CHAPTER 2

RESEARCH SETTING AND FIELD METHODS

Jachakala is located in the canton of La Joya, part of the Department of Oruro. The region is in the northern Bolivia altiplano, bordering the western foothills of the Cordillera Central (Figure 1). Stretching from the Lake Titicaca basin to Lake Poopó, this section of the altiplano is a high, flat plain covered by sand and little scrub vegetation, and broken by scattered groups of inter-montane hills (Montes de Oca 1989:153). In general, the plains vary in altitude between 3,700 and 4,600 m above sea level (Lavenu 1992:3). Jachakala itself is set next to the eastern slope of the Cerro Isahuara hill, the long, narrow extension of Cerro La Joya (the contour lines along the left edge of Figure 2), at an elevation of 3,708 m above sea level.

A Regional Perspective

The archaeological remains of 3,500 years of settlement in the canton of La Joya can be divided into three broad time periods based on ceramic stylistic affiliations between occupations of sites. These three chronological divisions cover the Late Formative complex of mound sites inhabited by the Wankarani culture between ca 1400 - 200 BC; three sites known to be contemporary with phases IV and V of the well-studied Tiwanaku State to the north (AD 800-1200); and a number of sites occupied roughly from the collapse of Tiwanaku (circa AD 1200) through the ethnohistorically-documented Contact Period (AD 1532) in the Bolivian altiplano. The chronological schema employed throughout this project appears in Figure 4.

The Wankarani population lived in small villages atop mounds of their ancestors' household and refuse remains, practiced subsistence farming, and were organized along egalitarian socioeconomic lines. In essence, the Wankarani archaeological record reveals a subsistence economy as defined in Chapter 1 (Johnson and Earle 1987:14). The work at Jachakala and the survey of the La Joya region indicate that patterns of inter-village relations, agricultural techniques, long-distance trade, iconographic affiliations, and tool manufacture all underwent significant changes between the end of the Late Formative and the establishment of the Tiwanaku-contemporary sites in La Joya.

Preliminary fieldwork by Marc Bermann and Jose Estevez Castillo in 1991 at Jachakala included limited surface collections as well as two excavation units, one located adjacent to the largest Jachakala Period household at the site and the second in the communal cemetery. This work established the Jachakala complex as one with various characteristics distinguishing it from the earlier Wankarani culture. Surface collection and test excavations at Jachakala (Bermann and Estevez 1993) identified two phases of occupation at Jachakala based on diachronic changes in ceramic styles. Their Niñalupita phase of occupation corresponded roughly to the Early Intermediate Period (AD 600-800), which pre-dates the expansion of Tiwanaku during Tiwanaku phases IV and V. The beginning of the Jachakala phase was marked by the appearance of Tiwanaku V-style materials as well as a decline in the proportions of particular undecorated local ceramic types. This latter occupation dates from AD 800-1000, coinciding with the Tiwanaku V Period (1993:331).

Timothy McAndrews's settlement survey of the La Joya region has established that Jachakala emerged at the apex of a site size and probable functional hierarchy during the Tiwanaku-contemporary occupation of the area. Jachakala measures 6.7 ha, the only large, nucleated village dating to the Early Intermediate/Middle Horizon Periods identified in McAndrew's survey of the La Joya region (McAndrews 1998:57). Contemporaneous sites include two small sherd scatters with no visible structures, both of which are quite close to Jachakala. The sites of LJ-P at 1.1 ha and LJ-Q at 2.0 ha probably represent outlying residences attached to the village (McAndrews 1998:146). A third scatter of Tiwanaku-style sherds, measuring 0.8 ha and accompanied by several stone basins, is located on the western side of Cerro Isahuara at the site of Alkipata

(McAndrews 1998:146-147). Finally, McAndrews describes LJ-V, composed of a few Tiwanaku sherds on top of Cerro La Joya, as likely representing an offering (1998:147). Of this total settlement area of 10.6 ha dating to the Early Intermediate Period, Jachakala's 6.7 ha makes up 64% of it. This site represents, therefore, considerable population nucleation. The degree to which this nucleation took place is further emphasized when one considers that the largest Wankarani site is Chuquiña at 1.6 ha (McAndrews 1998:202, Table 5). The spatial extent of Jachakala's earliest occupation is an estimated three to four ha, far larger than its predecessors. Jachakala's location at the base of a large hill is the same setting as that favored by the Wankarani, but no evidence exists to suggest that it was originally founded as a Wankarani site.

