
CLIMATE AND TECHNOLOGICAL INNOVATION AT KAMINALJUYU, GUATEMALA

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Abstract

During the years 2000 and 2001, a project was carried out to determine the paleoclimate in the Valley of Guatemala. There were two main objectives: (1) to compare and contrast the Highland data with that already obtained from the Maya Lowlands and the Caribbean region; and (2) to understand the relationship between climate and the disappearance of lakes and irrigated agriculture at the archaeological site of Kaminaljuyu in the Valley of Guatemala. Sediment cores have been recovered from Lake Amatitlan and the extinct Lake Miraflores associated with Kaminaljuyu. The samples have been transported to the United States for radiocarbon dating and for analysis of microfossils and pollen content. The paper summarizes the work and the results of the analysis obtained to the present.

The first inhabitants entering the valley of Guatemala in the post-Pleistocene era would have encountered a landscape dotted with small lakes, most of which were greatly diminished or gone by the time the Spanish arrived in the 1500s. The large site of Kaminaljuyu developed around 1000 B.C. in the vicinity of one of the larger lakes, known today as Lake Miraflores (Figure 1). This lake was probably the result of a tectonic-caused fault in the valley that produced a large depression that accumulated water from rainfall and small subsurface springs. Archaeological excavations carried out by the Carnegie Institution during the 1940s determined the ancient presence of this lake and also found evidence that it had dried up completely by around A.D. 100. Subsequent excavations and research carried out by the authors of this paper in the course of two consecutive projects (Kaminaljuyu San Jorge Project 1983–1985 and Kaminaljuyu Miraflores Project 1994–1995) revealed that the ancient inhabitants of Kaminaljuyu had engineered a system of canals to drain water from Lake Miraflores for the purpose of irrigated agriculture (Barrientos Q. 1997a, 1997b; Popenoe de Hatch 1997).

We have currently initiated investigations to determine the degree to which the disappearance of Lake Miraflores was due to human activity and how much was caused by climatic or environmental change. Before presenting the details of this paleoclimate project, it is necessary to describe the nature of the canals and the changes that can be observed through time.

THE CANAL SYSTEM AT KAMINALJUYU

Our investigations at Kaminaljuyu during the 1980s and 1990s revealed the presence of two main canals that drained water from Lake Miraflores into a fertile depression that was very suitable for the cultivation of vegetable crops. There was also evidence in the area of large hearths and earth ovens for the purpose of food preparation on a communal scale (Popenoe de Hatch 1997:33–

56). Our information showed that the earlier of the two canals (though perhaps not the earliest) was in use by 700 B.C. (Barrientos Q. 1997a, 1997b). Subsequently, around 400 B.C., this canal (which we call the Canal Miraflores) was closed, and a larger and more sophisticated one (the Canal San Jorge) was constructed immediately to the west, almost parallel to the first (Figure 1). We do not know the reason for this shift, but it is possible that the lake may already have been drying up, or tectonic movements may have shifted the topography and contour of the lake edges, causing an alteration in the direction of water flow. The latter hypothesis is supported by the fact that the Canal San Jorge follows the inclination of a small natural geological fault. However, it is apparent that the Canal San Jorge was abandoned sometime after A.D. 100, a date based on the ceramics obtained from the fill in the canal. The evidence of Early Classic occupation on what had previously formed the lake bottom shows that that Lake Miraflores was no longer in existence by that time.

The Miraflores Canal was excavated in 1995 by Tomas Barrientos Q. (1997a) as part of the investigations of the Proyecto Kaminaljuyu Miraflores. It drained from the southeastern edge of Lake Miraflores following the natural slope of the topography (Figure 2). Unfortunately, prior to the inception of our project, its intersection with the lake had been destroyed by the construction of a large building complex (known as Tikal Futura) in the immediate vicinity. The canal was originally cut into a layer of natural talpetate, a buried geological stratum probably formed from a weathered paleosol. When first exposed, talpetate is soft and easy to cut, but on contact with air it hardens and becomes impermeable—excellent for water retention. The excavations by Barrientos determined its total length to have been between 500 and 1,000 m, measuring 3.3 m in width and 5.8 m depth at the northern end near its connection with Lake Miraflores. At its southern termination in the fertile depression, where crops were cultivated, it measured 6 m in width and .85 m in depth. At the northern

