New Light on the Prehistoric Purrón Dam Complex:

Small Corporate Group Collaboration in the

Tehuacán Valley, Puebla, México

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Dedication

This paper is dedicated to Richard S. MacNeish and Richard B. Woodbury. To “Scotty” MacNeish for recognizing the potential importance of water management studies in the processes of Mesoamerican cultural development. To “Dick” Woodbury for asking Neely to do the “legwork” and share in the writing of the 1964 water management survey in Tehuacán.

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Abstract

Survey and test excavations at the Purrón Dam Complex (PDC) in the Tehuacán Valley, Puebla, México demonstrate the value of reworking previously studied areas, and provides new evidence indicating that it was completely constructed through small corporate group collaboration during the Formative Period. Ceramic chronologies and twelve chronometric dates indicate that the Purrón Dam was completed and the PDC had its highest population levels by the Middle to Late Formative (ca. 650 - 150 B.C.), a time when settlements were small and decentralized. Additional habitation sites and water management features, a cave with pictographs, and a major canal were discovered, increasing the total number of recorded sites from eight to fifty-seven. These findings have implications for better understanding the links between political complexity and agricultural intensification by supporting recent ethnographic and archaeological research challenging the argument that the construction of larger water management systems do not require advanced socio-political complexity or State organization.

Keywords

Mesoamerica, Formative Period, water management, pedestrian survey, corporate groups.
Introduction

Recent survey and test excavations at the Purrón Dam Complex (PDC) in the Tehuacán Valley, Puebla, México demonstrate the value of reworking previously studied areas, and provides new evidence indicating that it was completely constructed through small corporate group collaboration during the Formative Period. Ceramic chronologies and twelve chronometric dates indicate that the Purrón Dam was completed and the PDC had its highest population levels by the Middle to Late Formative (ca. 650 - 150 B.C.), a time when settlements were small and decentralized. Additional habitation sites and water management features, a cave with pictographs, and a major canal were discovered, increasing the total number of recorded sites from eight to fifty-seven. These findings provide insights into the development of water management technology within the barranca and have implications for better understanding the links between political complexity and agricultural intensification by supporting recent ethnographic and archaeological research challenging the argument that the construction, as well as the operation and maintenance, of larger water management systems do not require advanced socio-political complexity or State organization.

The Purrón Dam Complex (PDC) is located in the Barranca Lencho Diego in the southern portion of the Tehuacán Valley (FIG. 1). It consists of habitation and “administrative” sites, a cave with petroglyphs, prehistoric agricultural fields, and water management features – which includes the massive Purrón Dam. In its final form, the Purrón Dam is the largest prehistoric water management structure in Mesoamerica at 21 m high, 106 m wide, and 400 m in length (FIG. 2) with a total volume of construction material nearly equivalent to that of the Pyramid of the Moon at Teotihuacan (Scarborough 2002). The
Figure 1 Orthophoto map showing the components of the Purrón Dam Complex. Numbers in white circles indicate the survey’s geographic sub-areas noted in
the Methods section of the text. Inset shows the location of the site in south Mexico.

Figure 2  Longitudinal and transverse sections of the Purrón Dam. After Woodbury and Neely 1972: figure 8.

initial survey of the Barranca Lencho Diego by Peterson and MacNeish in 1961 (MacNeish and Cook 1972: 67) recorded several small sites as well as the important and subsequently excavated Purrón (Tc-272) and Abejas (Tc-307) caves. However, it was not until Neely’s 1964 survey in the barranca that the PDC was discovered and recorded. Woodbury and Neely (1972) later reported the PDC as part of the pan-valley study of irrigation and water
management (MacNeish 1967-1972). The chronology of the complex, based on ceramic assemblages, indicated that the initial permanent settlement and construction of the dam began at approximately 750 B.C., during the Middle Formative Period. Ceramic assemblages suggested near total abandonment during the Classic Period, with a reoccupation during the Post-Classic Period.

While Woodbury and Neely provided estimates of local population, manpower required for construction, and the dam’s reservoir capacity, they considered their study a “limited case history” due to a lack of time for more detailed survey, mapping, or excavations (Woodbury and Neely 1972: 81, 83). The only other substantive fieldwork at the complex was conducted by Charles Spencer in the late 1970s. His work attempted to relate the original survey’s findings to, “…. concurrent developments in social, political, and economic organization, determined by an analysis of the associated settlement patterns.” (Spencer 1979: 13). While his survey was more intensive and produced detailed site maps, artifact collections, and spatial analyses to better estimate population, site size, and chronology, Spencer only revisited the sites identified by Neely and did not record any new sites. He concluded that in the case of the PDC, settlement pattern chronologies in relation to water management features indicated there was a local elite and that social complexity developed out of the aggrandizer control over irrigation systems used to produce specialized tropical cultigens, which were traded as prestige goods for extra-local goods, such as obsidian (Spencer 1979: 74-75).

Interpretations of the chronology, function, and scale of the PDC based on these two studies have been incorporated into models of prehistoric cultural development in Mesoamerica for over forty years. The Purrón Dam is frequently mentioned in cultural
histories of Mesoamerica (e.g. Adams 2005; Evans 2004; Spencer and Redmond 2000) and is commonly cited in studies of prehistoric Mesoamerican agricultural technology (e.g. Doolittle 1990; Hunt 1994; Marcus 2006; Neely 2013a; Scarborough 2003; Scarborough et al. 2012; Smith 1985). It is even referenced outside of archaeology, such as in studies of engineering history (e.g. Lawton and Wilke 1979; Schnitter 1994) and as an example of a sustainable, pre-industrial agricultural technology (e.g. Bruins et al. 1986; Ore and Bruins 2012). Our continued interest is not simply because of its status as a large, early dam but rather because it has two critically important features acknowledged by both Spencer (1979: 16-17) and Woodbury and Neely (1972: 99): (1) arroyos cutting through the dam exposing profiles that show the complete construction sequence of the dam, which has the potential to correlate to changing settlement patterns; and (2) the appearance of a large public work project in the absence of a centralized state. Over the past forty years the PDC has been a bellwether for theories of social complexity and agricultural intensification in the region: Manzanilla (1994), arguing from an evolutionary perspective, saw the dam as too large a structure to be built in the Formative, and she questioned the entire chronology of the complex; Spencer (1979, 2000) proposed the PDC construction was made possible by the coercive power of an emerging elite; while Patterson (1990) suggested the PDC was built to supply food to nearby Zapotec garrisons. Scarborough (2006) proposed the PDC as a monumental construction to buffer advances by neighboring states; and most recently Carballo et al. (2012), building off of Spencer (2000), offered the PDC as an example of collective action driving social complexity.

As part of the valley-wide investigations initiated by Neely (e.g. Caran et al. 1996; Neely 2001b; Neely and Castellón Huerta 2003; Winsborough et al. 1996), the
PDC was revisited. Pilot field trips, as well as visits and mapping by local civil engineers and development workers (R. Hernández García Diego, personal communication 2003, 2004), renewed interest in the complex because new archaeological sites and water management features were found that challenged prevailing interpretations. Work at the PDC filled in many of the “gaps” that Woodbury and Neely recognized existed; collected data on new aspects of water management found since 1964; and addressed some of the prevailing interpretations derived from the original survey. In particular, how do the discovery of new sites, a better understanding of the environmental context, and a refined chronology of the water management system challenge existing interpretations of the need for advanced socio-economic complexity or State organization for the construction, operation, and maintenance of the Purrón Dam Complex?

**Methods**

Our investigations revisited localities described in the original site report and recorded new features and sites. To facilitate our restudy we divided the barranca into six geographic sub-areas: (1) the dam and reservoir area, (2) the western periphery, (3) the barranca floor upstream from Tr-15, (4) the eastern periphery, (5) the southern periphery and (6) the barranca floor downstream from the Purrón Dam (FIG. 1). We conducted pedestrian survey across these six areas, aided by aerial photographs, and GPS recorded site locations. Our survey of the PDC covered an area measuring about 600 m east-west by 800 m north-south (about 480,000 square meters).

