Supporting Information

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SI Discussion

Stable carbon isotope values from reservoir sediments provide evidence of vegetation in the watersheds. For example, high δ13C values suggest enrichment from plants with C4 (e.g., maize and other tropical grasses) or crassulacean acid metabolism (CAM) (e.g., cactus and other succulents) photosynthetic pathways. The highest mean stable carbon isotope values were found in sediments from Inscription and Terminos (−21.6), and the lowest values were from Vaca del Monte (−27.5). The highest δ13C values were found in Terminos sediments from Late Preclassic to Early Postclassic strata containing pollen from maize and Steraceae, Poaceae, Polygonaceae, and Solanaceae weeds. Terminos is located near a Maya age settlement with agricultural terraces and associated archaeological evidence for agriculture, disturbance, and clearing. These findings are comparable with those findings in the works by Beach et al. (1), Johnson et al. (2), Webb et al. (3), and Wright et al. (4). The nitrogen content of the sediments was extremely low, making it impossible to obtain nitrogen isotopic data. The extremely low nitrogen content suggests a relative absence of algal blooms, which may have resulted from a limited amount of human waste contamination (5–7).

1. Beach T, et al. (2011) Carbon isotopic ratios of wetland and terrace soil sequences in the Maya lowlands of Belize and Guatemala. *Catena Suppl* 85:109–118.
2. Johnson K, Wright DR, Terry R (2007) Application of carbon isotope analysis to ancient maize agriculture in the Peten Region of Guatemala. *Geoarchaeol Int J* 22:313–336.
3. Webb E, et al. (2007) Stable carbon isotopes signature of ancient maize agriculture in the soils of Motul De San Jose, Guatemala. *Geoarchaeol Int J* 22:291–312.
4. Wright DR, Terry R, Eberl M (2009) Soil properties and stable carbon isotope analysis of landscape features in the Petexbatun region of Guatemala. *Geoarchaeol Int J* 24: 466–491.
5. Angradi TR (1993) Stable carbon and nitrogen isotope analysis of seston in a regulated Rocky Mountain river, USA. *Regul Rivers Res Manage* 8:251–270.
6. Bratkic A, Sturm M, Faganeli J, Ogrinc N (2012) Semi-annual carbon and nitrogen isotope variations in the water column of Lake Bled, NW Slovenia. *Biogeosciences* 9: 1–11.
7. Kaushal SS, Lewis WM, Jr., McCutchan JH, Jr. (2006) Land use change and nitrogen enrichment of a Rocky Mountain watershed. *Ecol Appl* 16:299–312.

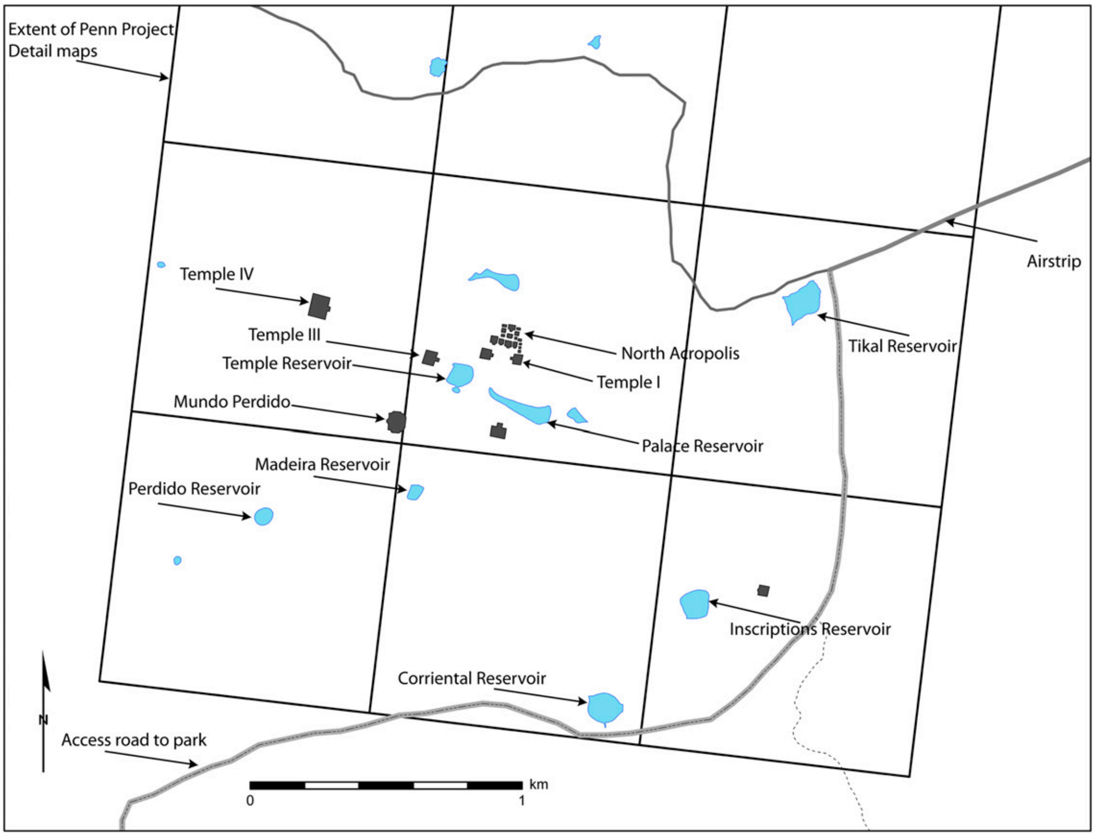

Fig. S1. Central Tikal layout showing key temples and reservoirs. The road into and out of the Park along with the University of Pennsylvania Project airstrip are also indicated. Throughout our project, the University of Pennsylvania maps of Central Tikal, Tikal Report #11 (1) are used as base maps. The extent of the nine University of Pennsylvania, Penn Project, detail maps is shown. The work reported here is primarily in Temple, Palace, and Corriental Reservoirs. We also worked extensively in Perdido Reservoir and along the East Brecha.