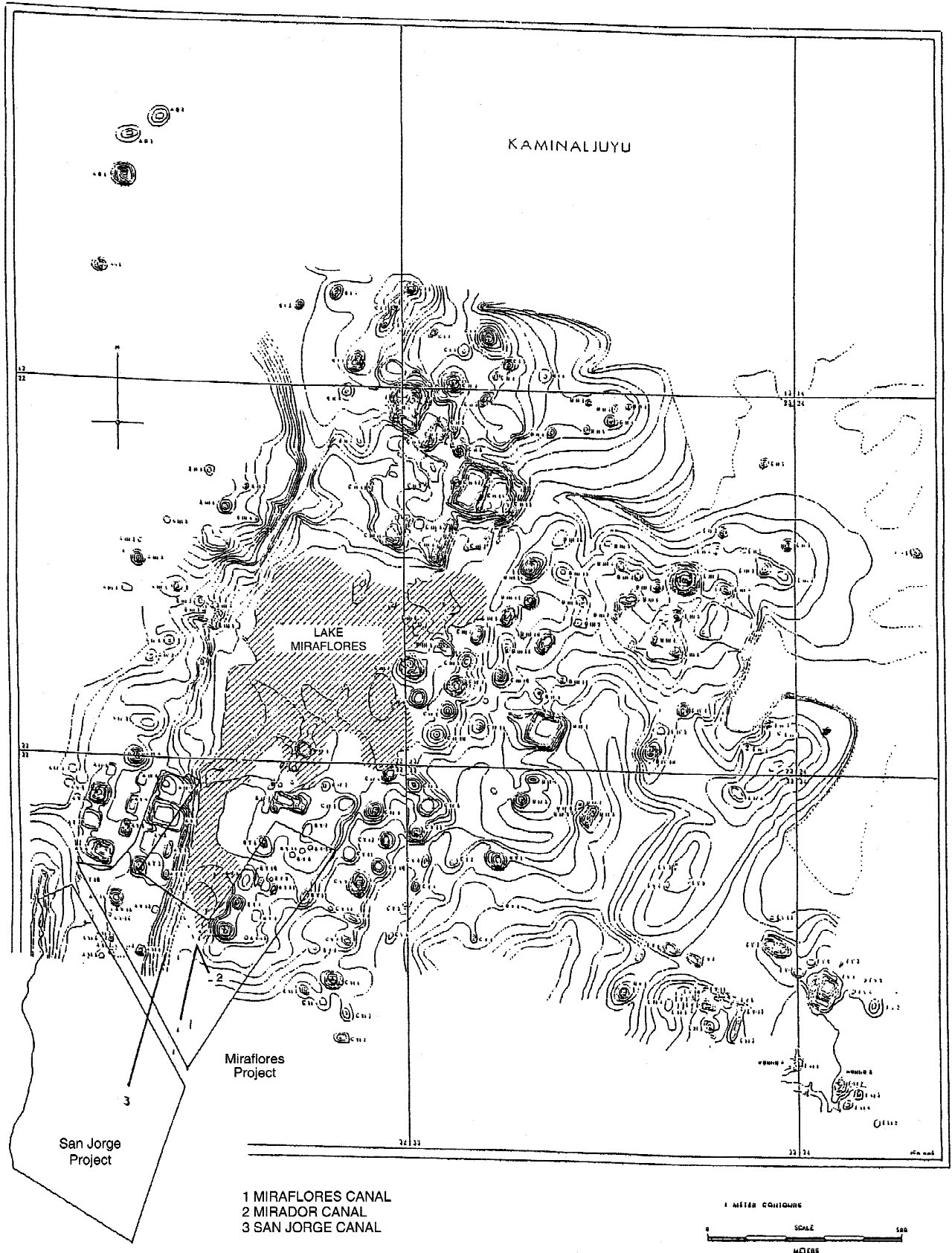


Figure 1. Map of Kaminaljuyu showing the location of the ancient Lake Miraflores, the areas investigated by the Kaminaljuyu San Jorge and Kaminaljuyu Miraflores archaeological projects, and the San Jorge, Miraflores, and Mirador irrigation canals (adapted by A. Roman after Michels 1979).

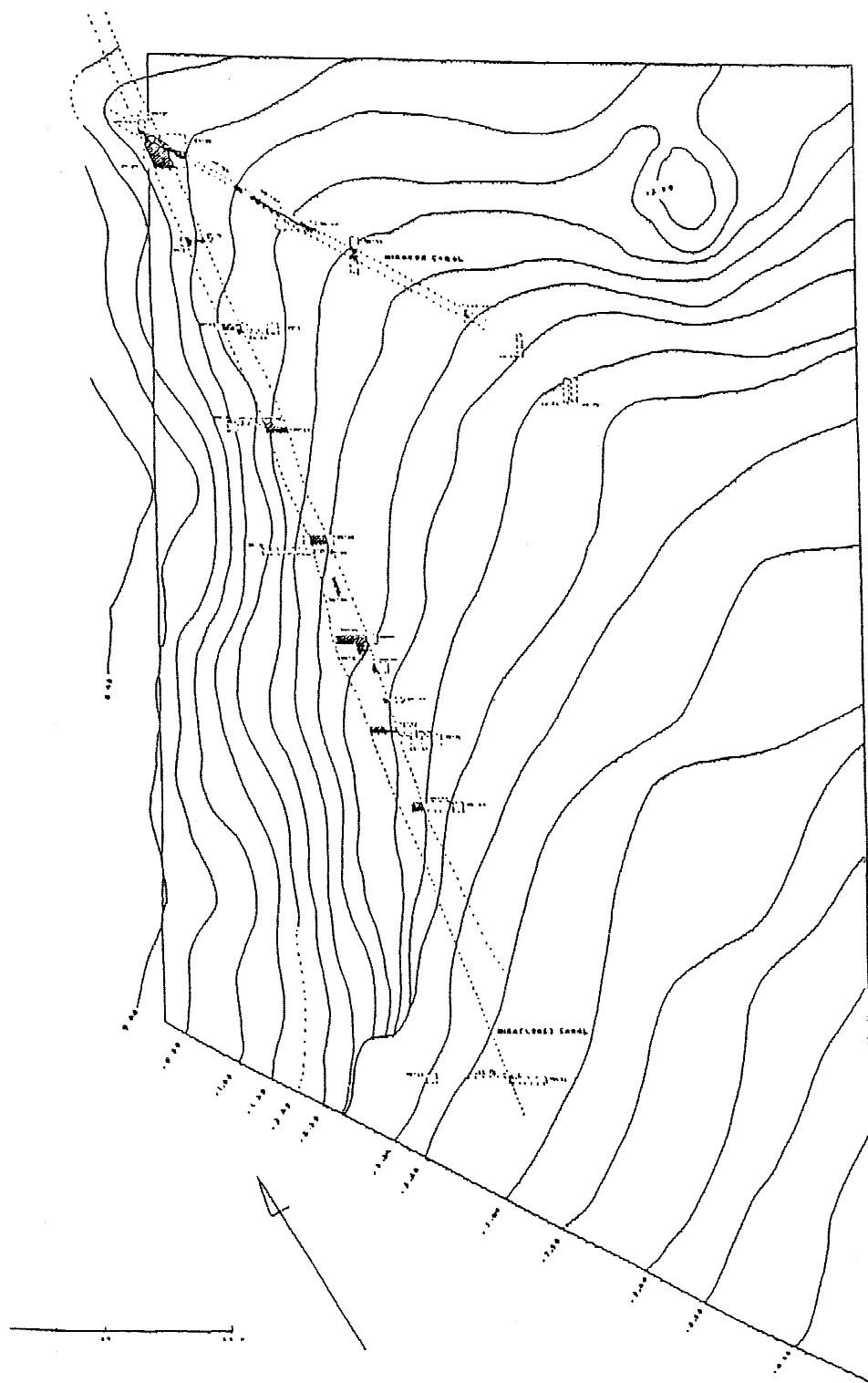


Figure 2. Plan view of the Canal Miraflores and the smaller Canal Mirador (at right) excavated in one sector of the Proyecto Miraflores (Barrientos 1997a:Figure 6; drawing by A. Roman).

end, the walls of the canal are inclined appears in profile in the form of a V, whereas continuing southward the walls become straighter, forming a U in section (Barrientos Q. 1997a:27).

It can be observed (Figure 3) that a series of platform mounds (B-V-3, B-V-4, B-V-5) are aligned parallel to the edge of Lake

Miraflores, just north of the Canal Miraflores. Our excavations and analysis of the associated ceramics determined that the construction of these mounds date to the Providencia phase (700–500 B.C.; see Figure 4), the time in which the Canal Miraflores was functioning. The excavations in these mounds suggest they were

