Before the Volcano Erupted

The Ancient Cerén Village in Central America

EDITED BY PAYSON SHEETS

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THE ANCIENT CERÉN VILLAGE IN CENTRAL AMERICA

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Dedicated to the life,
accomplishments,
and humanity
of our friend and colleague

VÍCTOR MANUEL MURCIA,

of Chalchuapa, El Salvador

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Preface

Payson Sheets

As with many archaeological sites, the Cerén site was discovered by accident, as a bulldozer was flattening a hill for a construction project. It took a couple years to realize what was there, but now the site is a World Heritage Site (listed with the United Nations) and well protected and curated by the government of El Salvador. It is to the officials of the Ministry of Education, and particularly of CONCULTURA (Consejo Nacional para la Cultura y el Arte), that we owe a great debt of gratitude for their dedication to the conservation of the site. They have also led the way to opening the site for public visitation. A nongovernmental organization called the Patronato Pro-Patrimonio Cultural has been of great assistance in training guides and designing the part of the site open to public access. The Patronato officials have been very helpful to the project as well.

The Museo Nacional David J. Guzmán has been highly professional in its care and curation of the great numbers of artifacts that have come from Cerén. The Jardín Botánico La Laguna has been helpful in the temporary storage of plant casts as well as assisting in field identification of plants found at the site.

The U.S. National Science Foundation has been supportive in providing funding for the major field seasons with grant no. 9006482 and others. The Committee for Research and Exploration of the National Geographic Society has awarded grants for other field seasons. The support of these institutions is greatly appreciated. The University of Colorado has assisted with supplementary grants and awards. The current participation of the Getty Conservation Institute in assisting with the monitoring of on-site conditions and the creation of a management plan for the region is appreciated.

A hearty "muchísimas gracias" is expressed to the crew of Salvadoran workers from Chalchuapa and Joya de Cerén who have learned such fine excavation and conservation techniques. It is an honor to work with such qualified and dedicated people.

The research reported herein is the result of the hard work of the professional staff of the Cerén Research Project. Their wide span of disciplines ranges from archaeology to volcanology and includes geophysics, ethnobotany, ceramics, and other specialties. It is difficult to express in words my appreciation for their dedication to the site, trying to understand what happened some 1,400 years ago in a village in southern Mesoamerica.

The authors of these chapters have tried to keep their words to a minimum, and to include only illustrations that are absolutely necessary, in order to keep printing costs, and thus the price to the public, reasonable. The data-rich and illustration-rich materials, as well as the full text of all reports written to cover each season's research, are available on the CD-ROM *An Interactive Guide to Ancient Cerén: Before the Volcano Erupted* by Jen S. Lewin, Mark A. Ehrhardt, Mark D. Gross, and Payson Sheets and at the Cerén Internet website (URL http://ceren.colorado.edu). Readers desiring more information or illustrations are encouraged to access one of these sources.

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Introduction

Payson Sheets, with an Appendix by Brian R. McKee

This chapter begins with consideration of the natural and cultural environments of the site, and then turns to the theoretical context within which the research is being conducted. That discussion is followed by a brief history of the property on which the site has been located over the past three decades, up to the present. Next follows a description of the multidisciplinary and interdisciplinary research project, in which archaeology, ethnobotany, volcanology, and geophysics are integrated with architectural and objects conservation, site and regional master planning, and outreach and educational efforts. The cooperative efforts of the Salvadoran government, particularly CONCULTURA within the Ministry of Education, and of the nongovernmental organization Patronato Pro-Patrimonio Cultural are then described. That is followed by an overview of the organization of the book and how the chapters integrate with the wealth of data, text, pre-eruption site reconstruction, and images available on the CD-ROM *An Interactive Guide to Ancient Cerén: Before the Volcano Erupted* and the Cerén website (the URL address is http://ceren.colorado.edu). The text and illustrations of this book have been deliberately kept to a minimum to keep costs down, but an abundance of illustrations and detailed data are available on the CD-ROM and the website.

The Natural Environment

The Cerén site is located in the northern end of the broad Zapotitán Valley in what is now El Salvador (Fig. 1.1). The site's elevation is 450 m, which combined with the 14°N latitude and topography gives the area a tropical monsoon climate (Sheets 1992a). The area receives 1,700 ± 300 mm of precipitation per year; thus dryland maize agriculture is generally quite productive. However, some years have either too much or too little rainfall, and traditional agriculturalists that are not irrigating their fields today must have ways to adjust to that range. Fully 96% of the rain falls in the rainy season from May through October, and the dry season is hot and very dry.

The average annual temperature is 24°C (75°F), with December the coolest month (mean 22°C [67°F]) and April the hottest month (26°C [83°F]). The temperature fluctuation from daytime to nighttime is greater than the seasonal fluctuation, and even in April the nights are comfortable. Markgraf (1989) found no evidence of significant climatic change within the past 3,000 years in Central America, but separating the climatic component from human impact on the environment is difficult. Thus, for our purposes here, we will take the present climate as a reasonable approximation of the climate during the mid-Classic Period.

