PREHISTORIC AGRICULTURAL EXPANSION AND POPULATION GROWTH IN NORTHERN HIGHLAND ECUADOR: INTERIM REPORT FOR 1989 FIELDWORK

by

J. Stephen Athens

INTERNATIONAL ARCHAEOLOGICAL RESEARCH INSTITUTE, INC.

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International Archaeological Research Institute, Inc.
949 McCully St., Suite 5
Honolulu, Hawaii 96826

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ABSTRACT

The present report initiates a project focused on the subjects of prehistoric population growth and agriculture in northern highland Ecuador. The underlying theoretical model guiding this research concerns resource competition, which is argued to be a fundamental process related to cultural adaptation and social change. Limited resources are the source of competitive pressures, which may be expected to intensify as population expands. Testing the competition model involves an evaluation of the role of population growth in cultural change.

For the present research, the primary methodology involves the recovery of maize pollen from cored lake sediments to quantitatively estimate agricultural production through time. Assuming that maize pollen influx is a function of the quantity of maize grown within the entire catchment basin, it is proposed that maize pollen density values per unit of time can serve as an index of agraicultural production and regional population size.

Two sediment cores were obtained from Lake San Pablo, a 6.2 km^2 valley-bottom catchment lake just outside of Otavalo. Also, a transect of depth soundings and bottom dredge sediment samples were taken across the central part of the lake.

The core samples, from a near-shore location, reached depths of 5.0 and 6.15 m, revealing 11 episodes of volcanic ash falls in the peat deposits. Five radiocarbon samples confirmed a calibrated basal date of about 2,000 B.C. for the deepest core and allowed a determination of the sedimentation rate and age estimates for the ash falls. Preliminary pollen analysis documented maize throughout the core, including the basal samples. Charcoal particle analysis in the basal core samples also confirmed the presence of maize, besides suggesting that forest clearance and agriculture must have been initiated sometime prior to 2,000 B.C.

A single analyzed deep-water dredge sample also contained maize pollen. This result confirms the viability of proposed future deep-water coring where pollen influx values will be less affected by near-shore problems of bioturbation and differential mixing.

Archaeological test excavations were undertaken at the La Chimba site (northeast of Cayambe), the Im-11 site (Otavalo), and the Tababuela site (Chota Valley) to develop a regional chronology of settlement, collect remains of cultigens, and to

obtain human skeletal material for stable isotope analysis for dietary inferences.

La Chimba was the primary focus of the field investigations, where a 3-meter deep stratified refuse deposit was documented. There were abundant remains of pottery, fauna bone, obsidian, charcoal, charred cultigens, and other materials. A radiocarbon sample below a deep volcanic ash fall layer provides a calibrated date range of 207-762 B.C. for the approximate initial occupation of the site. A listing and preliminary description of all remains are presented. An effort is underway to source the La Chimba volcanic ash and correlate it with that found in the other archaeological sites and the San Pablo cores.

Field research and a variety of detailed laboratory analyses are expected to continue as funds become available. The direction of future field investigations is outlined.

ABSTRACTO

Este reporte inicia un proyecto enfocado sobre los temas del crecimiento de la población y la agricultura prehistóricos en la sierra septentrional del Ecuador. El modelo teórico subyacente que guía esta investigación concierne a la competición sobre recursos, la cual se argumenta que es un proceso fundamental relacionado a la adaptación cultural y al cambio social. Recursos limitados son la fuente de presiones competidoras, las cuales pueden esperarse que se intensifiquen conforme la población se expanda. Probando el modelo de competición implica una evaluación del papel que desempeña el crecimiento de la población en el cambio cultural.

En la investigación actual, la metodología principal incluye la recuperacion de polen de maíz proveniente de columnas de sedimentos extraídos de un lago para calcular cuantitativamente la producción agrícola a través del tiempo. Suponiendo que el influjo del polen de maíz es una función de la cantidad de maíz que se crece dentro de la cuenca entera, se propone que los valores de densidad de polen de maíz por unidad de tiempo pueden servir como un índice de la producción agrícola y del tamaño de la población regional.

Dos columnas de sedimento fueron extraídas del Lago San Pablo (área de 6,2 km^2), una cuenca recogedora de sedimentos del valle en la vecinidad de Otavalo. También, un paso sistemático de transección se condujo para obtener sondeos de profundidad y muestras de rastreo de sedimentos del fondo a lo largo de la parte central del lago.

Las columnas extraídas, provenientes de la cercanía de la orilla del lago, llegaron alcanzar profundidades de 5,0 y 6,15 metros, descubriendo 11 episodios de caídas de ceniza volcánica en los depósitos de turba. Cinco muestras radiocarbónicas confirmaron una fecha base calibrada de aproximadamente 2.000 años A. de C. para los sedimentos extraídos más profundos y permitieron hacer una determinación del grado de rapidez de sedimentación y un cálculo sobre la edad de las caídas de ceniza volcánicas. Análises de polen preliminarios documentaron la presencia de maíz a través de la columna de sedimentos, incluyendo el fondo de la misma. Análises de partículas de carbón en las muestras del fondo también confirmaron la presencia de maíz, además insinuando que el despejo forestal y la agricultura debieron haber empezado algún tiempo antes de los 2.000 años A. de C.

Una sola muestra de rastreo proveniente del fondo del agua profunda analizada también contenía polen de maíz. Este resultado confirma la viabilidad de propuestos futuros esfuerzos para sacar columnas de sedimento en agua profunda donde los valores del influjo de polen serán menos afectados por los problemas de bioturbación y mezcla diferencial en las orillas del lago.

Excavaciones arqueológicas de prueba se llevaron a cabo en el sitio La Chimba (noreste de Cayambe), el sitio Im-11 (Otavalo), y en el sitio Tababuela (Valle del Chota) para desarrollar una cronología regional de asentamiento, colección de restos de cultivos, y para obtener material óseo humano para el análisis de isotopos estables para la inferencia dietética.

La Chimba fue el enfoque principal de las investigaciones del campo donde se documentó un depósito de basura estratificado de 3 metros de profundidad. Se hallaron abundantes restos de tiestos cerámicos, huesos animales, obsidiana, carbón, cultivos carbonizados, y otros materiales. Una muestra radiocarbónica de abajo de una capa profunda de ceniza volcánica produjo una fecha calibrada de entre 207-762 años A. de C., demarcando aproximadamente la ocupación inicial de este sitio. Se presenta una lista y descripción preliminar de todos los restos. Se está haciendo un esfuerzo al momento para determinar el origen de la ceniza volcánica y correlacionarla con aquellas halladas en otros sitios arqueológicos y en las muestras de las columnas de sedimento del Lago San Pablo.

Se espera que las investigaciones del campo y varias formas de análises detallados de laboratorio continuen conforme existan fondos monetarios disponibles. La dirección de las futuras investigaciones de campo también se detalla.

ACKNOWLEDGEMENTS

The present report derives from a 3 month Fulbright research fellowship granted to the author in 1989. Dr. Gonzalez Cartogenova, Executive Director of the Fulbright Commission in Quito, and Helena Saona, also of that office, were very supportive of the project. I am most grateful for their numerous favors, courtesies, and helpful advice throughout my stay in Ecuador. Upon arriving in Quito, Maria Isabel Silva, director of the Dept. of History and Archaeology at the Instituto Nacional de Patrimonio Cultural, facilitated the submittal and processing of my application for a research permit. Her advice and information concerning the proposed research proved invaluable. The Instituto Otavaleño de Antropología in Otavalo sponsored the project, and I am grateful to Sr. Marcelo Valdospinos R., its president, and to Sr. Edwin Narváez R., its general director, for extending to me use of the IOA's beautiful facilties while in Ecuador.

That so much was accomplished in so little time is due in no small measure to the assistance and whole-hearted support of *Lic.* José Echeverría of the Instituto Otavaleño de Antropología. His archaeological experience and knowledge of the region were indispensible, and the friendship he and his family provided will always be warmly remembered. In addition, the volunteer assistance of Lisa LeCount, a doctoral student from UCLA, is very much appreciated. She worked at both the Im-11 and La Chimba sites, providing us with the benefit of her extensive archaeological experience in highland Peru.

I would also like to acknowledge the family of Sr. Victor Nepas and his wife, Hortensia, for their kind hospitality while we were working at La Chimba. The dedicated assistance of Rosa Clorinda Ines at the site is also appreciated.

At Lake San Pablo I am most grateful to Ing. Eduardo Fernandez, manager of the Puerto Lago restaurant, and his family for use of their boat and floating dock for our lake coring work. This assistance did much to simplify a difficult job.

In undertaking the laboratory work that has been carried out to date, I am most grateful for the volunteer assistance of a number of highly respected specialists. Among these are Dr. Jerome Ward of California State University (pollen), the late Dr. Alan Solem of the Field Museum of Natural History (land snails), Dr. Robert Hershler and Dr. Gustav Paulay of the Smithsonian Institution (aquatic snails), Dr. John Isaacson of the University of Illinois (tephra), and Dr. David Welch of International Archaeological Research Institute (soils).

I have touched bases with numerous other people along the way for their advice and help on the many aspects involved in conducting a project such as mine. The success of this project reflects the sincere cooperation and dedication of these many people and those I mentioned above in lending a hand and providing a sympathetic ear. Truly, I offer a heartfelt thanks to everyone. Gracias.

J.S.A.

I: INTRODUCTION

This report summarizes recent archaeological field and laboratory investigations undertaken by the author in northern highland Ecuador. Fieldwork was performed during a 3 month period between August and November of 1989 while the author held a Fulbright research fellowship. As much of the analyses remain to be completed, the contents of this report should be regarded as preliminary. The primary objectives here will be to provide 1) a brief overview of the research orientation with background and related information, 2) a discussion of the field investigations, 3) a presentation the laboratory analyses conducted to date, and 4) an indication of the direction of ongoing and future laboratory analyses and possible field investigations.

The present field investigations were conducted under the sponsorship of the Instituto Otavaleño de Antropología of Otavalo, Ecuador, and with the collaboration of its archaeologist, *Lic.* José Echeverría A. Permission for undertaking archaeological fieldwork and exporting samples for specialized analyses was obtained from the Instituto Nacional de Patrimonio Cultural of Ecuador.

Environment of the Project Area

The study region encompasses Imbabura and northern Pichincha Provinces of highland Ecuador (Fig. 1). Fertile and generally well-watered temperate intermontane basins are situated between north-south trending eastern and western mountain ranges. The hot, dry, and relatively low elevation Chota and Guayllabamba River valleys form the north and south boundaries of this approximately 3,500 km² region. Large haciendas control much of the intermontane flat lands, while Indian farmers densely occupy the less productive valley slopes up to 3,000-3,400 m elevation. The town of Otavalo, at an elevation of 2,580 m, is centrally located in the intermontane basin of Imbabura Province just 25 km north of the equator. Situated in the wet and dry mesothermal climatic type of Köppen, it has a mean annual temperature of 13.9°C and receives an average of 950 mm of rainfall each year (Fig. 2). Most of the rain falls between October and May; the summer months are relatively dry. Several natural lakes are present within the region, including Lake San Pablo, which is just 2.5 km southeast of Otavalo. A relict natural forest zone is still found in some areas just below the high altitude *páramo* grasslands and above the altitudinal limit of agriculture (Acosta-Solís 1968, Ferdon 1950, Teran 1984).

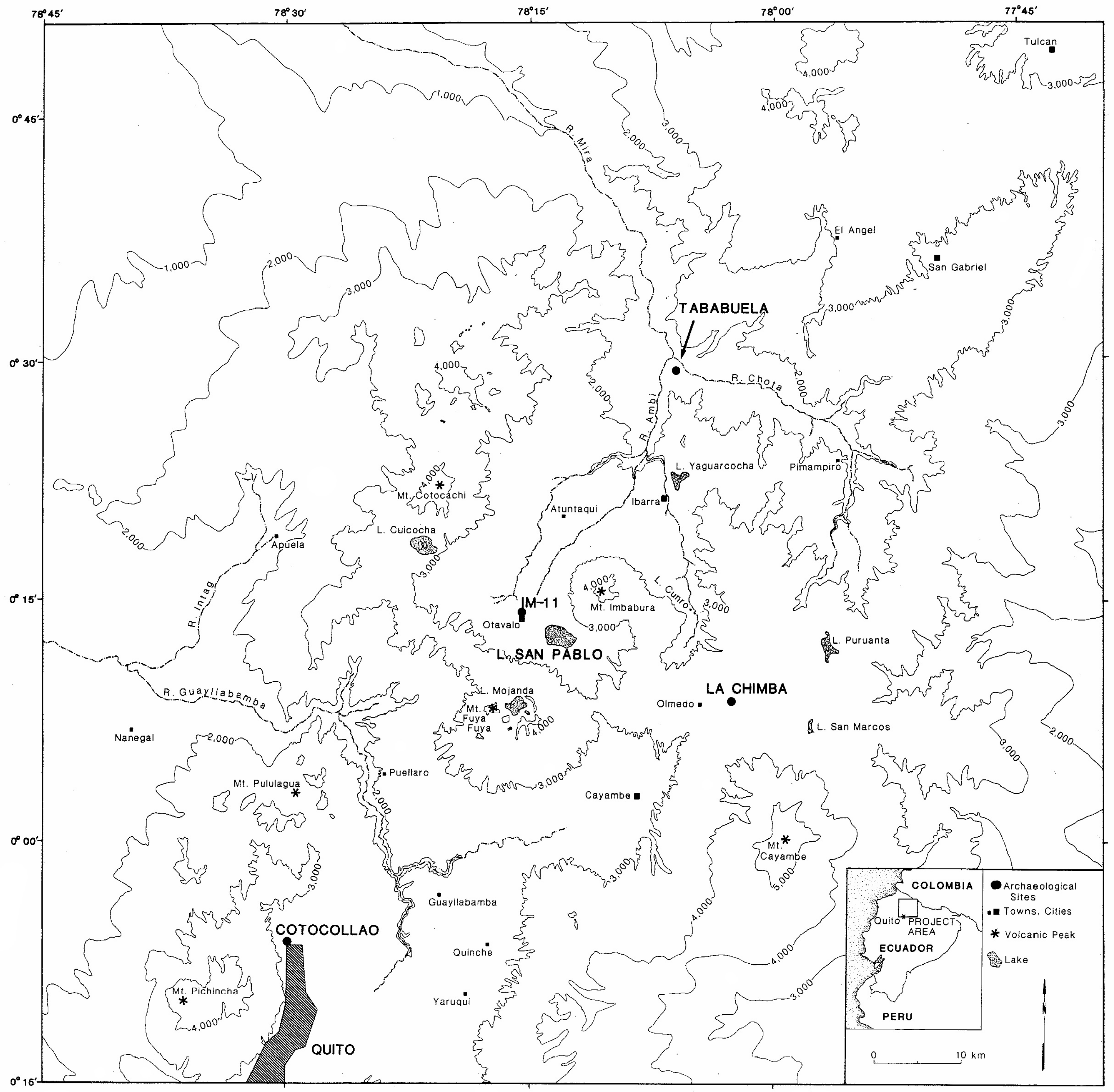


Figure 1. Map of northern highland Ecuador showing location of field investigations.

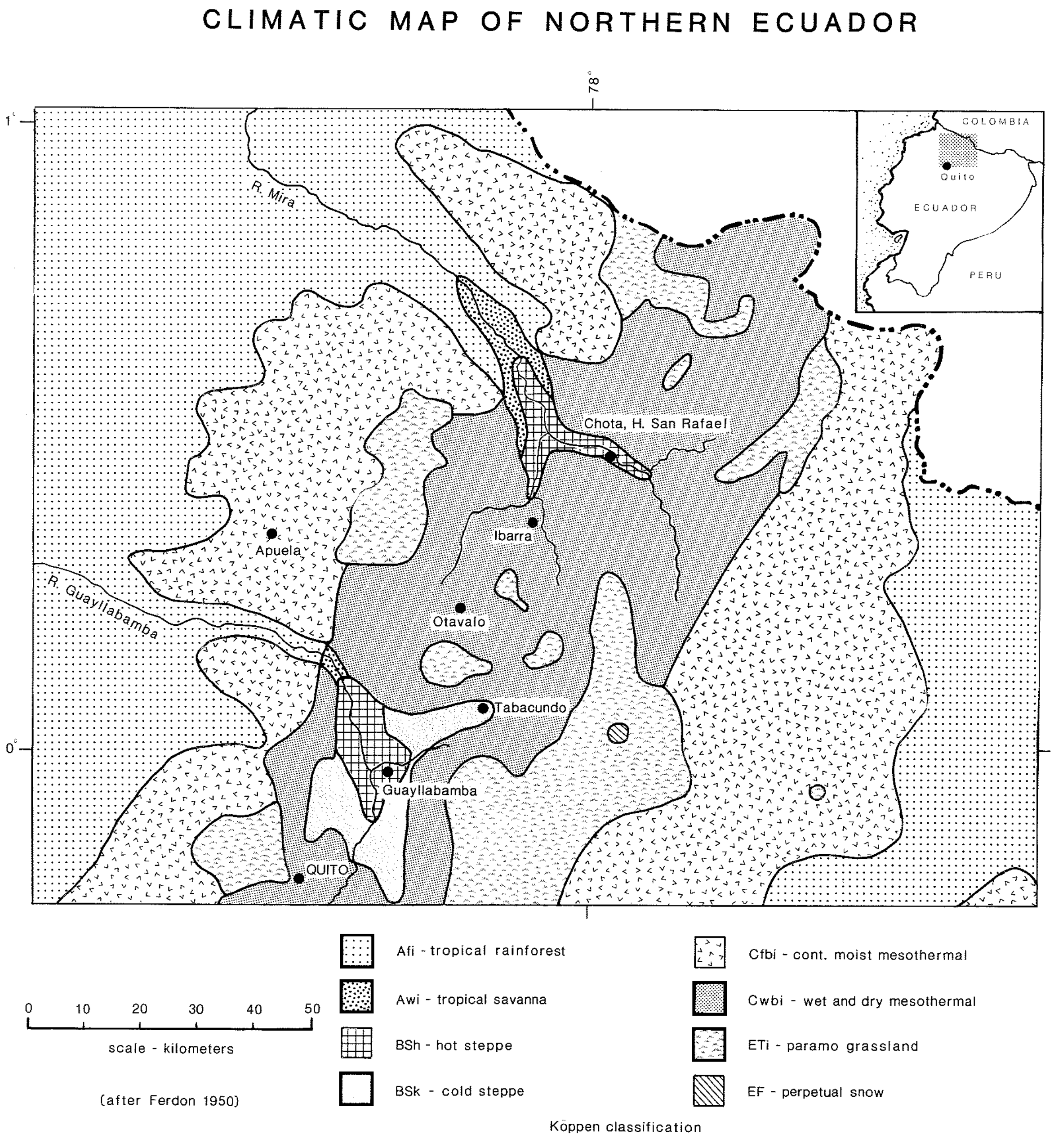


Figure 2. Climatic map of northern Ecuador (after Ferdon 1950).

Fieldwork

Fieldwork included test excavations at 3 sites: La Chimba near Olmedo, Im-11 on the outskirts of Otavalo, and Tababuela in the Chota Valley (see Fig. 1). In addition cored sediment samples were recovered from Lake San Pablo, and a transect of depth soundings and bottom dredge samples were taken across the lake.

The investigations at La Chimba were the most extensive; a site map was prepared and 3 units totalling 8 m^2 were excavated. The stratified habitation deposits at this site reached a depth of 3 m, yielding abundant remains of pottery, animal bones, obsidian flake debris, charred seeds and other plant remains, and many other materials. The ceramic sequence originally proposed by the author (Athens 1978a) for this site was substantiated, though several additional types and subtypes of chronological significance were also identified.

The lake coring work established a sequence of volcanic eruptions in the region besides providing over 6 meters of sediment samples for pollen and other kinds of analyses useful for documenting environmental conditions prior to and following the adoption of agriculture in the region. A preliminary pollen study indicates that initial settlement of the region by maize farmers may date to a considerably earlier time period than previously known or expected. Analysis of tephra (volcanic ash) samples is underway in an effort to correlate these samples with those from La Chimba, Im-11, Tababuela, and other archaeological sites and known volcanic eruptions outside of the region (e.g., Pululagua Volcano).

II: RESEARCH ORIENTATION AND BACKGROUND

The present research has the objective of investigating the processes of agricultural expansion, including intensification and population growth, on cultural change and the evolution of social complexity. This research is an outgrowth of a theoretical model in which competition between social units is considered to be the primary cause of evolutionary change in equable environments (Athens 1977, 1978b, 1980, n.d.1). Because of a stable climatic regime in an equatorial setting, prehistoric cultural development in northern highland Ecuador should fall within the purview of the model. From what is known of its prehistory as well as the particulars of its geographic setting, the region is expected to afford an excellent opportunity for evaluating the model.

Competition

Because competition is a result of limited critical resources needed for survival by organisms that depend on them, it must be directly related to population size and density within the area occupied by those organisms. Any increase in population size therefore, affects the survivability of the organisms. As a result, it is advantageous for these organisms to develop adaptations that enhance their competitive abilities to ensure survival. Such adaptations typically include high parental investment in a few offspring, territoriality, various complex behavioral traits, occupation of narrow ecological niches, highly specialized resource needs, and others. Competition is a well-established and pervasive selective process in the evolution of many organisms and the functioning of ecological systems (e.g., Kingsland 1985).

In the case of human populations dependent on agriculture as an energy base, food production becomes a limiting resource due to its inherent instability, which increases with intensification. This is compensated for by the application of "energy subsidies" (Athens 1977, 1978b, 1980, n.d.1) to overcome perturbations to the production system. Such energy subsidies encompass a variety of strategies, including planting multiple gardens in diverse locations, multicrop swidden systems, irrigation, terracing, the application of fertilizers, food storage, social mechanisms for food exchange and/or redistribution, and many others.

Boserup (1965) was the first to demonstrate that production efficiency in terms of the return on labor investment declines with the intensification of the production system in traditional (non-industrialized) cropping systems. As a result, extensive (i.e., long-fallow) cropping systems are favored over intensive cropping systems unless food demands require higher levels of production per unit area. Logically, increases in regional population size at some point in time must lead to expansion of food resources, which will usually be accomplished through agricultural intensification (see for example Turner *et al.* 1977). This in turn results in higher levels of competition since crop land has become a limiting resource and the problem of energetic security becomes greater with higher levels of intensification.