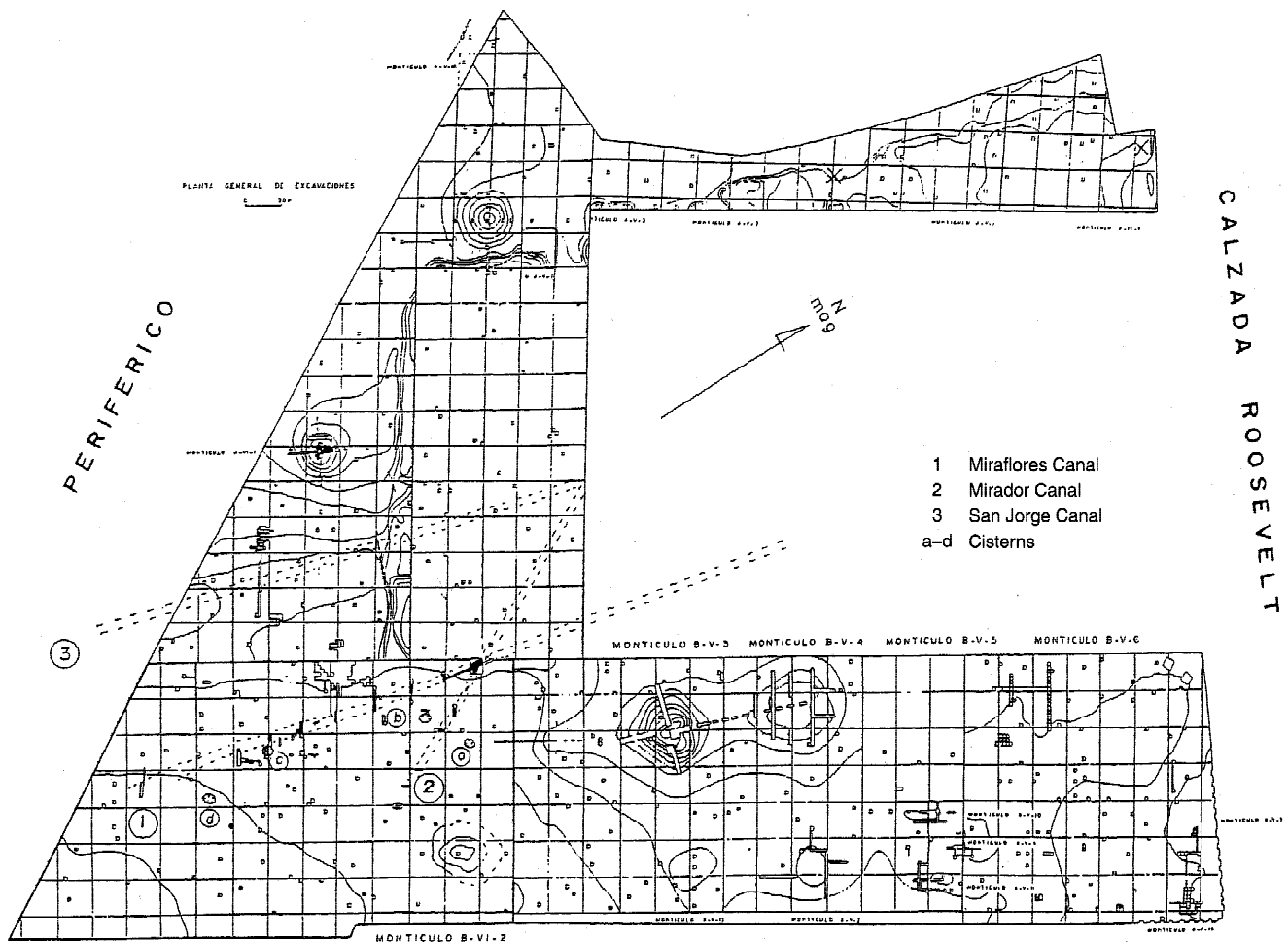


Figure 3. Plan view of the area investigated by the Kaminaljuyu Miraflores Project showing the location of the three canals (indicated by the numbers 1–3) and the various mounds. The test pits and trenches are indicated by small squares and rectangles; the wells and cisterns by the letters a–d (drawing by A. Roman).

not part of a residential or ceremonial complex but probably were related to the management of water distribution. Some may have functioned as residences of administrators, but the largest mound, B-V-5, at the extreme south end, has a type of construction that is very unusual at Kaminaljuyu. It consists of a compact clay ring with looser fill in the center, lacking the hard, tamped surface characteristic of platforms that were constructed to sustain buildings. We infer, following the hypothesis suggested by Charles Ortloff of the FMC Corporation in Santa Clara, California, that the objective was simply to build a platform high enough to convey signals to the workers, directing the water flow to certain fields, opening and closing the canal gates as needed. Barrientos (1997a:33) interpreted a narrow construction in the canal system as the location of one of these gates.

The excavations indicate that around 400 B.C. the Canal Miraflores and the associated B-V structures were abandoned. Simultaneously, the larger and more sophisticated San Jorge Canal was opened immediately to the west. We know that the Miraflores Canal was no longer in use at this time, because a very small canal drained water from the Canal San Jorge into the Miraflores area. This small canal (named Canal Mirador; Figures 1 and 2) crossed

over the old Miraflores canal bed but at a slightly higher level. To do this, the builders had to fill in the lowest level of this section of the Miraflores Canal to direct the Canal Mirador over it (Barrientos Q. 1997a:39). The ceramics from the fill sealed in below the Canal Mirador date to the Verbena phase and provide us with the approximate date of 400 B.C. for the construction of the Canal San Jorge.

The construction of the San Jorge Canal (Figure 5) was a more ambitious operation than that of the Miraflores Canal, obviously the product of having acquired more experience in managing water flow and velocity. This canal was excavated by Erick Ponciano (Popenoe de Hatch 1997:11–22) during the Kaminaljuyu/San Jorge Project. It measured more than 1,750 m in length and 18 m in width at its maximum. Like the Canal Miraflores, it was dug into the underlying impermeable talpetate layer. It drained from Lake Miraflores in a northwest-to-southeast direction. In section it appeared in the form of a U at the north where it drained from Lake Miraflores, becoming more trapezoidal toward the southern end.

When the presence of Canal San Jorge was first confirmed (before we learned about Canal Miraflores), we hypothesized that Lake Miraflores had become polluted or stagnant and that the

Period		Date	Phase
Postclassic	Late	1500	Chinautla
		1400	
	1300		
	1200		
Early	1100	Ayampuc	
	1000		
Classic	Late	900	Pamplona
		800	
		700	
	Early	600	Amatle
		500	
		400	
		300	
Preclassic	Terminal	200	Santa Clara
	Late	100	Arenal
		B.C.	
		A.D. 100	
	Middle	200	Verbena
		300	
		400	
		500	
		600	
		700	
Early	800	Providencia	
	900		
	1000		
	1100		
			Majadas
			Las Charcas
			Arévalo

Figure 4. Chronology of Kaminaljuyu (E. M. Shook and M. Popenoe de Hatch 1999:291).

inhabitants had drained its waters into the barranca to the south. However, the configuration of the canal contradicted this idea. As Ponciano proceeded with the excavations, going from north to south, the width of the canal continually increased until Trench A was reached. To our surprise, beyond this point the canal progressively decreased until it terminated at Trench H within the fertile depression, well before it reached the barranca.