Daugherty (1969) reconstructed the native climax vegetation of the Zapotitán Valley. Along the rivers and around the big lake in the center of the valley were gallery forests, composed of many different species, that had access to groundwater and thus remained green even at the height of the dry season. Over most of the rest of the valley were less dense forests of deciduous trees that would largely shed their leaves at the height of the dry season, but would remain lush for most of the year. Human impact on the natural vegetation must have been considerable by the Classic Period but not as great as it is in the valley today.

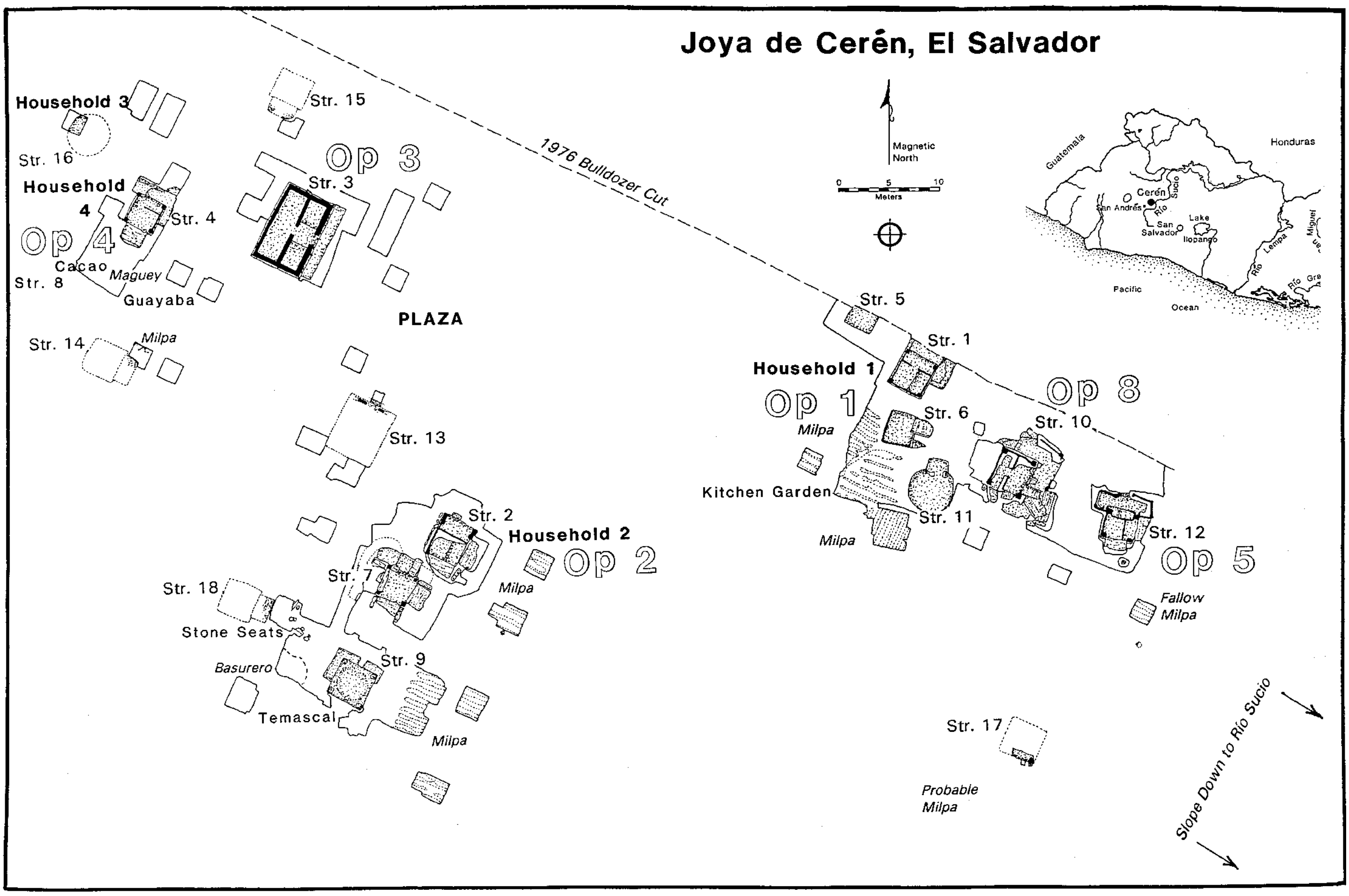

FIGURE 1.1. Map of the Cerén site, with operation and household numbers identified, and agricultural fields around them. The lines around the structures and agricultural fields are limits of excavations. Operation 1 includes all four buildings of Household 1. The two religious buildings, Structures 10 and 12, are in Operations 8 and 5 respectively. Operation 2 includes two household buildings of Household 2 and the sweat bath (Structure 9). Operation 3 includes Structure 3, and Operation 4 includes Structure 4 and the specialized gardens and orchard around it. The inset map shows the location of the Cerén site within western El Salvador.