1. Carr RF, Hazard JE (1961) *Map of the Ruins of Tikal, El Peten, Guatemala* (University Museum, University of Pennsylvania, Philadelphia).

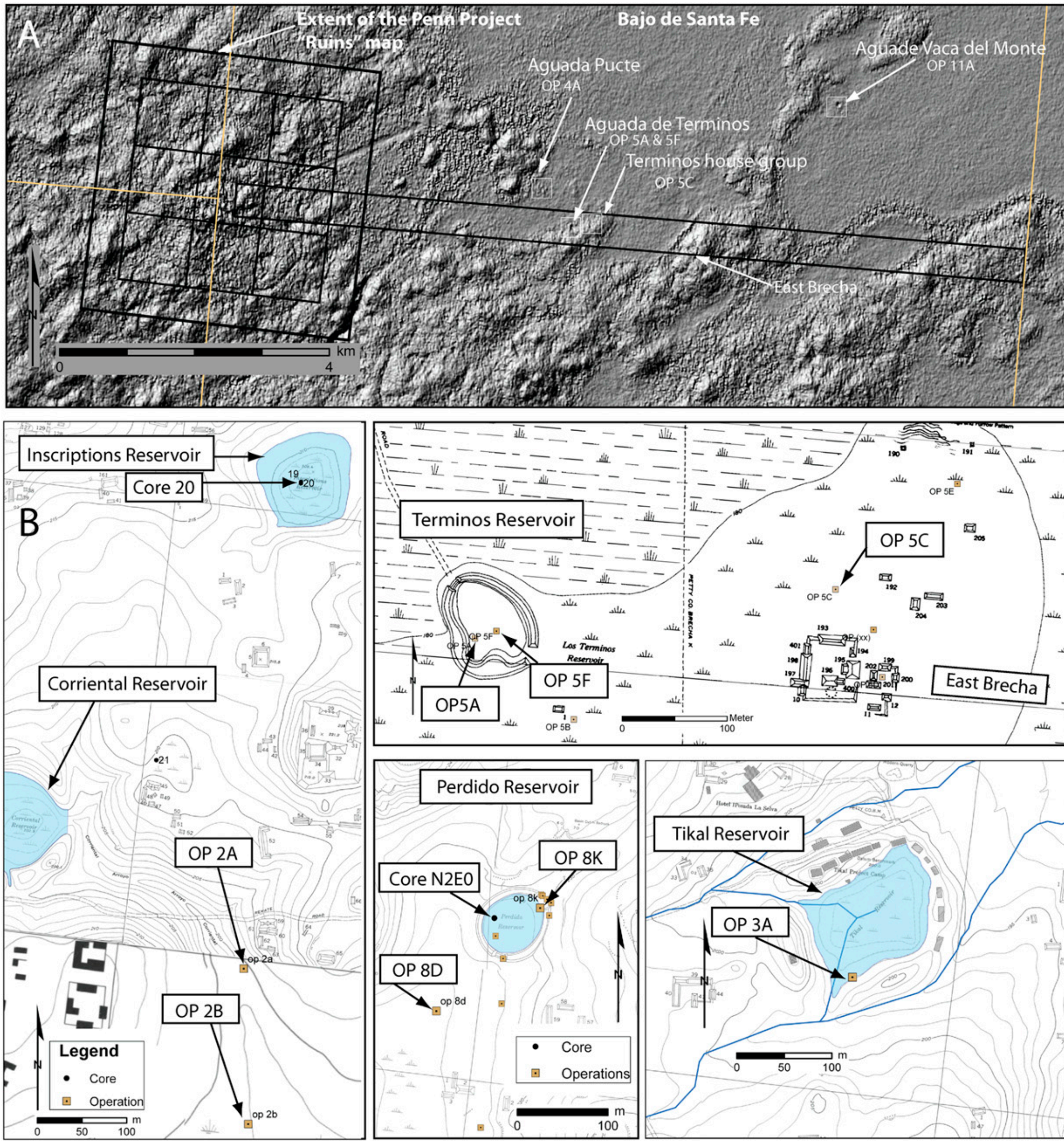

Fig. S2. Maps showing the locations of operations and cores to the east of Central Tikal for which we have C14 dates and isotopic data (Tables S1 and S2). (*A*) The map is a hillshade made from elevation data provided by the Jet Propulsion Lab airborne synthetic aperture radar mission in March of 2004. (*B*) Four additional detail maps showing those principle operations with only limited discussion in the text. The Inscriptions, Perdido, and Tikal Reservoir base maps are from Tikal Report #11 (1). The Terminos Reservoir base map is from Tikal Report #13 (2). The base maps are courtesy of the Penn Museum.

1. Carr RF, Hazard JE (1961) *Map of the Ruins of Tikal, El Peten, Guatemala* (University Museum, University of Pennsylvania, Philadelphia).
2. Puleston DE (1983) *The Settlement Survey of Tikal* (University Museum, University of Pennsylvania, Philadelphia).