The above model is elaborated upon elsewhere (Athens n.d.1); however, the above discussion is sufficient to indicate the identification of regional population size (or density) as a driving force in the competition model. Thus, as an initial step in evaluating the model, it would be extremely useful to document the size of population and the trajectory of its growth through time. This effort is at the heart of the present research project, for which the geographical location and archaeological remains of northern highland Ecuador would appear to provide an ideal test situation.

Previous Population Research

The significance of various population parameters (e.g., regional size, regional density) to socio-cultural phenomena is very much an unresolved anthropological issue. The literature is replete with references on the underlying importance of population size and density to various aspects of cultural development (e.g. Binford 1968; Carneiro 1967, 1970; Cohen 1977; Glassow 1978; Harner 1970; Hardesty 1977; Hassan 1981; Johnson and Earle 1987; Naroll 1956; Polgar 1975; Smith 1972; Spooner 1972). Cowgill (1975a, 1975b) among others, however, has tempered much of the enthusiasm for population based models with a very cogent discussion of some of the logical flaws and faulty assumptions of these arguments.

More recently, Feinman and Neitzel (1984) indicate that there is a low correlation between population variables and socio-cultural development, again suggesting that population variables may not be as significant as previously thought. Drennan (1987:320), providing a useful summary of the relevant literature, indicates that he "finds the relationships between demographic variables and social complexity...for chiefdoms to be very intriguing," though they cannot be considered as causes for chiefdom development. Perhaps the best indication of the present status of research is encapsulated in the following comment by Bellwood (1987:444):

> Hypotheses that invoke population pressure as a prime mover behind cultural development may be out of vogue, but hypotheses that deny roles to population growth and expansion in situations where agriculturalists had access to suitable environments...may be quite unrealistic.

Thus, there appears to be a strong feeling that population variables are important, but an unwillingness to regard them as paramount or in any sense causal. It is believed that this situation is due more to a lack of rigorous theory development and use of inductive research strategies than to any inherent ambiguity in the data.

Regional Archaeological Background

Until the late 1960s and early 1970s, knowledge of the prehistory of northern highland Ecuador between the Guayllabamba and Chota River valleys (the northern half of modern Pichincha Province and all of Imbabura Province in the highlands), was largely a product of field investigations conducted by the Ecuadorian archaeologist, Jijón y Caamaño (1914, 1920, 1952). Though these investigations were important for their characterization of the major types of archaeological remains found in this region, for delineating a prehistoric "culture area," and for providing a wealth of ethnohistoric and documentary data, they were severely limited by the theoretical orientation, techniques, and field methodologies of the time. A later synthesis of Ecuadorian archaeology by Meggers (1966) underscored the paucity of data for this region.

Between 1972 and 1976 Athens (1978a, 1978b, 1980b; Athens and Osborn 1974) undertook a program of dissertation field research aimed at elucidating the processual foundations of chiefdom society. This work was regional in scope, and it was focused on the latest prehistoric period of occupation (i.e., the Late Period). The findings of Oberem (1969, 1970, 1975, 1981) and Meyers (1975) at the Cochasquí site significantly contributed to this work. An overview of the Late Period incorporating some of the more recent investigations is provided by Athens (n.d.2).

During the course of the Late Period mound site investigations by Athens, several relatively early ceramic period sites were identified. One site, designated Im-11, is located on the outskirts of Otavalo at an elevation of 2,550 m. Another site, Pi-1 ("La Chimba"), is located at an elevation of 3,180 m on the Hacienda La Chimba in the eastern part of the study region (see Fig. 1). Not being central to the dissertation research focus of Athens, these sites were never explored in any detail (brief reports on testing are presented in Athens and Osborn 1974, Athens 1978b; Goff 1980 discusses the La Chimba pottery). Radiocarbon dates of 720 and 820 B.C. (uncorrected) were obtained for the Im-11 site. At La Chimba, a tripartite ceramic sequence was documented, with the earliest type also represented at the Im-11 site (see Athens 1978a). Unfortunately, the five radiocarbon dates obtained for La Chimba were stratigraphically inconsistent (Goff 1980:158). However, the available information suggested that the earliest occupation post-dated the Im-11 site (Athens 1978a).

Myers (1976) subsequently undertook a survey in the Lake San Pablo area, documenting a number of sites and testing several, none of which proved to have stratigraphic integrity. However, based on the supposed stylistic similarities of pottery from these sites to the early coastal Valdivia and Machalilla pottery, he believed there was evidence for an occupation dating from 2200 to 1100 B.C. This interpretation was subsequently critiqued by Athens (1978b) because of this pottery's similarity with the La Chimba middle period pottery and the associated stratigraphic and radiocarbon dating evidence. Nevertheless, there persists a belief in the presence of Machalilla affiliated ceramics in the northern highlands (e.g., Porras 1982).

Other recent archaeological research in northern highland Ecuador include an inventory of sites based on aerial photographs by Gondard and López (1983), a study of raised field agricultural systems by Knapp (1984, 1988) and Knapp and Denevan (1985), test excavations at a La Chimba "middle period" site in the Chota Valley by Berenguer and Echeverría (1988), a study of hill-top Inca fortifications by Plaza (1976), and excavations near Lake San Pablo by Molestina (1985). In addition, important work has been conducted by Lippi (1986, 1987) and Isaacson (1987) in the *montaña* region on the western slopes of the western cordillera in Pichincha Province. Finally, Villalba's (1988) detailed report on investigations at the Cotocollao site on the northern outskirts of Quito represents a landmark study of the Formative Period in an adjacent region of the highlands. The occupation at this site spans the period between 1500 and 500 B.C.

Regional Research Problems

Besides the general theoretical concern, there are a number of regional archaeological problems and issues that may be addressed by the present research project. In diverse ways, these are all related to competition and an understanding of human adaptive responses and causation in evolutionary change, but as specifically focused on the northern Andes. The major subsidiary research problems may be briefly summarized as follows:

1. Evaluate the recent suggestion by the ethnohistorian, Salomon (1986:42- 43), that prehistoric population levels were "thin" in the northern highlands relative to carrying capacity. As Salomon (42-43) states, "Although Athens and Osborne [sic] (1974) as well as Reichel-Dolmatoff [1961] postulate Malthusian pressure as a motor force of chiefdom politics, they offer no proof of its existence." This view is obviously directly contradictory to the competition model. It also seems to contradict some of the ethnohistoric poplulation data (cf. Knapp 1984:336-340). Finally, it ignores archaeological data concerning late prehistoric agricultural intensification and the energetic requirements needed to support such systems (Knapp 1984: 246-250,302-311). However, there is no firm archaeological data directly documenting prehistoric population size, which will be needed to firmly counter Salomon's argument.

2. Develop a solid chronological foundation for the prehistory of northern highland Ecuador. There is considerable dispute concerning the antiquity of Formative period sites (Myers 1976; Athens 1978b; Porras 1982), as well as the applicability of recent findings from the Formative Period Cotocollao site in the Quito basin (Villaba 1988) to the northern highlands. Besides radiocarbon dating, a chronology of diagnostic ceramic types is critical to resolving these problems.

3. Establish the timing of the earliest agriculture, including maize farming, in northern highland Ecuador. Despite a fair amount of archaeological investigation, the earliest occupation is presently dated at only 820 B.C. for the Im-11 site. Is the antiquity of sedentary farming communities substantially older in this region, and are we just overlooking the earliest sites? Investigations by Stothert (1985:621) on the Ecuadorian coast and by Brush *et al.* (1989) in the eastern Amazonian lowlands of Ecuador provide very provocative evidence for maize cultivation between 7000-8000 years B.P. and 6000 years B.P., respectively (see also Pearsall 1989). There is also emerging evidence for maize cultivation at approximately 6000 years B.P. in Peru, possibly 7500-8000 years B.P. in Argentina, and 4850-5900 years B.P. in Chile (Bonavia and Grobman 1989). Demonstration of very early maize agriculture in the northern highlands would tend to confirm these other early dates, which would result in a considerable revision in the way South American prehistory is conceptualized.

4. Evaluate the proposition by Isaacson (1987) that volcanic activity is responsible for the generally observed lateness of Formative Period settlement in the northern Andes (northern Ecuador and Colombia). In particular, what has been the role of volcanism in highland settlement and population movement?

5. Establish the nature and chronology for use of plant and animal domesticates in the northern Andes. In particular, nothing is known of the prehistoric variability and evolution of maize, which was the subsistence base for cultures of the later prehistoric and historic periods. Also, it would be of interest to establish the timing for the introduction of llamas into the area, which are known for the Late Period (Athens 1978a, 1980; Stahl 1988).

6. Evaluate and quantify the use of non-local products during prehistory. To what degree can early prehistoric social development in the northern highlands be considered autochthonous? To what degree was there trade and exchange for products from different environmental zones, or control over multiple environmental zones, by social units? A preliminary consideration of these questions and theoretically deduced predictions have been presented by Athens (n.d.2).

7. Establish baseline data for understanding the prehistoric natural environment and the process of landscape transformation.

8. Determine the contribution of maize to the prehistoric diet through time using stable isotope analysis of human bone.

9. Begin research on other archaeological concerns, such as source-specific obsidian hydration dating, functional analysis of pottery, stone tool technology (particularly obsidian use-wear analysis), and pottery residue analysis.

III: RESEARCH METHODOLOGY

The investigative strategy of the present research will rely on carefully sampled archaeological excavations at prehistoric habitation sites, as well as on the extraction and analysis of lake core sediments. These two methods are expected to produce complementary kinds of data, and together they will provide a reliable corpus of information with which to address the research questions posed above.

Lake Coring

Given the presence of a valley-bottom sediment catchment lake of sufficient antiquity, an integrated paleolimnological approach using cored sediment samples has the potential to provide detailed information on agriculture, land use, and environmental change within the study region (cf. Metcalfe *et al.* 1989). In particular, such sediment samples are expected to contain a pollen record documenting the initial use and expansion of maize agriculture, as well as a lengthy vegetation history and record of volcanism.

For this work, the project will focus on Lake San Pablo, a 2.3 x 3.5 km body of water located in the inter-Andean valley at an elevation of 2,670 m and 2.5 km southeast of the city of Otavalo (Fig. 3; Photo 1). The lake forms a sediment catchment for a region having an area of approximately 145 km^2, most of which is devoted to indigenous agricultural production on small land holdings. Steinitz-Kannan *et al.* (1983) provide results of a recent limnological study of the lake. Among other findings, they indicate that the lake has an area of 620 ha and a surface temperature of 18°C. Regarding the lake's depth, they also note that "much of the lake is about 30 m deep [a maximum of 48 m is cited in a table], although there are wide shallows" (Steinitz-Kannan *et al.* 1983:87).

Geological information suggests that the lake probably formed during the late Pleistocene (Sauer 1965:274-275). Zavgorodnyaya (n.d.:3), a geomorphologist, indicates that there are two levels of lacustrine terraces around the lake, demonstrating higher and variable levels of water in the past. The flat and marshy topography around much of the lake also suggests that it may have once been considerably larger than at present, perhaps 50% or more (see Fig. 3). Large groves of the *totora* sedge (*Scirpus totora*), harvested and woven into mats by the local Indian community, are presently found around most of the southern perimeter of the lake.

Lake San Pablo

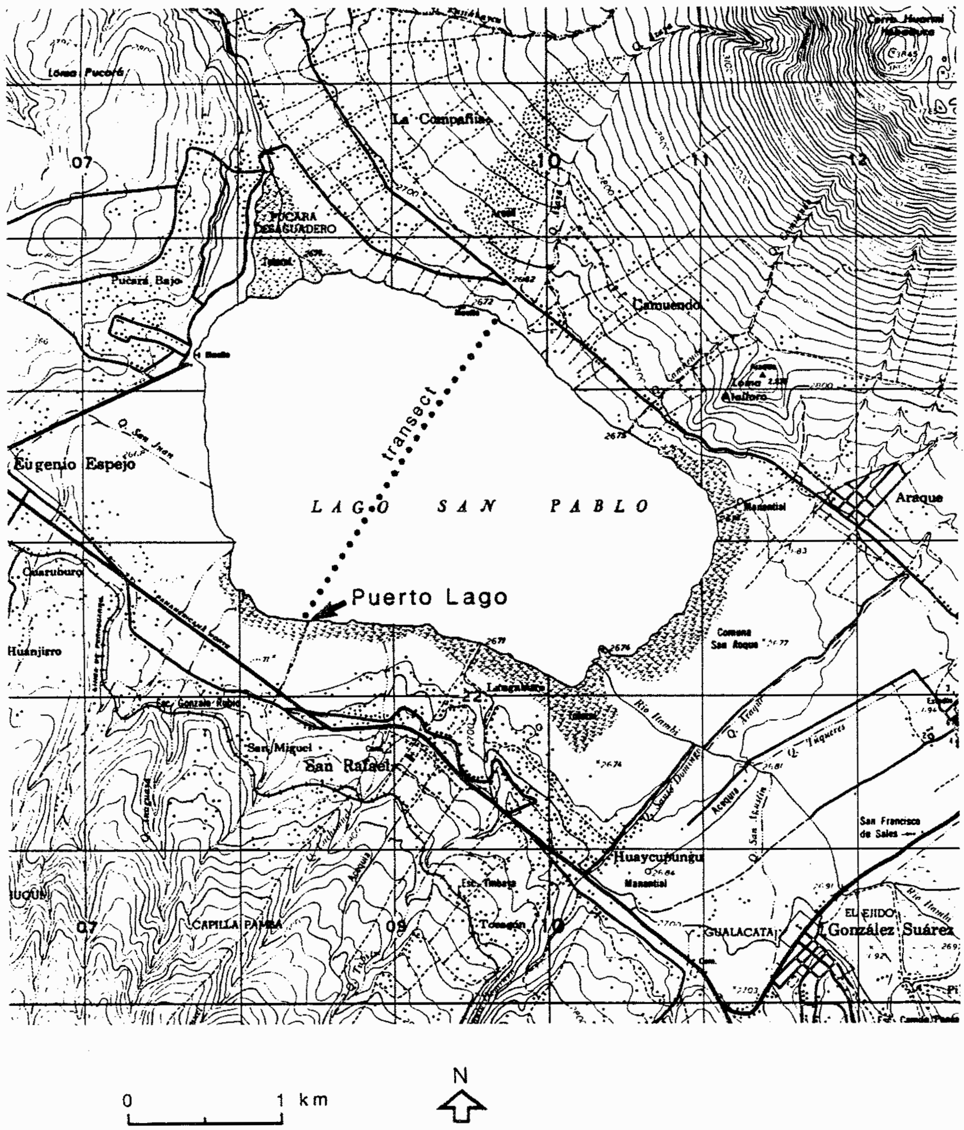


Figure 3. Map of Lake San Pablo showing bottom dredge sampling and depth sounding transect and location of Puerto Lago coring site.

In order to model the growth and development of agricultural production, which is assumed to directly relate to regional population size, primary reliance will be given to the close-interval measurement of maize pollen density through the relevant part of the cored sediment sequence (see Birks and Birks 1980 for a discussion of technique). A critical assumption in this endeavor, of course, is that the density of maize pollen in the sediments bears a proportional relationship to the quantity of maize that was produced within the catchment region. In so far as possible, this assumption will be tested using bottom dredge samples from different lakes in the region to compare modern maize pollen influx with the size of the catchment area and land use (see Gondard 1984 for technique using aerial photographs). However, the most telling validation of the methodology must await analysis of the core samples themselves; if the assumption holds, there should be some form of a growth curve from in the maize pollen influx values from bottom to top (with perhaps a dip after Spanish contact).

Given the ethnographic documentation of maize as a dietary staple along with its preference as a cultigen among indigenous farmers (PRONAREG-ORSTOM 1978), the use of corn pollen as an index of cultivation intensity seems well founded. In this respect, Knapp (1984:220) has also shown that corn is the preferred crop because of its greater labor efficiency as compared to potatoes, which are grown primarily at higher elevations where corn does not produce well.

In addition to pollen analysis, phytoliths will be analyzed as a check on the pollen findings, as well as to expand information relating to the vegetation history of the valley. Because of the relatively recent success in the identification of maize using phytoliths (Pearsall 1978, Piperno 1984, Russ and Rovner 1989), it will be possible to corroborate information relating to use of maize independently from the pollen data. This may be especially important in terms of establishing its initial period of use.

Close attention will be given to the identification of tephra layers in the core samples in order to evaluate the impact of volcanic activity on human settlement and the refuge concept of Isaacson (1987). Analysis of pollen samples immediately above and below the tephra samples may reveal the degree to which the environment was affected by such events. In addition, through geochemical analyses an effort will be made to correlate Lake San Pablo tephras with other known tephras (e.g., the Pululagua Volcano tephra--see Isaacson 1987) and any that may be found in archaeological sites.

Other analyses for the cored San Pablo sediments will include studies of diatoms (a good indicator of cultural eutrophication--Metcalfe *et al.* 1989), aquatic snails, sediment geochemistry, organic content, and charcoal particle counts, all of which may provide important information relating to agriculture and the environmental history of the Lake San Pablo basin.

Previous Lake Coring Studies

The only previous lake coring studies in the region have been conducted by Colinvaux *et al.* (1988; Steinitz-Kannan *et al.* 1983). A report has been published on his investigations at Lake Yaguarcocha, and some data has been presented on his work at Lake Cunro, both of which are situated within the inter-Andean plateau 2 km northeast and 13 km south of Ibarra, respectively. Colinvaux (pers. comm. 1984) also indicated that incomplete cores were taken from Lake San Pablo and Lake San Marcos, the latter being in the high *páramo* zone of the eastern cordillera. However, there have been no reports on this work (see Fig. 1 for locations of all lakes).

The findings from Lake Cunro, though only briefly mentioned in published reports, are particularly interesting in terms of the proposed research. This small lake, occupying a volcanic explosion crater (maare), is only 100 m in diameter and 5 m deep. It is situated at an elevation of 2,822 m, which is approaching the upper limit for optimal maize cultivation (see below). What is of special interest is that Colinvaux recovered a pottery sherd in sediments dating to about 1100 B.C. (Steinitz-Kannan *et al.* 1983:90). It is also reported that since the maare first filled with water about 6,000 years ago, 16 tephra layers have been deposited in the lake, "some more than 10 cm thick" (Steinitz-Kannan *et al.* 1983:90). Unfortunately, no account of the pollen findings are given for Lake Cunro, and no sedimentary profile is presented. Interestingly, however, in another paper Colinvaux *et al.* (1988:89) mention that a "detailed history" of maize pollen was recovered from Lake Cunro though they do not present any specific data.

In comparison to Lake San Pablo, the catchment area for Lake Cunro is tiny, being limited to only the crater rim. Thus, a maize pollen density study from this lake such as proposed for Lake San Pablo would be of doubtful value. However, it would be extremely interesting to know at what point maize first appears in the Lake Cunro core as this would provide a useful comparison with the Lake San Pablo data.

With respect to Lake Yaguarcocha, Colinvaux *et al.* (1988:89) make of point of discussing the lack of evidence for maize pollen. The pollen record indicates, nevertheless, that the period between 1,700 to 5,000 years B.P., which Colinvaux *et al.* believe to be a critical interval for the introduction and development of agriculture in the region, was characterized by a relatively dry climate. Among other findings, they note that the Andean *Weinmannia* forest characterized the region between 2,200 and 2,800 m (the elevations of Lakes Yaguarcocha and Cunro where data was collected) since at least the start of the Holocene. This forest type is represented by species of Melastomataceae, Ulmaceae, *Mimosa*, *Weinmannia*, *Hedyosmum*, and Urticaceae-Moraceae (Colinvaux *et al.* 1988:87). No mention is made of the total number of tephra layers, and because the finer stratigraphic layers are not represented in the profile, there may be more than the 7 tephra falls that are depicted.

Archaeological Excavations

Data from archaeological excavations will be essential to validate some of the assumptions involved in use of the coring data. For example, it is assumed that maize cultivation was the primary dietary staple of prehistoric sedentary farming populations, as is the case in modern times (see data in Knapp 1984:164, 166). This can be determined most efficiently from stable isotope analysis of human bone (van der Merwe 1982, Vogel and van der Merwe 1977, Farnsworth *et al.* 1985, Keegan and De Niro 1988, Ambrose 1987). While 2 samples of human bone are presently available for stable isotope analysis from the Im-11 site, at least another 8 to 10 samples from different time periods and geographical areas would be ideally needed for a preliminary evaluation of the significance of maize in the prehistoric diet. These additional sets of human remains will have to be obtained through new excavations.

Additionally, it will be important to obtain samples of the cultigens in order to evaluate their agronomic potential and also to have a better idea of what was being grown during the different time periods. Because of the presumed primacy of maize in the diet, it will be particularly important to understand the variability of this cultigen.

Another important methodological consideration concerns the pattern of initial inter-Andean settlement by agriculturalists. As Knapp (1984:24, citing Acosta-Solís 1962:107) observes, 2,800 to 3,000 m is usually considered the upper boundary for corn production in Ecuador (see also data in Gondard 1984:61-63). Although the caloric yield per hectare of potato production may be as high as corn for elevations above 2,800 m (Knapp 1984:143), the amount of labor required is considerably greater (see comparative labor figures by Knapp 1984:216). As Knapp (1984:217) concludes,

> For a given level of production per unit of total area, potato cultivation is less labor efficient than maize....this means that normally potatoes should not be grown where maize can be grown.

Thus, it can be inferred that agriculturalists will only move to the higher elevation areas when maize cropland is no longer sufficient to meet food requirements.

In terms of applying the above model to presently available data, it may be expected that whatever the initial date of occupation for La Chimba (located at 3,180 m elevation), earlier sites should exist in lower elevation "maize lands." The Im-11 site is a potential candidate, though this site has never been properly documented. The previously mentioned potsherd in the 1100 B.C. sediments of the Lake Cunro core would also indicate the possibility of early pre-La Chimba settlements.

Because there has been so little thorough documentation of the archaeological remains in northern highland Ecuador, other information relating to prehistoric sites cannot be ignored. Stylistic analysis of pottery, for example, may indicate the degree to which social development was autochthonous, functional analysis of pottery may help determine the dietary significance of certain cultigens as well as indicate something of the nature of task scheduling, social divisions, etc. The analysis of animal bone may indicate the chronology for introduction of domestic guinea pig and llama, which may in turn relate to dietary needs and/or cargo transport needs (in the case of the llama). The presence of exotic goods, such as marine shell, metals, possibly obsidian, pottery from outside the region, etc., may indicate the significance of trade and exchange networks through time, status differentiation, etc. Also, analysis of other items may be siginficant in terms of developing a balanced view of prehistory for the project area.