CHRONOLOGICAL CONSIDERATIONS

Extensive excavations at Jachakala from August 1997 through February 1998, as well as the results of a single calibrated radiocarbon date, suggest that Jachakala was founded sometime in the middle of the first century A.D., much earlier than originally estimated. Diachronic patterns in artifact assemblages, moreover, suggest a three-period chronology that better reflects overall shifts in material remains than the presence or absence of Tiwanaku-style ceramics. Consequently, I replaced the Niñalupita-Jachakala sequence with one that divides the site's history into three periods (Figure 4): the Niñalupita Phase (ca. AD 150-500), Isahuara Phase (ca. AD 500-800), and Jachakala Phase (ca. AD 800-1200).

The beginning and end of each of these three periods are marked by somewhat drastic shifts in the domestic economy of Jachakala households. These diachronic markers are particularly evident in two aspects of subsistence production: agricultural pursuits and camelid utilization patterns. Classes of lithic and faunal artifacts were converted into ratios for each stratigraphic level of each unit chosen for analysis. When these sets of graphs were placed next to one another, shifts in those patterns that occurred more or less across the site (i.e., changes in most if not all of the seven units representing all three zones) at the same level became apparent. There were marked changes in the

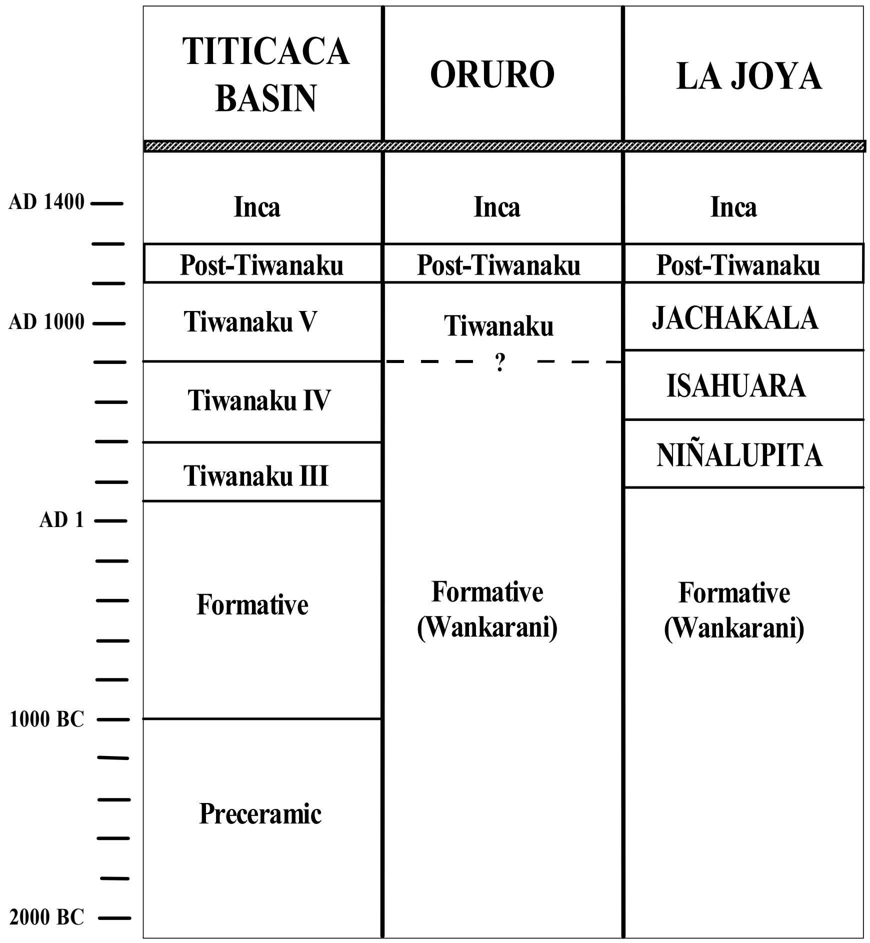

Figure 4. Chronologies for the Titicaca Basin and the La Joya region, including the Niñalupita, Isahuara, and Jachakala Periods at the site of Jachakala.

relative ratios of both lithic and faunal artifacts around Level 12 (120 cm below the surface) as well as Level 4 (40 cm below the site surface). The two graphs in Figure 5 illustrate one example of this shift, namely that between the Isahuara Period (Level 4) and Jachakala Period (Level 3). These shifts are the basis for the division of the two meters or so of cultural remains at Jachakala into the Niñalupita (surface remains down through Level 3), Isahuara (Levels 4 to 11), and Jachakala (Levels 12 to sterile soil) Periods.

