LANDSCAPE TRANSFORMATION IN AZTEC AND SPANISH COLONIAL TEXCOCO, MEXICO

Approved by
Dissertation Committee:

LANDSCAPE TRANSFORMATION IN AZTEC AND SPANISH COLONIAL TEXCOCO, MEXICO

by

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Dissertation

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Doctor of Philosophy

The University of Texas at Austin

May 1997

UMI Number: 9802849

UMI
300 North Zeeb Road
Ann Arbor, MI 48103

ACKNOWLEDGMENTS

I would like to thank Dr. Karl Butzer for his constant encouragement, and the support necessary to pursue this research, and for the precious time that he spent in supervision of this work. I am also thankful to the members of my dissertation committee, professors William E. Doolittle, Francisco L. Pérez, Stephen A. Hall, and James A. Neely for their help in the research and their comments on the paper.

I am grateful to my fellows Charles Frederick, James Abbott, Paul Lehman, Dean Lambert, Nina Baghai and Phil Crossley for their suggestions and help in all the stages of this research and the final writing of the dissertation treatise. In particular I am indebted to Dr. Charles Frederick for his valuable suggestions and comments on the grant proposal, and his advising during field and laboratory research; working with him has been a tremendous learning experience.

I am also indebted to Salvatore Valastro of the Radiocarbon Laboratory at the J. J. Pickle Research Campus in Austin, for cooperation, valuable comments and suggestions.

I am enormously indebted to Professor Jeffrey Parsons of the Museum of Anthropology of the University of Michigan for his comments, encouragement and access to information, without which this work would have been possible. Dr. Barbara Williams from the University of Wisconsin has also been very kind in commenting on my work and providing information on the area of Tepetlaoztoc. Dr. Mary Hodge, unfortunately deceased recently, was very helpful in the identification of pottery styles in the field. The University of Michigan Museum of Anthropology provided access to Jeff Parsons and Richard Blanton's original survey maps and field notes. Paul Goldberg, formerly at Texas Archaeological Research Laboratory, and now at the University of Boston, assisted with interpretation of thin sections.

In Mexico, I am indebted to José Lugo-Hubp, José Luis Palacio-Prieto, and Cuauhtemoc Torres-Ruata of the Instituto de Geografía, UNAM, for technical support and useful data for this research. I also thank Edith Ortíz of the Instituto de Investigaciones Antropológicas, UNAM, for her assistance in transcription of archival documents. I thank Lorena Gámez and Mauricio Garduño of INAH for their cooperation in the field and identification of pottery. I am also thankful to Linda Manzanilla and Luis Barba of the

Instituto Nacional de Antropología e Historia, and Mari-Carmen Serra Puche of the Museo de Antropología, for their valuable comments and suggestions. I am also indebted to Luis Morett, Eduardo Fernández de Arteaga, Gabriel Legorreta and Manuel Figueroa Mah-eng, for assistance in field work. In particular, I am thankful to Luis Morett for his hospitality and procurement of data and local support through the Museum of Agriculture at the Autonomous University of Chapingo.

This research was funded by the National Science Foundation Dissertation Improvement Grant SBR-9304967. Additional support for field research was provided by the Instituto de Geografía, UNAM, and the Museo de la Agricultura at the Autonomous University of Chapingo.

Fellowships received during the period of coursework, field and laboratory research and writing include the DGAPA fellowship from the National Autonomous University of Mexico (UNAM), the E.D. Farmer Fellowship, obtained through the Institute of Latin American Studies University of Texas at Austin, and a Dissertation Writing Fellowship from the Graduate Studies of the same University. Also, teaching assistantships in the Geography Department at UT Austin, and a research assistantship from the Higher Education Coordination Board of Texas allowed me to continue in the doctoral program.

On the personal side I am grateful to J. Carlos Espinosa, Lorenzo Vázquez-Selem, Eduardo Fernández de Arteaga, Miguel Aguilar-Robledo, and Annette Granat for their support and encouragement during the difficult moments of the five years of this enterprise. And lastly, I thank my fiancée Adrienne Sadovsky for her patience and the support needed for the completion of this dissertation.

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Publication No.____________

Carlos Cordova, Ph.D.
The University of Texas at Austin, 1997

Supervisor: Karl W. Butzer

Landscape modification in the eastern Basin of Mexico during the last three millennia, and particularly emphasis during the transition between the Aztec and Spanish Colonial periods, is the focus of this investigation. The methodological strategy combines geomorphology, stratigraphy, palynology, historical geography and archaeology.

The research revealed that the Aztec period was characterized by relative landscape stability, created by the formation of managed environments that were fragile when abandoned, but stable with regular human maintenance. The years following the Spanish conquest witnessed an ecological crisis caused by decimation of the population,

abandonment of fields, and changes in land use and settlement patterns, all of which coincided with a cluster of severe climatic events.

In order to evaluate the significance of landscape transformation during the transition from the Aztec to the Spanish Colonial era, it is necessary to examine previous cultural periods and evaluate their environmental impact through the study of both settlement history and the soil and alluvial stratigraphy. In doing so, two more ecological crisis were detected, one of which occurred in the Terminal Formative, between 200 B.C. and A.D. 100, and that coincides with a peak in upland colonization by farmers. The second ecological crisis is datable to the transition from the Classic to the Postclassic, between *ca.* A.D. 600 and 1000, and coincides with social instability as well as an increased magnitude of rainfall.

For all three ecological crises, the basic causes of soil erosion and subsequent accelerated alluviation of valleys were radical changes in settlement pattern and land use, coincident with rainfall perturbations that provided a natural catalyst.

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CHAPTER 1

INTRODUCTION

This dissertation investigates the issue of landscape modification associated with human settlement in the Basin of Mexico, emphasizing the topics of soil erosion and alluviation, and to a lesser degree vegetation disturbance and soil structure modification. I selected the Texcoco Region as the area to study landscape transformation because it is part of the Basin of Mexico (Figure 1.1), a cultural area that at the time of the Spanish Conquest had the densest population, the most highly differentiated urban centers, and the most complex political and economic organization in the history of Mesoamerican civilization (Sanders, *et al.* 1979: 1,2). Furthermore, the Texcoco Region offered several advantages to achieve the research objectives of a study on environment and settlement history, for it has a wealth of archaeological data recorded through systematic survey. The archaeological surveys of the area include the Texcoco Region (Parsons 1971), few stretches of the Ixtapalapa Region Survey (Blanton 1972) and the southern end of the Teotihuacan Valley Survey (Sanders *et al.*, 1975, and Evans 1980). The visibility of sedimentary sequences and the

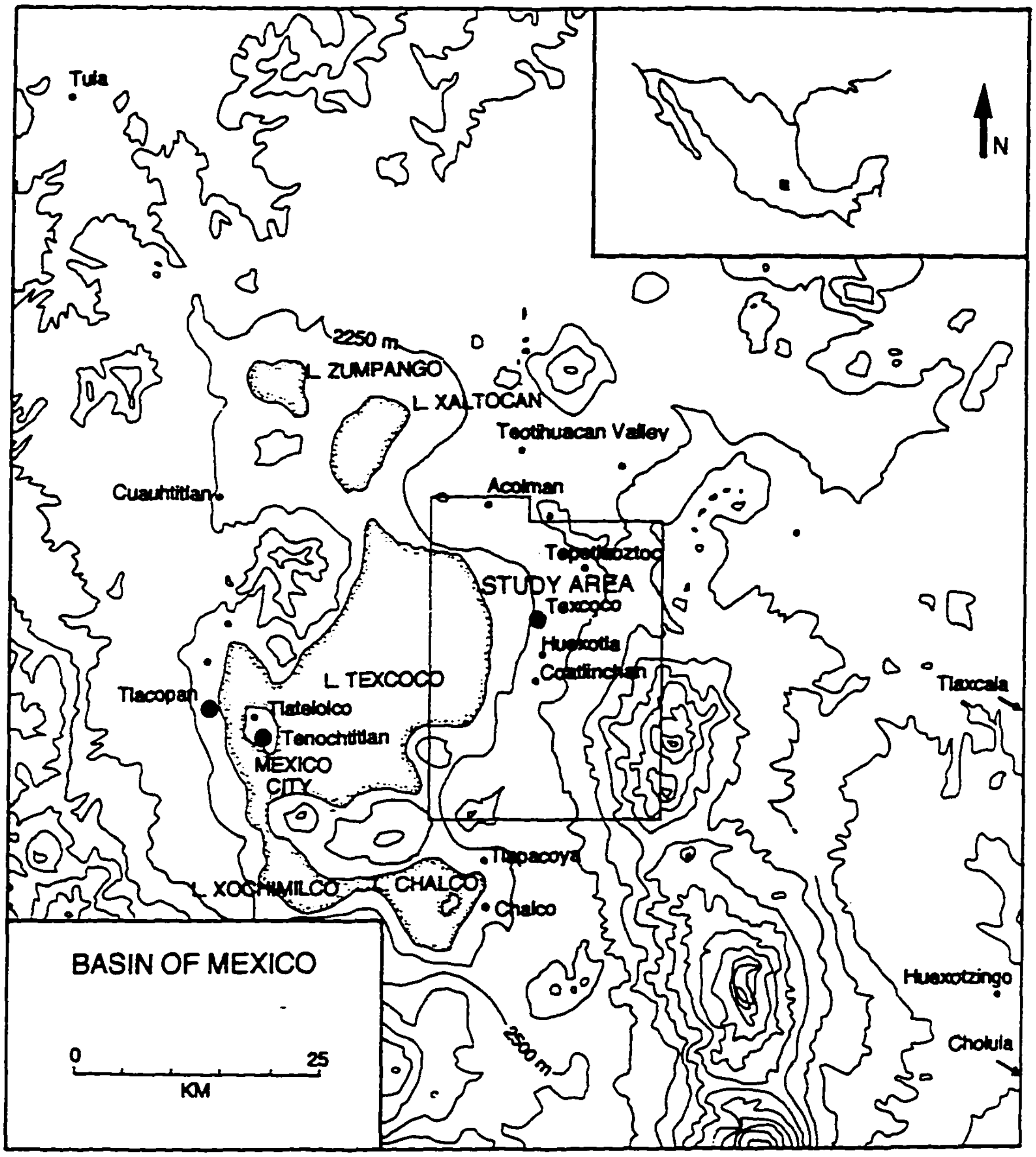


Figure 1.1 Map of the Basin of Mexico showing the location of the study area. Contours every 250 meters.

availability of historical documents, were also two important elements taken into account for choosing Texcoco for investigation. It is worth stressing that even though this study focuses on the Basin of Mexico, it also provides suggestive arguments for landscape transformation in the Mexican highlands, as well as those area of Mesoamerica that had high levels of population in pre-Hispanic times. It also provides arguments on universal problems such as soil erosion and rapid alluvial sedimentation as a result of land use and settlement pattern changes.

Although this research focuses on the transition from the Aztec to the Early Colonial landscapes, it also considers the transformation of the pre-Aztec landscapes, since the information recovered showed that there were important stages of landscape change during the incremental development of agricultural communities. In particular the early phases of sedentary occupation seem to be relevant to explain the transition from the pre-Hispanic into the Spanish land use system.

The relative ecological impact of indigenous and Colonial land use has been a matter of much discussion on the occasion of the Columbian Quincentenary. Controversy arose as to whether native American peoples did or did not alter or degrade the environment; and whether or not

European settlers had an immediate and drastically negative impact on the environment (Butzer and Butzer 1993, 1995).

One of the fundamental questions is what Denevan (1992) calls the myth of the pristine New World landscape, or the idea of a non-disturbed pre-Columbian landscape where people lived in harmony with nature. The pristine myth can be criticized in the light of substantial evidence that the landscapes of the New World were humanized, in many instances, modified and even degraded prior to 1492. For central Mexico diverse and extensive agricultural landforms were observed by early Spanish writers; these include hillside terracing, *chinampas*, and ridged fields that either remain visible in the landscape or have been verified by archaeological work (Whitmore and Turner 1992). Prehispanic land-use had its ecological repercussions, as recently examined in detail for the Lake Patzcuaro Basin, where three periods of regional soil erosion can be verified between 4000 B.P. and the first arrival of the Spaniards during the 1520s (O'Hara *et al.* 1993; Butzer 1993).

It must also be emphasized that the Spanish colonization of the New World had a major impact, through the introduction of new forms of land use and new biota, as well as epidemic disease. The resulting Indian depopulation and land use changes led to significant transformation of prehispanic landscapes (Butzer 1992c, Turner and Butzer 1992). To what degree and at what time the Spanish impacts may have caused ecosystemic disequilibrium remains unclear, and they will commonly have represented part of a continuum in the process of landscape change and alteration. The account of extant literature on the transformation of prehispanic landscapes, in highly populated areas of Mesoamerica and the Andes, suggests that the introduced, so called Spanish land-use system was rather a hybrid one, since it retained elements of the prehispanic systems (Whitmore and Turner 1992; Butzer 1995). Thus, by this hybridization we may expect the possibility that the impact of introduced biota and land use forms could have been less harmful to some areas of the continent where domestication of the landscape took place in pre-Hispanic times.

Given the variety of regions and aspects of the study of land degradation, the search for an answer to the question of prehistoric and historic environmental change involves a variety of research methods. One potential method to study land degradation is by high-technology limnological research, such as implemented by O'Hara *et al.*(1993) as part of a much larger project. Highly detailed study of lake cores can provide a minute, quantitative record of changing processes and parameters governing sedimentation, but its interpretation in terms of changing land use and specific environmental modification in the watershed must then be inferred.

The alternative approach put forward in this study is to focus directly on the landscape, combining traditional methods such as historical geography and geomorphology into a more directed geoarchaeological approach. Thus, land-use change, agricultural technologies, demography, soils and alluvial histories are examined. Specific objectives were set for each line of work, that are subsequently integrated to allow an assessment of regional and temporal change for a set of interrelated variables.

There have been countless studies of either such historical-archaeological components or earth science phenomena, with similar goals in mind; yet without a balance of inputs from both approaches, and their tight integration, such efforts do not yield a comprehensive understanding of complex landscape change. In effect, I am arguing for a much more refined and focused *geographical approach* to a four-dimensional diagnosis of regional landscapes and their transformation, that effectively integrates the human elements with their biophysical counterparts.

To give some examples, there have been many generic studies of soil erosion in central Mexico (Cook 1949, 1963; Kirkby 1972; Klaus and Lauer 1983; García-Cook 1986; Werner 1986), but these have lacked the specificity to provide temporal controls, or to link eroded soil products with their soil landscapes, or to identify the land use practices coeval with such erosion.

Recently, Frederick (1995) retrieved paleoenvironmental information from alluvial sequences of rivers of the northern Mesoamerican frontier. This study shed light on the possibilities in Mexico to use fluvial stratigraphic records to identify changes on past landscapes, whether they are the result of climatic fluctuations or human disturbance. There have also been studies dealing with archaeological reconstruction of settlement patterns (Sanders *et al.* 1979; Parsons 1971; Niederberger 1987) or archival reconstruction of Late Aztec-Early Spanish settlements (Charlton, 1969), Spanish land-holdings (Prem 1978, 1992; Licate 1981) and environmental deterioration by land use changes (Melville 1991, 1994), or a combination of documentary information and archaeological remains (Doolittle 1988) that contribute enormously to an understanding of land use or resources; but these studies are limited to either the Prehispanic or

Colonial period, and provide little insight on environmental impacts.

To address the problems initially raised on the issue of landscape modification, it was necessary to devise a methodology that treats both periods, pre-Hispanic and post-Conquest, and both human and biophysical phenomena, by using consistent criteria for the same region. Such an "integrative" methodology was intended to initially yield only qualitative understanding, but a detailed web of qualitative inductive understanding significantly complemented those deductive inferences drawn from local studies, *e.g.*, limnological interpretations based on single cores within a vertical approach only.

With respect to the issue of soil erosion, the two original hypotheses tested in this study considered that (1) soil erosion was triggered during the century preceding the Spanish Conquest, as a consequence of rapid agricultural intensification promoted by the Aztec state, and that later was controlled through terracing, and that (2) the abandonment of terraced Aztec fields and the introduction of new forms of land use at the end of the sixteenth century led to an unchecked process of soil erosion that partially contributed to the flooding in the valleys. Later, as research went on, I found that there was no apparent erosion datable to the Aztec period, for what I discarded the first hypothesis. However, the second hypothesis proved correct, since geomorphological, stratigraphic and documentary evidence indicated that severe erosion did occur in the Early Colonial period as a result of abandonment of lands on slopes and the lack of terrace maintenance.

What came to modify the first hypothesis was that there were at least two major phases of erosion and alluviation prior to the Aztec occupation, around the end of the first millennium B.C., and one between 500 and 1100 AD. The former was due to the rapid increase in land clearance and agricultural intensification, and the second due to abandonment and probably mismanagement of the land. This last statement, rather than a final result, I believe, is a new hypothesis, inasmuch as the erosional phases are still to be pinpointed in time under more detailed study at semi-mesoscale and mesoscale.

Following this introductory note, the main body of the dissertation is divided into three parts:

(a) basic information on the study area, methods and chronology of settlement (Chapters 2 to 4);

(b) the results and discussion of the two most relevant problems, soil erosion on the piedmont (Chapter 5), and alluviation in the valleys (Chapter 6), and the two minor complementary problems: a suggestive reconstruction of vegetation change from the palynological perspective and the array of modern plant communities (Chapter 7), and the dynamics of lake fluctuations and settlement (Chapter 8);

(c) the modeling of landscape transformation processes and the discussion of research problems in the context of ancient cultural and physical landscapes, stressing on the significance of settlement patterning and land use (Chapter 9).

Ten appendices contain lists of data gathered through this research. Further, a glossary at the end of the text contains all the Spanish and Nahuatl words written in italics through the text.

CHAPTER 2

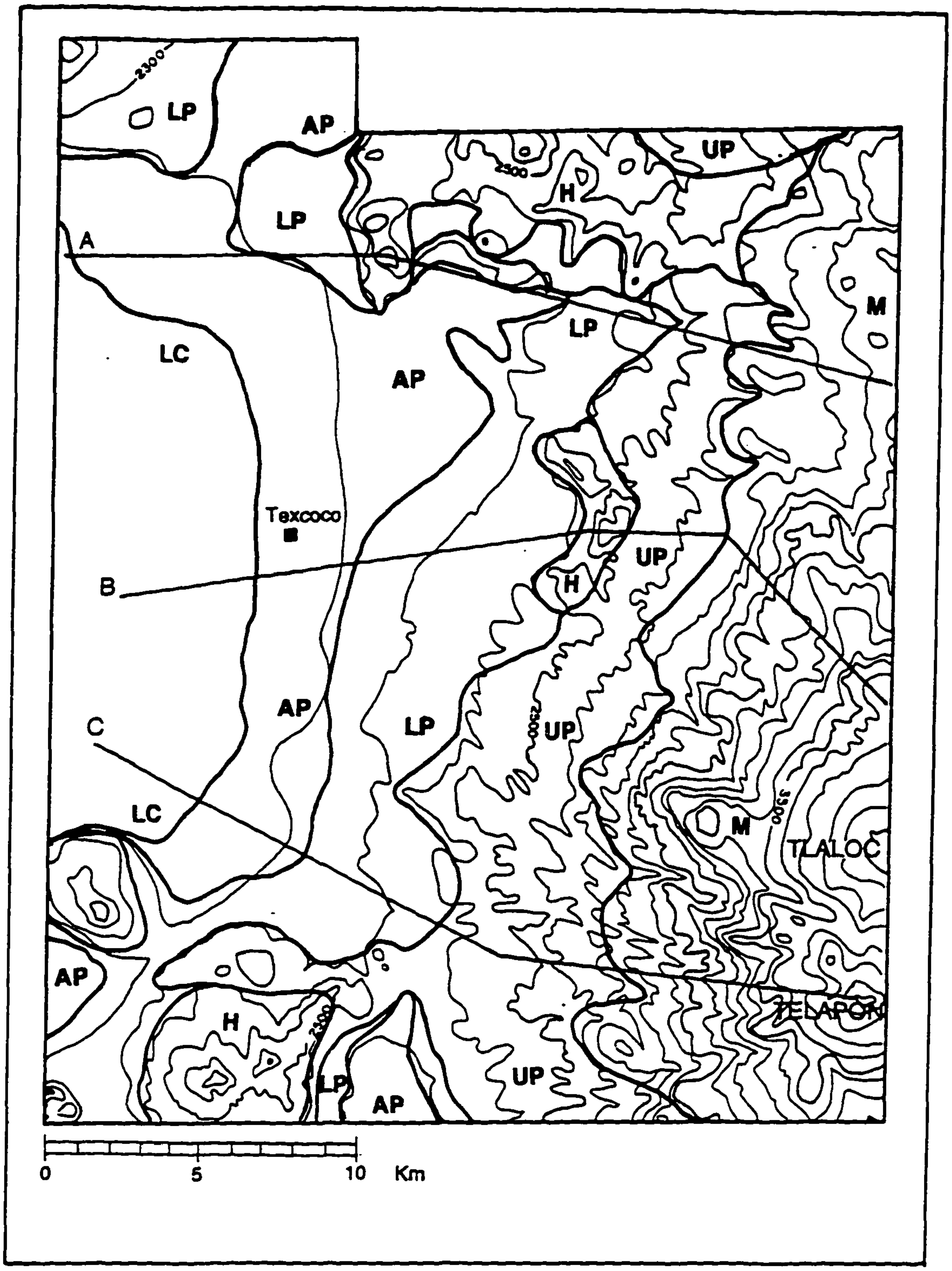
SETTING

Location and general aspects of the region

The region of Texcoco is situated in the eastern piedmont of the Basin of Mexico, approximately 30 km east of Mexico City, below the western slope of the Sierra Nevada (Figure 2.1). The area extends from 19° 37' N, on the north, to 19° 20' N, on the south, and from 98° 58' W, on the west, to 98° 43' W, on the east.

The highest elevations are the summits of two major volcanoes, Tlaloc (4120 m), and Telapon (4060 m), and the lowest is the bed of lake Texcoco (2240 m). The landscape of the study area can be divided into six ecological zones: mountain, hills, upper and lower piedmont, alluvial plain, and lake bed. Each of these units show a distinctive mosaic of soils and land use, and consequently a particular evolution of settlement patterns (Figure 2.2). A brief description of the landscape elements is given below as background to the main research problems of this dissertation.

Figure 2.1 Ecological zones. M, mountains; H, hills; UP, upper piedmont; LP, lower piedmont; AP, Alluvial plains; and LC, Lacustrine plain. The trace of profiles A, B, and C of figure 2.2 are also indicated.



LP
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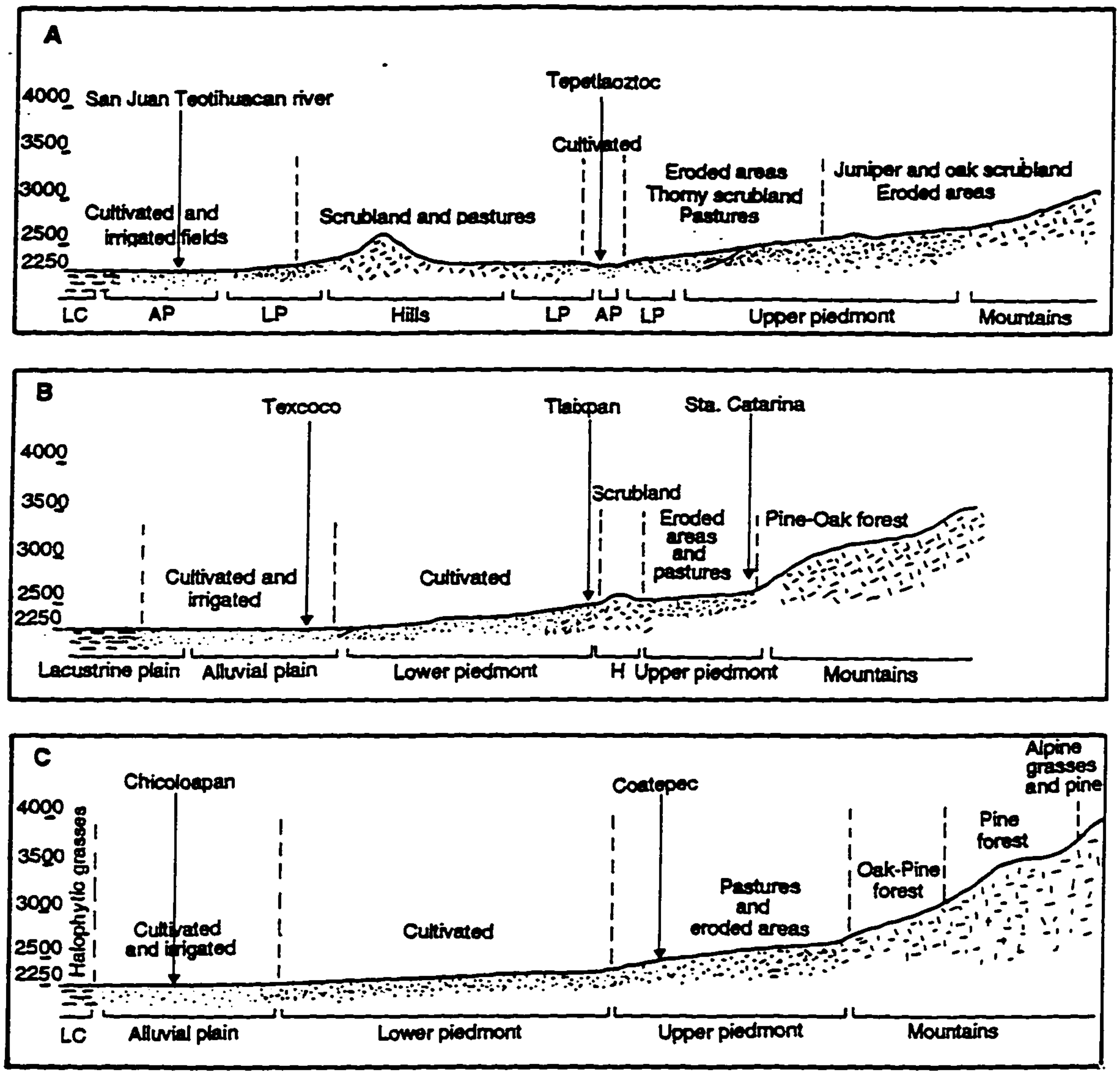


Figure 2.2 Profiles across the different ecological zones of the study area. See Fig. 2.1 for location.

Geology, geomorphology, and soils

The ecological units considered in this work are governed by the distribution of the major landform units resulting from a series of tectonic and volcanic processes that in the Tertiary and Quaternary formed the basin of Mexico (Mooser 1975), and their concomitant modeling by exogenic processes. A detailed description of the relationship geology-topography-soil for each ecological units is given below.

Mountains

The most prominent volcanic structures of Quaternary origin are the Telapon and Tlaloc volcanoes, which in turn stand on the volcanic structures of Pliocene age known as Sierra Nevada, comprised essentially of andesitic and dacitic lavas and tuff deposits (Mooser 1975, map).

The Quaternary deposits of the Sierra Nevada consist of dacitic lavas and pyroclasts with large amounts of pumice, that all together form the Tlaloc Formation of Middle to Late Pleistocene age (Vázquez-Sánchez and Jaimes-Palomera, 1989). None of these deposits have been dated, except for a a deposit of nuée ardente in the Río Frio Pass that was derived in the Telapon; a piece of wood embedded in the deposit yielded an age older than 35,000 BP (Cornwall 1969, 1970). However, more recent pyroclastic deposits as young as middle Holocene have also been reported in several parts of the slopes of the mountains and the piedmont. Overlying the Pleistocene deposit described above, there are several ashfall deposits. By relative chronology Cornwall (*op.cit.*) identified one of these ashes as the pumice with andesite of Tlapacoya dated 14,700±280, and that in turn is overlain by a deposit of fine ash upon which the present soil has formed. It is likely that the overlying ash is Holocene. On the western slope of the Sierra Nevada there is a white ash-fall deposit that in this research was dated to middle Holocene times between 3,933±156 and 5,313±51 B.P.; this date indicates that this ash is likely to be the "Pómez Marcadora Superior" reported by Mooser (1967) or the "Pomez de Grano Fino" (PGF) reported by Lambert (1986). Two dates in Tlapacoya bracket this ash between 4,250+110 and 4,880 BP (Lambert:1986:78; Flores Díaz, 1986: 114). Although geochemical analyses testify for the same ash in between the deposits dated, it has not been compared with the PGF samples from the deposits originally described. Therefore, the name PGF is used through this work as a tentative assignation. Probably because of their disperse character, these Holocene deposits have not been grouped into a formation, or into a minor lithostratigraphic unit.

The deep valleys dividing blocks of lava are the result of modeling by water and ice, since evidence of glaciation is conspicuous (Heine, 1975). The predominant high slopes and the young materials are a limitation to soil development; the main orders of soils are entisols and inceptisols, and large areas of rocky surface.

Hills

The same Tertiary volcanic units that form the base of the high volcanoes, extend from the main core of the Sierra Nevada giving rise to the low volcanic hills in the north (Sierra de Patlachique) and the center (La Purificación) (Mooser, 1975; Vázquez-Sánchez and Jaimes-Palomera, 1989).

The Sierra de Patlachique is a structure that runs east-west and consists of a Tertiary dacitic dome and various ash deposits with differential degree of consolidation, and various deposits of Early Pleistocene age that include fenobasaltic lavas and tuffs, part of the the El Pino Formation (Vázquez-Sánchez and Jaimes-Palomera, 1989). There is a large variety of soils that correspond to the different lithologies, slopes, differential erosion, and land use patterns. The most common orders of soils are inceptisols and entisols, in general sandy loam on the upper horizons and loam or clay loam in the lower horizons (Cachon, Nery, and Cuanalo 1974)

The volcanic structure of La Purificación, a few kilometers east of Texcoco, is an amphitheater-like structure, whose concave part faces west. It has been interpreted by Mooser (1975, map) as an old caldera rim with a composition basically of dacitic lavas and breccias. Due to its pronounced slopes, soils are thin and most of the structure has stony soils. At the base of the structure there is a considerable mantle of colluvial accumulation that enables the formation of sandy loam soils. In spite of the highly inclined slopes, artificial terracing along the middle and lower parts of the structure have made cultivation possible.

The low hills in the south, in the area of Chimalhuacan, consist of a series of small volcanic cones and structures ranging in age from Pliocene to Late Pleistocene (Mooser 1975; Vázquez-Sánchez and Jaimes-Palomera 1989). Two main structures make up this subunit, one to east corresponding to a cluster of three hills: Cerro Portezuelo, Cerro El Pino and Cerro Tecolote, separated from the Cerro de Chimalhuacan to the west by a saddle crossed by the road that connects the town of Los Reyes with Texcoco. The volcanic activity that formed these units is associated with part of the Sierra de Santa Catarina and Cerro de la Estrella in Ixtapalapa, and their deposits are grouped into El Pino Formation of Early to Middle Pleistocene age (Vázquez-Sánchez and Jaimes-Palomera, 1989). There is a variety of soils most of which are young, showing poor development of horizons; in most cases soils are dark-brown sandy loam of colluvial origin (Cachon et al., 1974). Most soils in this area overlie calcic horizons with platy structures at the bottom of the profile, probably corresponding with the so-called Horizonte Barrilaco in the traditional stratigraphy of the Basin of Mexico, established originally by Bryan (1948). These soils seem to be developed on young colluvial mantles that cover an old petrocalcic horizon.

Upper and lower piedmonts

These two landform units are described together as their origins are related to the same geomorphic processes. The two piedmonts are the result of continuous deposition of pyroclastic deposits, interbedded with a few lava flows and fluvial accumulations. This combination of deposits overlies the Tertiary lavas and breccias that form the core of the Mountains and Hills described above. There are no dates for the deposits forming the piedmonts, but they have been mapped as Tarango Formation (Mooser 1975, map;

Vázquez-Sánchez and Jaimes-Palomera 1989), whose tentative age is Pliocene. However, in a recent stratigraphic study of these deposits in the Basin of Mexico, Mooser *et al.* (1986) have considered that the pyroclastics of the so-called Tarango Formation are mostly of Pleistocene age. As shown in the more detailed stratigraphic description in this research, it is evident that the uppermost layer of ash is Holocene, which includes the aforementioned PGF ash.

A close analysis to the different exposures also reveals also long periods of quiescence between volcanic events represented by well developed soils, and periods of strong erosion represented by stratigraphic unconformities. It is also evident that a change probably in base level led to two generations of deposits, so that the pyroclastic deposits of the piedmont can be divided into two members. One of them forms the upper piedmont and consists of discontinuous deposits of pyroclastic flows and ashes that are indurated, showing also paleosols. The other member forms the lower piedmont, and is made of a series of coalescing volcanic fans formed by thick deposits of lahars, showing at least continuos accumulations; these deposits are younger or at least contemporaneous with the youngest deposits of the upper piedmont. The geomorphologic and stratigraphic relations between the two members suggest that the youngest lahars that form the lower piedmont flowed through the valleys that dissected the upper piedmont pyroclastics and were ejected onto the plains. Discrete terraces of pink lahar are found along some barrancas as is the case of the area studied in detail in Chapter 5.

In a general sense, the upper piedmont is made of the older indurated ashes of the Tarango Formation, and the lower piedmont is made of the younger coalescing lahar fans. This difference is what impose their characteristics in terms substrate and soil development which also have an indirect impact on use patterns, soil formation and susceptibility of soils to erosion (see profiles of Figure 2.2).

The older pyroclastic deposists of the upper piedmont are indurated in the form a hard material known locally as *tepetate*, a Nahuatl word that means 'rock mat', which corresponds to what the Soil Survey Staff (1992) defines as duripan. Because of the high impermeability, due to cementation, and clay horizons, these deposits are highly susceptible to erosion as pointed out in several areasof central Mexico (Schonals 1977). Continuous erosional episodes resulted in the predominance of badland type of landscapes of large barren surfaces, nowadays mostly reforested. The younger deposits of the lower piedmont consist of gravel and sand deposits that are not cemented, except for a petrocalcic horizon on top of the deposits, known as *caliche*. However, the sandy and sandy loam characteristics of these soils create good conditions for infiltration and reduction of surface runoff, which consequently has effects in the relatively low erodibility of the lower piedmont that contrasts with the high erodibility of those soils in the upper piedmont.

There are apparently several origins of the *tepetate* in the piedmonts of Texcoco. Although tepetate is in part the result of the welding of ashes at the time of deposition, as observed in some of the units, it is in large part the result of pedogenic induration (Nimlos and Ortiz-Solorio 1987; Dubreucq *et al.* 1989). Silica, as a cementing agent, is alsopresent in the low horizons in the soils of the upper piedmont, whereas calcium carbonate takes over as a cementing agent in the lower soil horizons in the lower piedmont (Dubreucq *et al.* 1989) . However, a micromorphological study of *tepetates* in central Mexico, focusing on the Texcocan piedmonts, shows that the process of induration consists of calcitic accretion independent from clay illuviation and pedogenic silica, and that the presence of silica is due to abundant volcanic glass shards and phytoliths (Fedoroff *et al.* 1994:471). This study shows also that calcitic accretion not only contributes to induration of *tepetates* by cementation, but to the formation of a laminar crust which gives the tepetates their impermeability. Experimental research on the hydrology and sediment budget of several small watersheds in the piedmonts shows that runoff on the *tepetates* after a rain shower is about 90% of the total volume of rain, whereas in the areas still covered with soils it is only 12% (Quantin *et al.* 1993: 42). This tremendous difference makes the soil to get saturated more quickly, so that the excess of water will run downslope on the tepetate which acts as an internal level of subsurface flow, causing sliding that eventually triggers gully formation (Bocco, 1993). Since the calcitic film protects the tepetate, the overlying, unconsolidated soil is removed by runoff. More details of this process in a particular case is discussed in Chapter 5.

Soil development in the piedmonts varies considerably. Most of the soils are developed on colluvial deposits and pyroclastic materials. In the upper piedmont, soils show a better profile development where Bt horizons are present, although continuous accumulation of volcanic ash or colluvial material buried the horizons creating a new superimposed soil, very much in the form of cumulic soils, haplustolls being the most common type registered through this investigation. Soil development in the lower piedmont is weaker, although a Bk horizon is in most cases present. The formation of this horizon is an independent process since the calcic horizons seem to be older, much in a way of an inherited horizon. Most of the soil profiles observed on the lower piedmont are entisols usually within the group of ustipsamments, although mollisols of the group of haplustolls are not uncommon.

Deep incision affects primarily the upper piedmont in a wide pattern, showing a different orders of gullies. The lower piedmont presents dissection in a more concentrated pattern, usually form of deep gullies corresponding to the main stream courses. Incision starts along fractures in the pyroclastic deposits and continues to reach the Tertiary lava flows of the basement, then expands headwards developing a network of gullies of variable depth. These gullies, whcih can reach up to 60 meters in depth, are called *barrancas*, a term that is widely used in volcanic areas of central Mexico, and that has now been included in the geomorphological lexicon (Whittow, 1984).

Alluvial plain

The alluvial plain consists of a series of coalescing floodplains and older alluvial surfaces; their stratigraphy includes basically thick sedimentary deposits resulting from the continuous accumulation of silts, sands, gravel and occasionally volcanic flows. Although fluvial and volcanic deposits of Pleistocene age are important, accumulation in the Holocene has been significant, especially in the last 3,000 years. There is no stream incision in the floodplain except in a very few reaches of rivers at the interface lower piedmont-alluvial plain, where accumulation is more massive and outspread in the form of alluvial fans. Farther downstream the gradient is so low that river courses meander and migrate, sometimes changing paths in the process of avulsion. A detailed description of recent river behavior and sedimentation is provided in Chapter 6.

Floodplains have a convex form, usually presenting ridges at the present channel of at places where there used to be a channel. Most settlements are located on the edges, and usually lie on artificial mounds of an older settlement. This aspect of mound buildup concomitant with fluvial aggradation is explained through different stratigraphic sections in Chapter 6. Although most flood deposits are relatively recent, at present, these rivers have been channelized and high artificial levees prevent the alluvial plains from flooding. Nonetheless small flood events are not uncommon.

Soil profiles in the alluvial plain vary according to the age of the parent material. Cachon et *al.* (1974)

have identified well developed profiles with a B horizon in higher places of the alluvial plain where recent aggradation has not occurred. However, in most cases soils are classified in the suborder of fluvents, where usually there is a cumulic sequence of weak A and AC horizons. Soil texture on the plain also varies horizontally, being silty loam and clay loam in the distal part of the flood plain, and sandy loam near the channel. The variability of texture also varies from basin to basin. For instance, in the north, on the floodplains of the San Juan Teotihuacan and Papalotla rivers, there is a predominance of fine sediments, usually silts; in the central part of the region, around the area of Texcoco, and the plains just west of Huexotla and Coatlinchan, soils are sandy, due to the high influx of sands from the lahar deposits of the lower piedmont; and in the south, the Arroyo Coxtitlan and Coatepec river floodplains show a combination of coarse and fine textures, since there is influence of some pyroclastic and colluvial deposits.

Lacustrine plain

The lacustrine plain is the surface that used to contain the waters of Lake Texcoco, that today is a surface with seasonal ponds, salt flats, halophyte grasses, coppice dunes and a few cultivated areas on the edges. The stratigraphy of the lake bed includes a continuous sequence of silts and clay deposits interbedded with volcanic ash layers. The high content of clay and the continuous extraction of underground water has led to a continuous cracking and subsidence of the surface, especially in the area west of Chicoloapan (Lugo *et al.* 1992).

The intense eolian activity on the now-exposed lakebed has created coppice dunes, which are made largely of clay aggregates and pumice (See Chapter 8).

Given the characteristics of the substrate and the hydrological dynamics, soils present several problems of drainage, high pH, and high salinity. For this reason most of the surface is not used for agriculture, except in those areas along the edges where irrigation has made possible the down-washing of salts in the profile. Most recently, the appearance of *colonias* settlements is taking place in several areas. The central part of the lake basin is a protected area run by the Comisión del Lago de Texcoco, a governmental organization engaged in the creation of the artificial lake (Lake Nabor Carrillo) and the protection of the fauna within the reserved area.

Climate and hydrology

The climate of the Texcoco region is characterized by mild winters and wet, moderate summers; the climatic types of the study area according to the Köppen classification vary from BS (semi-arid) on the plains to Cw (temperate with summer precipitation) on the piedmonts and mountains (Table 2.1). Located in the rain shadow of the Sierra Nevada, annual rainfall decreases from 900 mm or more on the mountains to 600 mm on the semiarid plains (García 1988). More than a 90% of the precipitation falls in the late spring and summer. This seasonal pattern of rains is the result of the northern migration of the Intertropical Convergence Zone (ITCZ) that creates instability in the air and consequently convectional rains between May and October, and the influence of tropical cyclones from the Pacific and the Gulf of Mexico towards the end of the summer. The summer rains in particular are thunderstorms that usually take place in the afternoon or at night. The amount of precipitation registered in January or February (known locally as *cabañuelas*), sometimes in the form of snow on the mountains, is the result of cold fronts that rarely reach this part of Mexico. While in some years frontal rains can be abundant and continuous over several weeks, in others are completely absent.

Temperatures across the study area are moderately seasonal and tend to be isothermal (the difference between the maximum and minimum monthly is less than 5°C), a condition

TABLE 2.1
LIST OF BASIC CLIMATIC INFORMATION AND CLIMATE TYPES ACCORDING TO KOEPPEN MODIFIED BY GARCIA (1988).

Station and elevation	Lat./ Long.	T (°C)	P (mm)	WP (%)	T O (°C)	Modified Köppen classification
Alluvial plain:						
Atenco (2253 m)	19°33' 98°55'	15.1	604.6	4.9	6.5	Cb(wo)(w)(i')g
Texcoco (2253 m)	19°31' 98°53'	15.9	691.5	3.7	6.1	Cb(w1)(w)(i')g
Chapingo (2250 m)	19°29' 98°53'	15.2	636.5	4.3	6.0	Cb(w0)(w)(i')g
La Grande (2300 m)	19°34' 98°54'	14.7	620.5	4.3	6.5	Cb(w0)(w)(i')
Lower piedmont:						
Tepexpan (2400 m)	19°37' 98°57'	15.6	587.8	4.7	6.4	BS1kw(w)(i')g
San Miguel Tlaixpan (2300 m)	19°32' 98°49'	14.7	621.0	5.2	5.2	Cb(w0)(i')g
Upper piedmont:						
Coatepec (2400 m)	19°23' 98°51'	15.7	637.1	5.4	5.3	Cb(w0)(i')g
Mountains:						
Río Frío (3000 m)	19°20' 98°40'	10.4	1074.3	3.6	4.0	Cb'(w2)(w)igw"

Notes:
T= mean annual temperature, P= mean annual precipitation, WP= pwinter precipitation, TO= temperature oscillation (difference between the highest 1 temperature and the lowest).
Source: Garcia, E. (1988).

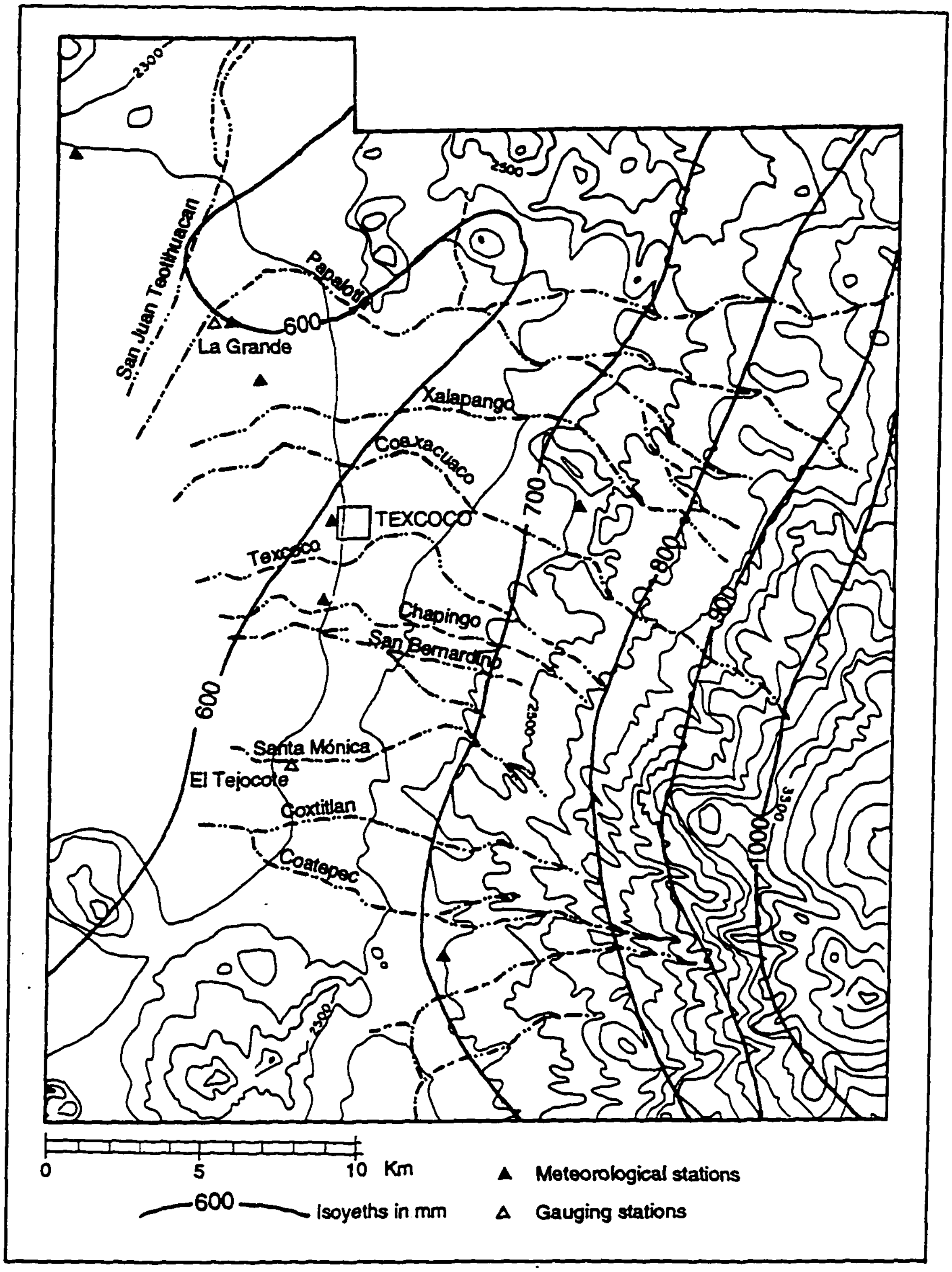
that becomes more pronounced at higher elevations (Table 2.1).

Differences in day and night temperatures tend to be more pronounced during the dry season than in the rainy season. The reason for such pornounced differences in the dry season is because of the low dew point and the relatively low humidity in the air. Frosts occur commonly in the area from late September to early May, which is the time with less humidity in the air and low incidence of clouds. Frosts are more frequent on the alluvial plain and lower piedmont, due to the thermal inversion of the air masses that results in the lowering of cold layers of air onto the ground surface, a frequent phenomenon in the Basin of Mexico. Cultivated areas at higher elevations, on hill slopes, are paradoxically less prone to the damage of frosts, because the rugged topography or because of the terraced slopes that create the air turbulence that hinder the formation of layers of cold air. Frosts are highly detrimental to crops, especially the early ones (September-October) which affect fertilization in corn and destroy the developing pods in beans, and the late ones (April -May) which affect the flowering process in some fruit trees, *i.e.* peach (Contreras-Arias and Baldovinos, 1954: 22, 34). The high intensity of rains is another meteorological phenomenon that has detrimental effects on agriculture, because they are a significant factor in the erosivity of soils. The summer rain showers are recognized as having a high erosive power, especially upon the susceptible soils of the piedmont, due in particular to the large size of the drops and their intensity (Figueroa-Sandoval, 1975). The most critical time of soil removal by intense precipitation is the beginning of the rainy season when soils are not saturated, so that unbound particles are easily removed by splash and overland flow, as demonstrated in experimental work in central Mexico (Palacio-Prieto and Vázquez-Selem 1990).

Prolonged rains, locally called *temporales*, are derived from hurricanes or tropical disturbances developed in the adjacent oceans more commonly towards the end of the summer. The amount of rain water that hits the ground during these *temporales* is such that exceeds the capacity of infiltration of soils and other surfaces materials such as the *tepetate*, resulting in an increase in runoff and water in the watersheds that usually have destructive effects such as landslides and gullying.

There are 11 fluvial basins in the area. All of them drain into the bed of Lake Texcoco, except for the southern streams that drain into the Chalco Basin (Figure 2.3). Variations in stream discharge depend on rainfall, since all the streams have an intermittent regime; during the

Figure 2.3 Fluvial network of the study area, showing location of climatic and gauging stations indicated by squares and triangles, respectively.


San Juan Teotihuacan
Papalotla
La Grande
Xalapango
Coaxacuaco
TEXCOCO
Texcoco
Chapingo
San Bernardino
Santa Mónica
El Tejocote
Coxtitlan
Coatepec
600
700
800
900
1000
2300
2500
3500
0
5
10 Km
Meteorological stations
Isoyeths in mm
Gauging stations

summer discharge increases as rains begin, reaching a peak during the wettest months, and declining at the beginning of the dry period. As the dry season advances, discharge decreases to the point that riverbeds become virtually dry.

TABLE 2.2
VOLUME PER YEAR OF WATER AND SILT IN SUSPENSION OF RIVERS IN THE TEXCOCO REGION (AFTER SANDERS 1976, TABLE 7).

River	Station	Period of observation	Average volume of water (in thousands of cubic meters)	Average volume of sediments (in thousands of cubic meters)
San Juan Teotihuacan	Tepexpan	1962-66	3,197*	7.525
Papalotla	La Grande	1962-66	7,727	55.280
Xalapango	Atenco	1961-66	1,468	8.203
Coaxacuaco	San Andrés	1961-66	2,997	26.214
Texcoco	Texcoco	1961-66	1,842	11.077
Chapingo	Chapingo	1961-66	1,687	18.834
San Bernardino	San Mateo	1961-66	2,290	21.416
Santa Mónica	Tejocote	1961-66	2,088	19.955

* This figure does not include water draining form the springs at San Juan Teotihuacan - approximately 18,000,000 cubic meters per year.

The Papalotla river has by far the largest discharge per year, and a more permanent flow of water, although the intensive use of springs depletes its flow during the dry season, which is the case of other spring-fed streams like the Coaxacuaco river.

The annual hydrological regime of the Texcocan streams is highly variable from year to year depending on rainfall, as appreciated in the plot of monthly maximum discharge of three rivers in four consecutive years (Figure 2.4). Although usually concentrated in the late summer, peaks occur at any time during the rainy season, sometimes showing no consistent trends between the basins. Over longer periods of time, variations in discharge are more evident, as displayed in the time series plot covering a period of 35 years (Figure 2.5). In both diagrams it is clear that river basins respond to the same extreme climatic events, although the comparison between a small basin (Santa Mónica) and a large basin (Papalotla) points out that in the latter the climatic events are more pronounced. On the other hand, there is a cyclic pattern in the recurrence of extreme climatic events, probably of 12 to 15 years, as shown by the 3-year running mean (Figure 2.5). To know how this pattern illustrates the trend of extreme climatic events in a longer term more data are needed.

The intermittent character of the stream flow seems to be recent, since there are references that account for a

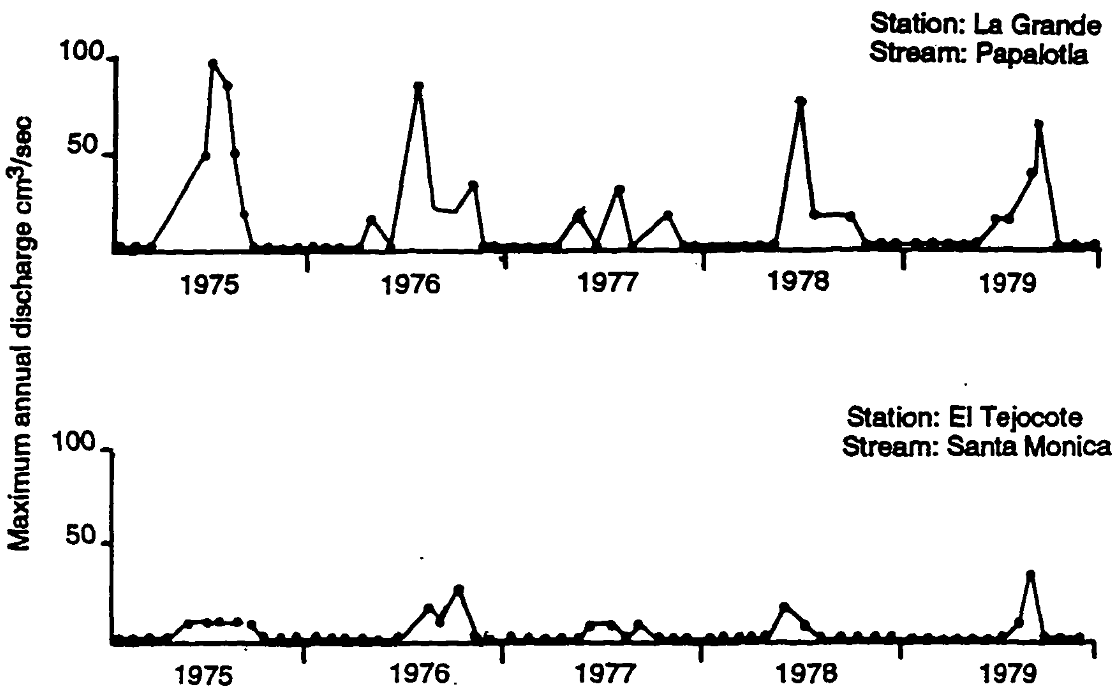


Figure 2.4 Plot of monthly maximum stream discharge for the four year period 1976-1980 at La Grande station (2.4a) on the Papalotla River, and El Tejocote (2.4b) on the Santa Monica River. Source: Torres-Ruata (n.d.).

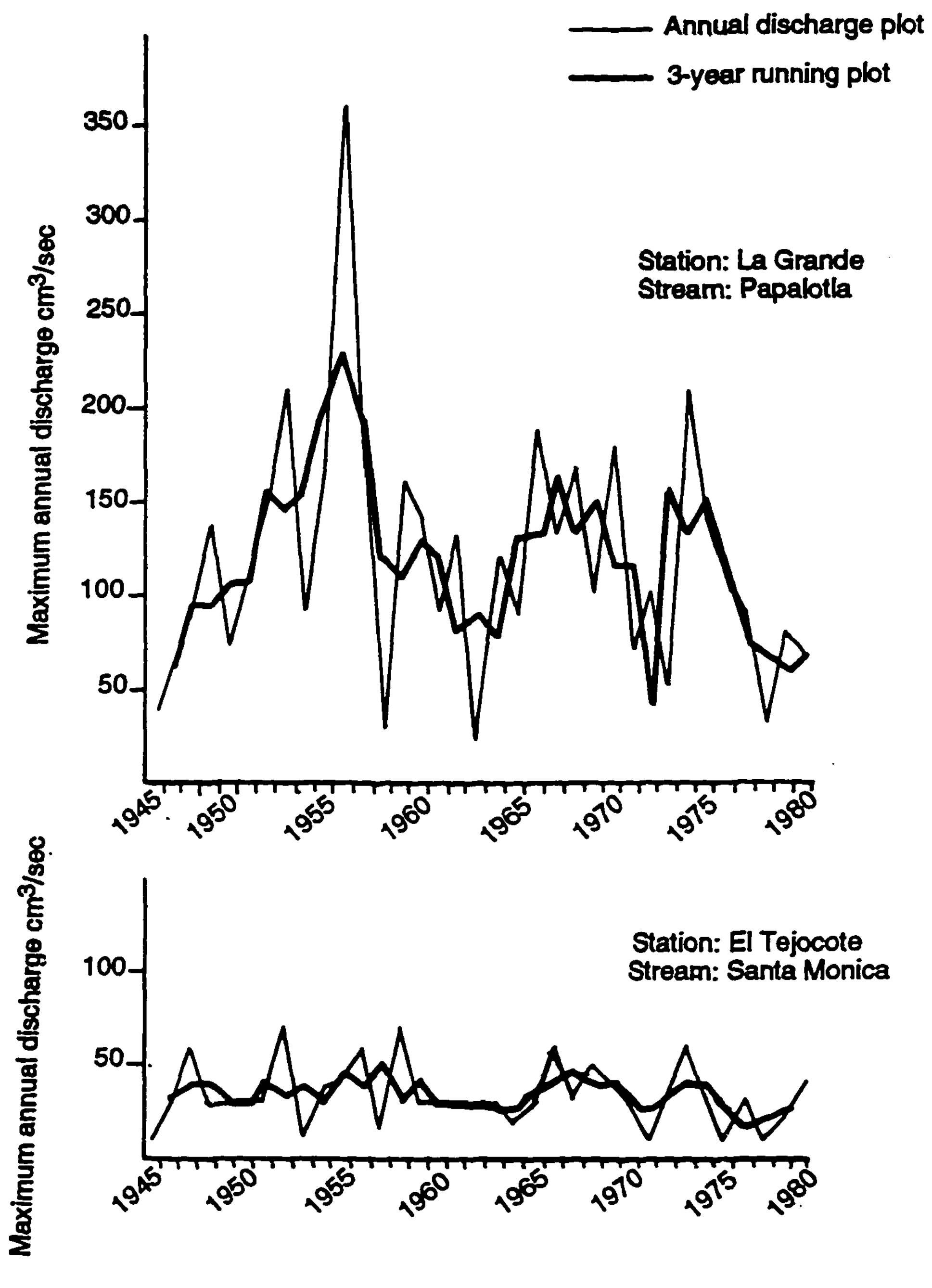


Figure 2.5 Time-series plot of the maximum annual discharge, and a 3-year running average for three gauges on the Papalotla river at La Grande station (2.5a), on the Texcoco River at Texcoco station (2.5b) and at El Tejocote on the Santa Monica River (2.5c). Source: Torres-Ruata (n.d.).

more permanent flow of water; Ixtilxochitl (1975, 1977) in numerous occasions alludes to the irrigation of gardens in the Aztec period, near the lakeshore. In Early Colonial times, the land grant documents (mercedes) mention numerous grants for irrigation tapping water from rivers, and for the establishment of gristmills (Colín 1967). Two possible causes may have depleted the flow of water in the Texcocan rivers, one may be the increase in water being tapped for irrigation from the springs, and the other may be the drop of the water table due to deforestation and excessive ground-water pumping. The network of canal irrigation, especially in the piedmonts, reported by Palerm and Wolf (1954) and by Sanders (1976) is mostly fed by springs, and in the plains by pumped water.

The volume of sediment per year (Table 2.2) is almost directly proportional to the volume of water per year, but still is relatively high for most of them, like in the case of the Papalotla. Its basin drains large tracts of eroded lands of the upper piedmont, and that can be equated with the incredible size of flood deposits in the past.

Vegetation and land use

The mosaic of primary and secondary plant communities largely reflects the distribution of soils, lithology, and elevation, as well as the history of settlement and land use. Each ecological zone displays a particular vegetation assemblage. Vegetation distribution patterns in the Texcoco Region form an altitudinal gradient that goes from mountain pine forest, mixed with other conifers (*Abies*, *Cupressus* and *Juniperus*) or with broadleaf trees (*Alnus*, *Quercus*), to shrub and grasslands in the piedmonts combined with cultivated land that extends down to the alluvial plains (see profiles in Figure 2.2). There are eleven vegetation types recognized by Rzedowsky (1975, 1978), some of which are original and slightly modified, such as the fir and pine forest. But for the most part they are secondary communities such as the oak and juniper scrub, or they are simply managed environments like grassland (*pastizal*). A description of each type and their main species presents an overview of the geobotanical relationships that will be re-assessed in the palynological study in Chapter 7.

Pine Forest

Although highly disturbed by human activities, the pine forest thrives in the Sierra Nevada between 2500 and

3100 m. Mean annual temperature of this altitudinal range fluctuates between 5° and 13.5°C, and mean precipitation fluctuates between 700 and 1200 mm. The most common species of pine are *P. montezumae*, *P. rudis*, and *P. leiophylla*; at highest elevation, at the upper limit of forest, *P. hartwegii* is associated with alpine grasses. The associated arboreal species of the pine forest are *Alnus firmifolia* (*aile*) and *Abies religiosa* (fir); shrubs in the lower strata are commonly *Alchemilla* sp., *Archibaccharis* sp., *Senecio* sp. and *Arbutus* sp.; the grasses present in the community are *Festuca* sp. and *Muhlenbergia* sp.

<u>Fir Forest</u> (*Bosque de Oyamel*)

Firs are always associated with the pine forest, as mentioned before, although they may be found forming a single community on those slopes with deeper soils and retaining more moisture, usually facing north. *Abies religiosa* is present between 2700 and 3500m, having associated sub-arboreal species similar to those of the pine forest. *Alnus firmifolia* may be found as an abundant component of these communities, being sometimes a successional phase in the re-establishment of damaged fir forest (Rzedowzky 1978: 356). In terms of both temperature and precipitation, fir has more requirements than pine forests.The *Abies* communities thrive in areas of annual temperature between 7.5 and 13.5 °C, and annual precipitation between 1000 and 1400 mm.

<u>Alder Forest</u> (*Bosque de Aile*).

The species of *Alnus* present in the area are either associated with pine forest, or with successional phases of the fir forest, in isolated locations, or thriving along streams at lower elevations. The species reported in the study area is *A. firmifolia*. The ecological requirements of the alder forests are deep and moist soil, for which reason they usually form the so called gallery or riparian forest along streams where they are associated with *Fraxinus* and *Salix*.

<u>Oak and Oak-pine forest</u>

The communities of *Quercus*, once more extensive, occupy similar habitats as *Pinus*, with a maximum of precipitation near 1000 mm. In elevations higher than 2500 m the species of oaks are *Q. laeta*, *Q. desserticola*, and *Q. obtusata*, occupying the same areas as *P. leiophyilla*, *Arbutus* sp. and *Cupressus lindleyi*. At higher elevations, up to 3100 m, the dominant species are *Q. rugosa* and *Q. laurina*, and associated species of *Arbutus* and *Abies*. More open communities of oak on piedmonts and volcanic hills include *Q. microphylla* and *Q. mexicana*. At lower elevations, that is to say areas of the upper piedmont and hills, there are isolated oak trees that may account for a once more widespread community in the past, a problem that will be discussed in Chapter 7.

Juniper Forest

This is an open community that can hardly be recognized as a forest, since junipers in the study area occur frequently as isolated individual in pastures, cultivated fields, oak forests and xerophytic scrubs. However, it is one of the arboreal species present in most ecological units; it is more common in the upper piedmont, but it is also found in hills and mountains, ranging between 2450 and 2800 m. Juniper is a tree that grows in areas of annual temperature between 11° and 14°C; it is highly-drought tolerant, usually growing within the range of 600 to 800 mm of annual precipitation. It has no preference for soils, although it is more likely to be found on very thin soils with and low moisture, very commonly found in the harsh environment of the barren tepetate surfaces on the eroded areas on the upper piedmont.

Juniperus deppeana is the most common species of juniper in the study area, and is considered to be a successional community established after the destruction of pine and oak forests (Rzedowsky (1975: 109). *Juniperus flaccida* is another species that is found at higher elevations as a successional element in the regeneration of fir forests.

In the study area junipers succeed on eroded areas and in general are associated with perturbed arboreal communities at different altitudinal levels. Based on this observation, it seems possible the fact that junipers are a good indicator of human impact on the environment, a point that will be discussed in Chapter 7.

<u>Oak scrub</u> (*Matorral de Encino*).

This is a low shrub-size community of oak, dominated by *Q. microphylla*. It is found in elevations between 2350 and 3100 m, on thin soils, and precipitation ranges between 700 and 900 mm, and mean annual temperature between 9° and 13 °C.

There are few species associated with oak in this community, being the most important species *Nolina parvifolia* and *Rhus standleyi*. The oak-scrub seems to be a community induced by fire on areas that formerly had pine and oak forest (Rzedowsky 1975: 109). Although this oak scrub seems to be a human-induced community, its localized character does not qualify it as a solid indicator of human disturbance.

Grassland or pasture (*Pastizal*)

Most of the pasture areas of the piedmont are are the result of fire and grazing. There is no definite boundary between pastures and other communities such as thorny scrub and oak scrub. Pastures occur also as isolated patches in surfaces of barren tepetate. They are usually found at an elevation between 2300 and 2700 m, occupying areas of the upper and lower piedmont, and volcanic hills. One of the dominant sepecies in this community is *Hilaria cenchroides*, which is accompanied by *Abildgaardia mexicana*, *Bouteloua radicosa*, *B. Hirsuta* and *Stevia serrata*.

In the alpine summits of the Sierra Nevada, above the pine forest, in areas between 4000 and 4300 m of elevation there are extensive communities of alpine grass known locally as *zacatonal*, characterized by tall and hard grasses. The dominant species of this community are *Muhlenbergia repens*, *Festuca myuros*, *Deschampsia pringlei*, *Cyperus sesleroides* and *Carex peucophila*. Below 4000 m these grasses appear in areas where pine forest has been destroyed by fire. Areas of intermontane valleys at high elevations with more soil moisture are characterized by meadows with the predominance of *Potentilla candicans*.

Xerophytic scrub (*Matorral xerófilo*)

Under this designation different types of mainly thorny plants can be grouped. The most widespread association of this type is the scrub, which contains species such as *Opuntia steptacantha* (*nopal*, or prickly pear), *Mimosa biuncifera*, *Zaluzania augusta*, *Cassia laevigata*, and *Eysenhardtia polystachia*; isolated elements of *Quercus* and *Juniperus* are found in some areas within this community. *Schinus molle* (pirul), a South American tree introduced in central Mexico during the Colonial period, grows wild in this community and has become a dominant element. Pirul also grows in urban areas, along river and canal courses, and streets in the piedmont and alluvial plains. Another element associated with this community, growing near or in stream beds is *Buddleia cordata* (*tepozan*), that grows also in other areas, such as the oak forests in the mountains, or along canals in the alluvial plain.

The xerophytic scrubs cover most of the slopes of volcanic hills and some areas of the upper piedmont, usually associated with thin soils, eroded areas, and fallowed and abandoned fields; as observed in the study area, the abundance of *Opuntia* sp. is remarkably indicative of archaeological sites.

This is therefore a secondary community in areas that probably once sustained an open oak forest that were subsequently cultivated, inhabited, or grazed. In regard to this point, Salas-Pulido (1982) reports species of *Quercus* surviving within a thorny scrub community in the volcanic hills of Tezcutzingo; as an interesting fact, oaks survive in those slopes that are more inclined and less attractive to human activities.

Halophytic vegetation (*Vegetación halófila*)

This community is characterized by grasses that grow in the salty and alkaline soils of the lacustrine plain at an elevation lower than 2500 m. There are two predominant grasses in this community, *Distichlis spicata* and *Eragrostis obtusiflora*, which form short and dense grass covers. These two species are physiognomically similar, although they rarely live together (Rzedowsky 1975: 114). Other frequent halophytes are *Atriplex linifolia*, *A. muricata*, *Sporobulus pyramidatus*, and *Suaeda nigra* (*romerito*).

Aquatic and subaquatic vegetation

There are two areas with this type of vegetation, one is the riparian communities along streams, and the other the cattail dominated communities around ponds in the lacustrine bed. The former is composed of arboreal elements as *Salix bonplandiana*, *Taxodiun mucronatum*, and *Alnus glabrata*, and shrubs of *Baccharis glutinosa*. Submerged in the streams are species of *Juncus*, *Carex*, and *Agrostis*.

The original aquatic and subaquatic vegetation of the lake bed has almost disappeared. In very few areas, usually within the protected areas, are still found the genus *Typha* (cattail) especially in artificial canals with sluggish water, where it is found with the floating *Lemna gibba*.

Reforested areas

Although usually considered as a plant community, the cultivated forests of recent origin are worthy of mention, practically because they now cover extensive areas in the upper piedmont, usually those former barren surfaces of tepetate where soils were severely eroded. The 'Secretaria de Agricultura and Recursos Hidráulicos' (SARH), a government agency, through the 'Comisión del Lago de Texcoco', initiated a program of reforestation in the early 1970s on the erosional belt of the upper piedmont of Texcoco. The procedure was to break the tepetate with machinery and create terraces where the trees were placed. Whether or not this was the correct procedure to reduce erosion and sediment yield, large areas of the piedmont now have communities of several species of *Pinus*, *Cupressus*, and more abundantly the alien *Eucalyptus*.

Modern settlements

The modern settlement pattern consists of nucleated towns and a few semi-dispersed settlements, which have their origins in the restructuration of communities during the Spanish Colonial period. Most of the largest towns lie on the remains of the former seats of the Aztec city states (*e.g.* Coatlinchan, Coatepec, Chiauhtla, Chimalhuacan, Tepexpan, Texcoco, and, only partially, Huexotla, among others). It is noticeable that clusters or bands of settlements are aligned along the interfluves between the main barrancas across the piedmonts and alluvial plains. The two most notorious bands are the one including Huexotla, San Bernardino Tlalmimilolpa, and San Pedro Chiautzingo; and the other that including Tequexquinahuac, San Dieguito, and Santa María Nativitas (Parsons 1971, 11). This settlement pattern seems to be the result of territorial extension of polities of Aztec times centered in the mentioned city states, that in this part of the basin, tended to stretch from the piedmont to the plains, perpendicular to the lakeshore.

The most common type of modern settlement in the area are nucleated towns, characterized by a lay-out of streets in a rectangular grid, if topography allows, and the administrative premises and church in the center. The semi-dispersed communities[1] still persist on the piedmont where their main characteristic is that houses are located within the terraced fields, usually irrigated (Wolf and Palerm 1955, 267). San Miguel Tlaixpan, San Jeronimo Amanalco, and San Pablo Ixayoc, are the best examples of these semi-dispersed communities, and although they follow the same rectangular pattern, in some cases the dispersion of houses located within fields may result in the fact that church, administrative building, and stores are located in the lower part of town (Perez-Lizaur, 1975). Recently, in the last 20 years, settlements called *colonias*, resulting from the sprawl of Mexico City, is appearing in the areas around the major cities in the alluvial and lacustrine plains. Large areas are being also covered by illegal settlers, or squatters, locally called "*paracaidistas*" (lit. parachutists), especially in the area around Chimalhuacan.

A comparative study of four rural communities in the piedmonts (Pérez-Lizaur, 1975), suggests that even though

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[1] The category 'semi-dispersed' is used in this report to denote those Colonial and Modern settlements on the piedmonts that still retain a dispersed character, though having the religious and administrative premises in the center. The category 'dispersed' is reserved to designate a specific category of prehispanic settlement in which houses are scattered over larger areas, and the communities lack administrative and religious architecture. It would be equivalent to what Sanders (1967) considers as 'scattered village' in which most of the crop subsistence is grown within the residencial area.

alarge part of the population is engaged in agricultural activities, there is movement of people out of the communities, that is balanced by the increasing birth rate and decreasing mortality rate. Also, people who were originally engaged in agricultural activities, now are turning to Mexico City for jobs. In most cases, given the fast means of transportation, people living in the towns of the alluvial plain and lower piedmont commute to the metropolitan area. Yet, inhabitants of some communities, although temporarily employed outside, are still engaged in horticulture; the cultivation of flowers has increased recently given the demand of this product in Mexico city. Most of the towns that are engaged in horticulture are located in the lower piedmont.

Another interesting phenomenon around the towns of the alluvial plain is the rapid growth of the adobe brick industry. The commercialization of bricks in the past two decades has been more productive than farming, which is an activity that in general in the entire country has been neglected, and continuously wiped out by economic crises. In the past few years, however, brick-making has declined, so that small *colonias* of workers are being developed inside the brickyard pits, that formerly were silty soils with high agricultural potential.

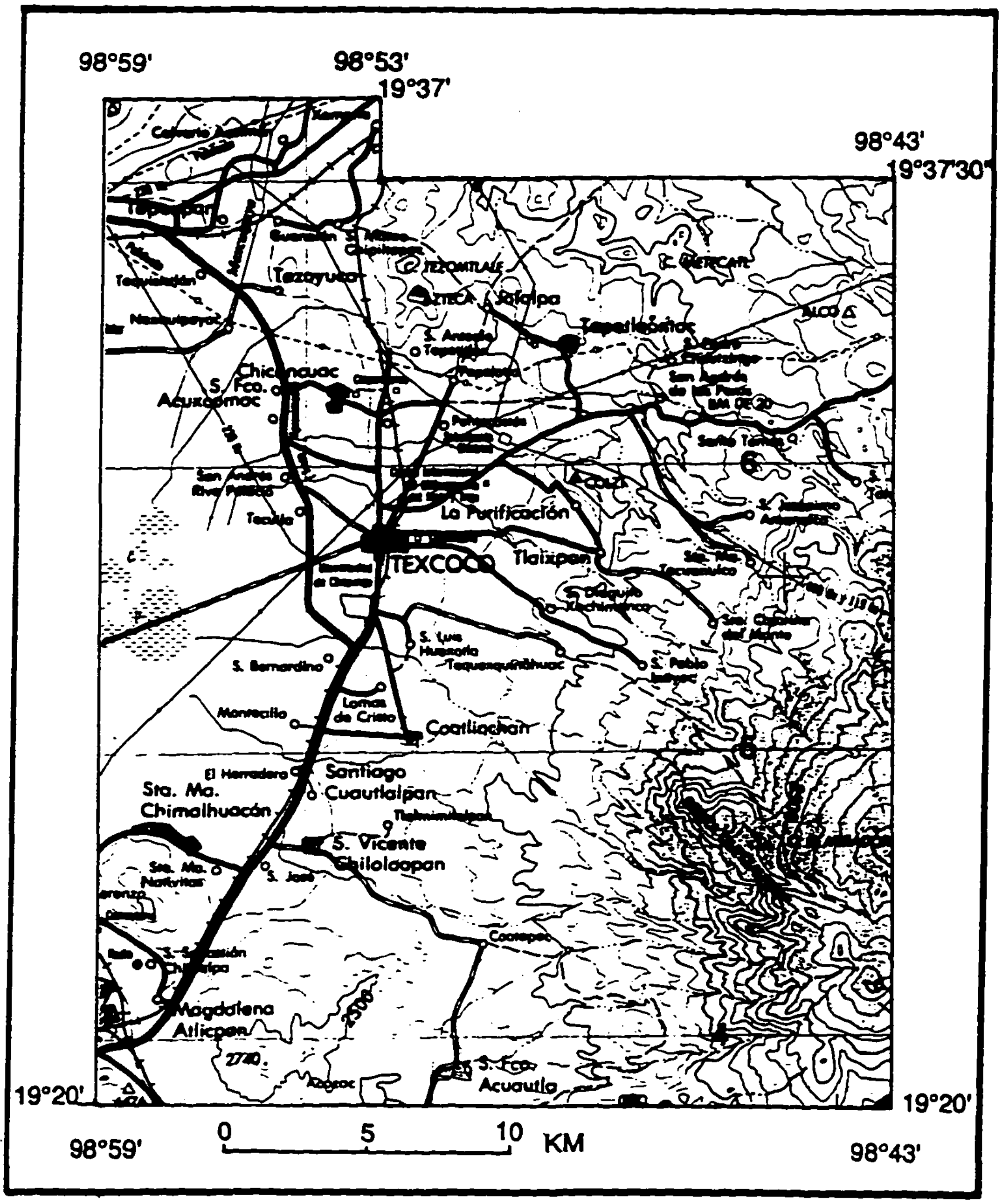


Figure 2.6 Modern settlements and roads. Source INEGI, Topographic map 1:250 000. Map in figure has been enlarged.

In terms of transportation, there are paved roads linking the towns and the area with Mexico City; dirt roads are still common in the mountains. The main access to the area is from the south, through the road of Los Reyes, from the north from the Teotihuacan Valley, from the east through the road that links Mexico City with Tlaxcala and Veracruz, and directly from Mexico City from the west through a toll road that runs across the lake bed. Settlements tend to appear and grow along these roads (Figure 2.6).

CHAPTER 3

RESEARCH METHODS

Geoarchaeological research strategy

The different problems to solve in this research required a strategy that combines methods of geomorphology, stratigraphy, historical geography and archaeology. An understanding of the processes of landscape reconstruction in relation to cultural development demands the establishment of a detailed chronology of cultural and environmental events based in the methodologies put in practice by Butzer (1981), Butzer *et al.* (1983), and Pope and Van Andel (1984) in the Old World, and by Butzer and Butzer (1993) and Frederick (1995) in the Central Mesa of Mexico. These methodologies involve the examination of cultural features of the landscape and its interrelation with soil and lithostratigraphic units, and a search of historical documentation.

The methodological strategy developed in this research has been adapted to the particular aspects of the environment and cultural history of the study area. Perhaps the most important environmental aspect is the rapid process of erosion and sedimentation due to strong physical variability caused by a steep altitudinal gradient. The cultural aspects include the materials available to interpret human history in the area, that is to say archaeological survey and excavation data and archival materials.

One of the basic data sets useful for the geoarchaeological research was the wealth of information produced by archaeological survey research projects, published by Parsons (1971), Blanton (1972), Sanders *et al.*(1979), and Evans (1980). Also, a look into field notes, sketches, and photographs taken during the survey, all of them provided by the Museum of Anthropology of the University of Michigan at Ann Arbor, greatly helped build a model of the evolution of the cultural landscape.

Field research

The initial step of field work was to locate the best sedimentary and soil exposures for stratigraphic study: brickyard pits and cut banks in incised streams. Since brickyard pits in the alluvial plain are the best places for a study of stratigraphy in a three-dimensional perspective, it was necessary to visit all of them. The search was facilitated by the use of aerial photographs, which in turn indicated were the incised streams were.

The criteria used for the selection of the stratigraphic sections were as follows: (1)long sequence of sedimentation or at least two visible aggradational cycles, (2) association with cultural features, especially occupational surfaces, and (3) availability of material suitable for radiocarbon dating, or at least diagnostic ceramics buried *in situ*.

At the same time it was necessary to find areas in the piedmont from where data useful for a chronology of soil erosion could be retrieved. The best places for this purpose are those having visible soil profiles and erosive landforms associated with cultural features. Thus, after an intense search on sites reported by Parsons (1971) five Aztec sites, containing also some remains of older occupations were selected, a task that was difficult since most of the original natural and cultural features have been obliterated through the process of bulldozer-leveling and reforestation that took place after the survey. Two sets of photographs were useful in this task, one at a scale 1:50,000 taken in 1956, and the other at a scale 1:35,000 taken in 1980. The area of the sites in the latter set of photographs had to be enlarged for a close appreciation of features and soils in the field. Using survey instruments, geomorphological plans and cross-sections for stratigraphic profiles were created.

Aerial photographs were also of immense help in the alluvial plain in the search for paleochannels, soil surface patterns indicating areas of recent sedimentation, and for the location of Early Colonial structures and sites.

An invitation to an archaeological excavation in a lacustrine site, El Tepalcate, opened the possibility to study the Late Quaternary lacustrine stratigraphy. This proved to be relevant to the objectives of this study because it provided insight into lake sedimentation, eolian processes and their possible correlation with regional climatic and human processes.

After finding the exposures and places where to record the information I began the second stage of field research which involved the description and sampling of stratigraphic sections in the alluvial plain and on the piedmont. The description of the sections consisted in the definition of zones, or discrete layers of sedimentary deposits and soil horizons, and the recording of the different characteristics of each zone: field texture, color, structure, reaction to HCl, roots and pores, and the designation of soil horizons; the drawing and photographing of the sections was a task that complemented the description. Soil and sediment samples for laboratory analysis were collected from the most relevant exposures; the sampling was done on each stratigraphic zone or horizon. Charcoal and humate samples for ^{14}C dating were also collected during description. The diagnostic ceramics were described, photographed, and drawn in place, and returned to the piles of pottery sherds where the brick makers accumulate the material that they find embedded in mud.

A parallel task carried out during field work was the search for Late Aztec and Early Colonial sites and features mentioned in archival documents. Among the features were irrigation canals, aqueducts and terraced fields.

The sampling of flowers for a reference collection of modern pollen was accomplished at the late stages of field work, at the time when I was re-visiting exposures to confirm my interpretations.

Stratigraphic information

The stratigraphic zones defined in each section were numbered from top to bottom using Roman numerals, and some times subdivided according to changes in facies by using lower case latin letters (a, b, c, etc.). This method of numbering layers contrasts with the traditional way used in geology, which consists in numbering from bottom to top, but it allowed sometimes to add more layers exposed in between field-work seasons as the brick makers dug down.

Also, a top-bottom numbering allows the adding of more information to the sections in the future.

In the designation of stratigraphic units I use capital letters ordered from bottom to top in the stratigraphy (A, B, C, D and E); where there were subdivisions I included an arabic numeral in subscript (*e.g.* B_1, B_2). Since most of the oldest non-consolidated alluvial deposits are Pleistocene, Unit A refers to everything older than 10 ka, which is not the focus of this research; B, C, D and E are Holocene units. Some of these units are separated by soil horizons designated with an S accompanied by an arabic numeral as a subscript only for chronological purposes. In order to include in the stratigraphic sections presented in this report with only the amount of information necessary, the soil horizons were not included except in the more detailed profiles of Chapter 5, in which horizons are indicated as recommended by the Soil Survey Staff (1992).

At the early stages of the interpretation of the alluvial sequences I tried to define formal allostratigraphic and pedostratigraphic units, but this method was not possible since the majority of the deposits studied comprise the last 3,000 years, so that there are no well developed soil horizons that might indicate limits in between the units. On the other hand, most units are of local occurrence so that they do not qualify for formal allostratigraphic units as established by the North American Code of Stratigraphic Nomenclature (NACOSN 1983). Nonetheless, an initial grouping of the stratigraphic units into possible formal allostratigraphic units is suggested in Chapter 6.

Laboratory analyses

Soils and sediments

Soils and sediments were treated as different categories of samples in terms of laboratory methods and techniques, since a different kind of interpretation was expected from them. Soils, on the one hand, required less detail in terms of particle size distribution, since only textural class is relevant. Alluvial, beach and eolian sediments, on the other hand, require a granulometric perspective in order to define specific depositional facies with different kinds of indices. In addition, some chemical and physical analyses are relevant only to soils (*e.g.* bulk density, organic matter, total phosphorus and soluble salts. All the soil analyses carried out in this research were intended to conform to the methodology and goals of the study of natural and cultural soils in a geoarchaeological perspective, as carried out in New Mexico and Peru by Sandor (1992), and Sandor *et al.* (1986a, 1986b, 1986c).

Most soil and sediment analyses were performed in the Geomorphology and Geoarchaeology Laboratory at the Geography Department of the University of Texas at Austin, with only the total phosphorus and soluble salts contracted to the Soils and Physical Geography Laboratory of the University of Wisconsin at Milwaukee.

Analysis of particle size distribution was carried out by means of sieve and hydrometer following Singer and Janitzky (1986) and Day (1965) for soils, and Tucker (1988) and Folk (1980) for sediments. Organic matter values were obtained through a modified Walkley-Black method using a photoelectric colorimeter for soils (Graham 1948), and by the method of organic carbon by loss on ignition (LOI) for sediments (Dean 1974).

Bulk density was determined on soils through the paraffin-clod method (Singer and Janitzky 1986), and was intended to differentiate natural and anthropogenic soil horizons. Total phosphorus was obtained by a digestion colorimetric method (University of Wisconsin, n.d.), and was applied to compare paleo-agricultural soils with their modern counterparts. Soluble salt values were obtained by the electric conductivity method (Rhoades 1982) and were used to determine traces of irrigation on ancient soil horizons. Thin sections of a few samples of Aztec agricultural soils isolated in pedestals by erosion were made by Spectrum Petrographics, and later were analyzed by Dr. Paul Goldberg, who looked at sorting and the existence of certain particles that helped characterize anthropogenic horizons so I could decide on the appropriate analyses to be performed.

Additional laboratory analyses included geochemical determination of the three volcanic ashes from three different sections in order to define the ash that in this work was identified as 'Pomez de Grano Fino'. The determinations were made by Bonder Clegg Inchape Testing Services. Trace elements (Sr, Nd, Sm and Rb) were obtained by X-ray fluorescence spectrometry, and major oxides (SiO_2, TiO_2 , $Al_2 O_3$, $Fe_2 O_3$, MgO, CaO, Na_2O, K_2O, P_2O_5, and Cr_2O_3) by the ECPM method.

Pollen analysis

The method of pollen extraction used on the sediment samples studied was adapted from the procedures used and recommended by Moore *et al.* (1991), Horowitz (1992) and Baghai (1996). The method was developed through trial and error and was fine-tuned to obtain a high quality pollen from alluvial sediments. The steps of the eventual method are described below.

Each sample consisted of 50 grams of air-dry sediment to which a tablet of *Lycopodium* sp. spores was added for monitoring of the processing and as a reference for the determination of pollen concentration. Although not necessary except for dissolving the *Lycopodium* tablet, the sample was then washed in 37% HCl and neutralized. The sample was then washed in approximately 20 ml of HF acid in a Nalgene® beaker, and after adding water it was let stand for six hours; afterwards it was neutralized by decanting approximately every two hours. Next the sample was transferred to four 100-ml test tubes, centrifuged, decanted, and placed into six 12-ml test tubes for heavy liquid separation with $ZnCl_2$ Heavy Liquid at a specific gravity of 1.98 which was added to fill the tube up to about 1 cm below the top, then stirred and centrifuged for 15 minutes. After the centrifuging, the supernatant liquid, which mostly contained organic matter and pollen, was saved in a 400-ml beaker full of water; from this beaker the residue was placed in 15-ml test tubes and centrifuged down in order to eliminate the $ZnCl_2$ and concentrate the sample residue for the next step which is pollen oxidation. This step consisted in dropping 5 ml of HNO_3 in each test tube, stirring for 15 seconds and filling it up with water, and then centrifuging for 4 minutes; the fill-up with water and centrifuging was repeated three times. The sample was next washed in KOH, exactly following the procedure for the HNO_3. The residue of this process was passed through a 10μm mesh sieve and stained with one drop of Safranin-O and centrifuged and decanted twice. The sample was stored in vials and later mounted on microscope slides using Cellusize and Elvacite to retain the cover slip. The process of slide mounting consisted of transferring by pipette one or two drops of water-suspended sample and a drop of Cellusize onto a cover slip with a drop of Cellusize, which was then dried on a hot plate at 37°-38°C. Thereafter, the cover slip was placed upside down on a microscope slide already covered with one drop of Elvacite. The slide was left on the hot plate at the same temperature for six hours to eliminate bubbles, which at low heat migrate from the center of the slide to the periphery.

Each sample consisted of 12 slides, from which I obtained the total pollen sum. Thus, each percentage refers to the amount of sample contained in all 12 slides, which is affected by the amount of sample in each slide. In order to overcome this problem, the value used for comparisons among the samples was pollen concentration, which in this case was calculated as number of pollen grains per gram of sediment (Stockmarr 1971) (see Appendix J, section II). In the diagram constructed and presented in Chapter 8, percentage of pine pollen was obtained from the total sum, while other groups of taxa were obtained from the total sum without pine. More detailed information and values of each sample is provided in Appendix J.

Radiocarbon assays

Except for the auxiliary use of ceramics and relative chronology, the main source of data to construct a chronological framework of the deposits was radiocarbon dating. The datable materials for radiocarbon were charcoal and humate fractions of soils or organic-rich sediments.

Pieces of charcoal were present in most alluvial deposits, but often only available in very low weights. The smallest piece weighed 2 milligrams, which only could be dated by an Accelerator Mass Spectrometer (AMS). For this reason 9 samples were submitted to the National Ocean Sciences AMS Facility (NOSAMS) of the Woods Hole Oceanographic Institution in Massachusetts; eight of the samples were pieces of charcoal and one was a fragment of an aquatic plant.

Another three charcoal samples were large enough to be dated by standard radiocarbon methods, and were submitted along with five soil humate samples to the Radiocarbon Laboratory of the University of Texas. The procedure of radiocarbon dating used in this lab is published in White and Valastro (1984).

Three of the humate samples showed dates inconsistent with their stratigraphic position. One soil humate date from an alluvial deposit (Tx-7779) dated older than it should, and two from a lacustrine sequence (Tx-7841 and Tx-7842) dated younger than expected. In the first case, the sample probably contained older soil organic matter or older clay-humus complexes. As discussed by Frederick (1995), pedogenically unmodified sediments, such as flood deposits, date organic matter that is assumed to have been suspended in the water column at the time of sedimentation, and therefore they are nearly always older than the flood event that deposited the sediment, not older than a thousand years, but often several hundred of years. For this reason, humate dating of young alluvial deposits is not recommended.

In the second case, where two dates came out younger when compared with the tephrachornology, they were probably contaminated with even younger material, since the sampling site was a wall in a well affected by fluctuating water levels and probably contaminated by sediment washed from the upper part of the section. Since the samples contained very little amount of charcoal it is possible that a small amount of contaminating charcoal may have affected considerably the date.

All Holocene ages were calibrated by two curves: OxCal/Cal.10 (Stuiver and Kra 1986) and OxCal/Cal.20 (Stuiver *et al.* 1993). These curves follow a probabilistic chronological method for which calibrated ages are given in ranges (*e.g.* A.D.880-990).

A summary of the radiocarbon assays, data, and calibrated ages is provided in Appendix E.

Archival research

As an invaluable source of information on the landscape, several written and pictorial documents of the Colonial period were located and studied. Although it was not possible to go through the incredible wealth of documentation available, certain groups and certain topics were selected to point out the details of environmental change in the entire region and in some specific locations.

The main body of archival documents studied were the Mercedes, or land grant titles of the Archivo General de la Nacion (AGN) in Mexico City. The entire collection was reproduced in microfilm by the University of California at Berkeley and acquired by Dr. Karl W. Butzer, who graciously loaned the reels corresponding to the study area. A guide to the documents with a summary of each title was published by Colín (1967) who helped find the location of documents in the reels. The reading of about 200 titles and requests for land and sheep *estancias*, allowed me to take notes on the descriptions of the landscape, including natural and cultural features used as hallmarks that were also mentioned in other contemporaneous documents and maps, information that helped me locate 111 of the 200 sites of the land grants and requests. The approximate location of the 111 land grant sites is presented in a series of maps in Chapter 4, and the information of each site is presented in an abridged form in Appendix A. The Mercedes documents were also incredibly helpful in tracking down Aztec sites that were abandoned or in the process of desertion, as well as providing clues to land degradation in the early years of the Colonial period, especially between 1560 and 1630.

Another valuable set of information was obtained from AGN documents of the *Tierras*, *Congregaciones* and *Bienes Nacionales* groups, some of them with accompanying maps. Excerpts of some of them with commentaries are presented in Appendices D and G. The documents are cited starting with the archive name, the *ramo* (e.g. Tierras, Mercedes, etc.), the volume (abbreviated as "v."), the *expediente* (abbreviated as exp.), and the *folio* (abbreviated as "f."). The maps attached to these documents are kept separate in the archive, so the catalogue number is indicated in the reference as it is assigned by the 'Centro de Información Gráfica del Archivo General de la Nación' (1979).

Another document added to the list was the Lienzo de Tequexquinahuac, a map of communal lands in the piedmont of Texcoco and Huexotla, dated 1609, that shows the rearrangement of communities after the depopulation of dispersed sites through settlement reductions or *congregaciones*. The maps of the *Relaciones Geográficas* (Acuña 1985-86) and the codices Xolotl and Mapa Tlotzin (Dibble 1980) were also among the most sources used in locating particular places and landscape features.

CHAPTER 4

SETTLEMENT HISTORY

Archaeological and historical chronology

Although this study focuses on landscape transformation in Aztec and Spanish Colonial times, it is necessary to consider the previous periods in order to explain the background of the Aztec cultural landscape. Thus, this chapter gives an abridged description of the most important aspects of site patterning and site hierarchy, extracted from the reports of the archaeological surveys, as a cultural background to the interpretation of environmental change in the Late Holocene.

The chronology used in this study is based on the phases established for the Texcoco Region Survey by Parsons (1971) with modifications. The equivalents in the broader chronology of the Basin of Mexico Project established by Sanders *et al.* 1979 are not mentioned in the text, but are indicated on the chronological table of Figure 4.1.

The two most important modifications to the chronology originally established by Parsons (1971) are the introduction of the new chronology of Postclassic ceramics

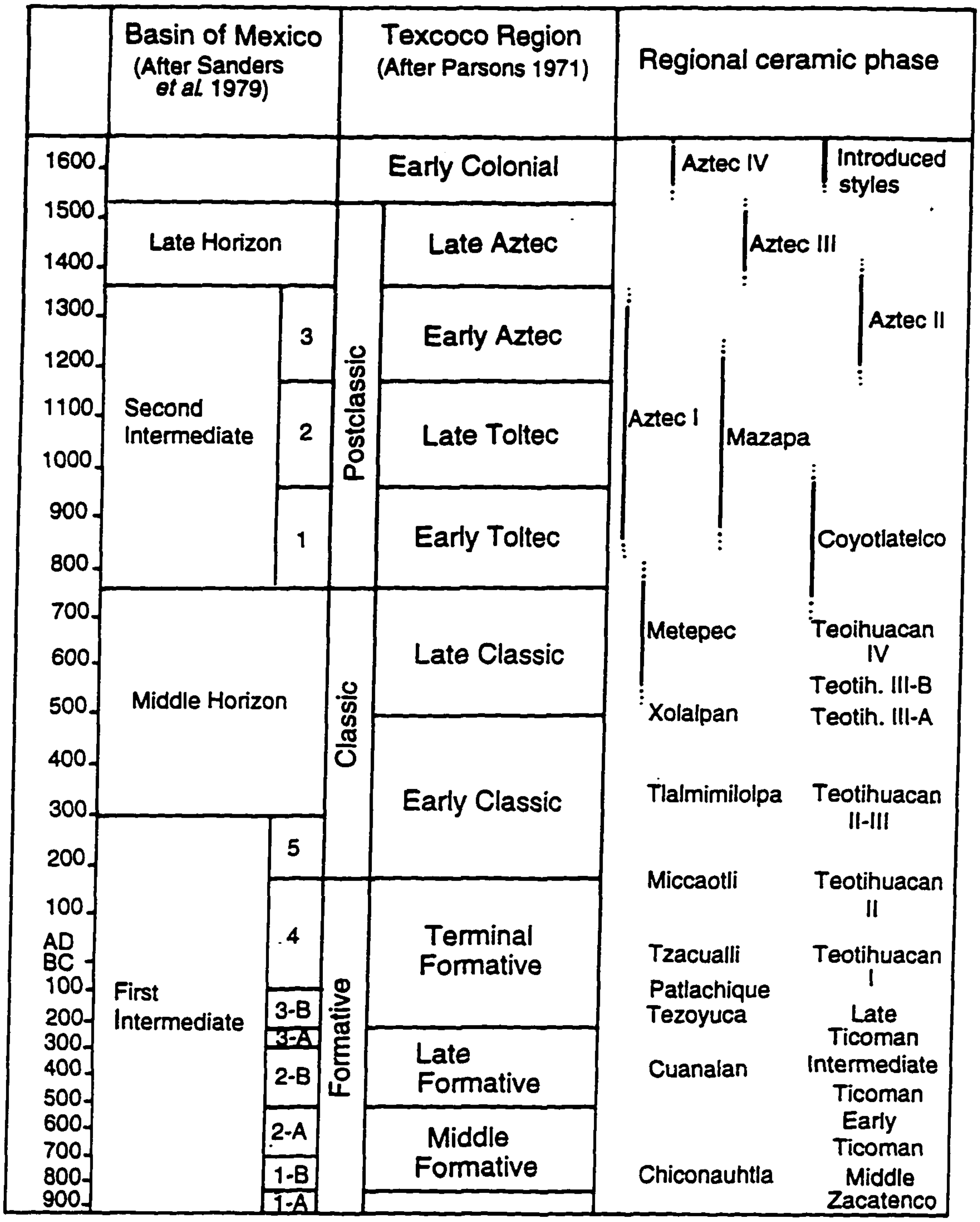


Figure 4.1 Archaeological chronology of the Texcoco region and the greater Basin of Mexico.

and the addition of the Early Spanish Colonial phase (Figure 4.1).

The new ceramic phases are based on ^{14}C dates and detailed analysis of form and decorative styles for the Postclassic and Early Colonial periods presented by Parsons *et al.*(1993), Hodge and Minc (1991), and Minc (1994), and for the Formative and Classic periods by Rattray (1991). Although there are subdivisions of some of the previous phases during the Preclassic and Classic, they have not been taken into account on the table, since their resolution is less precise. However, comments on relevant ceramic types of these earlier phases are made throughout the text and in the descriptions of some collections presented in Appendix I.

Two aditional phases were added to the cultural chronology: the Early Colonial (1520-1630) and the Late Colonial (1630-1821), divided arbitrarily according to criteria based on socio-economic transformations, as explained below. Of these two phases, only the former was mapped and indicated in Figure 4.1. The reason why they are also commented in this chapter is because the purpose of this research centers on the transformation of the landscape in the transition from Aztec into Spanish Colonial times.

The information contained in the pre-Hispanic site maps (Figs.4.3 to 4.12) has been taken from the archaeological survey maps of Parsons (1971), Blanton (1972), Sanders (1975), Sanders *et al.* (1979), and Evans (1980). The original content of the survey maps has been modified with additional settlement information generated through ethnohistorical research by Hicks (1982), Hodge (1994), and the present study. The settlement maps for the Spanish Colonial period are also the result of ethnohistorical research starting from description and maps contained in the *Relaciones Geográficas* (Acuña 1985-86) and from basic information compiled by Gibson (1964) and Gerhard (1982). The symbology used for Early Colonial settlement map is the same as that used for the pre-Hispanic sites maps, although the classifying criteria are different. The pre-Hispanic phases are based on both quantitative and qualitative criteria (Parsons 1971; Sanders *et al.* 1979), while the categories for the Early Spanish Colonial phase maps are based only on the qualitative descriptions of settlements and their appearance on maps.

Although the pre-Hispanic settlement maps are based on the original maps published by Parsons (1971) and Sanders *et al.* (1979), there are some modifications consisting of the simplification and grouping of some of

TABLE 4.1
SETTLEMENT TYPOLOGY AFTER PARSONS (1971) AND SANDERS ET AL. (1979).

Provincial or Regional Center		Large nucleated community with a population of 1000-10,000, with distinct civic-ceremonial-elite architecture.
Nucleated village		Community with light to moderate, or moderate concentrations of surface pottery*, little or no indication of ceremonial-civic-elite architecture.
Variants:	Large	500-1000+ people
	Small	100-500 people
Dispersed village		Community with generally light, occasionally light to moderate concentration of surface pottery. Indications of civic-ceremonial-elite architecture are rarely, if ever present present.
	Large	500-1000+ people
	Small	100-500 people
Hamlet		A residential community of fewer than 100 people. The settlements originally classified as encampments, especially as salt production sites, have been included in this category. Also, those settlements of the Early Spanish Colonial periods such as *estancias*, monasteries and *ranchos* have been included in this category.
Elite district		An isolated residential area with a high proportion of ceremonial-civic architecture.
Ceremonial center		A concentration of obviously ceremonial-civic architecture, and very limited occupational debris.
Ethnohistorical site		Late Aztec sites usually overlain by modern occupation known to be important centers in the historical sources.

Key to density of occupational debris:
1) Very light: a wide scattering of surface pottery, with single sherds visible only at intervals of several meters; 2) sherds distributed continuously, with single sherds at intervals of several centimeters; 3) light-to-moderate: a marked build-up of sherd density where sherds are visible everywhere. Some one-meter squares selected at random may yield roughly a count of 100 to 200 pieces of pottery.

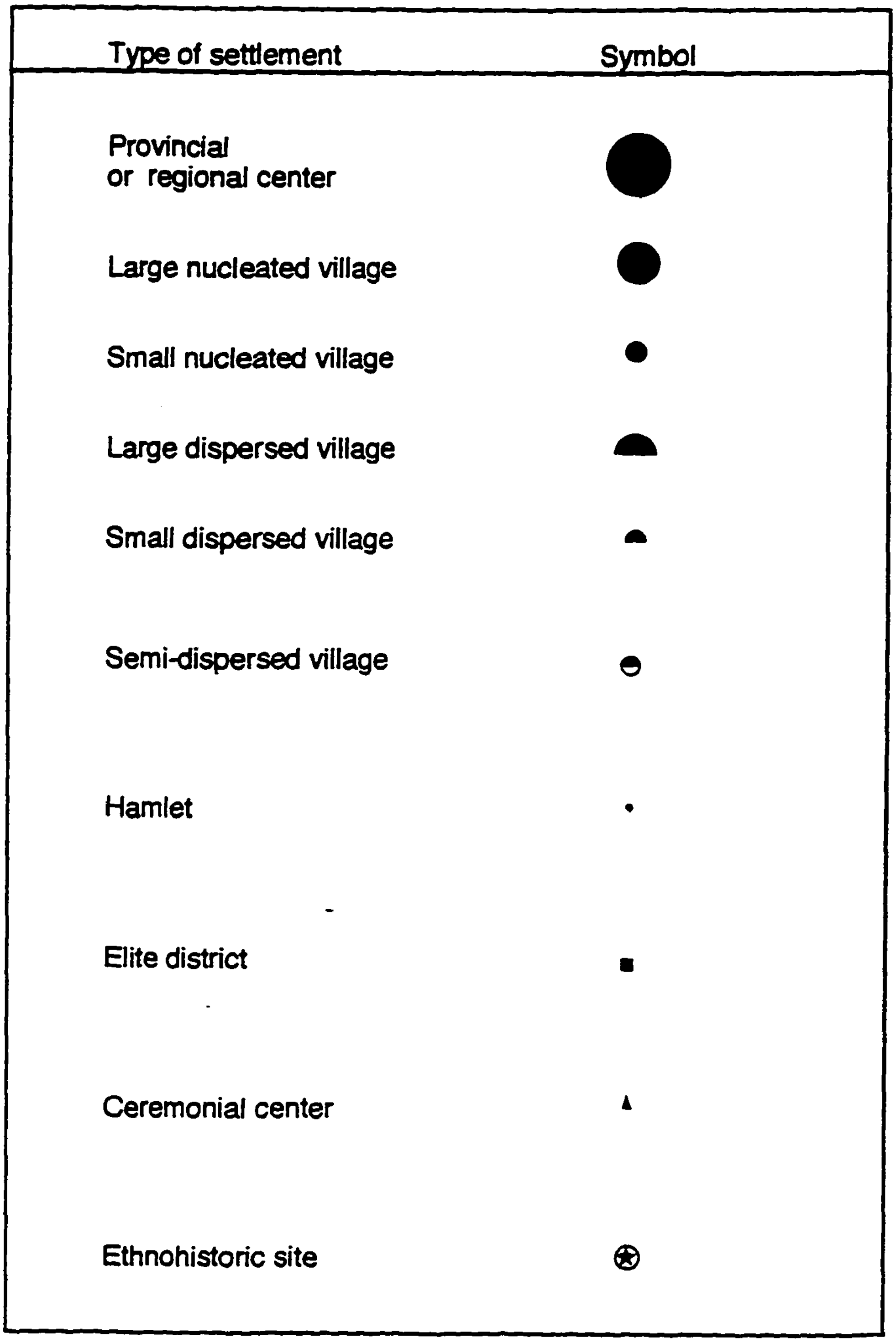


Figure 4.2 Key to the symbols used for the settlement pattern maps (Figures 4.3 to 4.12). Based on Parsons (1971).

the large, complex, high-hierarchy sites into Provincial Centers, and the creation of the "semi-dispersed village category", used only for the Early Spanish Colonial phase map (Figure 4.2, Table 4.1).

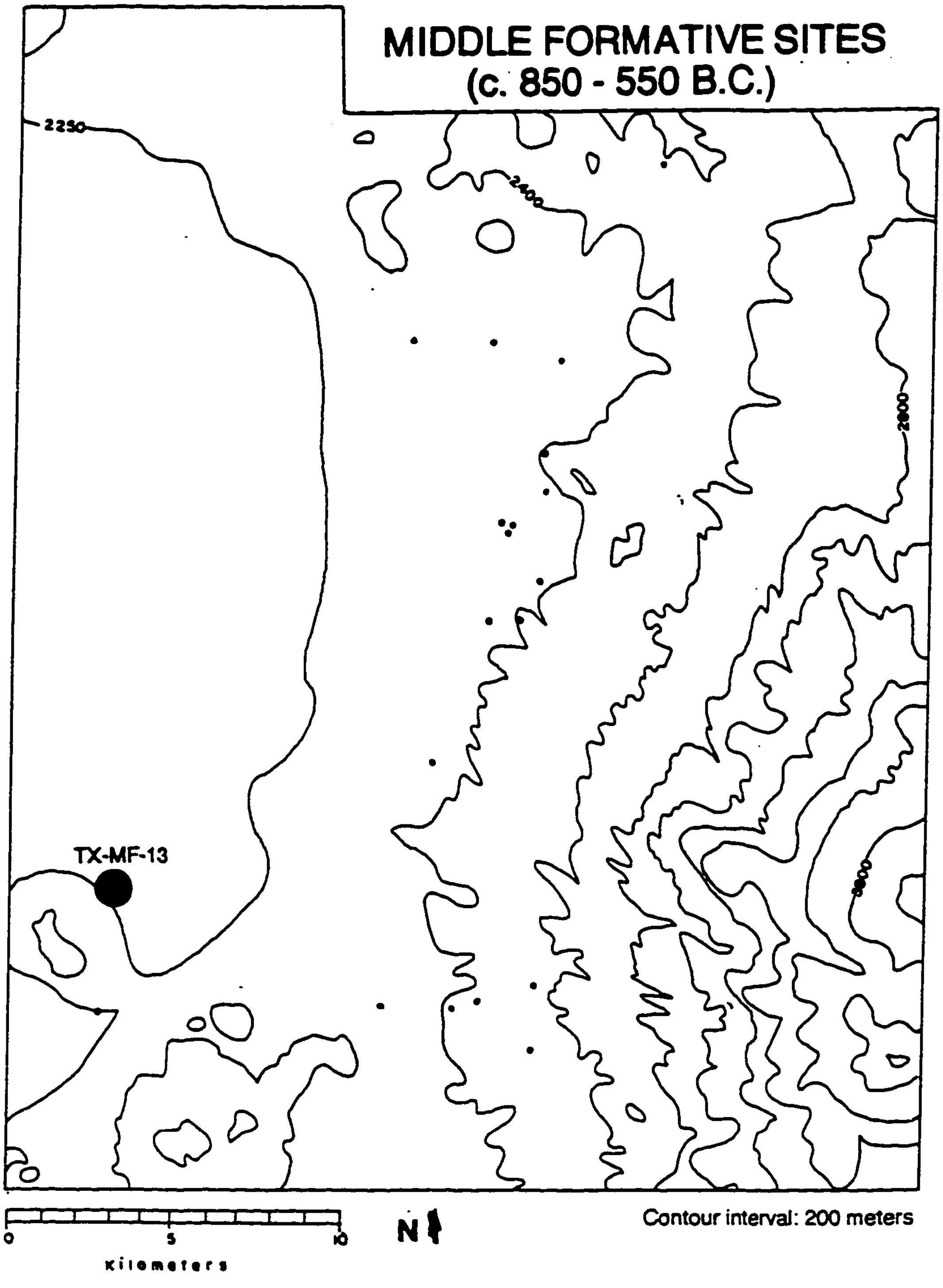
The pre-Aztec settlement

The Basin of Mexico has a long history of human occupation that dates back to the Late Pleistocene, but the most relevant archaeological periods in terms of human-induced landscapes encompass the time during which farming communities took over, that is to say the last 3,500 years. The archaeological survey maps provide us with information about settlements of the last three millennia, starting in what in the Basin of Mexico Chronology is known as the Early Horizon (1400-900 B.C.) or Early Formative. In the Texcoco region, however, the chronology starts with the Middle Formative ca. 850 B.C., since sites of previous periods were absent on the surface, and subsequently not recovered by survey. This absence of sites by ceramic-making peoples is also apparent in the northern half of the Basin, a situation that leads archaeologists to think that at that time the drier northern portion of the Basin was occupied by hunter-gatherers, a problem still to solve in the archaeology of the Early Formative of the Basin of Mexico (Parsons, 1989: 166). However, the lack of sites of this phase in Texcoco may not be the result of absence of sedentary communities, since there is a high probability that such sites are buried under several meters of alluvium, or destroyed by further occupation or erosion on the piedmonts. However, in the lake bed, where there is no important Holocene sedimentation, there were no sites reported.

Middle Formative (*ca.* 850-550 B.C.)

This is the first period recorded in the survey of the study area, and the earliest period with significant occupation in the Basin of Mexico (Parsons 1971). The Zacatenco ceramics, the distinctive style of this period, marks the cessation of the use of Olmec decoration, keeping designs of other parts of Mesoamerica (Blanton *et al.* 1993). In the Texcoco and Teotihuacan regions the Middle Formative is still a period characterized by a small number of sites. This is in contrast with the Chalco and Xochimilco regions where population levels are higher (Parsons *et al.* 1982). The Middle Formative period in the Texcoco region is represented by 19 small, scattered hamlets and a single nucleated site (Tx-MF-13)(Figure 4.3). Located near the modern town of Chimalhuacan, Tx-MF-13 is estimated to have two thirds of the total Middle Formative population of the Texcoco region (Parsons, 1971:180). The NW corner of the study region, in the lower Teotihuacan

Figure 4.3 Middle Formative sites in the Texcoco region. For this and all settlement maps of this chapter refer back to base map (Fig. 1.1) to see location of study area in the Basin of Mexico, and study area map (Fig. 2.1) to see ecological zones.



MIDDLE FORMATIVE SITES
(c. 850 - 550 B.C.)
2250
2400
2800
3800
TX-MF-13
0
5
10
Kilometers
N
Contour interval: 200 meters

Valley is characterized by a total absence of sites of this period. By the observations made in this study, there is the possibility that such sites are buried by recent alluvial sediments.

In the central and southern parts of the Texcoco region, 16 of the 20 Middle Formative sites are located on the lower piedmont where they are evenly distributed. This preference for the lower piedmont, that prevails through the Terminal Formative period, probably indicates the suitability of soils for agriculture on an economy based on rain-fed agriculture, perhaps combined with hunting in the upper piedmont and mountain forests.

No valid interpretations can be made for the distribution of sites of this period on the plains, due to the already mentioned of site visibility and distribution during survey. Therefore, only the distribution of Middle Formative sites on the piedmont may show a more valid picture of the relative location and distribution of the small farming communities of this period. As in other regions of the basin, there is a preference for the site location on the lower piedmont. The lake bed and lakeshore of Texcoco are basically unoccupied, which is not the case in other areas such as the southeastern foot of the Sierra de Guadalupe and the lacustrine area of Lake Chalco.

Late Formative (*ca.* 550-250 B.C.)

The most salient characteristic of this period is the substantial population indicated by both the appearance of new sites and the growth of preexisting sites (Figure 4.4), a trend that was experienced by most regions of the Basin of Mexico. This expansion is marked by the appearance and spread of the Ticoman ceramic tradition. Another significant characteristic of this period is the emergence of civic-ceremonial architecture, and the formation of a clear hierarchy of settlements (Parsons 1971). In the northern part of Texcoco, and in the Teotihuacan Valley, site distribution indicates a specific form of site hierarchy in which administrative centers on isolated hilltops were segregated from agricultural villages. Although these sites were originally assigned to the next phase, the Tezoyuca ceramic phase, it is probable that they are associated with the Ticoman ceramics of the Late Formative period. The fact that the Tezoyuca hilltop ceramics do not appear in the agricultural Ticoman sites of the surroundings, suggests that both, Tezayuca and Ticoman, may have been contemporaneous. The former perhaps being used by the elite while the latter was used by the peasantry. However, excavations and ^{14}C dates are needed before a secure placement of the Tezoyuca hill-top centers in Ticoman times is possible(Blanton *et al.* 1993, 115).

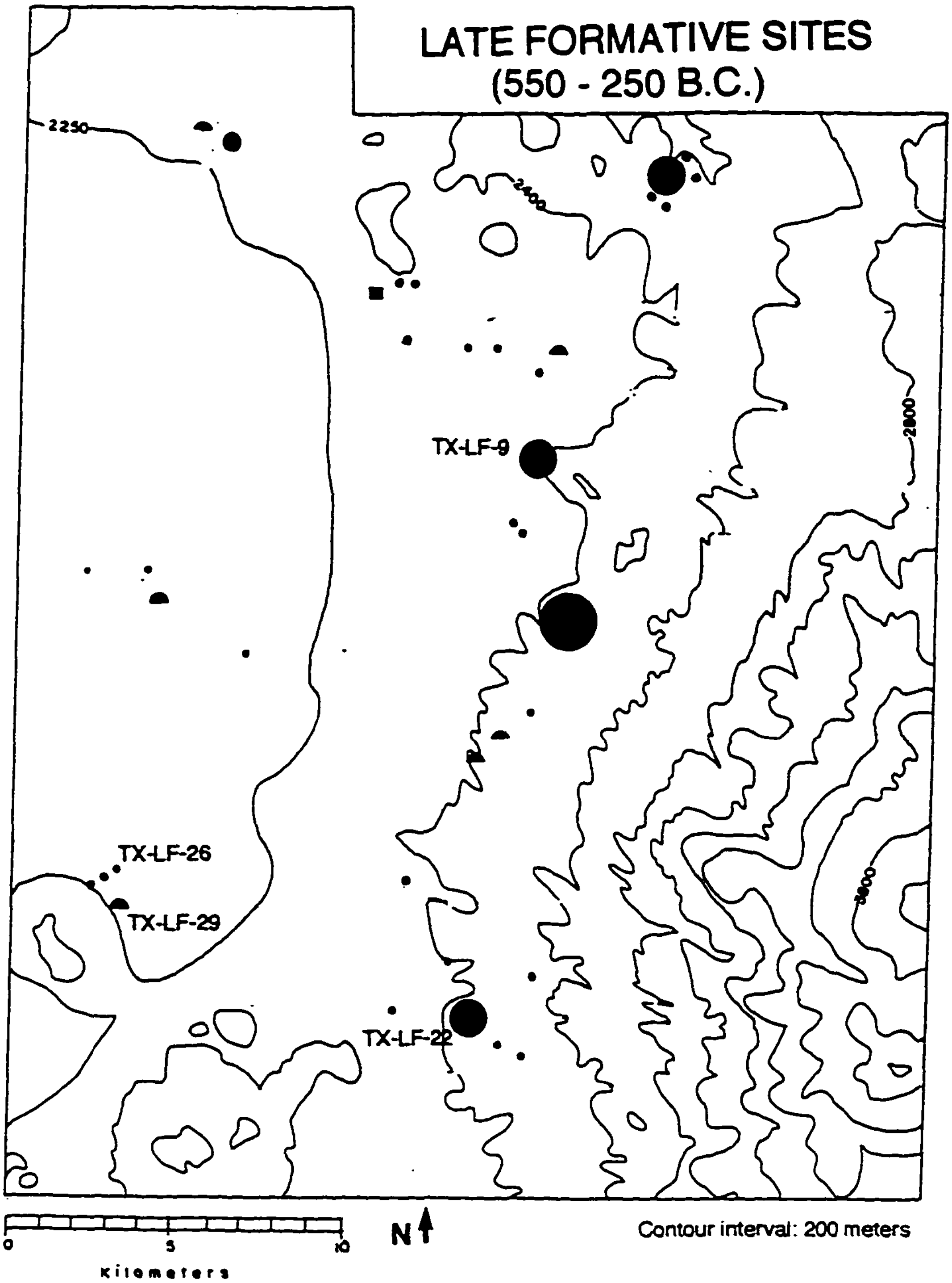


Figure 4.4 Late Formative sites in the Texcoco region.

In the central and southern parts of the Texcoco region, the existence of scattered sites in the lower piedmont prevails through this period. Sites tend to cluster together in two areas: one being around the volcanic hills of Tezcutzingo, and the other in the vicinity of the modern town of Tepetlaoztoc (Figure 4.4). New sites appear in the previously non-inhabited saline lacustrine plain, probably representing residences of people seasonally specialized the exploitation of lacustrine resources (Sanders *et al*. 1979: 98). One explanation of the evident colonization of the lake bed during both this and the next period lies probably in the fact that lake levels were low, which opened space for settlement and activities such as salt making and bird hunting. This is an hypothesis that is the basis of the case study presented in Chapter 8.

