A PRECLASSIC MAYA WATER SYSTEM

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The Late Preclassic Maya center of Cerros, northern Belize (300 B.C. to A.D. 150) has revealed evidence of a sophisticated water control system. Canals and raised field platforms have been examined inside the community center. An underlying limestone caprock was systematically removed during the quarrying of monument fill to maintain adequate drainage in the community. The result was a man-made relief or watershed across the entire core site area. The role of present and past microenvironments at Cerros is addressed.

WATER MANAGEMENT is a recurrent theme in prestate and state development and must be considered an important element in the evolution of Prehispanic Maya populations (Harrison and Turner 1978). Much literature has been devoted to the topic in an attempt to assess the level of sophistication that various complex societies have achieved (Steward 1955; Wittfogel 1957; Millon 1962; Sanders and Price 1968). More recently, it has been generally accepted that complicated water management schemes represent only one facet of the total societal framework by which the complexity of a society can be evaluated (Price 1971; Hunt and Hunt 1974). However, the presence of water management in the Maya Lowlands by the Late Preclassic period (300 B.C. to A.D. 150) does suggest that the semitropical Lowland Maya had attained a level of technological articulation with their environment comparable to that of other contemporaneous mesoamerican highland societies. In this paper I present the evidence for intensive agriculture and major landscape modification at the Late Preclassic community of Cerros, northern Belize.

LATE PRECLASSIC MAYA

The Late Preclassic period in the Maya Lowlands has been recognized as a time of coalescence which culminated in the technological and sociological achievements of the Classic Maya (Adams 1977; Freidel 1979). As a result of extensive investigation, it has become clear that the majority of large Classic centers had their origins in the Late Preclassic period (Coe 1965; Adams 1977). A key issue for the rise of Maya civilization has been the process by which the community, as a reflection of socioeconomic organization, developed from Late Preclassic antecedents toward the stratified “state” level of complexity manifest in the Late Classic period.

Population density in the lowlands was not great during the Early and Middle Preclassic periods (ca. 2000 to 300 B.C.). Prior to the Late Preclassic period, the Maya Lowlands contained a scattered distribution of small autonomous villages adapted to riverine, lacustrine, and coastal environments (Puleston and Puleston 1971; Rice 1976; Ball 1977a, 1977b, 1977c). Social control and social differentiation were less well defined and developed than in later periods. The Early Classic period demonstrates a strong tendency toward social as well as spatial centralization with the advent of widespread public architecture, an apparent overall population increase and a more elaborate settlement organization than is found in previous periods. Greater stratification and social control are suggested by the planning, construction, and maintenance of large “organizational centers.”

Although a great deal of variability exists, a “dispersed compact” pattern of settlement organization can generally be argued for the Maya Lowlands (Puleston 1973; Scarborough 1980).
This settlement design has received additional support in the recent literature showing intensive agriculture dating as early as the Preclassic period (Matheny 1976; Puleston 1977; Turner and Harrison 1981; Freidel and Scarborough 1982). Evidence suggests that large population aggregates could have been supported in the lowlands by employing these intensive techniques. Ridged fields have been documented in the Candelaria Basin of southern Campeche (Siemens and Puleston 1972) and along the Rio Honda of northern Belize (Belisle et al. 1977). Raised fields have been reported in Quintana Roo (Harrison 1977, 1982; Harrison and Turner 1978), along the Belize River of central Belize (Kirke 1980), and along the New River of northern Belize (Turner and Harrison 1981). Terraced fields have been reported in the Rio Bec region and in adjacent Quintana Roo (Turner 1974; Eaton 1975; Turner and Harrison 1978; Thomas 1981) as well as in the Cayo District of central Belize (Thompson 1931; Lundell 1940; Healy et al. 1980). Moreover, remote sensing techniques have been employed over the lowlands to locate canal networks believed to be associated with raised fields (Adams 1980; Adams et al. 1981). Such ancient technical advances reduce the significance of elaborate slash and burn subsistence equations for estimating the size of Precolumbian populations.

THE SITE OF CERROS

The Late Preclassic Maya community of Cerros is situated on the northern leeward shore of Lowry’s Bight, northern Belize (latitude 18° 12' 06" N, longitude 88° 21' 10" W) (Figure 1). Our research permitted examination of the Late Preclassic Maya settlement surrounding the Late Preclassic Maya central precinct which had been investigated previously (Freidel 1979). The near absence of later construction at Cerros has allowed the examination of Late Preclassic settlement patterns undisturbed by later site modifications or mixing of deposits.

Settlement Pattern

A systematic survey and excavation zone was arbitrarily defined during the 1978 field season (Figure 2). The survey design allowed for comparable areal coverage both inside and outside the main canal. The area inside the canal perimeter has been identified as the core zone and is associated with a concentration of residential and civic architecture. The area outside the canal perimeter has been defined as the periphery zone and is primarily residential space. A stratified sample of mound types has been studied, both inside and outside the core zone. Forty-one structures have been tested or horizontally exposed.

Inside the core area, but excluding the central precinct, 78 mounded features have been defined. Each of the various structure types are represented within the canal perimeter. The overall spatial design of the core zone reveals a planned symmetry in the community. The main canal circumscribes the community, forming a great arc with its focus at the central precinct. The canal system is associated with raised fields located within the core zone. A medial axis for the core zone runs north/south, through the middle of the site, bisecting the north/south axes of two ballcourts, terminating in the north at the foot of Structure 5C and dividing the main canal into two nearly equal segments. Complementing this division of the core zone is the western orientation of Structure 29. An east/west line from the summit of this structure intersects the medial site axis at a point equidistant between the two ballcourt alleyways. In addition, the two end superstructures at the summit of Structure 29B appear to be facing Structure 65 to the north and Structure 53 to the south, respectively. These two structures are equidistant to the summit of Structure 29B and they are positioned north/south of one another (Scarborough et al. 1982).