The area has been and continues to be very active volcanically, with volcanoes ringing the valley, dominated by the San Salvador volcano complex on the eastern side and the Santa Ana volcano complex on the western side. Even major volcanoes are strikingly recent; Izalco Volcano was born in 1770 and continued erupting until 1965. The area was active in the Pliocene and Pleistocene, with the cataclysmic Coatepeque eruption (sometime between 10,000 and 40,000 years ago) conceivably affecting early human populations. The huge Ilopango eruption (Sheets 1983) about 1,800 years ago[1] devastated the valley by covering it with a blanket of sterile, white acidic ash from 1 to 5 m deep, which wiped out flora, fauna, and people. The archaeological record indicates a century or two of weathering were necessary before soils and plants recovered sufficiently to support human reoccupation. The Cerén site was one of the pioneering communities reoccupying the valley, but it existed there for perhaps only a century before it was entombed by the Loma Caldera eruption. In contrast to the earlier great eruptions, the Loma Caldera eruption affected only the few square kilometers surrounding the vent. Some time around A.D. 1000, San Salvador Volcano erupted and deposited a thick wet blanket of ash over a moderately large territory. In the historic period, the latest eruption to deposit airfall volcanic ash over the valley was the A.D. 1658 eruption of Playón Volcano. Since that time, the most common eruptions have been lava flows that covered a few square kilometers at various times. Much of the reason for the high fertility of the soils in the valley is that they are volcanically derived in an area with sufficient moisture for exuberant plant growth.

The Cultural Environment

The southeastern portion of Mesoamerica, otherwise known as the Southeastern Maya periphery, encompasses the present country of El Salvador and western Honduras. Archaeological research began more than a century and a half ago in this zone with the work of Stephens and Catherwood. More recent research is summarized by Healy (1984) and Sheets (1984), and in the volumes edited by Urban and Schortman (1986), Pahl (1987), and Robinson (1987). Of course, most research has been in elite contexts, but there has been a steady growth of interest in commoners in the past couple decades, a topic developed in the next section.

Within the Zapotitán Valley of El Salvador, the earliest serious archaeological research was the excavations at Campana San Andrés, the largest site in the valley and certainly the religious, economic, and political center of Classic Period society. Unfortunately, that research is published only in four short preliminary reports and summarized in Longyear (1944: 10).

It is difficult to study ethnicity at sites without hieroglyphics in southern Mesoamerica, and the ethnicity of Classic Period residents of the Zapotitán Valley is not clear. They certainly had Maya-related architecture and artifacts, but the language they spoke in the Preclassic and Classic Periods is unknown. The multiple structures with specialized uses per household, the pervasiveness of Copador ceramics in commoner and elite contexts, the "flint" (really chert) eccentric and jades at San Andrés were all clearly Maya in derivation, but the lack of hieroglyphics in the Zapotitán Valley and the lack of household shrines at Cerén may reflect a non-Maya or frontier Maya background with significant acculturation to Maya architecture and artifacts.

Black (1983) described the settlement system in the valley contemporary with Cerén as a hierarchy from the large primary regional center of San Andrés to the isolated hamlet. Below San Andrés in the hierarchy were secondary regional centers with substantial pyramidal architecture, followed by large villages with ritual construction (smaller pyramids), large to small villages, and hamlets. Cerén fits well in this hierarchy as a medium-sized village. The production and distribution of obsidian implements was found to be quite sensitive to the settlement hierarchy, reflecting variation in access to long-distance traded commodities, craft specialization, and other factors (Sheets 1983). Population density in the Middle Classic Period was relatively high in the basin area around Lake Zapotitán and along the river courses, estimated by Black (1983: 82) at 165–440 people/km^2, but much lower in hilly and mountainous areas, for an overall regional population density of 70–180 people/km^2. The valley is thus intermediate between the exceptionally high densities of the Southern Maya lowlands and the Intermediate Area to the southeast.

The Theoretical Context

The theoretical context within which the Cerén Research Project has been conducted is household archaeology, focusing on the household as the domestic coresidential social and adaptive unit intermediate between the individual and the neighborhood. One reason for the strength and success of household archaeology is the breadth of its origins in settlement archaeology (Willey et al. 1965; Chang 1968), ethnography (Wilk 1988; Wisdom 1940), ethnoarchaeology (Kramer 1982b; Wauchope 1938), and cognate social sciences (Arnould 1986). It is now a field with ethnographic sophistication, improving field techniques (Hayden and Cannon 1984), and an emerging corpus of appropriate methods and theory (Netting, Wilk, and Arnould 1984; Wilk and Rathje 1982; Santley and Hirth 1993; Ringle and Andrews 1983; Wilk and Ashmore 1988).

Considerable household archaeology has been conducted in Oaxaca (Flannery 1976; Marcus 1989) and at Copán (Webster and Gonlin 1988), among other areas. The commoners living in the Copán area but at a distance from the big Copán site lived in very basic housing (Webster, Gonlin, and Sheets 1997). Housing closer to the site center was more formal and substantial, with rectangular substructures, terraces, and interior benches (some of which had niches). Cerén is most similar to the middle range of Copán residences.