Late Formative sites are, in general, more diversified. There is a relative coexistence of both dispersed and nucleated sites, with the former slightly prevailing. Four of the nucleated communities --Tx-LF-9, Tx-LF-12, Tx-LF-22, and perhaps TX-LF-29-- were discrete regional centers, each with a hinterland of dependent and dispersed rural population. Such a configuration suggests the existence of independent political entities, probably at the level of chiefdoms (Parsons, 1971: 184). In the study area, this process seems to indicate the initiation of two trends: one toward the nucleation of larger sites, and the other toward the general dispersion of small sites on the hinterland that occupy two previously unoccupied ecological zones, the upper piedmont and the lacustrine plain.

The largest villages tended to occupy the lower piedmont. This may indicate that some kind of agricultural intensification, with the management of water and soils on slopes presumably implemented, at the time when some kind of short fallow agriculture was being conducted on the upper piedmont. Thus, the main socioeconomic change achieved during this phase was that farming became an important activity together with the concomitant exploitation of non-agricultural lacustrine resources (Parsons 1971:185). Pollen records of this period at Tlapacoya in the Lake Chalco Basin show an increase in cultivated plants, which seems to account for a remarkable expansion of agriculture into different areas previously unoccupied (Niederberger 1987).

Terminal Formative (ca. 250 B.C.- A.D. 100)

The patterning of settlements during this period indicates a much more complex regional organization (Figure 4.5). A more differentiated vertical hierarchy of sites

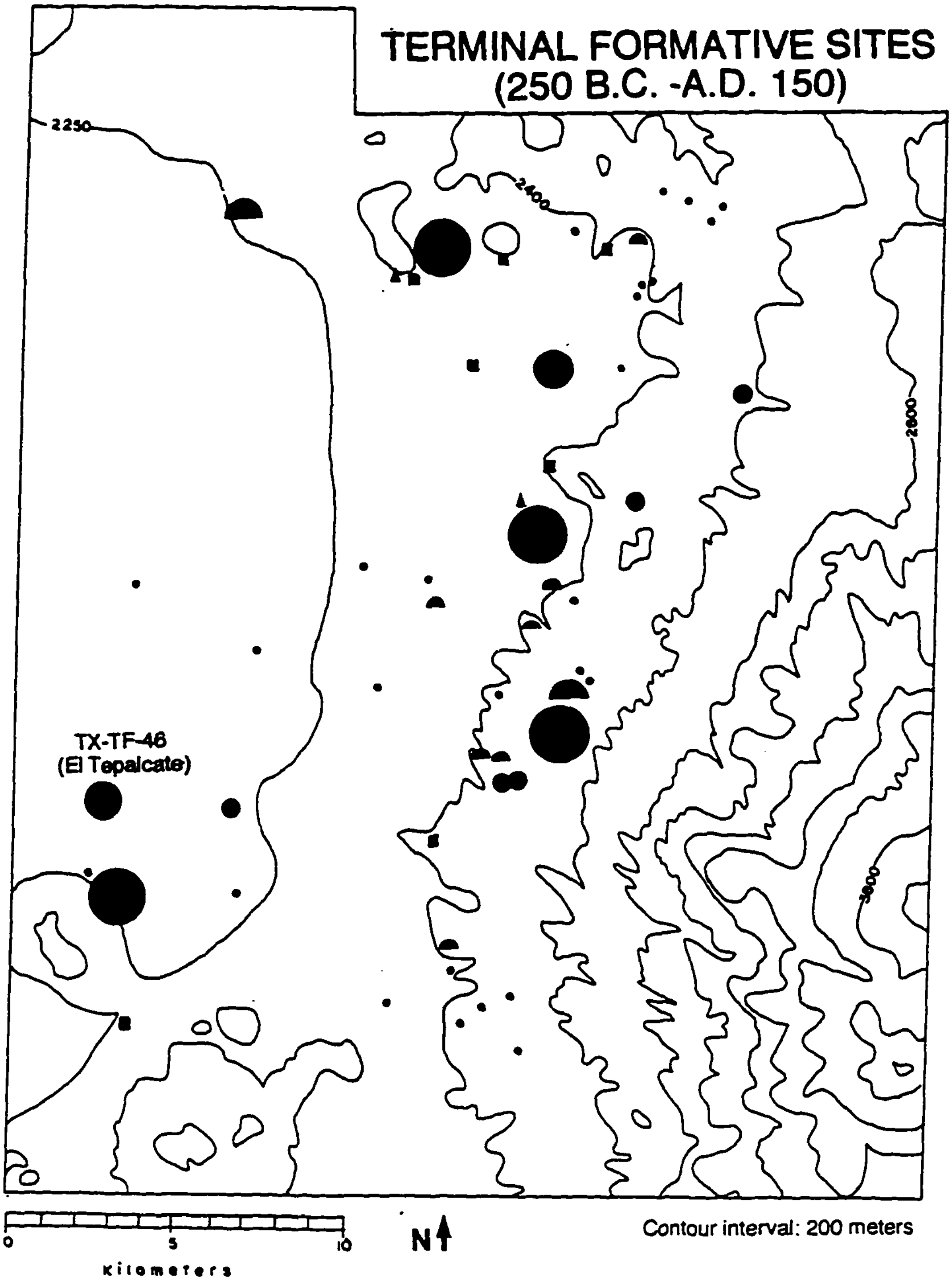


Figure 4.5 Terminal Formative sites in the Texcoco region.

exists than in the previous period. This is indicated not only by the persistence of the Tezoyuca hill-top centers, but also by the appearance of two major sites in the Basin, Cuicuilco and Teotihuacan, which are two regional centers out of the study area.

Considerable and complex population changes occurred in the area of Texcoco towards the end of this 250-year long phase, in which a rapid expansion onto empty areas was followed by the abandonment of some sites, marking the beginning of a gradual decline in population that continued through the Classic and the Early Toltec periods.

Based on this increase and decline of sites, this period is subdivided into two phases characterized by the existence of two ceramic traditions: Patlachique-Tezoyuca and Tzacualli.

The Patlachique-Tezoyuca ceramic phase of the Teotihuacan Valley, also known in the general chronology of the Basin of Mexico as the phase 3-B of the First Intermediate period, was accompanied by the substantial growth of pre-existent sites and the appearance of new communities on the lower piedmont, alluvial plains, and the lake-bed (Parsons 1971). The persistence of low lake levels may have attracted more settlers to the shallow areas of the lake, for there is a clear increase of settlement on the lacustrine plains (Figure 4.5). A geoarchaeological interpretation of one of these lacustrine sites, Tx-TF-46, and a discussion of lake level fluctuation is presented in Chapter 8.

Even the upper piedmont, practically unoccupied in earlier periods, saw the rapid establishment of new sites. Most of the new sites appeared in this period were dispersed farming villages, and hilltop centers which functioned as ceremonial precincts and/or as elite residential districts. These hill-top centers appeared on the hills of the Patlachique, Tezcutzingo-La Purificacion, and Chimalhuacan. On the alluvial plain, in the narrow pass through which the San Juan Teotihuacan River leave the Valley, the site of Cuanalan attained its maximum expansion during this period. This is the best known agricultural settlement in the study area and is documented by intensive survey and excavation (Sanders 1975; Manzanilla 1985).

Despite the increase in population, no important regional center has been reported in the remainder of the study area during this phase. In general, this phase shows a clear trend towards the dispersion of sites and heterogeneity of settlements, occupying large tracts of lands in the piedmont and plains.

The Tzacualli ceramic phase is characterized by a decrease in population signalizing the commencement of the demographic decline that continued into the Classic period.

Contrary to the decrease of settlers in Texcoco in this phase, the Teotihuacan Valley underwent a clear increase in population, especially in the urban area of Teotihuacan (Sanders *et al.* 1979). In the Texcoco region, the Tzacualli phase pottery is scarce or absent in most sites. However, the decrease of the local Texcoco variant of this phase, different from the style patterns of Tzacualli pottery in the Teotihuacan Valley, indicated that indeed there was a decline in Tzacualli sites in the Texcoco region(Parsons 1971:189).

The demographic change occurring between the Tezoyuca-Patlachique and Tzacualli phases is not reflected on the map of Figure 4.5, since the map displays the general site distribution for the entire Terminal Formative period. However, when compared with the two previous and the four subsequent periods, the Terminal Formative represents a period of high population levels, a wide coverage of most of the ecological zones, and an apparent dispersion of sites.

Classic (ca. A.D.150-750)

This period, known in the chronology of the Basin of Mexico as Middle Horizon, was originally subdivided by Parsons (1971) into the Early Classic (A.D. 150-500) and Late Classic (A.D. 500-750) phases. The more recent knowledge of the ceramic phases of this period and the phases of construction of the urban complex at Teotihuacan suggests that there should not be such a subdivision. Therefore, today archaeologists tend to combine the Early and Late Classic phases into the "Classic" (Parsons 1995, personal communication). Nonetheless, the analysis of settlement presented here is based on the maps (Figures 4.6 and 4.7) that still show that subdivision.

The Early Classic phase begins with the change from the transitional Miccaotli ceramic phase into the two ceramic styles of the Tlalmimilolpa phase, known also as Teotihuacan II and Teotihuacan II-III, respectively. During this time the Texcoco region underwent a process of settlement change never experienced before. There was a considerable decrease in the number of sites, and very probably the population density, that left large tracts of land empty in all ecological zones (Figure 4.6). Most of the Terminal Formative sites were abandoned, including the hill-top ceremonial centers that were still abundant in the previous period. Parsons (1971) points out that the configuration of Early Classic settlement represents an abrupt and complete reversal of the long established basic Formative trends characterized by community expansion, proliferation, and clustering into possible political entities. The causes of this overall decline in population

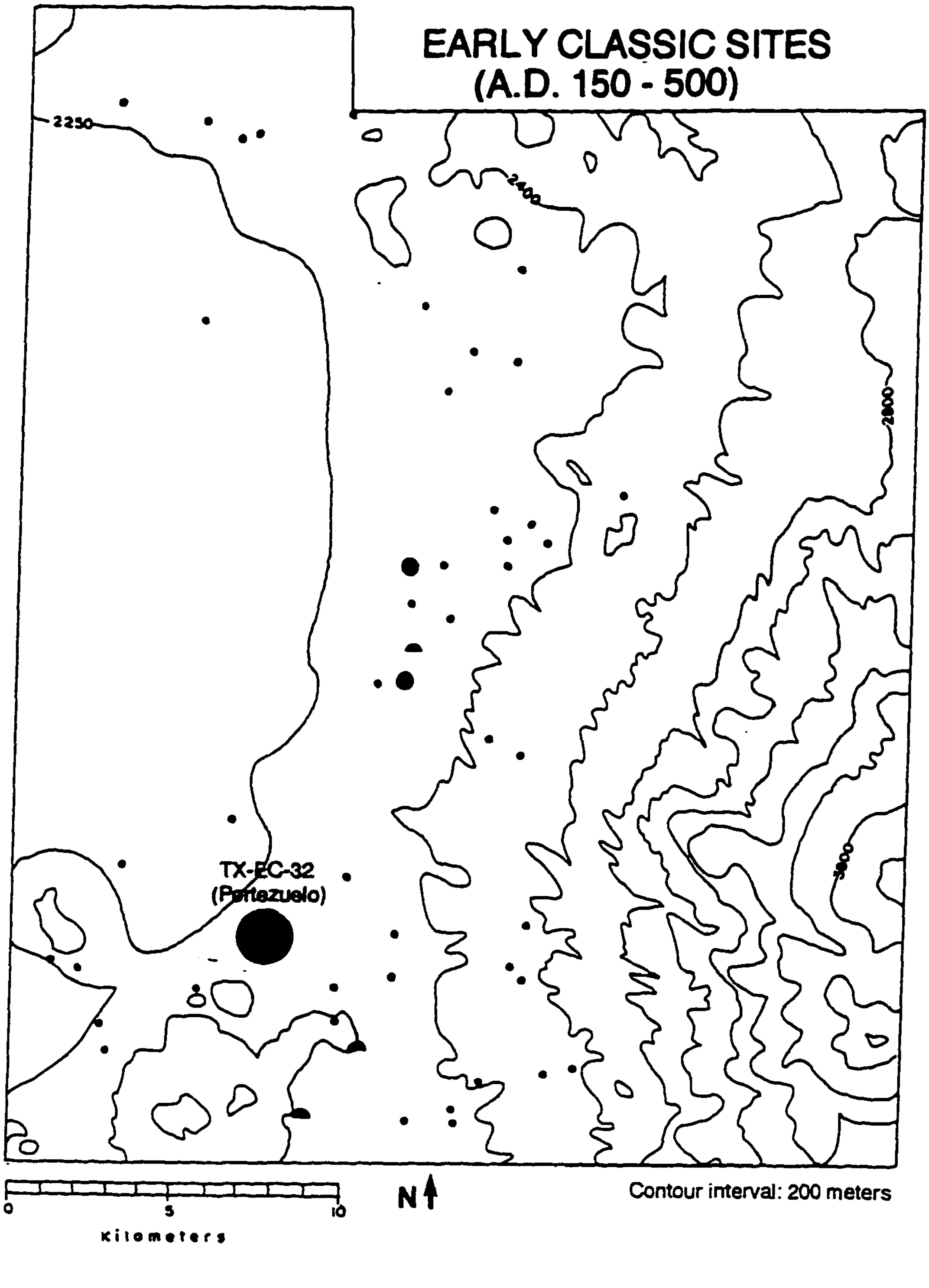


Figure 4.6 Early Classic sites in the Texcoco region.

in the Texcoco region and the entire Basin of Mexico except the Teotihuacan Valley, are attributed to the ever increasing absorption of population by the urban center of Teotihuacan (Parsons 1971, Sanders *et al.* 1979).

The picture of settlement in the study area during this period displays a small number of scattered hamlets showing no apparent clustering. This general decline of sites was accompanied by the only case of settlement nucleation in the area, site Tx-EC-32 (Portezuelo), whose expansion continued through Late Toltec times. To the south of this large community, in the Ixtapalapa Survey Region, there were small sites that seem to be clustering around it. In the center of the region, around the Tezcutzingo hills, there was a cluster of small settlements, with no apparent high-hierarchy center. The NW portion of the study area, although part of the Teotihuacan Valley, does not show a considerable number of sites. As pointed out above, this has been an area of recent sediment build-up that obscures sites, probably giving a false impression of the absence of settlement.

In general the study area shows not only a decline in the number of sites, but a reduction in the size of those that remained occupied. This reduction in site size clearly expressed in the site survey descripitions. The apparent lack of any architectural remains of even modest proportions at most Classic sites in the Texcoco Region might suggest seasonal or temporary residence perhaps by people whose permanent homes were in secondary regional centers or even in Teotihuacan itself (Parsons 1971: 198). As a matter of fact, most of the communities in the study area are classified as hamlets, where the small concentrations of people were probably engaged in a variety of specialized, state-directed exploitative activities that might have been tied directly to the economic network focused on Teotihuacan (Parsons 1971:198).

The Late Classic period (*ca.* A.D. 500-750) was the period of consolidation of Teotihuacan as a city, when its maximum of population and its fullest architectural complexity was achieved. Instead, the Texcoco Region, underwent a considerable decrease in number of sites, even more dramatic than in Early Classic times (Figure 4.7). it became, by far, the period with the lowest site density and population levels through the entire history of settlement since the Middle Formative times. This decrease in site density, however, was accompanied by the growth of the site of Portezuelo (Tx-LC-18), which increased 80 hectares (Parsons, 1971:199).

Other than the provincial center of Portezuelo, only one small nucleated village and a few small hamlets existed scattered on the lower piedmont. The character of

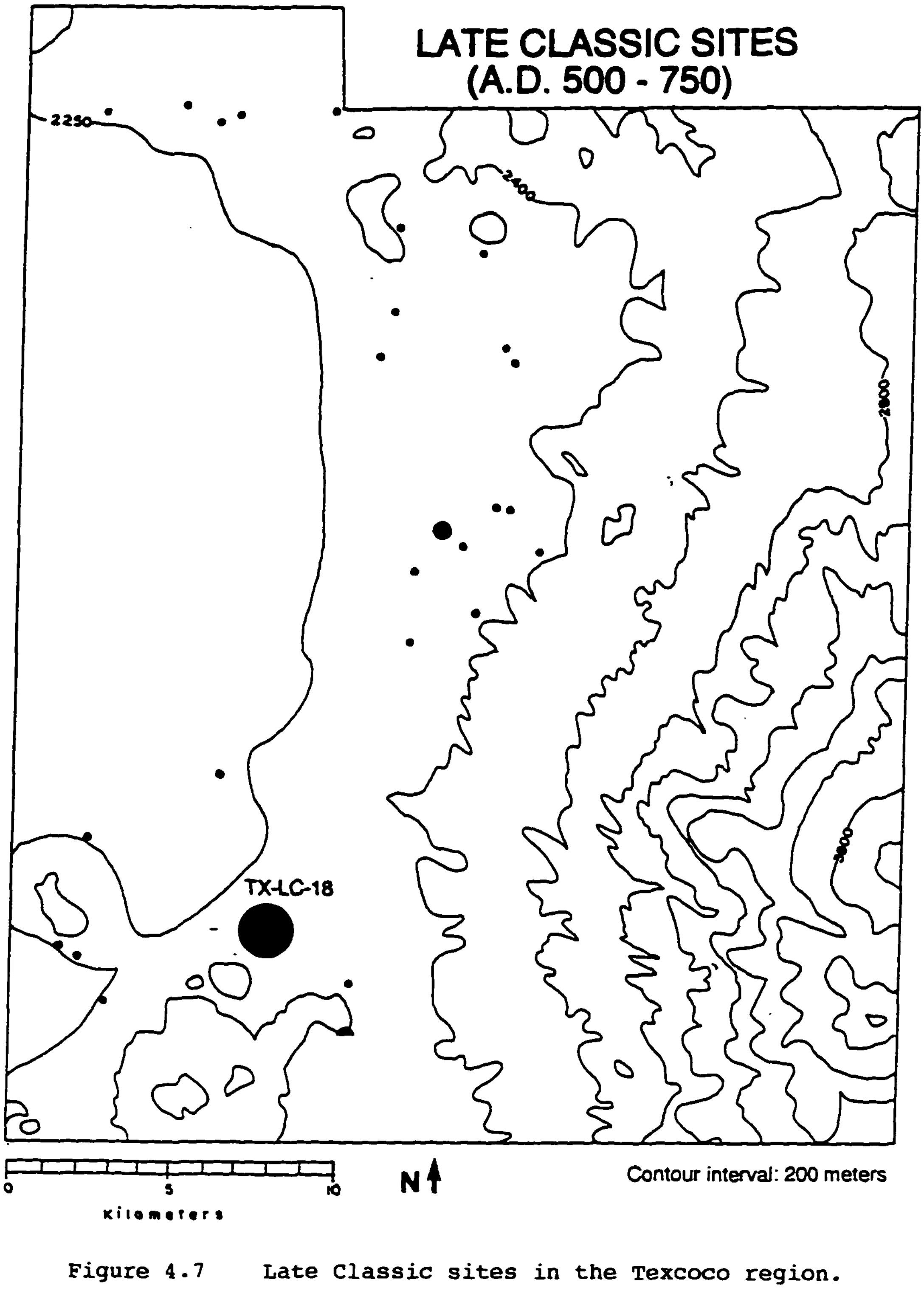


Figure 4.7 Late Classic sites in the Texcoco region.

these tiny settlements, like the Early Classic ones, is not only characterized by its small number, but by the small quantity of sherds found on the surface. In most cases the sherd density is reported as light and moderate in the scale of estimation used by Parsons (1971) (see bottom of Table 4.1).

Early Toltec (A.D. 750-950)

The end of the Classic period in the Basin of Mexico is characterized by profound changes in settlement configuration. However, in the particular case of the Texcoco Region population levels remained low, especially in the central portion where the small Classic communities became fully depopulated.

In a regional context, the geopolitics of the central Mexican highlands underwent substantial changes such as the rapid decline of Teotihuacan and the emergence of important cities out of the Basin of Mexico. Cholula, in the Valley of Puebla, and Xochicalco, in Morelos, became the two most important political centers. This period of approximately 250 years in duration was named the "Epiclassic" by Jiménez-Moreno (1959), and was seen as a transitional bridge into the Early Postclassic period. The Epiclassic in the archaeological record begins with the appearance of a red-on-buff ceramic ware named

'Coyotlatelco' by Acosta (1956). This was a diagnostic style that would endure through the Early Toltec phase.

Gradually, Tula, the new center at the northern borders of the Basin, gained popularity as the other political centers declined. The Epiclassic ended with the consolidation of two apparent states then in power, one centered in Tula and the other in Cholula. It is the first time in several centuries that the center of power moves out of the Basin of Mexico, a process that had enormous impact in settlement patterning. In the study area in particular, there was a virtual disappearance of sites in the central part of the region, while in the south the area around the site of Portezuelo (Tx-ET-18) still keeps levels of population similar to the previous phase (Figure 4.8). In the north, a strongly nucleated and clustered area of settlements appeared at the foot of the Patlachique range. Tx-ET-4 and Tx-ET-7 were the largest of these sites, which had ceremonial-civic architecture that contrasts sharply with the rural architecture that predominated in the two previous periods (Parsons 1971).

There is no conclusive explanation for the absence of sites in the central part of the region during this phase. However, ceramic styles in the Late Toltec period seem to indicate a diffuse political boundary somewhere in the uninhabited part.

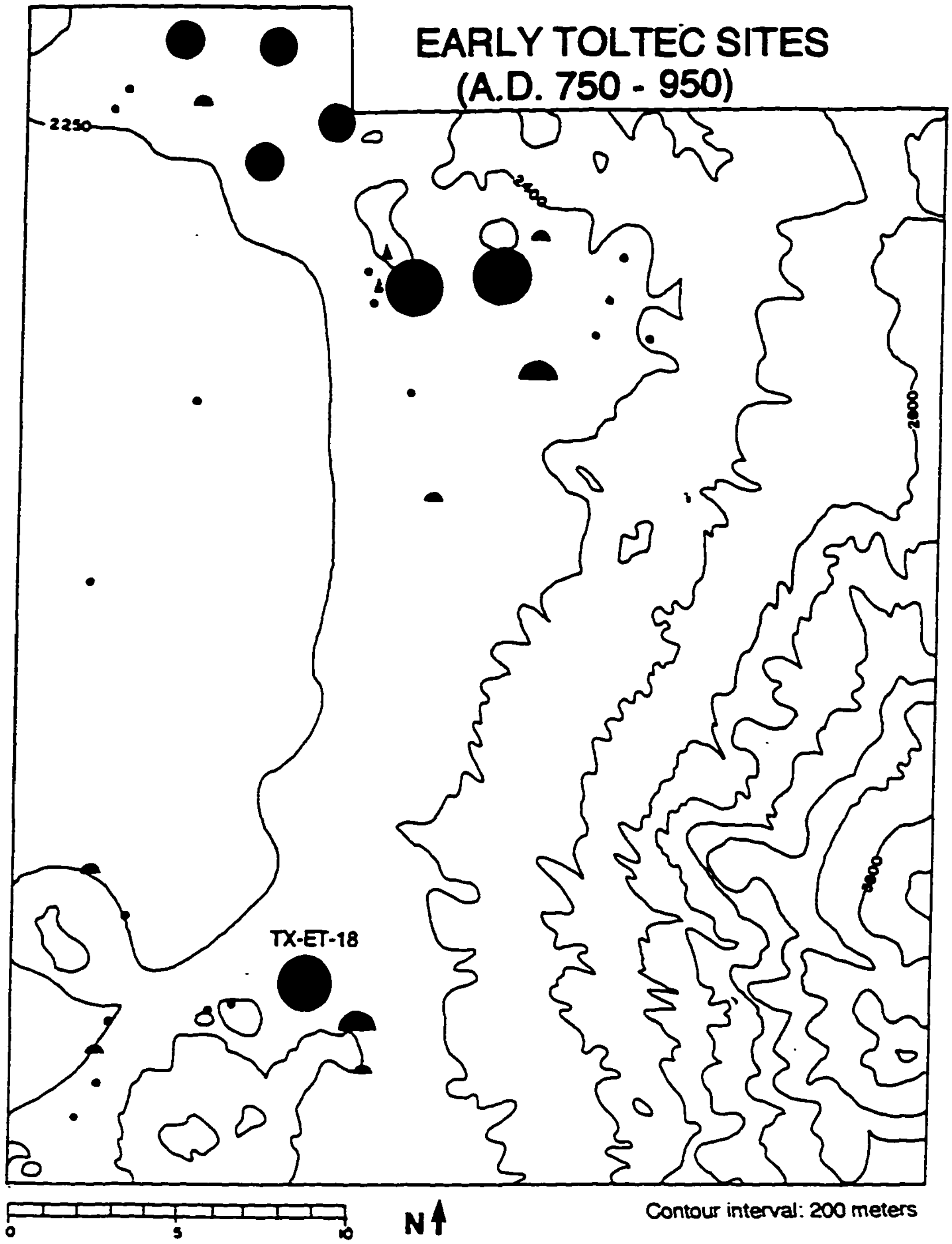


Figure 4.8 Early Toltec sites in the Texcoco region.

The two clusters of occupation in the north and south seem to occupy only the lower piedmont and alluvial plain; the rest of the zones are virtually unoccupied. More site clusters of this type are found in other areas of the Basin. They have been interpreted as small political entities that occupied enclaves with rich land or with rich land close at hand. It is believed that the Coyotlatelco phase was a time of intense warfare among such polities, so that there existed large "no-man lands" separating the polities. This assumption is based on the fact that the high-hierarchy centers that dominated the clusters are located on hilltop positions, and that there were large unpopulated areas separating the polities (Parsons 1989; Blanton *et al.* 1993).

Late Toltec (A.D. 950-1150)

This phase is marked in the archaeological record by the cessation of the Coyotlatelco pottery and the take-over of the Mazapa style. Ruralization and population dispersal in both the Texcoco region (Figure 4.9) and the Teotihuacan Valley still characterize the cultural landscape of this phase (Parsons, 1971). Settlement patterns at this time were almost identical to those of the Classic period; most of the communities were villages and hamlets. Nonetheless,

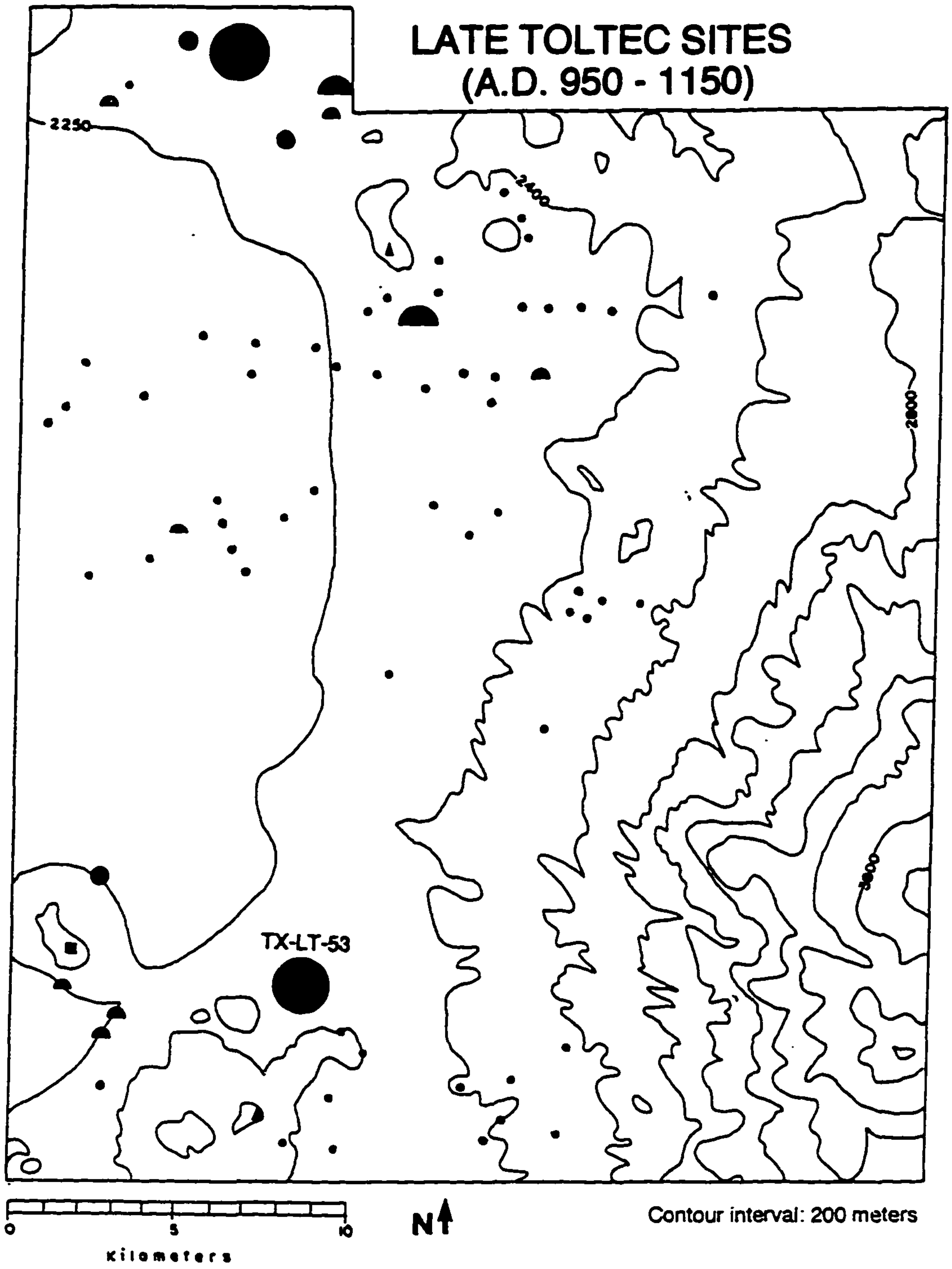


Figure 4.9 Late Toltec sites in the Texcoco region.

unlike the Classic period, during the Late Toltec phase, ecological zones like the lacustrine plain, the hills, and, to a lesser extent, the upper piedmont were gradually colonized. In particular, the lacustrine plain, without substantial occupation since Terminal Formative times, was settled in this phase by small communities engaged full-time in the exploitation of lacustrine resources (Parsons 1971:204, 205). In the north, the site cluster occupied since Early Toltec times expanded in all directions, preferentially onto the Papalotla river valley. In the Late Toltec phase there is a trend to occupy vacated during the Classic period and the Early Toltec phase. However, the Central portion of the region, although having more sites, was still poorly occupied. Some of the sites found in this period occupy the area of the present-day city of Texcoco. The south did not experience major changes, the areas remain occupied only around the site of Portezuelo. However, sites did diminish somewhat in number and size. The apparent concentration of the two most important ceramic styles, Mazapa in the north, and Aztec I in the south, led Parsons (1971:205) to interpret the emptiness of the central zone as a no-man's land between the two regional powers: Tula and Cholula. His argument is based on the fact that the Mazapa ceramic tradition is generally restricted to the northern and central sections, while the

Aztec I tradition is unknown in the Tula area, poorly represented in the entire Texcoco region and increasingly more abundant towards the south end of the Basin.

The Late Toltec is the first archaeological period that ethnohistorians can investigate with the rich, but complex, and often obscure, chronicles of Late Aztec times. The histories of the Toltec world, originally in the form of oral tradition, sometimes illustrated in codices, and eventually written in numerous Early Colonial chronicles, always relate to the legendary Toltecs and Tula, their capital. The existence of Tula in the historiography and myths of the Aztec, will influence the interpretation of the historical events of the Late Postclassic period (Davies, 1987). This influence is profoundly important in defining the two major ethnic groups, Toltecs and the Chichimecs, that will play a key role in the geopolitics of the Basin of Mexico in the following two phases.

The Aztec settlement

The Aztecs in the archaeological and historical records

The term "Aztec" was originally used to designate the Mexica, the leading group of the so called Aztec Empire, or Triple Alliance, who claimed an ancestral homeland in a remote place called *Aztlan* (Nahuatl: Land of Cranes). At the time of the conquest, in the chronicles and literature, the Spaniards referred to these people as Mexica. In some cases the Spanish more specifically referred to their tribal name (i.e. Tepaneca, Xochimilca, Acolhua, etc.). It was not until the 18th and 19th centuries that the original term "Aztec" reappeared again in scholarly studies, and now it is accepted as a generic name for the peoples of the Basin of Mexico at the time of the Spanish Conquest (Townsend 1992:55). The so called Aztec Society was consolidated after a long process of integration of several ethnic groups in a regional social system at the end of the period designated as 'Aztec'. However, the term 'Aztec' in the archaeological literature has a broader meaning and is used to refer to all ethnic groups that in the period A.D. 1150-1520 inhabited the Basin, as well as to their material culture.

The seriation of the Aztec ceramics has been the main resource to define Early and Late Aztec sites. Based on Vaillant (1938), this seriation traditionally included four groups: Aztec I, II, III, and IV. Another classification, resulting from recent studies by Hodge and Minc (1990, 1991); Parsons, *et al.* (1993), and Minc (1994) contains different designations and more detailed variants of each style. However, this new classification still follows the basic seriation established by Vaillant (1938). This new classification also contains those variants that are transitional between the basic types, for example the so-called Aztec III-IV. This new classification is used in this dissertation in the description of Aztec pottery that was used to date soils on the piedmont and occupation levels buried by flood deposits (see descriptions in Appendix I). However, for the purpose of analyzing the settlement pattern, the styles are grouped into Early Aztec (A.D. 1150-1350) and Late Aztec (A.D. 1350-1520), categories that were established by Parsons (1971) as a division of the Aztec period. Thus, in a general sense, the Aztec II tradition corresponds to the Early Aztec phase, and the Aztec III tradition corresponds to the Late Aztec phase. The other two basic styles --Aztec I and Aztec IV-- are, in effect, out of what chronologically is defined as Aztec. Aztec I is practically absent in Texcoco, and has been assigned to the end of the Toltec phases since it is partially coeval with the Mazapa pottery (Parsons *et al.* 1993). Aztec IV is a style basically of the Early days of the Spanish Colonial period. It apparently started to be made at the beginning of the sixteenth century on the eve of the Spanish Conquest, and is found in Early Colonial contexts (Charlton 1969; Charlton and Nichols 1992).

Unlike all the previous periods, the distribution, character, and size of the Aztec settlements in the Texcoco region are potentially easier to identify. This is because the largest sites persisted into the Colonial period, although in many cases they are covered by modern occupation. The rest of the sites in the countryside, that were not overlain by later occupation and were recorded by archaeological survey, can be searched for with the aid of documentary information of the sixteenth century, when they still occurred on the landscape as dwindling communities.

The documents that verify the distribution of Aztec sites in the Texcoco regioninclude: (1) Aztec pictorial sources such as the Codex Xolotl and Mapa Quinatzin (Dibble 1980), (2) Early colonial maps that show Aztec sites that eventually disappeared by the first decade of the seventeenth century, among which the most important are the maps of the *Relaciones Geográficas* (in Acuña 1985), the Map of Uppsala (in Linne 1948), and dozens of maps acompanying unpublished *Tierras* documents; 3) Early colonial documents such as land grants titles (*Mercedes*) and land litigations (*Tierras*), that very often refer to deserted sites on the landscape; and 4) sixteenth century chronicles written by Spaniards, such as Díaz del Castillo (1968), Cortés (1985), Durán (1964), Mendieta (1980) and Torquemada (1967). Local Aztec accounts handed down by oral tradition eventually written down, such as the Titles of Tezcutzingo published and translated by McAffe and Barlow (1946), and historical works by descendants of the Acolhua dynasty such as Alva-

Ixtilxochitl (1975, 1977) and Pomar (1985) are also useful. These documents not only provide information on the existence of sites, but the sequence of events such as dynastic succesions, movements of population, and even environmental disasters. However, part of this wealth of historical information has to be dealt with care, since in most cases overemphasize the achievements of certain groups, or show events that are legendary rather than real. This, for example, is the case with the information provided by the Codex Xolotl for the Early Aztec period. This codex has posed a lot of problems when correlating historical events with the archaeological record (Parsons 1970; Charlton 1973; and Calnek 1973). Yet, the brief descriptions of cultural and natural facts about the landscape are frequently mentioned, whose interpretation can be correlated across several sources, provide a good idea of land transformation. For this reason, those aspects of Aztec history relevant to this study are presented in the next section as a background to complement the understanding of settlement dynamics.

Historical events of the Aztec peoples in the Basin of Mexico

According to the historical sources, the beginning of the history of the Acolhuacan, the homeland of the

Texcocans, is marked by the arrival of peoples from the north, referred to as Chichimecs, who occupied several enclaves of the Basin, and eventually mixed with the local population recognized as 'Toltec'. The migration of the Chichimecs into the Basin of Mexico was led by the semi-legendary hero Xolotl and took place after the fall of Tula. This migration occurred in the 12th century according to most sources (Diehl 1983). The three main documents dealing with the Chichimec and Toltec histories in the Basin of Mexico are the Codex Xolotl, the Mapa Tlotzin, and the Mapa Quinatzin. All three show in a series of paintings the sequence of events from the arrival of the Chichimecs in the Basin of Mexico as groups of hunter-gatherers to the culmination of their process of acculturation achieved through the assimilation of the Toltec culture. These resources also document practice of agriculture as well as the formation of petty nations through intermarriage between Chichimecs and Toltecs. There is yet no consensus as to what the cultural traits of the Chichimecs were, even though the sources characterize them as nomads, or peoples engaged in hunting-gathering, having no knowledge of agricultural practices (Dibble 1980, Alva-Ixtilxochitl 1975, 1977). This idea is probably biased by the meaning of the term 'Chichimec' as used to designate the hunter-gatherers of the arid and semi-arid areas of northern Mexico when the chronicles were written in the sixteenth century (Reyes-García and Güemes 1995). The archaeological data of the Texcoco region survey does not support settlement by hunter-gatherers (Parsons 1970, 1971), so that the idea of nomads living in caves and hunting as depicted in the sources at the time of the Spanish contact is far from being proved.

The total lack of archaeological evidence to authenticate the arrival of hunter-gatherers has stirred up discussion concerning the cultural traits of the Chichimecs. Accordingly, there are suggestions that the Chichimecs of Xolotl were not necesarily like the hunter-gatherers of northern Mexico during the 16th century (Armillas 1964, 1969; Corona-Sánchez 1973, Reyes-García and Güemes, 1995). Armillas (1969) presents the most solid argument regarding the way of life of the Chichimecs, stating that the same people who migrated northward into the Northern Mesoamerican Frontier during the Classic and Epiclassic periods, did so when conditions in the north were more favorable for rainfed agriculture. They then returned to the central valleys, within the area that Kirchoff (1943) originally defined as Mesoamerica, at the time of the conquest. This southward migration probably occurred in waves through the Early Postclassic as conditions in the north became more arid. Armillas refers to these peoples as having a sedentary life adapted to the conditions of the north, for which reason differed from the local Toltecized people. This opinion, although lacking proof, seems to tear down the myth of the fully nomadic hunter-gatherer Chichimec of the Early Aztec period in the Basin. Based in numerous comparative facts between the cultures of west and northern Mexico with those of the Basin of Mexico in the Early Postclassic, Hers (1995) proposes that the peoples living in the Classic period in the sites of northern Jalisco and Zacatecas may well have been the immigrants that later arrived in the Basin. This seems to agree with Armillas' hypothesis, although the migrations according to Hers (1995) occurred somewhat earlier.

Sahagun (Dibble and Anderson 1963) reports that the Aztecs of the Basin of Mexico recognized three classes of Chichimecs in the sixteenth century: The 'Otomi' with low cultural level, but still closer to that of the informants; the 'Tamime', or those who master the art of the bow and arrow; and ultimately the true Chichimeca, the so called 'Teochichimeca' who had nomadic way of life. As can br gathered from this classification, even at the time of the conquest a Chichimec was not necessarily a hunter-gatherer. There is also the idea that at some point the term was used to refer to immigrants and foreigners (Corona-Sánchez 1973).

In my opinion, based on the numerous discussions in historical sources, archaeological evidence, and following the scheme presented by Armillas, the Chichimecs who arrived in the Basin of Mexico in the Early Aztec phase were highly mobile agriculturalists who also engaged in hunting-gathering. The strategy of subsistence appears to best match that which thusd in the drier environment from where they came. Obviously, their level of sedentarization contrasted with the local 'Toltecized' peoples settled in the Basin. There is no clue as to what language the Chichimecs spoke. Ixtilxochitl (1975, 1977) implies that in the acculturation process of the Chichimecs, they abandoned their language for Nahuatl, that is to say the language of the Toltecs. If that was the case, it could be that the Chichimecs spoke a language of the Oto-Pamian family, as most of the sixteenth century Chichimec groups. Otomi, a language of this family that is still spoken by the present-day Otomi peoples whose communities are scattered in the states along the northern Mesoamerican frontier, was spoken by certain minorities in the Basin of Mexico at the time of the conquest. This is the case of small communities of Otomi-speaking groups living in the Basin of Mexico among the nahuatl-speakers in the early fifteenth century mentioned by Alva-Ixtilxochitl (1977: 69). Similar Otomian communities have also been reported in the *Relaciones Geográficas* for Coatepec by Francisco de Villacastin (Acuña 1986:I, 140), and for Tepexpan by Jerónimo de Baeza (Acuña 1986: II, 247). These data, however, do not particularly support the arrival of otomian groups as the Chichimecs of Early Aztec times, since it is known that in the Late Aztec phase immigrants from different regions of the country came to settle in Texcoco (Alva-Ixtilxochitl 1975). It is also possible that part of the Chichimec people of the Early Aztec phase spoke Nahuatl like the Toltec people living in the Basin, a statement that agrees with Armillas' hypothesis as well, since he considers that the Chichimecs may have also been peoples from central Mexico that in wetter times moved north, and retreated when conditions became dry.

There is no clear archaeological evidence for the arrival of the Chichimecs of the Codex Xolotl as discussed by Parsons (1970, 1971), Charlton (1973), and Calnek (1973). However, a small piece of evidence that may shed light on the arrival of the Chichimecs into the Basin is the Aztec II or Tenayuca Black-on-Orange ceramics that are found mainly in the northern Basin of Mexico as stated by (Parsons *et al.* 1981). This ceramic type could have been developed by the new-comers in Early Aztec times that, according to the Codex Xolotl, preferentially occupied the northen portion of the Basin (Dibble 1980). The Aztec II pottery was also found in Tula lying directly above deposits of the Tollan phase (A.D. 950-1150), on the buried remains of the ceremonial center (Acosta 1956-57). Cobean *et al.*(1981) assigned the Aztec II occupation to the Fuego phase (A.D. 1150-1300), that by its scarcity suggests that the resident population was scattered around the urban zone. It is evident that these people, who started the looting of Toltec art objects, settled that area shortly after the Toltecs left (Diehl 1983:166). According to the sources consulted by Ixtilxochitl (1975, 1977), the Chichimecs arrived in the Basin of Mexico after visiting Tula, at the time when it had already fallen as a regional center. Could they be the people who made the Aztec II pottery? This is a question that cannot be answered with the current level of knowledge about this period.

The hunter-gatherer way of life of the Chichimecs as depicted by the Codex Xolotl, Quinatzin Map and Tlotzin map has no trace in the archaeological record, neither from the survey data nor from the few excavated sites in the area. Moreover, these three sources depict them dwelling in caves, a view that receives no support from the data recovered in caves. Piña-Chan (1956-1957), trying to investigate the cave-dwelling Chichimecs mentioned in the

Codex Xolotl, excavated several caves in the area of Tepetlaoztoc and Papalotla that yielded a great deal of ceramics. However, there seem not to be traces of the Chichimecs, just because the ceramic styles correspond to a period spanning from the Early Classic to the Late Aztec. Although there was a great amount of Black on Orange, Black on red, and polychrome wares of the Early Aztec period, they did not differ from the ones found in large settlements of that period elsewhere in the Basin. Therefore, there is no sense in the fact that nomadic Chichimecs inhabiting caves had a material culture similar to the people living in villages.

The blend of Chichimecs and Toltecs eventually formed several confederations or nations of Nahuatl-speaking peoples (Tepanecs, Acolhuas, Culhuas, Chalcas, etc.)(Gibson 1964). These confederations, often referred to also as 'tribes', were formed by alliances between the different polities for purposes of mutual defense and military campaigns, and their territorial configuration conformed the city states of the Early Colonial period.

The Acolhuas occupied the Texcoco region, where they were divided into several small polities or city states being the most important: Huexotla, Coatlinchan, Tepetlaoztoc, and Coatepec (Gibson 1964; Hodge and Minc 1990). These city states were at times engaged in continuous warfare forming temporary alliances among themselves or with other polities out of their ethnic group. Eventually, a solid alliance among them formed the Acolhua state, whose capital was finally centered in Texcoco. Their territory was called Acolhuacan, or Texcoco by some authors. According to the sources, Texcoco was ruled by a dynasty of 8 kings, who were descendants of the Chichimec leader Xolotl. Texcoco absorbed other territories inside and outside the Basin of Mexico, and eventually joined forces with the other two superpowers, Azcapotzalco and Tenochtitlan, to form the Triple Alliance, whose leadership was assumed by the Mexica of Tenochtitlan. The three partners of the Triple Alliance conquered lands out of the Basin and dominated most of the trade of central Mexico, where they established a tributary system that later was adopted with some modifications by the Spaniards in the Early Colonial period under the system of *encomiendas*.

The formation of the Triple Alliance took place in 1431 according to Alva-Ixtilxochitl (1975), and lasted until the arrival of the Spaniards in 1519. During this period, Texcoco flourished as a well organized state of the triple alliance, under the leadership of King Nezahualcoyotl (ruled 1428-1472), who transformed the Texcocan society by creating codes of law, an efficient system of tax collection and a highly complex political apparatus based on several institutions oriented towards the multiple needs of the kingdom and the empire. It is also well known that the transformation of the landscape during this period involved the direct intervention of the state via the nobility (Evans 1980). In the area of Texcoco, in particular, this system was organized on the basis of rewards in the forms of land grants to those elite members who helped Nezahualcoyotls in the fight against Azcapotzalco as stated by Alva-Ixtilxochitl (1975:379).

Temples, gardens, canals, dams, and aqueducts were built during his reign, some of which are still prominent features in the present landscape. His works were also known outside of his kingdom, in other areas of the empire; the most relevant feature of his engineering work was the dike built in Lake Texcoco to protect Tenochtitlan, the Aztec capital, from the influx of saline waters (Palerm 1973).

Nezahualcoyotl's succesors Nezahualpilli (1472-1515) and Cacama (1515-1519), preserved the policies and institutions created by Nezahualcoyotl until the coming of the Spaniards. Once the conquest of Mexico-Tenochtitlan was achieved, the Spanish preserved the Texcocan empire under two kings, Cohuanacochtzin and Ixtilxochitl, for a short period of time, while the territories of the empire were still being conquered (Alva-Ixtilxochitl, 1975).

Early Aztec (A.D. 1150-1350)

As noted above, the histories of the peoples of the Basin of Mexico in the Early Aztec period mention the existence of certain towns that held the power in the form of city states. In the study area, the archaeological data confirm the existence of these centers, such as Huexotla(Tx-A-87), Coatlinchan (Tx-A-88), Tepetlaoztoc (Tx-A-24), Coatepec (Tx-A-99)and Chimalhuacan (Tx-A-109), settlements of considerable size for that period.

Another characteristic revealed by archaeological surveys is the increase of population that began in this phase. This expansion of population operated from a base established in the Late Toltec times, since Early Aztec nuclei of sites grew in areas previously occupied (Parsons 1971:218). However, large number of sites appeared in areas previously empty or poorly occupied in the upper piedmont and hills (Figure 4.10). Whether or not settled by the immigrants, these zones were occupied relatively fast, opening up the possibilities of exploiting a large spectrum of the ecological mosaic of the region. Paradoxically, for reasons not yet explained, the lacustrine realm experienced a reduction of sites,

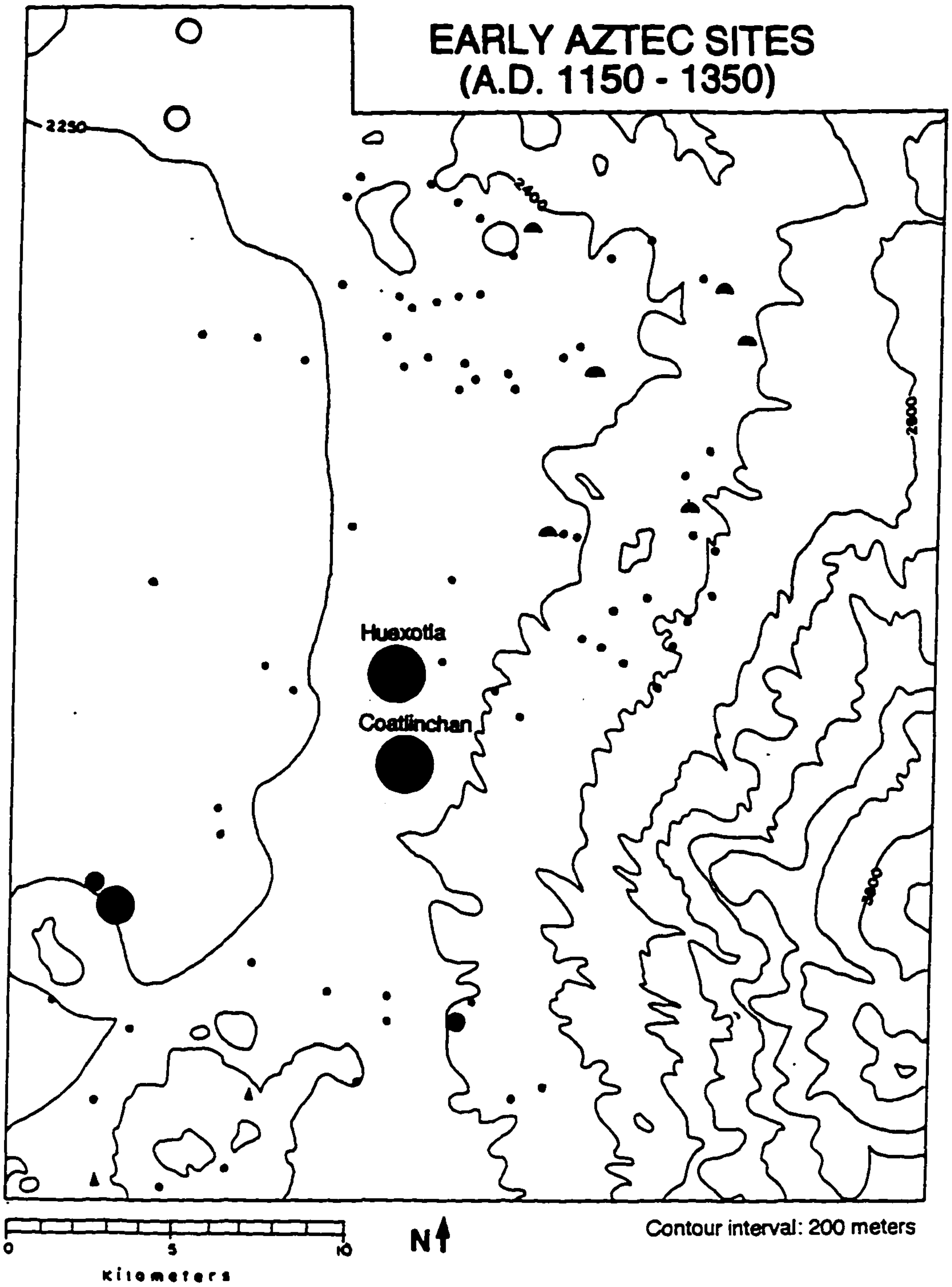


Figure 4.10 Early Aztec sites in the Texcoco region.

although the answer may lay on the dynamics of lake levels rather than on the orientation in resource exploitation.

Although nucleation and clustering are more common around the important centers mentioned, the general trend is towards a homogeneous dispersion, a process that continued through the Late Aztec phase. The real extent of the Early Aztec sites has been difficult to estimate because Late Aztec occupation overwhelms most of them (Sanders *et al.* 1979:150). However, this factor indicates the continuity in occupation of the same sites during the two periods, and the trend of expansion of communities both in place and towards their periphery, the latter being the trend towards settlement dispersal. The most occupied areas were on the lower piedmont and its contact with the alluvial plains, which suggests a preference for the best agricultural lands, which in turn reflects the sedentary character of the population, rather than the establishment of seasonal camps by the nomadic people alluded by the historical sources.

Parsons (1971) points out that one of the most interesting features of the Early Aztec occupation is that Huexotla and Coatlinchan, two large juxtaposed sites grew up in area where occupation in all preceeding periods was very sparse. In a regional scale this is the case of most new rural sites in the piedmonts. My interpretation for this process of land occupation is that the Early Aztec settlers, as well as the Late Aztec ones, faced the problem of settling areas previously devastated by erosion, that were suitable only through land reclamation. This point will be fully discussed with the presentation of soil data in Chapter 5.

Late Aztec (A.D. 1350-1520)

A dramatic expansion of population characterized this phase, reaching levels never experienced before (Figure 4.11). Although initiated in the Early Aztec period, the expansion of settlements and the emergence of new ones is attested by the ever increasing abundant quantities of Aztec III ceramics, a tradition that started in the 1300s and became common during the 1400s (Sanders *et al.* 1979; Hodge and Minc 1991; Parsons *et al.* 1991).

There is a strong concordance between the historical sources and the location of Aztec sites identified during survey (Evans 1980; Charlton and Nichols 1992; Hodge 1994). Regarding this fact, there are three interesting aspects of the Late Aztec occupation to point out: (1) the unification of political entities, that is testified by archaeological data, (2) the considerable growth of urban settlements, and the emergence of new large settlement (Texcoco, site Tx-A-57) in the alluvial plain in an area that previously sustained only small communities, (3) the political organization at different hierarchic levels is somehow reflected in the settlement pattern, and (4) the high levels of population are represented by dispersed settlements homogeneously distributed in all the ecological zones except the mountains.

The first aspect of settlement in this phase refers to the strong congruity between the historical accounts and the archaeological data. As in the Early Aztec phase, the Late Aztec provincial centers are large nucleated settlements corresponding to those of the sources. The best example of this aspect is provided by the exhaustive analysis of pottery styles performed on material recovered in survey and reported by Hodge and Minc (1990) and Minc (1994), that shows that similar ceramic assemblages characterize the Late Aztec phase, which indicates a more integrated system of exchange, probably resulting from the alliances of the polities that eventually conformed the Triple Alliance, contrary to the ceramic picture of the Early Aztec times, whose ceramic assemblages show more local forms as an indication of local market systems with little exchange with neighbouring polities.

The second aspect is a relevant one since Texcoco, a new center corresponding to the capital of the Acolhua kingdom, emerged on the alluvial plain, where in Early

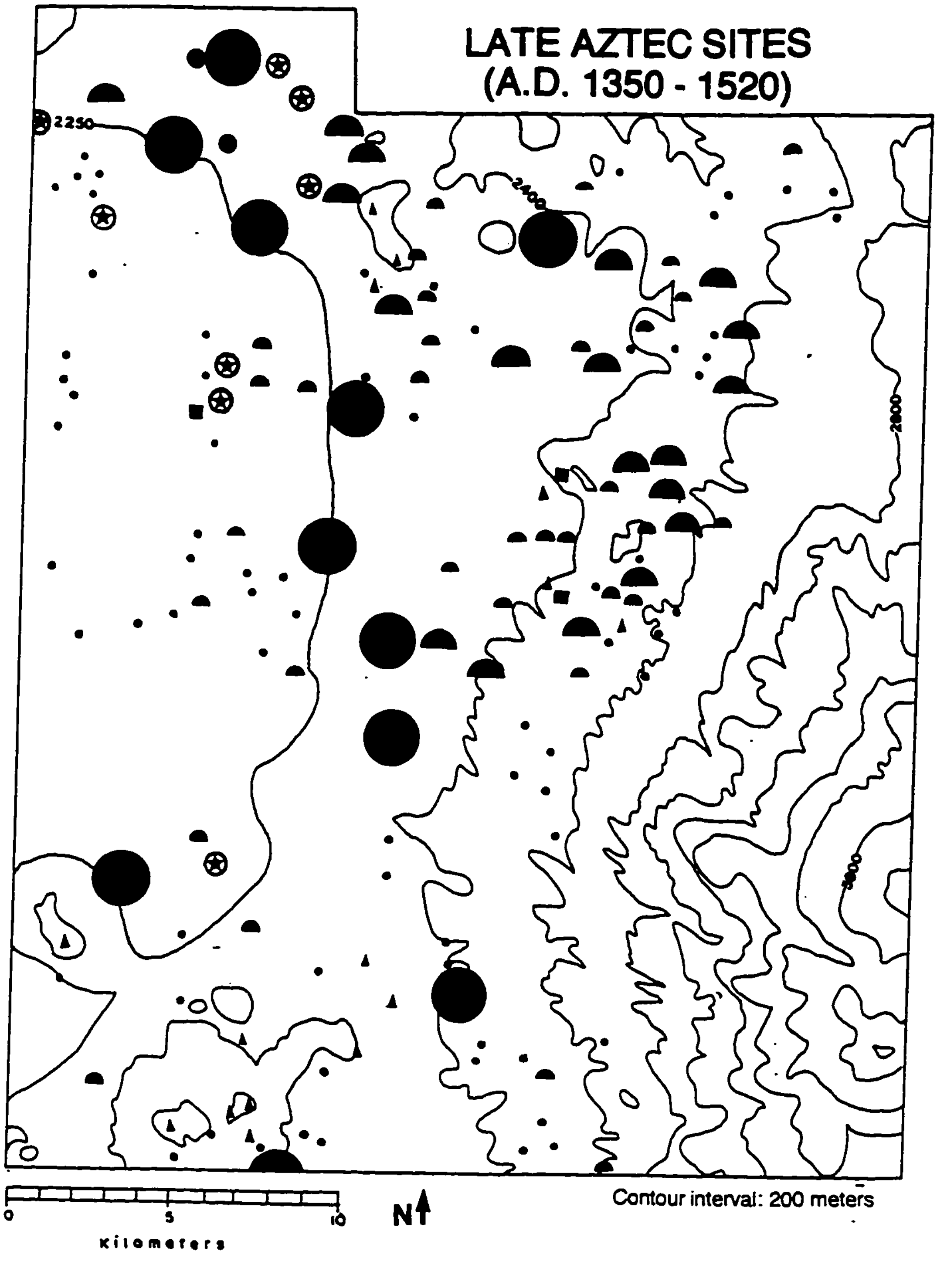


Figure 4.11 Late Aztec sites in the Texcoco region.

Aztec times and earlier periods there were only small settlements. It is likely that the center emerged around Nezahualcoyotl's palace, a facility that, as explained by Alva-Ixtilxochitl (1977:95), was rather a space devoted to host the governmental institutions. The city also contained a marketplace and an enclosure that kept the gods of all ethnic groups residing in the districts dependant of Texcoco (Alva-Ixtilxochitl, 1975). The different *barrios* (wards) were dispersed around the modern city of Texcoco, some of them of noble population and some of free commoners (Hicks, 1982). The dispersed character of settlement was not only confined to the peasantry, but noble settlements were dispersed communities as they are depicted in the Map of Oxtotipac published and commented by Cline (1972), some of which occupied extensive areas of the lower piedmont and the flood prone areas of the alluvial plain. The occupation of the latter seems to indicate that the control of the rivers allowed a stable area for a capital, as for the other provincial centers in the alluvial plains like Chiauhtla and Acolman.

Urban growth was also paralleled by the increase of rural population. There is no certainty as to what factors stimulated population growth, but it is possible that the main factor was the arrival of people from elsewhere; the historical sources always refer to the fact that the

Texcocan rulers favored immigration of peoples from places elsewhere in the Basin and remote areas as far as the present states of Oaxaca and Jalisco (Alva-Ixtilxochitl 1975-1977). The best known rulers that established such immigration policies were Techotlalatzin (1301?-1374) in the opinion of Offner (1979), and Ixtilxochitl (1374-1428) and Nezahualcoyotl (1431-1472) according to Alva-Ixtilxochitl (1975, 1977).

The third aspect of the Late Aztec occupation is that the hierarchy of settlement within the united political territories is also evident in the distribution of sites in the survey maps. Licate (1981) summarizes the highly centralized hierarchical system of Aztec territorial arrangements in three levels, province (empire), *altepetl* (state) and *calpulli* (local), all of which should have a spatial expresion in the landscape. The real definition of this hierarchical structure in the context and reality of the survey data is complicated. However, there are some attempts in the Texcoco region that seem to bear this simplified structure. Using mostly survey data, Evans (1980) confirms the hierarchical character of the provincial centers within the Teotihuacan Valley in which the small settlements seem to be what in the Aztec political organization is *calpulli*, known by the Spanish as small *barrios*. Hicks (1982) reconstructed the interactions between certain noble and *macehual* setlements using several 16th-century documents and the archaeological survey data by Parsons (1971), and showed that Texcoco, as the capital and *altepetl*, had its area of influence in which there were noble and *macehual* settlements in organized political and territorial entities called *tlaxilacalli*, each of which were to some degree formed by *calpultin* (pl. *calpulli*). Williams (1994) found in Tepetlaoztoc that the *tlaxilacalli* was in effect a sub-division of the *Altepetl*. Hodge (1994) reconstructs a model of territorial hierarchy in Coatepec, in which the villages and hamlets of the survey reported by Parsons (1971) are equated with the small *barrios* reported in the *Relaciones Geográficas*. This model confirms the function of the city-state of Coatepec as an *altepetl* as having a well defined territorial hinterland, working under the principle of corporate organization in which mound clusters within sites, often interpreted as small ceremonial-civic precincts, indicate the gravity center of a *calpulli* community. Although at the moment this seems to be a logical and effective argument, it is hard to believe, since many sites have been destroyed by urbanization or by erosion, disturbing the original architectural configurations (Sanders *et al.* 1979: 168).

The fourth aspect of the Late Aztec settlement is the rapid increase in population and its dispersion over the entire spectrum of ecological zones; more particularly, the upper piedmont and the volcanic hills where the dispersed village was the most typical type of settlement. Hamlets are abundant, lying in between the villages or in areas of steeper slope. The few nucleated settlements were basically those of the provincial centers, with the exception of Tepetlaoztoc, a large dispersed settlement, and to a certain extent Texcoco itself, whose urban complexity consisted of both nucleated and dispersed settlement, according to the descriptions by Alva-Ixtilxochitl (1975, 1977) and Pomar (in Acuña 1986). What seems clear is that the nucleated settlements were confined to the alluvial plain and the lowest areas of the lower piedmont, with the exception of Coatepec, located in the upper piedmont at the strategic position of the mountain saddle dividing the Texcoco and Chalco sub-basins.

The trend to occupy, use, and exploit the varied resources of all the ecological zones in Late Aztec times has been interpreted as the main strategy to sustain the growing population of the Basin, usually drawing the *chinampa* system in lakes Chalco and Xochimilco (see Armillas 1971; Calnek 1972; Parsons 1976; Sanders *et al.* 1979). However, the fact that the thin soils and severely eroded areas of piedmonts and hills were reclaimed is testimony that the process of land transformation extended to those ecological niches with apparent low productive potential. From the point of view of carrying capacity, Evans (1980) has shown that Aztec land transformation in the Teotihuacan Valley was motivated by the interaction of two processes, the intensification of agriculture, and the steady increase in the productivity requirement, both of them motivated at the same time the increase in population, and the demands of the growing noble class.

The intensive development of the Aztec agricultural landscape has been interpreted as state-sponsored projects that supported the formation of the Aztec super power, the so-called Triple Alliance, through the construction of public works (canals, dikes, terraces, dams, etc.) that increased the lads and wealth through the surveillance of local nobility whose working basis were the commoners (Brumfiel, 1983: 276). These free commoners, called *macehualtin*, were the inhabitants of the numerous villages and hamlets subjected to local nobles, as it is explained in a particular example of a village shown in Chapter 5.

The dispersed settlement was very common in the Aztec period, not only in the Basin, but in other areas of central Mexico such as Tlaxcala (Gibson 1952, Snow 1969), and in La Mixteca (Spores 1967). The formation and function of the dispersed settlement in pre-Hispanic times deserves attention since it contains some ecological significance for the environmental interpretation of this study and since it has practically disappeared from the modern landscape of central Mexico. Its most representative form was the dispersed village, defined by the archaeological survey of the Basin of Mexico as a light concentration of surface pottery with no evidence of civic, elite or ceremonial architecture, that in turn was arbitrarily divided into two categories, large (500 to 1000 people) and small (100 to 500) (Sanders *et al.*, 1979:56). However, there are different forms of dispersed villages according to the topography, the most common being both the radial village, usually established on areas of unbroken topography, and the linear village, most common in the piedmonts, like the study area, located along the interfluves in between the barrancas (Sanders *et al.* 1979: 167, 168). Dispersion took place also in the form of hamlets (less than 100 people), located at key points along the canals, and remote areas at the ecotone between the upper piedmont and the forest, or as salt production stations on the lake bed. Whether they were temporary camps or were linked to the neighboring villages is hard to define; they were part of the process of settlement dispersal.

At the end of the Late Aztec phase in the early 1500s, the area of Texcoco, especially in the piedmonts , was fully covered with disperse farming communities gravitating around large nucleated urban centers located near the lakeshore (Figure 5.11). The dispersed pattern of the rural landscape of the piedmont was noticed by Hernan Cortés, who crossed the piedmont diagonally on his way from Coatepec to Texcoco, via Huexotla on December 31, 1519. In his letter to king Charles V, he refers to this segment of his advance as "...*y va todo poblado*" -"it is all populated along the way" (Tercera Carta de Relación, 1522, in Cortés, 1990: 137). Amazed by the fact that dispersed rural settlements are rare in Spain (Butzer 1988), Cortés probably passed by the houses and fields of the Aztec dispersed villages reported in the archaeological survey maps.

<u>The Spanish Colonial Settlement</u>

The transition to a new socio-economic system

The Spanish conquest of Mexico-Tenochtitlan, accomplished in the summer of 1521, marks the beginning of a series of changes in the socio-economical and political structure of the territories that were part of the Aztec Empire. The processes of change were gradual, since many of the structures remained unchanged for some time, as is the case of tax collection; or changed at very slow pace, as is the case of political division of territories.

Society changed progressively as the Indian population was decimated by epidemics and forced labor, and the newcomers began to settle in the spaces left by the Indian collapse, as shown in the request for lands in the Mercedes documents. The most salient ecological change was the introduction of new biota (wheat, fruit trees, livestock, etc.) and new technologies for production, that in many cases consisted in the hybridization of Mediterranean and the native systems (Butzer 1996).

The result of this process of hybridization was the partial replacement of landscapes, or the creation of "*mestizo*" landscapes (Whitmore and Turner 1992: 401, 420). For instance, the Aztec terraces that used to produce maize, now produce wheat, and maize now is planted using plow; fruit trees brought from the Old World are planted in Aztec terraces and are irrigated with the systems devised by Nezahualcoyotl. Diffusion of the Spanish systems into the rural Mexican landscapes in Early Colonial times was achieved through a model of two basic units, on the one hand the numerous Indian pueblos and ranchos, and on the other the large Spanish estates or haciendas (Butzer 1991, 1992b). The former were characterized by the incorporation by the indigenous people of certain elements of European agroeconomy, especially chicken, pigs, and some fruit trees. The large estates, on the other hand, evolved a large-scale productive system involving irrigation agriculture of wheat, some fruit orchard and market gardening, and large-scale cattle and sheep raising.

There are three aspects of these new socio-economic changes that affected settlement pattern in Texcoco at the beginning of the Spanish Colonial period; they are population decline, property change, and land-use change. These three alterations gave way to the readjustment of settlements towards nucleation, leaving large tracts of land abandoned, a process that will be depicted by decades in the section dealing with land grants below. A brief explanation of the three aspects of socio-economical change that affected the landscape in the Early Colonial phase is given in the following paragraphs.

The first aspect is the collapse of the Indian population, which occurred during the century that followed the Conquest. This disastrous demographic decline that eventually affected all of Mesoamerica, was the result of the introduction of Old World diseases. In the Basin of Mexico, the population declined to a third of its former numbers by 1580, and to a fourth by 1600 (Sanders *et. al.* 1979: 243).

The data used to evaluate the demographic collapse includes civil tax censuses and ecclesiastic documents (see: Cook and Simpson 1948; Borah 1951; Cook and Borah

1960; Borah and Cook 1963). Although these sources pose some problems for the reconstruction of population, there are several ways to get an approximation of the actual figures. In this respect, Sanders *et al.* (1979: 36) explain that both sources of data were complementary to each other, since they were made for different purposes. They point out also that there are some problems in calculating the head tax for years before 1560, when the *encomienda* system was at its peak, because there was no consistency. However, by adding the multiple qualitative statements it is clear that the entire period from 1519 to 1610 was one of population decline.

Besides the toll taken by the epidemics on the Indian communities that accelerated the process of depopulation of the rural realm, the implementation of *congregaciones* was the decisive step in completing the process that left large tracts of land empty. The *congregaciones* (congregations) or *reducciones* were the removal and concentration of dispersed and shrinking settlements into nucleated towns to facilitate conversion and taxation. In the region of Texcoco and Coatepec, the *congregaciones* were consummated in the year 1603, being the head towns of the province the ones that absorbed most of the population, such as Texcoco, Huexotla, Chiauhtla, Coatepec, etc. (AGN, *Congregaciones*, vol. 1 f. 25-26).

The second of the socio-economic aspects was the change in land tenure, a complicated process of estate transference from Indian to Spanish hands. Prem (1992) summarizes the process explaining that as the encomienda system was gradually reformed and virtually disappeared, agriculture and stock raising became the major source of rural economy, producing as a result the competition between Spaniard and Indian over property that ended with partial dispossession of Indian land by the early 1600s. The depopulation of rural lands by epidemics and the reduction of Indian rural settlements by the congregaciones, left large tracts of lands that were subsequently granted mostly to Spaniards through the *mercedes*. This pattern of dispossession of Indian lands set in motion the process that culminated with the formation of large states called *haciendas*, which were institutions that absorbed the Indian population as workers.

The third socio-economic aspect, land-use change, was motivated by the introduction of new methods of land exploitation. Agriculture, although practiced in similar ways as in Aztec times, saw a great transformation with the introduction of plow, which facilitated the breaking of clay soils that are hard to till with the traditional pre-Hispanic implements. Thus, the alluvial and lacustrine realm where irrigation was possible became the focus of large-enterprise agriculture, especially from the hacienda owners. The slopes of piedmonts and hills of great value to the small house garden of the Indian farmers was underestimated, although still used by the Spaniards for agriculture and stock raising, and to a lesser degree by the remaining Indian population. Stock raising came to complete the new mosaic of land use, by the introduction of biota that was alien to the New World landscapes. In the study area, livestock largely consisted of sheep, and Texcoco became an important wool producer (Lewis 1976), especially in the Late Spanish Colonial phase.

All these political, economical, and social changes are reflected in the settlement pattern that gradually structured the Spanish Colonial landscape. The most drastic changes occurred at the beginning of the sixteenth century, as the Indian population declined, and the property was acquired by the Spanish, a process that was evident at its best in the Texcocan landscape by the 1630, an arbitrary date that marks the time when most of the land was granted through the mercedes. Thus, for the analysis of settlement and landscape transformation, in this study the Spanish colonial period has been divided into Early Colonial phase (1520-1630), or the transitional period between the Aztec and Spanish settlement pattern and land use, and the Late Colonial phase (1630-1821), or the maturation of the new system of settlement and land use.

The transformation of settlement pattern in the Early Colonial period

The map of the Early Colonial period shows the approximate distribution, size and number of settlements around 1620 (Figure 4.12). This period witnessed a profound transformation in settlement pattern which occurred in less than a century after the conquest. The hills, upper piedmont, alluvial and the lacustrine plain were depopulated. The alluvial plain and parts of the lower piedmont experienced an apparent growth and nucleation of sites. These settlements , originally Aztec, were re-traced under the new introduced urban configuration in which streets were laid out a as rectangular grid with the administrative and religious premises located in the center. In one particular case --Tepetlaoztoc-- the city was moved to a new place. Thus, Aztec Tepetlaoztoc, a dispersed settlement on the slopes of the Patlachique range, was brought to a valley bottom in the new designed for the Spanish town (Pérez-Lizaur 1975: 151). As experienced in other parts of Latin America, dispersion of rural settlement was disliked by the Spanish for whom agglomerations were one of the elements for civilized

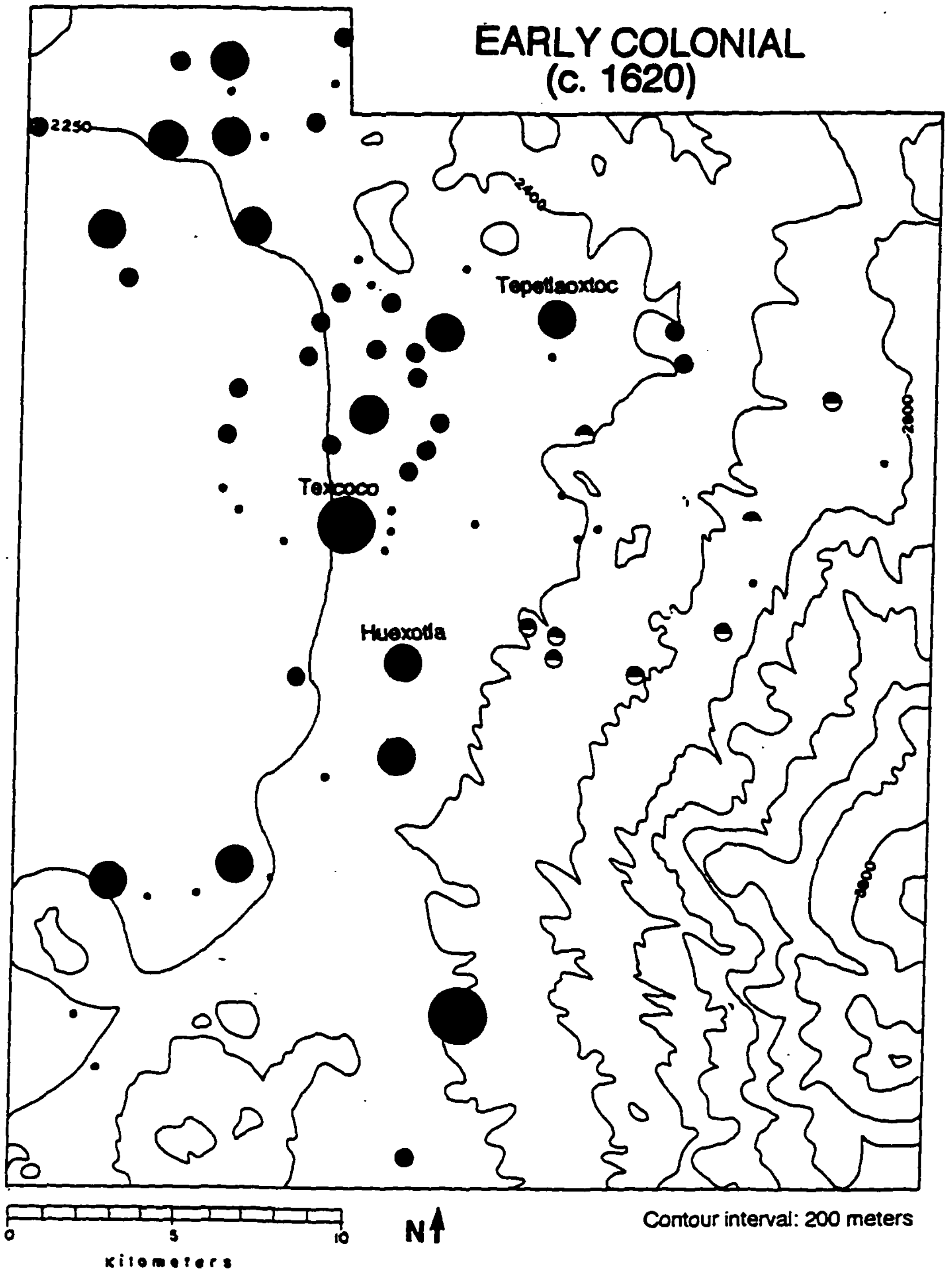


Figure 4.12 Early Colonial settlements (*ca.* 1620) in the Texcoco region.

living as their homeland in Extremadura, Andalusia and New Castile, where peasants lived in nucleated settlements (Gade 1992: 473).

Both the evident nucleation and disappearance of Aztec communities during the Early Colonial period are also reflected in the ceramic styles. The Early Colonial style known as Aztec IV increased notably at the nucleated sites together with other imported styles. In the periphery, on the contrary, especially in dispersed villages and hamlets, these styles are few or are absent, suggesting the concomitant shift of population towards the nucleated centers (Charlton and Nichols, 1992). This process is reflected clearly in the dispersed settlements studied in the upper piedmont of Texcoco, where Aztec IV and imported colonial styles were rare, if not absent, indicating the rather rapid process of rural depopulation.

By 1610 most of the dispersed villages of the piedmont disappeared; the few surviving ones were incorporated into the Spanish settlement system described above but still retaining part of the dispersed character. This type of new villages is named in this study as semi-dispersed settlement and the best examples Tequexquinahuac, San Miguel Tlaixpan, San Pablo Ixayoc, Santa Catarina del Monte, San Jeronimo Amanalco, and San Pedro Chiauhtzingo, all of which functioned as *barrios* of the major towns (*e.g.*

TABLE 4.2
SOME AZTEC SETTLEMENTS ABANDONED BY 1610
(SEE FIGURE 4.13 FOR LOCATIONS)

No.	Name, description and possible Aztec site.	Source
1	Chiconquauhitlimeyo, possible site TA-29 of Evans (1980). Large dispersed village.	Mercedes, vol. 18, 362 vta.
2	There are at least three disappeared settlements: Huexocalco, Tzacaltitlan and Ticoman within the area of site Tx-A-40 (Large dispersed village).	Mercedes, vol. 26, f. 32.
3	Chiapul. Settlement located next to the hill by the same name, within the location of site Tx-A-31 (Large dispersed village).	Mercedes, v. 23, 69.
4	Calalpan. Probably site Tx-A-55.	Mercedes, v.27, f.246.
5	Apantzingo.	Mercedes, v. 17, f. 130. Tierras, v. 2726, exp. 8.
6	San Juan Olopa. Tx-A-78 (Large dispersed village).	Mercedes, v.25, f. 435. Tierras, v. 2726, exp. 8.
7	Tezcohuac. Not reported as a site because it is overlain by modern town of San Nicolás Tlaminca.	Mercedes, v. 16, f. 190. Tierras, v. 2726, exp. 8.
8	Tecpan de la Asunción. Estancia subjected to Chicoloapan. Tx-A-110 (Small dispersed village).	Relación de Chicoloapan. Francisco de Villacastin (1579, in Acuña 1985).
9	San Pedro Chalma subject of Santiago Quatlapanca. Tx-A-102 (Hamlet).	Relación de Coatepec. Francisco de Villacastin (1579, in Acuña 1985)

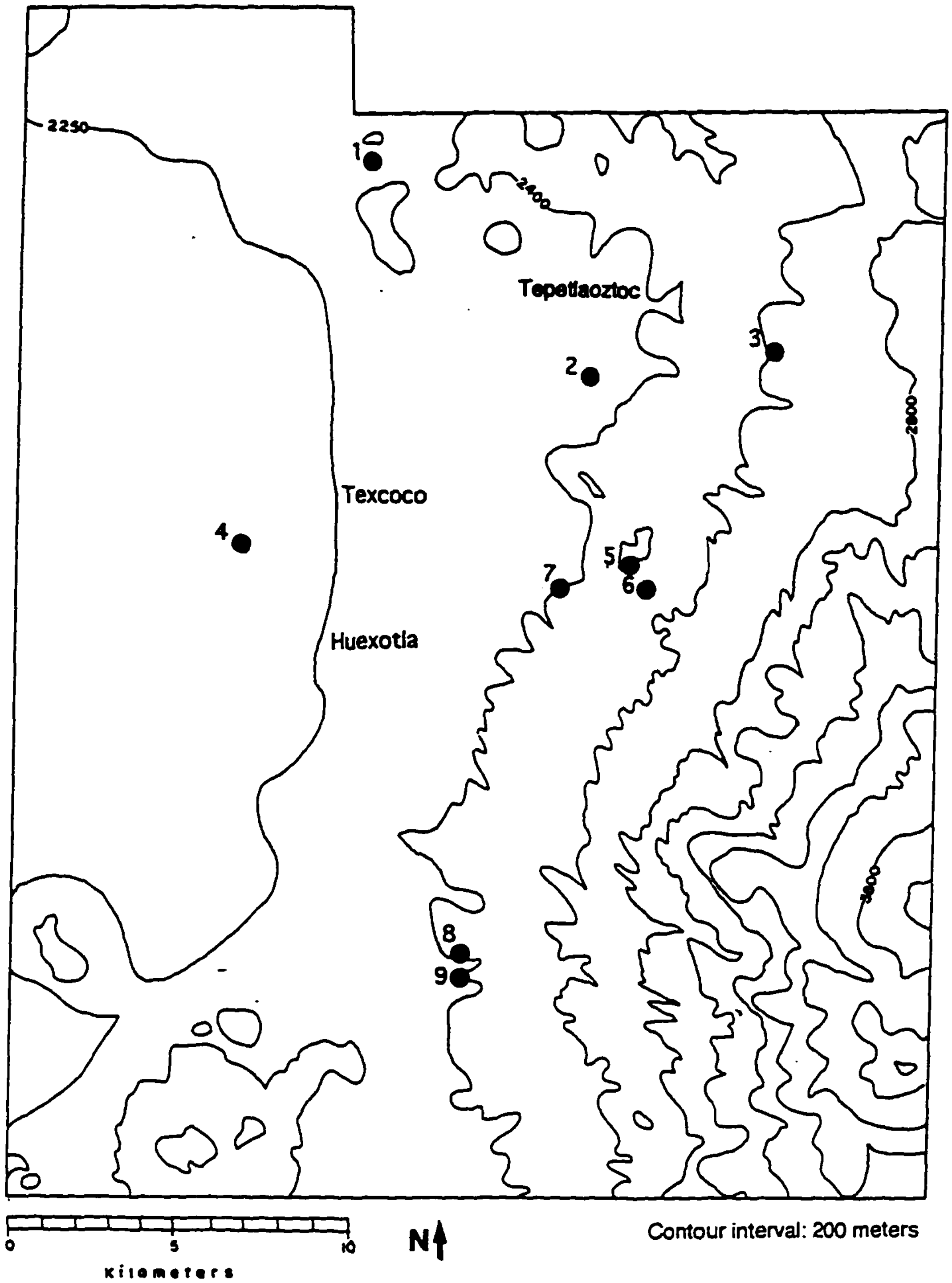


Figure 4.13 Some Aztec settlements abandoned by 1610 (See table 4.2 for explanation of the site numbers used).

Texcoco, Tepetlaoztoc, or Huexotla). There is no certainty whether these villages were already settled in Aztec times, even though most of the areas they occupy now show abundant Aztec surface material. San Miguel Tlaixpan, for instance, seems to have flourished as a dispersed settlement with irrigated orchards in terraces later during the Colonial period (see Pérez-Lizaur 1975). The other settlements are mentioned in late 1500 documents, such as the mercedes.

As for the disappeared settlements there are vague mentions in the *Mercedes* and *Tierras* documents, although in the case of Coatepec and Acolman they are portrayed in maps for the 1580s (See Acuña 1985-86). References in the *Mercedes* and *Tierras* documents allowed me to track down some abandoned settlements that disappeared when the congregaciones were accomplished (Figure 4.13) and equate them with reported Aztec sites by the archaeological survey (Table 4.2).

The deserted areas were eventually occupied by sheep estancias or cultivation fields, or simply remained empty for decades exposed to grazing and erosion.

Transformation of the landscape in the Early Colonial period as testified by land grant documents

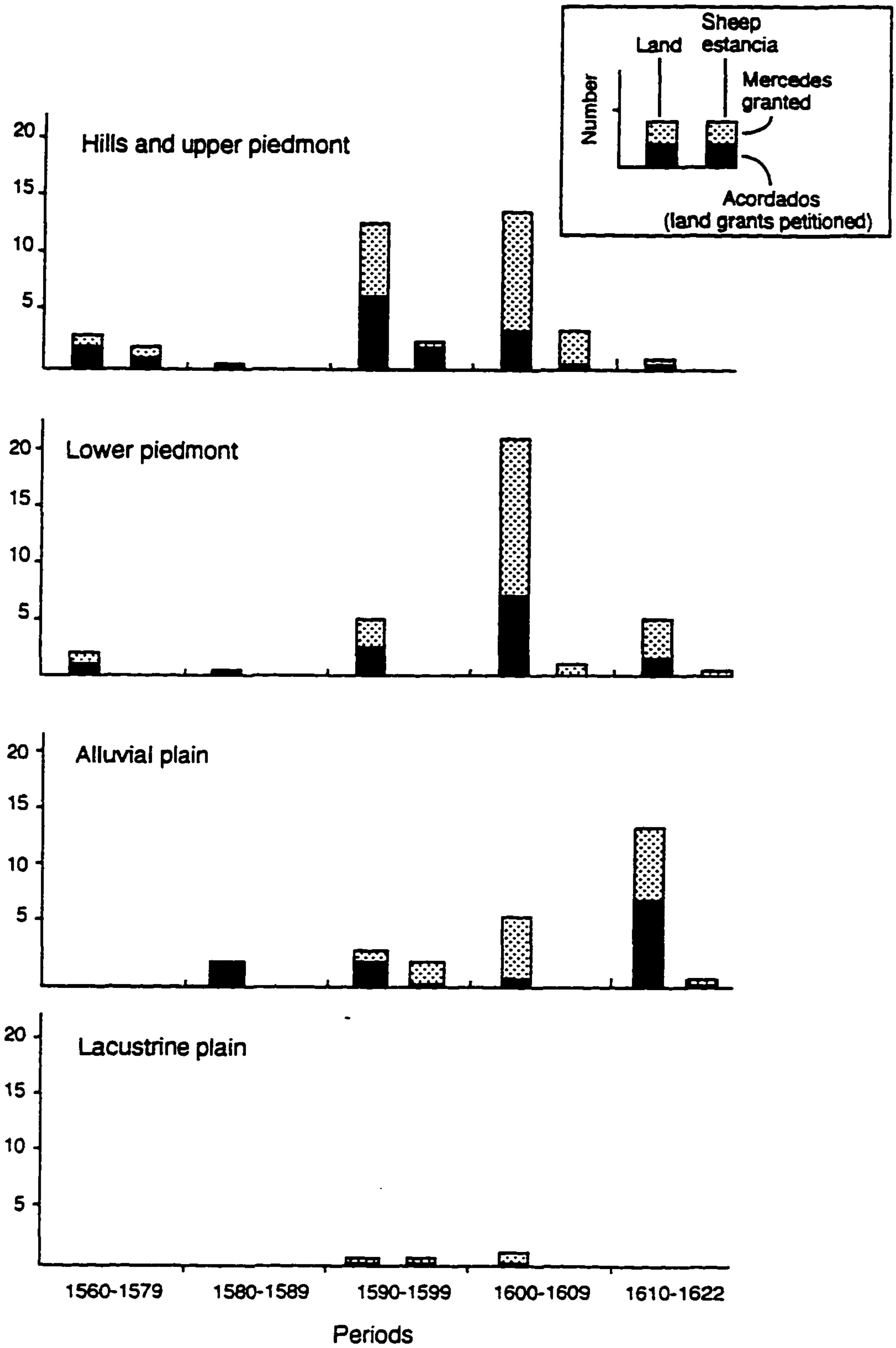
The process of land-use change through the first century following the Spanish Conquest can be reconstructed with the wealth of written and pictorial documents dealing with land limits, land conflicts and land grants.

The Mercedes is the set of documents that have been particularly helpful in the reconstruction of the landscape of the early Spanish Colonial days (Butzer and Butzer 1993). Also, when appreciated in chronological form, they show the gradual process of the Indian demographic collapse and the subsequent "filling-in-the-cracks" by the Spanish, as observed in other areas of central Mexico by Prem (1978, 1992).

Examination of nearly 200 documents facilitated description of the landscape, and it allowed me to find Aztec sites that disappeared in the first century of the Colonial period. Although only 111 sites were accurately or approximately located, the remaining 89 locations were estimated and assigned to an ecological zone, and plotted by zone and decade to show the ecological change (Figure 4.14). The location of 111 sites of requested or granted by decades between 1560 and 1622 was placed on maps by decades (Maps of Figures 4.15-4.20). The description and basic information contained in these 111 documents is summarized in Appendix A.

There are two types of *Mercedes* documents, the *acordado*, or the request for land, and the *merced* proper, which is the confirmation that the request was granted.

Figure 4.14 Land grants and requests by period and ecological zone in the Texcoco region.



Sheep
Land estancia
Number
Mercedes granted
Acordados (land grants petitioned)
20
15
10
5
Hills and upper piedmont
20
15
10
5
Lower piedmont
20
15
10
5
Alluvial plain
20
15
10
5
Lacustrine plain
1560-1579
1580-1589
1590-1599
1600-1609
1610-1622
Periods

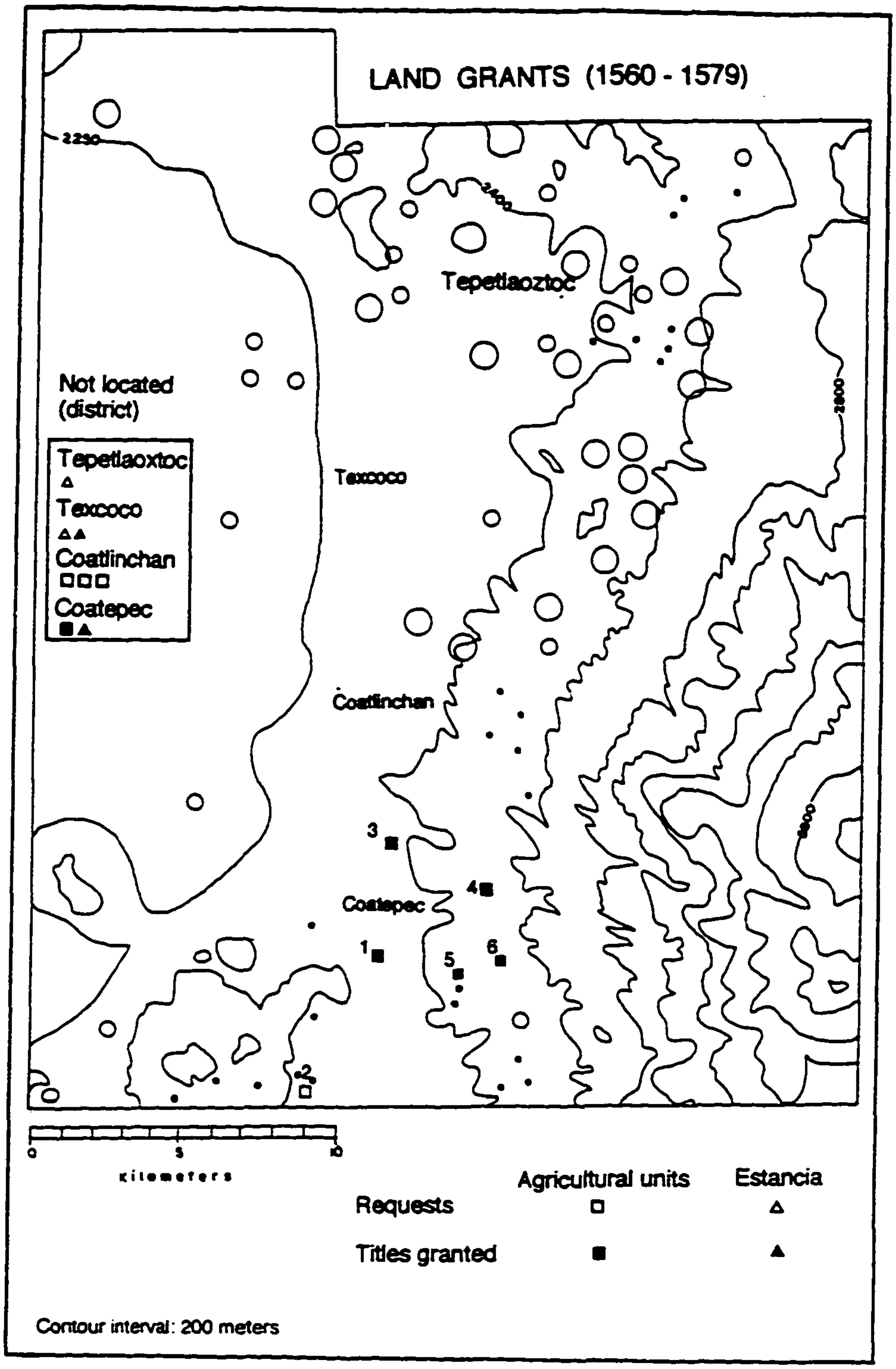


Figure 4.15 Land grants and land requests (1560-1579). The open circles in this series of maps indicate abandoned Aztec sites.

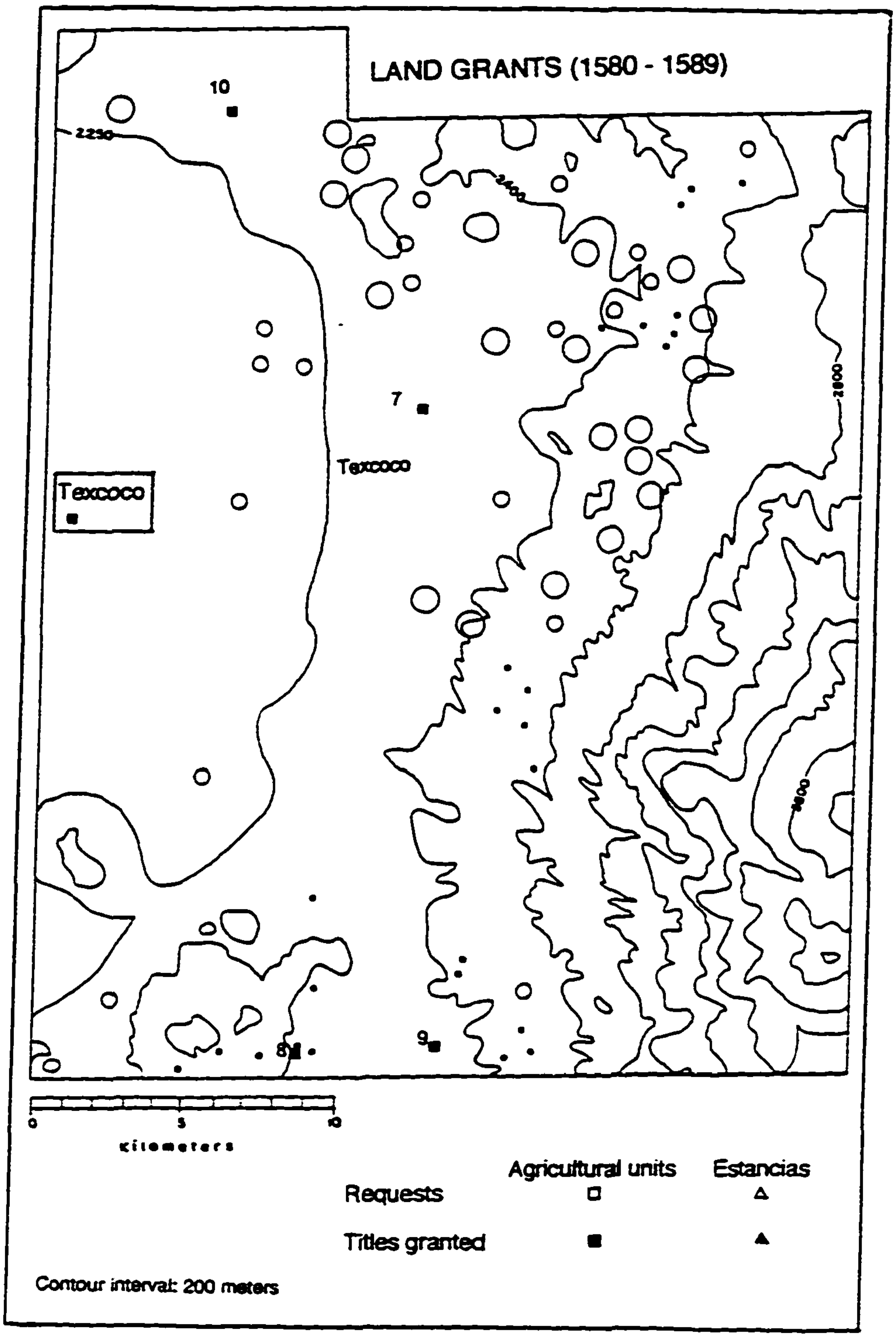


Figure 4.16 Land grants and land requests (1580-1589).

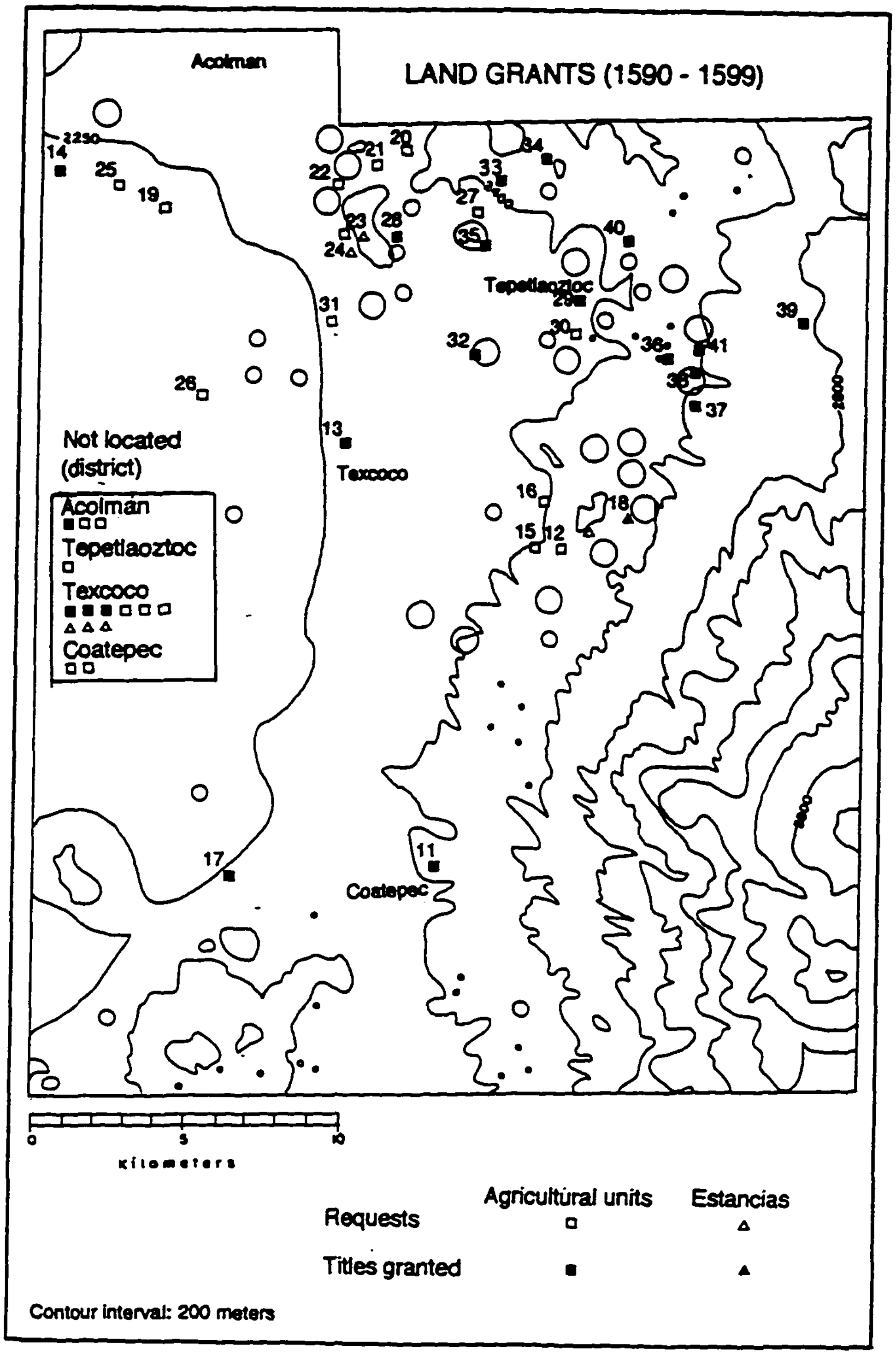


Figure 4.17 Land grants and land requests (1590-1599).

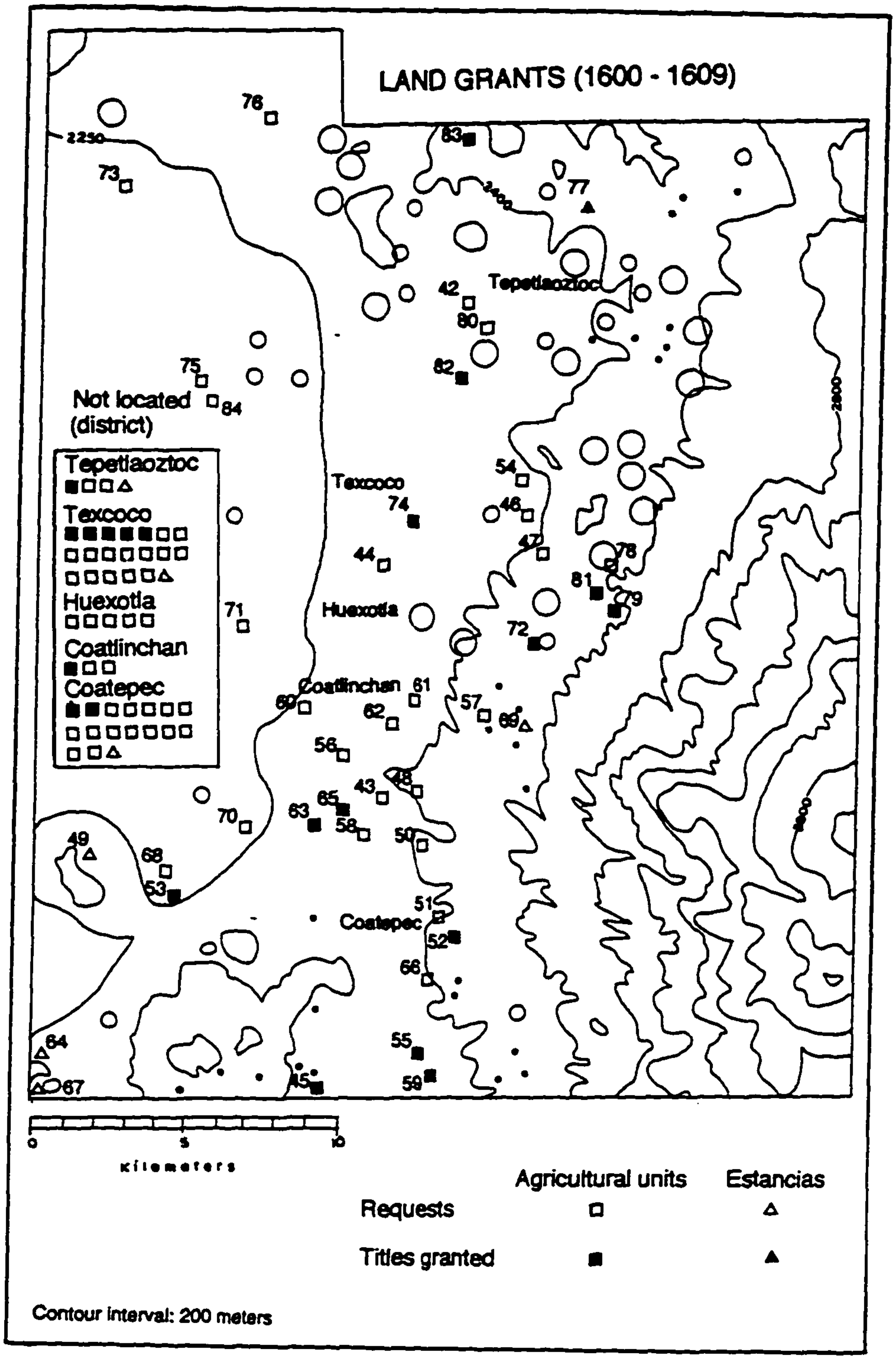


Figure 4.18 Land grants and land requests (1600-1609).

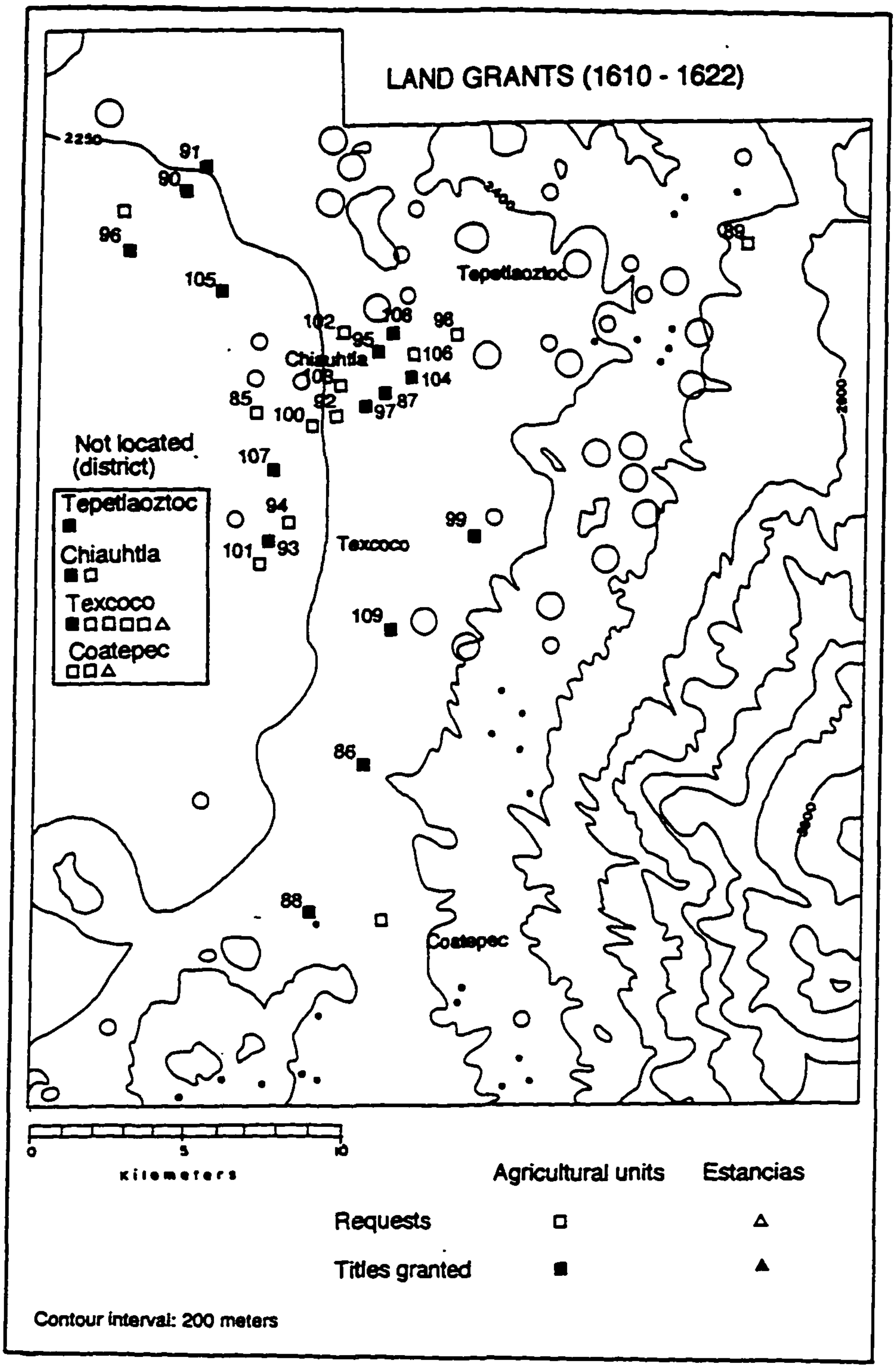


Figure 4.19 Land grant and land requests (1610-1622).

There were two types of properties requested or granted, the *tierra* and the *estancia*. *Tierra* was land for cultivation, usually measured in *caballería* units, which is approximately 21.4 ha (Butzer and Butzer 1993). The *estancias* were stations to keep livestock, that were "*de ganado menor*", for sheep and goats, and "*de ganado mayor*" for cattle, of approximately 7.76 km^2 and 17.49km^2, respectively, according to Gibson (1964:276). Water for irrigation and gristmill sites along rivers weas also granted as mercedes, but these items are treated separately in this study.

It seems that through the entire period studied (1560-1622) the piedmonts and hills were the zones with the largest number of requests and grants. The process began in the period 1560-1579 with few grants, especially in the south around Coatepec (Figure 4.15). During this period the area with most grants was the upper piedmont, suggesting that this was the first zone to experience the effects of slow depopulation. By this time two epidemics had reduced the Indian populace, one in the period 1545-1948 (Gibson 1964: 62), and the second in the 1570s (Pomar 1986: 99). In the next decade (1580-1589) the number of land requests was low, especially for the piedmonts and hills, although new requests appeared for the alluvial plain. In regard to this low number there is no apparent explanation. It is probable that the collection does not contain the entire number of documents for this period.

A sizable increase in lands requested and granted occurred in the decade of the 1590s, the area of upper piedmont and hills being the one with the largest number of requests (Figure 4.17). It is at this time when the Tierras documents and their attached maps also depict the lands of the upper piedmont and hills east of Texcoco, Huexotla and Coatlinchan as *tierras baldías* (unoccupied or deserted lands) or allude to former Aztec settlements or reduced settlements of Indians. However, in this decade, the majority of areas of land grants were no longer concentrated in the southern portion, but in the center, and north of the study area (Figure 4.17).

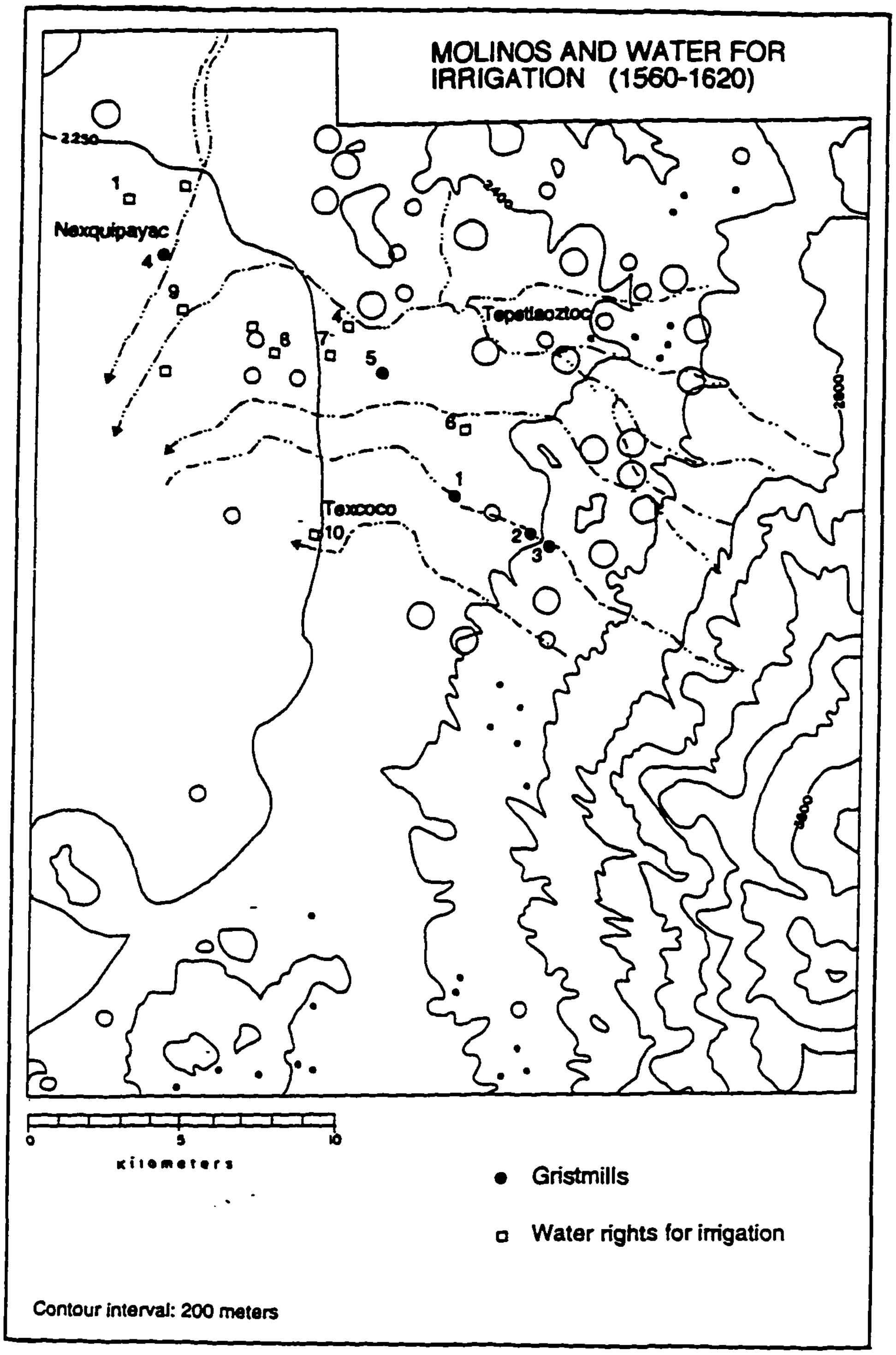
The first decade of the seventeenth century saw a great explosion in the number land grants, most of which where concentrated on hills and piedmonts, although it is the first time that tracts of the alluvial plain were granted (Figure 4.14). This decade (1600-1609) is the period when sites became totally abandoned as the result of the congregaciones, consummated in 1603. Most of the Mercedes documents refer to the disappearance of settlements in hills and piedmonts since frequently they mention that the requested site is "*abandonado de* *congregacion*" (abandoned through congregation) as a justification for the use of the *tierra baldía*.

The process of land grant continued through the decade of the 1610s and early 1620s when the requests and grants were concentrated in the alluvial plain. Probably at this time, most of available land on hills and piedmonts was already granted. It is also common that in this last period of Mercedes the requests for land are made on the exceeding lands of someone's property or grant, referred to in Spanish as "en las demasías de las tierras de", probably indicating that there was no much of new land to request.

Along the entire period studied (1560-1622), it is noticeable that most of the mercedes corresponded to grants for cultivation land, the number of sheep estancias being relatively small. In reality, what these grants depict is the use of land for stock raising at a small scale in a local scale. Sheep and goat raising was a large scale business with an immense number of heads that implied transhumance occupying seasonally vast areas of central Mexico including highlands and coastal plains (Butzer and Butzer 1992b, 1993). However, the effect of sheep grazing in the piedmonts may have been important, even at a small scale, since the lands are highly susceptible to erosion.

Water for irrigation and gristmill sites along rivers is another type of mercedes. Unfortunately, because

Figure 4.20 Grants and requests for gristmills (*molinos*) and water rights for irrigation for the period 1560-1620. See Appendix A, section II for table with explanation of site numbers and water right numbers.


MOLINOS AND WATER FOR IRRIGATION (1560-1620)
2250
2400
2800
3600
Nexquipayac
Tepetlaoztoc
Texcoco
1
2
3
4
5
6
7
8
9
10
0
5
10
kilometers
Gristmills
Water rights for irrigation
Contour interval: 200 meters

the descriptions are not very accurate, only a very small number of them were located on a map (Figure 4.20). However, they indicate that use of streams in the Colonial period was intensified for grain grinding, and the fact that irrigation became important, especially on the plains. In the piedmont, irrigation systems remained basically the same as the Aztec (Palerm and Wolf 1954). New systems were developed parallel to them in subsequent years as suggested by Palerm and Wolf (1954), Sanders (1976) and Pérez-Lizaur (1975), and by recent research on the modern canal systems (Marcianna L. Rodríguez 1993, personal communication).