Many of the structures in the core zone are oriented toward the central precinct. This radial pattern of orientation, directed toward the major monumental construction at the site, further suggests the planned order of the community during the Tulix phase (50 B.C. to A.D. 150) (see Robertson-Freidel [1980] for ceramic sequence). The base map demonstrates the shared orientation of Structures 13, 14, 15, 16, and the Structure 10 Group within the west-central portion of the core zone. These structures have the same orientation, apparently toward the center. Structure
19 in the western portion of the core zone may exhibit a tendency toward this radial orientation. In the eastern portion of the core zone only the small Structure 34, which was horizontally exposed, can be positively shown to manifest this orientation toward the center. However, the mounds in this eastern area are generally smaller and more isolated than those elsewhere in the core zone, and therefore more difficult to orient. (The orientation to the central precinct must be more pronounced than our base map indicates. As a matter of convention, we always oriented the structures to north unless other information suggested differently.)

Figure 1. Map of the Maya Lowlands.
Figure 2. Map of Cerros.
Figure 3. Map of Cerritos environs.
The vacant area in the eastern portion of the core zone is primarily depressed thornbush and *hulubol* (see Physical Environs below). This area appears to have been altered by a limited system of shallow canals that drained into the main canal. Groundlevel occupation has also been confirmed in this area.

The basin canals at Cerros are believed to be unique in the Maya Lowlands (though other examples are anticipated in similar *bajo* settings). Water was collected in the lower reaches of these features and was not allowed to drain away, in a manner not unlike the *tablones* of present-day highland Guatemala (Wilken 1971; Mathewson 1976; Denevan 1982). During heavy rainfall, the subsequent overflow was directed into a main canal and other large catchments via diminutive connecting channels. These minor drainage canals have not preserved well, but their presence is inferred from our contour maps. The known field platforms are restricted to a zone of 1 ha in the southern portion of the core area of the site. These fields are, in Turner and Harrison’s terminology (1981), both channelized and raised. The canal basins were carved into the limestone caprock, and the field platforms were supported by buttress stones. The original height of the earthen platforms is unknown, but the canal sediments are believed to be derived from their surfaces which have washed laterally into the depressions. The system is thought to have functioned as a “still-water” drainage system in which dry-season pot irrigation was practiced from the ponded basin canal water. During the wet season, drainage control was managed by numerous shallow ditches.

The alteration of the environs at Cerros goes beyond the construction of basin canals and associated raised fields. Our environmental data provide a general picture of the setting at Cerros during the Late Preclassic period. The growth and development of the community reveals a complicated quarrying scheme in which the elevated and well-drained caprock on which the site rests was converted into a man-made watershed. The fill for the platform structures and plaza space was obtained from these quarrying activities. Because the type of water management system at Cerros had not been documented elsewhere in the Maya Lowlands, a brief excavation account is presented here.

**Physical Environs**

Five microenvironments have been defined within the 1.51-km² area systematically surveyed on Lowry’s Bight (Figure 3). These settings have been identified by vegetational associations that correlate with our soils and drainage data (Scarborough 1980). The most extensive microenvironment extant in the systematic survey area is the *monte alto* and *huamil* setting. Wright et al. (1959) have defined this vegetation on Lowry’s Bight as deciduous seasonal broadleaf forest, rich in lime-loving species and having a maximum canopy height of 15 to 25 m. This setting is characterized by well-drained loamy soils.

The dominant vegetation in the next extensive microenvironment is *hulub* (*Bravaisia tubiflora*). This *hulub bajo* setting is the most depressed in the settlement, excepting the *aguadas* and portions of the low-lying *zacatal*. The mottled clay soils are not highly acidic, due to a superabundance of calcium carbonate, and do not suffer from cracking, owing to the high water table at Cerros. These soils do have high salt concentrations. The swamp dwelling snail *Pomacea flagellata* appears frequently in this setting.

In a very limited portion of the site, a grassland savanna or *zacatal* has been located. Although the vegetation cover is significantly different from that of other areas, the soils appear to be similar to those defined in the *hulub bajo* setting. These gley soils have a superabundance of calcium carbonate and a balanced proportion of other minerals, except for a phosphate deficiency. *Pomacea flagellata* pervade the setting and have severely disrupted the stratigraphy.

At the margins of the *zacatal* are the slightly better drained soils associated with the thorn scrub savanna. Much of the known canalization at Cerros is located in this microenvironment. The vegetation cover is dominated by *muk* (*Dalbergia glabra*). The soils are similar to those in the *zacatal*, although they have undergone less gleization. A thin A-horizon of loamy clays is underlain by compacted, mottled grey clays. The soils are charged with calcium carbonate, having a high
pH and, except for the phosphates, a suitable mineral matrix for most crops. This setting can be considered a transitional zone in terms of both vegetation and elevation.

A variation of the thorn scrub savanna setting occurs in a spotty distribution throughout the survey zone. These areas are better drained and higher in elevation than the low-lying thorn scrub savanna settings. These soils are understood to be quite thin, as evidenced by the exposure of the limestone caprock at some locations. Katsim [Acacia gaumeri] is the dominant thorn bush.

The final microenvironment at Cerros is the mangrove shoreline. This setting can best be understood as a river mouth association almost entirely defined by mangrove [Mangifera colorado]. The soil is typically entrapped beach sands.