Craft specialization is one among many means of production, and archaeologists have studied production and specialization most successfully in civilizations and in regions. Generally, the nature of preservation at most archaeological sites limits the extent to which production and specialization can be studied within a community and especially within a particular household. The exceptional preservation at Cerén permits a detailed study of household production and specialization, and even exploring possible service relationships between households and nearby institutions or specialized structures within the community. It also provides the opportunity to study exchanges between households within the community and craft production to exchange for distant items in the regional economy.

Wilk and Rathje (1982) certainly were correct in stating that households in sedentary societies were immersed in material culture. Even that observation did not prepare us for the astounding total of over seventy ceramic vessels per household at Cerén.

Each Cerén household is examined here for its artifacts, architecture, activity areas, food and craft production, and storage. As households did not exist in isolation, the relationships of each household to the community and the possible service relationships that each had to specialized facilities, such as a feasting structure and a communal sweat bath, are explored. Each household overproduced at least one craft or commodity and used that for exchange within the community and to obtain long-distance traded items that generally were produced by specialists, such as obsidian tools, hematite pigments, and jade axes.

FIGURE 1.2. The earthen columns and floor of Structure 1 in the bulldozer cut in 1978, during first recording. Below the structure is the fertile Preclassic soil, buried by white Ilopango volcanic ash in about A.D. 200. Weathering allowed for human reoccupation a couple of centuries later; the pits on the lower left are borrow pits for house construction. The alternating steam explosion layers (lighter colored) and direct airfall layers (darker) from the Loma Caldera eruption in about A.D. 600 buried the building and site deeply.

The Recent History of the Property and the Site

The property that includes the Cerén site has been in Salvadoran federal governmental hands for the past few decades. The northern part of the site belonged to the Instituto Regulador de Abastecimientos (IRA; Food Regulation Institute), which began constructing a grain storage silo complex in 1976 and made first contact with the site by means of a bulldozer blade. The Instituto Salvadoreño de Transformación Agraria (Salvadoran Agrarian Reform Institute) owned the adjacent southern part of the site. Both parts were transferred to the Ministry of Education in 1992 and are officially a National Archaeological Monument.

After the site was declared a National Archaeological Monument by the Salvadoran government, it was nominated for, and achieved World Heritage Site status by the United Nations (UNESCO) in 1993. The site and museum have been open to the public since 1993 and continue to receive a few thousand visitors per week.

The Research Project

The Cerén site and the surrounding territory were buried so rapidly and deeply by the Loma Caldera eruption at about A.D. 600 that they were forgotten and left untouched for centuries. In 1976 that abruptly changed during the bulldozing for the IRA grain storage silos. When the bulldozer operator encountered earthen architecture and ceramic artifacts, he stopped, notified the Museo Nacional David J. Guzmán (MNDG), and waited three days until the museum archaeologist inspected the site. The archaeologist stated that the site must be recent, because of its exceptional preservation, and the bulldozing should continue. We estimate that at least a dozen buildings were destroyed, but much of the site remained intact to the south and west. When I visited the site 2 years after the bulldozing, the floors of Structures 1 and 5 were visible in the bulldozer cut (Fig. 1.2). I too shared the initial impression of recency, but could only find Classic Period artifacts, and so submitted preserved roofing thatch for radiocarbon dating. The numerous samples yielded a composite C14 date of A.D. 590 ± 90 (Sheets 1983). The dating was substantiated and refined by Dan Wolfman (personal communication 1990), who used archaeomagnetism to date the eruption to between A.D. 585 and 600 (2-sigma range). As noted by Sheets (1992a) and Conyers (1996), the numerous seasonally sensitive plants preserved at the site indicate the eruption probably occurred in August. Further, the positions and conditions of artifacts indicate the eruption probably occurred in the early evening, after dinner was served but before the dishes were washed, likely between 6:00 and 7:00 P.M. Ironically, we are able to date the larger time category, the year, less precisely than the finer time categories, the month and time of day.

Zier (1983) described the 1978 excavations in Structures 1 and 5, adjoining areas, and two test pits that found a fallowed maize field and a maize field that had been harvested and recently replanted with the second crop. Supported by the National Geographic Society, geophysical explorations with ground-penetrating radar, resistivity, and seismic refraction were conducted during the succeeding two field seasons, in 1979 and 1980, in which anomalies were recorded and some were confirmed as Classic Period structures (Sheets et al. 1985). The Salvadoran civil war became too intense for sustained fieldwork for most of the 1980s, but we did return for research seasons in 1989, 1990–1991, 1992, 1993, and 1996, supported by the National Science Foundation and the University of Colorado. The Committee on Research and Exploration of the National Geographic Society is funding current research. The research has been overtly multidisciplinary and interdisciplinary, integrating archaeology with volcanology, ethnobotany, geophysics, and a conservation program that focuses on vegetation, architecture, and artifacts within the Classic Period landscape. Those endeavors are integrated with an educational outreach program that includes an on-site museum, trained guides, and educational paths that provide public access for viewing most excavated structures and the agricultural fields around them. Master plans for regional and site management are under development, with the assistance of the Getty Conservation Institute.