The Late Colonial period

At the end of the early colonial period, the foundations of the Spanish colonial system were consolidated, and the new system of settlement and land use matured. The result was the expansion of the hacienda system which had several implications. One is the appropriation of most of the cultivable land by the haciendas, a process that started with the mercedes in the 1500s. Thus, in the Basin of Mexico the great haciendas started with the mercedes land grants, and expanded and consolidated through purchase, and two other legal ways called *composiciones* and *denuncias* (Gibson 1964: 289). The *composición* was the legalization of a defective land title through the payments of fees, a process whereby "a weak title may be made good" (Gibson 1964: 285). The *denuncia* was a late colonial device in which an individual denounced a vacant or illegally occupied territory and composed the lands in question for himself (*op. cit.*).

The second implication of the growth of the haciendas was that they favored long-term employment, with the result that Indian families moved out of their traditional communities to settle within the confines of the haciendas (Prem 1992). Through this process , known as *repartimientos*, or temporary work conscription on Indians to work in Spanish properties as a form of tribute, the Indians became *gañanes*, or hacienda laborers.

As time progressed the haciendas expanded in an unchecked manner even into the Independence Period until the process was stopped by the fighting during the Mexican Revolution years in the early 1900s. In the meantime they took up the best lands available, and areas of the piedmonts and mountains, including Indian property. There are several litigations held in the Tierras documents of the AGN, regarding the abuses of the *hacendados* and the take up of Indian land (see an anotated list of documents in Colín, 1966). In response to the abuses and invasions of land, the viceroyal government established a policy of protection of Indian communities creating the *ejido* and the *fondo legal*.

As mentioned before, the extension of the hacienda lands covered zones of all the ecological zones in the study area. The houses are mainly located in the alluvial plain, where they originally started as land grants in the late 1500s and early 1600s (Figure 4.21). The hacienda de Chapingo, for instance, covered large tracts of the alluvial plain and certain areas of the so called *montes* (forest; brush or scrubland; mountain). There were numerous demands against Chapingo for abuses that range from possession of lands to the hindrance of the hacendados to the exploitation of wood in the forests (AGN, Tierras, v. 2520 exp. 3, p. 34; v. 1708, exp. 3, f. 9; v. 1531 exp. 15, f. 40). It seems that the hacendados controlled certain resources and charged the common people for the use of some tracts of lands. There is a demand against the Hacienda La Grande (Figure 4.21) for increase of rents to people who were herding in the grassland of the border of the lacustrine plain and for the exploitation of salt and *tequesquite* (Tierras, v. 1653, exp. 11, f. 73).

In summary, the history of settlement in the Late Colonial period is a continuation of the patterns established during the Early Colonial period, in which the hacienda and their settlements of laborers dominated the

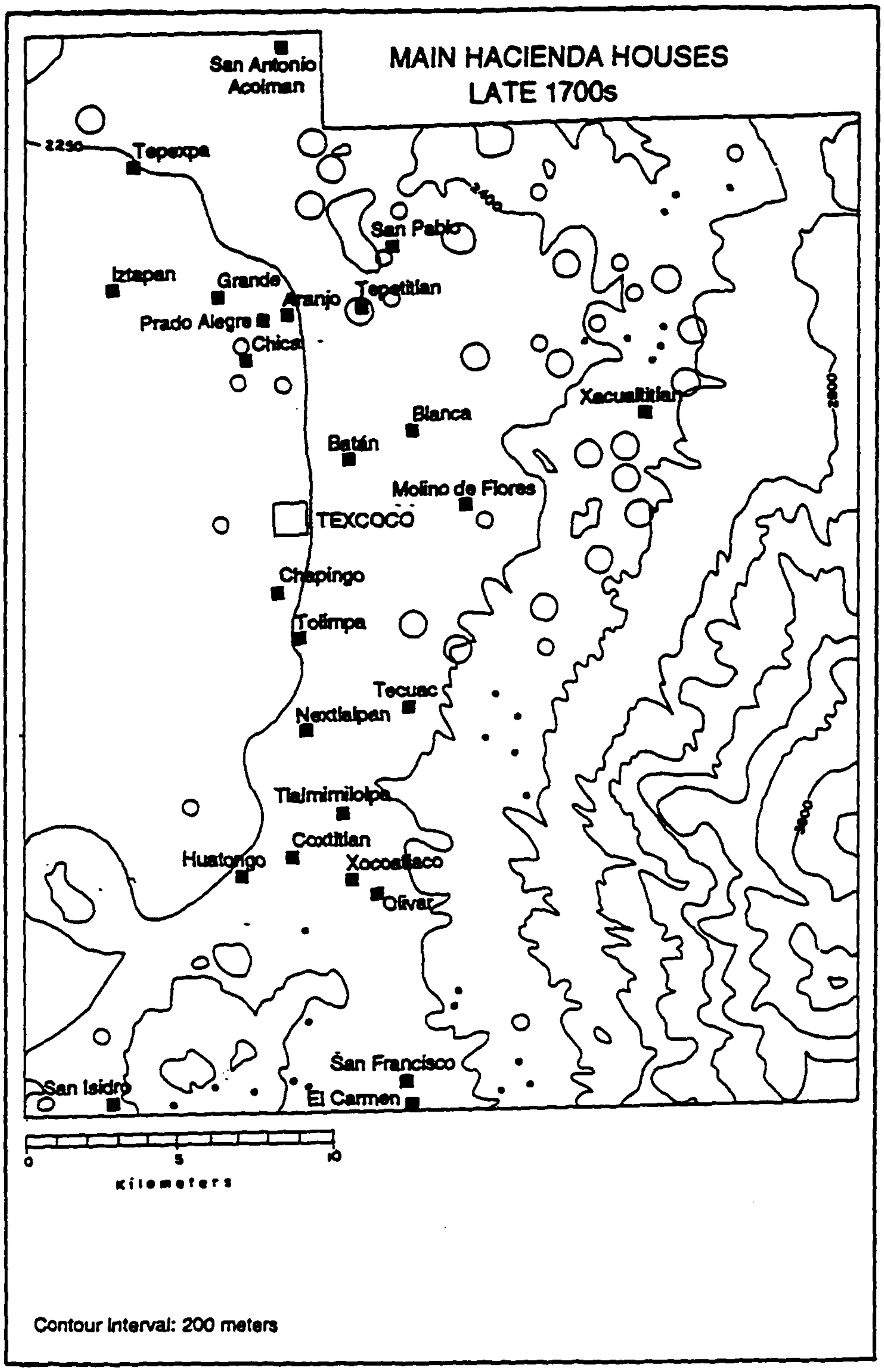


Figure 4.21 Haciendas of the Late Spanish Colonial period (*ca.* 1800). Based on Gibson (1964) with modifications.

rural landscape with a few remaining original Indian villages, and nucleated towns where the Spanish population and urban laborers resided.

Final considerations regarding settlement pattern trends

The diachronic analysis of settlement pattern, as presented in this chapter, is the basis for evaluating possible land-use forms to contrast with the paleoenvironmental data obtained through geoarchaeological research. Nucleation, dispersal and the relationship between site, site hierarchy, and ecological zone are the most relevant aspects of settlement pattern that will be integrated in Chapter 9.

Traditionally, scholars interested in the pre-Hispanic populations of the Basin of Mexico have taken the demographic parameter to assess ecological and socio-political changes. These demographic estimates are based on estimates obtained in a complex method that includes the calculation of number of inhabitants in a site by considering the number of domestic units multiplied by a family-members mean, or considering the area of residential zones in combination with densities of surface material adjusted to the length of each phase (see Parsons 1971: 22-23; and Sanders *et al.* 1979: 34-40). In the Texcoco region, for example, the curve that represents these estimates against time shows the slow increase of population in the Formative period, followed by the low occurred in Classic and Epiclassic, and the rapid increase through the Aztec phases that culminated in the Early Colonial period (Figure 4.22).

The population curve shows an interesting trend that was what gave me the first impression of population figures when I planned this research. However, for the purpose of this study I prefer to consider number of sites instead of population estimates, because my main concern is the spatial distribution of settlement types and associated land-use systems in ecological zones for each archaeological phase. For example, a plot of number of sites per ecological zone (Figure 4.23) shows different trends for each zone, which allowed me to define the main problems of this research. For example, in the upper piedmont and volcanic hills changes in site are dramatic from phase to phase, whereas in the lower piedmont changes are less intense. An explanation to this pattern probably lies in the high susceptibility of the upper piedmont and hills in terms of erosion, a limitation for maintaining stable levels of population, a problem that is discussed in Chapters 5 and 7. The alluvial plain shows a continuous increase in sites with time, which does not match the general trend. The problem here is that there is more

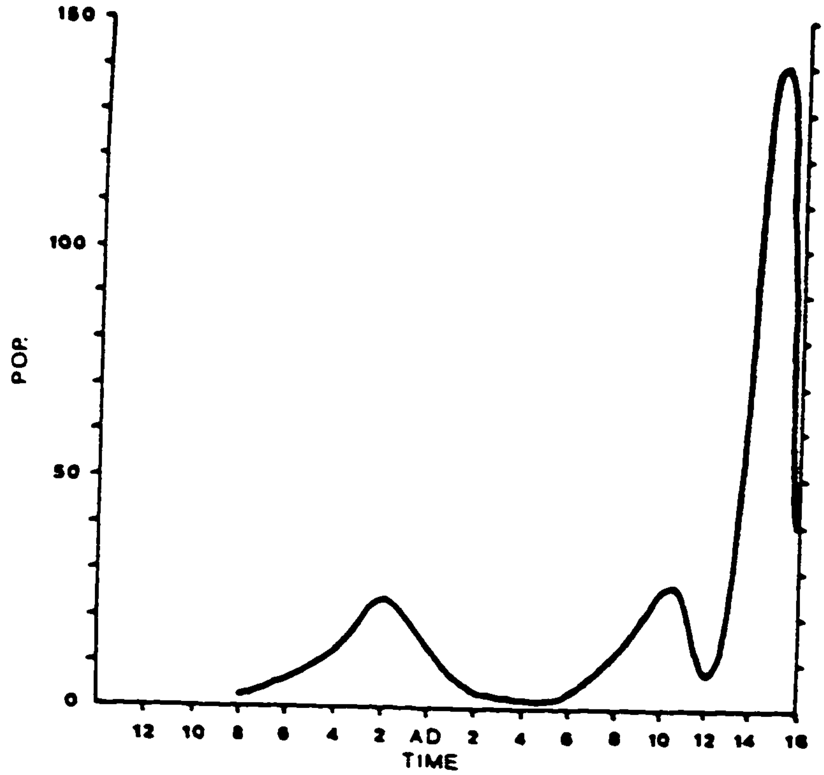
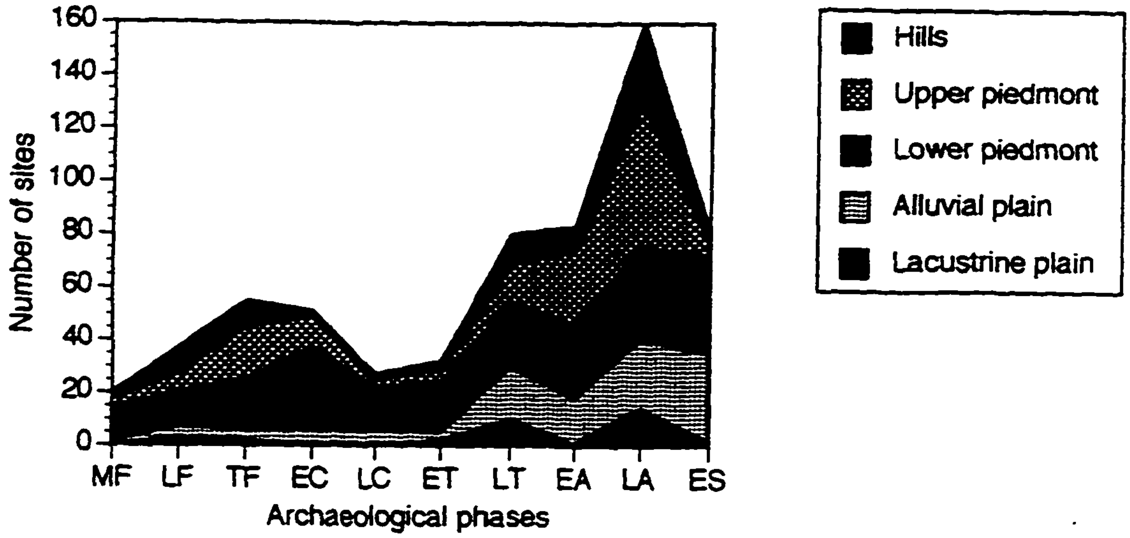


Figure 4.22 Population estimates for the Texcoco Region (Parsons, 1976).



MF Middle Formative
LF Late Formative
TF Terminal Formative
EC Early Classic
LC Late Classic
ET Early Toltec
LT Late Toltec
EA Early Aztec
LA Late Aztec
ES Early Colonial

Figure 4.23 Plot of number of sites per phase and ecological zone. The thick line shows the total for each phase.

possibility that older sites are buried in alluvium, since mantles of alluvial sediment have covered entire sites, affecting the old ones more, a problem that is illustrated in Chapter 6. And finally, the lacustrine plain shows a total decline for the Classic and Epiclassic periods, which can be the result of lake level fluctuations, an issue discussed in Chapter 8. A detailed tabulation of these sites per type and ecological zone is presented in Appendix A.

Finally, another aspect of settlement pattern change relevant to the process of landscape transformation is nucleation and dispersal and its association again with the ecological zones in each phase, which are a good indicators of land-use patterns. This aspect of settlement will be discussed in Chapter 9 on the basis of the data presented in the previous chapters.

CHAPTER 5

TRANSFORMATION OF THE PIEDMONTS AND SOIL EROSION CHRONOLOGY

One of the most outstanding marks in the landscapes of the piedmont is the severely eroded badland areas that conform a belt that extends along the upper piedmont. It is interesting that the areas affected by soil stripping and gullying coincide with the distribution of disappeared Aztec sites, most of which were dispersed settlements (Figure 5.1). It is because of this spatial relationship that the geoarchaeological study of erosion was focused on Aztec dispersed settlements on the piedmont.

In addition, it is noticeable in Figure 5.1 that the streams, whose floodplains underwent rapid sedimentation in the late Holocene, have their headwaters in the eroded areas of the piedmont. The study of the floodplains is presented in detail in the next chapter.

Five sites in the central sector of the study area have been selected to test soils and erosional features, and their association with cultural elements, in order to evaluate the causes of soil erosion and barranca incision in the context of the landscape transformation of the Texcocan Piedmonts. Two of the sites —Tx-A-78 and Tx-A-

86— were classified as large dispersed villages, and the other three —Tx-A-56, Tx-A-57, and Tx-A-87— as nucleated, urban, elite settlements. A detailed chronology of landscape transformation was only possible for site Tx-A-78, on which this chapter places more emphasis; the rest of the sites provided fragments of information useful that was correlate with the major events of soil erosion and land reclamation in Tx-A-78. At the end there is some piece of information obtained also from the northern part of the Texcoco region, around the area of Tepetlaoztoc that was included in this chapter since it is relevant to the study of alluvial sediments in the following chapters.

Several limitations such as the rapid spread of modern urbanization and recent destruction due to reforestation, constrained the recovery of information to only certain aspects of settlement. However, it is a good complement to the overall interpretation of the evolution of the Aztec and Early Colonial landscapes.

A discussion of several aspects of site selectivity, and internal structure of sites, as well as the character of soil erosion in the piedmonts in the area of the five central sites is given prior to presenting the specific pieces of evidence from each site. At the end of this chapter, a chronology of soil erosion is proposed drawing from the results achieved in each site.

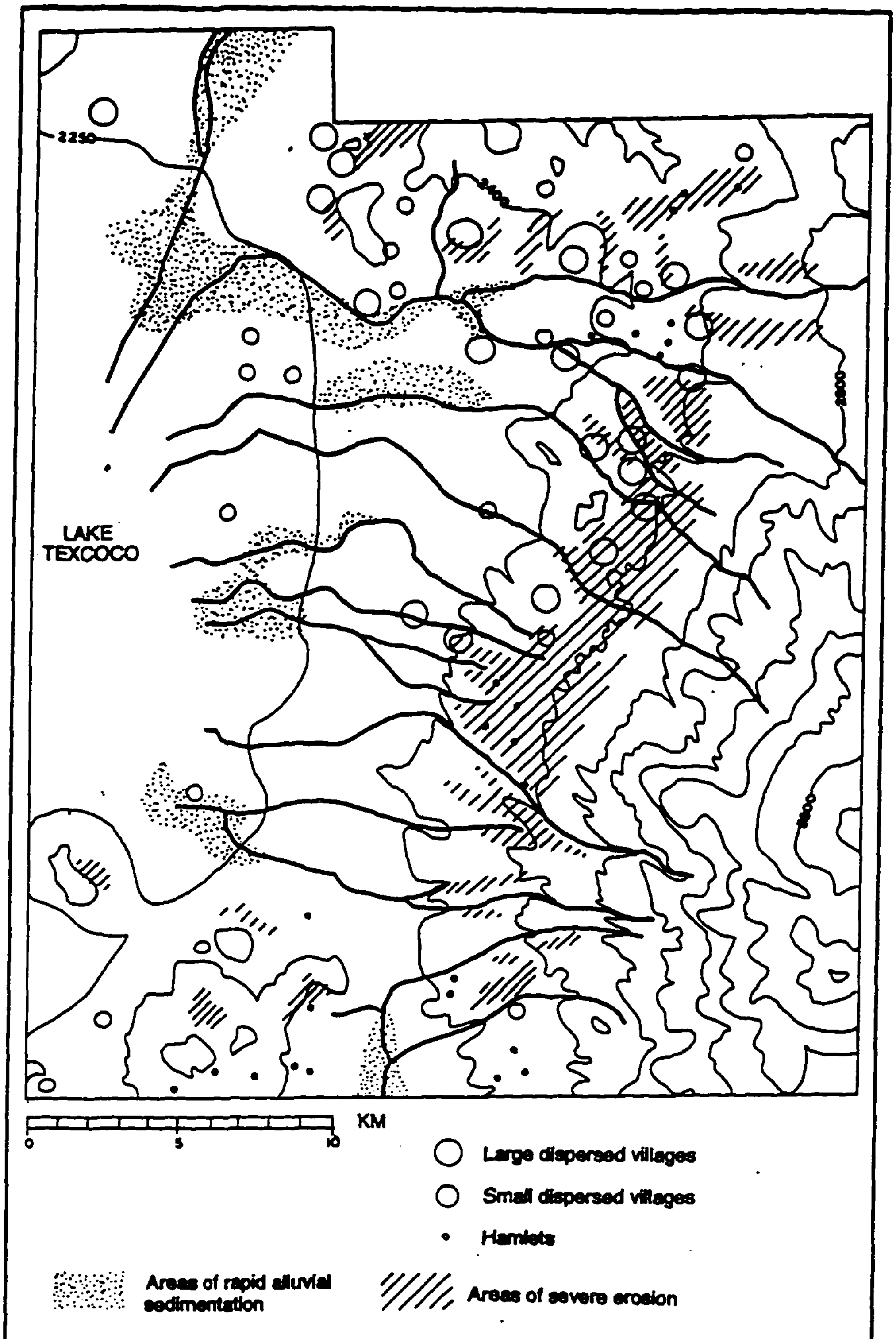


Figure 5.1 Eroded areas and Aztec settlements abandoned by 1610.

Environment, settlement, and land-use on the piedmonts

The character of the Aztec settlement on the piedmont

The Late Aztec phase or Late Horizon (A.D. 1350-1520) the archaeological survey maps of the Basin of Mexico show a large number of dispersed villages (Sanders *et al.*, 1979), suggesting that dispersed settlement was the most common form of occupation in the Aztec rural realm. Even sites considered to have played an important political role as provincial centers, such as the case of Tepetlaoztoc, were large dispersed settlements (Parsons, 1971:220). The piedmont east of Texcoco was fully occupied by rural dispersed settlements lining along the interfluvial surfaces (Fig. 5.2)

The survey maps of the Basin of Mexico (Sanders *et al.*, 1979) show also for areas other than Texcoco the Aztec dispersed villages were preferably located on piedmonts. This recurrent pattern suggests that the piedmont probably was the suitable type of rural settlement for areas of low agricultural productivity, due to thin soils, erosion, and low availability of water for irrigation. However, in some areas the distribution of lacustrine resources offered a situation in which dispersed settlement was not uncommon.

Several studies of rural Aztec communities have characterized various elements common to Aztec land use on

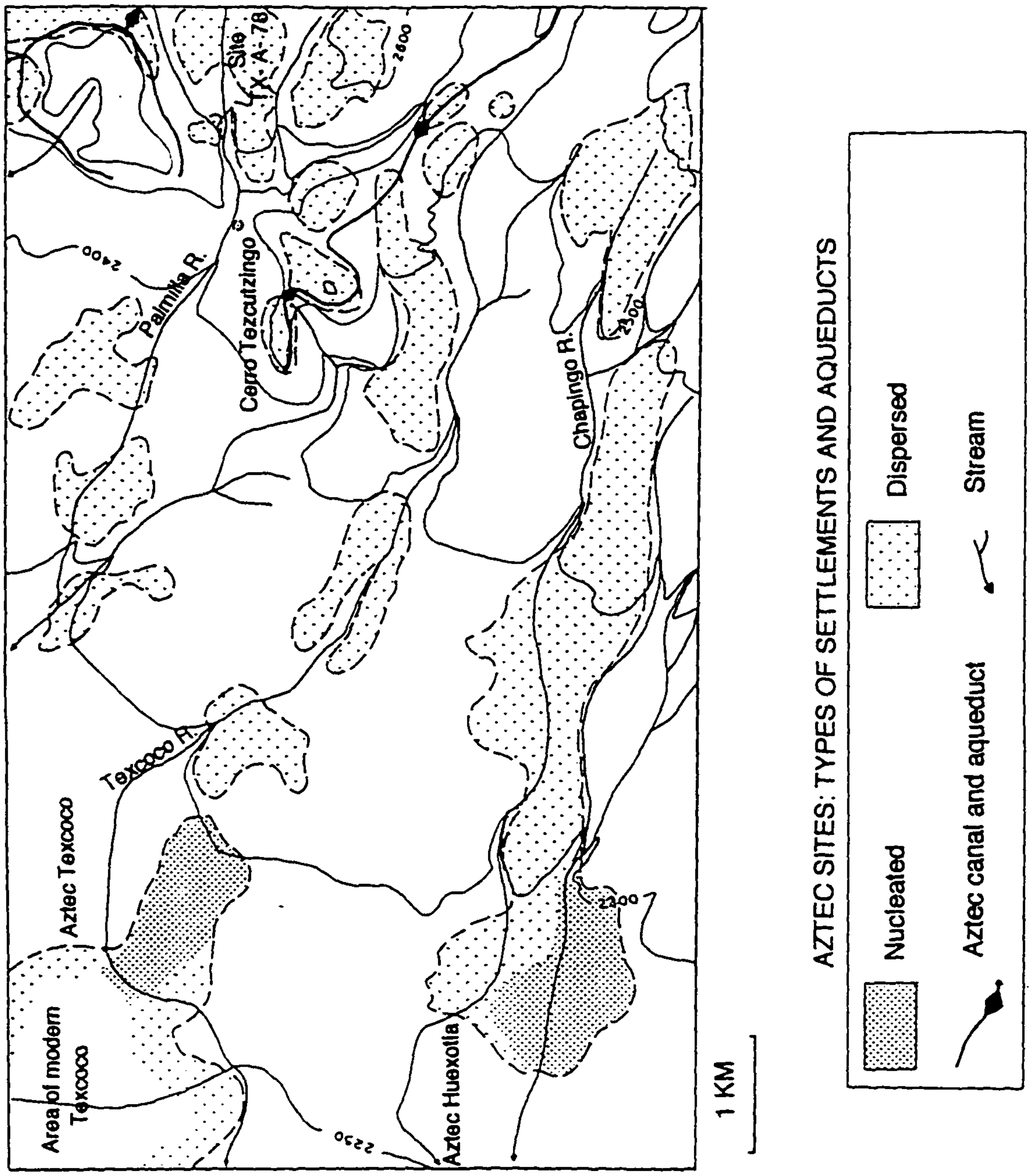


Figure 5.2 Scatters of Aztec material, canals, and aqueducts. After Parsons (1971).

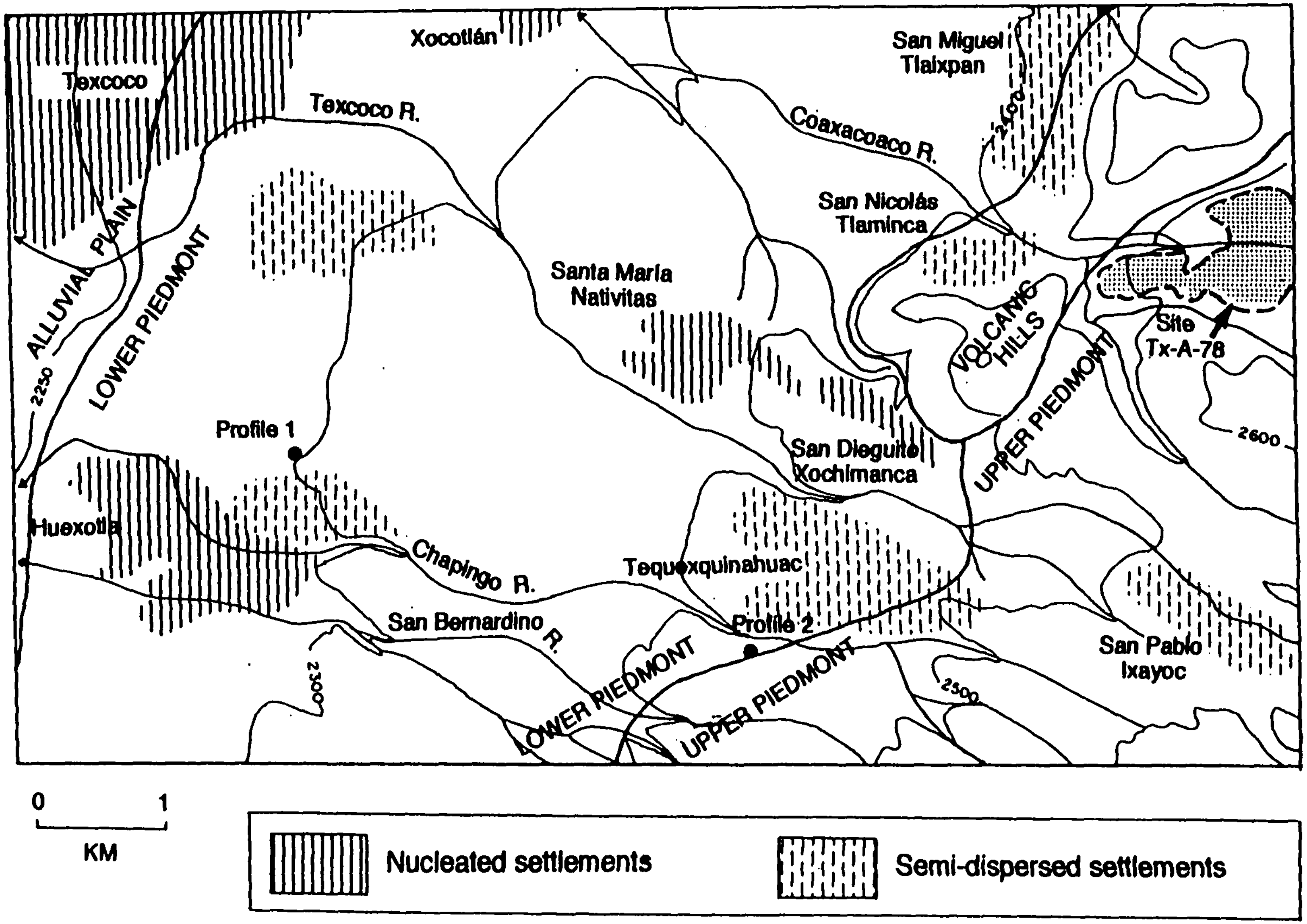
piedmont areas, especially in the management of slopes (Cabrero 1988; Evans 1994; Williams 1994). One of these elements is the use of stone-faced terraces, built in areas of steeper slope and rocky substrate; and the other is *metepantli*, a semi-terracing system consisting in the lay-out of rows of 'maguey' (*Agave* spp.). Both the terraces and metepantlis retained moisture and prevented soil erosion, critical to utilize the relatively dry and cold marginal lands (West, 1971; Donkin 1979; Sanders *et al.*, 1979, Parsons and Parsons, 1990). Metepantlis also played an important role in plot field demarcation, as has been demonstrated for Tepetlaoztoc (Williams, 1994), and Cihuatecpan in the Teotihuacan Valley (Evans, 1990). The location of dwellings within the fields was another common feature of the Aztec landscapes as depicted in the codices and demonstrated by modern analogues known as *calmil* (from the Nahuatl *calli* or house, and *milli*, field) (Palerm 1952, Sanders et. al. 1979).

After the Spanish conquest, during the sixteenth and early seventeenth centuries, the dispersed settlement pattern began to change through a gradual process of nucleation that came to form the rural communities that now persist throughout the basin, a pattern in which houses are aligned along streets laid in straight angles, with administrative and religious premises in the center. The only surviving close analogue is what in this research has been defined as the semi-dispersed village, still present in some areas of the piedmont (Figure 5.3). Since the Aztec dispersed village has no modern analogues and seems to be an important ecological adaptation, it is also the objective of this chapter to evaluate its importance in terms of soil conservation through the study of selected sites.

Soil erosion and stream incision

The upper piedmont has been severely eroded though a complicated process occurred in different phases during the Holocene, although the area still produces large amounts of sediments, since most of it is deprived of vegetation in spite of reforestation. A study on sediment yield in several sub-basins within the Texcoco River basin shows that erosion is an ongoing process in the area of bare tepetate where the estimated sediment loss is 16 tons/ha/year, a figure that contrasts with those areas of soil remnants where sediment yield values range between 1 and 3 tons/ha/year (Figueroa-Sandoval 1975). Studies on accelerated erosion on slopes in similar environments in central Mexico have modeled the processes involved in soil stripping and incision in areas of indurated substrates such as ignimbrite or several types of indurated ash deposits, or *tepetates* (See Chapter 2). These studies

Figure 5.3 Density of modern settlement.


Xocotlán
Texcoco
Texcoco R.
San Miguel
Tlaixpan
Coaxacoaco R.
2400
San Nicolás
Tlaminca
ALLUVIAL PLAIN
LOWER PIEDMONT
Santa Maria
Nativitas
VOLCANIC
HILLS
Site
Tx-A-78
UPPER PIEDMONT
2250
Profile 1
2600
San Dieguito
Xochimanca
Huexotla
Chapingo R.
Tequexquinahuac
San Bernardino R.
Profile 2
San Pablo
Ixayoc
LOWER PIEDMONT
UPPER PIEDMONT
2300
2500
0
1
KM
Nucleated settlements
Semi-dispersed settlements

include the analysis of the evolution of soil surface features such as scarplets, soil depressions, and gullies that have been meticulously observed to explain a complicated process of soil erosion, combined with shallow mass-movements produced by non-concentrated throughflow (Bocco, 1993). Similar features that favor soil stripping are present in the upper piedmont of Texcoco, where slope degradation begins with micro-sliding of the upper horizons, and the creation of scarps that retreat to uncover tepetate, leading eventually to a concentrated flow that produces deep incision. The characteristic high erodibility of these soils is due to the impermeability of the tepetate and the argillic B horizons, both operating as internal base level for subsurface flows, stimulating saturation in the horizons above them, and causing sliding that triggers subsequent gully formation (Bocco, 1993:498).

Once rills and gullies are formed, their headwaters tend to move foreward in the direction of divide line of the interfluve. At the same time they broaden to form some kind of erosional scar that eventually will merge with adjacent scars, leaving soil remnants in between that are called soil pedestals which are small flat-toped mesas that are useful in recontructing the paleotopography since their they are bnechmarks of paleosurfaces. Pedestals along or near the divide are larger, with ramifications that extend downslope paralleling the streams. For this reason, archaeological remains reported in surveys are better preserved along the divide.

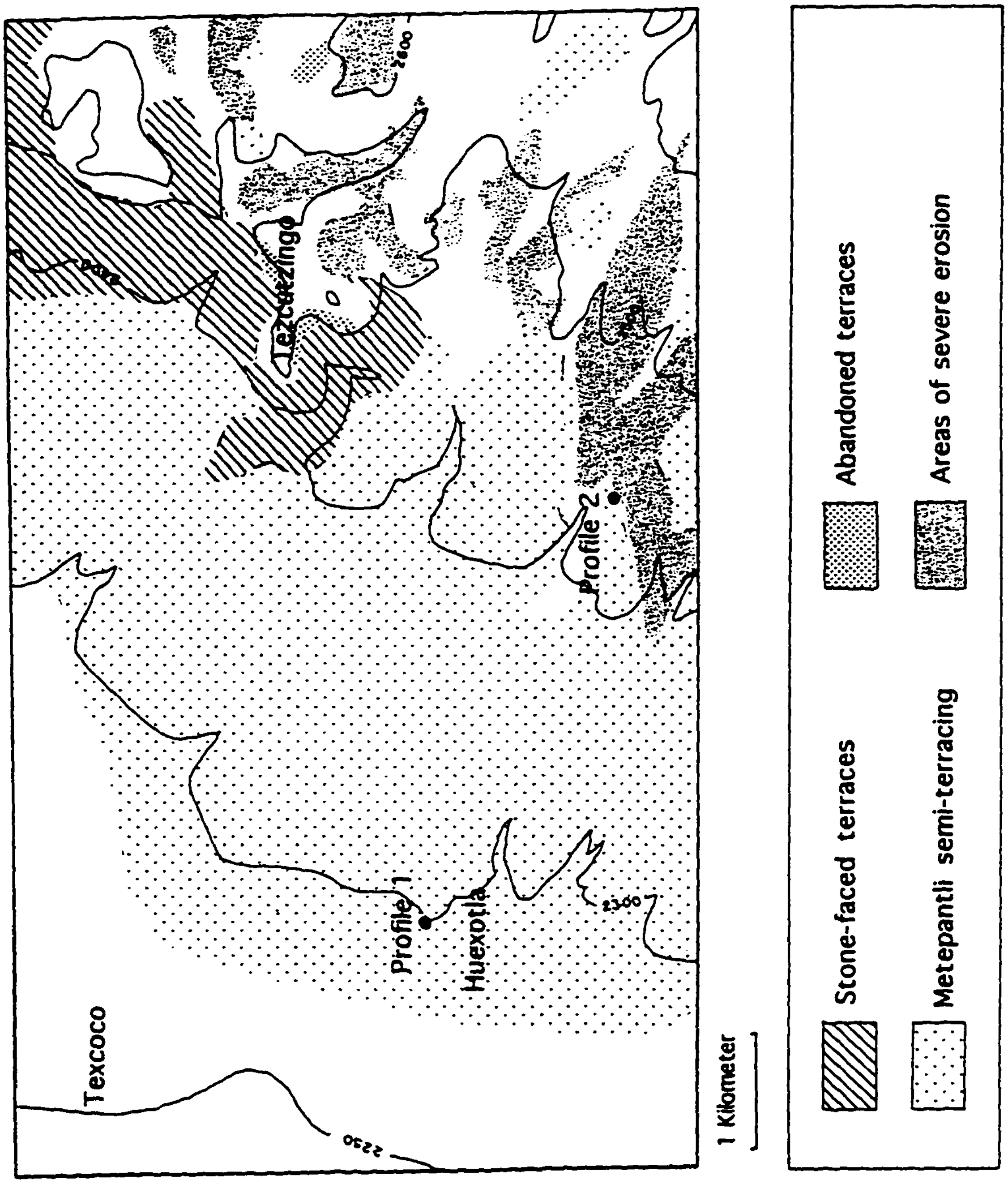
Terraces, metepantlis, and irrigation

The erosional belt of the upper piedmont contrasts with the semi-terraced surfaces of the lower piedmont and the terraces slopes of the Tezcutzingo hills (Fig. 5.4). Remains of terracing in the upper piedmont however accounts for attmepts of land reclamation in the past.

Terrace construction is a soil conservation procedure practiced in this region to control soil erosion on the slopes of volcanic hills and upper piedmonts east of Texcoco since Pre-Conquest times. Most of the modern and abandoned terraces are associated with Aztec sites, or contain abundant artifacts of this period. At present, two basic types of terracing coexist in the area of study: stone walled contour terraces, and *metepantli* semi-terracing, both of them widely practiced in pre-Hispanic times.

Stone-walled terraces occur on the slopes of the old volcanic structures in the Tetzcutzingo area where they have been irrigated since Late Aztec times. In fact, some of them were part of the royal gardens created by king Nezahualcoyotl (ruled 1428-1472) in which irrigation was

Figure 5.4 Soil erosion and terracing.


Texcoco
Profile 1
Huexotla
Tezcutzingo
Profile 2
2600
2300
2250
1 Kilometer
Stone-faced terraces
Abandoned terraces
Metepantli semi-terracing
Areas of severe erosion

implemented through a series of canals that carried water from the mountains across the upper piedmont, crossing depressions on a series of aqueducts (Wolf and Palerm, 1955; Parsons, 1971; Doolittle, 1990). In spite of the advance process of erosion in the upper piedmont, remains of this network of canals and aqueducts still stand out as archaeological features in the landascape (Figure 5.5). Parallel to the Aztec water-conduit network, some Post-Conquest canals tap water from permanent streams at different reaches in the upper piedmont. Stone-walled terraces are basically confined to the volcanic hills because faced stones are available from the abundant deposits of brecciated lavas, as is the common case in other volcanic areas in the Basin of Mexico (Córdova and Vázquez, 1991).

A type of semi-terracing, known as *metepantli* (from the Nahuatl: *metl*, maguey, and *pantli*, line or row), is widespread on the Texcocan piedmonts. Metepantli is a soil conservation method in which rows of maguey (*Agave* spp.) are laid out parallel to the slope in order to retain soil; they are common in the Mexican Highlands (West 1970). Although the basic element used in the retaining walls is maguey, in the area of Texcoco, the rows may also be formed by earth and rock. The purpose of the rooting system of maguey is to reinforce the mass of soil particles and the

Figure 5.5 Aztec aqueduct in the upper piedmont. The slopes in the back have been terraced recently.

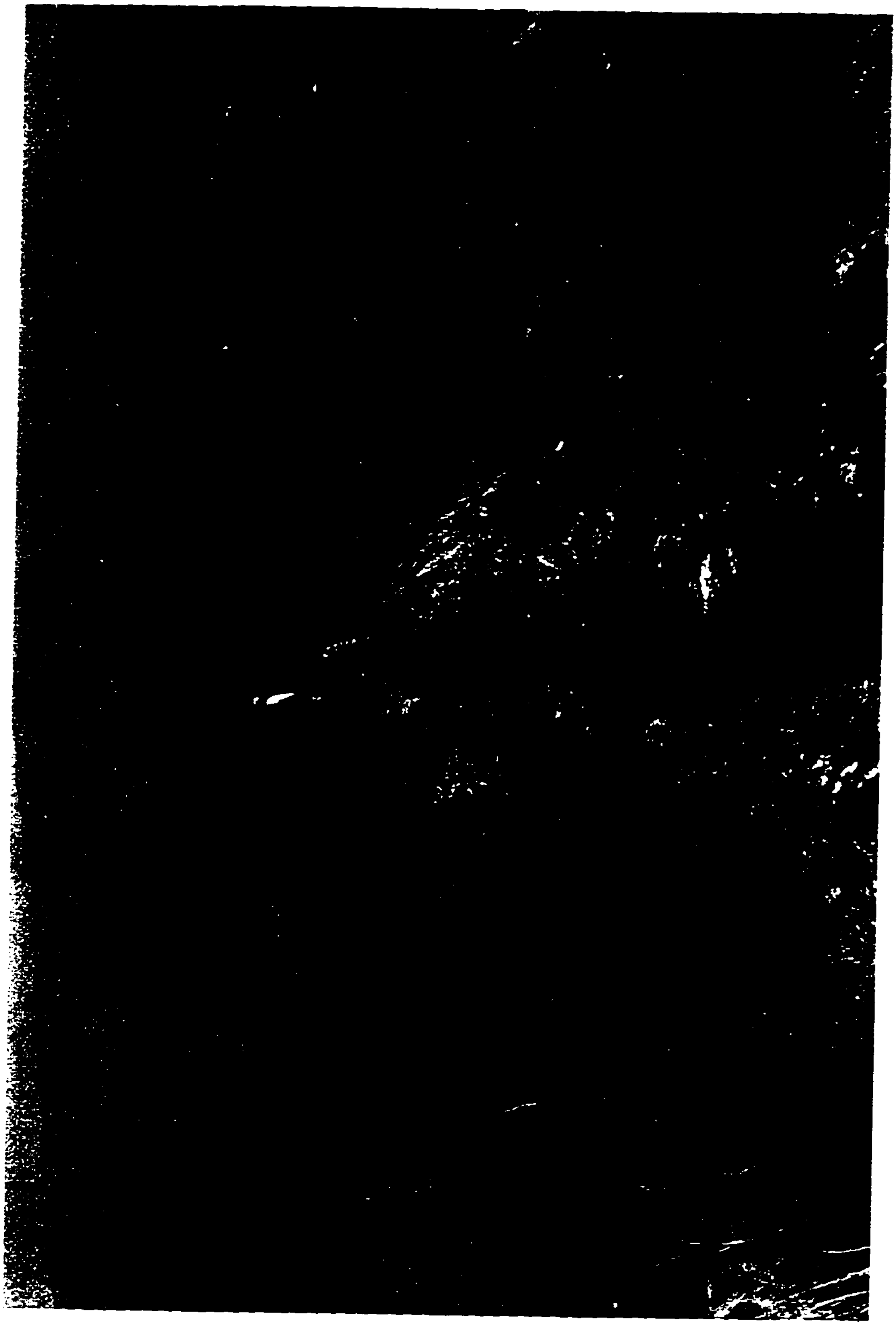
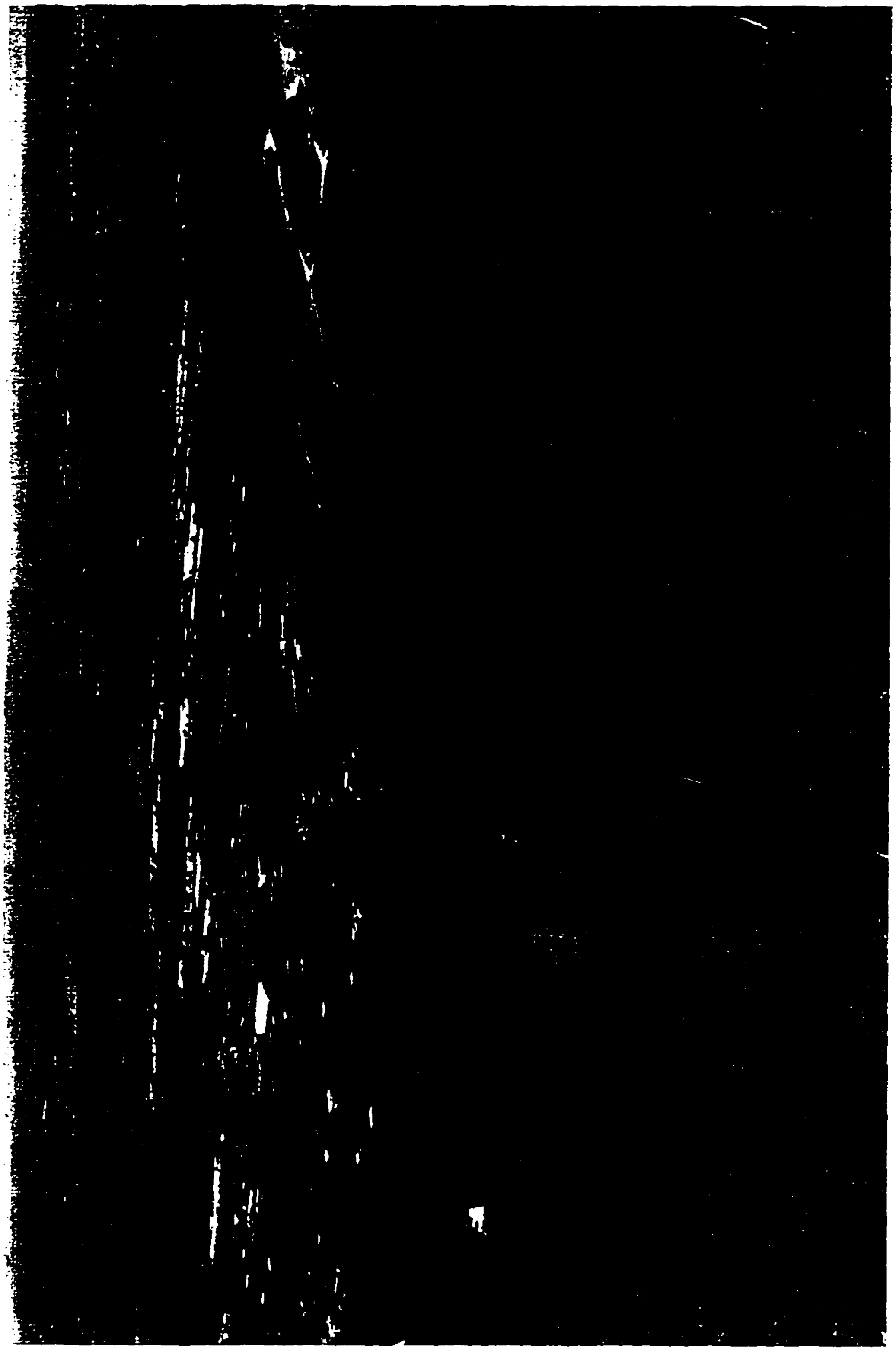


Figure 5.6 Metepantlis on the southern slope of Cerro Tezcutzingo.



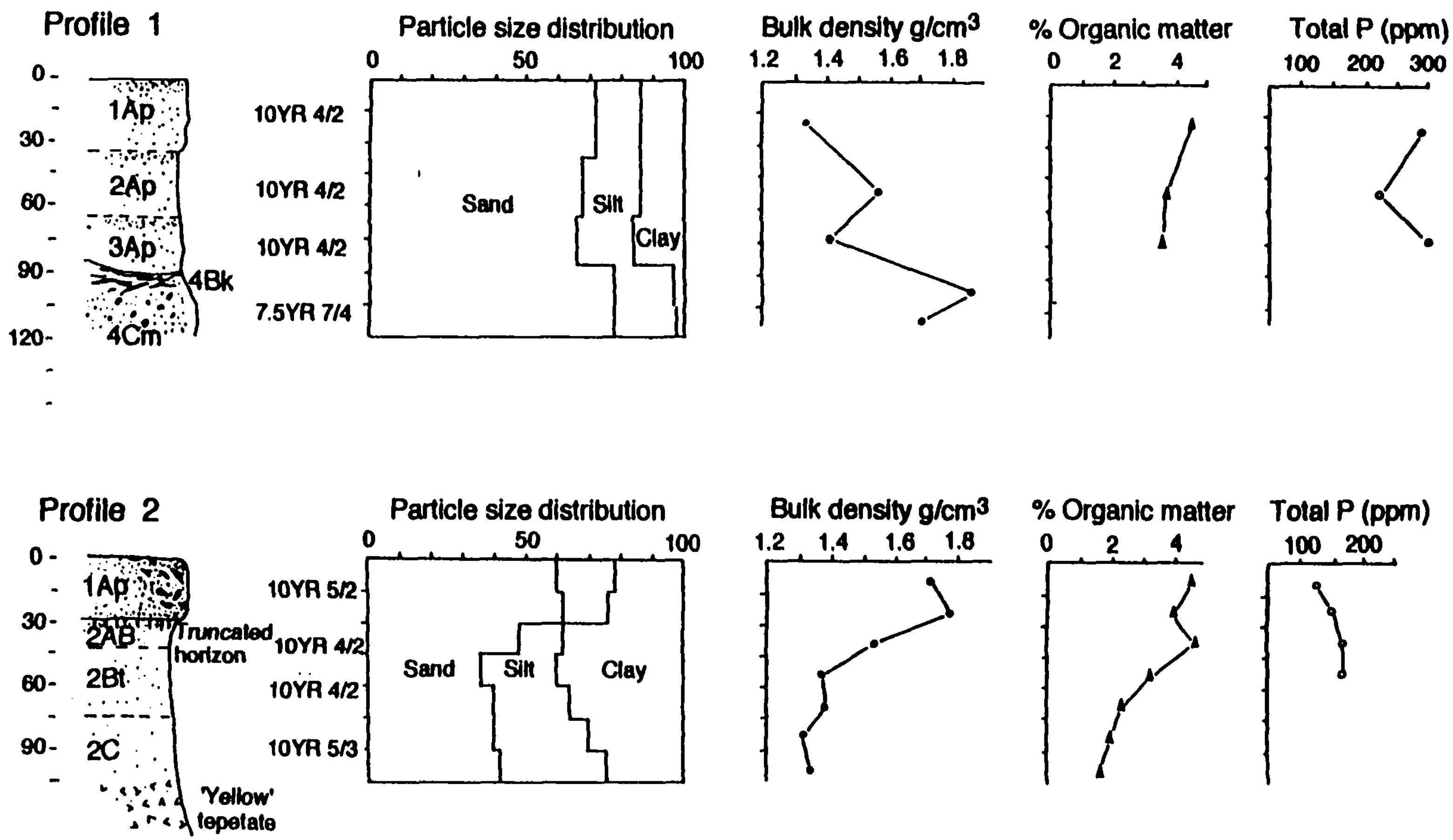
few stones within the bump created along the row. Metepantlis protect thin soils from erosion and increase soil thickness by catching sediments removed from up slope by overland flow or in general by colluviation, although artificial soil build-up is also practiced behind the rows. Thus, metepantli is a technique implemented to solve primarily the problem of erosion, although it seems to have been used to solve other concerns of prehispanic farmers such as the maintaining of soil texture, soil fertility and soil depth (Sanders *et al.*, 1979).

In the study area, metepantlis are widely spread on the lower piedmont, but they are also present on soil remnants of the upper piedmont, usually within Aztec sites, presently cultivated or abandoned (Figure 5.6). Since most of them have been reclaimed or been in use continously, it is hard to find and demonstrate the age of archaeological metepantlis, although they are common in the Basin of Mexico (Sanders *et al.* 1979:249). Current metepantlis are commonly associated with dry farming plots, except in some few areas within the semi-dispersed town of Tequexquinahuac where fields are irrigated.

Two soil profiles in current metepantli fields were studied in order to evaluate their typical structure and properties and make comparisons with archaeological metepantli soils. (see profiles in Figure 5.7 and locations in Figure 5.4). Soil profile 1 represents a long term process of reclamation of sterile surface indurated by calcium carbonate in the form of pedogenic calcrete. The Ap horizons present a low value of bulk density, probably because of the relatively high content of organic matter within a proportional mix of sand, silt and clay. In general, there are no significant changes across the three plow superimposed Ap horizons of this profile; the uppermost horizon ($1A_p$) is currently plowed, the middle horizon (2Ap) shows a relatively higher value of bulk density, and low value of total phosphorus, probably the result of intensive use; the lowermost horizon (3Ap) shows the result of the first reclamation, with similar parameters as 1Ap. Aztec potsherds are present in all three horizons. It is possible that reclamation started in the Aztec period, since this profile is located in the outskirts of the site of Aztec Huexotla.

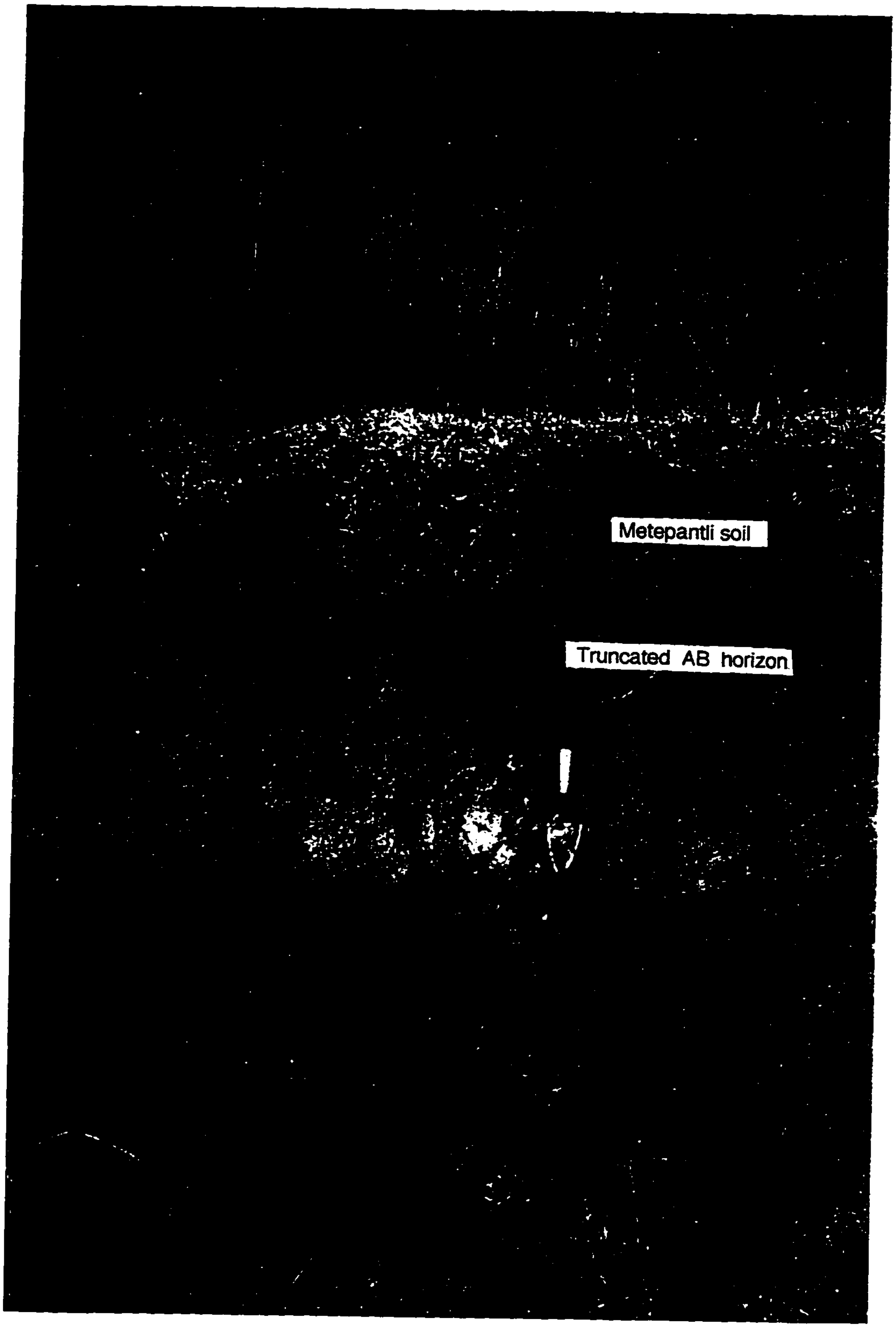
Soil profile 2 represents the reclamation of a soil from which a former A horizon was truncated by erosion (Figure 5.7 and 5.8). Metepantli were constructed on the surface of the 2ABt horizon, so that the 1Ap horizon basically is an artificial deposit of sandy material, mixed with some clay and silt brought in by overland flow. The organic content in this horizon is moderate to high, compared with other soils in the area. A large number of

Figure 5.7 Typical profiles of two metepantli soils (See map of Figure 5.4 for location).



Profile 1
Particle size distribution
Bulk density g/cm3
% Organic matter
Total P (ppm)
1Ap
2Ap
3Ap
4Bk
4Cm
10YR 4/2
10YR 4/2
10YR 4/2
7.5YR 7/4
Sand
Silt
Clay
Profile 2
Particle size distribution
Bulk density g/cm3
% Organic matter
Total P (ppm)
1Ap
2AB
2Bt
2C
Truncated horizon
'Yellow' tepetate
10YR 5/2
10YR 4/2
10YR 4/2
10YR 5/3
Sand
Silt
Clay

Figure 5.8 Profile of Aztec metepantli soil still recently in use (Profile 2).


Metepantli soil
Truncated AB horizon

Aztec sherds record its continuous use during that period, which implies nearby dwellings, confirmed by the large number of Aztec mounds in the area. Thin section study of this 1Ap horizon reveals a well sorted deposit of sand, with interstitial clay binding the sand particles together (Paul Goldberg, personal communication, 1994). Compaction and high density is probably due to this binding of particles, although it may also be due to intense use which is also reflected in a low content of phosphorus (Figure 5.7).

In summary, metepantli soils show a very distinctive Ap horizon built upon underlying horizons or substrate. Their particle size distributions show good sorting and are mostly sandy, with finer fractions introduced by overland flow. They also contain abundant pottery, which in the case of Aztec sites is indicative of the proximity of houses.

Reconstruction of soil erosion and barranca incision at site Tx-A-78

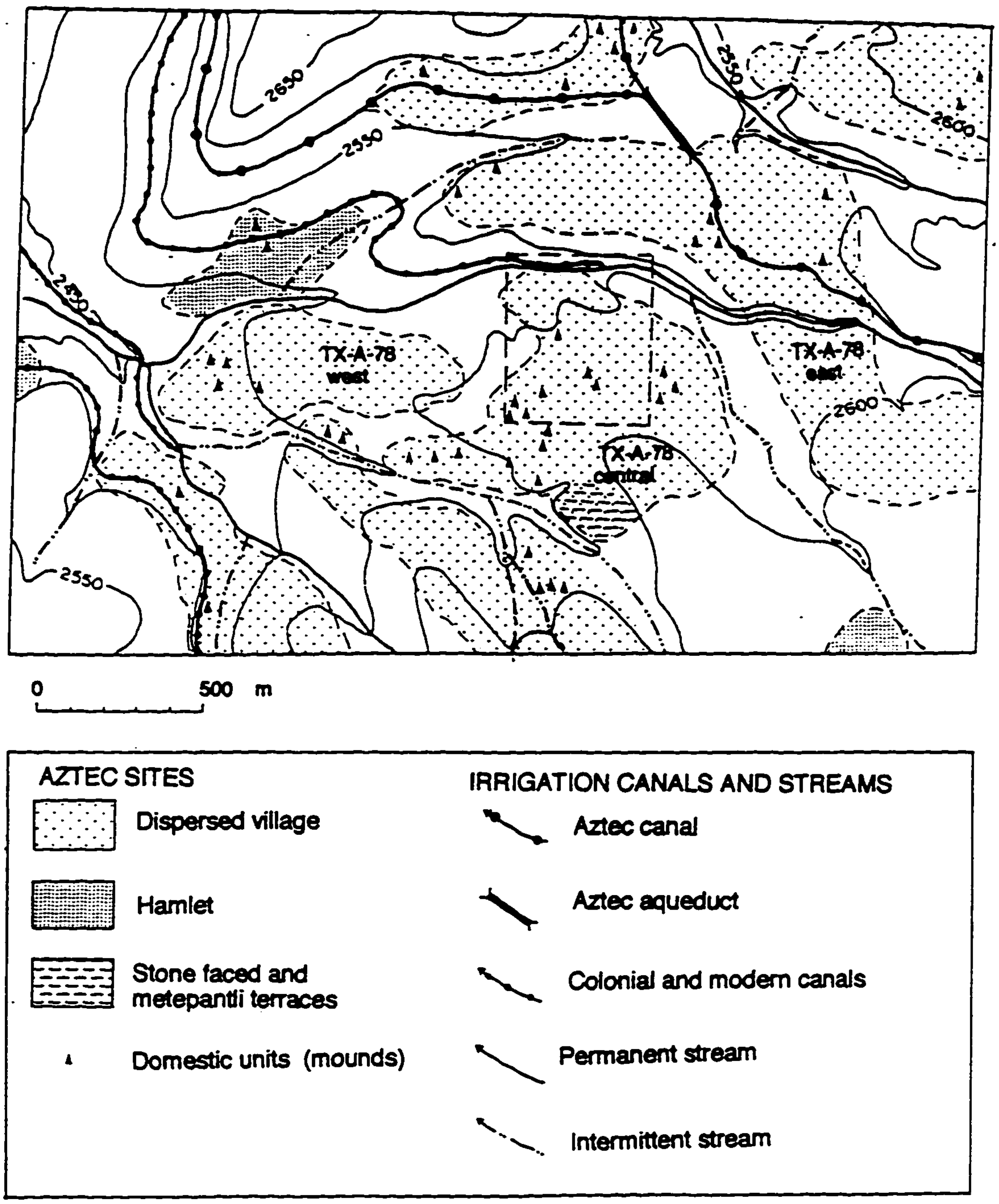
General description of the site

Tx-A-78 extends east-west over an area of elongated hills demarcated by streams. The site has been divided into three sectors by gaps created by eroded surfaces and barrancas. The eastern sector extends towards the mountains and merges with the modern settlement of Santa Catarina del Monte. The central sector is divided from the eastern one by a system of barrancas, and from the western section by a gap resulted from obliteration of the site created by a combination of post-occupational erosion and recent artificial leveling. The western and central sectors extend over a surface of gentle slope dipping north, into a stream with permanent flow; to the south the slope falls off abruptly into a deep barranca of an intermittent stream. This southern slope has been severely eroded, except for a substantial zone where former Aztec terraces have been repaired by a combination of stone-walled terraces and metepantlis; they contain fields that are currently cultivated.

The general aspect of the site is a surface of chaotic topography, due to a dissected tepetate surface interrupted by flat-topped mounds of soil remnants or pedestals. On the largest soil remnants, there are traces of mounds that correspond to domestic structures (triangles in Figure 5.9). The bulk of the ceramics collected from these mounds is Late Aztec, although Early Aztec is not uncommon (Parsons 1971).

The main activity of this village seems to have been rain-fed agriculture, for there is no evidence that irrigation was practiced in the site using the water of the

Figure 5.9 Site Tx-A-78 in the context of the Aztec settlement and irrigation network. Box in the central sector indicates the test area.


2650
2550
2550
2550
2600
2600
2550
TX-A-78 west
TX-A-78 east
TX-A-78 central
0 500 m
AZTEC SITES
Dispersed village
Hamlet
Stone faced and metepantli terraces
Domestic units (mounds)
IRRIGATION CANALS AND STREAMS
Aztec canal
Aztec aqueduct
Colonial and modern canals
Permanent stream
Intermittent stream

canals, except for the use of seepages and local springs, as in the case of a check dam described below. There is indeed no evidence that large scale irrigation was practiced in Aztec times among the dispersed villages of the piedmont, although at some point water for irrigation was requested from king Nezahualcoyotl by villagers elsewhere in the piedmont (McAfee and Barlow, 1946). Canal irrigation apparently was not implemented in this type of community; around Texcoco, canals and aqueducts were instead constructed to conduct water to royal gardens or to built-up areas for utilitarian purposes (Parsons, 1971; Offner, 1981; Doolittle, 1990). Even during the late 1500s, documentary sources mention that the canals crossing the area carried water to the city of Texcoco, to the gristmills downstream, and to the area of Tezcutzingo, where water was used to irrigate lots owned by the surviving Texcocan aristocracy (AGN, *Tierras*, vol. 2726, Exp. 8). At present, water is tapped for irrigation at different reaches of the northern stream and conducted by canals to the area of Tlaixpan.

Activities other than farming around the site probably included exploitation of maguey, fiber for textiles and the sap for preparing substances of nutritional value (*aguamiel, pulque* and cooked flesh) (Parsons and Parsons 1990). Maguey textile processing may have been present in the village, judging by a few spindle whorls recovered. However, this activity was primarily practiced in the towns of the piedmont, where much larger concentrations of spindle whorls are reported (Parsons, 1971; Brumfiel, 1976).

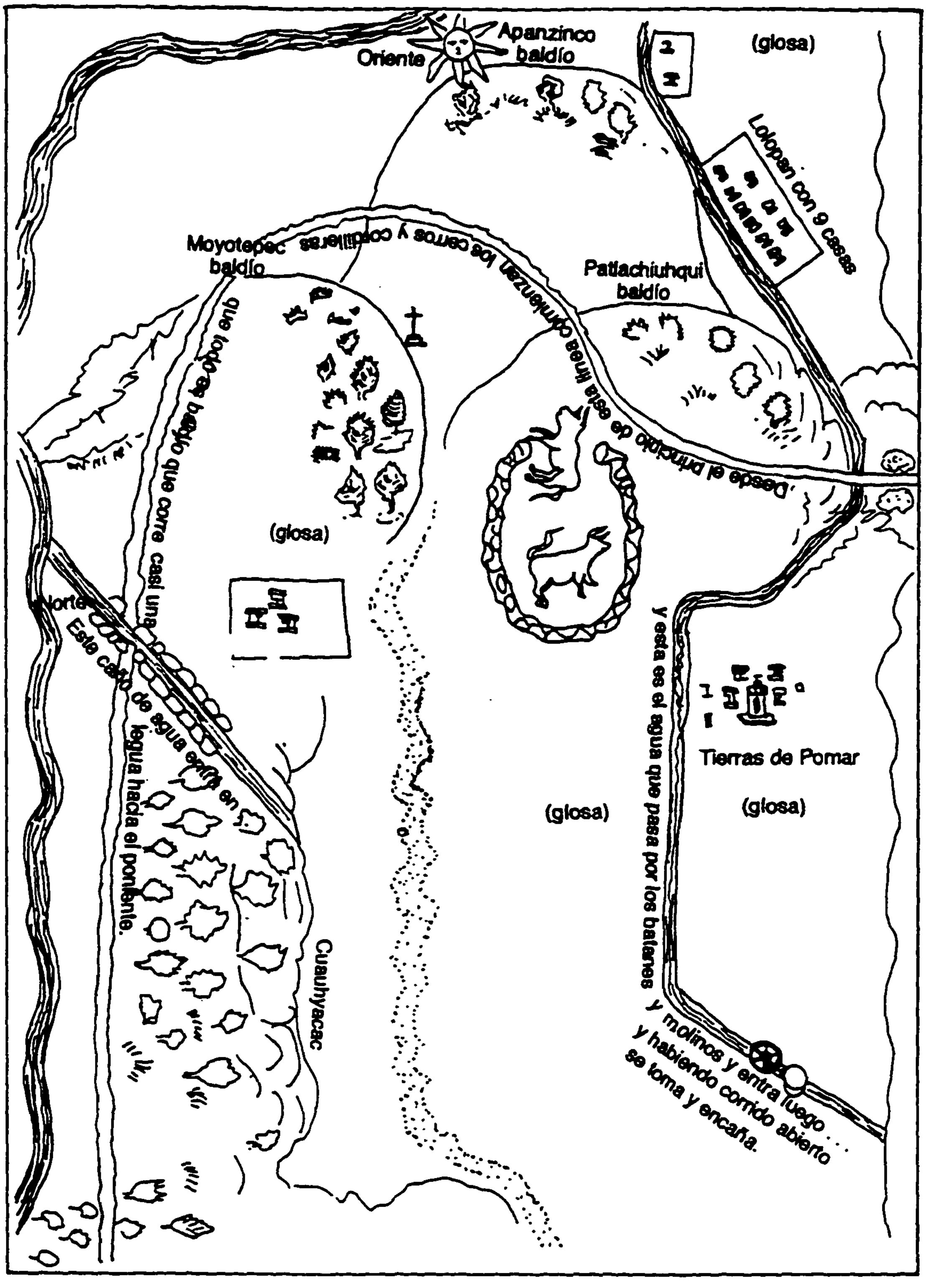
The history and abandonment of the site

The archaeological evidence and historical documents, allow an approximate delineation of site history from its foundation to its abandonment. In the various documents and chronicles the community is constantly referred to as Olopa. Although there are minor occupation traces from Early Aztec times, the community was probably not established until the early 15th century, so that in the historical events that led Nexahualcoyotl to power in 1428, Olopa is recognized by Alva-Ixtilxochitl (1977:69) as *puesto*, namely a small hamlet. The site grew in size and numbers as the century progressed and reaching their maximum at the beginning of the 15th century, based on the abundant Aztec III sherds transitional to Aztec IV. In the years that followed the Spanish Conquest, the community underwent a gradual decline. Probably, the community experienced a dramatic decrease of settlers in between 1576 and 1580 when the epidemics reduced population to one third of previous levels (Pomar 1986: 99).

In 1591, a document dealing with a land conflict, reports that a community by the name of San Juan Olopa had only 9 houses (AGN, *Tierras 2726*, exp.8, see Appendix D), probably located on the western end of the site, as shown on an accompanying map (Figure 5.10). By the descriptions given in this document it is implied that their ancestors represented the class of free commoners or *macehual* (Nahuatl, pl. *macehualtin*), as Hicks (1982) has shown for some communities of this type around Texcoco.

The settlement of Olopa was completely deserted by about 1603 (AGN Mercedes 25, f.435; Congregaciones, vol. 1, f. 25-26), although the decline of the community was gradual during the second half of the 16th century. In 1607, shortly after its abandonement, the area was requested by a Spaniard who asserted that the site was empty as a result of *congregación*, and that there were no claimants (AGN, Mercedes, vol. 25, f. 435). The document specifies that the area of the site was half a *caballería de tierra* , that is 21.4 ha (Butzer and Butzer, 1993); the fact that the documents specifies '*tierra*' (arable land) indicates that the site was not fully devastated by erosion as it appears today.

Figure 5.10 A map accompanying a land litigation document dated 1591. AGN, Tierras, vol. 2726, exp. 8. The map has been redrawn from the original.



Apanzinco
baldío
Oriente
(glosa)
Lolopan con 9 casas
Moyotepec
baldío
Desde el principio de esta línea comienzan los cerros y cordilleras
Patlachiuhqui
baldío
(glosa)
Norte
Cuauhyacac
(glosa)
Tierras de Pomar
(glosa)
y esta es el agua que pasa por los batanes y molinos y entra luego . . .
y habiendo corrido abierto
se toma y encaña.

Test area

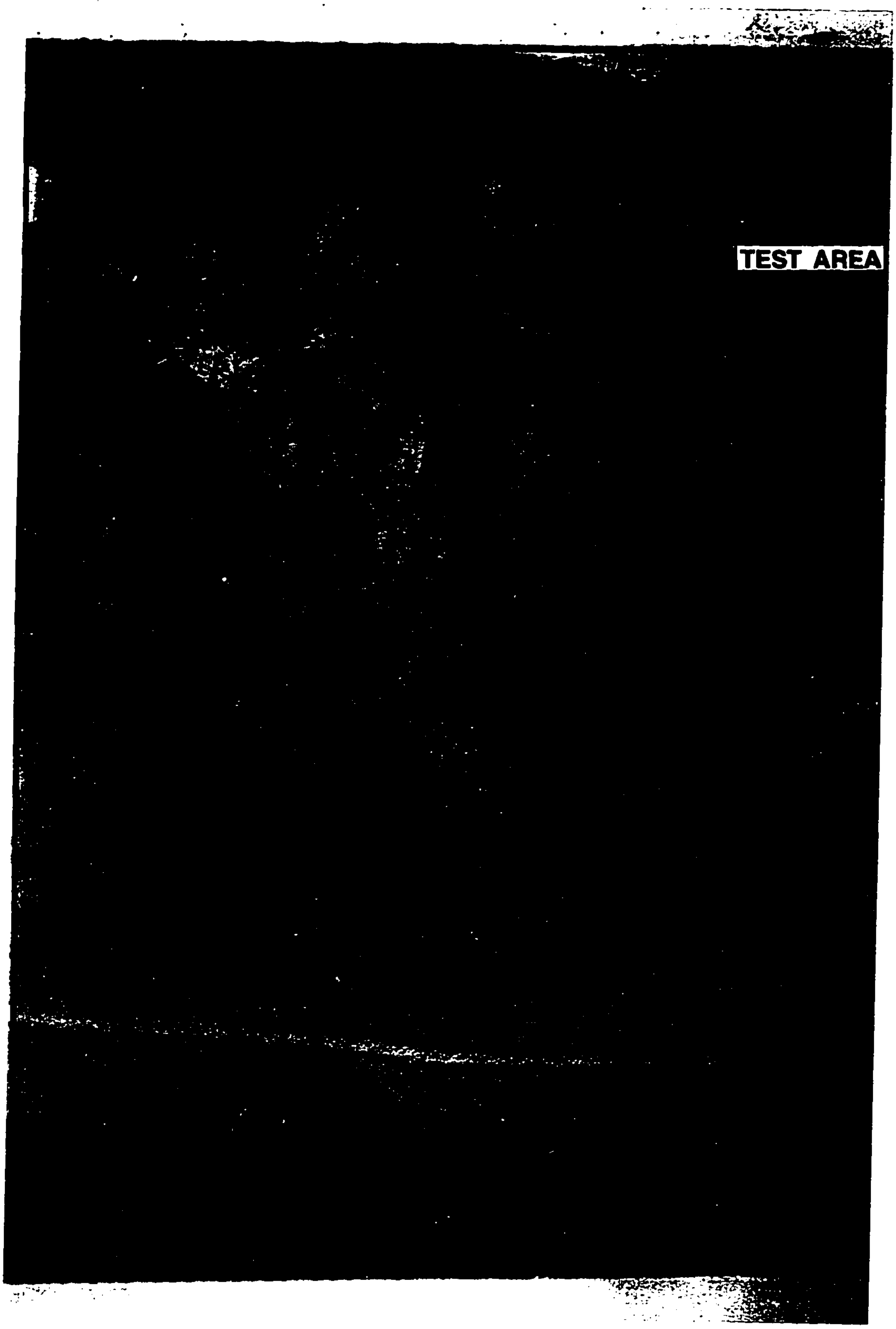
Using an enlarged aerial photograph of the central sector of the site taken in 1980 it was possible to locate some of the archaeological features recorded during the survey in the 1960s, as well as geomorphological features and soils that were not wiped out by land leveling (Figure 5.11). This was the best preserved area of the site selected as a "test area" (Figure 5.12). The general aspect of this area is a surface of tepetate, in some parts dissected by gullies, and in others covered with erosional remains or pedestals containing soils (Figure 5.13).

Stratigraphy and Geomorphology

The geologic stratigraphy of the test area (Figure 5.12) shows a series of Late Pleistocene and Early Holocene pyroclastic deposits originating in the volcanoes of the Sierra Nevada that have been diagenetically and pedogenically indurated to tepetate. These pyroclastic deposits overlie an andesitic flow and breccias of Plio-Pleistocene age (map in Mooser, 1975).

The lavas and breccias are the oldest deposit exposed by incision in the northern creek (Figure 5.14, section A-A'), covering only a minimal surface of the test area. The tepetates, however, are exposed in most of the eroded areas. Three consecutive horizons of tepetates have

Figure 5.11 Aerial photograph of the test area.


TEST AREA

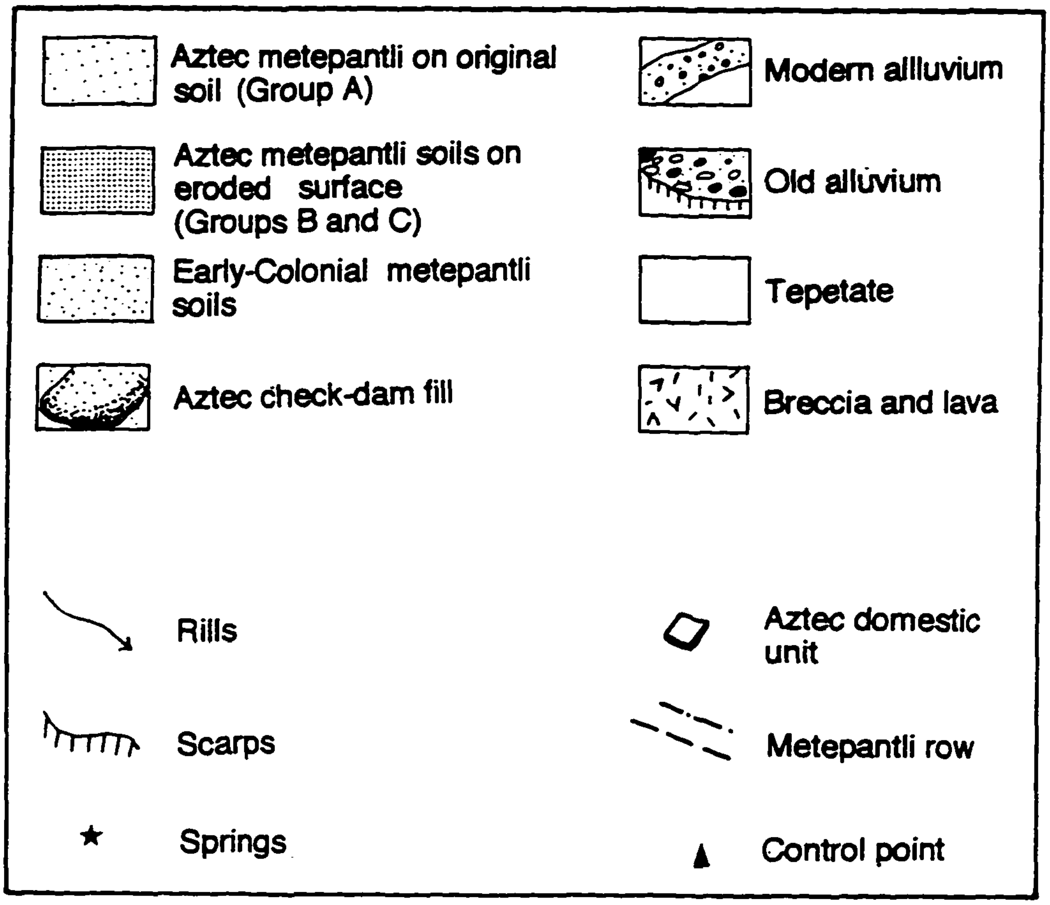


Figure 5.12 Test area in the central sector of Tx-A-78.

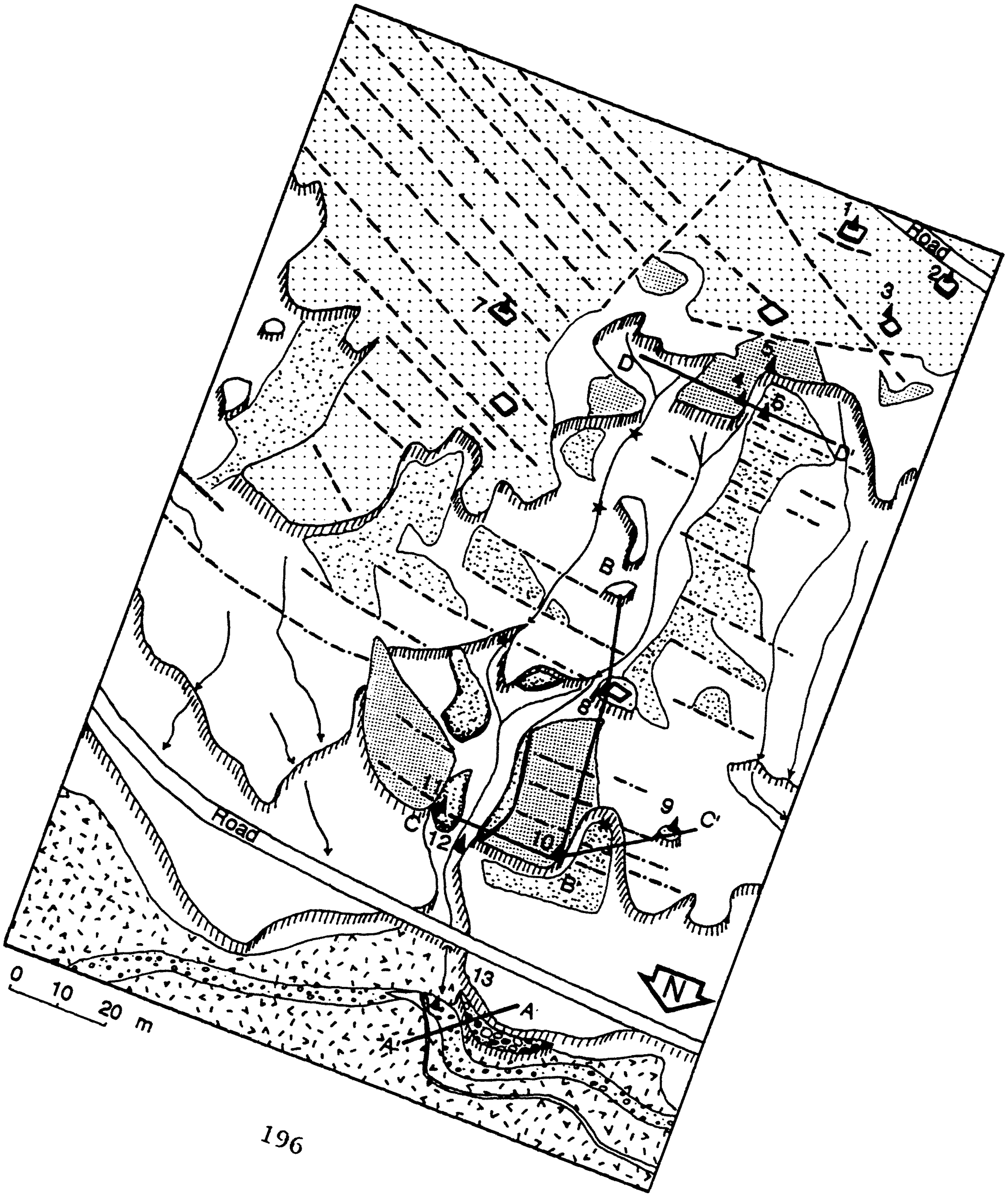
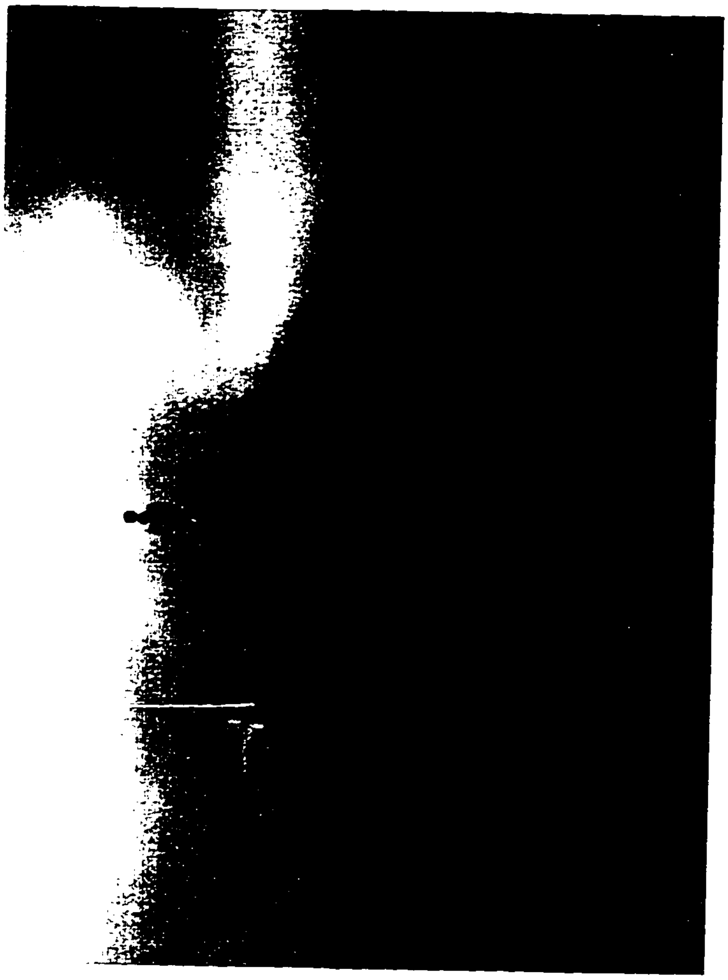
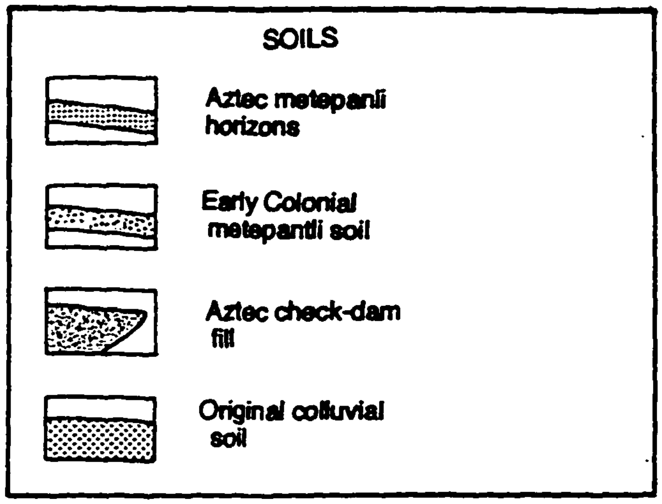

Road
Road
0 10 20 m
N
1
2
3
4
5
6
7
8
9
10
12
13
A
A'
B
B'
C
C'
D
D'

Figure 5.13 A view of site Tx-A-78. Pedestal containing a remnant of original soil with Aztec horizon and lying on barren surface of the so-called yellow tepetate.





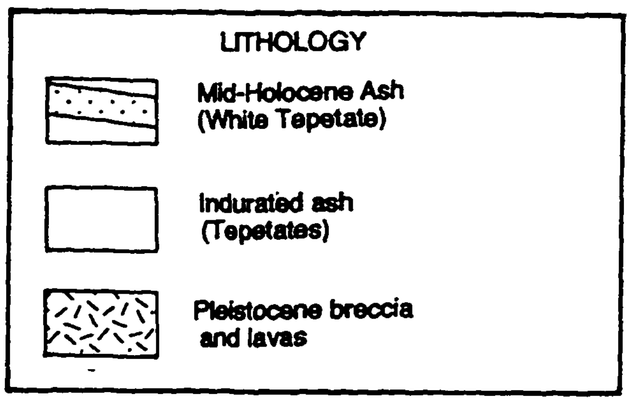
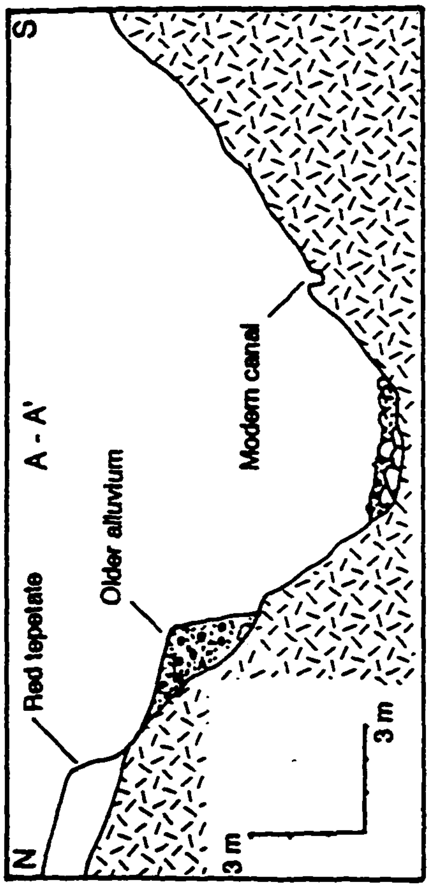
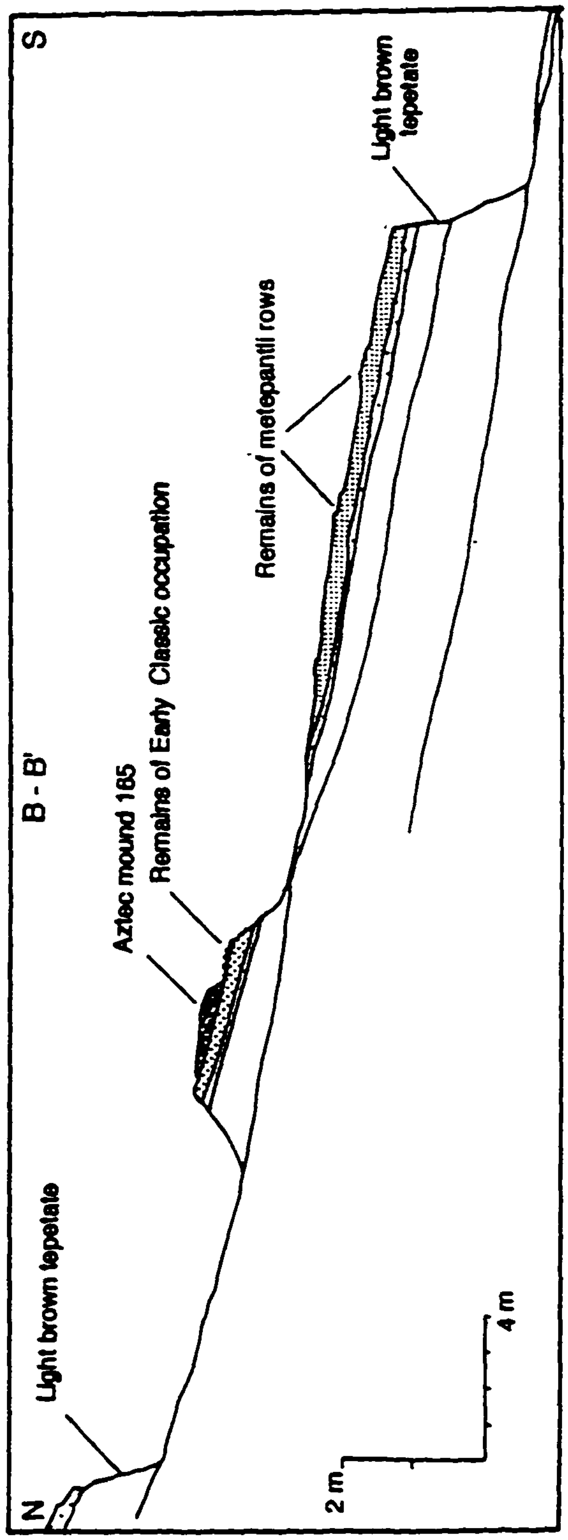


Figure 5.14 Geomorphological sections A and B. Refer to Figure 5.12 for locations.


N
S
A - A'
Red tepetate
Older alluvium
Modern canal
3 m
3 m


N
S
B - B'
Light brown tepetate
Aztec mound 165
Remains of Early Classic occupation
Remains of metepantli rows
Light brown tepetate
2 m
4 m

been reported in the piedmont and classified according to their overall color impression: the so-called, the yellow, and white tepetates of Pacheco (1979). In the test area of site Tx-A-78, four tepetate units have been identified, including the three tepetates reported. Overlying the breccias and lavas is the 'red' tepetate (7.5YR 4/6, brown, to 10YR 5/6, yellowish brown) which has a paleosol developed on top, at the contact with the 'yellow' tepetate (10YR 5/4, yellowish brown) (Figure 5.14, section B-B'). The yellow tepetate grades into a softer deposit here normally designated as the 'light brown' tepetate (10YR 5/3, brown), which in a very few exposures shows a paleosol. Overlying this deposit, or its paleosol, is the 'white' tepetate (10YR 6-7/3, pale brown) a uniform deposit of volcanic ash preserved in pedestals. In the area of Tepetlaoxtoc, this middle Holocene ash has been dated 5313 ± 51 BP (Tx-7781); the ash was altered by a soil that has either been eroded or buried by a series of colluvial soils. The sequence of tepetates and soils is most complete at the pedestal of section C-C' (Figure 5.15) and in soil profile 3 (Figure 5.16).

One erosional unconformity in the sequence of tepetates, ash, and soil horizons records a period of instability and erosion during the Holocene. The aforementioned light brown tepetate is a C horizon that

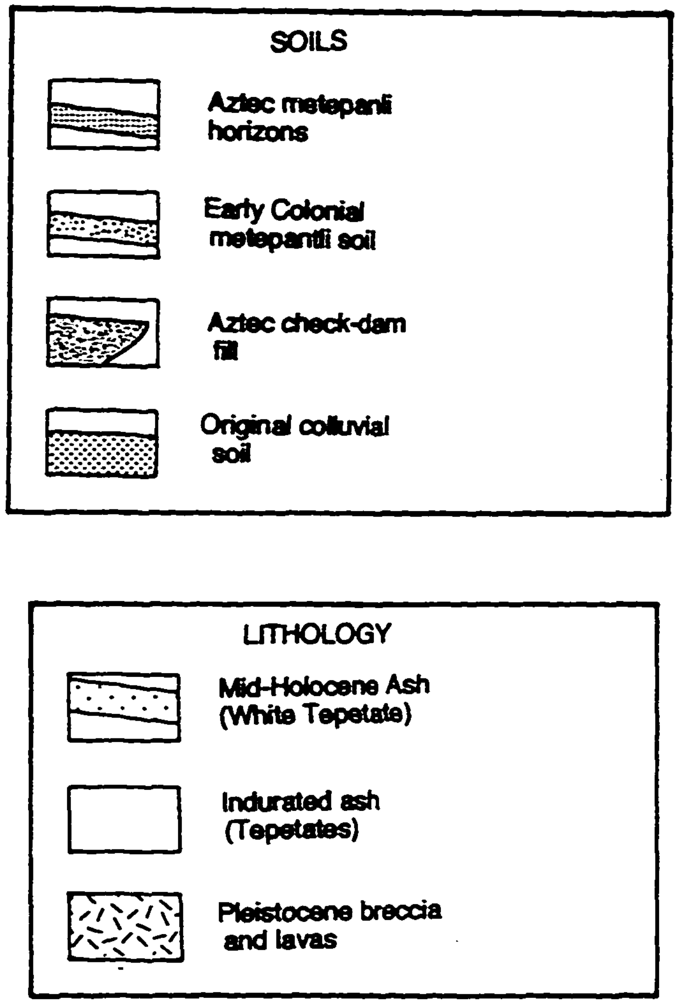
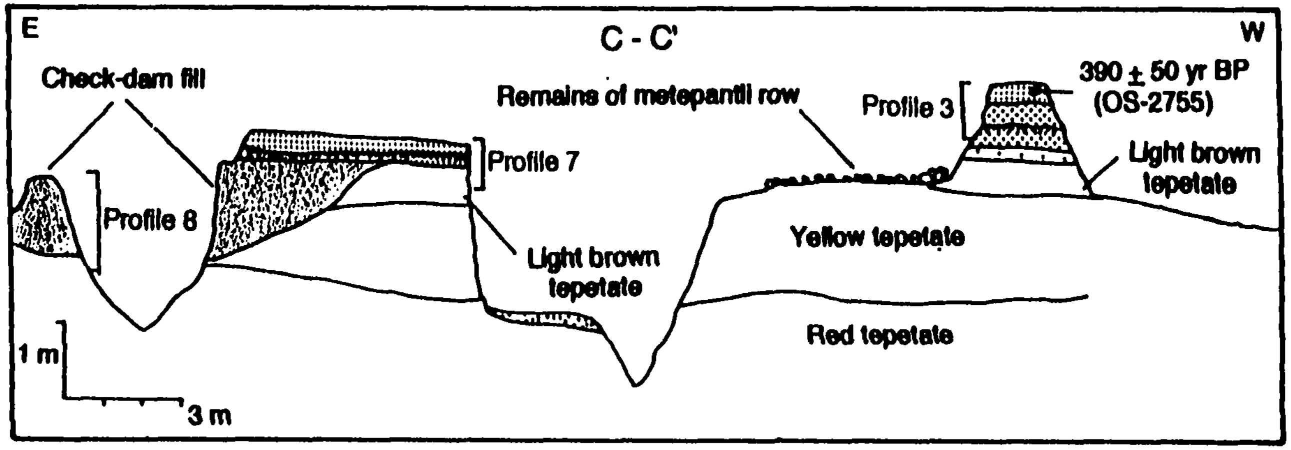


Figure 5.15 Geomorphological sections C and D. Refer to Figure 5.12 for locations.


E
C - C'
W
Check-dam fill
Remains of metepantli row
Profile 3
390 ± 50 yr BP
(OS-2755)
Profile 7
Profile 8
Light brown tepetate
Yellow tepetate
Light brown tepetate
Red tepetate
1 m
3 m

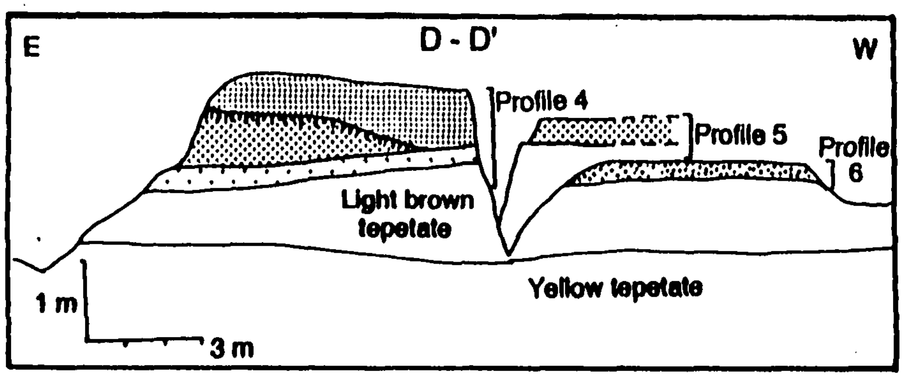
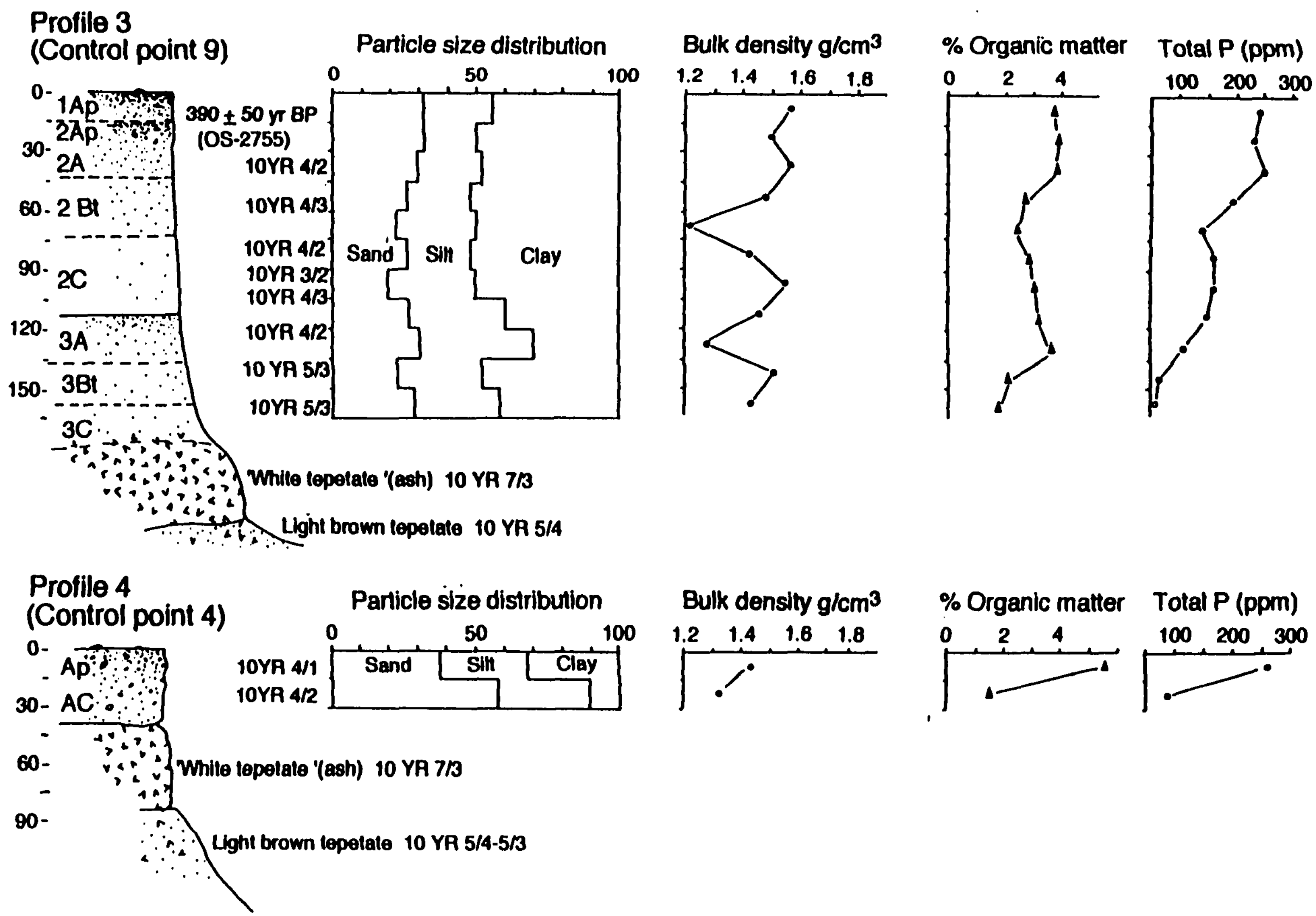

E
D - D'
W
Profile 4
Profile 5
Profile 6
Light brown tepetate
Yellow tepetate
1 m
3 m

Figure 5.16 Soil profiles 3 and 4, located at control points 9 and 4, respectively.


Profile 3
(Control point 9)
1Ap
2Ap
2A
2 Bt
2C
3A
3Bt
3C
390 ± 50 yr BP
(OS-2755)
10YR 4/2
10YR 4/3
10YR 4/2
10YR 3/2
10YR 4/3
10YR 4/2
10 YR 5/3
10YR 5/3
'White tepetate '(ash) 10 YR 7/3
Light brown tepetate 10 YR 5/4
Particle size distribution
Sand
Silt
Clay
Bulk density g/cm3
% Organic matter
Total P (ppm)
Profile 4
(Control point 4)
Ap
AC
10YR 4/1
10YR 4/2
'White tepetate '(ash) 10 YR 7/3
Light brown tepetate 10 YR 5/4-5/3
Particle size distribution
Sand
Silt
Clay
Bulk density g/cm3
% Organic matter
Total P (ppm)

appears extensively in the site, and is an erosional remnant of a soil, that was preserved in few places before the ashfall event, indicating severe erosion in Early to Middle Holocene times. This paleosol was visible in a section exposed recently by a bulldozer near control point 7 (Figure 5.12).

The development of at least two soil horizons on colluvium overlying the ash (white tepetate) suggests a long period of stability eventually interrupted by the first phase of erosion concomitant with human presence. These two soil horizons are visible in soil remnants (pedestal) such as that of profile 3 (Figure 5.16). The sequence of this soil is here referred to the 'original colluvial soil', in contrast with other soils that have anthropogenic horizons.

Arable soils account for only the 27 percent of the test area, including three soil units associated with metepantli semi-terracing, and one unit with the fill behind a check dam (See Figure 5.12 near conbtrol point 11 and 12). Metepantli soils are associated with rock and earth alignments that imply ancient metepantli rows of different ages. According to the orientation these rows and their associated edaphic horizons, these soils have been divided into three groups:

Group A. Metepantli on original colluvial soil

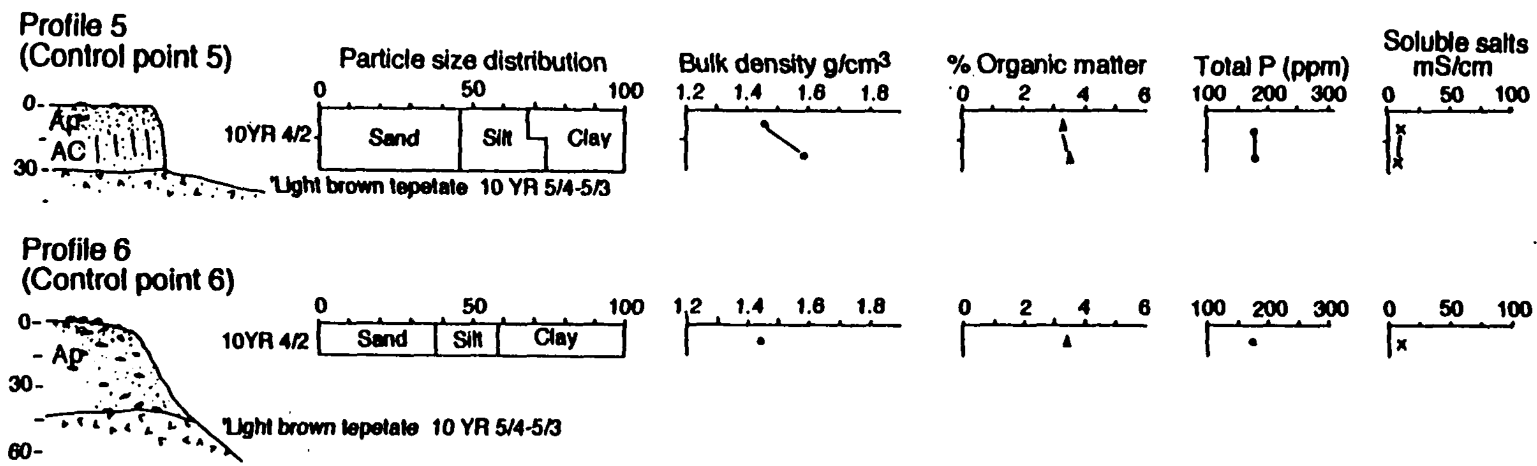
This soil unit covers most of the southern area of the site along the water divide, and is also found in erosional remnants or pedestals. It represents at least two different soils, one developed on the white ash and the other with a colluvial substrate converted to an anthropogenic A horizon by means of metepantli management (Figure 5.16, profile 3). These two soils have a Bt horizon which indicates a long period of stability, perhaps under wet conditions, subsequent to deposition of the ash. The relatively high content of clay and the darker tone of is horizons make this soil similar to the *tierra negra* (black soil) of the folk taxonomy in the area reported by Williams and Ortiz-Solorio (1981).

The Ap horizon (tilled soil) has more organic matter, and total phosphorus than other metepantli soils in the site, probably due to a larger influx and translocation of organic matter as well as the dumping of organic trash. The addition of domestic trash to soils has been reported by the 16th century sources as a method of fertilizing soils in fields near houses (Rojas-Rabiela, 1988); trash evidently included both organic and inorganic waste, as evident by the presence of broken sherds, *tezontle* (volcanic scoria), and obsidian flakes. The large number of sherds is mainly Late Aztec, covering the surface in a homogeneous way, except for large concentrations that represent mounds or remains of dwellings. Other origins for the accumulations of inorganic material include the practice of cultivating surfaces previously occupied by a house; such deposits were considered fertile soil, and were known in the Aztec soil classification as *callali* (Nahuatl: house soil) (Dibble and Anderson, 1963; Williams, 1985).

Group B. Metepantli soils on eroded surfaces

These soils are the result of land reclamation or attempts to check soil particles by setting up metepantli rows on a barren surface of tepetate; in this group there are two soil units, distinguished by age. One of the soil units represents Aztec attempts to recover areas for cultivation, probably when the village was founded or expanded; typical examples of this unit are profiles 4 and 5 (Figures 5.16 and 5.17, respectively). The other unit is younger and represents lower levels, after erosion had lowered the terrain (Figure 5.17, section D-D'). This suggests a struggle to contain soil erosion, either shortly before the abandonment of the village, or later by the new landowner. The typical horizonation of this type of soil is shown in profile 6 (Figure 5.17).

Figure 5.17 Soil profiles 5 and 6, located at control points 5 and 6, respectively.


Profile 5
(Control point 5)
Particle size distribution
Bulk density g/cm3
% Organic matter
Total P (ppm)
Soluble salts mS/cm
0 50 100
1.2 1.4 1.6 1.8
0 2 4 6
100 200 300
0 50 100
0-
Ap
AC
30-
10YR 4/2
Sand
Silt
Clay
Light brown tepetate 10 YR 5/4-5/3
Profile 6
(Control point 6)
0-
Ap
30-
60-
10YR 4/2
Sand
Silt
Clay
Light brown tepetate 10 YR 5/4-5/3

No additional horizons have been developed in these soils since they are relatively younger, probably younger than 600 years. By their overall characteristics mentioned above, this type of *metepantli* soil is similar to what has been described in the area as *tierra amarilla* (yellow soil) by Williams and Ortiz-Solorio (1981). In general, organic matter and nutrients in soils of this group tend to be lower than *metepantlis* created on original soils. Organic matter and total phosphorus contents are relatively high in profile 2, and low in profiles 5, 6 and 7. This variability reflects uneven concentration of organic waste; concentrations of broken sherds in an irregular pattern, suggesting that the farmers were dumping soil and trash brought from elsewhere; this incoming material was in turn mixed with particles carried by overland flow created by rain. The Aztec soils of this group are less variable in terms of waste concentration, possibly suggesting that this management lasted longer and required more careful work than their Early Colonial counterpart.

Sherds in these soils show a mixture of Early and Late Aztec sherds, including a few Early colonial pieces in the oldest unit, whereas the original metepantli soils presents a uniform cover of mainly Late Aztec sherds.

Group C. Metepantli soil on older anthropogenic horizons

This type of soil represents the attempt to trap sediment so as to build up a new horizon on a preexisting soil, either to improve its quality or level the terrain. The result is an older Ap horizon buried by younger sediment, turned into a new Ap through plowing and cultivation. There is no clue as to the age of the younger horizon; its elevation and associated artifactual debris indicate it may be Late Aztec, although its associated metepantli rows parallel the Early colonial ones (Figure 5.12). The oldest soil (2Ap) is probably associated with the Late Aztec check dam (Figure 5.15, section C-C'). Soil properties of these two Ap horizons are similar and comparable with soils of Group B.

Although metepantlis were the instrument used to produce the soils of this group, the strategy was different for each group. In the case of group A, metepantlis were set up as a preventive measure against erosion, whereas in the cases of Groups B and C they were implemented for constructive purposes. The two modern analogues from the lower piedmont, profiles 1 and 2, presented previously, do not have a precise equivalent with profile 3 in group A, except for the horizons developed on the indurated layer of volcanic ash, but the profiles of Groups B and C show similar anthropogenic horizons.

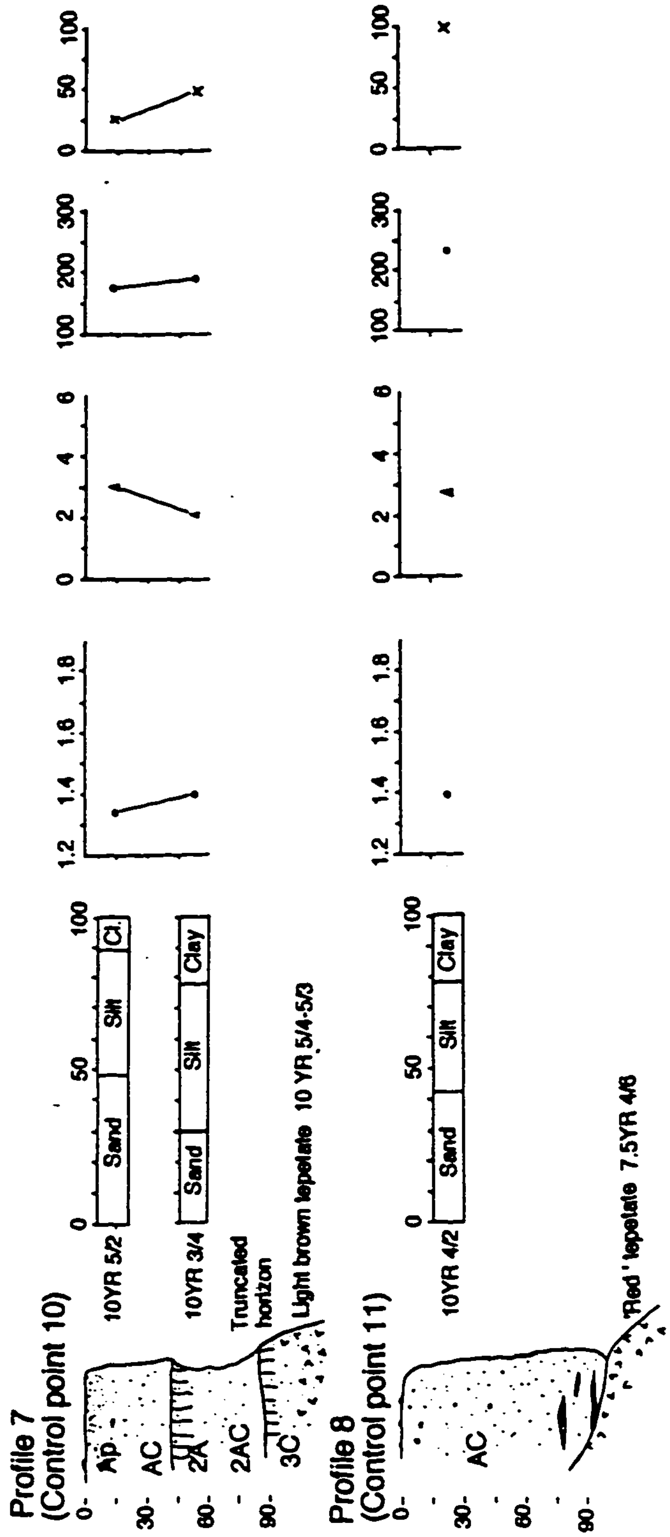
Thin sections also reveal differences in the nature of the A horizons. Those Ap horizons in group B corresponding to Aztec metepantlis show better sorting than those of Group A, derived from colluvial soils. This difference may be due to the fact that sorting in anthropogenic horizons results from the homogenization of the anthropogenic parent material, a very characteristic property created by dumping and favored by cultivation and fertilization of a former sterile material (Courty *et al.* 1989: 131).

The technique of breaking tepetate to make *tepetlalli* soils is described by Sahagun in the Florentino Codex and discussed by Williams (1972), but its application to these soils is uncertain. Fragments of white tepetate within the matrix of the Aztec soils of group B, specifically profile 2, may be of such origin. Foreign particles like *tezontle* (basaltic scoria), pumice, basalt and andesite, brought in by means of human agency, are also abundant, suggesting that fragments of tepetate may have been introduced in the same way.

Check dam deposit

Land reclamation during Late Aztec times included the barranca fill trapped behind the dam, perhaps in combination with trash dumped on it. The dam or retaining

Figure 5.18 Soil profiles 7 and 8, located at control points 10 and 12, respectively.


Profile 7
(Control point 10)
Ap
AC
2A
2AC
3C
10YR 5/2
10YR 3/4
Truncated horizon
Light brown tepetate 10 YR 5/4-5/3
Sand
Silt
Cl.
Clay
Profile 8
(Control point 11)
AC
10YR 4/2
'Red' tepetate 7.5YR 4/6
0
30
60
90
50
100
1.2
1.4
1.6
1.8
2
4
6
200
300

wall of this check dam has been removed by erosion, but rubble remains are preserved at control point 11. The topsoil of this deposit, which may have been topographically equivalent to profile 7 (Figure 5.18), has been lost to erosion (Figure 5.15, section C-C'). Only the underlying sediment remains, which was sampled for comparison with the metepantli soils (Figure 5.17, profile 6). It is a loamy mass of sediment without structure, except at the bottom, where it has lenses of sand and gravel; it has a very low density and moderate values of organic matter and relatively high values of total phosphorus. There is a high content of soluble salts, compared with the *metepanli* soils 5, 6, and 7, suggesting that soils behind this check dam may have been irrigated. However, there is no evidence of canals, and if they existed, such canals would have been easily removed by erosion. It is likely that this field benefited naturally from water seepage, so that water from the local springs that still exist at the head of the barranca may have been managed to provide moisture to the check-dam soil (Figure 5.18, profile 8.).

Erosional advance and barranca incision

The control points established within the test area served, on the one hand, to enable an association between pottery collections and soil units (Table 5.1), and on the other, to estimate the extent of land lost to erosion, the extent of soil reclaimed, and the depth of incision of the barranca in the center of the area at different periods (Table 5.2), for which control point 9 was the datum to measure depth. Two phases of soil erosion and two attempts at land reclamation can be identified in the test area.