The validity and importance of obsidian hydration dating has been well-established through the source-specific methods pioneered by Michels *et al.* (1983; see also Stevenson *et al.* 1989). To make this a practical technique for the project region, where obsidian is commonly present at archaeological sites, attention to the different sources and determination of the effective hydration temperature are needed. To these ends thermal and humidity cells will be implanted at selected sites, chemical characterization studies will be undertaken on the obsidian, and several source-specific induced hydration experiments will be run.

The fieldwork strategy at the Im-11 and La Chimba sites will include careful stratigraphic excavation and documentation of findings, screening of all archaeological sediments, and systematic collection of botanical remains through floatation and fine screening. The emphasis will be on establishing site stratigraphy and chronology through excavations in refuse deposits as opposed to areal excavations or work in specialized areas such as cemeteries. The importance of the latter is recognized; however it is necessary to apply the limited time and resources available for the project to that which is most directly related to problem orientation of the present research.

Although not anticipated prior to fieldwork, another site--Tababuela in the Chota Valley--was tested while conducting fieldwork in northern highland Ecuador. The investigations of this site through the invitation of Lic. Echeverría provided an unexpected opportunity to sample a "La Chimba Period" site in a very distinctive and entirely different kind environmental zone from the type site. The same field methodology was used at this site as at the La Chimba and Im-11 sites.

IV: FIELDWORK AT LAKE SAN PABLO

Investigations at Lake San Pablo comprised 3 days of fieldwork between Sept. 27 and 29, 1989 with the assistance of *Lic.* Echeverría. The first day was spent taking bottom depth measurements and sediment dredge samples along a transect of the central part of the lake from the southwest shore to the northeast shore. The second and third days were spent taking two sediment cores with a modified Livingston corer (Aaby and Digerfeldt 1986; Wright *et al.* 1984). The locations of these field activities are shown in Figure 3 and Photos 1, 2, and 3.

Depth soundings were taken from a rowboat using a fiberglass metric tape to which was attached a 20 ounce lead weight. Following each measurement, multiple bottom sediment samples were taken at most locations using a LaMotte bottom sampling dredge designed for the purpose. Each sample was placed in a sealed plastic bag immediately upon recovery. Horizontal distances from the shore were visually estimated. Depth measurement and bottom sampling began at the Puerto Lago restaurant on the southwest shore and terminated just east of the Club Náutico on the northeast shore, a distance of approximately 2.3 km. The results of this work are summarized in Table 1.

The maximum depth of the lake along the transect is 32.5 m. It is of interest that this depth occurs only 300 m from the northeast shore, suggesting the former presence of a stream channel or perhaps a fault line (or both) along the eastern margin of the lake. Overall, however, the lake has a very gently sloping bottom that trends downward to the east for almost 87% of its horizontal width, though dropping off rather sharply from both shorelines. As noted previously, Steinitz-Kannan *et al.* (1983) indicate that Lake San Pablo reaches a maximum depth of 48 meters; however they do not indicate where such a depth was recorded.

The dredge sediment (22 samples collected) consisted of fine black muck. Long strands of algae on the bottom prevented collection of samples in the relatively shallow water of the 50 and 100 meter sample locations. No evidence for bottom algae was noted in the other dredge samples.

The two core samples were taken from the floating dock of the Puerto Lago restaurant approximately 1 meter apart and 20 meters from the shoreline (Photos 2 and 3). While fill had been placed on the adjacent shoreline for construction of the restaurant and surrounding garden area, the shoreline of the immediate vicinity was marshy and had thick stands of <u>totora</u>

Table 1. Depth measurements and bottom dredge samples, Lake San Pablo (measurements in meters).

Distance from SW Shore at Puerto Lago	Bottom Depth	No. of Dredge Samples
50	5.7	0
100	17.8	0
200	21.3	2
300	22.4	4
500	24.0	3
800	26.0	3
1,000	27.0	3
1,200	27.0	0
1,300	28.0	1
1,400	29.6	0
1,500	31.0	3
1,600	32.4	0
1,700	32.2	0
1,900	32.0	3
2,000	32.5	0
2,050	31.0	0
2,150	26.0	0
2,200	16.0*	0
		22

* Measurement at floating dock in front of the Club Náutico.

* * * * *

reed (*Scirpus totora*). There was nothing to suggest disturbance in the water itself, and this was also confirmed in conversations with the restaurant personnel. Most of the land behind the marsh was under cultivation with maize being the principal crop.

Because water depth at the coring locations was 2.48 m, a 3 m long and 3 inch diameter PVC casing pipe was used to guide the corer into the same hole for each drive. The lake bottom was obscured by long strands of algae and somewhat murky water.

Core #1 reached a depth of 5.1 m and Core #2 reached 6.15 m (the latter required 9 drives). Except for the uppermost layer of mostly organic muck (down to 1.60 m; see below), the sediment was relatively firm and considerable effort was needed to drive the corer downward. A 2.5 inch diameter auger was used in Core #1 to penetrate the upper thick ash deposit (ash C; see below). However, the ash was so dense that the auger did not work as well as expected; even when loosened by the auger bit, the ash resisted moving upward and into the auger bucket.

For Core #2 it was found that the corer (having a sharpened and serrated edge) was actually more effective in penetrating the ash if substantial downward pressure was applied with a twisting motion. The auger was then used to slightly widen the bore hole once a depth of 4.32 m was reached. Friction was thereby reduced somewhat, making it possible to ultimately penetrate 1 meter deeper than was possible in Core #1.

The samples were extruded onto clean aluminum foil after each drive and divided into sub-samples of 5 cm lengths and less if there were stratigraphic changes (Photos 3 and 4). Each sample was placed in a labeled clean plastic bag upon removal from the core section. A clean trowel was used for slicing the samples (cleaned after each use), and an effort was made to remove loose sediment pieces and/or scrape the exposed sample surface before placement in the bag as an extra precaution. A total of 85 samples was collected from Core #1 and 118 from Core #2.

A profile of the deeper Core #2 is presented in Figure 4. Black, mostly organic muck occurs to a depth of approximately 1.60 m. From this point to the base at 6.15 m the sediment matrix is mostly a relatively fine peat with thin (0.5 to 1 cm thick) bands of fine black clay loam common. Within the peat there are 11 volcanic ash units. Two of these apparently represent relatively major eruption episodes. The ash units are labeled with letters "A" through "K" to facilitate future reference.

Regarding the thick ash units, the upper one--ash C--begins at a depth of 2.6 m and is 28 cm thick (Photo 4), while the lower one--ash I--begins at 5.02 m and is 11 cm thick. The other ash units are approximately 0.3 to 1 cm in thickness. Both of the thicker units consist of a light greyish very fine and dense ash and might be analogous to what is described as *cangagua* in terrestrial deposits (Sauer 1965:265-274). The upper one (C) seems to have some size sorting, with coarser sediment in the lower portion. Size sorting was not noted in the lower thick unit (I), though there was some thin banding of ash with black sediment in the uppermost part of this unit. The thin ash units all consisted of a sediment that was greyish or whitish. Except for the 0.3 cm thick lens at 4.86 m (ash H), which consisted of

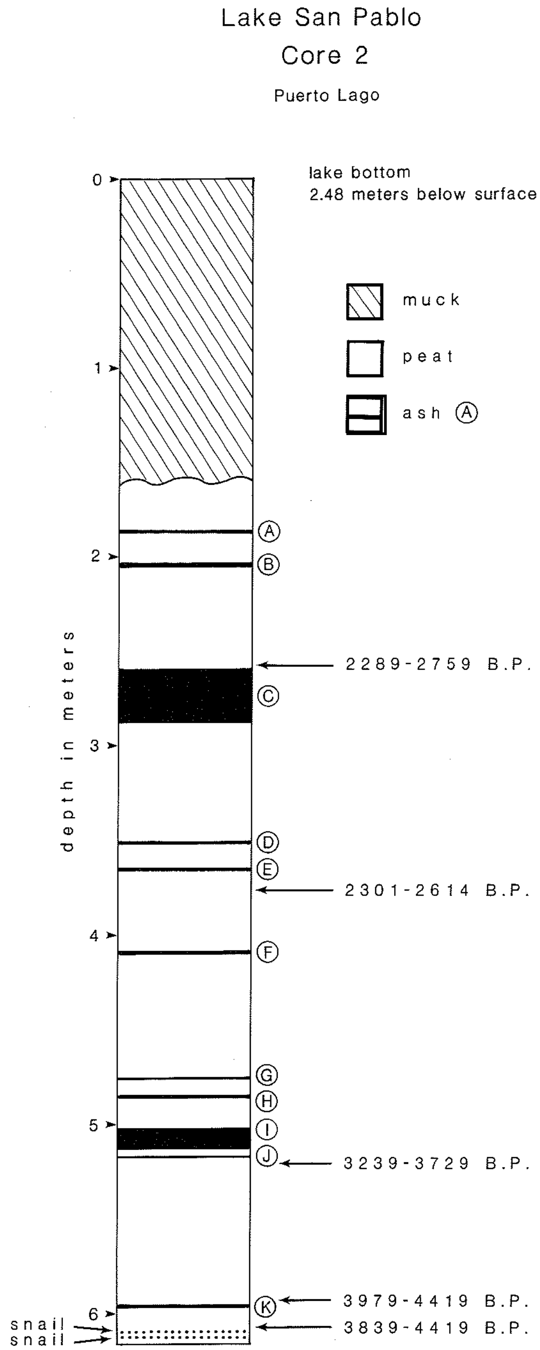


Figure 4. Profile of Core 2, Puerto Lago, Lake San Pablo. Radiocarbon dates are calibrated with 95% confidence interval.

very fine ash, the thin ash units tended to be granular in texture.

Near the base of Core #2 there were two thin lenses of fragmented shells of tiny mollusks (at 6.12 and 6.09 m). Both lenses, consisting of virtually solid shells, were about 0.5 cm thick. Mollusk shells were not observed elsewhere in the cores. The sediment matrix immediately above and below the shell lenses consisted of peat similar to that found in upper parts of the core.

V: ARCHAEOLOGICAL EXCAVATIONS

La Chimba

Fieldwork at the La Chimba site was initiated on September 5th and continued through September 19, 1989. During a prior reconnaissance on Sept. 1, arrangements and/or inquiries concerning fieldwork were made with the 3 landowners of the portions of the site where excavations were to be conducted (the site is now divided among at least 5 landowners). Also, arrangements were made for accommodations and meals with a local family in a nearby community (about 1 km away; the area is designated El Capuli on the 1979 IGM topographic map). Field personnel consisted of the author, José Echeverría, Lisa LeCount (Univ. of California, Los Angeles), and 1 to 2 local children who helped with dry screening).

Figure 5 illustrates the site area and location of previous and new excavation units. Figure 6, from a portion of a 1938 map (see below), shows the topographic setting of the site. The new excavation units are designated TP-5, -6, and -7, and these will be the main concern of the present discussion. TP-5 and -6 were 1 x 2 m in area, while TP-7 was 2 x 2 m. The site map, prepared with tape and compass, indicates that archaeological surface remains south of the La Chimba River extend over an area of approximately 12 ha (300 x 400 m). Of particular interest is the concentration of archaeological debris on at least 4 low mounds (2 adjoin each other) and the scarcity or low density of surface remains in some of the intervening areas (see Fig. 5).

The La Chimba site is known to extend to the north side of the river, which several area residents indicated is the locus of a prehistoric cemetery (this was also indicated by Crespi 1968:30-31). However, there was insufficient time to examine the area for surface remains. A spiral petroglyph is located within the *quebrada* on a large boulder next to the river (south side) and about 50 m west of the bridge.

The last time the La Chimba site was visited by the author was 15 years ago in 1974 when TP-1 through -4 were excavated with Alan Osborn (TP-A was excavated in 1972). Since that time the main change at the La Chimba site has been the distribution of formerly cooperatively held land to private owners and the bringing of the area within the *tapia* wall enclosure under cultivation (freshly inter-planted corn, melloco (*Ullucus tuberosus*, and probably other cultigens were beginning to sprout at the time of fieldwork). Previously this area contained only coarse bunch grass of a type typical of the high *páramo* region;

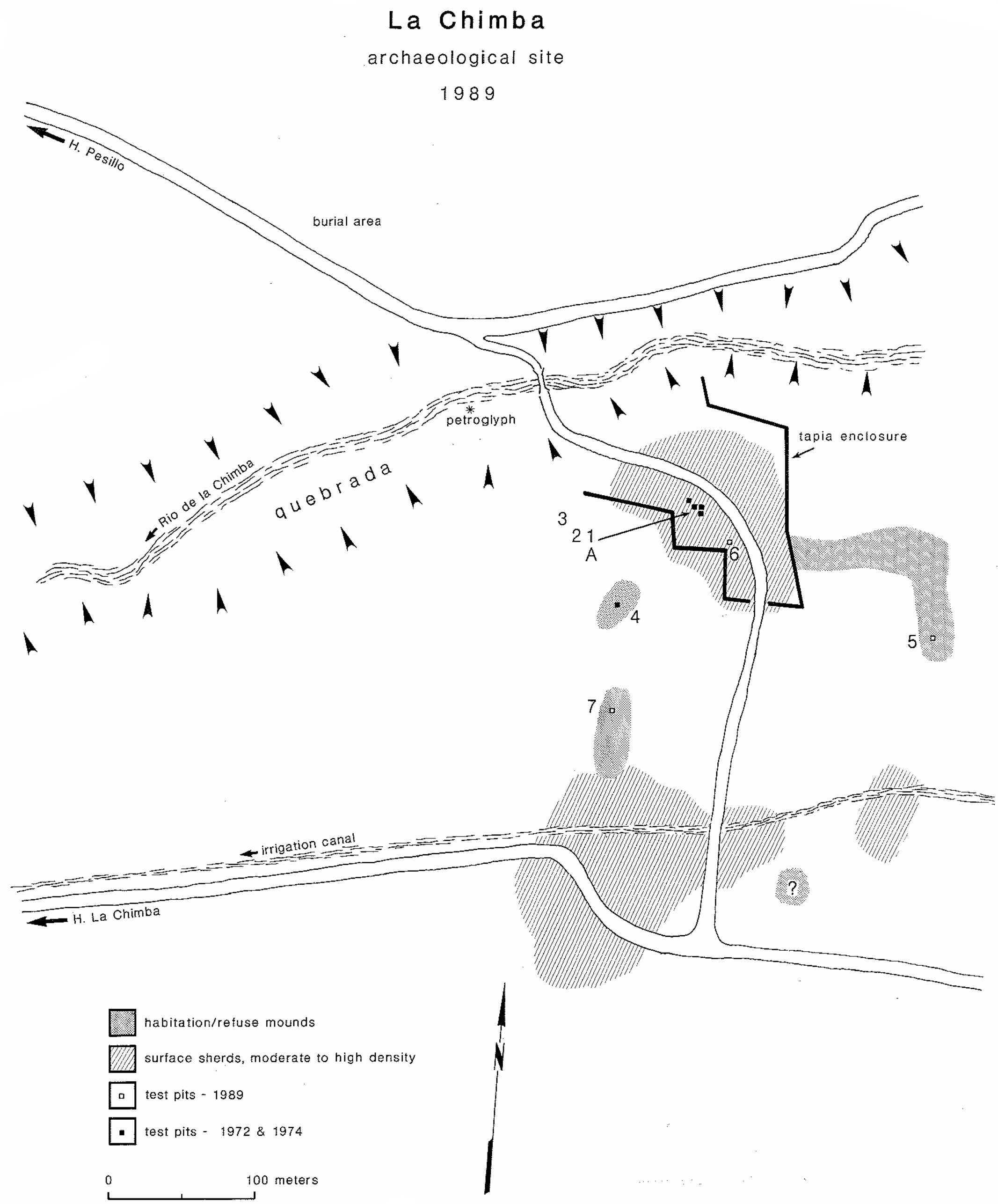


Figure 5. Map of La Chimba site showing archaeological testing locations and habitation/refuse mounds.

La Chimba

Archaeological Site Location

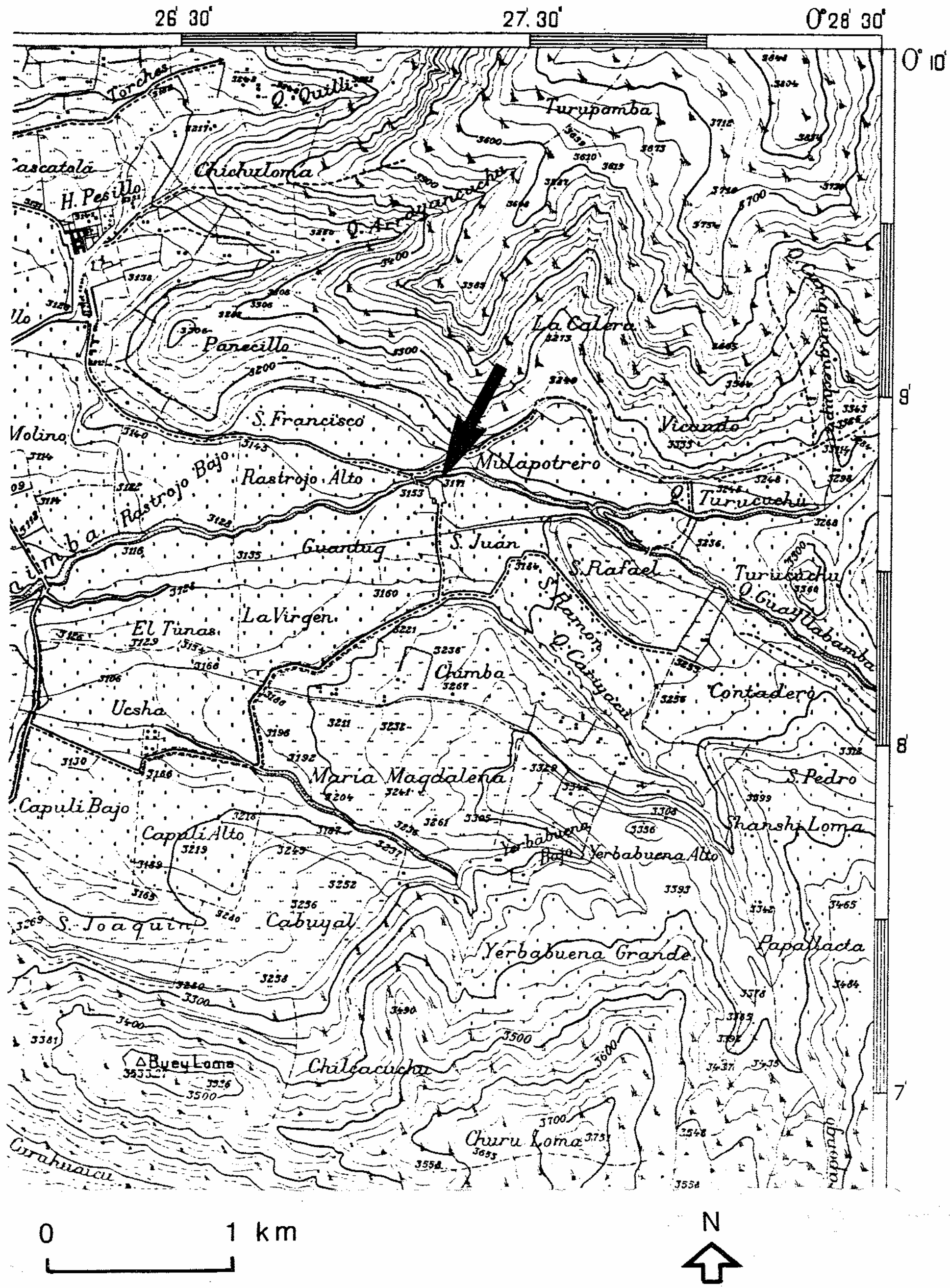


Figure 6. Portion of 1938 topographic map showing La Chimba and surrounding area.

it did not appear to have been previously cultivated. The *tapia* walls, shown on a 1938 topographic map (based on 1935 aerial photographs) suggest that the area may have been a corral for livestock (Fig. 6).

The locations of the previously excavated test units (TP-A, -1, -2, -3, and -4) are no longer visible. The units inside the enclosure contained approximately 0.9 to 1.2 m of archaeological deposits dating to the early and middle La Chimba ceramic periods (early period = punctate bowls; middle period = carinated bowls with diagonal incision; Athens 1978a; Goff 1980). The single unit excavated outside the enclosure--TP-4--contained 2.5 m of deposits dating to the early, middle, and late periods (late period = positive red paint designs on vessel exterior). All excavation units contained multiple ash lenses and burned surfaces (see profiles in Goff 1980), besides dense cultural remains of pottery sherds, obsidian flake debris, animal bone, and other materials. The 5 previous radiocarbon dates from La Chimba are not internally consistent. However, the two dates thought to be most reliable are those of 15 B.C. and 150 B.C. (uncorrected) from Levels 10 and 13, respectively, of TP-4 (see Goff 1980:158). While these dates were derived from levels bracketing the use of the middle period ceramic style (incised ware), it is probable that additional dating will expand the middle period temporal range.

At the time of the present project, the area outside the enclosure walls was under intensive mechanized barley cultivation, which was also the case in 1972 and 1974. The ground surface consisted of only stubble from the harvested grain in these areas. The fields were in the process of being disked and hand sown for a new barley crop. In addition to the barley, a large field of *chocho* beans (*Lupinus mutabilis*) was located at the southern margin of the site.

Test Pit 5

This was a 1 x 2 m unit excavated to a depth of 1.78 m below datum with cultural deposits extending to 1.59 m below datum (actual thickness of the cultural deposits averaged about 1.5 m). The unit was designed to test the nature of a low mound on the eastern margin of the site (see Fig. 5). The test pit, located at the top center of the mound, indicated that it was, as expected, entirely composed of prehistoric habitation refuse. The map location of TP-5 was determined with a tape and compass using the nearest corner of the *tapia* enclosure wall as a fixed reference point. Photo 5 shows the setting of this test pit.

Excavation proceeded by approximately 10 to 12 cm thick arbitrary levels except where stratigraphic changes were encountered (see Table 7 for exact level depths). All deposits were screened in 1/8 inch wire mesh with the entire bulk screen residue bagged for later water-screening and sorting (i.e., no attempt was made to sort archaeological remains from the screen in the field). The volume of screened sediment was tabulated for each level by counting buckets of sediment removed from the unit: each bucket had a volume of 12 liters (Table 7). Notes were taken for each level on standard forms, and a field catalog was maintained for all collected samples.