This Book, the Website, and the CD-ROM

If we published a detailed printed site report, with the full range of archaeological, volcanological, ethnobotanical, and geophysical research results, along with architectural and artifactual conservation, the cost would be prohibitive. Therefore, what is printed here represents the cream of the research results in each category, with the data for each season and discipline available on the Internet at the website (URL http://ceren.colorado.edu) and also available on the CD-ROM *An Interactive Guide to Ancient Cerén: Before the Volcano Erupted.* Thus, we believe this represents the best solution to the problems of data and interpretation availability, soaring printing costs, and the need to share a great amount of research data from a variety of disciplines at the Cerén site.

This volume begins with volcanology, geophysics, and paleoethnobotany in Part I. This is followed by Part II, which examines the four households excavated to date, one fully excavated and the others in varying stages of completion. The excavations at Cerén must be done with great care and are integrated with conservation, with an objects conservator present during all excavations, so that the result is very cautious research and thus a small sample. Only some 900 m^2 of the village have been excavated to date. The special buildings in the Cerén village are then presented in Part III. They include a civic complex, a sweat bath, a religious association, and a structure in which we believe a woman shaman practiced. Following, in Part IV, are chapters on artifacts, including ceramics, chipped stone, groundstone, bone and shell, and organic artifacts. Part V, the final section of this volume, covers topics such as conservation, agriculture, household production and specialization, an ethnographic overview of the present town of Joya de Cerén, and a summary and conclusions.

Table 1.1 presents each Cerén structure excavated, or at least partially excavated, together with its Operation number and the interpretation of its function or functions. To date we have completely excavated eleven buildings, and have excavated portions of seven others. Using geophysical techniques, particularly ground-penetrating radar but also resistivity and two other techniques, we have detected numerous other anomalies, most of which probably will turn out to be structures. As the buildings are excavated and their artifacts are analyzed, the functions of the buildings become clear, and we can begin to see groupings. Four buildings of Household 1 have been excavated, including a domicile (for sleeping, eating, and various daytime activities), a storehouse, a kitchen, and a ramada-style building that occasionally was used for chipped stone tool maintenance, among other functions (Structures 1, 6, 11, and 5, respectively). Two buildings of Household 2 have been excavated, the domicile and the storehouse (Structures 2 and 7). The kitchen has yet to be excavated, and we do not know if Structure 18 is a part of this household. Only a part of the kitchen of Household 3 is known (Structure 16). The storehouse of Household 4 has been

TABLE 1.1. Operation Numbers, Structure Numbers, and Functions of Structures at Cerén

Operation No.	*Structure No.*	*Function*
1	1	Domicile (living, crafts, sleeping) of Household 1
1	5	Some stone working, Household 1
1	6	Storehouse of Household 1
1	11	Kitchen of Household 1
2	2	Domicile of Household 2
2	7	Storehouse of Household 2
2	9	Sweatbath (temascal)
3	3	Special, probably civic
4	4	Storehouse, agave working, Household 4
5	12	Divination, probably by a woman
6	none	2 large test pits north of Structure 4
7	13	Special, probably civic
7	14	Unexcavated; bajareque, probably a household building
7	15	Unexcavated, bajareque, probably a household building
7	16	Slightly excavated, a kitchen, Household 3
8	10	Building for ceremonial feasting
9	17	Slightly excavated, corner of platform and earthen column

excavated, and it is a storehouse and much more (Structure 4). The maguey (*Agave americana*) garden south of the building produced fiber for about a dozen households; the leaves were depulped to liberate the fibers using Structure 4's northeast corner pole.

In the center of the site is a civic complex made of a constructed flat plaza surrounded by buildings. The large Structure 3 defines its west end and may have been used for ajudication of disputes, based upon the large benches perhaps symbolizing the authority of the village elders seated upon them. A similarly imposing building (Structure 13) is on the plaza's south side, and judging from the tiny portion excavated, it is loaded with artifacts. Radar has apparently detected two buildings on the east side of the plaza, and a person who witnessed the 1976 bulldozing claimed to have seen a similar large building to the north of the plaza, but we have no way to confirm this.

To the south of Household 2 is a large sweat bath, Structure 9, sufficient to seat almost a dozen people and thus probably a neighborhood or community facility. A thatched roof protected its elegant earthen dome. It is likely that Household 2 residents maintained the structure and perhaps the functioning of the sweat bath with firewood and water, but we have no direct evidence of that possible service relationship other than the large number of vessels in Structure 7 that could have stored water.