First phase of soil erosion (Pre-Aztec)

Erosion started before the Aztec occupation, based on the reclamation of lands that resulted in the building of soil in profiles 4 and 5. No exact span of time has been established, although the existence of Early Classic to Early Toltec material in a pedestal at point 5 suggests that there was a Classic settlement that was destroyed by erosion. The Early Aztec occupation of this site post-dates this interval of soil erosion, since its vestiges are confined to higher and lower areas; this association allowed me to date the intervening erosion between roughly A.D. 500 and 1000 for certain, with the possibility that itextended to ca. A.D. 1250, when the Early Aztec occupation started. Since a decline in population is

TABLE 5.1
CONTROL POINTS AND ASSOCIATED SOIL AND ARCHAEOLOGICAL FEATURES

Control point	Top soil surface	Cultural features	Surface ceramics and mound number*
1	Metepantli on original colluvial soil	Domestic unit	Late Aztec Mound 159
2	Metepantli on original colluvial soil	Domestic unit	Mostly Late Aztec. Some Early Aztec Mound 160
3	Metepantli on original colluvial soil	Domestic unit	Mostly Late Aztec. Some Early Aztec Mound 163
4	Metepantli soil on eroded tepetate surface. Profile 4	None	Late Aztec
5	Metepantli soil on eroded surface. Profile 5	None	Mostly Late Aztec. Some Early Aztec are present.
6	Metepantli soil on eroded surface (Post-Aztec). Profile 6	Trash mounds	Mostly Late Aztec. Some Early Aztec are present.
7	Metepantli on original colluvial soil	Domestic unit	Late Aztec Mound 164
8	Metepantli on original colluvial soil		Mostly Late Aztec. Some Early Aztec are present. Mound 165 Late Classic around the mound.
9	Metepantli on original colluvial soil Pedestal Profile 3	None	Late Aztec and low amount of Early Aztec. Mound 167
10	Metepantli soil resting on older anthropogenic soil	None	Late Aztec
11	Check dam soil resting on red tepetate	Check dam fill	Late Aztec
12	None. Red tepetate	Remains of check dam wall	None
13	None. Modern alluvium	Modern weir and irrigation canal	None

* Mound number and description in Parsons (1971). Early and Late Aztec designations are basically Aztec II and Aztec III, respectively.

TABLE 5.2
VALUES INDICATING EROSIONAL ADVANCE AND STREAM INCISION WITHIN THE TEST AREA IN TX-A-78*

Period	Tepetate surfaces in %	Arable land surfaces in %	Total arable land in site Tx-A-78 west and central in hectares	Depth of barranca incision in meters. (Reference datum, control point 9)	Incision of northern creek
Early Classic occupation	20	79	n.e.	<2	n.e.
Early Aztec prior to land reclamation	52	48	n.e	2.20**	6
Late Aztec	24	76	20 **	0.50***	n.e.
Early Colonial to present	73.5***	27.5***	14.8***	3.10***	1-2

* Figures and percentages are based on estimations unless otherwise indicated.
** Estimated according to land grant information
*** Values measured in the field and on aerial photographs
n.e. not estimated

established for the region during the Late Classic and Early Toltec phases, the area pressumably was deserted for a long period until settled again in the Early Aztec phase. Perhaps erosion set in as the land was abandoned, so that rains affected those compacted tilled soils that consequently increased surface runoff. The effects of abundant and intense rains on soil erosion is difficult to evaluate, since there are no proxy data to rely on. However, alluvial stratigraphic evidence in the lower valleys of the San Juan Teotihuacan, Papalotla and Coatepec rivers indicates that floods were frequent during the Classic and Early Toltec phases (Chapter 6). Evidence for high lake levels during the Early Toltec phase in Chalco (Hodge, Córdova and Frederick, forthcoming), are probably due to copious rains, so that the onset of a period of abundant precipitation may have contributed to river flooding in the basin, but more proxy data are needed to prove it.

Surprisingly, barranca incision in the site was less important than the formation of a great number of rills that carried away soil and subsequently the underlying white ash. The original extent of soil cover and barranca depth at the end of the Classic is unknown, but a rough estimate of 1.25 ha would imply that 79% of the area was covered with arable soil before site abandonment and subsequent erosion. At the end of this phase, pedestals of soils were isolated by small barrancas and areas of barren tepetate as the reconstruction of the test area suggests (Figure 5.19).

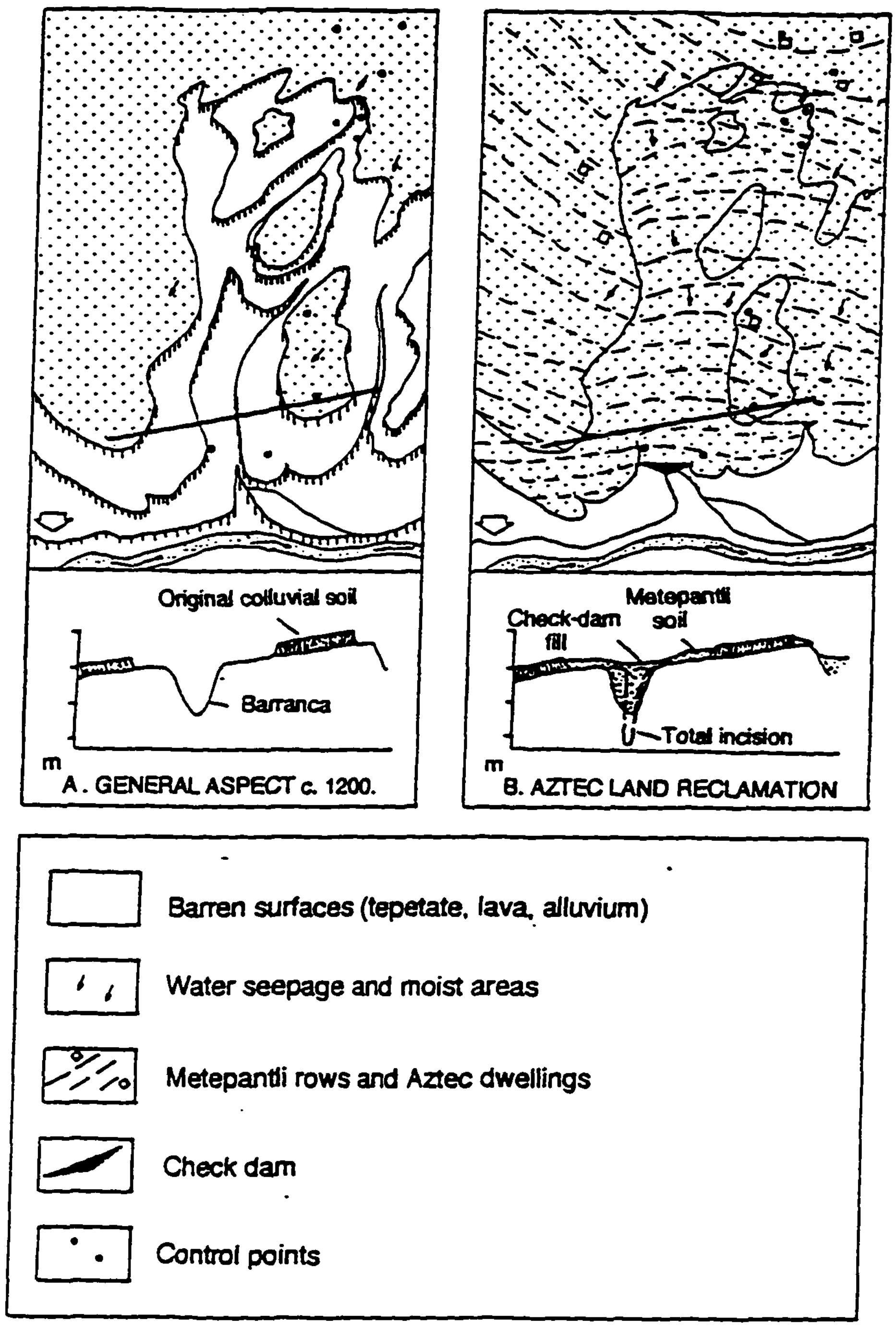


Figure 5.19 Reconstruction of the test area for the Early Aztec period prior to land reclamation (A) and the end of the Late Aztec period (B).

Aztec land reclamation

Notable changes date from the Aztec period: the area was resettled, metepantlis were constructed, soil was built and cultivated, and incision of the barranca and smaller gullies were controlled by means of check dams.

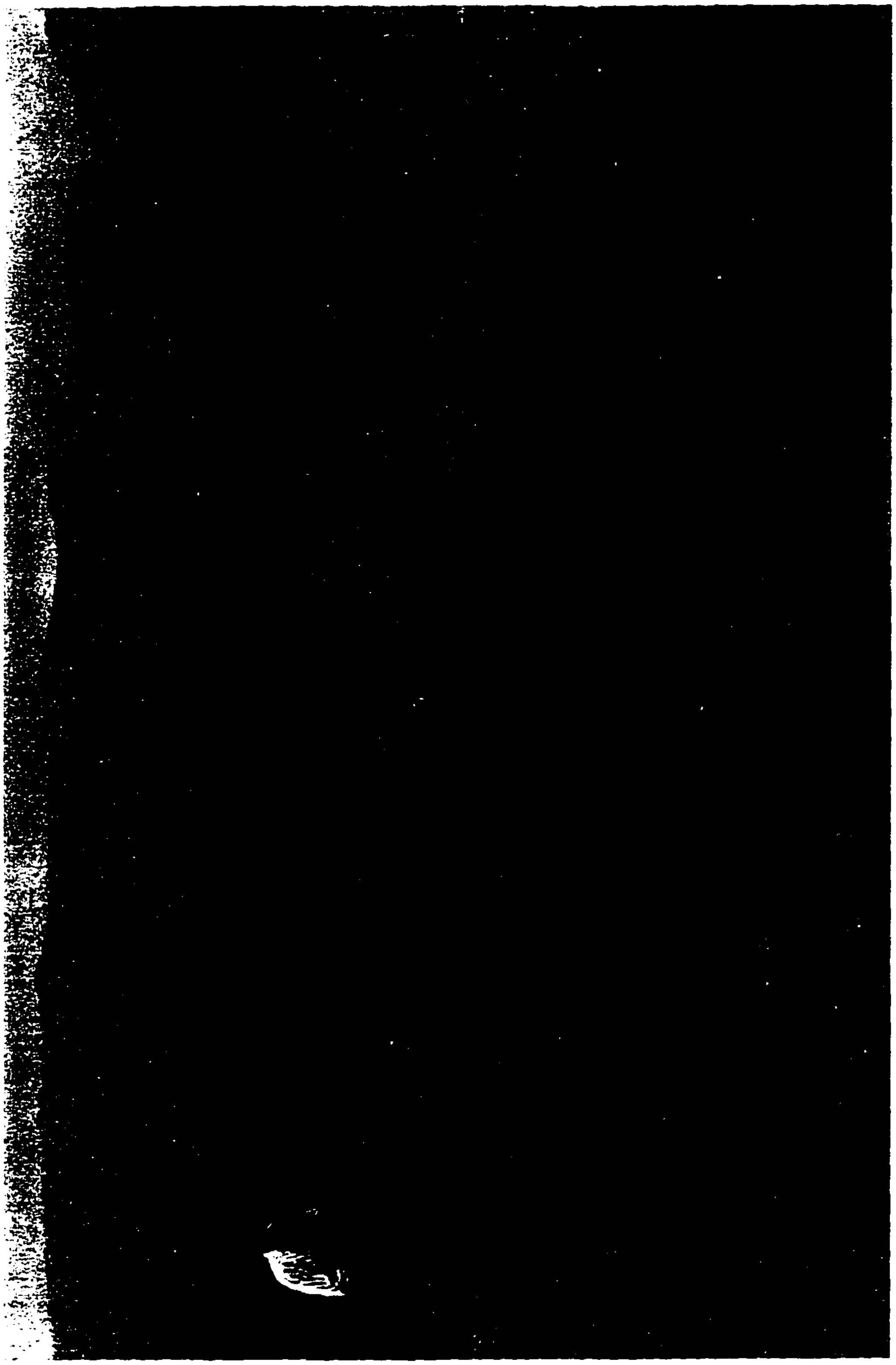
The wide distribution of pedestals containing Late Aztec reclaimed metepantli soils illustrates the extent of artificial soil accretion in a manner that the site can be reconstructed for the end of the Aztec period (Early 1500s) (Figure 10). Arable land is estimated at 1.2 ha, accounting for 76 % of the test area. Most of the land reclamation was probably carried out in Late Aztec times, since most of the dwellings recorded by survey, within and without the test area, have abundant Aztec III pottery. A recent analysis of the pottery collected, based on a more elaborate seriation by Minc (1994), shows that the variants of this pottery bespeak the rapid development of this dispersed settlement in the second half of the 1400s. As for the 1500s Aztec IV and Early Colonial imported pottery are very scanty, perhaps reflecting the gradual reduction of population. A radiocarbon assay from a piece of charcoal from the Ap horizon, collected at 15 cm below the surface of the pedestal at control point 8, yielded an age of 390$\pm$50 yr. BP (OS-2755)(A.D. 1485+73), indicating that the soil surface of this pedestal, now only 1.5 sq. meter in size, once was larger, and may still have been cultivated in the 16th century.

Second phase of erosion (Post-Aztec)

As site population declined, erosional processes may have gradually set in; once the site was completely deserted in the early 1600s, the land began to erode more rapidly. Evidence for attempts at land reclamation is give by some metepantli soils, generally dating to the colonial period, after erosion had already devastated most of the site area. Even thereafter, erosion eventually exposed a total of 1.17 ha, in contrast with the 0.38 ha during the early 1500s. The check-dam now broke up and was no longer rebuilt, and incision totalled 3.10 meters (Figure 5.19). This final phase of erosion shaped the site into its present configuration, to the point that in some parts of the site only the stone alignments of the metepantlis have remained (Figure 5.20).

The causes of post-Aztec erosion are several and can be discussed in the light of historical documents. The most evident cause of these erosional events was the desertion of the village, which in turn led to abandonment of structures constructed to control erosion, such as metepantlis and check dams that were destroyed by runoff. The first three decades of the 17th century are known for

Figure 5.20 Remains of metepantli rows. A combination of sheet erosion and rill erosion have taken away soils, leaving the rock alignment, and scatters of artifacts behind them.



extensive and continuous floods, produced by copious rains in the Basin of Mexico (Gibson, 1964; Boyer, 1973). In the plains of the Texcoco region, we have identified several alluvial deposits datable to this period. These catastrophic events probably took their toll on the abandoned semi-terraced lands and check dams of the piedmont. A possible modern analog is suggested at Meztitlán, Hidalgo, where a sequence of erosional and landslide events took place during the years after abundant rains produced by hurricane Gilbert in 1988 (Lugo *et al.*, 1993).

The introduction of sheep to the study area, mentioned in the land grand documents (*Mercedes*) is another factor to consider as to triggering post-Aztec soil erosion, since overgrazing may have impacted susceptible soils in the Mexican highlands (Melville, 1994). But very few sheep estancias were granted in the upper piedmont in the period 1580 to 1630 (Colín, 1967). The closest *estancia de ganado menor* (sheep place) was requested in 1591 (AGN, *Mercedes*, vol. 17. f.30 Appendix D), just north of the site, but was refused after a long conflict with the local people, according to a document written in 1592 (AGN, *Tierras*, vol 2726, exp. 8; Appendix D). However, this document does note that the farmers in the area had "all kind of livestock." Whether or not overgrazing was one of the main causes of soil erosion, soils in tepetate areas of Texcoco are highly susceptible to erosion even without livestock impacts, as the pre-Aztec erosional phase demonstrates.

During this last phase of erosion, the site area lost approximately 5 ha of soil cover. This figure is based on 20 ha of arable land at the site *c*.1600, compared with the 14.5 ha today, ignoring land recently reclaimed. The original 20 ha is an estimation of arable land for the site of San Juan Olopa, which covers most of the western and central sectors of the site, as based on the half caballería de tierra (approximately 21.4 ha) requested in 1607 (AGN Mercedes, vol. 25, f.435).

Early Colonial attempt at tepetate reclamation included metepantli construction, just as in Aztec times; the soils of Group C are the result this reclamation phase.

Observations in other sites

Site Tx-A-86

This site is located just east of the modern settlement of Tequexquinahuac, and the area examined within the site is located along a barranca (Fig. 5.21, transects A, B, C and D). The slopes adjacent to the barranca are characterized by tepetate surfaces deeply incised by

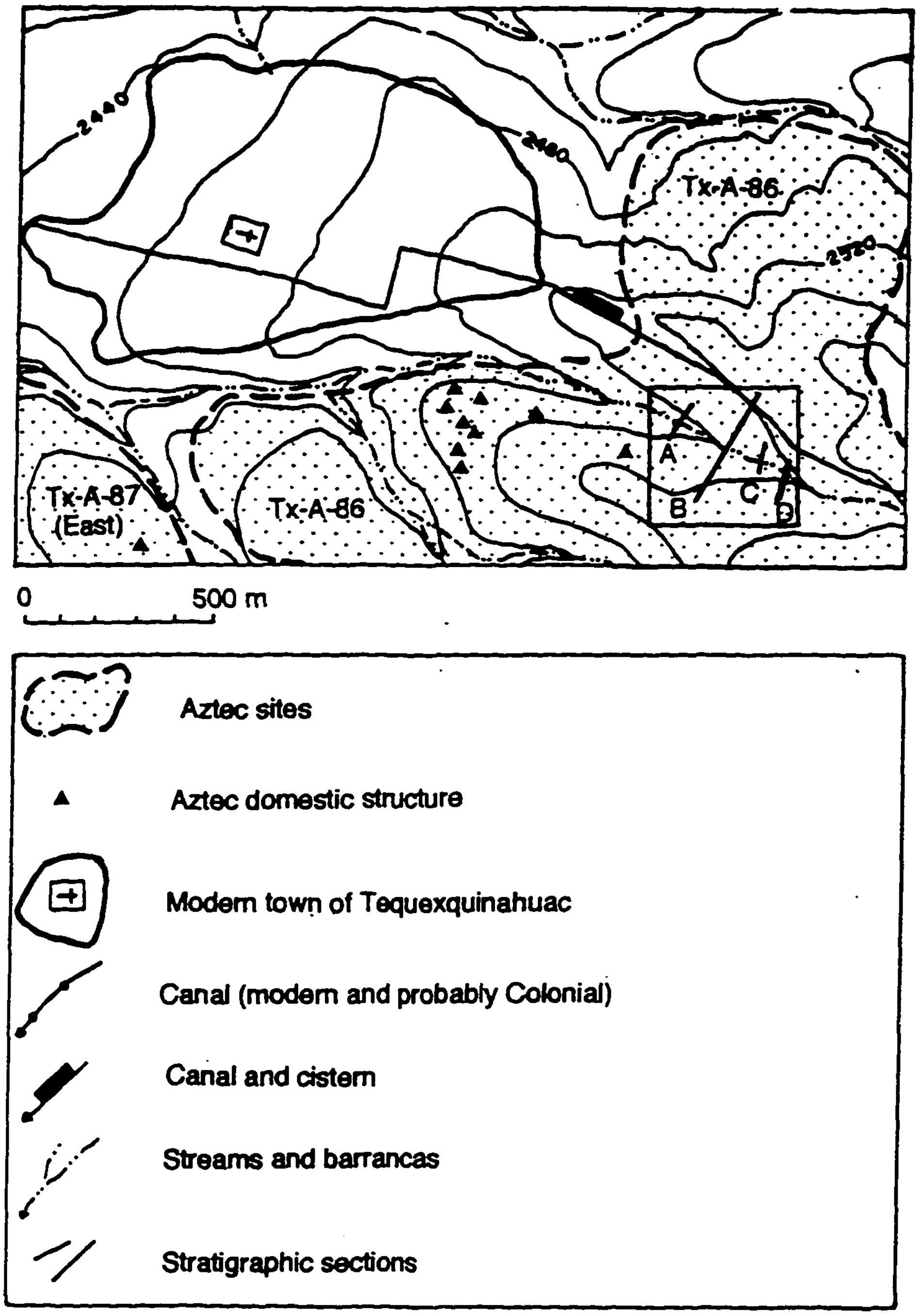


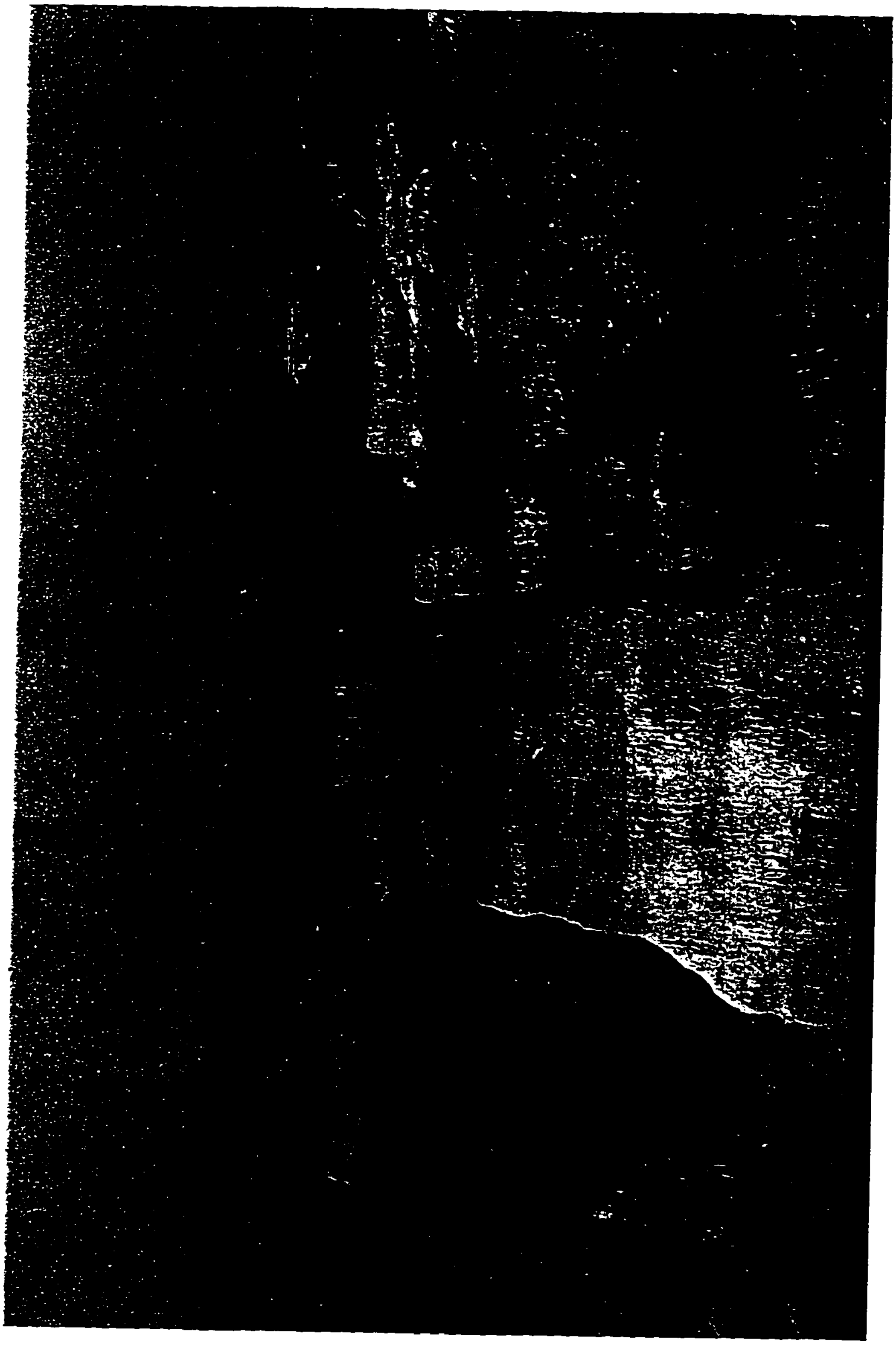
Figure 5.21 Site Tx-A-86 and location of area studied and sections.

gullies, and by pedestals that expose sediments of different ages with Aztec soils on top (Figure 5.22).

Site Tx-A-86, classified by Parsons (1971) as a small dispersed village, is similar to Tx-A-78 in terms of ecological context and chronology. Although the site has been severely eroded in pre-Hispanic and Early Colonial times the remains of Late Aztec occupation on some surfaces are still abundant. However, the geoarchaeological interpretation and paleolandscape reconstruction wasmore difficult than the previous example because cultural features and soils are not so well preserved.

The archaeological remains identified in several localities indicate that Tx-A-86 was essentially occupied only during the Late Aztec phase. There is no material of the Aztec-Colonial transition and no introduced pottery styles, what suggests that there was no occupation in Early Colonial times. As for earlier periods, there are very few diagnostic ceramic materials of the Early Aztec phase and no materials of Pre-Aztec times in the areas studied. Yet, Parsons (1971) reports some concentrations of Late Formative and Terminal Formative to the east and north of the site. Additionally, the remains of a large, Terminal Formative site (Tx-TF-25) are preserved on top of an erosional-remnant mesa just east of the site. As explained above, erosion on the upper piedmont removes soils on the

Figure 5.22 Badland topography at site Tx-A-86. The top of the pedestal in the picture is benchmark of land surfaces in Late Aztec times.



slopes before affecting the top of the interfluves where sites are better preserved. Thus, I presume that Terminal Formative occupation once extended over the area of Tx-A-86, and that its remains were obliterated by a combination of severe soil stripping and Aztec reclamation.

Unlike Tx-A-78, there is no written and pictorial documentation dealing directly with the existence and abandonment of Tx-A-86. A few Mercedes documents, and a *lienzo* map, make only vague references to the area, portraying the idea of emptiness. In spite of the paucity of documentation, soil stratigraphy and geomorphic features offer sufficient information to assemble a relative chronology of deposition, erosion and occupation.

Four sections across the barranca show the stages of sedimentation, stream erosion, and soil formation during the late Quaternary (Figures 5.23 and 5.24). Only one radiocarbon date was obtained from a humate sample from the bottom of the sedimentary sequence (Figure 5.23, section B).

Sedimentation occurred after the stream incised the tepetate, starting to fill up around 21 ka with volcanic ash flows, mud flows and alluvial silts. In this Late Pleistocene-Early Holocene sequence there are numerous remains of mammalian fauna of probably ungulate species.

Figure 5.23 Geomorphological sections A and B in site Tx-A-86. Refer to Figure 5.21 for locations.

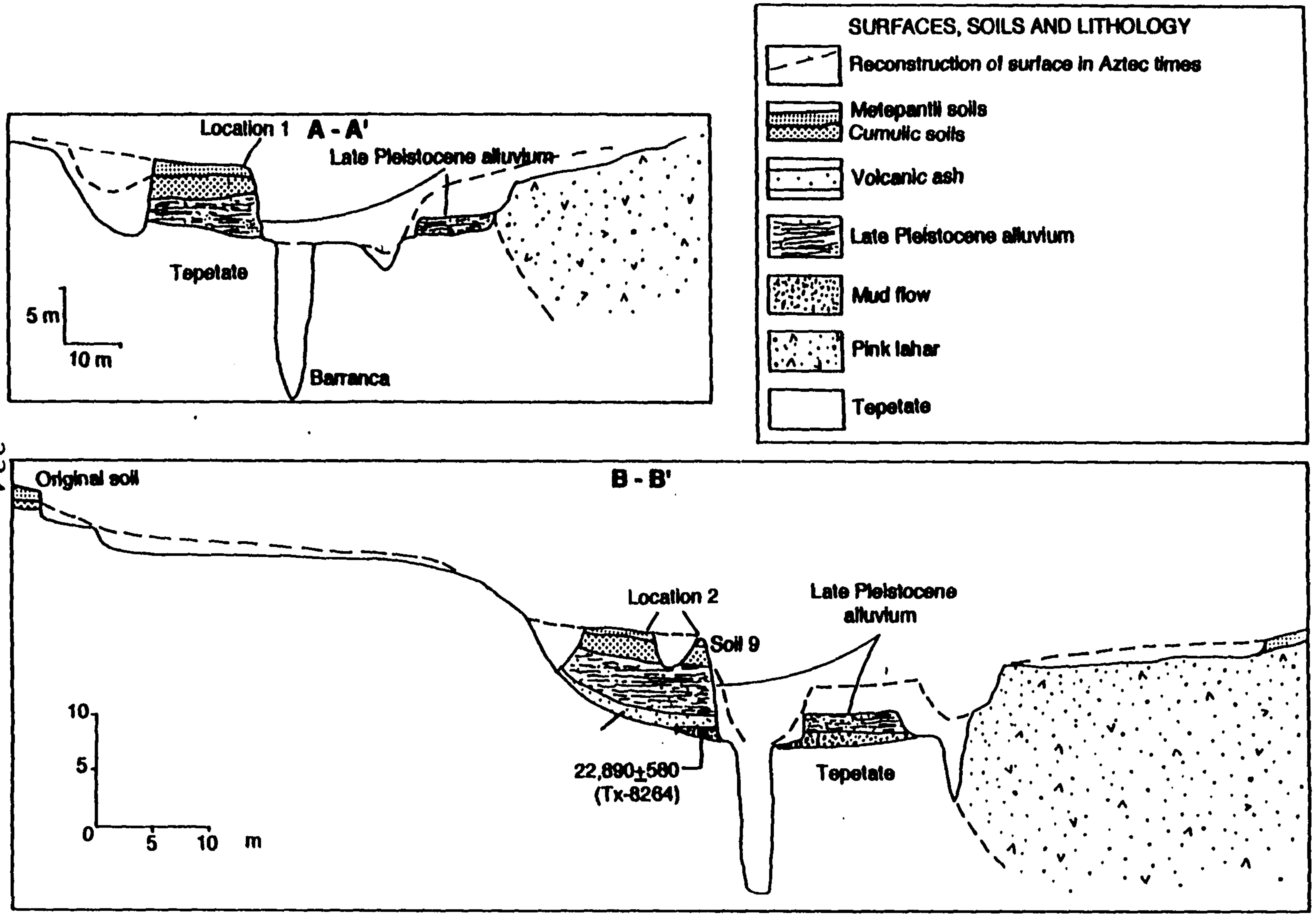
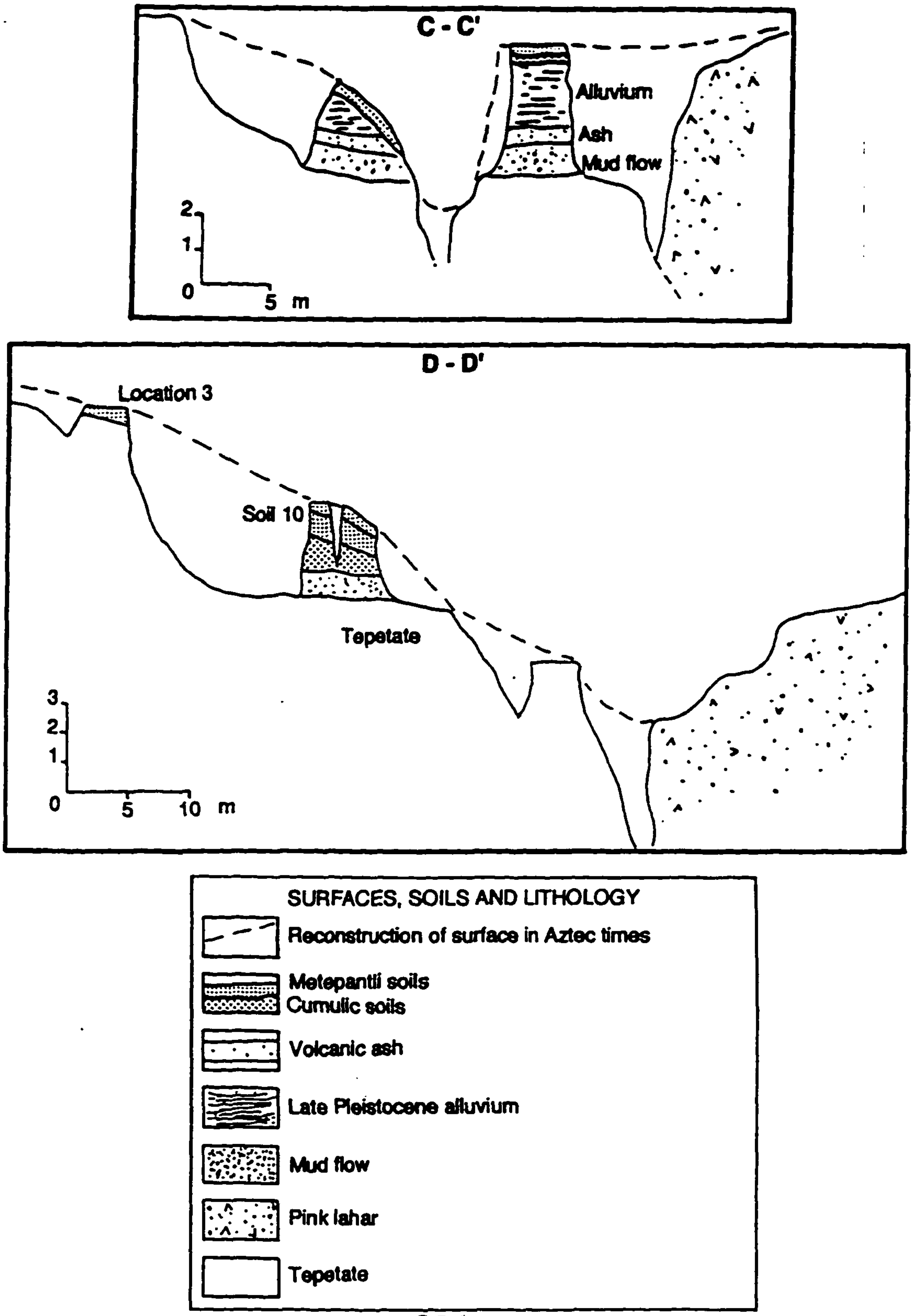

SURFACES, SOILS AND LITHOLOGY
Reconstruction of surface in Aztec times
Metepantli soils
Cumulic soils
Volcanic ash
Late Pleistocene alluvium
Mud flow
Pink lahar
Tepetate
A - A'
Location 1
Late Pleistocene alluvium
Tepetate
5 m
10 m
Barranca
B - B'
Original soil
Location 2
Soil 9
Late Pleistocene alluvium
22,890±580
(Tx-8264)
Tepetate
10
5
0
5
10
m

Figure 5.24 Geomorphological sections C and D in site Tx-A-86. Refer to Figure 5.21 for locations.

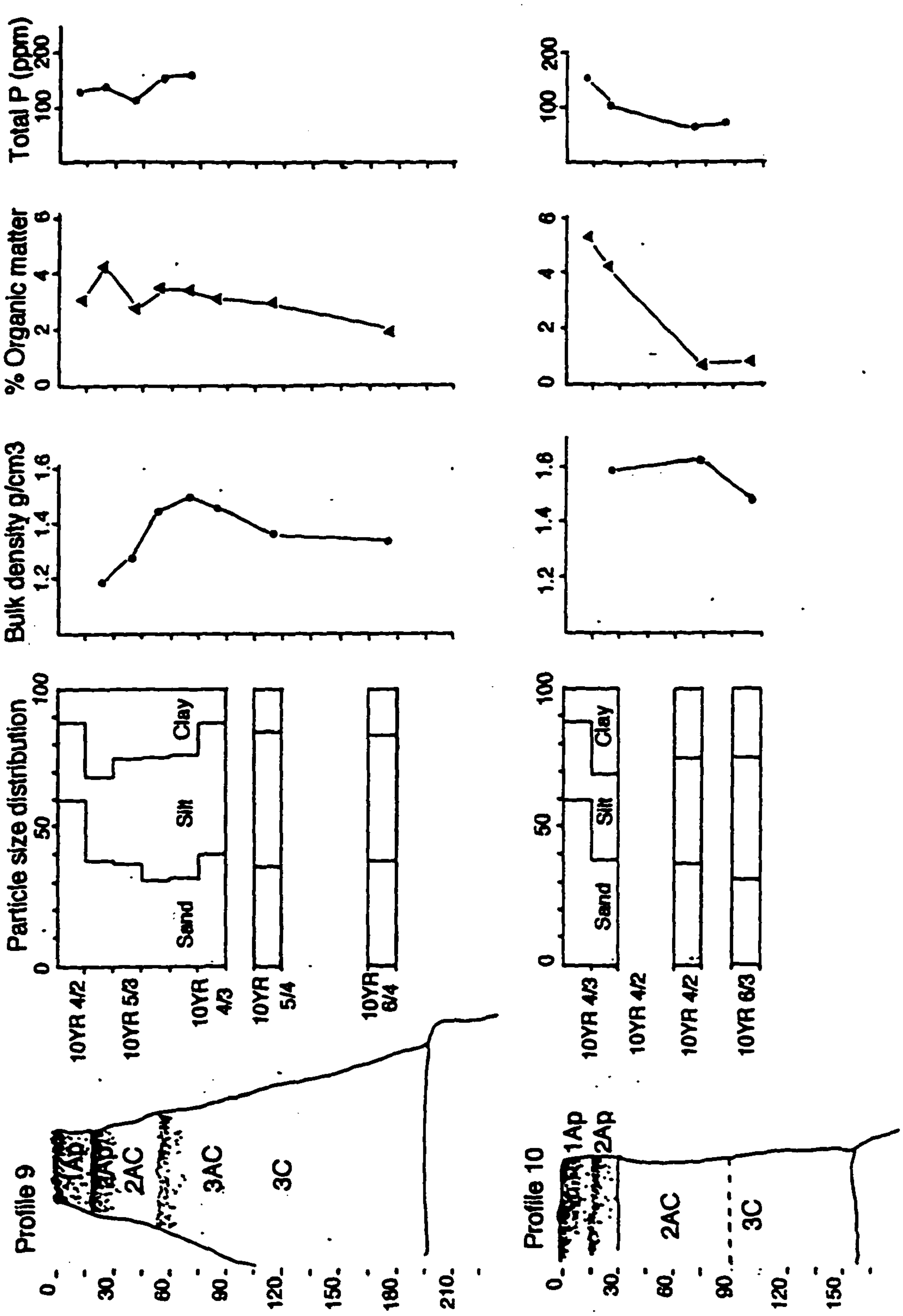

C - C'
Alluvium
Ash
Mud flow
2
1
0
5 m
D - D'
Location 3
Soil 10
Tepetate
3
2
1
0
5
10 m
SURFACES, SOILS AND LITHOLOGY
Reconstruction of surface in Aztec times
Metepantli soils
Cumulic soils
Volcanic ash
Late Pleistocene alluvium
Mud flow
Pink lahar
Tepetate

During this cycle of sedimentation the basin was probably closed or attained a very low gradient, since low energy silts characterize the upper part of the unit; later the basin was captured, or recaptured by the Chapingo river at the topographical threshold located just west of profile A (Figure 5.22).

Incision followed sometime before 5 ka, probably shortly after the basin was captured. Subsequently, a mud flow containing particles of ash, which may be from the PGF event, refilled the incised barranca. Following this event, there were two subsequent mud flows with soil horizons each. Incision again occurred sometime before the Aztec occupation, probably in the Classic-Epiclassic phases during which soils were stripped leaving large surfaces of barren tepetate.

Colluvial deposits covered the lower parts of the slopes near the barranca as seen also in sections C and D (Figure 5.24). Whether these are the result of sheetwash from the eroded uplands during the Post-Terminal Formative erosional phase or alluvial deposition is difficult to say because both are welded in the form of cumulic soils, as shown in the lower horizons of profile 9 (Figure 5.25). Metepantli soils overlie these colluvial/alluvial deposits, and in some cases they overlie the barren tepetate surfaces, which are the proof of Aztec land reclamation.

Figure 5.25 Soil profiles 9 and 10 in site Tx-A-86.



Profile 9
Profile 10
1Ap
2Ap
2AC
3AC
3C
10YR 4/2
10YR 5/3
10YR 4/3
10YR 5/4
10YR 6/4
10YR 4/3
10YR 4/2
10YR 4/2
10YR 6/3
Particle size distribution
Sand
Silt
Clay
Bulk density g/cm3
% Organic matter
Total P (ppm)

In some cases the accumulation of cultural deposits associated with these metepantli soils was continuous as suggested by the cumulative character of cultural horizons in profile 10 Figure 5.25). The pottery contained in the metepantli soils of locations 1, 2 and 3 (Figures 5.23 and 5.24) is only Late Aztec (see Appendix I for descriptions).

The geomorphological sections A, B, C and D, show a series of of soil surfaces on pedestals that help trace the topography for the Late Aztec times. At that time the barranca was not so deeply incised as it is today. In some reaches the flow of water of the catchment was split into two channels as is the case in Section B (Figure 5.22).

The late Aztec settlers were able to manage the environment of the barranca and the slopes. Land reclamation by metepantli semi-terracing, as seen in the properties of soils 9 and 10, does not differ from that of modern analogues and their contemporaries in Tx-A-78. At this time, perhaps most of the land in the watershed was terraced and the small gullies were controlled with check dams; numerous remains of terraces and metepantlis in the upper parts of site Tx-A-86 testify for the intensive work of land reclamation in Aztec times.

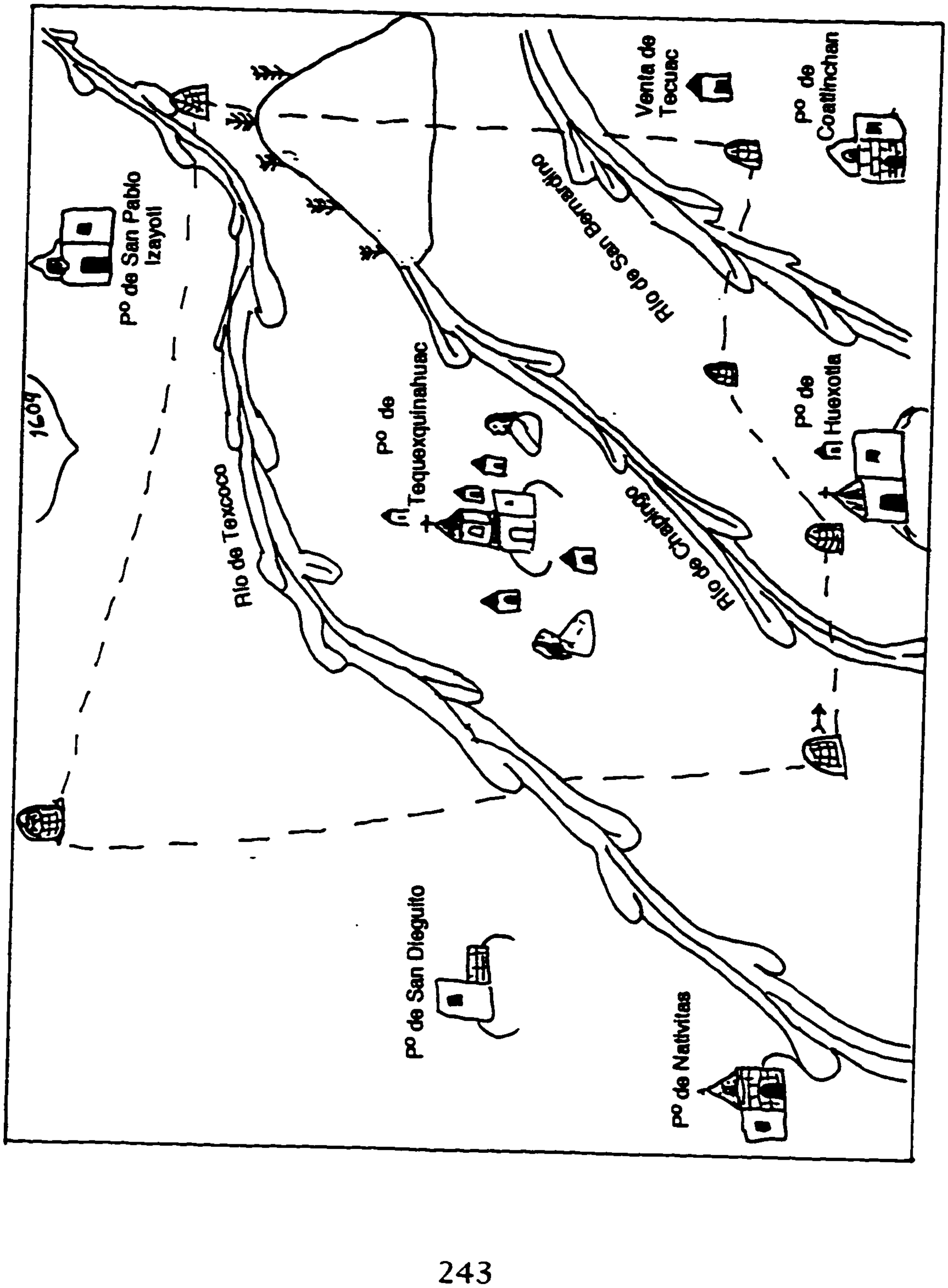
The absence of Early Colonial ceramics in the area, namely the Black/Orange Aztec IV and the introduced Colonial styles, suggests that the desertion of site Tx-A-

86 took place earlier than Tx-A-78. If so, it is probable that the initiation of severe erosion started early in the 1500s. The low resolution of the geoarchaeological data and the lack of documentation for this part of the piedmont are a limitation for determine a scenario of desertion and erosion.

A document written in 1606 and dealing with land grants in the area, mentioned that behind La Asunción (Tequexquinahuac) there was an area referred to as *pedregal* (bedrock surface) (AGN, Mercedes, v. 25 f. 69; see also location 72 in Appendix A), which means that probably at that time the land around Tequexquinahuac was already dramatically eroded and characterized by a 'pedregal' in contrast to 'tierra' (cultivable land). A map held in the municipal branch office at Tequexquinahuac, named in this study as the "Lienzo de Tequexquinahuac" shows the limits of the town in 1609 and the area of site Tx-A-86 appears void of population (Figure 5.26).

The most prominent characteristic of the erosional phase in the Early Colonial period after abandonment was the stripping of soil, the formation of pedestals, and the deep incision of the barranca, leading to the appearance that the place shows today Stream erosion tended to downcut the barranca in a headward direction in the form of discontinuous gullying in a way similar to the model

Figure 5.26 Lienzo de Tequexquinahuac, dated 1609. Redrawn from the original held in the municipal office of Tequexquinahuac.


1609
Pº de San Pablo Izayotl
Rio de Texcoco
Pº de Tequexquinahuac
Rio de San Bernardino
Rio de Chapingo
Venta de Tecuac
Pº de Coatlinchan
Pº de Huexotla
Pº de San Dieguito
Pº de Nativitas

proposed by Schumm and Hadley (1957). Since such a system of discontinuous gullying affects the entire basin, it is evident that the stream network in the entire piedmont responded to this change. Indeed, in the next two examples, incision shows the same patterns of discontinuous gullying for the same time.

Site Tx-A-87 (Aztec Huexotla)

Settlement change and concomitant geomorphic process are also discernible at different sections in the lower piedmont, like the case of the area around the Aztec city of Huexotla, where there is evidence of stream incision contemporaneous with the erosional phases in the upper piedmont. Because the core of the nucleated town of Aztec Huexotla has not been covered completely by modern occupation, it was possible for the survey team to produce a map of the Aztec town published by Parsons (1971), within which an extensive collection of surface material allowed interpretations regarding spatial distribution of activities within the city (Brumfiel 1976, 1980). The core of monumental buildings of Aztec Huexotla is limited to the west by a wall, and to the north and south by the Chapingo and San Buenaventura rivers, respectively; to the east there is no boundary, except that the surface archaeological material decreases in density (Figure 5.27). In the area located to the south of the southern barranca (San Buenaventura River) there was substantial domestic occupation that is distinguished by the high concentration of material on surface (Parsons 1971; Brumfiel 1976). This southern district is connected to the ceremonial civic-compound of the wall on the northern bank across the barranca by a bridge that is definitely Spanish Colonial, in spite of the mistaken belief that Tylor wrote about in his description:

> "There is an old Mexican bridge near Tezcuco which seems to be the original Puente de las Bergantinas, the bridge where Cortes had the brigantines launched on the lake of Tezcuco. This bridge has a span of about twenty feet, and is curious as showing how nearly the Mexicans had arrived at the idea of the arch. It is made in the form of a roof resting on two buttresses, and composed of slabs of stone with the edges upwards, with mortar in the interstices; the slabs being sufficiently irregular in shape to admit their holding together, like stones of a real arch"(Tylor, 1861: 153-154).

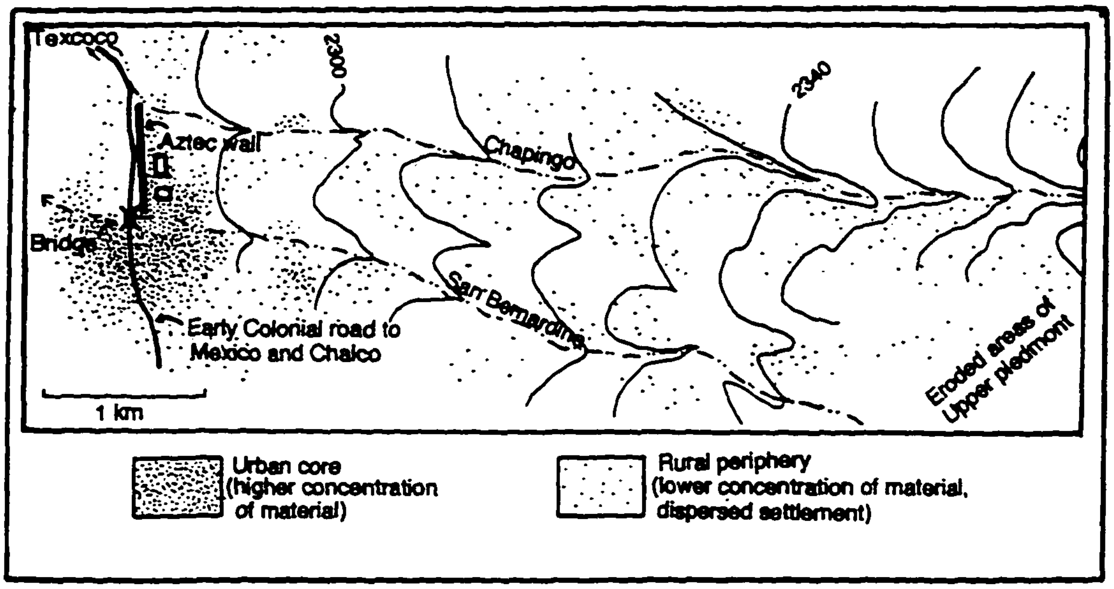


Figure 5.27 Location of the Huexotla bridge in the context of the archaeological material on surface. The information of this map is based on Parsons (1971) and Brumfiel (1980) with additional data from this study.

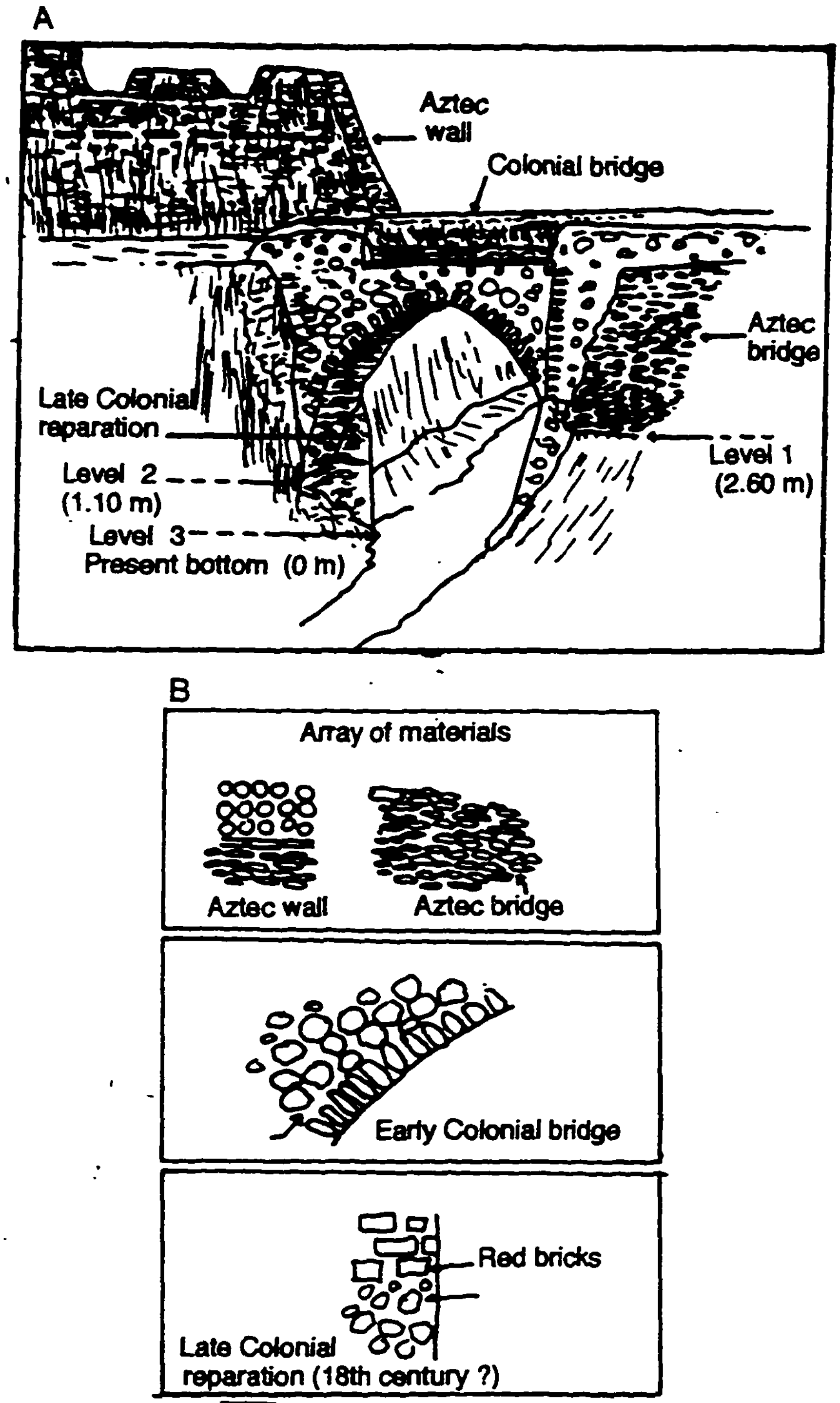
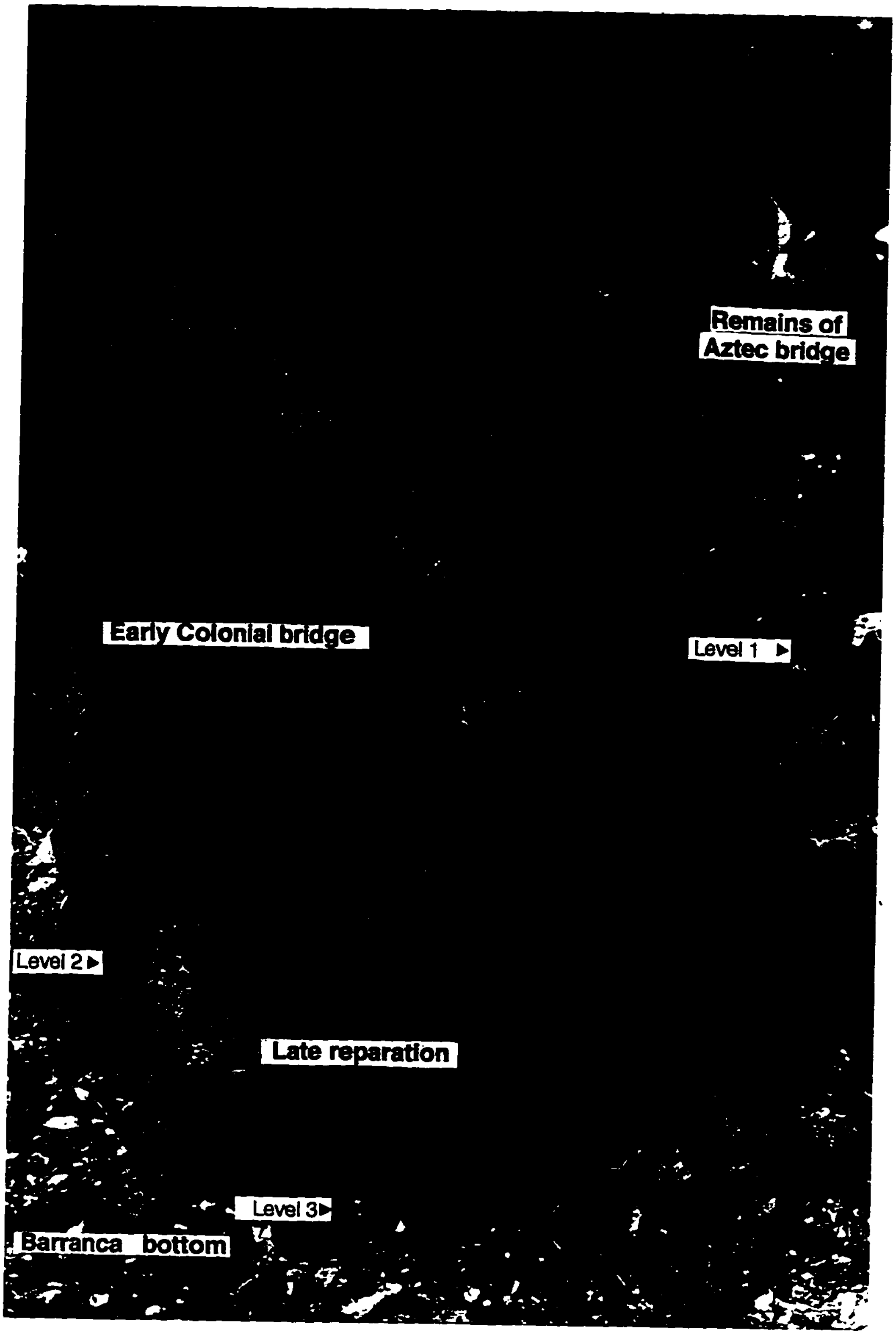


Figure 5.28 The Huexotla bridge: (A) phases of reconstruction, and (B) array of stones in each period of construction.

Figure 5.29 The Huexotla bridge (northeast side).


Remains of
Aztec bridge
Early Colonial bridge
Level 1
Level 2
Late reparation
Level 3
Barranca bottom

Although the description and accompanying illustration matches the actual bridge of Huexotla, the architecture of the bridge does not correspond to pre-Hispanic making. Doolittle (1990) initially agreed with Tylor, but has since change his mind (Doolittle, 1993, personal communication). Thus, neither the ancient Mexicans were close to the idea of the arch, nor this bridge had anything to do with the site where the brigantines of Cortés, since the lakeshore at the time of the conquest was far off this site, at least four kilometers away. After clarifying this mistake, it is pertinent to say that the Aztec bridge did exist, and its foundations, that Tylor did not see, still hang on both sides of the barranca next to the Colonial bridge (Figure 5.28, A, and Figure 5.29). The Aztec bridge structure presents the array of stones and mortar similar to the wall next to it (Figure 5.28, B), and shows scars of collapse and damage due definitely to river downcutting. The Colonial bridge also shows marks of damage that were repaired as the bottom of the barranca dropped. The phases of construction and reconstruction of the two bridges are the main interest in the problem of stream incision discussed in this section.

The base of the Aztec bridge (level 1), now about 2.6 meters above the present riverbed, indicate the bottom of the barranca at the time of its construction (Figures

5.28 a and 5.29). The bridge may have consisted of two stone-mortar structures in both sides of the barranca, connected by a wooden causeway, to tell by the fact that the false arch was never developed in this part of Mexico in Prehispanic times (Doolittle 1990). The Aztec bridge was substituted by a new bridge in the Early Colonial period, probably in the 1500s since this was an important road that linked Texcoco, Huexotla and Coatlinchan with Chalco and the road to Puebla. The Early Colonial bridge has its original the foundations about 1.1 meters (Level 2) above the present surface, and 1.5 meters below the foundations of the Aztec bridge (Level 1). Further repairs at the foundation of this colonial bridge account for the continuous lowering of the riverbed, leaving the foundations at level 3 at the present stream-bed level (Figure 5.28 a); this last repair was made probably during the 1600s or even the 1700s, since fired mud brick was used, a material that was more common in Late Colonial times. Although there are mentions of the bridge and the wall hallmark references in the Mercedes documents as of the early 1600s (Mercedes, v. 33, f. 128, vta, No. 109 in Appendix A), there is no further documentation regarding the history of the bridge itself. For this reason, a scenario of its construction and repairs is just a conjectural reconstruction. Thus, if incision occurred in pre-Aztec times, it was not so deep, probably a few meters, to judge by the fact that the Aztec bridge stands on a surface of barren tepetate. What is evident is the post-Aztec incision, when the river incised about 1.5 meters, making parts of the Aztec bridge structure collapse. Later, at the end of the Early Colonial phase or at the beginning of the Late Colonial phase the stream incised again 1.1 meters damaging the foundations of the bridge that had to be repaired.

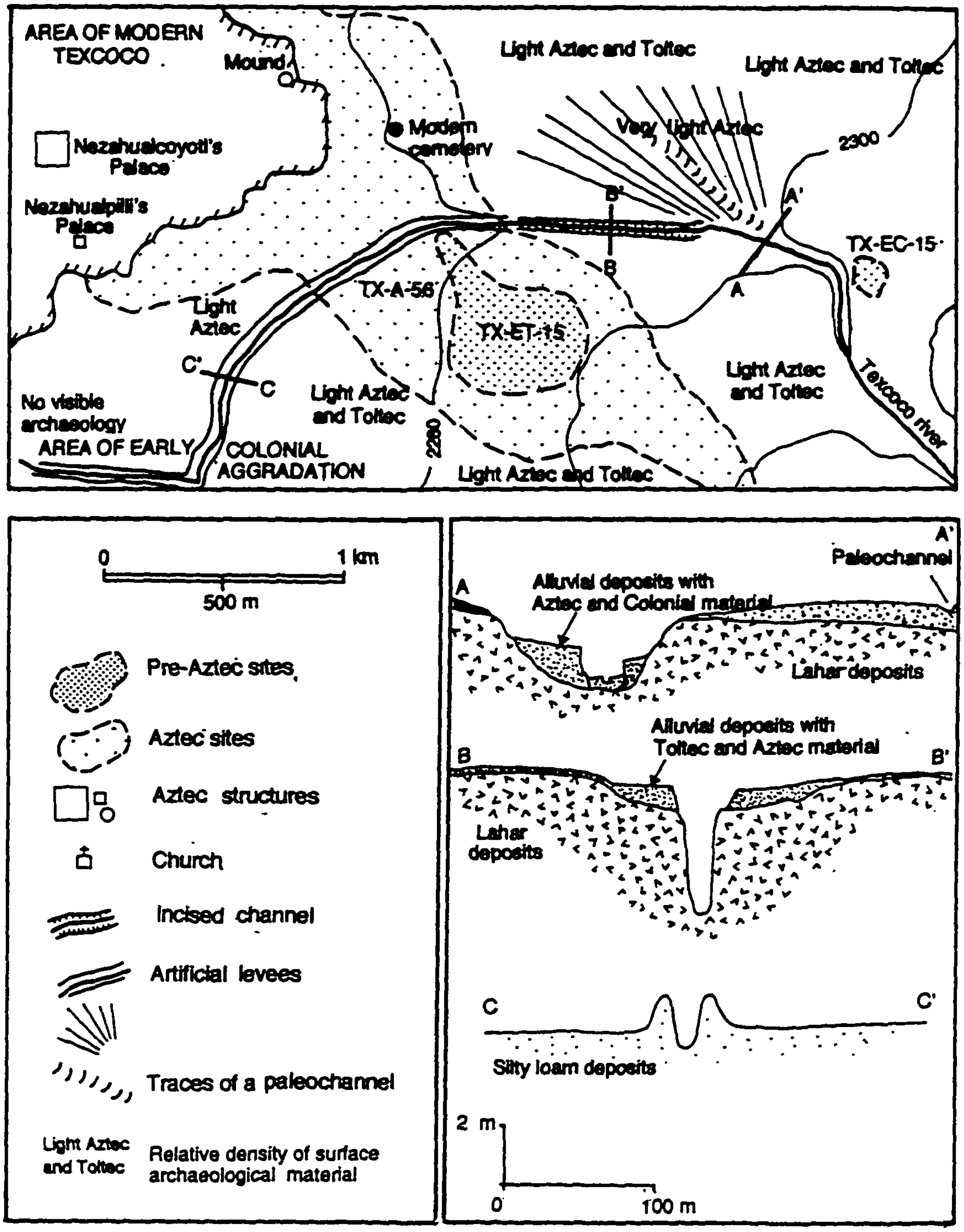
Site Tx-A-56 (East Aztec Texcoco)

The layout of Aztec Texcoco is only barely known by the descriptions of Early Spanish accounts (*e.g.* Díaz del Castillo 1968; 1985, Ixtilxochitl 1975, 1977, Pomar 1986), by few remains reported by Parsons (1971) and by ethnohistoric research (Cline 1972, Hicks 1982). The buildings and paved streets of Colonial and modern Texcoco cover approximately the 80% of the remains of Aztec Texcoco, one of the largest urban centers in Mesoamerica at the time of the conquest. The most prominent features mentioned in the sources are the royal palace, the market place, and the temples. All three features are not visible today and have not been excavated, for those we still have to rely on the archaeological and historical information available. Through several generations it has been passed down that King Nezahualcoyotl's palace used to be in the present location of the central square, a belief that does not conflict with the numerous descriptions by Ixtilxochitl (1975, 1977) and Pomar (1986) that describe it in the center of town. Although no archaeological investigation has been undertaken to prove so, I assume that the location of the King's palace stood somewhere downtown Texcoco.

Some of the Texcoco *barrios* extended onto adjacent areas in a clear dispersed pattern, as it is the case of the eastern portion site Tx-A-56, just east of Texcoco in the barrio of San Diego where there is also an Early Toltec site (Tx-ET-15) (Figure 5.30). This area, located just at the contact of lower piedmont and alluvial plain, is cut across by the Texcoco river which shows some interesting aspects of alluviation and stream downcutting that provide some clues as to how rivers affected the lands of Texcoco and how they were managed in Aztec and Colonial times.

The archaeological survey map shows that in general the off-site surface material in the area around Texcoco is predominantly Aztec and to a lesser degree Toltec, except for two areas: (1) the area south of Texcoco where post-Aztec alluvium has buried all vestiges of occupation, and (2) the are north of the Texcoco river, just east of Texcoco, where there is only scarce Aztec material on a coarse-grained surface. By its convexity and soil texture

Figure 5.30 Sites Tx-A-56 and Tx-A-57 and the Texcoco river sections.


AREA OF MODERN TEXCOCO
Mound
Nezahualcoyotl's Palace
Nezahualpilli's Palace
Modern cemetery
Light Aztec and Toltec
Light Aztec and Toltec
Very light Aztec
2300
A'
B'
B
A
TX-EC-15
TX-A-56
TX-ET-15
Light Aztec
C'
C
Light Aztec and Toltec
Light Aztec and Toltec
Texcoco river
No visible archaeology
AREA OF EARLY COLONIAL AGGRADATION
2280
Light Aztec and Toltec
0
1 km
500 m
Pre-Aztec sites
Aztec sites
Aztec structures
Church
Incised channel
Artificial levees
Traces of a paleochannel
Light Aztec and Toltec
Relative density of surface archaeological material
A
A'
Paleochannel
Alluvial deposits with Aztec and Colonial material
Lahar deposits
Alluvial deposits with Toltec and Aztec material
B
B'
Lahar deposits
C
C'
Silty loam deposits
2 m
0
100 m

it is clearly this surface is an alluvial fan. On this surface it is noticeable that there is a depression with even coarser material that extends in a northwestward; it seems to be that the depression is a paleochannel, that cut through the fan.

The geomorphic features and stratigraphy of section A (Figure 5.30) suggest that, after overflowing the banks onto the fan, the Texcoco river incised the present channel and then refilled again, completing two cycles of alluviation. Further downstream, the channel is straight but deeply incised into the Late Pleistocene pink lahar deposits as shown in section B (Figure 5.30). At the contact with the alluvial plain the channel bottom is no longer incised and runs almost at ground level reinforced with artificial levees across the plain of post-conquest silt deposits (Section C, Figure 5.30). The longitudinal profile of the barranca as it leaves the piedmont, where the pink lahars are common, shows a cascading system that tends to be deeper in those places where the channel is straight or where the gradient of the overall slope is higher. Thus, we find a difference in channel depth between section A and B, and between B and C. What we have again is the process of discontinuous gullying. Although Schumm and Hadley (1957) explain this process as a response of the stream to rapid alluviation in a resulting from gradient change, it seems that in the case under study there is a combination of rapid alluviation in the area of the fan with the straightening of the channel in some reaches where the erosive power of water increases. However, the general topography points out that the modern channel follows a rather forced route, and furthermore follows a path around the city of Texcoco. This fact gives the impression that the straight and incised reach of the river and the lower channel with levees may be the result of human intervention with the purpose of protecting the imperial capital from the floods as exemplified by the fan and by the amounts of silts in the area of Texcoco covering Aztec and Toltec occupation as seen in pits in the city of Texcoco (Parsons 1971:119, 120). In a road cut across from the cemetery (see Figure 5.30) I observed a 1.8-meter section showing at least two cycles of alluvial sedimentation separated by a complex layer of occupation with Late Toltec (Mazapa) and Aztec ceramics. The alluvial sediments in this section are sandy loam in contrast with the silt-loam deposits south of Texcoco, which suggests that the area of the cemetery was affected by a higher energy system, probably associated with the fan described above.

The fact that the alluvial fan does not contain Toltec and Early Aztec material, but a few Late Aztec and

Colonial material, indicates that this event may have occurred late in the Aztec period, probably at the time when under the auspices and direction of King Nezahualcoyotl the river was redirected. Although many allusions to stream correction are made in the sources, especially by Ixtilxochitl (1975, 1977) and Pomar (1986), there is no mention about the control of this river in particular. Although not mentioned either, the city of Texcoco was prone to alluviation in Early Colonial times, since today silts cover Aztec structures in several parts of the site as described by Parsons (1971). In the southeast limits of Texcoco, in the area known as "Los Ahuehuetes", the river channel was already in the place where it is today according to the descriptions of a Mercedes document (No. 93 in Appendix A). In this location floods seem to have been frequent during the Colonial period. A map of Texcoco, dated 1749 shows an area apparently inundated is referred to as the "*amanales de Texcoco*" (Illustration no. 1483 in Centro de Información Gráfica del AGN, 1979). *Amanalli* in Nahuatl means a place where there is water, but the fact that the map shows ponds, may be an area frequently flooded.

Incision in the straight segment of the river at section B, may be Colonial, and associated with the strong alluviation at the mouth of the incised channel south of

Texcoco, after the stream was transferred to its southern and present-day channel. It is probable that incision took place also simultaneously with this strong alluviation or shortly afterwards, and may have been contemporaneous with incision at the bridge section in Huexotla. In both cases, the streams at the limits between the lower piedmont and the alluvial plain responded to rapid erosion of soils and tepetate in the upper piedmont.

The Tepetlaoztoc area

The erosional belt of the upper piedmont to the east of Texcoco and Huexotla extends also over the piedmont of the Patlachique range to the north of Tepetlaoztoc where large surfaces of tepetate have been exposed and dissected by gullies. As in the case of the piedmont of Texcoco, presented in the previous examples, the settlement history of the area around Tepetlaoztoc shows a close correlation between abandoned sites and erosional forms. The best example of this correlation is the spatial coincidence between severely eroded areas (headwater rills and badland areas) and Late Aztec sites (Figure 5.31).

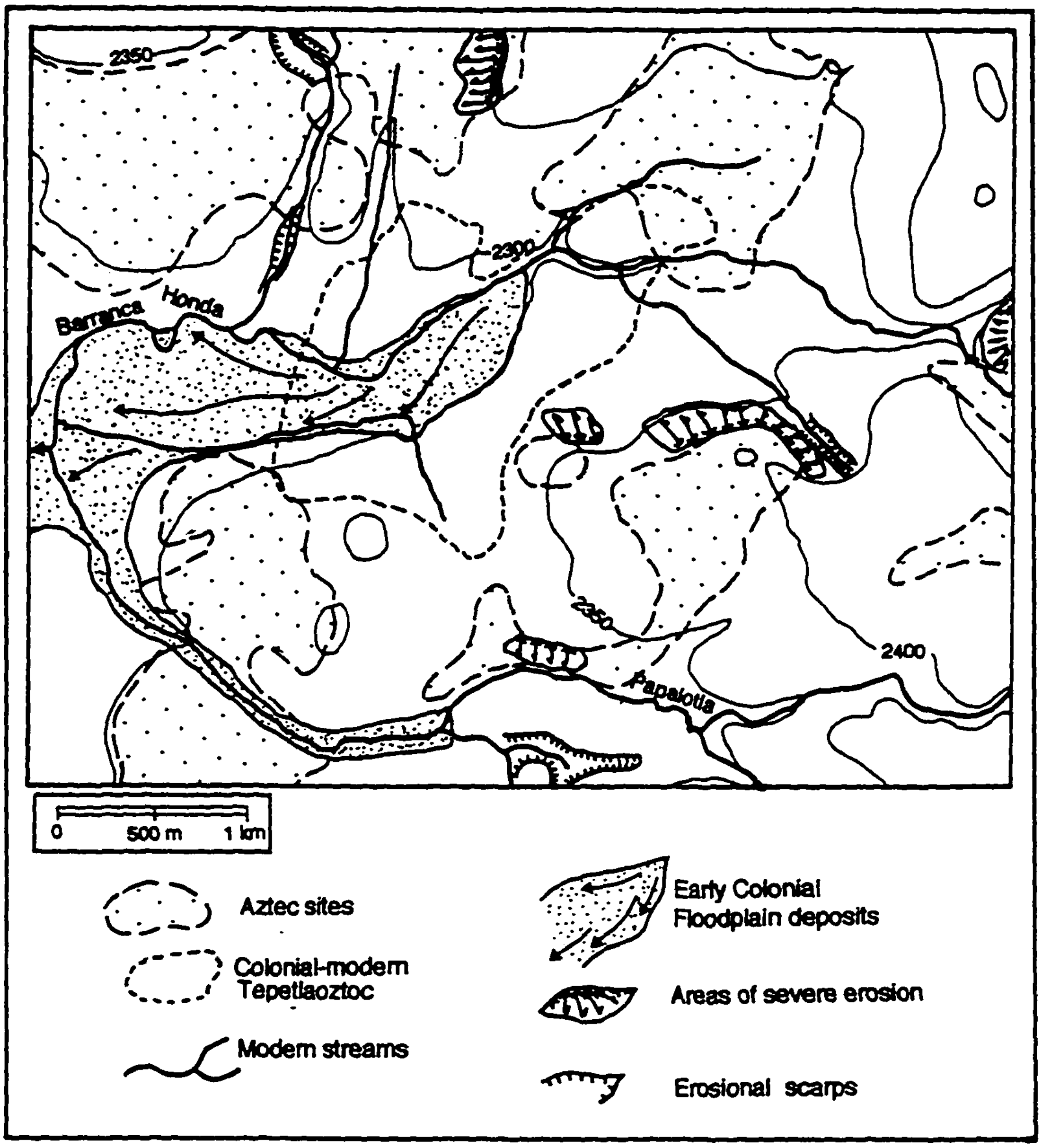


Figure 5.31 Aztec sites around Tepetlaoztoc, eroded areas, and alluvial plain.

The site of Aztec Tepetlaoztoc (Tx-A-24), located just north of the modern town of Tepetlaoztoc, is a large dispersed settlement where it is still possible to see remains of degraded terraces and check-dams associated with domestic mounds. Some of these features have been corroborated with the information depicted in the Codex Santa María la Asunción of the mid-1500s (Williams, 1995).

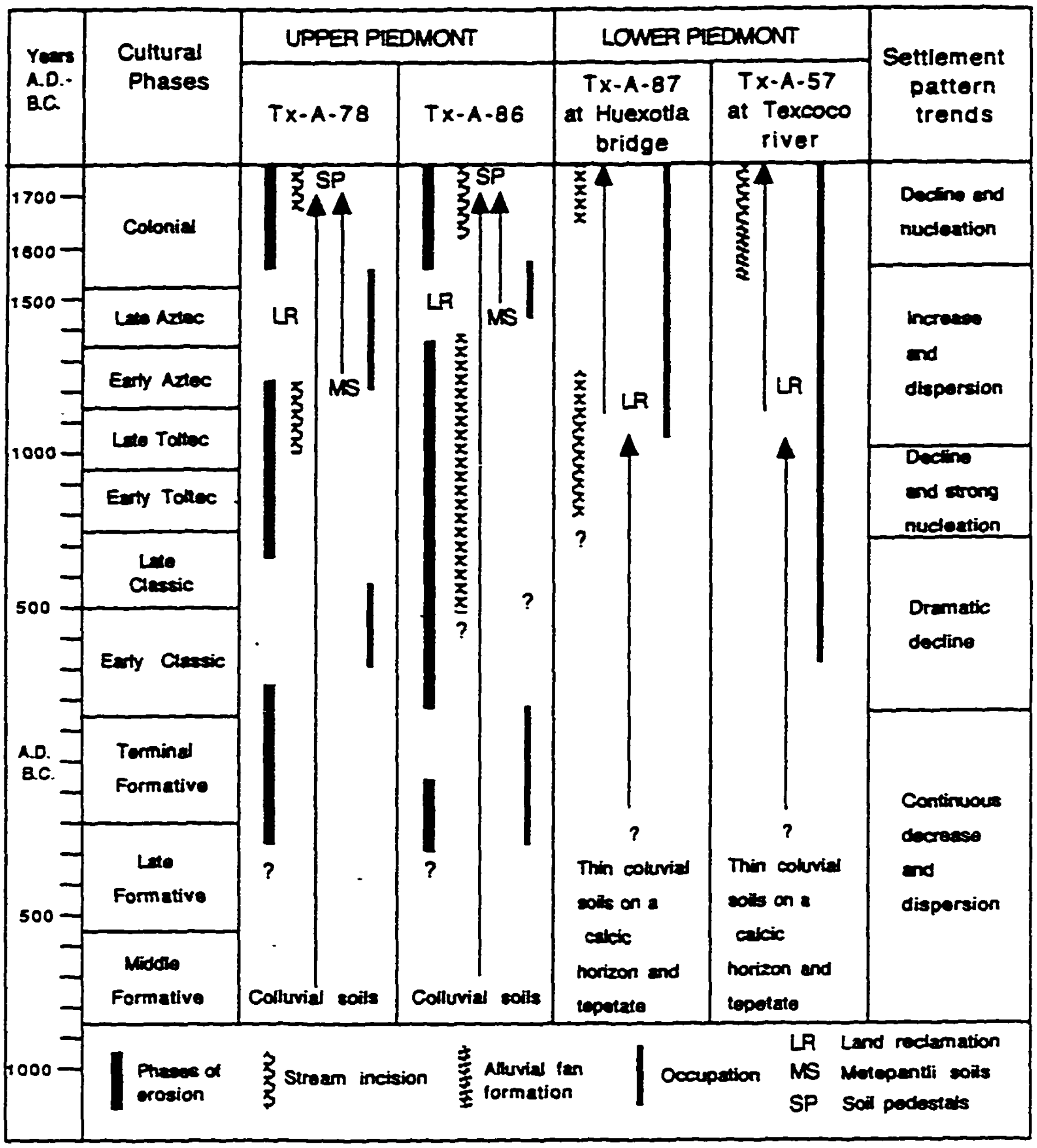
Additionally, Dr. Barbara Williams of the University of Wisconsin suggested the probable location of a dam reported in the Codex Santa María la Asunción. I visited the suspected location of the and located the remains of 5-meter long wall constructed across a barranca. The wall was definitely as old as Aztec, and although it was broken and the sediment eroded, it was evidently a check dam. Whether it was the dam of the Codex or not, it shows the fate of similar structures elsewhere in Aztec sites after they were abandoned in the Early Colonial phase. Thus, after abandonment, terraces and check dams without maintenance acted as sources of sediment to be carried down by runoff to the floodplains. It was after the desertion of the settlement initiated with the epidemics of the 1540s, and consummated with the *congregaciones* around 1600 that heavy rains took their toll on the terraced soils.

Another clue as to the associations between settlement dynamics and erosion in pre-Aztec times is provided by the distribution of sites of the Terminal Formative period and the Early Toltec phase. The Terminal Formative saw the proliferation of small sites in the area around modern Tepetlaoztoc, which may have implied stress on slopes. During the Early Toltec phase the appearance of nucleated sites and scattered may have created impact on the catchment. In fact, the alluvial record of the Barranca Honda watershed shows two aggradational cycles that correspond with the end of these three archaeological phases, a relationship that will be discussed in Chapters 6 and 7.

Correlation of events

In a regional perspective, the progression of erosion across the piedmont is a complex process that is concomitant with the declining number of sites and the shift from dispersed to nucleated sites. In a local perspective, the data of this research show that there is a close relationship between the end of occupation in sites Tx-A-78 and Tx-A-86 and the start of severe erosion in the upper piedmont and incision and alluviation in the lower piedmont and plains (Figure 5.32). The data recovered at the moment suggests the following scenario: the first phase

Figure 5.32 Chronology of soil erosion in the upper piedmont and stream incision in the lower piedmont.


Years A.D.-B.C.
Cultural Phases
UPPER PIEDMONT
LOWER PIEDMONT
Settlement pattern trends
Tx-A-78
Tx-A-86
Tx-A-87 at Huexotla bridge
Tx-A-57 at Texcoco river
1700
1600
1500
1000
500
A.D.
B.C.
500
1000
Colonial
Late Aztec
Early Aztec
Late Toltec
Early Toltec
Late Classic
Early Classic
Terminal Formative
Late Formative
Middle Formative
SP
LR
MS
?
Colluvial soils
Thin coluvial soils on a calcic horizon and tepetate
Decline and nucleation
Increase and dispersion
Decline and strong nucleation
Dramatic decline
Continuous decrease and dispersion
Phases of erosion
Stream incision
Alluvial fan formation
Occupation
LR Land reclamation
MS Metepantli soils
SP Soil pedestals

of erosion occurred sometime after sites declined in the Classic and Early Toltec phases. Later, the eroded lands were reclaimed by Aztec farmers who built terraces and check-dams. After the Spanish conquest, sites in the upper piedmont and hills declined while settlement nucleation took place in the alluvial plain and lower piedmont. Terraces and check dams in the upper piedmonts and hills were abandoned and subsequently destroyed by runoff produced by copious rains. The damage created by stock raising was not fundamental in triggering soil erosion but may have contributed to the disturbance of the landscape.

CHAPTER 6

TRANSFORMATION OF THE ALLUVIAL PLAINS AND THE CHRONOLOGY OF RECENT FLUVIAL SEDIMENTATION

A glimpse into the history of alluviation in the valleys complements the picture of land degradation on piedmonts and hills presented in the previous chapter. The data gathered from the alluvial sequences also helps explain the scarcity of sites that the survey in the 1960s reports for the alluvial plains. Although sites are present, they have been buried by recent, rapid sedimentation.

Investigation in the valleys was designed to reconstruct the ancient fluvial landscapes and to establish a chronology relating alluvial sedimentation to human occupation. This objective was achieved by creating models to explain the particularities of fluvial behavior of the Texcocan rivers in the past, based on the data gathered in the field.

Preliminary discussion on the research problems

Site visibility and alluvial sedimentation

The archaeological survey maps (Parsons 1971, Sanders *et al.* 1979) show a particular patterning of sites in relation to the distribution of floodplains in the Texcoco region: those areas lacking surface archaeological material coincide with the areas of recent flood-overbank deposition (Fig. 6.1 and 6.2).

After the archaeological surveys were completed the opening of brickyard pits in the alluvial plains exposed occupation surfaces lying beneath several meters of alluvium in those areas with no pre-Hispanic remains on the surface. The fact that the layout of the brickyard pits follow certain patterns along the main river courses and old channel ridges suggests that there is a preference for quarrying specific types of deposits. The brickyards are aligned parallel to either the modern channel or the old channel ridges, and expose the same kind of depositional sequence, consisting mainly of silt-loam and silt-clay deposits separated by weakly developed soil horizons and long lenses of sand and gravel. Based on what the workers say about the process of brick-making, it is evident that this textural distribution provides them with a mud mix that gives the needed consistence to the bricks when fired.

The spatial pattern of brickyards is well illustrated along the San Juan Teotihuacan and Papalotla Rivers (Figure 6.1) and along the lower courses of the Arroyo Coxtitlan and Coatepec rivers (Figure 6.2). In the central part of the region, the floodplains of the

Figure 6.1 Floodplains and visibility of archaeological remains along the Papalotla and San Juan Teotihuacan rivers.

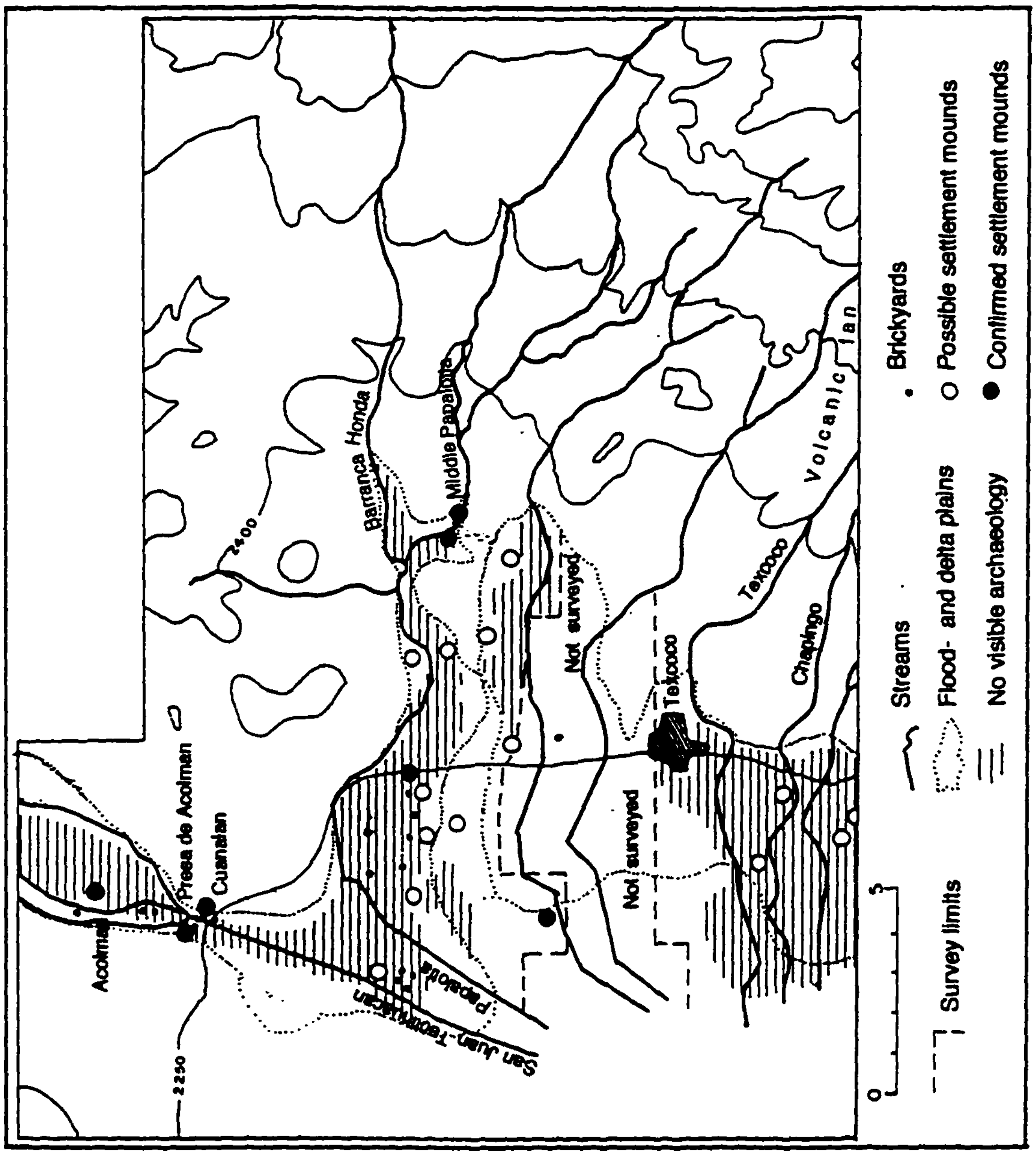
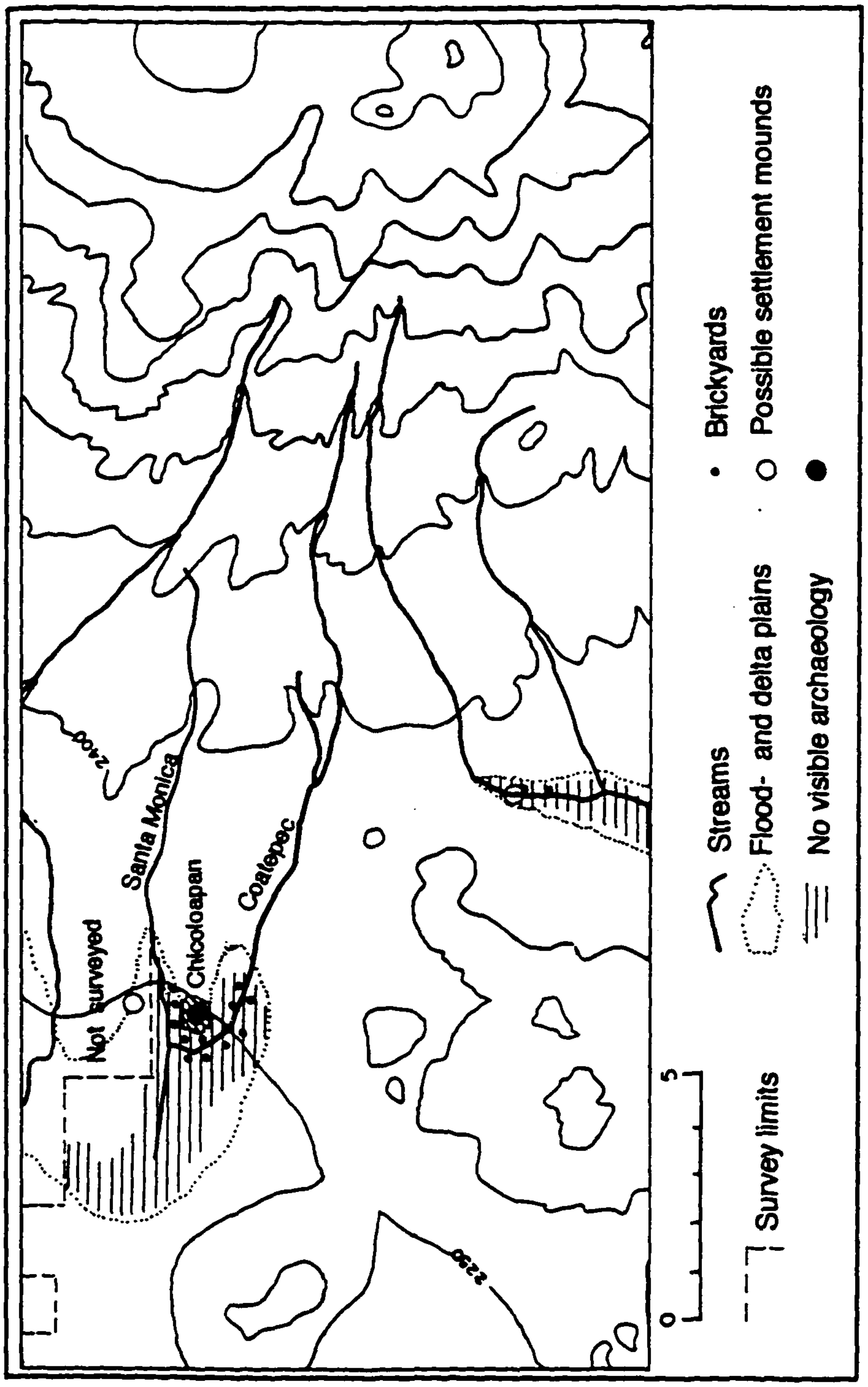

Acolman
Presa de Acolman
Cuanalan
2250
2400
Barranca Honda
Middle Papalotla
Papalotla
San Juan-Teotihuacan
Not surveyed
Not surveyed
Not surveyed
Texcoco
Texcoco
Chapingo
Volcanic
lan
0
5
Survey limits
Streams
Flood- and delta plains
No visible archaeology
Brickyards
Possible settlement mounds
Confirmed settlement mounds

Figure 6.2 Floodplains and visibility of archaeological remains along the Arroyo Coxtitlán and Coatepec rivers.



Not surveyed
Chicoloapan
Santa Monica
Coatepec
2400
2250
0
5
Streams
Flood- and delta plains
No visible archaeology
Brickyards
Possible settlement mounds
Survey limits

Coaxacuaco, Texcoco and Chapingo rivers do not host brickyards (Fig. 6.2). Although there might be another reason for the lack of brickyards, the textured deposits in this area are not suitable for brick-making. Pipeline trenches in these plains reveal predominantly sandy sediments, primarily because the rivers dissect a late Pleistocene volcanic fan containing deposits with large amounts of sands and gravel. In spite of the lack of good brickyard exposures, the rivers of the central part of the study area show an informative pattern of channel down-cutting in their upper reaches which provides certain clues to the general stream behavior in the area, as shown in the example of the Texcoco and San Bernardino rivers in Chapter 5.

In addition to the brickyards, cut-bank exposures in the incised reaches of some streams, such as the middle Papalotla and Barranca Honda, were also described and proved also be a good source of information on recent alluvial stratigraphy.

There are no local modern analogues to most of the deposits studied, since rivers no longer flood as they did in the past because of their control through artificial channelization, or because of recent stream trenching. However, other rivers in the Basin of Mexico show similar morphological and stratigraphic characteristics, and provide a useful model of comparison. Thus, I cite certain aspects of the Tlalmanalco and Amecameca rivers in the Chalco region, where I have worked, and the Cuatitlan river in the northwest part of the Basin, where I have made observations. Also, because of the lack of modern analogues, examination of other non-controlled streams outside the Basin of Mexico provided insight towards the construction of models to explain the evolution of alluvial plains based on the architectural elements and alluvial facies, as presented in the next section.

Although the deltaic plains were not studied due to the lack of exposures, they are worthy of mention. The distribution of deltas at the mouth of some of these rivers emptying into lake Texcoco is indicated by the lobe-like configuration of the 2250 m contour. These areas exhibit topsoil material that is consistently sandy-loam, and silt-loam in contrast to the clayey loam material of the lacustrine bed. Archaeological remains appear also scarce on these deltaic surfaces, although this fact is difficult to evaluate since some areas at the interface alluvial-lacustrine plain have not been surveyed. Based on all these parameters, the deltas of the San Juan River and Papalotla, Chapingo and San Bernardino are evident (Figures 6.1 and 6.2).

Parameters considered in the description of alluvial units

As explained in Chapter 3 (Research Methods), the alluvial sedimentary units are designated with a capital letter (A, B, C, D, and E). In some cases these units are broken down into subunits where there are short and temporary interruptions in the stratigraphy created by a an ash-fall deposit or by a paucity of floods due to artificial control of streams. In these cases, a subindex is attached to the capital letter (*e.g.* B_1, B_2, E_1, E_2). As also explained in Chapter 3, the designation of allostratigraphic units as proposed by NACOSN (1983) was not possible since most of the units studied present a local pattern of distribution, limited sometimes to one small floodplain. However, at the end of this chapter I have grouped them into major units that may well be definable as alloformations with additional work.

The buried soil horizons which usually mark breaks in sedimentation are named S_1, S_2, S_3, and S_4 from oldest to youngest. Because the time span of deposition is limited to the late Holocene, especially the last two millennia, there is no good development of soil profiles in the alluvial deposits; in most cases these soils consist of weak A, AC, or even weak C horizons that barely qualify for a 'fluvent' designation in the classification of the Soil Survey Staff (1992). Because of their poor development and because they are typically related to local non-synchronous alluvial events, Ferring (1992:13) suggests that such weak horizons not be used for correlation. Thus, in this research buried soils are only considered as breaks between pulses of sedimentation.

The dating of alluvial units

Because dating using soil development was untenable, a dating strategy that combined the following was employed:

(a) Associated ceramics, especially the artifacts of youngest age found in occupation layers and A horizons buried by flood deposits; those artifacts found embedded in mud flows or in channel were not used for dating, since it was assumed that they were in a secondary context, but were reported as a reference (Appendix E),

(b) ^{14}C assays obtained primarily from charcoal samples (se Table 6.1 for calibrated ages), and

(c) relative chronology of correlative deposits in a proximity, based in some cases on physical appearance and in others on comparison of grain size distribution and sedimentary structures.

TABLE 6.1

LIST OF CALIBRATED RADIOCARBON AGES OBTAINED FROM ALLUVIAL DEPOSITS

Lab No.	Depth (cm)	Material dated	Locality/ Stratigraphic unit	δ^{13} Corrected Radiocarbon age	2 Sigma Calibrated Age AD/BC Probability method
OS-3476	150	charcoal	ACOL-1-III	145±25	AD 1670 (0.82) AD 1890
OS-3477	218	charcoal	CUAN-3-V	355±30	AD 1450 (1.00) AD 1640
OS-3478	280	charcoal	TEP-3-V	2,070±54	200BC (1.00) AD 20
OS-3479	200	charcoal	PAP-4-IV	575±30	AD 1290 (1.00) 1420AD
OS-3481	495	charcoal	CUAN-4-XI	1,240±30	680AD (1.00) 880AD
OS-3482	225	charcoal	PAP-1-IV	350±30	AD 1450 (1.00) AD 1640
OS-3483	185	charcoal	CLP-3-V	365±55	AD 1440 (1.00) AD 1640
Tx-7780	200	charcoal	CLP-1-III	219±50	AD 1510 (0.09) AD 1590 AD 1620 (0.84) AD 1890
Tx-7781	175-180	soil humate	TEP-1-V	5,313±51	4330 BC (0.07) 4280 BC/ (6280 - 6230 BP) 4250 BC (0.93) 4000 BC/ (6200 - 5950 BP)
Tx-8094	100	charcoal	TEP-1-II	3933 ± 15	2900 BC (1.00) 2000 BC/ (4850 - 3950 BP)
Tx-8021	224	charcoal	CLP-3-VI	2,033±96	400 BC (1.00) AD 200

Note:
All ages were calibrated using the curve: OxCal v2. 18 cub r.4 sd:12 prob [chron] (Stuiver, Long, Kra 1993. Radiocarbon 35 (1)).

Classification of ancient fluvial environments

Alluvial facies model

The reconstruction of the ancient depositional environments in the floodplains of the study area was accomplished through the classification of alluvial facies and the development of an alluvial facies model that shows the three-dimensional array of deposits and landforms. This interpretive model is based on the approach known as analysis of the alluvial architecture (Friend 1983; Miall 1985).

The interpretive model developed for this study subsumes the various styles of sedimentation usually found in alluvial plain environments (Task Committee 1971; Lewin 1978). The five basic environments are: channel, channel margin (lateral accretion), overbank (vertical accretion), overbank splays and valley margin deposits. Each of these environments has a particular set of alluvial facies that are defined by their texture and internal structure (bedding and geometry of deposit). Based on such environments and facies, the deposits studied were classified using the 9 alluvial facies by Miall (1985) (See Table 6.2). Those facies composed of coarser material, such as gravel and sand, are associated with higher energy during deposition and are usually found in channels and channel margins, whereas those facies composed of a finer material (silt and clay) are associated with lower energy during deposition in overbank environments. For this reason, besides internal structure, the definition of alluvial facies in this research is also based on grain size and sorting, which are two important granulometric parameters for classifying sedimentary environments.

A population of 66 samples was taken from selected deposits whose internal structure was already defined. Most of the samples came from the floodplain deposits of the Lower San Juan river and from the Barranca Honda, which are the most representative of the two types of floodplains defined below; a few came from the Lower Papalotla and Coatepec and Arroyo Coxtitlán, and represent facies that are rare in the other basins (see sample provenience information in Appendix F, section II).

The 66 samples were treated statistically to obtain mean grain size (Mz) and sorting (σ^1), and plotted in scatter diagrams for each basin (Figures 6.3, 6.4, and 6.5). Figure 6.6 shows the scatter diagram of granulometric relationships between facies for the three basins. The values represented in the plot were used to define the environment of other deposits in the sections, and to correlate similar deposits.

The samples were then classified according to depositional environment and facies type (See Table 6.3).

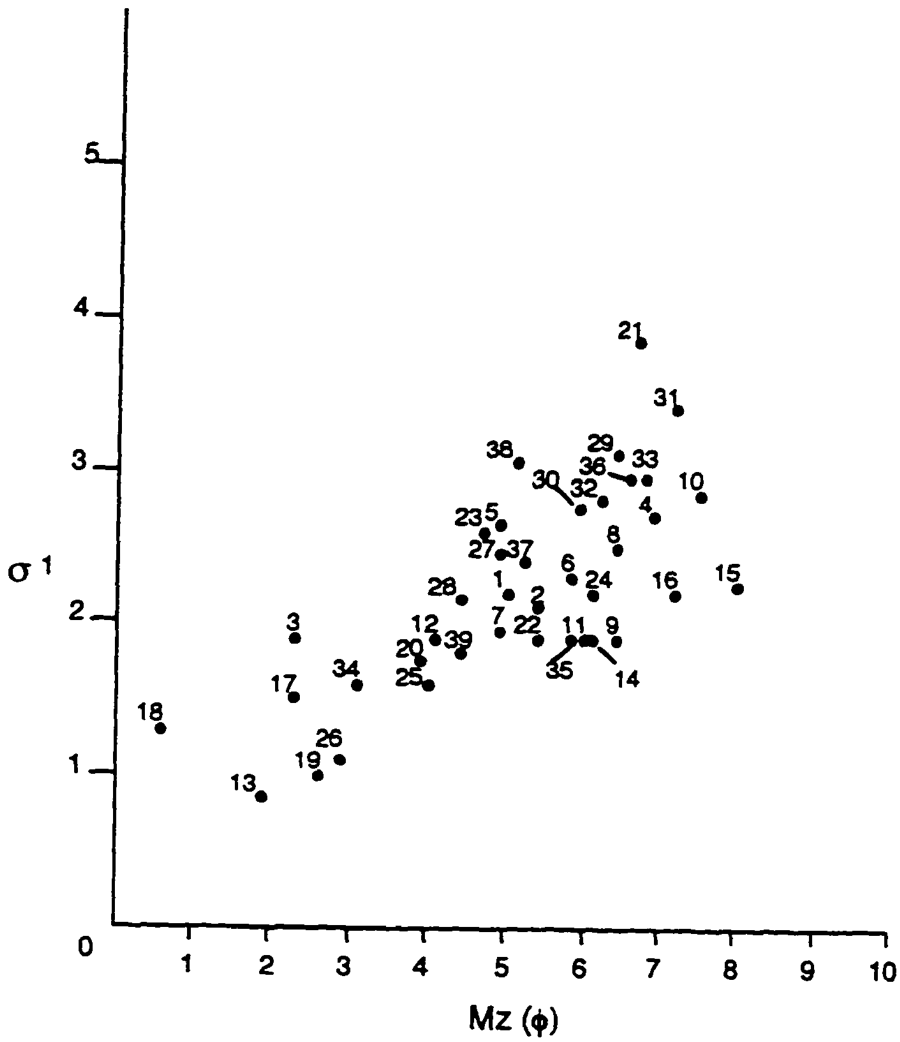


Figure 6.3 Mean grain-size (Mz) and sorting (σ^1) parameters obtained from samples from the lower Teotihuacan river floodplains.

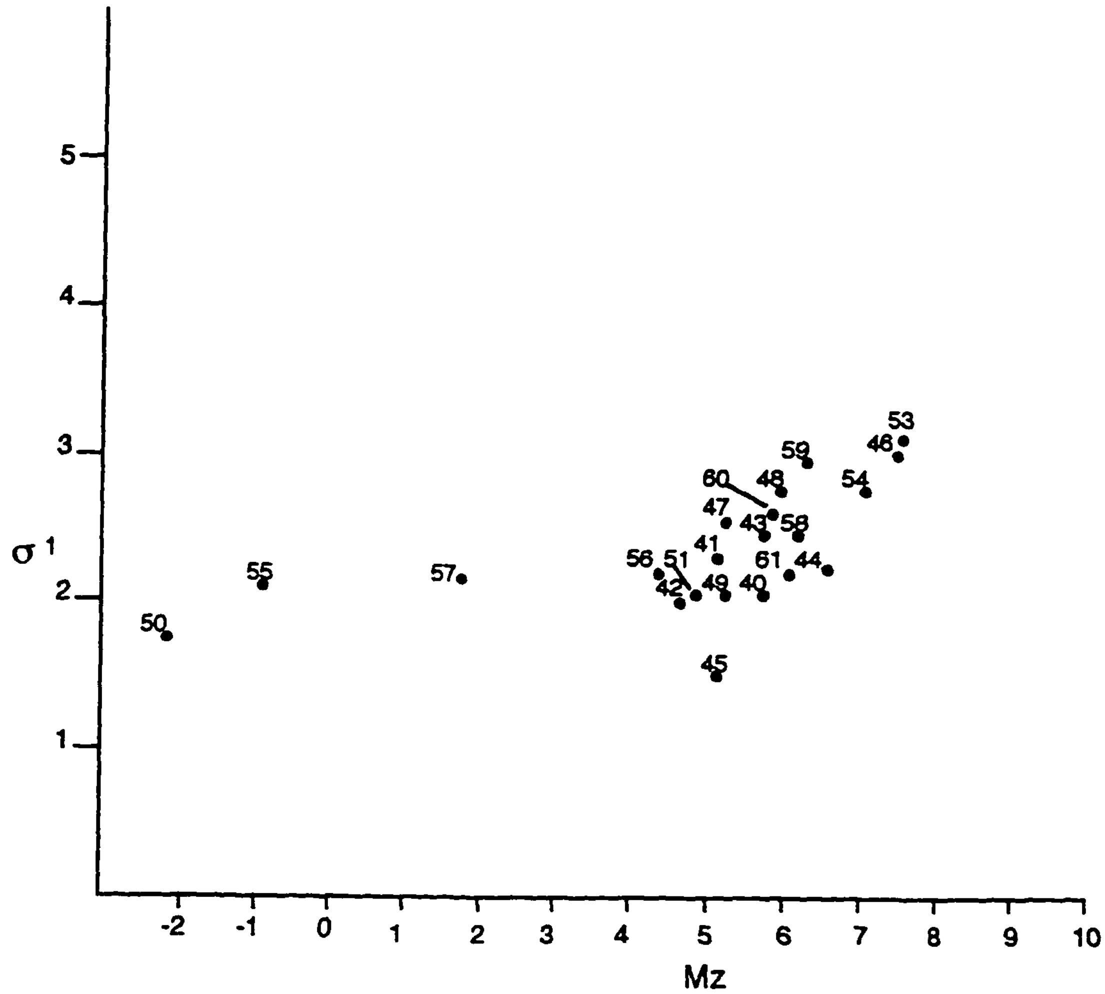


Figure 6.4 Mean grain-size (Mz) and sorting (σ^1) parameters obtained from samples from the Papalotla river floodplains.

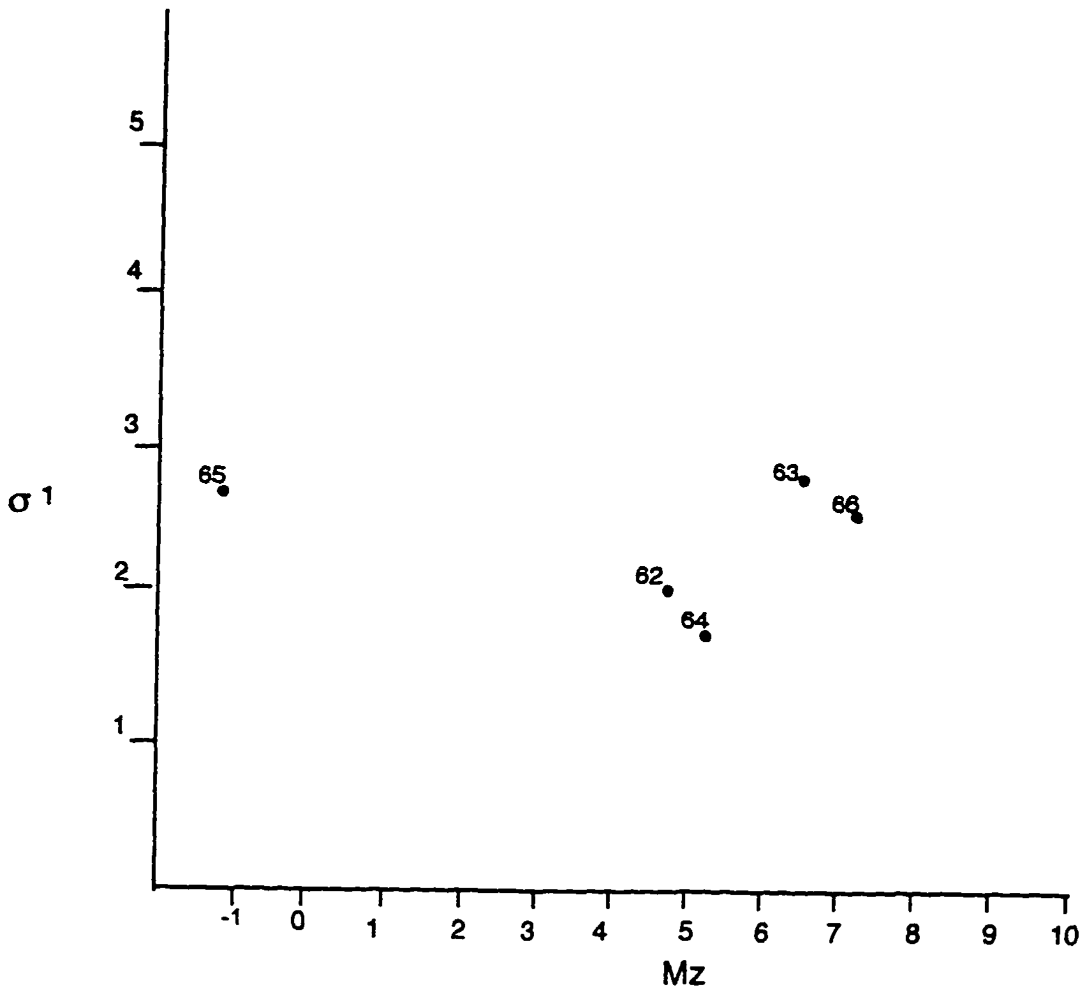


Figure 6.5 Mean grain-size (Mz) and sorting (σ^1) parameters obtained from samples from the Arroyo Coxtitlán and Coatepec river floodplains.

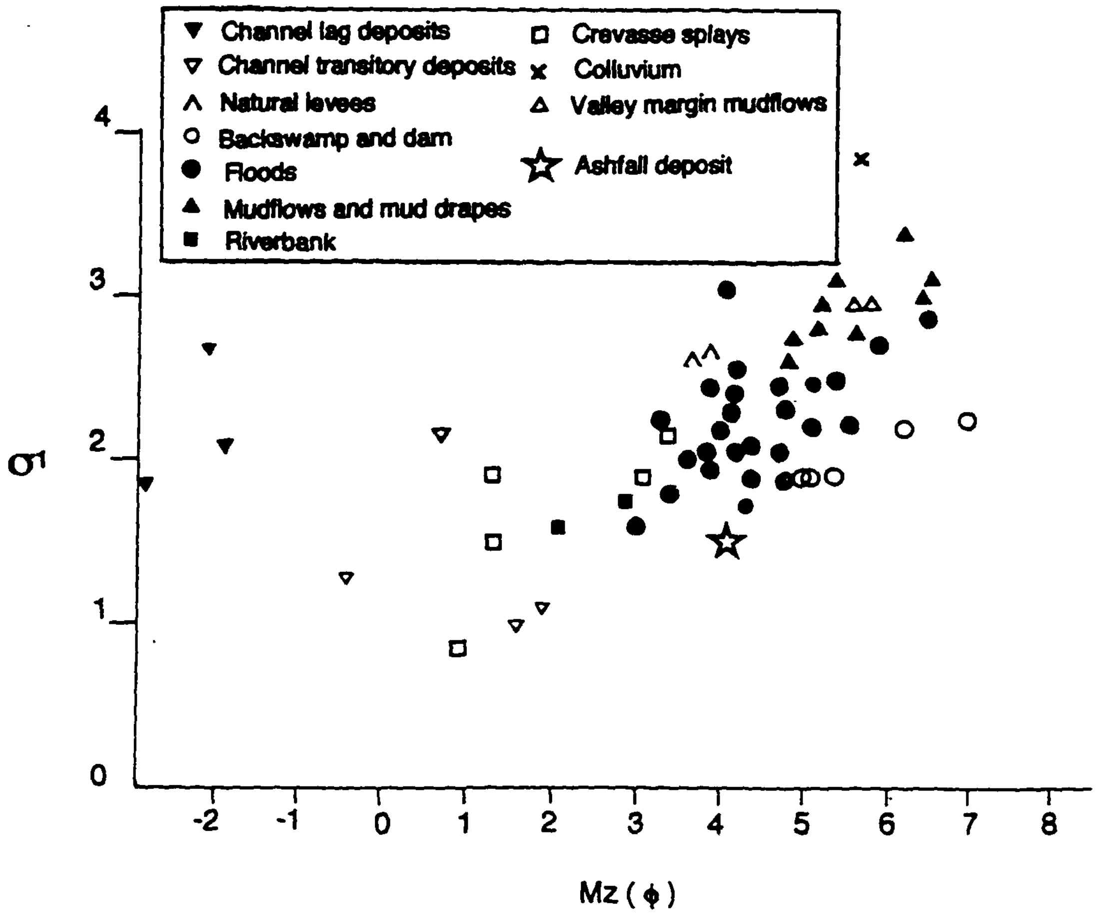


Figure 6.6 Distribution of the 66 samples according to mean grain-size, sorting, and depositional facies.

TABLE 6.2

ALLUVIAL FACIES FOUND IN THE SEDIMENTARY DEPOSITS STUDIED. THE CLASSIFICATION IS AFTER MIALL (1985).

Facies code	Lithofacies	Sedimentary structures	Interpretation
Gm	massive or crudely bedded gravel	horizontal bedding, imbrication	longitudinal bars, lag deposits, sieve deposits
Gt	gravel, stratified	trough crossbeds	minor channel fills
Sp	sand, medium to v. coarse, may be pebbly	solitary or grouped planar crossbeds	linguoid, transverse bars, sand waves (lower flow regime).
Sh	sand, very fine to very coarse. may be pebbly	horizontal lamination. parting or streaming lineation	planar bed flow (lower and upper flow regime)
Sl	sand, fine	low angle (<10°) crossbeds	scour fills, crevasse splays, antidunes
Fl	sand, silt, mud	fine lamination. very small ripples	overbank or waning flood deposits
Fsc	silt, mud	laminated to massive	backswamp deposits
Fcf	mud	massive, with freshwater mollusks	backswamp pond deposits
Fm	mud, silt	massive, desiccation cracks	overbank or drape deposits

TABLE 6.3
ARCHITECTURAL ELEMENTS AND CHARACTERISTICS OF THE ALLUVIAL DEPOSITIONAL ENVIRONMENTS IN THE DEPOSITS STUDIED. BASED ON MIALL (1985) MODIFIED

Element and symbol	Depositional en- virionment	Lithofacies assemblage code.	Samples
Channels CH	Channel lag de- posits (CHl)	Gm, Gt	50, 55, 65
	Channel transitory deposits (Cht)	Gt, Sl, Fm	17, 18, 26, 57
Channel margins or lateral accretion deposits LA	Riverbank deposits (LAr)	Sp, Sh	5, 20, 23, 24
	Backswamp/ dam/slack water deposits (OFs)	Fsc, Fcf	9, 11, 14, 15, 16
Overbank fines or vertical accretion deposits OF	Floods (OFf)	Fl, Fsc	1, 2, 4, 6, 7, 8, 10, 22, 24, 25, 27, 35, 37, 38, 39, 40, 41, 42, 43, 47, 49, 51, 52, 53, 54, 56, 58, 61, 64, 66
	Mudflows/mud drapes (OFm)	Fm	Mud flows: 44, 46, 48, 59, 63 Mud drapes: 29, 30, 31, 32
Overbank splays OS	Splays (OSc)	Sl	3, 12, 13, 19, 28
Valley margin VM	Colluvial de- posits (Vmc)	Poorly sorted deposits	21
	Mud flows (Vmc)	Fm and poorly sorted deposits	33, 36
Other deposits:	Ashfall		45
	Artificial		Mounds

Channel deposits (CH) are usually of two types: channel lag deposits (CHl) and transitory channel deposits (Cht). According to the Task Committee (1971), channel lag deposits consist of larger and heavier particles left behind by sorting in those deposits where the lighter clasts have been moved farther downstream; they usually contain coarse and well rounded material. Channel transitory deposits are typically the temporary accumulations of bed load resting in less durable channel fills, and exhibit structures such as ripples, dunes, and bars; they have finer material than the lag deposits since they also include some proportion of suspended material deposited by a rapid decrease in energy.