Newly discovered sites were designated in the same manner as those found earlier (MacNeish 1967: 27): they were given a prefix indicating the general nature of the site (i.e., “Tc” denoting a cave or rock-shelter, “Tr” indicating a site with visible architectural remains,
and “Ts” designating a site with no visible architectural remains) and a number continuing
the sequence of sites registered by the Tehuacán Project. As the number “500” was the last
site number assigned by MacNeish et al. (1972: 522-527), we continued the site numbering
with “501”. Representative collections of ceramic sherds were studied from loci considered
to be crucial in determining the temporal boundaries of the habitation sites and water
management features, or found during the stratigraphic tests. The collections were small, and
currently remain in Mexico in the care of Dr. Raúl Hernández Garciadiego in Tehuacán and
Sr. Pedro Miranda Pacheco in Zapotitlan Salinas.

In spite of the changes in dating for the Formative and Classic Periods occurring in
other regions of México, we have used MacNeish’s (2001) dating as it is based on a large
number of radiocarbon dates and we have no new information to make modifications
(FIG. 3).

Topographic mapping and limited excavations were also undertaken. A transit
was used to establish elevation relationships between water management features and
natural landforms. Determining surface elevations, establishing the average barranca
slope from topographic mapping, and observations of sedimentary sequences in arroyo
cuts allowed us to more precisely calculate the reservoir capacity. Limited test
excavations were restricted to non-habitation site locations associated with a prehistoric
canal and to expose the faces of water management features along arroyos to view
architectural elements and to collect charcoal and sediments for dating. To better refine
the Purrón chronology we compiled existing radiometric dates and conducted new dating,
reported in part by Aiualasit et al. (2010) but fully synthesized herein (TABLE 1).
Results of the New Survey

Our intensive survey expanded the total number of sites comprising the complex from the eight identified in the 1960s (Woodbury and Neely 1972: fig. 9) to 57, as summarized in the Appendix. Within each segment of the survey area discussed, the results of the new investigations are placed in direct comparison to the previous investigations to demonstrate the utility of the new survey and show the significance of the findings to our
<table>
<thead>
<tr>
<th>Locality and Sample Number</th>
<th>Dating Method</th>
<th>Sample Context</th>
<th>Uncalibrated age (yr B.P.)</th>
<th>Calibrated age range (BC/AD) at 1-sigma / 2-sigma [(14-C and AMS) and 1-sigma (OSL)]</th>
<th>Reference</th>
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<tbody>
<tr>
<td><strong>Purrón Dam (architecture)</strong></td>
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<tr>
<td>DIC-2030</td>
<td>14-C</td>
<td>Purron Dam, between level 1-2</td>
<td>2170 ± 100 BP</td>
<td>B.C. 364- 147 / 403 BC- AD 26</td>
<td>Drennan, personal communication</td>
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<td><strong>Purrón Dam (impoundment)</strong></td>
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<tr>
<td>Shfd06132</td>
<td>OSL</td>
<td>45 cm below, top of reservoir profile</td>
<td>0.78 ± 100 0.95 ± 120</td>
<td>A.D 1327 – 1127, A.D 1177 – 937</td>
<td>Aiuvalasit et al. 2010</td>
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<tr>
<td>Shfd06131</td>
<td>OSL</td>
<td>440 cm, base of fine grain sedimentation above gravels of Phase 3</td>
<td>2.78 ± 170</td>
<td>613 – 943 BC</td>
<td>Aiuvalasit et al. 2010</td>
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<tr>
<td>Beta-233267</td>
<td>AMS</td>
<td>Canal fill, 100 cmbs</td>
<td>1370 ± 40 BP</td>
<td>AD 632- 681 / AD 599-712</td>
<td>Aiuvalasit et al. 2010</td>
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<td>14-C</td>
<td>Canal fill, 190 cmbs</td>
<td>1790 ± 40 BP</td>
<td>AD 208- 258 / AD 127- 345*</td>
<td>Aiuvalasit et al. 2010</td>
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<td>Shfd06130</td>
<td>OSL</td>
<td>Canal fill 192 cmbs</td>
<td>2.26 ± 400</td>
<td>653 BC - A.D. 147</td>
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<td>Beta-233269</td>
<td>AMS</td>
<td>Charcoal from within TR-15 habitation structure</td>
<td>-23.5</td>
<td>2494- 2437 BC / 2503- 2336 BC</td>
<td>This volume</td>
</tr>
<tr>
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<td>Charcoal from below base of construction TR-15 sluice</td>
<td>-22.8</td>
<td>1060- 975 BC / 1131- 913 BC</td>
<td>This volume</td>
</tr>
<tr>
<td>Beta-233271</td>
<td>AMS</td>
<td>In red adobe plaster 40 cm below stucco of TR-15 sluice</td>
<td>-23.2</td>
<td>1129- 1005 BC / 1212- 972 BC</td>
<td>This volume</td>
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<tr>
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<td></td>
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<td>I-568</td>
<td>14-C</td>
<td>Zone H- stratigraphic horizon with first appearance of cultigens.</td>
<td>2220 ± 150 B.P.</td>
<td>413- 41 BC / 598 BC- AD 66</td>
<td>Johnson and MacNeish 1972: 23</td>
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<td>I-575</td>
<td>14-C</td>
<td></td>
<td>2590 ± 150 B.P.</td>
<td>899- 516 BC / 1090- 384 BC</td>
<td>Johnson and MacNeish 1972: 23</td>
</tr>
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</table>
interpretations of the PDC. A diachronic synthesis of the settlement of Barranca Lencho Diego and a Conclusions section complete the paper.

Sub-area 1: The dam and reservoir area

Nine sites were recorded in the dam and reservoir area; two of which (Tr-15 and Tr-435) were restudies of features recorded in 1964 (FIG. 1). The following discussion will proceed chronologically relative to the site being considered.

Tr-15 (THE “COFFERDAM”)

Tr-15 is a large arcuate stone and earthen structure that spans the barranca upstream of the Purrón Dam (FIG. 1). It is approximately 550 m long, 30 m wide, and ranges from 3-5 m high. The base of Tr-15 is at higher elevation than the maximum height of the Purrón Dam, therefore it was never within the impoundment area of the Dam, and Tr-15 impounded its own sediments as observed in arroyo cuts upstream of its construction (FIG. 4). Based on diagnostic ceramics found embedded in its construction and in a test

Figure 4  Purrón Dam Complex schematic cross-section drawing of the location and elevation relationships of the Purrón Dam with the other dams located upstream.
pit excavated immediately west of Tr-15 (Woodbury and Neely 1972: 93), evidence for the building of Tr-15 pointed to the Middle Santa María Phase (ca. 600 B.C.), roughly contemporaneous with the Level 2 construction in the Purrón Dam. Tr-15 was interpreted as a “cofferdam” that may have functioned in several ways (Woodbury and Neely 1972: 90, 96). Three newly identified habitation sites, Tr-504, 506, and 507, which based on ceramic assemblages date primarily to the Post-Classic, but may also have Middle to Late Formative components, were found atop or adjacent to Tr-15 (FIG. 1, Appendix).

In order to refine the chronology of Tr-15, two test pits were excavated into Tr-15 along the western branch of the Barranca Lencho Diego. Colluvium and localized alluvial deposits have obscured exposures of Tr-15; therefore, each test pit was placed to expose a cross-section of the structure and extended down to sterile soil. One pit was placed at the eastern edge of the barranca so that the pit’s eastern wall was formed by the Tr-15 construction (FIG. 1). This pit was directly east of, and about 15 meters across the barranca floor from, the “western sluice” reported by Woodbury and Neely (1972: 88-89, figs. 11-13). The second pit was placed at the western edge of the barranca, with the western sluice forming the western edge of the pit.

