

Clues From A Village: Dating a Volcanic Eruption



Aerial view of the Ceren site in El Salvador. The archaeological excavations are located under the metal-roofed sheds in the foreground. Construction of the grain silos south of the paved road led to the discovery of the site. Just above that road is the eroded crater rim of Loma Caldera, whose eruption buried the ancient village of Ceren. The heavily forested crater of Laguna Caldera, which erupted before Loma Caldera, lies to the north.

PAYSON D. SHEETS

During the early evening hours of a late summer's day sometime in the late sixth century, the lives of villagers in a small farming community in El Salvador were violently altered. Only 500 meters away from their houses, a relatively small but powerful volcanic eruption began along an active fissure zone. The eruption spewed out ash and cinders, which rained down on the countryside, burying everything within a radius of a few kilometers.

Although inhabitants of this volcanically active part of Central America were no stranger to such events, their proximity to the vent and the speed and violence of the eruption must have been terrifying. The populace quickly abandoned the village, never to return. They left behind everything important in their lives, including a wide range of utilitarian and ceremonial objects. Within a few days, their houses were covered by as much as seven meters of tephra. Whole fields of growing corn, orchards, gardens, and storerooms filled with agricultural products were buried and preserved under volcanic ash.

This cataclysmic event, which obliterated all visible signs of the village, produced one of the best preserved archaeological sites in the Western Hemisphere. Named after the nearby town of Ceren, the site's archaeological remains and associated volcanic stratigraphy record a "snapshot in time" that is helping us reconstruct both the lives of these ancient people and their short, but violent encounter with the volcanic forces that shaped this part of Central America. Using a multidisciplinary approach, archaeologists and geologists have determined the rapidity and magnitude of the eruption as well as the time of day and season in which it occurred.

ARCHAEOLOGY AT CEREN

The Ceren site was discovered in 1976 when the area was being bulldozed for the construction of grain storage silos. In a bulldozer cut, workers saw in profile the remains of what appeared to be an adobe house platform with standing columns at its corners. Singed but still

Lawrence B. Conquers

well-preserved roof thatch along with pottery shards and other artifacts lay on the floor of the structure.

Payson Sheets, an archaeologist with the University of Colorado in Boulder, happened to be surveying the region at the time and was informed of this unusually well-preserved feature. Sheets identified the pottery as coming from the "Classic Period." Radiocarbon assays later confirmed this finding, dating the pieces to A.D. 590, plus or minus 90 years.

Under Sheets' direction, a large contingent of archaeologists, geologists, geophysicists, paleobotanists, and other scientists have been excavating and studying the Ceren site since 1979. To date, 15 structures have been identified by excavation; 12 of these have been completely excavated. Using ground-penetrating radar, I have identified an additional 22 buildings and many other buried features nearby.

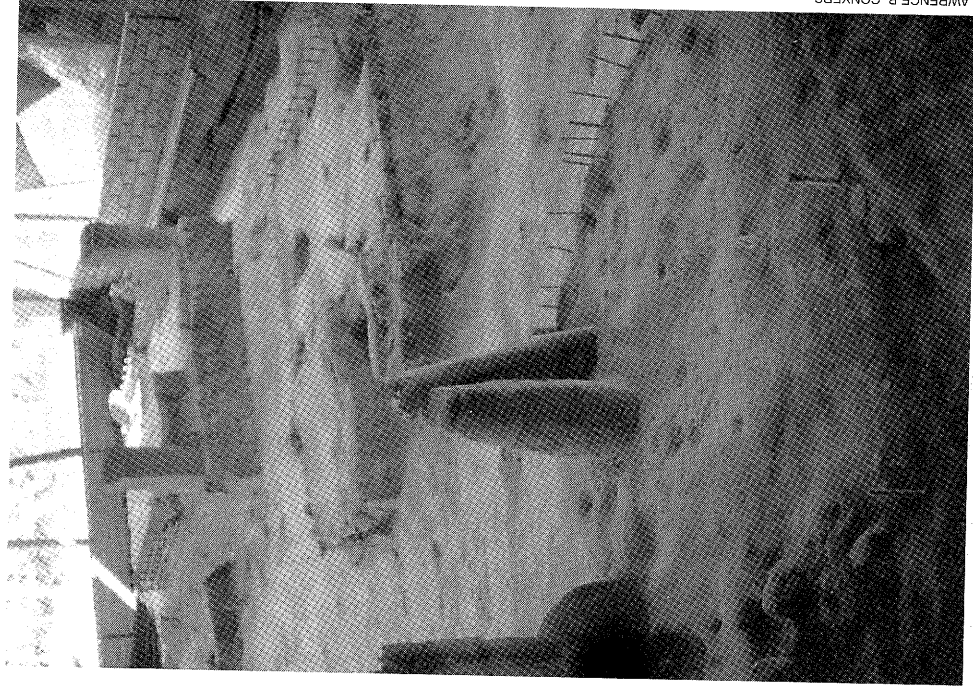
Excavations and geophysical surveys show that the village consisted of many individual households of three or more clustered structures. Each household typically included individual buildings for sleeping and eating, cooking, and food storage. Household clusters were separated by gardens which produced a variety of food, medicinal, and spice crops. Flowers and small orchards were also present. Well-worn footpaths connected individual households to each other, to the village center, and to outlying fields.