Two religious buildings are located at the topographically highest location of the site, overlooking the river. The structure closest to Household 1 clearly supported ceremonial feasting, with the sacred artifacts (e.g., deer skull headdress, obsidian blade with human hemoglobin residues, alligator vessel with achiote seeds for red pigment) stored in the innermost two rooms. The outer enclosure was for temporary food storage, processing, and disbursement to ceremony participants. There are strong indications that Household 1 had a service relationship to the feasting building. It appears a ritual was in progress or had just been completed at the time of the eruption, perhaps the Maya *cuch,* a ritual focusing on the first maize harvest, deer, and the fertility of nature (Brown 1996). The other religious building appears to have been where a diviner, apparently a woman, practiced. Unlike all other buildings at the site, both religious buildings were painted white with some red hematite decoration, and both were oriented away from the standard 30° east-of-north architectural and agricultural orientation.

One of the exceptional aspects of Cerén is the preservation of thatched roofs by the rapid tephra deposition. It is unprecedented for an archaeological site in the humid tropics to have thatched roofs preserved. The number of mice in the thatch is directly proportional to the quantity of food stored in buildings, with storehouses having about six each, other household buildings a few, and the sweat bath, civic building, and workshop roofs none at all.

Another exceptional aspect of Cerén is the preservation of agricultural fields with the plants growing in them. The maize fields are ridged, with clusters of three to five plants germinating in a single planting hole. The plants themselves decomposed within months or perhaps years after being encased in the volcanic ash, but fortunately the ash had enough consistency to preserve the form of a plant as a hollow space for 14 centuries. When we find such cavities, we explore them with fiber-optic proctoscopes and decide on a casting strategy, generally involving dental plaster. The range of species whose form is preserved in volcanic ash is great, and includes maize, beans, chiles, squash, manioc, maguey, various trees such as cacao and guayaba, and a number of palm and deciduous trees.

The Cerén site provides an unusually clear window through which we can view village life in southern Mesoamerica on an August evening some 13 or 14 centuries ago. The chapters in this volume are deliberately limited to the most essential information and interpretations. The wealth of multidisciplinary data and interdisciplinary research upon which they are based is presented via the website and CD-ROM.

Appendix 1A. Radiocarbon Dating and Chronology

Brian McKee

The Cerén site was occupied for a period of several decades to a century or so during the Late Classic Period, and seven samples from the site have been radiocarbon dated. All samples consisted of carbonized construction materials from the structures; five were grass roofing thatch and two were charcoal from posts used in construction.

Dean (1978) provides a useful theoretical framework for dating in archaeology. Two key components to his framework are the dated event and the target event. The dated event is the event dated by chronometric means. For the Cerén samples, the dated events are the death of the grass used for roofing thatch and the growth of the tree rings comprising the wood. The target event is the event to which the date is applied. Two events are targeted in this analysis: the construction and maintenance of the structures, and the eruption of Loma Caldera volcano and accompanying site abandonment. The samples submitted by the project are not appropriate for dating the initial occupation of the site following the Ilopango eruption.

I believe the dated events to be a reasonable proxy for the target events for several reasons. Biological decay is normally very rapid in the wet tropics, largely limiting the "old wood problem," although long-lived species can produce carbon that predates the target event (Schiffer 1986). The wooden posts were probably used in construction soon after the death of the tree, and the grass thatch was probably used within a few days of cutting. Grass thatch roofing must also be replaced every few years in El Salvador, so it is virtually certain that the thatch samples predate the eruption by less than a decade. The wooden posts may predate the eruption by a few more years, but the statistical analysis of radiocarbon dates presented below indicates the difference is not significant.

Table 1.2 and Figure 1.3 show the results of radiocarbon dating of materials from Cerén. Calibration curves are updated every few years, and many previously published dates have been presented using earlier curves or have not been calibrated. To facilitate comparison with other sites, both the uncalibrated and calibrated dates are shown in Table 1.2 and Figure 1.3.

The radiocarbon year estimate, as received from the laboratories, is presented in the column headed "Radiocarbon Age." The dates were calibrated using CALIB version 4.1.2 (Stuiver and Reimer 1993) to apply the INTCAL 98 radiocarbon calibration curve (Stuiver et al. 1998). The intercepts, 1-sigma, and 2-sigma ranges are presented in their respective columns in Table 1.2. One sample (TX-3120) had an anomalously large standard deviation and was ex-

TABLE 1.2. Radiocarbon Dates and Calibrations, Cerén Site

Sample #	*Radiocarbon Age*	*Calibrated Age*	*68.3% Confidence Interval*	*95.4% Confidence Interval*	*Nature of Sample*
TX-3113A	1330 ± 90 BP	AD 675	AD 645–773	AD 552–891	Grass thatch, Structure 1
TX-6601	1350 ± 90 BP	AD 669	AD 631–727, 736–769	AD 542–885	Grass thatch, Structure 2
A-10743	1360 ± 50 BP	AD 665	AD 648–683	AD 610–730, 736–769	Grass thatch, Structure 1
TX-3119A	1420 ± 50 BP	AD 645	AD 607–662	AD 545–680	Wooden post, Structure 1
ELS-40	1440 ± 135 BP	AD 631	AD 449–510, 523–686	AD 342–885	Grass thatch, Structure 1
TX-6600	1520 ± 70 BP	AD 546	437–619	AD 405–658	Grass thatch, Structure 3
TX-3120	1510 ± 390 BP	Not calibrated			Wooden post, Structure 1
Average	1403 ± 28 BP	AD 650	AD 636–660	AD 610–671	Pool of six samples above