To summarize, an attempt has been made to correlate the known vegetation and drainage conditions within the survey area with the soils. This has emphasized the various components in the physical environment today, but it will also permit a reconstruction of the past cultural environmental component.

**CANALIZATION**

The main canal at Cerros circumscribes the most dense and massive concentration of structures at the site. Including the central precinct, the 37-ha area enclosed by the 1,200-m-long canal contains 95 mound features. This area is comparable to that enclosed by the Late Preclassic (Pakluum phase) ditch at Becan, Campeche (Webster 1976; Ball and Andrews 1978).

Although surface contours along the length of the main canal indicate little consistent elevational difference within the trough of the feature, the canal bank registers a significant gradient across the settlement. In plan, the form of the canal is sinuous with a lobate bank, which periodically projects into the body of the depression. The eastern end of the canal strongly manifests this appearance.

The canal traverses three microenvironments in its course across the settlement. The western end of the canal area is dominated by hulubol and zacatal. As noted above, both of these vegetation zones define low-lying ground which is seasonally inundated. The southern third of the main canal is dominated by dense thickets of muk. This depressed thorn scrub savanna setting is an extension of the mukol located in the central portion of the core site area.

The eastern end of the canal is the best defined segment and is chiefly dominated by savanna grasses. Whereas the western quarter of the canal is predominately hulubol with savanna grasses at its margin, the eastern microenvironments define the canal course by savanna grasses with extensive hulub at its flanks. The vegetational cover clearly distinguishes the main canal in aerial photographs as well (Figure 4).

The main canal is breached at six locations. These causeways are distributed more or less uniformly around the course of the canal, although an absence of causeway construction along the eastern leg of the canal may indicate the disuse of the eastern site periphery following the Late Preclassic abandonment of the site.

There are approximately seven lateral canals that branch off the main canal in all manner of orientation. Most of these laterals require extremely fine mapping procedures to locate their courses. Their visibility is obscured in the extreme western end of the site as a consequence of historic land modifications, but in the south and east it is a function of siltation processes over the last 2,000 years.

The focus of our raised-field research has been in the southwestern portion of the core zone. The major lateral canal draining this area issues north of the main canal. It is well defined and clearly distinguishable in aerial photographs (Figure 5). It is approximately 80 m long and 10 m wide and leads to the margin of the raised field complex. A reservoir 30 m in diameter separates it from the known field locus. Another system of laterals was intensively mapped in the eastern core area. Although these less-well-defined features probably provided drainage control across the community, formal raised-field agriculture seems unlikely. The more pronounced topographic relief coupled with the pronounced rectilinearity of the depressions found in the southwestern portion of the site suggest that the eastern core area was probably not involved in raised-field agriculture.
Figure 4. Aerial photograph of Cerros, looking southwest prior to bush cutting. The core area is clearly defined by the main canal in the foreground. The New River occupies the marshy lowlands in the right background.

The known field plots are shallow rectangular platforms, heavily eroded and much reduced in their original height (Figure 6). The dimensions of the plots range from 14 \times 28 \text{ m} to 22 \times 40 \text{ m}. They are oriented to the cardinal directions. (See Siemens [1982:222] for other oriented raised fields in Mesoamerica.) At least five fields comprise the southwestern core complex, but another four may be present if badly eroded. Each earthen platform is circumscribed by a narrow shallow channel.

In addition to the raised fields in this depressed thorn scrub and zacatal setting, there is a system of reservoirs. Three discrete catchment basins are apparent in the vicinity of the fields. Moreover, the mapped and excavated basin canal segments circumscribing the plots functioned in a similar way. The basal contours of the lined basin canals are discontinuous and terminate before issuing into the main lateral, suggesting the impoundment of water for drier months. In addition, a shallow gradient system of elevated drainage canals is suggested by our contour map and is understood as having diverted excess runoff into the main canal.

A sacbe, or dike, separates the agricultural plots from the remainder of the intensively mapped area. Northwest of the sacbe are two of the three reservoirs as well as the southern margin of a large 40,000-m² subplaza (Structure 9A). It is likely that the runoff from the plaza space was directed into the reservoir system behind the sacbe. This arrangement would provide adequate potable water supplies and prevent the contamination of this drinking water by the fields to the southwest.

EXCAVATIONS

An excavation program was initiated to collect formal information about the canal system at Cerros. All naturally defined units were routinely screened for artifacts and macrofossils. Flota-
Figure 5. Aerial photograph of raised fields in the core area prior to bush cutting activity. The main canal circumscribes the major architecture as well as the known fields. The fields are best identified by the dark patches of muk separated by narrow channels of savanna grass.

tion samples were run from each stratum in the field and preliminary microfossil interpretations have been made (Scarborough 1980).

**Main Canal**

Five trenches across the main canal were placed perpendicular to its long axis. Each trench was positioned to retrieve specific information about the immediate surroundings in which the excavation was carried out, while addressing the overall function of the canal system. The two southern trenches are described in some detail in another article (Freidel and Scarborough 1982). Except for the southernmost trenches, the excavations were widely separated spatially.

The stratigraphy in the canal revealed it to be U-shaped in cross section, having been cut into the indurated caprock. The canal varied from 3.2 to 6.0 m in width (the former width suggesting the lobate form of the canal), and from 1.6 m deep in the west to 2.10 m deep in the northeast. In the west (OP157), the canal bank was buried by 80 cm of dark grey clays, which were formerly buttressed by a concentration of stone two to three courses high (Figure 7). There is some suggestion that raised fields may have immediately flanked the main canal at this location.