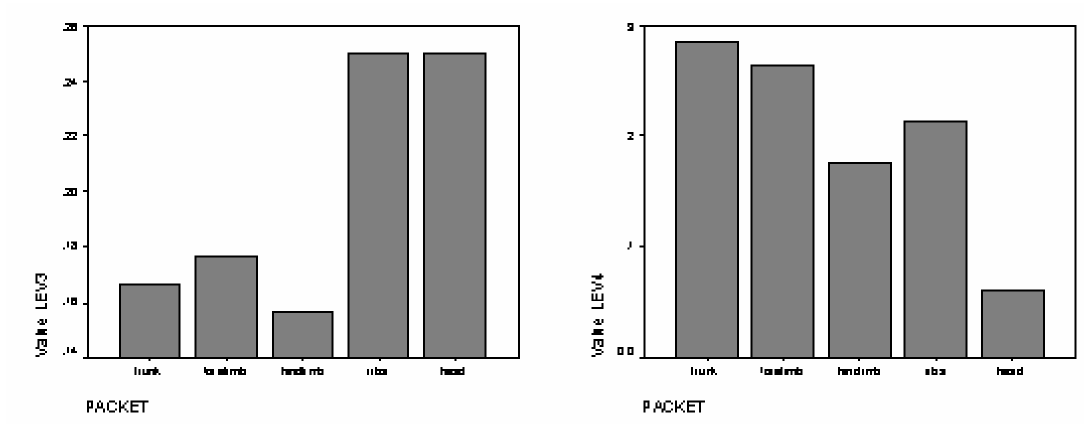

Figure 5. The shift in relative proportions of faunal meat packet remains from Level 3 (left) to Level 4 (right) in units such as this one (N416 E568) was the basis for the local chronology.

Though this latter chronological schema is somewhat at odds with that based on the absence (ca. AD 170-800) and presence of Tiwanaku IV (ca. AD 800-1000) and Tiwanaku V (ca. AD 1000-1200) ceramics, it provides for finer diachronic control over the timing of changes in the domestic economy. This three-period chronology extends and revises the general history of occupations of Jachakala over a longer period than Bermann and Estevez's schema. In doing so, furthermore, the three-phase chronology based on household economic changes rather than ceramic styles allows for better evaluations of factors that may or may not have played causal roles in the site's history. Comparing the domestic and political economies of different phases is more meaningful in this schema than the simpler pre-Tiwanaku/Tiwanaku-contemporary approach.

FIELDWORK METHODS

A sample of complete households, including house floors, surrounding activity areas, middens, storage pits, and other associated features, were exposed through excavations conducted by a crew of four La Joya residents, one student from the

Universidad Técnico de Oruro, and myself. Work proceeded for the most part in arbitrary 10 cm levels, though natural stratigraphic levels were occasionally employed. All excavated deposits were sieved through 1 cm screen meshes. Soil samples from house floors, middens, and hearths were also systematically collected for fine-screening and flotation analysis at some future date. Final collections are stored at a local facility in the village of La Joya under the care of José Estevez Castillo, the Bolivian Instituto Nacional de Arqueologia representative in Oruro.

Over the course of six months of excavations, a total of ten round and rectangular foundations were cleared completely to expose the internal layout of domestic features. Fieldwork began with the placement of three lines of wooden stakes with a theodylite. Stakes were set twenty meters apart on three north-south oriented lines, with forty meters between each line. The southwest corner of every excavation unit was measured from the nearest stake using long tapes and a compass. Each unit's designation represents, therefore, the number of meters north and east from the zero point, arbitrarily designated North 500 East 500, and placed more or less in the center of the site.

A series of adjacent 1x4 m trenches was employed in each case to fully expose both the foundation and activity areas. These were variably expanded or combined to form 2x2 m units placed in the center of the household midden. The 2x2 m units were then excavated in arbitrary 10 cm levels down to culturally sterile soil. In very few cases were natural stratigraphic levels used, because the ashy microstrata in middens were too thin to be of much meaning for the aims of this project. Because broad diachronic trends in household activities are the basis for fieldwork objectives, these thinner stratigraphic units seemed to me to be unnecessary to treat separately. Areas within and immediately outside of structural foundations were excavated in 10 cm levels to expose the original living surfaces if possible. After peeling back thick layers of adobe wall melt with few cultural inclusions, ash stained surfaces appeared with smaller artifact fragments lying flat on them (especially against the foundation stones). Given these characteristics, the field crew troweled all wall melt within foundations to this level, designated as the original interior and exterior living surfaces. With the exception of the northern zone non-domestic structures, floor levels occurred in all cases at the same level below the surface as the base of the foundation stones.