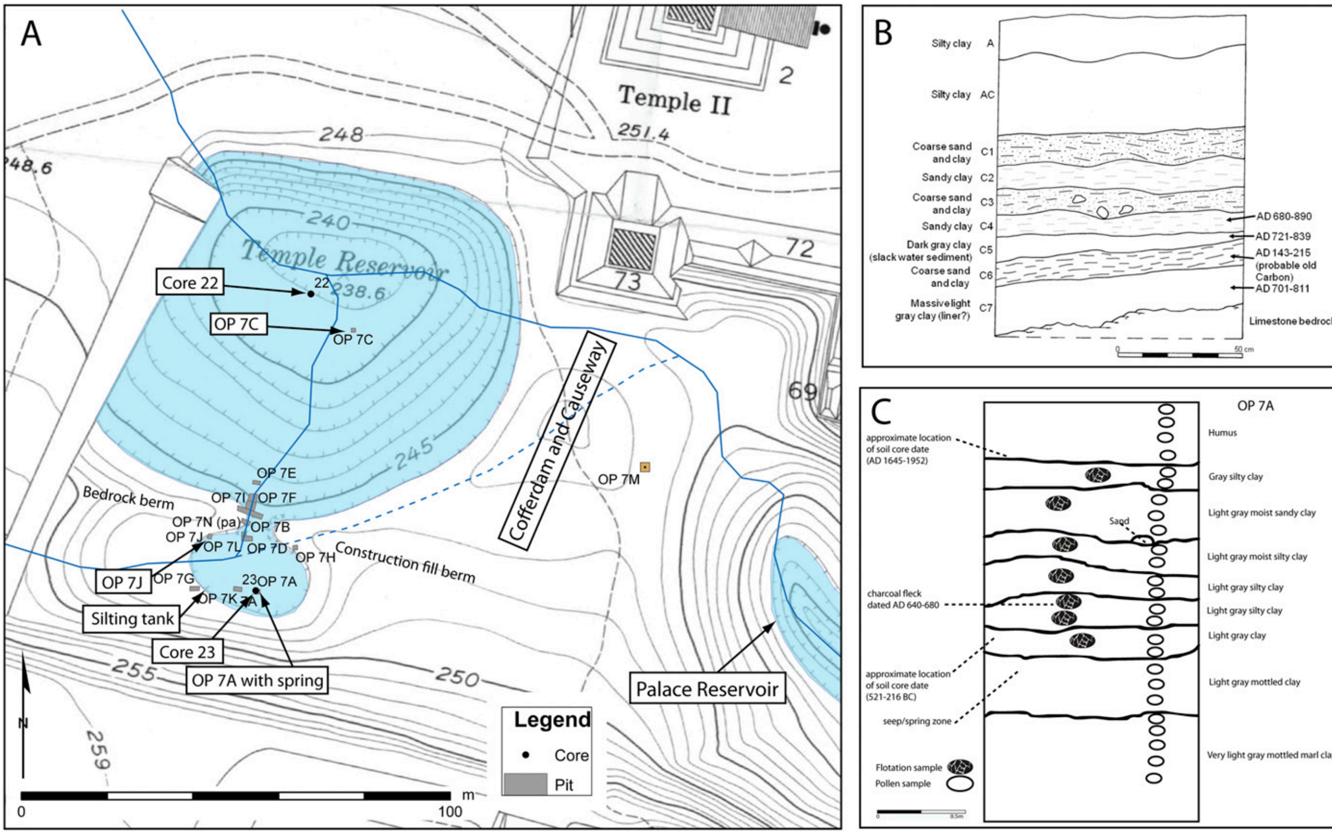

Fig. S3. Our excavations and pit profiles in the Temple Reservoir area. (*A*) Detail of Temple Reservoir with excavation pits (operations), cores, and subterranean spring exposure at pit OP 7A in the silting tank. The cofferdam, which forms Temple Reservoir and isolates it from Palace Reservoir, is indicated. The western and northern margins of the ancient arroyo were identified and found to have been partially quarried back. The berm separating the silting tank from the main tank was divided to the east and west by a narrow spillway. Excavations showed that the western berm was contoured bedrock but that the eastern berm was introduced through consolidated fill. We conclude that the western berm is the remains of the northern bank of the winding arroyo head, and the eastern berm represents fill redeposited into the original arroyo to form the constriction necessary for controlling water debouching from the deliberately hollowed silting tank feature. Water worn cobbles were identified at the silting tank's far northwestern margins in OP 7J. Here and on the other maps, our operations were located with Total Station and global positioning systems. The resulting positions were plotted on georeferenced versions of the Penn Project maps. The base map is courtesy of the Penn Museum. (*B*) Temple Reservoir main tank Profile OP 7C with four dates. The C7 clay layer may be a lining for the reservoir. Sand is present in multiple layers, likely washed out of a sand filtration box at the reservoir inlet periodically. (*C*) Temple Reservoir silting tank profile OP 7A with three dates (Table S1) from adjacent core 23 superimposed. Pollen and botanical remains were highly degraded here as well as elsewhere in our Central Tikal Reservoir sample. The zone of the spring seepage, under our earliest date, is shown.