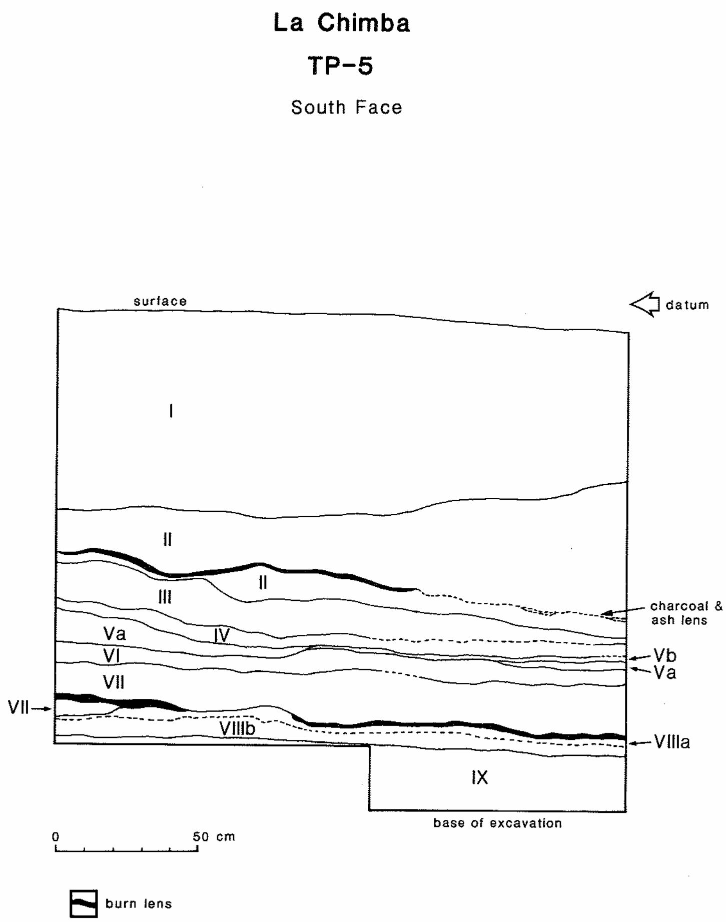
Except for the first level, bulk sediment samples of 6 liters (a full cloth bag) were taken for each level for flotation and fine water-screening (using 0.5 mm brass wire mesh) for recovery of botanical remains. Some of the charcoal samples were also recovered as bulk samples (also a full cloth bag), particularly where there were concentrations. Botanical remains, charcoal concentrations, artifacts, etc. were collected *in situ* and bagged separately when encountered during excavation with trowel and flat-bladed shovel.

Upon completion of the excavation, a measured profile was prepared of the south face (Fig. 7; Photo 6). The unit was then back-filled. Black-and-white and color photographs were taken during the excavation. Dry but extremely windy weather conditions prevailed throughout the period of fieldwork at La Chimba. On the last day of fieldwork the wind calmed and it rained sporadically throughout the day; this seemed to signal the onset of the rainy season.

A total of 9 soil layers were distinguished in TP-5. These are indicated in the profile (Fig. 7). The thickest layer, that of Layer I, consists of a silt loam. Layer II is a loam having an intervening burn lens which becomes a thin charcoal and ash lens on the west side of the test pit. Layers III and IV are both silt loams. The lower layers alternate between loams and ashy loams along with an intervening burn lens in Layer VII. Caliche-like peds and/or very hard ashy encrustations, usually very irregular in shape and up to 5 or 6 cm across, were encountered in the sediment matrix throughout the unit. However, they seemed to be more common above Level 8 (85-95/98 cm b.d.).

Archaeological materials were densely distributed throughout the deposit, including pottery, obsidian, animal bone, charcoal, etc. Layer III, however, is notable for having extremely dense midden remains (especially pottery). The sterile basal Layer IX, a brown silt loam, was easily recognizable because of its very compact nature. Volcanic ash deposits were not noted anywhere within the unit.

Land snail shells (locally called *churros*, apparently the same type that are eaten today) were found throughout the TP-5



I: Silt loam.
II: Loam.
III: Silt loam with very dense pottery.
IV: Silt loam (dark).
Va: Loam.
Vb: Ash and loam.
VI: Dark organic loam.
VII: Loam.
VIIIa: Ash and loam.
VIIIb: Ash lenses, dark organic loam, burned soil.
IX: Compact silt loam (no cultural materials).

Figure 7. Profile of TP-5, south face.

deposit. They were often especially dense in ashy and organically rich areas, suggesting that they may occur naturally in the site deposits. However, when questioned on the subject, local residents were unanimous in their insistence that such snails do not naturally occur in the environs of La Chimba. Rather, they thought the snails had been brought in from the Chota Valley where they grow in abundance and are collected for sale in surrounding communities.

An adult human burial, flexed, was found in Level 6 (topmost bone at 50 cm b.d. and base at 74 cm. b.d.). No burial pit could be distinguished, and no burial furniture was present.

A possible *tapia* wall remnant of very hard loam without midden materials in the matrix was noted on the western margin of the unit in Level 8. However, the exposed portion was too small to ascertain its nature. No post-holes or hearth features were found anywhere within the unit.

There is little doubt that the mound in which TP-5 was dug represents the accumulation of prehistoric living debris. The several burn lenses appear to be the oxidized remains of house floors or surfaces (preserved as a result of the house having burnt--see TP-7 discussion). If so, this suggests that residential structures may have been concentrated on the mound, and that trash gradually built up the mound through virtually continuous habitation over a number of centuries. The large size of many of the sherds and the fact that a number can still be joined together appears to confirm the inference that much of the refuse is in primary deposition.

Test Pit 6

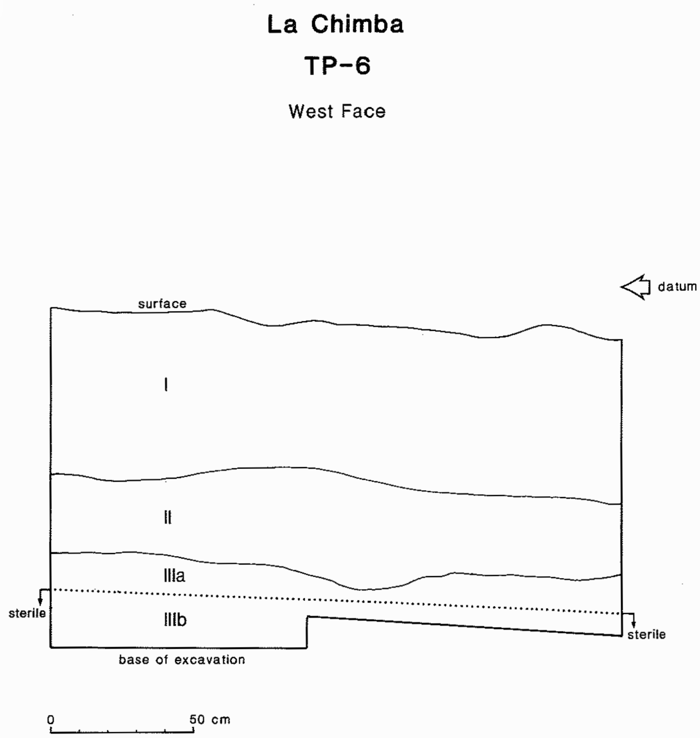
This unit, a 1 x 2 m test, was placed within the enclosure walls in the vicinity of the previous excavation units in this area (Fig. 5). The intention was to confirm the results of the earlier excavation units, as well as to provide full documentation of the nature of the deposits, stratigraphy, soils, and other aspects of archaeological concern. Photo 7 shows the general setting of TP-6.

In terms of field methodology, the procedure discussed for TP-5 was used for this unit with the important exception that 1/4 inch wire mesh screen was used instead of 1/8 inch mesh. This change was primarily the result of too much sediment being retained for the bulk-bagging both before and after water-screening, which created difficulties for transport, storage prior to laboratory processing, and finding enough polyester gunny sacks to contain the screen residue. As a result of observations during the initial water-screening efforts of the TP-5 material, it was apparent that very little would actually be lost in converting to use of the 1/4 inch screen. Also, some degree of fine screen control could still be maintained by the procedure of collecting bulk botanical and charcoal samples for fine screening.

TP-6 was excavated in 11 levels to a depth of 1.26 m below datum (Fig. 8). It was found to contain approximately 1 m of archaeological deposits. The surface around this unit, though not in cultivation at the time, was furrowed from cultivation during the previous season. The type of deposit encountered in much of this unit was of a very different character than that of TP-5. The sherds down to the base of Level 5 at 60/71 cm b.d. tended to be quite fragmented. Also, there was relatively little animal bone, and what there was tended to be fragmented and somewhat weathered looking. Virtually no charcoal was present though obsidian was common. The soil matrix, consisting of a fairly compact dark brown loam, also lacked any ash lensing or "micro" differentiation; it was nearly homogeneous throughout.

Below Level 5 the dark loam soil matrix became moister and softer, and the size of at least some of the sherds increased, suggesting a stratigraphic change (see profile, Fig. 8). Although the quantity of pottery was substantial, and the bone increased somewhat below this point and some charcoal was noted, the deposits were not at all like the primary refuse noted in TP-5. Land snails were virtually absent throughout the unit. Only in Level 8 at 83/90-96/101 cm b.d. was there a small area of burned soil. The basal sterile soil consisted of very compact brown silt loam identical to what was found in TP-5. No post-holes or other features were noted in TP-6.

Following excavation and preparation of a profile of the west face (Fig. 8), two pairs of thermal and humidity cells were placed in the unit to record subsurface temperature and humidity for obsidian hydration studies. Paired thermal and humidity cells were implanted in the west wall at the southeast corner of the unit at 57 and 84 cm below surface. Although TP-6 was probably not an ideal unit in which to undertake temperature and humidity readings due to its somewhat different character in terms of sediment matrix and archaeological remains compared to TP-5 and TP-7, it has the advantage of being easy to relocate after the 1 year period the cells must remain in the ground. This is because of the unit's nearness to a corner of the *tapia* wall, which provides an excellent ground reference point for relocating the unit. In contrast, TP-5 and TP-7 are situated in open fields with no nearby fixed reference points.



I: Dark loam, possibly disturbed.
II: Dark loam, not as compact as Layer I.
IIIa: Compact loam with cultural materials.
IIIa: Compact silt loam; no cultural materials.

Figure 8. Profile of TP-6, west face.

The TP-6 excavation demonstrated that at least a portion of the deposits within the enclosure walls may be disturbed, presumably as a result of recent agricultural activities. *Huaquero* disturbance does not appear to be a factor. In any case, these deposits appear to be of a different character than those reported by Athens and Osborn (1974) for the same area (see also profiles in Goff 1980). However, the deepness of the presumed disturbance--to a depth of 50-60 cm below the surface--seems unusual; perhaps something else is involved. More investigation of this area will be needed to clarify the problem.

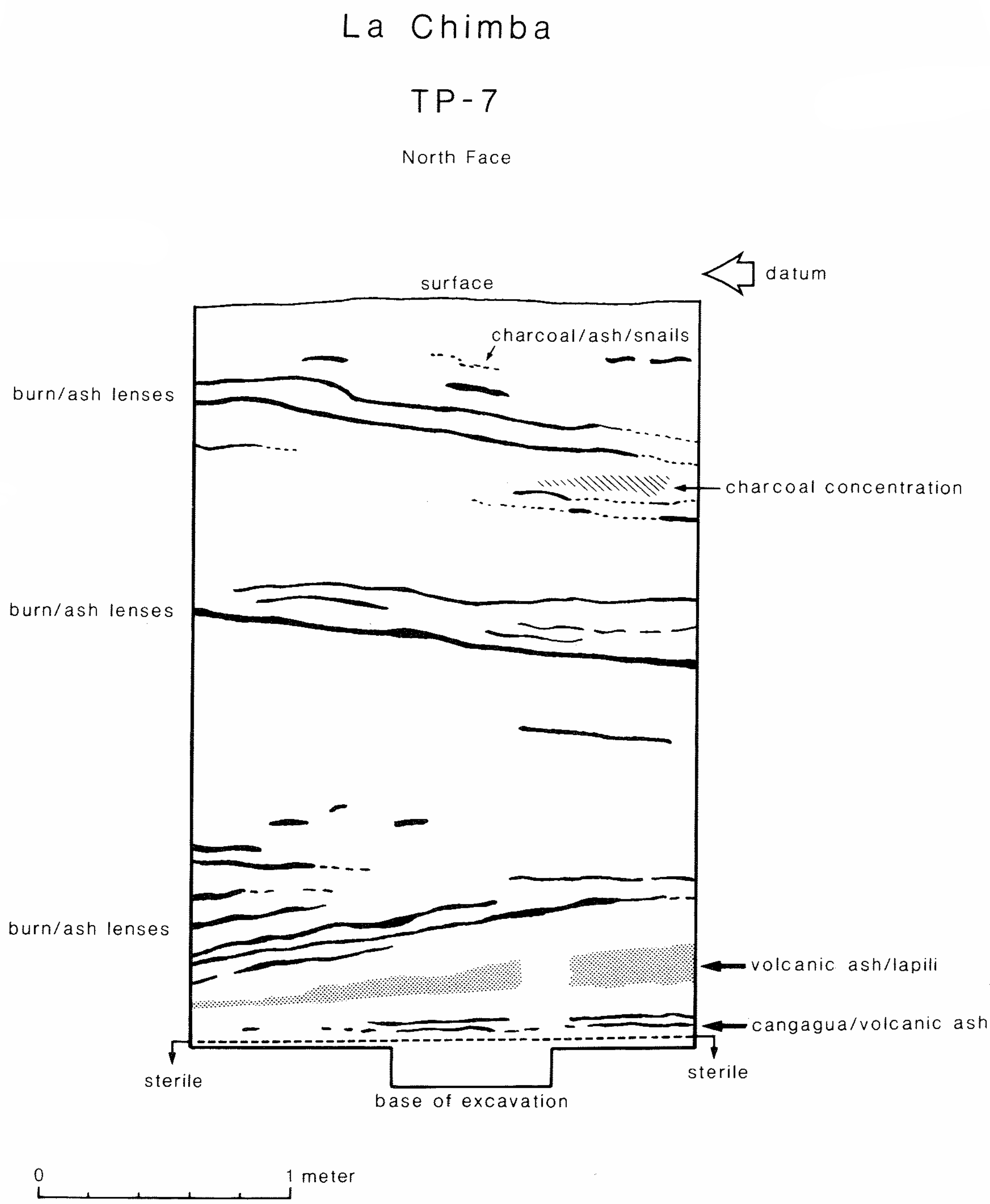
Test Pit 7

This was a 2 x 2 m unit excavated in the western-most mound of the La Chimba site (Fig. 5). This mound appeared to be the highest on the site, and the deepest deposits were expected here. Surface sherds and obsidian flake debris were dense on the mound as was the case with the other mounds. The excavation unit was more or less centered on the mound in an attempt to avoid steeply sloping stratigraphy along the mound's margins as well as to maximize chances of finding house floors. Photo 8 shows the setting of this test unit.

TP-7, reaching a depth of 3.22 m below datum, was excavated in 28 levels approximately 10 to 12 cm thick each (Table 10 lists the depths for each level as well as sediment volumes). The total thickness of the cultural deposit was 2.96 meters. As with TP-5, large amounts of cultural materials were present throughout the unit, including up to 19 burned probable occupation surfaces. The sediment matrix of the deposit consisted entirely of a brown loam with slight variations in color and texture throughout the unit. The basal sterile soil is a compact silt loam similar to that of the other test pits. A profile of the north face of TP-7 is presented in Figure 9. Photo 9 shows a profile view of the north and east faces.

Of particular interest in the profile is the presence of a light grey volcanic ash layer with abundant scoria near the base of the excavation in Levels 24 and 25. The powdery ash is 16 cm thick on the eastern side of the unit, though it tapers to a thickness of only a few centimeters on the western side (Fig. 9; Photo 10). The scoria ranges in size from glassy droplets to irregular and vesicular chunks 5 to 8 cm across. Also, approximately 16 cm below the ash is a thin (1 to 2 cm thick), whitish *cangagua* layer in Level 28 (Fig. 9; Photo 10). Apparent occupation surfaces are found above and below the *cangagua* layer.

The excavation methodology was the same as that utilized for TP-5, but as with TP-6, 1/4 inch mesh sifting screen was used



I: Loam above sterile line; it has slight variations in color and texture throughout, but no defined layering.

II: Compact silt loam below sterile line.

Figure 9. Profile of TP-7, north face.

instead of 1/8 inch. Beginning with Level 7, however, a 3 bucket (36 liter) 1/8 inch bulk screen sample was taken to ensure adequate recovery of the smaller-sized cultural materials (but no 1/8 inch samples were taken for Levels 25, 27, and 28).

During the course of excavation, three human burials were found in TP-7, and all were situated mostly within the profile faces of the unit. Two of these were infants, which were encountered in Levels 21 and 23. The adult burial, flexed and lying on its side, was found in Level 24, though a pit could be discerned in the profile face at least 3 levels above. Several very fragmented (apparently flattened in place) utilitarian vessels appeared to be associated with this burial; the infant interments contained no burial furniture.

Despite encountering 19 burn lenses of varying sizes--presumably occupation surfaces--no post-holes or hearth features were noted. However, there were a number of ash and charcoal concentrations, and these might have been the loci of hearths. The identification of the occupation surfaces as house floors is suggested by the presence of a considerable amount of charred *ichu* grass (or similar coarse *páramo* grass) on these surfaces, which did not occur in the deposits between the surfaces. This grass is still used for roof and wall thatch in the area. Presumably the houses were regularly burned, which would account for the oxidized surfaces and ashy deposits with charred *ichu* grass usually found on top of them.

The presence of a low, linear, *tapia*-like feature of very hard soil in Level 12 may be indicative of a remnant house wall. A burned floor segment was situated near its base, suggesting the two may go together. Combined with the evidence of *ichu* grass on the oxidized surfaces, it appears that house construction may indeed have been very similar to agricultural field houses presently found in the area (Photo 11).

As with TP-5, the TP-7 excavation revealed dense remains of residential trash, including pottery, obsidian, animal bone, charcoal, botanical remains, and miscellaneous artifacts throughout the unit. Land snails were also common and a number of partially reconstructable vessels were recovered.

The TP-7 excavation confirmed that the low hill was entirely made of stratified refuse. The presence of both a volcanic ash layer and a lower *cangagua* layer suggests that the basal deposits of TP-7 may date somewhat earlier than those of either TP-5 or TP-6. However, there was no apparent difference in the types of artifacts or pottery recovered from the basal deposits of these different units, suggesting that the postulated temporal difference is probably not great.

The particularly abundant botanical remains of TP-7 are especially notable in terms of the research problems this study is attempting to address. Corn cobs were relatively common, and there were a number of different types of charred seeds. Furthermore, it appears that several different types of charred tubers were also recovered.

The Im-11 Site

Two contiguous 1 x 1 m units were excavated intermittently at this site between August 31 and September 10th. Fieldwork was undertaken by the author with Lisa LeCount and José Echeverría. The unit was located 31 m north of the Panamerican Highway and 145 m west of the street, 31 de Octubre, where it enters the Panamerican Highway on the north side of Otavalo. The location was that of a corn field awaiting plowing for the coming season; dried corn stalks and furrows were still present from the previous year's planting (see Photo 12). The area contained relatively abundant surface remains of pottery and some obsidian.

The two units were designed as an exploratory attempt 1) to locate areas of intact cultural remains, 2) to better define the nature of the Im-11 site with whatever cultural materials might be present, 3) to obtain botanical samples, particularly corn, for comparative purposes of the different prehistoric varieties from different geographic zones and time periods, and 4) to obtain sediment samples from the previously identified *cangagua* layer and buried A Horizon paleosol beneath. The latter objective was particularly important in view of the possibility of correlating volcanic events identified in the Lake San Pablo sediments and the La Chimba site.

In TP-1 (south of TP-2), sediment from all 7 levels of the cultural deposit to a maximum depth of 113 cm below datum were screened in 1/8 inch mesh (datum was 5 cm above ground surface in the southeast corner). The volume of all screened sediment except Level 1, which was in the plow zone, was measured in buckets. Following screening, all artifacts were carefully picked from the screen after breaking up the unsifted peds. Only sediment from the possible pit feature in Level 7 was bulked-bagged for later water-screening.

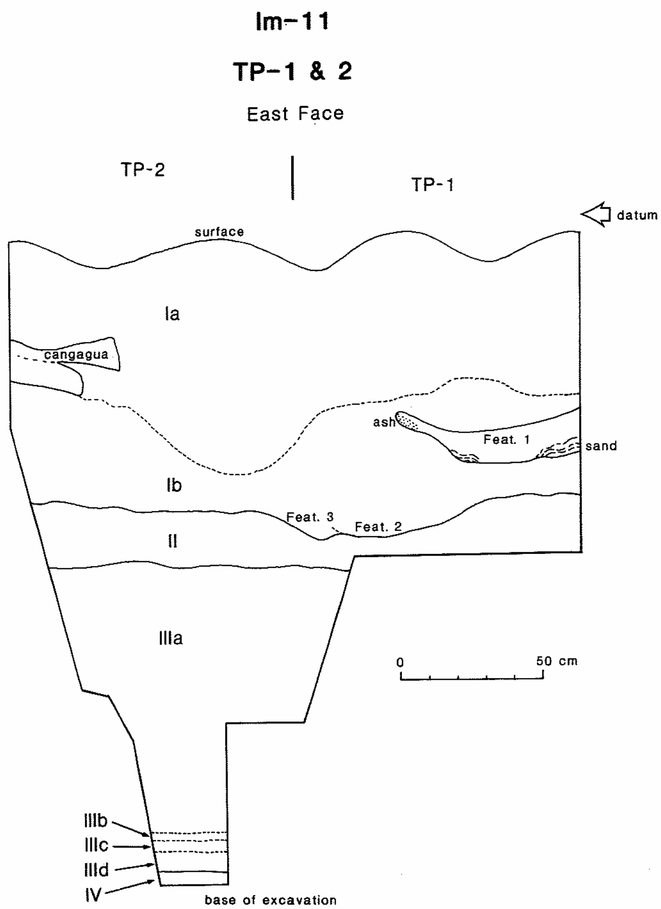
As for TP-2, Levels 1, 2, and 3 were screened in 1/8 inch mesh, while Level 4 and the basal Level 5 of the cultural deposit at 100 cm b.d. were screened using 1/4 inch screen. These lower levels were somewhat thicker than those of TP-1; however, the upper levels exactly correlate in depth with the levels of TP-1. These differences in sampling and digging between the two pits were the result of the need for expediency to finish the work.