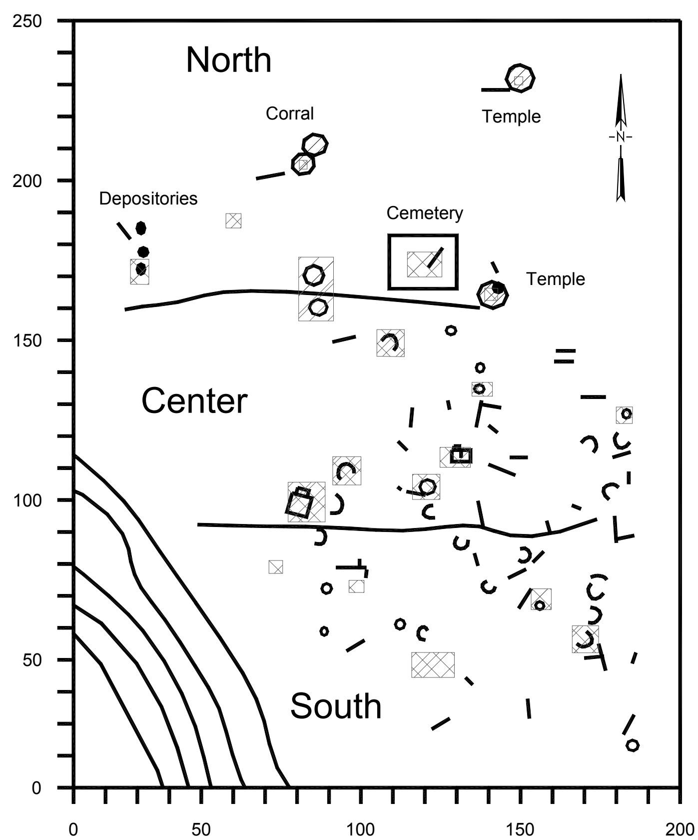

Figure 6. Location of horizontal exposures and units excavated to sterile soil at Jachakala, marked by hatching.

Each of these structures was judgmentally chosen for investigation based on the quality of their preservation as visible from surface indications. Additionally, features within and outside of house foundations, such as hearths, storage pits, ceremonial offerings, and so forth, were individually excavated, photographed, and described in field notes. Artifacts associated with those features were bagged separately for analytical purposes. Together then, artifacts and features from house floors, features, and adjacent middens form discrete household units. One typical set of domestic features associated with a house and its midden is illustrated in Figure 7 below.