Nonresidential structures included a large domed sweat-bath, which could hold as many as 20 people, and a well-built communal building where corn beer may have been dispensed. One structure may have been used for ritual activities by a shaman, while a nearby building provided space for communal food preparation and distribution. Excavated structures for storing food (called *bodegas*) still contain ceramic vessels full of seeds, cribs with dried corn, and hanging bunches of chile peppers.

Large fields of corn surrounded the village; most of the usable ground was under some sort of cultivation. (Plants encountered during excavation occur as hollow cavities in the volcanic overburden. Once unearthed, they are filled with plaster and preserved as casts.) Corn was planted in bunches of three to four plants, in rows aligned along ridges. Near one household stood an orchard containing guayaba trees (which produce a small green fruit the size of an apricot) as well as avocado, nance, and cacao trees. The majority of the plant remains discovered were domesticated varieties, indicating that the prehistoric inhabitants of Ceren had considerable knowledge of horticulture and a varied diet. Their staple food, however, was probably corn.

THE VOLCANIC ERUPTION

The volcanic stratigraphy at Ceren has been studied extensively by C. Dan Miller of the U.S. Geological Survey's Cascades Volcano Observatory in Vancouver, Wash. He concluded that the tephra units that buried the village, especially during the initial stages of the eruption, were deposited as wet, relatively low-temperature surge deposits. These deposits flowed into the village at high speeds, collapsing many of the less substantial building walls while encasing and preserving delicate plants and other organic material in wet ash. Because the initial layers of ash were emplaced at temperatures near 100°C, many of the



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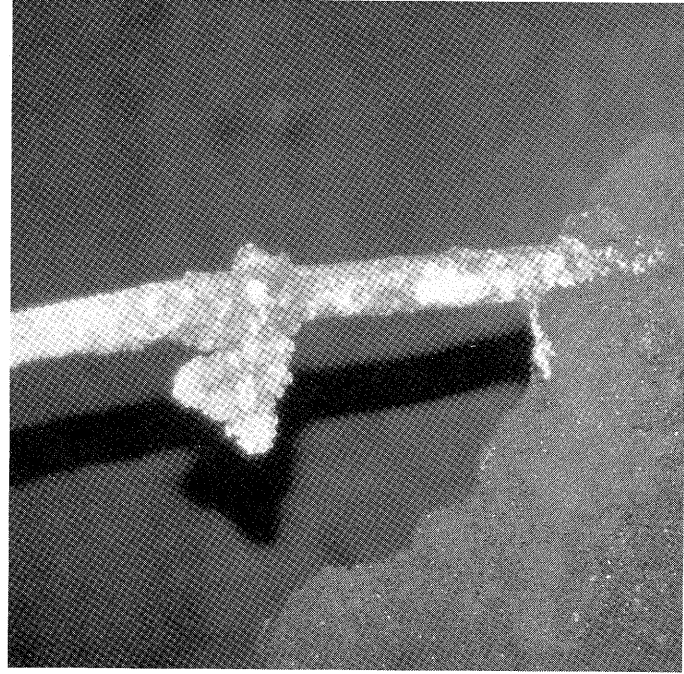
Excavated household cluster at the Ceren site. The round raised platform with adobe columns in the foreground was the cooking structure. A collapsed bodega where food was stored lies above it. The structure with two standing columns and a raised sleeping bench was the main domicile building of this household, used for sleeping and eating. Archaeologists removed between three and four meters of tephra to expose this portion of the ancient village.

plants growing in the community were not ignited.

Ash surge deposits at Ceren are interbedded with block and lapilli layers deposited at temperatures approaching 575°C. These air-fall units consisted of many ballistic bombs, which rained down on the village, collapsing roofs, crushing pottery, and starting fires.

The volcanic vent, called Loma Caldera, is located along an active north-trending fault that projects south toward San Salvador Volcano, one of the larger composite cones in the country. Today, Loma Caldera is an eroded tuff ring, which may have partially collapsed during the later stages of its eruption.