With the fine control in TP-1 and the lack of major cultural deposits, there did not appear to be any necessary reason to dig TP-2 in such a precisely controlled manner.

Following excavation of the cultural deposits to a depth of about 98 cm (a maximum depth of 113 cm b.d.), excavation continued in a narrow trench on the east side of the units in an effort to define the lower stratigraphic layers and obtain sediment samples. A maximum depth of 234 cm b.d. was reached, which was the depth of the buried paleosol. A profile of the east face of the excavation unit is presented in Figure 10.

The cultural deposit was found entirely within soil Layers Ia and Ib. Layer Ia is brown loam, while Layer Ib is a dark brown loam/sandy loam. A small amount of pumice (subangular small pebble-sized chunks) is present in both layers. Below 38 cm b.d., the soil becomes moist and heavy, forming large clods; above it is dry and becomes powdery when the clods are broken. In the northeast corner of TP-2 at the base of Layer Ia, there is a small area of both solid and mottled *cangagua*. The *cangagua* is clearly indicative of some kind of disturbance, but its nature remains unknown. Layer II, beginning at roughly 98 cm b.d. (except where the two possible pit features dip down to 110 and 113 cm b.d.) is entirely sterile of cultural remains. It is a brown loam very similar to Layer Ia, but with more abundant pumice gravel and pebbles. Small vertical holes, presumably drilled by beetle larvae or a similar organism, were common in Layer II. Light grey *cangagua*--Layer IIIa--began at 122 to 124 cm b.d. Its boundary with Layer II was somewhat diffuse. The *cangagua* continued until 216 cm b.d., where a *cangagua*/volcanic ash layer (IIIb) appeared with gravel-sized pumice. Layer IIIc, 219-223 cm b.d., consists of volcanic ash with a homogeneous medium grain sand texture, while Layer IIId, 223-230 cm b.d., consists of volcanic ash with a mixed medium and coarse grain sand texture and a small amount of gravel-sized pumice. At 230 cm b.d. the top of a dark brown silt loam, very compacted, appeared. This was defined as Layer IV.

The cultural material of TP-1 and TP-2 consisted primarily of a moderate concentration of pottery sherds and obsidian flake debris to the base of Layer Ib. There was not much variation in density throughout Layers Ia and Ib, though some increase in numbers seemed to occur toward the base of Level 3. The sherds seemed to be entirely undiagnostic; however, more detailed examination in the laboratory may reveal otherwise. Very little bone or charcoal were present, though several samples of the latter were obtained which would be of sufficient size for an accelerator radiocarbon date. No charred botanical remains were observed in the deposit.



Ia: Brown loam, small amount of pumice.

Ib: Dark loam/sandy loam, small amount of pumice (darker than Layer Ia).

II: Brown loam, virtually identical with Layer Ia but with pumice gravel and pebbles more abundant (no cultural material).

IIIa: *Cangagua*/volcanic ash, very fine texture, light grey, many very fine black grains in matrix.

IIIb: *Cangagua*/volcanic ash, grey, very fine texture but with numerous gravel-sized pumice fragments up to ca. 6 mm, tiny black grains in matrix.

IIIc: Volcanic ash, grey, medium sand texture (very homogeneous), lots of tiny black grains in matrix, no pumice.

IIId: Volcanic ash, grey/brown, mixed medium and coarse sand texture with small amount of gravel-sized pumice 2-3 mm.

IV: Dark silt loam, very compact.

Figure 10. Profile of TP-1 and TP-2 at the Im-11 site, east face.

With respect to features, a channel-like depression was revealed in Level 4 of TP-1, and 1 small possible pit feature was found at the base of Level 6 in TP-1, and another at the base of Level 5 in TP-2. These are illustrated in the east face profile of the units in Figure 10).

The channel-like depression, about 14 cm wide at mid-point and about 7.5 to 9 cm deep, had a lot of fine sand lensing. It appears that this is most likely either a natural erosional channel, or perhaps a prehistoric agricultural drainage or irrigation channel.

The sediment of both possible pit features was bulk-bagged and water-screened through 1/8 inch mesh. However, only a few non-diagnostic pottery sherds were present in both, and a very small amount of animal bone was found in one of them.

Unlike the previously excavated units at the Im-11 site (see Athens and Osborn 1984), the archaeological deposits of TP-1 and TP-2 did not extend all the way to the *cangagua* layer. Whether or not this reflects a temporal difference in the different areas of excavation is uncertain at this time. Additional field investigation is clearly needed at the Im-11 site.

The Tababuela Site, Chota Valley

The Tababuela site, located near Tababuela in the dry Chota Valley at an elevation of approximately 1,540 m was first described by Berenguer and Echeverría (1988, n.d.). Their studies indicate that the same incised style of pottery characteristic of the La Chimba middle period (see Athens 1978a), characterizes this site. Earlier and later pottery styles are apparently absent.

The Tababuela site is especially significant because it expands the known range of the La Chimba incised pottery style. Furthermore the location of the Tababuela site is intriguing as it is situated on a high terrace above the confluence of the Ambi and Chota Rivers. This is an area where agriculture is not presently feasible due to lack of water or rainfall. While this setting can be viewed as strategic for observing or controlling passage between the north and south highlands and/or the lowlands to the west, it could also simply signify the movement of agricultural peoples into a previously unoccupied and very marginal area. Assuming that the agricultural lands had become fully occupied in the highlands as suggested by the La Chimba site, continued population expansion may have left little choice for some people.

The motivation for the present work was primarily to obtain a carefully controlled sample of archaeological remains in order to determine the activities represented at the site, and also to attempt to radiocarbon date the site. Another and related interest was to evaluate the stratigraphic integrity of the site and assess the potential for finding intact features such as house floors, walls, hearths, etc. To this end, a single 1 x 2 m unit was excavated near the center of the site. This unit, designated TP-3, was located 30.5 m and 78 degrees (magnetic north) from the southeast corner Test Unit B, one of the two 2 x 2 m units excavated by Berenguer and Echeverría.

Prior to excavation, the entire site was reconnoitered. Grading for construction of the old cobblestone Panamerican Highway many years ago cut through the entire length of the site, exposing sherds and obsidian debris in the cut banks and piled back-dirt. Unfortunately, except for this exposure, very little in the way of archaeological remains is visible on the surface despite the essentially bare ground. A relatively shallow deposit of fine powdery sandy loam covers the site. The highway exposure indicated the length of the site to be approximately 150 m. The width is more problematic to determine, but the site appears to be 75 m wide with approximately 20 m of this total being on the west side of the highway. The ground surface slopes gently to the west and north toward the two rivers. Vegetation consists primarily of small, bushy algarrobo trees (*Acacia pellacantha*), the prickly pear cactus (*Opuntia* spp.) and another unidentified cactus, and the mosquera bush (*Croton wagneri*), though other species are present in minor quantities. Photo 13 illustrates the general setting of the site and the TP-3 excavation unit.

TP-3 was excavated to a maximum depth of 81 cm below datum (datum was 3 cm above ground surface in the unit's northwest corner). The cultural deposit, approximately 40 cm thick, was excavated in Levels 2 through 6. The first level, corresponding to Layer I, was 9 to 10 cm thick and contained no cultural material. A profile of the unit's east face is presented in Figure 11.

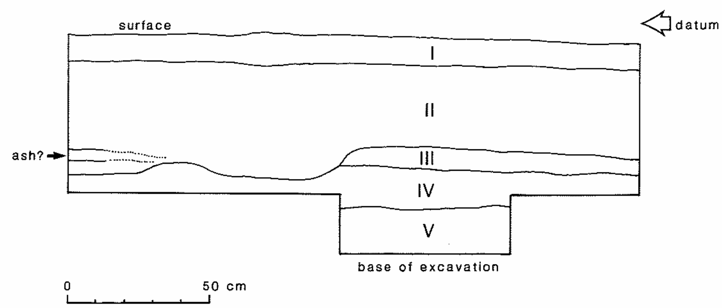
The volume of archaeological sediment was measured in each level prior to screening in 1/8 inch mesh screen. After screening the very loose and powdery sediments, all material remaining in the screen was bulk-bagged for later laboratory sorting. Because of the absolute dearth of charred remains, the collection of botanical samples for fine-screening and flotation appeared pointless and was not undertaken.

Layer I, comprising the upper 9 to 10 cm of TP-3, consisted of light tan and very fine, dry, and powdery sandy loam with a

Tababuela

Tp-3

East Face



I: Fine sandy loam; no cultural material.

II: Fine sandy loam, volcanic gravel, pebbles, cobbles; cultural deposit.

III: Grey medium/fine sand with poorly sorted volcanic gravel (not pumice); possibly colluvial deposit; no cultural material.

IV: Grey powdery fine *cangagua*/ash; tiny black grains in matrix.

V: Fine sandy loam with volcanic gravel, pebbles, cobbles; similar to Layer II but no cultural material.

Figure 11. Profile of Test Pit 3, Tababuela site, east face.

few basalt cobbles. No cultural materials were present in this layer, and no sample collections were made.

Layer II contains the entire cultural deposit. The sediment matrix was also a light tan and fine powdery sandy loam, though slightly moist. Unlike Layer I, however, volcanic gravel along with numerous pebbles and small cobbles were also present.

Below Layer II there was what is tentatively interpreted as a colluvial layer (Layer III) in the south half of the excavation unit (the north half may have been disturbed), and a deposit of dry powdery grey *cangagua* below this (Layer IV). This latter layer is indistinguishable from the *cangagua* deposit at the Im-11 site (Layer IIIa), though it is uncertain if it represents the same geological event. Below the *cangagua* the sediment becomes a gravelly and rocky light tan and fine powdery sandy loam similar to Layer II. This basal layer was designated Layer V. No cultural materials were recovered in Layers IV or V), though some sherds seemed to be present in Layer III.

Despite abundant pottery, obsidian, some marine shell, and small quantities of animal bone, only a single sample of charcoal was collected. This consisted of the possible charred remains of a bush or grass clump from Level 5 (34/35-48/49 cm b.d.). Otherwise, not a single piece of charred material was seen in the entire excavation. Snail shells were common throughout the cultural deposit.

Without additional testing it is difficult to evaluate the nature of the Tababuela site, particularly in terms of the potential presence of features such as house remains, hearths, pits, burials, etc., as well as the possibility that charcoal and charred plant remains may be more common elsewhere in the site deposits. However, the present excavations do suggest that the site may be very deflated due to erosional processes, especially as caused by wind in the site's very dry environmental setting.

Despite the dearth of charred remains for dating, one potentially good charcoal sample was collected that would be suitable for accelerator radiocarbon dating analysis. Also, once the laboratory investigations are completed, it should be possible to date the occupation of Tababuela with some degree of precision using the La Chimba pottery sequence.

VI: LABORATORY ANALYSIS:

Radiocarbon Dating

Although it is hoped that eventually a large suite of samples can be submitted for radiocarbon dating, at this time funds are available for processing only 6 samples. One of these is from the La Chimba site and the other 5 are from the Lake San Pablo cores. The La Chimba sample dates the basal cultural deposit of TP-7 (Level 28). The Lake San Pablo samples are from the following core depths 2.55-2.60 m, 3.75-3.80 m, 5.20-5.25 m, 5.90-5.95 m and 6.05-6.09 m (see Fig. 4). Only the first sample is from Core #1, which was collected immediately above the major ash/*cangagua* deposit (ash C); the others are from Core #2. The dating results are presented in Table 2.

Dating analysis was performed by Beta Analytic Inc. of Coral Gables, Florida using standard pretreatment and dating procedures. Because of the small sample size of the extracted carbon, all of the peat samples from Lake San Pablo were counted 4 times the normal counting period to reduce statistical error. All samples were adjusted for isotopic fractionation using the C13/C12 ratio. The dates were then calibrated to calendar years using the Stuiver and Reimer (1986) computer program, which also provided probability estimates for the resulting date ranges. The 10 year dataset and a 95% confidence interval was used for all samples. For the Lake San Pablo samples, the calibrated B.P. dates are presented in Figure 4; Table 2 shows the calibrated dates in calendar years.

La Chimba Radiocarbon Date

The La Chimba date indicates that occupation began at this site sometime between 762 and 207 B.C. as shown by the calibrated date ranges at a 95% confidence interval. Because the probability distribution figures indicate a range of 594-346 B.C. (2295-2543 B.P.) to encompass the most likely true age of the various ranges generated by the age calibration tables, the actual dating of the initial occupation can be narrowed somewhat. The most probable range--594-346 B.C.--in fact, is very close to what was anticipated given the previously accepted dates of 150 and 15 B.C. for levels 13 and 10, respectively, of TP-4. It was expected that the base of TP-7 would date somewhat earlier because of its greater depth. Also, the presence of volcanic ash and *cangagua* layers near the base of TP-7 were lacking in TP-4, also suggesting that the basal deposits of the former unit must be earlier.

Table 2. Radiocarbon dating results, northern highland Ecuador.

Site	Cat. #	Beta #	Provenience	Weight g	Age B.P.	C13/C12	Adjusted Age B.P.	Calibrated Age*	Probability*
La Chimba	237	34805	TP-7, Level 28, 305-309 cm b.d. (below cangagua)	30.9 charcoal	2320 ± 70	-24.4	2330 ± 70	B.C. 762-681 B.C. 658-632 B.C. 594-346 B.C. 322-226 B.C. 225-207	15% 2% 63% 18% 2%
San Pablo	C1,150-155	34806	Core 1, 255-260 cm depth, on top of major ash/ cangagua deposit	71.8 peat	2400 ± 130	-24.8	2400 ± 130	B.C. 810-340 B.C. 330-200	90% 10%
San Pablo	C2,6.05-6.09	36973	Core 2, 605-609 cm depth	54.3 peat	3750 ± 120	-25.3	3740 ± 120	B.C. 2470-1890	100%
San Pablo	C2,3.75-3.80	37518	Core 2, 375-380 cm depth	70.3 peat	2400 ± 90	-26.5	2370 ± 90	B.C. 787-666 B.C. 665-352 B.C. 295-230	23% 70% 7%
San Pablo	C2,5.20-5.25	37519	Core 2, 520-525 cm depth	80.0 peat	3260 ± 120	-26.4	3240 ± 120	B.C. 1878-1843 B.C. 1815-1793 B.C. 1780-1290	2% 1% 95%
San Pablo	C2,5.90-5.95	37520	Core 2, 590-595 cm depth	74.7 peat	3890 ± 140	-24.6	3890 ± 140	B.C. 2470-2030 B.C. 1991-1974	99% 1%

* Stuiver and Reimer (1986), 10 year data set; 95% confidence interval. The San Pablo core samples were sieved for modern rootlets prior to dating analysis. Because of small carbon content following laboratory processing, the San Pablo core samples were given extended counting (4 x normal) to reduce the statistical error. Carbon weights for the peat samples after pretreatment were as follows: B-34806 = 0.27 g, B-36973 = 0.32 g, B-37518 = 0.43 g, B-37519 = 0.37 g, and B-37520 = 0.27 g. The weights for the peat samples are wet weights.

The La Chimba radiocarbon date supports the critique originally presented by Athens (1978a) concerning the proposal by Myers (1976) that his Espejo Phase pottery from an area near Lake San Pablo, most which is identical to the La Chimba middle period pottery, is directly related to the early Machalilla and Valdivia cultures of the Ecuadorian coast. Despite the objections raised by Athens, other investigators (e.g., Porras 1982) have come to believe that both the Espejo and La Chimba pottery are examples of an Early Formative coastal derivative culture in the northern highlands. Obviously, however, the La Chimba radiocarbon dates indicate that the middle period ceramics would be much too young for such a relationship. Furthermore, the ceramic chronology of La Chimba suggests that such a relationship is unlikely given the presence of a stratigraphically earlier style that is definitely unrelated to known early coastal pottery assemblages.

Lake San Pablo Radiocarbon Dates

The Lake San Pablo samples provide an interesting suite of dates for purposes of analysis. To assist in this analysis, an "estimated age graph" was prepared in which the radiocarbon dates were plotted against actual peat depth (the ash was subtracted from the depth of the peat so that it would not bias the age estimates). The resulting graph is shown in Figure 12. The shaded area of the graph represents the estimated age range of the sediments for a particular depth. This shaded area was determined by means of plotting a line through both sides of the B.P. age range of the calibrated radiocarbon dates using only the highest probability range for each sample. The thickness of the line represents approximately the average age range of the radiocarbon dates, which is approximately 450 to 500 years. The line (i.e., shaded area) represents the "best approximation" of several slightly different positions that could have been used. As will be noted, one of the radiocarbon dates has been left out of the estimated age line. The explanation for this is as follows:

Part of the motivation for plotting the estimated age graph was to evaluate which of two dates having nearly the same age but separated by 85 cm of peat were correct. These are the Beta-34806 sample at 2.55-2.60 m, having a calibrated date of 2289-2759 years B.P., and the Beta 37518 sample at 3.75-3.80 m, having a calibrated date of 2301-2614 years B.P. One of these dates has to be incorrect since the 85 cm of peat that separates them must presumably represent a considerable temporal span.

In viewing the array of radiocarbon dates on the graph, it was immediately apparent that 4 of the dates formed a neat

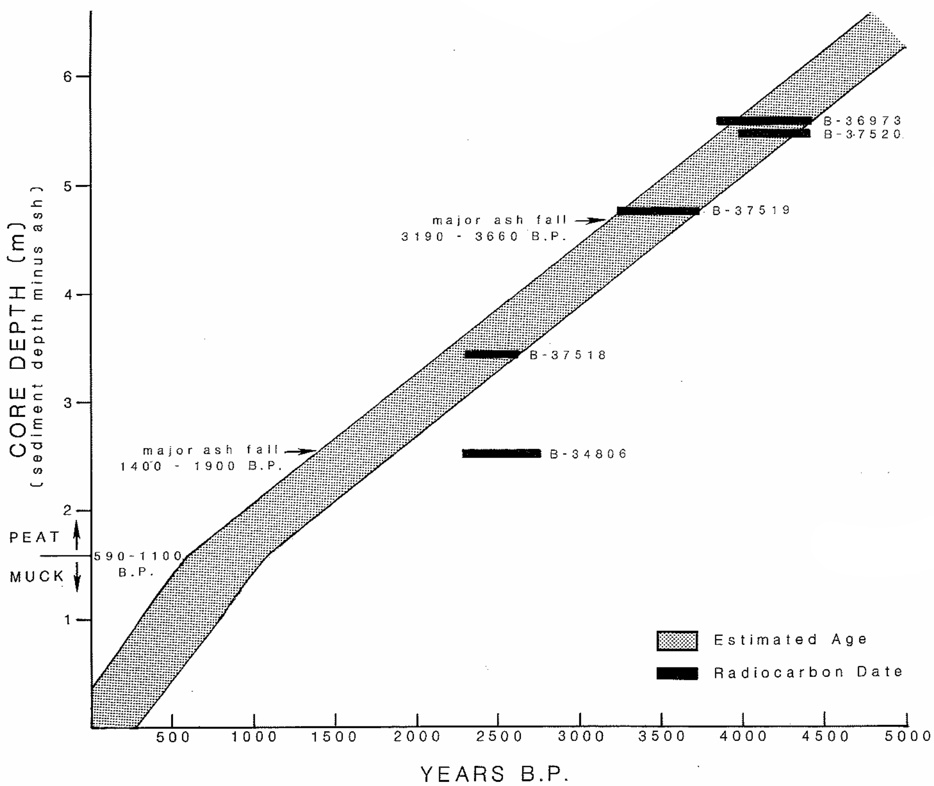


Figure 12. Age estimate graph, Lake San Pablo cores. The radiocarbon dates are calibrated and only the B.P. age range with the highest probability is used in the graph.

* * * * *

diagonal line, with a presumed slight deflection at the peat-muck interface. If there was no deflection, the age estimate line would suggest a future date for sediments up to a half meter deep--clearly an impossibility. Also, it is logical to assume that unconsolidated peaty sediments (i.e., the muck) should result in a greater sediment depth per unit of time than the deeper, compressed peat. In regard to the peat deposit, the diagonal line cleanly bypassed the Beta-34806 date. Thus, assuming a regular rate of peat accumulation, this date would be clearly incorrect.

If, on the other hand, the Beta-34806 date were assumed to be correct and the Beta-37518 date incorrect, it would be necessary for the diagonal line to take on a somewhat sigmoidal shape. The age estimate curve under this assumption (curve not depicted) implies a slow accumulation rate for the muck layer, a relatively rapid accumulation rate for the middle part of the curve, and a return to a slower rate of accumulation for the oldest part of the curve.

The sigmoidal curve with the Beta-34806 date is tentatively rejected, with the diagonal, regular-accumulation-rate line shown in Figure 12 accepted. The primary basis for rejection of the sigmoidal curve has to do with the protracted time period required for the accumulation of the muck layer. As noted above, it is logical to assume that the muck sediment, compared to the peat, would represent less elapsed time rather than more per unit of thickness because it is so loose and unconsolidated.

It should be emphasized that the estimated age graph is nothing more than a rather arbitrary approximation based on available data. The actual shape of the diagonal line can be easily tilted or moved slightly one way or the other with the results possibly being just a valid as the one shown in Figure 12. However, it is believed that enough information is available so that the age range indicated by the diagonal line (the shaded area) will encompass the true age despite whatever slight shifts or adjustments one may wish to make on the precise placement of the age line.

The sediment accumulation rates calculated from the radiocarbon dates for the San Pablo peat are presented in Table 3. These range from a relatively rapid 4.32 years per cm to a slow 9.93 years per cm with intermediate rates of 7.77, 7.78, and 8.03 years per cm. Because the Beta-34806 date is rejected based on the estimated age graph, it is not surprising that the sediment rate based on this date--4.32--is at variance with the other rates. It is also not surprising that the rates based on the Beta-37520 date are out of line with the others. As may be seen in Table 2, this sample has an adjusted B.P. date and calibrated range slightly older than the slightly deeper Beta-36973 sample. Thus, one of these samples must be wrong. Because the sediment rates based on the Beta-37520 sample--9.93 and 8.93--falls outside the pattern generated by the other accepted dates (i.e., 7.77, 7.78, and 8.03), it appears probable that this sample is the one that is incorrect. However, since the calibrated ranges of both samples substantially overlap with one

Table 3. Sedimentation rates for San Pablo peat.