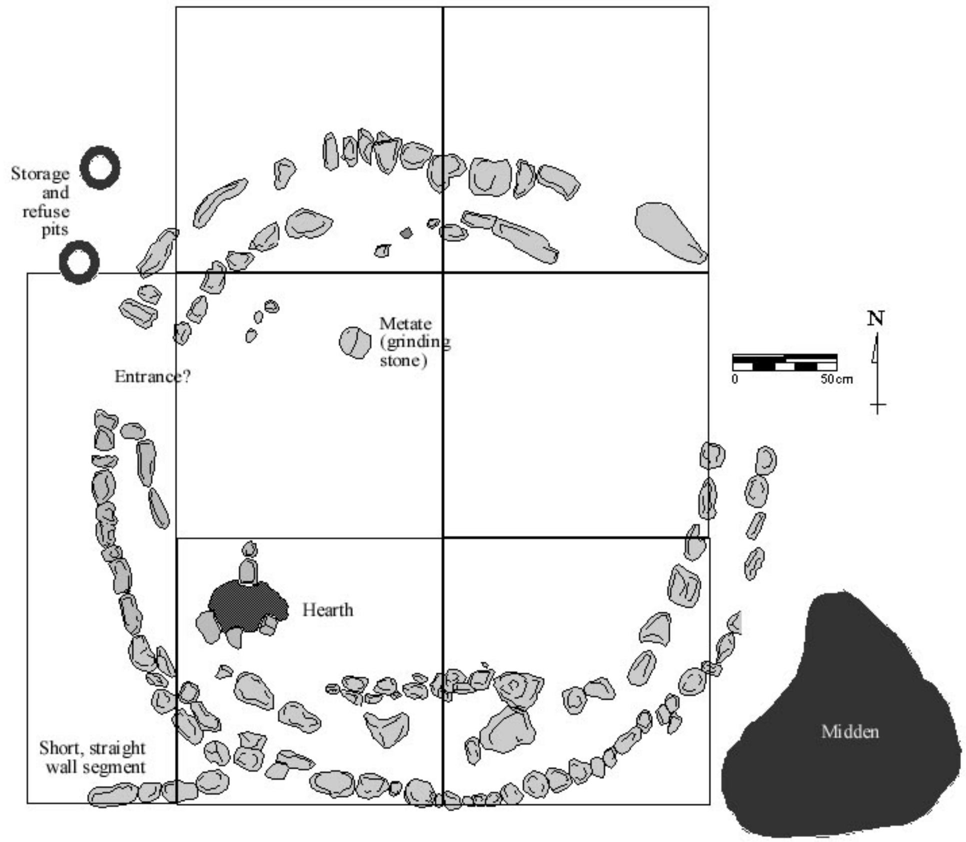

Figure 7. Example of a house floor, domestic features, and an adjacent midden, which together form a discrete household unit.

To attempt to determine the original function of the structures located in the northern zone, a series of 1x4 m trenches were placed inside the foundations of one of the temples, the camelid corral, and one of the small community depositories. Once domestic functions were ruled out, 2x2 m units were excavated down to sterile soil inside both temples and the corral. Several additional 2x2 m units were randomly placed within this zone, revealing that this area was unoccupied before the Jachakala Period. Because initial excavations by Bermann and Estevez in 1991 located a burial here, a larger area measuring 4x6 m was opened up to sample mortuary remains. The location of each of the horizontal excavations that exposed these structures as well as the ten households is depicted in Figure 6.

In addition to this judgmental sampling strategy aimed at reconstructing household organization, a total of seventeen 2x2 m pits (also located in Figure 6) were placed within randomly chosen 10x10 m grid squares drawn on a site map. Each was excavated to sterile soil with the express objective of sampling associated activity areas and features, as well as remains not associated with particular structures. The remains from some units are divided by zone and time period, the basis for the analyses presented in Chapters 3 and 4.

Aims of Artifact Analyses

Because I did not have enough time to analyze every artifact collected during the excavation season, I sampled materials by excavation unit. Sets of excavation units were chosen for the ceramic, lithic, and faunal analyses based on specific analytical objectives. All artifacts from all levels of those units were classified and recorded for the data analyses. These objectives center on developing a comparative, diachronic perspective on changes in the domestic economy of different areas of the site.

For the ceramic collection, typological analysis began with the schema originally developed by Bermann and presented in the 1993 article. A number of additional types emerged, defined by surface treatment, paste, temper, and decorative elements. The final typology is presented in Appendix A. Sherds from ten units were analyzed, including three southern, four central, and three northern zone structures. Artifacts from house floors, middens, and features are grouped together as single household clusters. These clusters were chosen based on their location and structural associations (i.e., household clusters are preferred over random, unassociated units to sterile). A sample of rims, bases, and handles of undecorated vessels from two units excavated to sterile soil were also drawn and described in terms of these same technical characteristics in order to identify diachronically sensitive vessel forms (Appendix A, Figures 62 to 64). Finally, a small amount of vessel reconstruction resulted in the illustrations included in Figures 65 to 67 (Appendix A), and Figures 93 to 94 (Appendix F). Second, all recovered Tiwanaku-

Table 1. Units and levels used in lithic, faunal, and ceramic artifact analyses.

Zone	*Units Analyzed*	*Levels*	*Lithics Analyzed?*	*Fauna Analyzed?*	*Ceramics Analyzed?*
South	1. N416 E568	Surface-Level 16	√	√	√
	2. N425 E526	Surface-Level 14	√	√	√
	3. N463 E516	Surface-Level 20	√	√	√
Center	4. N468 E480	Surface-Level 19	√	√	√
	5. N511 E509	Surface-Level 19	√	√	√
	6. N517 E450	Surface-Level 15	√	√	√
	7. N559 E589	Surface-Level 12	√	√	√
North	8. N567 E418	Surface-Level 6	no	√	√
	9. N581 E540	Surface-Level 19	no	√	√
	10. N673 E545	Surface-Level 7	no	√	√

style sherds were drawn, described, and photographed to form the data set explored in Chapter 6. Because all decorated sherds recovered from excavations are recorded and analyzed, that data set is complete.

