learned a great deal about the role played in Maya society by Maya figurines. You'll never guess! As he puts it, "Unlike all other Maya artworks, figurines were not just for the elites - They were accessible to everyone. Mark Van Stone is a lifelong autodidact, netsuke carver in Japan, clay-animator, Guggenheim Fellow, with a Ph.D. in Maya Hieroglyphs (UT-Austin).A gamma-ray astronomy tech with a BA in Physics, then a calligrapher, carver, and paleographer Mark is now professor of Art History. Mark's most recent book, Maya Mold Made (with co-author Paul Johnson), is a catalog of Ancient Maya ceramic molds and an investigation into the function of Maya figurines.

### 18th Annual Tulane Maya Symposium and Workshop Inequality Among the Maya March 16-19, 2023

Stay tuned for more announcements soon! <u>tms.tulane.edu</u> <u>tms@tulane.edu</u>

# **IMS Explorer**

#### IMS September Third Wednesday Zoom:

"Lives of the Gods: Divinity in Maya Art" with James Doyle, Ph.D.

Recording now on the IMS website: <u>Lives of the Gods</u>



A new exhibition organized by the Metropolitan Museum of Art and the Kimbell Art Museum will explore the rich imagery of Classic Maya deities. **James Doyle** is the Director of the Matson Museum of Anthropology and Associate Research Professor at Pennsylvania State University. He has organized exhibitions and public outreach initiatives, conducted archaeological and conservation fieldwork, and published widely on the material and visual cultures of ancient Mesoamerica, Central America, and the Caribbean.

### IMS September Fourth Wednesday Zoom: "The Big Reveal: Lidar-Aided Survey in the Northern Maya Lowlands"

with **Ken Seligson**, Ph.D. Recording now on the IMS website: Lidar The Big Reveal



**Dr. Ken Seligson** is Assistant Professor of Anthropology at California State University – Dominguez Hills in Los Angeles County.

Join the **Explorer**-ation! Scholar or not, we welcome submissions from IMS members and other Maya enthusiasts. Share what interests you with others. All articles and news items for the **IMS Explorer** should be forwarded to the newsletter editor at: mayaman@bellsouth.net

#### 2022 IMS New Membership and Renewal Info:

The Institute of Maya Studies is totally member-supported! If you are not a member, please take a moment and join us. If you've been a member in the past, please take a few moments to renew now and encourage your friends to join.

> Membership in the IMS includes access to monthly IMS Live Streaming Events; a year's subscription to our monthly IMS Explorer newsletter; Zoom recordings, and access to all features on our newly updated website.

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