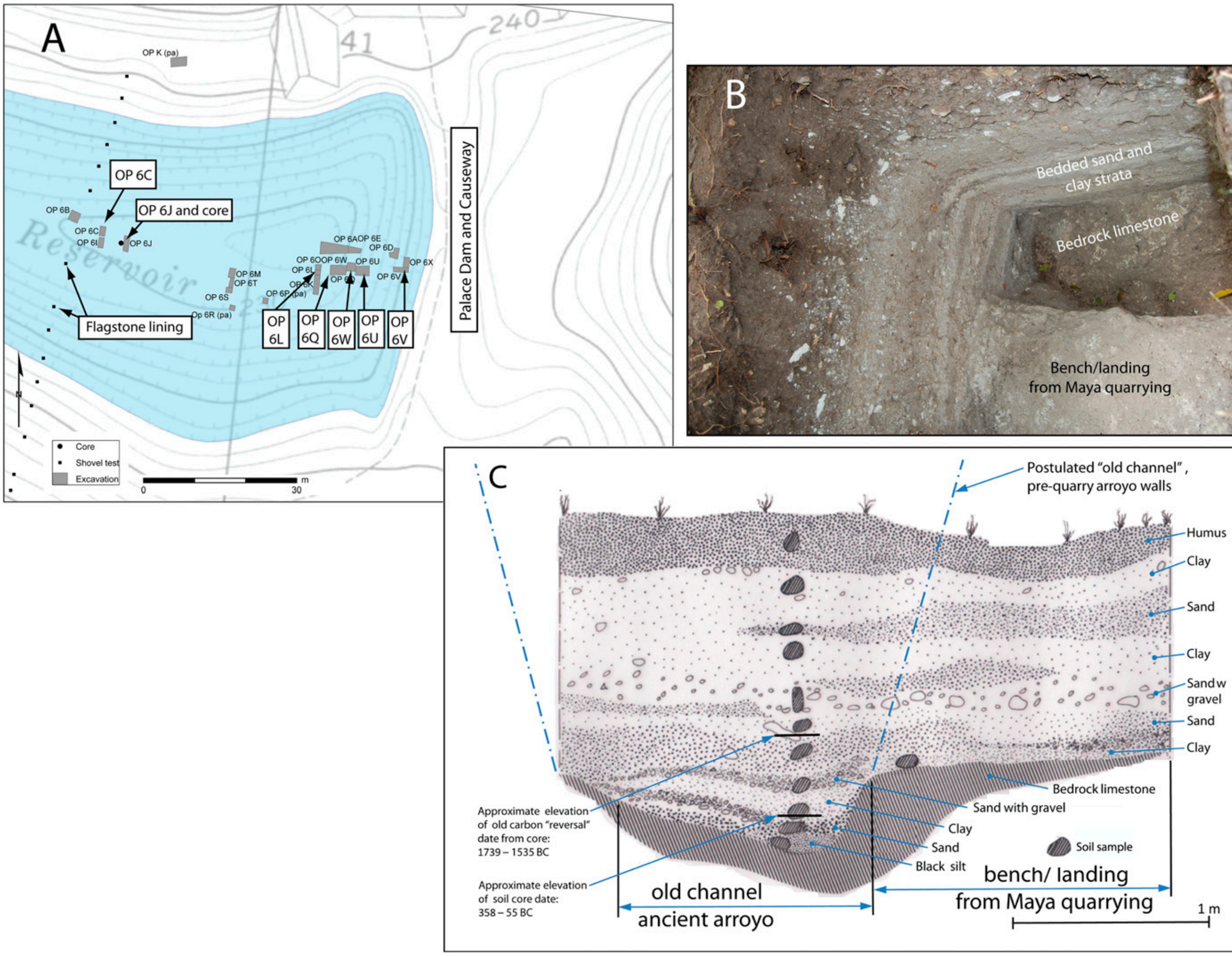

Fig. S4. Our excavations and pits in the central part of Palace Reservoir. (*A*) Detail of the Palace Reservoir Dam and causeway, highlighting key excavations in the reservoir floor and up the dam profile. Our operations OP 6A and OP 6E were a reexamination of open trenches originally dug by the University of Pennsylvania project (compare with Fig. S5). The base map is courtesy of the Penn Museum. (*B*) Photograph of OP 6C with bench and highly bedded strata. This operation, OP 6C, is immediately upstream of OP 6J and shows the continuation of the bedded strata and bench seen in the OP 6J profile. (*C*) West face profile of OP 6J in the midsection of Palace Reservoir. The two dates are from the core immediately behind this profile. It is postulated that Palace Reservoir was originally a relatively narrow arroyo that was widened by quarrying, leaving a bench, and then dammed. A layer of black silt (limo negro) was identified at the very bottom of the ancient channel under the 358–55 B.C. date. As in Temple Reservoir, multiple layers of sand were present, indicating the periodic washout of filter boxes at the reservoir inlet. Base drawing by R. Macano.