Channel margin deposits (LA) in the study area usually consist of riverbank accumulations (Lar), primarily point bars deposited on one side of the channel. Since these are temporary features near the channel they show similar structures and granulometries as transitory channel deposits (Cht). One of the main differences between transitory channel and riverbank accumulations is that in riverbank deposits the material is finer and the bedding is more inclined. Another type of channel margin deposit is the natural levees, although these are rare in the project area. Although present, most levees along these channels are human-made.

Overbank fine deposits (OF) represent environments of low energy on floodplains located away from the channels. The overbank fine deposits in the studied streams range from slack-water and back-swamp deposits, which are usually located in low areas far from the channels, to flood deposits that lie closer to the channel; in addition mud flows and mud drapes are also classified as overbank fines, and are usually interbedded with the flood deposits. When the granulometric parameters and the internal structure are combined, the different variants of overbank fines are easily identified in the field: slack water deposits are predominantly fine silts and clay with a mean size in the fine silts, and are horizontally laminated; flood deposits are predominantly silts and fine sand with the medium size in the medium and coarse silts, and are horizontally laminated with a slight inclination; and mud flow deposits have a highly variable loamy texture usually mixed with gravel, exhibit a variable mean grain size, are poorly sorted, and show no bedding structures.

Most of the deposits defined as slack-water sediments represent accumulation of silts and clay behind the dam of Acolman, although they are not uncommon in natural environments. The Acolman dam created conditions for a very low energy of deposition imitating the slack-water basins; the numerous Early Colonial maps of the area depict similar basins along the channel.

Overbank splays (OS) usually correspond to what is known in the literature as 'crevasse splays'. These deposits form when a levee is broken, allowing a high-energy flow to spill onto the overbank-fine areas of the floodplain. Although a splay has high content of sands and some gravel, it is not considered here as channel or riverbank. Because splay deposits are interbedded with overbank fines, and often grade up from sands into silts, I prefer to include them in the category of overbank or vertical accretion deposits.

Valley margin deposits (VM) usually represent colluvial material and mud flows originating on the slopes of the valley. In general, they are represented by poorly sorted materials that are sometimes interbedded with flood deposits (OFf).

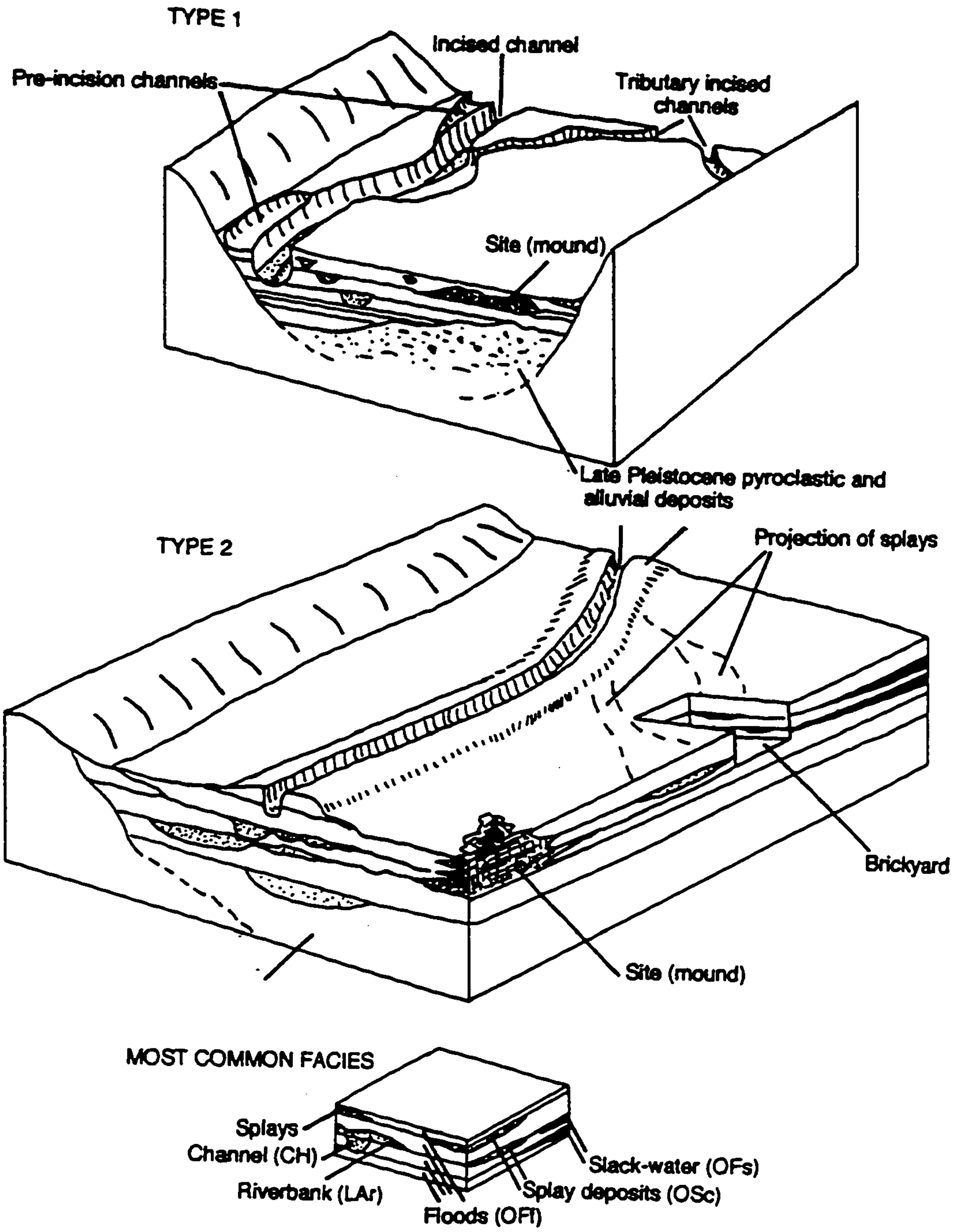
The sections studied also contain non-fluvial deposits such volcanic ash and several kinds of cultural accumulations including *tlatels* (archaeological mounds) and artificial levees. They are irrelevant in the sedimentological study, but of great help in dating the alluvial deposits.

Basic types of floodplains

On the basis of the classification of alluvial environments presented above, it is possible to simplify the features of the floodplains of the study area to three-dimensional diagrams in which archaeological sites are placed in a geomorphic matrix. In this manner, the floodplains can be simplified in two basic types (Figure 6.7). Type 1 is a convex floodplain that eventually grades into a deltaic plain at the lakeshore, and is characterized by non-incised channels with levees. This type corresponds to the lower San Juan Teotihuacan and lower Papalotla rivers. Type 2 is a narrow floodplain that exhibits rapid vertical accretion and repeated channel dissection; examples include the Barranca Honda and the Middle Papalotla river. The Coatepec river and the Arroyo Coxtitlán fall in between these two models, although they are closer to type 1 since channel incision is not common.

In both types, the sedimentation rate is relatively high, and the deposits bury and interfinger with accretionary occupation mounds. As some of the sections and examples shown below suggest, the build-up of such mounds was frequently concomitant with the vertical accretion of silts laid out by floods. When these mounds were abandoned, subsequent flood accumulation buried them completely, such that before the opening of the brickyards

Figure 6.7 Types of floodplain in the area of study. Type 1 represents the cases of the lower courses of San Juan Teotihuacan, Papalotla and at some extent the Arroyo Coxtitlán and Coatepec. Type 2 represents the Middle Papalotla and the Barranca Honda floodplains.


TYPE 1
Incised channel
Pre-incision channels
Tributary incised channels
Site (mound)
Late Pleistocene pyroclastic and alluvial deposits
TYPE 2
Projection of splays
Brickyard
Site (mound)
MOST COMMON FACIES
Splays
Channel (CH)
Riverbank (LAr)
Floods (OFf)
Splay deposits (OSc)
Slack-water (OFs)

there was no clue as to their existence on the surface. For this reason, these floodplains show no sites in the survey maps.

Alluvial stratigraphy

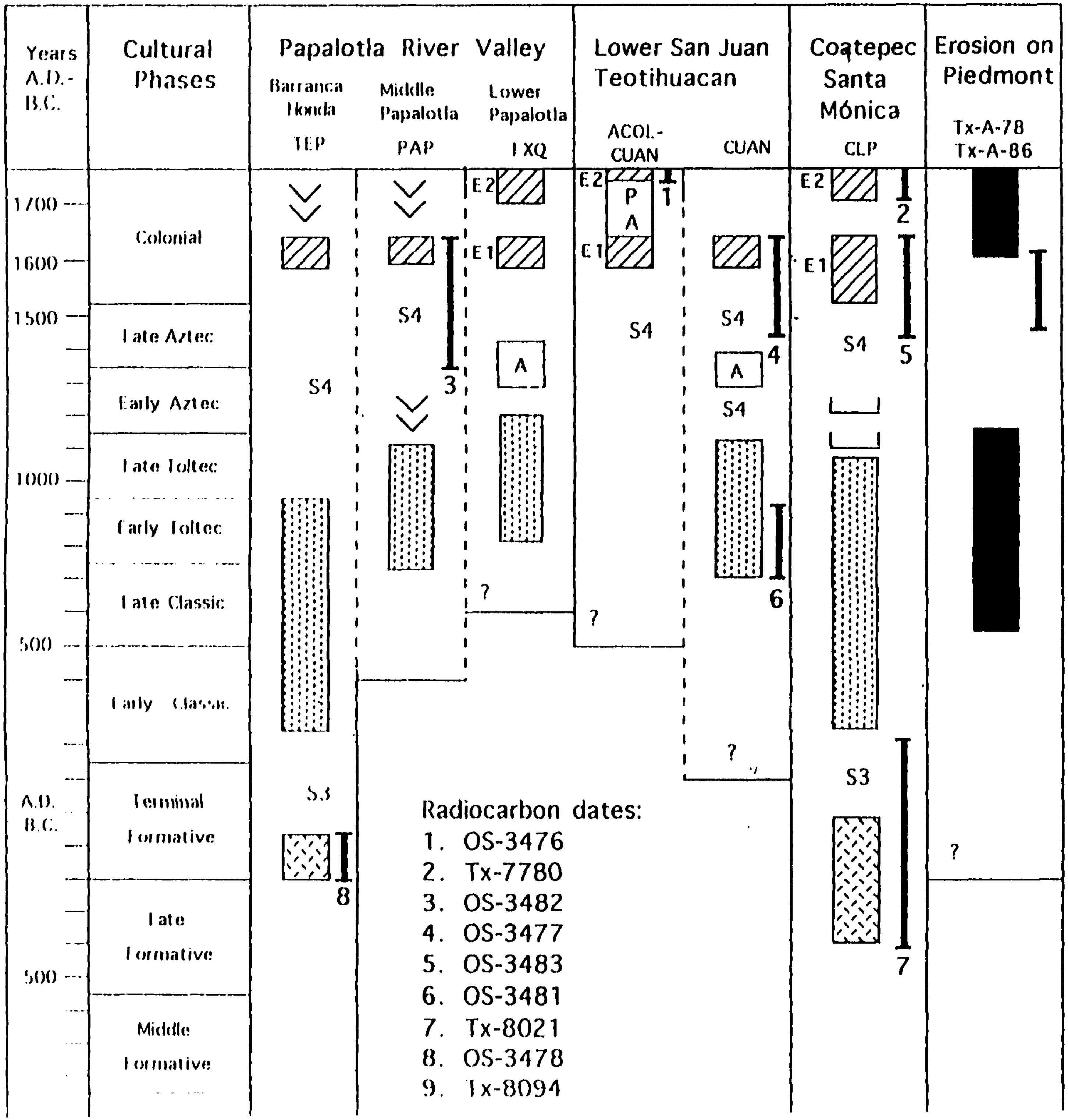
Depositional units and soil horizons

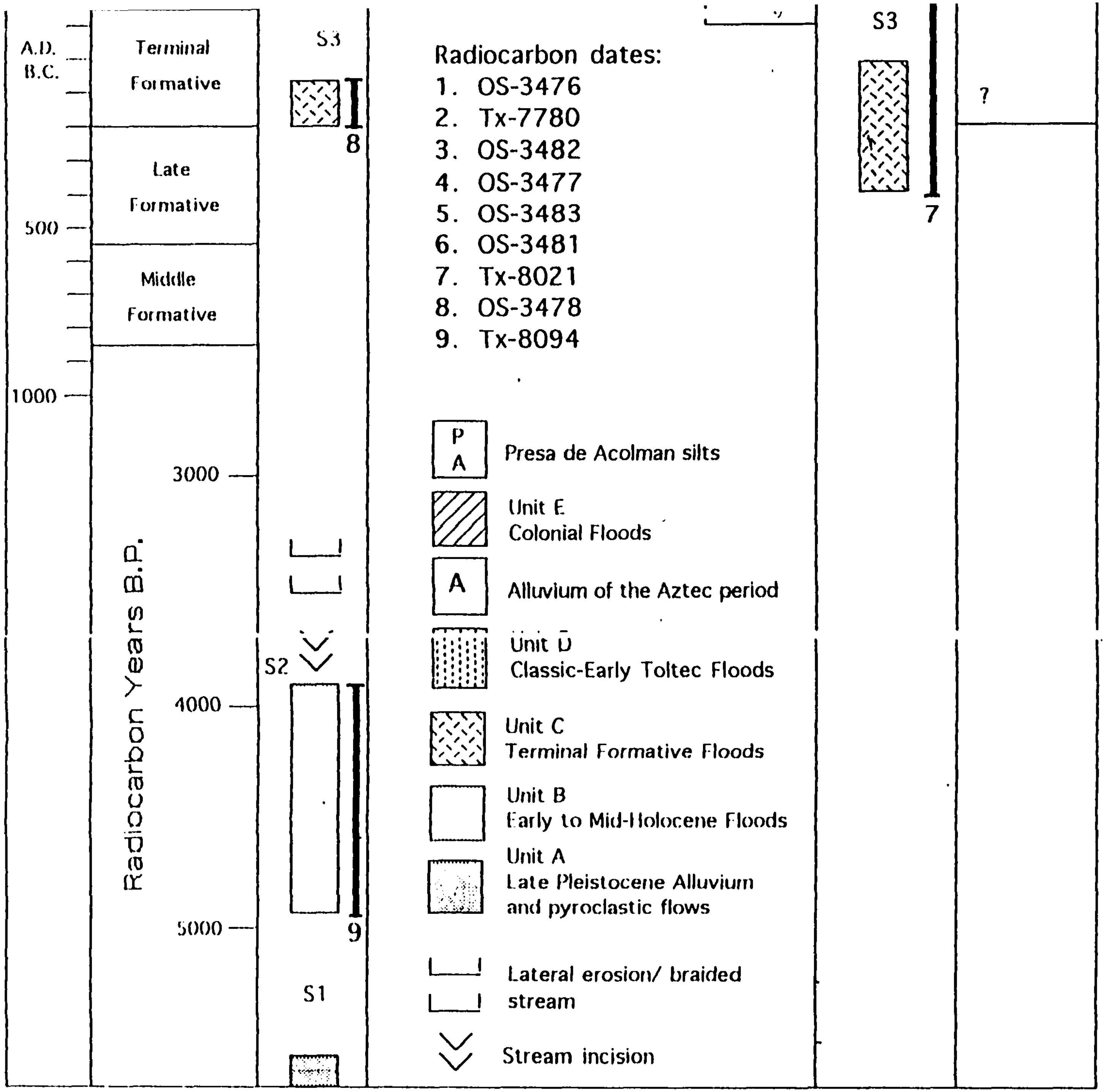
The alluvial deposits of the 27 stratigraphic sections described below have been grouped into a Holocene sequence of 5 major depositional units separated by either soil horizons, occupational surfaces, or erosional unconformities (Figure 6.8). In this section I present an introduction to the major alluvial units; the details of each profile are given in the next section.

Unit A

This unit consists of pyroclastic flow deposits and a braided stream channel scoured into them; their age is probably late Pleistocene to early Holocene. These deposits are visible only in the Middle Papalotla (section PAP-1) and the Coatepec-Arroyo Coxtitlán sections (CLP). In the latter, the pyroclastic flow deposits are capped by a calcic horizon that has been named S_1. In both valleys, this unit has been cut and extensively scoured by the modern streams. This unit is probably correlative with the latest lahar and pyroclastic deposits that make up the lower piedmont.

Figure 6.8 Generalized chronological sequence of the Holocene alluvial units defined in this study. The radiocarbon assyas indicated by their laboratory numbers are presented in table 6.1.


Years A.D.-B.C.
Cultural Phases
Papalotla River Valley
Barranca Honda
TEP
Middle Papalotla
PAP
Lower Papalotla
IXQ
Lower San Juan Teotihuacan
ACOL-CUAN
CUAN
Coatepec Santa Mónica
CLP
Erosion on Piedmont
Tx-A-78
Tx-A-86
1700
1600
1500
1000
500
A.D.
B.C.
500
Colonial
Late Aztec
Early Aztec
Late Toltec
Early Toltec
Late Classic
Early Classic
Terminal Formative
Late Formative
Middle Formative
E2
E1
P
A
S4
S3
Radiocarbon dates:
1. OS-3476
2. Tx-7780
3. OS-3482
4. OS-3477
5. OS-3483
6. OS-3481
7. Tx-8021
8. OS-3478
9. Tx-8094


A.D.
B.C.
500
1000
3000
4000
5000
Radiocarbon Years B.P.
Terminal Formative
Late Formative
Middle Formative
S3
8
S2
9
S1
Radiocarbon dates:
1. OS-3476
2. Tx-7780
3. OS-3482
4. OS-3477
5. OS-3483
6. OS-3481
7. Tx-8021
8. OS-3478
9. Tx-8094
P A
Presa de Acolman silts
Unit E
Colonial Floods
A
Alluvium of the Aztec period
Unit D
Classic-Early Toltec Floods
Unit C
Terminal Formative Floods
Unit B
Early to Mid-Holocene Floods
Unit A
Late Pleistocene Alluvium
and pyroclastic flows
Lateral erosion/ braided
stream
Stream incision
S3
7
?

Unit B

This unit consists of fine overbank, channel and mud flow deposits, and an interbedded volcanic ash, all of middle Holocene age, that are visible only in the Barranca Honda sections (TEP-1, 2, and 3). This unit is subdivided into two subunits: B_1 and B_2.

The B_1 subunit corresponds to overbank deposits and a soil horizon (S_{2-1}) that was capped by the 'Pomez de Grano Fino' (PGF) ash, followed by incision and lateral erosion. The B_2 subunit consists of a mud flow deposited on the ash surface and a truncated soil ($S2_{2-2}$) composed of an AB horizon and a C horizon on the mud flow. All these subunits, soil, mud flow, and ash are eroded and cut by a subsequent channel.

Unit C

This unit is a deposit of overbank laminated fines dated to the Terminal Formative phase, around 2 ka. It is visible in section TEP-3 in Barranca Honda and sections CLP-1 and CLP-3 in the Coatepec floodplain. The associated soil horizon (S_3) exhibits a weak A and AC profile, visible in TEP-3 section in the Barranca Honda; the equivalent soil in the Coatepec sections has been scoured by a braided channel in some places and altered by Early Classic occupation in others.

Unit D

This unit consists of a series of overbank deposits continually laid down in a period of six to eight centuries. Some of these deposits are separated by weak soil horizons, but were not subdivided because of a scarcity of radiocarbon dates. This low resolution in dating limits temporal placement of Unit D to a period of almost 800 years, from the Early Classic to the Early Toltec phase. In the Cuanalan area it seems to be at least Early Toltec in age; in the Barranca Honda and Middle Papalotla sections it demonstrably spans a longer period of time probably from the Late Classic phase to the end of the Early Toltec phase; and in the Coatepec-Arroyo Coxtitlán sections it is probably Late Classic in age.

Aztec soils and alluvia

In most sections a soil has formed on top of Unit D that lasted through the Late Aztec phase. This soil is therefore termed the 'Aztec Soil' (S_4) and represents a good marker for correlating the overlying deposits of Unit E. Three exposures of this soil were sampled and described in detail (Profiles 11, 12 and 13 in Appendix C). They are very young horizons that were tilled and probably irrigated; a comparison with the rest of the deposits indicates that texture and organic matter do not differ significantly from the non-weathered flood deposits in which have developed. This fact shows that soils in these plains were naturally productive, because the flood deposits on which they have been developed contain large amounts of organic matter and nutrients in addition to the mineral fraction. These components were displaced from areas upstream through the process of soil erosion.

Some minor overbank deposits lying on unit D were identified at sections CUAN-3, CUAN-4, IXQ-2, and IXQ-3, and named as 'Aztec Alluvium' since they are associated with Aztec occupation. They were not considered as a significant unit in the sequence because of their limited extent and distribution. However, they are the only evidence of alluviation in Aztec times.

Unit E and Acolman Silts

This unit consists of a series of thick overbank deposits and channels, that are divided into two subunits corresponding to the two major periods of alluviation during the Colonial period. The first period comprises floods that occurred from the mid 1500s to the early 1600s. Deposits attributable to these 'Early Colonial floods' are present in all the sections studied. The second period of flooding occurred during the 1700s, and is designated as 'Late Colonial floods.' In the lower San Juan river, a third subdivision of Unit E, which falls between the Early and Late Colonial floods, has been identified and designated the 'Presa de Acolman silts.' This deposit is a continuous fill that aggraded behind the Acolman dam from the early 1630s to approximately 1780.

Description of stratigraphic sections

The Lower San Juan River Basin

The area studied in the San Juan River consists of a segment of its lower course at the narrow pass between the low hills of the western Patlachique Range and the Chiconauhtla hills. It is located north of Tepexpan, and includes the Acolman dam area (Figure 6.9). The San Juan river floodplain ends at the shore of Lake Texcoco, where it forms a delta just north of the Papalotla delta in the area of Nexquipayac. These deltaic plains were not considered in this research because they represent complex stratigraphic relations that require mechanical excavation to address, since brickyards are limited to a small area near Nexquipayac. However, the delta represents a good potential source of data for future study, particularly on the relationships between fluvial sedimentation and lake level fluctuations.

For purposes of this study, the Lower San Juan river was divided into two sectors: the Acolman sector, or the area behind the Acolman dam, where sections ACOL 1, ACOL 3, ACOL 3, CUAN 1, and CUAN-2 are located; and the Cuanalan sector, where sections CUAN-3, CUAN-4 and CUAN-5 are located (Figures 6.9 and 6.10).

Behind the Acolman dam (which is no longer in use), the flow of the river has been split into four main channels: Canal de San José, to the west; the Rio de San Juan, which eventually merges with the former; and the Canal de Santa Cruz and San Antonio to the east and southeast, respectively. With the exception of the latter, these channels existed in the late sixteenth century before the construction of the Acolman dam, as depicted in the map of the *Relaciones Geográficas*, around 1580 (See map in Acuña 1986 vol.2, Relación de Tequizistlan[2]).

The spatial relationship of the fluvial architectural elements in the areas of Acolman (ACOL sections) and Cuanalan (CUAN sections) shows the late stages of the evolution of a convex floodplain and the continuous accumulation of overbank deposits accelerated by the construction of the Acolman dam. The silts retained behind the dam buried most of the pre-Hispanic and Early Colonial sites, including part of the 'Convento de Acolman' (Figure 6.10).

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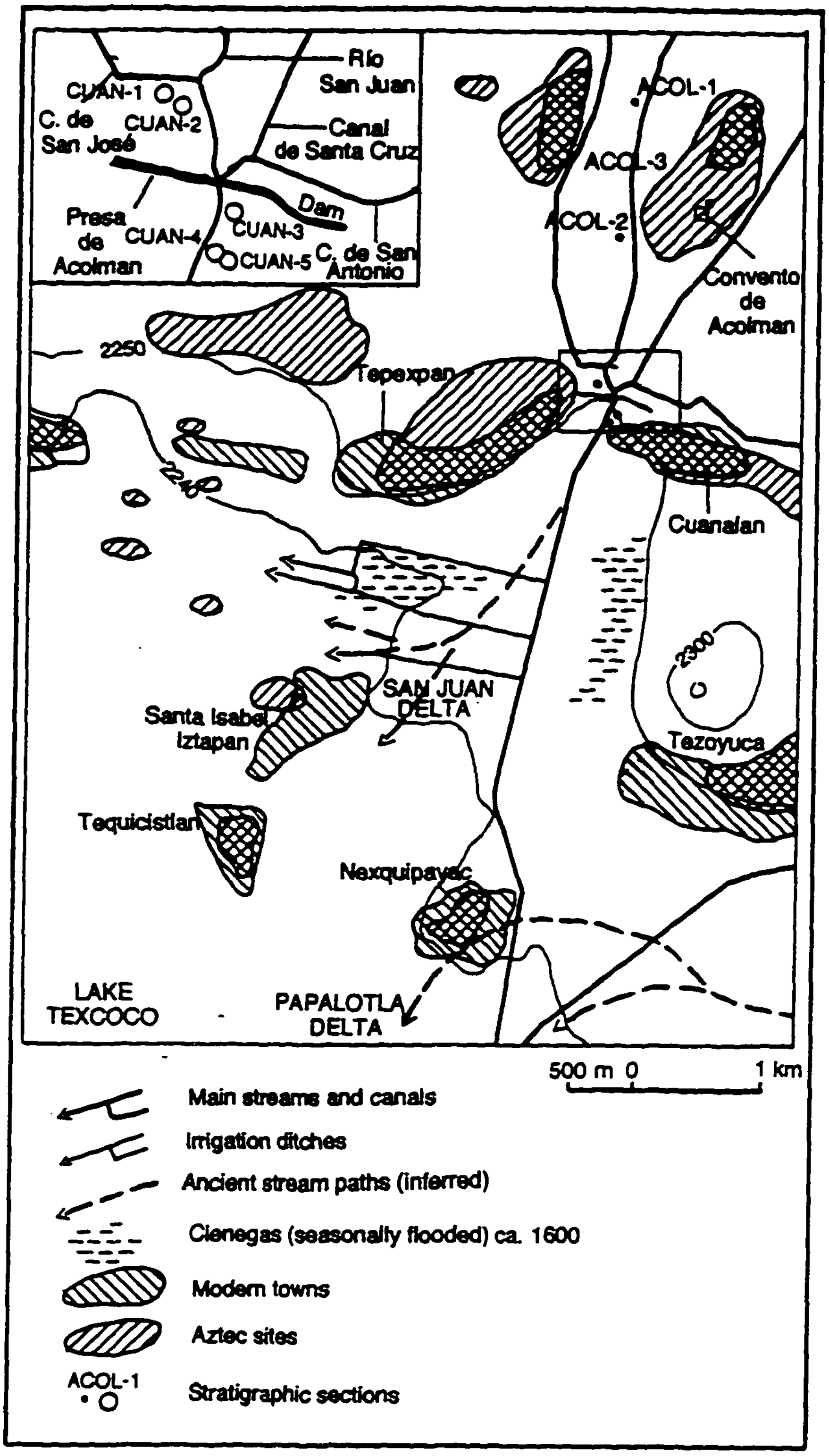
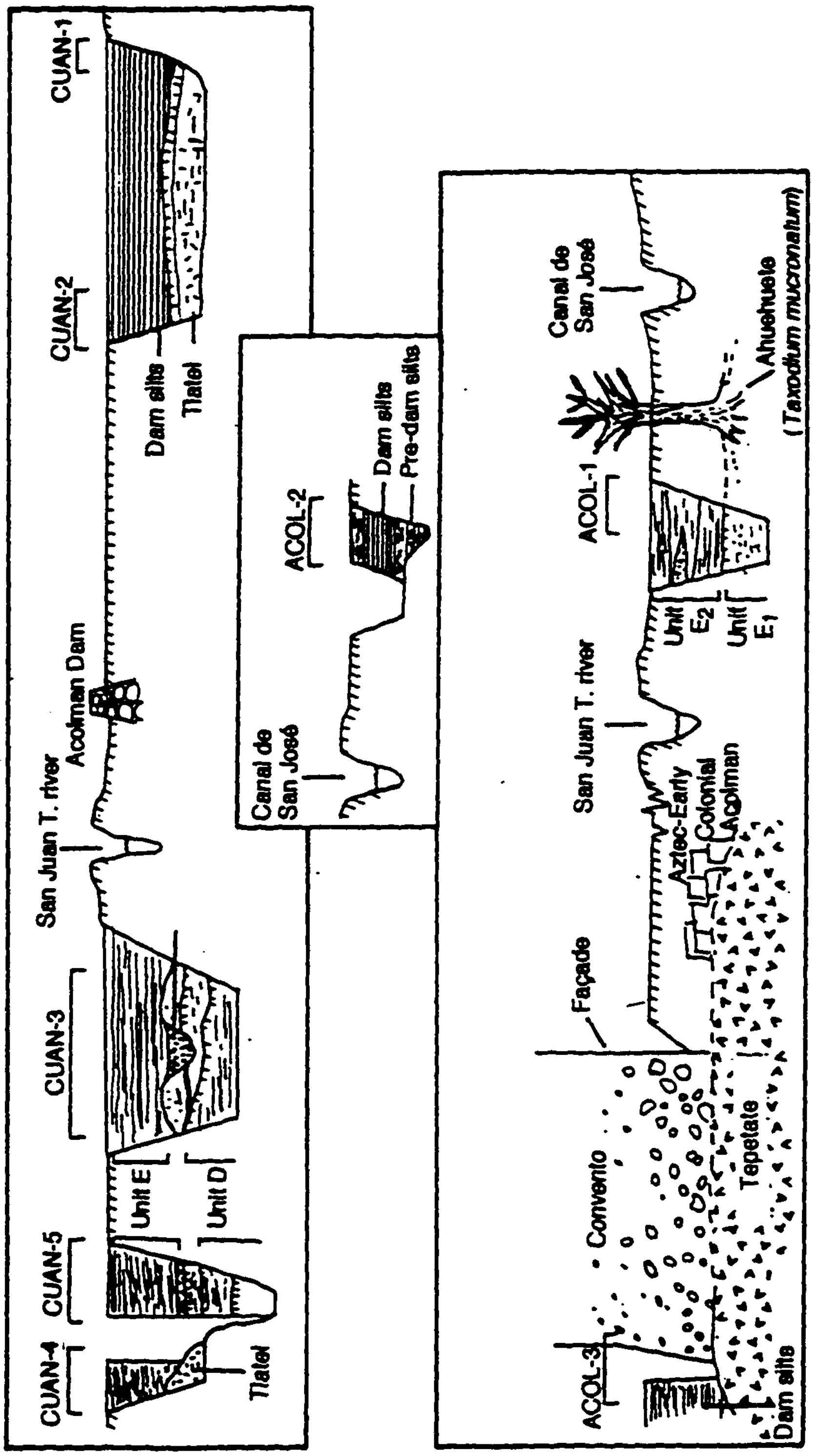
[2] The original map is from the AGI (Archivo General de Indias) Seville catalogued as "IG 1529, No. 386.

Figure 6.9 Lower San Juan Teotihuacan River and the Acolman-Cuanalan area.



Río San Juan
CUAN-1
C. de San José
CUAN-2
Canal de Santa Cruz
Dam
Presa de Acolman
CUAN-4
CUAN-3
CUAN-5
C. de San Antonio
ACOL-1
ACOL-3
ACOL-2
Convento de Acolman
2250
Tepexpan
Cuanalan
2300
SAN JUAN DELTA
Santa Isabel Iztapan
Tezoyuca
Tequicistlan
Nexquipayac
LAKE TEXCOCO
PAPALOTLA DELTA
500 m 0 1 km
Main streams and canals
Irrigation ditches
Ancient stream paths (inferred)
Cienegas (seasonally flooded) ca. 1600
Modern towns
Aztec sites
ACOL-1
Stratigraphic sections

Figure 6.10 Main alluvial-architecture elements in the Acolman-Cuanalan area.


CUAN-1
CUAN-2
Dam silts
Tlatel
Acolman Dam
San Juan T. river
CUAN-3
Unit E
Unit D
CUAN-5
CUAN-4
Tlatel
Canal de San José
ACOL-2
Dam silts
Pre-dam silts
Canal de San José
Ahuehuete
(Taxodium mucronatum)
ACOL-1
Unit E2
Unit E1
San Juan T. river
Aztec-Early
Colonial
Acolman
Façade
Convento
Tepetate
ACOL-3
Dam silts

In most of the sections studied the most prevalent unit is that of the Early Colonial floods, of whcih the Acolman silts are a subunit that lies behind the Acolman dam and consist of silt-clay horizontally laminated with lenses of medium-to-coarse sand splay deposits (Fig. 6.11). The dynamics of floods in all sections, including those periods before the construction of the dam, include a number of splay deposits that grade into low energy silts, which corresponds to the times when the artificial levees were broken during a high peak discharge resulting in the spill of a high energy flow that fanned out on the floodplain. The deposits start with sands (splay OS) as the overbank areas are inundated, then fine into silts and finally clays forming the overbank fine facies (OFf). This process was well depicted by the priest of Acolman in a map accompanying a document reporting damage to the church and installations belonging to the parish of Acolman in 1762 (Figure 6.12). An excerpt of this document is included in Appendix G.

The stratigraphy and fluvial architecture of this part of the valley is linked to the construction of the Acolman dam, a project devised by the viceroyal government to control the flow of water into Lake Texcoco, which had caused numerous floods in Mexico City in the early 1600s. The project was flawed, and the dam failed to control the

Figure 6.11 Stratigraphic sections of the Acolman dam area.

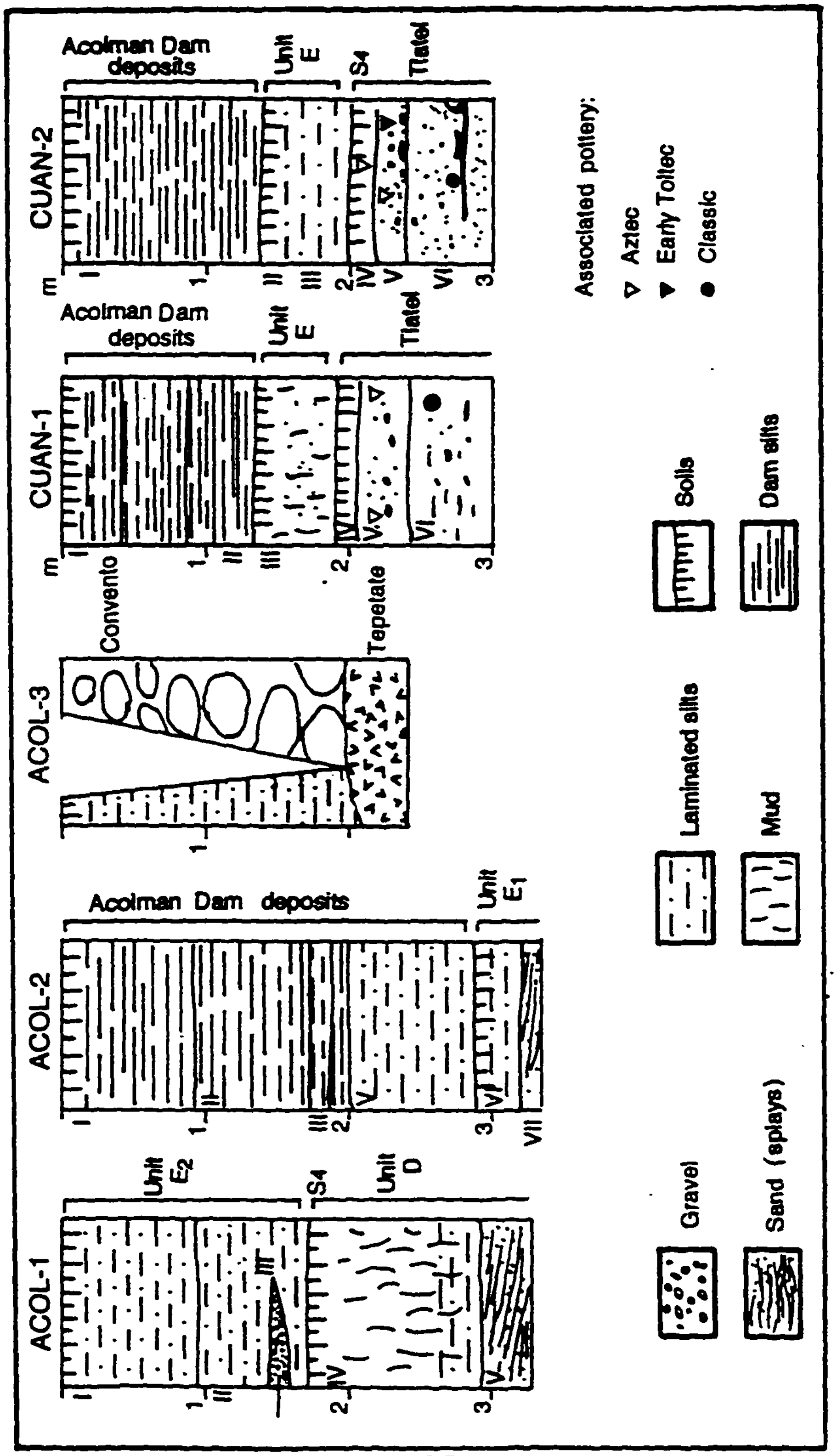
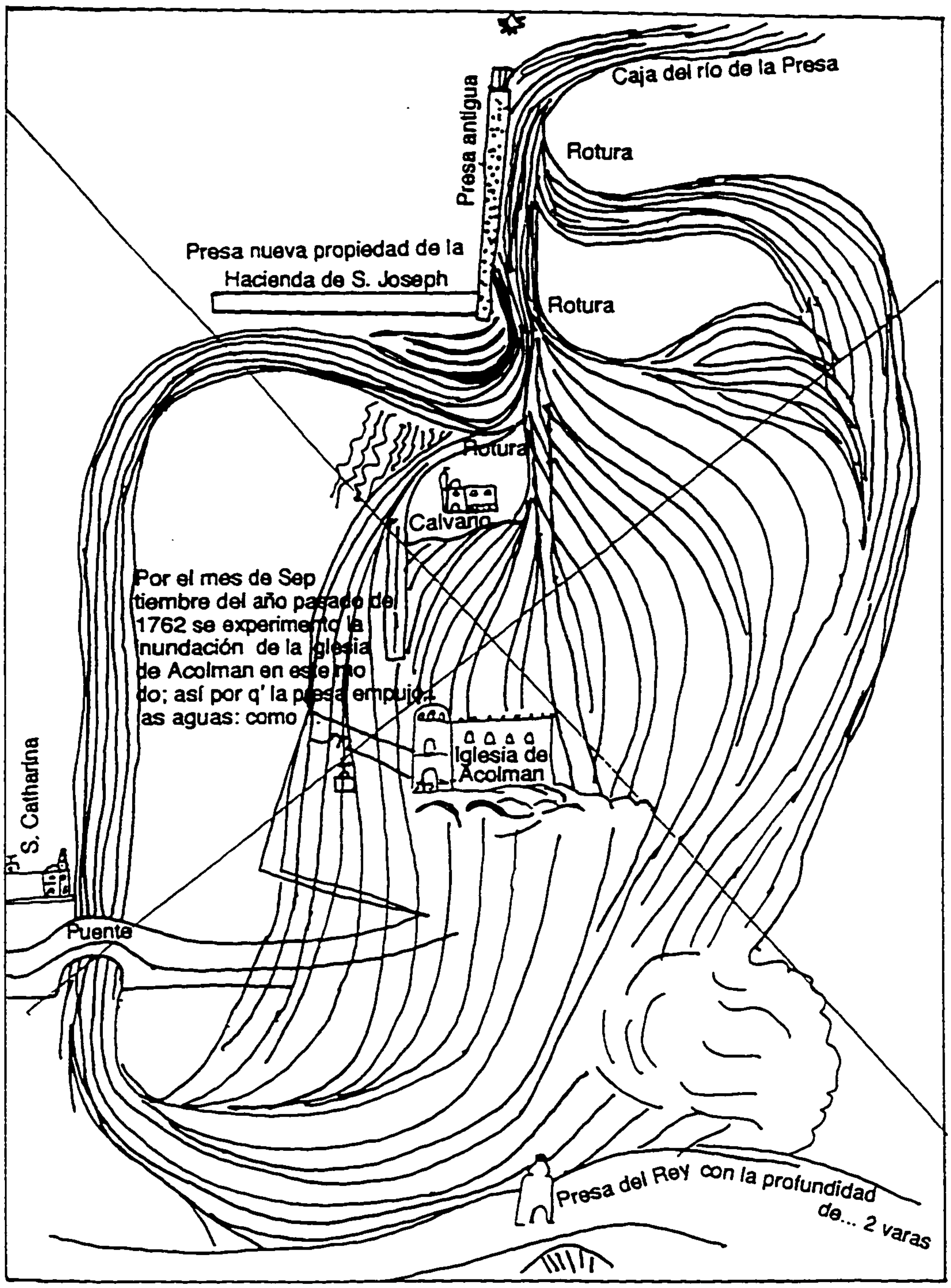

ACOL-1
Unit E2
S4
Unit D
ACOL-2
Acolman Dam deposits
Unit E1
ACOL-3
Convento
Tepetate
CUAN-1
Acolman Dam deposits
Unit E
Tlatel
CUAN-2
Acolman Dam deposits
Unit E
S4
Tlatel
Associated pottery:
Aztec
Early Toltec
Classic
Gravel
Sand (splays)
Laminated silts
Mud
Soils
Dam silts

Figure 6.12 Flood in the Acolman area as drawn by a priest in 1763 (AGN, Bienes Nacionales: leg. 1887, s/f, catalogue number: 4750.1). The splays due to the breaching of the levees are clearly depicted in this drawing.

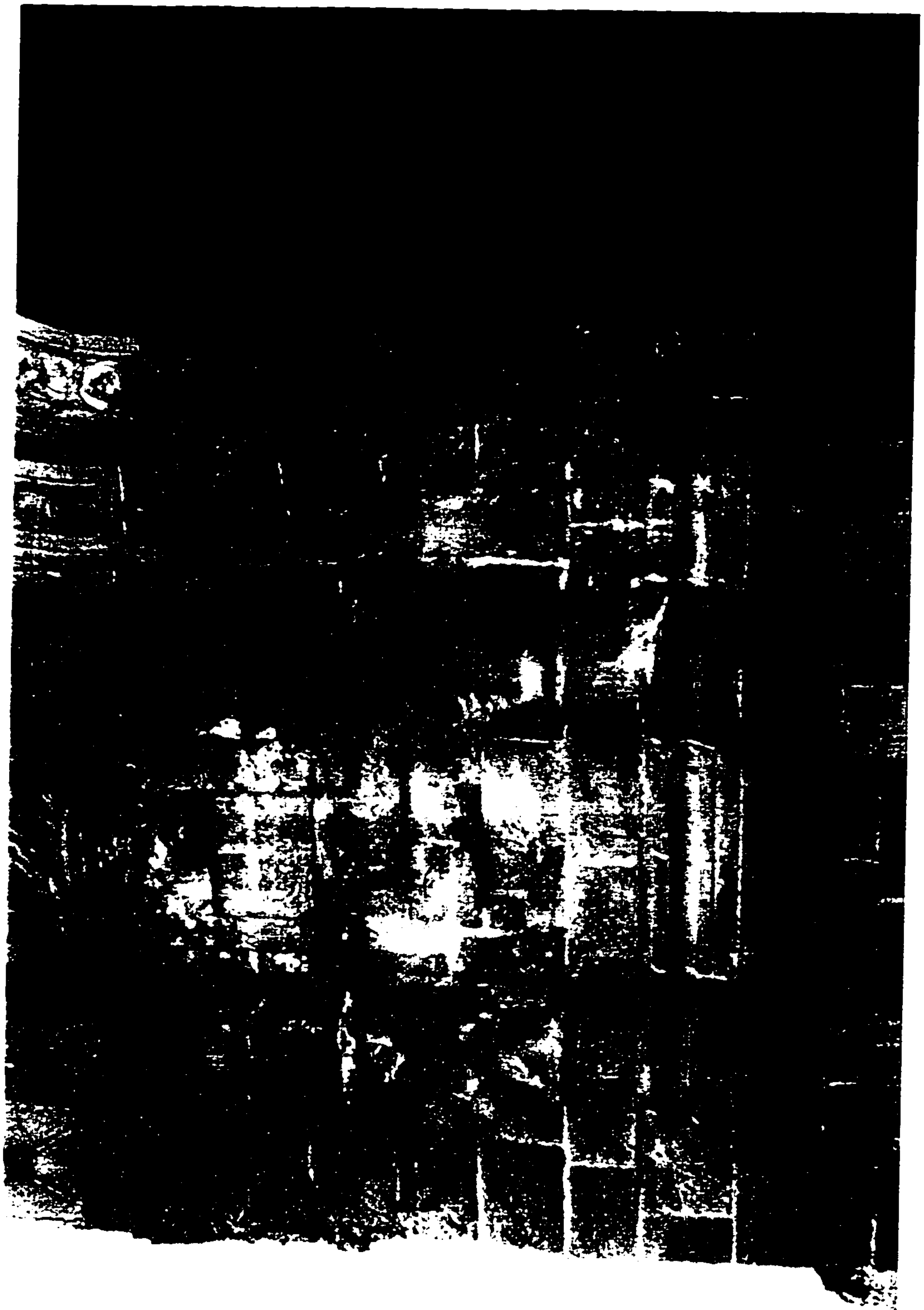

Caja del río de la Presa
Presa antigua
Rotura
Presa nueva propiedad de la
Hacienda de S. Joseph
Rotura
Rotura
Calvario
Por el mes de Sep
tiembre del año pasado de
1762 se experimentó la
inundación de la iglesia
de Acolman en este mo
do; así por q' la presa empujó
las aguas: como
Iglesia de
Acolman
S. Catharina
Puente
Presa del Rey con la profundidad
de... 2 varas

flooding of the city. In addition to failure to control flooding, the dam resulted in a rise in the levels of water and rapid sedimentation in the plains around Acolman. There is no firm information as to when the dam was built; after a documentary search, Gamio (1922) concluded that the project was initiated in 1604 and finished in 1629, which is the peak period of Early Colonial floods according to Boyer-Everett (1973). The formation of a lake is reported as early as 1608 by Enrico Martínez. At that time, the first towns had to be relocated, and a map of Sigüenza y Góngora from the period shows the town and church of Acolman on an island whcih could be reached from the northern and southern shores by two *calzadas* (causeways) (Espinos 1904; Gamio 1922). The dam was repaired on several occasions, in 1630, 1742, and 1748 (Gamio 1922, vol. 1), but the problem of flooding was out of control. The flood of 1645 damaged the church and several books of its archives were lost (Gamio, 1922, vol. 1: 371). The town of Acolman, the famous Aztec head-city of this polity that Cortés described in his letters, disappeared under the water and constant accumulation of silts that reached its maximum level during the floods of 1763 (AGN, *Bienes Nacionales*, leg. 1887, s/f, see Appendix G).

In 1772 the water covered the church and convent, so that the parish had to be relocated in 1781. In subsequent years, floods continued (Gamio, 1992). The last flood of great magnitude recorded in the sections corresponds to zones 1, 2 and 3 in section ACOL-1 (Fig. 6.11) which yielded a ^{14}C assay whose calibration spans a 300-year period that extends well into the 19th century (Table 6.1, assay OS-3476). These deposits may well be the result of the two major floods that affected the area as late as 1819 and 1823 (Gamio, 1922, vol. 1: 372). The new town of Acolman, to the west of the convent grew in the last two centuries, and the place were the old town used to be was re-settled after the waters receded. The former town of Acolman lies at least two and a half meters below the surface, as testified by the foundations of the convent visible in a ditch running on the along the eastern side of the church (Section ACOL-3, Fig. 6.11). The silts around the convent have been excavated in order to give access to the compound that is now a tourist attraction. The chemical deterioration of the façade is due to the action of salts contained in the silt, and is a graphic illustration to the thickness of the deposits that once covered the base of the church (Figure 6.13).

A large number of Aztec and older sites disappeared under the silts of the Acolman dam, as shown in one of the mounds exposed in a brickyard where sections CUAN-1 and CUAN-2 are located. This example of geomorphic bias

Figure 6.13 After the Convento de Acolman was flooded in 1763, salts contained in the sediments corroded the relief of the facade. The structure was partially buried in the silty deposits for two centuries.



suggests that the lack of sites indicated on maps of pre-Hispanic settlement in the lower San Juan floodplain needs to be critically evaluated in any interpretation concerning settlement patterns.

Downstream from the Acolman area, outside the Acolman dam on the floodplain between Cuanalan and Tepexpan, there is a group of brickyards to the east of the main channel that reveal several exposures. The stratigraphy of these sections also shows the transition from channel and riverbank deposits into overbank fine deposits, as well as an interesting relationship between the processes of alluvial aggradation and settlement formation. Section CUAN-3 shows a canal cutting across a deposit corresponding to Unit D and its respective S_4 horizon (Figure 6.14). Based on its dimensions and its east-west orientation, the exposed channel in CUAN-3 is not the San Juan's main channel, but a buried reach of the Canal de Santa Cruz or the Canal de San Antonio, which are artificial distributaries of the San Juan (see Figure 6.8 for reference). Although such channels are man-made, they developed the kind of deposits and features described for the type 1 floodplain model, suggesting that transition from channel lag deposits to riverbank and overbank fines and splays are present in the exposures nearby or in the neighboring brickyards. The channel in CUAN-3 consists of

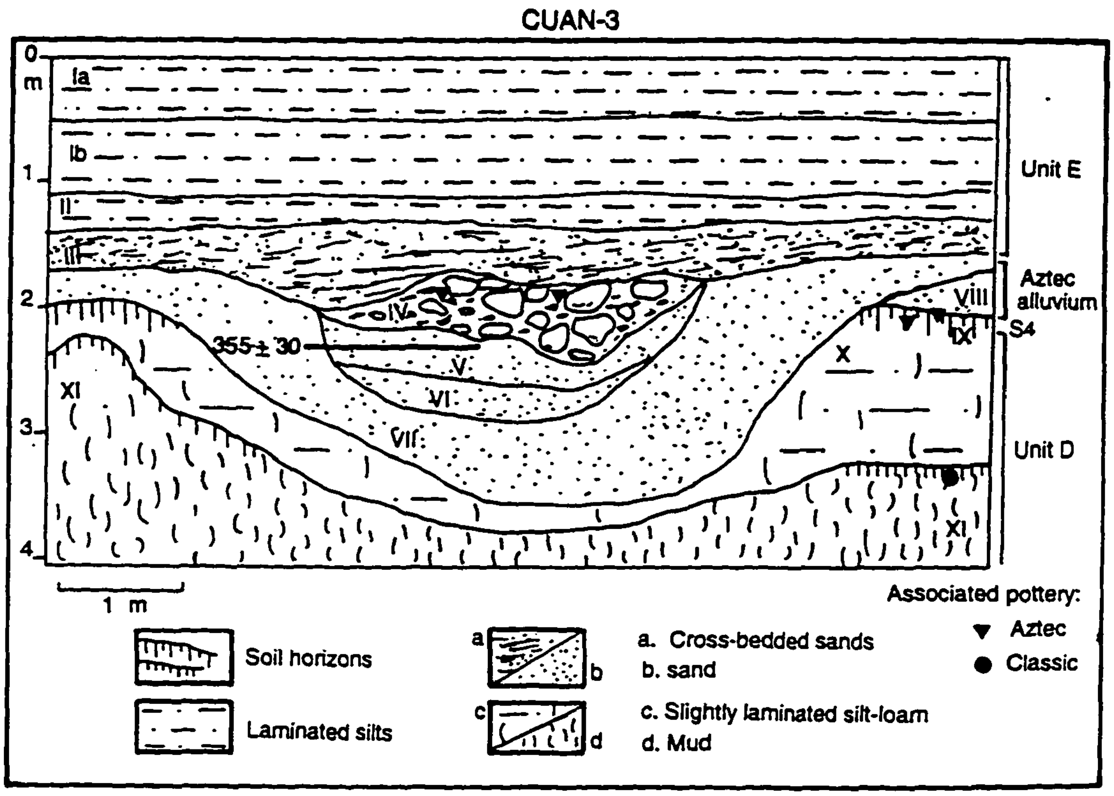
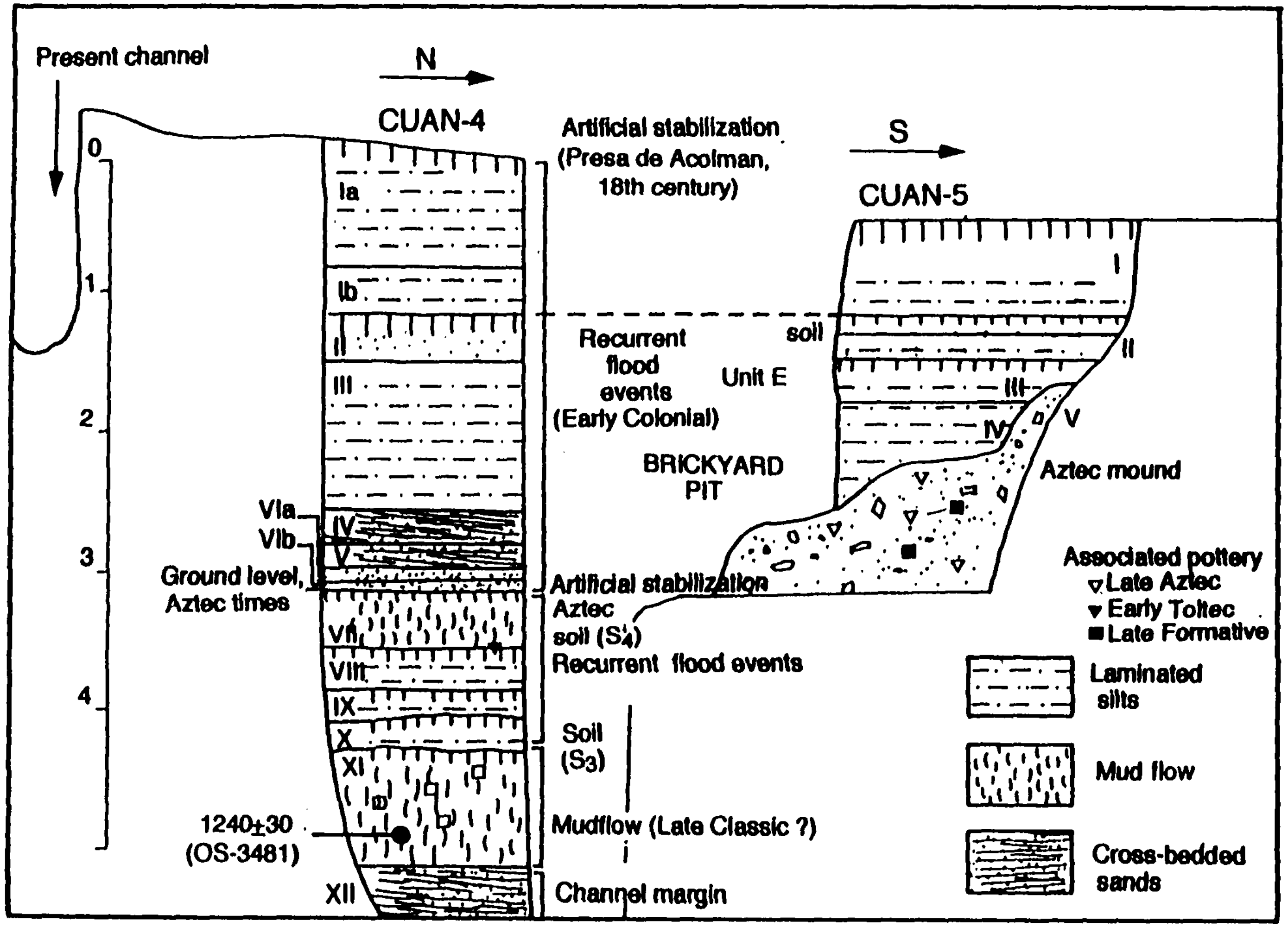


Figure 6.14 Section CUAN-3.

three coarse fills, one gravely-sandy fill that corresponds to a crevasse splay that filled the channel (zone VII), and two more sandy units that filled a scour and show a decrease in energy (zones VI and V). Capping the sand of zone V there is a pile of debris (zone IV) intentionally placed to clog the channel. This artificial plug was covered subsequently by a splay accumulation (zone III) and two cycles of overbank fines (zones II and I) which correspond to two Early Colonial floods (Unit E). The ceramics associated with the artificial channel clog is Late Aztec, and a piece of charcoal from the zone yielded a ^{14}C date of 355$\pm$30 years B.P.(OS-3477).

About 100 meters south, in a brickyard downstream, sections CUAN-4 and CUAN-5 (Figure 6.15) show a more complete overbank facies assemblage, some of which are correlative with the channel and riverbank deposits of CUAN-3. In the area of CUAN-4 and CUAN-5, as in the entire area around the modern town of Cuanalan, there are several occupational surfaces corresponding to the Late Formative and Aztec sites of Cuanalan as reported by Sanders *et al.* (1975) and Manzanilla (1985). In the sections studied, materials of these two phases are very common in occupational surfaces, in debris fills, and as a component of high energy deposits.

Figure 6.15 Sections CUAN-4 and CUAN 5.


Present channel
N
CUAN-4
0
1
2
3
4
Ia
Ib
II
III
VIa
VIb
IV
V
Ground level,
Aztec times
VII
VIII
IX
X
XI
1240±30
(OS-3481)
XII
Artificial stabilization
(Presa de Acolman,
18th century)
Recurrent
flood
events
(Early Colonial)
Unit E
soil
BRICKYARD
PIT
Artificial stabilization
Aztec
soil (S'4)
Recurrent flood events
Soil
(S3)
Mudflow (Late Classic ?)
Channel margin
S
CUAN-5
I
II
III
IV
V
Aztec mound
Associated pottery
Late Aztec
Early Toltec
Late Formative
Laminated
silts
Mud flow
Cross-bedded
sands

The sequence at CUAN-4 (Figure 6.15) shows several deposits that are grouped into unit D (zones XII to VII) with a mixture of Late Formative materials in a secondary context and Coyotlatelco (Early Toltec) ceramics on a soil surface (top of zone VII). A piece of charcoal from zone XI yielded a radiocarbon age of 1,240 $\pm$ 30 B.P. (680 to 880 A.D. at 2-sigma), which is consistent with the associated Early Toltec ceramics. Unit E (zones VI to I) consists of Early Colonial overbank splays and flood deposits which correlate the deposits burying the canal in section CUAN-3. They can be subdivided in two episodes, one comprising zones VIb, VIa, V, IV, III and II, with an AC horizon, and Ib and Ia. Both episodes occurred before the construction of the Acolman dam that probably ended flooding of this area. Section CUAN-5 shows correlative deposits, especially related to the Early Colonial floods (zones I to IV) that present finer overbank facies since they are located farther from the channel, and clear A and Ap horizons. These deposits bury an Aztec mound or tlatel (Figure 6.15).

The patterning of topographic and cultural elements of the landscape in the deltaic sector, in the areas of Tequisistlan and Santa Isabel Ixtapan (Figure 6.8) shows some problems not addressed in this dissertation, but are presented in the form of hypothesis. The fluvial network has been modified since the waters of the San Juan River have been channelized probably since the time of Nezahualcoyotl, based on the tall *ahuehuetes* along the channel are indicative of old age, and by numerous references given by Alva Ixtilxochitl (1975-77). As for the exact date of the construction of these canals, and of similar ones in the area of Acolman, it is difficult to say whether they are Aztec or Early Colonial. The only example dated here (section CUAN-3) seems to indicate that the channel is at least Early Colonial, although it may well be Late Aztec. The most striking feature in the overall landscape is a deltaic crest to the east of Tequicistlan (Fig. 6.8). The crest is limited in the north by a cienega, commonly referred to in the land grant documents, that nowadays occupies a lower area. Although there is a depression, the southern limit of the delta merges farther south with another crest that is possibly part of the Papalotla river deltaic system. These two convex deltaic surfaces exhibit soils with more sandy textures than the areas to the east and the north, which are presumably areas of lacustrine sedimentation. Except for the towns of Tequisistlan and Nexquipayac which are former Aztec settlements, there is a paucity of sites, which may indicate strong and relatively recent deltaic sedimentation dating at least to the Aztec period, when the rivers were probably channelized. However, only detailed stratigraphic assessment will clarify the type of facies and chronology of events that led to the formation of these two deltas.

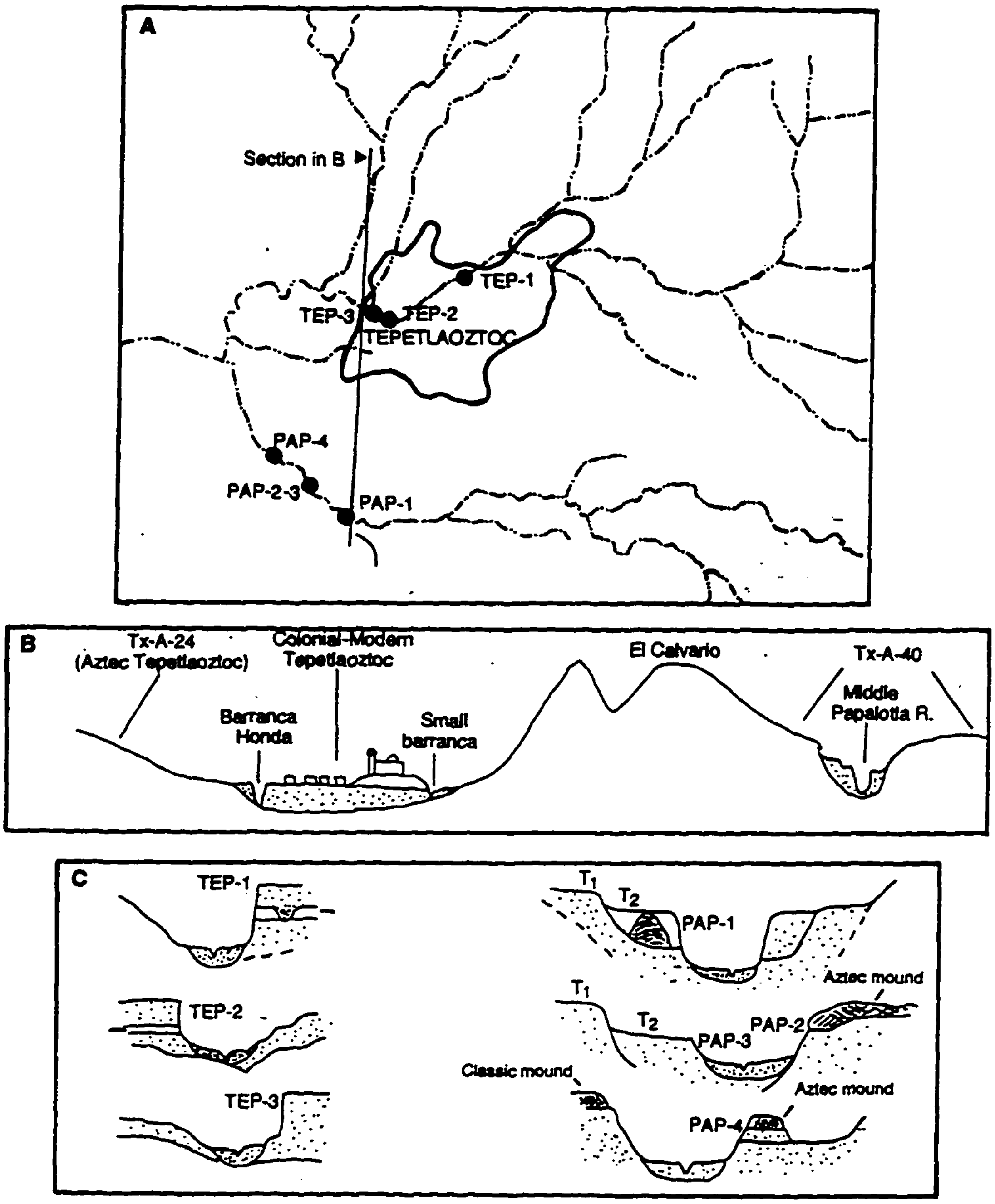
The Papalotla River Basin

For the purpose of this study, the Papalotla river basin is divided into the (1) upper basin, which drains areas of mountains, hills and upper piedmont; (2) the middle basin, whose main channel cuts across the lower piedmont and part of the alluvial plains; and (3) the lower basin which is the area where the floodplain fans out before reaching the deltaic-lacustrine plain. The stratigraphy of this river valley was studied only in the middle and lower basins. The profiles examined include three sections at the Barranca Honda, a tributary of the Papalotla, which are exposed on a cut bank of the entrenched channel in the outskirts of Tepetlaoztoc (TEP sections); at the Middle Papalotla River, south of Tepetlaoztoc (PAP sections), and at the Lower Papalotla Floodplain at San Bartolo Ixquititlan (IXQ sections). The upper reaches were not examined since exposures in the barrancas here show only Tertiary and Quaternary ashes (tepetates) and no recent alluvial sediments.

Although there are substantial differences in the processes of sedimentation operating in the middle Papalotla and Barranca Honda (floodplain Type 1) and the lower Papalotla (floodplain Type 2) the sequences in the three areas show that aggradational events are closely correlative. Stream downcutting is not apparent in the lower Papalotla, but stream incision in the middle Papalotla and the Barranca Honda correspond to an aggradational pulse in the lower floodplain.

The Barranca Honda and the middle Papalotla are located at about the same elevation, and the most significant difference between them is that the middle Papalotla floodplain is narrower (Figure 6.16). The Barranca Honda sections (TEP) present the most complete late Holocene sequence of all the studied sections, exposing Units B, C, D , and E. The middle Papalotla sections (PAP) present only A, D, and E, but they are correlative with those of the Barranca Honda. Because the latter is located in a narrower valley with a steeper gradient, it is possible that the missing B and C units were removed by scour. As a matter of fact, the extant Units D and E are represented only in the form of alluvial insets hanging in the concavities scoured in the Pleistocene volcanic deposits. The stratigraphic sequences are described in the following paragraphs.

Figure 6.16 The Barranca Honda and Lower Papalotla rivers. (A) Location, (B) cross section of the two valleys, and (C) profiles of the described sections.



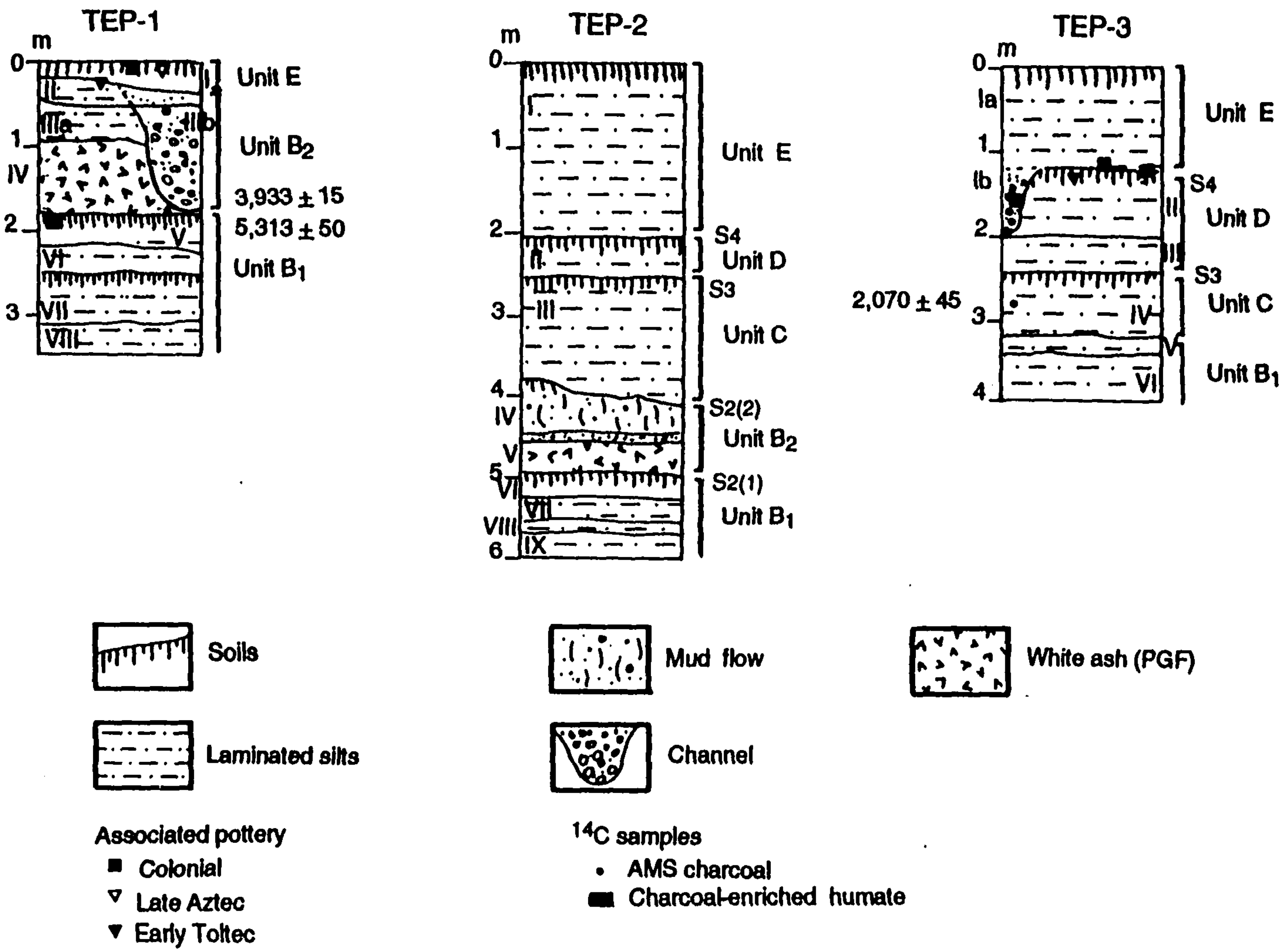
A
Section in B
TEP-1
TEP-3
TEP-2
TEPETLAOZTOC
PAP-4
PAP-2-3
PAP-1
B
Tx-A-24
(Aztec Tepetlaoztoc)
Colonial-Modern
Tepetlaoztoc
El Calvario
Tx-A-40
Middle
Papalotla R.
Barranca
Honda
Small
barranca
C
TEP-1
TEP-2
TEP-3
T1
T2
PAP-1
Aztec mound
T1
T2
PAP-3
PAP-2
Classic mound
Aztec mound
PAP-4

The Barranca Honda sections at Tepetlaoztoc

Three sections on the cutbanks of the Barranca Honda (Figure 6.17) were selected for this study because they show separate sequences that, when combined provide a relatively complete picture of aggradation and incision during the Holocene. In addition to stratigraphic control obtained by ^{14}C dating, the Mid-Holocene PGF ash provides a good marker to bracket the age of the deposits of these sections.

TEP-1 is a section that starts with a series of cumulic soils and flood deposits of Unit B_1 (zones VIII, VII, VI, and V) that are sealed by the PGF ash (zone IV). Overlying the ash deposits there is an accumulation of silts (zone IIIa) followed by a channel fill (Zone IIIb), both are interpreted as unit B_2. This unit is capped by two mantles of alluvium (zones II and I); the lower one has been altered, while the top one seems to be a combination of colluvial and cultural deposits, and contains a mixture of Toltec, Aztec and Colonial sherds. It may correspond to either Unit C or D. The PGF ash is bracketed by radiocarbon assay from the soil underneath (5,313 $\pm$ 51 B.P., Tx-7781) and another from the channel of unit B1 (3,933 $\pm$ 15, Tx-8094), indicating that its age is roughly 5 ka.

Figure 6.17 Stratigraphic sections in the Barranca Honda (TEP).


TEP-1
m
0
1
2
3
I
IIa
IIb
IV
V
VI
VII
VIII
Unit E
Unit B2
3,933 ± 15
5,313 ± 50
Unit B1
TEP-2
m
0
1
2
3
4
5
6
I
II
III
IV
V
VI
VII
VIII
IX
Unit E
S4
Unit D
S3
Unit C
S2(2)
Unit B2
S2(1)
Unit B1
TEP-3
m
0
1
2
3
4
Ia
Ib
II
III
IV
VI
Unit E
S4
Unit D
S3
Unit C
Unit B1
2,070 ± 45
Soils
Mud flow
White ash (PGF)
Laminated silts
Channel
Associated pottery
Colonial
Late Aztec
Early Toltec
14C samples
AMS charcoal
Charcoal-enriched humate

Section TEP-2, located about 500 m downstream, shows a similar sequence as TEP-1, except that the post-eruptive deposits are better represented (Figure 6.18). After the PGF was deposited it was covered by a mud flow that I believe is contemporary to the silts and channel of unit B_2 in TEP-1. Developed in the mud flow there are the remains of a soil with an AB/C profile, indicating that a soil was developed and then eroded. As a matter of fact, an erosional unconformity in these deposits is indicated by a sloping surface supporting a truncated soil horizon not present in the other sections. Above the erosional unconformity are three zones: III, II and I, which correspond to Units C, D, and E, respectively. In addition to the modern soil on unit E, two A horizons are developed on these units: S_3 on Unit C, and S_4 on unit D.

Unit C reflects continuous pulses of sedimentation represented in the form silt-loam deposits without pedogenic alteration, except for the soil developed at the top, which corresponds to S_3. Unit D presents weak A and C horizons of cumulic soils that indicate a series of minor sedimentation pulses separated by short periods of stability. Unit E represents a massive body of a yellow, subhorizontally laminated silt-loam that represent a single catastrophic pulse of sedimentation, although in other sections two pulses are represented.

Figure 6.18 Barranca Honda. Section TEP-2 showing Unit B, PGF ash, and Units D and E.

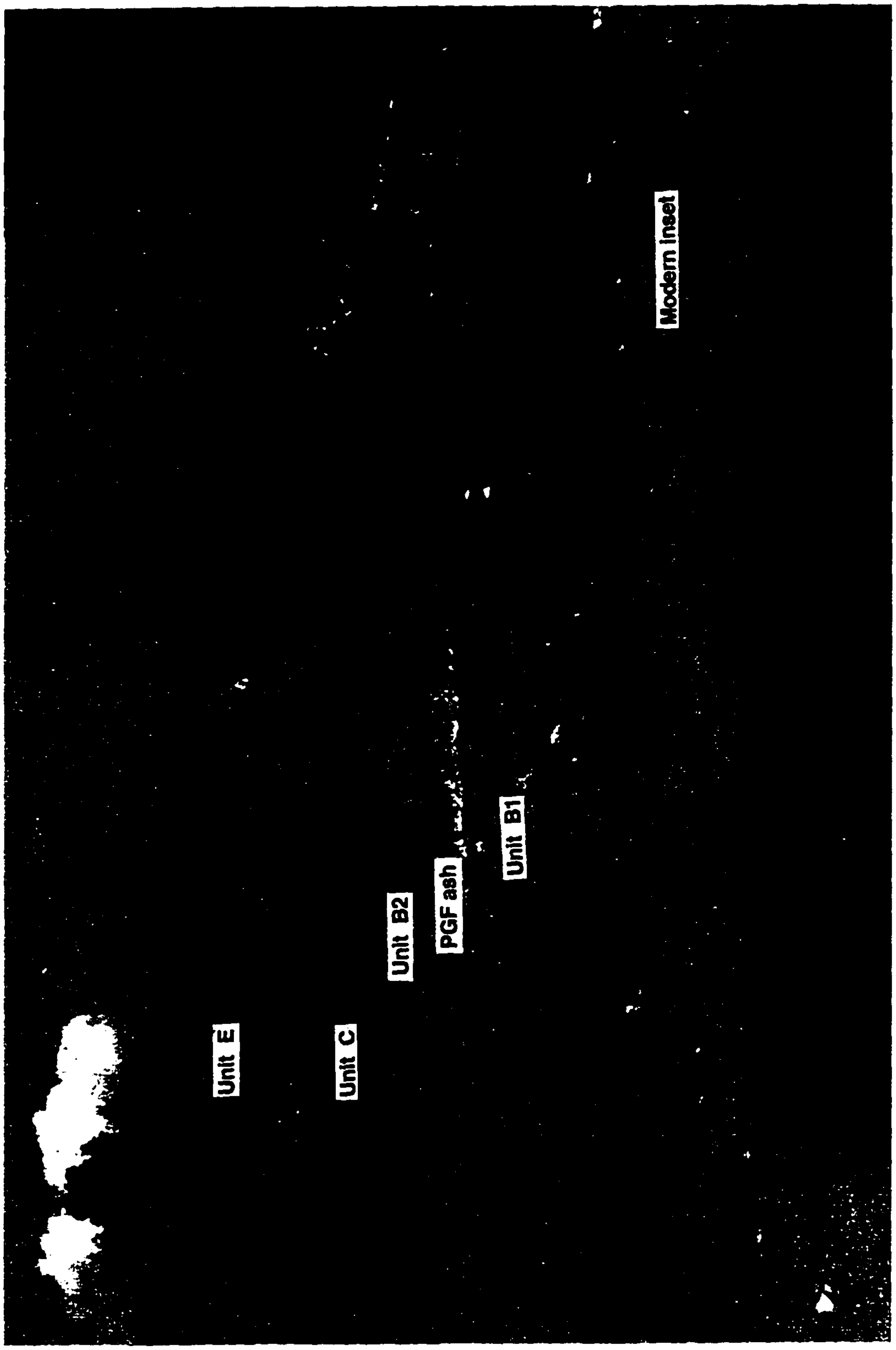
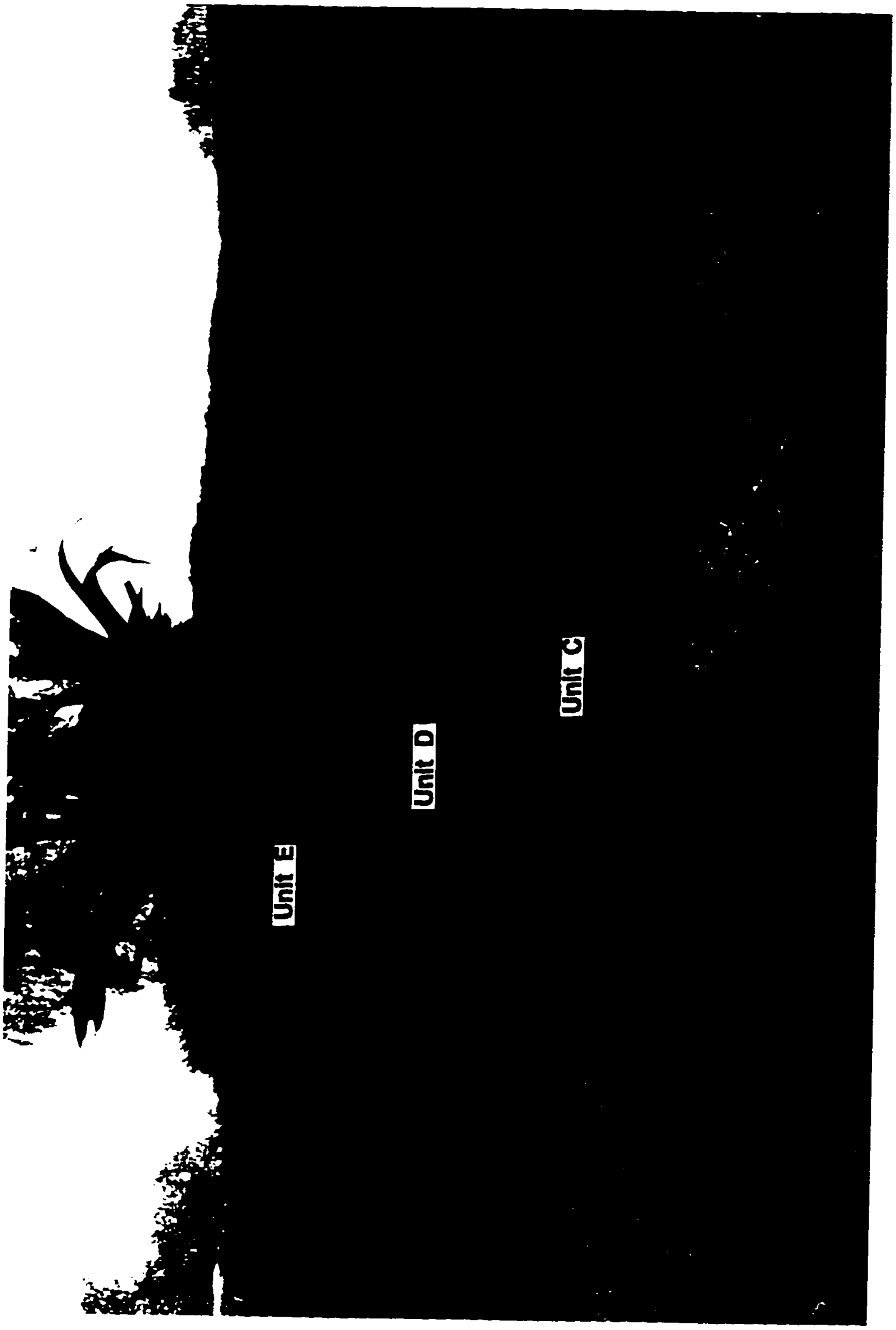

Modern inset
Unit B1
PGF ash
Unit B2
Unit E
Unit C

Figure 6.19 Section TEP-3.


Unit E
Unit D
Unit C

Section TEP-3 presents a stratigraphy that complements TEP-2 because units C and D are better represented (Figure 6.19). The two lowermost zones (VI and VI) in TEP-3 correspond to the bottom zones of Unit B_1 in TEP-2, as confirmed by sedimentological and pedological data. The topmost soil in unit B_1, namely $S2_{(1)}$, the PGF ash deposits, the mud flow, and the AB horizon ($S_{2(2)}$) present in section TEP-2 are missing in TEP-3, probably because they were wiped out by the widening or migration of the channel between the times of deposition of Units B_2 and C. However, Units C, D, and E, are better exposed in TEP-3. A radiocarbon assay of 2,070 ± 45 B.P. (OS-3478) provides a date for Unit C, and an assemblage of Early Toltec pottery provides the maximum age for Unit D. Unit E consists of a channel (zone Ib) that contains glazed Colonial pottery whcih in turn is associated a flood deposit (zone Ia) that covers a surface of Colonial pottery.

The Middle Papalotla sections

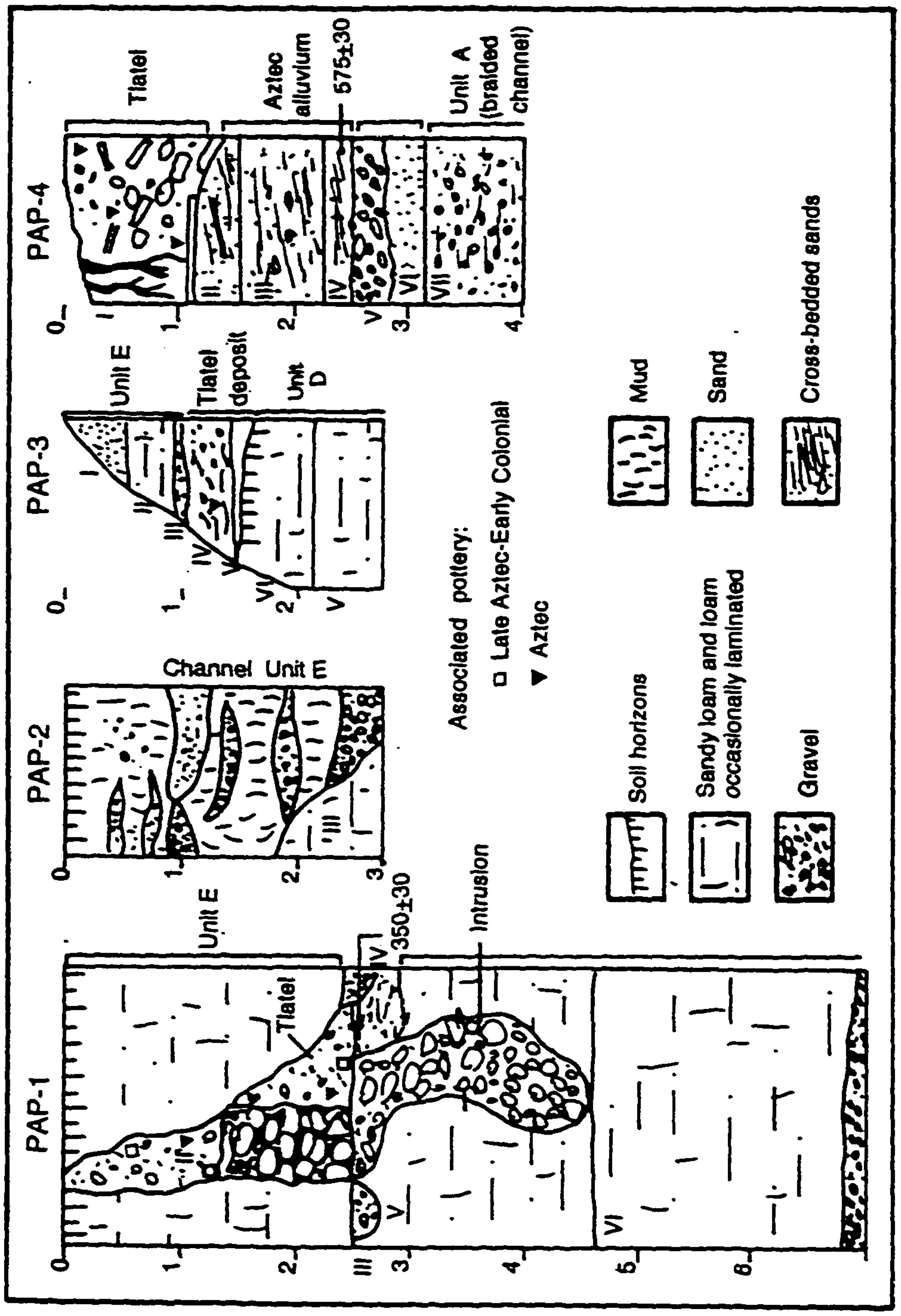
The section of the middle reach of the Papalotla shows a sequence of deposition and trenching different from the Barranca Honda, primarily because units B and C are missing. There are at least three periods of trenching, one after the deposition of Unit A, which is buried under younger alluvium, a second after the deposition of Unit D that formed terrace T1, and a third one after the deposition of Unit E, which formed terrace T2 and created the present channel (See Figure 6.16 C).

After the deposition of Unit D and its subsequent trenching there was a stable period during which there were settlements on or close to the channel. This phase is illustrated in sections PAP-1, PAP-2 and PAP-4, which contain tlatels that were buried and later exposed (Figures 6.16C and 6.20). The case of PAP-4 shows an Aztec tlatel with stucco floors that was established on riverbank deposits (zones IV, III and II). A radiocarbon age of 575±30 B.P.(OS-3479) was obtained from a piece of charcoal embedded in zone IV, which is a riverbank deposit underlying the tlatel. This radiocarbon assay and the pottery in the tlatel provided the estimated age of these riverbank sands, which are considered as 'Aztec Alluvium.'

The three tlatels were covered by the deposits of Unit E in Early Colonial times an re-exposed by subsequent trenching and scouring. Parts of the channel corresponding to Unit E is exposed in section PAP-2 (zones II and I).

There were additional exposures in the cutbanks of this river, but the stratigraphy was not clear since in most cases only one unit was exposed, and they are not documented. The complete sequence requires combining the four recorded sections. The late Pleistocene-Early Holocene

Figure 6.20 Stratigraphic sections from the Middle Papalotla (PAP).


PAP-1
PAP-2
PAP-3
PAP-4
Unit E
Tlatel
350±30
Intrusion
Channel Unit E
Unit E
Tlatel deposit
Unit D
Tlatel
Aztec alluvium
575±30
Unit A (braided channel)
Associated pottery:
□ Late Aztec-Early Colonial
▼ Aztec
Soil horizons
Sandy loam and loam occasionally laminated
Gravel
Mud
Sand
Cross-bedded sands

Unit A (zones VII, VI and V) appears in PAP-4, Unit D appears at the bottom of PAP-2 (zones VII and VI), in PAP-3 (zone III), and in PAP-1 (zones VII and VI). The Aztec Alluvium appears in PAP-4 (zones IV, III and II) and in PAP-2 (zone IV), and Unit E appears in PAP-1 (Zone I), PAP-2 (zones III, II and I) and in PAP-3 (zones I and II) channel facies.

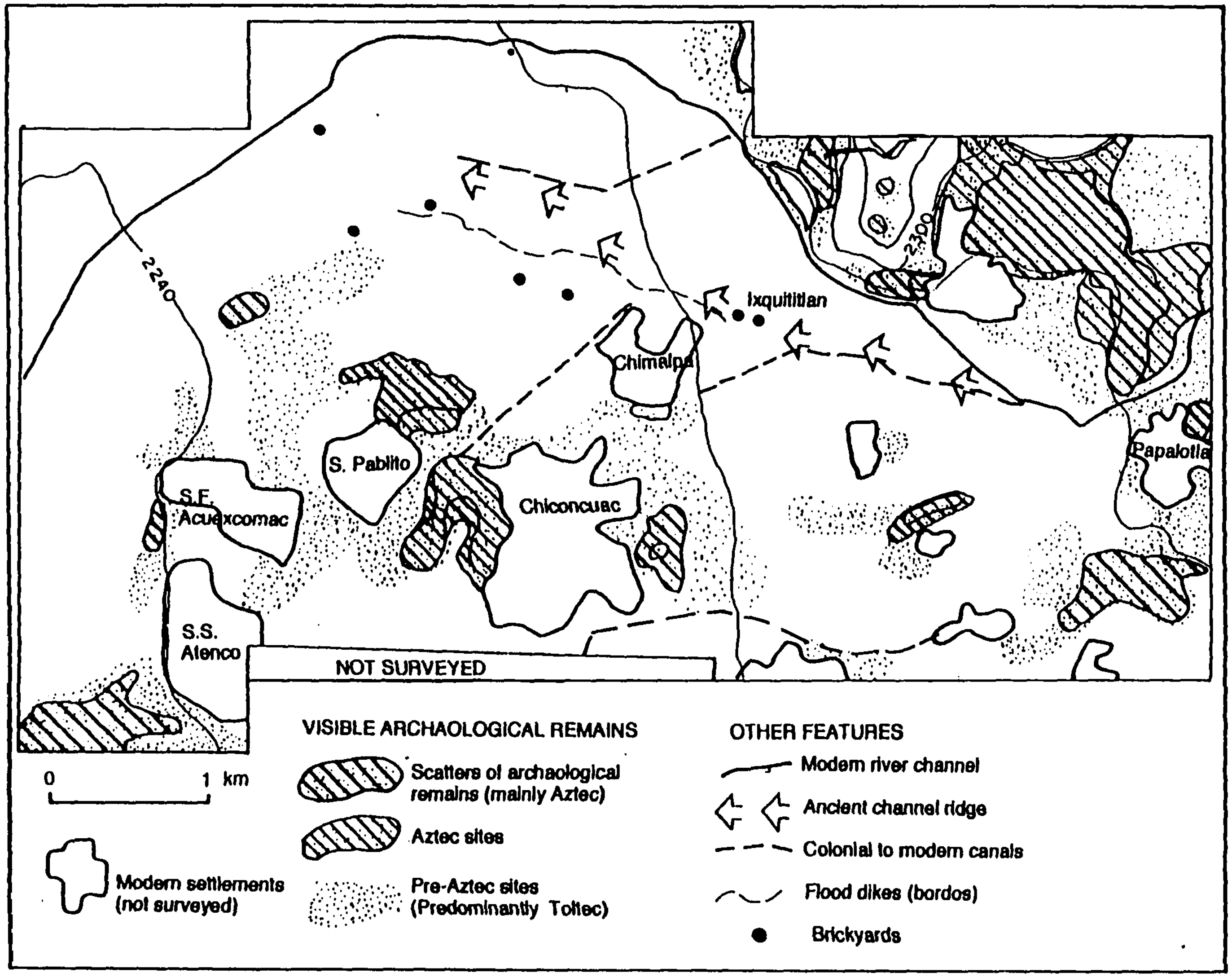
The Lower Papalotla sections

The Papalotla river forms in its lower reach a convex floodplain (Type 1) that has been subject to various processes such as channel shift (avulsion) and accelerated aggradation by flooding that has obscured most of the pre-Hispanic occupation in the center of the floodplain (Figure 6.21).

Channel incision is not apparent either in the modern or ancient channels on this floodplain. The conditions necessary for channel trenching seem not to have occurred on this floodplain, probably due to the low gradient of the channels and the general slope.

The study of the alluvial stratigraphy in the lower Papalotla floodplain is based on data recorded in one brickyard located at the edge of the settlement of San Bartolo Ixquititlan, in an area in between the modern channel to the north and the ancient channel ridge to

Figure 6.21 Lower Papalotla valley. Floodplain morphology and surface archaeology.


2240
2300
Ixquitlilan
Chimalpa
S. Pablito
Papalotla
S.F. Acuexcomac
Chiconcuac
S.S. Atenco
NOT SURVEYED
VISIBLE ARCHAOLOGICAL REMAINS
Scatters of archaological remains (mainly Aztec)
Aztec sites
Pre-Aztec sites (Predominantly Toltec)
Modern settlements (not surveyed)
0 1 km
OTHER FEATURES
Modern river channel
Ancient channel ridge
Colonial to modern canals
Flood dikes (bordos)
Brickyards

south. The brickyard is closer to the latter (Figure 6.21). Originally, the survey reported no sites on surface, but the excavation of the brickyard pit revealed a site buried beneath overbank fine deposits. This site is a tlatel with several interspersed occupation levels of and aggraded fines that seem to represent a steady rise in ground level through the accumulation of flood deposits (Figure 6.22). A church built on top of the tlatel deposits was inundated by the latest flood and abandoned. A possible interpretation of this interesting stratigraphy of interfingered cultural and natural deposits is that the tlatel was built up as the ground around it aggraded by steady sediment accumulation.

The sections described are located on the northern side of the brickyard where the tlatel is exposed. The east exposure shows the same deposits exposed on the north side, but thickening towards the location of the ancient channels; the southern exposure has been disturbed by modern occupation; the western flank has also been disturbed, but at its southern end shows a series of channel deposits that may be part of the same ancient channel or associated flood channels created by the scouring of sediments during a splay event. However, the trace of the old channel in aerial photographs and field examination of the topography suggests that the old channel followed a northwestward direction (See Figure 6.21).

Three sections were described in the brickyard: IXQ-1 shows the cultural material of the tlaltel capped by a late Colonial flood deposit (zone I); IXQ-2 shows the interdigitation of flood deposits and alluvial soils with the cultural material at the edge of the tlatel; and IXQ-3 that shows the most complete sequence of flood deposits and soil horizons exposed on the eastern flank of the brickyard (Figure 6.22).

There are no radiocarbon assays available from these deposits because: (1) the flood deposits and associated soil horizons did not contain charcoal, (2) the associated pottery indicated that the soil horizons, a possible source for humate samples, were too young, and (3) charcoal was abundant only in the tlatel deposits that contained large quantities of associated diagnostic pottery. Thus, given the reduced budget for radiocarbon dates, I decided to use the pottery dating and relative associations between the tlatel and the alluvial deposits.

Section IXQ-1 shows a complicated set of cultural strata that include occupation levels. The lowest occupation contains Coyotlatelco (Early Toltec) pottery; the middle occupation contains Aztec pottery associated with walls and several stucco floors, and the two uppermost

Figure 6.22 Brickyard at San Bartolo Ixquititlan in an area of no surface archaeological remains.

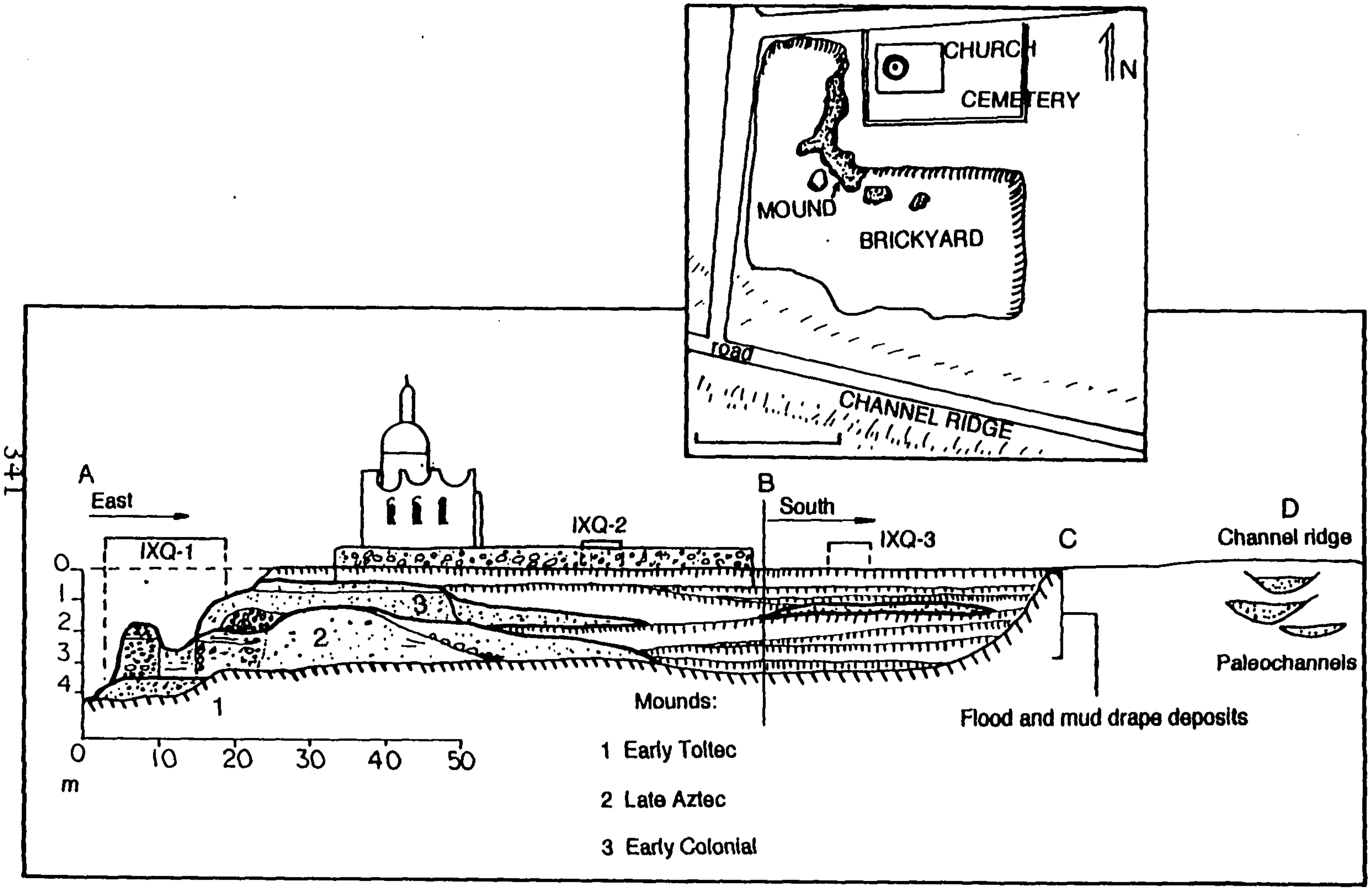
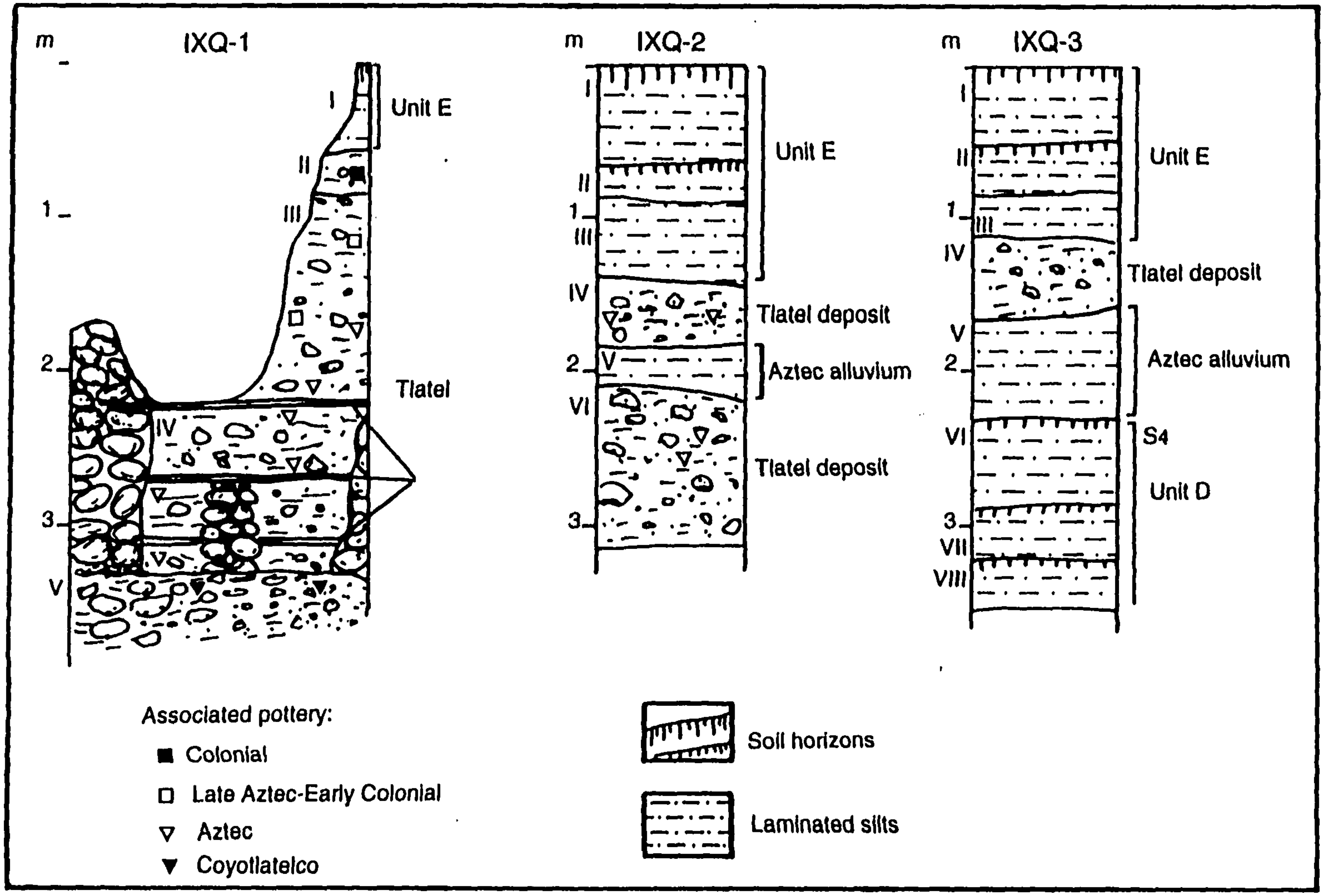

CHURCH
CEMETERY
N
MOUND
BRICKYARD
road
CHANNEL RIDGE
A
East
IXQ-1
IXQ-2
B
South
IXQ-3
C
D
Channel ridge
0
1
2
3
4
1
2
3
Paleochannels
Flood and mud drape deposits
Mounds:
1 Early Toltec
2 Late Aztec
3 Early Colonial
0
10
20
30
40
50
m

Figure 6.23 Ixquititlan sections (IXQ).


m
IXQ-1
1
2
3
I
Unit E
II
III
Tlatel
IV
V
m
IXQ-2
I
Unit E
II
1
III
IV
Tlatel deposit
2
V
Aztec alluvium
VI
Tlatel deposit
3
m
IXQ-3
I
II
Unit E
1
III
IV
Tlatel deposit
V
2
Aztec alluvium
VI
S4
Unit D
3
VII
VIII
Associated pottery:
Colonial
Late Aztec-Early Colonial
Aztec
Coyotlatelco
Soil horizons
Laminated silts

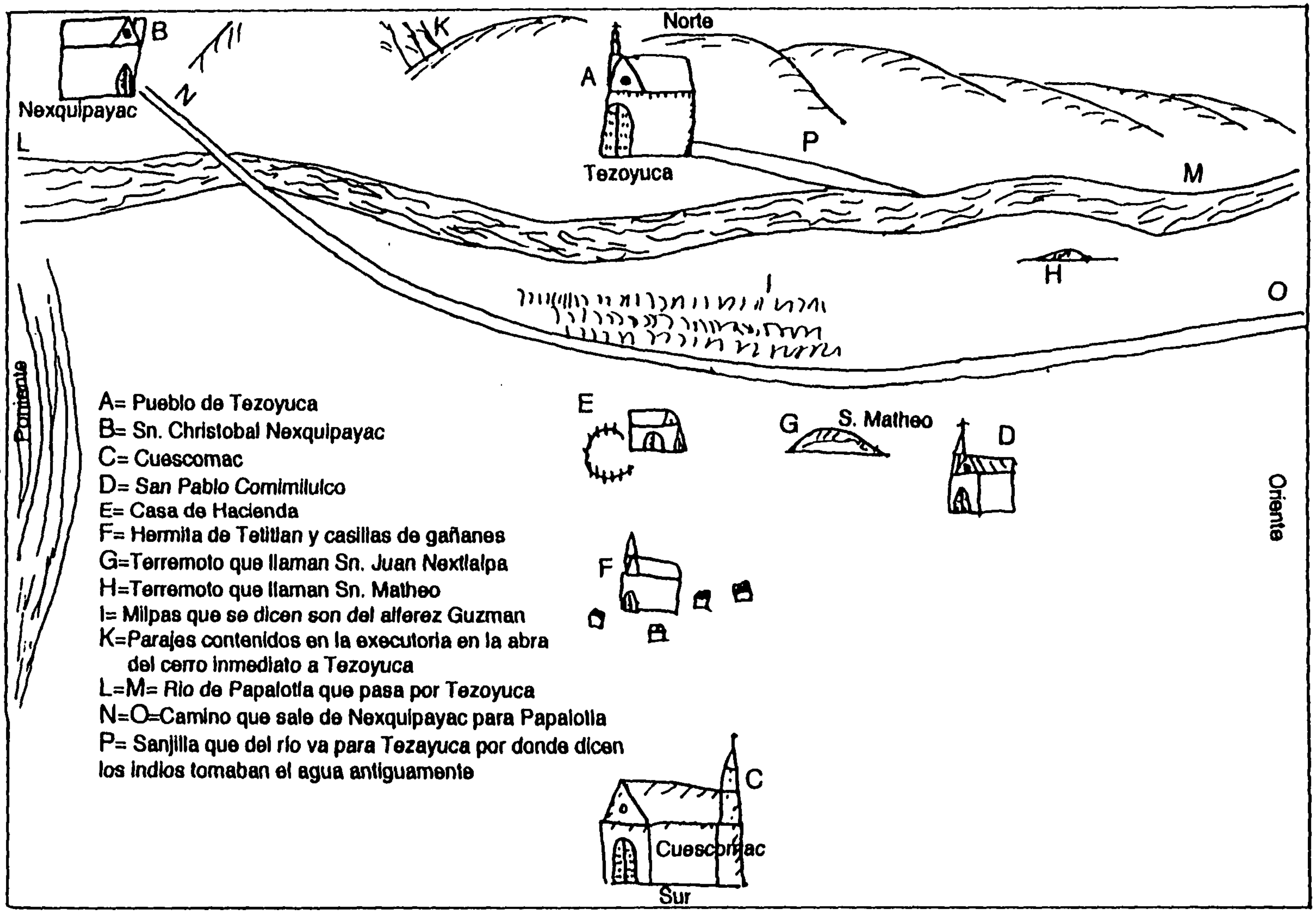
levels are associated with the church and have Late Aztec and Early Colonial pottery. The base of the church is buried by about 80 cm of a silt-clay deposit of the latest flood. People in the area say that the river overtopped its channel and damaged the church, which was subsequently abandoned[3] . They also say that at that time of the flood the river used to flow where the road is located (see Figure 6.22, inset map).

Whether a true scenario or not, everything else in pictorial maps seems to indicate that the river indeed used to flow where the road is, and sometime in the late 1700s or early 1800 moved to its present channel which runs along the northern edge of the floodplain near Tezayuca. A map drawn in 1692 and included in a *Tierras* document shows the path of the river somewhere south of the present channel, but because the map has no scale or references it is difficult to determine where exactly the channel was located (Figure 6.24). The map shows a northern channel that is referred to as 'a ditch that the Indians dug to carry water to Tezayuca' located at the modern channel. Another map drawn in 1797 shows the lands of the Hacienda Prado Alegre and the town of Chiconcuac; the Papalotla

[3] A Mercedes document of 1614 mentions a church that was destroyed by a flood (AGN, Mercedes, v. 28, f. 394; No. 105 in Appendix A). This is not the church of Ixquititlan because the description gives a location farther downstream near San Pablo. I searched for the location of the ruins but they happen to be located in an area of considerable aggradation.

Figure 6.24 The Lower Papalotla in a map of 1692 (AGN, Tierras, vol. 1264, exp. 5, f.82, catalogue number: 1151).

346

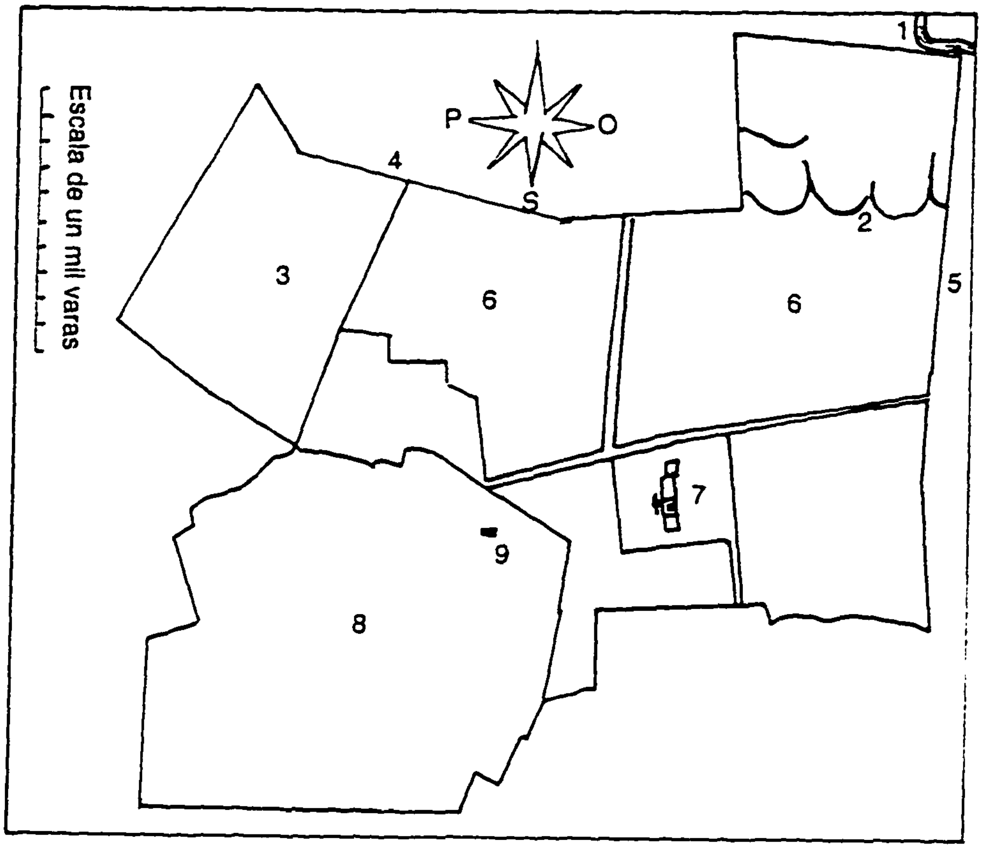

Norte
B
K
N
A
Nexquipayac
L
P
Tezoyuca
M
H
I
O
Poniente
E
G
S. Matheo
D
Oriente
F
C
Cuescomac
Sur
A= Pueblo de Tezoyuca
B= Sn. Christobal Nexquipayac
C= Cuescomac
D= San Pablo Comimilulco
E= Casa de Hacienda
F= Hermita de Tetitlan y casillas de gañanes
G=Terremoto que llaman Sn. Juan Nextlalpa
H=Terremoto que llaman Sn. Matheo
I= Milpas que se dicen son del alferez Guzman
K=Parajes contenidos en la executoria en la abra del cerro inmediato a Tezoyuca
L=M= Rio de Papalotla que pasa por Tezoyuca
N=O=Camino que sale de Nexquipayac para Papalotla
P= Sanjilla que del rio va para Tezayuca por donde dicen los indios tomaban el agua antiguamente

river appears to be still occupying its southern course, albeit north of the road that links Papalotla with Nexquipayac (Figure 6.25). The map shows a set of interesting features just south of the channel that are referred to as 'dams storing the flood-waters of the Papalotla'. The water was apparently used for the irrigation of labor lands (Von Wobeser 1989: 154), although such dams may have had the purpose of protecting the cultivation lands from floods. In either case, irrigation or protection, the presence of such dams help explain the rapid sedimentation created by each flood, and the thickness of the deposits.

Section IXQ-2 shows the combination of cultural deposits and flood deposits of the Aztec Alluvium subunit (zone V), the Early Colonial floods (Unit E_1 --zones III and II) and the Late Colonial Floods (Unit E_2 --zone I). Section IXQ-3 shows the entire sequence from Unit D (VIII, VI and VI), the Aztec Alluvium (zone V) and the three Colonial floods of Unit E.

The so-called "Aztec Alluvium" was defined by its association with the Late Aztec deposits of the tlatel. However, since two of the upper layers of the tlatel in IXQ-1 have a mixture of Early Colonial and Late Aztec pottery, it is probable that the deposit correlative with

Figure 6.25 Hacienda Prado Alegre (AGN: *Tierras*, vol. 1517, exp. 1 f. 7, catalogue number: 1076; taken from Von Wobeser, 1989). The dikes indicated on the map were constructed to contain the floods and store water.



Key:

1 Río de Papalotla

2 Presas que contienen las aguas del río

3 Tierras de pastos

4 Lindero del pueblo de Chimalpan

5 Camino real de Tescuco a San Juan Teotihuacan

6 Tierras de la Hacienda

7 Casas y oficinas

8 Plano de la superficie que posee el pueblo de Chiconcuac

9 Iglesia del pueblo.

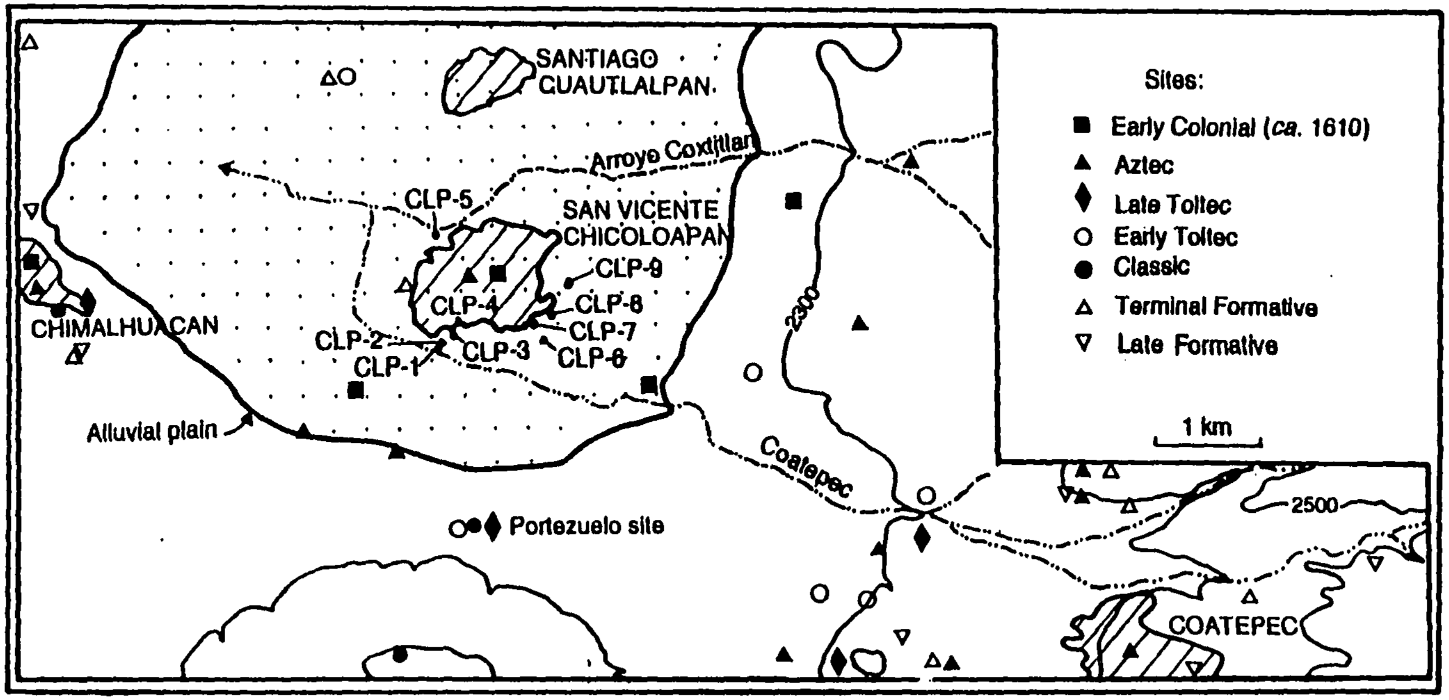
Aztec material that covers the alluvium is of the same age, so that the "Aztec alluvium" could well be part of Unit E.