For information regarding hydraulic engineering, we were able to consult with Ortloff, a specialist in this field with extensive experience in the analysis of irrigation canals in Peru. On examination of the configuration of the Canal San Jorge, and suspecting that a hydraulic jump was involved, he made a trip to the site to observe our excavations and the canal profiles. With these observations and the data, he determined through computer simulation that the jump was probably located somewhere between Trenches G and L (Ortloff in Popenoe de Hatch 1997:22–27). The hydraulic

jump may have been constructed in the form of an abrupt rise in the canal floor or by a wooden construction that could be raised or lowered manually, according to need. The canal slope was approximately 2.8% (1.95°); the water flowing downhill would have hit the jump, causing waves to move in reverse direction from the flow, thereby raising the level of the water and forcing it to spill over the edge of the canal into the irrigation ditches. The profiles of Trenches B, C, and D at the north end of the canal show the presence of two or three steps on the east side that may have been used to descend to clean the sediments from the canal floor, which accumulated over time.

The excavations carried out by the Kaminaljuyu/San Jorge Project provide some information about the history of the Canal San Jorge. The only platform mound in this area dated to the Late Preclassic Verbena and Arenal phases, roughly 300 B.C. to A.D. 100. We believe that the administrative units were located in a

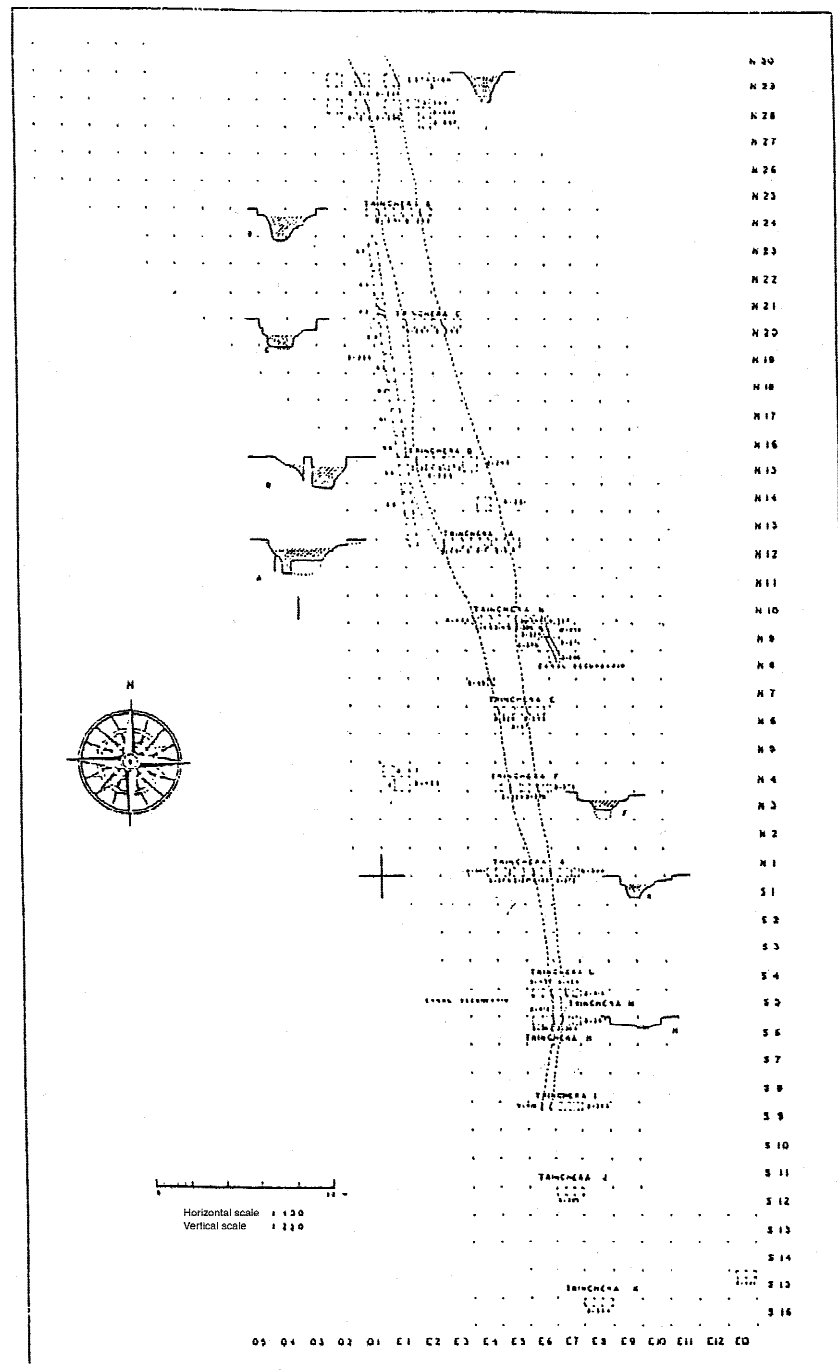


Figure 5. Plan view of the Canal San Jorge showing the excavations. The hydraulic jump was probably located between Trench G and Trench L (Popenoe de Hatch 1997:Figure 7; drawing by A. Roman).

group of mounds located slightly northeast of the site. There is evidence that, at some moment during the Arenal phase, the San Jorge Canal was cut to a deeper level in the talpetate. It appears that the canal was originally wider and shallower, but that it was subsequently modified and made deeper and narrower. We surmise that this modification may have been made because the lake level dropping, making it necessary to deepen the canal. This may have promoted the construction of the hydraulic jump as a means

to raise the water level enough to flood over the canal edges. An offering of three ritual vessels dating to the Arenal phase and seven well-finished obsidian knives were buried within the lower step of Trench C. The offering was associated with charcoal and gives the impression that a ceremony accompanied this modification of the canal.

The stratigraphy of a number of the excavations in the vicinity of the canal suggest that the water was used to irrigate what were

probably raised beds. One of these small canals, measuring 1–2 m in width, became evident in the profile of an excavation just east of Trench N (Figure 5). Another could be observed in excavations near Trench I, draining westward from the end of the main canal. This small canal measured 2–2.9 m in width and was shallow, about .9 m in depth. Even more interesting was that one profile in Trench H showed evidence of an elongated raised bed 6.5 m long, 4 m wide, and .6 m tall. In the Valley of Guatemala, where rainfall is plentiful, irrigation would not have been necessary for the cultivation of maize. We infer that intensive agriculture was necessary for year-round cultivation of vegetables such as chilis, tomatoes, and herbs, which suffer during the six-month dry season and do well in irrigated raised beds.