Excavations identified an incremental change in the construction materials from the use of slab-like, tannish-white gypsum stone in the earliest (lower) levels to block-like, reddish-brown sandstone in the later (upper) levels. This change of construction materials was observed in other arroyo cuts of Tr-15 (see Woodbury and Neely 1972: fig. 11) as well as in changes seen in construction between Level 2 and Level 4 of the Purrón Dam and differences in materials between Tr-501/502 and site Tr-549 (discussed below). Three radiocarbon samples were collected from these test pits, one from the eastern pit and two
from the western pit (TABLE 1). The resulting dates, from early to late, were \(3950 \pm 40\) B.P. (Beta Analytic #233269 - ca. 2420 B.C. - 2503 to 2336 CAL. B.C.) recovered from just above the transition from the tannish-white gypsum slabs to the reddish-brown sandstone blocks in the eastern pit; and from the western pit; \(2890 \pm 40\) B.P. (Beta Analytic # 233271 - ca. 1090 B.C. - 1212 to 972 CAL. B.C.) from charcoal found in the mortar of the faced red sandstone wall of the sluice; and \(2860 \pm 40\) B.P. (Beta Analytic # 233270 - ca. 1022 B.C. – 1131 to 913 CAL. B.C.) from charcoal found in the mortar at the base of the faced red sandstone wall of the sluice. While the dates from the western pit indicate Tr-15 was constructed in the Ajalpan Phase of the Early Formative, the very early date of ca. 2420 CAL. B.C., recovered from the stratigraphically lowest level exposed in the eastern pit, remains enigmatic. If this date is accurate, it suggests a much earlier initial construction of Tr-15, as early as the Abejas or Purrón Phase of the Archaic Period. The Ajalpan Phase dates have yet to be accompanied by the discovery of a corresponding habitation site other than Purrón Cave; however, it is feasible that the largely buried sites Tr-550 and Tr-538 may have an Ajalpan Phase component, and would fit into the “Waterway Hamlet” settlement type (MacNeish et al. 1972: 359). It is not yet determined when the entire arc of Tr-15 was constructed, but similarities in construction techniques observed in arroyo cuts suggest that it spanned a sizable portion of the barranca early in its history. While unlikely due to the presence of other small dams down stream, should the lowest level of Tr-15 be a continuous construction across the entire barranca, this would have been the earliest complete damming* of the barranca, preceding the complete damming by the Purrón Dam by several hundred years.
Tr-435 (THE PURRÓN DAM)

As during the original survey, the arroyo created north and south profiles of the Purrón Dam provided excellent exposures of its internal structure (FIGS. 1, 5). Our reinvestigation consisted of rappelling down the exposed southern face to closely observe the each level’s construction techniques and to take elevation measurements to facilitate correlations to upstream construction and sedimentation sequences. Measurements of the profile exposure and the dam itself confirmed the original five level sequence of construction, which in total consists of an approximately 21 m high dam construction sequence capped by a 5 m high Post-Classic pyramid (FIG. 2). At its thickest along the southern exposure, the dam is 106 m
wide and it completely spans the barranca’s 400 m width. Level 1 construction consisted of a 2.8 m high and 6 m thick dam of fine silts and gravels faced with unmodified cobbles and small boulders. Measurements show that it did not span the entire width of the barranca, confirming topographic relationships postulated by Woodbury and Neely (1972: 84).

Stratified layers of coarse gravels are found in profile behind Level 1, indicating the first phase of the dam impounded sediments from flashy stream deposits. The ceramic assemblage recovered from the Level 1 construction during the initial survey dated to the Early Santa María Phase. However, previously unreported charcoal collected by Robert Drennan (personal communication 2002) in 1979, from an ashy feature in the Purrón Dam profile found between construction Levels 1 and 2 of the dam, dates at a 2-sigma calibration of 403 B.C.-A.D. 26, a wide range from the Middle Formative into the Early Classic (TABLE 1).

Our elevation measurements show the 8 m high and 75 m thick Level 2 construction was the first to completely span the barranca, verifying earlier findings (Woodbury and Neely 1972: 86). The internal cellular construction, consisting of vertical walls made of stacked, large, well-rounded metamorphic cobbles and filled with well-rounded alluvial pebbles in a silt loam matrix, is analogous to the construction seen in the newly discovered dam Tr-501/502 found upstream.

Level 2 is overlaid by Level 3, which is a complex amalgam of 30-60 cm of alluvial deposits capped by a variously present 10 cm lime plaster cap and a 60-100 cm thick layer of alternating bands of gravel fill. The 30-60 cm deposit of bedded fluvial gravels and sand are unconformably positioned atop the Level 2 construction material. While this was observed in the original survey (Woodbury and Neely 1972: 87), what wasn’t observed was that this gravel bed serves as a traceable stratigraphic marker in the reservoir deposits impounded
upstream of the dam (FIG. 4). This lens, at our arbitrary 104-105 m elevation transit datum, was traceable approximately 150-200 m upstream of the dam. Therefore, because these fluvial deposits can be correlated with the reservoir sediments, the Level 3-construction/fluvial event serves as a chrono-stratigraphic boundary between earlier phases of dam construction and sedimentation below and later phases above. A sample for OSL dating was taken from impounded sediments immediately above the Level 3 gravels found atop a newly discovered dam (Tr-501/502). This sample provides a bounding chronology for the first three levels of dam construction at a 1-sigma age range of 943 - 613 CAL B.C. (Shfd06131), (FIG. 4) which more closely aligns with the ceramic chronology for Early Santa María Phase (Middle Formative Period) origins than the radiocarbon date supplied by Drennan.

Level 4 is the most massive and complex construction level of the dam. It is 9 m high, 75 meters wide, and spanned the entire barranca to be observed in both the northern and southern erosional cuts of the dam. Construction employed two techniques: internal cellular walls and a downstream curtain wall, using both shaped gypsum blocks from adjacent outcrops and unshaped fluvial rocks. Level 4 has horizontal cross walls at the top, center, and bottom of the construction, while the curtain wall of tabular gypsum blocks armored the entire downstream face of the dam. Ceramics recovered from Level 4 during the original survey could represent either the Late Santa María or the Early Palo Blanco Phase (Woodbury and Neely 1972: 94).

Level 5 consisted of two parts. The first is a 1-1.5 m thick deposit of gravels atop the Level 4 curtain wall and the internal cellular construction. The deposit fines upward from well- to sub-rounded metamorphic cobbles at the base to well-rounded small pebbles with some evidence of imbrication at the top. It is capped by an abrupt, and
possibly culturally derived, 4 cm thick clay siltstone lens. The upwardly fining sequence suggests that the first, lower part, of Level 5 is a flood deposit, representing a dramatic fluvial event to overlay Phase 4 construction. OSL dates from the top of the sedimentation sequence behind the dam (FIG. 4; TABLE 2) date to A.D. 1127–1327 and A.D. 937–1177 (at 1 sigma), which correlate to the Post-Classic Period. The second part of the Level 5 construction, using the Level 4 flooding event deposit and possibly constructed siltstone lens as a foundation, involves a large 5 m high pyramid as well as several platforms and small mounds (Woodbury and Neely 1972: fig. 9). This complex may have functioned as the politico-ceremonial center for the Post-Classic occupants of the barranca. Of the many Venta Salada Phase (Post-Classic Period) sherds covering the surfaces these structures, Coxcatlan Brushed Brown, Coxcatlan Brushed Black, Coxcatlan Polychrome, and Texcoco Black-on-red, were originally evaluated as representing a continuum from ca. A.D. 1100 to A.D. 1500 (Woodbury and Neely 1972: 94). However, considering our recent findings in the Tehuacán Valley, this date range may extend earlier. Excavations of the structures atop the dam and at Site Tr-453 are sorely needed to clarify the Post-Classic occupation of the barranca.

Tr-501/502 (BURIED DAM) AND Tr-549 (BURIED STRUCTURE STRATIGRAPICALLY ABOVE Tr-501)

New sites were discovered buried in the alluvium impounded behind the Purrón Dam. Segments of a new dam (Tr-501/502) were found exposed in two arroyo cuts draining the eastern side of the barranca about half way between the Purrón Dam and Tr-15 (FIG. 1). These segments, approximately 100 m apart and having similar construction and elevations, would have aligned to form a large earth and stone dam buried by about 5 m
of alluvium. This dam’s construction consisted of vertical retaining walls, single courses of dry-laid river cobbles and small boulders, 2.5 m high. The walls form cells filled with angular pebbles and channel gravel of gray siltstone, similar to Level 2 of the Purrón Dam. Gravel deposits, 30 - 75 cm thick, which correlate to the Level 3 fluvial event of the Purrón Dam, cap this dam. Above the gravel deposits are 4.5 m of alternating red and gray silty clay to silty loam deposits. Stratified sediments impounded behind Purrón Dam reflect each catchment’s lithology, with alternating deposits of red and gray sediments from flooding events originating from different segments of the catchment area.