The Lower Coatepec and Arroyo Coxtitlán floodplains

The stratigraphic sections of the lower Coatepec and Arroyo Coxtitlán floodplains (CLP) are located in the brickyards around the town of Chicoloapan where the two streams, now in artificial channels, merge before reaching the lakebed. The geoarchaeological study of the exposures of the Chicoloapan brickyards revealed numerous sites and occupation surfaces buried by flood deposits. Thus, the proposition that the floodplain was lightly occupied, as indicated by the survey, is as an artifact of geomorphic bias. The areas on the piedmonts and hills around the floodplain show a great number of sites of several periods that do have counterparts in the areas, but covered by alluvium (Figure 6.26).

The general picture resulting from the exposures in the Chicoloapan area demonstrates that the late Holocene floodplain developed within a valley created by the scouring of Pleistocene pyroclastic flows and alluvial deposits. Sedimentation in recent times infilled the scoured valley and leveled the terrain, resulting in merging at the Arroyo Coxtitlán and the Coatepec into one

Figure 6.26 The lower Coxtitlan and Coatepec rivers and the location of stratigraphic sections.

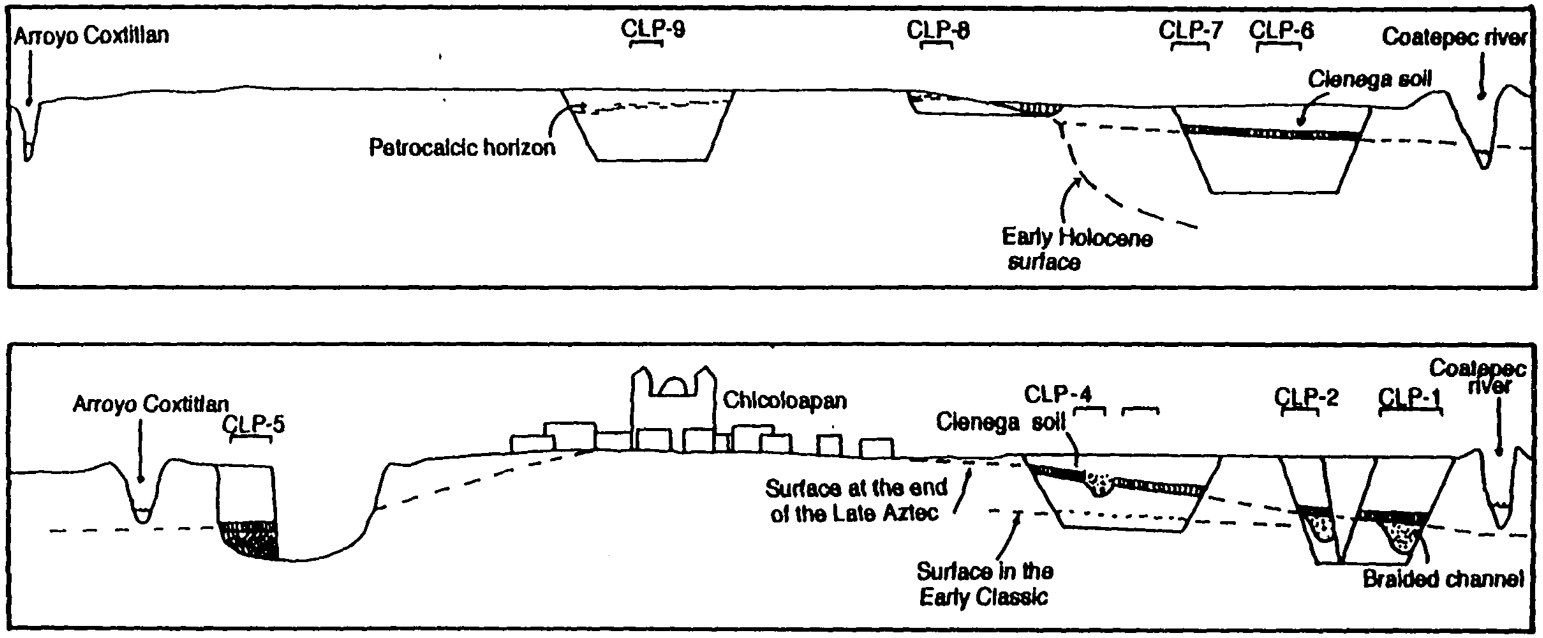


SANTIAGO
CUAUTLALPAN
Arroyo Coxtitlan
SAN VICENTE
CHICOLOAPAN
CLP-5
CLP-9
CLP-4
CLP-8
CLP-7
CLP-2
CLP-3
CLP-6
CLP-1
CHIMALHUACAN
Alluvial plain
Portezuelo site
2300
Coatepec
2500
COATEPEC
Sites:
Early Colonial (*ca.* 1610)
Aztec
Late Toltec
Early Toltec
Classic
Terminal Formative
Late Formative
1 km

common floodplain. The late Pleistocene deposits (Unit A) are capped with a calcic horizon labelled as S_1. It is upon this stable, relatively flood-safe surface that the Aztec, Colonial and Modern town of Chicoloapan stands, as illustrated in the transects across the floodplains (Figure 6.27).

The units represented in the Chicoloapan brickyards (A, C, D, and E) were defined by ^{14}C dating, pottery association, and cross-correlating information from the various exposures (Figures 6.28 and 6.29). Section CLP-1 starts with the aggradation of Unit D (zones VII and VII) and the scouring of it by a channel that developed into a braided type (zone VI). This channel was eventually stabilized or diverted, artificially or naturally, and is capped by occupational deposits containing material of the Early and Late Aztec phases (zone V). This occupation surface was buried by deposits of the Early Colonial floods, which formed a cienega, or permanent or semi-permanent waterlogged soil (zone IV), that was in turn buried by a series of flood deposits of Unit E, a splay (zone IV) and a series of flood deposits with plow horizons and occasional gravel lenses and abundant pockets of glazed sherds (zones III, II and I). The use of diagnostic pottery was helpful in obtaining an approximate date of the deposits in CLP-1. One ^{14}C assay was obtained from a piece

Figure 6.27 Section across the Coxtitlan and Coatepec floodplains. See location of profiles of Figure 6.26.



Arroyo Coxtitlan
CLP-9
CLP-8
CLP-7
CLP-6
Coatepec river
Cienega soil
Petrocalcic horizon
Early Holocene surface
Arroyo Coxtitlan
CLP-5
Chicoloapan
CLP-4
Cienega soil
CLP-2
CLP-1
Coatepec river
Surface at the end of the Late Aztec
Surface in the Early Classic
Braided channel

of charcoal in the splay deposit of zone III (219±50 B.P. (Tx-7780)). A humate age from zone IV turned out to be older than expected and rejected (See Appendix E for discussion).

Section CLP-2 is located about 15 meters north of CLP-1 and features of the braided channel (zone VI). The remainder of the sections exposed deposits correlative to those of Unit E in CLP-1 (Figure 6.28). The depth of the cienega soil is at the same level in the two sections, suggesting that in this area the cienega occupied a low and flat topography.

About 100 meters northwest of CLP-1 towards the town of Chicoloapan, three more sections reveal that the Unit E deposits pinch out as the ground level of Aztec-Early Colonial times rises (See Figure 6.27).

Away from the braided channel, CLP-3 shows deposits of Unit C at the bottom of the section (zones VII and VI) which present traces of occupation on top and are intruded by part of a burial that was dismantled by quarrying. The date obtained from this Unit-C deposit was 2,033±96 B.P. (Tx-8021). This is consistent with the occupation on top of the unit and the intrusion, both of which contain Early Classic pottery (see Appendix H for descriptions). A deposit corresponding to Unit D (zone V) overlies the Classic occupation surface. No radiocarbon date exists

Figure 6.28 Stratigraphic sections at Chicoloapan (CLP) on the floodplains of the Arroyo Coxtitlan and Coatepec river. Sections 1-5.

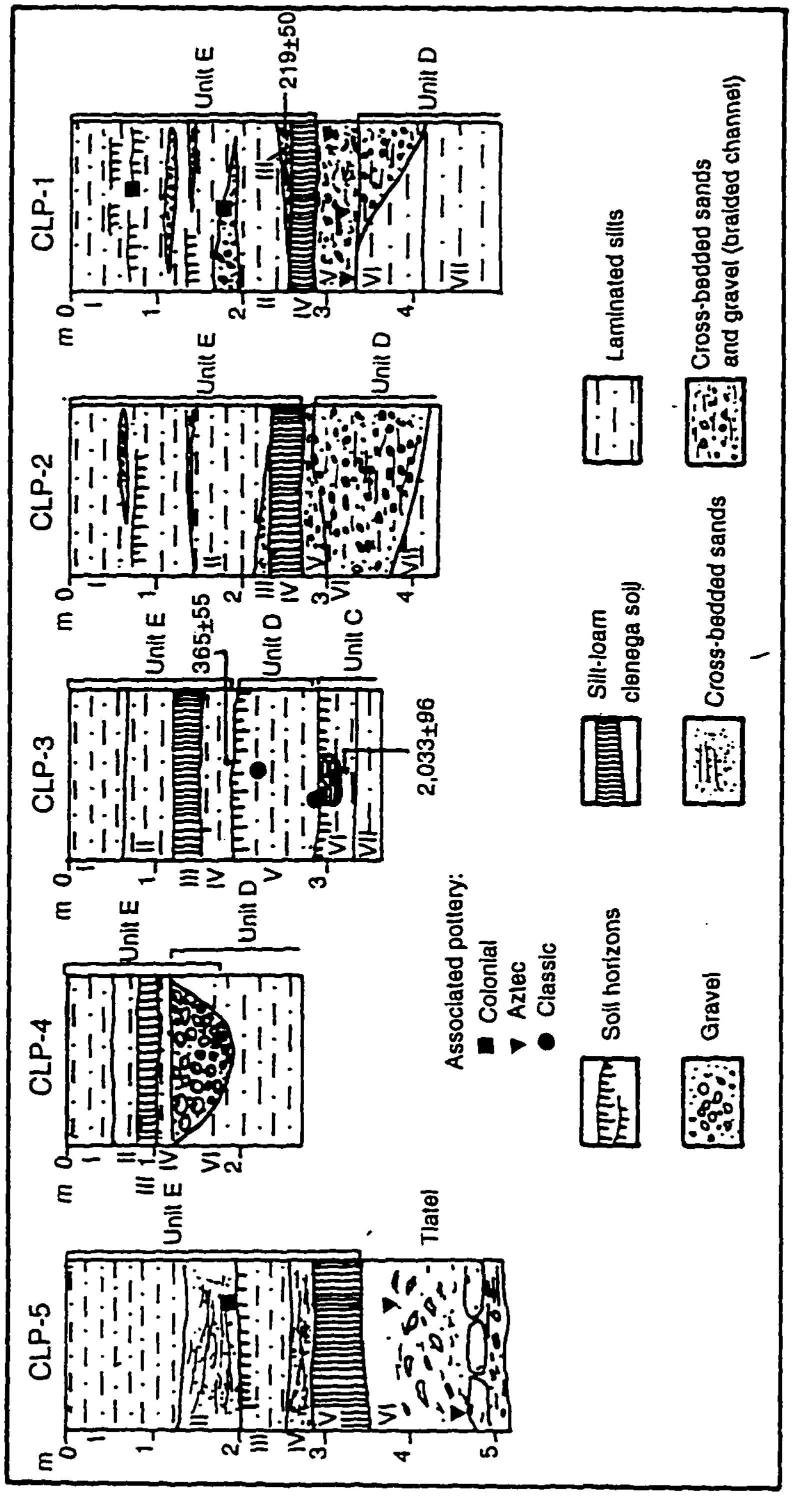
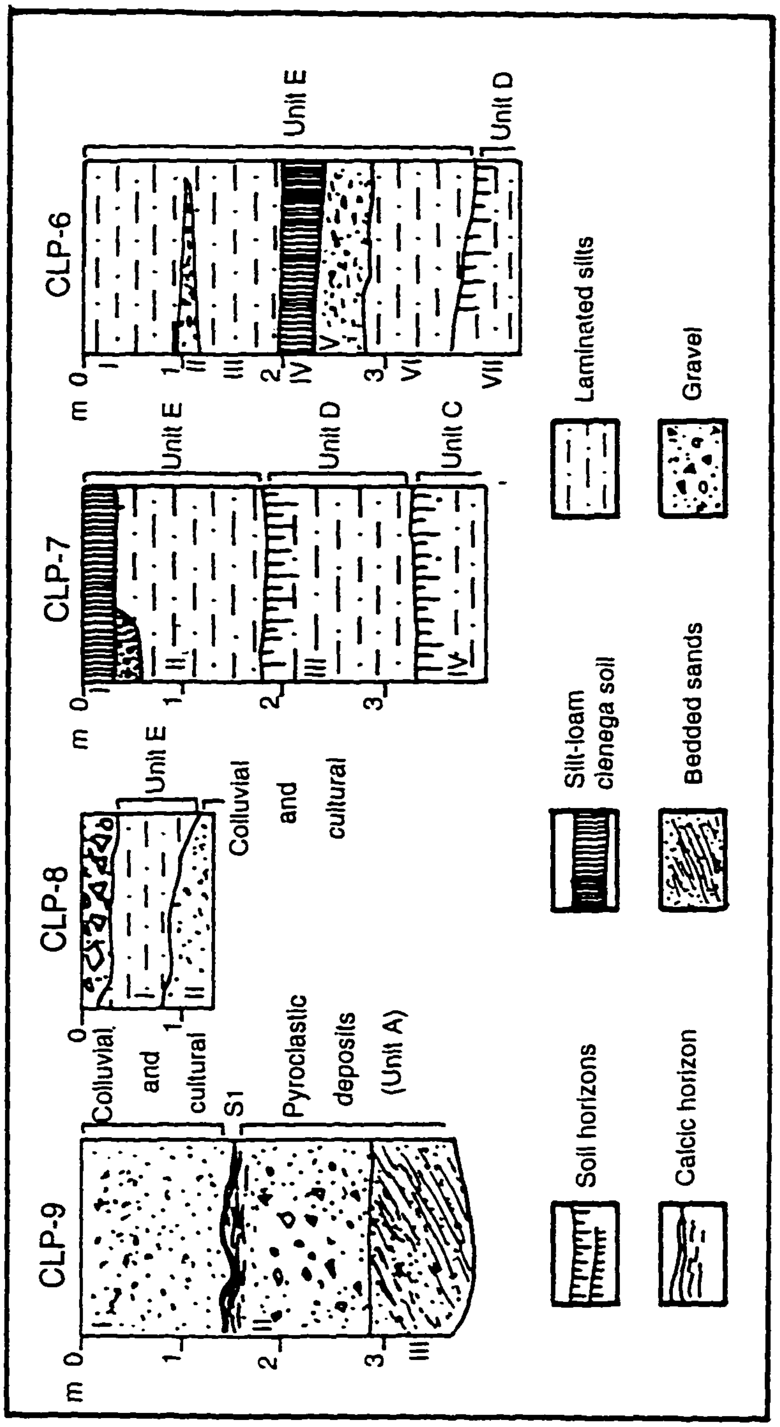

CLP-5
CLP-4
CLP-3
CLP-2
CLP-1
Unit E
Unit D
Unit C
Tlatel
365±55
2,033±96
219±50
Associated pottery:
Colonial
Aztec
Classic
Soil horizons
Silt-loam cienega soil
Laminated silts
Gravel
Cross-bedded sands
Cross-bedded sands and gravel (braided channel)

Figure 6.29 Stratigraphic sections at Chicoloapan (CLP) on the floodplains of the Arroyo Coxtitlan and Coatepec river. Sections 6-9.


CLP-9
CLP-8
CLP-7
CLP-6
m
0
1
2
3
Colluvial and cultural
S1
Pyroclastic deposits (Unit A)
Unit E
Colluvial and cultural
Unit D
Unit C
Soil horizons
Calcic horizon
Silt-loam cienega soil
Bedded sands
Laminated silts
Gravel

for this deposit, but a piece of the so-called 'Teotihuacan Thin Orange' pottery, which dates to the Early Classic period (Parsons: 1971:277) was found embedded in this deposit. On top of this unit lies the flood deposits of Unit E with the cienega deposit the lowest, as in sections CLP-1 and CLP-2.

Section CLP-4 shows a similar stratigraphy as CLP-3, the primary difference is that CLP-4 contains a channel with lag deposits (zone V) cutting trough the deposit of Unit D. This channel preceded the formation of the cienega. It is probable that this channel is associated with a flood, either acting as a distributary of the overflowing main channel, or an irrigation channel that was filled up with high energy deposits of the initial stages of the flood.

CLP-5 is located north of Chicoloapan in the Arroyo Coxtitlán floodplain. At the bottom of the section is a mound with Aztec material covered by the cienega deposit (zone V). The overlying deposits (zones IV to I) are similar to the sections previously described.

Along the eastern transect there is a similar stratigraphy that shows again the cienega soil in the Early Colonial flood deposits of sections CLP-6 and CLP-7. As in the western transect, the cienega soil and the overlying Late Colonial deposits pinch out and disappear towards town; section CLP-8 has no cienega soil but has a flood deposit of Unit E (zone I) overlying the late Pleistocene pyroclastic deposits of Unit A (zone II). Section CLP-9 presents only the series of pyroclastic deposits, a cross bedded sand at the bottom (zone III) and poorly sorted deposit with the appearance of a lahar (zone II) capped by the Bk horizon of the S_2 soil. On top of the calcic horizon there is a deposit that seems to be a cultural fill with colluvial component (zone I). The phase of the pottery contained in this deposit is difficult to determine, since the sherds are in small pieces. Despite lacking clear diagnostic properties, the paste, paint, and burnishing of the majority of these sherds is similar to the pottery of the Late Formative, although some more closely resemble ceramics of the Terminal Formative phase.

The Early Colonial cienega soil that appears in most of the exposures deserves more attention since it is a good stratigraphic marker and an indicator of a wetland environment. It is a silt-loam overbank deposit affected by pedogenesis and water level fluctuations. The deposit was apparently waterlogged in some places and subject to continuous drying and wetting in others. It exhibits orange and gray mottles that imply hydromorphic changes and the existence of a seasonally waterlogged soil or pond. The underlying deposits in some exposures show manganens, which confirm the presence of a high water table. The structure varies from weak-columnar and medium subangular-blocky in the lower levels (CLP-1, CLP-2, CLP-5 and CLP-6) to a medium granular and weak subangular blocky in more elevated areas (CLP-3, CLP-4, CLP-7). The description and granulometric parameters of the cienega soils sampled are included in Appendix F.

The *Relación Geográfica de Chicoloapan* mentions a body of still water near town that could be the origin of the cienega deposits. A glyph of water and birds on the map accompanying the document indicates that its location was southwest of town (See map in Acuña 1985, vol.1, 174). The description in the text reads:

> " Y, aunque tienen la fuente de agua manantial que se dice Chicoloatl, de donde este pueblo tomó su nombre, no beben della, porque no corre" (Villacastin, F.1579. In Acuña 1985, vol.1:170-171).

Although the description presents a body of water limited in size and location, it may have grown as flooding increased in subsequent years. This enlargement of the pond may have occurred either in the wet years of the mid-1500s or in the early 1600s. Chicoloapan in Nahuatl means 'the water of the owls'. That the name of the town alludes to water, implies that the deposit was sometimes larger.

It is possible that the body of water is a manifestation of a high water table that dropped gradually over time, since the *Relación* specifies that no river fed the pond. There are no other early documents that mention the environment of the Chicoloapan area. The only other maps that exist for the colonial period are attached to a *Tierras* document of 1747 in which the river channels have the present configuration.[4]

Ultimately, it is also necessary to point out that some of the youngest depositional events of Unit E in CLP-1 and CLP-2 show an interesting structure that can be interpreted as flood deposits that were continuously plowed. The structure differs from the regular flood deposits in that the plowed horizons have a massive structure and lack the laminations. Besides, the consistence of the plowed horizons is harder than any of the deposits and in most cases poorly sorted. I developed this explanation for such structures through a study of the deposits of the Amecameca and Tlalmanalco rivers where the levees are frequently and intentionally opened to flood agricultural fields adjacent to the channel, adding silt and organic matter and improving soil properties. Coincidentally, CLP-1 and CLP-2 are the two sections closer

[4] Tierras, vol 2770, exp. 3, fc. 138 and 164, catalogue numbers: 2090 and 2100 (Centro de Información 1979).

to the channel, so that a similar practice in the past here is probable.

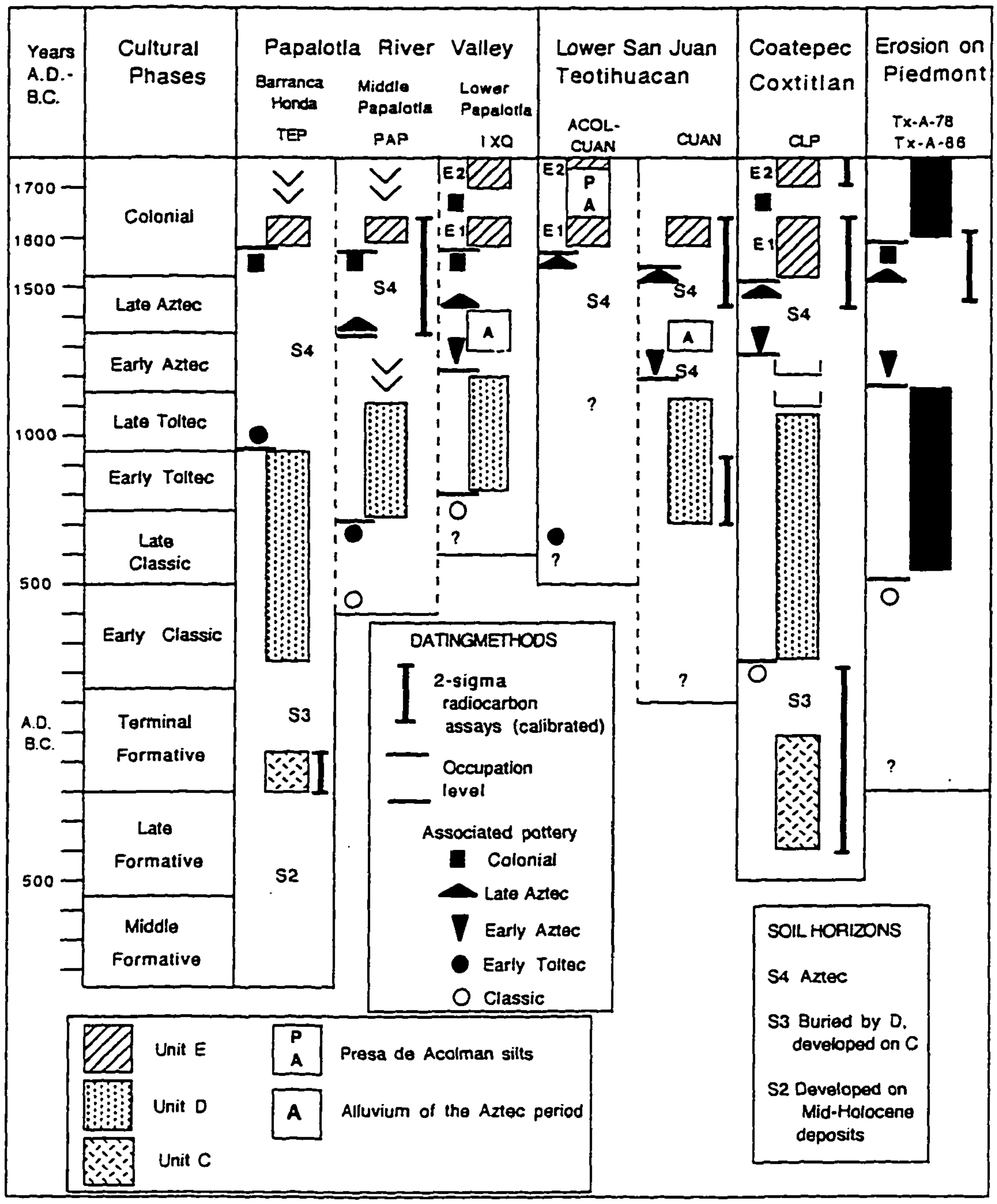
Alluvial chronology and fluvial response to environmental change

Phases of aggradation and dating problems

The general picture of the late Holocene alluvial stratigraphy of the Texcocan rivers permits a correlation across the different river basins of the major alluvial events and their relation to the cultural phases, attested by the occupation levels associated with each alluvial unit (Fig. 6.30). The correlation of some events from basin to basin is clear, although there are considerable differences. Butzer (1980) recognizes this problem of lack of correlation between basins even when they are contiguous, because of the ever present differences in bedrock, terrain type, ecozone, and even prehistoric and historic cultural differences. Waters (1992) showed an example of such differences in contiguous arroyo basins in which cultural development was similar.

The major alluvial events of deposition, usually recorded as flood deposits, are equivalent to the units defined in this study, which group several events that occurred in a relatively short period of time. Unit C, deposited in the Terminal Formative phase, coincides with

Figure 6.30 Late Holocene alluvial sequences, radiocarbon ages and associated ceramics.


Years A.D.-B.C.
Cultural Phases
Papalotla River Valley
Barranca Honda
TEP
Middle Papalotla
PAP
Lower Papalotla
IXQ
Lower San Juan Teotihuacan
ACOL-CUAN
CUAN
Coatepec Coxtitlan
CLP
Erosion on Piedmont
Tx-A-78
Tx-A-86
1700
1600
1500
1000
500
A.D.
B.C.
500
Colonial
Late Aztec
Early Aztec
Late Toltec
Early Toltec
Late Classic
Early Classic
Terminal Formative
Late Formative
Middle Formative
E2
E1
P
A
S4
S3
S2
?
DATINGMETHODS
2-sigma radiocarbon assays (calibrated)
Occupation level
Associated pottery
Colonial
Late Aztec
Early Aztec
Early Toltec
Classic
Unit E
Unit D
Unit C
Presa de Acolman silts
Alluvium of the Aztec period
SOIL HORIZONS
S4 Aztec
S3 Buried by D, developed on C
S2 Developed on Mid-Holocene deposits

the expansion of rural settlement on the piedmont and hill summits (hill-top centers), a process that had an impact on the mobilization and movement of soils and sediments into the alluvial plains. The chronological placement of unit C in the Terminal Formative is supported by two radiocarbon assays and by artifacts from associated occupation surfaces. Unfortunately, this unit was not positively identified in the lower San Juan and lower Papalotla floodplains because the exposures did not reach those levels deeper than Unit D.

A much broader time range is indicated by Unit D; although the top and bottom limits were dated, the different subunits were not dated due to budget constraints. Therefore, the unit has been assigned an age that spans a period of almost 600 years from the Late Classic to at least the end of the Late Toltec. Unfortunately, there is not much archaeological material to date in the unit, which is not surprising since it is known that these periods were characterized by low levels of population. However, drawing on the data recovered in the piedmont (Chapter 5) and on an estimation of the amount of material found in the alluvial deposits, I consider that most of the flooding occurred in the transition of the Classic to the Early Toltec, or the so-called Epiclassic (approximately A.D. 700-900). It is evident by the few examples shown in this chapter that the Coyotlatelco pottery not only caps this unit, but is also embedded in it, as shown in the cases of sections CUAN-4, IXQ-1, IXQ-2 and IXQ-3, and to some extent in sections TEP-1 and TEP-3.

The Aztec alluvium is concentrated in few sections and most of the time appears as riverbank deposits (CUAN-4 and PAP-4), or as a flood deposits of dubious age (IXQ-2 and IXQ-3). The only clear case of flooding during this time was the case of the Texcoco river (Chapter 5), although it was evident that the river was controlled shortly afterwards. It can be postulated that by the Early Aztec period the crisis of the Epiclassic had already settled and the system reached an equilibrium, so that floods were not common. The fact that the Texcocan rivers started to be controlled during this period (Ixtilxochitl 1975, 1977) is an explanation for the meager and localized cases of flooding, if any, in Late Aztec times, even though the population was growing. The Mercedes documents give reference to Aztec canals and irrigation ditches, especially the Canal de Xalapango[5]. The numerous descriptions in these documents and the maps of Uppsala (Linne 1948) suggest that this was likely the canal that carried water to Nezahualcoyotl's bald cypress forest,

[5] See Appendix A, section I, numbers 84, 87, 102, 103, 104 and 106 ; and section II.2, number 7.

which is located on the lakeshore. Also, the descriptions suggest that the Canal de Xalapango was a more complex irrigation network that also was fed by waters diverted from the Papalotla. Elsewhere in the Basin of Mexico, other rivers were also controlled and diverted such as the case of the Cuautitlan river in the northeast plain of the Basin (Doolittle 1990). However, more stratigraphic work in the rivers of the Basin is needed to confirm the hypothesis of Aztec river control.

Unit E is the best of all units in terms of chronological definition. Besides covering occupation surfaces with Late Aztec and Early Colonial sherds, three radiocarbon dates from three different basins show an amazing coincidence: 355±30 B.P.(OS-3477) in the lower San Juan, 350±30 B.P.(OS-3482) in the middle Papalotla, and 365±55 B.P.(OS-3483) in the lower Coatepec. The correlation goes beyond the floodplains to the upper piedmont where a ^{14}C age of 390±50 B.P. (OS-2755) was obtained from a soil formed on top of a pedestal containing Aztec IV pottery. Because this pedestal was an erosional remnant used as a benchmark to determine the maximum age for the initiation of soil stripping and incision on the piedmont in Early Colonial times, it is not a coincidence that erosion in the piedmont correlates with the general process of rapid alluviation in the plains.

The Early Colonial floods have been considered as subunit E_1, comprising an interval that roughly goes from 1520 to 1630 and including the two periods of intense rains: the mid-1500s floods and the catastrophic floods between 1604 and 1629 documented by Boyer-Everett (1973).

The particular case of the Acolman silts is worthy of mention, because it has been considered as a subunit of E, although there are differences in accumulation rates and sedimentological characteristics. Subunit E_2 represents a series of floods in the 17th century that apparently occurred in all the basins; there is no reliability to the radiocarbon dates of this subunit since they show several periods when calibrated (OS-3476, see Table 6.1). It is important to stress that the thickening of the Late Colonial deposits (E_2) may have been influenced by human control of the floodplains, either by establishing protective/irrigation dams, such as along the lower Papalotla, or by the case of silt accumulation caused by intentional breaching of the levees to spill water on the fields, as is the case of the Chicoloapan sections in the lower Coatepec, especially section CLP-1 (zones I to III). Regardless of this human manipulation, the deposits of Colonial period, especially the Early Colonial floods show an incredible amount of sediments was produced in the piedmonts and carried into the plains. The abandonment of terraced fields on the piedmont and hills, and to some extent the changes in land use during the Early Colonial period including the introduction of the plow and of cattle and sheep were factors involved in the production of sediments in unit E_1.

Finally, concerning the possible designation of allostratigraphic units in the alluvial deposits of the Texcoco region, I can only propose that Unit A can qualify as a single alloformation as long as it is dated. Units C, D and E together could form another alloformation, since they have a wide and well defined distribution and dates. Unit B seems to represent a local event, although this is difficult to determine since most of the brickyards studied did not expose early and middle Holocene deposits. If it was to be identified in a general area, Unit B would be a single alloformation. However, until more descriptions and data are obtained in the area it will be possible to apply the stratigraphic principles established by NACOSN (1983) for the designation of allostratigraphic units.

Other fluvial processes in the record

As shown in Figure 6.30, the formation of braided streams, channel incision, and channel avulsion are fluvial processes evident in the alluvial record of some of these rivers.

Braided channels

This type of channel is exemplified by some deposits in the Barranca Honda and middle Papalotla and in the Coatepec and Arroyo Coxtitlán basins. They appear at different periods in the three basins, although their association with unit A seems to indicate that they tend to be more common in the Early Holocene, probably when there were abundant coarser materials in the channels due to the deposition of pyroclastic flows. In one case, there is a braided channel recorded from more recent times, formed after the deposition of unit D in the Coatepec river, which seems to be a result of an adjustment to the new topographic conditions of the terrain after the flood.

No conclusive statements can be made in relation to the stimuli that resulted in the formation of braided channels because of the small number of examples. That there are no braided channels in other sections does not preclude the possibility that these deposits exist below the base of the exposures in the brickyards. Channels, unlike flood deposits, are more difficult to trace and correlate since their distribution is more limited. In contrast, flood deposits show a more even distribution, at least within the area of a brickyard or along the cutbanks of an incised channel.

Stream incision

As shown by the diagram of Figure 6.30, most cases of incision occurred in the upper reaches of alluvial plains, next to the boundary of the lower piedmont. Incision occurred on the piedmont and in those areas of the alluvial plain in contact with the piedmont, where an abrupt change in gradient creates conditions for entrenchment. This situation indicates that stream incision could have been due to several factors (*i.e.* base level change, lithologic factors, human control, etc.) in isolation and combination, and is difficult to evaluate given the complex response of the stream (Schumm 1977).

Within the limits of the stratigraphic record of this study, the only cases of incised channels occurred in the middle Papalotla (PAP sections) and the Barranca Honda (TEP sections) in which accelerated sedimentation depends directly on erosion of slopes and gullying on the piedmont, which seem to be the main factors favoring stream downcutting in the valley bottoms. How does this process work?

The link between soil erosion and gullying in the watershed and incision in valley bottoms has been discussed by Schumm *et al.* (1984), who observed that during a major flood event unstable valleys will trench. The process incorporates the concept of a 'geomorphic threshold'; when a threshold is exceeded by influence of certain variables inherent to the channel itself or by external variable changes, the system will respond with changes such as stream incision. In the case of the Texcocan rivers, the scenario would be: a reduction of vegetation and soil cover decreased the rate of infiltration due to the low permeability of the tepetate, increasing runoff that exceeded the velocity threshold and consequently eroded sediments of the floodplain during large floods. For this reason, in the case of the Barranca Honda and middle Papalotla floodplains, the periods of accelerated accumulation have always been followed by trenching. For example, the formation of T1 terrace in the middle Papalotla sections is the benchmark of incision occurred after the deposition of Unit D, in the same way that terrace T2 accounts for incision after the deposition of Unit E. In the Barranca Honda there is a similar situation, except that in the exposures there were no traces of incision after deposition of Unit D, although trenching may have occurred elsewhere in the valley, because the channel may have migrated by avulsion.

A lowering in water table, as a possible cause of incision, as in the case of some arid areas of the American Southwest (Butzer, 1976; Cooke and Reeves, 1976), is difficult to prove in the cases of incision of the

Texcocan floodplains because there is no data, physical or historical, to evaluate the process. Physical evidence of water table fluctuations includes hydromorphic characteristics in soils, like gleyzation and mottled surfaces, and the evidence of the growth of phreatophytes, which only occur in the lower reaches of the rivers near the lakeshore. Therefore, the scenario of rapid pulses of sedimentation followed by elevated discharges seems to be more evident in the Texcocan basins given the known process of soil stripping and gullying on the piedmonts.

Channel avulsion

Avulsion is the lateral migration of a channel and is the most common response of streams on the plain to changes following an aggradational event, especially in areas of low gradient and small channel radius. Avulsion occurred in the lower Papalotla until it was corrected in the early 1800s. The lower Papalotla at present flows in an artificial channel to the north of its northern path; the numerous descriptions and maps show that the river used to flow along one of the southern paths. However, these changes sometimes occurred as a result of human control, since waters were always re-distributed in the basin, or caused by changes in the landscape created by humans. Avulsion also seems to have occurred during the catastrophic event of the Early Colonial floods in Tepetlaoztoc, but the original channel was subsequently reoccupied. The case of the Texcoco river, presented in Chapter 5, also shows a case of avulsion during a catastrophic flood, when the river went out of its channel and formed an alluvial fan, just east of the Aztec town of Texcoco.

As a matter of conclusion: Human vs. climatic causes in fluvial response

The time span considered in these alluvial sequences covers a period from the mid-Holocene to present times, and has better resolution for the last three thousand years, during which the landscape saw perturbations caused by agricultural intensification and disturbance of mechanisms of the ecosystem. For this reason, it seems obvious that the fluvial systems responded more to human than to climatic factors.

Volcanic eruptions are one of the geologic factors that provoke rapid ecological crisis, in which there is a fast production of sediments because of the removal of pyroclasts by the eruption itself or by the elimination of vegetation. This was the case in mid-Holocene times in the record, when the last eruption occurred in the area, attested by the PGF in the Barranca Honda sections. In conclusion, volcanic eruptions and human presence are two factors that create a great deal of noise and obscure the real effects of climatic fluctuations. Unfortunately this is the case of the Basin of Mexico in the late Quaternary, and although volcanic influence decreases through the Early Holocene, human presence increases rapidly after the middle Holocene. Because of this problem, alluvial records in the Basin of Mexico should not be used to study long-term climatic fluctuations, but to evaluate the human impact on the landscape.

The role of extreme climatic events in shaping the landscape is a topic that geomorphologists are investigating especially in explaining the effects of land-use in archaeological interpretations (Bell 1982). In the alluvial record of the study region flood deposits and channel processes such as incision and avulsion have occurred under extreme climatic events following periods of disturbance or profound changes in land-use and settlement patterns. Therefore, if climatic influences on the shaping of the landscape are to be studied the emphasis has to be put on short-term fluctuations and extreme climatic events such as short periods of abundant rains and storms that produce such volumes of water in the basins that exceed the capacity of the streams and cause catastrophic flooding.

The case of Unit E confirms the occurrence of flooding in conjunction with extreme climatic destabilizing land-use changes. This connection is possible thanks to the historical data available, which is not the case of the previous units. However, similar events may have acted to rupture of the equilibrium and resulted in floods. I believe that the removal of sediments that came to form the previous alluvial units (C and D) is the result of similar climatic events acting upon susceptible areas created by human disturbance. It is not clear whether these disturbances arose from agricultural intensification, forest clearance or even abandonment.

The topic of the action of climatic changes vs. human impact on the landscape will be discussed in Chapter 9 in the light of more data presented in the subsequent chapters.

CHAPTER 7

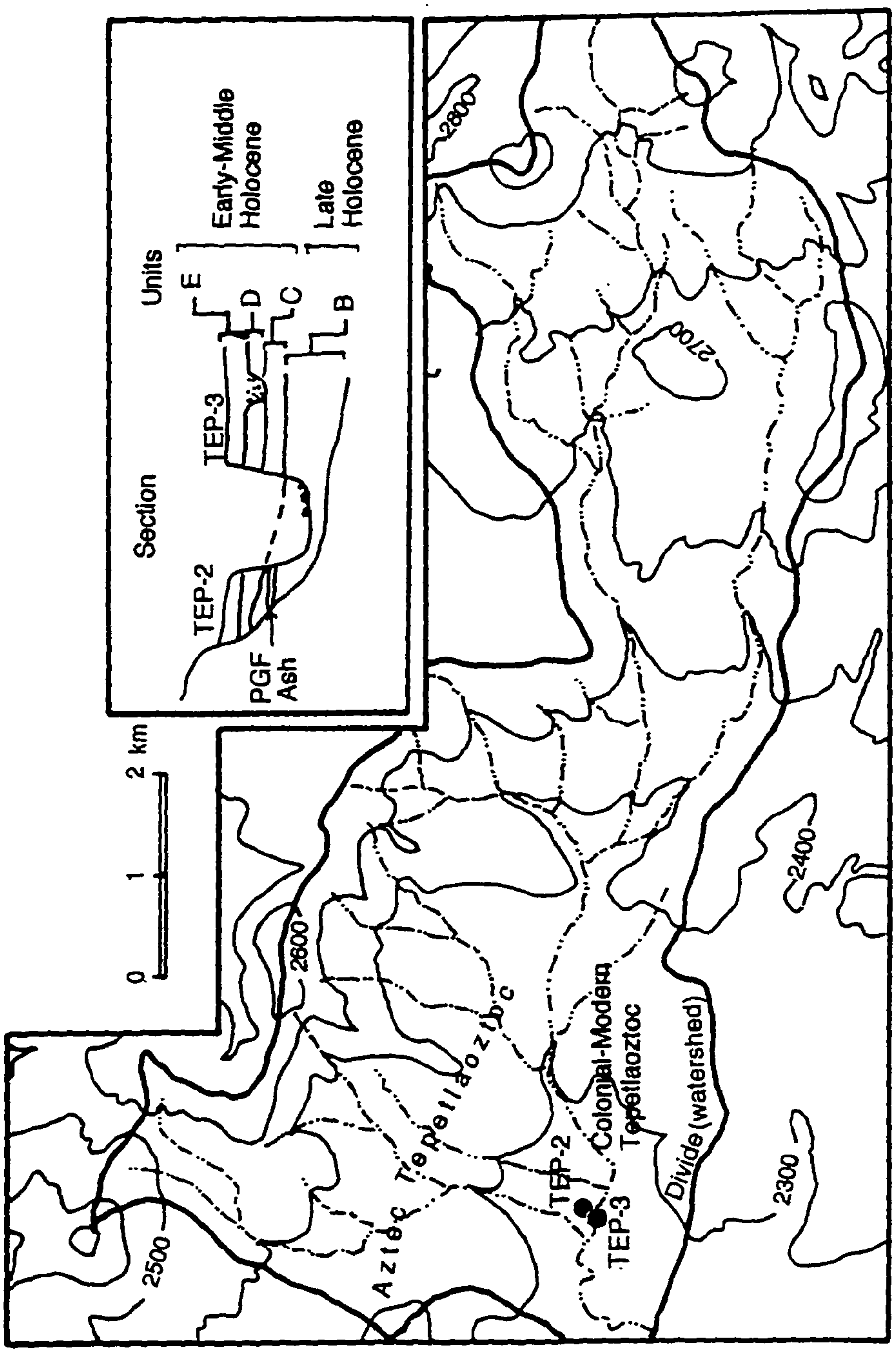
HOLOCENE ENVIRONMENTAL HISTORY OF A FLUVIAL BASIN THROUGH POLLEN SPECTRA

Research objectives for the study of alluvial pollen

The limited goal of this chapter is to present a number of pollen spectra from one complex alluvial sequence as a tentative impression of Holocene vegetation change in relation to settlement in a small river catchment. These palynological data represent only an ancillary part of the research project.

The stratigraphic section selected for this pollen study combines sediments and ages from sections TEP-1, TEP-2 and TEP-3, the three best dated sequences located in the Barranca Honda, near Tepetlaoztoc (Figure 7.1). The Barranca Honda river basin, a tributary of the Papalotla river, has an area of 45.9 km^2 and covers extensive areas of the upper piedmont and hills. The basin has an interesting history of settlement that, as discussed in previous chapters, had an impact on alluviation. The three phases with considerable numbers of sites are the Terminal Formative, the Early Toltec and the Late Aztec (Figure 7.2). This preliminary study contributes to understanding some of the linkages between vegetation change, erosional

Figure 7.1 The Barranca Honda River Basin and the location of the pollen diagram section (TEP-2-3).


Section
TEP-2
TEP-3
PGF
Ash
Units
E
D
C
B
Early-Middle
Holocene
Late
Holocene
0
1
2 km
2800
2700
2600
2500
2400
2300
Aztec Tepetlaoztoc
Colonial-Modern
Tepetlaoztoc
TEP-2
TEP-3
Divide (watershed)

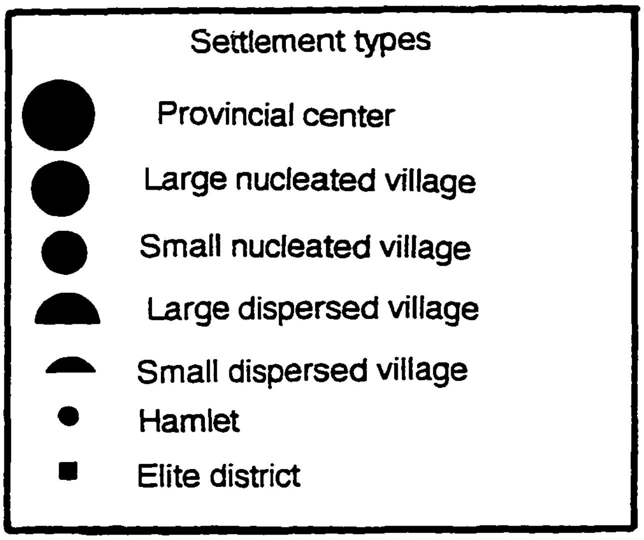
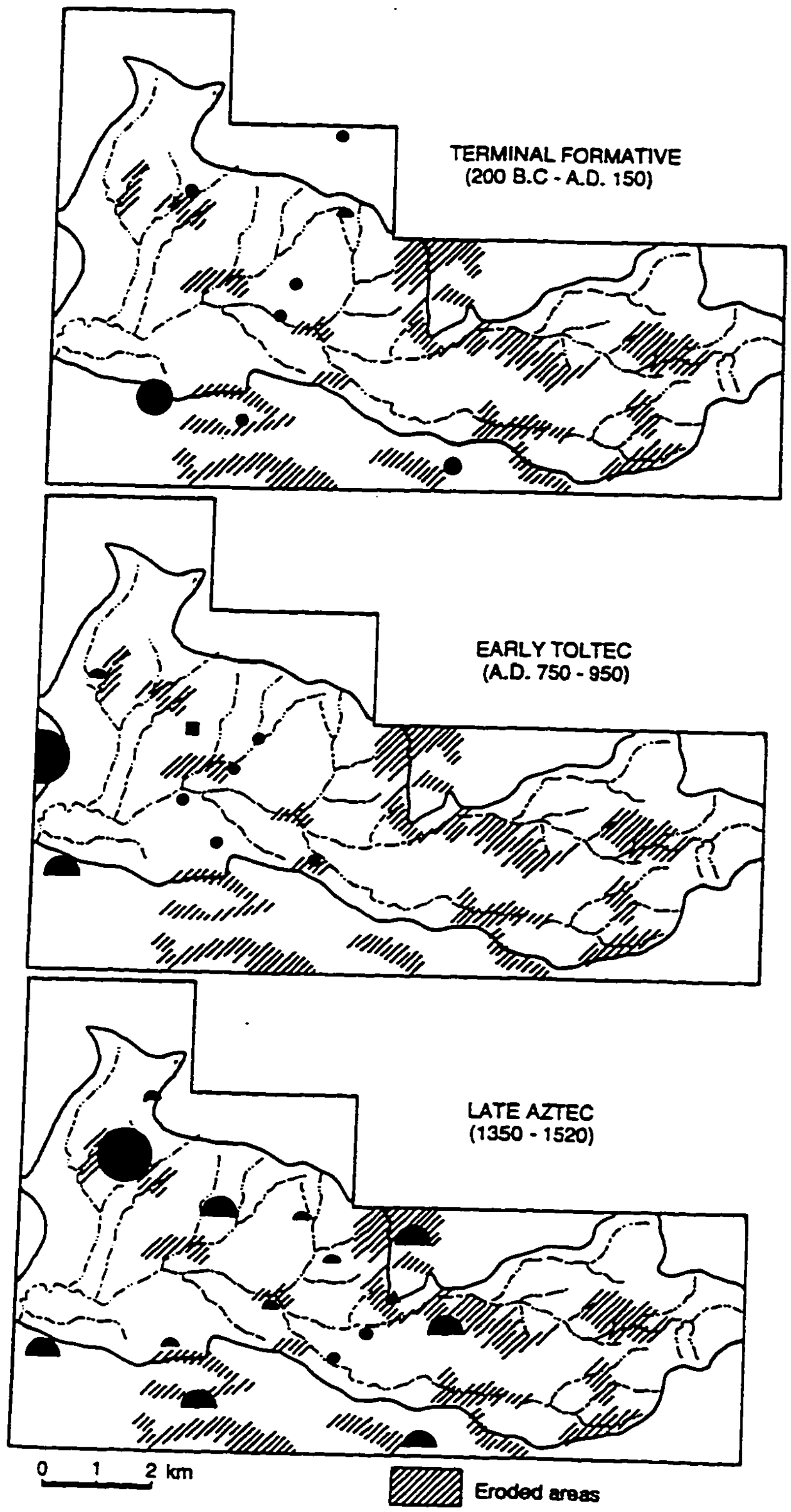


Figure 7.2 Distribution of archaeological sites at the 3 best represented phases in the Papalotla basin and adjacent areas.


TERMINAL FORMATIVE
(200 B.C - A.D. 150)
EARLY TOLTEC
(A.D. 750 - 950)
LATE AZTEC
(1350 - 1520)
0 1 2 km
Eroded areas

intervals, and phases of alluvial aggradation. It also may provide some insight in regard to how the original vegetation of the piedmont was modified by farmers since the Formative period, one of the main concerns in the literature on pre-Hispanic agriculture (Sanders *et al.* 1979; Rojas-Rabiela 1988).

Several studies, such as González-Quintero and Sánchez-Martínez (1980), González-Quintero (1986), García (1989), Lozano-García and Ortega-Guerrero (1994) utilized pollen from lacustrine deposits that inadequately represent local vegetation change beyond the lakeshores. The exploratory study discussed here examines a sequence of pollen deposited in alluvium in a small catchment area. The spectra obtained appear to be sensitive to local vegetation change, to suggest that more comprehensive palynological studies can be usefully applied to elucidate specific depositional environments. Studies on alluvial pollen in central Mexico have not been attempted, because the potential that alluvial pollen presents has been underestimated due to low pollen grain concentration and poor preservation. A few traditional palynological studies in the Basin of Mexico, such as that of Bopp-Oeste (1961) --at a location near Chicoloapan in the floodplain of the Coatepec river, Kovar (1970) --at El Tular alluvial plain of the Middle San Juan Teotihuacan river, and McClung *et* *al.*(1993)-- within the Teotihuacan Valley, showed that interesting pollen assemblages can be found in alluvial sediments. However, these studies fail to acknowledge the implications of the alluvial sedimentary matrix in the pollen spectra.

The pollen spectra of this study consists of eight samples from sections TEP-2 and TEP-3 combined, spanning a period from about 6 ka to the 17th century A.D. incision of the floodplain (Figure 7.3). Samples 1, 2, 3, 4, 7, and 8 come from flood deposits that have been slightly modified by pedogenesis, sample 6 comes from an A horizon, and sample 4 from a mud flow. Sample 2 is the only one that does not come from section TEP-2, since Unit D is only a few centimeters thick and has no pedogenically undisturbed sample in TEP-2, so that a stratigraphic equivalent was taken from the TEP-3 section.[6] The selection of flood deposits reflects testing of different sedimentary facies that suggested these had the highest pollen concentration. This is maybe because, during floods, palynomorphs accumulate with suspended sediment during the final phases of a flood. Further, while such fine-grained sediments dry out over a period of a few days, the wet mud will trap more pollen grains (Horowitz, 1992: 103).

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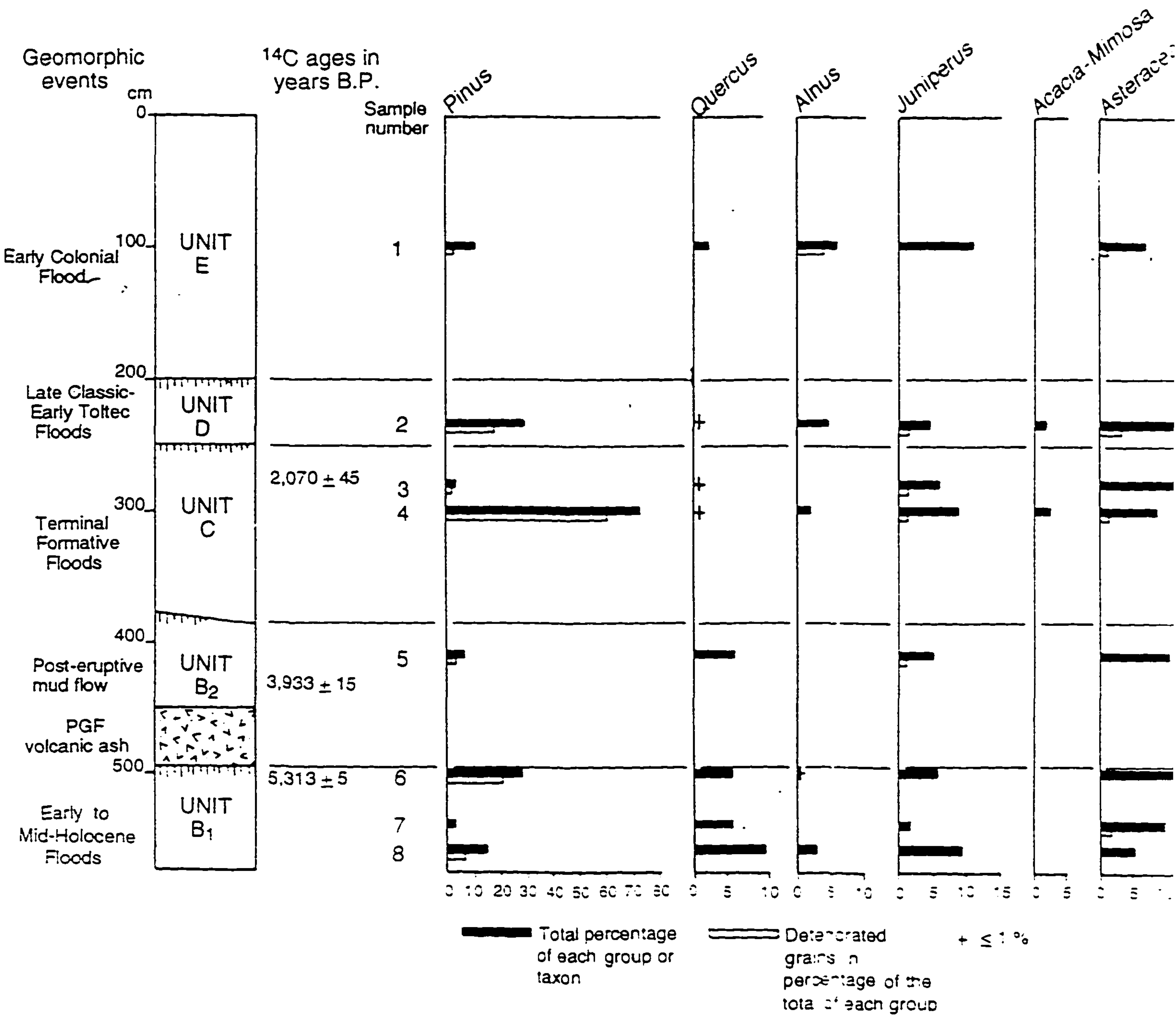
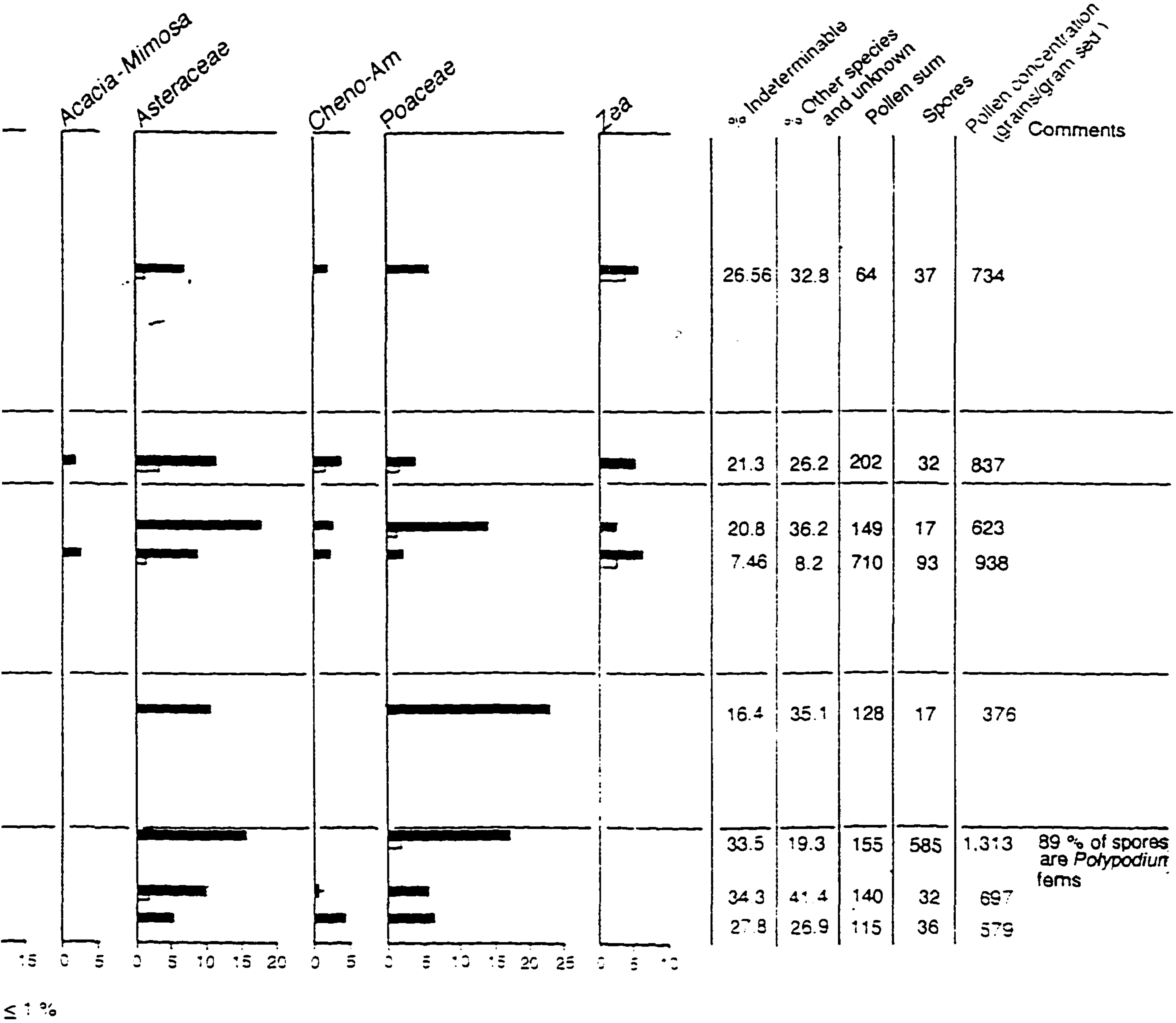
[6] For the details on alluvial facies and soil horizons of these sections refer to Chapter 6 (Barranca Honda Sections), and for the granulometric data and other sample properties to Appendix F.

Figure 7.3 Pollen spectra from sections TEP-2 and TEP-3 at the Barranca Honda near Tepetlaoztoc.



Geomorphic events
cm
14C ages in years B.P.
Sample number
Pinus
Quercus
Alnus
Juniperus
Acacia-Mimosa
Early Colonial Flood
UNIT E
Late Classic-Early Toltec Floods
UNIT D
2,070 ± 45
Terminal Formative Floods
UNIT C
Post-eruptive mud flow
UNIT B2
3,933 ± 15
PGF volcanic ash
5,313 ± 5
Early to Mid-Holocene Floods
UNIT B1
Total percentage of each group or taxon


Acacia-Mimosa
Asteraceae
Cheno-Am
Poaceae
Zea
% Indeterminable
% Other species and unknown
Pollen sum
Spores
Pollen concentration (grains/gram sed.)
Comments
26.56 32.8 64 37 734
21.3 26.2 202 32 837
20.8 36.2 149 17 623
7.46 8.2 710 93 938
16.4 35.1 128 17 376
33.5 19.3 155 585 1,313 89 % of spores are Polypodium ferns
34.3 41.4 140 32 697
27.8 26.9 115 36 579
0 5
0 5 10 15 20
0 5
0 5 10 15 20 25
0 5 10
≤ 1 %

Three radiocarbon assays were used to control age. Two come from TEP-1, from two correlated deposits, and another from TEP-3, all of which are included in the pollen diagram. A volcanic ash marker and ceramics on occupation surfaces complete chronological control of the section. The eight pollen samples were obtained from four units corresponding to four Holocene alluvial cycles. Four are from units B_1 and B_2 (Mid-Holocene), one from C (Terminal Formative), two from D (Classic-Early Toltec), and one in E (Early Colonial) (see Chapter 6, Figures 6.8 and 6.3)

The interpretation of alluvial pollen spectra raises issues regarding the sedimentology of palynomorphs. The formation of pollen assemblages in fluvial environments depends on several factors such as selection, transportation, and deposition of pollen that in turn considerably affect some of the characteristic of pollen spectra in alluvial environments (Solomon *et al.* 1982; Fall 1987; Hall 1989; Scaife and Burrin 1992). In this chapter I include an introductory, brief discussion of the main aspects of alluvial pollen interpretation, followed by a reformulating of a working hypothesis dealing with the reconstruction of vegetation. Next is a brief discussion of pollen sedimentology and pollen taphonomy that are related to the particular aspects of the data recovered through this research, and lastly the presentation of the data and suggestions.

An approach to the reconstruction of vegetation communities through the study of alluvial pollen

The summarized interpretation of the different aspects of alluvial pollen and the different views presented above indicate that the large number of factors involved in pollen production, transportation, deposition, and preservation in alluvial environments pose a delicate problem. Since this study was done with only 8 samples, a small population, it is difficult to support a strong argument about modes of selection, transport and sources of pollen grains in the environment. For the moment, the interpretation relies on the conclusion of Hall (1984), that pollen assemblages in alluvium represent a mixture of communities of an entire watershed. That means that a large number of taxa reflect not only the floodplain taxa but also adjacent and distant slopes, and therefore represent a large number of plant communities. For this reason, the present research was selective with regard to certain taxa, especially those more indicative of environmental change within the upper piedmont and hills. Consequently, a large number of taxa were excluded from the diagram, especially the ones that correspond to riparian vegetation. However, the different sedimentological and taphonomical variables of each sample are discussed in the next section as a way to start building up reference data for future studies of a similar kind in this region.

Pollen assemblages in alluvial deposits have been increasingly used to reconstruct paleovegetation and paleoclimates since the pioneer work of Sears (1937), Martin (1963), Mehringer *et al.* (1967), and Hall (1977). Only quite recently have new studies begun to test the viability of alluvial pollen for vegetation reconstruction, which differs from traditional methods used on pollen assemblages from bogs and lakes. The difficult questions of interpretation addressed by Hall (1977) have been further discussed by Solomon *et al.*(1982), Fall (1987), and Hall (1989). The two most common approaches to the interpretation of alluvial pollen are the 'taphonomy of grains' and 'pollen sedimentology.' In both, the basic questions about pollen selection and transportation are: (1) To what degree do stream-transported and air-transported grains contribute to the pollen spectra?; (2) To what extent do pollen assemblages reflect slope and floodplain vegetation?; (3) What are the sources of pollen grains within the basin?; and (4) How are these variables interpreted in the context of differential preservation?

Hypotheses for alluvial pollen research

The eight plant communities in the fluvial basin studied (Figure 7.4) are a subdivision of the communities described in Chapter 2. Although most of them are secondary and successional as the result of continuous human transformation (Rzedowsky 1975), it has been necessary to consider their distribution in the basin as a variable for the interpretation of fossil pollen spectra, since there are no modern analogues of either pollen embedded in modern flood deposits or pollen trapped from air.

I reconsider the hypothesis posed by Rzedowsky (1975), that the modern communities on the piedmonts of the Basin of Mexico are secondary vegetation, to the point that some of them, such as oak scrub, juniper forests and scrub are considered successional. If the above statement is true, then we may expect in the pollen spectra of the most recent deposits an increase of juniper and oak, parallel with an increase of cultivated plants, weeds and ruderals that in the pollen diagram are grouped as Cheno-Am (Chenopodiaceae-*Amaranthus*) and Asteraceae. In the same way, we may expect in more recent deposits an increase in species comprising the thorn scrub and pasture communities dominated by *Acacia* spp., *Mimosa* spp., and grasses, that at present cover abandoned fields and eroded areas. However,

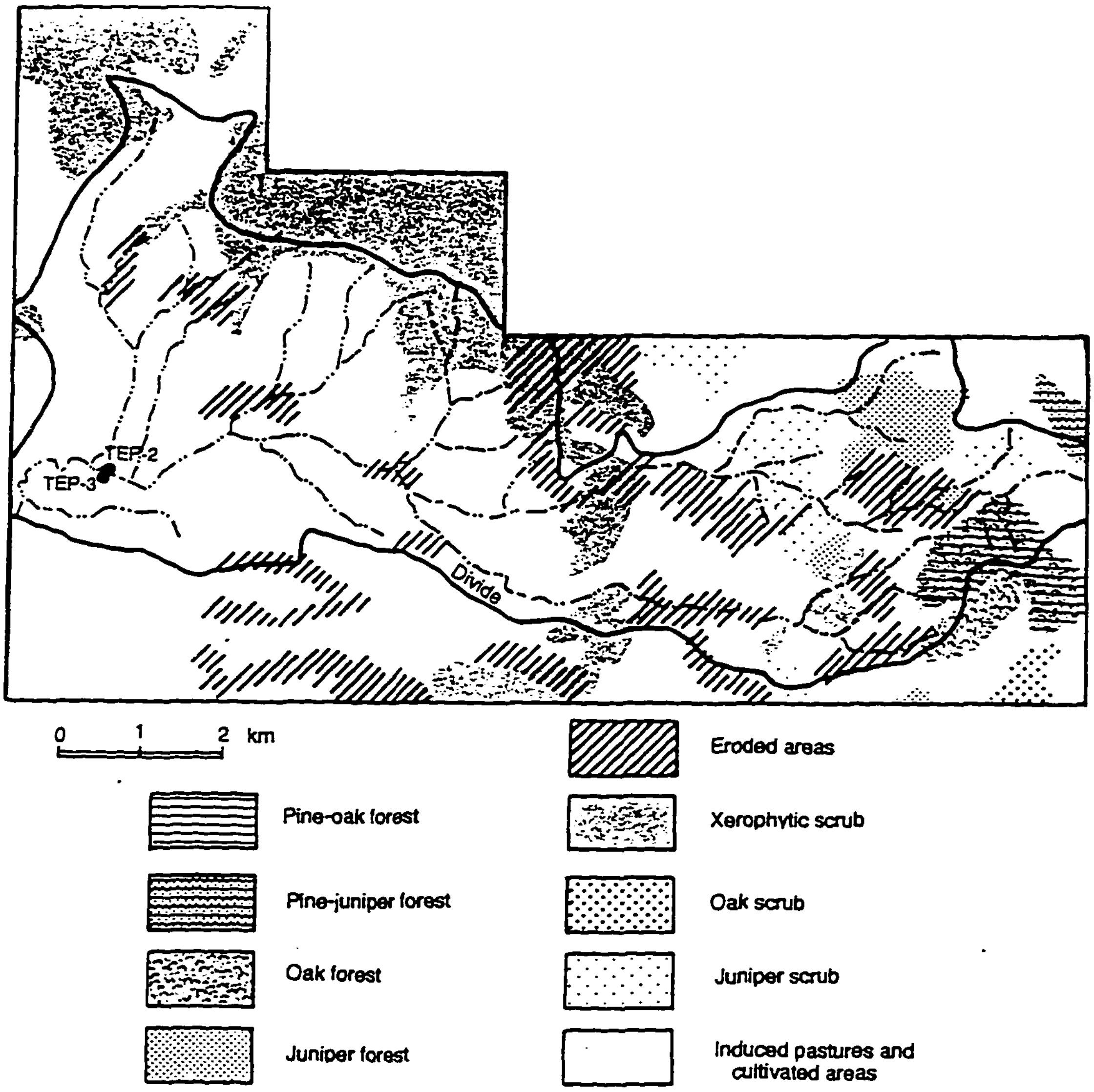


Figure 7.4 Modern vegetation in the Barranca Honda river basin and adjacent areas.

as it will be shown below, the data obtained through this study do vary slightly from the expected results, and do not support strongly the statements above in their entirety. Rzedowsky's hypothesis is re-formulated on the basis of the results obtained is given at the end of this chapter.

Particular characteristics of the pollen samples

In this section, I briefly discuss the palynological, sedimentological and taphonomical characteristics of the samples studied in order to add information to the interpretation of alluvial pollen for paleoecological reconstruction.

Pollen concentration

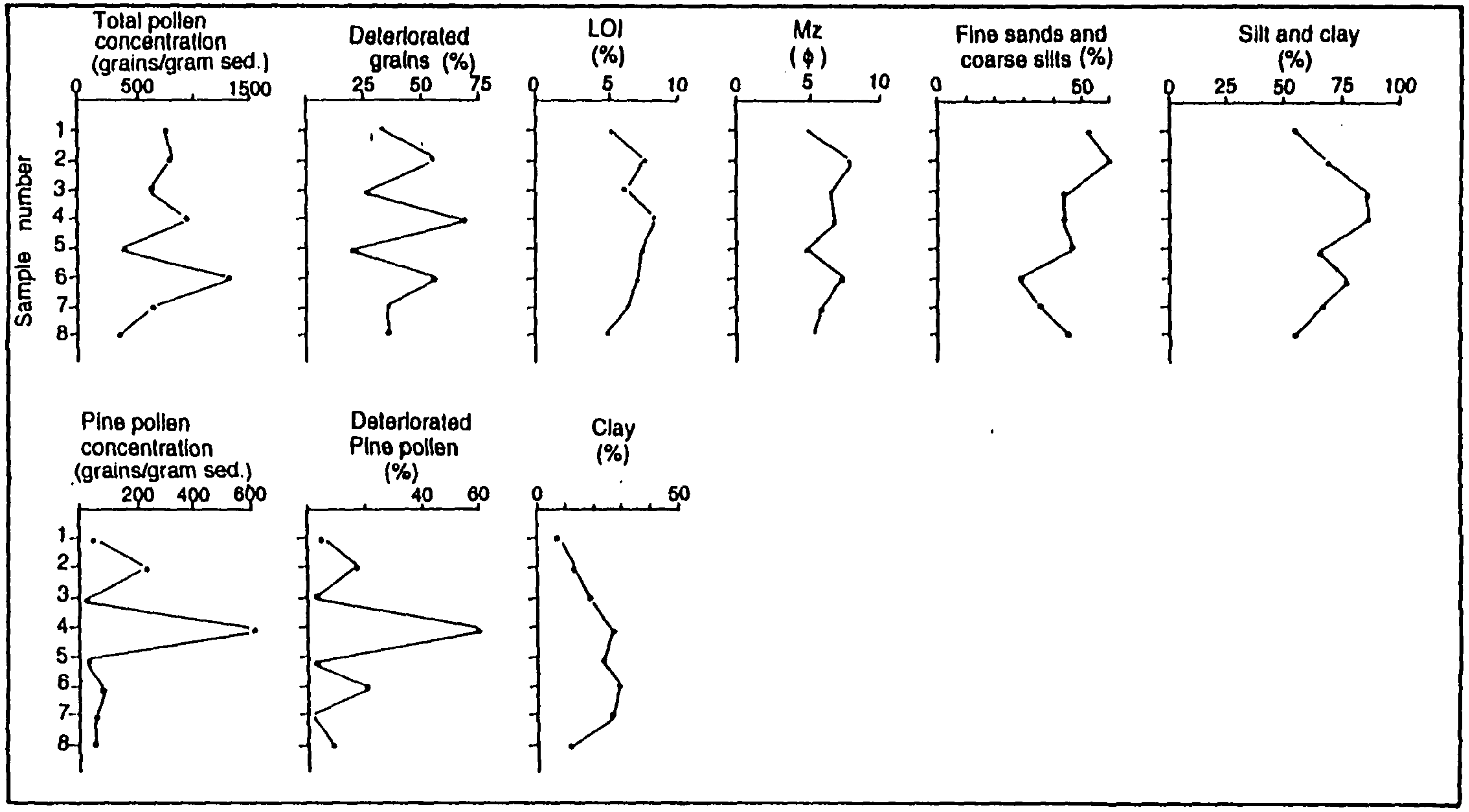
In the samples studied, pollen concentration is relatively low, which is itself not surprising since most alluvial pollen samples have low concentration (Hall 1984). Two values were calculated: total pollen concentration and pine pollen concentration. These values are useful in evaluating pollen deterioration because deteriorated pollen grains increase as pollen concentration decrease.

A third value, concentration of pollen and spore together, is considered in this analysis because it is important in evaluating the mode of transport and deposition of palynomorphs as explained in the section on sedimentary matrix. In this value, spores had to be considered since they are part of the range of sediment size that contains pollen.

In terms of these three types of grain concentrations, the data of the samples studied show that the greater the pollen concentration, the larger the percentage of deteriorated pollen (Figure 7.5). In other words, the percentage of deteriorated grains in samples of similar sedimentary facies tends to be consistent, from which I interpret to mean that over time pollen has been preserved in the sedimentary deposits, and that deterioration is pre- and syn-depositional. The same pattern is observable in pine pollen (Figure 7.5).

In general, the values in Figure 7.5 do not correlate well with each other when comparing pollen concentration and several environmental values, as we can appreciate visually in the graphs. The small number of samples makes it difficult to be confident about the relationships among the variables. Nonetheless, we still can talk about trends. For instance, the amount of organic matter tends to correlate with total pollen concentration, as well as some other sedimentological variables discussed in the next section.

Figure 7.5 Some relations between different properties of the pollen samples in terms of total pollen concentration and pine pollen concentration.


Total pollen concentration (grains/gram sed.)
0 500 1500
Deteriorated grains (%)
25 50 75
LOI (%)
0 5 10
Mz (ϕ)
0 5 10
Fine sands and coarse silts (%)
0 50
Silt and clay (%)
0 25 50 75 100
Sample number
1 2 3 4 5 6 7 8
Pine pollen concentration (grains/gram sed.)
200 400 600
Deteriorated Pine pollen (%)
40 60
Clay (%)
0 50
1 2 3 4 5 6 7 8

Sedimentary matrix

Flood deposits in the deposits studied show large percentage of silt and fine sand which is the granulometric range that corresponds to most pollen grain sizes (Folk 1980; Hall 1981). The mud flow (sample 5) yielded a very low concentration, even of pine pollen, that was fairly abundant in all other samples (Figure 7.5). The A horizon (sample 6) had a concentration above the average, but deterioration was high and pine pollen was low, arguing for the fact that the sample contains local pollen.

A fairly good correlation exists between total pollen and spore concentration and mean grain size (Mz); there is no good correlation with coarse silt and fine sand as was expected. However, pine pollen shows good correlation with the percentage of clay, a result that in other works is explained as a result of high capability of bisaccate grains for buoyancy (Fall 1987). Therefore, I would hypothesize that much of pollen is carried by air and deposited on an inundated surface after the coarse silts and sands have settled. However, testing this hypothesis because examination of more samples is required.

Pollen deterioration

The most common forms of deterioration found noted are degradation and mechanical damage, according to the classification by Delcourt and Delcourt (1980), which is partially based on Cushing (1967). Corrosion is a third class of deterioration that is also present in the samples studied, but is not common.

As grains were identified and counted, their class of degradation was determined. Theoretically, all the deteriorated grains would fall under the designation "indeterminable", but since most of the grains of selected taxa were very distinctive, it was still possible to taxonomically identify grains that were deteriorated to a certain degree. For this reason, the diagram includes an open bar indicating the percentage of deteriorated grains below the total percentage for each group of taxa (Figure 7.3). In most cases the degradation classes were combined but in the diagram only the total number of deteriorated pollen was considered; a more detailed division of percentages of deteriorated grains is presented in Appendix J.

Pollen deterioration was considered because along with the information provided by granulometry and alluvial facies, it is used as an element of pollen taphonomy to characterize the possible origins and modes of transportation of pollen grains and their post-depositional history. Thus, it is assumed that broken grains are the result of transportation and were not deposited as pollen rain on the flood sediment during and after deposition. Further, degraded and corroded grains are assumed to be the result of chemical activity in soils or within the sediments.

Selection of Taxa

Since the purpose of this study is to understand vegetation disturbance by farming communities and its association with soil erosion and alluviation, only those groups of taxa indicative of this process have been selected for pollen spectra in the diagram of Figure 7.4. In some of the groups I selected taxa of the genera (*Juniperus, Pinus, Quercus, Mimosa*), families (Poaceae and Asteraceae) and groups (Chenopodiaceae-*Amaranthus*). A large number of taxa has not been tabulated by name but rather summed as 'others and unknown', which together with the 'indeterminable' grains constitute the total pollen sum and pollen concentration.

The taxa grouped in "others" include species that were identified and reported in Appendix J, but not included in any of the groups of the diagram. Among the group of "others" there are floodplain elements such as *Taxodium, Fraxinus* and *Salix* (See Appendix J). Floodplain plants were not included because it is the purpose of this study to evaluate vegetation disturbance in the uplands.

However, *Alnus*, a tree of humid environments, was included because of its association with pine and oak in humid areas at higher elevations. *Alnus* is rarely found in floodplains at lower elevations.

The selected taxa include the *Pinus, Quercus, Juniperus, Alnus, Mimosa, Acacia* and *Zea* genera, the Poaceae and Asteraceae family, and the Chenopodiaceae-*Amaranthus* group.

Pinus pollen is abundant and a good indicator of a well defined elevation range, especially important because the source of sediments migrate upwards in elevation into the abundant cover of pine trees, as human disturbance progressed. *Quercus* has an interesting ecology because it was the main element of the forest that once covered the piedmont (Rzedowsky 1975). *Juniperus* is an important element of the interpretation because it tends to occur in disturbed areas. Despite its low concentration, the *Acacia-Mimosa* group was included because it is the main element of the thorny scrub community. The Asteraceae and Chenopodiaceae-*Amaranthus* (Cheno-Am) group was selected since they are the best indicator of disturbance especially by farming. The Poaceae group is believed to indicate natural pastures before the introduction of grazing in the area, although is not so important in the spectra studied to really be indicative of certain type of ecosystem. The presence of *Zea* is believed to indicate the beginnings of agriculture and correlate with the Asteraceae and Cheno-Am group.

None of the spores were identified, and they are not considered in the diagram. However, they were added to the comparative section dealing with concentration. Some recurrent and important spores are reported in Appendix J.

Presentation of data and discussion

The basic body of data is contained in figure 7.3, in which pollen percentages of each species are calculated on the total pollen sum excluding pine. Pine percentages were calculated on the basis of the total sum of pollen and spores, since its population was considerably large, probably because of high pollen production and differential preservation explained above. In order to shorten the diagram, others and unknown were presented in numbers at the right end of the diagram.

The total pollen sum, total pollen-spore sum, and spectra of each group are highly variable along the profile, but there are interesting trends to notice in each sedimentary unit, which in this case substitutes for the traditional "pollen zones". The main vegetation trends of the middle and late Holocene have been summarized in figures 7.6 and 7.7 and explicated below.

POLLEN	SETTLEMENT AND VEGETATION HISTORY	SOILS	ALLUVIAL DEPOSITS	AGE 14C YEARS BP
		S2. Truncated soil. A and AB horizons decapitated.		
Pine 5% Oak <1% Juniper 5% *Asteraceae* 11% Grass 23%	Volcanic eruption, ash fall, erosion and deposition of mudflow. Vegetation damaged.		Unit B1. Mudflow and channel.	--3,933±15--
			PGF ash.	
Pine 6% Oak 6% Juniper 5 % Grass 18% Fern spores 89% of spores	Pine and oaks dominate, although grasses are abundant.	S1. Late to Mid-Holocene soil. A AB, and C horizons.		--5,313±51--
Pine 2 - 11% Oak 5 - 9% Juniper 1 - 9% Grass 5%	Flood. Probably associated with volcanic activity. Oak forest predominates.		Unit B. Early to mid-Holocene flood.	

Figure 7.6 Pollen summary, and evolution of vegetation communities in the context of alluvial stratigraphy. Early to Mid-Holocene units.

Figure 7.7 Pollen summary, and evolution of vegetation communities in the context of alluvial stratigraphy, as well as settlement and land-use change. Late Holocene units.

POLLEN	SETTLEMENT AND VEGETATION HISTORY	SOILS	ALLUVIAL DEPOSITS	AGE 14C YEARS BP
	Nucleation into modern town of Tepetlaoztoc. Grazing and farming.	Present soil		
Pine 7% Oak 2% Juniper 11% *Asteraceae* 12% *Cheno-Am* 4 % Grass 6% *Zea* 6%	Abandonment of agricultural settlements and rapid erosion.		Unit E. Early Colonial Flood. Laminated silts and flood channels.	
	Increment of agricultural activities with landscape stability.	S4. Ap, A and AC horizon.		
Pine 18.6% Oak <1% Juniper 4% *Asteraceae* 12% *Cheno-Am* 4% Grass 5% *Zea* 5% *Acacia-Mimosa* 2%	Abandoned fields. Sporadic agriculture. Weeds, juniper and pine seem to be important in headwaters. Erosion on slopes.		Unit D. Classic-Early Toltec Floods. Laminated silts	
	Settlement declines and tends to nucleation.	S3. A and AC horizons		
Pine 63% Oak <1% Juniper 5-9% *Asteraceae* 8-17 % *Cheno-Am* 2% Grass 15% *Zea* 2-6%	Proliferation of agricultural settlements, reaching the limits of pine forest. Oak declines, while juniper increases. Erosion on agricultural soils.		Unit C. Terminal Formative Flood. Laminated silts.	--2,070±45--

UNIT B1 (pre-eruption flood deposits)

The distribution of percentages of each taxa in the two lowest samples (7 and 8), which represent the late to mid-Holocene, suggests that oak and juniper were the dominant elements in the landscape of most of the upper piedmont and part of the lower. The pine percentages in these two samples were low probably because in mid-Holocene times the eroded areas did not extend into the mountains. It is probable that disturbance at this moment was due to volcanic activity in the Tlaloc or Telapon, although the possibility of a dry and warm climate should not be discarded.

UNIT B1 (A horizon)

Sample 6 from the soil underlying the ash presents a mixture of transported pollen by flood and the influx of local vegetation. Pine pollen in this sample is generally affected by degradation, which may be the result of pedogenic activity on windblown and water transported grains. Other than pine, there are basically no deteriorated grains, and no evidence that grains were affected by the heat of the ash.

UNIT B2 (mud flow)

The mud flow that followed the deposition of the white PGF ash has low concentration of grains probably because of its poor sediment sorting (sample 5). It may be that the low content of pine, oak, and the lack of alder, constitutes a clue to locate the source of these mud flow sediments. Deterioration is not a general factor because it only occurs in juniper pollen grains, and the amount of indeterminable grains is relatively low.

Unit C

This is the unit that is contemporaneous with the population growth of the Terminal Formative. It may be associated with deforestation, farming and subsequent abandonment at the end of these period. The two samples of this unit (3 and 4) are separated by a very weak A horizon, demarcating two sub-phases of deposition. Sample 4 comes from the initial alluviation phase and has the largest concentration of pine pollen in the whole section. Approximately 85 percent of pine pollen grains show both degradation and mechanical deterioration. It is possible that this indicates transport of pine pollen from the lower limits of the forest, at the time when the uplands were open because of more intensive farming. The relatively high percentage of juniper and Asteraceae-type plants are indicative of the processes of disturbance. Most of *Zea* pollen grains are degraded and broken, but its presence does not suggest disturbance in the uplands since its size does not allow for far-flung transportation. Sample 3 shows a totally different spectrum, probably because it comes from a level slightly affected by pedogenesis, and comes from a sediment whose source was nearby. Pollen grains in this sample show a low percentage of deterioration, which besides indicating that pedogenesis did not affect the grains substantially, suggests transportation from a short distance in the lower piedmont since the percentage of pine pollen is the lowest in the entire section. Instead, juniper and Asteraceae are abundant, which further suggests that the source is in fact in the lower areas where continuous disturbance was occurring. There is also an increase in Poaceae, which may represent grasses covering fallow fields and eroded areas. Starting in this unit, oak decreases to essentially disappear without later recovery. This is probably the result of extensive clearance of the oak forest, the presumed original vegetation community of the piedmont, and replacement by a mixture of juniper, thorny shrubs, grasses, weeds and large tracts of eroded tepetate.

UNIT D

This unit corresponds to those floods in the Late Classic and Early Toltec, including the transitional 'Epiclassic' period. Once again erosion reaches higher levels in the upper piedmont, hills and probably mountains, since deteriorated pine pollen is prominent in sample 7. Whether this phase of erosion is due to abandonment is not clear. Probably the relatively high percentage of Asteraceae accounts for it, as the appearance of thorny scrubs of *Acacia* and *Mimosa* suggests. *Zea* pollen is well preserved but may again come from a nearby source.

UNIT E

This deposit represents the last pulse of flood accumulation occurred in Early Colonial times and is represented by sample 8. Pollen concentration diminishes notably, and is accompanied by relatively low LOI value and a light color. It is probable that although the sediment and pollen come from soil in the piedmont, such soils did not contain much pollen, especially pollen of pine and oak which were plant communities that at that moment might have been restricted to the mountains, as they are today. These values suggest that the source of Early Colonial sediment is the thin soils and barren tepetate surfaces of the upper piedmont. The scarcity of pollen in this unit is evident at different depths within the entire sedimentary unit. As a matter of fact, one of the samples from this unit, taken at a different depth, was discarded because it contained practically no pollen. The percentage of pine is low and juniper is relatively high, which argues for a source of sediment in the upper piedmont. Although Asteraceae and Cheno-Am have relatively low percentages, deteriorated pollen grains make up two thirds of the sample.

Suggestions

The pollen spectra studied here suggest a transition from a piedmont dominated by arboreal species such as oak and juniper, to a more open vegetation of non-arboreal elements. As for pine, it seems that its presence in the diagram shows erosion at the edge of the mountain forest. Rzedowsky's hypothesis of a piedmont dominated by oak is supported by this data set since the percentage of oak pollen clearly declines with time. The data, on the other hand, do not support the hypothesis that juniper becomes more widespread on the piedmont with disturbance. On the contrary, Juniper seems to be very stable through time. Therefore, the presence of juniper does not seem to be associated with human impact, but rather with its ability to thrive under any local condition.

As for the use of alluvial pollen for vegetation reconstruction, this study can reach no definite conclusions, because of both the limited number of samples studied and the problems posed by low pollen concentration values. For this reason, I advise the reader to take the interpretation and discussion of the data presented above as no more than a suggestive scenario for potential vegetation forms associated with soil erosion and alluviation in a small stream catchment during the late Holocene.

Despite its limitations, the modest palynological data presented here suggests useful insights for some of the questions posed with regard to soil erosion, and breaks new geoarchaeological and palynological ground in the Basin of Mexico in terms of objectives, empirical approach, and method.

CHAPTER 8

TRANSFORMATION OF THE LACUSTRINE ENVIRONMENT AND LATE QUATERNARY STRATIGRAPHY

Facts about the Lake Texcoco Basin and its research problems

Although this research deals mostly with landscape transformation on hills, piedmonts and alluvial plains, it includes a study case of landscape transformation in the lacustrine environment at the site of El Tepalcate on the bed of Lake Texcoco, where a set of paleoenvironmental information was recovered. This information is ancillary to the interpretation of landscape change of the entire region, because it is intended only to show an example of the interaction between settlement and lake level fluctuations. Although the data recovered through this study shows a low degree of resolution for the reconstruction of lake level fluctuations, it is proxy information that provides clues to the sequence of wet and dry periods in the past 3,000 years.

The geomorphological and stratigraphical identification of lake level fluctuations in the lake Texcoco basin has not been easy for two reasons, one is the high variability of seasonal and overall levels of the lake before its artificial drainage, and the other is the low rate of sedimentation. The former problem affects or inhibits the formation and preservation of shoreline deposits, and the latter affects the concomitant deposition of natural and cultural deposits, which makes geoarchaeological interpretations difficult.

Among other problems faced for the study of paleolacustrine geoarchaeology is the fact that Mexico City and its suburbs cover large part of the lake bed, especially those areas of potential geomorphological and archaeological interest such as former shorelines. Paradoxically, those areas not yet covered by the expansion of the urban areas have not been surveyed (Parsons, 1989).

Another problem for the reconstruction of paleolake levels is the poor definition of sedimentation styles, whether lacustrine or alluvial, so that the geomorphological context of peri-lacustrine sites in Texcoco is still a problem since the spatial and temporal distribution of the deltaic and lacustrine depositional environments has not been defined. Besides, given that alluvial sedimentation has been strong in the peri-lacustrine areas, it is assumed that many lake-shore sites may be buried by recent alluvium (Jeffrey Parsons, personal communication), as it is the case of numerous sites in the neighboring alluvial plains. Regarding this problem of site visibility on the lake shore, it is worth mentioning that an ongoing geo-archaeological project on the eastern shore of Lake Chalco has reported Toltec and Aztec lacustrine sites underlying alluvial deposits of Colonial age (Hodge, Córdova and Frederick, in press).

In addition to the poor stratigraphic knowledge of the basin, the uppermost layers of the stratigraphic sequence have been obliterated because of the exposure to the lake bed to eolian deflation, as it is proved in this chapter, and human destruction during the past three centuries, after the lake was drained. Further, the extraction of underground water has had an impact on the preservation of sediments, since the compaction of clays has created cracks that are being filled in with younger sediments. As I have observed around El Tepalcate, there are two problems generated from this cracking, one is that the filling of the ruptures and re-cracking of the deposits leads to the recycling and mixing of datable material (charcoal, humates and artifacts), a problem that affects interpretations based on core samples, and the other problem is that the stratigraphic units are affected in depth. For instance, in areas that have been sinking, I have observed up to 70 cm of difference between two sections very close to each other.

The paleoenvironmental information on Lake Texcoco thus far published, indicates that during the Late Pleistocene and Holocene there were considerable fluctuations of lacustrine conditions and evident vegetation change around the lake as attested by the study of fossil diatoms of Bradbury (1989), and by study of pollen by Gonzalez-Quintero and Fuentes-Mata (1980) and Lozano-García (1989). There are also studies on archaeological findings, such as the investigation of human remains found in Tepexpan, formerly thought to be the first human settlements in the Basin (De Terra, Romero and Stewart 1949), and the excavation of tlatels in near Tequisistlan (Litvak-King 1964), as well as numerous excavations of megafaunal remains (Aveleyra 1962; García-Cook 1968; Lorenzo and Mirambell 1986a). However, these paleoecological and archaeological studies oten lack radiocarbon dates and rarely combine their data with the information provided by the sedimentary matrix. Nonetheless, these studies, especially those dealing with megafauna remains, portray the low sedimentation rate during the Holocene as the remains of the Late Pleistocene fauna found in the lake which are usually found close to the surface, if not partially exposed (see Lorenzo and Mirambell, 1986a). Therefore, if there has been little sedimentation during the Holocene, it is expected that most archaeological remains are to be found on the lake-bed surface, unless they are buried by alluvium along the edge of the lake.

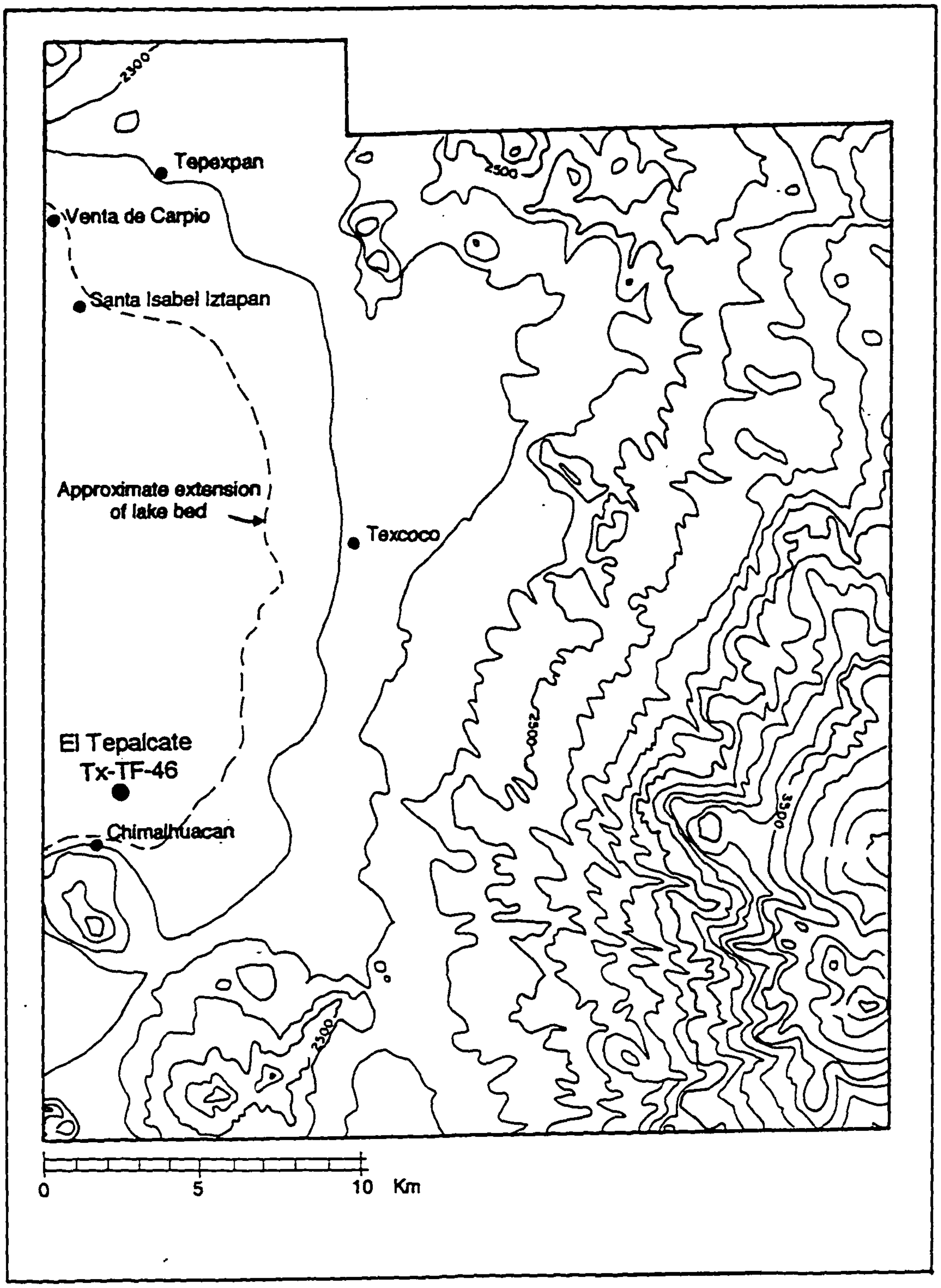
The investigation on pre-occupational and occupational stratigraphy and post-occupational geomorphic processes in the Terminal Formative site of El Tepalcates, presented in this chapter, discusses the problems and realities commented upon above, as well as approach a possible evidence for lake level fluctuation in the Late Holocene.

El Tepalcate (Tx-TF-46)

Description of the site

El Tepalcate site is located in the southern edge of the Lake Texcoco Basin, about two kilometers north of Chimalhuacan (Figure 8.1). It consists of a low mound approximately 200 long by 150 meters wide, capped by a one-meter-tall sand ridge that runs through the middle part of the site (Figure 8.2). The northern part of the ridge has a gentler and there is a wave-cut bench on the cultural deposits, not affecting the sand ridge. The southern slope is more abrupt and has no signs of wave erosion. The surface of the site is barren, except for patches of grass on the sand ridge (Figure 8.3). Large amounts of sherds cover the surface, a characteristic from which its name

Figure 8.1 The Lake Texcoco Basin and location of sites mentioned in text.



2300
Tepexpan
Venta de Carpio
Santa Isabel Iztapan
2500
Approximate extension of lake bed
Texcoco
El Tepalcate
Tx-TF-46
Chimalhuacan
2500
3500
2300
0
5
10 Km

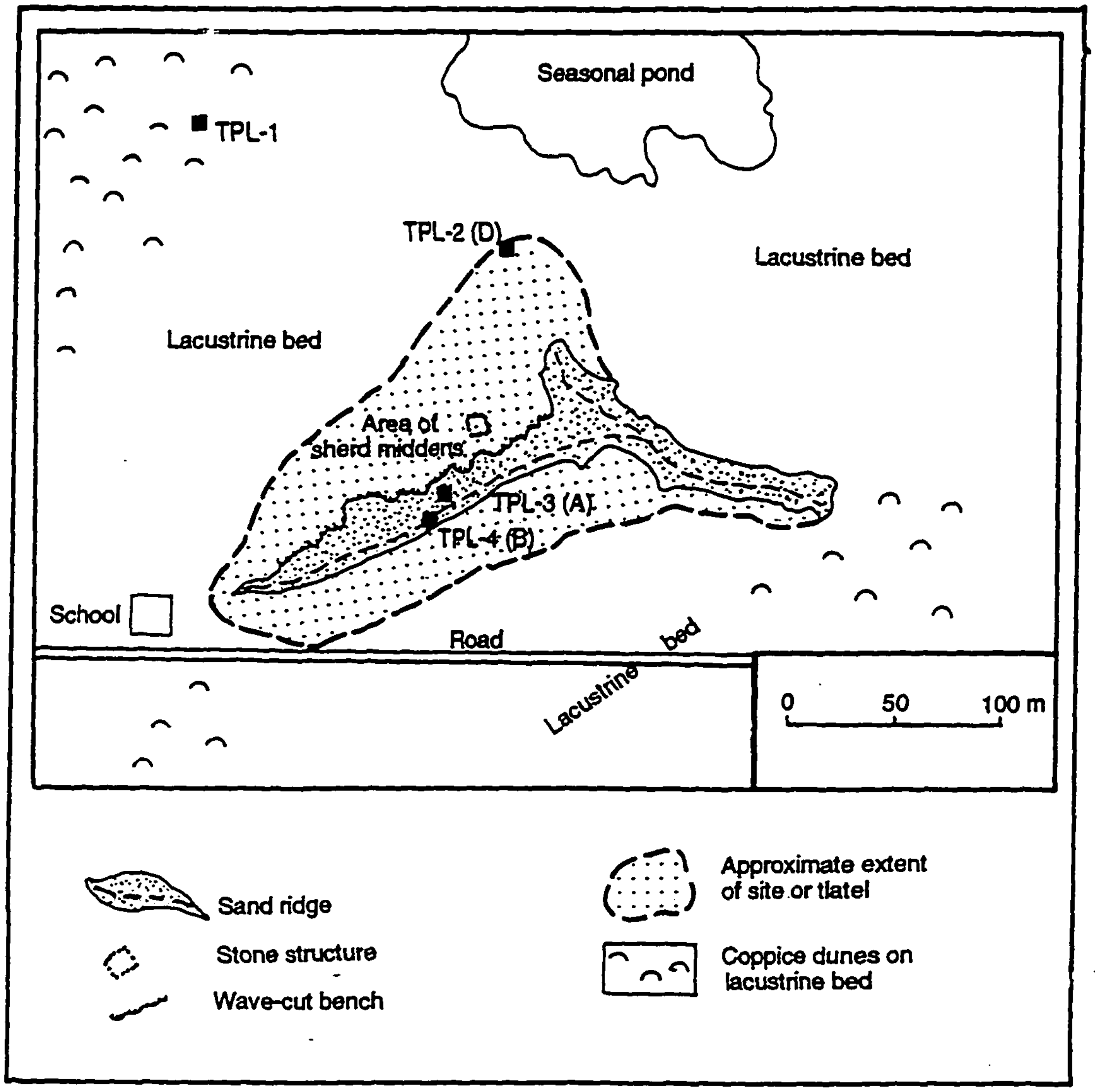


Figure 8.2 Site Tx-TF-46 (El Tepalcate).

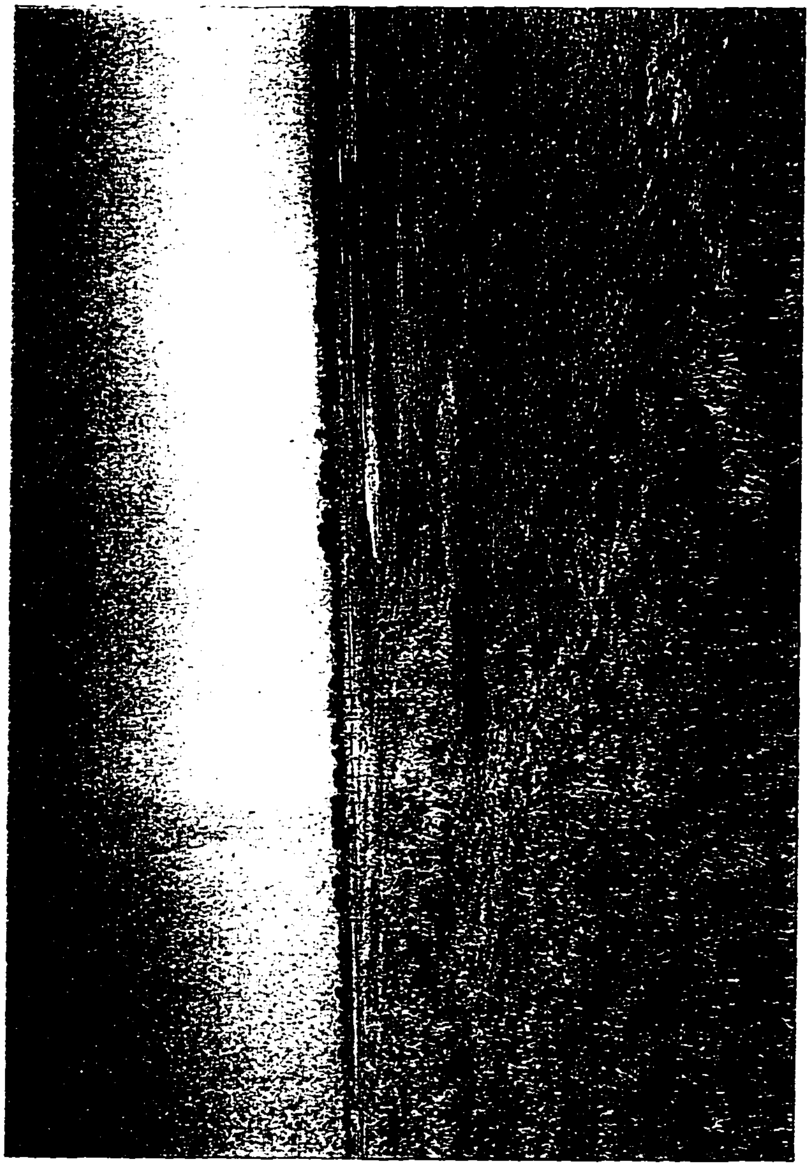
come from (Nahuatl,*tepalcatl*, sherd). Also, large amounts of basaltic scoria cover the site, along with scattered pieces of stone.

The site was originally described by Apenes(1943, 1944) and Noguera (1943), and surveyed by Parsons (1971), who assigned it to the Terminal Formative phase (200 B.C.-A.D. 150). Very low amounts of Aztec sherds are found scattered over the site, not being enough to qualify for an Aztec settlement. The site was apparently abandoned at the end of the Formative phase and not re-occupied, a trend that was common to most contemporaneous sites in Lake Texcoco.

Under the threat of being destroyed by modern settlements, the site was excavated in 1992 and 1993 by Lorena Gamez of the *Oficina de Salvamento Arqueológico* (Office Salvage Archaeology) of INAH. I joined the excavation to recover information that was to shed light on the geomorphological processes affecting the establishment, abandonment and preservation of the site.

With respect to the function of the settlement in the Terminal Formative, the hypothesis suggested by Parsons (1971) is that there was a community engaged in salt production. The assumption is based on the type of ceramics found in the site, known as textile fabric, and the fact that all over the site this kind of ceramics is found in

Figure 8.3 El Tepalcate. The southern slope of the sand ridge (left) an the site surface (right).



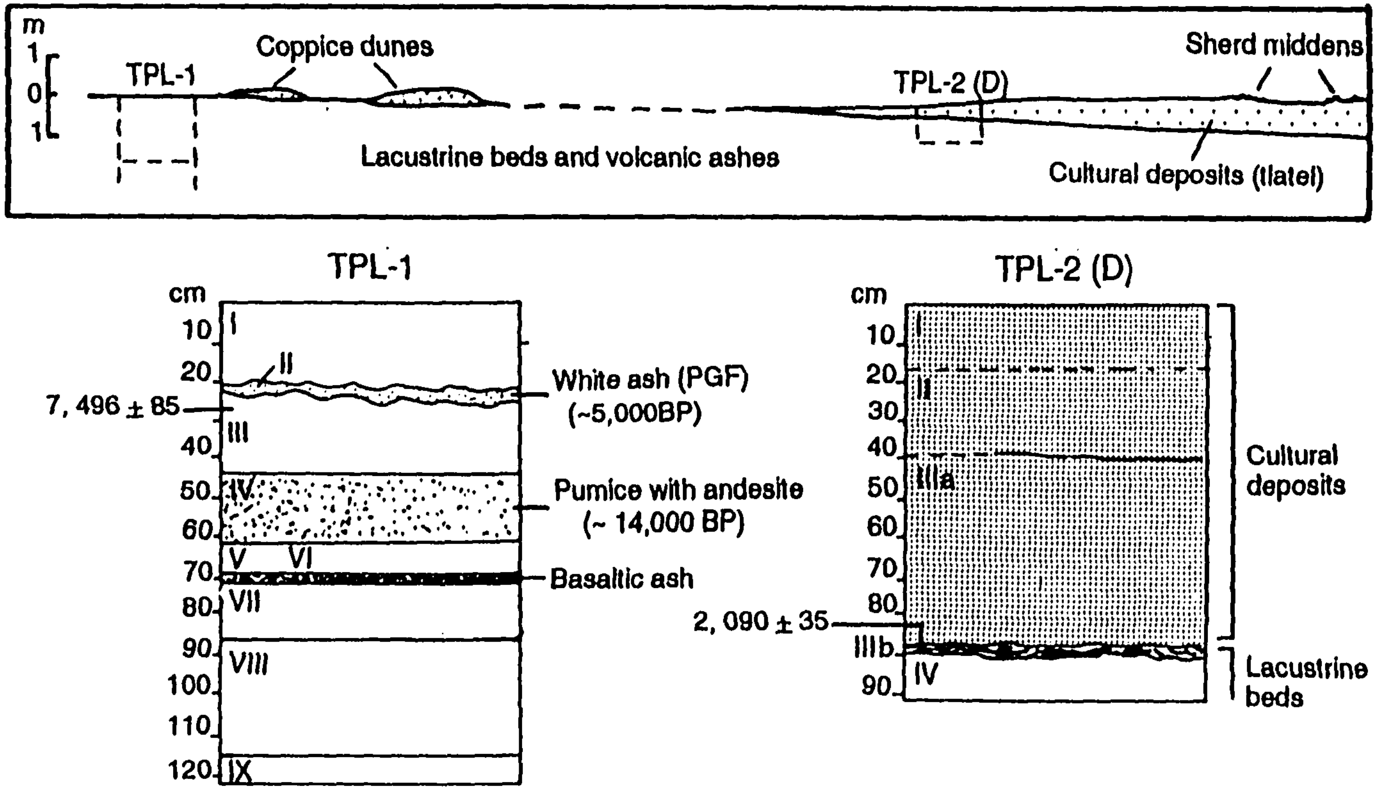
accumulations of sherds in what seems to be circular basins. These basins may have been used for evaporation water and precipitation of salts (Lorena Gámez, personal communication), but although the technique is better known for the Aztec period from ethnographic and historical sources (Parsons 1994), it is not a fact that El Tepalcate was a producing salt using the ethnographic method. Gámez-Eternod's excavation revealed that there were sizable residential units and structures that indicate that there was a permanent settlement, whether its inhabitants were producing salt or not.

Stratigraphy

The excavation was carried out in 6 squares (A, B, C, D, E, and F). A, B, and D, are the ones I chose for the geoarchaeological interpretation, and they were named in this work as TPL-3, TPL-4 and TPL-2, respectively. An additional unit, TPL-1, was described in a well dug about 150 m northwest of the site, and contains basically lacustrine and pyroclastic deposits pre-dating the occupation of the site (Figures 8.4 and 8.5).

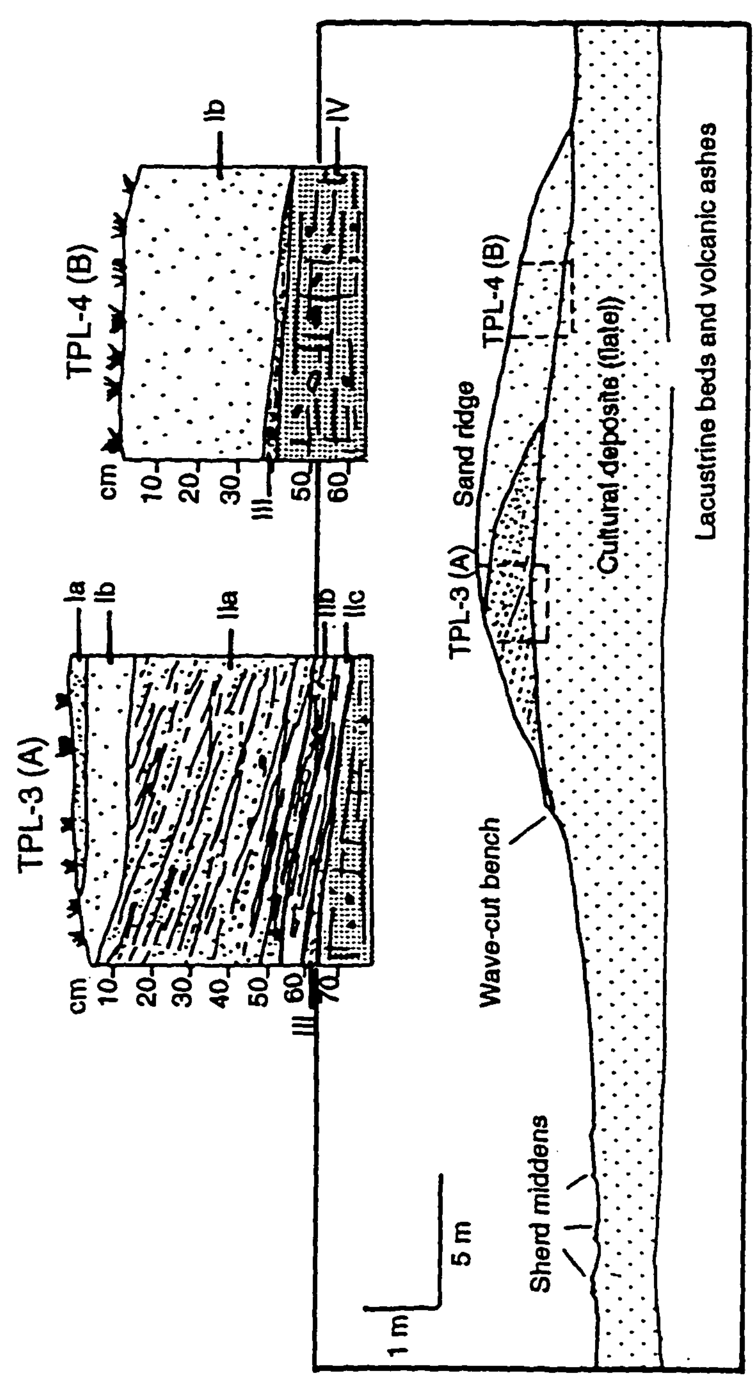
The 1992-1993 excavation focused on rock alignments found in the north of the site (square C) that revealed a wall, a talus of a pyramidal structure, floors and hearths (Gámez-Eternod 1993b). Square E, originally a test pit,

Figure 8.4 Site Tx-TF-46. Stratigraphic sections of the lacustrine deposits (TPL-1) and the northern edge of the site (TPL-2).



m
1
0
1
TPL-1
Coppice dunes
Sherd middens
TPL-2 (D)
Lacustrine beds and volcanic ashes
Cultural deposits (tlatel)
TPL-1
cm
10
20
7, 496 ± 85
40
50
60
70
80
90
100
110
120
I
II
III
IV
V
VI
VII
VIII
IX
White ash (PGF)
(~5,000BP)
Pumice with andesite
(~ 14,000 BP)
Basaltic ash
TPL-2 (D)
cm
10
20
30
40
50
60
70
80
2, 090 ± 35
90
I
II
IIIa
IIIb
IV
Cultural deposits
Lacustrine beds

Figure 8.5 Site Tx-TF-46. Stratigraphic sections on the sand ridge (TPL-3 and TPL-4).


TPL-3 (A)
TPL-4 (B)
cm
Ia
Ib
IIa
IIb
IIc
III
IV
Sand ridge
Cultural deposit (flats)
Lacustrine beds and volcanic ashes
Wave-cut bench
Sherd middens
5 m
1 m

revealed two occupational floors, and squares A and B, showed a residential unit with five occupational surfaces, all located under the sand ridge.

Section TPL-1 goes deeper into the Pleistocene, showing a sequence of silty deposits with interbedded ashes, the last one being a white ash that is presumed to be the PGF described before in the alluvial sections, that here is bracketed by a radiocarbon date in the sediment beneath that yielded an age of 7,496±85 B.P. The idea of including the upper part of this section is to show that this layer of ash, dated ca. 5, 000 years B.P. is found at least 25 cm below the beginnings of occupation of the site, *ca.* 2,090±35 B.P. dated from a patch of cattail (*Typha* sp.) overlain by the cultural deposits of the mound as shown in TPL-2, therefore indicating the slow rate of sedimentation. Details on the full TPL-1 section is given in Appendix H.

The fact that we have this patch of cattail squeezed by the dumping of cultural deposits is evidence that what we have here is the transformation of a shallow part of the lake into an habitable area by piling up cultural debris on cattail thickets. A modern analogue of this practice is reported in some lacustrine communities in Lake Kisale, Africa (Caputo, 1991:31).

The cattail remains yielded a ^{14}C date of 2090±35 B.P. (OS-3480), and the 2-sigma calibrated date ranging between 200 BC and 10 BC, which place this event in the Terminal Formative.

Details on the cultural deposits of the excavated squares in the mound are ignored for this interpretation, since the report is not published and the information is not allowed to be presented elsewhere. However, the end of the occupation is represented by the topmost cultural deposit in the center of the site (Zone IV in TPL-3 and TPL-4). The rest of the zones are different in nature, ranging from sands to gravel, representing post-occupational deposits laid down by waves and wind (Zones III, IIc, IIb, IIa, Ib and Ia), all of them post-dating the occupation of the site and discussed in the next section.

Beach and eolian deposits

The interpretation of the sequence of sandy deposits mantling the Late Formative site represented several problems that can be discussed on the basis of the sedimentary structures that they form and their granulometry. Zones IIb, Ib,III, and Ia originally were interpreted in the field as eolian deposits, since they show thin subhorizontal laminations; zones IIa and IIc were defined as beach deposits because of their cross-bedded structure and their content of gravel and eroded sherds, implying more energy and apparently lower degree of sorting; and zone Ib was defined as a deposit of sand disturbed by krotovinas (rodent burrows). When the samples were sifted the distribution of sands was deceitful because it did not show the expected relationship between mean size and sorting that will confirm the environment of deposition whether eolian of beach. For instance, IIb and III, two of the presumed eolian samples showed poor sorting (Figure 8.6).