Measurement Area (between dates)	Sediment Thickness (cm)	Years* Represented	Sediment Rate (years/cm)
B-34806 & B-37519	222	960	4.32
B-37519 & B-37520	72	715	9.93
B-37519 & B-36973	83	645	7.77
B-37518 & B-37519	132	1,027	7.78
B-37518 & B-36973	208	1,672	8.03
B-37518 & B-37520	195	1,742	8.93

* Elapsed time calculated from mid-point of calibrated B.P. date ranges.

* * * * *

another, and also because there is only a 10 cm depth difference between these samples, the dates are actually mutually supportive for the purpose of determining the age of the base of Core #2. Thus, despite the recognition of a problem with the Beta-37520 date, it nevertheless remains a useful date.

Based on the above analysis it appears that the correct sediment rate for the peat is probably in the range of 7.77 to 8.03 years per cm using the calibrated B.P. dates. It is not unlikely that there has been some variation in the rate during the entire sequence of sediment accumulation.

In terms of the antiquity of Core #2, it is of considerable significance that a reasonably reliable basal date of approximately 2400 to 1900 B.C. (4400 to 3900 years B.P.) can be assigned. Although this is not the antiquity that was initially anticipated for the base of such a deep core, it is nevertheless highly significant for purposes of the present research. For one thing, the base of the core goes back at least 1,000 years earlier than any previously documented archaeological materials in the region. It should therefore be possible to evaluate the possibility for an earlier and previously undocumented period of occupation by agriculturalists in the region using the core sediment data (see section on pollen analysis below for the apparent confirmation of such an earlier occupation). Another aspect of the significance of the basal date is that it indicates a considerable amount of sediment build-up for the time period encompassed by the core. Thicker sediments per unit of time should make it easier to distinguish differing intensities of agricultural production through time using pollen density data.

From the estimated age graph, it appears that the upper major ash layer (C) at 2.60 to 2.88 meters depth dates to approximately 1400-1900 years B.P. On first receiving the Beta-34806 date of 2400 years B.P. (adjusted date), which was from peat immediately on top of the ash, it was assumed that this ash probably was the same ash that was found in the La Chimba site just above the Beta-34805 date of 2330 years B.P (adjusted date). Because of the seeming coincidence of these dates and another one dating the Pululagua Volcano eruption north of Quito at 2305 ± 65 B.P. (see Isaacson 1987:321), it was thought that the both the La Chimba ash and the San Pablo ash (upper major event, C) were most likely from the same Pululagua event.

The significance of the Pululagua eruption is that it is known to have covered the Cotocollao site near Quito with ash and pumice and appears to form an excellent temporal marker over a large area of western Ecuador (see Isaacson 1987). Unfortunately, however, the estimated age graph renders the correlation of the thick ash layer (C) at San Pablo with the Pululagua and La Chimba event(s) highly unlikely. According to the dated volcanic events listed in Isaacson (1987:209), it is possible that the upper major ash fall event (C) at San Pablo correlates with the Tungurahua eruption of A.D. 300-500. Until further tephrostratigraphic research can be undertaken, of course, it is possible that the San Pablo ash could pertain to an entirely different volcanic event.

The La Chimba ash in TP-7, if it correlates with any of the ash layers in the San Pablo cores, most likely does so with the upper of the two thin bands of ash at 3.50-3.52 m (ash D) and 3.64-3.66 m (ash E), respectively (see Fig. 4). These are located immediately above the Beta-37518 date of 665-352 B.C. (most probable calibrated range). The lower of the two bands (E) may possibly correspond to the *cangagua* layer below the La Chimba ash. It should be possible to evaluate this interpretation through chemical sourcing analysis of the tephras. Whether any of these ashes are derived from the Pululagua source, of course, remains to be determined.

The lower of the two major ash falls--I--in Core #2 is estimated to date between 3190 and 3660 years B.P., based on the Figure 12 graph. This is just slightly younger than the Beta-37519 calibrated date of 3239-3729 years B.P. Isaacson (1987:207) cites Pululagua as possibly having another eruption at 1500 B.C. or earlier, which appears to correspond with the San Pablo date.

Isaacson also lists eruptions in Pichincha Province as occurring around A.D. 900 to 1200 with "thin tephra mantles being represented at Mojanda and Cochasqui." These tephras, in fact, may correspond to the upper two tephra bands, A and B, in the San Pablo core. According to the age estimate graph, these should date to approximately 810-1320 years B.P. (tephra A at 1.86-1.88 m) and 970-1460 years B.P. (tephra B at 2.03-2.06 m), which overlaps with the dates given by Isaacson.

The estimated dates for all of the San Pablo tephra layers are listed in Figure 4. As tephrostratigraphic research proceeds, it is likely that the age ranges eventually can be narrowed.

The transition between muck and peat is estimated to occur at 590 to 1100 years B.P. based on the age estimate graph.

Tephra Analysis

All volcanic ash, scoria, and *cangagua* samples from La Chimba (3), Lake San Pablo (19), the Im-11 (4) site, and the Tababuela site have been provided to Dr. John Isaacson at the University of Illinois for analysis. Dr. Isaacson has an on-going project to identify, chemically characterize, and correlate ash falls in the different regions of Ecuador. The significance of this work should be clear from the foregoing discussion of dating. At this time Dr. Isaacson's investigations are still underway and no results are available.

Based on the age estimate graph, Table 4 summarizes the dating of the tephra layers in Core #2. Although the age ranges for each layer are rather large (450 to 500 years), it would be unrealistic to attempt further refinement until more radiocarbon

Table 4. Age estimates for Lake San Pablo tephras.

Tephra	Date Range B.P.*
A	810 - 1320
B	970 - 1460
C	1400 - 1900
D	1950 - 2430
E	2070 - 2530
F	2430 - 2890
G	2970 - 3450
H	3050 - 3520
I	3190 - 3660
J	3220 - 3690
K	3870 - 4330

* Age estimates based on Figure 12 graph.

* * * * *

dating can be performed. The previous discussion on the dating of the San Pablo cores provides several comments on possible correlations with other known tephras and eruptive events in Ecuador.

Pollen Analysis

Pollen analysis of the Lake San Pablo core samples will be performed by Dr. Jerome Ward of California State University, Sacramento. Though a complete pollen study is not presently possible due to a lack of funding, Dr. Ward has undertaken a preliminary check of 5 core samples (Core #2, Samples 1.20-1.15, 1.90-1.88, 2.55-2.60, 6.00-6.05, and 6.10-6.12 m depth) and 1 bottom dredge sample (27 m depth and 1,000 m from west shore) for the presence of pollen and the general characteristics of the samples.

The bottom dredge sample was dominated by the green algae *Pediastrum* and *Scenedesmus*, and to a lesser extent by *Arcella*, an amoeboid protozoan. Palynomorphs were well-preserved and included *Zea mays*, other grasses, sedge, chenopodium/amaranthus, *Rumex*, *Dodonaea*, *Alnus*, *Hedyosmum*, fern spores, and several unknowns. It is especially significant that maize pollen was present as this suggests that its concentrations are not so diluted in deep water as to preclude adequate recovery and statistical analysis from deep water cores that may be taken in the future.

The samples from Core #2 also contained well-preserved palynomorphs, including maize, other grasses, sedge, chenopodium/amaranthus, *Polygala*, Acanthaceae, *Dodonaea*, *Alnus*, *Hedyosmum*, *Podocarpus*, fern spores, and several unknowns. Dr. Ward indicated that the two lowest samples (6.00-6.05 and 6.10-6.12 m) contained a distinctive pollen assemblage, probably indicating a somewhat different vegetation community for the time period represented by this sample.

It is, of course, extremely interesting that maize pollen was present in the basal samples as it indicates an agricultural occupation in the region by about 4,000 years B.P. This is over 1,000 years earlier than previously documented occupations (i.e., the Im-11 site and the Lake Cunro pottery sherd).

Ward also noted that charcoal particles were plentiful in the basal samples but very limited in the others. The charcoal particles were subsequently identified by Dr. Roger Byrne, Univ. of California, Berkeley, an expert in this area, as being from maize plants, which have a distinctive cell structure (Dr. Byrne also confirmed the identification of *Zea mays* pollen). Apparently maize stalks and leaves were burned following harvest.

Prior to examination of the charcoal particles by Dr. Byrne, it was believed that the high charcoal particle counts were probably indicative of forest clearance for agriculture. However, for this to have been the case, the charcoal particles would had to have been from dicotyledon plants, which they clearly were not, according to Dr. Byrne. The most important implication of this data is that corn must have been cultivated even earlier than indicated by the dating evidence from the base of Core #2. Assuming a completely forested inter-Andean valley prior to agriculture (see Colinvaux *et al.* 1988), there should be evidence for forest clearance to go along with the initial introduction of agriculture into the area.

The presence of two lenses of snail shells just below and between the two basal samples that were analyzed indicates a die-off of some sort. Presumably this could have been caused by siltation in the lake due to increased erosion from agricultural disturbance of the top soil. However, it is possible that other factors may have been involved in the snail die-off, such as climatic change or a change in water chemistry brought on by factors other than agriculture. These possibilities can be evaluated through a complete analysis of the pollen, diatoms, and sediment chemistry, which will be undertaken as funds become available. Further information concerning the snails is presented below.

Thus, the present data would seem to strongly indicate the presence of maize agriculture at a very early date--much earlier in fact than expected by many archaeologists working in the northern Andes. It is certainly early enough to require a re-evaluation of concepts regarding the presumed late agricultural settlement of the northern Andes. At this time there are no actual archaeological sites in northern Ecuador known to date to such an early time period. It is possible that this is because pottery was not made by the earliest maize cultivators in northern highland Ecuador, and as a result, these early sites are much more difficult to find.

Gastropods

Two lenses of mostly fragmentary gastropod shells were conspicuously present at the base of Core #2 from Lake San Pablo (Fig. 4). Abundant snail shells were also noted in the peat between the lenses, however no snails were observed elsewhere in either Core #1 or Core #2. Analysis of the snail lenses in Core #2 by Dr. Gustav Paulay of the Smithsonian Institution indicates that two small species of aquatic snails are present. One is almost planispiral in form, and the other is a taller, more turreted form. He indicates that,

> Both shells are extremely simple, neither posseses any sculpture, columellar or parietal folds nor do they have an unusual shape. To put it simply, there is nothing diagnostic in them to allow identification (pers. comm. 1990).

Dr. Paulay adds that identification of the snails would require a knowledge of the local freshwater snail fauna, which most likely has not been previously studied. Thus, the prospect of obtaining ecological information from the snails in the core samples is probably remote for the immediate future.

Terrestrial gastropods were plentiful at both the La Chimba and Tababuela sites. A sample of these snails were sent to the late Dr. Alan Solem of the Field Museum of Natural History in Chicago for identification. He reported that they are most likely a local form of *Naesiotus quitensis* (Pfeiffer 1848). The only modern report on this species is by Rehder (1940), who provides a general taxonomic discussion. According to Rehder (1940:115),

> This species inhabits the interandine plateau of Ecuador, from Otavalo and Ibarra, Prov. del Imbabura, south to near Riobamba, Prov. del Chimborazo. This narrow area, about 150 miles long and 30 to 40 miles wide, lies in the arid temperate life zone at an elevation of between 9,000 and 12,500 feet, between the main chains of the Andes, the western and the eastern Andes. Within this region, *Naesiotus quitensis* has become broken up into several geographically localized subspecies.

Dr. Solem indicates that the La Chimba specimens do not match exactly any of the "so called subspecies" named by Rehder. He suggests that the La Chimba species may be highly variable, or that they belong to a group of closely related species.

The above information indicates that this type of land snail probably does (or did) occur naturally in the La Chimba environs; its occurrence in the site, therefore, is most likely the result of natural processes. While some of the snails may have been used as food, the excavation context suggests that most were not so used. Because of the insistence by residents of the area that these snails do not naturally occur in the vicinity, it is possible that they have become locally extirpated in modern times, perhaps due to intensive cultivation.

Macro-Botanical Analysis

Botanical analyses will be undertaken by Dr. Deborah Pearsall of the University of Missouri once funding becomes available. The macro-botanical specimens were collected from La Chimba in all but the top level of TP-5 and TP-7, and Levels 1 through 4 in TP-6. Besides fine screen flotation samples collected for each of the indicated levels, many separate botanical samples were also hand-collected during excavation and sorting of the bulk screen samples and bulk charcoal samples. In all, there are 82 separately provenienced samples, most of which contain numerous individual plant specimens.

The botanical samples include corn cobs and kernels, beans, quinoa seeds, various other unidentified seeds, and what appear to be various types of tubers. In addition, there are the carbonized remains of numerous non-cultivated plants.

General Midden Analysis: La Chimba

A preliminary sorting of major midden components and a preliminary pottery analysis were undertaken in Otavalo for TP-5 and TP-7 of La Chimba. Lack of time prevented completing this work for the other test units, though it is expected that sorting will be completed during the next field season. The sorting work was performed primarily by the author and José Echeverría. A relative of Sr. Echeverría assisted with cleaning the pottery sherds.

Prior to sorting, all bulk screen samples were water-screened in 1/8 inch mesh to remove as much of the soil matrix as possible from the cultural material. After air-drying, the samples were sorted with tweezers into the major midden constituents of pottery, bone, obsidian, marine shell, charcoal, basalt debitage, artifacts (bone, stone, and ceramic artifacts, beads, etc.), and various miscellaneous categories (botanical specimens, mineral specimens, sherds with charred interior residue, etc.). In addition, the pottery was analyzed and separated into type categories, and the obsidian was examined for use-wear and source types. Approximately 150 pages of drawings were prepared of the pottery sherds and all artifacts.

Upon completion of the sorting, all materials for each level were recorded together on the same form. Except for the charcoal samples, which were only weighed, all midden samples were both weighed and counted. The charred botanical specimens collected individually (e.g., corn cobs) and the charred vegetal remains in the bulk flotation samples for botanical processing were not weighed. However, these samples were sorted for non-charcoal midden remains, which were added to the general midden samples. A laboratory notebook was used to record observations and procedures during the midden sorting.

Tables 5, 6, 8, and 9 list in summary form and by level all archaeological materials recovered from TP-5 and TP-7 except botanical samples and several samples of possibly exotic stones. The exact depth and volume of screened sediment for each level are provided in Tables 7 and 10. A complete description of this material will be presented in the final report. In the meantime, however, the following brief comments may be made.

Pottery

A total of 97,364 pottery sherds (511.46 kg.) were collected and analyzed from the two units. This initial analysis was primarily oriented at defining chronologically sensitive pottery types and stylistic elements. The results are indicated

Table 5. List of major midden components recovered from La Chimba, TP-5.

LEVEL	Pottery Sherds no.	Pottery Sherds kg.	Bone* no.	Bone* g.	Obsidian Debitage no.	Obsidian Debitage g.	Marine Shell** no.	Marine Shell** g.	Charcoal*** g.	Basalt Debitage no.	Basalt Debitage g.
1	4358	14.75	368	326.5	657	1204.4	4	3.5	0.0	24	491.2
2	1246	8.85	390	538.7	314	745.8	3	0.5	3.7	35	148.3
3	1324	14.00	385	584.3	392	1107.5	5	1.4	27.5	52	781.7
4	1824	20.50	607	876.7	336	762.8	5	2.4	178.8	39	237.3
5	1557	9.30	613	807.4	297	553.9	4	2.4	290.4	41	165.4
6	1434	9.13	592	662.6	372	718.9	5	2.0	480.6	32	195.5
7	961	5.50	355	479.7	235	355.3	5	1.0	203.0	22	128.3
8	942	6.25	289	395.2	83	352.7	17	7.7	189.7	34	241.9
9	3361	20.61	1639	1636.1	689	748.8	46	12.7	416.7	116	696.9
10	9371	53.50	1071	2275.8	427	776.6	5	1.0	74.2	177	1567.7
11	3634	12.50	455	483.1	301	436.1	3	1.2	80.5	108	564.9
12	2641	8.60	780	322.7	588	332.8	5	1.4	322.3	172	554.4
13	945	4.78	154	199.6	167	296.6	32	22.9	387.6	51	726.1
TOTAL	33598	188.27	7698	9588.4	4858	8392.2	139	60.1	2655.0	903	6499.6

* Figures include artifacts.

** Figures do not include shell beads.

*** Figures do not include botanical samples.

Table 6. List of artifacts recovered from La Chimba, TP-5.

LEVEL	Ax Frag.	Ax Flake	Antler Spear Point	Other Bone Artifacts	Beads Shell	Beads Stone	Sherd Disks		Pottery Figurine	Quartz Crystal	Basalt Grind-stone	Other
							Hole	No Hole				
1	1	3	-	1	-	-	1	2	3	-	-	-
2	-	-	-	1	-	-	1	1	2	-	1	1*
3	1	3	1	2	-	-	-	3	-	-	-	-
4	-	1	-	1	-	-	1	-	-	1	-	-
5	-	1	1	1	-	-	-	1	-	-	1	-
6	-	1	-	-	1	-	1	2	1	1	-	1*
7	-	3	-	-	2	-	3	-	1	-	-	-
8	-	1	-	-	1	-	-	-	-	-	-	-
9	1	8	-	2	1	-	1	1	-	-	-	-
10	-	9	-	-	-	1	1	-	1	-	1	-
11	-	9	-	2	1	-	-	-	-	-	-	-
12	-	3	-	2	-	1	-	-	-	-	-	-
13	-	1	-	2	-	1	-	1	-	-	-	-
TOTAL	3	43	2	14	6	3	9	11	8	2	3	2

* Level 2: Miniature greenstone ax (whole).
* Level 6: Small conical pumice abrader.

Table 7. Depth measurements (cm) and sediment volume (liters) for levels at La Chimba, TP-5.

LEVEL	NW	SW	NE	SE	Center	Volume
surface*	11	16	6	4	8	-
1	24	24	20	20	20	354**
2	30	30	30	30	30	234
3	40	40	40	40	40	258
4	54	54	50	50	50	282
5	60	60	60	60	60	207
6	74	74	-	73	72/75	282
7	85	85	85	85	70	234
8	95	95	95	95	95	189
9	112	115	107	105	-	306
10	128	130	115	115	120/123	336
11	140	140	128	128	133/135	210
12	154	154	138	138	144	237
13	160	160	154	154	155/157	276
					TOTAL	3405

* Measurements are below datum; datum located next to SE corner.

** Unit started as 2 x 2 meter unit, but was reduced to 1 x 2 meters when it became apparent that there was too much bulk sediment residue from 1/8 inch screening. An additional 168 liters were not screened from this level.

Table 8. List of major midden components recovered from La Chimba TP-7.

	Pottery Sherds		Bone*		Obsidian Debitage		Marine Shell**		Charcoal***	Basalt Debitage	
LEVEL	no.	kg.	no.	g.	no.	g.	no.	g.	g.	no.	g.
1	4185	21.60	309	318.5	963	2737.8	10	7.0	18.9	81	943.4
2	2402	28.10	290	468.9	821	2596.4	7	33.1	170.6	80	1062.6
3	1487	18.35	239	569.6	747	3013.7	0	0.0	190.1	70	645.7
4	2614	18.35	240	274.9	810	2070.5	4	9.0	123.8	64	313.2
5	4643	19.67	398	499.7	981	2112.5	7	6.1	297.6	148	942.0
6	2152	13.77	332	345.8	499	1330.8	0	0.0	274.7	39	453.9
7	3728	16.33	581	805.6	922	1709.3	16	16.7	383.9	116	611.3
8	2064	10.41	744	1402.7	664	1397.0	31	30.6	481.6	58	590.0
9	1942	10.60	829	1781.1	410	1039.3	26	40.0	447.2	195	1577.8
10	1839	13.80	883	1964.1	530	1287.4	10	8.3	307.7	135	1022.3
11	1900	9.97	690	1764.5	490	950.1	16	15.6	182.2	103	808.7
12	1406	9.70	740	1769.7	523	1322.0	6	9.1	326.3	152	1127.6
13	1176	7.62	622	2278.8	749	1377.2	13	13.9	413.7	106	348.5
14	1833	10.89	656	1892.4	435	853.1	21	5.8	268.6	60	937.4
15	1910	9.45	555	1668.1	453	626.2	20	7.1	351.4	103	510.8
16	3183	14.71	873	2031.2	606	941.4	28	12.7	340.2	122	496.6
17	4981	14.54	745	1011.0	684	766.7	18	9.0	426.7	137	695.2
18	6837	18.69	645	834.4	738	782.0	14	11.4	490.3	243	1176.1
19	1912	8.65	624	997.5	310	461.2	11	5.4	383.7	117	1052.8
20	2055	9.17	629	809.9	325	528.9	13	9.7	360.9	107	996.7
21	1781	7.29	422	617.8	287	539.5	16	4.6	268.6	61	709.3
22	2015	5.16	425	526.8	398	449.8	2	0.9	168.0	133	585.1
23	1843	7.46	291	328.2	202	274.0	3	0.7	342.7	74	337.4
24	2092	11.49	332	489.2	230	308.6	7	6.3	275.3	44	571.9
25	140	0.65	41	41.4	21	32.5	0	0.0	36.3	0	0
26	129	0.59	64	127.2	16	47.9	1	1.0	27.8	2	-
27	925	3.00	392	544.3	135	270.7	10	6.3	259.1	58	676.4
28	592	3.18	374	1532.1	136	221.3	6	21.7	106.1	79	828.6
TOTAL	63766	323.19	13965	27695.4	14085	30047.8	316	292.0	7724.0	2687	20021.3

* Figures include artifacts.

** Figures do not include shell beads.

*** Figures do not include botanical samples.

Table 9. List of artifacts recovered from La Chimba TP-7.