This dam significantly changes our understanding of water management within the PDC. No ceramics were recovered from this feature, but the OSL sample collected from the reservoir profile immediately above the Level 3 fluvial event marker horizon indicates Tr-501/502 is at least as early as the Middle Santa María Phase (TABLE 1). However, the Early Santa María Phase dating of Levels 1 and 2, and the similarity in construction to Level 2, suggest that Tr-501/502 also dates to the Early Santa María Phase. Therefore, during the Formative Period the PDC included a series of dams across the barranca floor, consisting of Purrón Levels 1 and 2, Tr-501/502, and Tr-15. Each of these dams would have formed small impoundments, which in the case of Tr-501/502, would have extended up to 45 m upstream of the feature.

Tr-549 is an isolated stonewall or platform cross-section found in profile just west of the exposure where Tr-501 was identified (FIG. 1). The feature is 1.7 m high and 14 m wide and is capped by 2.5 m of silts built up within the Purrón reservoir. No associated ceramics or occupation surfaces were identified. While Tr-549 was not found directly above Tr-501, it
is situated above gravels in stratigraphic position associated with the Level 3 fluvial event (FIG. 4). Therefore, Tr-549 post-dates Tr-501/502 and the earliest Levels (1-3) of the Purrón Dam. Architecturally, Tr-549 is significant because it is constructed of some dry-laid, shaped blocks of tabular gypsum and shaped blocks of red sand- and siltstone – which is similar to Level 4 of the Purrón Dam and the upper construction levels of Tr-15.

**ADDITIONAL SMALL DAMS (Tr-503, Tr-505)**

Two other small dams or check-dams buried in alluvium were observed in arroyo cuts in the reservoir area. Unlike Tr-501/502 or Tr-15, these isolated features could not be traced to other exposures. Their positions further up the drainage precluded making correlations to other construction features, and no diagnostic artifacts were recovered. Tr-503 is located between Tr-501 and Tr-15, and consists of a rock wall of approximately 10 courses of dry-laid angular gypsum blocks. This check-dam is 1.4 m high and 3.4 m wide and has impounded coarse gravels on the upstream side, like Level 1 of Purrón Dam. Tr-505 is located near Tr-15 and is buried by 120 cm of alluvium. It is 50 cm high, and hangs 50 cm above the down cut bottom surface of the arroyo. It is 5.3 m wide and is constructed of slabs and a few blocks of gypsum.

**Sub-area 2: The western periphery of the Barranca Lencho Diego**

The Western Periphery of the Barranca Lencho Diego has a series of step-like terraces and benches that rise above the barranca upstream of Tr-15 (FIGS. 1, 6). Alluvial terraces 1-2 m high flank the barranca bottom while higher colluvial, and possibly lacustrine, terraces are present 4 to 10 m above the barranca along the margins of the Cerro Lencho Diego foothills. Some of these surfaces were modified prehistorically to create level surfaces for habitations and agriculture. Our survey identified twenty-one
new sites representing a far more significant occupation of the *barranca* than previously realized. Habitation sites from both the Formative and Post-Classic periods were identified, as were an irrigation canal (Tr-508), a cavate site with petroglyphs (Tc-511), artifact scatters, and leveled agricultural field surfaces.

![Diagram](image)

**Figure 6** Schematic west to east cross-section of the Western Periphery geographic sub-area of the Purrón Dam Complex.

**Tc-511 (THE CUEVA SANTIAGO)**

This site is probably the small cave described as a: “… colonial period gypsum mine.” that MacNeish and Peterson recorded in February of 1961 (MacNeish and García Cook 1972: 67). The site was rediscovered during our reconnaissance near the center of the northern face of the Cerro Mequitongo (FIG. 5), a knob-like landform used as the natural bedrock buttress against which the northern end of the Purrón Dam had been constructed. The mouth and interior walls are heavily modified, and it might be more appropriately called a “cavate” (Powell 1886). Access to the first room is achieved through the 1.90-meter square mouth of the cavate. This room has its long axis oriented about 25° west of north, and measures 5.65 by 5.80 meters (FIG. 7). It is evident that humans cut the walls and ceiling of
gypsum (yeso) into roughly level planes, and many small petroglyphs have been incised, and pecked into the irregular surface of the north, east, and west walls (FIG. 8). At the rear of this room, in its eastern corner, is the entrance to a second room 5.70 m long and 1.25 m wide. Its west wall constitutes its long axis in the same orientation as the first room. Circular holes were cut into some areas of the upper walls, possibly for horizontal beams to support shelving. A possible third small room, or storage area, lies below the floor at the rear of the first room and the front third of the second room. It is approximately 3.0 m long by 2.5 m wide, and 90 cm high, its shape is irregular, and its long axis is parallel to the rooms above it. There is also what appears to be a human-constructed level area in front of the cavate’s mouth. Similar terrace-like platforms or porches have been reported by Tucker et al. (2005) in Central Mexico, and their findings relating to these platforms supports the theory that this cavate was used for ceremonial or ritual activities. These uses of the Cueva Santiago are also suggested by the numerous petroglyphs found on its walls by Carlos Rincón Mautner, and the presence of Coxcatlan Course pottery (MacNeish et al. 1970: 212-217). It is feasible that the central plaza group at the site of Quachilco was a somewhat later structural expression that subsumed the functions of the Cueva Santiago, perhaps analogous to the proposed transition from the Great Kiva to the pueblo central plaza in the American Southwest.
Figure 7  Plan view of the Cueva Santiago, showing the locations of some of the petroglyphs. Courtesy of Carlos Rincón Mautner.
The petroglyphs are found on the rough, porous, but sometimes plastered, walls of both upper rooms. The figures probably belong to different cultural periods because of varied styles of presentation, overlap, etc. Geometrics (circles, lines, rhomboids), anthropomorphs (stick figures, hunters armed with spear-throwers (atl-atls), and zoomorphs (quadrupeds, a lizard, a snake, and a turtle) constitute the assemblage that has been identified. The origin of these petroglyphs can be tentatively placed within the Late Archaic and Formative Periods, with some evidence of subsequent additions (cf., Rincón Mautner 2005a, b; personal communications 2004). For example, there are two H-shaped elements (FIG. 8) that may be related to the incised design (“ballcourt” glyph?) decoration seen on the limbs of some solid, polished, white, anthropomorphic figurines found in the Early Santa María phase (MacNeish et al. 1970: 97). Based on the petroglyphs and ceramics from the cavate and its terrace-like
platform/porch, we have dated this site as possibly used during the late Ajalpan, probably used in the Early Santa María, but securely dated to the Middle and Late Santa María and the Early and Middle Venta Salada Phases.

**Tr-508 (THE SANTA MARÍA CANAL)**

This canal was first brought to our attention by Raúl Hernández Garciadiego (personal communication 2003). It closely follows the contours of the east face of the Cerro Lencho Diego (FIG. 1), and based on our transit measurements the canal channel gradient was approximately 2.9 percent. It was excavated into the eroded talus materials accumulated along the face of the Cerro Lencho Diego, and topographic irregularities associated with the base of the cerro had to be overcome. The canal is clearly visible for a distance of 500 meters, from where it passes west of the Cerro Mequitongo and the Cueva Santiago toward the north-northeast, where it appears to take water from the Barranca Lencho Diego. However, reworking of alluvial surfaces along the barranca and its minor tributaries has obscured the precise location of the off-take, which might extend some 1,750 meters further north-northeast, possibly extending the length of the canal about 2,250 meters. Downstream, the canal extends an additional 200+ meters to the southwest of the Western Periphery, passing west of the Cerro Mequitongo and the Cueva Santiago and about 8 meters west of Site Tr-449 before it empties into the Barranca Lencho Diego downstream from the north end of the Purrón Dam (FIG. 1). Runoff from the eastern slopes of the cerro emptied into the canal, and undoubtedly augmented the waters flowing therein from the barranca.