The basal matrix in the canal was a sterile, friable, white marl or clean sascab. The bulk of the
Figure 6. Contour map of the west-central core area. The known raised fields lie to the south and west of the sacbe.
Figure 7. Contour map of the western canal segment.
overlying sediment consisted of a blocky, grey clay loam containing numerous gypsum crystals. Worm casts and snail burrows intruded the recemented matrix. A significant inventory of midden debris was retrieved from those exposures adjacent to mounded structures, with the great majority of identifiable ceramics dating to the Tulix phase. The lateral lensing of sediments and the bedding plane of sherds suggest a lateral slope wash source for the matrices. The canal trough was capped by a 10-cm-thick, viscous, black gumbo clay containing little limestone gravel.

It should be mentioned that the absence of bay beach sands in the basal sediments of the western canal cut suggests a change in the present shoreline. The proximity of the present beach sands and the elevated position of the bay level, relative to the bottom of the canal, indicate that the main canal would have been invaded by the bay if the bay level in the past had been the same as today. This evidence suggests that the land mass at Cerros was formerly at least 1 m higher along the coast or that the water level was a comparable amount lower.

In our eastern trench (OP154) a diminutive U-shaped trough in the center of the main canal depression was identified at the boundary between the humic horizon and the underlying grey clay loam (Figures 8 and 9). It appears to represent a stone-lined canal segment constructed 1.2 m above the base of the original canal cut. We believe this later feature dates to an Early Classic reuse of the canal system. Following the infilling of the canal system, this minor “echo” canal (after Haury [1976:149–150]) was crudely constructed to collect water in a manner not unlike that demonstrated at the southern margin of the core area (Freidel and Scarborough 1982: Figure 6).

At the northeast end of the visible main canal segment, another trench (OP156) examined a causeway location bridging the infilled canal (Figure 8). At approximately 1.70 m above the basal sediments in the canal trough and overlying the bulk of the canal sediments was a narrow limestone walkway about 1 m wide and at least 10 m long. It is believed to be Early Classic in date. The walkway capped two Tulix phase vessels resting above a basal caprock sill projecting from the eastern canal bank (Figure 10). Although the easternmost vessel was found whole and upright, resting 20 cm above the sill, the slightly larger vessel (12 cm in diameter) to the west was broken and disarticulated. Both vessels were red slipped jars containing no offerings and appear to have been portable water containers.

At this location the canal cross section revealed a stepped asymmetrical U-shaped basin with a broad platform or sill positioned at the eastern base of the canal. In addition, the eastern canal bank revealed two carved steps inset into the indurated canal-bank caprock. Although severely weathered, they appear clearly in our south profile exposure. The west bank of the canal was poorly defined but appears to have been stepped, dropping precipitously into the canal course. It had one step but no projecting sill.

The pots in the canal are believed to have been deposited during a rapid infilling event during the abandonment of the system. Both vessels appear to have rested on carved caprock treads, subsequently slipping into the muck early in the collapse of the adjacent field system. Although the type and presence of other pottery fragments in the canal may have some ritual significance (Garber 1981), our excavation data point to a more mundane explanation. We believe that the canal sediments were deposited over a period of a generation or more during the Terminal Late Preclassic phase. The extreme amount of sediment in this exposure, and the complete infilling of the canal segment north of this location, may indicate the presence of additional eroded fields.

On the eastern side of the core area, we traced the course of an apparent drainage network (Figure 8). Only the depressed linear troughs were recorded, due to the amount of vegetation that limited visibility. Excavations indicate that only a limited amount of caprock was removed to produce the troughs. The base of the ill-defined feature was approximately 2.5 m wide by 30 cm deep. However, the upper banks of the trough were separated by as much as 8 m, producing a dish-shaped cross section 80 cm deep.

Raised fields are not demonstrable in this area. Kitchen garden plots are likely to have been present, but clear archaeological associations are lacking. Given the presence of ground-level structures in this area, we suspect that these minor canals diverted water away from residential space and into the main canal.
The Fields and Associated Features

More extensive survey and excavation was conducted in the west-central portion of the core area (Figure 6), which was chosen to be the focus of our raised-field research because of the visibility of features, both on the ground and in aerial photographs. The south segment of the main canal in this zone, excavated at two locations (OP153 and OP116), revealed a 2-m-deep, 6-m-wide U-shaped canal cut that was later modified by an Early Classic check dam and stone-lined catchment pond. (See Freidel and Scarborough [1982] for details.) The bottom of the canal at this loca-
Figure 9. South profile section of Operation 134.

LEGEND

- CM-127A
- Op 134 site
- Back Gumbo
- Grey Clays
- Dark Grey Clays
- Rock
- Soil Sheets
- Stone

0 cm

Southern Profile

Crown Canal

Caprock

Unexcavated

Unexcavated

Unexcavated
Figure 10. Reconstructed section of the northeasternmost trenching operation in the main canal. The two vessels date to the Tulix phase (50 B.C.–A.D. 150) and were found sealed by an overlying Early Classic walkway.

tion is 1.60 m below site datum. The sediments associated with the Late Preclassic infilling of the canal suggest a raised field origin, given their depth and lateral lensing. In addition, we exposed a broad shallow lateral canal linking the main canal to the raised fields. The bottom of this canal is also 80 cm below site datum.