LEVEL	Ax Frag.	Ax Flake	Antler Spear Point	Other Bone Artifacts	Beads Shell	Beads Stone	Sherd Disks Hole	Sherd Disks No Hole	Pottery Figurine	Quartz Crystal	Basalt Grind-stone	Other*
1	-	5	-	1	1	-	-	9	-	-	2	3
2	1	-	-	2	1	-	1	8	1	-	1	2
3	-	2	-	1	-	-	-	9	1	-	1	3
4	-	1	-	1	-	-	4	3	1	1	-	4
5	-	1	1	1	-	-	2	7	-	-	-	-
6	-	-	1	-	1	-	-	8	-	-	1	-
7	1	2	-	-	1	1	-	5	1	1	1	-
8	-	4	-	1	-	-	2	4	-	-	-	-
9	1	5	-	-	1	-	-	-	3	-	-	-
10	2	5	-	3	1	-	3	1	-	-	-	-
11	1	7	-	4	1	-	1	-	-	-	-	-
12	1	11	1	-	-	-	1	1	-	-	-	-
13	-	18	-	2	-	-	1	2	-	1	-	1
14	2	3	3	-	-	-	1	1	-	-	-	-
15	-	1	-	-	1	-	2	2	-	-	1	-
16	-	2	-	2	-	-	1	2	-	-	1	2
17	-	5	1	-	-	1	3	-	-	-	-	-
18	-	4	-	1	1	1	3	-	-	-	-	-
19	-	2	-	4	-	1	3	1	-	-	1	-
20	1	5	1	1	-	-	1	-	-	-	-	1
21	1	-	-	3	-	-	-	1	-	-	2	-
22	-	1	-	4	-	-	-	-	-	-	1	3
23	1	-	-	2*	1	-	1	-	-	-	-	-
24	-	-	-	-	-	-	1	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-	1	-
26	-	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	2	-	-	-	-	1
28	-	1	-	-	-	-	-	-	-	-	-	1
TOTAL	12	85	8	33	10	4	33	64	7	3	13	21

"Other" Artifacts

Level

1. Small conical pumice abrader; pos. greenstone spear-thrower hook device; pos. stone artifact.
2. Small conical pumice abrader; pottery sherd figurine.
3. Small conical pumice abraders (3).
4. Small conical pumice abraders (2); bifacial basalt chopping tool; polishing stone, prob. basalt.

13. Possible basalt pebble polishing stone.

16. Lava stone with gold droplets from casting; ground slate artifact fragment.

20. Ground slate artifact fragment.

21. Ground slate artifact fragments (3), one perforated.

27. Stone pendant, perforated.

28. Stone disk, pumice-like material (possibly spindle whorl).

* One of the bone artifacts appears to be a spear-thrower hook device.

Table 10. Depth measurements (cm) and sediment volume (liters) for levels in La Chimba TP-7.

LEVEL	NW	SW	NE	SE	Center	Volume
surface*	12	13	8	12	11	-
1	25	27	22	24	24	528
2	40	40	40	40	40	738
3	51	52	48	51	50	534
4	60	62	61	64	61	480
5	73	73	73	71	73	582
6	82	83	84	82	83	444
7	94	93	93	96	93	486
8	104	105	106	106	104	444
9	117	117	116	115	117	498
10	124	127	128	127	127	522
11	138	138	136	139	138	498
12	145	143	148	150	148	498
13	156	157	160	157	158	522
14	165	165	165	172	164	378
15	175	175	175	175	175	474
16	185	187	185	186	185	738
17	201	200	197	201	200	564
18	211	215	217	217	217	882
19	223	227	227	230	226	450
20	236	236	239	239	239	555
21	250	251	251	251	250	652
22	260	263	258	260	259	516
23	272	273	269	265	267	612
24	282	287	278	277	282	612
25	293	297	278	277	-	186
26	296	302	283	282	291	480
27	302	308	292	295	303	612
28	309	317	306	312	312	624

* Measurements are below datum; datum located in center of east face about 12 cm from edge of test pit.

in Table 11 and 12. Figure 13 provides a graphic illustration of pottery density for each level in TP-7.

Figure 13 indicates considerable fluctuation in the density of sherds in each level. Major peaks occur in Levels 1, 4-5, 7, and 17-18, where approximately 8,000 to 9,000 sherds per cubic meter are found. The density declines substantially in Level 25 and below, where only 250 to 1,500 sherds per cubic meter are found. The average density per level is 4,112 sherds per cubic meter. Presumably the variation in density is referable in some sense to a combination of factors such as population size at the La Chimba settlement and number and proximity of residential structures in the immediate vicinity of the location of TP-7. Sorting out which of these factors may be involved for the specific density figures obtained in each level will be a difficult task. However, if comparable data can be obtained from different areas across the site, it may be possible to eventually investigate questions such as population size and site growth through time, distribution of residences within the site through time, refuse disposal patterns, etc.

In terms of the type and style analysis, the data presented in Tables 11 and 12 suggest that the original tripartite sequence proposed by Athens (1978a) is supported. In this sequence punctate bowls characterize the earliest period, fine-line incision on primarily carinated bowls define the middle period, and use of positive red painting signals the latest period. The present analysis, however, also shows that there is considerably more information that can be obtained regarding chronologically sensitive pottery indicators (see also Goff 1980). The fact that there is excellent correspondence between the findings of TP-5 and TP-7 in Tables 11 and 12 further suggests the validity of the stratigraphic associations that forms the basis of the ceramic chronology.

In general, the variety of vessel types and the size of vessels appears to increase through the long stratigraphic sequence of TP-7. This inference, which is based in part on informal laboratory observations as well as the general increase in the average weight of each sherd in each level from bottom to top, is corroborated from the data of TP-5, though this unit lacks pottery from the latest period. Also, TP-5, not having the volcanic ash layer found in TP-7, appears to lack the earliest part of the early ceramic period.

Within the "incised bowl" category there is a variant subtype having combed incision, which consists of 4 to 6 fine parallel diagonal lines, that only occurs in the later part of the middle period in both TP-5 and TP-7. Because this subtype does not occur at the Tababuela site, which is characterized by

Table 11. Pottery types and decorative elements, La Chimba TP-5.

Level	Positive Red Paint	Neg. Paint	Incised Bowls combed	Incised Bowls other	Punctate bowls	Punctate jars	Punctate body	Lipped Bowls plain	Lipped Bowls excision	Humped Shoulder Bowls	Bowls Annular Base	Bowls Flat Base	Appliqué Buttons	Bowls Shoulder Nicking	Bottle Spout	Strap Handle	Tripod Leg	Exotic Pottery Cosanga	Exotic Pottery Coast
1	-	-	8	7	-	-	-	-	-	-	1	-	2	2	-	1	-	23	-
2	-	-	3	2	-	-	-	2	-	-	-	4	6	-	-	-	4	6	-
3	-	3	2	2	-	-	-	5	-	1	1	1	2	-	1	4	2	6	-
4	-	-	2	9	-	-	-	5	-	1	1	1	2	-	-	-	1	16	-
5	-	-	2	8	1	-	1	4	-	-	-	-	2	1	-	-	3	23	-
6	-	-	1	1	-	-	-	5	-	4	-	-	6	4	-	-	-	15	-
7	-	1	-	3	-	-	1	1	-	-	-	-	-	1	3	-	-	3	-
8	-	-	-	3	-	-	-	5	-	1	1	-	4	-	-	-	1	6	-
9	-	-	-	12	1	-	2	5	-	4	4	2	5	3	-	-	1	18	-
10	-	-	-	13	14	7	100	32	-	17	22	1	6	3	2	4	15	6	2
11	-	-	-	4	2	-	14	2	-	2	1	-	1	-	-	-	1	-	-
12	-	-	-	-	8	-	27	-	-	-	1	-	-	-	-	-	-	1	-
13	-	-	-	-	6	4	10	-	-	-	2	-	-	-	-	-	-	-	-

Table 12. Pottery types and decorative elements, La Chimba TP-7.

Level	Positive Red Paint	Neg. Paint	Incised Bowls		Punctate		Punctate body	Lipped Bowls		Humped Shoulder Bowls	Bowls Annular Base	Bowls Flat Base	Appliqué Buttons	Bowls Shoulder Nicking	Bottle Spout	Strap Handle	Tripod Leg	Exotic Pottery	
			combed	other	bowls	jars		plain	excision									Cosanga	Coast
1	3	2	-	1	1	-	-	-	5	-	8	2	-	-	-	-	-	8	-
2	8	2	-	1	-	-	-	-	10	1	5	3	3	-	-	-	6	8	-
3	-	-	-	-	-	-	-	-	7	-	7	-	1	-	-	-	2	27	-
4	-	13	-	-	-	-	-	1	3	-	4	4	-	-	-	1	-	84	-
5	1	4	-	4	-	-	-	-	15	-	1	2	7	-	-	-	-	73	-
6	1	2	4	4	-	-	-	1	8	1	2	3	-	-	-	-	1	39	-
7	-	3	1	4	-	-	-	3	3	3	2	3	2	-	-	-	1	28	-
8	-	4	1	4	1	-	-	8	1	5	4	1	-	3	-	-	1	27	-
9	1	-	-	9	3	-	-	4	-	2	-	2	3	-	1	1	2	8	-
10	-	-	-	9	4	-	-	5	-	11	2	5	-	5	2	-	1	11	-
11	-	-	-	5	-	-	1	2	-	4	2	1	2	1	1	1	3	11	-
12	-	1	-	1	3	-	1	3	-	4	1	-	1	5	-	-	-	3	-
13	-	-	-	9	2	-	-	6	-	3	3	-	3	3	3	-	-	22	-
14	-	-	-	31	-	-	-	4	-	2	2	-	3	2	1	-	1	1	-
15	-	-	-	13	2	-	3	-	-	9	-	-	1	1	-	-	2	1	1
16	-	-	-	13	4	-	6	6	-	1	4	1	-	1	-	-	2	3	-
17	-	-	-	3	11	1	18	4	-	-	4	-	-	-	1	-	1	-	2
18	-	-	-	-	20	2	15	2	-	3	5	-	-	-	-	-	3	-	3
19	-	-	-	-	16	3	16	-	-	-	-	-	-	-	1	1	2	-	2
20	-	-	-	-	24	7	2	4	-	-	3	-	-	-	4	1	1	1	-
21	-	-	-	2	32	4	7	5	-	-	2	-	-	-	2	1	1	-	-
22	-	1	-	1	37	-	1	-	-	-	1	-	-	-	-	-	-	3	-
23	-	-	-	1	17	-	-	-	-	-	1	-	-	-	-	-	-	4	-
24	-	-	-	-	25	3	18	-	-	-	-	-	-	-	1	-	-	5	-
25	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27	-	1	-	1	35	2	-	-	-	-	1	-	-	-	2	1	-	2	-
28	-	1	-	-	18	-	-	-	-	-	1	-	-	-	1	-	-	-	-

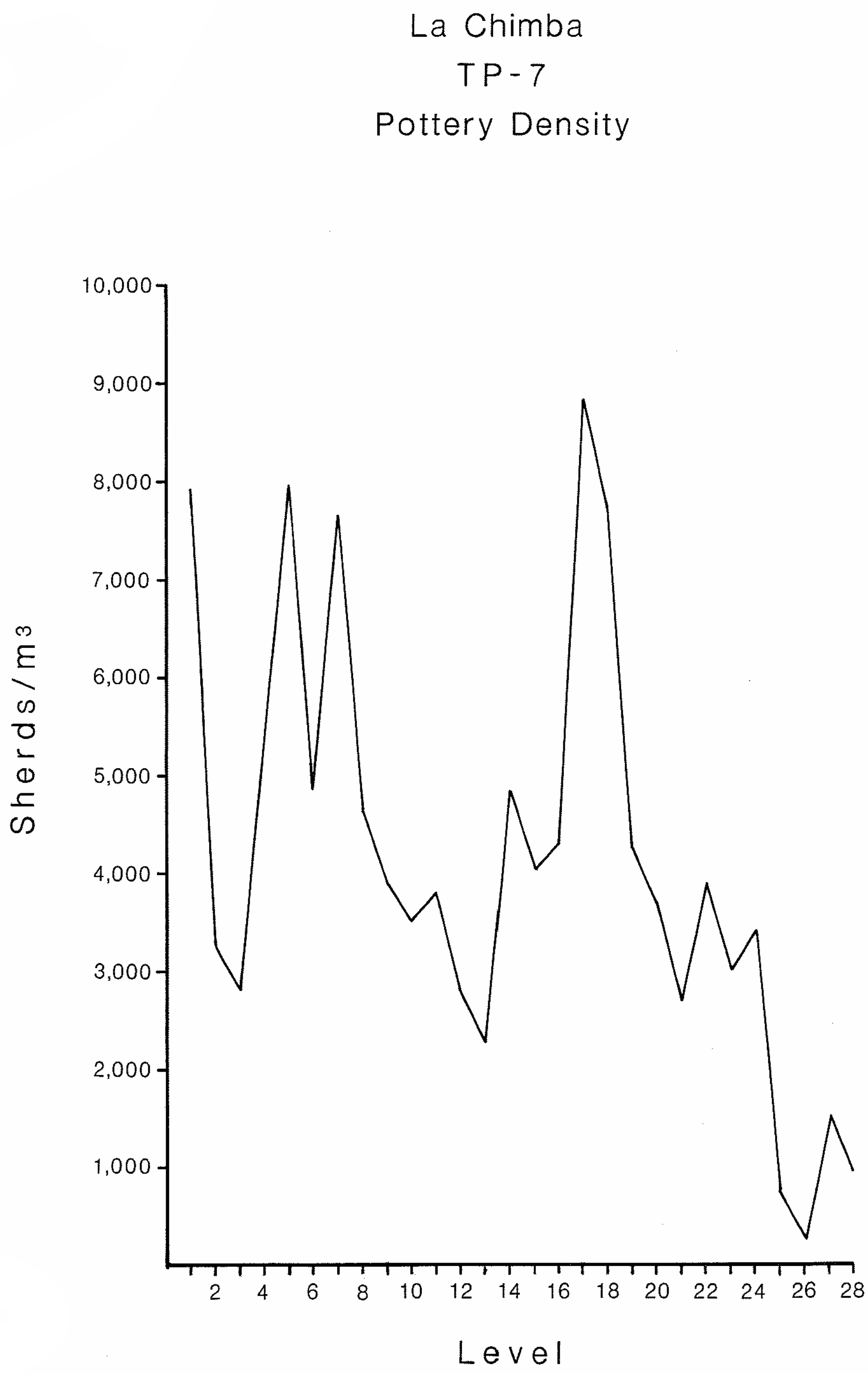


Figure 13. Graph of pottery density, La Chimba, TP-7.

the presence of pottery of the middle period ceramic style, it appears that this site must date to the earlier part of the La Chimba middle period.

With respect to the punctate style, it is clear that in TP-7 the vast majority of sherds with this decorative element occur from Level 17 and below. It is believed that the presence of punctate sherds above Level 17 is due to prehistoric disturbances in the refuse deposit rather than continued production of this type. That this may indeed be the case is suggested by the near absence of punctate sherds above Level 10 in TP-5. The same reason would also seem to apply for the presence of incised sherds below Level 17 in TP-7.

The lipped bowls comprise a very interesting type in that the two subtypes are both highly distinctive and temporally restricted in their occurrence. The excision variety (perhaps not the best type name), having one or more rows of a distinctive gouged/punctate design on the outer lip, usually with one or more incised lines above or below the excision designs that encircle the vessel, is both relatively common and restricted to the latter part of the TP-7 sequence. The non-excised subtype also appears temporally restricted, but occurring somewhat earlier and overlapping the punctate and incised time periods. The validity of this distribution is apparently confirmed in TP-5, where the excision does not occur, and the plain occurs in all but the earliest and latest levels. Here the latest period is missing, as is the earliest part of the early period (i.e., no red paint in upper levels, and no evidence of a volcanic ash fall in the lowest levels).

The humped shoulder bowls also comprise an interesting vessel type for their apparent chronological significance. Their stratigraphic occurrence is virtually identical with that of the incised pottery.

The technique of negative painting is present in the earliest levels, although in very low frequency, and it continues to be used through the latest period when it becomes more common. Spouted bottles with strap handles also have a similarly long period of use.

Other types of temporally diagnostic pottery types and decorative elements include bowls with flat bases, the use of appliqué buttons, shoulder nicking on bowls, and spouted bottles. Vessels with solid tripod legs occur in all but the earliest part of the early period, and bowls with annular bases are present throughout the sequence. Some of the solid tripod legs, it might be noted, have vent slits on their upper ends where they connect with vessel. This was done presumably to facilitate firing the vessel during the manufacture process. In addition to the above, there are figurine fragments, anthropomorphic figures on rim lips, and other vessel types and decorative elements in minor quantities.

The exotic pottery is primarily confined to that of the Cosanga Phase (Porras 1975), which comes from the eastern Ecuadorian lowlands. This easily recognizable pottery is present in most levels, though it is much more common in the later levels though not the uppermost levels in TP-7. The density graph (Fig. 14) shows the distribution of Cosanga pottery by level for TP-7. If the graph is interpreted as a measure of social interaction with the eastern lowlands, it is interesting to note that there is a florescence between Levels 3 and 8, and a substantial decline both earlier and later.

Coastal pottery is represented by only a few sherds, one being a tri-color type of possibly Chorrera affiliation (TP-5, Level 10). It is interesting that the occurrence of coastal pottery in TP-5 appears to be at approximately the same temporal point as that found in TP-7. Some degree of increased coastal interaction may be occurring at this time, which is suggested in part by the marine shell data (see below).

In regard to other possible cultural affiliations outside the region (adjacent highland areas as opposed to the coast or eastern lowlands), the distinctive pottery types of Carchi Province north of the Chota Valley (Francisco 1969) are absent from La Chimba. Also, the so-called "Negativo del Carchi" pottery types reported by Molestina-Zaldumbide (1985) for a site near Lake San Pablo appear to be absent.

On the other hand, the pottery of the Cotocollao site (Villalba 1988), which is located on the northern outskirts of Quito (see Fig. 1), does show affinities with La Chimba in respect to at least one of the pottery types. This is the type identified by Villalba (1988:119-125) as "Clase Formal I," of which the examples illustrated in his Figure 83 and the top two drawings in his Figure 87 (Villalba 1988:121) appear to be virtually identical to the excised lipped bowl type found at La Chimba (the Clase Formal I pottery of Villaba's Figures 84 to 87 [bottom 6 drawings of the latter figure] is *not* similar to the La Chimba pottery) appears during the latter part of the middle period and the late period.

At the Cotocollao site, Villalba dates the Clase Formal I pottery to the entire Cotocollao sequence from about 1500 to 500 B.C., though he indicates that the type diminishes in numbers through the sequence (Villalba 1988:120). In considering the date of the earliest La Chimba deposits--approximately 594-346

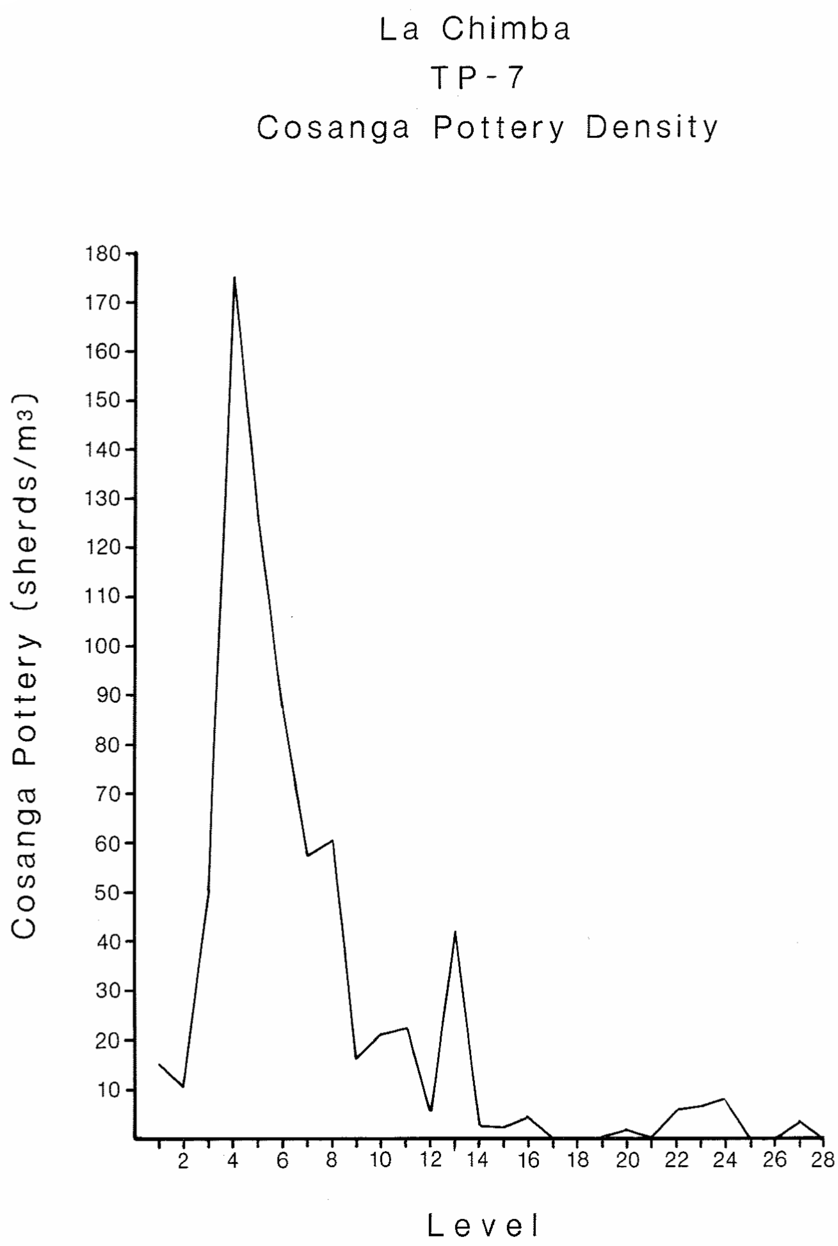


Figure 14. Graph of density of Cosanga pottery, La Chimba, TP-7.

B.C.--it is obvious that there is a large temporal discrepancy with Cotocollao if it is assumed that the Clase Formal I pottery and the similar La Chimba excised lipped pottery are related (note also that the La Chimba pottery referred to here is obviously much later than the basal La Chimba radiocarbon date for stratigraphic reasons). Because the distinctive designs appear to be identical, this very substantial temporal difference is difficult to understand. A detailed ceramic analysis and further radiocarbon dating of the La Chimba pottery sequence clearly will be a necessary first step in resolving this apparent problem.

With respect to the other Cotocollao pottery types, it is evident that they are generally quite distinctive from the La Chimba pottery types despite some of them sharing generically similar decorative elements (e.g., carination, diagnonal incision). There are also other aspects of the artifact assemblages and types of structural remains that make the two sites very different from one another.

Bone

A total of 21,663 fauna skeletal elements totalling 37.28 kg. were collected from the two test pits. Although identifications have not been made, it is clear that a wide range of species are represented with deer, rabbit, and guinea pig predominating. Until identifications can be made, it is uncertain whether camelids are present, though presumably they are.

During midden sorting of the animal bone, it was noted that nearly all of the large-animal long bones were fractured, usually near both the proximal and distal ends. It would appear, therefore, that marrow was being extracted.