Analysis of the ancient land surface in outcrops and archaeological excavations indicates that seismic shocks, slumping, and faulting occurred just before the eruption — events which may have warned the people that they needed to flee. No human bodies have been found at Ceren, suggesting that all the inhabitants may have escaped. But it is also possible that the villagers fled



BOTH PHOTOS: ANDREA GERSTLE

Botanical evidence used in determining the season and time of day of the Loma Caldera eruption. On the top is the plaster cast of a guayaba fruit that was blown out of a tree during the eruption. The green, nearly ripe guayaba fruit shown with it was picked from a tree near the site in early September. The preserved fruit supports a September date for the eruption. On the bottom is a plaster cast of a small cacao tree's trunk with a preserved blossom. Cacao trees usually blossom in the rainy season. Flowers open after sundown, drying up in the heat of the following day. Preservation of the open blossom suggests that the eruption occurred at night. (Photo originally published in Geoarchaeology, v. 11, no. 5, 1996. Copyright John Wiley and Sons.)

only a short distance before being overcome by the first quickly moving ash flow.

Numerous bodies of birds, which were probably blown out of their nests, have been found on the buried "living surface" of the village. Mice are preserved in roof thatch, and a domesticated duck tied up in one of the bodegas was also encased in ash.

DATING THE LOMA CALDERA ERUPTION

Geologists and archaeologists are usually content to date prehistoric events with a precision of a few centuries, or decades at best. Standard radiocarbon dating techniques, for example, tell us that Loma Caldera erupted sometime between 500 and 680 A.D. That 180-year interval is about as precise as we can be with respect to the actual year of the event. But the excellent preservation of botanical remains and artifacts at Ceren allows us to identify other temporal aspects of the Loma Caldera eruption far more precisely. We've been able to determine the season of the year, and even the time of day, when the first ash flow was deposited.

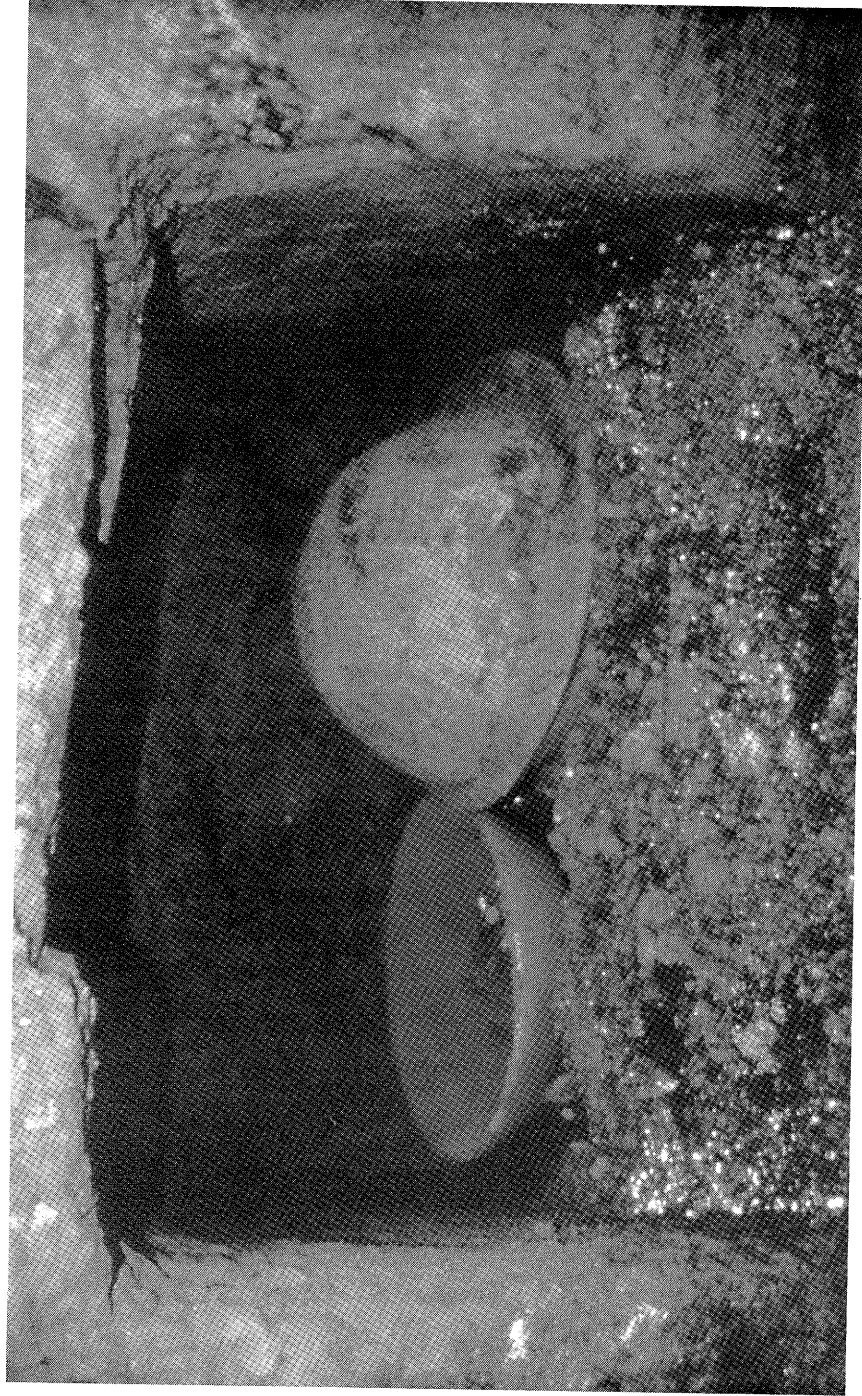
One of the best indicators of the season at Ceren is the maturity of the cultivated corn which was preserved in growing position. Four fields have been exposed, each containing plants at different stages of growth. In the tropics, the maturity of growing corn is almost wholly a function of the timing of the rainy season. In El Salvador, the summer rainy season usually begins in May and ends in October; 95 percent of yearly precipitation falls during this period. All of the yearly corn crop must be grown during these months.