The gypsum rock face of the *cerro* was cut to form the canal’s west wall, and the high berm of the east wall of the canal was formed using the earth and stone from the channel excavation and from sediment cleaned from the canal during its use. Two excavated trenches
provided profiles of the canal fill (FIGS. 9, 10). In cross-section, the canal channel appears to have been generally U-shaped, ranging from about 1.5 to 6.0 m in width at the top of the channel, about 60 cm in depth from the top of the eastern berm to the channel fill, and about 2.0 meters in depth to the channel floor. Variations in width may reflect natural post-use infilling. The canal fill consisted of bedded fine locally derived gypsic silts from slope wash and coarser siliclastic rounded sands from the barranca, indicating water was derived from both sources. Accelerated mass spectrometry dating of charcoal and direct

Figure 9  A view down the Santa Maria Canal, about 50 m north-northwest of the Cueva Santiago. Canal Test Trench #1 is seen in the far middleground.
dating of sediments by OSL (TABLE 1) indicate that the Santa María Canal was functioning by at least the Late Santa María Phase, which would have occurred after the construction of the first three to four phases of the Purrón Dam. This is significant as it demonstrates contemporaneity between the canal and Purrón Dam. A date higher in the profile shows that sedimentation of the canal continued into the Mid-Classic Period. The Late Santa María date noted above for the canal does not correspond with earlier dates assigned on the basis of surface ceramics to most of the habitation sites bordering the canal (see below). The reason for this disparity is probably due to dating siltation occurring well after the canal’s construction.

The function of the Santa María canal may either have been to divert water away from the Purrón Dam during repairs and the addition of construction levels and/or to shunt unusually great amounts of floodwaters around the dam and reservoir to protect them during heavy rains.

LOCI/SITES ASSOCIATED WITH THE SANTA MARÍA CANAL

The Santa María canal provided water for a complex of eighteen sites, which consists of nine habitation and “administrative” sites, seven prehistoric agricultural fields, one site (Tr-512) with a small structure in an agricultural field, and one wall alignment with a canal off-take (Tr-510) (FIG. 1). Each site is situated on a small terrace with sparse vegetation located between the eastern berm of the canal and the lower terraces (FIG. 11). Because of the site locations and the construction characteristics of the canal, an association of the canal and all 18 of the sites seems likely. Tr-550 was found in the Western Periphery (FIG. 1), but was apparently not directly associated with the Santa María Canal.
Based on the criteria used by Spencer (1979), four of the 18 sites found aligned with and down-slope from the Santa María Canal may also have had “administrative” roles. Of the administrative sites, only Tr-523 appears to have Early Santa María Phase pottery. Tr-516 and 523 had Middle and Late Santa María Phase ceramics, while Tr-519 and Tr-522 only had Late Formative assemblages. Although Formative ceramics were most numerous, a sparse Classic (Early Palo Blanco) assemblage was found at sites Tr-516, 519, and 522, while a larger yet still relatively low density Post-Classic assemblage was identified at sites Tr-516 and 523.

The habitation terraces ranged in area from about 130 m² (site Ts-513) to approximately 3,480 m² (site Tr-523), with an average area of about 1,177 m² (cf. Marcus
Four terraces with ceramics but without evidence of structures (Ts-513, 515, 517, 524) may have had structures constructed of perishable materials or wattle and daub

Figure 11  Tr-519, a Late Formative habitation/"administration" locus terrace, looking east-northeast, as seen from the east berm of the Santa María Canal. A 30 cm high, 2 by 4 m mound of earth and rock covered with dense vegetation lies at the north end of this terrace (see FIG. 12).

(MacNeish et al. 1972: 352), and have tentatively been labeled as “habitation sites.” Foundations of unmodified large cobbles and small boulders, and occasionally cut or pecked shaped stone blocks, were found. In a few cases (Tr-516, 519, 522, 523), small
platforms and/or mounds, ranging from about 2 by 4 m to 12 by 22 m, were distinguishable (FIG. 12 - Field Sketch Site Tr-519 - in process). Some of these small platforms/mounds had small structures (averaging about 2 by 4 m) on their summits. Site

Figure 12  Field map of habitation/"administration" locus/site Tr-519 (see FIG. 11). All distances paced.
Tr-523 was clearly the largest site and had the most structures with the most complex construction. One of these sites (Tr-512) had a small habitation structure (field house) directly associated with an agricultural field. Areas with visible construction were usually covered with dense vegetation. Sites were often first recognized by the presence of a distinctive columnar cactus, identified as Pachycereus *hollianus* and generally known as “baboso” and “acompe” (Bravo-Hollis and Sánchez Mejorada 1991: 524). The species produces copious amounts of mucilage and is reported as having been used in pre-Hispanic times as a bonding additive to architectural mortars.

Eight terraced areas have been identified as agricultural fields (Appendix). This is based on the presence of agricultural field furrows seen in the wavy irregular subsurface boundary at the base of an “A” horizon exposed by a small test pit at Ts-514, visible gaps in the east wall of the Santa María Canal above Ts-525, a rudimentary turn-out feature (Tr-510) located just above Ts-526, and the presence of linear borders of rocks in some of the areas. All eight of these fields appear to have had some leveling, and each may be associated with an adjacent habitation site. These terraces ranged in area from ca. 400m$^2$ (Ts-521) to 3,432m$^2$ (Ts-514), and had an average area of about 1,647 m$^2$.

None of the sites apparently associated with the canal were directly dated, however, surface collections of ceramics provided good estimates of site occupations. The area saw a possible Ajalpan occupation at Tr-550 and Early Santa María Phase occupations at Tr-523 and Tr-550; however, its densest and most securely dated occupation (all 19 sites) was during the Middle and Late Santa María Phases. An ephemeral Classic (Early Palo Blanco Phase) settlement was indicated at Tr-516, Tr-519,
and possibly Tr-522. Post-Classic ceramic types were recovered from 12 of the 18 habitation and agricultural field sites indicating Early to Late Venta Salada reoccupations.

**Sub-area 3: The barranca floor upstream from Tr-15**

Eleven new sites were recorded up-stream from Tr-15. These sites are located along the barranca floor between the active channel of the barranca to the west and the drainage divide formed by Cerro de la Isla to the east (FIG. 1). One of these sites (Tr-538) was founded in the Ajalpan or Early Santa María Phase; six had ceramics dating to the Santa María Phase; three (Tr-534, 536, 537) apparently had their origins in the Middle Santa María Phase, while two dated to late in the phase. Three of the six sites were habitations, while we tentatively classified a fourth site (Tr-538) as an “administration” site due to the presence of a mostly buried mound. Only two previously occupied sites (Tr-534, 537) in this geographic sub-area were found to have Palo Blanco Phase ceramics of the Classic Period, which suggests only a small, and/or seasonal/short duration reoccupation.

A short distance up-stream from Tr-538, erosion on the east bank of the west branch of the Barranca Lencho Diego exposed two alignments (Tr-534 and Tr-536) constructed of shaped stone blocks that had Middle and Late Santa María ceramics associated. Lack of time prevented us from gaining a better understanding of their nature. Since we found archaeological remains bordering the west branch of the Barranca Lencho Diego, it seems possible that this branch of the drainage did not exist, or was located differently.

The barranca floor saw significant reoccupation during the Post-Classic. Eight sites (Tr-528, 529, 530, 532, 533, 534, 535, 537) had Post-Classic ceramics; three of which (Tr-532, 534, 537) were reoccupations of Santa María Phase sites. Site Tr-532 had a 10 by 15
meter earth platform and what appeared to be a deposit of metallic slag. Three (Tr-528, 529, 530) were agricultural fields (FIG. 13). The fields, mostly characterized by linear borders, grid quadrangles (Doolittle and Neely 2004), and low terraces in shallow natural drainages (Neely 2005a), were often situated along lobate alluvial fans or low terraces, likely to take advantage of seasonal flows of run-off in the barranca.