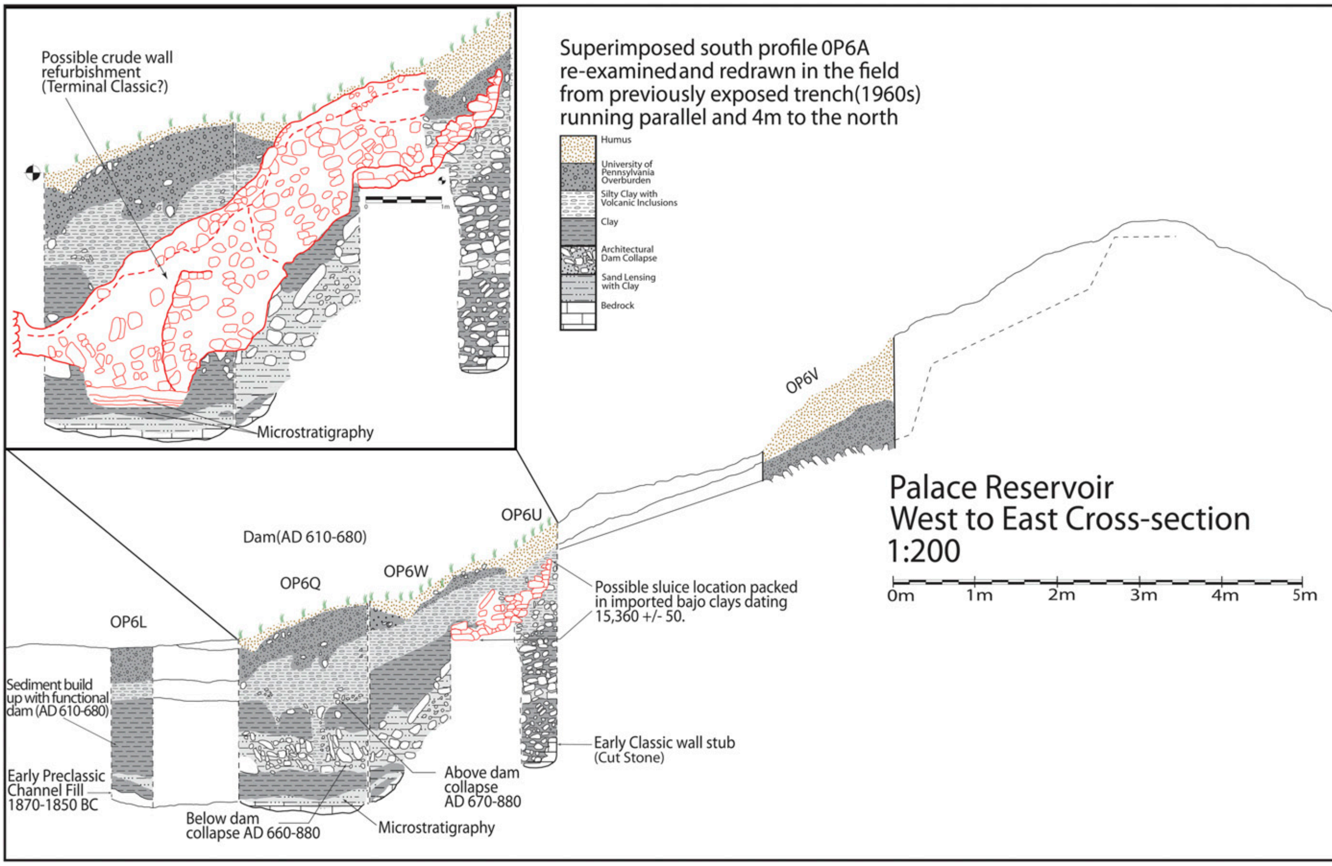

Fig. S5. Cross-sectional composite of dam profiles of OP 6L, OP 6Q, OP 6W, OP 6U, and OP 6V.

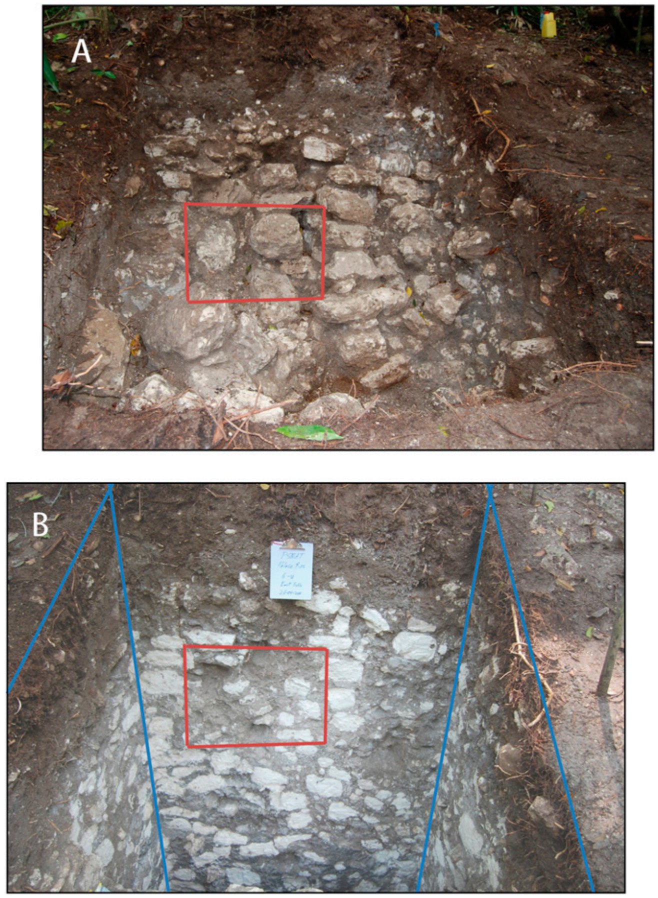

Fig. S6. Palace Dam excavations at sluice gate. (*A*) Veneer stones of dam on initial exposure in unit OP 6U. The postulated sluice, outlined in red, is now filled with the slump-down debris. (*B*) Continued excavation in exposure OP 6U. The collapsed sluice in the east exposure of the dam wall is exposed and outlined in red.