In one of the preserved fields, large mature ears of corn had developed, while in an adjoining field only juvenile plants with ears 15 to 20 centimeters long were found. In another field, the corn had been recently harvested, and in a fourth, mature corn stalks had been purposely bent over with the ears still attached — a traditional method of field drying that is still used by some farmers during the middle to late rainy season.

The different maturities and harvesting schedules of corn indicate that the rainy season was well advanced at the time of the eruption. Corn was nearly ripe in one field. Farmers had just finished harvesting a field and had replanted another, probably in the hope of growing a second crop during the same growing season. A mature crop was drying in a fourth field. Assuming that corn takes 120 to 140 days to reach maturity and that a typical rainy season started in May, a September eruption is most likely.

Other botanical indicators also point to an eruption in the rainy season. For example, chile peppers were found drying *inside* bodegas rather than outside, where they would have been hung during the dry season. Guayaba fruit, which was nearly ripe, was blown out of trees during the initial stages of the eruption. In El Salvador, guayaba usually begins to ripen in late August or early September.

One of the most delicate botanical remains discovered at Ceren was a small cacao tree, which had blossoms growing from its trunk. Cacao blossoms form during the rainy season and usually open soon after sundown. They stay open all night to allow pollination by ants, and then dry up during the heat of the day.



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Nested serving boulders found in a niche in one excavated structure. The boulders contain the remains of the evening meal, which villagers had consumed just before the eruption.

The preserved cacao tree with its open blossoms thus suggests that the eruption occurred not only during the rainy season, but probably after dark.

The placement of certain artifacts in or near houses indicates that the eruption began during the early evening. Field workers had returned from their fields, storing agricultural tools under the eaves of houses. Fires in the cooking structures had died out, and cooking pots had been stored away, some with the remains of the evening meal still inside. Sleeping mats were found preserved in the rafters of the domicile buildings; they had not yet been placed on the raised adobe sleeping platforms for the night. From these artifacts, we can conclude that workers had returned from their fields and that their evening meal had been cooked and consumed. But they had not yet retired for the night when the eruption of Loma Caldera disrupted their lives forever.

A reconstruction of this eruption using both geological and archaeological evidence shows that during a warm tropical evening in late summer, soon after the inhabitants of Ceren had eaten their evening meal, a violent earthquake occurred, accompanied by faulting and slumping of the ground. As the frightened inhabitants fled into the dark, leaving their possessions behind, a hot glowing cloud of ash surged into their village, burying everything in its path.

The volcano continued to erupt for a number of days, covering the village with alternating beds of ash and coarser volcanic bombs and cinders. The village was covered by as much as seven meters of tephra, leaving a wonderfully preserved time capsule of rural sixth-century Central America for archaeologists and geologists to study.

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Dr. Conyers has integrated geology and archaeology at archaeological sites throughout North America. His specialty is using ground-penetrating radar to reconstruct buried archaeological sites and ancient environments.

Additional Reading

"Archaeological Evidence for Dating the Loma Caldera Eruption, Ceren, El Salvador" by Lawrence B. Conyers. *Geoarchaeology*, v. 11, no. 5, p. 377-391, 1996.

The Ceren Site: A Prehistoric Village Buried by Volcanic Ash in Central America by Payson D. Sheets. Harcourt Brace Jovanovich College Publishers (Fort Worth), 1992.

The GeoRef database contains references on the author's topic. The following strategy was used to search GeoRef on CD-ROM through June 1996.

KEY WORDS	TOTAL REFERENCES
Ceren Site or Loma Caldera	8