During the 1979 field season, a trench was placed between two earthen platforms across a flanking minor feeder canal (OP152) (Figure 11), revealing a stone-lined canal segment. The stones were interpreted at the time as buttresses supporting the raised field platforms. The canal was 1 m wide by 1 m deep with its base located 1.10 m below site datum. Underlying and behind the stones defining the canal segments was an impermeable sascab, forming a diminutive levee in profile, secured in place by the outside buttress stones. The canal sediments appear to have eroded off the raised platform surfaces, and phosphate concentrations were found to be very high relative to those in other contexts in the settlement.

In the 1981 field season, we expanded this trench in an attempt to clarify the course of the feeder canal. In extending the unit east, we found that the stone buttressing terminated at the juncture of three apparent platforms. The sediment inside the canal basin was the same as that on the adjacent fields. The sascab did not appear to be mounded up on the east side of the canal basin as was observed elsewhere in the canal cross section, though the buttress stones were well defined. The quantity of soil on the adjacent platforms relative to other exposures in the settlement (OP155 and underlying house mound sterile fill), as well as the presence of lined canal segments and high phosphate readings, indicate that this area was intensively exploited for agricultural purposes. The entire exposure was capped by a thin lens of viscous, black gumbo clay.

At the other end of this canal basin (12 m south/southwest), we placed another trench (OP159) to further define the dimensions of this feature. Our exposure at the termination of the visible trough revealed a cul-de-sac depression. The canal basin was shown to terminate with boulder-
Figure 11. East profile section of Operation 152.
sized limestone caprock defining the feature’s southern margin. The canal profile revealed a 1-m-wide canal section excavated to a maximum depth of 70 cm.

The canal basin appears to have been formed partly by the removal of the caprock and partly by the mounding of soil for the fields. The platforms were buttressed by small boulders and, in one case, by natural caprock quarried to form an apparent dike support. The area to the south and west of operation OP159 appears to be a less impacted and elevated, caprock zone. It may have been modified to catch and direct runoff into the otherwise closed canal catchment basin.

To confirm the association of stone buttressing with linear depressions, we excavated on the north side of an adjacent platform (OP161). The trench confirmed the presence of another canal basin flanking and defining the north side of this large field platform and perhaps the south ends of two other platforms. We interpret the canal sediments as former raised field platform fill.

**Postholing Program**

More than 50 postholes were systematically excavated over the earthen platforms and adjacent canal basins over a 1,600-m² area. The postholes produced a series of schematized profiles which confirmed the nature of our excavation data. A subsurface contour map of the original indurated caprock surface underlying the platforms was drafted to illustrate the nature of the raised field complex. A comparison of the surface and subsurface maps has led us to believe that the raised-field complex is underlain by elevated caprock.

We believe that the margins and perhaps the planar surface of the underlying caprock were altered for agricultural space as well as quarried for monument fill. The field platforms were formed in part by simply excavating the margins of the high caprock, but some reworking of the soil matrices is suggested. However, we cannot equate our field platforms with the elevated *sascab* platforms defined by Puleston (1977) on Albion Island.

The confluence of the main canal with the major lateral canal in this same southwestern portion of the core zone was also probed with posthole diggers. No features were encountered, but the pronounced elevational difference between the two canals suggests a drainage function for the canal system rather than that of flow irrigation into the fields.

In the east, postholing was conducted to determine the lobate form of the canal plan. We placed a series of postholes across the main canal south of OP156 and north of OP154 to assess the width of the canal cross section (see Figure 8). Although the bottom of the canal could not be determined, the banks dropped rather abruptly. Our results indicate that the original main canal cut had irregular lobate walls. This is interpreted as facilitating the ponding of water for easy access during the dry season and a formal modification of the basin canals.

**INTERPRETATIONS**

The canal system at Cerros was specifically designed for the semitropical setting of the Late Preclassic period. The system functioned primarily for drainage and was a simple and harmonious adaptation to the environment.

The main canal was constructed during the C’oh phase (200 to 50 B.C.), at which time it may have had a defensive function. This date was derived from postcanal sherd deposits resting under the damlike feature noted in the southern main canal trenching section (OP116) and a termminus post quem derived from the deposits of an apparent dredging operation associated with the construction of Structure 98 at the southwest margin of the main canal (Scarborough 1980). A calibrated radiocarbon date of 422 ± 180 years B.C. (Freidel and Scarborough 1982) was obtained from under the causeway. The fill quarried from the ditch was used for monument construction rather than for an adjacent parapet or rampart. The lobate form of the canal bank is believed to be a device for collecting and conserving water in the dry season. Given the west to east downslope gradient of the main canal, it is believed that the lobate plan functioned in a manner similar to the basin canals directly associated with the raised fields. The main canal trapped water in its lower reaches with the projecting lobes, or sills, separating the elongated reservoirs.
Our two trenches across separate causeways breaching the main canal showed that the causeways postdate the infilling of the canal. We believe these features to be Early Classic in origin. We suggest that the canal sediments are derived from raised field platforms that have collapsed laterally into the adjacent canal. Although high winds and turbulent water have affected the nearby shoreline, it is unlikely that hurricane activity alone would account for the relatively sorted particle size and gross volume of grey clay loam sediments in the canal bed. It is suggested that the infilling occurred over a period of 100 ± years, when Early Classic occupants continued to maintain as much of the system as they could coordinate socially. The Tulix phase vessels underlying the presumed Early Classic walkway at OP156 indicate the initiation of Late Preclassic abandonment at Cerros.

No fields were identifiable in the eastern core zone, where our mapping program revealed a possible drainage system serving ground-level and larger residential structures. Our attempts to document the relief in the area north and east of the main canal proved unsuccessful. The amount of sedimentation coupled with the dense hulubol prevented the detection of significant relief. Given the proximity of the area to the core zone and the presence of two sizable plazuela groups (Structure groups 115 and 116) dating to the Late Preclassic in the middle of the bajo area, it is believed that this area was exploited during the Late Preclassic period.