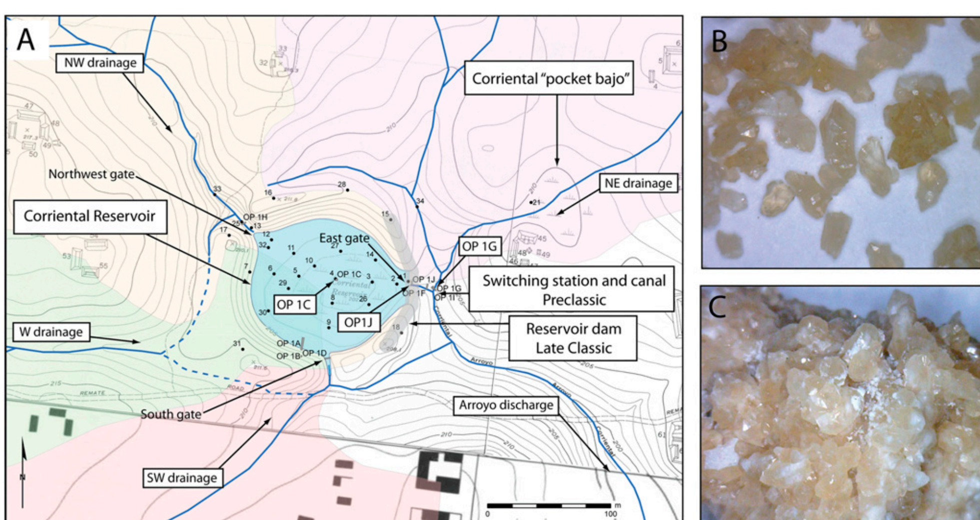

Fig. S7. The Corriental Reservoir area. (*A*) The main drainages leading to Corriental Reservoir—northwest, southwest, and northeast drainage—and the main drainage leading away from the reservoir, Corriental Arroyo. We postulate a switching station in Late Preclassic times (predam) to divert water from the northeast drainage—alternately into the incipient reservoir or directly into Arroyo Corriental. We and others postulate that the ancient Maya constructed a dam at this reservoir discharge as indicated by Reservoir Dam, Late Classic at a later date. The water level shown, 205 m elevation (ref. 1, p. 24), assumes this dam is in place. The work by Carr and Hazard (ref. 1, p. 14) also suggests another switching station shunt at the south entrance to Corriental Reservoir to direct water into or around the reservoir. The base map is courtesy of the Penn Museum. (*B*) Sand-sized authigenic quartz crystals taken from sand lensing within the Corriental Reservoir used for posited water filtration. (C) Soft, not fully solidified sandstone bedrock composed of authigenic quartz crystals located ~30 km from Tikal and source material for photomicrograph B. We know of no other potential sand sources within this 30-km radius.

1. Carr RF, Hazard JE (1961) *Map of the Ruins of Tikal, El Peten, Guatemala* (University Museum, University of Pennsylvania, Philadelphia).

Table S1. Chronostratigraphic data for Maya reservoirs and related contexts at Tikal, Guatemala, including AMS radiocarbon sample composition, provenience, stable carbon isotope analyses, context, measured radiocarbon years B.P., calibrated age at 2σ, and cultural period

Laboratory number	Composition	Sample provenience	$\delta\ ^{13}C$ (‰)	Depth (cm)	Measured ^{14}C (y B.P.)	Calibrated age (2σ)	Cultural period
88676*	SOM	Temple Silting Tank (Op 7, Core 23–2)	−26.23	70–80	195 ± 35	A.D. 1645–1952	Postconquest
88677*	SOM	Temple Silting Tank (Op 7, Core 23–2)	−22.3	110–120	2,330 ± 40	521–216 B.C.	Late to Middle Preclassic
β-298985†	Charcoal	Temple Silting Tank (Op 7A)	−25.6	130	1,370 ± 30	A.D. 640–680	Late Classic
β-281746†	Charcoal	Temple Main Tank (Op 7C)	−23.7	110	1,200 ± 40	A.D. 680–890	Late Classic
85584†	SOM	Temple Main Tank (Op 7C)	−17.1	130–140	1,230 ± 25	A.D. 721–839	Late Classic
85585†	SOM	Temple Main Tank	−20.4	140–162	1,830 ± 25	A.D. 143–215	Late Preclassic to Early Classic
85583†	SOM	Temple Main Tank (Op 7C)	−22.8	162–194	1,250 ± 35	A.D. 701–811	Late Classic
β-281750†	Charcoal	Palace (Op 6Q)	−25.3	Above dam collapse	1,250 ± 40	A.D. 670–880	Late Classic
β-281751†	Charcoal	Palace (Op 6Q)	−24.7	Below dam collapse	1,260 ± 40	A.D. 660–880	Late Classic
β-288914†	Charcoal	Palace (Op 6L)	−25.2	150 dam	1,380 ± 40	A.D. 610–680	Late Classic
β-281749†	Charcoal	Palace (Op 6U)	−23.1	Dam fill	15,360 ± 50	16860–16740 B.C.	Prehabitation?
β-281745†	SOM	Palace (Op 6O)	−19.0	Channel fill	3,310 ± 40	1870–1850 B.C.	Early Preclassic
88638†	SOM	Palace (Op 6J-13, Core 1–1)	−26.3	50–60	3,360 ± 30	1739–1535 B.C.	Early Preclassic
88682†	SOM	Palace (Op 6J-13, Core 1–2)	−25.1	100–110	2,150 ± 40	358–55 B.C.	Late Preclassic
β-258720†	Charcoal	Corriental (Op 1C)	−26.9	65–80	990 ± 40	A.D. 1010–1170	Early Postclassic
β-280839*	SOM	Corriental (Op 1L, Core 8)	−19.5	140–180	2,010 ± 40	340–30 B.C.	Late Preclassic
β-266124†	SOM	Corriental (Op 1C)	−20.2	162–194	2,110 ± 40	190–80 B.C.	Late Preclassic
β-280837*	SOM	Corriental (Op 1L, Core 8)	−20.3	180–230	2,120 ± 40	380–170 B.C.	Late Preclassic
β-258721†	SOM	Corriental (Op 1C)	−19.1	265–290	2,340 ± 40	760–400 B.C.	Middle Preclassic
β-270566*	SOM	Corriental (Op 1L, Core 8)	−23.1	310–312	8,960 ± 60	8290–7970 B.C.	Archaic
β-266122†	SOM	Corriental Arroyo (Op 2A)	−18.8	90 buried soil	2,110 ± 40	190–80 B.C.	Late Preclassic
β-274990*	Charcoal	Corriental Berm (Op 1L, Core 17)	−23.7	Anthrosol	1,560 ± 40	A.D. 400–570	Early Classic
β-266123†	SOM	Corriental Pocket Bajo 1 (Op 2B)	−20.6	60 buried soil	1,930 ± 40	90 B.C. to A.D. 80	Late Preclassic
88675*	SOM	Corriental Pocket Bajo 2 (Op 1L, Core 21–1)	−22.4	50–60	6,250 ± 35	5312–5076 B.C.	Archaic
88678*	SOM	Inscription (Op 1L, Core 20–1)	−21.5	50–60	4,170 ± 35	2884–2632 B.C.	Early Preclassic
88678*	SOM	Inscription (Op 1L, Core 20–2)	−21.8	80–90	3,840 ± 40	2462–2154 B.C.	Early Preclassic
88680*	SOM	Inscription (Op 1L, Core 20–2)	−21.7	90–100	3,000 ± 65	1410–1049 B.C.	Early Preclassic
88681*	SOM	Inscription (Op 1L, Core 20–1)	−27.2	120–130	11,600 ± 100	11761–11316 B.C.	Prehabitation?
β-281747†	Charcoal	Perdido (Op 8K)	−24.9	49–54 ingress	6,810 ± 40	5740–5640 B.C.	Archaic
β-289287*	SOM	Perdido (Op 8, Core N2E0)	−18.7	50–60	2,220 ± 60	390–180 B.C.	Late Preclassic
β-280828†	SOM	Perdido (Op 8A)	−20.2	110	1,540 + 40	A.D. 350–540	Early Classic
β-289286*	SOM	Perdido (Op 8, Core N2E0)	−20.8	180–190	15,110 ± 60	16860–16740 B.C.	Prehabitation?
β-289285*	SOM	Perdido (Op 8, Core N2E0)	−19.8	280–290	15,480 ± 60	16920–16780 B.C.	Prehabitation?
β-289284*	SOM	Perdido (Op 8, Core N2E0)	−18.8	390–395	15,310 ± 6	16820–16670 B.C.	Prehabitation?