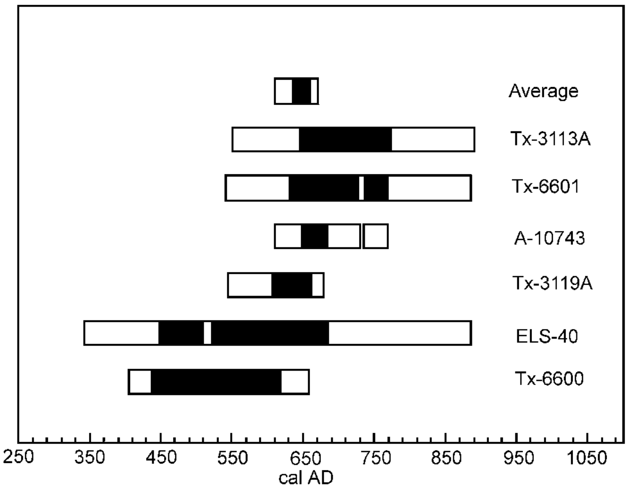

FIGURE 1.3. Graphical representation of the calibrated radiocarbon dates from the Cerén site. The black area of the bars shows the 1-sigma range, while the white area shows the 2-sigma range.

cluded from calibration and averaging. The uncalibrated date is presented in Table 1.2.

We recognized one potential problem in calibrating the Cerén thatch dates. David Lentz has noted the presence of *Trachypogon plumosus,* a C4 photosynthetic pathway plant, in the thatch at Cerén (Lentz et al. 1996). Plants that use a C4 photosynthetic pathway discriminate against the lighter carbon isotope 12C when compared with plants that use a C3 photosynthetic pathway (Van der Merwe 1982). The C4 pathway biases for an increase in the relative proportions of 13C and 14C, and C4 plants give a more recent radiocarbon age than C3 plants of the same age. This difference can be corrected for by applying the D13C value to a sample, but the TX and ELS laboratories do not indicate whether this correction was applied. The Arizona date (A-10743) was corrected for isotopic fractionation. If the TX and ELS dates were not corrected, they should differ from the Arizona date by several centuries, assuming that the samples are the same age. A T-test comparison (Thomas 1986: 249–250) indicated that the dates did not statistically differ. We also applied the D13C value from A-10743 to the other thatch dates to explore the possibility of correcting them, but the resulting calibrations did not pattern and were many centuries too early. For the above reasons, I assumed that the University of Texas Radiocarbon Laboratory applied the D13C correction to the TX dates, and I calibrated and averaged them accordingly.

All dates from Cerén clearly overlap at the 1-sigma level (see Figure 1.3), and that visual impression was confirmed by the T-test. The archaeological data and ethnographic analogy also indicate that the dates are contemporaneous and that the timing of the dated events differs by less than a decade. This demonstrates that the differences among the individual dates result from stochastic variation of isotopic decay and analysis, rather than from differences in the dated events. These reasons justified averaging the dates using a statistical function in the CALIB program. The results of that averaging are presented in Table 1.2 in the row marked "Average," and in Figure 1.3 in the bar marked "Average." The average central intercept is cal A.D. 650, the 1-sigma range is A.D. 636–660, and the 2-sigma range is cal A.D. 610–671. Those ranges are the most precise and accurate approximation for the dating of the final thatching of the roofs of Structures 1, 2, and 3, and for the eruption of Loma Caldera volcano and the abandonment of the Cerén site. The author expresses his thanks to Art MacWilliams, who helped with calibrating the radiocarbon dates and the assessment of the results. A conversation with Steve Kuhn led me to more explicitly justify the averaging of the dates. Mike Schiffer and Art MacWilliams critiqued an earlier version of this appendix. Their comments greatly improved the clarity.

Note

1. Research with Robert Dull and John Southern, too recent to have been included when this was written, indicates that this dating of the Ilopango eruption is too early. New AMS radiocarbon dates indicate the eruption probably occurred in the fifth century, and likely in the early part of that century.

PART ONE

Multidisciplinary Research

This first part of the book, supported by a CD-ROM (*An Interactive Guide to Ancient Cerén: Before the Volcano Erupted*) and website (http://ceren.colorado.edu), is multidisciplinary. The archaeology is introduced in the first chapter, beginning with the Precolumbian village called Cerén that functioned in the southern Maya periphery. It was a village of commoners, and as such in the minds of many students of Mesoamerica might be expected to be a rather poor group of households under the economic, political, and religious domination of the elite. After all, the largest and presumably most powerful elite site was only an hour's walk upstream, and about a dozen secondary centers with their elites were scattered about the valley. One of the primary objectives of our archaeological research is to understand what household and village life was like some 14 centuries ago in Cerén. The Cerén village, in what is now El Salvador, was much like hundreds of other villages while it was functioning, as far as we can tell. What makes it unusual when it is compared with other archaeological sites is its burial and preservation.