The quantity of lithics catalogued over six months of fieldwork again preempted analysis of all recovered remains. Therefore, seven of the same ten units were chosen, and all stone tool debitage from all levels was analyzed. A total of four household clusters in the center and three in the south were chosen for this part of the project. Basalt debris from the northern zone units was excluded, because the objective of the lithics study was to test for evidence of specialization or production for exchange in household-based biface production patterns. Obsidian and ópalo debris and artifacts, basalt projectile points, scrapers, and other non-agricultural implements were bagged and recorded separately in the field. A sample of each class of materials was also drawn and photographed (see Appendix D, Figures 72 to 75; Appendix E, Figure 83).

For faunal remains, the analysis was guided by the general aim of tracing consumption patterns of camelid meat, and not butchery or herding practices. Broadly speaking, this approach assumes that butchered animals were divided into large packets such as the ribs section, hindlimbs, and so on. The five faunal packets or meat units ultimately chosen for the data analysis are derived from Aldenderfer's study of the Peruvian Formative Period site of Asana (1998). As with the ceramic remains, bags from a sample of units in all three zones were chosen for analysis. Bone tools of all types and decorated (incised, pyro-engraved, or painted) fragments were also bagged, described, drawn and photographed separately (Appendix D, Figures 76 to 80).

ENVIRONMENTAL CONTEXT

The following sections address facets of central altiplano ecology, climate, and natural resources. In particular, the brief discussion of Lake Titicaca hydrology merits attention, because these characteristics determine the availability of water in the Río Desaguadero, crucial for the maintenance of animal populations, and human survival. Also covered is a list of vegetation found in the research area, including both wild and domesticated species.

Cultigens

Crops cultivated by modern Aymara farmers as well as, presumably, their pre-Colonial predecessors, consist of hardy, frost-resistant grains and tubers. Planting and harvesting schedules, plot rotation techniques, and the length of fallow periods are firmly fixed by regular seasonal variations in precipitation and temperature levels.

Aymara farmers typically plant fairly small plots (sometimes less than two hectares, but averaging five to ten hectares), gathering just a single annual harvest (Montes de Oca 1989:373). Different crops are therefore rotated on fixed schedules. The soil is turned in August and September, at which time the cereal quinua (Chenopodium quinoa) is sown. This grain, originally domesticated before 2500 B.C. (Hastorf 1993:114) in cold environs at high altitudes (2,000 to 4,000 meters above sea level) like the Bolivian altiplano, is fairly resistant to frost. However, both its long-growing season (harvested only in April) and its lateral root system requiring well-spaced furrows inhibit the intensification of quinua cultivation (Montes de Oca 1989:383).

Potatoes (Solanum tuberosum) are sown between the beginning of October and middle of November in a broader range of altitudes, between 300 and 4,000 meters a.s.l.

(though the greatest number of varieties thrive between 3,600 and 3,900 meters a.s.l.) (Montes de Oca 1989:385). These tubers are generally processed into chuño through freezing, sun drying, and soaking after harvest in March and April (Montes de Oca 1989:373, 384).

Additional cultigens utilized by modern Aymara peasant farmers include the grain cañahua (Chenopodium pallidecuale), which has similar sowing requirements, uses as food and fodder, and planting schedules as quinua, though it is considerably more resistant to severe frosts (Montes de Oca 1989:382). Different areas of the altiplano today are home to mixed cultivation strategies using any or all of these crops, as well as minor quantities of other plants able to grow in such arid, cold regions. Typical crop rotations occur in the following order: potato, quinua, and barley (a European-derived addition), followed by a fallow period of several years (Montes de Oca 1989:373). Although barley, alfalfa, and other modern crops were not cultivated by Prehispanic farmers, they may have practiced crop rotation on agricultural fields much like the Aymara today.

Methods of Intensifying Agricultural Production

In the La Joya region, fields are most commonly placed on the slightly sloped bottom of the Cerro La Joya and Cerro Isahuara hillsides, as well as nearby slopes. Given the moderate density of sherds and basalt hoe fragments scattered throughout currently active fields around the bottom of the two hills, prehistoric residents of the region likely farmed the same areas. This is an important point because, as Hastorf writes, “If settlements increase in size and there is no fissioning, local intensification must occur” (1993:140). Though agricultural land is abundant in this region, sloped plots (for distributing rainwater) on hillsides are not. The absence of extensive irrigation networks, artificial terraces, raised fields, or other technological means of increasing crop yields means that intensification more likely occurred through decreasing the space between plants, or reducing fallow times described below. Furthermore, the population nucleation represented by the appearance of a single community at Jachakala during the Late Formative Period larger than any Wankarani site predating it, supports an argument for local intensification of production.