Sub-area 4: The eastern periphery of the Barranca Lencho Diego

Four (Tr-539-542) of the six sites in this area were first recorded by our survey (FIG. 1), while Tr-451 and 452 were revisited sites located on terraces and slopes overlooking the barranca and had house mounds and stone foundations (see Spencer 1979: figures 2.6, 2.10). Ceramics recovered from Tr-451 suggest a possible Early Santa María Phase and definite Middle and Late Santa María Phase occupations. Site Tr-541 was a rock wall alignment, probably from a Middle and Late Santa María Phases house. No sites dating to the Classic Period were found. Four sites with Early Venta Salada occupations were recorded; Tr-540 and 542 (both small field house-like structures similar to those found in the barranca floor upstream of Tr-15) and reoccupations of sites Tr-451 and 452. Site Tr-539, an undated small earth and stone dam with construction techniques generally similar to Level 1 of the Purrón Dam, was found about 160 m northeast (upstream) of Tr-15.

Sub-area 5: The southern periphery of the Barranca Lencho Diego

Along the southern periphery of the barranca, our survey recorded three new sites (Tr-543, 544, Tr-545), and gathered additional information on a site (Tr-453) Woodbury and Neely (1972: figure 9) reported (FIG. 1). Tr-453 is a large site with a rock shelter, numerous stone foundations of houses, platform mounds, and a 3 x 4 m cut gypsum block “altar”. This large site was apparently occupied during the Late Santa María Phase, as
Dirt Road
To Locus Ty-528

Habitation Locus
GPS 14Q, 0699279, 2011466

Nearly Level

Locus Ty-529
Low Terraces in a Shallow Drainage Channel.

GPS 14Q, 0699285, 2011451.
Figure 13  Field map of Tr-529, a Post Classic field situated in a shallow drainage.

Stones cleared from the drainage were apparently used to construct the low terraces and armor the sides of the drainage. A possible habitation site was located at the southwest corner of this field area.

well as the Early, Middle, and possibly the Late, Venta Salada Phases. It was the largest Post-Classic occupation in the PDC. Two of the newly discovered sites (Tr-543 and Tr-545) are small sites, each with one small mound/platform, that were occupied during the Early through Late Santa María Phases. These two sites are unusual because of: their small size relative to the other Formative sites recorded, the presence of mounds at such small sites, and that they may have served as “lookout” sites due to their strategic locations overlooking the south end of the Purrón Dam and its reservoir. Site Tr-544, dating to the Middle/Late Santa María Phase, is an arcuate terrace wall, and was the only site here to have ceramics suggesting an Early Palo Blanco occupation. The Post-Classic also saw the reoccupation of sites Tr-543 and Tr-544.

Sub-area 6: The barranca floor down-stream from the Purrón Dam

Six sites, three of which were post-1964 finds, were recorded in this area (FIG. 1). Tr-449 apparently was the earliest habitation site occupied in this sub-area, and following Spencer (1979: 24-28, figure 2.4) it was classified as a “habitation-administration” site. Tr-67 (Spencer 1979: figure 2.7) was a site with broad terraces, descending in stair-step fashion toward the Río Salado, which supported many houses and had cultivated gardens and fields, some of which were irrigated. This site has a possible Early-, a definite Middle-, and a Late Santa María Phase, as well as an Early Venta Salada occupation.
The function of Tr-450, a single, large Middle and Late Santa María Phase mound north of the southwest end of the Purrón Dam, remains an enigma, although it was labeled as a “public building” by Spencer (1979: 30, figure 2.7). Tr-546 (see Spencer 1979: figure 2.7) is an Early and Middle Venta Salada Phase site, with two ca. 20 by 24 m platforms, each with a small centrally situated structure, and overlies a portion of site Tr-67. We were not able to date Site Tr-547; a stone-lined, mostly buried canal with a large west berm, but it probably was excavated in Middle Santa María Phase times to service site Tr-67. It possibly was re-excavated during the Late Santa María Phase, and yet again in the Early Venta Salada Phase to service site Tr-546 and the later fields cultivated on Tr-67. Tr-548 is a buried rock-lined canal visible only in the barranca profile, which courses southwest across site Tr-67 and probably supplied domestic and irrigation waters to that site, located about 80 meters west of the Purrón Dam. Based on its location, Tr-548 may be a continuation of the Santa María Canal. These two canals are cut into, and in some cases buried by, high-energy alluvial channel deposits. These deposits may represent the natural alluviation of the barranca, however, they suggest subsequent flows. Whether they came from catastrophic events following the breaching of the Purrón Dam can only be determined by future investigations.

**Diachronic Synthesis of Prehistoric Settlement in the Barranca Lencho Diego**

The discovery of so many sites and the acquisition of new radiometric dates, demand a reevaluation of the existing model of chronology and settlement patterns in the barranca. The long archaeological record in the Barranca Lencho Diego registers a deep history of human settlement, with major shifts in subsistence strategies and socio-political organization through time. For comparative purposes, we have revised Spencer’s (1979)
Table 2.1 to present our findings pertaining to site sizes and estimate populations (TABLE 2). As we have discussed, there do exist chronological syntheses, and our work largely refines the existing chronology. Our chronological framework is derived from the original devised for the Archaeological Survey (MacNeish et al. 1972), further summarized by MacNeish in 2001 (FIG. 3).

Our more intensive restudy of the PDC has revealed that probably by the latter part of the Archaic Period, in the Ajalpan Phase (ca. 1500-850 B.C.), the small hunter/gatherer group occupying Purrón Cave (Tc-272) had undertaken traditional maize agriculture and used simple water management in the form of small dams/check-dams such as the initial construction forming Tr-15, and perhaps Tr-501/502, beginning a developmental trajectory of larger and more complex of water management in the

Table 2  Santa María Phase (Formative Period) Habitation Site Sizes and Population Estimates for the Purrón Dam Complex.

<table>
<thead>
<tr>
<th>Site</th>
<th>Phase(s)*</th>
<th>Occupied Area (ha)</th>
<th>Number of Houses</th>
<th>Est. Population @ 5 persons/ House</th>
<th>Mean Pop. Density Persons/Hectare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tr-449</td>
<td>ESM/LSM</td>
<td>1.0</td>
<td>9-12</td>
<td>45-60</td>
<td>52.5</td>
</tr>
<tr>
<td>Tr-67</td>
<td>ESM/LSM</td>
<td>2.2</td>
<td>25-27</td>
<td>125-135</td>
<td>59.1</td>
</tr>
<tr>
<td>Tr-451</td>
<td>ESM/LSM</td>
<td>0.2</td>
<td>1</td>
<td>5</td>
<td>25.0</td>
</tr>
<tr>
<td>Tr-523</td>
<td>ESM/LSM</td>
<td>0.35</td>
<td>10</td>
<td>50</td>
<td>142.9</td>
</tr>
<tr>
<td>Tr-538</td>
<td>ESM/LSM</td>
<td>0.25</td>
<td>1</td>
<td>5</td>
<td>20.0</td>
</tr>
<tr>
<td>Tr-545</td>
<td>ESM/MSM</td>
<td>0.01</td>
<td>1</td>
<td>5</td>
<td>500.0</td>
</tr>
<tr>
<td>Tr-550</td>
<td>ESM/LSM</td>
<td>0.05</td>
<td>1</td>
<td>5</td>
<td>100.0</td>
</tr>
<tr>
<td>Tr-452</td>
<td>MSM/LSM</td>
<td>0.4</td>
<td>5-7</td>
<td>25-35</td>
<td>75.0</td>
</tr>
<tr>
<td>Tr-507</td>
<td>MSM/LSM</td>
<td>0.08</td>
<td>2</td>
<td>10</td>
<td>125.0</td>
</tr>
<tr>
<td>Ts-515</td>
<td>MSM/LSM</td>
<td>0.16</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Tr-516</td>
<td>MSM/LSM</td>
<td>0.11</td>
<td>1</td>
<td>5</td>
<td>45.5</td>
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<tr>
<td>Ts-517</td>
<td>MSM/LSM</td>
<td>0.06</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Ts-524</td>
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<td>0.04</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
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<tr>
<td>Tr-537</td>
<td>MSM/LSM</td>
<td>0.12</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
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<tr>
<td>Tr-541</td>
<td>MSM/LSM</td>
<td>0.04</td>
<td>0</td>
<td>0</td>
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</table>
Phase abbreviations: ESM = Early Santa María; MSM = Middle Santa María; LSM = Late Santa María. Only loci with structures, or those that were considered most likely to be habitation sites have been included in this table. This table presents maximum population estimates as several early sites have late components, and distinguishing early from late is not possible. Sites Tr-509 and Tr-512 are likely non-habitation sites, and therefore have not been included.