Skewness and kurtosis are granulometric parameters that also suggest the environments of the samples studied. Although with certain exceptions eolian deposits tend to be positively skewed and mesokurtic and beach deposits negatively skewed and leptokurtic (Folk 1980). As a matter of fact, Skewness (Sk) and kurtosis (Ku) of the dry-sifted samples suggest that units Ia and Ib are eolian; they are positively skewed andwith a distribution close to normal, whereas the rest of the samples are typically beach deposits, that is to say negatively skewed and leptokurtic.

A comparison of texture data of duplicated samples of each zone obtained by dry and wet sieving show the discrepancy of data (Table 8.1), indicating that we were dealing with sand-size clay aggregates. Thin sections were not possible because samples for such a purpose were not taken at the beginning, but a count of single grains showed that 25 out of 100 3-phi size particles were clay

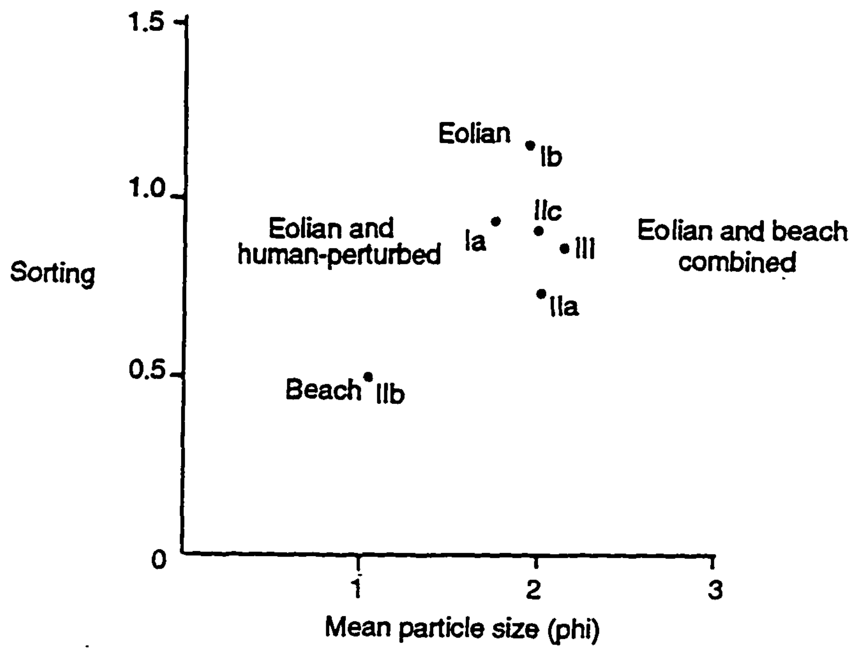


Figure 8.6 Plot of mean grain size (Mz) and sorting (σ^{I}) obtained from the sand ridge deposits.

aggregates, and that quartz was found in minimal quantities compared with pumice fragments which made a large part within the sample (Table 8.2). A quick visit to the field also brought me to coppice dunes formed on patches of halophyte grasses on the lake bed in the area around the site and on large tracts elsewhere on the lake bed surface (Figure 8.7). The wetting of the material from the coppice dunes showed that they were basically clay aggregates removed from the lacustrine deposits, just as units Ia and Ib on top of the site were. Studies in wind-tidal flat areas of the Coast of Texas show a high recurrence of sand-size aggregates of clay forming dunes (Huffman and Price, 1949; Price, 1963; Kibbler, 1994). These eolian deposits form by the influence of salt crystal development on saline dry lagoonal or lacustrine beds. According to Price (1963), the process consists in the crystallization or growth of the evaporite salts that develop a micro-relief pattern of pimples on the surface which breaks down when dry, producing cracked polygons which are mechanically disaggregated by the wind and transported by saltation, providing source of material for dune deposits.

Figure 8.7 Coppice dunes on the lake bed surface north of El Tepalcate.

TABLE 8.1
GRANULOMETRIC VALUES OF THE SAND RIDGE SAMPLES FROM TPL-3 AND TPL-4

Sample	% of textural groups by wet sifting		% of textural groups by dry sifting		Granulometric parameters from dry samples			
	Sand	Silt and clay	Sand	Silt and clay	Mz	σ	Sk	Ku
Ia	84	16	95	5	1.77	0.96	0.13	0.90
Ib	80	20	98	2	1.95	1.16	0.21	0.79
IIa	97	3	99.7	0.3	2.17	0.84	-0.05	1.09
IIb	98	2	99.8	0.20	1.07	0.51	-0.11	0.96
IIc	90	10	99	1	2.10	0.75	-0.08	1.23
III	80	20	96.5	3.5	2.20	0.88	-0.11	0.82

TABLE 8.2
100-GRAIN COUNTS FROM THE THREE LARGEST PHI PERCENTAGES FROM SAMPLE Ia

Fragments	0Φ	1Φ	2Φ	3Φ
Quartz	9	6	12	30
Pumice	43	66	9	32
Clay aggregates	12	4	12	25
Other	36	24	67	13

Since the bed of lake Texcoco meets the characteristic of being a clay surface with growth of salt crystals, it is highly probable that a similar system of clay aggregates formation occurs, although probably less intensely than in the examples cited for Texas. It is probable that sand drifts and coppice dunes bearing large amounts of clay aggregate like the coppice dunes that form at present, were deposited on islets and sites when lake levels were low in association with wave-laid sands.

The combination of beach and eolian deposits (zones III to II) shows probably a post-occupational rise and drop of lake levels, putting the top of the site under the action of waves, as can be interpreted from the wave-cut bench along the northern edge of the site (Figure 8.5). The reworked sherds in the beach deposits are largely Terminal Formative, although a few of them are Late Toltec and Late Aztec phase. The eolian deposits contain no sherds, except on the surface where there is a mixture of Terminal Formative and very small quantities of Late Aztec sherds. It is probable that the beach and eolian events mark the recession of the lake at the end of the Late Toltec through the Late Aztec phase, so that the appearance of the few sherds are not indicative of occupation, but are the remains of temporary camps, that may well be fishing or hunting stations. The last eolian event, represented by zones Ib and Ia, is probably the result of the dry-out of the lake through the Late Aztec and Colonial period, since there are no signs of lacustrine transgression. It seems evident by the deposits described, and by the shape and layout of the sand ridge on aerial photographs that it could well be a sand bar developed on a shallow area. Although the literature usually referred to them as features along seashores, they are not uncommon in lakes as I have observed in numerous lakeshore deposits in Mexico and Central America.

The sand bar at El Tepalcate may have formed when the site was partially exposed as the lake levels dropped sometime from the Late Toltec to Late Aztec times, judging by the large amounts of sherds of those periods. During the low stages of the lake the sand bar and the site were probably exposed during the Colonial period, but the maps of that time give no detail of such a feature.

Reconstruction of events

Lacustrine sedimentation in the Late Pleistocene and early Holocene was slow, except for an occasional layer of rapid accumulation of volcanic ash, like the Pumice with Andesite (*ca.* 14,000 B.P.), and the PGF (*ca.* 5,000 B.P.). The non-volcanic lacustrine deposits consist of silt and clay and occasionally granules of pumice. The growth of patches of cattail in the lake attracted the settlers in the Late and Terminal Formative period, since they were areas that were suitable to build up artificial islets and create an habitable surface in the lake to exploit the salts deposited by evaporation. After the abandonment of the site in the first century A.D. lake levels rose covering most of the site, if not all of it, through the Classic and Early Toltec.

The recession of the lake level occurred at different stages between the Late Toltec and Late Aztec phases created a series of beaches that in turn conformed a sand bar parallel to the lakeshore exposing the site to wind erosion giving as a result the partial deflation of clays on the lake bed and the formation of some kind of dune on top of the sand bar. The islet formed by the sand bar seems to have been temporarily occupied during the Aztec periods. However, lake levels at the end of the Aztec period are difficult to reconstruct since fluctuations were probably related to the dike built across the lake in a north-south direction, a project directed by King Nezahualcoyotl with the purpose of controlling the influx of brackish water into the waters around the Aztec capital of Tenochtitlan (see Palerm, 1973). The conquistador Hernán Cortés mentions that during the war against the Mexica of Tenochtitlan the dike was broken and that the salty lake (L. Texcoco) flowed over the fresh one (L. Mexico) implying that the levels of lake Texcoco where higher (Cortés 1985: 85, 140). If so, it is probable that for some time El Tepalcate may have been covered with water, or the level may have been near the top, so that this could be the time of the bar formation or the time of the erosion of the wave cut bench. After the conquest the lake levels began to drop, as described by Motolinía (1950:214, 215), although there was a significant recovery with the intense rains of 1555 (Gibson 1964:304), and definitely in the period of intense rains between 1604 and 1629 (Everett-Boyer 1973). However, the general trend was to continuous drop by desiccation and by the works of the *desagüe* (drainage) of the lakes, so that any activity of wave action on the site is far less possible; the eolian sedimentation of units Ia and Ib may have started in the Early Colonial phase.

A conclusion derived from this example would be that the history of lacustrine sedimentation during archaeological periods is minimal due to the slow rate of sediment deposition and the rapid loss by wind deflation when the lake was exposed. Therefore, it is difficult to obtain paleoecological data (pollen, diatoms, etc.). for the last 5,000 years. However, the fluvial sediments on the lake margins, especially on the deltaic surfaces offer better opportunities for paleocological studies. Thus the environmental history of the lake in the last 3,000 years can be reconstructed from data recovered in the interface lake-alluvial environments.

In relation to the abandonment of lacustrine sites at the end of the Formative period there is no conclusive statement as to whether this was due to socio-political or natural causes. However, what seems apparent through the example of El Tepalcate is that the possibility of a rapid rise in lake levels in the following periods may have impeded further re-settlement. This statement is only a hypothesis based on the trend of lake levels in the basin whcih rose during the Classic and Early Toltec phases, as the case of El Tepalcate suggests.

CHAPTER 9

LANDSCAPE TRANSFORMATION IN PRE-AZTEC, AZTEC AND EARLY COLONIAL TEXCOCO

Questions and hypotheses

Based on the data gathered through geoarchaeological research, it is possible to give some answers to the questions posed at the beginning to this investigation and test the general hypotheses of this study. The basic questions to answer are: (1) What are the patterns of landscape change that contributed to soil erosion and valley alluviation? and (2) How did landscape transformation affect soil erosion and sedimentation in transition from the Aztec to the Spanish Colonial periods?

The conclusions reached in a brief analysis of settlement history, presented in chapter 4, and the particular data sets presented in chapters 5, 6, 7 and 8, point to the significance of settlement pattern and land use changes as the two key factors.

In this chapter I first present a general model of landscape transformation through the interplay of ecological variables based on the data produced by this research. The model is a synchronic reconstruction of the ecological processes responsible for the activation of geomorphic processes that in turn created the landforms that themselves are hallmarks of the different stages of landscape transformation. Following the synchronic reconstruction of events, I present a diachronic approach to the transformation of the Texcocan landscape during the Holocene.

In addition, since severe soil erosion has been the main parameter used to evaluate landscape transformation, it is necessary to address its main issues and compare the results of this study with existing literature of the field. Thus, in the final section of this chapter I present some conclusions regarding the problem of prehistoric and historic soil erosion in the Basin of Mexico.

The ecological implications of settlement patterns and land use

Settlement patterns and land-use change

A broad view of landscape transformation and settlement in the Texcoco Region shows that periods of strong transformation coincide with changes in settlement patterns. The reconstruction of the chronology of landscape modification was possible because the settlement data recorded by the surveys contained information that correlated well with paleoenvironmental data. The particular aspects of the regional and site survey that were relevant to the interpretation of environmental change consisted of several variables: densities of artifacts, architectural features, off-site remains, and the systematization of data into categories (e.g. hamlets, small dispersed villages, large nucleated villages, etc.).

Although the influence of settlement patterning on landscapes has been considered important to explain environmental degradation in other parts of the world (Davidson 1980; Bintliff 1988; Van Andel, Zangger, and Demitrack 1990; Chester and James 1991), the literature on this matter is still scarce (Bintliff, 1992). The abundant literature on settlement patterns focuses largely on the explanation of socio-political interactions, trade networks among cities and regions, resource procurement, or even movements of hunting-gatherer groups (Butzer 1982).

For the case of central Mexico, and specifically the Basin of Mexico, the bulk of models and information created in settlement geography and spatial archaeology, the two academic fields concerned with the patterning of archaeological remains, still do not provide a satisfactory answer to the following questions:

1) How are sites patterned in relation to landscape zones?

2) How do settlement patterns reflect soil productivity and soil susceptibility to erosion?

3) How do settlement patterns conform with specific land-use patterns, especially in pre-Hispanic agricultural communities?

and most important of all in terms of the objectives of this dissertation:

4) How do settlement pattern and land-use changes cause the acceleration of severe, irreversible processes of soil erosion in highly susceptible areas that consequently will produce flooding and incision in the valley floors?

In a general sense, the literature on settlement pattern provides us with useful elements with which to build a conceptual framework able to answer the questions posited above, although it does not really provides sufficient elements to interpret the problem in any particular case study. However, the basic theoretical elements of settlement geography and spatial archaeology work in conjunction with the purpose of analyzing the distribution of artifacts, activities, resources, routes, and so forth of the peoples who ordered them (Clarke 1977). Their distribution is viewed at three scales: *micro*, that is at the level of the component houses and other structures; *meso*, or in regard to internal aggregation of farm complexes, agricultural villages, or multifunctional towns; and *macro*, meaining in terms of spatial and hierarchical configuration or interaction of settlements (Butzer, 1984: 925, 926). Elaborating upon these concepts, it is possible to develop conceptual models with the capacity to analyze the question of how settlement pattern and land use modified the physical environment and pushed various processes of landscape modification beyond equilibrium limits, bringing about extreme conditions such as severely eroded landscapes.

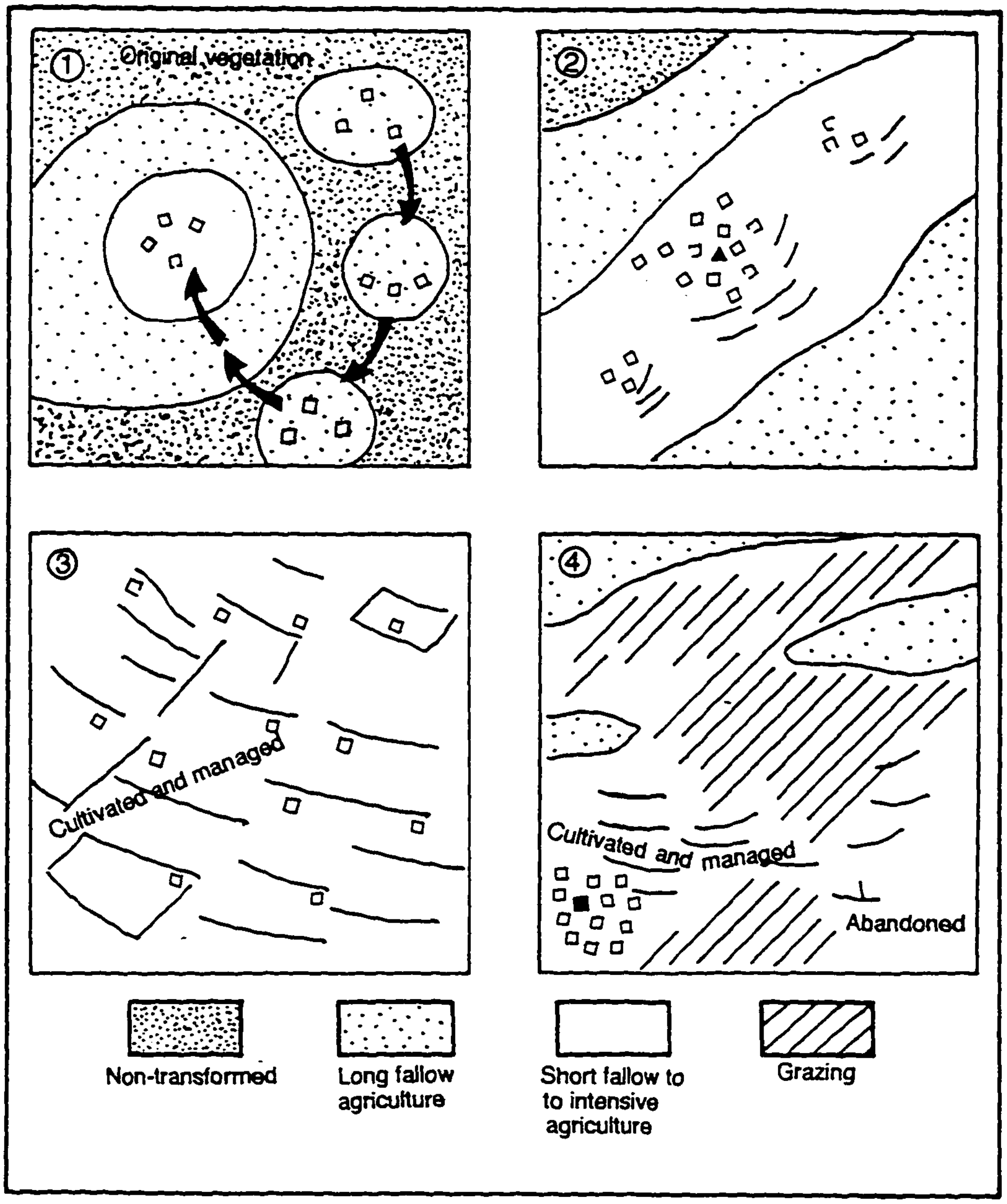
In the next section I present a model to interpret the development of soil erosion and stream alluviation in the Texcoco region. This model synthesizes the two variables that affect the functioning of elements in the landscape at two scales following Butzer (1982): first, the level of intrasite relationships (mesoscale), and second, the level of intersite patterning (macroscale). The other two levels suggested are microscale, which is not relevant for the processes considered here, and the semi-mesoscale, which was already used to analyze the evolution of Aztec dispersed villages in chapter 5.

The basic categories of settlement-scale land use units used in this model are based on the Landscape Modification Gradient of Forman and Godron (1986). Adjusted to this study, such categories are: (1) Natural landscape, or without significant human impact, (2) managed landscape, that is an environment where native species are managed and harvested, (3) cultivated landscape, with villages and patches of natural and managed ecosystems scattered within the predominantly cultivated landscape, and (4) abandoned landscape --with managed and cultivated landscapes no longer in use. The first category is a natural ecosystem that may or may not be in the process of being altered, whereas the fourth category, is a previous altered landscape. Categories two and three are 'managed environments' or 'managed ecosystems.' They differ from the natural ecosystems in that their biotic components are cultivars and livestock substituting for the natural vegetation and animals, and since their flows of energy and biotic diversity are culturally controlled, they require equilibrium conditions different from those of natural ecosystem (Butzer 1994:422). An abandoned landscape may undergo successional change towards natural conditions, although certain conditions, such as high susceptibility to erosion and degree of management, may create irreversible processes, thereby producing conditions of severely degraded environments. This is the critical point to the explanation of erosional phases in the Texcoco region.

The application of these four categories to the rural communities of pre-historic and historic Texcoco is the first step in constructing this conceptual model. Four models of settlement have been chosen based on the archaeological survey data to explain the processes of transformation in the framework of natural and managed ecosystems in relation to intrasite aggregation variables based on four types of sites: hamlet, nucleated village with satellite hamlets, dispersed village, and nucleated village with abandoned lands and unevenly used lands around it (Figure 9.1).

A hamlet is defined as a semi-permanent farmstead that in many cases occurs isolated or on the periphery of a larger settlement, usually a nucleated one. According to a re-classification of sites for the areas surveyed in the Basin of Mexico (Parsons *et al.* 1983), it is possible to recognize two types of hamlets: the simple, small, semi-permanent hamlet or camp, and the large permanent hamlet. In the settlement maps of Chapter 4 both were classified as 'hamlets'. Although present in all periods, the former is more likely to be found in the Middle and Late Formative periods, and to reach higher elevations during Terminal Formative times, when for the first time hamlets spread onto the erosion-prone areas of the upper piedmont and on steep slopes of the volcanic hills. Although the resolution obtained for the ceramic phases of this period does not provide an estimate of the duration of these small, semi-mobile farming communities, the hypothesis that long fallow was practiced in the Formative periods

Figure 9.1 Four models of intrasite aggregations for the ancient rural communities on the Texcocan piedmont.
(1)Isolated hamlets, (2) nucleated village with satellite hamlets, (3) dispersed Village, and (4) nucleated village, abandoned settlements and grazed lands.


1
Original vegetation
2
3
Cultivated and managed
4
Cultivated and managed
Abandoned
Non-transformed
Long fallow agriculture
Short fallow to to intensive agriculture
Grazing

(Sanders, 1976: 143) suggests that these semi-permanent hamlets were occupied for periods of no more that five years and were reoccupied six or seven years later. The second variant, the larger and more permanent hamlet is also found in all periods, but most common in the Classic and Toltec phases, when there existed a few small settlements that clustered toward higher-hierarchy settlements. The clustering of settlements into the compact site complexes may have been the response to defensive requirements (Flannery 1972). This may well be the case for the Early and Late Toltec phases, as clusters are believed to have formed polities involved in warfare with their neighbors (Blanton *et al.* 1993). In any case, hamlets occupied borderland zones around the polities (Sanders 1981: 172). If so, their distribution would imply that around the settlements there existed concentric bands ranging from areas of more intensified agriculture (managed landscapes) to areas of natural or less altered vegetation (natural landscapes) (Fig. 9.1, 1).

The second type of settlement of this typology is the nucleated village, very common in the lower piedmont in the Terminal Formative phase and the Toltec phases, although present in all phases. The main characteristic of a nucleated village is that population density of the residential area is markedly higher than in the total area used for subsistence. Also, in a nucleated village dwellings were concentrated around civic and/or religious structures. They were usually established where the environment had been transformed in previous periods, and were surrounded by smaller settlements on the periphery (Figure 9.1, 2). Conservation practices in the territory of nucleated villages may not have been optimal because concentration in the center may tend to result in the negligence and misuse of the outer environment. Ideally, in exceptional cases, a nucleated compound within a susceptible area can be successful in controlling the factors and agents of erosion over a limited area, but this seems no to be the case in the study area.

The third type of settlement is the dispersed village that existed in almost all the phases, becoming the most common type of settlement in the Aztec period. Unlike the nucleated village, the area devoted to crops in a dispersed village is intermixed with the residential area. As explained in Chapter 5, this type of settlement was characterized by a high efficacy in controlling geomorphic processes. Since farmers were dispersed over a huge area, each household was in charge of the management of certain units of land that collectively covered the territory in full (Figure 9.1,3).

The fourth type of aggregation is a variant of the nucleated village, differing in that the lands around it are both lacking residential areas and managed via a newly introduced technology and biota, namely new cultivars and new domesticated animals (cattle, sheep, goats and horses). Areas formerly dedicated to agriculture were now put under the stress of grazing (Figure 9.1, 4). In the settlement history of the study area, this type of village compound existed only in the Colonial period.

Before explaining the variables of the model it is useful to note that its conceptual framework is not fully empirical even though it is based on field data obtained in Texcoco. The functioning of the model is based on the following principles:

1) Prehistoric land-use is inferred from specific site patterning.

2) The main causes of the acceleration of geomorphic processes (*e.g.* soil erosion) are land use, which is a function of vegetation clearance, and soil management.

3) Climate is an independent variable in which only short-term extreme events are palpable because of the temporal scale considered in the model.

4) The effects of original clearance and abandonment of retaining features (terraces and check-dams) are based

upon modern analogues studied elsewhere in Mexico by the author.

Ecological variables of intrasite aggregations

The basis of this model of landscape transformation in the Texcocan piedmont is based on an understanding of the managed ecosystems associated with the four basic rural communities explained above. At the mesoscale, the transformation of the landscape through the development of these rural communities is explained through the interaction of spatial and technological-environmental variables.

The two spatial variables are the degree of clustering, which ranges from dispersed to nucleated, and the area of the managed environment occupied by settlers (Figure 9.2, arabic numerals in circle refer to the four types of settlement in Figure 9.1).

The four environmental-technological variables are:

(1) *The degree of management in the human* ecosystem, which is initiated when vegetation is first cleared and small-hamlet farmers begin cultivating, increases as more settlements appear or the existing ones grow, and reaches a high degree of management when a nucleated or dispersed village is able to intensify

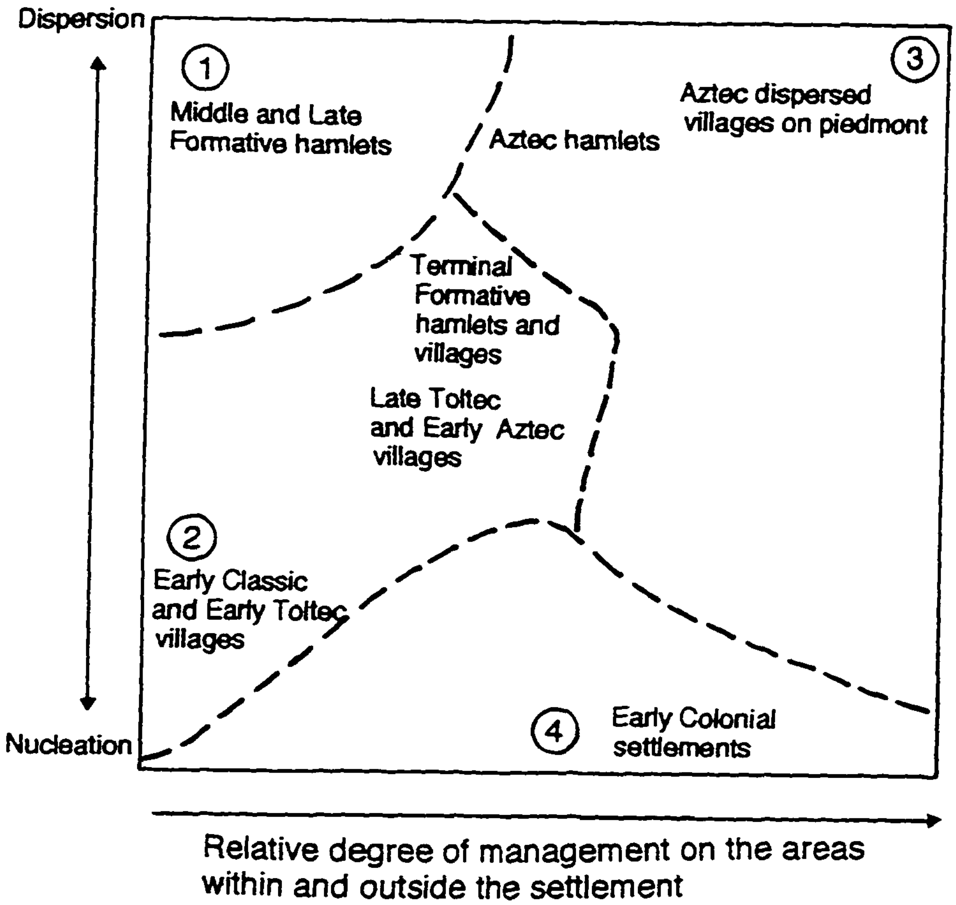


Figure 9.2 Intrasite aggregation variables (nucleation-dispersion) and area of occupation (Numbers 1 through 4 are referred to the intrasite aggregations of figure 9.1).

agriculture and mitigate the problems of soil erosion and low fertility.

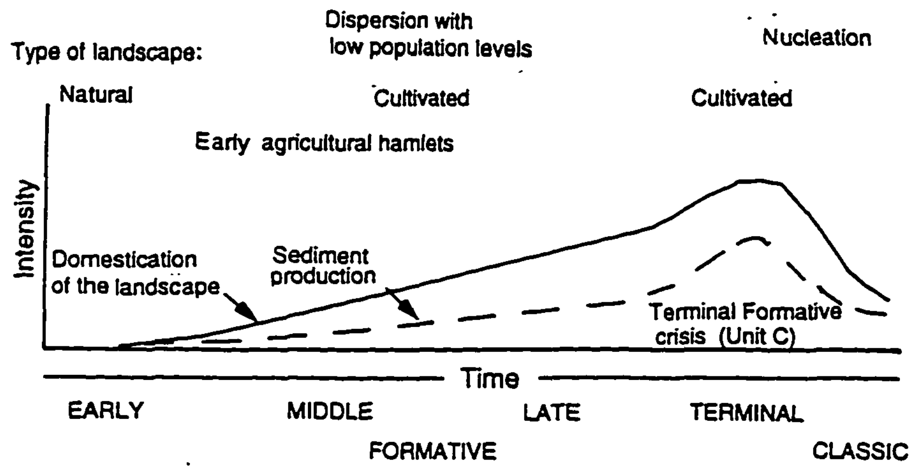
(2) *The area managed by farmers*, which increases as population density increases, especially if population is dispersed. Abandonment of the managed area implies changes that may create conditions for soil erosion under copious rains.

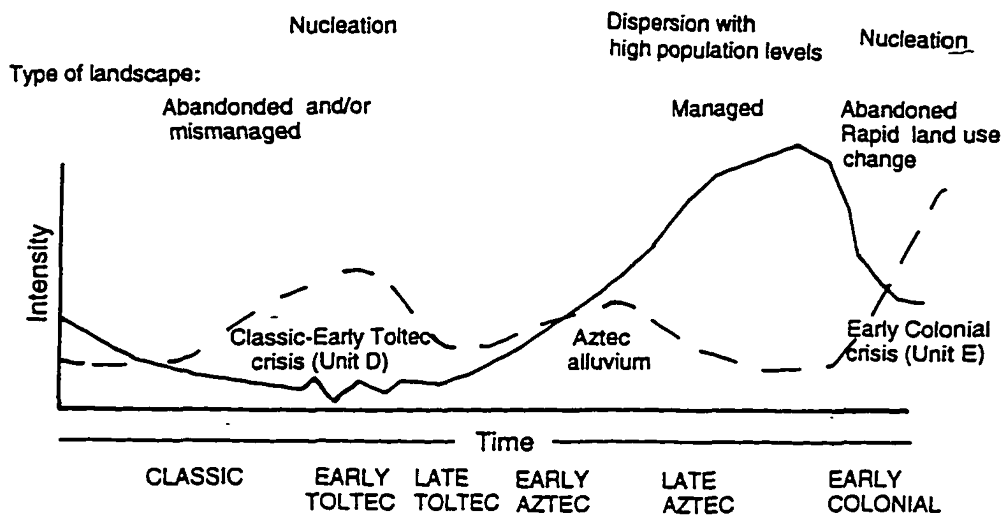
(3) *Abandonment of the managed ecosystems* is a variable closely linked to the to previous ones, and implies the cessation of human control of the geomorphic processes.

(4) *The introduction of new biota in the ecosystem*, such as cultivated plants and animals for which the landscape is not suited. In fragile environments this process has implications for the triggering of some geomorphic processes.

The interaction of these four variables in the modeling of landscape response to settlement and land use changes in Texcoco is a linear one and can be evaluated in terms of intensity of landscape domestication and mobilization of sediments (Figure 9.3). The scenario obtained from the model is the following: the removal of particles that culminated with severe soil stripping and substrate gullying began with the first forest clearance, and was enhanced by farming, of which effect was controlled

Figure 9.3 Model of landscape response to settlement and land-use changes in terms of lanscape domestication (management) and sediment production. Numbers in circles refer to intrasite aggregations of figure 9.1.


Dispersion with
low population levels
Nucleation
Type of landscape:
Natural
Cultivated
Cultivated
Early agricultural hamlets
Intensity
Domestication
of the landscape
Sediment
production
Terminal Formative
crisis (Unit C)
Time
EARLY
MIDDLE
LATE
TERMINAL
FORMATIVE
CLASSIC


Nucleation
Dispersion with
high population levels
Nucleation
Type of landscape:
Abandonded and/or
mismanaged
Managed
Abandoned
Rapid land use
change
Intensity
Classic-Early Toltec
crisis (Unit D)
Aztec
alluvium
Early Colonial
crisis (Unit E)
Time
CLASSIC
EARLY
TOLTEC
LATE
TOLTEC
EARLY
AZTEC
LATE
AZTEC
EARLY
COLONIAL

by terracing maintained by a dispersed farming population. At this point a high degree of landscape domestication was attained. Later, the abandonment of soil erosion control structures forced the system over a threshold which resulted in the rapid mobilization of sediments leading to changes in stream hydrology.

The adaptation of this 'model' scenario to the particular case of the Texcoco region is explained in the following paragraphs.

The initial transformation of the landscape during the Formative phases is represented by sediment deposition on the alluvial plain, which is recognized in the alluvial stratigraphy as unit C, and was the result of vegetation clearance and soils disturbed in the uplands when the farmers of the Late and Terminal Formative period established their hamlets and intensified agriculture in the piedmonts and hills of Texcoco.

The abandonment of managed landscapes deserves a thorough examination since the trend in ecology is to believe that soil erosion appears only with increasing intensity of land use or socio-economic intensification. When settlement is in the third category (dispersed village) the geomorphic processes are controlled to the point that the landscape has been 'domesticated' (Barbara Williams, in personal communication). In these terms, 'landscape domestication' includes the control of rills and gullies by building check-dams, and the control of slopes by terraces. These kinds of structures are maintained every year given that there is permanent population in charge of such an enterprise, a situation that was achieved with the high degree of organization under the Texcocan rulers of the 15th century. The condition achieved by this 'landscape domestication' is what I call a 'managed stability' in contrast to a "natural stability" which is in effect in non-human ecosystems. One vivid example of managed stability is the creation of terraced soils in the Aztec period, as described in chapter 5, or the formation of soil S_4 , described in the alluvial stratigraphy of Chapter 6 as 'Aztec Soils'. These soils are not the result of climatic factors, but of managed stability created by technological control of the environment.

During the Early Colonial period, rapid population decline in population and the policy of reduction led to the desertion of managed landscapes, so that maintenance of terraces and check dams was no longer effective. This lack of maintenance eventually caused ruptures in the barriers that retained potential energy of sediments and water. Therefore, such structures became insufficient to control the flow of water and sediment, and also contributed to create waterfalls at the site of the ruptures. This resulted in an increase of small scale and local base levels that the potential energy of materials behind dams transformed into kinetic energy originating irreversible processes of gullying and soil stripping, a clear indication that a threshold has been passed (refer to Figure 9.3). The sizable alluvial deposits of unit D and particularly of unit E in the floodplains of the Texcocan rivers are the result of sediment originating from abandoned landscapes on the slopes of the piedmont since they mark the end of two periods of expansion of management environments: the Terminal Formative and the Late Aztec phases. These are also the two times in the history of settlement in Texcoco that pre-historic terraces were commonly in use (Parsons 1971).

The implications that settlement abandonment have for sediment production, soil stripping and increased runoff seem to apply to lands with a long history of farming and dramatic fluctuations in landscape management. In the Mediterranean, for example, studies on sediment production from abandoned terraced fields have confirmed the effects of abandonment on these managed environments (Llorens and Gallart 1992; Jorda and Provansal 1990). Although there are obvious differences in term of cultural history and landscape transformation between the Mediterranean region and the north-central Mexican highlands, there are several environmental facts that support the idea that we have much to learn from the Mediterranean experience. After all, the Mediterranean record appears to be analogous to the more fragmentary evidence currently emerging from Mexico and Central America (Butzer 1996: 145). There is a climatic variable that the two regions share, which is the onset of intense rains after a long period of drought, whether it occurs in winter or summer. Thus, in a general sense, both agricultural intensification and land abandonment are a cause of soil erosion in managed environments.

The implications of intensification and subsequent rapid abandonment on the instability that leads to soil erosion, valley sedimentation and stream incision, upon which I based my hypothesis, is based partially on an ethnographic study of the process of vegetation clearance, cultivation, overgrazing, and abandonment in a region of Nahuatl-speaking people in the Balsas region southern Mexico (Córdova 1991). The results obtained from empirical research prove that the abandonment of *ranchos* (small semi-permanent settlements) in the first decades of the 20th century was the most obvious cause of soil erosion on the slopes, most of which were terraced or had soil erosion control structures that had to be maintained. The desertion of these ranchos occurred in the first years of the unstable period of the Mexican Revolution between 1911 and 1915; intense rains in subsequent decades led to the destruction of check dams and stone fences and the removal of soil particles. Today, most of the slopes are stable or in the process of stabilization on lithologies like Cretaceous sedimentary rocks and Tertiary volcanics, whereas gypsum and other continental sedimentary and Tertiary surfaces are still producing sediments beyond any possible control.

To what extent climatic fluctuations influenced erosion and alluviation in Mexico, is stilldebated (Frederick 1995). We know more about the past five centuries thanks to the direct or indirect accounts that in some parts of Mexico are available (Metcalfe 1987; O'Hara 1993). However, during this period environmental change was the result of land use changes, so that the appreciation of climatic change is difficult. Studies in those parts of the Old World with longer historical accounts, whereby it has been possible to track down the effects of intense rainfall events, show that the human factor involving land transformation and abandonment has played an important role in the triggering of rapid alluvial sedimentation (Bintliff 1992). To illustrate this statement, it is worth mentioning the case studied by Brookes (1987) in western Iran in a fluvial basin with a massive flood deposits that shows an aggradation event of catastrophic proportions occurred following the 13th century. Brookes attributed this event to two causes: (1) the stalling of a Mediterranean winter 'low' over the basin that produced copious rains, and (2) the sudden abandonment of fields due to the agricultural collapse resulting from the Mongol invasions in the 1220s.

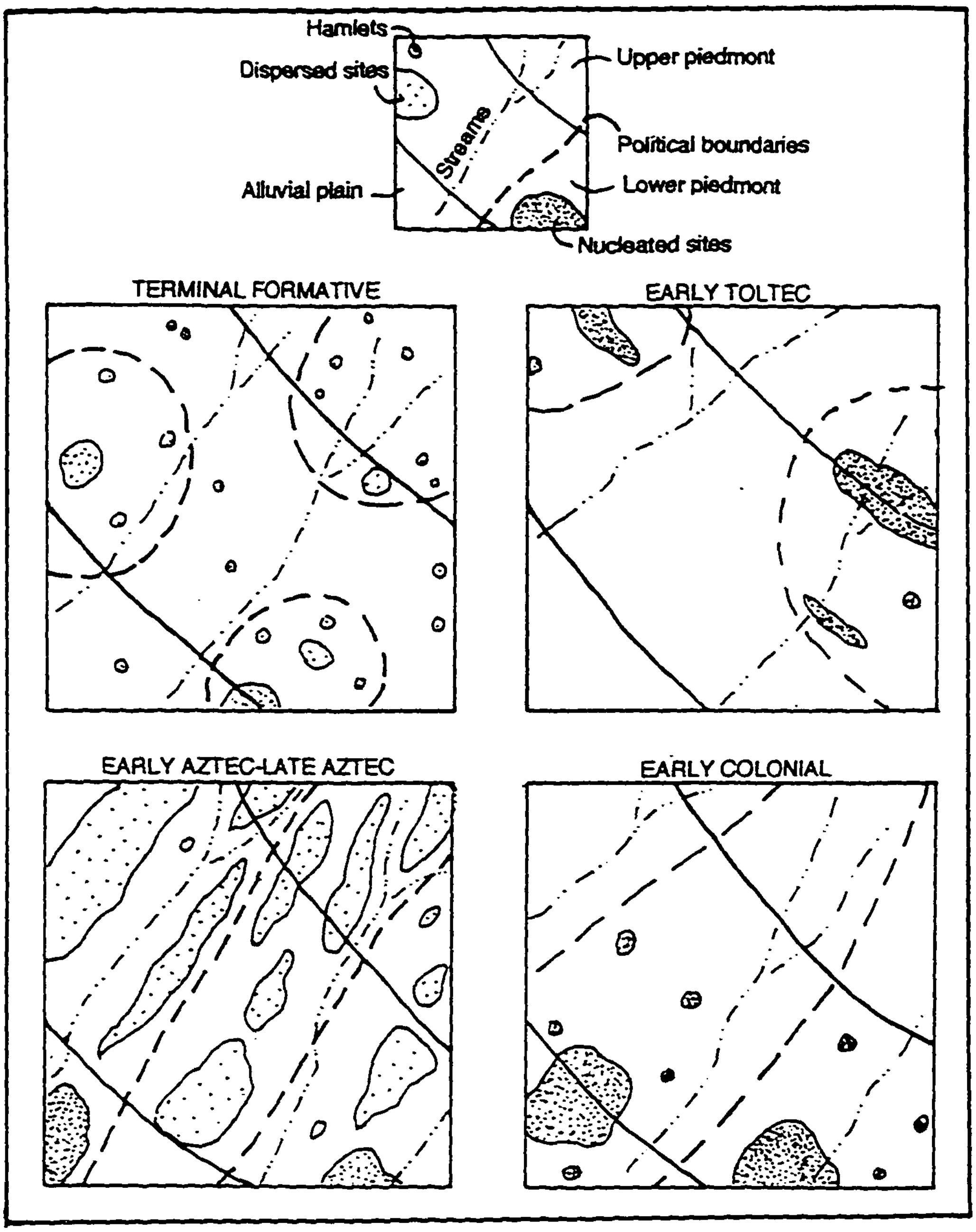
As demonstrated in chapter 6, the erosional phase initiated in the Early Colonial period is associated with abundant rains, and specifically with extreme storms that caused catastrophic flooding. However, since there are no historical documents to prove it, there is no clue as to whether flood deposits in pre-Hispanic times were also associated with similar extreme climatic events. The rise in lake levels recorded at El Tepalcate (Chapter 8) seems to indicate a humid period in the Classic and Early Toltec phases, although we are not sure about the intensity of rains. For the same period, Frederick (1995) reports alluviation in the Río Almeria Valley near the site of Villa de Reyes, Guanajuato. However, in any case we do not have detailed records to determine extreme climatic events, regardless of whether or not they occurred.

Climatic factors are important, but not crucial, for we are dealing with highly managed landscapes and clear disturbance of susceptible environments. This argument is also supported by the recent study in the Balsas region, a semi-arid area of southern Mexico by Córdova (1991). The study showed that at the end of the 19th century and beginning of the 20th century the dispersal of small settlements of farmers and livestock raisers of San Juan Tetelcingo onto the surrounding slopes coincided with a period of abundant rainfall. The slopes were managed and there were no major erosional problems. However, the abandonment of terraces and check dams after the initiation of the Mexican Revolution, erosion attacked the slopes, at the time when rains diminished.

Ecological variables of intersite patternings

An understanding of site distribution within the environmental matrix is also important to evaluate the process of landscape transformation, regardless of the degree that internal nucleation or dispersion reached and the area occupied. The survey maps show that site patterning in the matrix of ecological zones varies through the different phases, so that it is possible to generalize patterns of settlement-environment relations (Figure 9.4). The Terminal Formative, for example, is characterized by clusters of small settlements, sometimes gravitating around a larger one and covering the ecological units evenly. Early Toltec sites tend to be aligned parallel to the

Figure 9.4 Diagrammatic model of the typical distribution of sites with respect to ecological zones for four cultural phases.

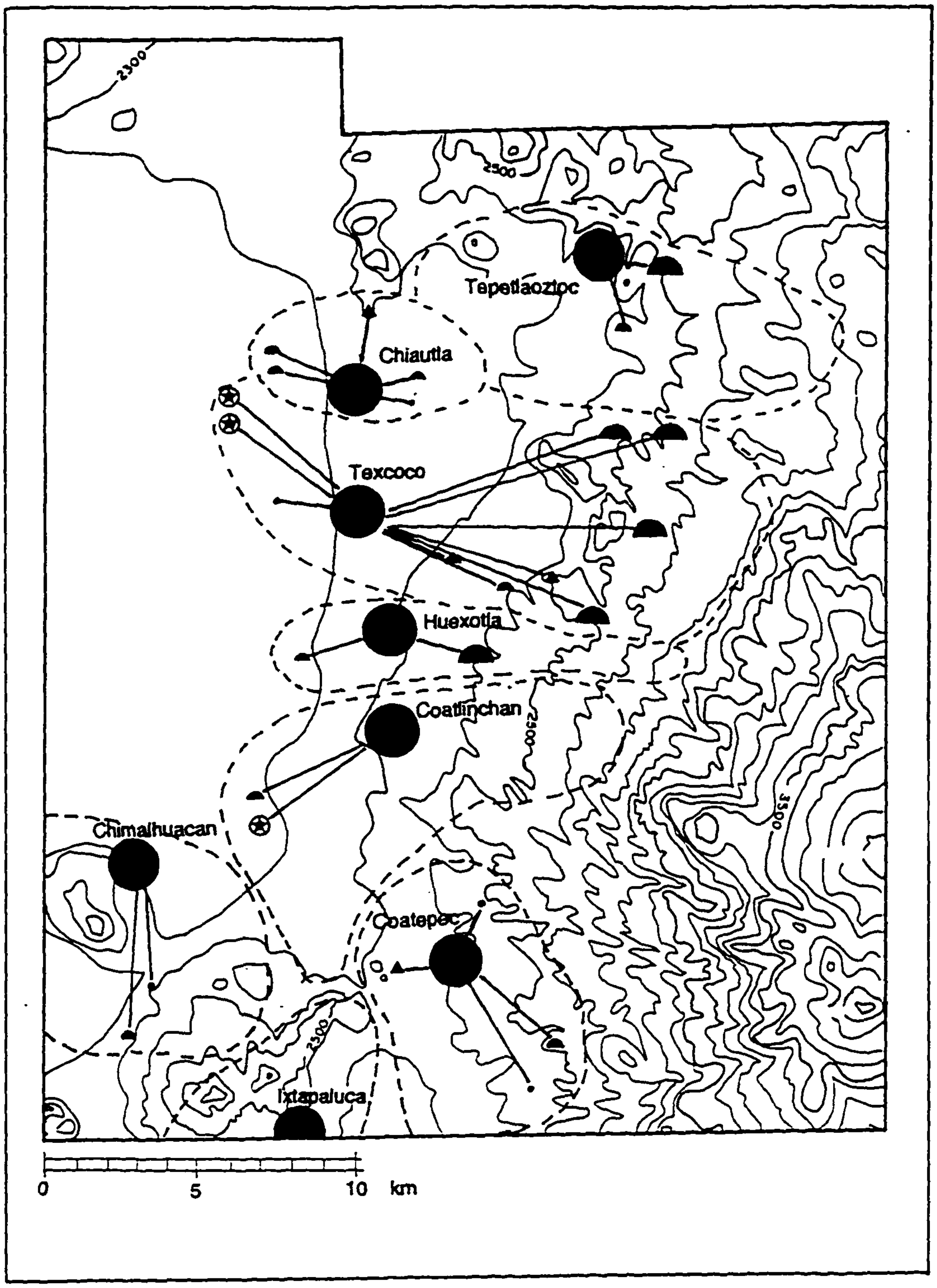


Hamlets
Dispersed sites
Upper piedmont
Streams
Political boundaries
Alluvial plain
Lower piedmont
Nucleated sites
TERMINAL FORMATIVE
EARLY TOLTEC
EARLY AZTEC-LATE AZTEC
EARLY COLONIAL

contours and ecological units and also perpendicular to streams, whereas Early and Late Aztec sites are, in contrast, aligned perpendicular to the contours, usually covering more than one ecological unit as can be appreciated in the territorial configuration of the Aztec city-states postulated by Sanders *et al.* (1979), who combined survey data and historical accounts in which some territorial polities extended from the lakeshore to the base of the mountains (Figure 9.5). The formation of this patterning has been confirmed also by a coincidence between these territories and the configuration of Aztec local ceramic style zones whose territories are very close to the configurations of Early Aztec polities (Hodge and Minc, 1990). The surviving settlements of the Early Colonial period, although nucleated, still kept the Aztec territorial patterning, each lead by a *cabecera* (head town). Such changes in site patterning across the archaeological phases had a tremendous impact on the environment, especially during the transition from one type of patterning to a radically different one. It is evident through this example that after the natural landscape is altered, dispersion of settlements was the best formula to keep erosional processes under control.

Combining the settlement information presented in Chapter 6 and the environmental records it is evident that

Figure 9.5 Territorial and settlement hierarchy of Aztec sites in the Texcoco region. The territorial configurations and sites were taken from Map 18 in Sanders *et al.* (1979).


2300
2500
Tepetlaoztoc
Chiautla
Texcoco
Huexotla
Coatlinchan
2500
3500
Chimalhuacan
Coatepec
2500
Ixtapaluca
0
5
10 km

settlement dispersion in pre-Hispanic times was the best formula to control processes of erosion in an upland environment severely impacted in previous periods. The recent case studied in the Balsas Basin (Córdova 1991), mentioned above, confirms the efficacy of dispersed settlement pattern in controlling erosion, even when an intensive type of agriculture and stock-raising are practiced.

Stages of landscape transformation in the study area

Early Holocene landscapes (10,000-5,000 B.P.)

Paleoenvironmental records from various parts of central Mexico show that the earliest stages of this period were somewhat wetter than today but a shift towards drier conditions occurred at about 7 ka B.P.(Bradbury 1989; González-Quintero 1986; Metcalfe *et al.* 1991). This trend is also apparent in the paleoglacial records from the high mountains of the Transmexican Volcanic Belt where there were vestiges of glaciation during the early stages of this period, as testified by the MIII advances on La Malinche (Heine 1975, 1984, 1988b), the Albergue glaciation on Ajusco (White and Valastro, 1984; White *et al.* 1990), and a glacial advance on Teyotl that Vázquez-Selem (1991) correlates with Albergue. The lack of glacier formation between ca. 8.5 ka B.P. and 3-2 ka B.P. on Iztaccihuatl and Ajusco (White 1987) and Malinche (Heine 1975, 1988b), is probably indicative of a rather dry climate in Early to Middle Holocene times, if we accept the idea proposed by Heine (1988b) that glacial advances in central Mexico may have been controlled more by precipitation than by temperature.

Pollen records from Lake Texcoco show a total dominance of pine and absence of spruce that indicate that the early Holocene was wetter and warmer than the preceding and subsequent periods. but after 8.5 ka B.P. pine pollen starts to decline, which indicates a slow trend to desiccation that culminates in mid-Holocene times (Brown, 1985:84). González-Quintero and Sánchez-Martínez (1980) present a pollen diagram from a core in Lake Texcoco that, when excluding the pine values, shows a general decrease in arboreal species which is probably the manifestation of a trend to drier conditions. Ohngemach and Straka (1978) examined a core from Tlaloqua crater situated at 3100 m in the Oriental Basin in the State of Puebla (Figure 9.6), that was also interpreted as showing dry and warm conditions taking over towards the middle Holocene as pine forests establish themselves and spruce disappears. However, *Zea* pollen makes its appearance between 8,300 and 6,000 B.P. as well as the Cheno-Am group and grasses, which thereafter start to show higher and constant values as pine declines due to a slow increase in human disturbance (Brown 1985).

The paleolimnological record also indicates a transition from wet to dry climates between 10 and 7 ka B.P. Bradbury (1989) notes that during this period Lake Chalco became a saline marsh, and its peripheral areas, such as Tlapacoya, were dry. Lozano-Garcia *et al.* (1993) inferred from paleolimnological data the brackish waters of Lake Chalco became fresh that between 12.5 and 9 ka, and that this is the result of a more humid climate that later shifts towards drier conditions in the middle Holocene.

Based on the analysis of sediments at El Tepalcate (Chapter 8), the deposits of Lake Texcoco do not show good resolution for the Holocene because of low rates of sedimentation and the intensive eolian deflation occurred when the bed was exposed. Instead, alluvial deposits provide better information. The example presented in Chapter 7 suggests that from about 6000 B.P. onwards there was an increase in alluviation in the forms of cyclic floods separated by poorly developed soils that qualify only as Fluvents in the USDA classification. These cycles culminate with the deposition of the PGF ash in 5 ka, after which there were further floods, probably resulting from the impact created by volcanic activity. Therefore, the cyclic floods may not necessarily reflect climatic change but recurrent igneous activity on vegetation. As a matter of fact, most of the sediments have an ashy appearance in the lower deposits corresponding to late to mid-Holocene times, although they may well be older ash deposits reworked from upstream. As indicated before, alluvial sequences in active volcanic areas are not good indicators of climatic change. The pollen record from these deposits suggests an extensive community of oaks and juniper on the piedmont and low hills combined with more open vegetation of grasses and shrubs.

Studies on the prehistory of the Basin of Mexico are scarce, and few of them indicate the presence and nature of activities around the lakes of the Basin (Niederberger 1979, 1987; Lorenzo and Mirambell 1986a, 1986b). There is no clue as to how the early inhabitants of the Basin of Mexico interacted with the environment of the alluvial plains, piedmonts and hills. Therefore, we assume that human impact on these ecozones was minimal, and fluctuations of vegetation communities were rather the result of climatic change, and volcanic eruptions.

Early farming landscapes (5,000-3,000 B.P.)

If not warmer, this period may have been close to the present-day climate, since no glacial advances are reported for the high mountains of central Mexico during the middle Holocene. The proxy records show a variety of data that has been interpreted from different views. For instance, Flores-Díaz, (1986) and González-Quintero (1986), based on palynological and sedimentological data from the northeastern shore of Lake Chalco at Tlapacoya, infer high lake levels as a consequence of higher precipitation. Lozano-García *et al.* (1993), based on palynological and magnetic susceptibility data from the center of the lake basin, infer that Lake Chalco was more saline and alkaline until *ca.* 4 ka which is indicative of drier conditions. However, in this case we may consider that alkalinity and salinity are not necessarily the result of dry conditions. Bradbury (1989) postulated the idea that at high levels, Lake Texcoco would spill its saline and alkaline waters onto Lake Chalco. However, the discrepancies in proxy data, the bad resolution of the sedimentation record of these periods in lakes, and the increase in cultural activity make identifying the real climatic conditions for this period problematic.

What seems to be evident in the paleoenvironmental records is the increasing presence of human activities. After 6,000, *Zea* pollen values increase along with the Cheno-Am group and grasses reach a climax around 3,400 B.P.

as pine pollen decreases (González-Quintero and Fuentes-Mata, 1980; Brown, 1985).

There are no archaeological sites reported for the Early Formative period in the Texcoco region, and very few in the Basin, especially in the south. Although the possibility that the visibility of sites was reduced due to post-occupational destruction, erosion or alluviation, it is evident that the levels of population were low and farming sites were small. Our knowledge about the early agricultural communities is still very poor, and we have no clue as to how they farmed the soils of the alluvial plains and piedmonts. From the biological remains recovered from some of the sites, it is known that they hunted and foraged within a great variety of micro-environments that covered an area from the lakes to the mountains.

Although most sites around the lake were oriented toward lacustrine subsistence, there were also large communities at higher elevations. One of the largest sites, that appeared at the end of this period in what is called the Early Horizon is Coapexco, located at a relatively high elevation (2700 m) in the Amecameca Valley. Its location in one of the accesses to the Basin suggests that it was a center connecting the Basin of Mexico with the south and east (Tolstoy 1989) . Excavation yielded exotic obsidian, suggesting that Coapexco was a trade center. However, there is no indication as to what kind of agriculture was practiced in the area. Coapexco is located at the edge of the coniferous forest near a high alluvial plain of recent soils with andic properties that currently are fairly good for agriculture, although they are limited by low temperatures. There is no equivalent alluvial environment at high elevation in the Texcoco region in which similar socio-economic development in Texcoco would be possible.

The other large sites of this period were Ticoman and Cuicuilco, located at the piedmont-alluvial plain interface, but there are no data that accounts for their impact on vegetation, soils and streams in all the various ecological units around them. Since there are no similar sites in the Texcoco region for the Early Formative, it may be that if there were groups, they were mobile and foraged and hunted in parts of the piedmont and alluvial plain, creating minimal impact on vegetation and soils, and if they ever practiced agriculture, this was sporadic and limited in space since food demands were low, given the low levels of population.

The pollen diagram from the Barranca Honda presented in Chapter 7 suggests that oak forest was an important community on the piedmont before 3 ka, and that low values of *Compositae* and Cheno-Am suggest a minimal disturbance. Nonetheless, the effects of the eruption and deposition of the PGF ash, introduce noise to any interpretation of human influence on vegetation.

In summary, the landscape during this phase was not deeply modified by extant populations, so that for the most part it would still qualify as a 'natural environment' in the classification presented above. The possible disturbance by related hunter-gatherers and temporary farming communities created changes in vegetation, but did not produce significant alluviation.

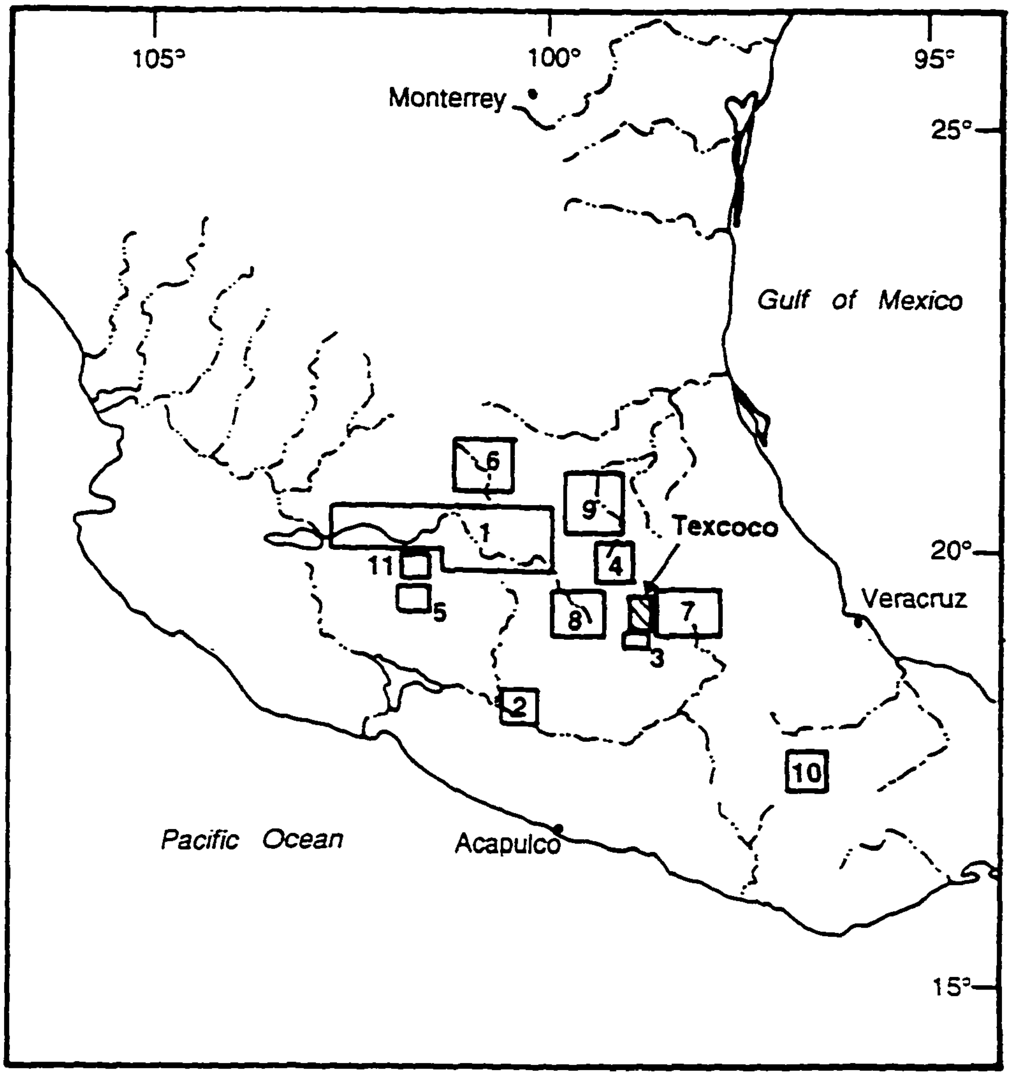
Pre-Aztec landscapes (1,000 B.C.-A.D.1,200)

The rapid proliferation of farming communities in the Basin of Mexico took place at the beginning of this period, but nevertheless settlements in general remained scanty so that large areas were apparently unoccupied, and there were large tracts of uncultivated soils and possibly patches of pre-farming vegetation communities in the piedmonts and hills. Later, in the last half of the first millennium B.C., the agricultural settlements covered areas not occupied before. This scenario is also true for the Texcoco region, starting in the Middle Formative (ca. 650 B.C.) settlements grew in size and number to reach a maximum in the Terminal Formative (*ca.* 100 BC).

Pollen diagrams from lake cores indicate that from *ca.* 1,000 B.C. to the present there was a continuous increase of human impact on vegetation and soils. Since resolution is limited due to the low sedimentation rate in Lake Texcoco, the records show again only trends. González-Quintero and Fuentes-Mata (1980) recorded that while pine values reached their minimum around 2,500 B.P., *Zea*, and Cheno-Am maintained constant values. During the same time, a dramatic drop in oak pollen values followed the low in pine approximately 500 years later. The record also shows that, unlike pine, oak had no further recovery. One reason for this is that oak occupied those tracts on the piedmont open for agriculture, while pine was located higher.

The development of large communities, such as Tlatilco and Cuicuilco, and the increasing advance of hamlets onto the piedmonts during the Formative period, especially between 3 and 2 ka, definitely had an impact on vegetation. During this period, farming communities increased in number and size and reached the lower edge of the pine forest. The decrease in oak pollen recorded in the lake by González-Quintero and Sánchez-Martínez (1980) is also apparent in the diagram from Barranca Honda. Pine values instead show a different trend: paradoxically pine undergoes an increase in values with the advance of populations onto the piedmont. The reason for this, as explained in Chapter 7, is that the upward advance of disturbed and eroded areas reached the edge of the pine forest, and from here, great amounts of pine pollen were carried down into the plains, a long way from the source areas near the pine forest at high elevations. The relative amounts of oak and pine pollen show that the former decreased because it could not thrive again in the eroded landscape of the upper piedmont, which probably was subsequntly covered with shrubs, juniper and ruderals, most of which are Asteraceae.

Climatic fluctuations at the beginning of this period are not clear due to the lack of resolution and the noise created by early human disturbance in the paleoenvironmental record preserved in lakes, the source of most proxy data in the region. However, paleoglacial studies indicate an increase in precipitation since the mountains again experienced glacial activity, although to a lesser degree than in the Pleistocene. The deposits left by this minor glacial advance are called 'Neoglaciation' by White and Valastro (1984) in the Ajusco, and the MIV moraine by Heine (1975) in La Malinche. There must have been dry conditions towards the beginning of our era, since glaciers withdrew and lake levels dropped. Thus, during the Late and Terminal Formative phases, that is to say between 2.5 and 2 ka, large tracts of the lake bed were exposed and occupied by sizable and apparently steady communities, such



1 Bajío
2 Balsas
3 Chalco
4 Huasca
5 Pátzcuaro
6 Río de la Laja
7 Puebla-Tlaxcala
8 Upper Lerma-Toluca Valley
9 Valle del Mezquital
10 Yanhuitlan
11 Zacapu

Figure 9.6 Central Mexico regions and localities mentioned in text.

as El Tepalcate in Lake Texcoco (Chapter 8) and Torremote in Lake Chalco (Serra-Puche, 1988).

In the phases following the Early Formative there were extreme changes in the cultural landscape that provide a clue to explain soil erosion and alluviation. In terms of rapid soil erosion in the Texcoco region during the era between the Middle Formative (*ca.* 850 B.C.) and the formation of the Aztec confederations around the 12th century, there were two major phases of soil destruction and rapid alluviation, one in the Terminal Formative phase (200 B.C.- A.D.100) that is represented in the alluvial stratigraphy by Unit C, recorded in Barranca Honda and Lower Coatepec floodplains, and the second in the Classic-Early Toltec period (ca. A.D. 200 - A.D. 100), which comprises a complex set of deposits grouped into Unit D. The study of soils and erosional features in the piedmont (Chapter 5) showed erosional phases concomitant with Unit D. The one equivalent to Unit C was not recorded, but it is implied by the existence of Formative sites in the piedmont, and testified to by the reworked material found in anthropogenic soils created by semi-terracing in the Postclassic.

The Terminal Formative soil erosion, accounted for by Unit C, coincides with an increase in the number of sites and in agricultural activities in the piedmont and volcanic hills. It is at the end of this period, specifically the Tezoyuca-Patlachique phase, that large number of terraces are known to be associated with settlements, which can be interpreted as a form of soil erosion control taken after the problem had become evident.

The causes of soil erosion in the Classic-Early Toltec period, represented by the alluvial Unit D, are different. The initial denudation events may be associated with the overall abandonment of rural sites in favor of the urban area of Teotihuacan, although it is likely that most of the phases are the result of the back-and-forth process of settlement occupation and desertion during relatively short periods of time due to the political instability of the Epiclassic, or the transition from Classic to Early Toltec (Sanders *et al.* 1979, Parsons 1971, 1989; Blanton *et al.* 1979). This political instability had an impact on settlement distribution that in turn affected the landscape stability of those areas in the borderlands around the Early Toltec polities engaged in warfare with each other, which were themselves separated by truce zones. The scenario that I propose, based on the analysis of the survey data, is that the strongly nucleated polities deliberately left spaces only occupied with temporary hamlets that were intermittently abandoned leaving neglected those recently managed landscapes in or near the truce zones. The alluvial deposits of Unit D are always associated with occupation levels bearing Coyotlatelco pottery. In the piedmont the few Classic sites and most of the Early Toltec sites were severely affected by erosion and reclaimed later by the Aztec, as it is the case of Tx-A-78, Tx-A-57 (east), Tx-A-40, and Tx-A-24 (Aztec Tepetlaoztoc).

There is no certainty as to how climatic fluctuations triggered erosion and alluvial aggradation in these two phases of ecological crisis since there are no detailed proxy data to testify to short-term fluctuations. However, the high water levels recorded in lake Texcoco at El Tepalcate (Chapter 8) and Lake Chalco (Hodge *et al.*, in press) during the Classic and Early Classic suggest an increase in precipitation that may well have been in the form of frequent storms similar to those that produced the Early Colonial floods of the Unit E deposits.

During the Formative, Classic and Early Postclassic periods in the Basin of Mexico, there were erosional phases reported in other regions of central Mexico as well. During the Early and Middle Preclassic periods elsewhere in Mexico, which are equivalent to Early and Middle Formative in the study area, soil erosion is recorded in the Puebla-Tlaxcala region (Heine 1983, Werner, 1986), in the Hoya de San Nicolás de Parangueo in the Upper Lerma (Metcalfe *et* *al.* 1989) and in the basin of Lake Patzcuaro (O'Hara, 1993), all presumed to be the result of disturbance of the original vegetation by early farmers (see Figure 9.6 for locations). In the piedmont of Huasca, Hidalgo, Vázquez-Selem and Zinck (1994) dated an erosional phase to between 450 B.C.to A.D. 280, which is synchronous with the Terminal Formative erosional phase in Texcoco. However, a lack of archaeological survey data in this area makes it difficult to assert similar environmental histories between the two regions.

During the time of the Classic-Early Toltec phases, erosional phases have been reported elsewhere in central Mexico. Phases of soil erosion have been recorded in the Upper Lerma (Metcalfe *et al.* 1989) and the Nochistlan and Yanhuitlan Valleys (Spores 1969; Kirkby, 1972), both of which are presumed to be the result of an increase in population. In the Epiclassic, equivalent with the Early Toltec in Texcoco, there was severe erosion associated with population decline recorded for the Puebla-Tlaxcala region (Heine 1983) and in the Zacapu Basin (Tricart 1992).

There is still an active debate as to how climate influenced settlement and soil erosion in central Mexico in pre-Hispanic times that has been difficult to solve because there is no definite chronology of the climatic fluctuations for this period. However, some clues provided by various data sets suggest certain climatic trends that are consistent between the different regions of central Mexico. The most discussed trend is that of the Classic period, which seems to have been characterized by abundant rains in general, a climatic optimum that created sufficient conditions for the rise of Teotihuacan (Sanders *et al.* 1979). García (1974) presents a scenario based on analogy to modern teleconnections in global climate whereby she develops a model in which most of the Classic in the Basin was characterized by wet conditions that were deteriorating towards desiccation in the second half of the first millennium A.D. This desiccation, according to García's interpretation, was one of the fundamental causes that provoked the fall of Teotihuacan. This hypothesis, however, has never been tested or supported with paleonvironmental data. At a different regional scale, Armillas (1969) and Braniff (1989) are of the opinion that the Classic period was wetter based on the fact that the northern Mesoamerican frontier, as defined by the farming sites, shifted northwards. The assumption regarding lake levels in Lake Texcoco, interpreted from the example of El Tepalcate and settlement pattern (Chapter 8), shows that lake levels dropped in the Terminal Formative, and rose again in the Early Classic. It seems that this rise may have been the result of an increase in precipitation, although it may just as well have been related to changes in the flow of water into Lake Texcoco after the eruption of the Xitli, when several streams were diverted by the lava flow into the Lake Texcoco basin (Córdova et *al.* 1994).

Data from the Puebla-Tlaxcala region indicate also that there were rather wet conditions there, especially between A.D. 300 and 650 (Lauer 1979; Heine 1983, 1988a). All the references, data and hypotheses point out that during Classic times there was a climatic improvement characterized by a high in precipitation. However, with the scarcity of data it is difficult yet to specify the way in which rains were scattered through the year and how intense they were.

The Early Toltec seems to have been still a moist period, probably with fluctuations, tending to a rapid aridity that culminated in the early-mid-1300s (O'Hara et al. 1994), a period which encompassed the end of the Early Toltec phase, the Late Toltec phase and the Early Aztec phase. The levels of lake Texcoco were high but tending to drop, as testified by the beach deposits at El Tepalcate (Chapter 6). The levels of Lake Chalco were again high in the second half of the first millennium A.D. and receded in subsequent centuries. The evidence for this comes from the eastern shore of the lake where a marsh developed around a

Coyotlatelco settlement (Early Toltec) south of modern Chalco (Hodge, Córdova and Frederick, in press). Ever after the Early Toltec period Lake Chalco shows only low water levels or marshy deposits, which implies a continuous drop of lake levels.

The retreat of agricultural settlements from areas of north-central Mexico, or the northern Mesoamerican frontier accompanied by Chichimec invasions may have been the result of the onset of dry conditions that affected more severely those areas north of the Basin as hypothesized by Armillas (1964, 1969) and sustained by Street-Perrott (1994). The Aztec chronicles collected and written in the 16th century refer to a period of drought around the time of the Fall of Tula, which occurred according to the different stories at the end of the 10th century (Sanders *et al.* 1970, Appendix A; Sanders *et al.* 1979; Florescano et al. 1980). There is no certainty as to whether this transition from wet to dry conditions between the 11th and 13th century was related to the so-called Medieval Climatic Anomaly, or simply the Medieval Warm of Europe, for which there exists evidence in paleoclimatic records for the United States and Canada, where it manifested itself as anomalous climatic conditions resulting in landscape instability around A.D. 900 and 1000. (Frederick 1995: 182). The reality is that the effects of such climatic fluctuations on vegetation, hydrology and landscape stability in this period of global warmth, are not known for central Mexico where the main question should be: How did this warm period affect precipitation?

In spite of a lack of solid evidence, it still can be postulated that climate shifted towards wetter conditions between A.D. 100 and 300, remained wet through the Epiclassic, around A.D. 600, and thenceforth rapidly deteriorated towards drier conditions at the beginning of the Late Toltec phase (by A.D. 1100), and remained dry until the Early Aztec phase in the mid-1300s. There is a correlation between these phases and the alluvial chronology of this investigation. Thus, the wet period of the Epiclassic (6th to 8th centuries A.D.) was characterized by abundant rains which in turn eroded the frequently abandoned lands of the piedmonts, producing thereby the sediments of unit D. As a matter of fact, most of the pollen grains deposited in the Barranca Honda in unit D are those of weeds, grasses and to a lesser degree juniper, which suggests that most of the eroded lands were abandoned before sediment and pollen grain mobilization (Chapter 7).

A contemporaneous episode of erosion has been reported for the Puebla-Tlaxcala region during the Texcalac phase (A.D. 700-1100) (Lauer 1979; Heine 1983; Werner 1986). However, the difference with the equivalent Early Toltec phase in Texcoco, which had low population density, is that the Texcalac phase was characterized by high population levels. Yet, the climatic conditions are consistent with those of Texcoco in the sense that this phase is also recognized as a period of higher precipitation that in Puebla-Tlaxcala had an effect on soils damaged under the impact of agricultural intensification (Heine 1988a). During the Texcalac phase, the Tlaxcala region underwent an agricultural expansion that brought the upper limit of farming on the volcanoes to an elevation of 3,000 meters (Heine 1983).

Aztec Landscapes (1200 - 1520)

This period, known also as the Late Postclassic, is characterized by great demographic pressure on the lands of different regions in central Mexico. Landscape instability during this phase has been reported in several regions of central Mexico, as testified by the sedimentary records from several lake basins of the state of Michoacan (Street-Perrot *et al.* 1989) and by the erosive features in both the Puebla-Tlaxcala region (Heine 1983; Werner 1986; Garcia-Cook 1986) and the Yanhuitlan and Nochistlan Valleys (Spores 1969; Kirkby 1972). In all these cases soil erosion was presumably due to an increase of farming activities and consequent vegetation disturbance. In the Nochistlan and Yanhuitlan valleys in Oaxaca, soil erosion is even interpreted as the result of intentional clearing of vegetation and disturbance of slopes with the purpose of producing sediments that were led downhill and caught in terraces (Kirkby 1972).

The Texcoco region presents a different picture since there are no alluvial deposits or piedmont erosional features resulting from a phase of intense erosion. Instead, there is an apparent stability that is evident for the last part of the Early Aztec phase and the entire Late Aztec phase. As discussed in Chapters 5, 6 and 7, the reason for such a stable landscape is the land reclamation process carried out by Aztec farmers in the piedmonts, stimulated by the high levels of population that was evenly dispersed on slopes, which contrasts strongly with the rest of central Mexico, where high levels of population and land-use intensification triggered soil erosion.

Climate during the Late Aztec phase seems to have improved in comparison with the previous phases, but still showed low precipitation with sporadic and profound fluctuations. There are no proxy data from sediments that document the climate of this period in central Mexico. In the area of Michoacan conditions were apparently wet during the Late Postclassic as testified by historical evidence from the levels of Lake Patzcuaro (O'Hara 1993).

For Texcoco, the numerous Aztec chronicles indicate short periods of drought, like the well known 1450-1554 episode (Ixtilxochitl 1977). Lake levels seem to have been lower than in the Classic and Early Toltec phase but higher than in the Late and Terminal Formative. However, since hydrological control of the lake took place in the second half of the 15th century when the dikes were built, it is hard to estimate the real lacustrine levels for this phase. The descriptions made by Cortés (1975), Díaz del Castillo (1968) and Motolinía (1950) suggest that the levels of all the lakes in the Basin were high at the time of the conquest. Unfortunately, there are no proxy data produced by this dissertation that really tell about the climate of this time because of the short span covered by the Aztec phases and the lack of either alluvial or lacustrine deposits. The only inference that can be made from the case of El Tepalcate is that the islet that was covered in the Classic and Early Toltec was a sand bar exposed at times in the Aztec phases, which is thus an indication of variable lake levels.

Spanish Colonial landscapes (1520 - 1810)

Landscape response to human perturbation in the Spanish Colonial period in Mexico has been debated among scholars working in geography, history and anthropology. During Spanish colonization the impact created by the introduction of different methods of farming and specially stock raising caused environmental disturbance. However, the interpretations vary among scholars working in different regions of Mexico because the rates of change and degradation caused by land use changes in the Colonial period in central Mexico vary from region to region as does the fragility and resilience of each environment. In other words, the degree of landscape transformation in pre-Hispanic times depended on the type of land-use implanted by the new-comers as well as the history of degradation of previous land-use in the area.

The methodological focus adopted by individual researchers has sometimes created certain biases. For example, most projects include archival research, although few include *both* archival documentation and physical evidence (geomorphologic, stratigraphic, botanical, etc.). A brief review of some of the investigations in this section is intended to provide an illustration of such regional variations, into which the case of the Texcoco region is to be placed.

Melville (1990, 1994) presents one of the most suggesting examples of land deterioration documented with archival research but without observations on the sedimentary sequences. Her work centers on the Valle del Mezquital, a semi-arid area north of the Basin of Mexico. Her documentary sources are varied, and include the *Relaciones Geográficas*, land descriptions in land litigation cases, censuses of landholdings, and land grants (Mercedes). Her parameters are usually changes in vegetation and hydrography as well as geomorphic events such as stream incision and slope gullying. The argument presented by Melville is that the Early Colonial period was a time of catastrophic land degradation due to sheep overgrazing. Butzer and Butzer (1993) have questioned this research, pointing out the possibility that the land degradation described by Melville has a strong background in the environmental perturbations initiated in the pre-Hispanic period, as purported originally by Cook (1949). Melville's study not only provides few details about degradation from pre-Hispanic times but does not go beyond the sixteenth century into Late Colonial times (Butzer 1992a). Frederick (1995: 242) considers the possibility that some geomorphic changes reported by Melville, such as stream entrenchment, may be related to fluvial response to climatic anomalies, which is rather more plausible in light of the data obtained in Texcoco.

In a reconstruction of the sixteenth-century environment of the Bajío Region, Butzer and Butzer (1993) found in land grant documents (Mercedes) that there was no evidence for a scenario of Spanish stock raising and agriculture having an impact on the vegetation or the hydrological cycle as of about 1590, and that there is no evidence of degradation for the period 1592-1643 since the colonization of the better lands was accompanied by a de-emphasis of stock raising with sheep transhumance expanding to the north and consequently reducing the grazing pressures in the Bajío (Butzer and Butzer 1993: 89).

It seems that some areas with pre-Hispanic agriculture were degraded, especially those that had higher populations in pre-Hispanic times (Metcalfe *et al.* 1989). The Basin of Mexico and the Tlaxcala region, for example, had levels of population and land use intensification that were higher than in colonial times, which is not the case for areas with more nomadic populations, farther north. For instance, in the state of Guanajuato, just north of the Mesoamerican frontier of the sixteenth century, Frederick (1995) found evidence for flooding, incision of rivers and infilling behind *bordos* (dams) as a consequence of erosion, indicating landscape response to agricultural intensification in the eighteenth century.

In a paleoenvironmental study of the sediments of Lake Patzcuaro, O'Hara *et al.*(1993) show that sedimentation due to soil stripping on slopes in pre-Hispanic times was more significant than during Colonial times. They argue that landscape instability indeed decreased after the conquest, and that because populations in the Early Colonial period collapsed there was less pressure on the environment. However, other examples, including the present study in Texcoco, suggest that population collapse does not necessarily leads to landscape stability. Spores (1969) noted that most of the soils destroyed by erosion in the Yanhuitlán region were associated with population decline, terrace abandonment, and slope settlements that have occurred from Early Colonial to modern times.

In the Texcoco region, the sequence of degradation in both Late Aztec and Colonial periods seems to be different from those of the regions mentioned above. The Basin of Mexico had at the time of the conquest a large, stable, and well organized nucleus of population that enabled large, relatively stable agro-enterprises such as the farming of lake beds (*i.e* the *chinampa* system), irrigation networks and terraced complexes. This research has showed that the abandonment of agricultural features such as terraces and check-dams, and the concentration of population in nucleated settlements within the century following the Conquest, induced the landscape to a disequilibrium that led to slope and sediment destabilization and to intense geomorphic activity. Rapid alluviation and stream incision are the best example of how the rupture of retaining devices (e.g. terraces and check-dams) in a transformed and managed landscape produces large amounts of sediments and runoff that cause the fluvial system to exceed geomorphic thresholds.

The bottom line is that the Texcoco region underwent dramatic changes in settlement and land-use after the Conquest within the context of a landscape that had been profoundly transformed, degraded, and reclaimed several times in pre-Hispanic times. Land-use changes, such as grazing and plow agriculture, and settlement patterning changes, consisting in the abandonment of dispersed settlement and concentration in nucleated towns, were not the only cause of degradation since intense rains triggered erosion on the abandoned and overgrazed areas. In this case, the pre-disposition of the landscape to erosion is decisive to trigger an environmental crisis for which periods of intense rain are just a 'climatic stimulus' (Frederick 1995: 242). Thus, two major climatic crises occurred in Early Colonial times, one in the mid-1500s and the other in the period between 1604 and 1629; both of which are represented by the flood deposits of subunit E_1. In the Late Colonial phase, paused periods of rains interluded with droughts occurred in the 1700s and with lesser frequency and intensity in the 1800s. Altogether these rains provoked more floods that resulted in the deposits of subunit E_2. Of these two subunits of deposits, E_1 (Early Colonial) was more catastrophic given the massive character of the deposits; E_2 (Late Colonial) was characterized by several pulses of sedimentation of less intensity separated by plowed soils. This E_2 subunit is thicker in some places because of intentional flooding for irrigation or due to the construction of dams or *bordos* to protect lands and store water in the floodplains. Therefore, the most dramatic change in the Texcocan landscape seems to have occurred in the Early Colonial phase between 1550 and 1630, and the later environmental crises were not as severe either because either the geomorphic system was tending to equilibrium or there was artificial control of the system.

In regard to the intensity of geomorphic activity in the early stages of the Spanish colonization for which Melville (1994) reports many cases of barranca incision in the Valle del Mezquital, Frederick (1995: 242) makes the observation that the occurrence of these geomorphic processes is the result of a climatic anomaly since the trend towards desiccation in the Colonial period has been evident in the light of research by Metcalfe (1987) and O'Hara (1993). Such climatic anomalies are thought by Melville (1994) to be the result of the peak years of the Little Ice Age, but no details are given by any author in relation to the possibility of such an event. Although the trend was towards drying conditions through the Colonial period as Motolinia (1950) noticed after the 1520s, the onset of short periods of intense rains is apparent, and rain was increasingly more abundant towards the early 1600s, declining afterwards and beginning the drying trend with lower recurrence in the mid-1700s where less intense floods are reported. As a matter of fact, Gibson (1964) noted that the governmental concern for the construction of the *Desagüe* , or lake drainage, in the Basin was more intense in the late 1500s and early 1600s period, since the lakes by themselves were in a natural process of desiccation.

The scenario of landscape degradation presented from the observations in Texcoco contradicts the idea stated by Denevan (1992) that the landscape of A.D. 1750 was less affected than was the landscape of A.D. 1492, based on the fact that at the end of the pre-Hispanic era there was more degradation due to large populations and transformed lands associated with degradation, and that after depopulation, the landscape slowly recovered until the end of the colonial period, when European settlement became significant.

A geoarchaeological view of pre-historic and historic soil erosion

The causes of ancient soil erosion have been an issue debated by archaeologists, geographers and geologists working in many regions of the world. The issue is the relative influence of a variety of climatic and human factors (Butzer 1974, 1982; Knox, 1977; Bintliff 1992; Boardman and Bell 1992). The various approaches and methods used in studies of soil erosion in prehistory have resulted in a variety of interpretations that complicate a general consensus as to what is the real influence of climatic changes, whether long- or short-term, and what is the kind of human impact most effective in triggering soil erosion.

There are four factors that create bias in the results of such studies: (1) the physical characteristics of the study area, (2) the availability of information, (3) the methodological approach applied, and (4) the time scale considered. For example, study of the probable human causes of soil erosion in the Mediterranean and in the Mesoamerican regions pose different problems, since in the former we are dealing with different environmental variables, a longer history of sedentary life, and different availability of historical information. Although rugged topography and seasonal rains are to be found in other regions, the Mediterranean realm presents special physical characteristics in regard to the erosivity of precipitation because the rainy season takes place in winter, when shorter insolation periods impede the rapid and effective development of a plant cover. Because of this, vegetation plays a primary role with the interaction of humans (Thornes 1987). On the other hand, in central Mexico, the rainy season is in summer when, because of longer day-light time, the tropical vegetation can grow faster and in abundance, and in some cases is able to keep up with the action of erosive rains.

However, variations not only occur from region to region, but within similar physiographic units (Butzer 1980). In Greece, Van Andel *et al.* (1990) points out the problem between areas that are similar in cultural history, and Frederick (1990) illustrates this problem in north-central Mexico with alluvial chronologies that are disimilar in an area long considered as homogeneous in physical and cultural traits.

The real methodological problem of research projects that attempt to define the causes of soil erosion lies in the focus on one single factor from the beginning of the study, and the consequent establishment of one working hypothesis in mind. In relation to this problem Schumm (1991) points out that the 'multiple-hypotheses approach' is the most appropriate methodological strategy for studies involving earth dynamic processes such as stream modification and erosion, a statement that relies on the fact that the processes involved are highly complex, and of such a nature that two different processes, say climatic and human-induced ones, may result in the construction of a similar landform or deposit (convergence) or one single process may undergo changes along the line and produce two or more different landforms or deposits (divergence). This complexity is reflected in the numerous examples of prehistoric soil erosion and alluviation in the literature. To cite an example, the long debate on arroyo cut and fill in the American southwest has shown that this phenomenon has multiple causes (Cooke and Reeves, 1976). Incision in the 1880s is not only the result of vegetation clearance and the impact of cattle but of a climatic shift that consists in a reduction of winter rains and an increase in more-erosive summer rains (Butzer 1982).

Each region has its own set of problems that are always discussed in the different generations of studies. For instance, in the Mediterranean it is the relative impact of agriculture and grazing, and the rise and decline of civilization, in the American southwest it is the relative influence of climatic change.

In central Mexico, the numerous studies on soil erosion have discussed the causes of soil erosion by focusing on the question of whether intense erosion came with European land use or not. The present research engages this question concluding that in Texcoco soil erosion was indeed severe after the Conquest, but there were periods of intense erosion in pre-Hispanic times as well. It has been shown that in the densely populated areas in pre-Hispanic times intense periods of erosion occurred before the ecological crisis followed the conquest (O'Hara, 1993; Butzer, 1993). Even in areas of North America with low densities of native population, it has been pointed out that even though the impact of European settlers and agricultural systems in North-America was sizable, the natives did create minor disturbances (Trimble 1974).

The results of the present research emphasize the abrupt changes in settlement pattern and land use, on the one hand, and the action of extreme climatic events on the other, both of which occurred in pre-Hispanic and Colonial times.

The literature traditionally blames clearance of forests and land use intensification for triggering soil erosion, which is a process that can imitate climatic fluctuations in a short period of time and create similar deposits and forms in alluvial systems (Knox 1977; Frederick 1995). This assumption for all regions of the world has misled understanding of the problem, since cultures interact differently within the varied environments of the world, and environments have different susceptibilities and rates of resilience. Once again, a multiple-hypotheses approach is required, since there might been different human factors involved.

The implementation of a geoarchaeological approach and methodology is the most appropriate way of tackling the problem of soil erosion and rapid sedimentation, for it allows cooperation between specialists in earth sciences, biological sciences, archaeology and history. Such a geoarchaeological strategy will vary depending on the availability of data. The use of the entire-basin approach, the consideration of ecological zones, settlement histories and a detailed stratigraphy are the necessary elements for accurate interpretation. Intensive survey data as the main source of information on demographic trends in prehistoric times is necessary for studies of soil erosion in prehistory, as shown in the Old World by Van Andel *et al.* (1990) and Chester and James (1991).

The contribution of this research to the knowledge of prehistoric and historic soil erosion in central Mexico and in the scope of geoarchaeology can be summarized as follows:

1. The two main human factors in erosion were changes in settlement pattern and land use.
2. Forest clearance and the creation of managed environments may lead to conditions of instability that reach equilibrium by natural, self-regulatory processes or by human influence. In the latter case, abandonment is the cause of severe soil erosion under the action of post-abandonment extreme climatic events, and short term climatic fluctuations.
3. Given the significance of human impact on soil erosion, climatic factors are secondary, and since no detailed paleoecological information is available it is hard to evaluate the significance of long-term fluctuations. Short-term fluctuations are evident, but seem to be regional or local.
4. Other non-climatic catastrophic events, such as volcanic eruptions, are an ancillary factor of land degradation and consequently rapid alluviation.

5. A geoarchaological approach requires survey data, including off-site remains, and detailed microstratigraphic study. Archival documents, if available, are a very helpful additional tool in this approach.

CHAPTER 10

CONCLUSIONS

This study has illustrated the ecological effects of settlement dynamics and landscape transformation during the last three millennia in the Basin of Mexico. It also contributes to our knowledge of environmental change during the Holocene and yields an insight into potential research problems regarding landscape degradation in pre-Hispanic and post-Conquest times, not only in central Mexico and also in other areas of the New World that experienced dramatic fluctuations of population. The main thrust of this dissertation, the transformation of the Texcocan landscape in pre-Aztec, Aztec and Colonial times, has been evaluated from a geoarchaeological perspective, within a broad geographical approach. Several conclusions can be offered as follows:

1. The Aztec period was characterized by rapid population growth, as evident in the large number of sites that covered most of ecological zones, with exception of the mountains. This rapid increase, especially during Late Aztec times, had an impact on the geomorphic systems in the form of alluvial deposits. However, the alluvial deposits of this period never equaled the magnitude of either the pre-

Aztec or the post-conquest periods of rapid alluvial aggradation.

2. The interlinkage between various cultural features (*e.g.*,terraces, check-dams, aqueducts, reforested areas), soils, and landforms suggests that the processes of erosion and sediment production were brought under control through reclamation of lands previously devastated by erosion. This reclamation process was possible because of the high level of socio-political organization attained by the Aztec-Texcocan society under the aegis of the Acolhua dynasty.
3. The result of this state-sponsored land reclamation process led to the creation of managed environments that in turn sustained an artificial stability of the landscape. This was only achieved by the growth of a peasant population that provided the labor to manage the landscape, under the supervision of the king or the nobility, who in turn controlled the complex tribute system linked to agricultural production.
4. Although these managed environments of the Aztec period were effective in the control of geomorphic processes as long as they were maintained, they were fragile in cases of mismanagement or abandonment. Thus, the population collapse of the sixteenth

century brought irreversible, negative changes to these landscapes.

5. There is no indication of a climatic anomaly involving intense rains during the Aztec phases either in the written chronicles or in proxy data. The latter, however, are difficult to assess since the Aztec period covers a short time span only.
6. The years following the Spanish conquest witnessed an ecological crisis that is well documented. Catastrophic population decline, the abandonment of fields on piedmonts and hills, changes in land use, as well as a switch from dispersed to nucleated settlement pattern, coincided with a cluster of high-magnitude precipitation events that pushed the geomorphic systems across a threshold, that resulted in soil stripping on the slopes, incision in the piedmont and alluvial plains, and catastrophic flooding across the plains.
7. The Early Colonial economy was based on small Spanish enterprises and focused on commercial agriculture and sheep raising, but did not cope well with the pre-existing but abandoned, Aztec system of slope management. The small properties awarded mostly to Spanish, and to a lesser degree to Mestizos and Indians, did not function to create a large

cooperative system of land management or reclamation. Put differently, the Early Colonial economic system did not substitute for the well-adapted, preceding economy that was anchored in a highly controlled dispersed farming system, supported by the homogeneous distribution of a growing peasant population.

8. The stratigraphy of alluvial and geomorphic features such as thick flood deposits and incised stream channels, as well as the large inventory of archival documents studied, suggest that the critical period in terms of environmental change was the Early Colonial phase (1520-1630). During the Late Colonial phase (1630-1820), there also was flooding, accounting for the effects of land degradation, on the one hand, and periods of alternate drought and intense rains, on the other. However, towards the end of the eighteenth century the growth of the haciendas as powerful economic units made the control of geomorphic systems a more viable way of keeping the big estates productive. Thus, rivers were channelized and there were attempts to control erosion in the piedmont.

In addition the evidence presented to support these eight points, it is pertinent to summarize the ecological crises associated with landscape transformation during the same region in pre-Aztec times. This older record is critical to evaluation of landscape transformation during the Aztec/Spanish Colonial transition:

1. During the Formative period there was a slow and ever increasing population, reflected in gradual colonization of the uplands, creating disturbance through vegetation clearance and the use of slope soils for farming. The result was an increase in soil erosion and alluviation of the valleys, that reached a peak in the Terminal Formative period, at the end of the first millennium B.C. At about this time the first terraces appear in the area, indicating efforts to control erosion.
2. Depopulation through most of the Classic period probably returned the systems to equilibrium, but the damage was done, and the system remained highly fragile. Occasional floods occurred at this time, although they were limited to a few basins.
3. The political instability following the collapse of Teotihuacan --from the end of the Classic period and beginning of the Early Toltec phase during the second half of the first millennium A.D.-- was reflected in

an unstable, highly nucleated pattern of settlement. Parts of the uplands were repeatedly occupied and abandoned, promoting instability in the case of poorly managed landscapes. This period was also relatively wet, and intense rains probably took their toll on disturbed lands. There are numerous instances of erosional features and alluvial deposits dating to this period.

4. The damaged landscapes related to these two crises were subject to profound changes in vegetation and soil removal, so that large areas of bedrock and tepetate were exposed. Because the rates of vegetation re-growth and soil formation are low, these landscapes remained barren for centuries, until the Aztecs began to reclaim them during the late 1300s. Earlier, these badland areas had not been attractive for agricultural communities, which seems to explain why settlements remained scarce during the Early Toltec, Late Toltec, and part of the Early Aztec periods.

In addition to the impact of climatic anomalies on the processes of soil erosion and alluviation, there were two critical factors influencing landscape transformation: settlement pattern and land-use change. After the land had been devastated in the early stages of agriculture, a dispersed settlement pattern and intensive agriculture was the only way to keep the lands of the piedmont working and under control, as the case of the Aztec dispersed settlements shows. Settlement nucleation was as low as it had been during earlier periods, characterized by a massive mobilization of sediments. In pre-Hispanic times, those areas beyond the nucleated settlement borders were poorly managed. During the Colonial phase, areas outside the settlement perimeters were abandoned and subject to grazing or plow agriculture o the shallow soils of steeper slopes.

The different study components presented here elucidate an approach to explain landscape change in Texcoco in the late Holocene, identifying the key, underlying mechanisms. However, other problems in Texcoco and other areas of the Basin of Mexico remain to be solved through future research:

1. The effects of dispersal and nucleation on other types of lithology and less susceptible soils.
2. The phases of erosion in other parts of the Basin of Mexico. The chronology of events in Texcoco should not be used to generalize erosional and depositional phases in other areas of the Basin, since settlement histories were different elsewhereregardless of proximity. The results of an ongoing project in Chalco in which I am participating show some

differences in the timing of events. For instance, the first period of intense erosion and alluviation that is associated with settlement activities took place during the Middle Formative --nearly 400-500 years earlier than the first comparable crisis in Texcoco. In the case of the Colonial phase, similar periods of alluviation were evident, although in the particular case of the Amecameca river, sedimentation was more intense during the Late Colonial period, which diverges from the evidence for the Texcocan rivers.

Although the main focus of this research is specific to a particular region, both the methodology and interpretation may contribute to more general questions of anthropogenic soil erosion and valley sedimentation, especially as they relate to ancient changes in settlement patterns and land-use.

APPENDICES

APPENDIX A

MERCEDES LAND GRANTS LOCATED ON MAPS (1560-1630)

I. LAND AND ESTANCIAS

See figures 4.12 to 4.17 for location on map.

1
Year: 1564 Town: Coatepec Place name: Camino a San Mateo
Type of grant: tierra
Status: Merced
Size: caballería y media
Index number in Colin: 215
Document: Mercedes, v.7. f.388 vta.
Requested by Diego de Viedma
Neighbors: Jorge Cerón Carvajal
Zone: Upper piedmont.

2
Year: 1565 Town: Coatepec-Ixtapaluca
Place name: Chichilco
Type of grant: tierra
Status: acordado
Size: 3 caballerías
Index number in Colin: 216
Document: Mercedes, v. 8, f. 149 vta.
Requested by Gerónimo de Bustamante
Zone: Lower piedmont

3
Year: 1565 Town: Coatepec Place name: Matlaxapusco and Metenco
Type of grant: Tierra
Status: Merced
Size: 2 caballerías
Index number in Colin: 217
Document: Mercedes 8, f. 197 vta.
Requested by Juan de Castilla
Zone: Lower piedmont

4
Year: 1567 Town: Coatepec Place name: Tequimitla
Type of grant: tierra Status: merced
Size: 2 caballerías
Index number in Colin: 220
Document: Mercedes
Requested by Antonio de Espinosa
Zone: Upper piedmont

5
Year: 1567 Town: Coatepec
Type of grant: Tierra Status: merced
Size: 2 caballerias

Index number in Colin: 221
Document: Mercedes v. 9 f. 123.
Requested by Pedro Perez.
Neighbors: Hortuño Ybarra and Isabel de San Pedro.
Zone: Upper piedmont

6
Year: 1567 Town: Coatepec
Type of grant: tierra. Status: merced.
Area:
Index number in Colin: 222
Document: Mercedes, v. 9 f.150.
Requested by Andres Estrada.
Neighbor: Juan Navarro.
Zone: Upper piedmont
7
Year: 1583 Town: Texcoco Place name: Xaltelulco
Type of grant: Tierra Status: merced.
Size: 2 caballerias.
Index number in Colin: 2241
Document: Mercedes, v. 12, f. 29 vta.
Requested by Juan de Cueva.
Zone: Alluvial plain

8
Year: 1584 Town: Coatepec-Ixtapaluca Place name: Suchitenco
Type of grant: Tierra Status: merced
Size: 1 caballeria
Index number in Colin: 225
Document: Mercedes, v. 13, f. 77 vta.
Requested by Alonso Martínez.
Neighbors: Not mentioned
Zone: Upper piedmont

9
Year: 1585 Town: Ixtapaluca Place name: Loma San Francisco
Type of grant: tierra Status: Merced
Size: 1 1/5 caballeria
Index number in Colin: 817
Document: Mercedes, v. 13, f. 192.
Requested by Diego de Tariffa
Neighbors: Francisco Rodríguez Chacon.
Zone: Lower piedmont

10
Year: 1589 Town: Acolman Place name: Not specified
Type of grant: Tierra Status: Merced
Area: 1 caballería
Index number in Colin: 1325
Document: Mercedes, v. 15, f. 22.
Requester: Diego de Aguilera

Neighbors: Not specified
Zone: Alluvial plain
Environmental information: Refers to an area that is constinuously flooded and seasonally with water. This seems to be the pond that with the construction of the dam became the lake of Acolman.

11
Year: 1590 Town: Coatepec Place name: Mihuanpachalco Tepetlatengo
Type of grant: Tierra Status: Merced
Area: 4 caballerías
Index number in Colin: 227
Document: Mercedes v. 15, f. 247 vta.
Requester: Antonio Jiménez
Neighbors: To the north, Juan de Villegas; to the east, the lands of the indians of San Miguel and La Trinidad, two estancias of Coatepec.
Zone: Lower piedmont
Environmental information: The place is refered as a hill by the name Mihuanpachalco Tepetlatengo that divides the lands of the Santo Domingo Monastery whose name is Tlacusatlauhco.

12
Year: 1590 Town: Texcoco Place name: Tlamimilulpa
Type of grant: Tierra Status: Acordado
Area: 2 caballerías
Index number in Colin: 2246
Document: Mercedes v. 15 f. 123.
Requester: Diego Ortíz de Oyardía
Neighbors: Not mentioned.
Zone: Upper piedmont
Environmental information: Olopa (Site Tx-A-78) is mentioned as existin on a hill (loma).

13
Year: 1590 Town: Texcoco Place name: Barrio de Santiago Talpica
Type of grant: Tierra Status: Merced
Area: 2 caballerías
Index number in Colin: 2247
Document: Mercedes v. 15, f. 240 vta.
Requester:Alonso de Castañeda
Neighbors:To the north, Diego de Aguilera
Zone: Alluvial plain

14
Year: 1591 Town: Tepexpan Place name: Not mentioned
Type of grant: Tierra Status: Merced
Area: 2 caballerías
Index number in Colin: 2060
Document: Mercedes, v. 18, f. 51.
Requester: Hernando Jaramillo
Neighbors: Jerónimo de Baeza; Beatriz de Herrera.
Zone: Alluvial plain

Environmental information: There is a canal to the north o this land, and a cienega to the south (See 19 below).

15
Year: 1591 Town: Texcoco Place name: Teluycan
Type of grant: Tierra Status: Acordado
Area: 4 caballerías
Index number in Colin: 2252
Document: Mercedes, v. 16, f. 190
Requester: Juand de Rueda
Neighbors:
Zone: Hills
Environmental information: The site locted next to Cerro Tezcutzingo, and nest to a noble settlement Tezacoalco (Tezacouhuac). This used to be an Aztec disappeared settlement (See table 4.2 and map of Figure 4.11 in Chapter 4).

16A
Year: 1591 Town: Texcoco
Place name: Palachiuque, Moyotepec, Apantzingo and Cuauhyacac, all of them hills in La Purificación-Tlaixpan area.
Type of grant: Tierra Status: Acordado
Area: 3 caballerías
Index number in Colin: 2253
Document: Mercedes, v. 17, f. 130.
Requester: Pedro Mejía de Bocanegra
Neighbors: Not mentioned
Zone: Hills
Environmental information: This is a piece of land that Pomar claims as part of his patrimony inherited from his ancestors (Tierras, vol. 2688, exp 35, f. 373; Tierras, vol. 2726, exp. 8, see Appendix G).

16B
Year: 1591 Town: Texcoco
Place name: Palachiuque, Moyotepec, Apantzingo and Cuauhyacac, all of them hills in La Purificación-Tlaixpan
Type of grant: Estancia Status: Acordado
Area: Not specified
Index number in Colin: 2253
Document: Mercedes, v. 17, f. 130
Requester: Pedro Mejia de Bocanegra
Neighbors: Not mentioned, but definetly the indians of Olopa and Apantzingo.
Zone: Hills
Environmental information: This is an estancia that is next to Olopa (Tx-A-78). A litigation on the rejection of the request is in the document Tierras, vol. 2726, exp. 8 of which there are some excerpts in Appendix G).

17
Year: 1592 Town: Coatepec Place name: Not mentioned
Type of grant: Tierra Status: Merced
Area: 1 caballería

Index number in Colin: 228
Document: Mercedes, v. 17, f. 197 vta.
Requester: Juan de Villegas
Neighbors: Not mentioned
Zone: Lower piedmont

18
Year: 1592 Town: Texcoco
Place name: Iztlahuacan, Tlajomulco and Totolteupan.
Type of grant: Estancia Status: Merced
Area: Not specified
Index number in Colin: 2255
Document: Mercedes, v. 19, f. 47.
Requester: Pedro de Contreras Salazar
Neighbors:
Zone: Upper piedmont
Environmental information: The estancia is located near the springs at the base of the mountains.

19
Year: 1593 Town: Tepexpan and Tequicistlan Place name: Not mentioned
Type of grant: Estancia Status: Acordado
Area: Not specified
Index number in Colin: 2060
Document: Mercedes v. 19, f. 156
Requester: Bernardino de Casasola
Neighbors: Jerónimo de Baeza, Hipólito Tovar
Zone: Alluvial plain
Environmental information: The estancia is just west to the river that takes water to the gristmill of Pedro de Requena. The place is located next to a seasonally inundated meadow (cienega).

20
Year: 1593 Town: Texcoco and Tepetlaoztoc
Place name: Chiconquiauhitlemeyo.
Type of grant: Tierra Status: Acordado
Area: 3 caballerías
Index number in Colin: 2257
Document: Mercedes, v. 18, f. 272
Requester: Juan de molina
Neighbors: Not mentioned
Zone: Hills
Environmental information: Chiconaquiauhtlimeyo at this time was an estancia (barrio), that disappeared during the congregaciones. It used to be an Aztec dispersed village (See table 4.2 and map of Figure 4.11 in Chapter 4).

21
Year: 1593 Town: Texcoco Place name: Cerro Aztecate
Type of grant: Tierra Status: Acordado
Area: 3 caballerías

Index number in Colin: 2259
Document: Mercedes, v. 19, f. 148 vta.
Requester: Pedro de Maseguer
Neighbors: Not mentioned
Descriptive location: Hills

22
Year: 1594 Town: Tezoyuca Place name:Not mentioned
Type of grant: Tierra Status: Acordado
Area:4 caballerías
Index number in Colin: 2261
Document: Mercedes, 19, f. 244 vta.
Requester: Bernardino de Casasola
Neighbors: Not mentioned
Zone: Lower piedmont.

23
Year: 1594 Town: Texcoco Place name: Cerro Aztecate
Type of grant: Estancia Status: Acordado
Area: Not specified
Index number in Colin: 2262
Document: Mercedes, 20, f. 2 vta.
Requester: Pedro Martínez de Movillas
Neighbors: Diego de Aguilera; Bartolomé Ficallo
Zone: Hills.

24
Year: 1595 Town: Texcoco Place name: Cerro Aztecatl
Type of grant: Estancia Status: Acordado
Area: Not specified
Index number in Colin: 2263
Document: Mercedes, v. 20 f. 2 vta.
Requester: Cristóbal Hernández
Neighbors: Not mentioned
Zone: Hills

25
Year: 1596 Town: Tequicistlan, Tepexpan and Acolman
Place name: Not mentioned
Type of grant: Tierra Status: Acordado
Area: 6 caballerías
Index number in Colin: 2170
Document: Mercedes, v. 25, f. 53
Requester: Diego de Oballe
Neighbors: Not mentioned
Zone: Alluvial plain

26
Year: 1596 Town: Texcoco Place name: Arboleda de la Transfiguración
Type of grant: Tierra and Estancia Status: Acordado
Area: 2 caballerías
Index number in Colin: 2264

Document: Mercedes, v. 22, fs. 22 and 62 vta.
Requester: Juan Martínez del Campo
Neighbors: Not mentioned
Zone: Lacustrine plain.
Environmental information: This piece of land is located on the lakeshore, near the forest of Ahuehuete (*Taxodium mucronatum*) planted by Nezahualcoyotl.

27
Year: 1597 Town:Tepetlaoztoc Place name:Patlachuza and Cerro Teponazco
Type of grant: Tierra Status: Acordado
Area: 4 caballerías
Index number in Colin: 2011
Document: Mercedes, v. 22, f. 159 vta.
Requester: María de Arriaga
Neighbors: Not mentioned
Zone: Hills

28
Year: 1597 Town: Tepetlaoztoc Place name: Tezontepec and Aztecatl
Type of grant: Tierra Status: Merced
Area: 3 caballerías
Index number in Colin: 2020
Document: Mercedes, v. 22, f. 288 vta.
Requester: Leonor de Saavedra
Neighbors: Not mentioned
Zone: Upper piedmont.

29
Year: 1597 Town: Tepetlaoztoc Place name: Tejalpa Tecalucac
Type of grant: Tierra Status: Merced
Area: 3 cballerías
Index number in Colin: 2026
Document: Mercedes, v. 23, f. 66 vta.
Requester:
Neighbors:
Zone: Lower piedmont.
Environmental information:

30
Year: 1597 Town: Tepetlaoztoc Place name: Cerro Chiapul
Type of grant: Tierra Status: Acordado
Area: 2 caballerías
Index number in Colin: 2014
Document: Mercedes
Requester: Gonzalo de Salazar
Neighbors: Not mentioned
Zone: Lower piedmont.

31
Year: 1597 Town: Texcoco

Place name: Not mentioned but is just south of Chiconcoac.
Type of grant: Tierra Status: Acordado
Area: 2 caballerías
Index number in Colin: 2267
Document: Mercedes, v.22, f. 142 vta.
Requester: Hernando de Núñez
Neighbors: Not mentioned
Zone: Alluvial plain.

32
Year: 1598 Town: Tepetlaoztoc Place name: Not mentioned
Type of grant: Tierra Status: Merced
Area: 3 caballerías
Index number in Colin: 2015
Document: Mercedes, v. 22, f. 168
Requester: Inés de Perea
Neighbors:Gonzalo Vázquez
Zone: Lower piedmont.

33
Year: 1598 Town: Tepetlaoztoc Place name: Cerro Patlachiuhque
Type of grant: Tierra Status: Merced
Area: 4 caballerías
Index number in Colin: 2016
Document: Mercedes, 22, f. 168 vta.
Requester: Ana de Arriaga
Neighbors: Juan Velázquez de Salazar
Zone: Hills.

34
Year: 1598 Town: Tepetlaoztoc
Place name: Cerro Patlachihque and Cerro Guixasto
Type of grant: Tierra Status: Merced
Area: 2 caballerías
Index number in Colin: 2021
Document: Mercedes, v. 22, f. 229.
Requester: Gonzalo de Salazar
Neighbors: Not mentioned
Zone: Hills

35
Year: 1599 Town: Tepetlaoztoc Place name: Teponazco
Type of grant: Tierra Status: Merced
Area: 2 caballerías
Index number in Colin: 2022
Document: Mercedes
Requester: Manuel Chiora Cano
Neighbors: Ana de Arriaga
Zone: Hills

36
Year: 1599 Town: Tepetlaoztoc

Place name: Totoltepeque, and Cerro Chiapul
Type of grant: Tierra   Status: Merced
Area: 4 caballerías.
Index number in Colin: 2024
Document: Mercedes, v. 23, f. 60
Requester: Marías de Mosquera
Neighbors: Bernardo del Pozo

37
Year: 1599   Town: Tepetlaoztoc   Place name: Chicocuayo
Type of grant: Tierra   Status: Merced
Area: 1 caballerías
Index number in Colin: 2023
Document: Mercedes, v. v. 23, f. 50
Requester: Isabel Cortés
Neighbors: Not mentioned, only the lands belonging to the Barrio de San Bernardino
Zone: Hills

38
Year: 1599   Town: Tepetlaoztoc   Place name: Tzitzicastla
Type of grant: Tierra   Status: Merced
Area: 1 caballería
Index number in Colin: 2025
Document: Mercedes, v. 23, f. 65 vta.
Requester: Cibrián de Santa María
Neighbors: Not mentioned. The town of Santo Tomás Apipilhuasco.
Zone: Mountains

39
Year: 1599   Town: Tepetlaoztoc   Place name: Tecalucal
Type of grant: Tierra   Status: Merced
Area: 3 caballerias
Index number in Colin: 2027
Document: Mercedes, v. 23, f. 67
Requester: Marías de Mosquera
Neighbors: Juan Velázquez de Salazar
Zone: Mountains.
Environmental information: The merced includes also a site for a gristmill.

40
Year: 1599   Town: Tepetlaoztoc   Place name:La Trinidad Amalinalpa
Type of grant: Tierra   Status: Merced
Area: 3 caballerías
Index number in Colin: 2028
Document: Mercedes, v. 23, f. 68
Requester: Inés de Perea
Neighbors: Not mentioned
Zone: Hills

41
Year: 1599   Town: Place name: Chiapul

Type of grant: Tierra Status: Merced
Area: 2 caballerías
Index number in Colin: 2029
Document: Mercedes, v. 23, f. 69
Requester: Ana de Arriaga
Neighbors: Not mentioned
Zone: Upper piedmont.

42
Year: 1600 Town: Tepetlaoztoc Place name: Not mentioned
Type of grant: Tierra Status: Acordado
Area: 3 caballerías
Index number in Colin: 2030
Document: Mercedes, v. 23, f. 76 vta.
Requester: Alonso de Santoyo
Neighbors: Hernán Perez and Juan de Alvarado
Zone: Alluvial plain.

43
Year: 1601 Town: Coatepec Place name: Not mentioned
Type of grant: Tierra Status: Acordado
Area:3 caballerías
Index number in Colin: 235
Document: Mercedes, v. 24. f. 82 vta.
Requester: María de Santillán
Neighbors: Lope de Cerón
Zone: Lower piedmont.

44
Year: 1601 Town: Huexotla Place name:
Type of grant: Tierra Status: Acordado
Area: 2 caballerías
Index number in Colin: 706
Document: Mercedes, v. 24, f. 68
Requester: Juan Angel
Neighbors: Juan de Espinosa, Francisco Senteno and Bartolomé de Entrambasaguas.
Zone: Lower piedmont.

45
Year: 1601 Town: Iztapaluca and Coatepec Place name:
Type of grant: Tierra Status: Merced
Area: 6 caballerías
Index number in Colin: 834, 841
Document: Mercedes, v. 24, f. 69 vta.; v. 24, f. 106
Requester: Silvestre de Aybar
Neighbors: Miguel Ruíz and Baltasar de Ochoa. To the north, the lands of the Indians of Coatepec
Zone: Lower piedmont.

46
Year: 1601 Town: Tlaixpan Place name: Not mentined

Type of grant: Tierra Status: Acordado
Area: 4 caballerías
Index number in Colin: 2387
Document: Mercedes, v. 24, f. 82
Requester: Antonio de Novoa
Neighbors: Not mentioned
Zone: Lower piedmont.
Comments: The document mentions that these are the lands left by Pomar. This is probably after his death.

47
Year: 2388 Town: Tlaixpan Place name:
Type of grant: Tierra Status: Acordado
Area: 3 caballerías
Index number in Colin: 2388
Document: Mercedes, v. 23, f. 203
Requester: Juan de Cantoral
Neighbors: To the north and the east, Luis Dueñas (El Molino) and lands of the city of Chiauhtla; to the west, Juan de la Torre; to the south, empty lands (tierras baldías).
Zone: Hills-Lower piedmont.
Environmental information: Two haciendas mentioned: Tleixpa and El Llano. Haciendas oowned by Juan de Pomar. The Cerro Tezcotzingo is mentioned still as a recreation place.

48
Year: 1602 Town: Coatepec Place name: Not mentioned
Type of grant: Tierra Status: Acordado
Area: 3 caballerías
Index number in Colin: 236
Document: Mercedes, 23, f. 232 vta.
Requester: Martín de San Juan.
Neighbors: Lope de Cerron, across the barranca; Doña Marías de Santillán, towards the mountains.
Zone: Upper piedmont.

49
Year: 1602 Town: Coatepec Place name: Not mentioned
Type of grant: Estancia Status: Acordado
Area: Not specified
Index number in Colin: 238
Document: Mercedes, v. 23 f. 248.
Requester: Juana de Santillán.
Neighbors: Not mentioned
Zone: Hills

50
Year: 1602 Town: Coatepec Place name: Xalpatotolaque
Type of grant: Tierra Status: Acordado
Area: 1 caballería
Index number in Colin: 243
Document: Mercedes, v. 24, f. 109 vta.
Requester: Pablo de San Juan

Neighbors: Lope de Cerón
Zone: Lower piedmont

51
Year: 1602 Town:Coatepec Place name: Not mentioned
Type of grant: Tierra Status: Acordado
Area:2 caballerías
Index number in Colin: 244
Document: Mercedes, v. 24, f. 116.
Requester: Baltasar Ochoa de Lexalde
Neighbors: Tierras de los indios de San Juan.
Zone: Upper piedmont

52
Year: 1602 Town: Coatepec Place name: Lomas Tlalchichilco and Tepetlazingo
Type of grant: Tierra Status: Merced
Area: 2 cabalerías
Index number in Colin: 246
Document: Mercedes, v. 24, f. 117
Requester: Pedro de Herrero
Neighbors:
Zone: Upper piedmont
Environmental information: A reservoir (jagüey) that today exists is mentioned

53
Year: 1602 Town: Chimalhuacan/Chicoloapan Place name: Not mentined
Type of grant: Tierra Status: Merced
Area: 2 caballerías
Index number in Colin: 605
Document: Mercedes, v. 23, f. 250 vta.
Requester: Silvestre de Aybar
Neighbors: Tierras de Xuchitengo
Zone:lower piedmont

54
Year: 1602 Town: Texcoco Place name:
Type of grant: Tierra Status: Acordado
Area: 3 caballerías
Index number in Colin: 2276
Document: Mercedes, v. 23, f. 247 vta.
Requester: Pesro de Villaroel
Neighbors: Juan de La Torre, Luis Dueñas, Haceinda El Llano and Cerro Tezcutzingo.
Zone: Lower piedmont

55
Year: 1603 Town: Coatepec Place name: Not mentioned
Type of grant: Tierra Status: Merced
Area: 2 caballerías
Index number in Colin: 249

Document: Mercedes, v. 23, f. 326.
Requester: Diego de Tello
Neighbors: Not mentioned
Zone: Lower piedmont

56
Year: 1603 Town: Coatepec/Coatlinchan Place name: Not mentioned
Type of grant: Tierra Status: Acordado
Area: 4 caballerías
Index number in Colin: 251
Document: Mercedes, v. 23, f. 337
Requester: Juan Martín del Campo
Neighbors: Frailes dominicos, the indians of Chicoloapan, Juan de Palencia and the hacienda of Pedro del Corral
Zone: Lower piedmont

57
Year: 1603 Town: Coatepec/Coatlinchan Place name:
Type of grant: Tierra Status: Acordado
Area: 2 caballerías
Index number in Colin: 254
Document: Mercedes, v. 23, f. 341 vta.
Requester: Alonso de Ledesma
Neighbors: Pedro de Venas
Zone: Upper piedmont
Landscape information: The document mentions that before making arrangements for the grant, the judge hast to verify that the congregation is accomplished. Apparently, the Indians of the area were congregated in Huexotla and Coatlinchan.