Research on traditional Andean agrarian organization shows that land is usually organized on the level of the ayllu kin group or community, though production occurs on a household level (Hastorf 1993). Under the sectoral fallow system described by Hastorf, this larger social group cycles fields for cropping and fallow stretches of land used for grazing. Individual households receive plots in sections to be cultivated in exchange for labor on communal works. This system is especially prevalent, she continues, in the less fertile tuber-growing regions of the Andes (Hastorf 1993:32). Intensifying agricultural production under such a system involves simply increasing the size of areas to be farmed and/or decreasing the periods of time that other tracts are left fallow. It is possible that Jachakala's residents employed a similar system to organize production around the base of Cerro La Joya and Cerro Isahuara. Because the site grew considerably over time, this would be one way to intensify agricultural production without investing much labor in irrigation networks or terraces. I did, however, carefully walk over the natural terraces that line the slopes of Cerro La Joya, as well as the areas around the bottom of both hills to look for evidence of agricultural terracing and irrigation canals. I found not a single sherd from any period of Jachakala's history; while this certainly does not mean that residents did not cultivate these areas, I found no traces of such features.

Water Resources

Because irrigation canals and artificial terracing are rare in this region, agricultural yields are connected to precipitation rates. With an average annual rainfall of only 742 mm (Montes de Oca 1989:136), the eighty-five percent that accumulates during the rainy season of December through March can take the form of devastatingly torrential downpours. The occasional rainy afternoons that precede the onset of the rainy season, particularly during late October and November, make up most of the remaining fifteen percent. By contrast, almost no precipitation whatsoever falls during the dry, cold winter from late April through, more or less, the beginning of November.

During the rainy season, large but very shallow "lakes" form on the flat plains on either side. A local mine geologist recognized evidence for minor flooding events in the stratigraphic profiles of several excavation pits at Jachakala (Paul McLeod, personal communication). Agricultural plots dependent on rainfall would receive adequate water during the rainy season from a combination of almost daily storms and occasional minor flooding events, without the benefit of irrigation networks connecting fields to the somewhat distant rivercourse (currently two kilometers to the east, and too salty for irrigation purposes). The river channel has wandered considerably over time, and has been modified extensively both close to Lake Titicaca and occasionally along its course, so the river flow might have been much more impressive in the past.

Wild and Domesticated Animal Resources

Vegetation is sparse on the altiplano. Thick grasses, moss, shrubs, and a large variety of cacti, cluster on and around hillsides (Montes de Oca 1989:414). The plains boast only widely spread tufts of Stipa grass, on which herds of camelids, sheep, and cattle graze.

Regarding indigenous animal populations, the llama (Lama glama) and alpaca (Lama pacos) are the two large domesticated species herded in sizeable numbers throughout the altiplano region. These two species, which were fully domesticated by 2500 B.C. (Richardson 1994:40), make good use of the region's sparse pasturage, adapt well to the cold, arid climate, and serve multiple purposes for indigenous Andean populations. Archaeological evidence, ethnohistoric documentation, and modern surveys throughout the Andes indicate that both llamas and alpacas have been exploited for millennia for their fine wool, meat, and cargo transport capabilities.

In addition to these two domesticated species, there are two wild species of camelids roaming the altiplano in small groups. Vicuñas (Vicugna vicugna) and guanacos (Lama guanicoe) are considerably smaller than their domesticated cousins, resembling small deer from a distance. Both animals are hunted intensively for their meat and wool, though vicuñas are a protected species today. Unfortunately, these four camelids are so morphologically similar that only Andean faunal experts are generally able to distinguish between their fragmented archaeological remains.

Though very few non-camelid bones were recovered from Jachakala, alternative sources of protein available to altiplano residents should be mentioned. Guinea pig or "cuy" (Cavia porcellus, Cavia cobaya, and Cavia cutheri) (Montes de Oca 1989:491), chinchilla (Chinchilla intermodia), and mouse (Phyllotis andeum) (Montes de Oca

1989:500) are all occasionally used to supplement the human diet. South Andean deer (Hippocamelus bisulcas), Andean fox (Pseudalopex culpaeus), and rabbit (Sylvilagus sp.) are also hunted sources of meat that contributed to faunal collections from archaeological sites in the region. Additionally, vertebrae from an unknown species of snake, and several bones that appear to be from a dog, were excavated.