<table>
<thead>
<tr>
<th>Site</th>
<th>Phase</th>
<th>Loc.</th>
<th>Pop.</th>
<th>Age</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tr-543</td>
<td>MSM/LSM</td>
<td>0.04</td>
<td>1</td>
<td>5</td>
<td>125.0</td>
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<tr>
<td>Tr-546</td>
<td>MSM/LSM (?)</td>
<td>0.25</td>
<td>2</td>
<td>10</td>
<td>40.0</td>
</tr>
<tr>
<td>Tr-453</td>
<td>LSM</td>
<td>0.25</td>
<td>5-10</td>
<td>25-50</td>
<td>150.0</td>
</tr>
<tr>
<td>Ts-513</td>
<td>LSM</td>
<td>0.01</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Tr-519</td>
<td>LSM</td>
<td>0.04</td>
<td>1</td>
<td>5</td>
<td>125.0</td>
</tr>
<tr>
<td>Tr-522</td>
<td>LSM</td>
<td>0.18</td>
<td>1</td>
<td>5</td>
<td>27.0</td>
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<tr>
<td>Tr-531</td>
<td>LSM</td>
<td>0.02</td>
<td>2</td>
<td>10</td>
<td>500.0</td>
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<tr>
<td>Tr-532</td>
<td>LSM</td>
<td>0.05</td>
<td>3</td>
<td>15</td>
<td>300.0</td>
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<td>All (7) ESM Sites</td>
<td></td>
<td>4.06</td>
<td>48-53</td>
<td>240-265</td>
<td>62.2</td>
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<tr>
<td>All (17) MSM Sites</td>
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<td>5.36</td>
<td>59-66</td>
<td>295-330</td>
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<td>All (22) LSM Sites</td>
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<td>5.90</td>
<td>70-82</td>
<td>350-410</td>
<td>64.4</td>
</tr>
</tbody>
</table>

It is feasible that the largely buried sites Tr-550 and Tr-538, found just west and north (up-stream) from the northwest portion of Tr-15, and probably of the “Waterway Hamlet” settlement type (MacNeish et al. 1972: 359), have an Ajalpan Phase component, and that Tr-511 (Santiago Cave) does also. However, excavations, more robust chronological control, and increased knowledge of rock art styles are required to validate their dating. Nevertheless, the Ajalpan date is supported by the existence of the water well at San Marcos Necoxtlá (Caran et al. 1996; Neely et al. 1995; Neely 2013a), located about 35 kilometers northwest of the PDC and dating to ca. 7900 B.C., and other early water management infrastructure in Mesoamerica (Doolittle 1990, 2004; Flannery 1983; Neely 2013a) and the American Southwest (Damp et al. 2002; Mabry 2008).

Our survey increased the total number of Santa María Phase habitation sites within the PDC from the four discussed by Spencer (1979: Table 2.1 - Spencer [1979: 30] considered Tr-450 to be a form of “public building”) to 23 (TABLE 2); an increase of
475%, with 16 of these sites occupied throughout that phase. With the advent of the Early Santa María Phase (ca. 850-650 B.C.) the population had evidently increased in number; represented by seven well-documented habitation sites and Santiago Cave in the Barranca Lencho Diego, and Zone I in Purrón Cave, but their agriculture continued to be maize dominated. Water management techniques had not changed save for additional constructions illustrated by Level 1 of the Purrón Dam (reservoir volume of about 14,714 m$^3$), and other small dams/check dams (e.g., 501/502).

By the Middle Santa María Phase (ca. 650-450 B.C.) the site loci were larger and more complex. In addition to Tr-511 (Santiago Cave), there was a significant increase in the number of habitation loci occurring during the transition from the Early (seven sites) to the Middle (17 sites) Santa María Phase, an increase of 142.9%. The agricultural complex had expanded to include “exotic” domesticates (i.e., White sapote, Black sapote, Cotton, and Avocado) that would have required irrigation to survive in this locale, but the dominant crop appears to still have been maize according to the findings in Zone “H” in Purrón Cave (Woodbury and Neely 1972: Table 12). We also noted that it is during this sub-phase that the collection of Agave surges, and its continued prevalence suggests that it was a “tended” or semi-domesticated plant. Water management technology had increased in size and complexity to produce the second and third levels of construction on the Purrón Dam (reservoir volume of about 216,216 m$^3$), Tr-15, and perhaps the Santa María Canal (Tr-508).

By the Late Santa María Phase (ca. 450-150 B.C.) the number of open habitation site loci had increased to 21, in addition to the Santiago Cave. Although not as great, the transition from Middle to Late Santa María Phase (22 sites) is still impressive at
29.4%. Cooperation may well have been sought from the occupants of site Tr-131 (cf. Spencer 1979: 34-38, figures 2.8, 2.9), and possibly from the Coxcatlan Cave area, for the major 4th construction level undertaken on the Purrón Dam. Both Tr-131 and Coxcatlan Cave (Tc-50) are located outside of the Barranca Lencho Diego, about 1.3 and 4 airline kilometers to the northwest and north of the PDC, respectively, but the pass through the Cerro Lencho Diego we discovered during our survey (FIG. 1) facilitated access to the barranca and the Purrón Dam. During this sub-phase the agriculturalists apparently continued the cultivation of exotic plants. Level G of Purrón Cave indicates that several new domesticates (e.g., Squash, Ciruela, and *Jatropha neopauciflora*) were added, and that the overall production of comestible and useful plants greatly increased. The agriculturalists efforts in the construction of Level 4 of the Purrón Dam, (reservoir volume of about 979,740 m$^3$), evidently reflect the apparent goal to increase production.

During the subsequent Classic Period’s Early Palo Blanco sub-phase (ca. 150 B.C.-A.D. 250) dramatic changes in settlement within the barranca are likely reflective of both local and regional influencing forces. Occupation within the PDC drops precipitously. Only four open habitation sites were found, three along the Western Periphery (Tr-516, Tr-519, Tr-522) and one upstream of Tr-15 on the barranca floor (Tr-537), all of which apparently had very small or seasonal occupations. Ceramics from Phase 4 of Purrón Dam and Tr-15 indicate that some construction occurred in this sub-phase, while an upper radiocarbon date from the Santa María Canal suggests that the canal may have continued to function. Plant remains from Levels F, E, and D in Purrón cave indicate a general increase in plant production early in this sub-phase and then a
decrease in production, possibly as a result of the Purrón Dam’s reservoir filling with silt and becoming less useful. The plant remains from the upper levels of Purrón Cave suggest that the Purrón Dam no longer functioned, and the barranca appears to have been abandoned for the remainder of the Classic Period.

The majority of the occupants of the PDC apparently moved about 1.0 km to the southwest to the mountain top sites Tr-73 and Tr-79 (see Spencer 1979: figures 2.11, 2.12) early in the Classic period. The reason for this move is not known, possibly resulting from the loss of the Purrón Dam, a number of regional droughts that affected Mesoamerica (e.g., Grindling 2009; Medina-Elizalde and Rohling 2012; Stahle et al. 2011), or due to political pressures from the Valley of Oaxaca (Marcus and Flannery 1996: 203-206; Spencer and Redmond 1997: 600-603).