The amount of canal fill apparent at the north end is so great that the course of the canal is completely obscured. This may be indicative of the amount of field platform matrix that has eroded into the adjacent canals. However, the only well-studied raised field plots rest in the west-central portion of the core area. The earthen platforms were defined by carved or quarried caprock removed to create the adjacent basin canals. The basin canals were stone lined in part to maintain catchment runoff throughout the dry season but also to buttress the sides of the flanking fields.

In sum, the system was designed as a catchment or watershed. During the rainy season, diminutive canals directed runoff into the basin canals and reservoirs throughout the site. Additional water was diverted by a shallow network of runoff canals which followed the present relief into the main lateral, and ultimately the main, canal. None of these minor feeder canals have been clearly identified, but their form is presumed to have been similar to the small, late “echo” canal at OP154.

During the dry season, water would have been conserved in the lined basin canals as well as in the reservoirs and main canal. It is likely that given the wide uninterrupted distribution of the canal system, this water would have been available to everyone in the community. However, this water may have been somewhat contaminated by agricultural byproducts, residential waste and the stagnant nature of the system. Community-wide maintenance of the system would have been necessary during the low water levels of the dry season. There is evidence for the dredging of the main canal during the time of its peak usage.

Private potable water sources complemented the community water system. These reservoirs may have been maintained by households or extended kin units. Such reservoirs would have held a less contaminated water source for private consumption throughout the year.

The dichotomy between public and private water sources is most evident in the 2 ha mapped in detail in the west-central portion of the core area. Here the sacbe crosses the depressed zone dividing the apparent field loci from the area to the north and east. Two sizable reservoirs and additional low-lying terrain suggest that this area was a large private water source for those individuals associated with subplaza 9A (Structures 12-16 and the Structure 10 Group). The sacbe may have separated the two water sources both functionally and symbolically.

AN ENVIRONMENTAL RECONSTRUCTION

Cerros was initially colonized by fisherfolk who rapidly adapted to an intensive commercial exchange system. The primal environment is thought to have been a lagoon-estuarine setting (Cliff 1980; Freidel and Scarborough 1982). We suggest that the overall environment of the site at that time was more similar to a well-drained monte alto setting than to the depressed, poorly drained
environments of the present. The vegetation would have been closer to climax than are the present biomes. This hypothesis is suggested on grounds that the initial residents at Cerros would have selected a well-drained site for supplemental agricultural pursuits, as well as the broad-spectrum exploitation of mammals and tree resources available in this setting. Our evidence for a lower relative sealevel would further indicate a well-drained setting in the past. The nucleated village midden debris associated with the earliest occupation at Cerros (Ixtabai phase, 300 to 200 B.C.) appears to support this hypothesis. The well-drained nature of this village is supported by the presence of only ground-level structures and by the absence of any identified Pomacea flagellata from the midden (see below).

Exploitation of and adaptation to the forest resources is further suggested by the presence of an Ixtabai component at or near the large aguada 2 located 1.5 km south/southeast of the early nucleated village. The amount and distribution of pottery collected from the rim of this aguada indicates the presence of another Ixtabai community. If our freshwater lagoon-estuary reconstruction for the site is correct, then a usable water supply from this aguada for the shoreline nucleated village would have been unnecessary. Given their proximity to one another, these two communities would not have differed significantly in their formative adaptations to the environment. Only later would the shoreline position of the nucleated village have permitted the maritime adaptation necessary for long-distance trade and the subsequent florescence at Cerros (Freidel 1978).

During the next phase of construction and occupation at Cerros (C’oh phase) our data show that the community underwent a residential transition. The resulting pattern was an extension of the well-drained, ground-level, compacted village arrangement best defined in the earlier Ixtabai phase. The structures, clustered around the central precinct, rest on a steely blue alluvial clay. The C’oh phase settlement appears to reflect an infield/outfield agricultural settlement system. The environment during this period is hypothesized to have been similar to that defined for Ixtabai times but with kitchen gardens and the creation of an “artificial rain forest” (after Lundell 1937; Geertz 1963; Wiseman 1978; Folan et al. 1979) within the confines of the site. The soil and the vegetation are believed to have been characteristic of a well-drained setting. This is supported partially by the absence of Pomacea flagellata from any archaeological context associated with this or any other phase within the Late Preclassic period at Cerros. Considering the frequency of this gastropod at a similar time at other sites in northern Belize (Feldman 1979) and the apparent relish for this species on the part of the Late Preclassic Maya at Cuello (Donaghey et al. 1979), its total absence at Cerros is peculiar. This absence suggests that the site was well drained until its Late Preclassic abandonment.

Late in the C’oh phase, there appears to have been a further change in the settlement pattern and agricultural base. It is at this time that the main canal was excavated around the site and that the concentration of molded features was constructed. Structure 76 at the margin of aguada 1 was erected, as were additional structures clustered around and overlying the earlier ground-level C’oh phase residences. The fill used in the construction of these structures is thought to have been taken from the canal and aguada excavations. With the initiation of the canal the Cerros community experienced its significant environmental transition. However, as will be demonstrated below, the main canal was not solely a drainage device. Most of the monumental architecture had not yet been erected, and little extensive quarrying had been initiated.

During the Tulix phase, the previously well-drained setting was significantly altered by construction. Major construction occurred in the central precinct, as did the construction or reuse of over 90% of the plaza and structure space defined on the settlement map, including Structure 29 and the two ballcourts. Raised plaza space was created throughout the settlement, capping earlier C’oh phase structures. Complementing this erection of monumental architecture was the series of depressions resulting from the necessary quarrying activities. This complementarity is readily apparent on our contour map.