The Canal San Jorge continued to function throughout the Verbená and Arenal phases. However, by about A.D. 100, in the final part of the Late Preclassic Santa Clara phase at Kaminaljuyu, Lake Miraflores was drying up and the Canal San Jorge could no longer function. The fill of the canal shows that it was no longer in use in Early Classic times. The stratigraphy of Trench C reveals that this area of the canal was filled in artificially by tossing in earth from the east side. The soil and trash, probably pushed in or tossed in by basketfuls, slid toward the bottom to form the sloping layers visible in the profile. Whether this section was filled in to facilitate the movement of traffic across the now dry canal or it served as a dike to contain the diminishing water and direct it into the small Canal Mirador is not yet clear. Other areas of the canal show more horizontal layering caused by the gradual accumulation of sediments over time.

When Lake Miraflores dried up around A.D. 100, hydraulic agriculture by means of canal irrigation in that area was abandoned. However, new technology apparently was developed to adapt to the altered situation, and the area where the Canal Miraflores had existed again became a zone of artificial water manipulation. As the canal system no longer provided the means of obtaining water, a series of wells were dug parallel to the old canal. These wells reached the subsurface water table at a slightly greater depth in the talpetate than the original canal floor (Figure 6). Four of these wells, which can be observed in the plan view of Figure 3, had the form of cylindrical holes, about 2 m in depth

and 1.5–3 m in diameter (Barrientos Q. 1997a:30). At the same time, a new jar form was devised that has no antecedents at Kaminaljuyu. The jar is elongated and tear-shaped, with large handles opposite each other that extend horizontally from the jar rim, then change direction abruptly at a 90° angle to reach their attachment on the upper wall of the jar body (Figure 7). Such a form would be efficient for lowering the jar into the well by a rope, allowing it to tip on its side and drag along the floor of the well, then to be hauled up vertically to the surface. A similar jar form is used today in Oaxaca to obtain water from wells and irrigate small vegetable plots by hand (Wilken 1987:163–175). The abundance of sherds from these jars recovered from the agricultural zone of Kaminaljuyu suggests they may have been used to irrigate vegetable plots as they are in Oaxaca, or they may simply have been employed to obtain water for domestic use.

THE PALEOCLIMATE PROJECT

It can be assumed that the numerous small lakes in the valley of Guatemala were formed at the end of the Pleistocene epoch, when the climate was more humid. Our present objective is to determine the degree to which the changes in the water supply available for the canal system at Kaminaljuyu resulted from climatic factors or from human alterations of the environment. Investigations into climatic change have been carried out in the area of the Caribbean and the Yucatan Peninsula (Brenner 1994; Curtis, Hodell, and Brenner 1996; Curtis, Brenner, Hodell, Balsler, Islebe, and Hooghiemstra 1998; Hodell et al. 1995; Islebe et al. 1996; Leyden, Brenner, Hodell, and Curtis 1993; Leyden, Brenner, Whitmore, Curtis, Piperno, and Dahlin 1996; Leyden, Brenner, and Dahlin 1998), but little is known regarding the Guatemalan Highlands; nor is it clear how closely the pattern for the Highlands reflects or parallels that of the Lowlands. For the Maya Lowlands, the chronology has already been worked out using radiocarbon dating associated with changes in pollen and isotope geochemistry (the standard delta notation $\delta\text{O}-18$) of carbonate shells (Leyden et al. 1996). These data were used to infer past changes in the relationship between evaporation and precipitation (E/P). The pat-

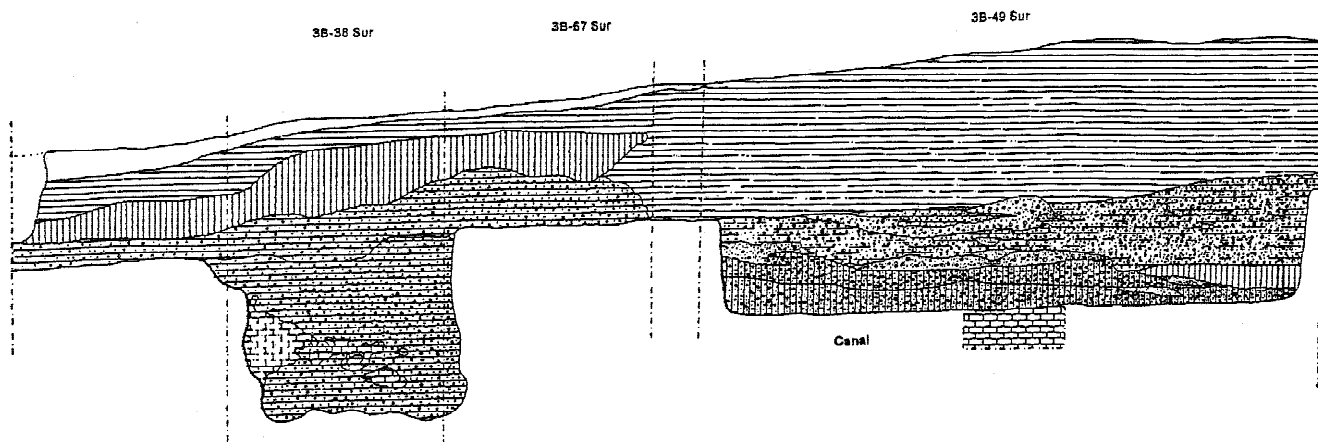


Figure 6. Profile of a well or cistern located near the Canal Miraflores, in use after Lake Miraflores dried up. The location of the cistern is at point c on Figure 3 (Barrientos 1997a:35, Figure 24; drawing by A. Roman).

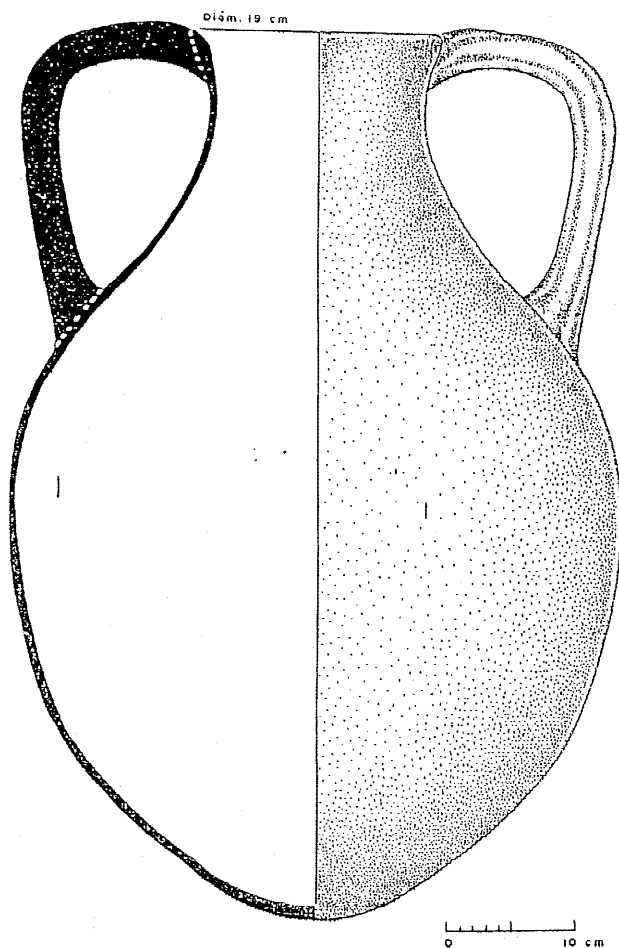


Figure 7. Jar form dating to the end of the Late Preclassic period, common in the area of Kaminaljuyu Miraflores (drawing by A. Roman).