58
Year: 1603 Town: Coatepec Place name: Loma de los Zapotes
Type of grant: Tierra Status: Acordado
Area: 1 1/2 caballería
Index number in Colin: 257
Document: Mercedes, v. 24, f. 145 vta.
Requester: Ana de Aguilar
Neighbors: Juan Martín del Campo and Lope Cerón.
Zone: Lower piedmont

59
Year: 1603 Town: Coatepec Place name: Miracopa
Type of grant: Tierra Status: Merced
Area: 1 1/2 caballería
Index number in Colin: 258
Document: Mercedes, v. 24, f. 153
Requester: manuel Jimenez de Armentos
Neighbors:
Zone: Lower peidmont

60
Year: 1603 Town: Coatlinchan Place name: Nextlalpa

Type of grant: Tierra Status: Acordado
Area: 4 caballerías
Index number in Colin: 275
Document: Mercedes, v. 23, f. 24
Requester: Juan de Espinosa
Neighbors: not mentioned
Zone: Alluvial plain

61
Year: 1603 Town: Coatlinchan Place name: not mentioned
Type of grant: Tierra Status: Acordado
Area: 2 caballerías
Index number in Colin: 277
Document: Mercedes, v. 23, f. 333
Requester: Miguel Senteno
Neighbors: Martín Delgado and Juan Martínez del Campo
Zone: Lower piedmont

62
Year: 1603 Town: Coatlinchan Place name:
Type of grant: Tierra Status: Acordado
Area: 3 caballerías
Index number in Colin: 278
Document: Mercedes, v. 24, f. 152
Requester: Francisco de Arellano
Neighbors: Juan Martínez del Campo
Zone: Lower peidmont

63
Year: 1603 Town: Chicoloapan Place name: Cocoquitlán
Type of grant: Tierra Status: Merced
Area: 4 caballerías
Index number in Colin: 563
Document: Mercedes, v. 23, f. 337
Requester: Pedro del Corral
Neighbors: not mentioned
Zone: Lower piedmont

64
Year: 1603 Town: Chimalhuacan Place name: Cerro La Caldera
Type of grant: Estancia Status: Acordado
Area: not specified
Index number in Colin: 609
Document: Mercedes, v. 23, f. 319
Requester: Hernando Rangel
Neighbors: not mentioned
Zone: Lower piedmont

65
Year: 1604 Town: Chicoloapan Place name: not mentioned
Type of grant: Tierra Status: Merced
Area: 2 caballerías

Index number in Colin: 564
Document: Mercedes, v. 24, f. 191 vta.
Requester: Juan Martín del Campo
Neighbors: Estancia de Santa María Nativitas, Jan de Palencia and the 'religiosos de Santo Domingo'.
Zone: Lower piedmont

66
Year: 1605 Town: Coatepec Place name: Not mentioned
Type of grant: Tierra Status: Acordado
Area: 4 caballerías
Index number in Colin: 260
Document: Mercedes , v. 25, f. 20
Requester: Pedro de Badillo
Neighbors: Lope Cerón Carvajal and Bernardino de Estrada
Zone: Upper piedmont

67
Year: 1605 Town: Chimalhuacan Place name: Cerrp La Caldera
Type of grant: Estancia Status: Acordado
Area: Not specified
Index number in Colin: 612
Document: Mercedes, v. 25, f. 17.
Requester: Juan de Miranda
Neighbors: Not mentioned
Zone: Hills

68
Year: 1605 Town: Chimalhuacan Place name: Guatongo
Type of grant: Tierra Status: Acordado
Area: 4 caballerias
Index number in Colin: 667
Document: Mercedes, v. 25. f. 29.
Requester: Martin de Urquiaga
Neighbors:
Zone: Lower piedmont

69
Year: 1606 Town: Coatlinchan Place name: San Jerónimo Suapitlan
Type of grant: Estancia and Tierra Status: Acordado
Area: 2 caballerías for land, and not specified for the estancia
Index number in Colin: 280
Document: Mercedes, v. 25, f. 89
Requester: Nicolás de Espinosa
Neighbors: Juan López de Erojal (estancia)
Zone: Upper piedmont

70
Year: 1606 Town: Chicoloapan Place name: Cuautitlan
Type of grant: Tierra Status: Acordado
Area: 2 caballerías
Index number in Colin: 565
Document: Mercedes, v. 25, f. 108

Requester: 2 caballerías
Neighbors: Not mentioned
Zone: Alluvial plain
Environmental information: The spring called Hijualoatl is mentioned as a reference of one of the limits of the land. This spring appears in the map of the Relaciones Geográficas (Acuña 1986) under the name of 'Chicualoatl', from where the town took its name. In further documents the spring is not mentioned.

71
Year: 1606 Town: Huexotla/Coatlinchan Place name:Barrio de San Bernardino Atengo.
Type of grant: Tierra Status: Acordado
Area: 2 caballerías
Index number in Colin: 711
Document: Mercedes, v. 25, f. 37
Requester: Hernando de Sandoval
Neighbors: Not mentioned
Zone: Alluvial plain

72
Year: 1606 Town: Huexotla Place name: La Asunción
Type of grant: Tierra Status: Merced
Area: 2 caballerías
Index number in Colin: 713
Document: Mercedes, v. 25, f. 69.
Requester: Alonso Lazo de la Vega
Neighbors: The indians of Huexotla
Zone: Upper piedmont
Environmental information: The town of La Asunción [Tequexquinahuac] is mentioned as being close to a 'pedregal'(wastelands). It probably refers to the badlands were site Tx-A-86 is located.

73
Year: 1606 Towns: Tequicistlan, Tepexpan and Acolman
Place name: Not mentioned
Type of grant: Tierra Status: Acordado
Area: 6 caballerías
Index number in Colin: 2170
Document: Mercedes, v. 25, f. 53 vta.
Requester: Jerónimo Bermúdez
Neighbors: Not mentioned
Zone: Alluvial plain
Environmental information: Located in the area between Tepexpan and Tequicistlan.

74
Year: 1606 Town: Texcoco Place name: Ximilpa, Chimilpa and Teliuca
Type of grant: Tierra Status: Merced
Area: 2 caballerías
Index number in Colin: 2288 and 2295
Document: Mercedes, v. 23, f. 158

Requester: Francisco de Arellano
Neighbors: Andrés de Montalvo
Zone: Lower piedmont

75
Year: 1606 Town: Texcoco
Place name: Isquipayac (La Transfiguración)
Type of grant: Tierra Status: Acordado
Area: 4 caballerías
Index number in Colin: 2297
Document: Mercedes, v. 25, f. 166 vta.
Requester: Francisco Coronado
Neighbors: Hernando de Santoyana
Zone: Alluvial plain

76
Year: 1607 Town: San Buenaventura and Cuanalan
Place name: Cerros Quauhtepuchi, Conquiautl and Tlamanto and in the 'llano' next to them
Type of grant: Tierra Status: Acordado
Area: 6 caballerías
Index number in Colin: 177
Document: Mercedes, v. 23, f 448
Requester:Francisco de Leyva
Neighbors: Not mentioned
Zone: Alluvial plain
Lanscape information: The 'llano' plain is the San Juan river floodplain. It mentions a seasonal pond formed in this area that seems to be the back-swamp in some parts of the floodplain.

77
Year: 1607 Town: Tepetlaoztoc. Place name: The slopes named as Metepec Acoyogua Milepan and Quahuyo
Type of grant: Estancia Status: Merced
Area: Not specified
Index number in Colin: 2037
Document: Mercedes, v. 25, f. 263
Requester: The natives of Tepetlaoztoc
Neighbors: Not mentioned
Zone: Hills

78
Year: 1607 Town: Texcoco Place name: San Juan [Olopa]
Type of grant: Tierra Status: Acordado
Area: 1/2 caballería
Index number in Colin: 2302
Document: Mercedes v. 25
Requester: Alonso Laso
Neighbors: Alonso Pérez Villazón
Zone: Upper piedmont
Environmental information: The document mentions that the settlement that used to be in this site was depopulated by congregation, and that the former settlers, all of them Indians, were moved to Texcoco.

79
Year: 1607 Town: Texcoco Place name: Los Altos, estancias de San Jerónimo, San Marcos and la Ascención de San Agustín.
Type of grant: Tierra Status: Merced
Area: 2 caballerías
Index number in Colin: 2305
Document: Mercedes, v. 25, f. 260 vta.
Requester: Martín de Urquiaga
Neighbors: Not mentioned by name, but it can be assumed that the neighbors are the estancias listed above as 'place name'.
Zone: Upper piedmont
Environmental information: There is mention of this road that runs along the upper piedmont and leads to Puebla, probably via Río Frio. This is the so called Camino de los Altos (See also 81).

80
Year: 1607 Town: Texcoco Place name: Not mentioned
Type of grant: Tierra Status: Acordado
Area: 2 caballerías
Index number in Colin: 2306
Document: Mercedes, v. 25, f. 263
Requester: Juan de Gámiz Echavarría
Neighbors: Not mentioned
Zone: Lower piedmont

81
Year: 1607 Town: Place name: Los Altos
Type of grant: Tierra Status: Merced
Area: 4 caballerías
Index number in Colin: 2310
Document: Mercedes
Requester:Alonso de Villafaña
Neighbors: Pedro de Contreras (dueño de hacienda)
Zone: Upper piedmont
Environment information: Los Altos or Los Altos de Texcoco is the name that was used to refer to the upper piedmont in the Colonial period.

82
Year: 1608 Town: Tepetlaoztoc
Place name: Zacatitlán, Huexocalco and Chimalpa.
Type of grant: Tierra Status: Merced
Area:
Index number in Colin: 2041
Document: Mercedes
Requester: Juan de Gámiz Echevarría
Neighbors: The Indians of Xaltepeque and Teocaltitlan
Zone: Lower piedmont
Environmental information: The rodad to Calpulalpan is mentioned. Xaltepeque and Teocaltitlan, two Indian settlement, are also mentioned. The 'Pago de Tlaxayoc, is also an important landmark.

83
Year: 1609 Town: Tepetlaoztoc/La Purificación
Place name: La Purificación, Ostotipac and Patlachuca.
Type of grant: Tierra Status: Merced
Area: 2 caballerías
Index number in Colin: 2042 and 2043
Document: Mercedes, v. 26, f. 18
Requester: Leonor de Saavedra
Neighbors: Pueblo de la Purificación.
Zone: Hills
Landscape information: The two caballerías granted are intended to compensate land formerly requested to settle Indians during the congregation.

84
Year: 1609 Town: Texcoco Place name: La Transfiguración/ Atengo.
Type of grant: Tierra Status: Acordado
Area: 12 caballerías
Index number in Colin: 2316
Document: Mercedes v. 26, f. 239
Requester: Hernán Vázquez de Acuña
Neighbors: Pueblo de la Transfiguración
Zone: Alluvial plain
Environmental information: It mentions a canal that leads water to Nezahualcoyotl's forest. The document mention that the indians know the canal as 'Atengo' that probably carried the waters of the Papalotla as suggested by the Uppsala map (Linne 1948). Aerial photograph observations, as well as field observations made think that this is the ditch built by Nexahualcoyotl and mentioned by Pomar (1985).The ditch is now covered in some parts, in other is still in use, and in others is part of the Xalapango river channel.

85
Year: 1613 Town: Atengo, La Transfiguración Place name:
Type of grant: Tierra and Estancia Status: Acordado
Area: 4 caballerías
Index number in Colin: 105
Document: Mercedes, v. 28, f. 235.
Requester: Juan de Ayala
Neighbors: Diego de Ochandiano
Zone: Alluvial plain
Environmental information: The lakeshore is mentioned as a boundary. A canal is also mentioned, which probably is either the Papalotla or San Juan river channels. Two natural mounds are also mentioned, Tepecingo and Cuatepec.

86
Year: 1613 Town: Coatlincahn, Cuautlalpan, Chicoloapan and Coatepec Place name: Not mentioned
Type of grant: Tierra Status: Merced
Area: 2 caballerías
Index number in Colin: 283
Document: Mercedes, v. 27, f. 217 vta.
Requester: Juan Martín del Campo.

Neighbors: Not mentioned
Zone: Lower piedmont

87
Year: 1613 Town: Chiauhtla Place name: Nidepampa, Indapampa
Type of grant: Tierra Status: Merced
Area: 2 caballerías
Index number in Colin: 554 and 555
Document: Mercedes,
Requester: The mayor and governor of Chiauhtla
Neighbors: Not mentioned
Zone: Alluvial piedmont
Environmental information: The land limits are the Papalotla river to the north and a canal to the south. It is likely that this canal is the so-called Atengo of 84.

88
Year: 1613 Town: Chicoloapa Place name: not mentioned
Type of grant: Tierra Status: Merced
Area: 2 caballerías
Index number in Colin: 566
Document: Mercedes, v. 27, f. 216
Requester: Luis Moreno
Neighbors: Juan Martínez del Campo, Pedro del Coral and Tomás Marteinez
Zone: Lower piedmont

89
Year: 1613 Town: Tepetlaoztoc Place name: Xalapa
Type of grant: Tierra Status: Acordado
Area: 3 caballerías
Index number in Colin: 2046
Document: Mercedes, v. 28, f. 79 vta.
Requester: Francisco Teellez
Neighbors: Juan de Lequízamo
Zone: Mountains
Environmental information: Mention of landmarks and hills.

90
Year: 1613 Town: Tepexpa/Tequicistlan Place name:
Type of grant: Tierra Status: Merced
Area: 6 caballerías
Index number in Colin: 2064
Document: Mercedes, v. 27, f. 168 vta.
Requester: Pedro Serrano del Arco
Neighbors: Fernando de la Marcha and Francisco Gómez
Zone: Alluvial plain
Landscape information: Canals and landmarks are mentioned.

91
Year: 1613 Town: Tepexpan Place name: Amitlali
Type of grant: Tierra Status: Merced
Area: 2 caballerías

Index number in Colin: 2066 and 2068
Document: Mercedes, v. 31, f. 287 vta.
Requester: the community of Tepexpan
Neighbors: Juan Castillo
Zone: Alluvial plain
Environmental information: The canal of the San Juan river is mentioned as having ahuehuetes along.

92
Year: 1613 Town: Texcoco/Chiauhtla Place name: not mentioned
Type of grant: Tierra Status: Acordado
Area: 3 caballerías
Index number in Colin: 2321
Document: Mercedes, v. 27, fs. 186 vta. and 196 vta.
Requester: Diego Vázquez Sámano
Neighbors: Hacienda de Jerónimo Treviño and Pueblo de San Simón.
Zone: Alluvial plain
Environmental information: Landmarks mentioned.

93
Year: 1613 Town: Texcoco Place name:
Type of grant: Tierra Status: Merced
Area: 2 caballerías
Index number in Colin: 2322 and 2323
Document: Mercedes
Requester: Nicolás de Ahedo
Neighbors: not mentioned
Zone: Alluvial plain
Environmental information: The Texcoco river channel is mentioned as emptying into the lake near the 'embarcadero' (port).

94
Year: 1613 Town: Texcoco Place name: Calalpan
Type of grant: Tierra Status: Acordado
Area: 2 caballerías
Index number in Colin: 2325
Document: Mercedes, v. 27, f. 246
Requester: the community of Texcoco
Neighbors: Barrios of San Felipe, Santa inees and Santa Cruz
Zone: Alluvial plain

95
Year: 1613 Town: Texcoco Place name: Buenavista and Mazatlán
Type of grant: Tierra Status: Merced
Area: 6 caballerías
Index number in Colin: 2329 and 2333
Document: Mercedes, v. 28, f. 151
Requester: Governor, mayor and regents of Texcoco
Neighbors: not mentioned
Zone: Alluvial plain

96
Year: 1613 Town: Texcoco/Tequicistlán Place name: not mentioned

Type of grant: Tierra Status: Merced
Area: 6 caballerías
Index number in Colin: 2330
Document: Mercedes, v. 28 f. 35 vta.
Requester: Francisco Domínguez
Neighbors: not mentioned
Zone: Alluvial plain
Environmental information: There are several cultural features mentioned in the area of Nexquipayac. There is a dike (albarrada) that could have been placed to contain the floods of the San Juan or Papalotla rivers.

97
Year: 1613 Town: Texcoco Place name: La Presentación
Type of grant: Tierra Status: Merced
Area: 1 caballería
Index number in Colin: 2331
Document: Mercedes, v. 28, f. 125 vta.
Requester: Domingo de Alaiza
Neighbors: Juan de la Torre
Zone: Alluvial plain
Environmental information: There is mention of an arroyo that comes from Papalotla to the church of San Pablo [Chimalpan?]. This fact denotes the southernmost channel of the Papalotla river.

98
Year: 1614 Town: Tepetlaoztoc
Place name: Tepayacan
Type of grant: Tierra Status: Acordado
Area: 3 caballerías
Index number in Colin: 2050
Document: Mercedes
Requester: The community of Tepetlaoztoc
Neighbors: The lands of Chiautla
Zone: Lower piedmont
Environmental information: According to the descriptions, the place is probably the so-called cerro Aztecatl. This is a small scoria cone with caves.

99
Year: 1614 Town: Texcoco, Coatlinchan and Huexotla
Place name: Xolotepa
Type of grant: Tierra Status: Merced
Area: 2 caballerías
Index number in Colin: 2336
Document: Mercedes, v. 28, f. 323
Requester: Nicolás de Ahedo
Neighbors: Andrés Montalvo and José de Mendoza
Zone: Lower piedmont

100
Year: 1614 Town: Texcoco/Chiauhtla Place name:

Type of grant: Tierra Status: Acordado
Area:4 caballerías
Index number in Colin: 2337
Document: Mercedes, v. 28, f. 323
Requester: Juan de Ayala
Neighbors: Juan Martínez del Campo
Zone: Lower piedmont

101
Year: 1615 Town: Coatepec Place name: Jocoatlaco
Type of grant: Tierra Status: Acordado
Area: 2 caballerías
Index number in Colin: 269
Document: Mercedes, v. 32, f. 24
Requester: Alvaro López de Soria
Neighbors: Lands of the Coatepec Indians
Zone: Upper piedmont

102
Year: 1615 Town: Chiautla
Place name: Zapotlán and Cuetlan Tequepan
Type of grant: Tierra Status: Acordado
Area: 4 caballerías
Index number in Colin: 559
Document: Mercedes, v. 30, f. 187
Requester: Juan de Ayala
Neighbors: not mentioned
Zone: Alluvial plain
Environmental information: The Xalapango canal is mentioned and its location described.

103
Year: 1615 Town: Chiautla Place name:La Purificación, La Asunción, San Bartolomé [Ixquititlan] and Pago de Tapotlan, Cuetlan Tequepan.
Type of grant: Tierra Status: Acordado
Area: 4 caballerías
Index number in Colin: 559
Document: Mercedes, v. 30, f. 187
Requester: Juan de Ayala
Neighbors: Juan Muñiz del Campo and Leonor de Dueñas
Zone: Alluvial plain
Landscape information: Fairly accurate description of the Xalapango canal. The text indicates that the canal passes just south of Chiautla. The Xalapango canal brought water from the Papalotla to the Ahuehete forest since the times of Nezahualcoyotl. The document refers to this canal as "zanja antigua" ancient ditch.

104
Year: 1615 Town: San Simón
Place name: San Simón Hueycaliapango
Type of grant: Tierra Status: Merced
Area: 2 caballerías
Index number in Colin: 1480

Document: Mercedes, v. 30, f. 294
Requester: Governor and community of Texcoco
Neighbors: Agustina Bermúdez and the lands of Chiautla
Zone: Alluvial plain
Environmental information: The Xalapango ditch is also mentioned.

105
Year: 1615 Town: Texcoco
Place name: Not mentioned
Type of grant: Tierra Status: Merced
Area: 3 caballerías
Index number in Colin: 2340 (request), 2343 (merced)
Document: Mercedes, v. 28, f. 394, and v. 30, f. 204 vta.
Requester: Juan García de Ponce
Neighbors: Not mentioned
Zone: Alluvial plain
Environmental information: There is mention of the old Papalotla Channel paralleling the road connecting Nexquipayac and Papalotla, near San Pablo. There is mentioned of a church (an hermitage) damaged by a flood (See also Colín, No. 2340).

106
Year: 1615 Town: Texcoco Place name: San Simón Hueycali Ayapango
Type of grant: Tierra Status: Acordado
Area: 2 caballerías
Index number in Colin: 2341
Document: Mercedes, v. 30, f. 187
Requester: Governor and mayor for the community of Texcoco
Neighbors: Not mentioned
Zone: Alluvial plain
Environmental information: Location near the Xalapnago canal.

107
Year:1615 Town: Texcoco Place name:
Type of grant: Tierra Status: merced
Area:2 caballerías
Index number in Colin: 2346
Document: Mercedes, v. 32, f. 10
Requester: Mayor and regents for the community of Texcoco.
Neighbors: Not mentioned
Zone: Alluvial plain

108
Year: 1616 Town: Place name:
Type of grant: Tierra Status: Merced
Area: 2 caballerías
Index number in Colin: 2344 and 2355
Document: Mercedes, v. 32, f. 195.
Requester: Juan de Vargas
Neighbors: Not mentioned
Zone: Alluvial plain

109
Year: 1617 Town: Huexotla Place name:
Type of grant: Tierra Status: Merced
Area: 1 caballerías
Index number in Colin: 721
Document: Mercedes, v. 33, f. 128 vta.
Requester: Pedro Sánchez
Neighbors: Not mentioned
Zone: Alluvial plain-lower piedmont
Environmental information: Aztec wall and Early Colonial bridge are mentioned.

110
Year: 1617 Town: Tepexpan/Tequicistlán Place name:
Type of grant: Estancia Status: Acordado
Area: 6 caballerías
Index number in Colin: 2069 and 2071
Document: Mercedes, v. 333, f. 80
Requester:Fernando de Baeza y Marcha
Neighbors: Not mentioned
Zone: Alluvial plain

111
Year: 1622 Town: Texcoco/S. J. Teotihuacan Place name:
Type of grant: Tierra Status: Acordado
Area:
Index number in Colin: 2365
Document: Mercedes, 35, f. 175 vta.
Requester: Felipe Martínez
Neighbors: Diego de Ochandiano and Felipe Cobo de Soberanis, to the north. Antón Vizcaino, to the east.
Zone: Alluvial plain
Comments: The area requested is divided into two locations. One in the Teotihuacan Valley and the other in the Alluvial-lacustrine plain west of Huexotla. The location considered in the map is the latter.

II. GRISTMILLS AND IRRIGATION GRANTS
(Only the ones located on the map of Figure 420).

II.1 Gristmills

1
Year: 1585-1586 Town: Texcoco Place name: Cuzcacuaco, Cuzcana
River: Coaxacuaco Status: Merced
Index number in Colin: 2243
Document: Mercedes, v. 13, f.147
Requester: Pedro de Dueñas
Environmental information: This is the location of the Hacienda Molino de Flores.

2
Year: 1586 Town: Texcoco Place name: Cuzquana
River: Coaxacuaco Status: Merced

Index number in Colin: 2243
Document: Mercedes, v. 13, f. 226 vta.
Requester: Juan Maldonado de Montejo
Environmental information: There is a waterfall at the place mentioned.

3
Year: 1597 Town: Texcoco Place name: Tlaixpan
River: Coaxacuaco Status: Acordado
Index number in Colin: 2266
Document: Mercedes, v. 22, f. 129 vta.
Requester: Juan de Pomar

4
Year: 1613 Town: Texcoco/ Nexquipayac Place name: Not mentioned
River: San Juan Teotihuacan Status:
Index number in Colin: 2320
Document: Mercedes, v. 27, f. 164 vta.
Requester: Juan López de Castilla

5
Year: 1607 Town: Tepetlaoztoc Place name:
River: Xalapango Status: Merced
Index number in Colin: 2040
Document: Mercedes, v. 25, f. 445 vta
Requester: Diego Molina y Padilla

II.2 Irrigation

1
Year: 1600 Town: Tepexpan Place name:
River: San Juan Teotihuacan Status: Acordado
Index number in Colin: 2062
Document: Mercedes, v. 24, f. 29
Requester: Hernando de Jaramillo

2
Year: 1608 Town: Texcoco Place name: San Pablo
River: Papalotla Status: Merced
Index number in Colin: 2313
Document: Mercedes, v. 26, f. 41
Requester: Juan García Ponce

3
Year: 1614 Town: Atengo/La Transfiguracion
Place name: La Transfiguracion
River: Papalotla Status: Acordado
Index number in Colin: 106
Document: Mercedes, 28, f. 303 vta.
Requester: Juan de Ayala

4
Year: 1617 Town: Papalotla
Place name: San Bartolomé Tezoquipan and Cuauzyacac
River: Papalotla Status: Acordado

Index number in Colin: 1426
Document: Mercedes, v. 33, f. 118 vta.
Requester: Antonio Padilla

5
Year: 1613 Town: Tepexpan Place name: Not mentioned
River: San Juan Teotihuacan Status: Acordado
Index number in Colin: 2063
Document: Mercedes, v. 27, f. 145 vta.
Requester: Mariana de la Marcha
Neighbors: Not mentioned
Zone: Alluvial plain

6
Year: 1612 Town: Texcoco Place name: Not mentioned
River: Coaxacuaco Status: Merced
Index number in Colin: 2318
Document: Mercedes, v. 27, f. 47 Bis.
Requester: Agustina Bermúdez
Neighbors: Not mentioned
Zone: Alluvial plain

7
Year: 1614 Town: Place name:
River: Papalotla/Xalapango Status: Merced
Index number in Colin: 2335
Document: Mercedes, v. 28, f. 288
Requester: Juan de la Torre
Neighbors: Not mentioned
Zone: Alluvial plain

8
Year: 1615 Town: Place name:
River: Papalotla Status: Merced
Index number in Colin: 2343
Document: Mercedes, v. 30, f. 204 vta.
Requester: Juan García de Ponce
Neighbors: Pedro de Campos
Zone: Alluvial plain
Environmental information: More details on the southern Papalotla channel.

9
Year: 1616 Town: Texcoco Place name: Not mentioned
River: San Juan Teotihuacan Status: Acordado
Index number in Colin: 2349
Document: Mercedes, v. 31, f. 101
Requester: Diego de Ochandiano
Neighbors: Not mentioned
Zone: Alluvial plain
Environmental information: Laguna de Zozolapa (Totolapa) is mentioned. This is probably the lake formed near Acolman even before the construction of the dam.

10
Year: 1616 Town: Texcoco Place name: Tetlanapa (arroyo)
River: Texcoco Status: acordado
Index number in Colin: 2353
Document: Mercedes, v. 32, f. 72
Requester: The city of Texcoco
Neighbors: Diego de Isceña
Zone: Alluvial plain
Environmental information: This is the Texcoco river. The ahuehuetes that still exist SE Texcoco are mentioned.

APPENDIX B
NUMBER OF SETTLEMENTS BY TYPE, PHASE AND ECOLOGICAL ZONE

Key: MF: Middle Formative

LF: Late Formative

TF: Terminal Formative

EC: Early Classic

LC: Late Classic

ET: Early Toltec

LT: Late Toltec

EA: Early Aztec

LA: Late Aztec

ES: Early Spanish Colonial

Types of settlements are defined in Table 4.1

HILLS

Types of settlement	MF	LF	TF	EC	LC	ET	LT	EA	LA	ES
Provincial center		1								
Nucleated villages										
Large		1								
Small	1		1							
Dispersed villages										
Large										
Small		1						1	5	
Semidispersed villages										2
Hamlets	1	6	4	1	2	1	8	6	15	3
Elite district			4				1		2	
Ceremonial precinct		1	1	1		2	2	2	8	
Total	2	10	10	2	2	3	11	9	30	5

UPPER PIEDMONT

Types of settlement	MF	LF	TF	EC	LC	ET	LT	EA	LA	ES
Provincial center			1						3	1
Nucleated villages										
Large		1								
Small			3		1			1		
Dispersed villages										
Large			1		1	1			10	
Small		2	4			2	1	3	11	1
Semidispersed villages										2
Hamlets	4	4	9	12	1	2	14	24	26	
Elite district			1							
Ceremonial precinct			1						5	
Total	4	7	20	12		5	15	28	55	4

LOWER PIEDMONT

Types of settlement	MF	LF	TF	EC	LC	ET	LT	EA	LA	ES
Provincial center			2	1	1	3	1	2	5	
Nucleated villages										
Large	1	1	1			3		1		5
Small		1		2		1	2	1		15
Dispersed villages										
Large			1			1	1		8	
Small		2	4	4		2	5	2	9	1
Semidispersed villages										3
Hamlets	11	9	8	23	15	9	15	22	10	13
Elite district			2							
Ceremonial precinct			1	1					2	
Total	12	13	19	31	16	19	24	28	34	37

ALLUVIAL PLAIN

Types of settlement	MF	LF	TF	EC	LC	ET	LT	EA	LA	ES
Provincial center			1						3	1
Nucleated villages										
Large						1			1	7
Small			1						3	16
Dispersed villages										
Large							2		1	
Small		1				1	1		9	
Semidispersed villages										
Hamlets	2	3	2	6	6	1	17	17	15	9
Elite district										
Ceremonial precinct										
Total	2	4	4	6	6	3	20	17	27	33

LACUSTRINE PLAIN

Types of settlement	MF	LF	TF	EC	LC	ET	LT	EA	LA	ES
Provincial center										
Nucleated villages										
Large			1							
Small										
Dispersed villages										
Large										
Small		1					1		1	
Semidispersed villages										
Hamlets		2	1			2	9	1	12	2
Elite district									1	
Ceremonial precinct										
Total	0	3	2	0	0	2	10	1	14	2

APPENDIX C

SOIL PROFILE DESCRIPTIONS AND DATA

I. <u>Soils on the piedmonts</u>

Sites Tx-A-86 (Aztec Huexotla), Tx-A-86, and Tx-A-78

Profile 1

Site Tx-A-87 northern section. San Isidro Huexotla.
Soil consisting of three superimposed plow horizons, created by metepantli semiterracing levelling on a calcareous horizon. Abundant Aztec, Colonial, and modern ceramics.
Description was taken from an exposure in storage pit.
Classification: Typic ustipsamment.

Horizon	Depth (cm)	Description
1Ap	0-40	Dark grayish brown (10YR 4/2) dry, sandy loam; massive to weak subangular blocky structure; slightly hard; few very fine irregular randomly oriented pores and few fine randomly oriented roots; clear wavy lower boundary.
2Ap	40-60	Dark grayish brown (10YR 4/2) dry, sandy loam; massive to weak subangular blocky structure; hard, common very fine, irregular, randomly oriented pores; common to abundant very fine, and fine randomly oriented roots. Clear wavy lower boundary.

3Ap	60-85	Dark grayish (10YR 4/2) dry, sandy loam; massive to weak granular structure; slightly hard, many very fine, and fine irregular randomly oriented pores; common, very fine randomly oriented roots; few worm casts, and very few, very fine clay skins in pore linings, and abrupt wavy lower boundary. This horizon seem to have been a former A horizon subsequently plowed.
Bk	85-120	Pink (7.5YR 7/4 to 7/3) dry, sand with granules; moderate, fine, platy structure; extremely hard, calcareous (stage IV*), very few, very fine irregular, randomly oriented pores; gradually irregular lower boundary. This horizon is probably the so called caliche, or Barrilaco pedocal, assumed to be formed in early to late Holocene times.
Cm	105-120	Pink (7.5YR 7/4) dry, gravelly sand, massive structure; very hard, very weakly calcareous (stage I**); very few, very fine, irregular, randomly oriented pores; lower boundary grades irregular into parental material, consisting of pink (7.5YR 7/4) lahar deposit.

* Upper part of solid carbonate layer with a weakly developed platy structure.

** Dispersed powdery and filamentous carbonate.

Depth cm	Particle size distribution % Sand	Silt	Clay	Gravel weight %	Bulk density g/cm^3	pH	Organic matter %	Total P	Color
0-40	72	14	14	10.0	1.33	7.30	4.40	294	10YR 4/2
40-65	68	18	14	14.3	1.57	7.43	3.80	226	10YR 4/2
65-85	66	18	16	16.2	1.40	7.23	3.70	298	10YR 4/2
85-105	78	19	3	6.6	1.86	7.36	0	-	7.5YR 7/4
105-120	78	20	2	10.5	1.70	7.78	0	-	7.5YR 7/4

Profile 2

Site Tx-A-86, east. South of Barranca Chapingo River, south of Tequexquinahuac.

Main characteristics: A and ABt horizon of an original soil that was truncated by erosion and reclaimed by creating an anthropic epipedon, by metepantli terracing.

Classification: Former typic haplustoll truncated and subsequently covered by an anthropic epipedon.

Horizon	Depth (cm)	Description
1Ap	0-30	Grayish brown (10YR 5/2) dry, sandy loam; moderate, coarse subangular blocky structure; very hard consistence; few, very fine irregular, randomly oriented pores; few fine randomly oriented roots; abrupt and smooth lower boundary. Anthropic epipedon, with large amounts of artifacts, basically Aztec ceramics.

2ABt	30-42	Dark grayish brown (10YR 4/2) dry, sandy clay; moderate, fine to medium angular blocky structure; slightly hard consistence; few, very fine, irregular, randomly oriented pores; few, fine, vertically oriented roots; very few thin clay films on ped faces; gradual and wavy lower boundary.
2Bt	42-75	Brown (10YR 5/3) dry, clay loam; moderate, medium subangular blocky to weak medium granular structure; hard to very hard consistence; few, very fine, and fine, irregular, randomly oriented pores; few, randomly oriented roots; few, thin, clay skins on pore linings; few worm casts; clear and wavy lower boundary.
2C	75-105	Dark brown (10YR 3/3) dry, loam; moderate, medium subangular blocky to weak, fine, granular structure; slightly hard to hard consistence; few, very fine, irregular, randomly oriented pores; very few, randomly oriented roots on ped faces; Clear and wavy lower boundary. This horizon contains granule-size fragments of andesite and yellow tepetate.
	105 to bottom	Parental material. "Yellow" tepetate, brown (10YR 5/2-5/4) dry sandy loam; medium subangular blocky to weak platty structure, very hard consistence.

Depth	Particle size distribution %			Gravel	Bulk density	pH	Organic matter	Total P	Color
cm	Sand	Silt	Clay	weight %	g/cm^3		%		
0-15	60	18	22	3.7	1.72	6.78	4.55	127	10YR 5/2
15-30	62	14	24	2.1	1.78	6.47	4.00	140	10YR 5/2
30-45	48	18	38	<1.0	1.54	6.15	4.75	164	10YR 4/2
45-60	36	24	40	<1.0	1.38	6.22	3.25	161	10YR 4/2
60-75	40	24	36	<1.0	1.39	6.67	2.35	-	10YR 5/3
75-90	40	30	30	<1.0	1.32	6.52	2.00	-	10YR 5/3
90-105	42	34	24	<1.0	1.34	6.72	1.70	-	10YR 3/3

Profile 3
Site Tx-A-78. Pedestal on tepetate located south of road Tlaixpan-Santa Catarina del Monte.
Main characteristics: Soil with no metepantli terracing isolated by erosion. This soil has been cultivated during prehispanic times through probably the mid-sixteenth century.

Classification: Cumulic haplustoll with anthropic epipedon.

Horizon	Depth (cm)	Description
1Ap	0-15	Dark grayish brown (10YR 4/2) dry, loam; weak, subangular, blocky to moderate granular structure; slightly hard; few very fine, and common fine randomly oriented pores; common randomly oriented roots; and gradual wavy lower boundary.
2Ap	15-26	Dark grayish brown (10YR 4/2) dry, loam; strong subangular medium blocky structure; slightly hard; few very fine, and common fine randomly oriented pores; common randomly oriented roots; and gradual smooth lower boundary.

2A	26-43	Dark grayish brown (10YR 4/2) dry, loam; weak subangular blocky structure; slightly hard; few very fine, and common fine vertically oriented pores; common randomly oriented roots; and gradual smooth lower boundary.
2Bt	43-77	Brown (10YR 4/3) dry, clay loam; strong, medium, angular blocky structure; hard; very few, fine randomly oriented pores; common fine vertically oriented roots; gradual, smooth lower boundary.
2C	77-110	Dark grayish brown (10YR 4/2) dry, loam; hard; moderate coarse subangular blocky structure; common very fine, randomly oriented pores; no roots; clear, smooth lower boundary.
3A	110-137	Very dark grayish brown (10YR 3/2) to brown (10YR4/3) dry, loam; hard; weak , medium, subangular blocky structure; common, very fine and fine randomly oriented pores; few randomly oriented roots; clear, smooth lower boundary.
3Bt	137-158	Brown (10YR 5/3) dry, clay loam; very hard; moderate, medium angular blocky to moderate medium subangular blocky structure; few very fine irregular, randomly oriented pores; few very fine randomly oriented roots; gradual lower boundary.
3C	158-180	Brown (10YR 5/3) dry, loam: hard; weak coarse subangular blocky structure; few very fine and fine irregular, randomly oriented pores; few very fine randomly oriented roots; gradual, smooth lower boundary.

180-230 Parental material. PGF (Pómez de Grano Fino)
10YR 7/3

Depth cm	Particle size distribution % Sand	Silt	Clay	Gravel weight %	Bulk density g/cm3	pH	Organic matter %	Total P ppm	Color
0-15	32	24	44	<1.0	1.57	6.78	3.70	245	10YR 4/2
15-30	32	18	50	<.1.0	1.50	6.88	3.80	239	10YR 4/2
30-45	30	22	48	<1.0	1.54	6.95	3.70	250	10YR 4/2
45-60	26	22	52	--	1.48	7.12	2.60	189	10YR 4/3
60-75	22	28	50	--	1.22	7.24	2.35	139	10YR 4/3
75-90	24	24	52	--	1.42	7.39	2.75	154	10 YR 4/2
90-105	18	32	50	--	1.55	7.58	2.90	153	10YR 3/2
105-120	26	34	40	--	1.46	7.42	3.10	145	10YR 4/3
120-135	30	40	30	--	1.29	7.42	3.60	107	10YR 4/2
135-150	22	30	48	--	1.51	7.32	0.95	61	10YR 5/3
150-165	28	30	42	1.7	1.43	7.15	0.70	65	10YR 5/3

Profile 4

Site Tx-A-78, located south of road Tlaixpan-Santa Catarina del Monte. Metepantli soil on erosional surface on tepetate, exposed on the side of an erosional scarpment.
Main characteristics: Accumulation of sediment and trash behind metepantli rows on barren tepetate surface,probably in Aztec times.

Classification: Anthropogenic soil that may qualify for an inceptisol.

Horizon	Depth (cm)	Description
Ap	0-15	Dark grayish brown (10YR4/2) dry, sandy loam; massive to weak, medium subangular blocky u; hard consistence; few to common fine irregular, randomly oriented pores; and very few randomly oriented roots; gradual and wavy lower boundary.

AC	15-38	Dark grayish brown (10YR4/2) dry, sandy loam; moderate medium subangular blocky to weak fine prismatic structure; hard consistence; very few fine irregular, randomly oriented pores; and very few randomly oriented roots; abrupt and wavy lower boundary.
	38-75	PGF ash.
	75-bottom of profile	Light brown tepetate (10YR 5/4-5/3, dry)

Depth cm	Particle size distribution % Sand	Silt	Clay	Gravel weight %	Bulk density g/cm³	pH	Organic matter %	Tot. P ppm	Soluble salts mS/cm	Color
0-15	46	22	32	2.8	1.47	6.88	3.15	128	0.10	10YR 4/1
15-30	46	28	26	1.1	1.59	6.90	3.40	128	0.10	10YR 4/2

Profile 5

Same as profile 4, except that this soil has a lesser development of structure and lies on an eroded surface on the light brown tepetate.

Horizon	Depth (cm)	Description
Ap	1-18	Dark gray (10YR 4/1) dry, sandy loam; massive to weak, medium subangular blocky structure; hard consistence; few, very fine and fine irregular, randomly oriented pores; very few fine randomly oriented roots; very few worm casts; gradual and irregular lower boundary.

AC 18-30 Dark grayish brown (10YR4/2) dry, sandy loam; massive to weak, medium subangular blocky structure; hard consistence; very few fine irregular, randomly oriented pores; and very few randomly oriented roots; abrupt and wavy lower boundary.

30 to bottom of profile Light brown tepetate.

Depth	Particle size distribution %			Gravel	Bulk density	pH	Organic matter	Tot. P	Soluble salts	Color
cm	Sand	Silt	Clay	weight %	g/cm^3		%	ppm	mS/cm	
0-15	38	30	32	5.4	1.44	6.54	5.50	207	0.17	10YR 4/2
15-30	58	32	10	<1.0	1.35	7.17	2.00	87	-	10YR 4/2

Profile 6

Accumulation of trash and sediment behind a metepantli as procedure to create soil on a tepetate surface.

Horizon	Depth (cm)	Description
Ap	1-42	Dark grayish brown (10YR 4/2) dry; sandy to sandy loam with gravel and large amounts of sherds; massive to weak medium granular; slightly hard consistence; very few irregular very fine and fine pores, randomly oriented; few to common randomly oriented roots; few worm casts; abrupt and wavy lower boundary.
	42 to bottom of profile	Light brown tepetate.

Depth	Particle size distribution %			Gravel	Bulk density	pH	Organic matter	Tot. P	Soluble salts	Color
cm	Sand	Silt	Clay	weight %	g/cm^3		%	ppm	mS/cm	
0-15	38	20	42	1.72	1.45	6.82	3.30	128	0.09	10YR 4/2

Profile 7

Aztec metepantli soil

Horizon	Depth (cm)	Description
1Ap	1-15	Grayish brown (10YR 5/2) dry, sandy loam; soft; massive to weak, medium subangular blocky structure; common fine vesicular, randomly oriented pores; common vertical roots; gradual smooth lower boundary.
1AC	15-42	Grayish brown (10YR 5/2) dry, sandy loam; slightly hard; massive to weak, medium subangular blocky structure; few vesicular, randomly oriented pores; common vertical roots; clear smooth lower boundary.
2A	42-60	Dark yelllowish brown (10YR 3/4) loam; very hard; moderate, medium subangular blocky structure; few very fine irregular randomly oriented pores; few vertical roots; gradual smooth lower boundary.
2AC	60-90	Dark yellowish brown (10YR 3/4) loam; very hard; moderate, medium subangular blocky structure; very few very fine irregular randomly oriented pores; very few vertical roots; abrupt wavy lower boundary.

3C 90-105 Truncated soil.
Yellowish brown (10YR-5/4) to brown (10YR 5/3) dry, loam; very hard; moderate, medium subangular blocky structure; very few, very fine irregular randomly oriented pores; no roots; gradual smooth lower boundary.

105 to bottom of profile Light brown tepetate (10YR-5/4-5/3).

Depth	Particle size distribution %			Gravel	Bulk density	pH	Organic matter	Tot. P	Soluble salts	Color
cm	Sand	Silt	Clay	weight %	g/cm^3		%	ppm	mS/cm	
5-20	48	41	11	<1.00	1.34	8.10	2.85	126	0.26	10YR 5/2
45-60	30	48	22	1.23	1.40	6.46	2.00	139	0.48	10YR 3/4

Profile 8

Check dam deposit. Former soil horizons on top were stripped by erosion.

Horizon	Depth (cm)	Description
AC	0-90	Dark grayish brown (10YR4/2) dry; very hard; massive to weak coarse columnar; common very fine and fine, randomly oriented pores; no roots; abrupt wavy lower boundary.
	90 to bottom of profile	Red tepetate (7.5 YR 4/6).

Depth	Particle size distribution %			Gravel	Bulk density	pH	Organic matter	Tot. P	Soluble salts	Color
cm	Sand	Silt	Clay	weight %	g/cm^3		%	ppm	mS/cm	
0-15	42	36	22	1.76	1.40	6.82	2.75	183	0.95	10YR 4/2

Profile 9

Aztec soil in pedestal in site Tx-A-86. Location 2 in Figure 5.23, section B. Profile is drawn in Figure 5.25.

Horizon	Depth (cm)	Description
1Ap	0-18	Dark grayish brown (10YR 4/2) dry, sandy loam; soft; weak medium subangular blocky structure, few fine tubular and irregular, randomly oriented pores; few fine irregular vertical roots; clear, smooth lower boundary.
2Ap	18-30	Dark grayish brown (10YR 4/2) dry, clay loam; slightly hard; massive to weak medium subangular blocky structure; few fine vesicular randomly oriented pores; few fine vertical roots; gradual, smooth lower boundary.
2AC	30-52	Brown (10YR 5/3) dry, loam; very hard; moderate medium subangular blocky structure; few fine, randomly oriented pores; few random and vertically oriented roots; gradual, wavy lower boundary.
3A	52-65	Brown (10YR 5/3) dry, loam; very hard; moderate medium subangular blocky structure; few fine, randomly oriented pores; few randomly oriented roots; gradual, smooth lower boundary.
3AC	65-85	Brown (10YR 4/3) dry, loam; hard; moderate medium subangular blocky structure; common fine and medium, randomly oriented pores; few randomly oriented roots; gradual, smooth lower boundary.

3C 85-105 Yellowish brown (10YR 5/4) dry, loam; hard; moderate medium subangular blocky structure; common fine and medium, randomly oriented pores; few randomly oriented roots; gradual, smooth lower boundary.

Parent material Upper alluvial fill.

Depth	Particle size distribution %			Gravel	Bulk density	pH	Organic matter	Total P	Color
cm	Sand	Silt	Clay	weight %	g/cm^3		%	ppm	
0-15	60	28	12	1.76	-	6.60	3.10	128	10YR 4/2
15-30	38	31	31	<1.00	1.20	6.20	4.35	141	10YR 4/2
30-45	37	38	25	<1.00	1.29	6.17	2.85	115	10YR 5/3
45-60	31	44	25	<1.00	1.45	6.29	3.60	157	10YR 5/3
60-75	32	44	24	<1.00	1.51	6.61	3.60	158	10YR 4/3
75-90	40	48	12	<1.00	1.47	6.94	3.10	-	10YR 4/3
105-120	36	49	15	1.80	1.38	6.77	3.10	-	10YR 5/4
165-180	38	46	16	1.00	1.35	6.88	2.00	-	10YR 6/4

Profile 10

Aztec soil on a pedestal. Location 3 in Figure 5.23, section D. Profile is drawn in Figure 5.25.

Horizon	Depth (cm)	Description
1Ap	0-14	Brown (10YR 4/3) dry, sandy loam; soft; massive to weak medium subangular blocky structure; common very fine and fine, randomly oriented pores; abundant vertically oriented roots; clear, smooth lower boundary.
1A	14-31	Grayish brown (10YR 4/2) dry, loam; hard to very hard; massive to weak medium subangular blocky structure; common very fine and fine, randomly oriented pores; abundant vertically oriented roots; clear, smooth lower boundary.

2Ap	31-45	Grayish brown (10YR 4/2) dry, loam,; very hard; moderate, medium subangular blocky structure; common very fine and fine, randomly oriented pores; common vertically oriented roots; clear, smooth lower boundary.
2C	45-100	Grayish brown (10YR 4/2) dry, loam,; very hard; moderate, medium subangular blocky structure; common very fine and fine, randomly oriented pores; few vertically oriented roots; clear, smooth lower boundary.
3C	100-150	Pale brown (10YR 6/3) dry, loam; hard, few tubular, randomly oriented pores; common vertically oriented roots. Gradual discontinuous lower boundary into the tepetate.

Depth	Particle size distribution %			Gravel	Bulk density	pH	Organic matter	Total P ppm	Color
cm	Sand	Silt	Clay	weight %	g/cm^3		%		
0-15	60	28	12	<1.0	1.00	6.31	5.50	161	10YR 4/3
15-30	38	31	31	2.0	1.60	6.96	4.25	110	10YR 4/2
60-75	37	33	25	2.0	1.64	7.08	0.75	69	10YR 4/2
90-105	31	44	25	<1.0	1.48	7.01	1.00	74	10YR 6/3

II. Aztec soils in the alluvial plains (S4)

Profile 11

Buried soil in CUAN-3, zones IX and X. Aztec soil (Soil S_4).

Horizon	Depth (cm)	Description
Ap	220-235	Dark gray (10YR 4/1-4/2) dry, loam; hard; weak medium subangular blocky structure; few fine and medium irregular randomly oriented pores; common fine and medium randomly oriented roots; clear, smooth lower boundary.
AC	235-260	Dark grayish brown (10YR 4/2) dry, clay loam; hard; weak medium subangular blocky structure to weak columnar; few fine and medium irregular randomly oriented pores; few fine and medium randomly oriented roots; gradual, smooth lower boundary.

Depth	Particle size distribution %			Gravel	Bulk density	pH	Organic matter	Tot. P	Soluble salts	Color
cm	Sand	Silt	Clay	weight %	g/cm^3		%	ppm	mS/cm	
220-235	43	35	22	< 1	1.43	7.51	3.45	302	0.32	10YR 4/1-2
245-260	36	28	36	< 1	1.37	7.50	2.55	311	0.26	10YR 4/2

Profile 12

Buried soil in CUAN-4, zones VII and VIII. Aztec soil (Soil S_4).

Horizon	Depth (cm)	Description
Ap	325-337	Dark grayish brown (10YR 4/2) dry; slightly hard; moderate, medium subangular blocky structure; few , medium, randomly oriented pores; few vertical roots: Clear, smooth lower boundary.
AC	337-345	Brown (10YR 4/3) slightly hard; moderate, medium subangular blocky structure; few , medium, randomly oriented pores; very few vertical roots: Gradual, smooth lower boundary.
C	345-362	Brown (10YR 5/3) slightly hard; moderate, massive structure; few , medium, randomly oriented pores; few vertical roots: Clear, smooth lower boundary.

Depth	Particle size distribution %			Gravel	Bulk density	pH	Organic matter	Color
cm	Sand	Silt	Clay	weight %	g/cm^3		%	
325-348	40	37	23	0	1.36	7.3	7.2	10YR 4/2
348-360	49	34	17	0	1.36	7.5	5.6	10YR 5/3

Profile 13
Buried soil in TEP-3, zones II and III. Aztec soil (Soil S_4).

Horizon	Depth (cm)	Description
Ap	130-140	(10YR 3/1) dry, clay loam; very hard, weak, medium, subangular blocky structure; few medium and fine, randomly oriented pores; common, randomly oriented roots; clear, wavy lower boundary.

A	140-150	(10YR 3/1) dry, clay loam; very hard, weak columnar to moderate medium subangular blocky structure; few to common, fine and medium, randomly oriented pores; very few fine and medium, randomly oriented roots; clear, wavy lower boundary. This unit contains Toltec sherds.
AC	150-170	(10YR 5/2) dry, silt-loam; hard; massive to weak, medium subangular blocky structure; common fine and medium randomly oriented pores; very few randomly oriented roots; clear, smooth lower boundary. There are Toltec sherds lying on top of this unit.

Depth	Particle size distribution %			Gravel	Bulk density	pH	Organic matter	Color
cm	Sand	Silt	Clay	weight %	g/cm^3		%	
130-145	21	38	41		1.52	6.7	6.6	10YR 3/1
160-175	29	60	11	< 1.0	1.22	7.0	6.5	10YR 5/2

APPENDIX D

TRANSCRIPTION OF SOME EXCERPTS OF DOCUMENTS REGARDING SITE TX-A-78 IN THE LATE SIXTEENTH CENTURY

1. Conflict over the land before the abandonment of the site.

1.1 Document: AGN, *Mercedes*, v. 17, f. 190 vta.

In this document Pedro Mejía de Bocanegra requests estancia for sheep and land for cultivation in the area of Tlaixpan near the site of Olopa.

En la ciudad de Texcoco el 26 de noviembre de 1592, se dio mandamiento para que el alcalde mayor de esta ciudad vea un sitio de estancia para ganado menor en términos de esta ciudad en los cerros de Patlachuhque, Apantzingo, Moyotepec y Cuauhyacac, y tres caballerías de tierra para el sustento de la dicha estancia que pide Pedro Mejía de Bocanegra.

1.2 Document: AGN, *Tierras*, exp. 2726, exp. 8.

The accompanying map is in Figure 5.10.

In this doccumment there is a litigation to revoke the request for the estancia that Pedro Mejía de Bocanegra requests in the Merced document above.

Excerpt 1. Folio 111-112

In this paragraph Juan Lopez de Treviño, native of Texcoco, as a witness explains the inconveniences of a sheep estancia requested in the hill of Moyotepec. There is a description of four surviving Aztec sites, about to disappear, one of them is Ololpan, the settlement corresponding to site Tx-A-78.

En la ciudad de Texcoco a trece días del mes de febrero de 1592 años Juan López de Triviño vecino de esta ciudad del cual fue recibido juramento por Dios Nuestro señor en forma de derecho so cargo del cual prometio de decir verdad preguntando por el mandamiento acordado de su señoria ilustrísima y auto del alcalde mayor dijo que conocía las partes y que sabe las tierras contenidas en este mandamiento dde mas tiempo de treinta años a esa parte y lo que estancia de ganado menor lugar y no cabe por causa que esta todo cercaado de cuatro barrios y caserías de naturales y demás de esto pasa por

ahi el caño que viene a esta ciudad para el sustento de los vecinos y religiosos de ella por lo cual sabe este testigo que si hiciese dicha merced del dicho sitio sería parte para que los indios se despoblasen por los agravios y daños que recibirían y que en lo que toca a las tres caballerías de tierra sabe este testigo porque como tiene treita annos que vino a esta ciudad y entonces este testigo y vido por vista de ojos labrar a los naturales las dischas tierras los dichos descendientes de Nelegualpintzintli por que este testigo demás de ser público y notorio lo vió muchas veces y preguntó y le respondieron eran de los dichos herederos y por lo que dicho tiene sabe y entiende que recibirán daño y prejuicio los dichos naturales y que no se puede hacer merced sinque reciba el dicho perjuicio y que esto sabe ... para el juramento que echo tiene en que se afirmó e ratificó en no firmó por no saber y que es de edad de más de cincuenta años y que no le tocan las generales... en este negocio y ... quien tuviere justicia, ante mi
Juan Díez Robles
Escribano

Excerpt 2

Another group of witnesses declares against the land grant. The declaration states also that the settlements of Olopan (Tx-A-78) and Moyotepec (probably Tx-A-77), seems to be the ones affected by the sheep owned by the Spanish. This argument is against the granting of the land for estancia. Among other things, it is mentioned that the canal runs near the site of Olopan. The settlements in this document and other other documents in the same file always refer to the indian settlements as caseríos (group of few houses).

El Gobernador, Alcaldes , consejo e universidad de esta ciudad de Texcoco por el pro y utilidad della y por defensa y amparo de los naturales de los barrios de San Jan Olopan y Moyotepec en que tiene pedido Pedro Mejía de Bocanegra sobre un mandamiento acordado de su señoreia ilustrísima en que pretende se le haga merced de un sitio de estancia para ganado menor en teerminos de esta dicha ciudad y tres caballerías de tierra. Decimos que en la parte y lugar donde el susodicho de estopide el dicho sitio que es en el

cerro que llaman Patlachique conforme a los linderos declarados en el dicho mandamiento acordado es en grave perjuicio de esta dicha ciudad. Y de los naturales circunvecinos a quien toca en aquel distrito y así hacemos contradicción en forma de la dicha medida que se pretende ...vid y forma que más a nuestro derecho convenga. Lo primero por ser en el medio más importante de las tierras y laborea de los naturales que están en las faldas de aquella serranía llamada Patlachique y Moyotepec, donde con las labores de los españoles están estrechados y molestados por el perjuicio que se les sigue por los ganados y ... que apenas los sustentamos en que asientos para que no se ausenten todos como lo han hecho muchos y si hubiese efecto a la dicha medida se acabarían de despoblar porque el ganado es imposible de entrar en las caserías y las labores de San Juan Olopan y de Moyotepec que están en ... de dicho cerro y lo otro no es de menos perjuicio y consideración el caño de agua descubierto que viene a esta ciudad para sustento de ella en la fuente de la plaza del monasterio y otras partes que no hay seiscientos pasos al dicho sitio. De manera que el dicho caño de agua de tanta importancia y las dichas caserías comprende el dicho sitio que contra todo derecho y a las ordenanzas que se refieren a esto hay en las ... caballerias de tierra en la parte que llaman Tlaixpan es cosa notoria y a vuestra merced le consta ser el patrimonio de los herederos de Nezahualpilzintli, señor y caciqe que fue de esta dicha ciudad que está por indiviso com v.m. lo ha visto por vista de ojos, atento a lo cual a v. m. le pedimos y suplicamos que habida nuestra realación por verdadera y la parte que baste mande declarar a su parecer y no haber lugar de hacer la dicha merced del dicho sitio de estancia y caballerías de tierra atento a lo referido y al daño que sobre ello podrá acaecer a esta dicha ciudad y a los demás naturales y pedimos justicia y lo necesario.
Otro si pedimos y suplicamos a vuestra merced mande que los testigos que por nuestra parte fueren presentados se examinen por tenor de esta partición justicia.
Firmas y Rúbricas
Dn Huan de Alvarado
Miquel de Rivas

Don Gabriel de Ayala
Agustín de Galicia
Lorenzo Ortíz
Elías de Santa María

Excerpt 3

Another witness, an old man, testifies also for the situation of how the indian settlements have been harrassed by the spanish and their sheep. The settlements are referred to as "barrios de casuchas y de muchas tierras" (districts of huts and lots of lands) which indicates the dispersed character of the settlements.

En la ciudad de Texcoco a trece días del mes de febrero de 1592 años, el gobernador, alcaldes y regidores de esta ciudad para la dicha información presentaron pro testigo a un indio que mediante Marín Muñoz interprete se dijo llamar Cosme de San Francisco y ser natural de esta ciudad del barrio de San Juan Mexicapan del cual fue recibido juramento por Dios nuestro señor en forma derecho so cargo del cual prometió de decir verdad y preguntando por su petición dijo que sabe del sitio de estancia y 3 caballerías de tierras que Marcos Mejía ... su parte pide y de más de 50 años a esta parte y las sabe y que lo sabe y lo que pasa es que donde se pide el sitio de estancia de ganado menor es tierra muy estrecha y no cabe sitio de estancia además de que está cerca de tres o cuatro barrios, de casuchas y de muchas tierras, y que venía gran danno a los naturales sirviendo vecinos además que por el dicho sitio pasa el caño del agua descubierto que viene para el sustento de los vecinos de esta ciudad y convento del pueblo y asimismo sabe de este testigo que si se hiciese la merced del dicho sitio de estancia vendria grnb daño y perjuicio a los naturales del pueblo de Moyotepeque y otros pueblos y se podran venir por agravios que se les hiciese despoblar y en los de las tres caballerías de tierras, sabe este testigo que no hay lugar atento y que son tierras del patrimonio de Necegualpilcintli y de sus herederos y así son labradas y cultivadas del los herederos del dicho Necegualpilcintli y que por lo dicho tiene y sabe que viene gran daño a los naturales y espannoles si se hiciera la dicha merced y

que esto sabe y pasa es la verdad para el juramento que hecho tiene en que se afirmó y ratificó e lo firmó de su nombre y que es de edad de más de 60 años y que no le tocan la gnerales ni nada en este negocio que lo venza quien tuviere justicia.
Ante mi

Andrés Robles (escribano)

Juan de... Altamirano

Cosme de San Francisco

2. The land is requested again after the site was abandoned.

2.1 Document: AGN, *Mercedes*, v. 25, f. 435

After the site was abandoned because of the congregacion in 1603, there is a request for the land in 1607. It is mentioned that when it was depopulated there were only 10 indians, probably 10 families. The map of the Tierras document below, shows that in 1592 there were only 9 houses.

En esta ciudad de Texcoco a siete dias de junio de 1607 se dio mandamiento acordado para que el alcalde mayor de esta ciudad vea media caballería de tierra que pide Alonso Laso, la que linda por todas parte con tierras de Alonso Pérez Villazazón, en el pago que llaman de San Juan que está despoblado de congregación sujeto a la ciudad de Texcoco y era de diez indios.

APPENDIX E
RADIOCARBON DATES

I. Radiocarbon assays

Lab No. OS-3476 Depth (cm): 150 Material dated: charcoal
Locality/stratigraphic unit : ACOL-1-III
δ^{13} Corrected radiocarbon age BP: 145±25
2 sigma calibrated age AD/BC: 1670AD (0.82) 1890AD

Lab No. Tx-7780 Depth (cm): 200 Material dated: charcoal
Locality/stratigraphic unit: CLP-1-III
δ^{13} Corrected radiocarbon age BP: 219±50
2 sigma calibrated age AD/BC: 1510AD (0.09) 1590AD
1620AD (0.84) 1890AD

Lab No. OS-3482 Depth (cm): 225 Material dated: charcoal
Locality/stratigraphic unit: PAP-1-IV
δ^{13} Corrected radiocarbon age BP: 350±30
2 sigma calibrated age AD/BC: 1450AD (1.00) 1640AD

Lab No. OS-3483 Depth (cm): Material dated: charcoal
Locality/stratigraphic unit: CLP-3-V
δ^{13} Corrected radiocarbon age BP: 365±55
2 sigma calibrated age AD/BC: 1440AD (1.00) 1640AD

Lab No. OS-3477 Depth (cm):218 Material dated: charcoal
Locality/stratigraphic unitL CUAN-3-V
δ^{13} Corrected radiocarbon age BP: 355±30
2 sigma calibrated age AD/BC: 1450AD (1.00) 1640AD

Lab No.OS-2755 Depth (cm): 15 Material dated: charcoal
Locality/stratigraphic unit: Tx-A-78, profile 3
δ^{13} Corrected radiocarbon age BP: 390±50
2 sigma calibrated age AD/BC: 1430 (1.00) 1640 AD

Lab No. OS-3479 Depth (cm): 200 Material dated: charcoal
Locality/stratigraphic unit: PAP-4-IV
δ^{13} Corrected radiocarbon age BP: 575±30
2 sigma calibrated age AD/BC: 1290AD (1.00) 1420AD
Comments:

Lab No. OS-3481 Depth (cm): Material dated: charcoal
Locality/stratigraphic unit: CUAN-4-XI
δ^{13} Corrected radiocarbon age BP: 1,240±30
2-sigma calibrated age AD/BC: 680AD (1.00) 880AD

Lab No. OS-3478 Depth (cm): 280 Material dated: charcoal
Locality/stratigraphic unit : TEP-3-V
δ^{13} Corrected radiocarbon age BP: 2,070±54
2-sigma calibrated age AD/BC: 200BC (1.00) 20AD

Lab No. OS-3480 Depth (cm): 50 Material dated: Fragment of cattail (*Typha* sp.)
Locality/stratigraphic unit : TPL-4-III
δ^{13} Corrected radiocarbon age BP: 2090±35
2-sigma calibrated age AD/BC: 200 BC (1.00) 10BC

Lab No.Tx-8021 Depth (cm): 224 Material dated: charcoal
Locality/stratigraphic unit: CLP-3-VI
δ^{13} Corrected radiocarbon age BP: 2,033±96
2-sigma calibrated age AD/BC: 400 BC (1.00) 200AD
Comments:

Lab No. Tx-8094 Depth (cm): 100 Material dated: charcoal
Locality/stratigraphic unit: TEP-1-II
δ^{13} Corrected radiocarbon age BP: 3933 ± 15
2-sigma calibrated age AD/BC: 2900 BC (1.00) 2000 BC/
(4850 - 3950 BP)

Lab No. Tx-7781 Depth (cm): 175-180 Material dated: soil humate
Locality/stratigraphic unit : TEP-1-V
δ^{13} Corrected radiocarbon age BP: 5,313±51
2-sigma calibrated age AD/BC: 4330 BC (0.07) 4280 BC/
(6280 - 6230 BP)
4250 BC (0.93) 4000 BC/
(6200 - 5950 BP)

Lab No. 7843 Depth (cm): 27-44 Material dated: sediment humate
Locality/stratigraphic unit: TPL-1-III
δ^{13} Corrected radiocarbon age BP: 7496±85
2-sigma calibrated age AD/BC: 6460 BC (1.00) 6160 BC
Comments:

Lab No. Tx-8264 Material dated: sediment humate
Locality/stratigraphic unit : Tx-A-86 profile B-B', below profile 9.
δ^{13} Corrected radiocarbon age BP: 22,893±583
Not calibrated
Comments:

II. Radiocarbon dates rejected

Lab No. Tx-7779 Depth (cm): 200 Material dated: soil humate
Locality/stratigraphic unit: CLP-1-V

δ^{13} Corrected radiocarbon age BP: 2,291±44

2-sigma calibrated age AD/BC: 410 BC (1.00) 200 BC
Comments: The archaological material in the underlying deposits is younger.

Lab No. Tx-7842 Depth (cm): 115 Material dated: sediment humate
Locality/stratigraphic unit: TPL-1, top of zone IX

δ^{13} Corrected radiocarbon age BP: 10,392±197

Not calibrated

Lab No. Tx-7841 Depth (cm): 280 cm Material dated: sediment humate
Locality/stratigraphic unit: TPL-1, bottom of zone IX

δ^{13} Corrected radiocarbon age BP: 11,922±108

Not calibrated
Comments: These two dates are not consistent with the tephrochronology. Both are below the Pumice with Andesite of 14,000 BP. Compared with the dates presented by Brown (1985) and Bradbury (1989), they are young.

APPENDIX F

DESCRIPTION OF ALLUVIAL SEDIMENT SAMPLES AND LABORATORY DATA

1. Identification number of alluvial sections.

Lower San Juan Teotihuacan

Acolman area:

ACOL 1:Brickyard located west of Acolman, on the left side of westernmost channel of present hydrographic network.
Latitude: 19° 38' 20" Longitude: 98° 54' 50"
Northing: 2171450 Easting: 14 508700

ACOL 2:Brickyard located south of Acolman, just south of the toll road to the Teotihuacan Pyramids. Samples 6-15
Latitude: 19° 37' 32" Longitude: 98° 55' 07"
Northing: 2170050 Easting: 14 508700

ACOL 3:Ditch on the NE corner of the Convento de Acolman.
Latitude: 19° 37' 55" Longitude: 98° 55 07"
Northing: 2170650 Easting: 14 509350

Cuanalan area:

CUAN 1: Brickyard located just north of the Acolman dam.
Latitude: 19° 37' 15" Longitude: 98° 55' 20"
Northing: 2169250 Easting: 14 508400

CUAN 2: Same location as CUAN 1.
Latitude: 19° 37' 15" Longitude: 98° 55' 20"
Northing: 2169250 Easting: 14 508400

CUAN 3: Brickyard just south of the Acolman dam and on the NW outskirts of Cuanalan.
Latitude: 19° 37' 08" Longitude: 98° 55' 09"
Northing: 2169050 Easting: 14 508555

CUAN 4: Brickyard located W of Cuanalan.

Latitude: 19° 37' 00" Longitude: 98° 55' 09"

Northing: 2168050 Easting: 14 508555

CUAN 5: Same as CUAN 4.

<u>Lower Papalotla</u>

IXQ 1, IXQ-2, and IXQ-3.

Brickyard located northwest of Chimalpa, on the road Papalotla-Nexquipayac.

Latitude: 19° 34' 17" Longitude: 98° 53' 00"

Northing: 2163800 Easting: 14 512800

<u>Middle Papalotla</u>

PAP-1, PAP-2, PAP-3, and PAP-4.

These sections are exposed by erosion in an incised channel of the Papalotla river between the old and the new road Texcoco-Tepetlaoxtoc.

PAP-1 Latitude: 19° 34' 21" Longitude: 98° 49' 23"

Northing: 2162047 Easting: 14 518140

PAP-2 and PAP-3 Latitude: 19° 34' 37" Longitude: 98° 49' 17"

Northing: 2162067 Easting: 14 5178020

PAP-4 Latitude: 19° 34' 45" Longitude: 98° 49' 50"

Northing: 2162080 Easting: 14 517770

<u>Barranca Honda</u>

TEP-1, TEP-2, and TEP-3.

These sections are exposed by erosion in an incised channel known as barranca de Sila, within the town of Tepetlaoxtoc.

TEP-1 Latitude: 19° 34' 97" Longitude: 98° 48' 00"

Northing: 2164500 Easting: 14 5192500

TEP-2 and TEP-3 Latitude: 19° 34' 27" Longitude: 98° 45' 25"

Northing: 2169250 Easting: 14 508400

Coatepec rivera and Arroyo Coxtitlán at Chicoloapan

CLP-1, CLP-2, CLP-3, and CLP-4. Brickyard located to the SW of Chicoloapan by the channel of the Coatepec river.

CLP-5 Brickyard located to the north of Chicoloapan, by the modern channel of Arroyo Coxtitlán.

CLP-6 and CLP-7 Brickyard located to the SE of Chicoloapan.

CLP-8 Ditch located east of Chicoloapan.

CLP-9 Gravel/sand pit located east of Chicoloapan

CLP-1 and CLP-2 Latitude: 19° 24' 41" Longitude: 98° 55' 37"
Northing: 2146050 Easting: 14 509780
CLP-3 and CLP-4 Latitude: 19° 24' 41" Longitude: 98° 55' 40"
Northing: 2146150 Easting: 14 509830
CLP-5 Latitude: 19° 25' 15" Longitude: 98° 55' 35"
Northing: 2147200 Easting: 14 509740
CLP-6 Latitude: 19° 24' 41" Longitude: 98° 56' 18"
Northing: 2146050 Easting: 14 510950
CLP-7 Latitude: 19° 24' 41" Longitude: 98° 55' 37"
Northing: 2146050 Easting: 14 509780
CLP-8 Latitude: 19° 24' 41" Longitude: 98° 56' 16"
Northing: 2146380 Easting: 14 510850
CLP-9 Latitude: 19° 25' 02" Longitude: 98° 55' 37"
Northing: 2146750 Easting: 14 510850

2. Sediment description of some sections

Keys: Depth is in centimeters. Color is on dry sample. NT= not tested for bulk density and % LOI (loss on ingnition). For facies code (e.g.Fl, Fs, Sp, etc.) see tables 6.2 and 6.3.

Section: ACOL-2

Zone: I

Depth in cm: 0 - 95

Description: Silt loam mud with no laminations and pedogenically altered by worms and roots; hard consistence; weak, medium subangular blocky structure; few fine irregular pores; common fine to medium, vertically oriented roots; gradual, clear, smooth lower boundary.

A and Ap horizon on top 45 cm.

Color: 10 YR 4/3 % LOI: 8.4 %

Gravel: 0 % Sand: 27 % Silt: 61 % Clay: 12 %

Facies: Overbank fines. Fsc. Sample: 6

Zone: II

Depth in cm: 95 - 145

Description: Loam with laminations; slightly hard consistence. Massive to weak, medium subangular blocky structure; very few fine, irregular randomly oriented pores, and no roots. Clear, smooth lower boundary.

Color: 10YR 5/3 % LOI: 6.5 %

Gravel: 0 % Sand: 49 % Silt: 45 % Clay: 6 %

Facies: Overbank fines. Fl. Sample: 7

Zone: III

Depth in cm: 145-168

Description: Silt loam deposit pedogenically altered; hard consistence; weak medium subangular blocky structure; few fine and very fine , randomly oriented pores; common vertical oriented roots. Clear, smooth lower boundary. Weak A horizon on top.

Color: 10 YR 5/3-5/6 Bulk density: 1.21 g/cm^3 % LOI: 6.8 %

Gravel: 0 % Sand: 26 % Silt: 66 % Clay: 8 %

Facies: Overbank fines. Fsc. Sample: 8

Zone: IV

Depth in cm: 176-192

Description: Silt loam deposit with fine laminations; slightly hard consistence; moderate, medium, subangular blocky structure; very few medium to fine, randomly oriented pores; common fine, vertical-oriented roots filled with material from the above deposit. Gradual smooth lower boundary.

Color: 10YR 4/3 Bulk density: NT % LOI: 8.4 %

Gravel: 0 % Sand: 16 % Silt: 63 % Clay: 20 %

Facies: Slack water deposit. Fsc. Sample: 9

Zone: V

Depth in cm: 192 - 288

Description: Silty clay deposit with fine laminations; hard consistence. Massive to weak medium subangular blocky structure; very few fine randomly oriented pores; no roots;

Color: 10 YR 3/1-4/1 Bulk density: 1.52 g/cm^3 % LOI: 9.7 %

Gravel: 0 % Sand: 14 % Silt: 40 % Clay: 46 %

Facies: Overbank fines. Fsc. Sample: 10

Zone: VI

Depth in cm: 288 - 310

Description: Silt loam with very fine laminations; hard consistence. Weak subangular blocky structure; very few, fine, irregular, randomly oriented pores; very few fine, vertical roots; clear, smooth lower boundary.

Color: 10YR 5/2 Bulk density: NT % LOI: 7.6 %

Gravel: 0 % Sand: 18 % Silt: 72 % Clay: 10 %

Facies: Overbank fines, slack water deposits. Fsc. Sample: 11

Zone: VII

Depth in cm: 310 - 344

Description: Sandy loam deposit with parallel bedding; hard consistence; massive structure; very few fine, irregular, randomly oriented pores; very few fine to medium, no roots; clear, smooth lower boundary.

Color: 10YR 5/3 Bulk density: 1.28 g/cm^3 % LOI: 5.1 %

Gravel: 0 % Sand: 58 % Silt: 34 % Clay: 8 %

Facies: Overbank flood splay. Sl. Sample: 12

Zone: VIII

Depth: 344 - 354

Description: Medium to coarse sand with granules and cross-bedded, massive structure; abrupt, smooth lower boundary.

Color: Gray Bulk density: 1.13 g/cm^3 % LOI: 5.1 %

Gravel: 0.5 % Sand: 97.5 % Silt: 2 % Clay: 0 %

Facies: Overbank flood splay. Crevasse splay. Sl. Sample: 13

Zone: IX

Depth in cm: 354 - 375 (bottom of section).

Description: Silt loam with laminations; hard consistence. Weak, medium, subangular blocky structure; common, fine, randomly oriented pores; few randomly oriented roots. AC horizon.

Color: 10YR 6/3 Bulk density: 1.15 g/cm^3 % LOI: 8.1 %

Gravel: 0 % Sand: 16 % Silt: 72 % Clay: 12 %

Facies: Overbank fines. Slackwater deposit.Fsc, Fcf. Sample: 14

Section CUAN-2 (Selected zones)

Only the Acolman dam deposits are described. They comprise two zones:

Zone I

Depth in cm: 0 - 135

Description: Silty clay with horizontal laminations; hard consistence; very few fine, irregular pores; very few roots; clear smooth lower boundary. Weak A and plowing horizon on top.

Color: 10YR 6/2-7/2 LOI: 2.4 %

Gravel: 0 % Sand: 6 % Silt: 59 % Clay: 35 %

Facies: Fsc Sample: 15

Zone III

Depth in cm: 150 - 200

Description: Silt loam with horizontal, fine laminations; hard consistence; very few fine, irregular pores; very few roots; clear smooth lower boundary Weak A horizon on top (Zone II).

Color: 10YR 6/2-7/2 LOI: 2.1 %

Gravel: 0 % Sand: 11 % Silt: 68 % Clay: 21 %

Facies: Fsc Sample: 16

Zones III to V are soil horizons and cultural deposits.

Section: CUAN-4

Zone Ia

Depth in cm: 0 - 95

Description: Silt loam with fine subhorizontal laminations; slightly hard consistence; massive to weak medium subangular blocky structure; very few fine and very fine, irregular, randomly oriented pores; very few fine to medium roots; gradual smooth lower boundary.

Color: 10YR 5/3 % LOI: 6.8 %

Sand: 35 % Silt: 57 % Clay: 8 %

Fraction larger than 2 mm: 0 %

Facies: Fl Sample: 22

Zone Ib

Depth in cm: 95 - 118

Description: Sandy clay loam; soft consistence. Massive structure; subhorizontally laminated sands; very few pores and roots. Clear, smooth lower boundary.

Color: 10YR 5/3 % LOI: 5.5 %

Sand: 56 % Silt: 35 % Clay: 9 %

Fraction larger than 2 mm: 0 %

Facies: Transition Sh to Fl Sample: 23

Zone II

Depth in cm: 118 - 160

Description: Ap horizon. Silty loam; hard consistence; weak, medium subangular blocky structure; very common fine and medium, randomly oriented pores; common, irregular, randomly oriented roots; few worm casts; gradual, wavy lower boundary.

Color: 10YR 4/2 % LOI: 7.4

Sand: 56 % Silt: 35 % Clay: 9 %

Fraction larger than 2 mm: <1% %

Zone III

Depth in cm: 180 - 263

Description: Silty loam; hard consistence; granular structure on top to weak medium subangular structure in the center to massive structure at the bottom; common fine pores; few randomly oriented roots; gradual smooth boundary.

Color: 10YR 5/3 % LOI: 4.2 %

Sand: 22 % Silt: 65 % Clay: 13 %

Fraction larger than 2 mm: 0 %

Facies: Fl Sample: 24

Zone IV

Depth in cm: 263 - 290

Description: Sandy loam, subhorizontally laminated; soft consistence; very few fine pores; no roots, few randomly oriented roots; clear, smooth lower boundary.

Color: 10YR 5/3 % LOI: 4.2 %

Sand: 72 % Silt: 25 % Clay: 3 %

Fraction larger than 2 mm: 0 %

Facies: Fl Sample: 25

Zone V

Depth in cm: 290 - 310

Description: Sand in crossbedded structure; clear, smooth lower boundary.

Color: Gray % LOI: 2.2 %

Sand: 90 % Silt: 2 % Clay: 8 %

Fraction larger than 2 mm: 0 %

Facies: Sp Sample: 26

Zone VIa

Depth in cm: 310 - 318

Description: Silt-loam horizontally laminated; slightly hard; massive; very few, very fine and fine irregular, randomly oriented pores; very few randomly oriented roots; gradual smooth lower boundary.

Color: 10YR 5/2-6/2 % LOI: 7.3 %

Sand: 19 % Silt: 71 % Clay: 10 %

Fraction larger than 2 mm: 0 %

Facies: Fl Sample: 27

Zone VIb

Depth in cm: 318 - 325

Description: Sandy loam subhorizontally laminated; soft; clear, smooth lower boundary. This deposit grades into Via.

Color: 10YR 4/3 % LOI: 4.4 %

Sand: 67 % Silt: 25 % Clay: 8 %

Fraction larger than 2 mm: 0 %

Facies: Sl Sample: 28

Zone VII

Depth in cm: 325 - 345

Description: Loam; slightly hard; weak, medium subangular blocky structure; very few fine pores; few randomly oriented roots; clear, smooth lower boundary.

Color: 10YR 4/2-4/3 % LOI: 7.2 % (on soil horizon)

Sand: 40 % Silt: 37 % Clay: 23 %

Fraction larger than 2 mm: 0 %

Facies: Fm (mud drape). Sample: 29

Zone VIII

Depth in cm: 345 - 365

Description: Loam; slightly hard; massive to weak, medium subangular blocky structure; very few fine pores; no roots; clear, smooth lower boundary.

Color: 10YR 5/3 % LOI: 7.6 %

Sand: 49 % Silt: 34 % Clay: 17 %

Fraction larger than 2 mm: 0 %

Facies: Overbank fines. Fm (mud drape) Sample: 30

Zone IX

Depth in cm: 365 - 390

Description: Clay-loam; moderate medium subangular blocky to granular structure; abundant fine and medium, randomly oriented pores; abundant vertically oriented roots; worm casts; clear, smooth lower boundary.

Color: 10YR 4/2

10YR 4/2 % LOI: 7.6 %

Sand:22 % Silt: 40 % Clay: 38 %

Fraction larger than 2 mm: 0 %

Facies: Fl Sample: 31

Zone X

Depth in cm: 390 - 325

Description: Silt-loam; very hard; moderate, medium subangular blocky structure; common fine and very fine, randomly oriented pores; common randomly oriented roots; worm casts; gradual; clear, smooth lower boundary.

Color: 10 YR 5/2 % LOI: 7.0 %

Sand: 22 % Silt: 55 % Clay: 23 %

Fraction larger than 2 mm: 0 %

Facies: Fm (mud flow) Sample: 32

Zone XI

Depth in cm: 495 - 510

Description: Clay-loam; granular structure; common fine and medium randomly oriented pores; abundant randomly oriented roots; abundant worm casts; abrupt, lower boundary.

Color: 10YR 4/1 % LOI: 6.7 %

Sand: 22 % Silt: 51 % Clay: 31 %

Fraction larger than 2 mm: 0 %

Facies: Fm (mud flow) Sample: 33

Zone XII

Depth in cm: 510 - bottom

Description: Sand; soft; massive structure.

Color: Gray % LOI: 2.3 %

Sand: 85 % Silt: 8 % Clay: 7 %

Fraction larger than 2 mm: 0 %

Facies: Sp Sample: 34

Section TEP-2

Zone I

Depth in cm: 0 - 216

Description: Loam with subhorizontal laminations; soft to slightly hard consistence; massive; few to common, very fine and fine irregular, randomly oriented pores; common, fine and medium, randomly oriented roots; abrupt, wavy lower boundary.

Color: 10YR 4/2 % LOI: 5.2 %

Sand: 46 % Silt: 46 % Clay: 8 %

Facies: Fl Sample: 42

Zone II

Depth in cm: 216 - 258

Description: Silt-loam; hard; weak, medium subangular blocky to weak, medium columnar; abundant, fine and medium, randomly oriented pores; very few randomly oriented roots; clear, smooth lower boundary.

Color: 10YR 4/2 % LOI: 7.5%

Sand: 32% Silt: 54 Clay: 14%

Facies: Fl

Zone III

Depth in cm: 258 - 400

Description: Silt-loam; hard; weak, medium columnar to weak subangular blocky structure; common, fine and medium, irregular and tubular, randomly oriented pores; few randomly oriented roots; clear, wavy lower boundary.

Color: 10YR 4/1 % LOI: 6.7%

Gravel: 0 % Sand: 16% Silt: 65 Clay: 19 %

Facies: Fl Sample: 43

Zone IV

Depth in cm: 400 - 445

Description: Silt-loam; hard; weak, medium subangular blocky structure; common, few, randomly oriented pores; very few randomly oriented roots; abrupt, smooth lower boundary

Color: 10YR 5/2 % LOI: 7.5%

Sand: 36 %   Silt: 41 %   Clay: 23 %

Facies: Fm (mud flow)   Sample: 44

Zone V

Depth in cm: 445 - 520

Description: Volcanic ash. Pómez de Grano Fino (PGF) ash.

Color: White   Bulk Density: 1.03 g/cm^3

LOI: 7.1%

Sand: 27%   Silt: 65   Clay: 8 %

Facies: Ashfall   Sample: 45

Zone VI

Depth in cm: 520 - 535

Description: Sandy loam; soft to slightly hard; weak, medium columnar, to weak, medium subangular blocky structure; few fine, randomly oriented pores; very few randomly oriented roots; gradual lower boundary.

A horizon (Soil S2).

Color: 10YR 5/2   % LOI: 7.1%

Gravel: 0 %   Sand: 16%   Silt: 45   Clay: 29%

Facies: Fm (mud flow)   Sample: 46

Zone VII

Depth in cm: 535 - 560

Description: Silty clay loam with slight horizontal laminations; slightly hard; massive to weak, subangular blocky structure; few fine, randomly oriented pores; no roots; clear, smooth lower boundary.

Color: 10YR 4/1   % LOI: 6.3 %

Sand: 22%   Silt: 51 %   Clay: 27 %

Facies: Fl   Sample: 47

Zone:VIII

Depth in cm: 560 - 580

Description: Sandy loam deposit with slight laminations; soft consistence; massive to weak, medium subangular blocky structure;

common fine randomly oriented pores; very few randomly oriented roots; clear, smooth lower boundary. Weak A horizon.

Color: 10YR 4/1-4/2 % LOI: 6.5 %

Sand: 29% Silt: 47 % Clay: 18 %

Facies: Fm (mud flow) Sample: 48

Zone IX

Depth in cm: 480 - 497

Description: Silt-loam; slightly hard; massive; very few fine pores and roots. It looks like a slightly pedogenically altered ash.

Color: 10YR 5/2 % LOI: 4.9%

Sand: 32% Silt: 44 % Clay: 12 %

Facies: Fl Sample: 49

Section TEP-3

Zone Ia

Depth in cm: 0 - 130

Description: Sandy loam deposit with slight laminations; soft consistence; massive; few to common, very fine and fine irregular, randomly oriented pores; common, fine and medium, randomly oriented roots; abrupt, wavy lower boundary.

Color: 10YR 4/2 % LOI: 6.1 %

Sand: 39 % Silt: 46 % Clay: 7 %

Facies: Fl Sample: 51

Zone Ib

Depth in cm: 120 - 150

Sand: 24 % Silt: <1% Clay: <1% Gravel: 75.7 %

Facies: Gt Channel lag deposits. Sample: 55

Zone II

Depth in cm: 130 - 160

Description: Clay loam; hard; moderate, medium subangular blocky structure to weak, medium columnar; common fine and medium, randomly oriented pores; few randomly oriented roots, gradual, wavy lower boundary. Two sequences of soil formation: One with Ap and AC horizon on colluvium, bearing Toltec to Colonial sherds, and an A horizon with an apparent Bt on a flood deposit (described here). This deposit is correlative with zone III in TEP-2.

Color: 10YR 3/2 (3/1 on A horizon) % LOI: 6.6 %

Sand: 21 % Silt:38 % Clay: 41 %

Facies: Fl, pedogenically altered Sample: 52

Zone III

Depth in cm:160 - 242

Description: Silt-loam; hard; weak, subangular blocky structure; few medium, randomly oriented pores; common randomly oriented roots; clear lower boundary.

Color: 10YR 5/2 Bulk Density: 1.03 g/cm^3

% LOI: 6.5 %

Sand: 29 % Silt: 60 % Clay: 11 %

Facies: Fl Sample: 53

Zone IV

Depth in cm: 242 - 320

Description: Sandy loam deposit with laminations; slightly hard; weak medium subangular blocky structure; few medium, randomly oriented pores; common randomly oriented roots; clear, wavy lower boundary. A horizon developed on top (Soil S3).

Color: 10YR 4/1 Bulk Density: 1.03 g/cm^3

% LOI: 8.2 %

Sand: 14 % Silt: 59 % Clay: 27 %

Facies: Fl Sample: 54

Zone V

Depth in cm: 320 - 340

Description: Silt-loam; slightly hard; massive; very few fine pores and roots; clear, smooth lower boundary. It looks like a poorly altered ash. It is the same deposit as zone IX, in TEP-2.

Color: 10YR 5/2

Zone VI

Depth in cm: 340 - bottom

Description: Similar to the one above (zone V).
Color: 10 YR 5/2.

CLP Cienega soils (selection)

Section CLP-1

Zone IV

Depth in cm: 260 - 290
Description: Silt-loam deposit; hard consistence; weak, medium columnar structure; very few fine randomly oriented pores; very few roots; mottles; clear, smooth lower boundary.
Color: 10 YR 4/3; 5YR 5/6 (mottles)
Sand: 28 % Silt:51 % Clay: 21 %
Facies: Fl Sample: 63

Section CLP-5

Zone V Cienega soil

Depth in cm: 290 - 350
Description: Silt-loam deposit; hard; granular to weak columnar structure; common fine and medium randomly oriented pores; common randomly oriented roots; mottles; gradual, smooth lower boundary.
Color: 10 YR 5/3; 5 YR 4/3 (mottles)
Sand: 14 % Silt: 60 % Clay: 26 %
Facies: Fl Sample: 66

3. Granulometric indices

Sample 1

ACOL-1 Zone: I
Mean (Mz): 5 ϕ Sorting (σ^1): 2.14

Sample 2

Section: ACOL-1 Zone: II
Mz: 5.4 ϕ σ^1:2.06

Sample 3

Section: ACOL-1 Zone: III

Mz: 2.35 ϕ σ^1: 1.82

Sample 4

Section: ACOL-1 Zone: IV

Mz: 6.9 ϕ σ^1: 2.70

Sample 5

Section: ACOL-1 Zone: V

Mz: 4.95 ϕ σ^1: 2.62

Sample 6

Section: ACOL-2 Zone: I

Mz: 5.85 ϕ σ^1: 2.31

Sample 7

Section: ACOL-2 Zone: II

Mz: 4.85 ϕ σ^1: 1.91

Sample 8

Section: ACOL-2 Zone: III

Mz: 6.35 ϕ σ^1: 2.49

Sample 9

Section: ACOL-2 Zone: IV

Mz: 6.35 ϕ σ^1: 1.88

Sample 10

Section: ACOL-2 Zone: V

Mz: 7.55 ϕ σ^1: 2.87

Sample 11

Section: ACOL-2 Zone: VI

Mz: 6 ϕ σ^1: 1.83

Sample 12

Section: ACOL-2 Zone: VII

Mz: 4.15 ϕ σ^1: 1.90

Sample 13

Section: ACOL-2 Zone: VIII

Mz: 1.95 ϕ σ^1: 0.87

Sample 14

Section: ACOL-2 Zone: IX

Mz: 6.1 ϕ σ^1: 1.91

Sample 15

Section: CUAN-2 Zone: I

Mz: 8.05 ϕ σ^1: 2.25

Sample 16

Section: CUAN-2 Zone: II

Mz: 7.15 ϕ σ^1: 2.21

Sample 17

Section: CUAN-3 Zone: V

Mz: 2.35 ϕ σ^1: 1.48

Sample 18

Section: CUAN-3 Zone: VI

Mz: 0.6 ϕ σ^1: 1.23

Sample 19

Section: CUAN-3 Zone: VII

Mz: 2.6 ϕ σ^1: 0.99

Sample 20

Section: CUAN-3 Zone: VIII

Mz: 3.9 ϕ σ^1: 1.74

Sample 21

Section: CUAN-3 Zone: X

Mz: 7.0 ϕ σ^1: 3.84

Sample 22

Section: CUAN-4 Zone: Ia

Mz: 5.4 ϕ σ^1: 1.90

Sample 23

Section: CUAN-4 Zone: Ib

Mz: 4.8 ϕ σ^1: 2.63

Sample 24

Section: CUAN-4 Zone: III

Mz: 6.15 ϕ σ^1:2.20

Sample 25

Section: CUAN-4 Zone: IV

Mz: 4.05 ϕ σ^1: 1.60

Sample 26

Section: CUAN-4 Zone: V

Mz: 2.85 ϕ σ^1: 1.10

Sample 27

Section: CUAN-4 Zone: VIa

Mz: 4.85 ϕ σ^1: 2.47

Sample 28

Section: CUAN-4 Zone: VIb

Mz: 4.45 ϕ σ^1: 2.16

Sample 29

Section: CUAN-4 Zone: VII

Mz: 6.45 ϕ σ^1: 3.11

Sample 30

Section: CUAN-4 Zone: VIII

Mz: 5.8 ϕ σ^1: 2.81

Sample 31

Section: CUAN-4 Zone: IX

Mz: 7.25 ϕ σ^1: 3.39

Sample 32

Section: CUAN-4 Zone: X

Mz: 6.45 ϕ σ^1: 2.79

Sample 33

Section: CUAN-4 Zone: XI

Mz: 6.85 ϕ α 2.93

Sample 34

Section: CUAN-4 Zone: XII

Mz: 3.1 ϕ α 1.66

Sample 35

Section: CUAN-5 Zone: I

Mz: 5.75 ϕ σ^1: 1.95

Sample 36

Section: CUAN-5 Zone: II

Mz: 6.8 ϕ σ^1: 2.96

Sample 37

Section: CUAN-5 Zone: III

Mz: 5.2 ϕ σ^1: 2.36

Sample 38

Section: CUAN-5 Zone: IV

Mz: 5.05 ϕ σ^1: 2.58

Sample 39

Section: CUAN-5 Zone: V

Mz: 4.4 ϕ σ^1: 1.78

Sample 40

Section: IXQ-1 Zone: II

Mz: 5.7 ϕ σ^1: 2.12

Sample 41

Section: IXQ-2 Zone: V

Mz: 5.15 ϕ σ^1: 2.33

Sample 42

Section: TEP-2 Zone: I

Mz: 4.75 ϕ σ^1: 2.03

Sample 43

Section: TEP-2 Zone: III

Mz: 5.75 ϕ σ^1: 2.51

Sample 44

Section: TEP-2 Zone: IV

Mz: 6.45 ϕ σ^1: 2.28

Sample 45

Section: TEP-2 Zone: V

Mz: 5.15 ϕ σ^1: 1.56

Sample 46

Section: TEP-2 Zone: VI

Mz: 7.4 ϕ σ^1:3.06

Sample 47

Section: TEP-2 Zone: VII

Mz: 5.15 ϕ σ^1: 2.44

Sample 48

Section: TEP-2 Zone:VIII

Mz: 5.95 ϕ σ^1: 2.71

Sample 49

Section: TEP-2 Zone: IX

Mz: 5.2 ϕ σ^1:2.08

Sample 50

Section: TEP-1 Zone: II

Mz: -2.2 ϕ σ^1: 1.72

Sample 51

Section: TEP-3 Zone: Ia

Mz: 4.9 ϕ σ^1: 2.08

Sample 52

Section: TEP-3 Zone: II

Mz: 7.55 ϕ σ^1: 3.05

Sample 53

Section: TEP-3 Zone: III

Mz: 5.75 ϕ σ^1: 2.21

Sample 54

Section: TEP-3 Zone: IV

Mz: 7.1 ϕ σ^1: 2.78

Sample 55

Section: TEP-3 Zone: Ib

Mz: -0.05 ϕ σ^1: 2.15

Sample 56

Section: PAP-4 Zone: IV

Mz: 4.45 ϕ σ^1: 2.21

Sample 57

Section: PAP-4 Zone: VI

Mz: 1.7 ϕ σ^1: 2.24

Sample 58

Section: PAP-2 Zone: V

Mz: 6.15 ϕ σ^1: 2.43

Sample 59

Section: PAP-1 Zone: Va

Mz: 6.25 ϕ σ^1: 2.97

Sample 60

Section: PAP-1 Zone: Vb

Mz: 6 ϕ σ^1:2.57

Sample 61

Section: PAP-1 Zone: VII

Mz: 6.2 ϕ σ^1: 2.3

Sample 62

Section: CLP-1 Zone: III

Mz: 4.7 ϕ σ^1: 2.13

Sample 63

Section: CLP-1 Zone: IV

Mz: 6.55 ϕ σ^1: 2.82

Sample 64

Section: CLP-1 Zone: VII

Mz: 5.15 ϕ σ^1:1.77

Sample 65

Section: CLP-4 Zone: V

Mz: -1.15 ϕ σ^1: 2.71

Sample 66

Section: CLP-5 Zone: V

Mz: 7.15 ϕ σ^1: 2.56

APPENDIX G

TRANSCRIPTION OF PARTS OF A DOCUMENT DEALING WITH THE 1762 FLOOD IN ACOLMAN

1. Document accompanying the map of Figure 6.12 in which the flood of 1762 is depicted.

The document also deals with the comision to move the parish of Acolman to a safer place.

Source:AGN, *Bienes Nacionales*, leg. 1887, s/f

Sr. Provincial y Vicario General
El cura y juez eclesiastico del Partido de San Agustin de Acolman en vista del superior decreto del Ilustrísimo Sr. Arzobispo mi señor, el que está prompto a poner en execucion , haciendo presente a ser el informe, que tiene hecho en el año pasado en el día doce de septiembre , en que tambien se inundó la Iglesia Parroquial , por haber tomado nueva corriente el río que viene de San Juan Teotihuacan, y derechamente viene a el Barrio de San Nicolás del Calvario, el que actualmente se haya inundado como contaría nuevamente por vista de ojos, y el mudar, o colocar alli al divinísimo, y pila baptismal ... y dar en casi todas, lo que tengo figurado en el mapa que tengo presentado en mi respuesta que se halla en los autos: delante de que imposibilita la administración, por la cicunvalación de la agua, que se haya de barrio, y con peligro para los ministros, y para remediar el que los parroquianos que nacieran en el dicho no carezcan de la gracia del baptismo; no estea tan distante de este lugar, que puedas pedir el que los traigan a él, pues solo esta poco más de media legua; como lo hacen, aun los que están mas distantes, viven compelidos, y teniendo pilas baptismales en sus iglesias, pues así veis en el corto distrito de esta jurisdicción. El adorno que dicen los naturales tener en la capilla del del barrio del Calvario, en el mismo que tiene la Parroquia de Acolman, salvo el colateral. Su capacidad en la que tengo representada, que no pasa de tres pequeñas bovedas. Estos fueron los motivos que representa al Ilustrísimo Señor en el año pasado, y una justificación que sirvió de mandarme mantuviese en este pueblo de Santa María Magdalena de Tepexpan, y siendo la misma causa la que oí, no tuve más arbitro que... me a lo que tengo expresado, y atar a lo que el Ilustrisimo Señor Arzobispo y se me preceptuaren , lo que executaré con ciega voluntad. Nuestro Señor Guarde al S. M. Tepexpan, y septiembre d11 de 1763.

[Signature]

2. Document dealing with the moving of the parish of Acolman.

Source: AGN, *Bienes Nacionales*, leg. 1887, s/f.

The citizens of Tepexpan request that the head town and parish and parish be moved from Acolman to Tepexpan, since Acolman was inundated and Tepexpan is in a flood-safe place. The document also describes

the flood event of 1762 and its consequences. It is complementary to the map attached to the previous document.
There is an attached map not presented in this paper. The map is number 4750 in the catalog (Centro de Información, 1979).

Joseph Basulto, Joseph Roldán, Dn. Rafael Medina, Dn. Juan Zarate, Dn. Miguel Mejía, Dn. J. Basulto el chico y demás vecinos del pueblo de Sta. María Magdalena Tepexpan sujeto de la cabecera de Oculma, como mejor proceda decimos: Que el pueblo se halla sujeto a la cabecera de Aculman cuyo curato se compone de los pueblos siquientes que todos se administran por cura y sus vicarios, a saber: Tepexpan, Sn, Bartholome Tequisistlan, San Miguel Totoltzingo, San Pablo, Sta. Catharina Calvario, Xometla, San Bartholome, San Agustín, San Marcos. Y con la ocasion de que dicha actual cabecera de Oculman se halla situada en el plano que hace una laguna que todos los annos se inunda y aniega, habido en este presente año, y en los venideros con mayores excesos, por haber sido tan abundantes y copiosas las lluvias como es notoria y su abundancia dio lugar a que el río, dejando su antigua caja, tomo una nueva corriente que viene a salir su desagüe a la parroquia de la cabecera, y tierras contíguas nombradas, las huertas, porque antes derramaban sus corrientes en la presa que contenía todas las aguas y que se destinó para este fin y ahora ha acontecido lo contrario por haber acumulado sus corrientes y para este caso y asegurar a esta capital de una inesperada inundación. Tuvo a bien que se mudara a la cabecera a otro paraje más apropiado... que los propios feligreses han sentido este daño , por lo que experimentan mayor quebranto, han desamparado la cabecera, fundando sus barrios en el calvario de Santa Catharina, dejandola sola...y aún en este presente anno con las copiosas agua ha habido inundación, incomodidades que con obligado de cura y vicarios va a salirse del corriente, pasarse a vivir a otra parte distante para el seguro de sus personas, por haberse anegado todo el corriente, y la iglesia hasta los altares, que hasta hoy no han podido visitarse.
El Pueblo de Sta. María Magdalena Tepexpan, está enteramente facil y expedita la administración de todos los referidos pueblos, lo que no dijese de la expedición Aculma que hay algunos de ellos que dificilmente se administran por los mismos caminos que se llenan de pantanos y mucho todo en tiempos de agua y se pide que haya visita para que se confirme todo lo expresado.

APPENDIX H

SEDIMENT DESCRIPTION OF A LACUSTRINE SECTION AT EL TEPALCATE

<u>Lacustrine and ash deposits of the TPL-1 section.</u>

1.1 Sediment description

Unit	Description	Thickness (cm) Unit	Cumulative
I	Mud, silty-clay, gray (2.5Y 6/1), moderate HCl reaction, salt concretions. Lacustrine.	23	23
II	Ash, silt and very fine sand, white. Undulating bedding due to clay-plasticity turbation of upper and lower units. Probably equivalent to so-called Pomez de Grano Fino, dated about 5,000 yrs. B.P.	4	27
III	Sandy loam, gray (10 YR 6/1), with weak HCl reaction. Contains a few fragments of rounded pumice (2-3 mm). ^{14}C sample Tx-7843 (7496 $\pm$ 85 B.P.) collected 5 cm below top of unit. Lacustrine deposition, with pumice transported by flotation.	17	44
IV	Ash, fine sand, olive gray (5Y 4/2). Vitric grains and pumice. Stratigraphic position corresponds to the local Pumice With Andesite, dated about 14, 450 yrs. B.P.	17	61
V	Sandy loam like unit 3, but a lighter gray (2.5Y 6/1), with a strong reaction to HCl. Gleyic lacustrine deposition.	9	70
VI	Ash, medium to fine sand, dark gray to black. Vitric and lithic grains. Basaltic ash, probably from a nearby eruption.	2	72
VII	Silty clay, light gray to white (10YR 8/1), with strong HCl reaction, pH 10.6, the highest in the sequence. Lacustrine deposition, probably in a very alkaline environment .	14	86
VIII	Silty clay, light gray (2.5Y 7/1) with strong reaction to HCl. Lacustrine.	29	115

Munsell color designations taken on dry samples.

APPENDIX I

DIAGNOSTIC CERAMICS ASSOCIATED WITH SOILS AND ALLUVIAL DEPOSITS

This appendix contains only descriptions. The drawings are in possession of the author. For ceramic styles, traditions and phases refer to the diagram of figure 4.1.

I. Sites on the piedmont

I.1 Site TX-A-78

See Figure 5.12 for location of control/sample points

Location: Control point 5. Aztec metepantli soil.

1. Aztec spindle whirl. Diameter, 2.7 cm; surface color: 2.5YR 4/4.
2. Transitional Early-to-Late Aztec, or Late Aztec, black-on-orange dish. Rim. Paste: 5YR 6/8; core: gray. Close to variant D (Hodge and Minc 1990).
3. Late Aztec black-on-orange cajete. Slab. Paste: 5 YR 6/8; core: black.
4. Probably transitional Early-to-Late Aztec, tripode bowl. Tripod and base fragment. Paste: 5YR 6/6; core: 10YR 5/4. Close to subvariant B-1 (Hodge and Minc 1990).
5. Transitional Early-to-Late Aztec, dish or cajete. Paste: 5YR 6/8-5/6; core: black. Subvariant B-1 (Hodge and Minc 1990).
6. Late Aztec black-on-orange dish. Paste: 2.5 YR; core: black. Variant D (Hodge and Minc 1990).
7. Transitional Early-to-Late Aztec, black-on-red bowl. Rim fragment. Paste: 7.5YR 6/3-6/4; core: gray.
8. Transitional Early-to-Late Aztec, black-on-red bowl. Rim fragment. Paste: 7.5YR 6/6; core: gray.

Location: Control point 6. Colonial metepantli soil.

1. Late Aztec, transitional between Aztec III and IV, black-on-orange cajete. Fragment of rim, body and bottom. Paste: 7.5YR 6/8, core: gray. Close to subvariant E (Hodge and Minc 1990,).
2. Late Aztec, black-on-orange dish. Body fragment. Paste: 5YR 6/8; core: gray. Subvariant D2 (Hodge and Minc 1990).
3. Late Aztec black-on-red bowl. Rim. Paste: 7.5YR 6/6; core: light gray. Subvariant C-1 (Hodge and Minc 1990).
3. Late Aztec, transitional to Contact period, black-on-red bowl. Rim. Paste: 5YR 5/6; core: black. Subvariant B-1 (Hodge and Minc 1990).

Location: Control point 7 (Mound 164 in Parsons 1971).

1. Late Aztec, black-on-orange molcajete. Body fragment. Paste: 10YR 5/8; core: gray. Probably in variant D (Hodge and Minc 1990).
2. Probably Late Aztec black-on-orange cajete. Slab support. Paste: 5 YR 6/8; core: dark gray to black (Refer to Hodge, 1992: 431).
3. Early colonial, Aztec IV, black-on-orange dish. Rim. Variant I (Hodge and Minc 1990).
4. Late Aztec comal. Rim. Paste: 10YR 5/6; core gray. Direct rim variant; efer to Parsons(1971: 302, 304).

5. Late Aztec comal. Rim. Paste: 10YR 5/6; core gray. Direct rim variant; refer to Parsons(1971: 302, 304).

Location: Control point 8 (Mound 165 in Parons 1971); pedestal with soil.
1. Classic-Epiclassic cantaro. Rim.
2. Classic-Epiclassic flat rim olla. Paste 7.5 YR 6/6, core 10YR 6/4.
3. Early Aztec (Aztec II) Black-on-orange basin. Body fragment. Paste 7.5 YR 6/6. Variant B (Hodge and Minc, 1990:).
4. Late Aztec Black-on-red bowl. Rim. Paste 7.5 YR 5/6. Subvariant C 1 (Hodge and Minc, 1990:).
5. Late Aztec Black-and-white-on-red bowl. Rim. Paste is too thin to take color; the core takes most of the section area. Variant G Hodge and Minc 1990).
6. Probably Late Aztec black-on-orange cajete. Slab support. Paste: 5 YR 6/8; core: dark gray to black (Refer to Hodge, 1992: 431).
7. Late Aztec-Early Colonial black on orange dish. Rim. Paste 5YR 6/8. Transitional Aztec III-IV corresponding to subvariant E 4 (Hodge and Minc 1990).

Location 9. Topsoil of erosional remanant (pededestal).

1. Transitional Aztec III-IV, balck-on-orange bowl. Rim. Paste: 5YR 6/8; core: 5YR 5/6. Subvariant E-1 (Hodge and Minc 1990, Minc 1994).
2. Early Aztec (Aztec II), black-on-orange basin. Body fragment. Paste: 5YR 6/8; no core. Variant B (Hodge and Minc 1990).
3. Transitional Early-to-Late Aztec, or Late Aztec, black-on-red bowl. Rim. Paste: 10TR6/5; core: black. Subvariant C-1 (Hodge and Minc 1990).
4. Late Aztec, Texcoco, incensario. Censer rim fragment. Paste: 7.5YR 6/6; core: black (Mary Hodge, personal communication).
5. Late Aztec comal. Rim. Paste: 10YR 5/6; core: gray. Direct rim variant; refer to Parsons (1971: 302, 304).

Site TX-A-86
See Figures 5.23 and 5.24 for location of control/sample points. The following locations are on top of pedestals isolated by erosion usually associated with metepantli soil horizons.

Location 1
1. Transitional Early-to-Late Aztec, black and white on red bowl. Rim fragment. Paste: 5YR 5/6; no core. Close to subvariant D-1 (Hodge and Minc 1990).
2. Transitional Early-to-Late Aztec, black-on-red basin. Rim fragment. Paste: 5 YR 6/6. Core: gray. Variant A
3. Transitional Early-to-Late Aztec, black-on-orange dish. Rim fragment. Paste: 5YR 5/8. Variant B.

4. Late Aztec, comal Rim. Paste 7.5YR 6/6. No core. Direct rim. Refer to Parsons (1971: 302, 304).

5. Late Aztec, comal Rim. Paste 7.5YR 6/6. No core. Direct rim. Refer to Parsons (1971: 302, 304).

Location 2

1. Late Aztec, black-on-orange plate or molcajete. Rim fragment. Paste: 5YR 6/8; core: black. Subvariant: E-1
2. Aztec. Black on orange. Molcajete support. Paste: 5YR 6/8. Core: black.

Location 3

1. Late Aztec, Black-on-orange ware. Rim fraqment. Paste: 7.5 YR 6/6. No core. Variant:

2. Late Aztec, Black-on-orange ware. Rim fragment. Paste: 7.5 YR 6/8; no core. Variant:

3. Late Aztec, Black-on-orange bowl. Rim fragment. Paste: 7.5 YR 6/8; core: slightly visible. Variant:

4. Transitional Early-to Late Aztec, black-on-red bowl. Rim fragment,; painted only outside. Paste: 7.5YR 6/4.

5. Aztec. Orange ware. Bowl. Farment of rim, body and part of bottom. Paste: 5YR 6/6. Core: slightly visible.

<u>II. Sites from alluvial plain locations</u> (Selection)
See Appendix F for locations.

IXQ-1 zone II

1. Early Colonial (probably a late variant of Aztec IV) black-on-orange plate. Pate: 5YR 5/6; core: 7.5YR 5/6. Accompanying this item there are numerouss Late Aztec sherds

IXQ-1 zone III

1. Colonial glazed ware with incisions. Paste: 7.5 YR 6/8; no core.

IXQ-1, zones V and VI

Bottom occupational deposits exposed occupational in the tlatel.

1. Early Toltec crater rim. Paste 10 YR 4/3. Usually found in association with Proto-Coyotlatelco and Coyotlatelco (A.D. 650-750) See Parsons (1971) for reference on this style.

2. Early Toltec red-on-buff bowl. Rim. Paste 10 YR 6/6. Coyotlatelco phase (A.D. 650-750). See Parsons (1971) for reference on this style.

CLP-3 Zone VI

1. Early Classic, bowl. Burnished surface: 10YR 2/2. Paste: 7.5 YR 5/6. Phase: Teotihuacan II-III Müller (1978). Entire broken bowl in a mortuary offering. Most of the burial, including bones were already dismantled by the brickyard workers.

APPENDIX J

ADDITIONAL POLLEN DATA

I. Values not included in the pollen diagram of Figure 7.4

Key:

Indeterminable is the group that comprises those pollen grains that because of their degree of deterioration were not identified. However, those deteriorated grains still recognized are counted within the group of selected taxa. Total deteriorated grains in the sample combines both indeterminable and identified deteriorated grains.

Unknown are those grains in good condition but not identified because they were not considered in the reference collection. Other species are pollen grains that were identified but not taken into account in the main groups of taxa because their occurrence is scanty.

Others are those grains that were identified but were not included individually, because its low number,or its irrelevance to the intepretation. They are mentioned in the following paragraphs, where I also included individual groups within some of the groups of taxa included in the diagram (i.e. Asteraceae).

Sample 1

Total pollen sum: 64

Indeterminable: 26.56 %

Unknown and other species: 32.8 %

Other species (number of grains in parentheses): *Salix* sp. (1)

Observations: Some of the grains in the Asteraceae group correspond to *Selloa glutinosa*

Sample 2

Total pollen sum: 202

Indeterminable: 21.3 %

Unknown and other species: 26.2 %
Other species (number of grains in parentheses): *Eysenhardtia polystachia* (2)

Sample 3
Total pollen sum: 149
Indeterminable: 20.8 %
Unknown and other species: 36.2 %
Other species (number of grains in parentheses):
Observations: A tricolpate grain occurs abundantly in this sample, although it is present in small quantities in other samples. The species has not been determined.

Sample 4
Total pollen sum: 710
Indeterminable: 7.46 %
Unknown and other species: 8.2 %
Other species (number of grains in parentheses): *Eysenhardtia polystachia* (3); Tubiflorae (2); *Agave* sp.? (2).
Observations: *Selloa glutinosa* is common among the Asteraceae. Approximately a 85% of *Pinus* grains are corroded and/or broken.

Sample 5
Total pollen sum: 128
Indeterminable: 16.4 %
Unknown and other species: 35.1
Other species (number of grains in parentheses): *Prosopis* sp. (1), *Salix* sp. (1).

Sample 6
Total pollen sum: 585
Indeterminable: 33.5 %
Unknown and other species: 19.3 %

Other species (number of grains in parentheses): Tubiflorae (5)

Observations: The 89% of the spores are *Polypodium* ferns

Sample 7

Total pollen sum: 140

Indeterminable: 34.3 %

Total deteriorated grains in the sample:

Unknown and other species: 41.4 %

Other species (number of grains in parentheses):

Observations: Most of the Asteraceae in this sample are of the genera *Taraxacum* sp. and *Helianthus* sp.

Sample 8

Total pollen sum: 115

Indeterminable: 27.8 %

Unknown and other species: 26.9 %

Other species (number of grains in parentheses): None

II. Exotic markers and pollen concentration values

Pollen concentration was defined with the formula:

The exotic marker used was spores of the genus *Lycopodium* (tablets of 11, 267 $\pm$ 370 spores in each). Pollen concentration, expresed in number of grains per gram of sediment was calculated by the method of Stockmarr (1971) that in this case is:

$$\frac{11,267 \times \text{palynomorphs counted on a slide}}{\text{number of Lycopodium spores counted}} = \text{number of palynomorphs in a sediment sample}$$

To obtain the number of grains per weight it is necessary to divide the value obtained from the formula above by the total weight of the sample. In this case all the samples consisted of 50 grams.

GLOSSARY

Key: (N) Nahuatl, (S) Spanish, (pl.) plural.

Acordado (S). 1. Request for a land grant. 2. Appointment to revise a land-grant request.

Altepetl (N, pl. *altepeme*). Town. Also the term refers to a city-state or small polity including subjects.

Ahuehuete (N, *ahuehuetl*). Conifer of riverine environments (*Taxodium mucronatum*)

Baldías (S). Vacant or public lands. The term is usually used as 'tierras baldías'.

Barranca (S). Deep ravine cut by stream action. The term 'barranco' is also used for the same features, although less common.

Barrio (S). Town subdivision.

Bordo (S). Dike or small dam as for retaining water and sediments of small catchments or to contain flood waters.

Caballería (S). Unit of agricultural land.

Cabañuelas (S). Rains due to occasional cold fronts in January and February.

Cabecera (S). Head town.

Cajete (N, *caxitl*, pl. *caxime*). Literally means bowl. In the archaeological literature it refers to certain kind of bowls with a rough bottom used to grind chili peppers and tomatoes.

Calmil (N, *calmilli*). A household farm and residence.

Calpulli (N, pl. *capultin*). Territorial unit or the group of families occupying it. In some cases is a division for tax-collecting purposes, in other cases is a division of ethnic groups. The Spanish equated the term 'calpulli' with 'barrio.'

Calzada (S). In a general sense it is a street or road. In the historical literature it refers to the causeways that connected elevated portions of settlement or islets in the lakes.

Chinampa (N). Raised planting platform made of organic rich soils on a lakebed.

Ciénega (S). Cienaga. Small marshy patches or springs in surface depressions where the water table is near or at the ground surface.

Composición (S). Legalization of land title.

Colonia (S). In the modern urban lexicon refers to a settlement, especially a new one.

Congregación (S). Congregation or concentration of scattered population.

Denuncia (S). Accusation or statement of land claim.

Desagüe (S). Drainage. In the Colonial Basin of Mexico it means the series of projects implemented to drain the lakes.

Ejido (S). Type of community land.

Encomienda (S). Grant of Indians, mainly as tribute payers, or the area of the Indians granted.

Estancia (S). 1. Subordinate Indian community or barrio. 2. Farm or place to keep livestock.

Gañán (S). Hacienda laborer.

Hacendado (S). Hacienda owner.

Hacienda (S). Large landed state.

Lienzo (S). Literally means 'canvas', and also a painting on canvas. In Early Colonial times it refers to a map of an Indian town and surrounding lands painted on canvas, usually being the document that demarcated the land limits of an Indian community.

Macehual (N, *macehualli*, pl. *macehualtin*). Class of free commoners usually peasants.

Merced (S). Grant, generally of land.

Metepantli (N, pl. *metepantin*). Row of maguey (*Agave sp.*), earth and stones to create a sediment trap on slopes or keep soils from erosion. Metepantli are considered a system of slope terracing widespread in the central Mexican highlands.

Monte (S). Region of brush, scrub or forest; mountain.

Paracaidistas (S). Parachutists. In modern suburban Mexico City is the term used for abusive settlers occupying illegally a territory.

Ranchería (S). Agricultural community of small dimensions.

Rancho (S). Small farm usually as a satellite of a Hacienda.

Repartimiento (S). Distribution, forced sale, encomienda, or, most frequently, labor draft.

Temporal. A period of prolonged rains caused by one or several continuous tropical storms.

Tepetate (N, *tepetlatl*). Literally this terms means 'rock mat'. It refers to a hard surface crust or substrate that cannot be plowed and is unproductive.

Tequesquite (N, *tequisquitl*). Soil impregnated with salts usually from a dry lakebed.

Tlatel (N, *tlaltelli*, pl. *tlalteltin*). Mound. Usually used in the literature for an archaeological mound.

Tlaxillacalli (N, pl. *tlaxillacaltin*). Local level polity, usually a subdivision of an altepetl (town). In some cases it refers to the physical location of a calpulli.

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