The soils and vegetation during the Tulix phase are understood to have been well drained. Most of the setting was artificially altered to produce a cultural relief having good agricultural potential. The poor condition of the present-day soils is not thought to reflect their original fertility.
Although the site surroundings drained seasonally to accommodate wet season intensive agriculture and prevent waterlogging of soils, the main canal itself could not have contained the anticipated runoff from the intrasite area alone. The dimensions of the main canal are roughly 2 m in depth, 6 m in width, and 1,200 m in length, which would have provided a 14,400-m$^3$ catchment volume for draining the site area. There are 37 ha within the confines of the site as defined by the main canal perimeter. If only this area were drained by the canal (and our contour map would indicate a much more extensive drainage system), it would take less than 5 cm of runoff across this area to immediately fill and overflow the canal. Wright et al. (1959:17) state: “falls of rain are often of an intense kind; 5 inches in 24 hours [12.8 cm] is experienced not infrequently.” The exposed impermeable clays underlying the quarried caprock, as well as the exposed lower and denser caprock, allow little absorption of precipitation. For example, Cowgill and Hutchinson (1963:20) indicate that only 20% of the runoff into the Bajo de Santa Fe is absorbed by the soil. Although the large depression near the center of the core zone at Cerros as well as the known hypothesized feeder canals across the site would have held a large amount of water, an external drainage mechanism must have been present. The severity of flooding was most clearly appreciated in July of 1976 when we negotiated stagnant chest-high water as we walked the 9.5-m contour interval (datum assumed) through the settlement. Only a well-managed system of hydraulic control could have reduced the damage to soils, to say nothing of household disruptions as a consequence of this high water. The amount of fill necessary to construct the limestone rubble core supporting the bulk of the structures at Cerros has been calculated to be 226,395 m$^3$. This fill could have been obtained locally if most of the 2-m-thick caprock were removed back to the 10.5-m contour surrounding the site. This contour break corresponds to the approximate location at which the pock and pitted caprock defining the impacted site area changes to a more level and flat relief.

This quarrying is believed to have been carefully monitored to produce a man-made watershed across the entire core area. Although the caprock at Cerros may have undulated slightly across the settlement and its thickness may have varied slightly, we used our exposure of its thickness in the main canal profile as an approximate figure for its proportions across the settlement. It is suggested that the fine particle fraction and clay size sediment underlying the caprock permitted a continuous bedding plane for the caprock on Lowry’s Bight. Further support for the homogeneous bedding of the caprock is suggested by the absence of carbonate nodules in the matrix (Reeves 1970:358).

*Landscape Modifications*

As indicated above, Ixtabai and C'oh phase residential structures appear to cluster around the main plaza and precinct center with most dwellings resting on alluvial clays. Our exposures show that these clays, in turn, rest upon a sterile yellowish granular sascab. We do not believe that the caprock was removed from these locations, but rather, that it has been resorbed by the rising water table associated with subsidence. The alluvial clays were deposited by the New River before the site was occupied as is indicated by the absence of any cultural debris associated with them. The restricted shoreline distribution of these alluvial sediments reveals the northern course of the river and indicates that the New River estuary had been transgressing for some time before the site was colonized.

The major source of error in determining the fill volume for the site comes from the eroded shoreline. The eastern portion of the site appears to have eroded less than the western. Cliff (1980) argues for the presence of a docking facility immediately east of the central precinct, whereas the western shoreline of the site is littered with eroded cultural debris and plagued with shallow-lying limestone chunks trailing 100 m into the bay. The extent of the fill error is in part balanced by the incalculable mass of these small structures.

Because of the ubiquitous and apparently continuous distribution of caprock outside the site area, it is suggested that the residents of the Tulix phase systematically quarried away more than 189,451 m$^3$ from within the core area as defined by the main canal. This figure compares
favorably with the 210,986 m$^3$ of structural fill recorded in the core area. A significant portion of the area within and defined by the 10.5-m contour line was also quarried away, but it is apparent from our volumetric comparisons that a portion of the present eastern hulub bajo was depressed prior to extensive quarrying operations. This area may represent the remnants of an interior drainage locality receiving the runoff from the canals and reservoirs when they overflowed.

Although not all areas were completely excavated of caprock to maintain and define the course of channels and canals, some areas were extensively quarried down below the sterile clean white soscub level. This appears to have been the case within the zacatal in the center of the core area, though additional excavations are required to test this hypothesis.

The site environment at the time of occupation, therefore, was unlike its present appearance. However, the present setting can tell us something about the past. The extensive presence of yax‘om or bajo soils and accompanying vegetation indicate a great deal of sedimentation from the adjacent high ground. The zacatal settings appear to have undergone the most silting in the settlement. The bulk of these denuded blocky clays are thought to have eroded from an extensive raised field complex that collapsed into the more depressed locations within the site. There is little dispute that bajo settings throughout the lowlands have undergone substantial infilling from the mass wasting of adjacent well-drained rendzina (mollisols) soils (Lundell 1937; Ricketson and Ricketson 1937; Cowgill and Hutchinson 1963:274). In the case of Cerros, some of the fill has found its way in from the adjacent crest running through Lowry’s Bight, but the relief from the spine of this ridge to the edge of Corozal Bay is less than 6 m over a distance of 1.5 km. This sedimentation has affected the perimeter of the site outside the canal much more than the core area of the community. This is suggested by the presence of numerous depressions in the peripheral zone that are only partially infilled. For this reason, the bulk of the sediments within the core area defined by the main canal are wasting from plaza margins and the more friable field platforms. The depth of these sediments can only be assessed in our canal exposures, which indicate more than a 1.5-m-deep deposit of clay and silt.