Table S1. Cont.

Laboratory number	Composition	Sample provenience	$\delta\ ^{13}C$ (‰)	Depth (cm)	Measured ^{14}C (y B.P.)	Calibrated age (2σ)	Cultural period
β-281748[†]	Charcoal	Perdido Pocket Bajo (Op 8D)	−24.6	76–79 alluvium	1,570 ± 40	A.D. 400–570	Early Classic
β-258722[‡]	SOM	Tikal (Op 3A)	−20.4	37	3,000 ± 40	1430–1260 B.C.	Early Preclassic
β-258723[‡]	SOM	Pucte (Op 4A)	−26.7	27	1,080 ± 40	A.D. 900–1300	Early to Late Postclassic
β-266125[‡]	SOM	Terminos (Op 5A)	−27.0	15	320 ± 40	A.D. 1480–1660	Late Postclassic to Postconquest
β-258724[‡]	SOM	Terminos (Op 5A)	−21.9	33	2,000 ± 40	170 B.C. to A.D. 30	Late Preclassic
88684[†]	SOM	Terminos (Op 5F)	−26.1	40	950 ± 30	A.D. 1024–1156	Early Postclassic
88674[†]	SOM	Terminos (Op 5F)	−26.6	70	590 ± 30	A.D. 1298–1413	Late Postclassic
β-279737[†]	SOM	Terminos (Op 5F)	−23.0	100	1,940 ± 40	50 B.C. to A.D. 120	Late Preclassic
β-266126[†]	SOM	Bajo de Santa Fe (Op 5C)	−18.5	60	2,850 ± 40	1310–1040 B.C.	Early Preclassic
β-279738[‡]	SOM	Vaca del Monte (Op 11A)	−27.5	27	400 ± 40	A.D. 1440–1640	Late Postclassic to Postconquest
β-288915[‡]	SOM	Vaca del Monte (Op 11A)	−23.5	37	1,340 ± 40	A.D. 620–690	Late Classic

Samples were collected from excavation profiles and wet and dry cores. The process of collecting a dry core compresses the stratigraphy to a greater or lesser extent depending on the sediment matrices. Compressed depths for cores are reported. Uncompressed depths are plotted in Fig. 5*B*, Figs. S3*C* and S4*C*, and Table S2. SOM, soil organic matter.

*Dry core with some compression.

[†]Sample collected from an excavation profile.

[‡]Wet core with compression.

Table S2. Elemental Analyzer–Isotope Ratio Mass Spectrometer stable carbon isotope values for insoluble soil organic matter from the reservoirs of Tikal, Guatemala, with sample provenience, stratigraphic context, age approximation, and cultural period