tern of alternating cool and dry and warm and wet periods in the pre-Columbian Guatemala Lowlands and Yucatan are as follows:

3859–1800 B.C.	moist conditions
1800 B.C.–A.D. 1	long-term drying trend
A.D. 1–900	oscillation to wetter and more seasonal
A.D. 900	historical resumption of drying trend

The long-term drying trend from 1800 B.C. to A.D. 1 is of particular interest to us because it may have been one of the causes of the diminishing water supply in the Valley of Guatemala during Preclassic times.

In 1999–2000, we initiated a project to determine the paleoclimate of the Guatemala Highlands, with a special focus on the Valley of Guatemala. Our interests focused on two basic questions: (1) To what degree did the paleoclimate of the Guatemala Highlands coincide with the pattern of the Lowlands? and (2) To what degree was climate a factor in the desiccation of the old Lake Miraflores and the irrigation system at Kaminaljuyu? Funding for this project was provided by the Foundation for the Advancement of Mesoamerican Studies (FAMSI).

In the course of the Kaminaljuyu Miraflores Project during 1993, we had the opportunity to observe the profile of a deep cut made by a construction company for the basement parking lot of a large building now known as Tikal Futura. The profile revealed at

a depth of 4.2 m a layer of blue-gray gley that is formed by lake-deposited sediments (H. Popenoe, personal communication, 1993), a clear indication of the existence of Lake Miraflores in this area in ancient times. In September 1999, Mark Brenner of the University of Florida at Gainesville arrived in Guatemala. Under his supervision, a 2- × 2-m test pit was excavated (Figure 8) close to the sector where the profile had been exposed in 1993. The objective of this preliminary excavation was to determine the feasibility of obtaining indicators of climatic change from the sediments. Samples of the fill were extracted by Brenner from each 20 cm of the profile and transported to the University of Florida at Gainesville for analysis. The results of his analysis showed that diatoms of the genus *Aulacoseira* were present at a depth of 1.45 m below the present ground level. These form only in standing water, such as a lake or pond.

The paleoclimate investigations in the Valley of Guatemala continued during March 2000. Brenner returned to carry out the work, this time accompanied by his colleague Jason Curtis, also of the University of Florida at Gainesville, to collaborate with two investigators in Guatemala: Marion Popenoe de Hatch and Licenciado Erick Ponciano. During this period, the test pit in Kaminaljuyu was reopened to obtain more samples from the ancient bed of Lake Miraflores, further excavating the pit to a depth of 315 cm, where the sedimentary deposits became extremely hard and difficult to excavate. Brenner employed the same methodology as that used the previous September, extracting by trowel samples of soil at 5-cm intervals from the side wall of the pit. The samples were extracted from the west profile, beginning at 50 cm below surface and continuing down to 315 cm. These samples were transferred to labeled Whirl-pak bags and transported to the United States by Brenner and Curtis to be analyzed.

Sufficient soil was removed also to provide stratigraphic samples for Ingeniero Franklin Matzdorf to carry out an analysis of physical properties in the Civil Engineering Laboratory at the Universidad del Valle de Guatemala. Based on his analysis, the contents of the pit fall into three major strata: (1) 50–100 cm, (2) 100–210 cm, and (3) 210–315 cm. He reported that Strata 2 and 3 show extreme impermeability, which would be characteristic of lake-bottom sediments. The details of the physical characteristics will have relevance when correlated with the pollen and microfossil analysis.

In addition to the excavation in the ancient Lake Miraflores, Brenner and Curtis took cores from the floor of the large Lake Amatitlan located just south of the Valley of Guatemala. The main equipment used for lake coring was brought from the United States by Brenner and Curtis; appropriate tubing, rope, and other necessary materials were purchased in Guatemala. A boat was lent by the Friends of Amatitlan through the help of Dr. Guillermo Mata, a Guatemalan academic with experience in underwater archaeology, who provided information and a map showing the depths at closely spaced intervals around the lake. Three stations were selected as appropriate for coring (Figure 9). At all stations, sediment/water interface cores were sampled at 4 cm intervals and extruded into a tray attached to the top of the core barrel. The sediment was transferred to labeled Whirl-pak bags, then placed in Ziplock bags and stored in a Rubbermaid container. All core material was subsequently transferred to the University of Florida's Department of Fisheries and Aquatic Sciences, where it was stored in a cooler kept at 4°C.

The coring was carried out as follows (Popenoe de Hatch and Brenner 2001).