In sum, the six microenvironments defined on the peninsula can be lumped into three soil and drainage groups that reflect the original drainage of Tulix phase Cerros. The low-lying hulub bajo and zacatal reveal the quarrying locations and canal system. The elevated well-drained monte alto/ huamil as well as the elevated thorn scrub savanna define the original caprock surface or raised cultural relief. The thorn scrub savanna and huanal mark the transition zone between high and low ground. Generally, in computing the area effectively quarried, we have considered only the hulub bajo and zacatal settings.

CONCLUSIONS

Judging from the spatial organization of the settlement at Cerros, we argue that the site was selected carefully for environmental as well as spatial considerations during the Tulix phase. The trading posture of the community has been outlined by Freidel (1979) and discussed by myself (Scarborough 1980). However, the agricultural potential of the site has received little attention. The conversion of the site from natural topographic relief to the complicated cultural landscape developed during the Tulix phase must be considered in socioeconomic terms. Simple drainage of the natural setting can hardly be seen as a cause for the extensive quarrying, given the good drainage postulated for the outset of occupation. Monument construction was a major force behind quarrying at the site, but the excavation of the main canal appears to antedate the major monuments by at least 100 years. The initial construction of the main canal would appear to have been for reasons other than simple drainage or monument fill. Although the main canal provided a clear territorial boundary for the community, its inception is believed to represent the initiation of drained-field management.

Irrigation of a year-round flow water system connected to the aggrading New River cannot be argued given the present evidence. However, the interpretation of an elaborate catchment reservoir system designed with a series of sills, servicing the entire site, is supported by the west-to-east downslope gradient of the main canal and the lobate plan of the feature (see Hauck [1973] for
the drainage sills at Edzna). The constricted areas in the main canal course are viewed as sills and the wider segments are believed to be basin canals that held water long after the rainy season. The extremely high salt content throughout the site and especially in the fields (Scarborough 1980:345), coupled with the very poorly drained clays occupying the eastern quarter of the site in the location most likely to receive the fine particle fraction in a west-to-east gradient flow, suggests a worn-out prehistoric drainage system.

The subsidence on Lowry’s Bight has had an accelerating effect on the infilling of the system (Scarborough 1980:35–37). Although the poorly drained internal catchment defining the core area at Cerros may collect a meter and a half of standing water today, it would be much different if the entire site were raised a meter and a half and allowed to drain into the postulated lagoon. Even then, dry season basin canals would have been maintained.

The exact nature of the transition from C’oh phase to Tulix phase is not clear, but it is argued that at least the core site area was partially covered at this time by an artificially controlled water level. The impermeable clays at the basal reaches of the canals would retain most of the water, preventing the vertical percolation of moisture. Evaporation-retarding plants may have further conserved water levels, but the humidity would have been always quite high.

Although raised fields, or earthen platforms, have been defined within the core site area, their elaborate form and orientation, as well as the presence of cultural debris and high phosphate concentrations more than 60 m from the nearest mounded feature, suggest ground-level residential loci. The prospect that fields were fertilized and mulched using household trash from other locations within the settlement has been postulated elsewhere (Freidel and Scarborough 1982), but the large size of the sherds collected from our 1979 exposure of OP152 indicates primary deposition on well-drained kitchen gardens. The ground-level occupation characteristic of Ixtabai and C’oh phases, coupled with the rectangular shape of the Tulix phase raised fields that were identified inside the main canal, suggest a residential function for some of these features. (By widening the field platform, one increases the distance one must carry water to the interior of the plot. If this is considered a less efficient agricultural adjustment, then at least one other cultural component enters the description. We suggest that a household living on the plot would have such an effect.)

Adhering to Freidel’s model of trade, we posit that commercial, as well as social, interaction rested upon maritime exchange. At the intrasite level of analysis, the site is thought to have been a garden city during at least a portion of the dry season. Cropping based on pot irrigation from the basin canals would have been most productive at this time of year. If the settlement dried out from February through May, high ground would have connected most public and private space and facilitated foot traffic. This is illustrated by the 210-m-long sacbe 1 traversing the most depressed zacatal terrain in the settlement.

During the wet season, and perhaps during a portion of the dry season as well, the main canal is believed to have made canoe traffic possible to many points in the settlement. The greater depth of the main canal would allow larger canoes access to interior locations, and shallow-draft dugouts may have been able to venture around the site even during the dry season. I have suggested elsewhere (Freidel and Scarborough 1982) that some of the causeways or check-damlike features bridging the main canal were utilized by the Late Preclassic occupants of the site, but I now believe that those are Early Classic or later in origin. Our cross sections through these features (OP116 and OP156) indicate that they are later in time, following the cessation of the Late Preclassic occupation at Cerros.

A drainage system such as that envisioned at Cerros is perhaps hinted at by Denevan (1966) in his discussion of the chiefdoms of Mojos in northern Bolivia. The major challenge to his description for the Cerros setting is the existence of the resultant reservoirs of stagnant water throughout the settlement. This factor would have allowed the growth of insect pests unless the system were periodically flushed or predatory fish were introduced to such ponds (Cooke 1931:287; Thompson 1974). The former remedy would be met by dredging the canals for muck to be used in surfacing the fields. The latter strategy would have provided a welcome source of protein (see Puleston [1977]).
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