The Early Venta Salada sub-phase (ca. A.D. 700-1150) of the Post-Classic Period saw a rapid resettlement of the PDC that apparently lasted until late in the phase. A total of 25 sites with either radiometric dates or diagnostic artifacts were identified, the most notable being the very large rock shelter Tr-453 and the pyramid complex atop the Purrón Dam. About 64% of these sites were reuses of previously occupied sites. The area that sees a marked expansion is along the barranca bottom upstream of Tr-15, where settlements and agricultural field areas along lobes of alluvial fans appear to intensify. These agricultural fields appear to be passively utilizing rainfall and run-off along the fans with well-placed stone alignments suggesting the non-irrigated cultivation of maize, and possibly beans, squash, chili, and even agave and Opuntia (Field Sketch Tr-529 Ag. Field – FIG. 13). Unfortunately, as the occupation of Purrón Cave ended with the thin-layered deposit “A” dated to the terminal Palo Blanco phase, we have no plant remains to
give us tangible evidence of the subsistence strategy changes indicated. The Santa María canal may have functioned during this period, as nearly all of the sites and agricultural fields along the Western Periphery show evidence of Post-Classic occupation. Some lines of evidence suggest that while the sites were largely reoccupied there was an appreciably different form of settlement and subsistence strategies within the barranca. The latter suggests a shift from the intensive cultivation of exotics to staple, subsistence-based crops that need far less water for crop production. In some instances, resettlement is perhaps a too general concept as some of the Post-Classic sites reoccupy the complex in novel ways (e.g., a platform mound and pyramid complex placed atop the Purrón Dam and small sites with mounds placed atop Tr-15).

When put into perspective by Drennan and Haller’s (2007) study, it is interesting to note that the above pattern of a significant Formative occupation, near abandonment during the Classic, and reoccupation during the Post-Classic was evidently also present at Quachilco (Alden 1979: figures 4.7-4.9).

Conclusions

Over the last 40 years there have been many changes in archaeological method and theory. It was our intent to apply some of the more appropriate of these to our restudy of the PDC. In an attempt to follow the tenets of “Full-Coverage” intensive survey (Fish and Kowalewski 1990), this project has recorded many additional sites and revealed a great amount of new information that has refined our knowledge and understanding of the chronological development as well as the settlement system associated with water management technology in the greater PDC area. However, perhaps the most important
contribution of our study is to provide additional information that clarifies the nature of
the socio-political milieu in which the construction of the PDC took place.

The results of our recent study, which involved survey and radiometric dating of
water management features of the PDC, challenges the dataset underlying the theoretical
discourse that links the rise of elites and a more complex socio-political system to
agricultural intensification. A small, but significant, number of direct dates by optically
stimulated luminescence of sediments impounded behind the Purrón Dam and
radiocarbon dates from strategic loci within the PDC suggest the dam was built entirely
during the Formative period (ca. 1100-150 B.C.), rather than extending into the Early
Classic (ca. 150 B.C.- A.D. 250) as originally thought. Our survey increased the number
of occupations in direct association with the PDC from eight to 57, with 46 of those sites
having occupations dating to the Formative period and most of which are small with a
few households and mound-groups. The population of the area is seen as living in
dispersed corporate local communities or farmsteads/households, as opposed to the Early
Classic when local communities become aggregated with clear signs of ranking, craft
specialization, and monumental architecture. These new data based on survey and small
test excavations appear to discredit the existing top-down models of agricultural
intensification. Instead, the largest prehistoric water management feature, and one of the
largest earthen constructions, in all of Highland Mesoamerica may have been built
entirely by dispersed communities of small corporate groups during the Middle and Late
Formative. This challenges Spencer’s (1979) assertion that the largest construction phase
of the dam was accomplished by a ranked society with managerial elite and casts doubts
on the long-standing notions of what level of social complexity is required to facilitate agricultural intensification and large-scale public works.

If the dam was constructed prior to clear displays of social ranking in the archaeological record, then what is the most likely explanation for how the Formative communities in the PDC organized themselves to undertake such a massive construction? If the sequence of dam construction pre-dates the Classic, then the collective action of corporate communities in the PDC during the Formative must have undertaken the construction, and, in the case of the PDC, the construction of an intensified agricultural complex is not commensurate with increased social complexity. This explanation is sympathetic to Clark Erickson’s (2006) challenge for archaeologists to take a landscape perspective when addressing issues of agricultural intensification, political economy, and social complexity. Citing multiple ethnographic studies from a global perspective, Erickson identified many examples of small-scale societies constructing and managing large-scale agricultural systems without a central authority. Erickson argues for a bottom-up approach, using general and specific analogies to better understand intensification and social complexity, with a greater attention to landscape.

Ethnographic and archaeological evidence from Mesoamerica and the American Southwest exists concerning water management at the lower end of the socio-political scale of decision-making – the household and village/community corporate groups. According to numerous sources, the household and village were primary decision-making entities in the construction of water management systems (e.g., Enge and Whiteford, 1989; Evans, 1990; Hunt, 1972; Hunt and Hunt 1972; Hunt et al. 2005; Kirkby 1973; Mabry 2008; Neely 2013a, b; Neely and Castellón Huerta 2013; Neely and Lancaster
Based on the settlement patterns associated with the PDC and the above studies, this pattern of household/village-level decision-making evidently existed from the Formative Period into the Modern Period in Highland Mesoamerica!

But why would the PDC community have undertaken such a massive construction? Botanical remains in the nearby Purrón Cave suggest that many tropical exotics were being grown in the Formative in the geographically/climatologically restricted southern end of the Tehuacán Valley. From a functional standpoint, the PDC appears to have been an intensified agricultural community focused on the production of exotic foodstuffs for trade. Relatively short distance trade of these tropical exotics, possibly from the PDC, has been documented at the site of Quachilco, located about 26 airline kilometers to the north-northwest (Smith 1979: 218-222). On a symbolic level, the dam and associated water management systems would have been a very impressive construction feature and the associated farmscapes (Morehart 2010) would have been very conspicuous. If corporate groups built the dam during the Formative, such a construction could have served to display or reinforce community solidarity, like that proposed by Scarborough (2006) and Carballo et al. (2012). The early date of the PDC and the nature of its settlement pattern is conspicuous and appears to corroborate Carballo et al.’s (2012) model of the decision making process of corporate communities facilitating large-scale projects, as well as the ultimately unintended consequences (Joyce 2004) towards the later rise of social complexity.

Finally, when did the dam fail and how did the use of the PDC change through time? There are multiple lines of evidence (e.g. the rapid rate of silt filling the reservoir,
debris flows downstream of the dam, etc.) that indicate the dam ceased to operate by the end of the Formative. As a result, the socially stratified Early Classic communities would have had a significantly different basis for their economy than the preceding settlements.

The shift away from tropical domestics in the Classic Period in Purrón Cave’s Levels C-A suggests a movement away from the production of exotic domesticates and instead a focus on staple crops that would require far less specialized agrosystems. Shifting Classic settlement patterns away from the PDC to aggregated communities (i.e., Tr-73 and 79) indicate the abandonment of the area by the Mid-Classic. Today, the Barranca Lencho Diego is used for pasturage, hunting, and the collection of wild and semi-domesticated plant resources. Like in other portions of the Tehuacán Valley, antecedent settlement patterns and agricultural systems can have deleterious impacts on agricultural production (McAuliffe et al. 2001), and the failure of large-scale systems, regardless of the cause of failure, can have unintended long-term consequences (e.g. Borejsza et al. 2011; Fisher 2005; Joyce and Goman 2012; Leigh et al. 2011).

The Purrón Dam Complex appears to be a remarkable example of rapid agricultural intensification by small cooperating corporate groups during the Formative Period to facilitate the cultivation of maize, probable semi-domesticates (e.g., Chupandilla), and a specialized production of tropical species in an arid environment. As the culmination of a probable trial and error development over time, this large water impoundment structure provided the infrastructure and water necessary to support local and exotic agriculture, which in turn supported Formative Period occupations that were larger than originally thought. Abandonment in the Classic Period is still unexplained, but it is likely due to a combination of dam failure and region-wide political upheaval.
that affected the settlement pattern. Finally, significant reoccupation during the Post-
Classic Period shows a return to the agriculture-based settlement of the *barranca*.
However, it is not the production of tropical exotics, but takes the form of subsistence
agriculture more typical of arid lands, primarily dry-farming and the manipulation of
local drainage patterns to conduct small-scale irrigation of corn, semi-domesticated
plants, and agave. This is an unusual example of agricultural production and
intensification that became less complex through time, and that illustrates agricultural
intensification is not concomitant with socio-political complexity.

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