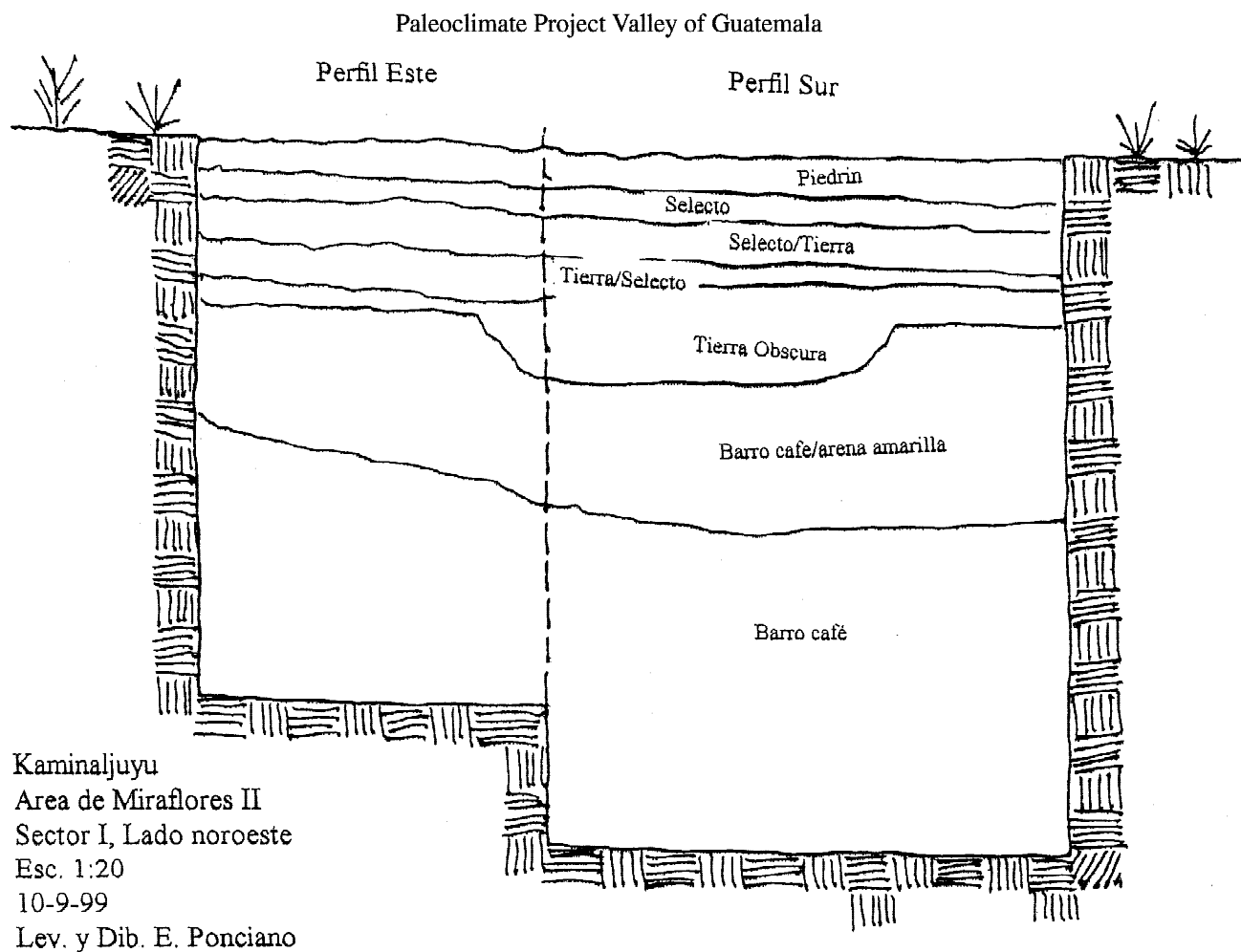


Figure 8. Profile of the test pit excavated to a depth of 200 cm in the area of Kaminaljuyu Miraflores during September 1999. Layers 1–3 pertained to recent activity; layers 4–5 contained a few Preclassic sherds; layer 6 consisted of clay mixed with disintegrated pumice particles; and layer 7 was composed of dark-brown clay that became increasingly compact in the lower levels.

Station 1 (Site 13-III-2000) was established in the bay just north of the railroad crossing that separates the lake into two basins. The water depth at this site was 13 m. Seven drives were completed, ultimately reaching a depth of 475 cm below the sediment/water interface.

Station 2 (Site 14-III-2000) was in the bay in the southeastern area of the lake (southern basin). The water depth was 11.05 m. Eight drives were accomplished, obtaining samples down to a depth of 544 cm.

Station 3 (Site 15-III-2000) was in the northwestern area of the lake (northern basin). The water depth was about 13.6 m. At this station, nine drives were made, obtaining samples down to a depth of 701 cm.

THE ANALYSIS

At the end of June 2000, Brenner took the cores to the laboratory at Florida State University, Tallahassee, and submitted them to the Multi-Sensor Core Logger to determine their magnetic-susceptibility profiles. This analysis will reflect the input of vol-

canic materials, helping to correlate the stratigraphy between the core samples and the associated AMS C-14 dates. In addition, the cores will be being analyzed for strontium in order to calibrate these values across broad stretches of landscape.

We were fortunate that Brenner was able to make an arrangement with the Center for Accelerator Mass Spectrometry at the Lawrence Livermore National Laboratory in California to analyze the dates of the Lake Amatitlan cores. In December 2000, we received the results of the analysis. The AMS radiocarbon dates from the cores are in general quite young, ranging from about 600 B.C. to sometime between A.D. 1200 and 1300. The AM-15-III-00 date is apparently an anomaly, probably a reflection of the high sedimentation rates in the lake area. The dates are shown in Table 1.

Although the dates will provide little information regarding post-Pleistocene climate changes, they will be highly relevant for correlating climatic variations that may have affected the Kaminaljuyu irrigation system that existed between 600 B.C. and A.D. 200. At present, we do not know the degree to which the disappearance of Lake Miraflores was due to climatic factors or environmental changes caused by human activity.