Non-camelid protein sources include riverine resources as well. The nearby Río Desaguadero is home to a number of bird and fish species, which people may have hunted with the very small projectile points recovered at the site in large numbers. These may have included several species of Andean duck (though most of the fifty duck species native to the altiplano reside permanently around the shores of Lake Titicaca), Andean goose (Chloephaga melanoptera), and the Chilean flamingo (Phoenicopterus chilensis) (Dejoux 1992:464-65).

Fishing with spears and hand-cast nets in the Desaguadero might yield any of a number of native species. Three kinds of catfish (Trichomycterus) and several species of killifish (Orestias sp.) travel down river from Lake Titicaca (Lauzanne 1992:405-07). Though smaller members of the latter family are often captured during the summer months (particularly in January), the suchis are mainly fished when water levels were very low, in August and September (Vellard 1992:497-499). Lake fishermen have been historically observed descending the Río Desaguadero for some distance in totora reed boats to capture large numbers at once (Vellard 1992:499).

The Río Desaguadero

The Río Desaguadero basin connects the Titicaca and Poopó lakes in the altiplano. It runs south down a course averaging thirty kilometers in width, and totaling 370 kilometers in length. The drop of 124 meters over its length translates into a very gradual gradient of just 0.03 percent (Montes de Oca 1989:153). Interestingly, the river does not meander in any section except around La Joya (Montes de Oca 1989:414).

As one of Lake Titicaca's major outlets, this watercourse's flow rates and sedimentation loads vary to some extent with lake levels. There are also a couple of small rivers that contribute to the Desaguadero. For Lake Titicaca, outflow via the river accounts for less than five percent of the total annual water losses (Lavenu 1992:3).

Because hydrological studies have established that the Titicaca Basin assumed its present form between 2000 and 1000 BP, at which time the Desaguadero also became an effective outlet (Wirrmann et al. 1992:48), reconstructions of flow rates taken from Titicaca research can be effectively applied to estimates of water availability during the time of Jachakala. This research concludes that maximum outflow rates for the river occurs in April while maximum levels of inflow into Lake Titicaca occur in February. The annual drop in the lake level is, therefore, gradual (Roche et al. 1992:78). These findings are important because the danger of flooding over the plains between Jachakala and the Río Desaguadero would be greatest at the end of the growing season or the beginning of winter. Agriculture on the hillsides or against the bottom of the Cerro La Joya and Cerro Isahuara slopes would have been primarily dependent, moreover, on rainfall rather than floodplain irrigation.

However, this assumes that the river was as distant then as it was during fieldwork in 1997 and 1998. That the La Joya section of the Desaguadero does meander in this area means that it is probable that it ran much closer to the community at some point(s) during Jachakala's occupation. Indeed, evidence for flooding in the stratigraphic profiles of excavation units throughout the site suggests that the structures and fields on the other side of them were occasionally washed over by the swollen river. Rainfall can also vary from year to year by a factor of two (Roche et al. 1992:83), which must have

Table 2. Volumes of water exiting Lake Titicaca by the Río Desaguadero from 1964 to 1978 (Montes de Oca 1989:248).

Volume	*1964-65*	*1965-66*	*1966-67*	*1967-68*	*1968-69*	*1969-70*	*1970-71*
m^3/year *m3/second*	1120 35	655 21	241 8	296 9	256 8	56 2	126
Volume	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78
m^3/year *m3/second*	-105	-72	107 3	59 2	237 8	184 6	129 4

had sometimes devastating effects on Jachakala crop yields. The figures presented in Table 2 from another source show greater variability in the flow rates of water exiting Lake Titicaca through the Río Desaguadero than Roche and his colleagues estimated.

Broader periods of drought and wetter periods can be briefly addressed through paleoclimactic studies published over the past twenty years. Reconstructions of climactic conditions from Lake Titicaca sediment cores (Abbot et al. 1997) and Quelccaya glacier ice cores (Sandweiss et al. 1996; Thompson et al. 1985) reveal a record of regular periods of drought and extra rainy years dating back five millennia. The following statements are confined to those relevant to the eight-hundred to thousand years of Jachakala's occupation. Though their results do not correspond exactly, they jointly conclude that the following periods were especially wet ones in the altiplano: 610-650 BP and 760-1040 BP. In contrast, these periods were notably drier: 540-560 BP, 570-610 BP, and 650-730 BP (Thompson et al. 1985:973). The two wetter periods both fall within the Isahuara phase. Because the three-period chronology used in the Jachakala analysis is not fine enough to distinguish subsistence trends during one century from another, these paleoclimactic figures cannot be compared directly to archaeological evidence of Jachakala farming practices.