∂ ^{13}C	Provenience	Depth	^{14}C (y B.P.)	Cultural period
−18.5	Corriental	145	2,010 ± 40	Late Preclassic
−25.2	Corriental	155	2,010 ± 40	Late Preclassic
−21.9	Corriental	165	2,010 ± 40	Late Preclassic
−27.2	Corriental	175	2,010 ± 40	Late Preclassic
−18.9	Corriental	185	2,110 ± 40	Late Preclassic
−22.3	Average			
−21.9	Corriental Pocket Bajo 2	40	<6,250 ± 35	Archaic
−22.8	Corriental Pocket Bajo 2	50	6,250 ± 35	Archaic
−19.4	Corriental Pocket Bajo 2	60	6,250 ± 35	Archaic
−22.9	Corriental Pocket Bajo 2	70	>6,250 ± 35	Archaic
−21.5	Corriental Pocket Bajo 2	80	>6,250 ± 35	Archaic
−21.7	Corriental Pocket Bajo 2	90	>6,250 ± 35	Archaic
−22.5	Corriental Pocket Bajo 2	100	>6,250 ± 35	Archaic or earlier
−21.8	Average			
−20.2	Inscription	15	3,000 ± 65 to 4,170 ± 35	Early Preclassic
−20.3	Inscription	25	3,000 ± 65 to 4,170 ± 35	Early Preclassic
−20	Inscription	35	3,000 ± 65 to 4,170 ± 35	Early Preclassic
−20	Inscription	45	3,000 ± 65 to 4,170 ± 35	Early Preclassic
−19.8	Inscription	55	3,000 ± 65 to 4,170 ± 35	Early Preclassic
−20.6	Inscription	65	3,000 ± 65 to 4,170 ± 35	Early Preclassic
−20.4	Inscription	75	3,000 ± 65 to 4,170 ± 35	Early Preclassic
−20.8	Inscription	85	3,000 ± 65 to 4,170 ± 35	Early Preclassic
−20.7	Inscription	95	3,000 ± 65 to 4,170 ± 35	Early Preclassic
−24.1	Inscription	105	3,000 ± 65 to 4,170 ± 35	Early Preclassic
−25.7	Inscription	115	3,000 ± 65 to 4,170 ± 35	Early Preclassic
−26	Inscription	125	11,600 ± 100	Prehabitation?
−21.6	Average			
−20.3	Perdido	10	2,220 ± 60	Late Preclassic
−21.5	Perdido	20	2,220 ± 60	Late Preclassic
−20.6	Perdido	30	2,220 ± 60	Late Preclassic
−21.9	Perdido	40	2,220 ± 60	Late Preclassic
−20.7	Perdido	50	2,220 ± 60	Late Preclassic
−23.6	Perdido	70	1,540 ± 40 to 2,220 ± 60	Late Preclassic or after
−25.7	Perdido	80	1,540 ± 40 to 2,220 ± 60	Late Preclassic or after
−24.1	Perdido	90	1,540 ± 40 to 2,220 ± 60	Late Preclassic or after
−23.6	Perdido	100	1,540 ± 40 to 2,220 ± 60	Late Preclassic or after
−23.6	Perdido	110	1,540 ± 40	Late Preclassic or after
−25.9	Perdido	120	>1,540 ± 40	Early Classic or before
−25.2	Perdido	130	>1,540 ± 40	Early Classic or before
−25.4	Perdido	140	>1,540 ± 40	Early Classic or before
−23.2	Average			
−28.1	Temple (Main Tank)	10	<1,200 ± 40	Late Classic or after
−26.9	Temple (Main Tank)	20	<1,200 ± 40	Late Classic or after
−26.8	Temple (Main Tank)	30	<1,200 ± 40	Late Classic or after
−25.1	Temple (Main Tank)	40	<1,200 ± 40	Late Classic or after
−24.2	Temple (Main Tank)	50	<1,200 ± 40	Late Classic or after
−23.2	Temple (Main Tank)	60	<1,200 ± 40	Late Classic or after
−25.7	Average			
−28.2	Temple (Silting Tank)	10	<195 ± 35	Postconquest or after
−27.7	Temple (Silting Tank)	20	<195 ± 35	Postconquest or after
−25.5	Temple (Silting Tank)	60	<195 ± 35	Postconquest or after
−28.9	Temple (Silting Tank)	70	195 ± 35	Postconquest or after
−27.5	Temple (Silting Tank)	80	195 ± 35	Postconquest or after
−24	Temple (Silting Tank)	90	1,370 ± 30 to 2,330 ± 40	Late to Middle Preclassic to Late Classic
−23.7	Temple (Silting Tank)	100	1,370 ± 30 to 2,330 ± 40	Late to Middle Preclassic to Late Classic
−22.8	Temple (Silting Tank)	110	1,370 ± 30 to 2,330 ± 40	Late to Middle Preclassic to Late Classic
−23.4	Temple (Silting Tank)	120	1,370 ± 30 to 2,330 ± 40	Late to Middle Preclassic to Late Classic
−25.7	Average			
−30	Terminos	0	<320 ± 40	Postconquest
−29.2	Terminos	5	<320 ± 40	Postconquest
−29.3	Terminos	10	<320 ± 40	Postconquest

Table S2. Cont.

$\partial\ ^{13}C$	Provenience	Depth	^{14}C (y B.P.)	Cultural period
−28.2	Terminos	15	320 ± 40	Early Postclassic to Postconquest
−27.1	Terminos	25	320 ± 40 to 950 ± 30	Early Postclassic to Postconquest
−27.5	Terminos	30	320 ± 40 to 950 ± 30	Early Postclassic to Postconquest
−26.6	Terminos	35	320 ± 40 to 950 ± 30	Early Postclassic to Postconquest
−25.9	Terminos	45	950 ± 30	Early Postclassic
−25.9	Terminos	50	950 ± 30 to 1,940 ± 40	Late Preclassic to Early Postclassic
−25.3	Terminos	55	950 ± 30 to 1,940 ± 40	Late Preclassic to Early Postclassic
−25.7	Terminos	60	950 ± 30 to 1,940 ± 40	Late Preclassic to Early Postclassic
−26.2	Terminos	65	950 ± 30 to 1,940 ± 40	Late Preclassic to Early Postclassic
−17.5*	Terminos	75	950 ± 30 to 1,940 ± 40	Late Preclassic to Early Postclassic
−18.8*	Terminos	80	950 ± 30 to 1,940 ± 40	Late Preclassic to Early Postclassic
−12.9*	Terminos	90	1,940 ± 40	Late Preclassic
−12.9*	Terminos	95	1,940 ± 40	Late Preclassic
−14.2*	Terminos	100	1,940 ± 40	Late Preclassic
−21.6	Average			
−28.6	Vaca del Monte	1†	<400 ± 40	Late Postclassic to Postconquest
−28.4	Vaca del Monte	7†	<400 ± 40	Late Postclassic to Postconquest
−28.3	Vaca del Monte	13†	<400 ± 40	Late Postclassic to Postconquest
−30.3	Vaca del Monte	19†	<400 ± 40	Late Postclassic to Postconquest
−26.6	Vaca del Monte	25†	<400 ± 40	Late Postclassic to Postconquest
−27.1	Vaca del Monte	28†	400 ± 40 to 1,340 ± 40	Late Classic to Postconquest
−26.6	Vaca del Monte	31†	400 ± 40 to 1,340 ± 40	Late Classic to Postconquest
−23.8	Vaca del Monte	34†	400 ± 40 to 1,340 ± 40	Late Classic to Postconquest
−27.5	Average			

Acetanilide was used as a C3 standard, and cornstarch was used a C4 standard. Precision of standards at 1σ was 0.1425.

*These strata contained pollen from Steraceae, Poaceae, Polygonaceae, and Solanaceae weeds associated with nearby agriculture, disturbance, and clearing. Maize pollen is also common. It is associated with nearby Maya age settlement, including agricultural terraces.

†Wet core; depth does not represent the actual stratum because of compression.