Obsidian Debitage

A total of 18,943 pieces of obsidian were collected and these weighed a total of 38.44 kg. All of the obsidian is the result of flaking activities, and some pieces represent flake tools. Roughly 10% to 25% of all flake debris with a maximum dimension larger than 1 cm (about half of the collection) have evidence of use wear and/or possibly retouch in some cases. These flake tools have a variety of forms and sizes, and it appears that they must have been used for a number of different tasks. All obsidian tools were individually wrapped in tissue paper at the time of sorting to protect them from inadvertent, post-collection, edge damage.

Most of the obsidian was either translucent or opaque/black in terms of color. As there seems to be a gradation between these color differences, separation into the two colors was sometimes ambiguous and therefore not attempted. Also, it is uncertain whether differences in quarry sources are involved. It is possible that the same quarry produces the color variation in at least some of the specimens.

A previous chemical characterization study of 8 samples of the La Chimba obsidian (Stevenson 1987) indicated that 2 types of obsidian are present and that none of these correlate with other known obsidian sources in Ecuador (cf. Asaro *et al*. 1981a, 1981b; Salazar 1985). The present research, however, demonstrates that at least one other type of obsidian is also present at La Chimba, and this is what has become known as Mullumica obsidian after its source location about 30 km directly east of Quito (Salazar 1985:137-139). Although Mullumica obsidian is characterized by variations in color and texture, the presence of brown, brown-red, or bright red colors can be taken as a fairly definite identifying characteristic of this source. At La Chimba, Mullumica obsidian is present in relatively small quantities in all but the earliest levels where it is largely absent.

No obsidian cores were recovered from La Chimba, though many of the flakes and debitage pieces had evidence of extensive prior flaking. In fact, many of the obsidian pieces are thick and multi-faceted as opposed to laminar in form, suggesting that the stone may have been continually reworked and/or used as sources for additional flakes until further reduction became too difficult or impossible.

Marine Shell

Marine shell was found in nearly all levels of both TP-5 and TP-7. A total of 455 shell fragments were recovered, and these weighed 352.1 grams. A graph of the density of shell fragments in each level of TP-7 is presented in Figure 15. As may be seen, shell density is quite variable throughout the excavation, though there is a tendency for low densities early and late in the sequence, and several peaks of very high densities in the middle. It would appear that TP-5 may also have the highest densities during the middle part of the sequence, though with only two of the middle levels having a greater abundance of shell, there is not enough of a sample to be certain of a pattern.

Though formal species identifications have not been made, it is apparent that at least 4 types of shell are present, with two of these--Spondylidae and probably Strombidae--being much more

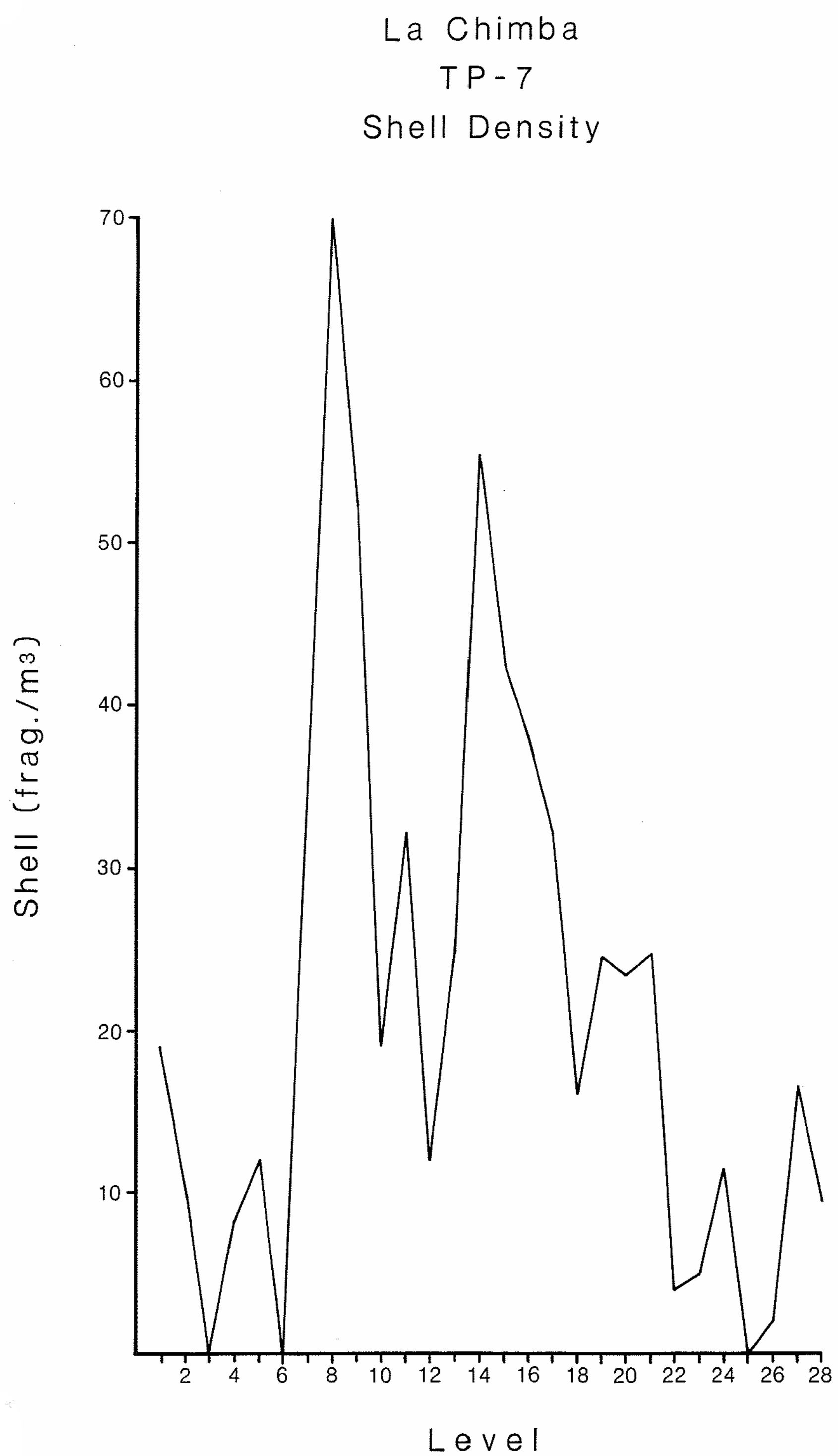


Figure 15. Graph of marine shell density, La Chimba, TP-7.

common than the other two. The other types of shell include species of pearl shell and a cone shell (the least common).

An interesting aspect of the shell remains is that they tend to occur only as very small and fragmentary pieces. From this it is inferred that the shell probably was brought in whole from the coast for the manufacture of artifacts at the site; finished shell products were evidently not the object of trade or exchange.

Charcoal

A total of 10,379 grams of charcoal was collected exclusive of charred botanical specimens or charcoal in the bulk botanical flotation samples. It was present in considerable quantities in all but the top levels of both test pits. Besides use for radiocarbon dating, the charcoal may provide valuable information on the local environment through wood species identification.

Much of the charcoal appeared to be somewhat mineralized. Once collected in the laboratory, it was apparent that many of the foil pouches weighed substantially more than would be normally the case. Also, it was noted for some samples a large proportion of the charcoal in the botanical fine screen samples did not float during the process of water screening. In fact, charcoal recovery in a few of these samples was very low despite the presence of a substantial amount of charcoal.

Laboratory testing of the charcoal with hydrochloric acid (1.0 N) showed considerable chemical reaction in the most obviously mineralized samples, indicating the presence of carbonates. It is possible that these carbonates were the source of the radiocarbon dating problems in the past (Beta Analytic was advised of this potential problem at the time of submittal of the present sample from TP-7, Level 28).

Basalt Debitage

This category consists of all purposely worked basalt material, including flakes and shatter. A total of 3,590 pieces were recovered, and these had a total weight of 26.52 kg. The basalt tended to be mostly a medium grain material derived from locally available rounded stream cobbles. Most of the chipping debris consisted of relatively small (less than 5 cm in maximum dimension) fragments. The basalt flaking appeared to be of a very expedient nature with minimal selectivity in type or preparation of the material.

Artifacts

Totals of 106 and 293 artifacts were recovered from TP-5 and TP-7, respectively.

The ax fragments and flakes were mostly produced from a very hard and fine grain greenstone basalt, though a black basalt was also sometimes used. This stone does not appear to have been derived from the immediate vicinity of the La Chimba site. The ax fragments were all of the "T"-shape variety where form could be determined. Nearly all of the fragments had evidence of extensive flaking following breakage. Many of these flakes were recovered, most being relatively small (under 3 cm in maximum dimension) and still retaining very sharp edges.

The antler spear points were all made from sharpened antler tines. The basal part of the artifacts had been hollowed to form a socket for the spear or dart shaft. The spear points range in length from 4.4 cm to 13 cm, averaging 8.44 cm (n = 7 for whole points). Most of the spear points were broken at the socket.

The "other" bone artifacts consist of a variety of implements, including scoops or ladles, probable weaving implements, a possible spear-thrower hook device, and various miscellaneous items and unidentifiable fragments.

Both shell beads and stone beads were present. The shell beads consisted of both Spondylidae "barrel" type beads as well as the small, disk type. The stone beads were all of the disk type. A total of 16 shell and 7 stone beads were recovered.

The category of sherd disks consists of both perforated and unperforated types. The perforated types, which have a hole in the center, are presumed to be spindle whorls. The non-perforated types, while sometimes considered spindle whorl blanks in the literature, may in fact be smoothing or polishing implements. The edges of many of these artifacts had been well-smoothed, sometimes giving the "disk" a polygonal or rectangular shape rather than a rounded shape. It is of course possible that some of the non-perforated disks are in fact spindle whorl blanks. There were a total of 42 perforated and 75 non-perforated sherd disks.

The category of pottery figurines includes both fragments of presumably "free-standing" hollow figurines as well as figurines molded onto a vessel (but not appliqué figures on bowl lips). All examples in this category are very fragmentary, though substantial portions of two heads are present. Considering the stratigraphic distribution of the 15 fragments, it would appear that pottery figurines are more common in the later part of the La Chimba sequence.

The quartz crystals, all of clear stone, were small, being 1 to 2 cm in length. Only 5 were recovered in the excavations.

The grindstones consisted of oval "mano" implements as well as fragments of flat stones perhaps used for sharpening other stone tools. Most of the stone is basalt, though other volcanic rock was also used as well as a probable schist and quartzite in two cases. A total of 16 grindstones were recorded in the excavations.

The "other" artifact category includes a miscellaneous assortment of artifact types, including a miniature greenstone ax, 5 small conical pumice abraders, 3 laminar ground slate artifact fragments, a pottery sherd figurine, 2 possible hook devices for spear throwers (1 stone and 1 bone), a bifacial basalt chopping tool, a lava stone with droplets of gold presumably from casting, and several other objects. While the pumice abraders appear to occur late in the La Chimba sequence, the other artifacts are too few to establish any chronological parameters in their stratigraphic occurrence. The evidence for gold casting is especially interesting in that it marks the first secure datable context for use of gold in the northern highlands.

General Midden Analysis: Im-11 & Tababuela

Because the samples collected from these sites have not been sorted, there is very little that can be said about the material remains at this time.

With respect to the Tababuela site, two levels--4 and 5--were washed in 1/8 screen at the laboratory. Casual inspection of the material indicated that the combed incised ware found at La Chimba, an apparently late variant of middle period incised ware, was not present. As there was no pottery of the early La Chimba period, it appears that the Tababuela occupation must date to the earlier part of the La Chimba middle period.

With respect to the pottery, there were no sherds that suggested an affinity or derivation from Carchi Province to the north.

It was also noted that Mullumica obsidian was present at Tababuela, although in relatively small quantities compared to the other obsidian that was present. No Mullumica obsidian was noted at the Im-11 site, though no actual cleaning or sorting of this material was undertaken.

VII: DISCUSSION AND CONCLUSION

Because most of the laboratory analyses have not been undertaken, the primary research problems identified in the introductory section of this report--that of measuring the rate of agricultural expansion and population growth--cannot be addressed at this time. In addition, while the lake coring effort was successful in retrieving a long stratigraphic record for the northern highlands, its ultimate utility for maize pollen density studies--a critical aspect of the present research--remains uncertain due to possible bioturbation processes in near-shore sediments and the lack of uniform pollen mixing and deposition in near-shore waters.

Though laboratory analyses remain incomplete, it is nevertheless clear that the first field season of research was quite successful. There is every indication that high quality data will be forthcoming on all of the research problems. The main obstacle at this point will be the acquisition of adequate funding for analyses. Proposals are presently being submitted to cover the expected costs.

To summarize the main accomplishments thusfar, the following points may be noted:

1. The feasibility of extracting deep cores from Lake San Pablo has been established. Also, preliminary pollen analyses has demonstrated that pollen preservation is excellent and that it will be possible to prepare a detailed vegetation history of the region. Furthermore, preliminary pollen analysis has demonstrated that maize pollen is present in both the core samples and the dredge samples, establishing the potential for conducting studies of maize pollen density.

2. Maize agriculture was demonstrated to be present in the region at least by about 4,000 B.P. This date pushes the time back for settlement and agriculture in the region at least 1,000 years earlier than what was previously known.

3. Charcoal particles were dense in the basal core samples. These were identified as being derived from corn plants, further substantiating the presence of early agriculture. Importantly, the maize charcoal particles suggest that initial agriculture in the region should date to an even earlier period. This is because the earliest agriculture should be associated with charcoal particles from dicotyledon plants from forest clearance. There is no evidence for forest clearance for the time period represented by the lake cores.

4. The lake cores provide an unambiguous record of volcanic activity for the region. A series of 5 radiocarbon dates provides the basis for an "estimated age" graph based on the sediment accumulation rate. It is therefore possible to date the 11 documented ash falls with an accuracy of 450 to 500 years. The thickest upper ash layer (ash C) was assigned a date of 1400-1900. The lower major ash layer (ash I) dates to 3190-3660 years B.P.

5. Excavations at La Chimba yielded an extraordinary wealth of data concerning the cultural and agricultural history of the region. The most spectacular aspect of the La Chimba investigations was the documentation of a stratified refuse deposit approximately 3 meters thick and with 19 probable occupation surfaces. In addition, there was a volcanic ash deposit near the base of the unit and a thin *cangagua* layer below the ash. It may be possible to tie these volcanic eruptive events to those of Lake San Pablo, as well as other archaeological sites in the region. In accordance with the age estimate graph, the La Chimba ash and *cangagua* may correlate with the San Pablo ash at 3.50-3.52 m (ash D) and 3.64-3.66 m (ash E), respectively. Whether or not these correspond to the Pululagua Volcano eruptive event of about the same time remains undetermined.

   The chronology of the La Chimba site is important because it suggests a time frame for the initial use of marginal agricultural lands. A single radiocarbon assay established the initial occupation at La Chimba at 594-346 B.C., which is in accord with previously accepted radiocarbon dates from this site.

   The rich deposit of La Chimba provides a detailed ceramic chronology for the region, which will be eventually firmly tied to a radiocarbon chronology. Initial findings substantiate the original tripartite chronology proposed for La Chimba, as well as indicate a number of other types and subtypes that can be used as temporal markers.

   The detailed ceramic record will also help document possible affiliations or connections with other regions of Ecuador. Initial findings indicate considerable interaction with the Eastern lowlands except for the earliest and latest part of the sequence. Some interaction with the coast was also noted in terms of the pottery, though marine shell may be a better indicator of coastal contacts.

   There was no evidence for interaction with Carchi Province or other nearby regions in terms of the pottery evidence. However, one of the pottery types at La Chimba (the excised lipped bowl) did have a definite similarity with pottery from Cotocollao. The significance of this single instance of similarity in bowl form and decorative technique is unknown since the sites appear to date to entirely different time periods (Cotocollao is earlier).

The rich botanical remains recovered from La Chimba are a crucial element of the present research focus. Such remains were systematically collected throughout the deposits, and include maize kernels and cobs, probable beans, quinoa, other seeds, and various probable tubers. In addition, numerous non-agricultural vegetal remains were also collected in the fine screen flotation samples.

The extremely large collection of animal bones will provide detailed information on hunting practices and use of animal products. In addition, it is expected that this material will provide information on the initial date of the introduction of the domesticated llama to the region.

The finding of evidence for gold working was unexpected and quite important in terms of establishing the antiquity of metal-working in the northern highlands.

Other aspects of the La Chimba data include a substantial collection of obsidian, which will contribute important information concerning tool use and raw material procurement in the region.

The presence of two adult human burials in the La Chimba excavations are important in that they provide sample material for stable isotope analysis for determining the extent of maize consumption at the site.

6. Volcanic ash samples have been collected from Lake San Pablo, La Chimba, Im-11, and Tababuela which should allow for precise temporal correlation between sites if the volcanic events are the same. Also, it should be possible to evaluate the effect of volcanism on prehistoric human settlement in the region. It should also be possible to determine if the ash falls documented in northern Ecuador are related to the Pululagua event, which provides major temporal marker over a wide area of Ecuador.

7. Thermal and humidity cells for recording effective hydration temperature for obsidian dating were implanted at the La Chimba site.

Future Field Investigations

The primary needs for future fieldwork with respect to the research problems of the present investigations may be listed as follows:

1. It will be necessary to take deep water cores from Lake San Pablo to circumvent the potential problem of bioturbation of the sediment deposits in the shallow water cores, as well as the potential problem of sample bias due to differential mixing and deposition of suspended agricultural pollen in near-shore waters.

2. Collection of archaeological botanical remains, especially maize, is needed from a sample of sites in different environmental zones and different time periods. Variations in maize varieties over time must be documented to assist in the determination of maize productivity for different time periods. An initial effort should be made at the Im-11 site, which is known to have the earliest ceramic-period remains thus far documented in northern highland Ecuador (with the exception of the single Lake Cunro sherd). The nature and extent of this site remain poorly understood.

3. Human skeletal remains are also needed from sites in different environmental zones and different time periods for an evaluation of the dietary contribution of maize.

4. Field laboratory analysis of the Im-11 and Tababuela samples are incomplete and must be finished.

Along with the above investigations, there are many other kinds of supplementary research problems that would be useful to pursue. Among these are 1) a functional analysis of ceramic remains, which might include the analysis of interior residues of pottery, and 2) further work on obsidian hydration dating, of which implantation of thermal and humidity cells at sites in different environmental zones is essential. It would also be of interest to conduct use-wear studies on the La Chimba obsidian artifacts to establish artifact function.

In terms of possible major field research projects for the future, the La Chimba site remains poorly understood in terms of intra-site layout and the configuration of habitation structures. Also, nothing is known of the possible burial area on the north side of the river. A major excavation project at this site, while a formidable undertaking, would certainly prove extremely rewarding.

Along with major excavations at La Chimba, it would be of great interest to conduct an intensive archaeological survey of a stratified sample of the entire Rio de La Chimba drainage. This would provide much needed information on the nature of settlement distribution through time, functional variation, types of sites, etc.

Because of the lake core evidence for very early agricultural settlement in the Lake San Pablo area, some attempt should be made to locate habitation sites of the early farming population through deep excavations or trenching. It is likely that such sites are deeply buried as a result of at least 4 millennia and possibly more of accelerated erosional deposition due to agriculture in the inter-Andean valley. Volcanic ash falls during the prehistoric period would further add to the deep burial of archaeological sites.

PHOTOGRAPHS

Photo 1. Panoramic view of Lake San Pablo from town of San Rafael. Mt. Cotocachi is to the left and Mt. Imbabura is to the right.

Photo 2. Lake San Pablo and floating dock of Puerto Lago coring site.

Photo 3. Recording core samples that have just been extruded from corer.

Photo 4. Close-up of core sample. The light-colored middle area of sample is ash fall "C" of Core #2.

Photo 5. La Chimba, Test Pit 5. View to southeast.

Photo 6. Profile, south face of Test Pit 5.

Photo 7. Excavation of Test Pit 6 inside *tapia* enclosure. View to southeast.

Photo 8. Excavation of Test Pit 7. View to northwest.

Photo 9. Profile of north and east faces of Test Pit 7.

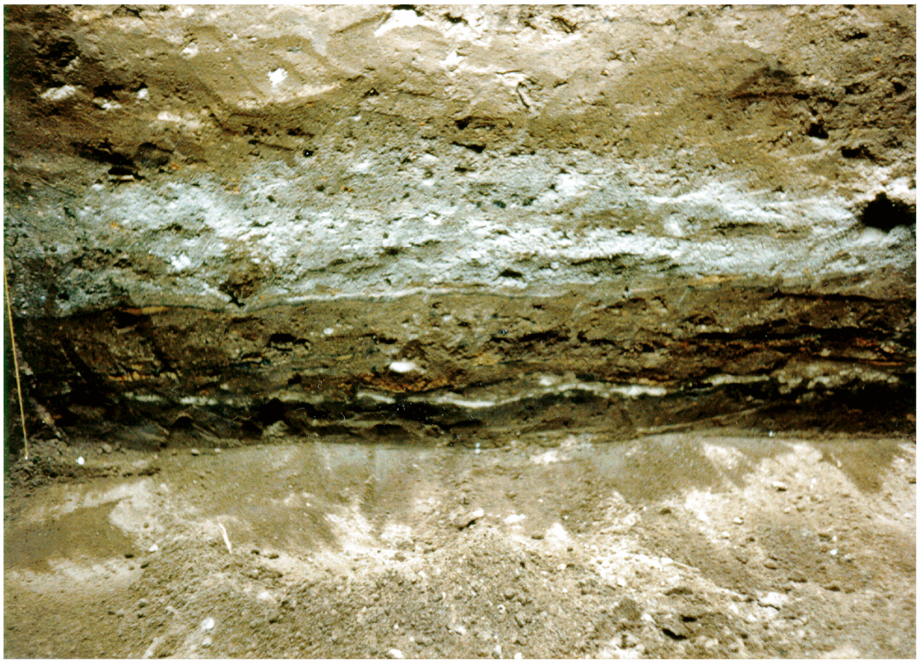


Photo 10. Close-up of basal profile section of north face of Test Pit 7. Note volcanic ash layer and thin *cangagua* layer below it.

Photo 11. Field house for agriculture at La Chimba. The lower walls, obscured by the *ichu* grass roof thatch, are made of *tapia*.

Photo 12. Excavation at the Im-11 site, Test Pits 1 & 2. View to northwest.

Photo 13. Excavation of Test Pit 3 at the Tababuela site, Chota Valley. View to east.

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