As the villagers went about their everyday activities, a hot magma was gradually working its way upward. That magma chamber first made contact with water from the Río Sucio just north of town and generated a small earthquake, almost certainly accompanied by noisy steam emissions. The villagers fled, presumably heading south, leaving their buildings, their crops, and most of their artifacts behind. As Dan Miller reconstructs the volcanology, the first volcanic deposit to affect the site came from a steam explosion, and the moist, warm (100°C), finegrained volcanic ash covered roofs, packed around plants, and coated the countryside. The eruption shifted to a dry phase, with particles of all sizes raining down, including some very hot lava bombs (over 575 °C) that caught thatched roofs on fire when they punched through. Ultimately, 5 m of volcanic ash accumulated, and the village was sealed and forgotten for almost 1,400 years.

The very depth of Cerén's burial has provided us with a large challenge in our efforts to detect archaeological features such as buildings and patios, as well as the rest of the Classic Period ground surface. Larry Conyers and Hartmut Spetzler have responded to that challenge by using a wide range of geophysical instrumentation to try to "see through" the volcanic ash to detect elements of the village and landscape. They have been most successful with resistivity, and especially with ground-penetrating radar, in more recent years.

The fine, moist volcanic ash that covered the landscape from the first and third units of the eruption had the salutary effect of tightly packing around the plants that were growing in the village. It packed around corn (maize) plants, for instance, and after a plant decomposed, a faithful cast of that plant remained buried, awaiting our excavations. At Cerén we are fortunate to be able to count the number of corn plants per unit area, to study the size of the ears of corn, and to estimate productivity per unit area. Other plants are similarly preserved as hollow casts, which we generally fill with dental plaster to preserve them into the future. Cerén is an unusual archaeological site in which the vegetation is preserved, and David Lentz and Carlos Ramírez-Sosa look closely at the plants and how they related to household and village life.

P.S.

Volcanology, Stratigraphy, and Effects on Structures

C. Dan Miller

Introduction

Geological and volcanological studies at the Cerén site were designed to provide a stratigraphic framework for archaeological and other investigations at the site, to provide information about the character of the eruptions that destroyed and buried structures at the site, and to provide details about the source and distribution of volcanic deposits that mantle the site.

Stratigraphic sections were measured and described in excavations at each of the main structures at Cerén (Fig. 1.1) to reconstruct the sequence of eruptive events and to allow comparison of the sequence of deposits from one structure to the next. Relationships between stratigraphic units and roof thatch and walls were noted to determine the timing of the destruction of structures during the eruption. The character and thickness of deposits preserved inside of structures varied greatly from undisturbed sections outside, and were dependent upon the timing of damage to walls and roofs. At each site, stratigraphic units were sampled and textural and granulometric characteristics were analyzed.

In addition to excavations at the Cerén site, more than forty distal sections of the Cerén sequence were examined to determine the distribution and thickness of deposits and to produce an isopach map.

I gratefully acknowledge assistance in the field by Brian R. McKee and Eduardo Gutiérrez. I thank Marvin Couchman, U.S. Geological Survey, for doing sieve analyses of eruptive units at Cerén. Chemical analyses of Cerén deposits were performed by David Siems, U.S. Geological Survey.

Origin and Character of the Cerén Sequence

GEOLOGIC SETTING

Excavations at Cerén have exposed a uniform series of pyroclastic deposits slightly more than 5 m thick (Fig. 2.1). The sequence sits on up to 50 cm of tierra blanca joven (TBJ) tephra, a distinctive whitish dacite tephra that erupted about A.D. 260 (Hart and Steen-McIntyre 1983) during the catastrophic eruption of Ilopango Volcano, about 40 km to the southeast. Nearly 5 m of the Cerén sequence is derived from eruptive source(s) within about 1.4 km of the Cerén site. Near the top of the Cerén sequence are tephras inferred by Hart (1983) to have come from eruptions of nearby Boquerón and Playón.

The bulk of the Cerén sequence was produced by eruptions that occurred at one or more vents within a distance of about 1.4 km north and east of the Cerén site, as suggested by Hoblitt (1983) and Miller (1993). The vents lie along a fissure that extends in a north-northwest direction from San Salvador Volcano (Zier 1983). Historically, the fissure has been the locus of several eruptions during the past several thousand years, along a line of vents between Laguna Caldera Volcano and the north flank of Boquerón (San Salvador) Volcano (Fig. 2.2). Magmas from the fissure are basaltic andesite with compositions of about 56% silica (Table 2.1). Magmas that erupted from some parts of the fissure had no significant interaction with surface water or ground-