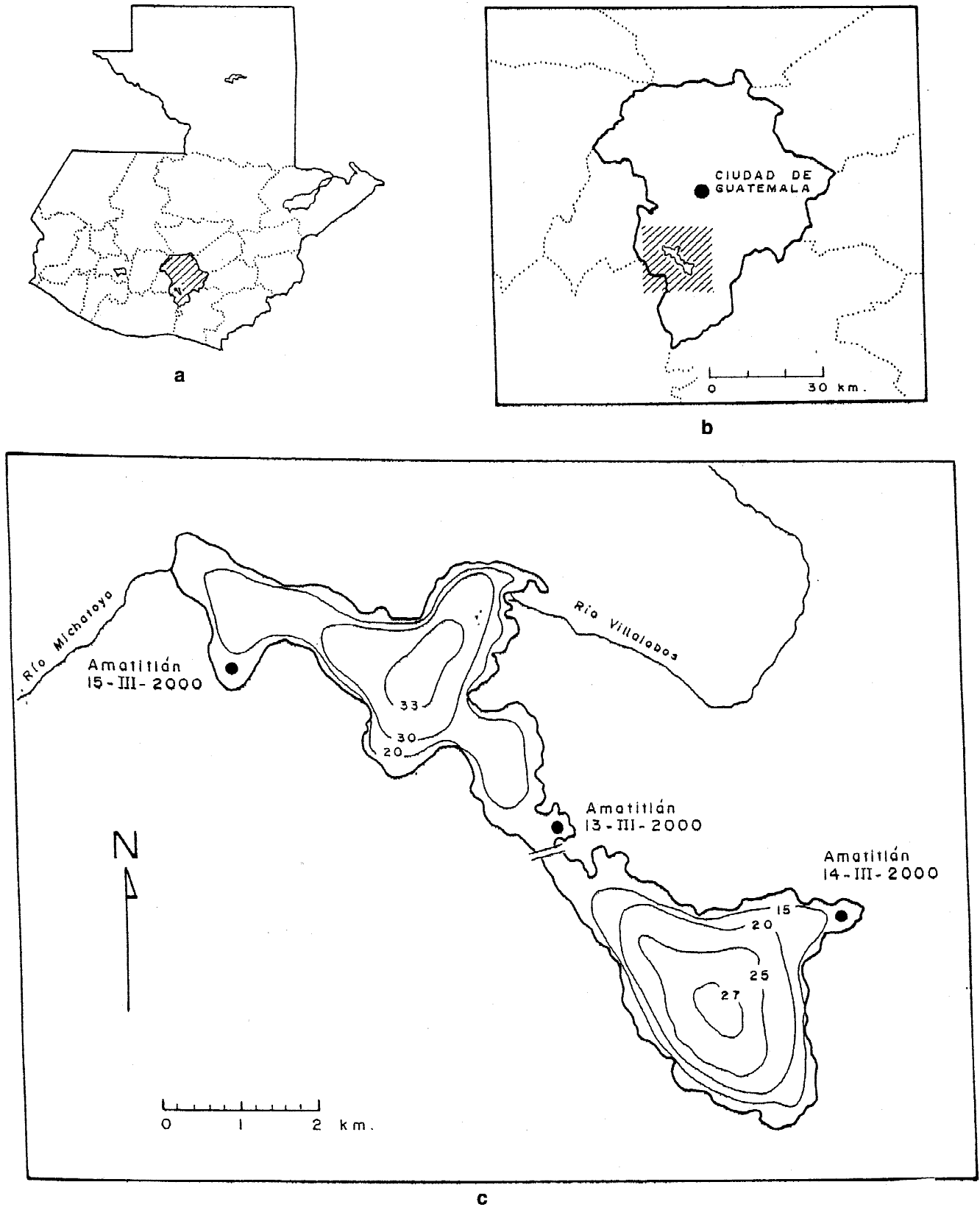


Figure 9. Map of Guatemala and Lake Amatitlan. (a) Location of the Valley of Guatemala and Lake Amatitlan; (b) location of Guatemala City and Lake Amatitlan (hatched area); (c) plan view of Lake Amatitlan, copied from a portion of the Instituto Geográfico Nacional de Guatemala (1:50,000) map of the area. The plan shows approximate contours of the lake and location of stations used for vertical coring sections.

Table I. Cores taken from the floor of Lake Amatitlan

Location	Depth (cm)	Radiocarbon Date	Approximate Calendar Year
AM-13-III-00	419–421	660 ± 60	A.D. 1290
AM-14-III-00	541–543	1650 ± 50	A.D. 300
AM-15-III-00	240	710 ± 50	A.D. 1240
	340	2910 ± 130	960 B.C. (anomaly)
	440	1540 ± 190	A.D. 420
	540	2010 ± 100	A.D. 60
	610	2340 ± 110	390 B.C.
	690	2570 ± 40	620 B.C.

RESUMEN

Durante los años 2000 y 2001 el Departamento de Arqueología llevó a cabo un proyecto para determinar el paleoclima del Valle de Guatemala. Este proyecto contó con la colaboración de dos especialistas de la Universidad de Florida en Gainesville. Nuestros objetivos eran los siguientes: (1) descubrir hasta qué grado el paleoclima del Altiplano de Guatemala coincidía o difería del patrón de las tierras bajas; (2) descubrir hasta qué punto el cambio climático fue un factor en el secamiento del extinto Lago Miraflores y en el abandono del sistema de irrigación de Kaminaljuyu aproximadamente en 200 d.C. El financiamiento para este proyecto de paleoclima fue generosamente proveído por la Foundation for the Advancement of Mesoamerican Studies (FAMSI).

Probablemente Kaminaljuyu fue el centro más importante del Altiplano de Guatemala durante el período Preclásico (1000 AC a 200 d.C.), el cual continuó habitado hasta cerca del 900 d.C. Recientemente se descubrió que en tiempos del Preclásico esta gran ciudad se mantenía en parte por un sistema de agricultura con irrigación, que se basaba en un sofisticado sistema de canales. Sin embargo, entre 100 y 200 d.C. ocurrieron cambios radicales. Uno de los factores evidentes es que durante este intervalo el sistema de canales se secó; una de nuestras preguntas es hasta dónde esto fue ocasionado por la actividad humana o por el cambio climático. Aproximadamente al mismo tiempo, entró al área una población nueva y tomó el control del centro. Los primeros habitantes abandonaron el lugar y se dirigieron a un destino por ahora desconocido.

Los dos científicos visitantes que participaron fueron el Mark Brenner, especialista en geoquímica de isótopos y el Jason Curtis, especialista en microfósiles. Anteriormente ambos habían realizado estudios de paleoclima en el Caribe, la península de Yucatan y Peten. Su interés se concentró en el cambio climático posterior al Pleistoceno que sucedió en Mesoamérica, y más específicamente que tanto el patrón del Altiplano

The cores' pollen content is now being investigated by Barbara Leyden of the University of South Florida. Curtis is analyzing the samples for isotope ratios on microfossil (gastropods and ostracod) shells, the most critical indicators in tracing climatic change. His work will include an analysis of the geochemistry of the sediments, including evidence of volcanism. We expect to have these results within the next few months. When they are correlated with the radiocarbon and magnetic-susceptibility data, final conclusions will be made and published.

Our hope is that the investigations of the paleoclimate in the Guatemala Highlands will assist us not only in understanding the nature of human–environment interaction at Kaminaljuyu but also contribute to understanding long-range climatic change in post-Pleistocene times and its effect on cultural ecology in general.

difiere de los datos obtenidos de las tierras bajas. Los participantes locales fueron la Marion Popenoe de Hatch y el Lic. Erick Ponciano, ambos del Departamento de Arqueología de la Universidad del Valle de Guatemala y que previamente habían llevado a cabo las excavaciones arqueológicas que descubrieron los canales de irrigación en Kaminaljuyu que datan del 700 a.C. al 200 d.C. El Charles Ortloff, un especialista en el antiguo sistema de canales del Perú, analizó el sistema de ingeniería hidráulica en Kaminaljuyu, cuando fue descubierto por las excavaciones arqueológicas.

Para el proyecto paleoclima se planificó obtener núcleos de lagos o antiguos lechos de lagos, si es que todavía se encontraban húmedos. Brenner y Curtis visitaron Guatemala con el propósito de obtener las muestras. Se excavó un pozo estratigráfico e el antiguo lecho del Lago Miraflores y se tomaron muestras de un perfil a intervalos de 5 cm hasta llegar al suelo estéril que se ubicaba a 3.15 m. Luego se llevó el equipo para obtener los núcleos al Lago Amatitlán, que es un importante cuerpo de agua al suroeste del Valle de Guatemala. Las muestras para obtener los núcleos llegaron a una profundidad de 7 m. Posteriormente los núcleos fueron transportados a los Estados Unidos para ser analizados.

Brenner arregló que las muestras de carbón del Lago Amatitlán se analizaran en el Lawrence Laboratory en Livermore, California. La fecha más antigua es 700 a.C., no tan antigua como se esperaba pero excelente para el análisis del sistema de canales de Kaminaljuyu. Actualmente el Curtis está analizando las muestras a fin de buscar microfósiles (gastropodos y ostracod). La Barbara Leyden, de la Universidad del Sur de Florida, ha realizado los estudios preliminares del contenido de polen en las muestras, para observar las especies de plantas representadas. Por el momento la interpretación de los datos continúa en marcha y será completada próximamente.

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